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BUILDING REHABILITATION: A PROMISING TOOL FOR URBAN REVITALIZATION IN DETROIT, MICHIGAN

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ABSTRACT

BUILDING REHABILITATION: A PROMISING TOOL FOR URBAN REVITALIZATION IN DETROIT, MICHIGAN

By

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In United States, due to the augmented rate of development pattern, urban areas are now undergoing urban sprawl, in which the cities begin to extend into surrounding areas as low-density development. Despite the fact that there is a great concentration of people in urban areas in United States, many cities are reported to be losing population. This is more evident in many older cities that were developed during the early 1800's and 1900's. Since 1950, Detroit has lost nearly half of its population. Revitalization of these urban centers is essential to sustain valuable urbanization. As development occurred in these major cities in the early urban era, most of the existing building stock, a vital component of the built environment, are now aged and are in dilapidated condition.

The goal of this research is to identify and demonstrate the potential of promoting urban revitalization through rehabilitation of old, vacant and underutilized building stock adopting the new Michigan Building Rehabilitation Code in the City of Detroit and to expand the existing urban revitalization models by incorporating this new component called the built environment along with the existing social, economic, political and cultural factors. For this purpose, a case study building was identified in Detroit and a comprehensive code-based rehabilitation cost analysis was performed to identify the potential savings of using the new rehabilitation code. Based on the identified impacts, an expanded urban revitalization model was developed to achieve successful urban revival.

Dedication

This thesis would be incomplete without a mention of the support given to me by the below mentioned people, to whom this thesis is dedicated. They have always sown the seeds of confidence in me and kept my spirits up when ever it was really needed. Without their lifting me up when this thesis seemed interminable, I doubt it should ever have been completed. My heartfelt dedications to the people mentioned below for the support and encouragement provided to me at the right time, in the right manner and in the right magnitude. I wish I could write more...

Dedicated to "The Syal Family"
Dr. Matt Syal, Ms. Dianne, Sita, Neil, and Leila
For always reminding me a home away from home

&

Dedicated to my Professors at Anna University,
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For providing me the enthusiasm to achieve higher goals

&

Dedicated to my most loving Mom, Dad and Brother
For always being there with me for ever

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CHAPTER ONE

INTRODUCTION AND PROPOSED RESEARCH

1.1 OVERVIEW

Over the centuries, cities worldwide have served as centers of economic development in terms of fiscal growth, quality of life and new opportunities. In the year 2000, over 47% of the world's population resided in urban areas, and researchers predict that by 2025, over 60% of the Earth's people will live in urban areas [Gow and Pidwirny 1996]. A fast paced urbanization is occurring in developing countries when compared to the current development rate of developed countries. While urban growth in developing countries is around 3.5% per year, the developed countries have a dawdling growth of less than 1% per year, as these areas underwent urbanization almost a century ago. The fact that over 70% of the population in the United States and Europe live in urban areas rationalizes the kind of development that occurred in the early 1900's. Figure 1 signifies the level of world urbanization comparing some of the most developed countries with that of the developing countries.

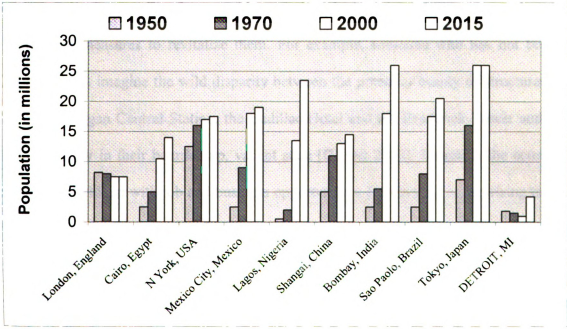

Figure 1: United Nations, *World Urbanization Prospects* [Modified from PRB 2000]

In United States, due to the augmented rate of development pattern, urban areas are now undergoing urban sprawl, in which the cities begin to extend into surrounding areas as low-density development. Almost three quarters of the United States's population lives in urban areas while one quarter lives in rural settings. Despite the fact that there is a great concentration of people in urban areas in United States, many cities are reported to be losing population. This is more evident in the older cities that were developed during the late 1800's to the early 1900's. For example, since 1950, Detroit has lost nearly half of its population. Similarly, between 1980 and 1990, the following cities became smaller: Pittsburgh (-12.8%), St. Louis (-12.4%), Cleveland (-11.9%), New Orleans (-10.9%), Buffalo, (-8.3%), Chicago (-7.4%), and Atlanta (-7.3%). Other shrinking cities include Philadelphia, Baltimore, Washington, D.C., Toledo, Cincinnati, Denver, Memphis, and Kansas City [WRI 2002].

Why is this happening? Revitalization of these old is needed to sustain this valuable urbanization. The focus of this study is to look at these dying cities and explore the feasible measures to revitalize them. For example, someone who has not been in Detroit cannot imagine the wild disparity between the potential beauty of structures like the old Michigan Central Station, the Cadillac Hotel and the Broderick Tower and how they look now in their boarded-up, vacant state [Detroit 2002]. Detroit is the economic capital of Michigan with job and business opportunities. However, it is surprising to note that Detroit has become the first major city in US history to have fallen below a population of 1,000,000. Newly released 2000 US Census data shows the city to have a population of 951,270, down 7.5 % from the 1,027,974 registered in the 1990 census. This is in contrast to other large Eastern and Midwestern central cities that experienced a population turnaround (such as New York, Boston, Chicago, and Minneapolis). Detroit reached its population peak at 1,850,000 in 1950. Table 1 shows the wide range of population fluctuations in the city over the period, 1850 to 2000 [DEM 2002].

Table 1: City of Detroit Population from 1850 to 2000 [DEM 2002]

Year	Population	Increase	%
1850	21, 000		
1860	46, 000	25, 000	119.0%
1870	80, 000	34, 000	73.9%
1880	116, 000	36, 000	45.0%
1890	206, 000	90, 000	77.6%
1900	286, 000	80, 000	38.8%
1910	466, 000	180, 000	62.9%
1920	994, 000	528, 000	113.3%
1930	1,568, 000	574, 000	57.7%
1940	1,623, 000	55, 000	3.5%
1950	1,850, 000	227, 000	14.0%
1960	1,670, 000	-(180, 000)	-9.7%
1970	1,514, 000	-(156, 000)	-9.3%
1980	1,203, 000	-(311, 000)	-20.5%
1990	1,028, 000	-(175, 000)	-14.5%
2000	951, 000	-(77, 000)	-7.5%

Many social, economical and physical factors contribute to this out-migration of population from downtown cities, a critical issue. Similar to social and economic factors like higher central city crime rates, declining neighborhood quality, poor central school education, higher central city public service costs, and inferior quality of services, the built environment factors such as poor infrastructure and old, dilapidated building stock also contribute to this out-migration from cities. Availability of healthy infrastructure,

increased economic activities; good schools, low crime rate, quality of life and new opportunities contribute to the overall model of urban revitalization. This study's focus is on the built environment factors, especially the old, vacant and/or underutilized building stock, as a significant physical pull factor in achieving urban revitalization in Michigan.

1.2 NEED STATEMENT

One key resource for urban development is the availability of infrastructure. As development occurred in these downtown urban centers in the early urban era (during the late 1800's to the early 1900's), most of the available infrastructure is now aged and in dilapidated condition. The important infrastructure segment left unnoticed or ignored is the valuable commercial buildings along the majestic downtown crossings. There is a great potential in rehabilitating this ignored infrastructure, and converting them to suitable uses that can attract people back to these historically significant downtowns. A possible solution for this urban revitalization is the economical conversion of old/vacant office buildings and commercial centers into a large residential use. This study is focused on reducing the wide disparity that exists in the usage of old, vacant building stock in Detroit. The potential is high for economically converting smaller, mid-block, and high-rise office buildings no longer reasonable for office use into residential units.

The greatest physical asset offered by most older buildings is location. In many major cities, older buildings occupy prime downtown locations while industries are located near the Central Business District (CBD). The existing old/vacant buildings were built in the early 1900's and most of these buildings are either not in use or underutilized.

This commercial building stock may be converted into residential use at an affordable cost using the new Michigan Building Rehabilitation Code, which incorporates the factor of economical feasibility in rehabilitating the stock of older buildings. The significant element of this research work is to identify the potential of building rehabilitation adopting the new Michigan rehabilitation code in encouraging urban revitalization in overlooked downtown areas of Detroit. The cost-benefit factors in adopting the new rehabilitation code over the existing building codes are analyzed and its impact on urban revitalization is investigated.

1.2.1 AGING OF EXISTING BUILDING STOCK

In United States, the stock of existing commercial, residential and industrial buildings continues to age. In 1995, the median age of the housing stock was nearly 30 years, and almost 34% of housing units were constructed before 1950. The situation of commercial and industrial buildings is no different from that of the residential stock. Figures 1 and 2 represents the age of the commercial and residential building stock in the United States, categorized as built before 1945/1950, from 1945/1950 to 1980, or after 1980.

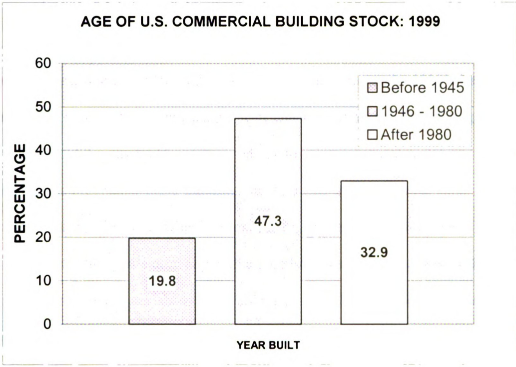

Figure 2: Age of Commercial Building Stock in United States [Energy 2001]

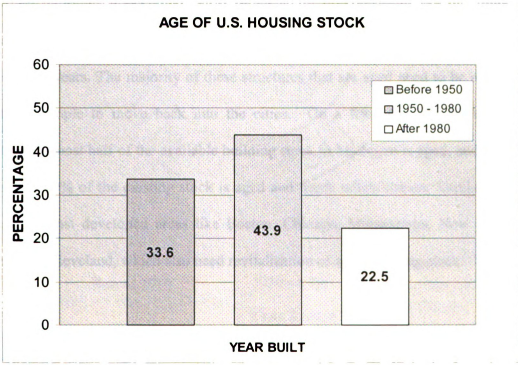

Figure 3: Age of Housing Stock in United States [US Census 2000]

These residential and commercial buildings represent a national asset vital to meeting the demand for housing and commercial development. In almost all of the developed U.S. states, the primary cities that facilitated development in the early 1900's began to lose population as people started migrating out of cities in search of better living conditions. This left most of the city buildings deserted due to improper maintenance and upkeep. As there were no occupants, these buildings deteriorated in quality over time, leaving the concrete blocks aged without rehabilitation. Michigan's case is no different.

Detroit, Michigan's only city with a population over 250,000, lost 76,707 or 7.5% of its 1990 population, as shown in Table 1 earlier. Meanwhile, the suburbs of the Detroit/Flint/Ann Arbor metropolitan region increased by 7%, and suburban districts of other urban counties (for example, Kent, Ingham, and Ottawa) increased by 12.6% (*Suburbs of Detroit metro*) [Menchik 2002] This sprawl left most of the historically important buildings unoccupied. Most of elegantly lined-up high-rise buildings along Woodward Avenue in downtown Detroit are currently vacant for more than twenty consecutive years. The majority of these structures that are aged need to be rehabilitated to attract people to move back into the cities. On a fifty-year life cycle theory of buildings, almost half of the available building stock in Michigan is aged, and in Detroit, more than 70% of the existing stock is aged and needs rehabilitation. Similar situations prevail in most developed areas like Boston, Chicago, Minneapolis, New York, New Jersey, and Cleveland, which also need revitalization of aged building stock.

1.2.2 AGING HOUSING STOCK AND GROWING DEMAND

For a sustainable urban model, housing is one key element that keeps people intact with the urban neighborhoods. As the existing U.S. housing stock ages, the need to update and modernize becomes critical to continued use. Figure 4 demonstrates that around 43.9% of housing units currently available in the U.S. were built during the period 1950 – 1980, and around 33.6% of the units were built before 1950. Michigan's housing conditions are similar to those of the nation. The need and opportunity for rehabilitation work is even greater in older cities such as New York, where almost 75% of the cost associated with building permits was for work on existing houses [Syal et al. 2002]

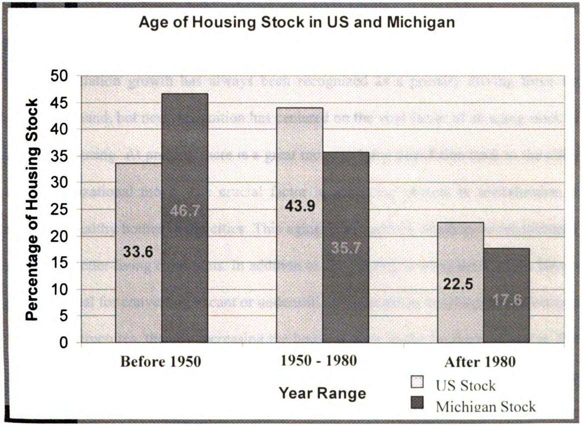

Figure 4: Age of Housing Stock in US and Michigan Calculated Using Historical Census of Housing Table Data [US Census 2000]

In Michigan, there are 3.85 million housing units, and around half of these were built in 1959 or earlier [MI-Census 1990]. Around 1.23 million housing units have already crossed the fifty-year age threshold and may be candidates for rehabilitation. However, the cost of rehabilitation is often so significant that it precludes the reuse of aging housing stock, leaving it abandoned to deteriorate further. As shown in table 3, according to the Southeast Michigan Council of Governments, the city of Detroit issued 20,676 building permits for new residential building construction over a thirty-year period from 1970 to 2002, whereas 165,012 permits were issued for the demolition of residential buildings during the same period [SEMCOG 2002]. This indicates significant potential for rehabilitation-related work in the city. If even a small percentage of these buildings could have been rehabilitated as affordable housing, it would have made a huge difference in the affordable housing crisis in the city.

Population growth has always been recognized as a primary driving force for housing demand, but new recognition has centered on the vital factor of an aging stock of available housing. At present, there is a great move to bring population back to the cities as a revitalizational move. The crucial factor in achieving success in revitalization is providing healthy homes in the cities. This aging housing stock needs to be rehabilitated to provide better living conditions. In addition to the existing housing stock, cities have a great potential for converting vacant or underutilized commercial buildings to market-rate residential structures, thereby increasing the housing stock in the commercial center. For example, Detroit has an amazing stock of buildings ranging from high-tech office and commercial structures to luxury condominiums. Detroit's developmental problems are well known, and the city reached its depths of despair in the 1980's. Numerous commercial buildings in the Detroit downtown area are still vacant and underutilized. These buildings can be converted to housing units to serve the demand for affordable housing for people at varied income levels. This conversion encourages mixed use of buildings, bringing more harmony to the urban lifestyle. The aging stock and growing demand for housing instigate the need for revitalization through rehabilitation.

1.2.3 NEED FOR DOWNTOWN REVITALIZATION

Downtown areas are dying as people are moving to the suburbs in large numbers. These historically significant downtowns must be revitalized to bring back the charms of downtown living. Downtown revitalization may call up visions of new stores and buildings rising from decaying downtowns. In reality, downtown revitalization is a people process. Through it, people make decisions about their community and work to make those decisions bear fruit. It is more realistic to envision downtown revitalization as a progression of decision-making steps that, through commitment and work, finally result in a dynamic downtown.

In downtown Detroit, the new and large projects like Compuware's Headquarters, sports stadia, casinos, the Renaissance Center (under GM ownership), and so on have received a lot of attention. The Stuber-Stone, the Venn, the Garfield Building, Canfield Lofts, the Gem Theatre, the "Good Housekeeping" building, the Addison, the CPop Gallery, Brush Park mansions, Ferry Street mansions, and too many more to mention are all welcome additions [Detroit 2002]. Nevertheless, there is an immense need to bring the decaying buildings along the historic downtown corridors back to use.

1.2.4 BUILDING CODES

Building codes govern the way buildings may be built and used. Building codes are primarily developed to protect the life, safety and health of the public. When these codes were first developed, they were used principally for new construction, thereby eliminating unsafe buildings from use. Adaptive re-use of existing buildings is an effective tool in fighting urban sprawl and revitalizing urban centers, bringing people back to cities.

Building rehabilitation increases the available housing stock and fosters new businesses in central city areas. Most building codes, however, actually discourage building rehabilitation, as they are primarily intended for new construction and minor changes to existing structures. While it is relatively straightforward to set out requirements for the design and construction of new buildings, predictable regulations for the rehabilitation of older buildings have proven a challenge. Building officials generally have wide discretion in determining the nature and extent of improvements required when buildings are renovated or converted to new uses [Hicks 2000]. The traditional building codes are formulated for new construction with little emphasis on rehabilitation work, forcing building officials to impose excessive, non-cost-effective regulations for rehabilitation permits.

There are set laws for building rehabilitation, which in most cases make it more cost effective to pull down the existing building and construct a new building. Due to the lack of uniformity in regulations, developers often avoid renovating buildings because they are unsure of the cost of the project. As a result, existing buildings, usually found in older urban centers, become underutilized. New Jersey became the first state to address this problem in January 1998 when the Department of Community Affairs created the *Code for Rehabilitation of Existing Buildings*, or the rehabilitation subcode [Hicks 2000].

Any prospective buyer of a building will calculate the economies of scale in purchasing it, keeping in mind the investment that must be made in the building for it to become a viable, income-producing piece of property. This factor, requiring owners to spend in excess to rehabilitate the property, has discouraged development through rehabilitation. The application of existing building codes for such rehabilitation proves to be highly uneconomical in rehabilitating buildings and bringing them back to use. The drive for a separate code for rehabilitation, started by New Jersey and then followed by the U.S. Department of Housing and Urban Development (HUD), which published the Nationally Applicable Recommended Rehabilitation Provisions (NARRP), inclined states to think about the need for rehabilitation of old buildings to achieve revitalization.

The International Code Council (ICC) made efforts to unite different building codes into one single code, the International Building Code (IBC), as a national move to adopt a unified code system in the United States. Different states adopted this unified code, with specific amendments made to the IBC suiting their local conditions and needs. Surprised at the pace of the move for rehabilitation of existing buildings, the ICC more recently felt the need for a separate unified code for rehabilitation of existing buildings, forming the International Existing Building Code (IEBC), which will be in place from the year 2003. The final draft of this IEBC is now available. Following the national move, Michigan felt the importance of this existing building code, as evident from the article, "Implementing a Building Rehabilitation Code in Michigan" [Syal and Shay 2001].

A unique building code for rehabilitation that can bring existing structures back to use less expensively will encourage owners and developers to rehabilitate buildings instead of demolishing them. In many cases, it is simple to make a turn-of-the-century building comply with this rehabilitation code. Foreseeing the above stated need, this work is intended to investigate the potential of Michigan's new building rehabilitation code to achieve the greatest savings in building rehabilitation, thus revitalizing urban areas.

1.2.5 REHABILITATION COSTS

Modern building codes treat unique older structures like outlaws. Surviving building elements in existing structures, such as the windows, stairways, and ceilings, are often ripped out and replaced to conform with the modern codes. In most cases, this replacement is performed even though the existing elements are perfectly safe and sound. Local codes requiring entire existing buildings to meet modern standards ultimately make rehabilitation highly non-lucrative. The elevated cost of rehabilitating the structures, in many cases, impels building owners to tear down the entire structure. More often, these costs make rehabilitation a less profitable investment and potentially leave structures abandoned, causing urban uncohesiveness.

Table 2 demonstrates the number of building permits that were issued in the City of Detroit over thirty years and the cost involved for each type of permit: new construction and demolition. Table 3 depicts the number of structures that were demolished over the past thirty years. The critical factor in this immense demolition is the cost of rehabilitating these structures.

Table 2: New Construction, Rehabilitation, and Demolition for One and Two Family Dwellings in the City of Detroit [Detroit 1999]

Type	New Construction Permits	Cost (In Millions)	Additions & Alterations Permits	Cost (In Millions)	Demolition Permits
One Family Dwellings	163	$16.94	4,808	$42.99	1,914
Two Family Dwellings	2	$0.01	479	$4.54	566
Total	**165**	**$16.95**	**5,287**	**$47.53**	**2,488**

New Jersey took a lead in identifying the need for, developing and adopting the nation's first rehabilitation sub-code to successfully remove this major impediment to redevelopment in most of its cities and downtown areas.

For example, William A. Connolly, a key person in New Jersey rehabilitation code development as director of the division of codes and standards for the state, explains the impact of rehabilitation-specific code on the cost of rehabilitation in New Jersey. It is demonstrated that there is as much as 50% savings by using rehabilitation code over the codes for modern buildings. In an article published by Ben Forest, it is validated that a four-story senior citizen complex and day care center at 203 Academy Street in Jersey City saved $391,000 in building costs compared to those under the existing code [Forest 1999].

Table 3: Summary of Building Permits Issued in City of Detroit over 30 Years [SEMCOG 2002]

Year	New Units Permitted			Demolition Permits			Totals		Net
	Single Family	Two Family	Multi Family	Single Family	Two Family	Multi Family	New Units	Demo Units	
1969	350	14	222	0	0	1,339	586	1,339	-753
1970	828	20	801	683	836	939	1,649	2,458	-809
1971	788	36	861	1,011	1,130	912	1,685	3,053	-1,368
1972	379	12	1,747	3,001	2,690	1,014	2,138	6,705	-4,567
1973	61	2	956	3,583	2,222	1,592	1,019	7,397	-6,378
1974	20	4	868	2,016	1,644	2,021	892	5,681	-4,789
1975	13	0	1,193	1,594	1,252	2,366	1,206	5,212	-4,006
1976	11	0	577	2,741	1,428	2,786	588	6,955	-6,367
1977	19	0	377	1,922	1,296	2,733	396	5,951	-5,555
1978	9	0	610	2,423	1,464	1,784	619	5,671	-5,052
1979	6	0	775	2,178	1,032	1,228	781	4,438	-3,657
1980	13	0	915	2,165	2,236	1,104	928	5,505	-4,577
1981	7	0	1,365	2,482	3,340	1,850	1,372	7,672	-6,300
1982	3	40	1,238	1,497	1,216	1,304	1,281	4,017	-2,736
1983	9	0	156	1,173	2,272	1,728	165	5,173	-5,008
1984	12	0	57	1,192	1,598	1,566	69	4,356	-4,287
1985	2	4	213	1,097	2,004	1,736	219	4,837	-4,618
1986	1	0	123	1,548	2,080	2,428	124	6,056	-5,932
1987	2	0	298	1,821	1,562	1,413	300	4,796	-4,496
1988	3	0	362	1,609	1,420	3,272	365	6,301	-5,936
1989	1	0	345	2,936	1,954	1,028	346	5,918	-5,572
1990	0	0	659	1,945	1,512	1,274	659	4,731	-4,072
1991	18	0	338	1,163	920	1,624	356	3,707	-3,351
1992	163	4	333	1,702	998	740	500	3,440	-2,940
1993	40	2	201	1,296	748	1,160	243	3,204	-2,961
1994	39	0	356	964	682	627	395	2,273	-1,878
1995	67	0	138	2,391	1,414	2,144	205	5,949	-5,744
1996	35	20	31	1,223	864	6,345	86	8,432	-8,346
1997	68	2	25	2,167	1,156	1,515	95	4,838	-4,743
1998	79	2	235	1,984	928	1,541	316	4,453	-4,137
1999	176	4	374	1,914	1,132	1,771	554	4,817	-4,263
2000	84	18	216	1,517	768	2,225	318	4,510	-4,192
2001	62	4	155	2,345	1,120	1,212	221	4,677	-4,456
2002	0	0	0	223	162	105	0	490	-490
Totals	**3,368**	**188**	**17,120**	**59,506**	**47,080**	**58,426**	**20,676**	**165,012**	**-144,336**

Under the old code, the rehabilitation would have cost $1,536,000; under the new rehabilitation code, it cost $1,145,000. Before the rehabilitation, the building – formerly an apartment and retail complex – had been vacant for eight years.

The success of the rehabilitation code in New Jersey, followed by its success in Maryland and other states, has encouraged Michigan to develop its own building rehabilitation code, which is based on the International Existing Building Code (IEBC) developed by the International Code Council (ICC). This new Michigan rehabilitation subcode should promote renovation of older buildings, thereby affecting the over all model of urban revitalization. The demolitions permits that total more than 8 times the amount of the new construction, as seen in Table 3, can be radically decreased in number, bringing effective revitalization to Michigan, and Detroit in particular.

1.2.6 TECHNOLOGY AND EDUCATION

Rehabilitation of existing buildings is an imperative mechanism to revitalize and to meet the growing demands of urban centers. Scores of research are conducted on technologies and processes to reduce the cost of rehabilitation. Even though the rehabilitation industry tends to be very slow in adopting new technologies, a survey of new technologies could help promote more cost-effective practices. This includes advances in materials, products, tools, equipment and systems and their applications, methods used during the design and construction process, and new and improved equipment used in diagnostics or construction activities. In addition to rehabilitation code research, such technology innovations could also significantly impact changes in revitalization. While there is a clear move for new technologies, advances and innovations in the existing rehabilitation, technologies should be brought by amplified research activities for materials, products, tools, equipment and existing systems.

Some of the major technology innovations in terms of rehabilitation construction methods and materials, design manuals for rehabilitation, innovative site utilities, Cost Effective Energy Conservation Standards (CEECS) in existing buildings, innovations in rehabilitating septic systems, electrical and plumbing technology guidelines, thermal compliance for old buildings, and on-site waste water treatment and disposal systems for existing urban structures can cause accelerated revitalization in terms of technological back up for innovative codal solutions [HUD 1995]. Rehabilitation technology training must be initiated to implement successful research in real rehabilitation fields.

Owners of old, dilapidated, unused and under used buildings in urban corridors must be educated of the need for revitalization through rehabilitation to bring real change in existing urban settings. Developers, owners, and city officials must be made aware that Rehabilitation subcode reduces project costs in order to encourage them to implement it. Training programs, continuing education for contractors and developers, and published research -results will initiate this mass building rehabilitation.

1.3 EXISTING RESEARCH

The three major research areas that initiated this study are the need for building rehabilitation, manifestation of the building rehabilitation codes, and urban revitalization with growing demand for urban infrastructure. As urban problems result from intertwined social and economic factors, combating these problems requires a collaborative effort from various entities involved in the urban conglomerate. No extensive research has been performed investigating building rehabilitation as a vital tool to achieve urban revitalization. This is the unique target of this research work. The second chapter, the literature review, details various literature contributing to this discussion.. A variety of research articles and reports related to urban revitalization and building rehabilitation code serve as sources of existing research.

1.3.3 URBAN REVITALIZATION

Urban revitalization is an economic and social strategy that has been necessitated by decreased interest in both residential and commercial buildings within major cities. Throughout the United States, many major metropolitan cities have witnessed this decreasing interest pattern over the years. Revitalization initiatives have been created and are being effectively implemented in various cities across the United States. These initiatives are described as comprehensive, integrated strategies and initiatives, multidimensional and holistic in nature, with a focus on social, economic, physical or political components of community development [Kadushin 1996]. The study performed by Abraham Kadushin [1996] on the *Neighborhood Transformation Design Model* at the University of Michigan illustrates a comprehensive community revitalization design model highlighting planning processes, neighborhood stabilization, children and families, sustenance, shelter and security, and culture and spirit. The author synthesized all these components to constitute a comprehensive strategy for the diagnosis and treatment of many dysfunctional segments and systems of a declined neighborhood, such as housing, human services, health care, education, employment, and safety. Figure 5 modifies the ideas of Kadushin [1996] into a model form of urban revitalization encompassing social, physical and economic fabrics, which are the essential ingredients of a neighborhood transformation design model.

Scholars in urban studies who feel the need for urban revitalization have performed in-depth research identifying the social, economical and political factors hindering the growth of distressed cities. The study performed by Sherie Mershon [2000] on corporate social responsibility for effective urban revitalization highlights the need for participation of private, business-sponsored civic associations to participate in revitalizing deprived cities. In addition to transforming the city's social image and growing its economy, this study was also focused on defending the local autonomy that hinders revitalization. Another case study by Richard Kujawa [1990] highlights the local social and political efforts with strong emphasis on economic restructuring, critical components of urban revitalization.

This study examines these comprehensive revitalization ingredients and models and analyzes key factors that affect revitalization. Based on the existing information, the author proposes to improve the existing urban model by adding a physical factor called building rehabilitation to the various parameters affecting revitalization (Figure 5).

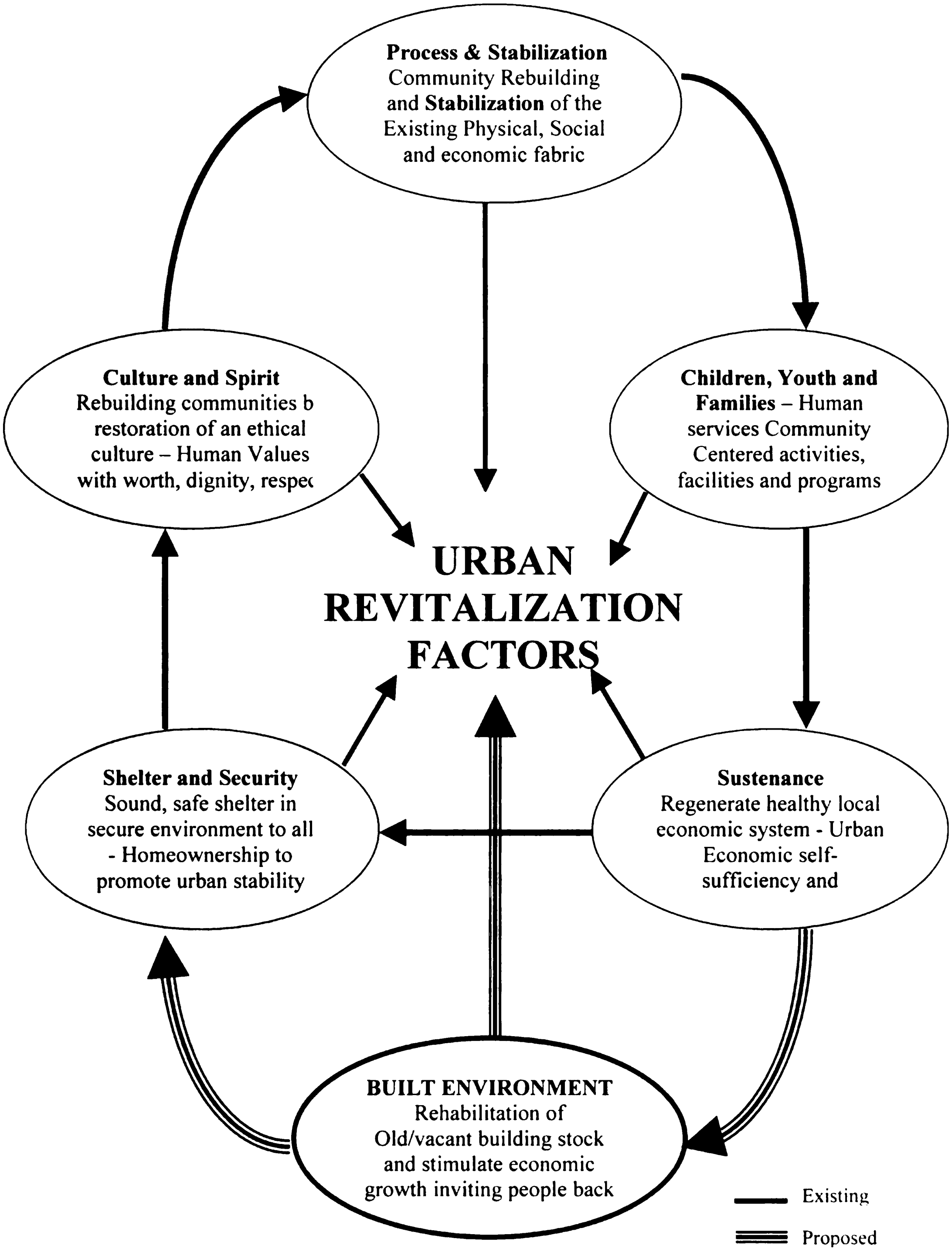

Figure 5: Urban Revitalization Model [Modified from Kadushin, 1996]

1.3.4 BUILDING REHABILITATION

As buildings age, the need to rehabilitate them and keep them up to occupancy standards necessitates the proper tools and techniques to perform building rehabilitation. Even though much research has been performed to identify technological solutions for building rehabilitation, very little emphasis has been placed on identifying the effect on and worth to urban revitalization. Providing new building stock is not the only way to meet the growing demand for commercial infrastructure. Rehabilitation, renovation, or improvement in the value of vacant and underutilized commercial buildings can contribute considerably to overall urban revitalization.

"Innovative Building Rehabilitation Technologies" [HUD 1995], a study performed by the U.S. Department of Housing and Urban Development (HUD), explored new opportunities for cost-effective rehabilitation techniques. This study also identified the most effective ways to regulate the rehabilitation of existing buildings. In "Innovative Rehabilitation Provisions" [NAHBRC 1999], another HUD study, research efforts recognized the need for a new and predictable approach to rehabilitation regulations, identifying the prevailing difficulties for building rehabilitation as interpreting and dealing with the current inconsistent and unrealistic requirements that discourage renovation. The increased interest in and initiatives for building rehabilitation are a positive signs for urban revitalization.

1.3.5 BUILDING REHABILITATION CODE

The volume of rehabilitation work is growing throughout the United States. Rehabilitation expenditures have steadily increased from $11.4 billion in 1962 to over $120 billion in 1998 [Census 1999]. These numbers clearly indicate the need to develop a nationwide building strategy that includes a focus on rehabilitation. One major aspect of this strategy is to create a building rehabilitation code independent of the code for new modern buildings. Rehabilitating dilapidated building stock will pave the pathway for better urban infrastructure. New Jersey brought the building rehabilitation issue to the forefront due to its own growing need; based on a fifty-year life cycle; about half of all houses were candidates for possible rehabilitation within the next ten years [Syal and Shay 2001].

New Jersey's initiative in developing a rehabilitation code was also due to years of ambiguity in traditional building codes. From the early years of building codes until the late 1970s, the three major building codes (BOCA, SBBCI, and ICBO) used a formula called the 25/50 rule to determine the acceptability of proposed rehabilitation work [NAHBRC 1999]. The 25/50 rule allowed a considerable amount of latitude for the local building official to make changes to a proposed plan. Many building professionals cited this latitude as an obstacle to rehabilitation work. Without knowing the work's exact scope and associated requirements, the rehabilitation project's cost could not be estimated accurately. As a result, the estimators were forced to apply additional safety factors to their estimates and the resulting estimated cost numbers were often high enough to discourage rehabilitation. The building industry strongly felt that, by developing rules that could be accurately applied, rehabilitation projects would have realistic costs [NAHBRC 1999].

During the 1970's, there was a growing awareness that building codes would have to be adjusted somehow to address rehabilitation. In 1978, the U.S. Congress recognized the need for and entrusted the Department of Housing and Urban Development (HUD) with the task of developing guidelines to assist with the rehabilitation industry. These guidelines were not meant to be adopted as a building code; instead, they were meant to supplement the current building codes. In 1995, HUD organized a symposium and, later, a survey on the rehabilitation guidelines in order to assess their effectiveness. The final analysis indicated that the guidelines were not sufficient for rehabilitation use and would need to be substantially expanded in order to be effective [Survey 1995].

The analysis of guidelines provided an impetus for the development of independent rehabilitation building codes. New Jersey began developing a separate rehabilitation subcode [Connelly 1998, Forrest 1999] which was the basis for the national version of the rehabilitation subcode, developed by HUD. The final HUD subcode is referred to as the Nationally Applicable Recommended Rehabilitation Provisions (NARRP) [NAHBRC 1999]. This version of the code is used as a basis to develop independent rehabilitation codes for many states, including Michigan. Nationwide recognition of the need for a separate code for existing buildings encouraged the International Code Council (ICC) to expand Chapter 34 of the International Building Code (IBC), which covered existing buildings, into a separate exhaustive code called the International Existing Building Code (IEBC). This code will be available for use by January 2003. Many states started developing statewide existing building codes based on the available final draft of the IEBC. Michigan is no exception in capitalizing on this outcome of the ICC. Michigan has already developed a detailed statewide code called the Michigan Existing Building Code (MEBC), which is based on the final draft of the IEBC.

The author will focus on analyzing the impact of Michigan's new rehabilitation subcode on building rehabilitation leading revitalization in urban Michigan. Some of the key research publications used by the author are:

- National Survey of Rehabilitation Enforcement Practices, UIUC and HUD, 1995
- Uniform Construction Code – New Jersey rehabilitation subcode developed and implemented in 1998 by the New Jersey Department of Community Affairs, Division of Codes and Standards
- Innovative Rehabilitation Provisions - Demonstration of the Nationally Applicable Recommended Rehabilitation Provisions (NARRP), prepared by HUD and the NAHB Research Center, 1999
- Implementing a Building Rehabilitation Code in Michigan - policy paper, Community and Economic Development, Michigan State University. Published by Matt Syal and Chris Shay, 2001.
- Smart codes in Your Community – A Guide to Building Rehabilitation Codes. Prepared by HUD, 2001.
- Other research articles about the rehabilitation code and urban revitalization.

1.4 SCOPE AND UNIQUENESS OF RESEARCH

The scope of this research is to identify and demonstrate the significance of building rehabilitation as an effective urban revitalization tool. In addition, this research work will attempt to look at the effect of rehabilitating vacant buildings on the entire urban revitalization cycle. The author will attempt to investigate the economic issues in rehabilitating old/vacant buildings in downtown Detroit using the new Michigan Rehabilitation Code as compared to the traditionally used Michigan Building Code. The author will not attempt to investigate the social and cultural factors of urban revitalization. The author will address the issues related to the traditional code parameters that increase the cost of rehabilitation, thus creating more obstacles to rehabilitation of buildings in urban centers. The author plans to conduct a detailed case study with an old/vacant abandoned mid-rise building in downtown Detroit for the purpose of validating the cost parameters involved with the new rehabilitation code versus the traditional building code and then project the new code's impact on renaissance in downtown Detroit. The author plans to modify the existing urban revitalization models by incorporating the built environment revitalization factor (i.e., building rehabilitation).

Although Detroit and similar cities feel the need for rehabilitation, the process has not sped up to meet the growing demands due to many factors, including the cost involved in rehabilitation. This defines the uniqueness of this research, as the author explores the opportunities for economical rehabilitation pooled with supportive factors like market dynamics and available incentives in Detroit facilitating rehabilitation of uninhabited structures. The built environment, non-social dimension to urban resurgence and its effect on economical factors makes the author's research unique.

1.5 GOALS AND OBJECTIVES

The overall goal of this research is to identify and demonstrate the potential of promoting urban revitalization through cost effective rehabilitation of old, vacant and underutilized building stock. The major objectives of the work are categorized as below:

1. To study the pattern of existing old and vacant building stock in the City of Detroit and analyze the current market trend in rehabilitated residential units converted from old existing building stock.
2. To study the current code regulations in the urban Michigan for rehabilitation and reuse of existing old and vacant buildings and investigate the scope and potential of using the new Michigan Rehabilitation Code.
3. To develop a set of specifications for rehabilitation and conversion of old/vacant buildings into residential units with the help of a case study in Detroit.
4. To calculate and analyze the cost savings for the rehabilitation of the selected case study building in Detroit based on both the Michigan Building Code and the Michigan Existing Building Code.
5. To illustrate existing building rehabilitation as a critical factor in overall urban revitalization by performing a market analysis based on the case study project.
6. To modify existing models of urban revitalization by incorporating the built environment factor into them based on lessons learned from objectives four and five.

1.6 METHODOLOGY

Methodology for this research work is categorized based on the objectives defined by the author to accomplish the specified goal. Detailed models have been prepared to illustrate the working procedure to accomplish each of the author's objectives. A comprehensive model representing the methodology for each specified objective is presented in the next sections. A detailed action plan of how the work is to be accomplished is shown in figure 6, outlining the sequence of activities set up to achieve the goal.

The author has categorized the entire work into three phases. Objective one is accomplished with the general data collection and literature review. Objectives two through four are realized by adopting phase 1 of the comprehensive methodology model. Phase 2 of the methodology accomplishes objective 5, while Phase 3 is adopted to achieve the last objective. Each of the methodology models is explained.

Objective 1: *To study the pattern of existing old and vacant building stock in the City of Detroit and analyze the current market trend in rehabilitated residential units converted from old existing building stock.*

Data collected from Detroit is compiled and categorized by tabulating building type, year built, historic usage, current occupation status, physical condition of the structure, and any available rehabilitation history of the structure.

1.6.1 PROPOSED ACTION PLAN

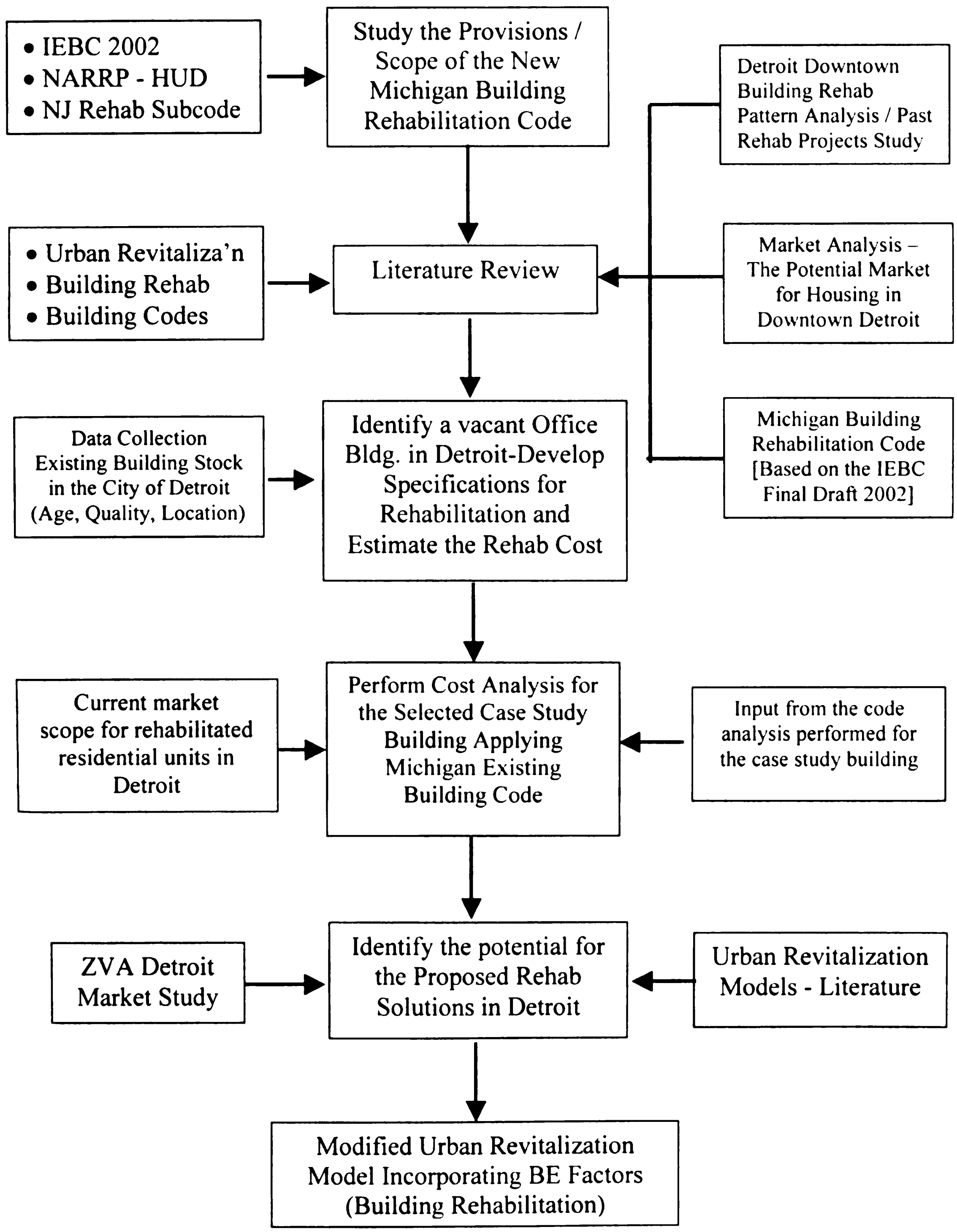

Figure 6: PROPOSED RESEARCH ACTION PLAN

Rehabilitated vacant structures in downtown Detroit that have been converted to a different use are studied to identify the market potential of such rehabilitated structures. Also, demographic data for Detroit will be collected.

Objective 2: *To study the current code regulations in the urban Michigan for rehabilitation and reuse of existing old and vacant buildings and investigate the scope and potential of using the new Michigan Rehabilitation Code.*

Phase 1 of the comprehensive methodology model is adopted to achieve objective two. The codes that are currently in use in Michigan, and particularly Detroit, will be studied. The detailed model for this objective is shown in figure 7. This model is a graphical representation of the methodology with a sequence of yes or no questions. More efforts will be rendered to understand the Michigan rehabilitation code and to determine the scope of adopting this new code in rehabilitation works in Detroit.

Objective 3: *To develop a set of specifications for rehabilitation and conversion of old/vacant buildings into residential units with the help of a case study in Detroit.*

Objective three is also achieved through phase 1 of the comprehensive methodology model. To study the real dynamics of rehabilitation code, a case study building is identified in downtown Detroit. This building is of the required category: a commercial building that is vacant, old and underutilized over several years. The scope of the rehabilitation that needs to be done is defined and based on this scope, detailed specifications necessary for rehabilitation are developed. A complete code analysis and cost analysis is performed based on these specifications.

1.6.2 COMPREHENSIVE MODEL OF METHODOLOGY [OBJECTIVE 2 to 6]

Phase 1: Calculate Cost Savings Using Rehabilitation Code [OBJECTIVE 2,3,4]

Identify a potential old/vacant office building and develop a set of specifications – arrive at the rehab cost using the new Michigan Building Rehabilitation Code

- Study the Michigan Rehab Code's provisions and limitations in rehabilitation
- Develop a set of specifications for rehabilitation intended to performed
- Scope of rehabilitation of old/vacant office buildings into residential units
- Cost of rehabilitation (direct & indirect costs) – use case study to find savings percentage in comparison with the traditional building codes

⇩

Phase 2: Cost Analysis and Rehabilitation Recommendation

Perform proposed cost analysis and literature market study of rehabilitated residential units from old/vacant commercial buildings in Detroit (viability).

- Comprehensive rehabilitation cost analysis
- Market area dynamics (proposed use with surrounding land uses)
- Study of demand and supply – Draw areas (ZVA 2002)
- Analysis of competition and capture rate (rehab market segmentation)
- Study the potential available for rehabilitated units in relation to the market available and analyze the potential for revitalization

⇩

Phase 3: Expand Existing Models of Urban Revitalization [OBJECTIVE 5, 6]

Expand existing models of urban revitalization by incorporating built environment factor based on lessons learned from phases one and two above.

- Study the existing urban revitalization models and identify the key components that influence urban revitalization and the magnitude of their effects.
- Modify the existing model of urban revitalization by incorporating the built environment factor, with focus on the subcomponent, existing building stock.

Figure 7: COMPREHENSIVE MODEL OF METHODOLOGY

Objective 4: *To calculate and analyze the cost savings for rehabilitation of the selected case study building in Detroit based on both the Michigan Building Code and the Michigan Rehabilitation Code.*

As above, phase 1 of the comprehensive model addresses this objective. See figure 8 for a flow chart of the process that will be followed to achieve this objective. Based on the specification developed in objective 3, detailed code analysis and cost analysis is performed. The code analysis includes evaluating the building to meet the code requirements. This is performed using both the Michigan Building Code and the new Michigan Rehabilitation Code. Based on the code requirements, rehabilitation cost estimates are prepared for this case study project.

Then the costs will be tabulated into two categories: the costs with the regular code and the costs related to the new rehabilitation code. This cost then serves as an input to the market analysis that is to be performed to achieve objective 6. This objective also validates the cost savings factor of the new rehabilitation code over the available modern building code or the Michigan Building Code. This objective, accomplished with the case study project, forms a vital part of the further analysis.

1.6.2.1 DETAILED METHODOLOGY FOR OBJECTIVE 2, 3, & 4

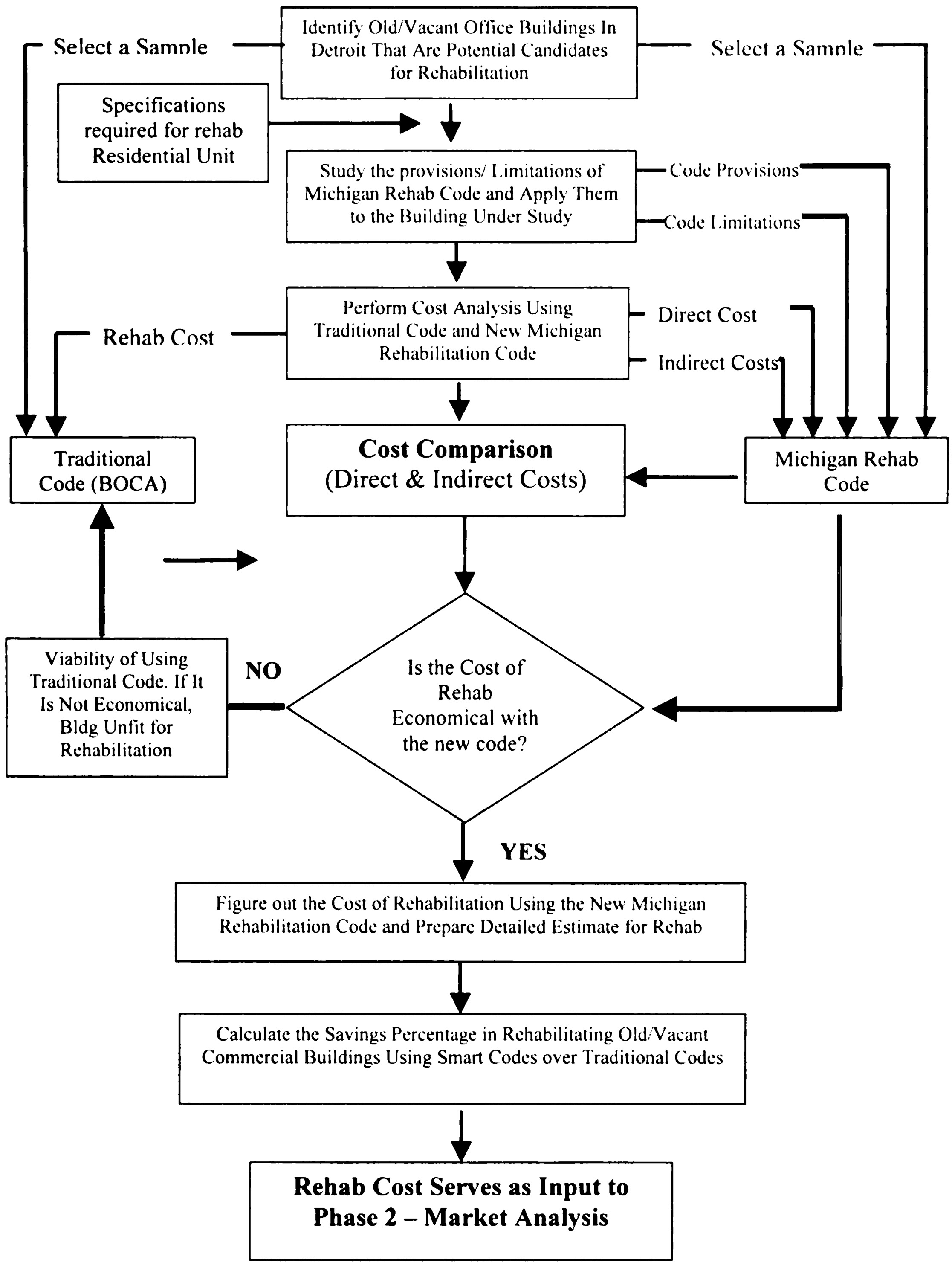

Figure 8: Calculate Cost Savings Using Rehabilitation Code

Objective 5: *To illustrate existing building rehabilitation as a critical factor in overall urban revitalization by performing a market analysis based on the case study project.*

Phase 2 of the comprehensive model accomplishes this objective. A market analysis and feasibility study is performed for the proposed building rehabilitation to identify the demand that exists in Detroit for residential units rehabilitated from old/vacant commercial buildings. The market analysis study conducted by Zimmerman Volk Associates on behalf of Greater Downtown Partnership in identifying the potential market for housing in downtown Detroit will be used as an important resource for this phase of study.

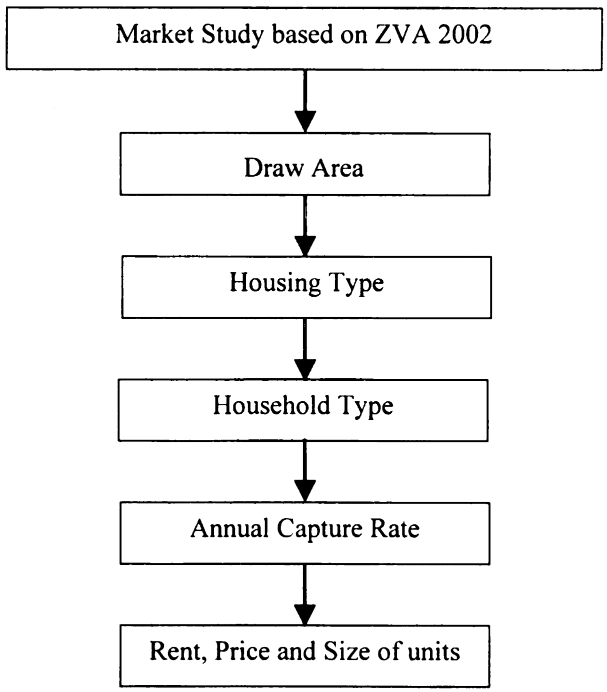

Figure 9: Market Study based on Zimmerman Volk Associates study [ZVA 2002]

Also, interviews will be conducted to identify different private and public funding sources such as the commercial banks' flexibility in rehabilitation lending, the Small Business Administration Loans (SBA Loans), Business Development Center loan programs, local banks and financial institutions lending, Real Estate Investment Trust (REIT), and Limited Partnership funds [ULI 2000] and equity opportunities available for building rehabilitation projects are identified by conduction interviews.

Urban revitalization programs will be successful only if there is a cumulative effort from various participants in the urban centers. Considering this as a significant part, objective 5 will help the researcher to identify the market dynamics of rehabilitated buildings and their effect on overall urban revitalization in Detroit.

Objective 6: *To modify existing models of urban revitalization by incorporating the built environment factor into them based on lessons learned from objectives four and five.*

Objectives one through five will help to validate whether the new Michigan Building Code is a viable solution that will bring about an economical rehabilitation process. Once the structures are rehabilitated and converted to residential use and other mixed-use types of developments, the market available in Detroit need to be determined. The market analysis performed earlier for downtown Detroit is also used to accomplish this objective. The changes that this element, building rehabilitation, will bring the overall urban revitalization model is then studied to measure the significance of this process. Incorporating the identified built environment factor, building rehabilitation, modifies the urban revitalization model from literature with varied socio-economic factors. In addition, the effect of this input on the urban revitalization cycle is studied and documented. Figure 6 illustrates the proposed modification to the existing urban revitalization model.

1.7 CASE STUDY PROJECT TO BE STUDIED

For this research work, a case study building has been identified. The case study building selected is a commercial building (office building) built around 1910 on the historically significant Woodward Avenue in downtown Detroit. This building is lying vacant without any use for more than 15 years excepting a very small first floor area that is occupied by retail shops. The owner of this building permitted the researcher to access the building to estimate rehabilitation costs in order to accomplish objectives three and four.

The total area of this commercial office building is around 80,000 Sq. Ft. The building is structurally sound and architecturally very pleasing. The researcher selected this building as a case study candidate based on the codal complications that this building has in terms of rehabilitation. The rehabilitation plans have been obtained from the architect and these drawings are used to develop the specification as defined in objective three. The Michigan Rehabilitation Code- and the traditional Michigan Building Code-based cost estimates are calculated with these drawings obtained from the architect through the owner of the case study building.

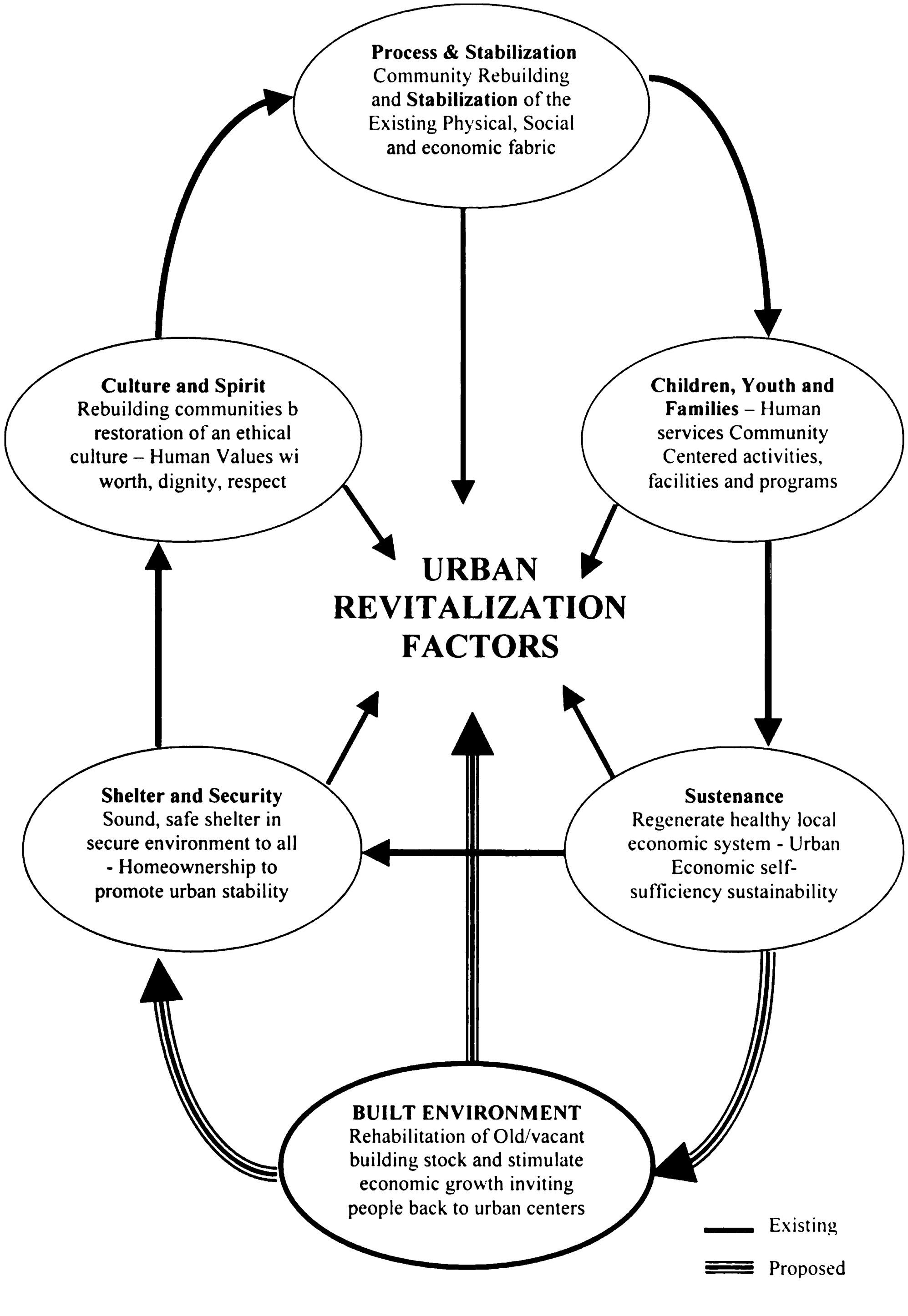

Figure 10: Urban Revitalization Model [Modified from Kadushin, 1996]

1.8 DELIVERABLES / OUTCOME

As an outcome of this thesis, the author plans to produce a comprehensive model for urban revitalization with building rehabilitation as a key instrument. The author will depict the urban resurgence cycle in the form of an Urban Revitalization Model. The other major deliverables would be:

- Compilation of the specifications and rehabilitation cost estimates of selected case study project in Detroit.
- Code analysis report presenting the differences between using the regular Michigan Building Code and the new Michigan Existing Building Code, with tabulated values of cost savings.
- Literature based market study for the proposed rehabilitation process and identification of building rehabilitation as a potential factor for urban revitalization in the City of Detroit.
- Deliver an expanded urban revitalization model incorporating the Built Environment factor and compile the recommendations for potential revitalization based on the rehabilitation of existing buildings, a defined component of the built environment.

1.9 SUMMARY

Many old cities like Detroit understand the necessity of revitalization and have initiated the process. However, despite continued efforts for urban revival through social transformation, incredibly little emphasis has been placed on the economic factors such as the cost of revitalization. The one such crucial factor probed in detail in this work is building rehabilitation, encompassing all the supportive factors such as innovations in codes, new technologies, increased incentives, the growing market and accelerated demand. No attempts have been made to understand the social and affordability issues in urban renaissance even though they have considerable impact on the overall revival life cycle. This thesis is an attempt to better understand this issue of revitalization through rehabilitation.

Through this proposed research, the author has tried to emphasize the need for implementation of innovations that are taking place to bridge the gap between the growing demand and the declining supply to meet people's needs. The objectives and methodology of this research will result in better understanding of the building codes and the ways and means of achieving an unblemished urban society through urban revitalization.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The literature in this chapter can be divided into three major categories: urban revitalization, building rehabilitation and building codes as shown in Figure 11. The author has used the wide domain of urban renewal and revitalization research encompassing social, economical, political and other built environment parameters in introducing the research community with terminology and literature related to urban revitalization. As this thesis illustrates various urban revitalization parameters, the author has detailed issues such as community rebuilding and stabilization, community centered human services, regeneration of local economic system, shelter and security, and neighborhood regeneration, which form a substantial cluster of the urban revitalization model developed in this research.

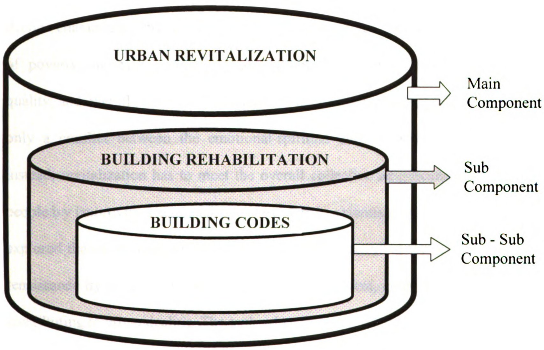

Figure 11: Component Model for the Literature Study

This section will introduce the reader to various building rehabilitation procedures, recommended rehabilitation provisions and rehabilitation projects. The author has used literature with more emphasis on the impact of the building codes on the process of building rehabilitation. Shay (2001) explored the need and implementation of a building rehabilitation code in Michigan, and the author has used this work as the baseline literature detailing the evolution and impact of the new building rehabilitation subcode. The author will present both terminology and existing literature related to all these three fields.

2.2 URBAN REVITALIZATION

The concept of "urban revitalization" is the need to address the concerns of people who live in cities and urban centers that have been undergoing a process of decline characterized by urban sprawl leading to continuing population loss, higher levels of poverty, increasing unemployment, rising fiscal stress, degrading environmental quality, and overall physical deterioration of the existing physical infrastructure. It is not only a conflict between the emotional-spiritual and the social–economical–political; instead, revitalization has to meet the overall collective neighborhood objectives of the people by improving their quality of life. Urban scientists and social researchers have explored the cause and signs of urban distress and identified the opportunities for urban renaissance by defining the social, economical, political, emotional and spiritual factors contributing to urban decline. The author has looked at each of these revitalization factors detailed in various research studies and hopes to expand the existing urban revitalization models.

2.2.1 COMPONENTS OF URBAN REVITALIZATION DESIGN

The basic urban parameters that constitute effective urban renewal (such as social, economical, cultural and political factors) are further broken down and organized under these terms: Planning Process, Stabilization, Children and Families, Sustenance, Shelter and Security, and Culture and Spirit [Kadushin 1996]. The urban regeneration model is woven through all of these components as a social, economical, cultural and political thread. If one closely observes all of the above components it is interesting to note that a constant physical thread, building, which facilitates and supports all of these revitalization components, is present. For better understanding of how these components can constitute a comprehensive strategy for the diagnosis and treatment of distressed urban communities and ultimately lead to revitalization, the author has used the literature to detail each of these components as detailed by Kadushin (1996) in the following sections:

2.2.1.1 *Planning Process*

The planning process is a basic part of towards achieving successful urban community regeneration, including organizational development, envisioning and goal setting, leadership training and development, community organizing, collaboration, coalition and capacity building as strategies for successful and meaningful urban planning and rebuilding process. It begins with an understanding of existing physical, social and economic conditions, assets, opportunities, and h uman needs people have in the urban community. This planning process then helps to set priorities and prepare the required physical, social and economic programs and designs [Kadushin 1996]. The planning process in an urban revitalization lifecycle facilitates creation and adoption of a comprehensive urban revitalization strategy that provides a framework for solving the puzzle of urban revitalization. This basic planning process helps the urban scientist to define the problems persisting in a distressed urban community in terms of social, economical, political and other pull factors and to generate solutions to achieve urban renaissance.

2.2.1.2 *Stabilization*

Stabilization of the existing physical, social and economic conditions is a major step towards achieving revitalization. Two of the primary factors, physical and economic stabilization, can be achieved to a considerable magnitude through rehabilitation of the existing residential and commercial structures. These rehabilitation projects seem to have a small and inconsequential impact on revitalization; however, their real economic impact will be great [Kadushin 1996]. The value of the existing structures, once rehabilitated, will begin to stabilize, thereby also stabilizing overall property values, and resulting in increased investment in the designated urban neighborhood. This will bring a change in the pattern, which ultimately brings in physical and economical stabilization.

A secondary stabilization factor that determines success or failure of revitalization is social stabilization. Local institutions such as churches, schools and many CDCs, can serve as mediating bodies to bring social stabilization into a distressed urban community [Kadushin 1996]. Because increased support of church leaders, school districts and CDCs will foster effective urban stabilization, efforts are already in place to promote

Detroit's church-based leadership organizations in order to bring in new momentum to the revitalization process.

2.2.1.3 *Children, Youth and Families*

Children, youth and families form the most vital part of any society. Programs and services targeted at promoting child development, youth development and family functioning contribute critically to the success of any revitalization design. Facilities such as parks, libraries and community centers and services targetting such issues as child welfare and family health care should be provided to meet the needs of the children, youth and families who form the most integral part of the successful urban community. Community-centered development activities supporting the future of these groups will promote people-friendly urban regeneration.

2.2.1.4 *Sustenance*

Sustenance has many different interpretations but generally alludes to economic development in a manner which can be sustained in the long run. This component of the urban regeneration model seeks to rebuild a healthy local economic system with individual, family and community economic self-sufficiency as primary goals. Kadushin (1996) states that a 'sustainable urban community' is one that meets the basic needs of all its inhabitants. One major goal in achieving sustenance is to provide employment opportunities and training suitable to secure them to urban residents, leading to greater financial security and a higher standard of living. Economic stimulus can be brought to distressed communities by the active participation of financial institutions and community development banks. Sustaining all these economic developments will support urban rebuilding, giving it endurance and strength. Sustenance requires a constant improvement and an effort-based approach to achieve regeneration.

2.2.1.5 *Shelter and Security*

In a stable, secure, safe and sound urban environment, it is possible for the urban population to engage in the usual activities of life with less worry and stress [Kadushin 1996]. To achieve this stability, this safe place to live, Shelter is a primary need. Irrespective of the structural stability and spatial conformability of a living space, the external security of the urban setting and safety of the neighborhood is equally important. Ensuring livable, secure buildings and ending the worry of homelessness are main objectives in promoting urban revitalization and bringing people back to cities that are now considered to be neither safe nor secure. Developments should occur in such environments promoting a sense of security. The revitalization model should incorporate factors related to achieving this sense of security, such as the condition, value and type of developments that are revitalized; the type of ownership; the investments planned for promoting existing infrastructure; and investments related to increasing the public safety and policing powers of the regenerated urban center.

Programs such as comprehensive crime prevention, reduction, and control programs; community-oriented policing programs; and existing building and infrastructure maintenance programs can lead to an increase in individual, family and neighborhood safety in an urban locality, which will serve as a key to successful urban regeneration [Kadushin 1996]. Even though these factors may seem more like social scientists' thoughts, the author is attempting identify to the relation of these factors in the overall urban revitalization model as one valuable outcome of this research.

2.2.1.6 *Culture and Spirit*

The cultural and spiritual values of a neighborhood define the way one should behave and the way one can lead a happy life. It brings a sense of oneness with the neighborhood, which is almost totally absent in the current city lifestyle. Cultural and spiritual values in to these distressed cities will answer the questions such as: "What should city life be like?" and "What sort of life should be lived?" [Kadushin 1996]. These questions will cause urban residents to think and generate better living conditions. Religious institutions – often termed church-based community development corporations – provide the cultural and spiritual values in the community. These have become one of the most effective vehicles for urban revitalization.

2.2.2 STRATEGIES OF URBAN REVITALIZATION

Successful urban revitalization experiences have been achieved with innovations in the strategies adopted. Christopher Howes (1986) at the University College of London identified some successful strategies for achieving urban revitalization encapsulating social, economical and political programs, which the author will be using to define the urban revitalization model in the later part of this research.

Inner City Redevelopment

Inner city redevelopment can be achieved through extensive measures initiated to improve the economic, social and functional urban structural fabric. Some of the strategies that are adopted to achieve this redevelopment are [Howes 1986]:

- Developing more retail space and promoting retail businesses with incentives and motivation;
- Creating more residential space within the inner city, thereby inviting new population into the distressed city;
- Modernizing old and historic buildings, giving them new life and new use;
- Creating diversified play areas for children, recreational facilities and public community gathering centers;
- Removing existing slums and unsafe inhabited buildings and providing better and safer living conditions; and
- Initiating intensive public participation through awareness programs and community gatherings.

Brownfield Redevelopment in Inner Cities

A brownfield is an abandoned, unused, or underused industrial or commercial facility where expansion or redevelopment is complicated by a real or perceived environmental contamination [MBR 2002]. Brownfield redevelopment forms an important urban revitalization component as it helps in recycling devastated industrial properties for various purposes. This improves and facilitates the overall revitalization process.

Urban Neighborhood Environmental Improvement Strategy

Increasing the pedestrian areas of the existing city road networks, improving and increasing public and private green spaces will facilitate environmental improvement of existing urban neighborhoods.

Creation of Low-Rental Public and Private Housing

In order to bring people back to cities in large numbers, it is very important to create large amounts of low-cost public and private rental housing with safer living conditions. The absence of affordable, quality rental housing can adversely impact both the labor market, by reducing geographic mobility, and equality, by hurting the urban poor. Based on the lessons learned from past successful revitalization projects, it is evident that creation of low-income rental housing promotes better and faster urban revitalization.

Rehabilitation and Conservation of historic buildings and landmarks

Abandoned, unused and dilapidated buildings pose a threat to the rebuilding of the city. These old buildings must be rehabilitated because of their historical importance. They must be assigned new uses, thereby promoting increased investments in rehabilitating and conserving landmark historical structures.

The author has divided the urban revitalization literature study into two major parts. Part one identifies the various important components of and strategies for urban revitalization, which will be used in the later part of the research to develop a comprehensive revitalization model. Part two focuses on literature related to the urban revitalization efforts taken by major U.S. cities and on the lessons learned in revitalization. This second part in particular details the efforts taken by these cities in achieving revitalization by defining new uses for older or dilapidated buildings (i.e., building rehabilitation). The author uses this literature as an important support for his definition of rehabilitation as a vital tool for urban revitalization.

Looking at successful urban revitalization strategies that are practiced in many cities in the U.S. and other developed countries, the author delves into the strategy of rehabilitation and conservation of old, dilapidated historic buildings as a tool for revitalization. Revitalization that occurred in major cities in New Jersey, Maryland, and other states through the process of building rehabilitation is studied and analyzed in detail as part of this literature study.

2.2.3 Revitalization Efforts in New Jersey

Though the fourth smallest state in the country, New Jersey is the eighth highest populated state, constituting almost 4% of the nation's population. New Jersey's population has grown by almost five times in the last 100 years, which is an alarming rate for an urbanized U.S. state. New Jersey's population is expected to increase from 8.15 million people in 2000 to 9.1 million by the year 2020—an increase of approximately 12%. [NJ State 2002].

With a negative migration trend found in most cities and developed states, New Jersey's efforts to revitalize its urban centers have proven successful in bringing in new people and new life. This growing trend is a sure effect of the revitalization efforts that are in place in the state, meeting the growing demands of the population. Many of New Jersey's cities are experiencing a renaissance, including Jersey City, Hoboken and Perth Amboy [NJ Online 1999]. People in New Jersey's cities are rediscovering the advantages of urban life: the opportunity for broader cultural, social, economic and political experiences. With the ease of getting to Wall Street and the other businesses and benefits of New York, New Jersey had always been successful in attracting residents and maintaining the attracted population in order to make a living in its cities. The urban planners and state developers have taken steps forward in formulating various Urban Enterprise Zones (UEZ), which have become a hallmark for urban revitalization and a cornerstone for economic growth and development.

In the state of New Jersey, the number of Urban Enterprise Zones has expanded from an original 10 in 1984 to the 30 zones in 35 municipalities today. Moreover, the program has helped create 65,070 full-time and 5,000 part-time jobs within the zones. This represents an estimated $13.8 billion in private investment by these businesses [NJ Commerce]. The investments generated through these revitalization zones are in turn offered as incentives for further developments. Revitalization efforts carried out by the state of New Jersey adopted all of the major strategies discussed above such as inner city redevelopment, turning brownfields into greenfields, making the state revitalization plan work through regional partnerships, creating urban redevelopment partnerships, protecting sensitive environmental resources, creating homes for working families, creating housing that makes sense in locations and addressing the need, promoting economic diversity and revitalization, building communities near jobs, providing special housing for those with special needs, helping low-income families save for the future, revitalizing New Jersey's older cities and suburbs, community-based neighborhood planning, providing financial resources and incentives to rehabilitate old commercial and residential buildings in cities and towns, revitalizing traditional mixed-use centers, encouraging city living, ensuring the safety of urban residents, and being more responsive to meet urban demands.

One of the significant efforts taken towards revitalization is the investments that have targeted defining new uses for old existing buildings, which in turn served the growing demand for both residential and commercial space in the urban centers. Even though this mode of achieving revitalization through bringing old buildings to new use was slow, there was a clear increase in the later 1990's, starting from 1996 when the state initiated this mode of revitalization at a greater magnitude. The outcome of these significant efforts was the development of a separate code for building rehabilitation called the Rehabilitation Code for the State of New Jersey. This research work is based on success achieved in New Jersey in developing a separate rehabilitation code, which created a unique momentum for urban revitalization that was later followed by many other dying U.S. cities. The literature relevant to the development and impact of the new building rehabilitation code and its effects on rehabilitation costs and overall revitalization is discussed in the later part of this literature study.

2.2.4 Revitalization Efforts in Maryland

Maryland has demographical and geographical characteristics very similar to New Jersey. Maryland is the seventh smallest state in United States, yet it has almost 2% of the country's population (5,296,486 people spread over 12,406.6 square miles of area) [Facts

2002]. Maryland, being located at the economic hub of the eastern coast, has experienced quick growth as well as fast urban decline over the past 100 years. This dynamic change in gaining and losing population in Maryland's major cities initiated the need for effective revitalization and regeneration plans for the dying cities. The fundamental goal of the state planning and development agencies was to assure that Maryland's unique quality of life would be preserved for generations to come. This move brought vivid changes in the pattern of urban design and revitalization in Maryland.

Maryland began several Smart Growth initiatives to return the dying cities to healthy, livable communities and centers of economic momentum. Maryland was the first state to attempt and to achieve success at using incentive-based efforts to reverse the costly, inefficient, and often unsightly patterns of development known as "sprawl" by investing in old cities and towns and brining people back to cities [Maryland 2002]. Some of the main goals that were set and achieved by the state as a part of the revitalization plan are [Maryland 2002]:

- To strengthen and revitalize older towns and cities;
- To permanently preserve the state's most beautiful historic buildings, commercial centers, and natural landscapes and most valuable environmental resources;
- To save taxpayers the high cost of building new infrastructure required to support sprawl developments;
- To bring new uses to old, vacant buildings;
- To generate a focused economic momentum in distressed cities and urban centers

- To sharply increase state spending on school renovation and expansion in older communities;
- To encourage cleanup and redevelopment of contaminated "brownfields";
- To spur job development by offering tax credits for job creation within targeted growth areas;
- To fight crime by targeting "hot spots," particularly cities like Baltimore, where crime is the worst
- To resolve economic and social problems caused by the abandonment of older cities and urban centers; and
- To assure that Maryland's unique quality of life is preserved for generations to come.

The Smart Growth initiatives addressed multifaceted urban needs in cities such as Baltimore, Columbia, and Silver Springs, which were facing problems of urban decline. In the case of Baltimore, most of these strategies were adopted at a higher level of importance as the city was losing population at an alarming rate in the late 1980s and early 1990s. During the 1990s, Baltimore lost nearly 85,000 people (11.5%), the largest absolute decline and the fourth largest percentage decline of any city in the country of 100,000 or more in population. This decline corresponded to a loss of more than 18,000 households [Maryland Planning]. The state development and planning department identified various corrective measures to prevent urban decline and bring people back to the city, adopting the aforementioned strategies for the problems identified in the historical downtowns and cities.

One of the important and effective strategies adopted by Maryland and Baltimore in particular was to revitalize and reuse the old, deserted and dilapidated buildings along the downtown corridor. Based on the analysis and detailed study performed by the Downtown Partnership of Baltimore, it was found that there existed a great potential to renovate the old structures and bring them into new use. On analyzing the number and kind of old unused buildings in the city, it was noted that a large number of vacant buildings were in the commercial building category. Class A office buildings were relatively new and were in great demand, while the class B and class C buildings were lying vacant and posing a sense of death to the city atmosphere. As a part of the revitalization, the city and the state made efforts to identify the scope of rehabilitating these vacant structures and make use of them to fill the available demand in the city. As developmental activities increased both socially and economically, people started migrating to the city (a reverse phenomenon), and these vacant buildings found a great a scope of renewal if converted to residential units. This rehabilitation activity gave a great momentum to urban revitalization in Baltimore, which is very evident from the fact that the population in Baltimore has increased from 2,382,172 in 1990 to 2,552,994 by the year 2000 with a net increase of 7.2%, showing a positive trend in population growth after a long period of declining population [Census Scope].

Further discussion of the kind of rehabilitation performed and investigation of the lessons learned in terms of urban revitalization and the cost related to rehabilitation are covered in the next part of the literature study, focused on exploring building rehabilitation with a focus on building codes.

2.3 BUILDING REHABILITATION

The process of building rehabilitation not only serves spatial and functional needs, but also acts as a tangible symbol of regeneration and new growth, which supports healthier urban life [Kadushin 1996]. In areas of slow growth and accelerated deterioration, rehabilitation can act as a catalyst and a motivator for sustained development that would include reuse of old diversified building groups such as commercial, educational, industrial, institutional, mercantile, residential, storage, utility and other miscellaneous structures.

2.3.1 PRE REHABILITATION CODE INITIATIVE

Any building or structure erected prior to **November 6, 1975,** is designated as an existing building as per the International Building Code. This is because, before 1975, structures that were erected did not follow a prescribed, nationally or regionally accepted standard building code. Different regions were using different model codes developed by three major code agencies in the United States: the Building Officials and Code Administrators (BOCA), the International Code of Building Officials (ICBO), and the Southern Building Code Congress International (SBBCI). Discussion of the code agencies and a brief history of building codes is offered in the later part of this literature. The local building departments validated and offered acceptance based on whichever model code was used in that region, or, in a few cases, using their own set criteria either based on experience or locally documented technical specifications. This discussion of the pre-rehabilitation code period is further divided into two parts: rehabilitation before the 1970's and rehabilitation between 1970 and 1998.

2.3.1.1 Building Rehabilitation before the 1970's

Rehabilitation works performed prior to 1970 were based on the three model building codes developed by the BOCA, the ICBO, and the SBBCI. These building codes adopted the 25/50 rule to determine the kind of rehabilitation work and the acceptability of the proposed work. If the rehabilitation project's value was lower than 25% of the building's value, the local building official had the flexibility to determine how much of the rehabilitation must conform to current codes. If the rehabilitation value was determined to be between 25% and 50%, then the entire rehabilitation work scope had to conform to all new building codes. If it was greater than 50%, the entire building had to be brought up to the current building codes [NAHBRC 1999 and Shay 2001].

As per the research study performed by the NAHB Research Center, it is found that rehabilitation works carried out with the 25/50 rule often end up with estimates that are not realistic with higher costs without knowing the exact work scope and associated requirements. The lack of standard rules and methods to determine the scope of rehabilitation often resulted in costs that were enough to strongly discourage rehabilitation, leaving old structures without any reuse. In many cases, when owners plan to rehabilitate some parts of a building, they end up as victims of this 25/50 rule. They are forced to spend many times more than what is needed for that planned renovation, leaving them without any further option other than leaving the building vacant. The author strongly feels that this might be one of the main reasons for so many vacant buildings in urban areas to stay unused.

2.3.1.2 Building Rehabilitation between 1970 and 1995

Based on the growing need for and awareness of the need for rehabilitation of existing old structures, efforts were made to replace the system that linked the compliance of rehabilitation work to the model building codes. The inefficient 25/50 rule was revisited in many ways to formulate a better system to meet the requirements of rehabilitation in a way that could be accurately applied to realistically estimate costs associated with the rehabilitation work [NAHBRC 1999]. In the late 1970's, the U.S. Congress asked HUD to provide leadership in this regard. As a result, HUD introduced a set of guidelines to streamline and simplify the approval of rehabilitation work. These guidelines were not meant to be adopted as a building code. Instead, they were meant to supplement the three existing model building codes. As an outcome of this move, HUD initiated a study, the National Survey of Rehabilitation Enforcement Practices [Shay 2001, Survey 1995].

Following the survey performed in 1995, HUD prepared rehabilitation guidelines from the lessons learned and these guidelines were used in conjunction with local building officials' building codes. Since these guidelines were not comprehensive enough to meet the diversified rehabilitation needs across the country, there was some dissatisfaction and numerous concerns were raised. These concerns lead to a detailed study initiative by HUD, organized along with the University of Illinois Urbana-Champaign to conduct a thorough study of the guidelines and their enforcement. This study identified the need for comprehensive guidelines and enforcement practices standardized throughout the nation. This survey acted as the first stepping-stone towards the formation of a separate subcode for rehabilitation works. This era between 1970 and

1995 was the crucial period for the identification of the need for a separate rehabilitation code.

2.3.2 POST-REHABILITATION CODE INITIATIVE

The National Survey of Rehabilitation Enforcement Practices performed in 1995 gave a good head start to the rehabilitation initiative in some state code organizations. One of the imperative players was New Jersey, which took a clear lead in analyzing the national survey and identifying the need for extensive rehabilitation code research to meet the growing needs of rehabilitation in the state. The New Jersey State Department of Community Affairs – Codes and Standards Division began in 1996 to develop a comprehensive rehabilitation subcode called the New Jersey Uniform Construction Code - Rehabilitation Sub Code, which was adopted statewide in 1998. Following the success of rehabilitation economics in New Jersey, many states that faced similar problems of aged existing buildings began to develop rehabilitation codes. Parallely, based on New Jersey's success, HUD developed the Nationally Applicable Recommended Rehabilitation Provisions (NARRP). Later, NARRP served to make various states aware of the need to develop a separate rehabilitation code. Before chronologically detailing the rehabilitation code development process, the author offers a summary and a brief history of building codes and code development organizations for better understanding of rehabilitation code development discussions.

2.4 BUILDING CODES

2.4.1 SUMMARY OF HISTORY AND DEVELOPMENT OF BUILDING CODES

A brief definition of building codes and standards is given in the terminology section of this literature review. Codes are the standards, the set of regulations, with which a building must comply in order to protect the life, safety and health of the public. Building codes were first used in Babylon around 2000 B.C. These codes were crude instruments used to associate building failures with the death of the builder. Since that time, many different codes have been developed, often being spurred on by major tragedies within a society. The first building code used in the United States was in New Amsterdam, New York (now New York City), in 1625. Likewise, the first construction code was established in New York City in 1862. [Shay 2001].

Awareness of the need for more comprehensive building codes increased in the early 1990's, which lead to the development of various model code organizations that developed model building codes that were used in many states either directly, to regulate the construction process, or indirectly, as a guideline for developing their own building codes. The BOCA, the SBCCI, and the ICBO are the three model code organizations that still exist and work to develop standards and regulations in building construction. The model codes developed by these organizations were used by various states and local governments in the United States until a national move made it possible to develop an international building code encompassing the knowledge and expertise of these three major model code organizations through the formation of the International Code Council. Table 4 details the history of code organizations.

Table 4: History of Code Organizations [Shay 2001]
(Yatt 1997, ASCE 1999, ACI 1999, ANSI 1999)

S.No	Year of Formation	Code Organization Formed
1	1852	American Society of Civil Engineers (ASCE)
2	1894	United Label (UL)
3	1896	American Society of Testing and Materials (ASTM)
4	1896	National Fire Protection Association (NFPA)
5	1905	American Concrete Institute (ACI)
6	1915	**Building Officials and Code Administrators (BOCA)**
7	1918	American National Standards Institute (ANSI)
8	1922	**International Code of Building Officials (ICBO)**
9	1940	**Southern Building Code Congress International (SBCCI)**
10	1972	**Council of American Building Officials (CABO)**
11	1994	**International Code Council (ICC)**

The three model code organizations were brought to the same platform through the formation of the International Code Council (ICC) in 1994. The first draft of the IBC was prepared in 1997 by five drafting committees appointed by the ICC, which held one public hearing in 1998 and two in 1999. The final IBC was published and released nationwide in 2000. This was a major successful move as the International Building Code (IBC) was developed more generically, which enabled most states to modify the IBC to suit local needs and conditions and to use it as the state building code. Following are brief descriptions of each of the three model building code organizations in the U.S. and of the ICC:

Building Officials and Code Administrators – BOCA

Building Officials and Code Administrators (BOCA) was started on May 14, 1915 in New York City. The first conference of the BOCA was an informal meeting that focused on floor loads, hollow tile for outside and bearing walls, automatic sprinklers, enclosure of stairways, and certificates of occupancy [Becker 1975, BOCA 1999, Shay 2001]. Later BOCA developed the detailed BOCA code that is used even today by some states and local governments.

International Code of Building Officials – ICBO

The International Conference of Building Officials (ICBO) was started in 1922 with the expressed purpose of creating a code that all communities could accept and enforce. The first of the organization's model codes was released in 1927 as the Uniform Building Code. The code was adopted by governments around the United States, many of the Caribbean island nations, and other governments worldwide [Shay 2001]. This was the first successful move to develop international code regulations and was successful in reaching across the globe.

Southern Building Code Congress International - SBCCI

The Southern Building Code Congress International (SBCCI) was created in 1940 and included forty original southern cities within its ranks. By 1999, these 40 cities had expanded to include 2300 cities. The area covered by the SBCCI includes almost the entire Southeast United States. It had wide recognition and acceptance from a diversified group of architects, engineers, owners, developers and city departments.

International Code Council – ICC

These three model code developers have joined to work under an umbrella organization called the International Code Council (ICC). The ICC was formed in 1994 and was assigned the task of developing a comprehensive building code to replace the three organizations' existing codes. The ICC also developed a series of international codes such as the International Energy Conservation Code, the Fire Code, the Fuel Gas Code, the Mechanical Code, the Plumbing Code, the Private Sewage Disposal Code, the Maintenance Code, the Residential Code, the Zoning Code and the International Electrical Code.

2.4.2 CHRONOLOGICAL LITERATURE RELATED TO REHABILITATION SUBCODE DEVELOPMENT

- Congressional Action During the 1970's and Follow-up in 1995
- The Status of Building Regulations for Housing Rehabilitation prepared by the HUD Office of Policy Development and Research (1995)
- National Survey of Rehabilitation Enforcement Practices prepared by Housing Research and Development and Building Research Council at the School of Architecture, University of Illinois Urbana-Champaign (1995-1998)
- New Jersey Uniform Construction Code - Rehabilitation Subcode developed and adopted by the State of New Jersey, Department of Community Affairs – Division of Codes and Standards (developed in 1996 and adopted in 1998)
- Nationally Applicable Recommended Rehabilitation Provisions (NARRP), Prepared for HUD by NAHB Research Center and Building Technology, Inc. (1997-1998)
- Innovative Rehabilitation Provisions – A Demonstration of Nationally Applicable Recommended Rehabilitation Provisions (NARRP), prepared by the HUD Office of Policy Development and Research (1999)
- Maryland Building Rehabilitation Code – Smart Codes developed by the State of Maryland for rehabilitation works [adopted in 2001]
- Smart Codes in Your Community – A Guide to Building Rehabilitation Codes, prepared for the HUD Office of Policy Development and Research, by Building Technology, Inc. (2001)

- International Existing Building Code – an expanded version of chapter 34 of the International Building Code, developed by the ICC (final draft prepared and released August 2001, final publication expected in 2003)
- Rehabilitation Subcode Initiatives by various states based on New Jersey's and the national trend. (2002 to Future)

Congressional Action During the 1970's and Follow-up in 1995: [1970 – 1995]

In the late 1970's, the U.S. Congress identified the need to develop a systematic process to address the growing issue of aged buildings. HUD was appointed to perform research to develop rehabilitation requirements and formulate guidelines for the rehabilitation process. HUD performed some interesting studies during this period even though the magnitude of action taken was smaller. As a result of them, HUD introduced a set of guidelines in the late 1970's to streamline and simplify the approval of rehabilitation work. These guidelines were not meant to be adopted as a building code. Instead, they were meant to supplement the three existing model building codes [SURVEY 1995]. Though the guidelines developed by HUD were useful in addressing the issues of rehabilitation, there was a great factor of dissatisfaction among the users, and this lead to the revision of these guidelines. In the course of revising the guidelines, HUD joined hands with the University of Illinois Urbana-Champaign to conduct a national survey of rehabilitation enforcement practices in 1995.

The Status of Building Regulations for Housing Rehabilitation [1995]

To meet the growing demand for housing and to resolve many regulatory issues pertaining to housing rehabilitation, HUD published *Residential Rehabilitation Guidelines*. However, these guidelines did not achieve success as each of the model building codes addressed the subject of building rehabilitation in different ways. In response to the need to regulate rehabilitation in a more consistent manner, HUD sponsored the first National Symposium on the Status of Building Rehabilitation Regulations in May 1995. The meeting established the status of and trends in rehabilitation regulation, and it resulted in recommendations for follow-up activity by industry, the three model code organizations, and HUD [Report 1995]. Even though this symposium addressed only issues related to housing rehabilitation, the ideas generated served as a catalyst for further U.S. research on various areas of rehabilitation. HUD made five action recommendations in the report published as an outcome of this symposium:

- To develop a national policy on housing rehabilitation
- To conduct a national survey of code enforcement practices related to rehabilitation
- To develop a national model rehabilitation code
- To formulate a compendium of acceptable compliance alternatives for rehabilitation
- To develop methods of complying with legislative mandates related to rehabilitation

Out of these five, the National Survey of Code Enforcement Practices related to rehabilitation achieved immediate attention. Thus the symposium conducted to address the Status of Building Regulations for Housing Rehabilitation became the vital base for future efforts in building rehabilitation by identifying the need for the national survey.

National Survey of Rehabilitation Enforcement Practices [1995 – 1998]

The national survey is one of the 5 recommendations made by the National Symposium on Housing Rehabilitation conducted by HUD in 1995. The model code organizations as well as some individual states (Massachusetts and Georgia) have developed and adopted some regulations that encourage rehabilitation. The enforcement of earlier rehabilitation regulations relied on the extensive exercise of discretion by code enforcement personnel. The code organizations had no information on how this discretion was exercised at the state and local levels and whether the objective of encouraging rehabilitation was achieved or not. To address this question and concern of the model code organizations, a national survey was performed to identify all regulatory constraints to rehabilitation so that they could be removed. The Building Research Council at the University of Illinois Urbana-Champaign performed the survey for HUD between 1995 and 1998.

One of the important findings of this survey was that the extent of code enforcement varies from one jurisdiction to another. The HUD survey also found that different regions tend to focus on different code provisions. Some of the interesting findings about code enforcement brought out by the national survey are [Survey 1998]:

- In some communities, code administration and enforcement for rehabilitation follows the same procedures that exist for new construction. Others have developed processes and procedures specifically tailored to rehabilitation.
- More than three-fourths of the administrators responded that their local processes provided for pre-application reviews that are a part of the review process for rehabilitation construction projects.
- Rehabilitation professionals had a more positive view of pre-application reviews than did the code administrators.
- Twenty-nine percent of the administrators indicated that building permits are *always* required while 40% *always* required construction documents.
- If there was a change of use in the existing building, the entire building had to meet the code requirements for new construction in 35% of the cases; another 35% invoked the new construction code if the new use was more hazardous than the old use.

The survey results HUD published provided important perspectives that were useful in future efforts to revise building codes and practices to accelerate the conservation of the nation's existing building stock. This survey's results were also useful for the three model code organizations, and state and local code agencies in developing efficient rehabilitation construction codes. New Jersey took a lead in capitalizing on the lessons learned in the national survey and started developing a comprehensive rehabilitation code. This code was greatly successful in terms of revitalization and savings in rehabilitation expenditures, as discussed in detail in the next section.

New Jersey Uniform Construction Code - Rehabilitation Sub Code [1996 – 1998]

New Jersey issued building permits authorizing construction valued at over $7 billion in 1996. Additions to and alterations of existing structures accounted for about 47% of this amount, and this rate kept increasing as more structures aged [NJ code]. These old buildings, which were built to comply with an earlier building code or with no code, were often still safe and sound. However, the new building codes penalized owners deciding to improve existing structures by requiring compliance with regular building codes at shifting, unpredictable levels, causing rehabilitation costs to be irrational and unpredictable. The building codes that were prepared to meet the requirements of new construction had very little room for existing structures, which in turn resulted in either a costlier rehabilitation process or the owners choosing just to abandon the building to avoid huge investments in rehabilitating the structure. This challenged New Jersey to develop provisions for existing buildings that were rational and predictable and that delivered safe, sound rehabilitated structures [NJ Code].

Capitalizing on the knowledge gained and the lessons learned from HUD's national survey to identify enforcement of rehabilitation regulations in the United States, a rehabilitation subcode committee was formed by the Department of Community Affairs with guidance from a 30-member committee under the coordination of the Center for Urban Policy Research at Rutgers University. The committee was composed of code officials, fire officials, architects, historic preservationists, advocates for people with disabilities, and government representatives [NJ Code].

This committee, formed to work with the rehabilitation guidelines to develop a exclusive rehabilitation subcode, was the first of its kind in the entire nation. The committee published its first draft of the rehabilitation subcode in the New Jersey Register on August 18, 1997, for public comments and opinions. After conducting two public hearings, the rehabilitation subcode was finally released and adopted throughout the state on January 5, 1998. The published code became the first comprehensive code for existing buildings. The new rehabilitation subcode achieved overwhelming success as it made restoration and reuse of old dilapidated buildings possible at reasonable costs, which inspired numerous building owners to rehabilitate their vacant buildings and bring regeneration to the state. As a reward for its success, the rehabilitation subcode or ***"rehab code"*** won the national "Innovations in American Government" award in 1999, earning the code's creator, the New Jersey Department of Community Affairs, a $100,000 prize [NY GORR]. The effect of the new subcode was amazingly positive, increasing the total rehabilitation spending dramatically in the state's largest cities as shown in Table 5.

Table 5: Estimated Cost of Rehabilitation Construction Authorized by Building Permits Statewide and in Selected New Jersey Cities: 1996, 1997, and 1998 [NJ DCA]

Year / Area	**1996** (million $)	**1997** (million $)	**1998** (million $)	**Percent Change** **1996-97**	**1997-98**
Newark					
Housing rehab	22.2	19.3	15.2	– 12.9	– 21.2
Nonresidential rehab	36.4	48.8	93.3	34.2	90.9
Total rehab	58.6	68.1	108.5	16.4	59.2
Jersey City					
Housing rehab	22.5	16.7	17.6	– 25.7	5.5
Nonresidential rehab	29.0	31.8	71.4	9.8	124.4
Total rehab	51.5	48.5	89	– 5.7	83.5
Trenton					
Housing rehab	14.4	8.0	10.3	– 44.4	27.8
Nonresidential rehab	18.1	12.9	19.1	– 28.5	47.7
Total rehab	32.5	21.0	29.4	– 35.6	40.1
New Jersey					
Housing rehab	1,274.3	1,395.6	1,561.3	9.5	11.9
Nonresidential rehab	2,028.9	2,401.7	2,527.3	18.4	5.2
Total rehab	3,303.2	3,797.3	4,088.6	15.0	7.7

The Codes and Standards Division of New Jersey's Department of Community Affairs (DCA) estimated that rehabilitation costs were lowered by around 50%, varying between 10 and 60% depending upon the condition of the structure. The long-felt need to address the issue of rehabilitation cost was duly addressed by this new rehabilitation subcode. As an example of the success and benefit of the rehabilitation code, as stated by William Connolly, Director of New Jersey DCA [Forest 1999], "a four-story senior citizen complex and day care center at 203 Academy Street in Jersey City saved $391,000 in building costs thanks to the new code. Under the old code, the rehabilitation would have cost $1,536,000; under the new code, it cost $1,145,000. Before the rehab, the building-formerly an apartment and retail complex-had been vacant for eight years". Many similarly triumphant projects have been completed in the state under the new subcode. Attracted by the economic and implementational successes, many other states (such as New York, Massachusetts, and Maryland), the International Code Council (ICC) at the national level, and local governments started developing rehabilitation codes.

Nationally Applicable Recommended Rehabilitation Provisions [1997 – 1998]

The NARRP was a continuation of the efforts of HUD in sponsoring the National Symposium on the Status of Building Regulations for Housing Rehabilitation, convened by the NAHB Research Center in May 1995. One of the symposium's five major recommendations was to develop detailed national rehabilitation recommendations. Simultaneously, New Jersey was developing its rehabilitation subcode based on the need identified by HUD's national survey. New Jersey's *Code for Rehabilitation of Existing Buildings* served as the starting point for the development of the NARRP. The important focus of the NARRP was to make the existing rehabilitation regulations addressed in the model codes more comprehensive such that an existing building in which work is to be undertaken need not be brought up to full compliance with the code requirements for new construction [NARRP 1999].

In general, the model codes (BOCA, ICBO and SBBCI) categorized work related to existing structures into four categories: repair, alteration, change of occupancy and addition. The level of flexibility that was offered by these four categories often left most buildings with few options for rehabilitation. Identifying this factor, the NARRP expanded alteration (most important in many rehabilitation projects) into three parts, thereby increasing the total number of categories to six instead of four. They are:

- Repair
- ***Renovation***
- **Alteration**
- ***Reconstruction***
- Change of occupancy
- Addition

Rehabilitation work on existing structures is classified into these categories in order to facilitate structuring proportional requirements for additional work instead of penalizing owners with additional regular building code c ompliance requirements. Following the New Jersey Rehabilitation Subcode's success, the NARRP gained valuable recognition among various states and local governments in the nation. The NARRP helped to set forth a recommended framework for addressing all types of rehabilitation work in all types of buildings (residential, commercial, etc.). These provisions were developed to be suitable for use by any state, local jurisdiction or model code organization with a minimum of adaptation [NARRP 1999]. Some states and cities that benefited immediately from this were New York State; Massachusetts; Maryland; Minnesota; Rhode Island; Wichita, Kansas; and Kansas City, Missouri. Also, some of the major code development organizations such as the ICC, the Uniform Code for Building Conservation (UCBC), and the National Fire Protection Association (NFPA) adopted the NARRP as a revision to their work on existing building codes. The UCBC was revised in the year 2000 based largely on the NARRP's concepts of work area and categorization of rehabilitation work, changing its name to Uniform Code for Existing Buildings (UCEB).

The ICC used various resources in 1999 when it established a code drafting committee to develop a code exclusively for building rehabilitation, called the ***International Existing Building Code*** [SMART CODES], primarily the New Jersey Rehabilitation Subcode and the NARRP. Thus, these two major innovations served as the base for all future research, development and deployment related to building rehabilitation codes in the United States. In these past five years since the implementation of the New Jersey Rehabilitation Code and the NARRP, rehabilitation of existing structures widely has been more lucrative.

Innovative Rehabilitation Provisions by HUD [1999]

HUD received an overwhelming response to the NARRP publication that followed the New Jersey Uniform Construction Code - Rehabilitation Subcode. To address a wide audience about the need for and importance of the rehabilitation code, HUD decided to prepare a publication as a follow-up to the NARRP with a real-time rehabilitation project encompassing the costs related to rehabilitation using the regular model building codes and the new NARRP guidelines. HUD requested that the NAHB Research Center conduct this study in conjunction with a remodeling group based in New Jersey, Asdal Builders. As a case study project, a 200 year old home in Chester, New Jersey, was selected [HUD 1999], and a complete study was performed identifying the cost of rehabilitating this home with the old ***New Jersey Uniform Construction Code*** (NJUCC) and the NARRP/New Jersey Rehabilitation Subcode.

The case study project in Chester, built 200 years before, had a variety of code issues to comply with in the NJUCC. It had been in need of remodeling for a long time and had been lying vacant for more than ten years. This project was selected as it met the requirements of the study in terms of code issues, age of structure and study location, New Jersey. The old code, the NJUCC used the 25/50 rule for rehabilitation requirements and, as per this rule, if renovations exceeded 50 percent, the structure was required to comply with the regular building code. This project exceeded more than 50% of the value of the building and, hence, the entire structure would have had to comply with the code requirements for new structures [HUD 1999]. On the other hand, the study revealed that the new rehabilitation subcode took a lead over the old Uniform Construction Code with the new benefits to rehabilitation. This study, sponsored by HUD, had some interesting findings in terms of identifying key areas of cost in rehabilitation of existing structures using the rehabilitation code, such as:

- Cost of compliance of the existing ***Foundations***
- Cost of compliance of the existing ***Egress Windows***
- Cost of compliance of the existing ***Corridor Width***
- Cost of compliance of the existing ***Stair Geometry***
- Cost of compliance of the existing ***Ceiling Heights***

On completion of this study, it was found that there was a net savings of **20.6%** in rehabilitation cost using the new rehabilitation code over the NJ Uniform Construction Code [HUD 1999]. Cost related benefits were made evident through this study performed by HUD and the NAHB Research Center.

Maryland Building Rehabilitation Code [1998-2000]

The Maryland Building Rehabilitation Code (MBRC) was created as a part of the Smart Codes Initiative during Maryland's 2000 General Assembly session after seeing the success of the New Jersey Rehabilitation Code. The Maryland Department of Housing and Community Development, along with the Maryland Rehabilitation Code Advisory Council, proposed the rehabilitation regulations in February 2001; the final version of the code became effective throughout the state on June 1, 2001 [MBRC 2001]. The code is organized in a manner very similar to the NARRP, excepting a few changes in terms, redefining the NARRP's "alterations" as "modifications." These changes were made to suit Maryland's local amendments.

Smart Codes in Your Community by HUD [2001]

This study, performed for the HUD Office of Policy Development and Research by Building Technology, Inc., serves as a guide to the building rehabilitation codes that were developed in the late 1990's, including HUD's effort, the NARRP. Though this study was not very comprehensive, it helped to examine the aspects of the current regulatory system and identify some areas of complexity in the existing provisions and new codes that may act to impede the rehabilitation of existing buildings [SMART CODES]. This study also reviewed the major provisions of HUD's NARRP, issued in 1997, which established a model regulatory framework for possible adoption at the state or local level throughout the nation. This study was a part of HUD's continued effort to encourage the local communities to address the need for revitalization through rehabilitation of existing buildings that are dilapidated and abandoned.

International Existing Building Code followed by Chapter 34 of IBC [2001-2003]

The ICC successfully united all three model codes and formed a comprehensive international code called the International Building Code (IBC). The IBC followed a pattern similar to the three model codes and did not have much emphasis on work related to existing structures. Chapter 34 of the IBC, meant for existing structures, was addressing the same four categories (alteration, repair, addition and change of occupancy) as the three model codes. Chapter 34 failed to address all the complex issues related to work in existing structures, as the work's flexibility was limited. The ICC came to see the importance of work in existing structures based on rehabilitation code development in New Jersey, followed by HUD's NARRP. This lead to the ICC's formation of a technical committee to develop a draft of a comprehensive existing building code consistent with the family of similar international codes developed by the ICC [IEBC 2001]. Thus, Chapter 34 of the IBC was drafted into a comprehensive existing building code, and the final draft was released for public hearings and comments in August 2001. At this stage the issues addressed by the IEBC are more related to the IBC and future work will be carried out by ICC to make it more comprehensive in relation to its other codes, such as the Fire Code, the Mechanical Code, the Electrical Code and others.

A comparison between the New Jersey Code / NARRP and the IEBC is shown below. The IEBC categorized as three levels of alteration what the NARRP called renovation, alteration, and reconstruction. Definitions related to these terms are compiled in the terminology section that follows this literature review.

Categories of Work in NJ Code / NARRP

- Repair
- ***Renovation***
- ***Alteration***
- ***Reconstruction***
- Change of occupancy
- Addition

Categories of Work in IEBC

- Repair
- ***Alteration - Level 1***
- ***Alteration - Level 2***
- ***Alteration - Level 3***
- Change of occupancy
- Addition

2.4.3 MICHIGAN REHABILITATION CODE

The State of Michigan adopted a single statewide building code, named the Michigan Building Code, based on State Public Act 245 of 1999. This code is based on the International Building Code with some minor changes suiting the state's needs. The level of benefits that the state code offered for rehabilitation of existing structures was similar to the ICC code's Chapter 34. The study by Shay and Syal [2001] identified the need for implementing a building rehabilitation code in Michigan, which is facing a similar situation in terms of rehabilitation of existing structures to other states such as New Jersey and Maryland. Having seen the success of rehabilitation codes and having felt the need for and importance of a rehabilitation code for the state, the Michigan Department of Consumer & Industry Services (CIS) formed a rehabilitation code committee to consider the adoption of a rehabilitation code for Michigan. The committee began its work by looking at three nationally accepted options for rehabilitation of existing buildings, such as:

1. The New Jersey Rehabilitation Subcode
2. HUD's Nationally Applicable Recommended Rehabilitation Provisions
3. Chapter 34 of the International Building Code

The efforts that started in November 2000 lead to the active participation of many experts in the State of Michigan and to the release of a detailed rehabilitation code for discussion. Meanwhile, the ICC released the IEBC final draft in August 2001; later, this became the primary source for the Michigan Rehabilitation Subcode. CIS recently filed the Michigan

Rehabilitation Code for Existing Buildings with the Secretary of State to become effective as of October 2002.

Michigan Department of Consumer & Industry Services Director, Noelle Clark, during the code release session said, "Without these new rules, our communities would undoubtedly continue to see property owners and developers investing in new construction rather than using existing buildings. This would mean more aging buildings would be left abandoned, which would only exacerbate the development of valuable farm land, increase urban blight and decay, and reduce the tax base that is necessary to make Michigan cities economically viable" [CIS 2002]. The need for applying this code is more acute in the old cities of Michigan, such as Detroit, which have a large stock of old, dilapidated buildings. This research is intended to identify the effectiveness of the new Michigan Rehabilitation Code to bring urban revitalization to the state, particularly Detroit, which needs early attention.

2.5 TERMINOLOGY

This section details the terminology that is used in the later part of the thesis to explain rehabilitation code use and analysis. These terms are adopted from the International Building Code (IBC) and the final draft of the International Existing Building Code (IEBC). A few important terms related to the research discussion are detailed in this section; the remaining terminology is attached as an appendix in the last part of this report.

BUILDING:

"Building" means a combination of materials, whether portable or fixed, forming a structure affording a facility or shelter for use or occupancy by persons, animals, or property. The term does not include a building incidental to the use for agricultural purposes of the land on which the building is located if it is not used in the business of retail trade.

BUILDING OFFICIAL:

"Building official" means the person who is appointed and employed by a governmental subdivision charged with the administration and enforcement of the state code or codes and who is registered in accordance with the requirements of 1986 PA 54, MCL 338.2301 et seq.

BUILDING CODE:

Building codes, as defined by the National Fire Protection Agency (NFPA 1999): "A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards."

BUILDING STANDARDS:

Building standards, as defined by the National Fire Protection Agency (NFPA 1999): "A document the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Non mandatory provisions shall be located in an appendix, footnote, or fine print note and are not to be considered a part of the requirements of a standard."

DWELLING:

A building that contains one or two dwelling units used, intended, or designed to be used, rented, leased, let or hired out to be occupied for living purposes.

DWELLING UNIT:

A single unit providing complete, independent living facilities for one or more persons including permanent provisions for living, sleeping, eating, cooking and sanitation.

EXISTING STRUCTURE:

A structure erected prior to the date of adoption of the appropriate code, or one for which a legal building permit has been issued.

REPAIR:

The restoration to a good or sound condition of materials, systems and/or components that are worn, deteriorated or broken, using materials or components identical to or closely similar to the existing.

RENOVATION:

The removal and replacement or covering of existing interior or exterior finish, trim, doors, windows, or other materials with new materials that serve the same purpose and do not change the configuration of space. Renovation shall include the replacement of equipment or fixtures.

ALTERATION:

The rearrangement of any space by the construction of walls or partitions or by a change in ceiling height, the addition or elimination of any door or window, the extension or rearrangement of any system, the installation of any additional equipment or fixtures, and any work which reduces the loadbearing capacity of or which imposes additional loads on a primary structural component. The IEBC breaks alteration down into three levels:

- ***Alteration Level 1:*** Level 1 alterations include the removal and replacement, or the covering of existing materials, elements, equipment or fixtures using new materials, elements, equipment or fixtures that serve the same purpose.

- ***Alteration Level 2:*** Level 2 alterations include the reconfiguration of space, the addition or elimination of any door or window, the reconfiguration or extension of any system, or the installation of any additional equipment.

- ***Alteration Level 3:*** Level 3 alterations apply where the work area exceeds 50% of the aggregate area of the building

RECONSTRUCTION:

Any project where the extent and nature of the work is such that the work area cannot be occupied while the work is in progress and where a new certificate of occupancy is required before the work area can be reoccupied. Reconstruction may include repair, renovation, alteration or any combination thereof.

CHANGE OF OCCUPANCY:

A change in the purpose or level of activity within a structure that involves a change in application of the requirements of the building code or of these provisions.

EQUIPMENT OR FIXTURE:

Any plumbing, heating, electrical, ventilating, air conditioning, refrigerating and fire protection equipment, and elevators, dumb waiters, escalators, boilers, pressure vessels and other mechanical facilities or installations, which are related to building services. Equipment or fixtures shall not include manufacturing, production or process equipment, but shall include connections from building service to process equipment.

HISTORIC BUILDING:

Any building or structure that is:

1) Listed in the state or National Register of Historic Places,
2) Designated as a historic property under local or state designation, law, or survey,
3) Certified as a contributing resource within a National Register-listed or locally designated historic district, or
4) Certified or judged by the State Historic Preservation Officer or the keeper of the National Register of Historic Places to be eligible to be listed on the state or National Register of Historic Places either individually or as a building contributing to a historic district.

CONSTRUCTION DOCUMENTS:

Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit.

FIRE PARTITION:

A vertical assembly of materials designed to restrict the spread of fire in which openings are protected.

FIRE-PROTECTION RATING:

The period of time that an opening protective assembly will maintain the ability to confine a fire as determined by tests prescribed in Section 714. Ratings are stated in hours or minutes.

FIRE RESISTANCE:

That property of materials or their assemblies that prevents or retards the passage of excessive heat, hot gases or flames under conditions of use.

FIRE-RESISTANCE RATING:

The period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both as determined by the tests, or the methods based on tests, prescribed in Section 703.

FIRE WALL:

A fire-resistance-rated wall having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.

SHAFT:

An enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and roof. Shaft enclosures are the walls or construction forming the boundaries of a shaft.

HABITABLE SPACE:

A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered habitable spaces.

IMPORTANCE FACTOR, I :

A factor that accounts for the degree of hazard to human life and damage to property.

MEANS OF EGRESS:

A continuous and unobstructed path of vertical and horizontal egress traveling from any point in a building or structure to a public way. A means of egress consists of three separate and distinct parts: the exit access, the exit and the exit discharge.

MEZZANINE:

An intermediate level or levels between the floor and ceiling of any story with an aggregate floor area of not more than one-third of the area of the room or space in which the level or levels are located

BUILDING PERMIT:

An official document or certificate issued by the authority having jurisdiction which authorizes performance of a specified activity.

EXIT:

That portion of a means of egress system which is separated from other interior spaces of a building or structure by fire-resistance-rated construction and opening protectives as required to provide a protected path of egress travel between the exit access and the exit discharge. Exits include exterior exit doors at ground level, exit enclosures, exit passageways, exterior exit stairs, exterior exit ramps and horizontal exits.

REHABILITATION:

Any work, as described by the categories of work defined herein, undertaken in an existing building.

TECHNICALLY INFEASIBLE:

An alteration of a building or a facility that has little likelihood of being accomplished because the existing structural conditions require the removal or alteration of a loadbearing member that is an essential part of the structural frame, or because other existing physical or site constraints prohibit modification or addition of elements, spaces or features that are in full and strict compliance with the minimum requirements for new construction and which are necessary to provide accessibility.

UNSAFE BUILDINGS OR EQUIPMENT:

Buildings or existing equipment that are unsanitary or deficient because of inadequate means of egress facilities, inadequate light and ventilation, or which constitute a fire hazard, or are otherwise dangerous to human life or the public welfare, or which involve illegal or improper occupancy or inadequate maintenance, shall be deemed an unsafe condition.

2.6 SUMMARY

In this chapter, a detailed review of the literature and the terminology used in urban revitalization, building rehabilitation and building rehabilitation codes have been provided. The chronological explanation of rehabilitation code development in the United States provides the reader with a clear understanding of the need for and use of building rehabilitation code. The next chapter serves as the foundation to the use and application of rehabilitation code as it introduces the current practices and a comparison with the new rehabilitation code provisions.

CHAPTER THREE

TRADITIONAL REHABILITATION PRACTICES AND NEW REHABILITATION PROVISIONS

3.1 INTRODUCTION

The rehabilitation practices currently adopted in Michigan for existing structures are highly unpredictable and left to the discretion of the local building official. Given the state's growing supply of vacant and deteriorating structures, efforts are underway to implement a building rehabilitation-specific code in the state. In this chapter, the author has made an attempt to summarize the existing building rehabilitation practices with the regular building codes and compare them with the provisions developed in the new rehabilitation code. Specific benefits offered by the new rehabilitation code over the regular building codes are discussed in this chapter with suitable examples. The New Jersey Rehabilitation Code, which is the first of its kind, is used to introduce this chapter and later illustrations based on international code and Michigan's code are offered for better understanding. This chapter is divided into five sections:

- Traditional approaches to building rehabilitation
- The New Jersey Rehabilitation Subcode
- Provisions of the International Building Code – Chapter 34
- International Existing Building Code (IEBC)
- The Michigan Rehabilitation Subcode

The purpose of these codes and provisions is to encourage rehabilitation and reuse of legally existing buildings, permitting repairs, renovations, alterations, reconstructions, additions, and change of occupancy. Each of these processes is illustrated with suitable examples for the benefit of the reader.

3.2 TRADITIONAL APPROACHES TO BUILDING REHABILITATION

This section is categorized into three sub divisions, two detailing the traditional rehabilitation approaches that were practiced in various states and local governments in the United States, and the third division summarizing the critical issues in traditional rehabilitation practice.

3.2.1 REHABILITATION PRACTICES USING PERCENTAGE VALUES

Traditionally rehabilitation works in existing buildings are primarily dependent on the cost of rehabilitation associated with the project. The higher the cost of rehabilitation, the greater the need for the entire structure to comply with the standards that are enforced for new construction. This system of rehabilitation adopted in many states is widely known as the 25/50 rule. For example, in New Jersey before the rehabilitation subcode was introduced, the Uniform Construction Code (UCC) was used statewide for all works related to existing structures. The UCC used the same 25/50 rule to determine the level of compliance of the structure with the code requirements for newly built structures [NAHBRC 1999 and Shay 2001]. Under this rule, the total value of a building was determined and then compared with the total estimated cost of the rehabilitation work by calculating the percentage of value (PV).

$$\textbf{Percentage of Value (PV)} = \left(\frac{\text{Cost of Rehabilitation}}{\text{Cost Value of the Building}} \right) * 100$$

Based on the PV calculated for the structure, the required degree of compliance to the requirements for new buildings is determined. Three areas of threshold percentage values are determined based on the relation of the cost of rehabilitation to the cost value of the building:

(a) PV less than 25% of the building's value

(b) PV between 25% and 50% of the building's value

(c) PV over 50% of the building's value

In case of a percentage value less than 25 percent, where the cost of the work is under 25% of the value of the structure, the building code provides flexibility to the local building code official to determine the degree to which the alteration work should meet code requirements similar to those for new construction. In many such cases, to avoid the risk of liability that may fall on the shoulders of the building code official in the future, it was found that usually the structures were rehabilitated with the new structure requirements. This situation offered the building code officials greater levels of discretionary powers, leaving the owners with very little predictability of the costs involved in rehabilitation and often resulted in a very high cost for rehabilitation.

In the second case, where the percentage value of rehabilitation is between 25% and 50%, the building code requires all altered or repaired portions to meet the requirements of the new construction. This requirement of the alteration to comply with the new code was often not permitted or was technically infeasible with the existing configuration of the structure. As a result of this infeasibility, projects result in high levels of variation in the existing parts of the structure that are not altered of changed.

The owner who wanted to add a small thing like a storeroom or a restroom to the existing building was forced to rework most of the parts of the building; that made rehabilitation a costly issue. In addition, it lead to increased levels of unpredictability for the owner in investing in smaller rehabilitations to improve the conditions of the structure to new construction standards.

Table 6: REHABILITATION PROCESS WITH PERCENTAGE VALUES

S.No	Disadvantage of using Model Codes	PV Less than 25%	PV Between 25% - 50%	PV Greater than 50%
1	**Procedure Adopted for Compliance Requirements**	Code Official (CO) decides degree of compliance of the project to code	Code requires the alterations made to comply with new structure requirements	Code requires that the entire structure comply with new structure requirements
2	**Effect on Cost of Rehabilitation**	Higher cost as CO increases scope to reduce liability	Project penalized with very high rehabilitation cost	Very high cost of rehabilitation
3	**Effect on Rehab Process (Owner)**	Low predictability of rehab cost by owner – increased variation	Infeasibility of project often results in high levels of variation	Often owners avoid rehab, afraid of cost associated

In the third case, where the percentage value of the rehabilitation work exceeded 50%, the building code declared the building unfit for reuse and forced the entire building to be rehabilitated as per the requirements for new construction. This not only affected the rehabilitation scope of the project, but also affected the portions of the building that were not planned for rehabilitation. For example, a building which has three stories and has an occupant load of 200 people, built in the early 1900's, would often have one means of egress. Assume that the owner submits a proposal to add a extra floor to the existing building to meet increased demand, and a building evaluation process is performed on the structure. If the percentage value is more than 50 percent, then the entire building has to comply with the new structure requirements. In this case, the building that had only one means of egress is forced to be rehabilitated with two means of egress as per the building code, and this leaves the owner with higher costs of rehabilitation. Because of this, many structures that have potential for reuse are left vacant and allowed to dilapidate over time.

In addition to the percentage value-based code compliance regulations for existing structures, there were three other major limitations of using the regular building codes such as:

- Area modification in existing structures during the rehabilitation process when additions were made to the existing configuration
- Accessibility requirements in existing structures
- Change of occupancy compliance requirements, where the change of use is made in the existing structure

This can be more vividly explained with an example of an existing structure. Let us consider a structure that was built 50 years ago, used as an Educational facility and classified as a Group E building. If the owner decides to rehabilitate this old educational facility and has two options: to rehabilitate the building to the same use again or to convert this school building into a institutional facility under Group I, an occupancy group including hospitals, penal or correctional facilities or day care and child care facilities. For option two, the code requirements under the regular building codes are very severe.

Let us first consider first the option of rehabilitating the structure to the same use. As this structure was erected prior to November 6, 1975, and did not follow any prescribed standard building code, the area limitations and the accessibility requirements of the new code are not similar to the state of the building. When additions to such old structures during rehabilitation exceed 5% of the area of the existing building, then the existing structure is required to meet current building code for items such as interior finishes, lighting, ventilation, means of egress, sizes of windows, open space, seismic requirements, and fire protection and safety. If the value of the rehabilitation of the existing structure is more than 50% of the actual building value, then the accessibility compliance imposed by the modern building code during rehabilitation is considerably strong. The new rehabilitated structure needs to address accessibility requirements such as elevators, platform (wheelchair) lifts, stairs and escalators, ramps, dining areas, performance areas, assembly areas, toilet rooms, sales and service counters and, maximum height of thresholds at the doorways.

Now, let us consider the second option in which the owner decides to change the use of the existing building from an educational use to an institutional use. As per the model building codes, whenever a change in use is proposed for an existing structure, then the entire structure needs to comply with the proposed new use group's building code requirements, Group I's requirements in this case. When an entire building must be brought to compliance with the new code requirements, the scope of rehabilitation is very high, and this situation often leaves the owner with highly unpredictable rehabilitation costs. Many existing structures have had rehabilitation plans shelved in the past because of these code complications and higher rehabilitation costs, leaving behind old and dilapidated structures.

3.2.2 BENCHMARKING OF EXISTING STRUCTURES WITH NEW STRUCTURES

The method of benchmarking an existing structure with a similar new structure to determine the scope of rehabilitation was widely found in the model codes, in particular the BOCA National Building Code. This method is outlined in detail in Chapter 34 of the BOCA code. This method is an alternative approach to the percentage value method. The benchmarking method [Connolly 1999] is based on an extensive evaluation of the existing structure for its condition and features. Benchmarking is performed with the standards of a new structure and points are designated during the evaluation process. These points are then used to determine the scope of rehabilitation.

Various features in the existing building such as the general building height and area, type of construction, fire protection systems, interior finishes, means of egress, accessibility, energy efficiency, condition of exterior walls, roof assemblies, structural design, condition and stability, windows and doors, glazing, electrical systems, mechanical systems, plumbing systems, elevators and conveying systems, the encroachment of structures into the public right-of-way, and standards and quality of the materials used in the building, are compared to the existing levels in new structures and points are assigned to the existing structure.

Let us consider an example with one of the features of the existing structure, the means of egress. In the old building under rehabilitation, the design, construction and arrangement of means of egress components, which are required to provide an approved means of egress from the structure, are studied and benchmarked with the same qualities of the new structure's means of egress standards. If the structure has sufficient features that either meet or exceed the code requirements for a new structure, then positive points are assessed to the existing structure. Negative points are assessed for the features in the existing building that are evaluated as hazardous and not safeguarding public health and safety. Zero points are awarded for those features that neither have a positive effect nor have a negative effect [Connolly 1999].

If the net cumulative points of the evaluation are positive, then the building code official has the authority to decide upon the level and scope of rehabilitation to be performed on the structure. If the evaluation yields negative points, then without any further option, the entire structure must comply with the code requirements for new structures. In this case, means of egress features such as egress width per occupant served, door openings into the path of egress travel, egress ceiling height, minimum headroom, type of walking surfaces of the means of egress, changes in elevation, egress continuity, exit signs, and the openness of the egress to minimize the accumulation of smoke or toxic gases during emergencies contribute to the points assessed in the evaluation. This system was widely used in determining the scope of rehabilitation, but often penalized owners by requiring additional costs to improve the standards and features of the existing building to make them similar to those of new structures.

3.2.3 SUMMARY OF CRITICAL ISSUES IN TRADITIONAL PRACTICE

Some of the critical issues in traditional building rehabilitation practice, that often increased the scope and cost of rehabilitation and were not addressed by the model building codes or the state and local codes are as follows:

(a) The primary critical issue is the code compliance related to change of occupancy in an existing building. When there is a change of use in the proposed rehabilitation, the entire structure must comply with the requirements of the proposed new use as per the regular building code.

(b) There is a possibility that the building materials and methods used in old structures built over the past 100 years not meeting the current building codes' material and method standards. These codes often impose change in the building's existing materials to meet the current standards, thereby increasing the cost of rehabilitation.

(c) Compatibility of the geometry of the existing structure with the current building codes' geometric standards is often not possible because of the change in people's tastes and architectural styles over time. For example, the new requirements for stairway geometry with the minimum tread (11 inches / 279 mm minimum) and maximum riser (7 inches / 178 mm maximum) dimensions causes existing stairs to be declared too steep and forces replacement as per the new stair standards. The stair rooms that were designed for the existing stairs cannot accommodate the new stair dimensions, which often results in complete demolition of the existing stairs and provision of new stairs, a massive investment for the owner

(d) Enforcement of new building requirements and regulations on existing structures generates a strong barrier to the rehabilitation of historic structures. Most historic structures lose their important historical value when remodeled with the code requirements of new buildings. This serves as a barrier to historical preservation efforts [Connolly 1999]. Some building code parameters that often pose danger to historical structures are the stairways, doorway width, corridor width, interior and exterior finishes, and the materials used in the building.

(e) The dimensional requirements of existing structures such as minimum room widths, minimum ceiling heights, room sizes, dead-end corridor lengths and dimensions of the structural elements necessitate change in the existing structures to a magnitude which is close to building a new structure. Changing these dimensions in the existing structure results in very high costs of rehabilitation.

(f) Uncertainty among different building code officials in the same region in defining the scope of rehabilitation that is necessary to improve the safety of the existing structure. Because of this uncertainty, building owners are left with minimal information about the costs associated with the rehabilitation process, which often results in shelving the project without rehabilitation.

(g) One other critical issue in the traditional rehabilitation procedure is the absence of preliminary discussions and meetings between building code officials, designers and building owners to define the scope of the proposed rehabilitation work, which will decrease the level of uncertainty that exists in rehabilitation projects.

3.3 NEW JERSEY REHABILITATION CODE

New Jersey adopted the Uniform Construction Code (UCC) in January 1977 for all new construction in the state. Until recently, the same code was used for both new construction and existing structures. The UCC used the 25/50 Percent Percentage Value (PV) rule for all the works related to rehabilitation. As explained in the previous section, the 25 and 50 percentages refer to the cost of the building's rehabilitation work, which determines the required degree of compliance to the Uniform Construction Code. If the value of the rehabilitation work is within 25% of the total building value, then the code official has the authority to decide the level of compliance. If the value of work is between 25% and 50% of the structure's value, then the sections of the building that undergo alteration should comply with the new building requirements, and if the cost is more than 50% of the total value, then the entire structure must comply with the requirements of a new structure.

In New Jersey, out of the total $7 billion spent on construction works, about 48% is spent for works related to alterations and additions to existing structures. This percentage has grown over the years as more and more structures are aging and requiring rehabilitation. The 25/50% rule in many cases made it very difficult for owners to afford rehabilitation, as the new additions or alterations that were made often exceeded 50% of the value of the building. As the need for rehabilitation in the state grew, the Department of Community Affairs - Codes and Standards Division formed a 30-member Rehabilitation Subcode Committee under the guidance of the Center for Urban Policy Research at Rutgers University [NJ CODE]. This committee worked over a period of two years starting in 1995 and releasing the first complete draft of the rehabilitation subcode for public hearing in 1997. The rehabilitation subcode was finally approved and adopted throughout the state in January 1998. This became the nation's first individual rehabilitation.

The core concept of the rehabilitation subcode was to designate the compliance requirements for rehabilitation of existing buildings based on the nature of the work instead of cost of the work to be executed. The compliance requirements of existing buildings are entirely different from the requirements of new construction, which caused the rehabilitation code committee to formulate four different sets of compliance requirements for works related to existing buildings [Connolly 1999]. The four sets of requirements categorized by the rehabilitation code are:

- Materials and methods
- New building elements
- Basic requirements
- Supplemental requirements

These five sets of requirements form the skeleton of the rehabilitation project and determines the compliance standards of the work to be executed.

3.3.1 Materials and Methods: The materials used in new construction and the methods adopted for executing particular work in new construction are very different from the ones used many years ago. The new rehabilitation code specifies the material requirements and explains how to use the materials for the selected project. The scoping requirements (provisions that define what must be done for compliance) that model codes adopted for new buildings were revised, developing new material and method requirements for rehabilitation projects. These requirements were developed considering the standards and materials used in the late 1800's and the early 1900's for construction. For example, the fire protection systems that are required as per the regular code use advanced materials and methods. Changing the materials and methods to those used in new buildings will impose very high rehabilitation costs. This problem is addressed in the requirement section of the rehabilitation code.

3.3.2 New Building Elements: Any new building element that is added to the existing building as a part of the rehabilitation project shall comply with the requirements of the new construction without affecting the existing building elements. Examples of new building elements defined in this section of the code are new corridors, installation of a new floor system which did not previously exist, new additional stories put up without increasing the height of the building, new floor openings, new door openings, newly created exit stairways, fire escapes, newly constructed mezzanines, new stages and platforms, newly installed electrical service equipments, and new window openings.

3.3.3 Basic requirements: These are the most fundamental scoping requirements, which are essential as health and safety standards. The basic requirements are only imposed on the areas of the project that are under rehabilitation, which is very different from traditional practices. Some of the important parts of a rehabilitation project covered under these basic requirements are:

1. ***No. of Exits***: Exit requirements for a defined story level and occupant load in an existing building in the presence of the existing exits and newly planned exits.

2. ***Egress Doorways***: Minimum number of egress doorways required for a given number of rooms for a specified occupant load and a particular travel distance from the farthest point in the building to the nearest exit.

3. ***Capacity of Means of Egress:*** Determination of the minimum and allowable capacity of the means of egress for the given occupant load in a building to serve emergency exit needs.

4. ***Dead End Corridors:*** Length and dimension requirements of the existing dead ends and corridors.

5. ***Means of Egress Lighting:*** Artificial lighting requirements in the means of egress path with specifications on intensity of the light and the spacing of the lighting elements. The requirements also specify the need for electrical system compliance with the National Electrical Code (NEC) NFPA 70.

6. ***Illuminated Exit Signs:*** Illuminated exit signs required for all means of egress, rooms and spaces leading to exits. Requirements of exit sign visibility and supplemental directional signs when necessary are covered in this section.

7. ***Handrails:*** Stairways having three or more risers which are not provided with handrails or have existing handrails that are in danger of collapsing when used for

emergency must be supplied with handrails complying with the requirements of this section.

8. ***Guards:*** Guard requirements exist for every portion of a stair, landing or balcony which is more than 30 inches above the floor grade, including new provisions and existing areas which have guards in danger of collapsing when used in emergency conditions.

9. ***Vertical Opening:*** Vertical opening protection in the interior stairways and the openings connecting different floor levels.

10. ***Structural Elements:*** Compliance requirements for structural elements that are uncovered during the course of rehabilitation and found to be unsound or otherwise structurally deficient. The load carrying capacity and deflection allowed are specified in these requirements.

11. ***Plumbing Fixtures:*** Requirements for the substitution or omission of fixtures as specified in the plumbing code, such as water closets, lavatories, drinking water facilities, and service sinks, based on the total serving occupancy load.

12. ***Mechanical Requirements:*** Need for either natural or mechanical ventilation systems in the existing building. Natural ventilation includes provision of openable doors, windows, louvers, and other openings in the building with

requirements specifying minimum openable area with respect to the floor area being ventilated. Mechanical ventilation includes provision of HVAC systems with minimum Cubic Feet per Minute (CFM) of ventilation air per person.

13. ***Interior Finishes:*** Flame spread rating requirements for existing interior finishes of walls and ceilings. Materials permitted for interior finishes and treatment procedures for the existing materials to secure compliance with code requirements are detailed in this section.

14. ***Specific occupancy areas:*** Specific occupancy areas such as paint shops that contain chemicals, incinerator rooms, physical plant maintenance shops, and laundries in excess of 10 square feet in area shall comply with the requirements specified in this section.

3.3.4 Supplemental Requirements: Supplemental requirements are the additional work scoping requirements that are essential to meet health and safety standards in any building in which the work area exceeds a certain size. Each supplemental requirement is designated with its own threshold values dependent upon the existing building under rehabilitation. These requirements are developed as an alternative to the 50% and above characteristics of the percentage value approach to building rehabilitation.

1. ***Automatic Fire Suppression System:*** Installation of an automatic fire suppression system throughout the building for the work area exceeding the threshold work area limit (gross enclosed floor area) is required.

2. ***Automatic Alarm Systems:*** When the work area exceeds a certain percentage of the gross enclosed floor area of the building, installation of an automatic fire alarm system that complies with NFPA 72 is required in the area under rehabilitation. The percentages are calculated for each occupancy.

3. ***Manual Alarm Systems:*** Based on the number of stories, work area percentage and occupant load, manual alarm systems are made essential as per the requirements imposed for each occupancy group.

4. ***Vertical Opening Protection:*** When the work area exceeds 50 percent of the gross enclosed floor area of the building, vertical opening protection requirements are enforced and are assigned based on occupancy group.

5. ***Requirements for High-Rise Buildings:*** Any building or structure having one or more floors used for human occupancy located either more than six stories or more than 75 feet above the lowest level accessible to a fire department vehicle is designated as a high rise building. If rehabilitation works in existing high rise buildings are more than a specified percentage of the total work area, then the supplemental requirements such as approved smoke control or smoke removal

systems, emergency control devices in elevators and others are necessitated as per the condition of the existing high-rise structure.

The fourteen basic requirements and five supplemental requirements detailed above are formulated in the new rehabilitation code based on the lessons learned by the expert committee studying various constraints that exist in the work related to the existing buildings. Each of these basic and supplemental requirements is explained in detail for all the ten groups of buildings (as shown in Table 7) classified based on the occupancy type and use. One of the occupancy groups is chosen for discussion of all the above-mentioned requirements with suitable examples for better understanding.

3.3.5 CATEGORIES OF WORK DEFINED BASED ON SCOPE OF REHABILITATION

Before the rehabilitation subcode's formation, all rehabilitation projects fell into three categories: minor alterations, major additions and change of occupancy. The scope of each category of work was defined by the 25/50 rule. The rehabilitation subcode committee's first successful effort was to define the scope of rehabilitation work in existing buildings more clearly and categorize the work into smaller, more detailed units that are easier to understand and use. The six major categories of rehabilitation work as categorized by the New Jersey Rehabilitation Subcode are:

Table 7: CLASSIFICATION OF BUILDINGS BASED ON OCCUPANCY

S.No	Type of Classification GROUP	Sub Group Classification	Intended Use	Examples
1	Assembly Group **A**	A-1 to A-5	Use of a building for the gathering together of persons for purposes such as civic, social or religious functions, recreation, food or drink consumption or awaiting transportation.	• Churches • Community halls • Courtrooms • Performance Theaters Restaurants
2	Business Group **B**	NIL	Use for office, professional or service-type transactions, including storage of records and accounts.	• Air traffic control tower • Animal hospitals • Banks • Post offices
3	Educational Group **E**	NIL	Use by six or more persons at any one time for educational purposes through the 12th grade.	• Schools • Day Care
4	Factory Industrial Group **F**	F-1 and F-2	Use for assembling, fabricating, finishing, manufacturing, and packaging, operations that are not classified as a Group H hazardous occupancy.	• Foundries • Glass products • Gypsum • Metal products

5	Hazardous Group **H**	H-1 to H-5	Use that involves the manufacturing, processing, generation or storage of materials that constitute a physical or health hazard in quantities in excess of those permissible.	• Cryogenic liquids • Flammable gases • Explosives • Organic peroxides • Toxic materials
6	Institutional Group **I**	I-1 to I-4	Use in which people having physical limitations because of health or age are harbored for medical treatment or other care or treatment, or in which people are detained for penal or correctional purposes or in which the liberty of the occupants is restricted.	• Hospitals • Old age homes • Child care facilities Alcohol and drug centers • Prisons and jails
7	Mercantile Group **M**	NIL	Use for the display and sale of merchandise, and involves stocks of goods, wares or merchandise	• Department stores • Drug stores • Markets - Sales rooms
8	Residential Group **R**	R- 1	Occupants are primarily transient in nature (less than 30 days)	• Boarding houses transient • Hotels
		R-2	Occupancies containing more than 2 dwelling units where the occupants are primarily permanent in nature	• Apartment houses • Dormitories • Fraternities
		R-3 and R-4	Occupants are primarily permanent in nature and not classified as R-1, R-2	• Assisted Living
9	Storage Group **S**	S-1 and S-2	Used for storage that is not classified as a hazardous occupancy.	• Storage areas
10	Utility Group **U**	U-1	Used for utility Purposes and maintenance	• Maintenance room

- Repair
- Renovation
- Alteration
- Reconstruction
- **Change of use**
- **Additions**

} **REHABILITATION** (Repair, Renovation, Alteration, Reconstruction)

In general, the six categories of work can be grouped into three divisions: r***ehabilitation, change of use*** and ***additions.*** The first task in any rehabilitation project is to define the work as one or more of the above categories and then follow the basic and supplemental compliance requirements for each category as defined in the rehabilitation subcode. For better understanding of the categories of work, the following definitions are adopted from the New Jersey Rehabilitation Subcode:

Rehabilitation as defined by the subcode is the process that comprises repairs, renovations, alterations and reconstruction depending upon the condition of the existing building under consideration. These four categories of rehabilitation are defined in the rehabilitation subcode [NJ CODE] as follows:

REPAIRS: Repair is the restoration to a good or sound condition of materials, systems and/or components that are worn, deteriorated or broken, using materials or components identical to or closely similar to the existing.

RENOVATION: Renovation is the removal and replacement or covering of existing interior or exterior finish, trim, doors, windows, or other materials with new materials that serve the same purpose and do not change the configuration of space. Renovation shall include the replacement of equipment or fixtures.

ALTERATION: Alteration is the rearrangement of any space by the construction of walls or partitions or by a change in ceiling height, the addition or elimination of any door or window, the extension or rearrangement of any system, the installation of any additional equipment or fixtures and any work which reduces the load bearing capacity of or which imposes additional loads on a primary structural component.

RECONSTRUCTION: Reconstruction is any project for which the extent and nature of the work is such that the work area cannot be occupied while the work is in progress and for which a new certificate of occupancy is required before the work area can be reoccupied. Reconstruction may include repair, renovation, alteration or any combination thereof. Reconstruction shall not include projects comprised only of floor finish replacement, painting or wallpapering, or the replacement of equipment or furnishings. Asbestos hazard abatement and lead hazard abatement projects shall not be classified as reconstruction solely because occupancy of the work area is not permitted.

3.3.5.1 REPAIRS

Repairs of existing buildings should not cause any diminution of existing structural strength, system capacity, and existing mechanical ventilation. For the works in this category, new introduced fixed loads should not exceed the load criteria as defined by the standard building code. For better understanding, some of the works that are considered renovation, alteration, and or reconstruction and do not fall into the category of repairs are given below [NJ CODE]:

- The cutting away of any wall, partition, or portion thereof;
- The permanent, partial or complete removal of any primary structural component;
- The removal or rearrangement of any part of a required means of egress;
- Addition to, alteration or relocation of:
    (1) Any fire protection system piping;
    (2) Water supply, sewer, drainage, gas, oil, waste, vent, or similar piping;
    (3) Electrical wiring, other than wiring for a low voltage communication system in a one or two family dwelling;
    (4) Mechanical system components such as ductwork; or
    (5) Elevator devices.

The products and practices that are not allowed as per the rehabilitation code are detailed in a manner so as to avoid confusion of the materials and methods to be used. For example, in repair works of potable water systems in existing buildings, solder having more than 0.2% of lead may not be used. Similarly, existing electrical materials and supplies in a building can be used for repair works provided they are approved by the standard testing laboratories for safety issues. Existing systems and materials in the building are accepted by the new code provided they are accepted as per the national standards as defined by the rehabilitation subcode.

3.3.5.2 RENOVATIONS

Unlike repairs, renovations facilitate the replacement of materials in the existing building to a certain level to restore the building for improved use without reconfiguring the existing space. Renovation works include replacement of interior finish materials and replacement of worn out doors and windows. For example, in renovation works, windows may be replaced with windows like those existing without meeting the size requirements of the building subcode. In an example where the size of window openings is being changed, as per the rehabilitation code at least one window shall:

- Be openable;
- Have a sill height of not more than 44 inches;
- Have a width of at least 20 inches, a height of at least 24 inches with a minimum total area of 5.7 square feet measured from head to sill.

Exception: New window openings in sleeping rooms shall not be required to meet these requirements in buildings where the sleeping room is provided with a door to a corridor having access to two remote exits or in buildings equipped throughout with an automatic fire suppression system.

3.3.5.3 ALTERATIONS

While working on a rehabilitation project, if there is a need to reconfigure the existing space in any part of the building to suit changed needs or to improve the existing configuration, then the work is categorized as alteration. The requirements (both basic and supplemental) for works related to alterations are higher than those for repair and renovation.

Similar to repair and renovation, alteration work should not cause any diminution of existing structural strength, system capacity or mechanical ventilation. The replacement or addition of fixtures, equipment or appliances should not increase loads on the existing systems unless the system is upgraded in accordance with the applicable Uniform Construction Code (UCC) subcode to accommodate the increased load. During alteration works, the existing fire alarm, fire suppression and standpipe systems should not be removed without replacement and these systems should be maintained as per the requirements specified in the rehabilitation code. Some of the factors in an existing building that are affected by alterations should comply to the requirements put forth in the rehabilitation code.

For example, n an existing building where the existing space is altered, an accessible path of travel to the altered space should be provided up to the point at which the cost of providing accessibility is disproportionate to the cost of the overall alteration (a cost is considered disproportionate if it exceeds 20% of the cost of the alteration work). The accessible path of travel should include an accessible parking space, an accessible exterior route, an accessible building entrance, an accessible interior route to the altered area, accessible restrooms, accessible drinking fountains, and accessible telephones serving the altered primary function space. Under primary circumstances, priority should be given to providing an accessible entrance or accessible restrooms where possible.

3.3.5.4 RECONSTRUCTION

In a rehabilitation project, if the work performed or to be performed in phases is so extensive that the project would require a new certificate of occupancy, and if the work were performed at one time, then as per the rehabilitation subcode, the construction official has the right to designate the project a reconstruction project. The structure should comply with the requirements (basic and supplemental) of the reconstruction section of the rehabilitation code for the respective occupancy classification.

Generally, a reconstruction-type rehabilitation project involves extensive work on facets of the interior of a building such as doors, windows, electrical receptacles, floor coverings, plumbing materials, water closets, bathrooms or toilet rooms, room fixtures, entrance steps into the building, vertical access (elevators or platform lifts), existing appliances and their circuits, handrails and guardrails at the means of egress and vertical openings, mechanical and electrical systems, and changes in the permissible dimensions of building elements such as corridor width, egress width, the longest path of travel to egress and others.

The primary responsibility of code officials or building owners is to clearly define a rehabilitation project into one of the above-explained four categories. Once the right category of work has been chosen, the requirements for code compliance are detailed as per the respective section of the rehabilitation subcode for the structure's corresponding occupancy group. If the owner decides either to change from the existing use or to add more structure to the existing building, the compliance requirements specified by remaining the two categories, change in use and additions, are followed.

3.3.5.5 CHANGE OF USE

Change of use in an existing building usually is based on two parameters: if the occupancy group of the building is changed from one group to the other, or if there is a change in the nature or intensity of the same use group. For example, if a building that was used for an institutional purpose (Group I) such as an hospital or a child care facility is planned to have a change in use to a educational facility (Group E), then the project is designated to have a change in use. Traditionally, all the projects that have a change of use should comply to the code requirements similar to that of a new building irrespective of the type of change made and the magnitude of hazard involved.

This attempt to address the change of use is considered one of the best in the entire rehabilitation subcode's efforts. The rehabilitation code categorizes the occupancy groups into certain hazard levels by assigning numerical values to each group. The relative use group hazard ranges from 1 to 5, where 1 designates the highest hazard level and 5 the lowest hazard level. Also, the rehabilitation code categorizes the occupancy groups with some specific subsections to address the specific requirements raised by that subsection. The subsections for which basic requirements of compliance have been established are: means of egress, enclosure of vertical openings, height and area limitations, exterior wall fire resistance, fire suppression systems, fire alarm systems, fire detection systems, accessibility, structural soundness, and plumbing, electrical, and mechanical systems. Table 8 illustrates the relative use group hazard for the ten occupancy groups.

Table 8: Hazard Category for Occupancy Classification Groups [NJ CODE]

RELATIVE USE GROUP HAZARD	
Relative Hazard	**Occupancy Group**
1 (Highest)	H-1, H-2, H-3
2	A-1, A-2, H-4, F-1, I-3, M, S-1
3	A-3, A-5, B, F-2, I-2, R-1, S-2
4	A-4, E, I-1, R-2 more than two stories in height or more than four dwelling units
5 (Lowest)	R-2 two stories or fewer in height and four dwelling units or fewer, R-3, R-4, U

In general, all the work related to rehabilitation will be based on the relative use group hazard rating of each hazard level. If when the change of use is executed the building remains in the same hazard level or moves to a lower hazard level, then the rehabilitation code specifies the compliance requirements for the change, which are very flexible. When the use of a building is changed to a higher relative use group hazard as shown in Table 8, then the basic requirements of Uniform Construction Code should be applied throughout the building for the new use group, unless otherwise provided. This relative use group hazard is used for determining all compliance requirements, but certain important subsections, as mentioned previously, are further researched and the specific relative hazard values pertaining to that particular subsection (element) were tabulated in the rehabilitation code. For all work related to m***eans of egress*** in a change of use rehabilitation project, the relative hazard value for the corresponding occupancy group is specified by the specific relative hazard table, Table 9, and all the work executed related to means of egress must comply to the code specifications for a respective change in the hazard category.

Table 9: Hazard Category for Subsection MEANS OF EGRESS [NJ CODE]

MEANS OF EGRESS HAZARD CATEGORIES AND CLASSIFICATIONS	
Relative Hazard	**Occupancy Group**
1 (Highest)	H-1, H-2, H-3
2	I-2, I-3
3	A, E, I-1, M, R-1, R-2
4	B, F-1, R-3, R-4, S-1, H-4
5 (Lowest)	F-2, S-2, U

For example, when a change of use to a higher hazard category is made as shown in Table 9, vertical opening protection should be provided for all stairs that are part of a required means of egress serving the proposed floor of work all the levels of exit discharge. Some of the elements of the buildings are made essential as a part of means of egress when the change in use to higher hazard is made. For example, when a change of use is made to any residential use group (R-1, R-2, R-3 or R-4) or to use group I-1, every sleeping room below the fourth story should have at least one openable window or exterior door that can serve as an means of egress in case of emergency. Table 10 illustrates the relative hazard category developed based on the height and area limitations in a rehabilitation project involving change of use.

Table 10: Hazard Category for Subsection HEIGHT AND AREA [NJ CODE]

HEIGHT AND AREA LIMITATIONS HAZARD CATEGORIES AND CLASSIFICATIONS	
Relative Hazard	**Occupancy Group**
1 (Highest)	A-2, H-1, H-2, I-2, I-3
2	A-1, A-3, E, F-1, H-3, H-4, M, I-1, S-1
3	A-4, B, R-1, R-2
4 (Lowest)	F-2, R-3, R-4, S-2, U

3.3.5.6 ADDITION

Any additional structure built to the existing structure changing the overall building area and dimensions (height, width, frontage etc.) must comply with the requirements imposed by this section of the rehabilitation subcode as similar to new buildings, while changes caused in the existing structure because of this addition are addressed by the aforementioned rehabilitation code work categories (such as repair, renovation, alteration, and reconstruction). Based on the magnitude of the addition being constructed, it is essential to identify the work category under which the existing structure is rehabilitated to suit the new addition. The compliance requirements for the identifified work category are then followed for rehabilitation.

Some of the primary criteria set forth by the rehabilitation code address change in overall height and area of the existing structure due to the addition. No addition shall increase the height of an existing building beyond that permitted under the applicable provisions of the building subcode for a new building of the same use group. Also, no addition shall increase the area of an existing building beyond that permitted under the applicable provisions of the building subcode unless a fire wall is provided in accordance with fire protection requirements of the building subcode. The new rehabilitation subcode offers some interesting exceptions to these requirements in certain groups of occupancy.

For example, existing one and two story buildings may be expanded beyond what is permitted by the local building code / regulations by up to 25% of the existing floor area without providing fire separation. This exception may be applied only once in the life of the building or may be used in increments that total not more than 25% over the life of the building.

3.3.6 ACTUAL PROCESS OF USING THE REHABILITATION SUBCODE

In any rehabilitation project using the new rehabilitation code, the primary task is to designate the building under consideration within one of the six categories of rehabilitation (***repair, renovation, alteration, reconstruction, change of use*** and ***addition***). Once the category of work is identified, the compliance requirements, both ***basic*** and ***supplemental,*** are detailed for the intended scope. Based on these requirements, the detailed scope (specifications) for rehabilitation are prepared. This process reduces factors of uncertainty by clearly defining the scope of work in the intended work area.

To facilitate better understanding of the rehabilitation code provisions, the author explains the ***basic requirements*** for a particular occupancy group and for a defined work category. As an example, let us assume we are rehabilitating a old office building which was traditionally used for professional services. This building is classified under the occupancy group B. Based on the existing conditions, it is assumed that building rehabilitation work is categorized as alteration. For this defined scope, a complete set of basic requirements as per the rehabilitation code compliance requirements is detailed in tabular format in the next section. For each of the basic requirements, the corresponding exceptions and suitable examples are provided for better understanding.

BASIC REQUIREMENTS (For Occupancy Group "B")	Exceptions Allowed (With examples)
(a) Exits: • Two exits shall be required for stories with less than 500 occupants. • Three exits shall be required for stories with 501 to 1,000 occupants. • Four exits shall be required for stories with more than 1,000 occupants. • Two means of egress are also required from all mezzanines with an occupant load greater than 50 and with exit travel distance greater than 75 feet.	**Exceptions Permitted:** 1. When more than one exit is required, existing fire escapes shall be accepted as Providing one of the required means of egress unless judged to be dangerous for use under emergency exiting conditions. For use of fire escapes, access shall be through a door except when serving an occupant load of 10 or fewer. All occupants shall have unobstructed access to fire escapes without having to pass through a room subject to locking. i. When more than one exit is required and there is not sufficient space for an exterior stair within the lot line, a new fire escape shall be accepted as providing one of the required means of egress. 2. A single exit is permitted in the story at the level of exit discharge when the occupant load of the story does not exceed 50 and the exit access travel distance does not exceed 75 feet. 3. A single exit shall be permitted in buildings of not more than two stories in height, with not more than 3,000 square

	feet per floor when the exit access travel distance does not exceed 75 feet and a minimum fire resistance rating of one hour is provided for the exit enclosure and the opening protection.
(b) **Egress Doorways:** • A minimum of two egress doorways shall be required for all rooms and spaces with an occupant load greater than 50 or in which the travel distance exceeds 75 feet. • All egress doors serving an occupant load greater than 50 shall swing in the direction of exit travel.	**Example:** The existing one egress doorway is accepted if the automatic sprinkler system is installed in the building. This system helps to retards the rate or slower the rate of spread of fire and under this provision one egress doorway is permitted for occupant load greater than 50 or in which the travel distance exceeds 75 feet. **Exception:** Storage rooms with a maximum occupant load of 10 shall not be required to have two egress doorways.
(c) **Capacity of Means of Egress:** • The capacity of the means of egress in each work area shall be determined in accordance with Table 1 in Section 6.11(b) of the New Jersey rehab Code (Page 40).	**Example:** In a class B building, the egress capacity is validated based on the number of occupants it is serving. This varies with building with and without fire suppression system. In case of egress stairways for every 60 occupants, a unit of egress width (22 inches) should be provided. If there is a fire suppression system, then the for same width 90 occupants can be served.

(d) Dead End Corridors: Existing dead end corridors shall not exceed 35 feet in length.	**Exceptions are allowed as follows:** 1. Dead end corridors may be up to 50 feet in length in a building with an automatic alarm system installed in conformance with the building code in effect at the time of its installation. 2. Dead end corridors may be up to 70 feet in length in a building with a suppression system installed in conformance with the building code in effect at the time of its installation. **Example:** Assume in a building that was built before 50 years, the dead end corridors were built with a length of 45 feet. However, as per the regular code this need to be demolished and rebuild costing huge amounts. Whereas the new code permits this to be set at 50 feet if a automatic alarm system is installed. This is a major benefit in the rehab code.
(e) Means of Egress Lighting: • Artificial lighting with an intensity of not less than one foot candle at floor level shall be required during all times that the conditions of occupancy of the building require	**Example:** Most of the existing buildings does not meet the lighting standards required in the means egress such as the stairways, corridors, closed passages serving as means of egress. The requirement for

that the exits be available. • In all buildings, rooms or spaces required to have more than one exit or exit access, means of egress lighting shall be connected to an emergency electrical system conforming to NFPA 70 (NEC) to assure continued illumination for not less than one hour in the case of primary power loss.	providing proper lighting for the means of egress is necessitated in this subsection of the rehabilitation code. Number and location of lighting are determined based on the dimensions of the egress (width, length) and also the serving occupant load.
(f) Illuminated Exit Signs: Illuminated exit signs shall be provided for all required means of egress in all buildings, rooms or spaces required to have more than one exit or exit access. Exit signs shall be visible from the exit access and supplemented by directional signs when necessary.	**Exception:** Approved main exterior doors that are clearly identified as exits are not required to have exit signs. Exit signs shall meet the following criteria: 1. Red or green letters at least six inches high; minimum width of each stroke 3/4 Inch on a white background or in other approved distinguishable colors. Arrows, if provided, shall be such that the direction cannot readily be changed. The word "Exit" shall be clearly discernible when the sign is not energized. 2. Exit signs shall be illuminated at all times when the building is occupied by a

	source providing at least five foot candles at the illuminated surface or shall be approved self luminous signs which provide evenly illuminated letters with a minimum luminance of 0.06 foot
(g) Handrails: Every required exit stairway having three or more risers and not provided with handrails or in which the existing handrails are in danger of collapsing when used under emergency exiting conditions, shall be provided with handrails for the full length of the run of steps on at least one side. All exit stairways more than 66 inches wide shall have handrails on both sides unless the full width of the stairway is not needed to accommodate the design occupancy.	**Example:** In old group B buildings handrail provisions are not standard and in few cases the geometric design doesn't permit Safer handrails. These complications must be resolved with the provisions of this section based on the stairway dimensions and occupant load served by the stairway
(h) Guards: Every open portion of a stair, landing or balcony which is more than 30 inches above the floor or grade below and is not provided with guards or those in which the existing guards are in danger of collapsing when used	**Example:** In earlier rehabilitation cases, based on the regular building code, if the guards are not of the safety standards as per the code then the entire stairway rehabilitation is affected. In some cases, it is up to the magnitude of removing and replacing the

under emergency exiting conditions, shall be provided with guards.	existing egress with new one. With the provisions in rehab code, the guards can be replaced with similar materials complying with the safety standards of the regular building code.
(i) Vertical Opening Protection: Vertical opening protection for interior stairways and other vertical openings should be provided in the existing structure.	**Compliance Requirements:** 1. For vertical openings connecting more than six floor levels, approved assemblies having a fire resistance rating of not less than two hours with approved opening protectives shall be required. 2. For vertical openings connecting four to six floor levels, approved assemblies having a fire resistance rating of not less than one hour with approved opening protectives shall be required. 3. For vertical openings not exceeding three stories, a minimum 30 minute fire barrier shall be required, with the following exception: i. No vertical opening protection shall be required for vertical openings of up to three stories in buildings not exceeding 3,000 square feet per floor or in buildings with suppression throughout.

(j) Structural Elements: Structural elements which are uncovered during the course of the rehabilitation and which are found to be unsound or otherwise structurally deficient, shall be reinforced, supported or replaced in accordance with the applicable structural design criteria of the building subcode.	**Exception:** Where structural elements are sound, there is no excessive deflection {defined as deflection in excess of the standards set forth in section 6.7(c).}, and fixed loads are not changing in a way that will increase the stresses on existing structures beyond that which is permitted by 6.7(c), existing structural elements shall be permitted to remain.
(k) Plumbing Fixtures: Plumbing fixtures shall be provided as per the plumbing code, where the plumbing subcode allows for the substitution or omission of fixtures. Such substitutions or omissions shall also be permitted under this section in compliance with the Plumbing Code.	**Example:** In a class B building plumbing fixtures will be provided based on *Total Occupancy.* For determining the plumbing fixture requirements, total occupancy calculated for the building under normal use conditions and based on this calculation, fixtures such as water closets (Unisex, male and female), lavatories, drinking water facilities, and service sinks, are determined.
(l) Mechanical Requirements: All spaces intended for occupancy shall be provided with either natural or mechanical ventilation.	**Example:** For Natural ventilation: • Spaces intended to be naturally ventilated shall be provided with openable doors, windows, louvers,

	or other openings to the outdoors. • The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated. • The rooms without openings to the outdoors are ventilated through an adjoining room, the unobstructed opening to the adjoining room shall be at least 8 percent of the floor area of the interior room or space, but not less than 25 square feet. • The ventilation openings to the outdoors shall be based on the total floor area being ventilated. <u>For Mechanical ventilation:</u> • Newly installed HVAC systems shall comply with the requirements of ASHRAE 62-89. • Existing systems that are altered or extended shall not reduce the amount of outside air below the existing rate per person or the rate included in ASHRAE 62-89, whichever is lower. • As a minimum, mechanically ventilated spaces shall be provided

	with 5 CFM per person of outdoor air and 15 CFM of mechanical ventilation air per person
(m) Interior finishes Interior finishes shall comply with flame spread ratings determined by ASTM E84 into three classes such as: • Class I Flame Spread – 0 to 25 • Class II Flame Spread – 26 to 75 • Class II Flame Spread – 76 to 200 In all of the above three classes, the Smoke developed rating determined by ASTM E84 should not exceed 450. The specifications of the materials used in the interior finishes contain these test values.	**Example:** The interior finish materials used in old buildings in the work area defined for rehabilitation shall comply to the flame spread ratings and for new finishes that are added in the work area, the flame spread ratings are usually kept in the class I and II unless the existing condition forces to use a Class III material.
(n) Specific Occupancy Areas: Specific occupancy areas within the work area, as listed in Section 6.30(h) {paint shops, soiled linen collection rooms, incinerator rooms, maintenance shops), shall comply with the requirements established this section of specific occupancy areas.	**Example:** If there is an incinerator room present in the building, then a two-hour fire separation assembly should separate it from other portions of the building and also it should be provided with an automatic sprinkler and/ or fire suppression system.

3.4 PROVISIONS OF INTERNATIONAL BUILDING CODE – CHAPTER 34

The ICC developed the IBC, used by many different states and local governments for any new construction. Based on the need felt and identified in many states and cities for work related in existing buildings, rehabilitation, a separate chapter was introduced in the IBC 2000 named "Chapter 34 – Existing Structures." The provisions of this chapter were intended to address the four major work categories in the rehabilitation process: alteration, repair, addition and change of occupancy.

This rehabilitation work was made to comply with the provisions for alterations, repairs, additions and changes of occupancy in the International Fire Code, International Fuel Gas Code, International Plumbing Code, International Property Maintenance Code, International Private Sewage Disposal Code, International Mechanical Code, International Residential Code and ICC Electrical Code leaving very little room for flexibility. This forced rehabilitation of existing structures to comply with code requirements similar to those for new construction. Chapter 34 of the IBC addressed existing structure issues similar to those addressed by the New Jersey Rehabilitation Code: *additions, alterations or repairs, fire escapes, glass replacement, change of occupancy, historic buildings, moved structures, and accessibility.* As the provisions detailed in Chapter 34 of the IBC were very similar to the provisions for new buildings, the ICC formed a Rehabilitation Subcode Committee, which lead to the development of the International Existing Building Code final draft in 2001 and its complete adoption in 2003.

3.5 INTERNATIONAL EXISTING BUILDING CODE (IEBC)

The ICC developed the IEBC with the knowledge gained from the New Jersey Rehabilitation Subcode and the Nationally Applicable Recommended Rehabilitation Provisions (NARRP). The concepts adopted in the International Existing Building Code are quite similar to that of the New Jersey Rehabilitation Subcode, except the organization, the categorization of the work scope and the definitions given to the rehabilitation work categories. The categories of rehabilitation formulated by the New Jersey Rehabilitation Subcode were repair, renovation, alteration, reconstruction, change of use and addition. The work categories defined by the International Existing Building Code (IEBC) are as follows:

- Repair
- ***Alteration - Level 1***
- ***Alteration – Level 2***
- ***Alteration - Level 3***
- Change of occupancy
- Addition

(Repair and Alteration Levels 1–3: **REHABILITATION**)

Even though the terms coined by the IEBC for the rehabilitation categories sound different, the scope of work defined by them is very similar to that of the New Jersey Rehabilitation Subcode. Instead of renovation and reconstruction, the IEBC expanded alteration into three levels based on the intent of work to be performed and the level of applicability of code regulations:

Alteration Level 1: Level 1 alterations include the removal and replacement or the covering of existing materials, elements, equipment or fixtures using new materials, elements, equipment or fixtures that serve the same purpose.

Alteration Level 2: Level 2 alterations include the reconfiguration of space, the addition or elimination of any door or window, the reconfiguration or extension of any system, or the installation of any additional equipment.

Alteration Level 3: Level 3 alterations apply where the work area exceeds 50% of the aggregate area of the building

3.5.1 ORGANIZATION OF WORK CATEGORIES IN THE IEBC

The IEBC committee developed fourteen chapters addressing the general issues and classification of rehabilitation work based on the scope as categorized below:

- Chapters 1 and 2: ***Administration and Definitions***
- Chapter 3: ***Classification of Work***
- Chapter 4: ***Repairs***
- Chapter 5: ***Alterations – Level 1***
- Chapter 6: ***Alterations – Level 2***
- Chapter 7: ***Alterations – Level 3***
- Chapter 8: ***Change of Occupancy***
- Chapter 9: ***Additions***
- Chapter 10: ***Historic Buildings***
- Chapter 11: ***Relocated Buildings***

Chapter 4 to 11
CLASSIFICATION OF REHAB WORK

- Chapter 12: ***Compliance Alternatives***
- Chapter 13: ***Construction Safeguards***
- Chapter 14: ***Referenced Standards***

Similar to the New Jersey rehabilitation code, first a project is to be identified and designated as one of the rehabilitation work categories based on the existing condition and the future scope of the building. Once the work category is identified, the compliance requirements of the project are then defined pertaining to that particular work category (chapter), which is used to detail the scope of rehabilitation based on the intent and extent of work involved rather than the traditional cost based percentage value or benchmarking approach. Each work category, herein also referred to as a "chapter," is then divided into various subsections addressing various critical rehabilitation factors such as ***heights and areas, special use and occupancy, building elements and materials, fire protection, means of egress, accessibility, structural, electrical, mechanical, plumbing, energy conservation, and other requirements.*** Depending upon the work category, each of the above factors is further detailed for compliance requirements. These requirements are developed specifically to address the rehabilitation needs of the existing structure, which differentiate them from the requirements for a new building.

Table 11 shows the list of critical issues addressed in each work category. Subsections in each work category vary dependent on the scope of work to be executed once the existing building is identified as a specific category. The subsections are similar to the issues addressed under the b***asic*** and s***upplemental requirements*** in the New Jersey Rehabilitation Subcode.

Table 11: CLASSIFICATION OF REHABILITATION WORK AND ISSUES ADDRESSED IN EXISTING STRUCTURES [IEBC 2001]

Work Category	**Subsections - Issues Addressed**
Repairs	Special Use & Occupancy, Building Elements & Materials, Fire Protection, Means of Egress, Accessibility, Structural, Electrical, Mechanical, and Plumbing
Alteration – Level 1	Special Use & Occupancy, Building Elements & Materials, Fire Protection, Means of Egress, Accessibility, & Structural
Alteration – Level 2	Special Use and Occupancy, Building Elements and Materials, Fire Protection, Means of Egress, Accessibility, Structural, Electrical, Mechanical, and Plumbing
Alteration – Level 3	Special Use and Occupancy, Building Elements & Materials, Fire Protection, Means of Egress, Accessibility, & Structural.
Change of Occupancy	Special Use and Occupancy, Building Elements and Materials, Fire Protection, Means of Egress, Accessibility, Structural, Electrical, Mechanical, Plumbing, Change of Occupancy Classification.
Additions	Heights and Areas, Structural, Smoke Alarms, Accessibility, and Energy Conservation
Historic Buildings	***Repairs***, Fire Safety, ***Change of Occupancy, Alterations,*** Structural
Relocated Buildings	General Requirements

3.5.2 COMPLIANCE REQUIREMENTS FOR SUBSECTIONS

The subsections detailed under each work category have specific compliance requirements based on the existing building's characteristics. These requirements vary from building to building depending on the building's condition, existing materials, its systems' mechanisms and its architectural significance. For better understanding, this section explains these subsections for a general work category.

Heights and Areas: The heights and areas of existing buildings and structures shall comply with the requirements of the rehabilitation code based on the hazard categories defined in the rehabilitation code. For example, if a building is undergoing a change of use to higher hazard category as defined in the rehabilitation code, then height and area requirements need to comply with the regular International Building Code. If the change is made to an equal or a lesser hazard category, then the allowable heights and areas of the rehabilitation is detailed in the rehabilitation code.

Special Use and Occupancy: Any special use and occupancy building other than the standard classification should comply to the requirements specified in the International Building Code. The degree of compliance is dependent on the category of rehabilitation. In other words, compliance requirements are more severe for higher categories of work such as Alteration Level 3 (additions) when compared to the lower categories such as repair or Alteration Level 1.

Building Elements and Materials: Materials in the existing building that are permitted during rehabilitation are specified in this subsection. For example, hazardous materials such as asbestos and lead-based paints are no longer permitted in the rehabilitation process, while existing old glass block walls, louvered (an opening provided with one or more slanted fixed or movable fins to allow flow of air but to exclude rain or sun or to provide privacy) windows and jalousies (adjustable glass louvers) can be repaired with similar materials even though they are not permitted as per the regular building code.

Fire Protection: Compliance requirements for the fire protection systems that exist in the building such as automatic sprinkler systems, fire suppression systems, fire alarm systems, smoke detection systems, fire escapes, standpipes, and the Fire Resistance Rating (FRR) of various building elements such as partition walls, vertical shafts, egress walls, etc. are detailed in this subsection for different work categories.

Means of Egress: Existing buildings' means of egress requirements, such as number of exits, number of fire escapes, egress requirements at mezzanines, egress doorways (location, travel distance, door swing, door closing, panic hardware), openings in corridor walls (corridor doors, transoms [horizontal crossbar in a window, over a door, or between a door and a window], wall widths), dead end corridors, means of egress lighting, and exit signs, are defined for each category of rehabilitation work.

For example, as per the building code, dead end corridors in any work area shall not exceed 345 feet in length. The new requirements for existing buildings permit dead end corridors to be 50 feet and 70 feet for specific occupancy groups. Greater lengths are accepted with the provision of automatic fire alarm systems in the existing structure.

Accessibility: Accessibility requirements such as elevators, platform (wheelchair) lifts, stairs, escalators, ramps, dining areas, performance areas, assembly areas, toilet rooms, sales and service counters, and the maximum height of thresholds at the doorways are addressed in this subsection based on the work category identified. As most of the existing buildings are 50 years old or more, the accessibility compliance requirements are relatively more stringent than other subsections in this rehabilitation code.

Structural: Rehabilitation work should be performed on a structure without decreasing the structural strength or the stability of the building. If the existing structural elements are subjected to additional loads, the compliance requirements are set based on the category of work. Important load factors addressed by this subsection include gravity loads, lateral loads, and snow drift loads.

Electrical: In a given work area, the regular building code would require the existing electrical equipments and wiring to be changed, while this requirement is relaxed somewhat in the new rehabilitation code. Correction of existing unsafe electrical connections, required service upgrades of existing systems, and the number of electrical outlets permissible are covered in this subsection. The work categories for which the electrical subsection is defined can be seen in the previous table.

Mechanical: Mechanical requirements such as ventilation systems (both manual and automatic) and local exhaust units and openings (windows, doors, wall openings) must be met to avoid any adverse effect on occupants, including impaired health and discomfort.

Plumbing: This subsection details the minimum number of fixtures that are required in a structure based on the service needed for the defined occupant load. If in a building, the rehabilitation work results in increased or different plumbing fixtures or increased water supply and sewage needs, then the compliance requirements are generally based on the International Plumbing Code and not the rehabilitation code.

Energy Conservation: In rehabilitation projects, if there is any addition to the existing structure then the rehabilitation code requires that the new addition comply with the requirements of the International Energy Conservation Code, as this code is developed only for new construction. Some provisions exist to facilitate existing buildings' compliance with the International Energy Code, but they are not mandatory.

Other Requirements: Some of the requirements addressed by the relocation subcategory include the location of the existing building on the lot in accordance with the code requirements, wind loads, structures in flood hazard areas and inspection requirements.

One of the major differences between the IEBC and the New Jersey Rehabilitation Code is in the change in occupancy section. The New Jersey rehabilitation code categorized the relative hazard levels both for general hazard and for different subsections such as means of egress, height and area limitation, exposure of exterior walls, fire suppression, structural load categories, and ventilation rates. On the other hand, the IEBC has only one three hazard categorization subsections: life and safety exits, heights and areas, and exposure of exterior walls. This reduces the scope of rehabilitation in crucial elements such as fire suppression, structural load categories, and ventilation rates.

Table 12: Hazard Category for Subsection HEIGHT AND AREA [IEBC]

HAZARD CATEGORIES AND CLASSIFICATIONS: LIFE SAFETY AND EXITS	
Relative Hazard	**Occupancy Group**
1 (Highest)	H-1, H-2, H-3, H-4, H-5
2	I-2, I-3, I-4
3	A, E, I-1, M, R-1, R-2, R-4
4	B, F-1, R-3, S-1
5 (Lowest)	F-2, S-2, U

Based on the author's observations, it is found that the relative hazard levels assigned by the IEBC and the New Jersey Rehabilitation Code for the change in occupancy work category are very different. For example, in the hazard category classification for heights and areas in the New Jersey Rehabilitation Code, the occupancy groups business B and residential R-2 are in the same relative hazard level and hence this change in occupancy need not comply to the regular building code, whereas, in the IEBC, the occupancy groups business B and residential R-2 are in two different relative hazard levels. The most critical factor is that the relative hazard level of group B is 4 (lowest hazard) and the relative hazard level of group R-2 is 2 (second highest hazard). In this case, if an existing building of group B is changed for use in group R-2, then the entire change must comply with new construction requirements as per the regular building code for occupancy group R-2. This difference between the New Jersey rehabilitation code and the International Existing Building Code makes the relative hazard classification inconsistent.

Since Michigan is adopting the International Existing Building Code with minor amendments as the Michigan Existing Building Code, all future code analysis is performed with the provisions detailed in the International Existing Building Code.

3.6 MICHIGAN REHABILITATION CODE

Efforts have been under way in Michigan to develop a separate rehabilitation code for work related to existing buildings. The Michigan Department of Consumer and Industry Services (CIS), Division of Codes and Standards formed a Rehabilitation Code Committee chaired by Tom Martin, Director of CIS, Office of Policy and Legislative Affairs, to develop a rehabilitation code. The committee was composed of individuals and experts knowledgeable about rehabilitation issues both nationally and statewide. The committee began its work by looking at the three nationally accepted options for rehabilitation of existing buildings:

- The New Jersey Rehabilitation Subcode
- HUD's Nationally Applicable Recommended Rehabilitation Provisions (NARRP)
- Chapter 34 of the International Building Code (IBC)

Michigan adopted a single statewide code, based on State Public Act 245 of 1999 and known as the Michigan Building Code. This code is a version of the IBC with amendments made to suit Michigan's needs. This expert committee developed a detailed ***Rehabilitation Code Matrix***, which addressed issues pertaining to rehabilitation work in existing buildings using the Michigan Building Code. During the same period, the International Code Council (ICC) was developing the International Existing Building Code (IEBC) which was very similar to but more comprehensive than the rehabilitation code matrix that CIS developed and offered for public hearings. Once the IEBC final draft was published by the ICC, Michigan decided to adopt this code as the Michigan Rehabilitation Code for Existing Buildings, effective on October 31, 2002 [CIS 2002].

The changes that were made to the IEBC to suit the specific needs of Michigan include:

- **Section 104.8** : Liability of code officials
- **Sections 108.2 through 108.6** : Schedule of permit fees, building permit valuations, commencement of work before permit issuance, and related fees

- **Section 112.2** : Limitations on authority
- **Section 112.3** : Qualification of members
- **Section 114.3** : Unlawful continuance
- **Sections 506.1 through 506.2** : Accessibility and alterations affecting an area containing a primary function
- **Sections 1005.1.1 through 1005.1.5 :** Accessibility requirements related to site arrival points, multilevel buildings and facilities, entrances, toilet and bathing facilities and ramps.

A detailed version of the changes and amendments made to IEBC for adoption as the Michigan Existing Building Code can be found in the Appendix section of this report.

3.7 SUMMARY

In this chapter, the author has made an effort to present major changes in the process of rehabilitation over time and the efforts taken to address the growing demand for rehabilitation in United States by development of a separate building code for existing structures. The traditional approaches, such as the Percentage Value method (PV) and the benchmarking methods that were used previously to rehabilitate buildings have also been discussed. Two major rehabilitation codes, the New Jersey Building Rehabilitation

Subcode and the International Existing Building Code, were discussed with explanations and suitable examples from the rehabilitation process. Finally, the Michigan Rehabilitation Code for Existing Buildings has been discussed. This code will be used further for the case study analysis in the next chapter detailing the various rehabilitation benefits offered by the new Michigan rehabilitation code.

BUILDING REHABILITATION: A PROMISING TOOL FOR URBAN REVITALIZATION IN DETROIT, MICHIGAN

Volume II

By

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CHAPTER FOUR

REHABILITATION CASE STUDY IN URBAN MICHIGAN - DETROIT

4.1 INTRODUCTION

In Chapter 3, traditional rehabilitation practices and the new rehabilitation provisions adopted for works related to existing buildings were discussed. In addition, the New Jersey Rehabilitation Subcode and the International Code Council's (ICC), International Existing Building Code (IEBC) were detailed with specific examples. The Michigan Existing Building Code (MEBC), the provisions of which were explained in the previous chapter, will be used for the rehabilitation case study in this chapter.

This chapter attempts to document the downtown Detroit area's stock of existing buildings that are potential candidates for rehabilitation and reuse, and, further, to perform a comprehensive rehabilitation analysis. The rehabilitation analysis discussed in this chapter includes: definition of rehabilitation scope in the selected case study building; formulation of the rehabilitation specifications based on the rehabilitation code analysis; comparison of rehabilitation cost based on a cost analysis using both the Michigan Building Code (MBC) and the MEBC; and finally, tabulation of cost savings for the case study project's rehabilitation process.

As discussed in the research methodology and in the previous chapters, a typical old, vacant and underutilized structure in the downtown Detroit area was selected as a case study building, encompassing all of the earlier discussed social, political, cultural, economical and cost related issues. Of these, the cost factor related to rehabilitation is explored further. The new Michigan Existing Building Code (MEBC), based on the International Code Council's International Existing Building Code (IEBC), is used for this research study. The rehabilitation cost analysis and the results of using the MBC and the MEBC for the case study project are summarized in the forthcoming sections of this chapter. To offer better understanding, an overview of Detroit's urban growth and existing building stock is described below.

4.2 OVERVIEW OF DETROIT AND ITS EXISTING BUILDING STOCK

Detroit is well known as the *"Automobile Capital of the World,"* which grew very fast during the early 1900s due to the high rate of industrialization. Detroit's development can be categorized into seven eras (the first five are excerpts from Fischhoff, 1983):

- ***Birth Era*** : The Village is Born (1701 – 1815)
- ***Early Era*** : The City Emerges (1816 – 1865)
- ***Modern Era*** : Modern Detroit Emerges (1866 – 1900)
- ***Automotive Era*** : The Automotive City (1901 – 1945)
- ***Metropolitan Era*** : The Metropolitan Area (1946 – 1965)
- ***Out Migration Era*** : Wake of the 1967 Riots (1967-1994)
- ***Redevelopment Era*** : Urban Redevelopment (1994 – Present)

The period of the city's development lifecycle between 1901 and 1945 was named the Automotive Era as Henry Ford's Model T automobile rolled off the first moving assembly line in 1915, catapulting Detroit, Michigan, to the international spotlight and declaring Detroit the city of modern industrial production and innovation. The assembly line that revolutionized manufacturing was an outstanding innovation by Ford. When

Ford announced that workers would make $5 for an 8-hour shift-in contrast with the standard wage of $2.75 for a 10-hour shift, crowds of eager workers besieged factory doors. Job seekers came not only from neighboring states but also from as far away as Ireland and Eastern Europe. Large numbers of both whites and blacks came from the deep South in search of jobs and opportunities [Woodford 1979].

Paradoxically, the automobile, the best means of mobility, innovated and established in great numbers by the "Automobile Capital of the World," also served as the primary cause and heart of a new urban transition after the 1970's: *suburban flight, or the well-known urban sprawl.* As people moved out of the city in search of better living standards and safer lifestyles, the central city of Detroit (downtown) constantly struggled to revitalize itself. This condition blemished Detroit's central city with abandoned buildings, spray-painted graffiti (researcher witnessed various inscriptions and drawings on many public surfaces and buildings), and other signs of the *hopelessness and frustration of poverty* [WRI 2000]. As people abandoned cities and moved to nearby suburbs, the city had more vacant lots and buildings than occupied ones, and these vacant structures pose a threat throughout the year as a haven for drug users and as targets for arsonists.

A major portion of Detroit's building stock was built during the automotive era, prior to World War II. The majority of these buildings are older and in a state of decay and abandonment. The amount of new construction has declined rapidly, in particular after the wake of the 1967 riots, as people who could afford housing elsewhere left the central city. Despite the fact that this rate of new construction did not decline as rapidly as the city's population (as stated earlier, Detroit has become the first major city in US history to have fallen below a population of one million). Many historically well-built structures stood as symbols of despair as people abandoned these structures and fled to the safer suburban life styles. Between 1970 and 1990, some 119,000 Detroit houses were torn down, leaving 410,000 units in 1990. The city of Detroit issued 20,676 building permits for new residential building construction over a thirty-year period from 1970 to 2002, whereas 165,012 permits were issued for the demolition of residential buildings during the same period [SEMCOG 2002]. The state of commercial buildings is no different from that of the residential structures, as the same effect was felt in the commercial building market, as more businesses started moving outside the city to the suburbs.

4.2.1 EXISTING BUILDING STOCK IN DETROIT – DATA COLLECTION

The Central Business District (CBD) of the city served as an epicenter of all business activities in the southeastern part of the state. However, as people slowly started moving out of the city area, so did the businesses, leaving a lot of commercial structures either vacant or underutilized. Table 13 below shows the commercial office market area as of 2002 existing in the City of Detroit and its suburban neighborhoods.

Table 13: City of Detroit and Southeastern Michigan Office Market as of December 2002 [GDP 2003]

Southeastern Michigan Office Market Area (Total Square Feet)	
Office Submarket	**Total Sq Ft.**
Troy	19,672,660
Detroit	**19,025,152**
(Detroit CBD)	***12,952,913*** (70% of City)
Southfield	18,020,730
I-275 Corridor	8,051,792
Birmingham/Bloomfield	7,723,574
Farmington/Farmington Hills	6,113,894
Ann Arbor	5,482,907
Dearborn / Romulus	4,348,538
Southern Macomb	3,609,989
Flint	669,500
Total and Southeastern Michigan	**92,718,736**

From the table above, it is evident that more business moved to the suburbs, leaving behind less interest among investors in the CBD area. This also had a great impact on the existing buildings that were previously used for office and commercial purposes. These buildings started aging, faster than expected due to lack of maintenance and occupation. For example, the century-old Madison-Lenox hotel shown in figure 12a was built in 1901[Freep 2002]. The old hotel, with its broken out windows and boarded up doorways has the architectural value typical of such buildings. All its inhabitants were evicted 10 years ago so the building could be transformed into a luxury hotel, but the transformation never happened. This building was abandoned from 1987 and has been lying vacant for the past fifteen years.

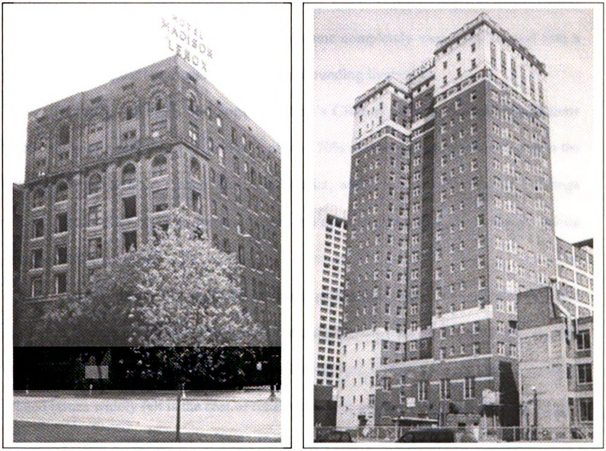

Figure 12a: The old Madison Building opened in 1901 at Harmonie Park. It is open to vagrants and totally abandoned.

Figure 12b: The vacant 1917 Fort Shelby Hotel. Built in 1917, it closed in 1998 and finally became completely vacant.

Figure 12: Historic Buildings that are Vacant and Abandoned in Detroit [Preservation 2003]

Many efforts to rehabilitate this building in the past have failed for various reasons, one of which was the cost factor. Similarly, the historical famous Fort Shelby hotel shown in Figure 12b was built in 1917 by the then-famous design firm of Richard E. Schmidt, Garden, & Martin at a cost of $890,000 [Kohrman 2003]. This hotel was used until 1973 after which it was closed and abandoned. This was right around the time of onset of the 1967 riots in Detroit. For many years, the only tenant of the building was a bar named Shelby's. It occupied part of the lobby space. This building was totally closed in 1998 and the Fort Shelby Hotel finally became completely vacant and turned into a place of public threat in terms of safety and surrounding livability.

There are numerous buildings in Detroit's CBD of similar abandoned conditions which are lying vacant. As per Table 13, almost 70% of the total office market area in the City of Detroit is in the Central Business District, which is full of abandoned buildings thereby opening up asylums for drug users and creating social insecurity for the public living in the CBD areas.

Of the many factors (social, cultural, political, economical, etc.) the researcher studied in investigating the reasons for this mass abandonment, it is evident that the cost of bringing these deteriorating buildings back to use was a critical factor. One of the cost-related issues widely felt is the cost of rehabilitation in order to make the building comply with the current code standards. The existing buildings that were built almost 100 years ago many times do not comply with the standards and requirements of the new building codes, as these structures were not built to a specific building code. This results in high rehabilitation expenditures in order to make the building comply with the current code, leading to a higher factor of uncertainty among the building owners whether it is more economical to invest in rehabilitating the building or just to abandon it without spending excessive amounts on rehabilitation. This section shows a compilation of such existing vacant structures in downtown Detroit that have potential for rehabilitation and reuse but have not been rehabilitated.

The distinctive pattern of streets and the alignment and function of buildings and public spaces in relation to one another make Detroit's urban design a unique one. Judge Augustus B. Woodward envisioned this characteristic honeycomb pattern as early as 1807 and this pattern still forms the base pattern for all urban developments in Detroit even today [GDP 1997]. Woodward's honeycombed urban development pattern resulted in the formation of several well-defined business districts in the city, one of which is the Central Business District of Detroit. Each of the developed districts was focused to serve a particular market niche, gradually growing from the edge of the Detroit River. Based on these developments, many avenues were formed, of which the main one is named as Woodward Avenue. On the east part of Woodward Avenue was the East District that housed the industrial sectors, marketplaces, and housing for the immigrants to the automotive city. Government facilities, utility providers, financing organizations and upper-end housing dominated the west district [GDP 1997]. This fast paced development along Woodward Avenue brought in numerous buildings and much infrastructure for the various public and private sector operations. Most of these buildings were built in the early 1900's when the automotive-based growth in the city was alarming.

Let us consider the CBD section of Detroit for this research study, identifying those among the existing building stock that are either vacant or on the drawing boards waiting for investments for rehabilitation and reuse. Figure 13 shows a detailed representation of the condition of the existing building stock in downtown Detroit along

Figure 13: Pictorial Representation of Downtown Detroit's Existing Building Stock [GDP – 1 2003]

east and west corridors of Woodward Avenue. The figure indicates existing vacant lots and buildings in downtown Detroit, divided into four different categories [GDP-1 2003]:

- Category 1: Existing vacant buildings that are either planned and financed for rehabilitation, or under construction by bringing down the existing building on the same site
- Category 2: Existing vacant and long standing abandoned city-owned buildings
- Category 3: Existing vacant and deteriorated buildings that have potential for rehabilitation into lofts and market rate residential units based on their location and existing conditions.
- Category 4: Existing vacant and abandoned privately owned buildings waiting for 50/50 matching funds from public and private funding agencies for rehabilitation or redevelopment on the existing building lot.

Even though new developments are coming up in the downtown Detroit area, more than *50% of the existing buildings* are vacant without any proper use. This is evident from the figure detailing the existing vacant building stock along the eastern and western districts of Woodward Avenue. Most of these buildings are being planned for reuse as a part of the city's movement for revitalization of the downtown area but remain without rehabilitation due to various parameters discussed in the earlier chapters related to building rehabilitation.

Table 14 gives a comprehensive list of existing buildings in the City of Detroit that are declared to be in the vacant / not in use category under the register of Wayne County, Michigan by the National Register of Historic Places [NRHP 2003]. The buildings that are listed in the table are of historical importance and were built during the period of urban growth in the automotive capital of the world. These structures were mostly used for commercial purposes and the details of their respective historical use and current function / status are given in the listing. Most of the buildings categorized are high-rise structures that form the skyline along the elegant avenues of the city.

Most of these existing buildings are privately owned and in some cases jointly owned by the local government and the private sector. The periods of significance for these structures mentioned in the table are the periods when they experienced the complete use of the building for the specified historical use. After these periods of significance, the buildings were either underutilized or completely abandoned for various reasons discussed in the earlier chapters of this report. Very few of these existing buildings are currently in use, and even if in use, they are highly underutilized as small retail shops and businesses occupy hardly 20% of the structure. The buildings tabulated are in two formats: individual buildings and groups of buildings declared part of a historic district that are lying vacant and unused (see the "number of buildings" section of the table). If a part of the building is in use, it is mentioned in the "current use" category.

Table 14: Comprehensive List of Existing Vacant Buildings in the City of Detroit That Are Declared to Be in the Vacant / Not in Use Category under the Register of Wayne County, Michigan by the National Register of Historic Places [NRHP 2003]

S. No	Building Name / Building Group (>1)	Location in City of Detroit	No. of Bldg. (>1)	Period of Significance	Owner Type	Historic Use of the Building	Current Use Status of Bldg.
1	Architects Building	415 Brainard St	1	1900 – 1949	Private	Commerce/Trade	Vacant/Not in Use
2	Boydell W. House	4614 Cass Ave	1	1875 – 1924	Private	Domestic	Vacant/Not in Use
3	Capitol Park Historic District	Bounded region	17	1875 – 1949	Local Govt. Private	Financial Instit., Facility, Plaza	Commerce/Trade Vacant/Not in Use
4	Corktown Historic District	Bounded region	115	1825 – 1949	Local Govt. Private	Domestic Single Dwelling	Single Dwelling Vacant/Not in Use
5	Cornice and Slate Company Building	733 St. Antoine at E. Lafayette	1	1875 - 1899	Private	Commerce/Trade	Vacant/Not in Use
6	Dodge Mansion, aka. Rose Terrace	12 Lakeshore Dr, Grosse Pointe	1	1925 – 1949	Private	Domestic Single Dwelling	Vacant/Not in Use
7	Dunbar Hospital	580 Frederick St	1	1875 – 1924	Private	Health Care	Vacant/Not in Use
8	East Grand Boulevard Historic District	Bounded Region	123	1875 – 1949	Private	Commerce/Trade Domestic/Religion	Vacant/Not in Use Domestic/Religion
9	Farwell Building	1249 Griswold St	1	1900 – 1924	Private	Commerce/Trade	Vacant/Not in Use
10	Fort Shelby Hotel, aka. "The Shelby"	525 W. Lafayette St	1	1900 – 1949	Private	Domestic/Hotel	Vacant/Not in Use

11	George Edwin Bldg (Garfield Building)	4612 Woodward Ave	1	1900 – 1949	Private	Commerce/Trade Processing Indus.	Vacant/Not in Use
12	Globe Tobacco Bldg	407 E. Fort St	1	1875 – 1899	Private	Industry/Extract-tion/Processing	Manufacturing Vacant/Not in Use
13	Grand Rivera Theater	9222 Grand River Ave	1	1925 – 1949	Private	Recreation and Culture / Theater	Vacant/Not in Use
14	Harvey, John House	97 Winder	1	1875 – 1924	Private	Domestic Single Dwelling	Vacant/Not in Use
15	Highland Park General Hospital	357 Glendale Ave	3	1900 – 1949	Private	Domestic, Health Care	Vacant/Not in Use
16	Hook & Ladder House Fire Dept. Repair Shop	3400 – 3434 Russell St	2	1875 – 1949	Local Govt. Private	Government, Transportation	Vacant/Not in Use
17	Jefferson Intermediate School	938 Selden	1	1900 – 1924	Private	Education School	Vacant/Not in Use
18	King, L.B. & Co. Bldg (Annis Furs Building)	1274 Library Street	1	1900 – 1949	Private	Commerce/Trade Specialty Store	Vacant/Not in Use
19	Lancaster and Waumbek Apartments	227-29 and 237-39 E. Palmer	2	1900 – 1924	Private	Domestic Multiple Dwelling	Vacant/Not in Use
20	Lower Woodward Ave Historic District	1202-1449 and 1400-1456 Woodward Ave	17	1875 – 1949	Local Govt. Private	Department Store, Professional, Specialty Store	Commerce/Trade Specialty Store Vacant/Not in Use
21	Marx House	2630 Biddle Ave	1	1850 - 1874	Local Govt.	Single Dwelling	Vacant/Not in Use

22	Medbury's—Grove Lawn Subdivisions Historic District	Bounded by Hamilton, Louise & Woodward Av	502	1875 – 1899	Private	Domestic, Secondary Struct., Single Dwelling	Secondary Struct, Single Dwelling Vacant/Not in Use
23	Norris, Philetus W., House	17815 Mt. Elliott Ave	1	1850 – 1899	Private	Domestic Single Dwelling	Vacant/Not in Use
24	Orchestra Hall	3711 Woodward Ave	1	1900 – 1924	Private	Recreation And Culture	Vacant/Not in Use
25	Park Avenue Historic District	Park Ave, Adams Ave, Fisher Fwy.	13	1876 – 1949	Local Govt. Private	Commerce/Trade, Domestic, Social	Correctional Facil. Vacant/Not in Use
26	Patterson, John House	6205 N Ridge Rd	1	1825 – 1874	Local Govt.	Single Dwelling	Vacant/Not in Use
27	Ponchartrain Aparts. (Renaissance Aparts)	1350 E. Jefferson Ave	1	1900 – 1924	Private	Domestic Multiple Dwelling	Vacant/Not in Use
28	Sibley, Frederic Bldg	6460 Kercheval	1	1900 – 1949	Private	Commerce/Trade	Vacant/Not in Use
29	Sprague, Thomas S., House	80 W. Palmer	1	1875 – 1899	State	Domestic Single Dwelling	Vacant/Not in Use
30	The Clay School	453 M L K Blvd	1	1875 – 1899	Private	Education	Vacant/Not in Use
31	Third Precinct Police Station Building	2200 Hunt St	1	1875 – 1899	Private	Correctional Facility	Vacant/Not in Use
32	West Canfield Historic District	2/3, Calumet Ave & W Canfield	22	1850 – 1949	Private	Commerce/Trade Domestic/Religion	Vacant/Not in Use Domestic/Religion
33	Wilson Barn Building	W. Chicago Rd	1	1875 – 1924	Private	Animal Facility	Vacant/Not in Use
TOTAL VACANT / NOT IN USE BUILDINGS IN DETROIT			**839**	***These vacant buildings are of varying areas and most of them are high-rise commercial buildings with private ownership***			

The total list of 839 vacant and historical buildings in the City of Detroit listed under the National Historic Register are so identified because most of these structures are of historical significance and carry a peculiar architectural importance of olden times. Most of these buildings are high-rise structures and vary from a few hundred square feet in area to almost as high as a million square feet in a few high-standing structures in the city's skyline. A large group of buildings is planned for rehabilitation under various city development programs with a target of the 2006 Super Bowl in Detroit [GDP 2003].

4.2.2 POTENTIAL REHABITABLE BUILDING STOCK

The existing unutilized or underutilized buildings are growing in number, as more and more owners are reluctant to invest in existing structures and bring them back to use. The reasons for this daunted enthusiasm vary from building to building, but there are primary factors in common such as the market demand for commercial buildings in Detroit, social factors, political factors, and also economic factors such as the cost of rehabilitation. Major parts of the existing stock of buildings are structurally sound and are potential candidates for cost-effective rehabilitation. However, the buildings' style, kind of architecture and dimensional standards are very different from those found currently under standard building codes. This often results in higher costs of rehabilitation. In this chapter, one such building with these complications and with historical significance is considered as a case study building. A complete rehabilitation code analysis and cost analysis is performed using the new Michigan Existing Building Code in comparison with the regular Michigan Building Code. The larger group of buildings tabulated above carry physical and historical characteristics similar to the case study building used for this research and hence all are potential candidates for rehabilitation and reuse. Rehabilitating these vacant buildings and bringing them back to use would have a huge positive impact on urban revitalization in Detroit.

4.3 REHABILITATION CODE AND COST ANALYSIS FOR CASE STUDY BUILDING

Among the old and vacant existing building stock in Detroit, a case study building, hereinafter referred to as "the building," was identified for a code and cost analysis of using the new Michigan Existing Building Code (MEBC) over the regular Michigan Building Code (MBC) for the process of building rehabilitation. The selected building holds all the characteristic properties of old, vacant and underutilized buildings in downtown Detroit, as they were almost all built during the same period of historical significance. This is evident from Table 14 earlier, which shows a unique period of historical significance between 1850 and 1950.

4.3.1 CASE STUDY BUILDING DETAILS:

Detroit's development has been triggered in a positive direction with the fresh additions to the city such as the new Tiger Stadium and the proposed Campus Martius Development. The building identified for this case study is located in this strategic development area identified by the city, which is in the Lower Woodward National Register Historic District. This building is listed on the historic register as it contributes to the historical value of the district and the city. This building consists of two buildings, *"building A"* and *"building B,"* tied together to form a single case study building. Building A is on the northern side while building B occupies the southern lot.

Building A is a six-story structure with a two-story penthouse on top of the sixth floor. Building B is an eight-story structure having almost equal ceiling heights between all the floors. On the other hand, building A's original sixth floor has a relatively tall ceiling height. An over-story was constructed creating a seventh floor within the volume of the sixth floor. As a result, the seventh floor of building A has two floor levels, 7 and 7A, equivalent to only one seventh floor in building B. The total area of the building is 113, 966 square feet (Building A = 61, 958 sq. ft.; B = 52, 008 sq. ft.). Table 15 details the floor area of the buildings A and B. The floor areas in bold print are the planned rehabilitation floor areas, while the italicized floor areas are not considered under the defined rehabilitation scope. Based on the scope defined in the next section, the total area considered for the case study is 90,518 sq. ft. (A = 49,958 sq. ft. and B = 40,560 sq. ft.). In the case of work related to all vertical shafts (stairs), the entire building, including the basement, is considered.

Table 15: Floor Area Description of the Case Study Building [Schwartz 2002]

EXISTING FLOOR AREAS OF THE CASE STUDY BUILDING		
Floor Level	**Building A** (Square Feet)	**Building B** (Square Feet)
Basement	*6,000*	*5,724*
1st	*6,000*	*5,724*
Mez (Lobby + Stairs)	**1,958**	**492**
2nd	**6,000**	**5,724**
3rd	**6,000**	**5,724**
4th	**6,000**	**5,724**
5th	**6,000**	**5,724**
6th	**6,000**	**5,724**
7th	**6,000**	**5,724**
7A	**6,000**	**-**
8th	**6,000**	**5,724**
Subtotal of Area	61, 958	52, 008
(In Bold Print) Subtotal of Area Affected by this **Rehabilitation** (Mez + 2nd to 8th floor)	**49, 958 sq. ft.** (61958 – 1200)	**40, 560 sq. ft.** (52,008 – 11448)
Total Area of Building	:	**113, 966 sq. ft.**
Total Area Affected by this Rehab Project: [49, 958 sq. ft. + 40, 560 sq. ft.]		**90, 518 sq. ft.**

Constructed around 1910, the building has been historically used for commercial / business purposes and is classified as a Group "B" use structure according to the classification specified by the building code (see the discussion of building classifications in Chapter 3). A single business used both buildings A and B with some retail use on the first floor. About fifteen years ago, the users vacated the building and now it is lying vacant with very little retail use in the first floor. When the researcher inspected the building, it was evident that the building was relatively clean and structurally sound. The building also carries a unique architectural value evident from Figure 14 depicting the pleasing, carefully designed architectural styles.

Figure 14: A View of the Architectural details of the Case Study Building

Buildings A and B are tied together into a single building sharing a common set of three elevators opening into building A at each floor level with doorway access from building A to B at the side walls next to the elevator. Except for the seventh floor, A and B's adjacent floor levels are relatively even, making for an easy transition from one building to the other. The difference in floor heights is approximately 4 '8" between floor 7 of building A and floor 8 of building B, requiring a half flight of stairs to connect these two floor levels in the structure. This can be witnessed from Figure 15, an elevation drawing of the buildings. In building A, all floor levels up to the fifth floor are of similar heights, around 13 feet, while the ceiling heights of floors 6, 7 and 7A are different, as detailed in the elevation drawing.

A photographic view of the case study building (including both A and B) is shown in Figure 16. Building A and B are separated completely for the first two floors with separate egress access and entrances. After the second floor, access to each of the buildings is provided through a doorway across the dividing wall. The existing windows (seen in both photographs) in elevation above the second floor at the front facade and at all floors at the rear facade and penthouse are original windows of historical value with single pane glass. The ninth floor in building A is the mechanical room and has the highest roof level in this building. The total building height above the ground level is 135 feet and overall height of the structure including the basement is 149 feet. See Figure 15 for details.

FRONT ELEVATION OF THE CASE STUDY BUILDING

Two Buildings "A" and "B" Tied Together into One Case Study Building

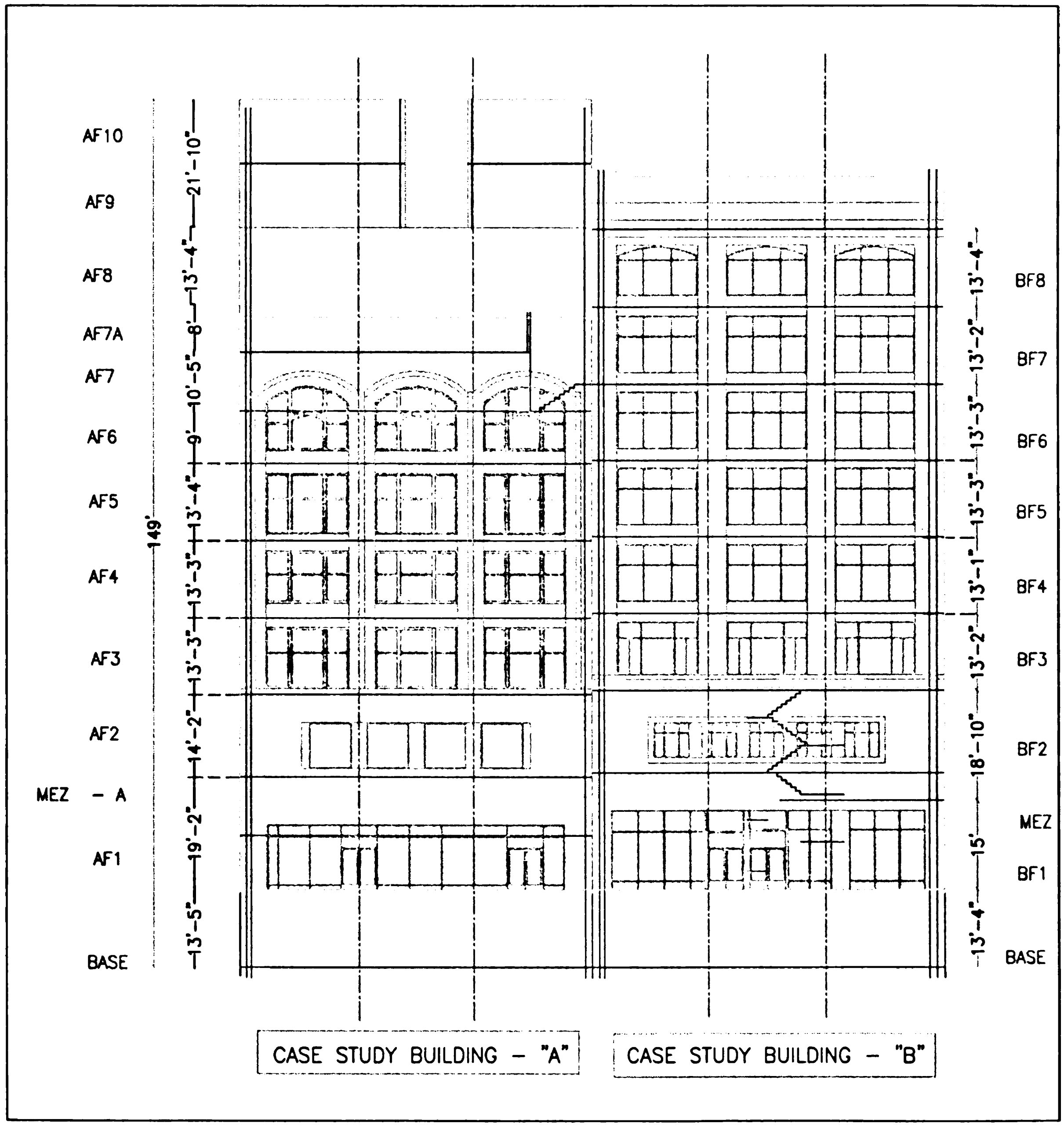

FIGURE 15: FRONT ELEVATION OF THE CASE STUDY BUILDING

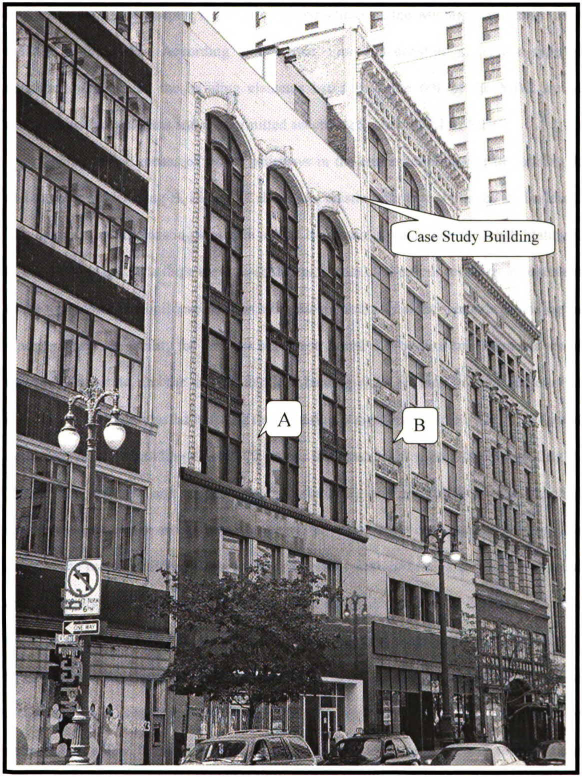

Figure 16: Case Study Building (A& B) in Downtown Detroit, Pictured in August 2002

The ***type of construction*** found in the building, based on the classification defined in Section 602.3 of Chapter 6 (types of construction) of the Michigan Building Code (MBC), is type I-B. According to the code, type I-B construction is that type of construction in which the building elements listed in Table 601 of the MBC are of noncombustible materials and are permitted according Section 603.1 of MBC.

There are two means of egress stairways in the entire building, one in building A and the other in building B. Figure 17 shows the existing third floor plan of the building. The openness of the existing structure makes it a potential candidate for rehabilitating it to any suitable use. The three elevator shafts run across all the floor levels from basement to the top floors. The building also has a fire escape stairway at the rear side providing an emergency escape facility for both the buildings, A and B. The structural elements are of reinforced concrete, and the exterior and load bearing walls are built of brick masonry as is typical of the buildings built during this historically significant period. The floor area at each floor level of building A is 6,000 square feet, and 5,724 square feet in building B. The existing windows and window trim in the building hold good architectural value and can be retained in the rehabilitated structure, based on their condition and value. The stairs at the rear of building B are made of cast iron with decorative cast iron risers and architecturally significant guards/railings. The stairs at the rear of building A have minimal wood railings and are of marginal architectural significance [Knibbe 2002]. Most of the existing walls and ceilings in both the buildings are of a plaster finish and, on observation, it is evident that this plaster is non-decorative in most places and completely damaged on a few floors. The existing floor coverings on the sixth and seventh floor levels are damaged severely as the plumbing systems underneath the floors broke due to

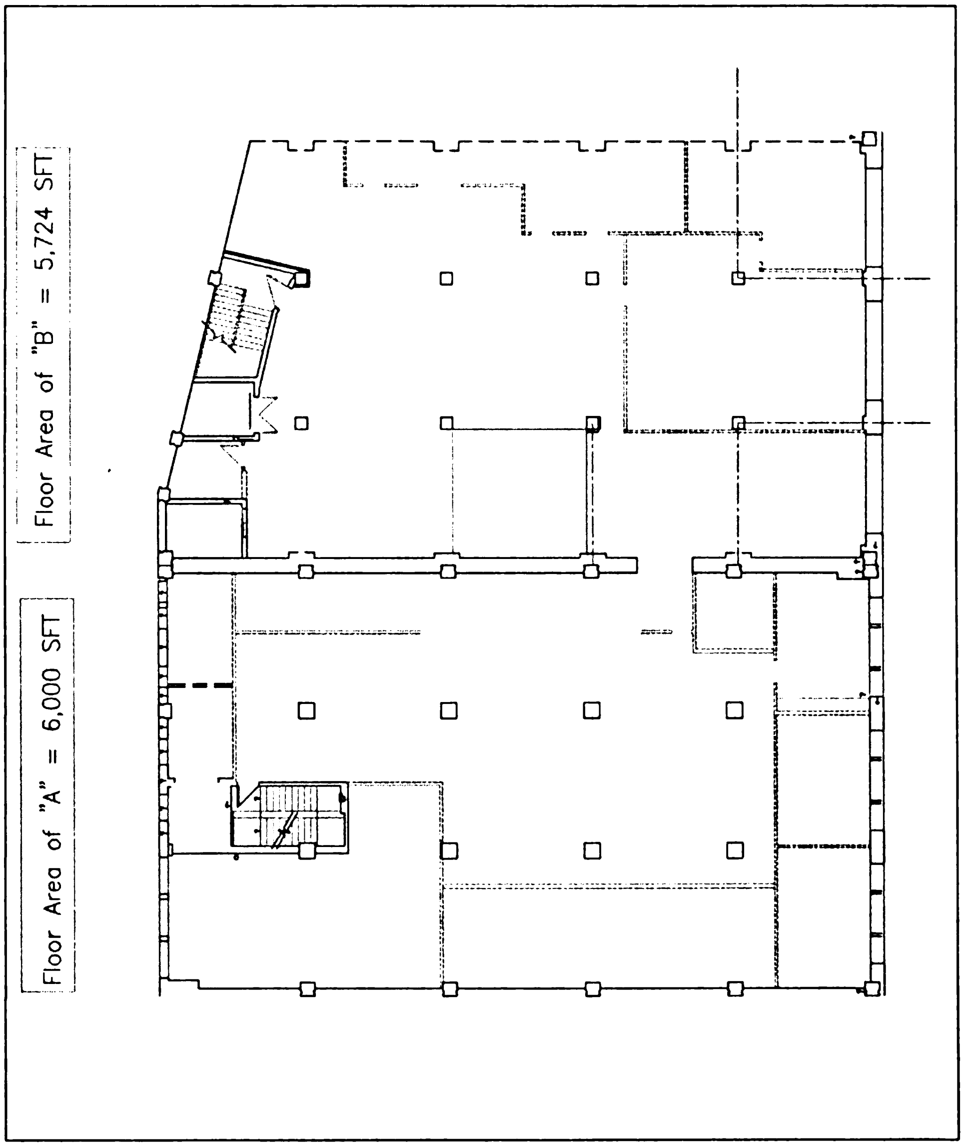

FIGURE 17: THIRD FLOOR PLAN OF EXISTING BUILDING

4.3.2 SCOPE OF THE REHABILITATION PROJECT

The scope of rehabilitation of the case study building is defined in this research based on the owner's needs, available market potential in downtown Detroit, and the architect's input and suggestions. With these parameters in mind, the existing business use (group B) of the vacant building is planned to be changed to a new use group and occupancy, group R-2 (multilevel residential dwelling units), at the existing second floor level and above. Definitions of and details about various use groups, as described by the Michigan Building Code, were discussed in chapter three. The existing retail use of the first floor is retained as the same mercantile use group (M) without any change. The areas affected by the proposed rehabilitation are marked in bold in Table 15, shown in a previous section of this chapter. This change of occupancy from use group B to group R-2 results in conversion of the vacant building into efficient market rate apartment units, averaging about ten units per floor.

The proposed floor plan of the new residential use is shown in figure 19, detailing the third floor plan after rehabilitation. Based on the existing code complications in the building, some of the existing building components such as the stairs, mechanical rooms, and bathrooms with raised floors are removed and redesigned in new locations to meet the code standards. For example, in the new proposed design, when compared to the existing floor plan shown in figure 17, the existing stairs have been completely removed from its current location and has been moved along the sidewalls (party walls) of the structure. This new location of stairs shown in figure 19 is designed to offer more efficient dwelling units, in terms of both number of units and their design, without

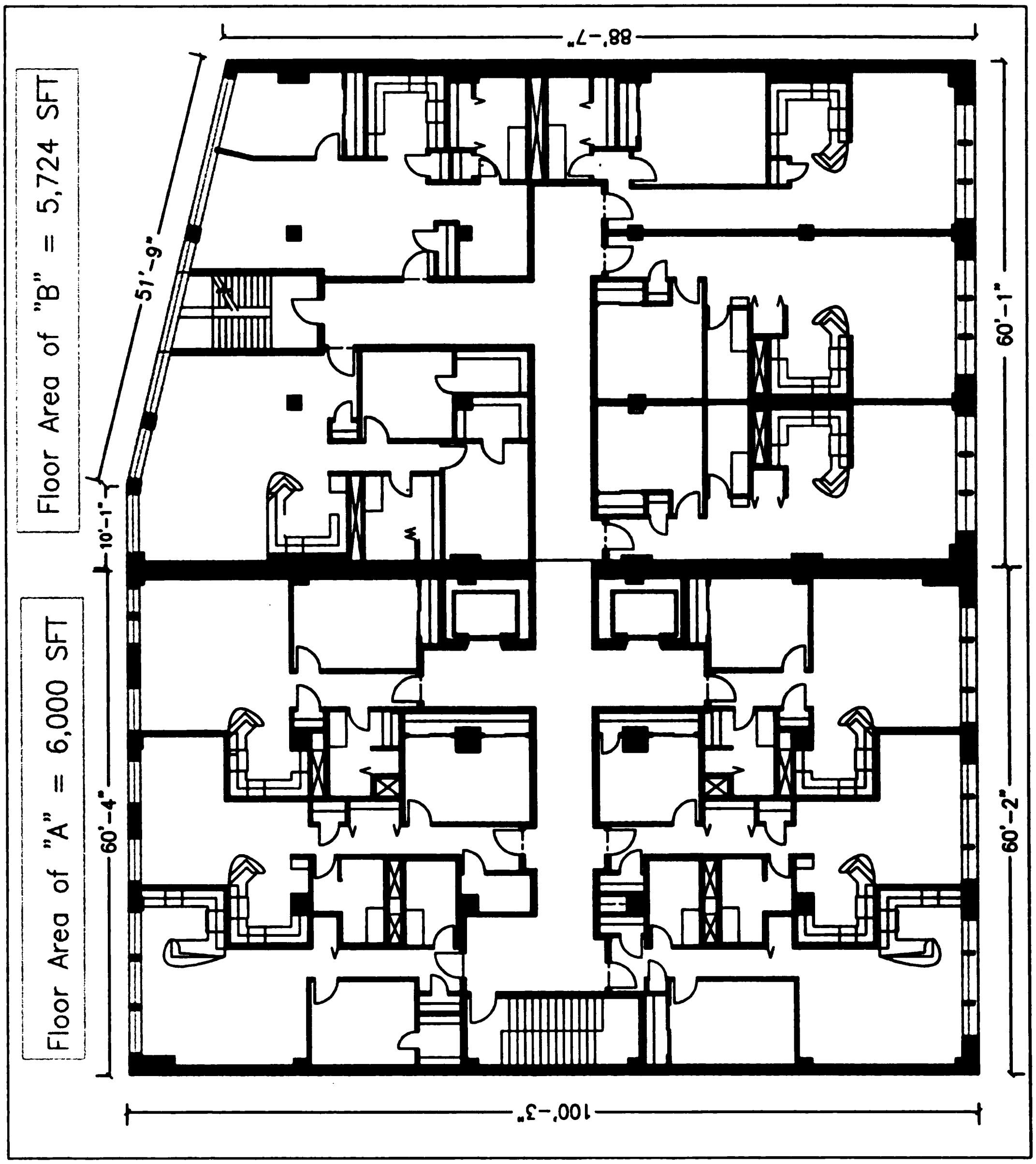

FIGURE 19: THIRD FLOOR PLAN OF NEW AFTER-REHAB USE

leaving units too large or too small. The photographic view of the existing floor in the building, shown in figure 20, demonstrates the openness of the existing floors and the ease of defining a new use for the building.

Figure 20: Sixth Floor Level of the Case Study Building, Showing the Existing Openness of Past Use Group B, Pictured in September 2002.

The floor plan shown in figure 19 details the location of the units and other building components. When observed in detail between figure 17 and figure 19 it can be noted that of the three elevators that are in the existing building, the center elevator is removed in the new use, as two elevators are sufficient to serve the occupant load of 2-4 occupants per dwelling unit. This creates the increased corridor space in the new R-2 use.

The change of occupancy of the building from group B to R-2 requires approval and a change of occupancy certificate from the Buildings and Safety Department. Since the existing structure is mostly open, all the new building components that are added for the new R-2 use will comply with the regular building code. The existing components are checked for compliance with the code, which is the one of the important areas of concentration of this research work, and approved based on their physical and dimensional conformity to standards.

Other than the major change of occupancy rehabilitation, existing exterior and interior components will be rehabilitated to conform to the health and safety standards in the local building code. The existing masonry work must meet rehabilitation standards requiring the use of gentle cleaning techniques, custom mortar, and matching masonry. Since the building is listed in the National Historic Register and located in one of the City of Detroit's local historic districts, the rehabilitation scope will meet and incorporate the requirements of the historic preservation standards to gain the benefits offered by the respective historical preservation programs. All the code-related issues in the existing building are explored in detail and for the defined scope of change of occupancy, rehabilitation specifications are developed complying with the requirements of the regular Michigan Building Code and the new Michigan Existing Building Code. The code and cost analysis results are summarized in the later sections of this chapter. Since this building is registered under the national and local historic registers, the scope of rehabilitation will conform to these standards to be eligible for Federal Investment Tax Credits and also to qualify for the Michigan Historic Preservation Tax Credits [Knibbe 2002].

4.3.3 REHABILITATION WORK SCOPE ANALYSIS

Rehabilitation projects are of two major types, rehabilitation for the same existing use and rehabilitation for a new use, involving a change of occupancy. Generally, the first type of rehabilitation involves minor repairs, renovations, restorations and in some cases additions to the components of the existing structure. The second type of rehabilitation demands substantial change to the existing components of the building, in some cases even resulting in higher dollar values for rehabilitation than for new construction. When rehabilitation work is performed within the same use, the compliance requirements are not as severe as for a change of use. The use categories are defined based on the type of use and its relative hazard to life and safety. The compliance requirements for a change of use from a lower to a higher use hazard category are entirely different from those for a change from a higher to a lower use hazard category. The respective building code adopted in that region states these requirements.

In this case study building, a change of occupancy is proposed from use group B to group R-2. This change of occupancy places the building in a higher hazard category as per the building code. All the code analysis performed in this chapter focusing on making the building comply with the code requirements is based on this proposed occupancy change. The suitable sections relevant to this change from group B to group R-2 are studied in detail. As per the proposed goal and related objectives of this research, the code analysis for the defined rehabilitation scope is performed under two categories using:

- **Michigan Building Code (MBC) - *Regular Construction Code***
- **Michigan Existing Building Code (MEBC) – *Rehabilitation Code***

A comprehensive code analysis using both the MBC and the MEBC was performed and the results have been summarized in this subsection, detailing the code related issues in the proposed rehabilitation along with some critical findings. The more detailed version of the code analysis is presented as an appendix (Appendix A).

4.3.3.1 MICHIGAN BUILDING CODE (MBC) BASED ANALYSIS

By passing State Public Act 245 of 1999, the State of Michigan adopted as its single statewide building code the Michigan Building Code (MBC), which is adapted from the International Building Code (IBC) developed by the International Code Council. In the MBC, a separate chapter (Chapter 34) is dedicated to work in existing structures, but this chapter is not very comprehensive in addressing the issues that prevail in existing structures built during historical periods. The provisions of this chapter control the alteration, repair, addition and change in occupancy of existing structures to a smaller magnitude. As per the MBC, the portions of the structure that undergo additions, alterations or repairs need to conform to the requirements of the code for new construction. Additions or alterations that will cause an existing structure to be in violation of any provisions of the MBC should not be made. Chapter 34 permits portions of the structure that are not altered and not affected by the alteration to avoid complying with the code requirements for new construction of a similar kind.

According to Section 3405 in Chapter 34 of the MBC, no change will be permitted in the use and occupancy of the building that would place the building in a different division of the same occupancy group (for example, changing from group R-1 to R-2 or R-3) or in a different occupancy group (for example, changing from group B to group R) unless such building is made to comply with the requirements of the MBC for such division or occupancy group. However, if the new or proposed occupancy use is less hazardous (refer to hazard categories for different use groups discussed in chapter 3) than the existing use (based on the life and fire risk), the building official has the authority to permit the change in use without conforming to all the requirements imposed by the MBC for that respective use group. If this benefit of approval is offered by the building official, a certificate of occupancy should be obtained, where it has been determined that the requirements for the new occupancy classification have been met as per the requirements put forth to address the health and safety issues.

If a change of use made to an existing structure raises the building to a higher hazard category, then the entire building must comply with all the requirements of the MBC that are similar to new construction for the proposed use group. In the ***case study building,*** the proposed use group results in change of the existing group B lower hazard use to group R-2, a new, higher hazard use. This change makes it compulsory for the entire building to comply with the MBC and meet all requirements similar to a new group R-2 type construction.

In the case study building, all the existing components and elements were analyzed for their condition and conformity with the standards defined by the MBC for group R-2 construction. Since the existing structure is fairly open with only the exterior enclosures enclosing the structural elements, all the new components that will be added for the new R-2 use will comply with the MBC standards in any case. All existing elements are considered for this code analysis. Some of the existing building elements identified for further analysis are (see figure 17 for plan):

- Existing exterior enclosure masonry walls (party walls at North and South ends)
- Continuous wall separating building A and building B (see plan)
- Existing windows, window frames and window glass panes
- Existing floors and ceilings along all the floor levels in both buildings A and B
- Existing means of egress stairs – this includes:
    - Continuous stairs in Building A (see plan)
    - Continuous stairs in Building B (see plan)
    - Mezzanine stairs in Building A
    - Fire escape stairs in the rear side common to buildings A and B
- Existing structural elements (columns, beams, joists and slabs)
- Existing three elevators opening into building A
- Existing mechanical, electrical and plumbing fixtures
- Existing floor and ceiling finishes and other building materials
- Existing vertical enclosures running along the height of the building

(All the above elements also been studied for dimensional conformity with code.)

Based on the code analysis performed in the case study building using the MBC, four major categories (in terms of cost impact) of non-compliance have been identified:

- **FIRE PROTECTION: FIRE-RESISTANCE-RATED CONSTRUCTION**
    - **SECTION 703: Fire-Resistance Ratings**
    - **SECTION 704: Exterior Walls**
    - **SECTION 707: Shaft and Vertical Exit Enclosures**

- **MEANS OF EGRESS**
    - **SECTION 1003.2 System Design Requirements**
        - **1003.3.3 Stairways**
            - **1003.3.3.1 Stairway Width.**
            - **1003.3.3.2 Stairway Headroom**
            - **1003.3.3.3 Stair Treads and Risers.**
            - **1003.3.3.3.1 Dimensional Uniformity**
            - **1003.3.3.4 Stairway Landings**
            - **1003.3.3.6 Vertical Rise**

- **INTERIOR ENVIRONMENT**
    - **SECTION 1207: Interior Space Dimensions**
        - **1207.2 Minimum Ceiling Heights.**

- **INTERIOR FINISHES**
    - **SECTION 803: Wall and Ceiling Finishes**

These four major categories identified from the code analysis performed on the existing building were critical in terms of cost involved for making these non-complying building elements comply with the MBC. This limited list of items is a summary based on the cost impact analysis performed by the researcher in the later part of the research. Based on the existing conditions of the case study building, all the remaining components for the new R-2 use will be new anyway and will comply with the MBC. A detailed description of these four identified components and their non-compliance is furnished in this section of the report. Each main section is detailed with the subsections mentioned above, and each sub-section is explained in three categories:

- *Compliance requirements as per the MBC* (CR-MBC)
- *Existing condition of the building component* (EC-BC)
- *Rehabilitation work scope to make the component comply with the MBC* (RCC)

4.3.3.1.1 FIRE PROTECTION: FRR CONSTRUCTION

In any building construction, fire-resistant materials and assemblies should be used for resisting the spread of fire and smoke within a building and the spread of fire to or from other buildings. Fire-resistance-rated construction is adopted to create the required separation of adjacent spaces and critical building components such as structural members and load carrying members from continuing fire spread and to safeguard against collapse and disaster. This section illustrates the fire protection and the fire resistance of the existing building components in the case study building.

Fire-Resistance Ratings (MBC Section 703)

Fire Resistance Rating (FRR) is the period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests or the methods based on tests, prescribed in

Section 703 of the MBC. FRR is calibrated as the number of hours of resistance that a particular component or assembly offers during fire. The fire-resistance rating of building elements shall be determined in accordance with the test procedures set forth in ASTM E 119. As per the MBC, engineering analysis performed on similar building element designs having fire-resistance ratings as determined by the test procedure set forth in ASTM E 119 can be used to determine the FRR of the existing old assemblies that does not have FRR records.

Based on the researcher's discussion with practicing architects in the Detroit area, it is assumed that all the buildings of a similar type built in the city during the same period as the case study building have a FRR of o***ne hour.*** Assuming this fact is applicable for the case study building, the primary components of rehabilitation (by cost impact) such as exterior walls, shaft and vertical enclosures and fire partitions, are analyzed based on the MBC.

Exterior Walls (MBC Section 704)

The existing exterior walls in the building are open to the main street and common alley on the east and west sides of the building. The north and south walls are party walls, joined with adjacent buildings. According to the assumption above, all the exterior walls in the building have a one-hour FRR. Following is the analysis using the MBC:

- <u>*Compliance requirements as per the MBC:*</u>

  According to Section 704.5 of the MBC, all exterior walls should be fire-resistant rated in accordance with Tables 601 and 602 of the MBC. Based on Table 601 and 602, as detailed in section 4.3.2 of this chapter, the case study building is classified under

"Type I-B" construction. According to Section 704.5 and Table 601 and 602 of the MBC, the exterior walls and their components that are load bearing need to have a minimum two hour FRR. The fire-resistance rating of exterior walls with a fire separation distance of greater than 5 feet (1524 mm) should be rated for exposure to fire from the inside. Any wall located on a property line between adjacent buildings which is used or adapted for joint service between the two buildings (party wall), shall be constructed as a fire wall without openings in accordance with Section 705 and shall create separate buildings. This section requires the party walls have a minimum two hour FRR.

- *Existing condition of the building component:*

All the exterior walls of the case study building are rated with just a one-hour FRR, including the party walls on the north and south sides of the building. Since it is assumed that all the buildings of a similar type built in the city during the same period as that of the case study building have FRRs of o***ne hour*****,** the building is not conforming to the requirements of the MBC as specified in Sections 704 and 705 and this fire-resistance rating must be increased to the current minimum of two hours.

- *Rehabilitation work scope to make the component comply with the MBC:*

The existing exterior walls of the case study building do not comply with the requirements set forth by the MBC; their fire-resistance rating must be increased from *one hour* to *two hours.* Various methods can be adopted to increase the existing FRR of the walls by a minimum of one hour. For example, to achieve a one-hour fire-resistant rating for the existing brick masonry walls, a minimum of 5/8" thick gypsum wall board can be fixed on the existing walls by furring and lathing with minimum 7/8" channels, galvanized and placed at 12" O.C. This will provide the existing wall with an additional layer of protectiveness, adding an additional one hour to the FRR, making it a two-hour fire-rated wall. Details on the particular building materials used for this process can be obtained from section 4.3.5.5. In some cases, any protective coating such as cement mortar, pure plaster, vermiculite plaster or cement can be used to increase fire resistance. Also, fire resistance can be increased in the existing walls by grouting with certain fire-resistant chemicals. For the purposes of cost analysis, this research work assumes the gypsum board with furring on the existing masonry wall is used.

Shaft and Vertical Exit Enclosures (MBC Section 707)

The existing vertical enclosures in the case study building such as the stairwell enclosures, elevator room enclosures and utility shafts are of one-hour fire resistance rated materials. Similar to the exterior walls, the vertical shafts also need to comply with the MBC.

- *Compliance requirements as per the MBC:*

  Section 705 of the MBC is applicable to all vertical shafts in a building where such shafts are required to protect openings and penetrations through floor/ceiling and roof/ceiling assemblies. According to Section 707.4 of the MBC, shaft enclosures including exit enclosures shall have a fire-resistance rating of ***not less than 2 hours*** where connecting four stories or more, and 1 hour where connecting less than four stories. Shaft enclosures shall have a fire-resistance rating not less than the floor assembly penetrated, but need not exceed 2 hours.

The continuity of the vertical shafts and enclosures is an important compliance requirement as per the MBC. According to Section 707.5 of the MBC, shaft enclosure walls should extend from the top of the floor/ceiling assembly below to the underside of the floor or roof slab or deck above and should be securely attached thereto. These walls should be continuous through concealed spaces such as the space above a suspended ceiling. The supporting construction should be protected to afford the required fire-resistance rating of the element supported. Hollow vertical spaces within the shaft enclosure construction wall should be fire stopped at every floor level.

- *Existing condition of the building component:*

All the existing vertical shafts and enclosures in the case study building are rated with an FRR of just one hour, including the existing stairwell enclosures in buildings A and B, because of the assumption that all the buildings of a similar type built in the city during the same period have the same FRR. This ***one hour FRR*** must be increased to the current minimum of two hours in order to meet MBC Section 705 requirements.

In building A the stair shaft is discontinuous for one floor level at the second floor level, where the mezzanine stairs and second floor stairs of building B provide access to further floors of building A. This also is not compliant with the MBC requirements.

- *Rehabilitation work scope to make the component comply with the MBC:*

The existing vertical shafts and enclosures of the case study building do not comply with the requirements set forth by the MBC; it is essential to increase the fire resistance rating of vertical shafts and enclosures from *one hour* to *two hours.* Methods described in the earlier section can be adopted to increase the FRR of the vertical shafts and enclosures by a minimum of one hour. For example, to achieve a one-hour fire-resistant rating for the existing vertical shafts and enclosures, a minimum of 5/8" thick gypsum wall board can be fixed on the existing vertical shafts and enclosures with furring and lathing on the inner sides of the shafts with minimum 7/8" channels, galvanized and placed at 12" O.C. This will add an hour to the FRR, making it a two-hour fire-rated enclosure. Details of the particular building materials used for this process can be obtained from section 4.3.5.7.

To address the issue of continuity of the stairs (vertical shaft) new stairs may be constructed in the place of discontinuity or the whole stairway may be demolished and rebuilt. This issue is addressed in the cost analysis part of this chapter.

4.3.3.1.2 MEANS OF EGRESS

Means of egress is a continuous and unobstructed path of vertical and horizontal egress travel from any point in a building or structure to a public way. A means of egress consists of three separate and distinct parts: the exit access, the exit and the exit discharge. The means of egress is designed based on the number of persons (occupant load) the building is designed to support. Chapter 10 of the MBC specifies the general requirements for means of egress applicable to all elements of the means of egress system, in addition to those specific requirements for the exit access, the exit and the exit discharge detailed in other sections of the building code.

System Design Requirements (MBC Section 1003.2)

The means of egress system design requirements include various design factors such as multiple occupancies in the building, design occupant load, egress width, ceiling height, floor surface of egress path, elevation change, egress continuity, exit signs, egress illumination, accessible means of egress, elevators, escalators, and moving walks. One of the primary sources of egress is the building's stairs. The case study building has two continuous stairways, one in building A and one in building B. Both of these stairways have a code c omplication that makes them not compliant with the MBC. Some of the major design requirements related to stairs in this section of the building code include stairway width, headroom, stair treads and risers, stairway landings, stairway construction (including walking surface of the stairs), vertical rise of the stairways (also defining the slope of the stairs), handrails (height, continuity, clearance), design requirements related to roof access of stairs, dimensional uniformity and profile of treads and risers.

Out of the various design components of the existing means of egress in the case study building, code issues related to the existing stairways were felt by the researcher to be prominent; those components that have a critical cost-based impact on the process of rehabilitation are discussed in detail in the following subsections.

Stairways (MBC Section 1003.3.3)

In the MBC, Section 1003.3.3 details the requirements for stairways that include the design of various stairway components, the materials to be used in construction and the positioning requirements. Existing stairways A and B in buildings A and B are studied for all these code requirements and the key issues are discussed. Both the stairways in the case study building must comply with Sections 1003.3.3.1 through 1003.3.3.12.1 of the MBC.

Stairway width (MBC Section 1003.3.3.1)

- *Compliance requirements as per the MBC:*

The allowable width of stairways in a building is determined as specified in Section 1003.2.3 of the MBC. According to this section, the total width of means of egress in inches (mm) shall not be less than the total occupant load served by the means of egress multiplied by the factors in Table 1003.2.3 and not less than specified elsewhere in the building code.

Follow the calculations as per this section: According to Table 1003.2.3 of the MBC, the minimum stairway width in inches per occupant for a building with a sprinkler system is 0.2. Based on a building capacity assumption of a total of 500 occupants for both the buildings A and B, each stairway has an occupant load of 250 each.

Occupant load per stairway = 250

Width per occupant = 0.2

Total width of stairs = 250 * 0.2 = 50 inches = **4' 2" minimum**

These calculations are based on the occupant load for the new use in the case study building after rehabilitation, occupancy group R-2, with an assumption of three occupants per dwelling unit at a rate of 11 dwelling units per floor. In addition, according to Section 1003.3.3.1 of the MBC, no stairway may be less than 44 inches (1118 mm) wide as a base minimum. Considering these two design values, it is recommended that the stairs be no less than 50 inches wide, but it is required for the stairs to be a minimum of 44 inches wide. For this research purpose, 44 inches is used as the minimum width.

- *Existing condition of the building component:*

The existing stair width in the case study building is not in conformance with the new standards. The existing stair width is 40 inches in both buildings A and B, which is not compliant with the minimum requirement of 44 inches in the Michigan Building Code.

- *Rehabilitation work scope to make the component comply with the MBC:*

The stair width must be increased from 40 inches to 44 inches. The existing stairwell does not support this change, as the existing dimensions of the stairwell cannot accommodate the increased width. This necessitates the removal of the existing stairs, including the stairwell enclosures, and the introduction of new, compliant stairways. This defines the scope of the rehabilitation work to make the building comply with the Michigan Building Code.

Stairway Headroom (MBC Section 1003.3.3.2)

- *Compliance requirements as per the MBC:*

According to Section 1003.3.3.2 of the MBC, stairways shall have a minimum headroom clearance of 80 inches (2032 mm) measured vertically from a line connecting the edge of the nosing. Such headroom should be continuous above the stairway to the point where the line intersects the landing below, one tread depth beyond the bottom riser. The minimum clearance should be maintained along the full width of the stairway and landing. If in a building there are spiral stairways complying with Section 1003.3.3.9, a headroom clearance minimum of 78inches (1981 mm) is allowed by the MBC.

- *Existing condition of the building component:*

In the case study building, headroom clearance is less than the minimum requirement of 80 inches. In building A the headroom clearance varies because the building's floor heights vary on higher floors (see the elevation drawing of the building detailed in the previous section).

- *Rehabilitation work scope to make the component comply with the MBC:*

To make the existing stairs compliant with the MBC's headroom clearance requirements, they must be removed, including the stairwell enclosures, and rebuilt.

Stair Treads and Risers (MBC Section 1003.3.3.3)

- *Compliance requirements as per the MBC:*

According to Section 1003.3.3.3 of the MBC, stair riser heights shall be 7 inches (178 mm) maximum and 4 inches (102 mm) minimum. Stair tread depths shall be 11 inches (279 mm) minimum. The riser height shall be measured vertically between the leading edges of adjacent treads. The tread depth shall be measured horizontally between the vertical planes of the foremost projection of adjacent treads and at right angle to the tread's leading edge.

- *Existing condition of the building component:*

This is a very critical problem found in most vacant buildings that were built before modern-day building codes were established and used. Designers at that time usually designed the risers more than 8 inches high and the treads less than 11 inches wide. This resulted a smaller number of risers between different floor levels. But as new codes came to use, the riser and tread requirements were changed to reduce climbing strain. In the case study building neither the riser heights nor the tread depths meet the MBC standards, as the risers are 8 inches high and the treads are 10 inches wide in most places in building A and building B. Some parts of the stairs in Building B, metal stairs carrying rich architectural value, comply with the MBC standards.

- *Rehabilitation work scope to make the component comply with the MBC:*

To make the existing stairs compliant, riser heights and tread dimensions must be altered, which means that the existing stairs and stairwell enclosures must be removed and rebuilt.

Dimensional Uniformity (MBC Section 1003.3.3.3.1)

- *Compliance requirements as per the MBC:*

According to Section 1003.3.3.3.1 of the MBC, stair treads and risers shall be of a uniform size and shape. The tolerance between the largest and smallest riser or between the largest and smallest tread shall not exceed 0.375 inch (9.5 mm) in any flight of stairs. In addition, Section 1003.3.3.3.2 details the profile requirements. The radius of curvature at the leading edge of the tread shall be not greater than 0.5 inch (12.7 mm) and beveling of nosings shall not exceed 0.5 inch (12.7 mm).

Risers in the stairs should be solid and vertical or sloped from the underside of the leading edge of the tread above at an angle not more than 30 degrees from the vertical. The leading edge (nosings) of treads shall project not more than 1.25 inches (32 mm) beyond the tread below, and all projections of the leading edges shall be of uniform size, including the leading edge of the floor at the top of a flight.

- *Existing condition of the building component:*

A certain level of dimensional non-uniformity was noted in the case study building's stairs. This must be modified to meet the code standards.

- *Rehabilitation work scope to make the component comply with the MBC:*

Parts of existing stairs that do not meet MBC standards must be removed and rebuilt to make the building compliant.

Stairway Landings (MBC Section 1003.3.3.4)

- *Compliance requirements as per the MBC:*

According to Section 1003.3.3.4 of the MBC, there should be a floor or landing at the top and bottom of each stairway. The width of landings should not be less than the width of stairways they serve. Every landing should have a minimum dimension measured in the direction of travel equal to the width of the stairway. Such dimension need not exceed 48 inches (1219 mm) where the stairway has a straight run. According to the minimum stair width requirements of 44 inches set by the MBC, the stairway landing also takes the same minimum requirement of 44 inches.

- *Existing condition of the building component:*

The existing stairway width in buildings A and B, including landings, is 40 inches, as mentioned in the previous section detailing stairway width. Since the stairway width does not comply with the MBC requirements, the existing landing too does not comply with the MBC's minimum width requirement of 44 inches.

- *Rehabilitation work scope to make the component comply with the MBC:*

Existing stairway landings must be demolished and reconfigured according to the MBC's dimensional requirements of a minimum of 44 inches. As the previous code parameters necessitated the removal of existing stairs, this becomes a part of the same scope of rehabilitation work.

Vertical Rise (MBC Section 1003.3.3.6)

- *Compliance requirements as per the MBC:*

According to Section 1003.3.6 of the MBC, no flight of stairs should have a vertical rise greater than 12 feet (3658 mm) between floor levels or landings.

- *Existing condition of the building component:*

On most floors, the stairs meet the vertical rise requirement of the MBC. But on three stories of building A (floor levels 6, 7 and 7 A), the stairs have non-confirming vertical rises due to story heights different from the other floors of buildings A and B.

- *Rehabilitation work scope to make the component comply with the MBC:*

In the case study building, many code c omplications are observed in the upper floors of building A, including the stairway and its components. The existing stairway at the sixth and seventh floor levels of building A must be demolished a nd reconfigured according to the MBC's dimensional requirements as detailed above. As the previous code parameters necessitated the removal of the existing stairs on these floor levels of building A, this becomes a part of the same scope of rehabilitation work.

4.3.3.1.3 INTERIOR ENVIRONMENT

In any building it is highly essential to comply with the building code provisions that govern requirements related to the interior spaces of buildings, including ventilation, temperature control, lighting, yards and courts, sound transmission, room dimensions, surrounding materials and rodent proofing. According to the natural ventilation requirements, any occupied space should be provided with ventilation through windows, doors, louvers or other openings to the outdoors. The operating mechanism for the ventilation systems and other openings should be easily accessible so that the openings are readily controllable by the building occupants as required. In the case study building, the existing huge, decorative windows meet all the requirements for lighting (the minimum net glazed area shall not be less than 8 percent of the floor area of the room served) and ventilation. Since the walls, partitions and door assemblies separating dwelling units in the new rehabilitated residential use will be new, sound transmission from dwelling units or from public or service areas shall meet sound transmission class requirements as defined by the MBC. The primary component detailed under this section of the code that has compliance complications is related to minimum ceiling height. This has a considerable cost impact on the rehabilitation project.

Interior Space Dimensions (Section 1207)

Primary parameters addressed by this section of the MBC include minimum room widths, minimum ceiling heights, room areas, and the efficiency of dwelling units. Of these parameters, the most critical one related to the case study building is the ceiling height.

Minimum Ceiling Heights (MBC Section 1207.2)

- *Compliance requirements as per the MBC:*

According to Section 1207.2 of the MBC, any occupiable spaces, habitable spaces and corridors shall have a ceiling height of not less than **7 feet 6 inches (2286 mm).** Bathrooms, toilet rooms, kitchens, storage rooms and laundry rooms shall be permitted to have a ceiling height of not less than 7 feet (2134 mm). The 7 feet 6 inches is the net ceiling height available for living.

- *Existing condition of the building component:*

Complications related to the minimum ceiling height requirements are very severe in Building A. Table 16 shows the ceiling heights of the upper floors of building A. In the floor details, A – F 6 means the sixth floor of Building A. Figure 21 shows the real picture of the seventh floor level of the case study building, the ceiling of which is around 7 feet high, less than the code requirement. Thus, two floors in building A have ceiling heights less than the minimum requirements and must be reconfigured to comply with code.

Table 16: Details of Ceiling Heights in Building "A" in Case Study Building

Floor Level of Building A	Height of Ceiling in Feet
Floor **A – F 6**	7 Feet
Floor **A – F 7**	8 Feet
Floor **A – F 7A**	7 Feet
Floor **A – F 8**	11 Feet

Figure 21: Seventh Floor Level of Building A with Low Ceiling Height of Just around 7 Feet, Making it Not Compliant with the MBC Minimum of 7'6"

- *Rehabilitation work scope to make the component comply with the MBC:*

The researcher identified two options for working with the existing floors of building A to make them comply with the MBC. Option 1 is to demolish and reconfigure the existing floors 7, 7A and 8 of building A and space the three floors with a equal floor-to-floor height of 10 feet each. This option will result in four floors of 10 feet floor-to-floor height, for which the minimum ceiling height of 7'6" can be obtained after deducting 2' 6" for the ducting and flooring. See figure 22.

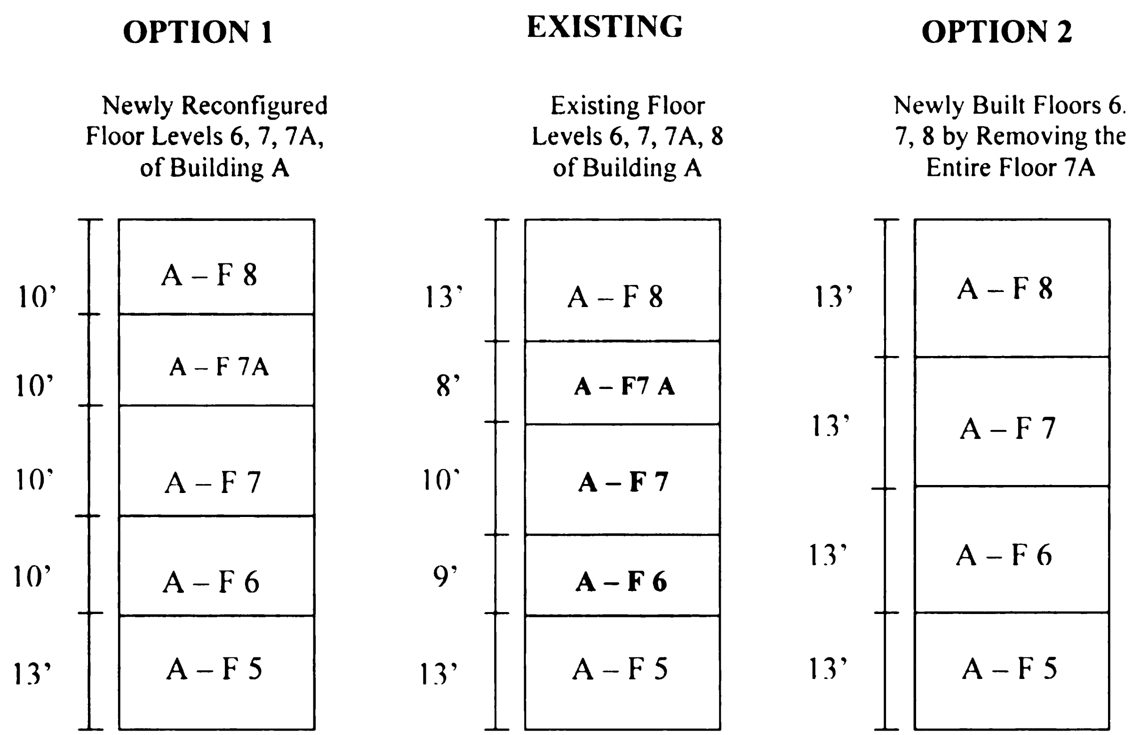

Figure 22: Two Options Devised by the Researcher to Reconfigure the Existing Floor-to-Floor Height to Make the Ceiling Height Compliant

Option 2 is to demolish the complete floor level 7A and reduce the number of floors to three with equal floor-to-floor heights of 13 feet each. This will change floors 6, 7, 7A and 8 to floor 6, 7 and 8, resulting in the loss of six dwelling units in building A.

For this research purpose, option 1 is selected for further analysis. Based on the option selected, the scope of rehabilitation work involves demolition of existing three floors and rebuilding the same with new floor-to-floor heights as shown in figure 22. This will involve the removal of existing floor slabs, floor finishes, ceiling finishes and related duct works.

4.3.3.1.4 INTERIOR FINISHES

Interior finishes form a primary part of the completed, usable building. This division of the building code governs the use of materials as interior finishes, trim and decorative materials. These provisions limit the allowable flame spread and smoke development based on location and occupancy classification. As per Section 805.1.2, the permissible amount of flame-resistant decorative materials shall not exceed 10 percent of the aggregate area of walls and ceilings. Material used as interior trim shall have a minimum Class C flame spread index and smoke-developed index. Combustible trim, excluding handrails and guardrails, shall not exceed 10 percent of the aggregate wall or ceiling area in which it is located.

According to the Michigan Building Code, interior wall and ceiling finishes are grouped in the following classes in accordance with their flame spread and smoke-developed indexes.

- **Class A:** flame spread 0-25; smoke developed 0-450.
- **Class B:** flame spread 26-75; smoke developed 0-450.
- **Class C:** flame spread 76-200; smoke developed 0-450.

As per Table 803.4 of the MBC, detailing interior wall and ceiling finish requirements by occupancy, in a group R-2 use building with a sprinkler system, interior finishes of Class C material or higher must be used for all rooms and enclosed spaces, vertical exits and exit passageways, exit access corridors and other exit ways. In the case study building, most of the floors need new floor finishes, as the existing floor finishes are damaged and need to be changed for the new R-2 use. Existing wall and ceiling finishes in the building are usable, but they need to be checked for code compliance.

Wall And Ceiling Finishes (Section 803)

- *Compliance requirements as per the MBC:*

As per section 803 of the MBC, interior finish materials should be applied (materials like paints for example) or otherwise fastened (for example if a vinyl or gypsum board is fastened to furring on the wall) in such a manner that these materials will not be detached or destroyed when subjected to room temperatures of 200°F (93°C) and above for more than 30 minutes. According this section of the building code, it is essential for the walls and ceilings to be fire-resistance-rated and made of noncombustible construction materials. The interior finish material should be applied directly against existing superstructure materials or to furring strips not exceeding 1.75 inches (44 mm) in width applied directly against such surfaces. The intervening spaces between the furring strips used to fix the interior finish materials can be filled with inorganic or Class A material. It can also be fire blocked at a maximum of 8 feet (2438 mm) in any direction in accordance with Section 716. An interior wall or ceiling finish that is not more than 0.25 inch (6.4 mm) thick can be applied directly against a noncombustible backing. For the new group R-2 occupancy use, it is essential that all the interior finish materials are non-combustible and Class C or higher, based on their flame spread and smoke-developed indexes.

- *Existing condition of the building component:*

The wall and ceiling finishes that were initially installed in the building need to be tested for flame spread and smoke developed indexes, as historical data for these tests are not available for the case study building. However, irrespective of the class of materials existing, the conditions of the finishes needs to be altered significantly. Figure 23 shows the existing condition of the ceiling and wall finishes in the case study building.

Figure 23: Existing Wall and Ceiling Finishes in the Case Study Building as Used During the Earlier Occupancy Group B, Pictured in September 2002.

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- *Rehabilitation work scope to make the component comply with the MBC:*

On most floors of the building, the existing wall and ceiling finishes are damaged extensively, as seen in the previous figure. The main reason for this deterioration is lack of maintenance, as the building has been lying vacant for more than fifteen years. In order to make this building suitable for habitation by use group R-2, all the existing damaged wall and ceiling finishes must be ripped off and reapplied in accordance with the current flame spread and smoke-developed index standards. According to Table 803.4 of the MBC, for a use group R-2 use building with a sprinkler system, Class C material or higher (based on flame spread and smoke-developed index) must be used for all rooms, enclosed spaces, vertical exits, exit passageways, exit access corridors and other exit ways.

4.3.4.1.5 RECAP OF CODE ANALYSIS USING THE MBC

This code analysis, performed using the Michigan Building Code, discussed components that were critical in terms of adding cost to the rehabilitation budget. In the case study building, existing components that have code compliance issues were detailed in three categories:

- *Compliance requirements as per the MBC*
- *Existing condition of the building component*
- *Rehabilitation work needed to make the component comply with the MBC*

The third category details the *scope of work* or the *specifications* for rehabilitation that must be performed to make the building comply with the MBC's requirements. A cost analysis for the related scope is given in later sections of this chapter. Also, a detailed code analysis has been performed for the case study building and attached in the appendix of this research report. Though the *code analysis* provided in the appendix is based on the new Michigan Existing Building Code (MEBC), for each code issue discussed, its suitable comparison with the regular Michigan Building Code has been developed and detailed in the Allowable / Required Limits section of the code analysis table. Refer to appendix for details on this code analysis. Since the Michigan Building Code is a replica of the International Building Code (IBC), the sections identified in the appendix analysis report will mention MBC sections as sections from the IBC. In addition, sections that are marked with "$$$" in the code analysis report have a related cost impact. Detailed notes corresponding to each cost impact are furnished in the code analysis worksheets provided in the appendix.

4.3.3.2 MICHIGAN EXISTING BUILDING CODE-BASED ANALYSIS

A comprehensive discussion of the new Michigan Existing Building Code's (MEBC) history, reasons needed, development and implementation has been furnished in chapters two and three of this research report. The ICC developed an exclusive code for addressing the issues related to rehabilitation in existing buildings, called the International Existing Building Code (IEBC) which was very similar to but more comprehensive than the rehabilitation code matrix that was developed and opened up for public hearings by the Michigan Department of Consumer and Industry Services (CIS), Division of Codes and Standards. The State of Michigan adopted this code as "Michigan

Existing Buildings Code" (MEBC) effective October 31, 2002 [CIS 2002]. Since the IEBC has been almost completely adopted as the MEBC, with very few changes as detailed in section 3.5 of this research report, all the rehabilitation code analysis performed in this chapter is based on the final draft of the IEBC.

A detailed *rehabilitation code analysis* has been performed and tabulated as a primary outcome of this research. The rehabilitation code analysis is attached in the appendix of this research report. It is essential to follow the code analysis worksheet in detail for this part of the MEBC-based code analysis. Important cost-based code impacts of the MEBC in comparison to the regular MBC are discussed in the following section. The researcher recommends following the code analysis worksheet for better understanding.

4.3.3.2.1 DESCRIPTION OF MEBC ANALYSIS IN CASE STUDY BUILDING

The MEBC is categorized into thirteen different chapters, discussing rehabilitation procedures based on the identified scope. The first, most important consideration using the MEBC is to define the scope of rehabilitation. Once the scope is defined, then the relevant chapters of the MEBC are followed to check the compliance requirements of the existing building as per the code standards.

In the case study building, based on the scope of rehabilitation detailed in section 4.3.3 of this chapter, all the compliance requirements need to be met as per Chapter 8 of the MEBC, ("Change of Occupancy"). The case study building has been completely analyzed for compliance requirements as per the MEBC and the same has been detailed in the code analysis worksheet provided in the appendix of this research report. Since there is a change of occupancy from group B to group R-2 in the proposed scope of rehabilitation of the case study building, all the sections of Chapter 8 and other related sections required by Chapter 8 are summarized in the notes and remarks column of the code analysis table in the appendix.

CHANGE OF OCCUPANCY AND RELATIVE HAZARD AS PER THE MEBC

When there is a change of occupancy in a rehabilitation project, the change must comply with the standards set forth by Section 812.2 of the MBC, detailing "hazard category classifications." The relative degree of hazard of different occupancy groups shall be as set forth in the hazard category classifications, shown in Table 17, 18 and 19. The change of hazard groups can be of two types :

- Change of occupancy classification to an equal or lesser hazard (Section 812.2.1 of the MEBC)
- Change of occupancy classification to a higher hazard (Section 812.2.2 of the MEBC)

An existing building shall comply with all the applicable requirements of Chapter 8 of the MEBC based on the respective hazard groups into which the change intended falls. The three major hazard category classifications detailed in the MEBC are:

- **Means of egress:** Hazard categories in regard to life safety (refer to Table 17)
- **Heights and areas:** Hazard categories in regard to heights and area (refer to Table 18)
- **Exterior wall fire resistance ratings:** Hazard categories in regard to fire resistance ratings of exterior walls (refer to Table 19)

Table 17: Hazard Category for Subsection Life Safety and Exits [MEBC 2002]

HAZARD CATEGORIES AND CLASSIFICATIONS: Life Safety and Exits	
Relative Hazard	**Occupancy Group**
1 (Highest)	H-1, H-2, H-3, H-4, H-5
2	I-2, I-3, I-4
3	A, E, I-1, M, R-1, **R-2**, R-4
4	**B**, F-1, R-3, S-1
5 (Lowest)	F-2, S-2, U

Table 18: Hazard Category for Subsection Height and Area [MEBC 2002]

HAZARD CATEGORIES AND CLASSIFICATIONS: Height and Area	
Relative Hazard	**Occupancy Group**
1 (Highest)	H-1, H-2, H-3, H-4, H-5
2	A-1, A-2, A-3, A-4, I, R-1, **R-2,** R-3 R-4
3	E, F-1, S-1, M
4 (Lowest)	**B**, F-2, A-5, R-3, S-2, U

Table 19: Hazard Category for Subsection Exposure of Exterior Walls [MEBC 2002]

HAZARD CATEGORIES AND CLASSIFICATIONS: Exposure of Exterior Walls	
Relative Hazard	**Occupancy Group**
1 (Highest)	H-1, H-2, H-3, H-4, H-5
2	F-1, M, S-1
3	A, **B,** E, I, **R**
4 (Lowest)	F-2, S-2, U

In the case study building, based on the scope of the project, the change in occupancy is from group "B" to group "R-2". For this change, the first two categories of relative hazard related to means of egress and heights and areas are raised from a lower hazard category to a higher hazard category, whereas the third relative hazard category, related to exterior wall fire resistance ratings, remains at the same level. All the provisions related to the above detailed relative hazard classifications must comply with the MEBC provisions. For detailed comments on these sections of analysis, refer to the code analysis worksheet.

4.3.3.3 CRITICAL FINDINGS OF CODE ANALYSIS

Some of the critical findings of the code analysis of the case study building using both the Michigan Building Code (MBC) and the Michigan Existing Building Code (MEBC) define the clear difference in the scope of rehabilitation between using the MEBC and using the MBC. In this section, the major findings are summarized under four different categories that have a significant cost impact on the overall process of rehabilitation work:

- **FIRE PROTECTION: FIRE-RESISTANCE-RATED CONSTRUCTION**
- **MEANS OF EGRESS**
- **INTERIOR ENVIRONMENT**
- **INTERIOR FINISHES**

To facilitate better understanding, these critical findings are summarized under two major subsections: requirements of the MBC and requirements of the MEBC.

- **FIRE PROTECTION: FIRE-RESISTANCE-RATED CONSTRUCTION**

Requirements of MBC: Refer to section 4.3.4.1.1 of this chapter for MBC requirements related to Fire Protection and FRR construction.

Requirements of MEBC: Refer to section 804 of Rehabilitation Code Analysis, attached in the ***appendix of this research report,*** for the MEBC's requirements related to fire protection and FRR construction in the case study building.

- **MEANS OF EGRESS**

Requirements of MBC: Refer to section 4.3.4.1.2 of this chapter for the MBC requirements related to means of egress.

Requirements of MEBC: Refer to section 805 of Rehabilitation Code Analysis, attached in the *appendix of this research report*, for the requirements of the MEBC related to means of egress.

Table 20: Summary of Critical Differences in the Provisions of the MBC and the MEBC Related to Stairways, a Means of Egress Component (Cost Impact)

Differences in the Provisions of MBC and MEBC Related to Means of Egress		
Stairway Components	**As Per the MBC**	**As Per the MEBC**
Means of Egress Width	Min 50" for 500 occupants, but not less than 44"	At least 22" (559 mm)
Stair Riser Heights	Not more than 7" and not less than 4"	Not more than 8" (203 mm)
Stair Tread Depths	Not less than 11"	Not less than 8" (203 mm)
Stairway Landings	Not less than 44" wide by 44" long.	Not less than 40" wide by 36" long
Stair Slope	Maximum of 1:1.5	Maximum of 1:1

- **INTERIOR ENVIRONMENT**

Requirements of MBC: Refer to section 4.3.4.1.3 of this chapter for MBC requirements related to the interior environment.

Requirements of MEBC: Refer to section 601.3.4 of Rehabilitation Code Analysis, attached in the *appendix of this research report*, for the requirements of the MEBC related to the interior environment requirements (particularly ceiling height).

- **INTERIOR FINISHES**

Requirements of MBC: Refer to section 4.3.4.1.4 of this chapter for requirements of the MBC related to interior finishes.

Requirements of MBC: Refer to section 803 of Rehabilitation Code Analysis, attached in the *appendix of this research report,* for the MEBC requirements related to building elements and materials (interior finishes).

The code analysis critical findings furnished in the above section are related to the change in occupancy made in the case study building. Since, in two out of the three hazard classifications (as per the MEBC) the proposed scope of rehabilitation raises the building to a higher hazard category, the above summarized findings were only identified as cost critical in the entire process of proposed rehabilitation. In any general rehabilitation that does not involve a change of occupancy, or if there is a change of occupancy and the change of occupancy is made to an equal or lesser hazard category (as per section 812.2.1 of the MEBC), then many more benefits can be achieved in the the rehabilitation process using MEBC over the regular MBC. In the rehabilitation code analysis attached in the appendix of this research report, few such cost critical benefits of the MEBC for rehabilitations without a change of occupancy are mentioned. If there is no change of occupancy in a rehabilitation project, then based on the scope of the project, any one of the four categories of work (repairs, levels 1 to 3 of alterations, renovations, and reconstructions) would have increased benefits from these cost-effective rehabilitation provisions that help to save costs significantly in rehabilitation of old and vacant structures.

4.3.4 COMPREHENSIVE COST ANALYSIS OF REHABILITATION

Based on the code analysis performed, key cost elements have been identified. Using the R.S. Means Square Foot Costs Construction Data – 2000 [Means 2000] and R.S. Means Repair and Remodeling Cost Data – 2002 [Means 2002], rehabilitation costs of the case study building have been calculated and tabulated in Table 21. This table summarizes the total costs of rehabilitation of the case study building using the MBC and the MEBC in comparison with the cost of constructing a new building similar to the existing case study building. The general costs of construction and related elements for an apartment building similar to the rehabilitated case study building are shown in Table 21, and this data is used for the overall cost analysis summarized in Table 22 and Table 23. This cost analysis section is divided into four major sections:

- *Cost for construction of a new structure similar to the case study building*
- *Cost of rehabilitating the case study building using the MBC*
- *Cost of rehabilitating the case study building using the MEBC*
- *Cost comparisons and summary of rehabilitation cost analysis*

The different cost parameters adopted for each respective code analysis (MBC and MEBC) are discussed under each related section. The costs of rehabilitation items are taken from the Means construction cost data book, and the related explanation is offered in this section of the research report. As per the design proposed for conversion of current use group B to new use group R-2, building A and B together result in *10 to 11 dwelling units per floor*, totaling *around 70 dwelling units* in the entire building after the proposed rehabilitation and conversion. Based on the geometry of the existing building, dwelling unit floor plans have been designed by the architect (see Figure 19 for an example). The floor area of *each dwelling unit averages around 1000 square feet*, thereby creating a *total of around 80,000 square feet of dwellable area* in a building that is currently old, vacant, and abandoned without any use or value. In the cost analysis performed for the scope of this research, the researcher used the unit square feet costs of entire residential units and the unit line item costs for the rehabilitable building components from the

Means books. Based on the detailed estimates prepared, the costs obtained are summarized in the cost analysis tables, Table 21, Table 22 and Table 23.

4.3.4.1 COST FOR NEW CONSTRUCTION OF SIMILAR BUILDING

In order to better understand the costs involved with the rehabilitation and reuse of existing buildings, the costs for constructing a new building similar to the case study building in terms of type, size, area and location (Detroit) for the proposed use (group R-2) are calculated and summarized in Table 21. For this exercise, model costs are calculated for an apartment building (Group R-2) that is 15 stories high with a 10'6" story height and 162,000 square feet of floor area using R. S. Means Square Foot Costs building cost data. The unit square foot cost of a building similar to that of the case study building is identified and with this unit square foot cost, the cost of a new building for an area of 108,000 sq. ft. (the area of case study building) was calculated to be $9,238,320.00 (approximately 9.3 million dollars). For details, refer to section C of the summary cost comparison shown in Table 22.

Table 21 details the cost of new construction under twelve subsections. Based on the unit costs table, new construction will cost $80.70 per square foot, excluding the contractor's and architect's fees. The price of construction before these additional fees is considered for the cost analysis in this research. Since the case study building is located in Detroit, the *City Cost Index* of *106.5* is added to the base national cost. With this, the new construction will cost $85.54 per square foot, excluding the contractor and architect's fees. The unit square foot cost is used for further cost analysis in the research work.

The various sections under which the new construction costs categorized include: site work, foundations, substructure, superstructure, exterior enclosures, roofing, interior construction, conveying systems, mechanical systems, electrical systems, and related special construction. The related percentages of costs involved with each section is tabulated and these percentages are used to define the rehabilitation cost percentages in comparison with new construction in the later sections of this cost analysis. In addition, the existing building must be demolished to use the site of the case study building to construct a new structure. Hence the costs of demolishing the existing structure, with a gross area of 108,000 square feet, and clearing the debris are included along with the construction cost of the new building in the cost comparison (Table 22, under Section E). The demolition costs are taken from the R.S. Means Repair and Remodeling Cost Data 2002 [Means 2002].

The total cost of constructing a new structure similar to the case study building in the same location is obtained by adding the new structure construction cost ($9,238,320) and the existing structure demolition cost ($945,000), resulting in about $10,183,320 or approximately 10.2 million dollars. This construction value is used in the cost comparison and cost savings Table 22 and 23 for further cost analysis.

Table 21: SQUARE FOOT COSTS OF APARTMENT (8-24 STORY) [MEANS 2000]

Model Costs Calculated for a 15 Story building with 10'-6" story height and 162,000 SFT of floor area

			Unit	Unit Cost	Cost Per SF	% of Sub-total
1.0	**Foundations**					
0.1	Footings & Found.	Poured concrete; strip and spread footing and 4' wall	S.F.Ground	11.55	0.77	1.00%
0.4	Piles & Caissons	N/A	-	-	-	
0.9	Excavat. & Backfill	Site preparation for slab & trench for found. wall & footing	S.F.Ground	0.96	0.06	
2.0	**Substructure**					
0.1	Slab on Grade	4" reinforced concrete with vapour barrier	S.F. Slab	3.27	0.22	0.30%
0.2	Special Substructures	N/A	-	-	-	
3.0	**Superstructure**					
0.1	Columns and Beams	Gypsum board fireproofing on columns	S.F. Floor	2.68	2.68	16.10%
0.4	Structural Walls	N/A	-	-	-	
0.5	Elevated floors	Open web steel joists, slab form, concrete, steel columns	S.F. Roof	9.66	9.02	
0.7	Roof	Open web steel joistswith rib metal deck, steel columns	S.F. Floor	3.77	0.25	
0.9	Stairs	Concrete filled metal pan	Flight	3900	1.04	
4.0	**Exterior Closure**					
0.1	Walls	Ribbed precast concrete panel *87% of wall*	S.F. Wall	16.21	6.58	11.00%
0.5	Exterior wall finish	N/A	-	-	-	
0.6	Doors	Aluminium and glass	Each	1527	1.16	
0.7	Windows and glz wall	Aluminium horizontal sliding *13% of wall*	Each	298	1.15	
5.0	**Roofing**					
0.1	Roof coverings	Built-up tar and gravel flashing	S.F. Roof	2.55	0.17	0.30%
0.7	Insulation	Perlite / EPS composite	S.F. Roof	1.29	0.09	
0.8	Openings & Specials	N/A	-	-	-	
6.0	**Interior Construction**					
0.1	Partitions	Gypsum board on concrete block and metal studs	S.F.Partition	8.24	8.24	29.90%
0.4	Interior Doors	15% solid core wood, 85% hollow core wood	Each	456	5.7	
0.5	Wall finishes	70% paint, 25% vinyl wall covering, 5% ceramic tile	S.F.Surface	1.09	2.17	
0.6	Floor finishes	60% carpet, 30% vinyl composition tile, 10% ceramic tile	S.F. Floor	4.22	4.22	
0.7	Ceiling Finishes	Painted gypsum board on resilient channels	S.F.Ceiling	2.74	2.74	
0.9	Interior/Exterior surf.	Painted gypsum board on furring *80% of wall*	S.F. Wall	3.01	1.07	
7.0	**Conveying**					
0.1	Elevators	Four geared passenger elevators	Each	228,420	5.64	7.00%
0.2	Special conveyors	N/A	-	-	-	
8.0	**Mechanical**					
0.1	Plumbing	Kitchen, bathroom fixtures, supply and drainage	Each	1692	8.06	23.80%
0.2	Fire Protection	Standpipe and wet pipe sprinkler system	S.F. Floor	2.01	2.01	
0.3	Heating	oil fired hot water, baseboard radiation	S.F. Floor	3.84	3.84	
0.4	Cooling	Chilled water, air cooled condenser system	S.F. Floor	5.28	5.28	
0.5	Special Systems	N/A	-	-	-	
9.0	**Electrical**					
0.1	Service & Distribution	1200 ampere service, panel board and feeders	S.F. Floor	0.46	0.46	8.20%
0.2	Lighting & Power	Incandescent fixtures, receptacles, switches, and A.C.	S.F. Floor	4.73	4.73	
0.4	Special Electrical	Alarm systems, emergency lighting, antena and secrity	S.F. Floor	1.43	1.43	
11.0	**Special Constrcution**					
0.1	Specialities	Kitchen cabinets	S.F. Floor	1.92	1.92	2.40%
12.0	**Site Work**					
0.1	Earthwork	N/A	-	-	-	0.00%
0.3	Utilities	N/A	-	-	-	
0.5	Roads and parking	N/A	-	-	-	
0.7	Site Improvements	N/A	-	-	-	
	SUB- TOTAL				**80.70**	**100%**
	Contractor Fees (General Req: 10%, Overhead: 5%, Profit: 10%)			25%	20.18	
	Architect Fees			6%	6.07	
	TOTAL BUILDING COST				**106.95**	

4.3.5.2 COST OF REHABILITATING CASE STUDY BUILDING USING MBC

The discussion in this section is based on Table 22, the cost comparison table developed for the case study building. Follow the "Rehabilitation using MBC" section of Table 22 for related cost analysis of using the MBC for rehabilitation projects. As shown in section **A** of Table 22, the total percentage of new construction in the case study building for new use group R-2 is around 71.60%; this is obtained by excluding all existing components of the building that can be used for the new residential use. The components of the existing building that constitute the remaining 28.40% include site work, foundations, substructure, superstructure and the exterior enclosures. All the remaining components such as roofing, interior construction, conveying, mechanical, electrical and special construction for the R-2 use need to be built new, as the existing building is mostly open without any interior partition walls or other related systems. This is irrespective of rehabilitation using the MBC or the MEBC.

In order to make the case study building comply completely with the standards of the MBC, some of the existing building components in the 28.40% category need to be worked on. These components were discussed in detail in earlier section 4.3.4.1, *"Michigan Building Code (MBC) Based Analysis,"* detailing the requirements of rework to make the structure comply with the MBC. The major components that have a substantial cost impact in terms of rehabilitation are estimated to determine the rehabilitation costs using the MBC. For preparing rehabilitation estimates, R.S. Means Repair and Remodeling Cost Data 2002 [Means 2002] and R.S. Means Square Feet Cost Data 2000 [Means 2000] were used. The four major cost impactive parameters in the rehabilitation process identified in the MBC code analysis include these costs of rehabilitation and building reconstruction (as required by MBC and detailed in code analysis):

- ***Means of egress (existing stair demolition and stair reconstruction) - $1,106,290***
- ***Improving FRR of exterior enclosures and existing walls - $ 227,590***
- ***Altering ceiling heights for compliance (Section 4.3.4.1.3.1.1) - $ 307,570***
- ***Improving FRR of vertical shafts and enclosures - $ 34,440***

These costs add up as part of the 71.60% new construction cost in defining the cost of rehabilitation. In addition to these two costs shown in Section D and F of Table 22, the costs of improving the appearance of and repairing the existing building components are compiled in section G of Table 22. The cost of improvement includes cost of improvement of existing materials (such as windows, doors, and wall finishes) and cleaning and restoration of the existing masonry walls. Based on the existing condition of the case study building, this cost was estimated at $930,000.

Accounting for all these cost components, the total rehabilitation cost of the case study building using the MBC sums up to $9,220,528, approximately 9.2 million dollars. The major benefit that the process of rehabilitation brings over demolition and new construction is that the historical value of the building is retained and this in turn helps in maintaining the rich historical status of the city. These costs are further used in Table 23 to determine the cost savings of rehabilitation using the MBC and the MEBC.

Table 22: NEW CONSTRCUTION vs REHABILITATION COST COMPARISON TABLE IN CASE STUDY BUILDING

S. No	BUILDING COMPONENT / ACTIVITY	% Value	For Total New Construction	Rehabilitation using MBC	Rehabilitation using MEBC
1.0	Foundations	1.00%	New foundations (1.00%)	***Not required as existing (0%)***	***Not required as existing (0%)***
2.0	Substructure	0.30%	New substructure(0.30%)	***Not required as existing (0%)***	***Not required as existing (0%)***
3.0	Superstructure	16.10%	New Superstructure (16.1%)	Rehab work needed (see below)	***Not required as existing (0%)***
4.0	Exterior Closure	11.00%	New Exteriors closure (11.00%)	Rehab work needed (see below)	***Not required as existing (0%)***
5.0	Roofing	0.30%	New Roofing (0.30%)	New Roofing (0.30%)	New Roofing (0.30%)
6.0	Interior Construction	29.90%	New Interior Construc. (29.90%)	New Interior Construc. (29.90%)	New Interior Construc. (29.90%)
7.0	Conveying	7.00%	New Conveying (7.00%)	New Conveying (7.00%)	New Conveying (7.00%)
8.0	Mechanical	23.80%	New Mechanical (23.80%)	New Mechanical (23.80%)	New Mechanical (23.80%)
9.0	Electrical	8.20%	New electrical (8.20%)	New electrical (8.20%)	New electrical (8.20%)
10.0	Special Constrcution	2.40%	New Special Construc. (2.40%)	New Special Construc. (2.40%)	New Special Construc. (2.40%)
A	**SUBTOTAL**	100%	**100%**	**71.60%**	**71.60%**
B	**Total area of building under consideration**		108,000 SFT	108,000 SFT	108,000 SFT
C	Construction Cost per square feet -Detroit City (without fees)		$85.54	$85.54	$85.54
D	**COST 1: D = (A*B*C)**		**$9,238,320**	**$6,614,638**	**$6,614,638**
E	**COST OF DEMOLITION**		$945,000	NOT APPLICABLE	NOT APPLICABLE
F	**COST OF REHABILITATION**		NOT APPLICABLE		Not Needed as per MEBC
	1. Means of Egress (Stairs)		NOT APPLICABLE	$1,106,290	Not Needed as per MEBC
	2. Fire Resistance Rating of Walls		NOT APPLICABLE	$227,590	Not Needed as per MEBC
	3. Interior Dimensions (Ceiling height)		NOT APPLICABLE	$307,570	Not Needed as per MEBC
	4. Vertical shafts & enclosures-FRR		NOT APPLICABLE	$34,440	Not Needed as per MEBC
G	**COST OF IMPROVEMENT**				
	1.Improvement of existing materials		NOT APPLICABLE	$630,000	$630,000
	2.Masonary restoration and cleaning		NOT APPLICABLE	$300,000	$300,000
H	**TOTAL COST OF USING THE BUILDING FOR R-2 USE (H = D + E + F+ G)**		**$10,183,320** *100%*	**$9,220,528** *90.55%*	**$7,544,638** *74.09%*

4.3.5.3 COST OF REHABILITATING CASE STUDY BUILDING USING MEBC

Based on the rehabilitation analysis performed using the MBC and the MEBC, the existing building components that need to be rehabilitated to make the case study building comply with the MEBC are identified and explained in *section 4.3.4.2*. The benefits offered by the MEBC over the MBC are discussed in the same section, based on which the scope of rehabilitation and related costs have been identified. The major existing problems the case study building had with the requirements of the MBC, such as means of egress (stairs), fire-resistance ratings of building components, interior dimensions (ceiling height) and the vertical shafts and enclosures, are relaxed under the provisions of the new Michigan Existing Building Code. As per section F of Table 22, these costs of rehabilitation are not needed under the MEBC as the existing components comply with the MEBC's requirements.

However, since the building was vacant and not used for more than fifteen years, general improvement of the existing building components to acceptable and livable standards is highly essential. The cost of improvement of these components was estimated to be $930,000 (See section G of Table 22 under the MEBC category). Therefore, adding the costs of new additions and changes suiting the use group R-2 (71.60% as shown in section A of Table 22), and the costs of improvement, the total rehabilitation expenditures for the case study building using the MEBC for compliance requirements are estimated at $7,544,638, approximately 7.5 million dollars. The cost of rehabilitation using the MEBC is 81.82% of the new construction cost, as shown in Table 22.

4.3.4.1.1 REHABILITATION COST SAVINGS BY ADOPTING THE MEBC OVER THE MBC–ANALYSIS BASED ON SUMMARY COST TABLE

The comprehensive rehabilitation cost saving analysis was performed as an outcome of the code based cost analysis. The rehabilitation cost savings are then categorized as under the MBC or under the MEBC. These costs are then compared with the cost of new construction similar to the case study building, and with each other to determine the cost benefits and savings of using the MEBC over the MBC for the rehabilitation of existing old, vacant and / or underutilized buildings. The detailed cost savings are shown in Table 23.

Rehabilitation using the MBC accounted to savings of around $962,792 over new construction, which is about 9.45% savings in terms of cost of using the building for use group R-2. On the other hand, rehabilitation using the MEBC accounted for savings of around $2,638,682 over new construction, which is about 25.91% savings.

One of the imperative objectives of this research was to identify and tabulate the rehabilitation cost savings of using the new MEBC over the regular MBC to address the growing rehabilitation needs in Michigan. In the selected case study building, a total savings of 18.18% of rehabilitation costs was achieved even with a change of occupancy from a lower hazard use group to a higher hazard use group. The savings achieved in the proposed rehabilitation project based on the code and cost analysis performed was to the tune of about $1.7 million, which can be witnessed from the rehabilitation cost savings Table 23 developed to meet the defined research objectives.

In the case study building, existing first floor is used for retail purposes and

Table 23: SUMMARY OF COST SAVINGS IN REHABILITATION USING MEBC OVER MBC

S.No	Parameter of Cost	New Construction similar to case study building	Rehabilitation to Use Group R-2 using MBC	Rehabilitation to Use Group R-2 using MEBC
1	**TOTAL COST OF USING THE BUILDING FOR GROUP R-2**	$10,183,320	$9,220,528	$7,544,638
2	**TOTAL COST SAVINGS** *Compared in relation to the highest cost category - New Constrcution*	Base Value	$962,792	$2,638,682
3	**PERCENTAGE OF COST** *Percentage based on new constrcution costs*	100%	90.55%	74.09%
4	**PERCENTAGE COST SAVINGS** *% Savings with respect to New constrcution*	Base Value	9.45%	25.91%
5	**PERCENTAGE REHAB COST SAVINGS** *% Savings Using MEBC over MBC. The Cost savings Using MEBC are compared with costs involved in using MBC for rehabilitation work*	NOT APPLICABLE	Base Value	18.18%

rental income that is capitalized by leasing to the retailers serves as an input into the cost savings factor as that can be taken as a source of investment towards the rehabilitation work. Also, the residential units that are brought in by the process of rehabilitation along the downtown crossings increases the potential for more and more retail shops that in turn has a significant impact on the rolling economy for both the city as well as the individual building owners who decide to rehabilitate. In the case study building there is no change made to the first floor retail shops as, recently some alterations has been performed only at this level, and this rental income coupled with the rehabilitation cost savings can create a significant impact on the cost parameters related to rehabilitation.

4.4 ASSUMPTIONS FOR THE CASE STUDY ANALYSIS

The case study building was built in early 1900's and hence there were no precise documentation made for the building element's properties that were used during construction. Based on this factor of uncertainty, the author made some assumptions after discussions with practicing architects and code officials in the City of Detroit to address the issues of buildings that were built in the same period in the similar surroundings. Some of the assumptions made include:

- The Fire Resistance Rating (FRR) values of different building elements that exist in the case study building are not available. But FRR values are essential to determine the fire resistance capacity of the structure. In consultation with the practicing architect and code officials, a FRR of *one hour* is assumed to be existing in all of the existing building elements in the case study building

- The structural strength of the building was assumed to be in permissible limits as the building is converted from Group B use to Group R-2 use. There were no standard structural testing results available to be used during the analysis.
- Gravity loads, seismic loads, snow loads, and wind load factors are assumed to be under permissible limits for the new residential use in the code analysis
- The issues related to the lead based health effects were not considered under the defined scope of this research work
- A total occupant load of 500 was assumed for the entire building at a rate of 4 persons per dwelling unit. This assumptions was used for various capacity calculations in the code analysis (e.g. Means of egress, lighting, ventilation etc.)

4.5 LIFE CYCLE OF THE REHABILITATED BUILDINGS

The life cycle of any building that is constructed either new or rehabilitated depends upon the quality of operation, maintenance, repair and services rendered at proper intervals. According to the State of Minnesota, sustainable building guidelines, life cycle of a building in general is calculated for a minimum of 50 years, out of which a 50 year life for major building structural components, exclusive of interior construction, finishes, and furnishings is established as a basic design criteria in most construction projects [MSBG 2003]. In most cases, the structural components of a building are more durable and as such, they sustain for a longer period. However, the interior construction that includes the mechanical, electrical, plumbing systems and other finishes need constant maintenance for better life. As most of the non-durable elements discussed above are changed during rehabilitation process, the life cycle of the structures must be as good as new structures with a very minimal factor of failure probability.

4.6 SUMMARY

A comprehensive code and cost analysis of using the Michigan Building Code (MBC) versus the new Michigan Existing Building Code (MEBC) for rehabilitating existing old, vacant and underutilized buildings was documented in this chapter. Based on the author's knowledge of building codes and visits to the case study building in Detroit, detailed rehabilitation specifications related to the code and cost analysis were developed and documented. Two major building codes, the MBC (Michigan Building Code 2000) and the MEBC (Michigan Existing Buildings Code 2003), were used to analyze the identified case study building for code compliance requirements and their significant impacts on cost of rehabilitation.

In this research, the case study building identified is proposed to be converted from business use group B into a high-rise residential use group R-2. Since in this particular rehabilitation scope there is a change in occupancy from a lower hazard use group to a higher hazard use group, as defined by the new rehabilitation code, only around an 18 percent cost benefit over new construction was achieved. However, based on the researcher's findings, it is evident that if rehabilitation results in either the same use group or a use group in the same or a lower hazard category, the cost benefits provided by the new rehabilitation code would be significant.

CHAPTER FIVE

IMPACT OF BUILDING REHABILITATION ON URBAN REVITALIZATION

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5.1 INTRODUCTION

The previous chapters attempt to explain the different code compliance requirements for the process of rehabilitating existing old and vacant buildings. The code compliance requirements as per the Michigan Building Code (MBC) and the Michigan Existing Building Code (MEBC) were applied to define and explain the rehabilitation scope in the process of building rehabilitation. In chapter 4, the author identified a case study building in the City of Detroit that can be characterized as in the old, vacant and underutilized category of buildings and performed a comprehensive code and cost analysis by defining the scope of rehabilitation based on the compliance requirements of the identified building codes.

The author analyzed various subsections of the building codes (MBC and MEBC) to check the compliance requirements for the defined scope of rehabilitation and identified critical cost-saving factors in the process of building rehabilitation. The results were tabulated and the effectiveness of using the new Michigan Existing Building Code (MEBC) over the regular Michigan Building Code (MBC) for the process of building rehabilitation was validated by the cost savings achieved in the code-based cost analysis furnished in Chapter 4. This chapter delves into the impact of cost-effective rehabilitation (adopting the MEBC) of old, vacant and underutilized existing buildings that form an integral part of the Built Environment on the overall process of urban revitalization.

Various social, economic, political and cultural researchers and urban scientists have studied the process of revitalization of deprived urban communities carefully. These studies have been brought together on one common platform to solve the puzzle called "successful urban revitalization," initiating the development of revitalization models incorporating various social, economic, political and cultural issues. In this chapter, the existing urban models are studied and an extended urban revitalization model is developed encompassing a newly defined element, the *Built Environment Factors.*

5.2 URBAN REVITALIZATION POTENTIAL BASED ON MARKET STUDY OF REHABILITABLE BUILDINGS

As detailed in the literature survey, the decline of many old urban centers is characterized by overall deterioration of the existing buildings and infrastructure. This decline needs to be studied and plans should be chalked out for the successful revitalization of the deteriorating urban centers. One of the important parameters that lead to urban decline, as identified and investigated by the author, is the aging and abandonment of buildings and infrastructure that were built during early years of urban growth. These old and vacant buildings, once used efficiently, are now abandoned and standing as symbols of despair along the majestic downtown crossings. These structures were abandoned as people fled to suburban lifestyles, an outcome of urban sprawl, which is initiated by various social, economic, political and cultural factors. This section delves into identifying the potential of achieving urban revitalization in Detroit by adaptive re-use of existing buildings and infrastructure, which will facilitate attraction of new inhabitants in addition to retention of the current population. This is thought of as need of the hour by many urban scientists, considering the fact that Detroit has become the first major city in US history to have fallen below a population of 1,000,000 [DEM 2002]. In addition, the available market for the rehabilitated buildings in the city and the code-based cost impact of rehabilitation on the revitalization process are discussed in this section of the report.

5.2.1 STUDY OF EXISTING DEMAND FOR BUILDINGS

The developmental activities in the City of Detroit that started in early 1990s created the first momentum for the city's rebirth. These activities were initiated and led by automotive frontrunner General Motors (GM), which stayed committed to Detroit's development by setting up its world headquarters, called the "Renaissance Center," in the renaissance zone of the city. Along with this development, prestigious projects like the Detroit Tigers' Comerica Park, the Michigan Opera Theatre, the casinos and the soon-to-be-new Detroit Lions stadium, as well as the efforts of individual entrepreneurs, spurred new and active developments in the city that brought a new outlook to the declined urban area [STEIN 2000]. As new developments and events increasingly emerged in the city center, it propelled novel investments, which created an increased economic thrust.

Even though the City of Detroit is famously designated as the "Automobile Capital of the World," many kinds of new trades and markets recently started opening up, energized by the new economic outlook and benefits for businesses in the city. For example, Compuware Corporation, a Michigan-based information technology solution provider, is setting up its 1.2 million square foot world headquarters in downtown Detroit as a part of the Campus Martius development. According to Patrick O'Keefe, a Michigan real estate consultant [DUBE 1999], Campus Martius has major significance for Detroit's revitalization. Compuware Corporation, a large, non-automotive, suburban Detroit employer, setting up its world headquarters in the downtown Detroit area is a great sign of diversified business moving back to the city. This is a positive sign of revitalization in Detroit because, viewed from a national perspective, Detroit has tried to diversify in various businesses for the last 20 years but was never very successful. These developments in the city will encourage many new companies to explore Detroit's business potential, which, in turn, will continue to create a high demand for buildings and infrastructure to serve the growing population.

As new developments are increasingly brought into the city's renaissance zone, low vacancy rates and climbing rents at Metro Detroit apartment complexes are attracting the attention of long-time area real estate developers. Based on a recent forecast by Marcus & Millichap, a real estate investment brokerage firm in Southfield, the apartment vacancy rate in Metro Detroit was documented at the low rate of 3.2% in 2001, down significantly from the 5.8% rate recorded in 1995 [KING 2001]. This equation of revitalization is quite interesting. As the revitalization process creates more economic momentum, the need for buildings and infrastructure to serve the growing population becomes vital.

In the wake of increased social, economic and cultural activities and the new stadia culture (the Detroit Tigers' Comerica Park and the new Detroit Lions stadium), more and more people are attracted by the city life, creating an alarming need for both residential and commercial buildings and the infrastructure to match. When compared to the commercial building market, the residential building (housing) market is projected to have high demand, based on the growth pattern observed in the City of Detroit. According to the Association for Community Researchers, the Detroit region's cost of living is estimated as only 10.75% above the national average. Compared to other major U.S. metropolitan areas, Detroit is declared an affordable place to live. In a report published by the Detroit Economic Growth Corporation, in 1999 the median home price in the Detroit area was $134,000, which was highly affordable when compared to that of Oakland, California at $237,000 and Boston, Massachusetts at $170,000 [DEGC 2003].

Since Detroit has started creating targeted tax and business incentive zones, thousands of working people who live in the surrounding suburbs will be coming downtown to take benefit of the growing market and commercial activities. This movement is expected to favorably impact the housing demand in the city, creating new markets for residential development. The growing demand for buildings and infrastructure can be met not only by new construction, but also by rehabilitating the city's old, vacant and underutilized existing structures.

5.2.2 MAGNITUDE OF POSSIBLE REHABILITATION

The growing demand for both residential and non-residential buildings, as discussed in the previous section, clearly illustrates the need for rehabilitation and adaptive re-use of the abundant numbers of old, vacant and underutilized buildings standing as deteriorated structures in the City of Detroit. A detailed compilation of the unutilized and underutilized building stock is summarized in ***section 4.2.1*** of Chapter 4. Table 14 shows the comprehensive list of Detroit's buildings that are declared part of the vacant / not-in-use category under the register of Wayne County, Michigan by the National Register of Historic Places [NRHP 2003]. The 839 buildings tabulated in Chapter 4 are declared on the national, state and the city historic registers, but, on the other hand, there are many similar old, vacant and deteriorated buildings in Detroit that are not declared under the historic registers due to their locations (i.e., not in a historic district) or historic status.

All these old and vacant buildings together constitute a major source of rehabilitable building stock in the city, which, when effectively rehabilitated for either the same historic use or for a new market-defined use, will form an valuable addition to growing residential and commercial usable building stock. This process of rehabilitation not only helps in restoring the historic importance of the city, but also prevents the additional financial requirements for constructing new buildings and infrastructure, in addition to demolition and debris removal costs related to constructing new buildings by pulling down existing abandoned vacant buildings currently open to vagrants. The magnitude available in the Detroit is immense in terms of cost and value.

5.2.3 MARKET CAPTURE RATE FOR REHABILITATED BUILDINGS

Based on the observations made by the researcher in earlier sections and the discussions held with a diverse group of building owners, city planners, practicing architects, real estate professionals and downtown development analysts, it is identified that the residential market is more attractive in the current scenario than the commercial building market. In addition to the business developments, people are also moving to the city for better social and cultural lifestyles (perhaps because of the new sports and stadia momentum in Detroit), which makes the residential market more attractive and lucrative for investments by both public and private developers. Considering this fact, the market study discussed in this section is based on the available potential for residential units that are created by rehabilitation and adaptive re-use of existing old, vacant and underutilized commercial buildings. In addition, the rehabilitation scope of the case study project chosen for this research, as discussed in chapter 4 (see section 4.3.3), involves conversion of old and vacant use group B buildings into multi-story residential units with use group R-2. Based on these circumstances, the market study is targeted at identifying the m*arket potential for housing units in Downtown Detroit*. The market capture rate and vacancy rate discussions will be based on these rehabilitated housing units, not new construction.

The market capture rate is derived by dividing the annual forecast absorption of the housing units, in aggregate and by housing type, by the number of households that have the potential to purchase new housing or rent from the available stock within a specified area in a given year [ZVA 2002].

The market analysis performed by *Zimmerman Volk Associates, Inc.* (ZVA 2002) to determine the potential market for housing in downtown Detroit, Wayne County, Michigan on behalf of *The Greater Downtown Partnership, Detroit* is used as the primary source for the discussion related to rehabilitated residential units' market capture rate and potential to bring revitalization to the city.

To define any real estate market, the primary factors to be considered are the available potential and the strategies adopted to attract the target populations. Based on the analysis performed by ZVA, the market potential study can be divided into five subsections [ZVA 2002]:

1. Identification of the "*draw areas*" for the new market-rate housing units
2. Study of market potential based on *housing type*
3. Study of market potential based on *household type*
4. Analysis of *annual capture rate* depending on housing type
5. Determination of *rent, price, and size ranges* for rehabilitated units

The potential market available in Detroit for residential units rehabilitated from existing buildings includes two major groups of people: the households who are already living in the city (retention of the existing population) and the households who are likely to move into the city if suitable housing options are available. The latter part includes households who are attracted to the city based on available opportunities for growth, a better social, economic and cultural lifestyle, and availability of flexible housing options (rental and for-sale housing).

5.2.3.1 Identification of the "*draw areas*" for the new market-rate housing units:

The foremost factor that defines a new market for residential units is the "*draw area*" from which the households are attracted to make their living in the city. During the revitalization process, the primary emphasis should be on retaining the existing population living in the city by providing them with better living conditions and flexible housing options. Detroit being the city that lost a huge population in a short period of time makes this retention crucial. In addition to the local population, households who fled the city as an outcome of urban sprawl are the next major draw candidates. Based on the characteristics of the population and lifestyle in Detroit, the market-rate housing potential study performed by Zimmerman Volk Associates [ZVA 2002] identified *four* major draw areas for the newly created residential units. They are:

- ***Local Draw Area:*** Households already residing in the City of Detroit and Detroit-bound Wayne County areas)
- ***Regional Draw Area:*** Households from the regional Detroit Metropolitan Statistical Area (MSA)
- ***Major Metro Draw Area:*** Traditional craw from major metropolitan areas like Chicago – households from Chicago Metro draw area
- ***National Draw Area:*** Households moving to the City of Detroit from different parts of the nation, attracted by revitalization

The potential market available in Detroit based on these four major draw areas is summarized in Table 24. A major percentage of the available draw for new housing is from the households who already live in the city and are looking for better housing options. The second major draw area is from the Detroit Metropolitan Statistical Area (MSA), which includes Lapeer, Macomb, Monroe, Oakland, St. Clair, and Wayne Counties. See Appendix B for a detailed map showing the potential MSA draw [FRBC

1998]. The projected fifteen percent draw from the balance of the United States, as shown in the table, is another sign of the city's revitalization and active, ongoing economic stimulation in the city's central business district. The number of households shown in the table illustrates the need for housing units for the potential draw from the defined regions.

Table 24: Draw Area Distribution of Market Potential in the City of Detroit [ZVA 2002]

MARKET POTENTIAL BY DRAW AREA ***In the City of Detroit, Wayne County, Michigan***		
Draw Area	Number of Households	Percentage of Draw
City of Detroit / Wayne County (***Local draw area***)	21,410	73 %
Detroit Metropolitan Statistical Area (***Regional draw area***)	3,170	11 %
From Chicago Metro (***Other metropolitan draw area***)	320	1 %
Balance of United States (***National draw area***)	4,280	15 %
Total Draw	**29,180**	**100 %**

5.2.3.2 Study of market potential based on "*housing type*"

City populations, in general, are susceptible to frequent in-and-out migration in search of better opportunities and lifestyles. Taking into account this basic fact, it is clear that *rental housing* has the greatest demand of all types of housing. As shown in Table 25, rental multi-family housing units such as apartments are in higher demand than for-sale housing units. This constitutes more than fifty percent of the market demand when compared to single and multi-family for-sale housing units, which holds 22.4% and 18.3% respectively. Conversion of the old and vacant existing buildings into multi-family rental housing units has a great potential in terms of market value and further reducing the vacancy rate.

Table 25: Delineation of Annual Market Potential for Downtown Detroit [ZVA 2002]

ANNUAL POTENTIAL FOR MARKET RATE HOUSING UNITS ***In the Downtown Detroit, Wayne County, Michigan***		
Housing Type	Number of Households	Percentage of Total
Rental Multi-Family (***Apartments, leaseholder***)	2,360	**59.30%**
For-Sale Multi-Family (***Apartments, condo/co-op ownership***)	890	22.40%
For-Sale Single-Family Attached (***Row houses, fee-simple ownership***)	730	18.30%
Total	**3,980**	**100 %**

5.2.3.3 Study of market potential based on "*household type*"

The household types constitute a vital part in identifying the market potential, as the success of the downtown market-rate housing units are characterized by the households relocating to them, or the "takers." Table 26 details the market potential available in the City of Detroit based on the household type. The three major household types that define the success of the new housing market are the younger singles and couples, the empty-nesters and retirees, and finally the traditional and non-traditional families. The younger singles and couples constitute more than half of the market potential, as these households generally prefer communities with a diverse mix of people and flexible housing options [ZVA 2002]

Table 26: Market Potential for New Market-Rate Housing Units in Downtown Detroit Characterized by General Household Type and Housing Unit Type [ZVA 2002]

MARKET POTENTIAL BASED ON HOUSING TYPE *In the Downtown Detroit, Wayne County, Michigan*				
Household Type	Percent of Total	Rental Multi-Family	For Sale Multi-Family	For-Sale Houses
Younger Singles and Couples	58 %	61 %	62 %	45 %
Empty-Nesters and Retirees	27 %	25 %	26 %	34 %
Traditional and Non-Traditional Families	15 %	14 %	12 %	21 %
Total	**100%**	**100%**	**100%**	**100%**

5.2.3.4 Analysis of "*annual capture rate*" depending on housing type

For any residential market to be successful, it is essential to determine how well and how fast the units are rented or sold, thereby reducing the city housing market's vacancy rate. The *Absorption Rate* characterizes the market's success. Table 27 details the capture or absorption rate that is available in the downtown Detroit area, based on the type of housing and the number of households. The capture rate is calculated based on the migration and mobility analysis performed by Zimmerman Volk Associates [2002] and the findings demonstrate a higher capture rate available for the multi-family rental housing units in Detroit than for multi- and single-family for-sale housing units.

Table 27: Annual Capture of the Market Potential for Downtown Detroit Depending on Housing Type [ZVA 2002]

ANNUAL CAPTURE RATE OF MARKET POTENTIAL ***In the Downtown Detroit, Wayne County, Michigan***			
Housing Type	Number of Households	Capture Rate	Number of New Units
Rental Multi-Family (***Apartments, leaseholder***)	2,360	10 %	236
For-Sale Multi-Family (***Apartments, condo/co-op ownership***)	890	5 %	45
For-Sale Single-Family Attached (***Row houses, fee-simple ownership***)	730	5 %	37
Total	**3,980**	-	**318**

5.2.3.5 Determination of *"rent, price, and size ranges"* for rehabilitated units

Pricing a product right defines its success rate in the market. It is essential to determine the price and size ranges of the housing units generated by rehabilitation and adaptive re-use for efficient ROI (Returns On Investments) and also to meet the housing needs of the targeted households. The rental price and for-sale price ranges are usually determined by analysis of the *tenure preferences* of the households moving into the city from the defined draw areas and also the *income and equity levels* of these households based on the national income and equity data of households from the respective draw areas [ZVA 2002]. This analysis also takes into consideration the availability of new opportunities fostered by the revitalized urban center. The three major housing types that are generated by rehabilitating existing old and vacant buildings in the city are:

- *Courtyard Apartment Buildings*
- *Loft Apartment Buildings* (rehabilitation scope of case study building)
- *Row Houses*

Considering the fact that Detroit boasts a huge stock of high-rise commercial buildings built in the early 1900's that are currently vacant, loft apartments are often well thought-out as major contributors to the new housing stock. Table 28 shows the rental price and size ranges for soft and hard lofts created by rehabilitation and the price and size ranges of for-sale housing units. The rehabilitated lofts are often created from vacant non-residential buildings that typically have high c eilings and commercial windows. Hard lofts are those that are unfinished or minimally finished and pose the same commercial look, while soft lofts are fully finished and have modified interior partitions to suit residential needs and outlooks.

Table 28: Range of Rents, Prices, and Sizes for New Developed Market-Rate Residential Units in Downtown Detroit [ZVA 2002]

RENTAL PRICE AND SIZE OF NEW RESIDENTIAL UNITS ***In Downtown Detroit, Wayne County, Michigan***			
Housing Type	**Rent / Price Range**	**Size Range**	**Rent / Price Per Sq. Ft.**
	RENTAL		
Unfinished/Minimally finished lofts	\$500 - \$2,000 Per Month	450-2,000 sft	\$1.00 - \$1.11 per sq. ft.
Fully finished lofts with partition walls	\$600 - \$3,500 Per Month	450-3,000 sft	\$1.16 - \$1.33 per sq. ft.
	FOR SALE		
Unfinished/Minimally finished lofts	\$50,000 - \$175,000	450-1,500 sft	\$111 - \$116 per sq. ft.
Fully finished lofts with partition walls	\$75,000 - \$500,000	600-2,500 sft	\$125 - \$200 per sq. ft.
Town homes	\$125,000 - \$300,000	900-2,000 sft	\$138 - \$150 per sq. ft.

5.2.4 IMPACT OF CODE-BASED POTENTIAL COST SAVINGS

Cost is an inevitable factor in any developmental activity. When the researcher explored the reasons for the huge stock of buildings lying vacant along the downtown crossings, among various reasons such as social, cultural and political factors that influence market dynamics, the economic factor of the cost to rehabilitate old buildings stood out as important. Rehabilitation costs as per the current building code requirements for the same use group or a new use group are *very high,* often discouraging or penalizing the building owners who are considering rehabilitating their property and defining new uses for structures in accordance with market needs.

To address this code-based cost issue in the process of rehabilitation of existing old and vacant buildings, a comprehensive code and cost analysis were performed to compare the e fficiencies of using the regular Michigan Building Code (MBC) and the new Michigan Existing Building Code (MEBC). The code and cost analysis are performed on a typical old, vacant and underutilized building in the City of Detroit. Considering the cost of rehabilitation, using the MBC as the base, the cost savings that can be achieved by using the MEBC is tabulated and discussed in detail in s*ection 4.3.5* (Comprehensive cost analysis of rehabilitation using MBC and MEBC) of chapter 4. Around 18% cost savings over new construction was achieved for the defined scope of rehabilitation in the case study building. Investigating the *overall rehabilitation potential* that exists in the City of Detroit, the eighteen percent cost savings in the rehabilitation process facilitates a *substantial impact* on the overall revitalization process of the entire city involving billions of dollars of investments made towards achieving successful urban revitalization.

5.3 EXPANDED URBAN REVITALIZATION MODEL

Many researchers have investigated the process of urban revitalization and identified various social, economic, political and cultural factors that affect the process. These recognized factors were together called an "Urban Revitalization Model," which has been used for many studies related to revitalization. As one of the primary objectives of this research work, the existing urban revitalization models were studied in detail and various sub-components of the primary factors (social, economic, political and cultural) that constitute the process of revitalization were identified. After conceptualizing the existing urban revitalization models, the author explored the possibilities of expanding the existing urban revitalization models by incorporating a new factor called *"The Built Environment."* An expanded, comprehensive urban revitalization model detailing the interaction of the new factor, built environment, on the other existing revitalization factors (such as social, economic, political and cultural), is developed and the impact of the new model defined on the overall process of urban revitalization is then summarized, highlighting the possibilities for achieving successful revitalization.

The author has used two primary and two secondary sources of literature detailing the research related to the urban revitalization models. The two primary research materials used are:

- "Neighborhood Transformation Design: A Case Study of Islandview Village, Detroit," a dissertation submitted at the University of Michigan, 1996, by Kadushin, Abraham [Kadushin 1996].

- "Redevelopment Process of North American Downtowns and Consequences in the Public Realm: A Case Study of Downtown Denver, Colorado," a dissertation submitted at University of Colorado, 2002, by Yilmaz-Saygin, Nicel [Yilmaz 2002].

The two secondary sources of research used were:

- "Local Social Relations and Urban Revitalization: The Case Study of Lewiston, Maine," a dissertation submitted at the University of Iowa, 1990 by Kujawa, Richard [Kujawa 1990].
- "Corporate Social Responsibility and Urban Revitalization: The Allegheny Conference on Community Development, 1943 – 1968 (Pennsylvania)," a dissertation submitted at Carnegie Mellon University, 2000 by Mershon, Sherie [Mershon 2000].

The urban models in these works were not presented as real models, but the text based explanations offered were defined by the author of this study in the form of a model and further expanded into a comprehensive urban revitalization model. To offer better understanding, the author's perception of the term "built environment" and its role in the process of revitalization is discussed in the following sections.

5.3.1 INTRODUCTION TO THE BUILT ENVIRONMENT FACTOR

The term "Built Environment" has been defined and used accordingly by various research disciplines such as urban and regional planning, architecture and landscape architecture, housing, and construction to address the wide range of components in our built environment. Some of these components include buildings, facilities, interior spaces, infrastructure, neighborhoods, and land use. "Built Environment" is defined as "the buildings and the related facilities that are built by human beings on a defined space, and their related interactions with the surrounding natural environment, society and the community as a whole" [MSU 2003].

There are numerous research-specific definitions for "built environment." The author's conceptualization of the built environment as a component of urban revitalization is based on the following three primary entities:

- *Existing old, vacant and underutilized buildings and dilapidated infrastructure*
- *Design and construction of new buildings and infrastructure*
- *Urban land use management*

Of these three subcomponents, the focus of this research is on the existing old, vacant and underutilized buildings. As the built environment also constitutes parts of other entities like neighborhoods, society, and communities, as defined by many urban and social scientists, the primary entity defined by the author, existing buildings, is checked for its interaction with the subcomponents of social, economic, political and cultural factors of urban revitalization. Hereinafter, the term "Built Environment" refers to the three primary entities as defined above by the author, more focusing on the first entity.

5.3.2 EXISTING URBAN REVITALIZATION MODELS

Various components that encompass the process of urban revitalization were discussed in detail in chapter two, the literature review. In the literature, urban revitalization models were defined with four primary factors (such as *Social, Economic, Political* and *Cultural)* along with their related subcomponents. Initially, a diverse group of social, economic, political and cultural scientists started defining their individual components as the primary center of the revitalization model, until the urban scientists created a common platform called successful urban revitalization. Figure 24 illustrates the four primary components of urban revitalization.

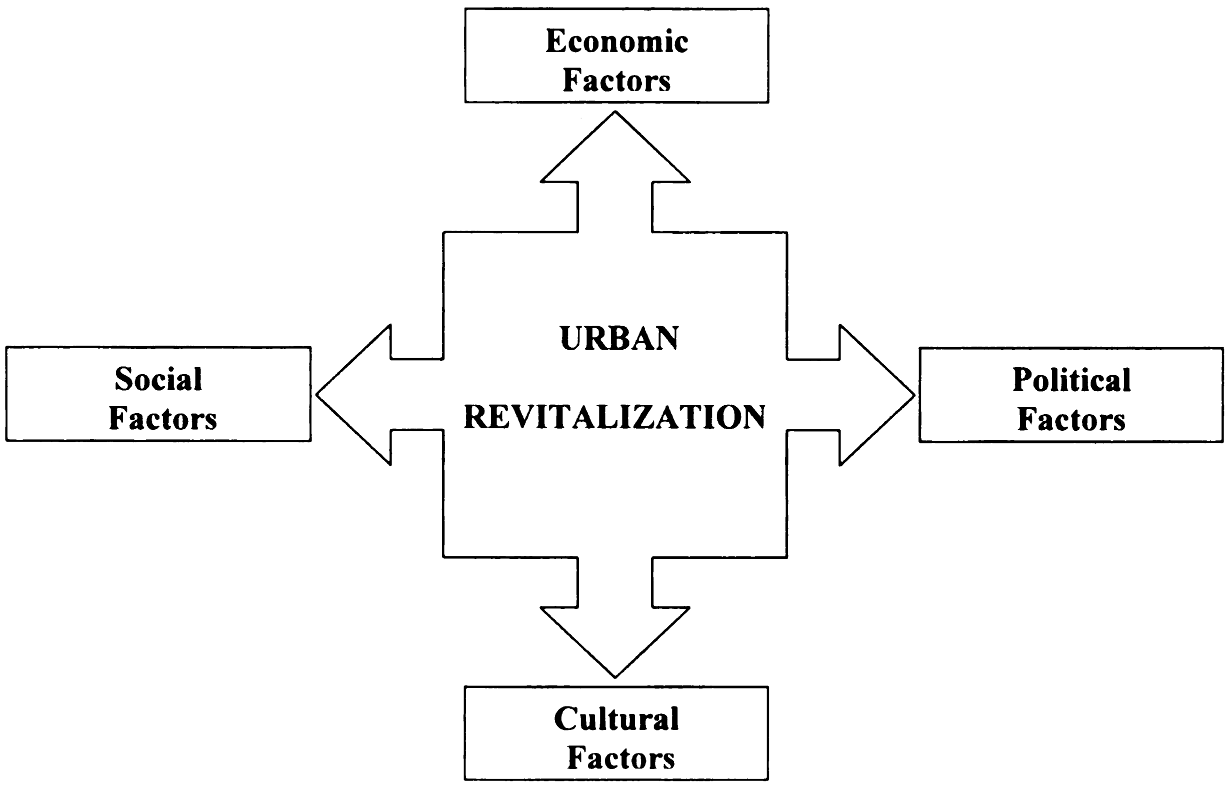

Figure 24: Major Components of Existing Urban Revitalization Models

Each of these individual components then began to interact with one another, and the related outcomes were studied with the common platform of urban revitalization in mind. For example, the interactions of the social component with economic, political and cultural components were described as *Socio-Economic*, *Socio-Political*, *Socio-Cultural* subgroups that interact to define a new scope of urban revitalization. Similarly, each component interaction addresses specific issues of urban revitalization. Figure 25 shows the four-way interaction between the major components of urban revitalization.

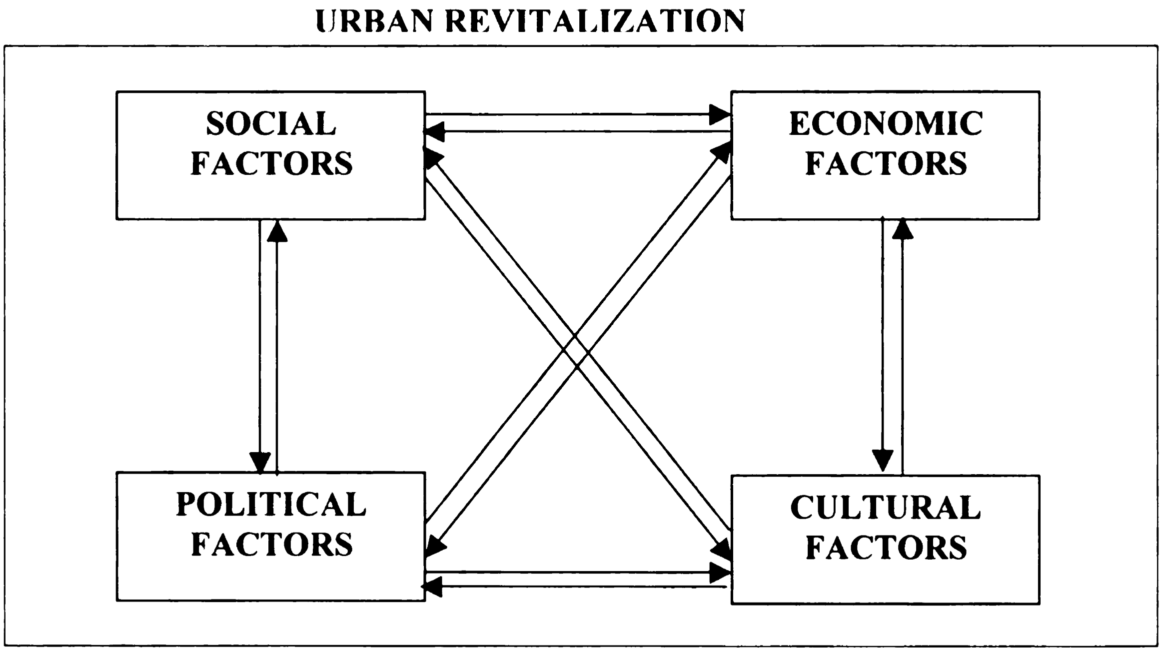

Figure 25: Interaction Between Existing Urban Revitalization Components

Based on the interaction between these primary components, revitalization effects in terms of community rebuilding and stabilization; community-centered activities, facilities and programs; a self-sufficient and sustainable economic system; and, above all, a safe and secure urban environment are created as an outcome of urban revitalization

[Kadushin 1996]. Figure 26 shows the existing urban revitalization model, embracing all four primary components as discussed and their effects on urban revitalization.

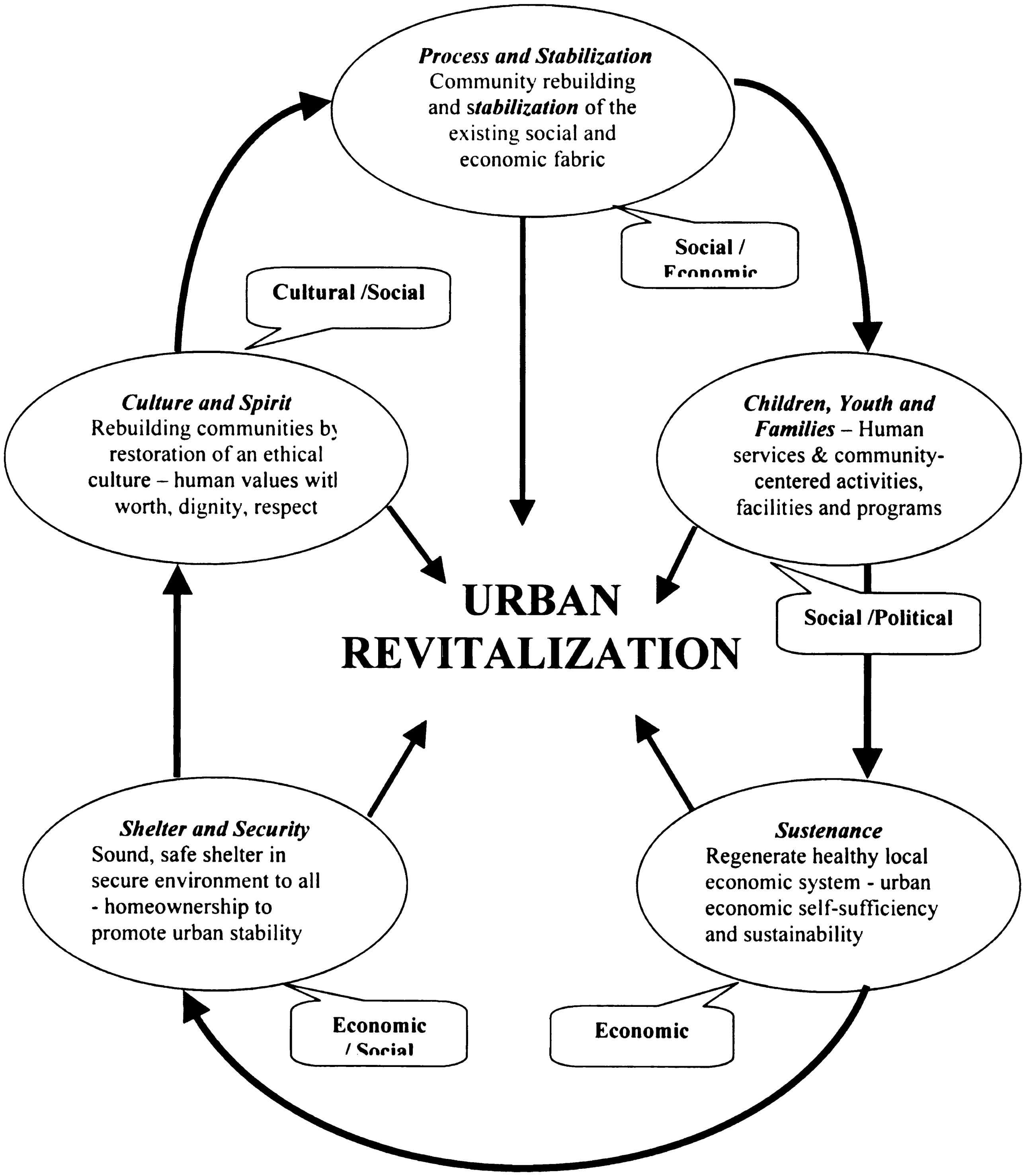

Figure 26: Existing Urban Revitalization Model [Modified from Kadushin, 1996]

The factors emphasized to achieve revitalization in a sustainable approach as detailed by Kadushin [1996] include:

- The basic process of stabilizing the community, which in turn stabilizes the social, economic and cultural fabric of the system
- Sustenance of the local economic system to generate a higher level of economic stability and self-sufficiency in the community,
- Shelter and security for a better kind of life in the urban centers,
- Last is the factor of culture and spirit that strengthens community rebuilding by promoting human values with worth, dignity and respect.

While Kadushin's urban model did not focus on the political component that impacts the revitalization process, Nicel Yilmaz-Saygin [Yilmaz 2002] developed a conceptual model for downtown development with a case study of downtown Denver, Colorado. This study enveloped four main components and defined them as the model for redevelopment, or in other words, revitalization. They are:

- Broader effects (national economic policies and programs, global economic structure, and the local economic structure of the urban center under revival)
- Local political culture and redevelopment process (mayoral leadership, political power, and so on.)
- Urban character (land use, economy, and morphology), and
- The public and the private realm

Yilmaz [2002] emphasized the political and economic components of the overall model more, while his focus on social and cultural components was minimal.

In terms of secondary sources of existing urban models, the study performed by Sherie Mershon [2000] on corporate social responsibility for effective urban revitalization highlights the need for participation of private, business-sponsored civic associations in revitalizing deprived cities, and based on the author's understanding, Mershon defined the social and economic components related to the process of urban revitalization with very little emphasis on other primary components. However, in addition to economic growth and transforming the city's social image, this study was also focused on defending local autonomy hindering revitalization. In an other case study by Richard Kujawa [1990], the local social and political efforts needed for revitalization and a strong emphasis on economic restructuring were identified as critical components of urban revitalization.

Even though these urban revitalization models defined by various experts are elaborate, the author feels that they are not as comprehensive and consistent in addressing the issues of the revitalization process as they could be. While some models emphasize social and economic factors more, others focus on political and combined components. But none of the urban revitalization models detailed in the literature incorporated the *"built environment"* factor, which also forms a vital component of the overall system with a level of impact similar to that of the existing components. This leads to a need to expand existing revitalization models.

5.3.3 EXPANDED URBAN REVITALIZATION MODEL

The existing urban revitalization literature overlooked one of the primary resources for urban growth, development and sustainability, which is *the built environment factor*. After looking at the importance of the built environment component and its contribution to the overall process of urban revitalization, it is highly essential to check for this component's potential in relation to the other existing social, economic, political and cultural components.

An expanded urban revitalization model is developed in two phases:

- **Phase 1:** Formulation of the link between the existing components (social, economic, political and cultural) and the new component, built environment – see Figure 27 for details.

- **Phase 2:** Developing a complete input (components), process (changes) and output (effects) *urban revitalization model* with primary focus on the built environment component – see Figure 28 for details.

Based on the literature studies, it is has been apparent that any component that is defined as a primary element in a revitalization model interacts with all the other components to define the scope of revitalization. For example, let us consider the case of the social component in the model. This interacts with the economic component and defines a revitalization process called "socio-economic" changes that are necessary to achieve revitalization in a urban setup. Similarly, interactions with political and cultural components are also defined as socio-political and socio-cultural, which creates a multi-dimensional approach to the overall process of urban revitalization. In the same manner, the four vital components all interact with one another and the outcome of interaction is characterized by a combined effect of two or more components at any given stage of revitalization.

When we define any new component that has a significant impact on the revitalization process and the existing vital components, the first responsibility lies in defining the new component in relation with the existing four components. To accomplish this task, it is essential to formulate a interaction model detailing the interface of the new component with all the existing components. In this research, the author identified the built environment as one of the vital components that is equally as important as any of the existing components that currently define the revitalization model. Figure 27 illustrates this essential interaction of the built environment factor with the existing social, economic, political and cultural factors. Of the three sub-components of the built environment, the "*existing old, vacant and underutilized buildings and dilapidated infrastructure*" factor is taken further, and the interaction of this sub-component with the primary revitalization components is detailed in the model shown in Figure 27. As the initial step towards designating the built environment as one of the primary components of the model, this stage of defining interaction is highly essential.

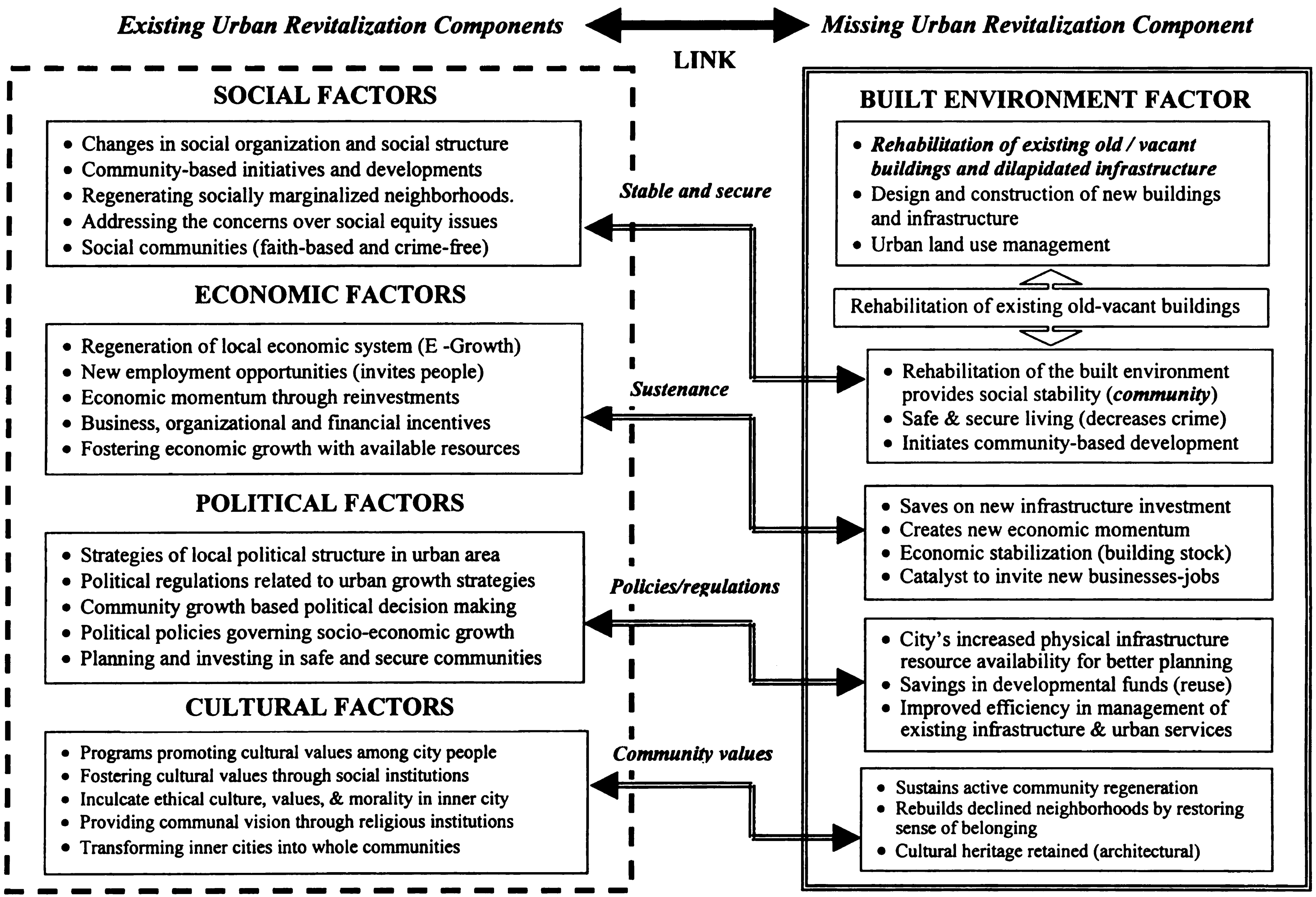

Figure 27: URBAN REVITALIZATION MODEL: BUILT ENVIRONMENT AS A SIGNIFICANT FACTOR

The built environment component's imperative interaction with the primary existing components validates the expansion of the existing revitalization model incorporating the built environment on a scale similar to that of the social, economic, political and cultural factors. Figure 28 demonstrates a comprehensive, expanded urban revitalization model integrating the built environment as one of the input factors.

The model shown in Figure 27 is developed in the form of an "Input – Process – Output" modeling format, in which the input elements are the Built Environment (BE) and Social (S), Economic (E), Political (P) and Cultural (C) factors. The process is the actual interaction between the primary components. The model shown in Figure 27 describes only the interaction of the built environment factor with the remaining four primary factors. As the interactions between the other four components are explored in detail by various researchers, those interactions are not detailed in the model developed here. This process of individual interaction between factors results in an overall process called "urban revitalization," the outcome of which is defined in the output part of the model. In addition to the primary inputs to the model, some external factors create a considerable impact on the revitalization process. The two major such external factors identified by the author include:

- ***Programs*** that support revitalization (tax credits, incentives, investments, and providing assistance for building rehabilitation)
- ***Funding*** availability for revitalization (loans, support from public and private bodies, and funding from banks and mortgage agencies)

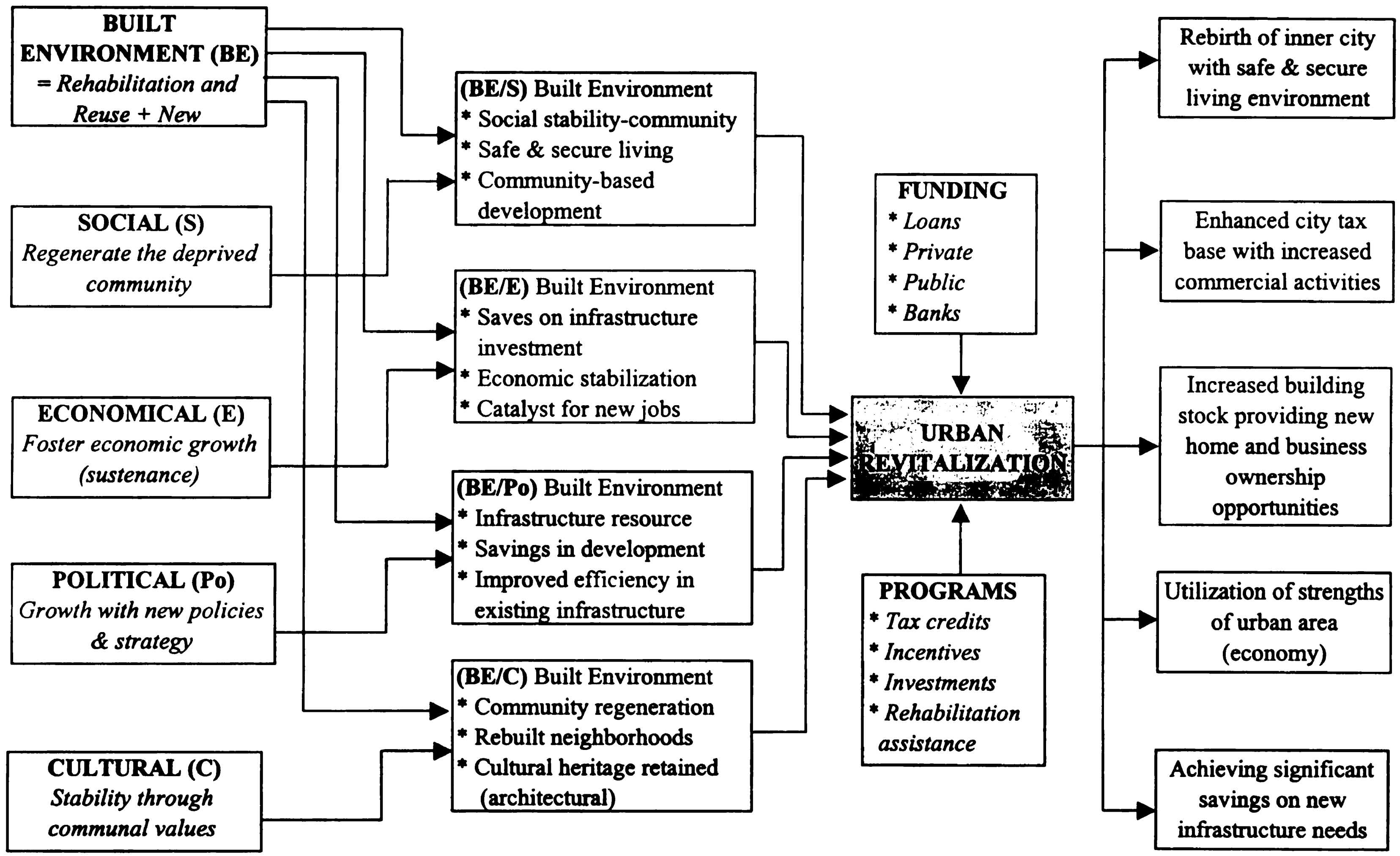

FIGURE 28: URBAN REVITALIZATION MODEL: OUTCOME OF SUCCESSFUL REVITALIZATION

5.3.4 IMPACT OF SUCCESSFUL URBAN REVITALIZATION MODEL

One of the key impacts that the new expanded urban revitalization model creates is that it opens up scope for probing into possibilities of defining new components as primary components of revitalization (similar to what is done here with the built environment factor) and/or identifying new sub-components within the existing primary factors, which will advance the knowledge of how successful regeneration of declined urban centers is achieved. With respect to these research findings, the impact of a successful urban revitalization model as discussed in this section of the report focuses on the built environment and, specifically, the rehabilitation of existing old, vacant and underutilized buildings. Some of the significant impacts fostered by this element of revitalization model include:

- Rehabilitation of existing old, vacant and underutilized buildings adds new resources to the built environment, which promotes the rebirth of the declined inner city, once considered the eminence of developments

- Built environment revitalization, in interaction with the social, economic, political and cultural factors, facilitates a safe and secure living environment in the reborn inner city as an outcome of revitalization.

- The buildings that are aging due to lack of maintenance and non-utilization, once rehabilitated, give a new look to the declined urban center, thereby actively inviting new population

- Changes in the built environment (rehabilitation of buildings) will enhance the city's tax base by bringing new, active additions to the existing tax rolls (building taxes), and also creating a positive momentum in the local economic structure due to increased commercial activities in the city

- The buildings that are rehabilitated increase the existing building stock in the city, opening up broad opportunities for home and business ownership in the economic hubs of the city

- Incorporating building rehabilitation as a component of overall urban revitalization efforts achieves significant cost savings in providing new buildings and infrastructure for growing needs

- The economic momentum created as a result of revitalization can be utilized for further developments in the city, and this urban strength in turn plays a vital role in drawing new households to the city by improving facilities and providing flexible options. One such example is the availability of diverse housing options (the resulting rehabilitated buildings) to accommodate the populations showing an in-migration trend to the city.

5.4 SUMMARY

This chapter presented an expanded urban revitalization model depicting the potential impact of building rehabilitation on the revitalization process. The first section described the market available in the City of Detroit for rehabilitation and adaptive re-use of existing old and vacant buildings. Different types of market parameters that define the capture rate of the rehabilitated units were discussed. Finally, a detailed model representing the urban revitalization process was explained, and discussions detailing its potential impacts were presented.

CHAPTER SIX

SUMMARY AND CONCLUSIONS

6.1 OVERALL SUMMARY

The primary goal of this research was to identify and demonstrate the potential of achieving urban revitalization in the City of Detroit by rehabilitation and adaptive re-use of vacant and underutilized buildings with a promising building rehabilitation code. This goal was achieved by defining six major objectives, and the results were summarized under two principal sections. The first principal section documented the impact of code-based potential cost savings in building rehabilitation, and the second principal section was developed and expanded the existing urban revitalization models by incorporating the new "built environment" component. A case study building with characteristic properties of the defined research scope was identified in the study area, a complete cost-based code analysis was performed, and the results were used to expand the existing urban revitalization models.

The Urban Affairs Programs at Michigan State University funded this research as part of its Housing and Infrastructure Initiative. The entire research report was organized into five chapters. Chapter 1 starts with an overview of the proposed research, detailing the goals, objectives and methodology to be adopted. The need statement, scope and uniqueness of the research work were presented in this chapter of the report.

Chapter 2 provided a detailed literature review and an overview of the terminology used in three key areas: urban revitalization, building rehabilitation procedures and process, and the building codes that are used for the rehabilitation process. The area of building codes was further subdivided into two major sections: the regular building codes (in this case, the regular Michigan Building Code or MBC) and the new rehabilitation code (in this case, the new Michigan Existing Building Code or MEBC). The key terminology related to the research discussion was presented in this chapter.

In Chapter 3, a detailed description of the different rehabilitation practices adopted traditionally and in the current scenario was presented. This was done mainly to investigate the historical practices that influence the process of building rehabilitation in the current scenario in terms of both methods and practices. A few of the popular traditional rehabilitation practices, such as the percentage value analysis of rehabilitation work and the system of benchmarking existing structures with new structures, were discussed to give a better insight into the impact of traditional practices on current-day systems. The specific developments and innovations achieved by the State of New Jersey in developing the nation's first code exclusively for building rehabilitation, were then discussed, including the categories of work defined by the new rehabilitation code. A detailed summary of how the New Jersey Rehabilitation Code's requirements were formulated and adapted for compliance requirements was presented with suitable illustrative examples. In addition, the provisions of the International Building Code (IBC) and the International Existing Building Code (IEBC) for the rehabilitation process were discussed. Since the State of Michigan adopted the IEBC with a few amendments as the state's rehabilitation code, naming it the new Michigan Existing Building Code (MEBC), the discussion of the MEBC is presented in common under the IEBC section. This rehabilitation code discussion forms the vital base for chapter four's case study project, a rehabilitation code-based cost impact analysis.

Chapter 4 was divided into two major sections. In the first section, a detailed compilation of Detroit's vacant, historically registered building stock was made, including details such as the name of the building, its location in the city, its historic use, and its current status. The second section holds the most vital role in the research as it details the complete code analysis performed for the defined scope of rehabilitation in the selected case study building adopting both the MBC and the MEBC. A comprehensive code analysis and code-based cost analysis were performed, and the results were documented with tables summarizing cost savings and analysis. The complete rehabilitation code analysis for the case study project is presented in the appendix section of the report. The cost savings impact of the building rehabilitation process adopting the new MEBC was then taken as the prime source of discussion to identify the impact of this on the overall process of urban revitalization discussed in chapter 5.

Based on the rehabilitation code-based cost impact on building rehabilitation and ultimately urban revitalization, a new component called the built environment factor was defined by the author and incorporated into the existing urban revitalization models. A comprehensive expanded urban revitalization model was developed and presented in chapter 5, and discussions related to its impact on the renaissance of the City of Detroit were summarized.

6.2 SUMMARY BY OBJECTIVES

The overall goal of this research was to identify and demonstrate the potential of promoting urban revitalization through cost effective rehabilitation of old, vacant and underutilized buildings by adopting the new Michigan Existing Building Code in the City of Detroit. This section discusses the results achieved for each of the defined objectives as a summary by objectives.

6.2.1 To study the pattern of existing old and vacant building stock in the City of Detroit and analyze the current market trend in rehabilitated residential units converted from old existing building stock.

This objective was addressed and achieved in two different sections of the research. The first part to study the pattern of existing old and vacant building stock in the City of Detroit was presented in detail in Chapter 4 under the Detroit urban overview and existing building stock discussion. Also, a detailed compilation of the existing old, vacant and underutilized building stock data was tabulated projecting the kind and number of the existing rehabilatable building stock in the City of Detroit. The second part detailing the market trend in rehabilitated residential units converted from old existing building stock is discussed in detail in Chapter 5, which illustrates the market capture rate and potential market available for the rehabilitated residential units in the city. In addition to market capture rate, discussion related to the potential draw area, house type, household type and size and prize ranges of the rehabilitated units were tabulated.

6.2.2 *To study the current code regulations in the urban Michigan for rehabilitation and reuse of existing old and vacant buildings and investigate the scope and potential of using the new Michigan Rehabilitation Code.*

Based on the building rehabilitation practices and building codes literature, the author had detailed the current code regulations adopted in urban Michigan for the process of rehabilitation and adaptive re-use of existing old and vacant buildings. Comprehensive code analysis was performed for the process of rehabilitation in the selected case study building using both the regular Michigan Building Code and the new Michigan Existing Building Code, and the analysis was documented in the form of a comparison table and presented in the appendix section of this research report.

6.2.3 To develop a set of specifications for rehabilitation and conversion of old/vacant buildings into residential units with the help of a case study in Detroit.

The case study building was identified such that it possessed all possible characteristic code-based complications with rehabilitation. The scope of rehabilitation was then defined based on the available market in Detroit, the building owner's interests, and the views of city planners, practicing architects, real estate professionals and downtown development analysts. This scope was to convert the vacant case study building, historically used for business (use group B) purpose into multi-story residential rental units (apartments).

The author then performed a comprehensive code analysis using both the MBC and the MEBC, and based on the code compliance requirements, a detailed set of specifications was prepared for the case study building. This discussion is presented under the rehabilitation investigation section of chapter 4 and also in the appendix detailing the rehabilitation code analysis in comparison with the regular building code.

6.2.4 To calculate and analyze the cost savings for the rehabilitation of the selected case study building in Detroit based on both the Michigan Building Code and the Michigan Existing Building Code.

Based on the detailed code analysis performed using both the MBC and the MEBC, specifications for the rehabilitation work were developed based on the compliance requirements defined by each building code. For the respective rehabilitation specifications, the corresponding cost of rehabilitation was calculated and used for the cost analysis. In order to better understand the importance of retaining the existing buildings, the cost comparisons were made on the basis of three different parameters: the cost of new construction for a structure similar to the case study building, the cost of rehabilitation using the MBC, and the cost of rehabilitation using the MEBC. These three costs were analyzed and the vitality of rehabilitating the structures is documented.

Later, the cost of rehabilitation of the case study building using the MBC was taken as the base value and compared with the cost of rehabilitation using the MEBC.

This analysis was then used to derive the actual benefits and cost savings of adopting the new MEBC over the regular MBC. (Results were tabulated in Chapter 4 under the comprehensive rehabilitation cost analysis section.) In the case study project, around 18% cost savings was achieved by using the MEBC over the MBC for the defined scope of rehabilitation. The code-based cost analysis performed as part of this objective was focused on major cost savings components in the defined scope of rehabilitation using both the codes, ignoring minor cost-related factors that do not make a substantial impact on the cost savings in order to adhere to the broader scope of the research.

6.2.5 *To illustrate existing building rehabilitation as a critical factor in overall urban revitalization by performing a market analysis based on the case study project.*

As an outcome of the code-based cost analysis, the building rehabilitation factor is seen as potentially playing a significant role in the city's overall renaissance. Based on the cost analysis results, the author emphasizes with strong validation that the 18% savings achieved forms a substantial portion of the rehabilitation cost, which is understood to impact the overall process of building rehabilitation widely, which in turn affects the process of urban revitalization.

The sheer number of buildings that are characterized as old, vacant and underutilized buildings in the City of Detroit illustrates the potential that they possess to create a wide-felt impact through rehabilitation. When more buildings are made available along with better infrastructure, people start moving into the city, which in turn creates an increased economic momentum and a revived outlook for and on the urban center. Discussions detailing the impact of building rehabilitation on the revitalization process are presented in chapter 5 of the research report.

6.2.6 *To modify existing models of urban revitalization by incorporating the built environment factor based on lessons learned from objectives four and five.*

A vital research component that completes this study was to expand the existing urban revitalization model to encompass various factors that affect revitalization in one single comprehensive model, helping to achieve successful revitalization through a more thorough explanation of how revitalization works. Based on the literature study, primary factors constituting the existing urban revitalization models were studied in detail and the interactions between these primary factors were understood as an opening stride. A new factor called the built environment was then defined and checked for its critical interaction with all the four primary existing revitalization factors (social, economic, political and cultural). Once the interaction between the existing components and the new component was illustrated, a detailed input, process, output model was developed as an expansion of the existing revitalization models. The input elements were the Built Environment (BE), Social (S), Economic (E), Political (P), and Cultural (C) factors. The interaction between the new BE component and the existing components were detailed in the model, and the related process results in successful revitalization, which is shown as the output component of the model. This is a conceptually expanded model and is primarily based on the rehabilitation of existing buildings as a subcomponent of the built environment factor. Though the other two subcomponents of the built environment factor (design and construction of new buildings and infrastructure, urban land use planning and management) were not explored in this model, it opens wide areas of potential future research that may lead to the refinement of this expanded revitalization model with more validation and substantiation.

6.3 LINGERING EFFECT OF BUILDING REHABILITATION ON URBAN REVITALIZATION

Building rehabilitation as discussed in detail, creates a vivid impact on the process of urban revitalization. However, one should also look at various other associated factors that are initiated by rehabilitating the deteriorated building stock. Some of the factors are, the existing infrastructure, utility systems, transportation networks, business activities, recreational and cultural centers and other services that are directly associated with the population that these resources serve. Detroit had its population peek in 1950 with over 1.85 million people during which all the above said resources were developed to serve this huge urban population. However, Detroit lost population at an alarming rate as shown in Table 1 resulting in reduced usage of the available resources, which inturn resulted in higher costs for the current users as well as lesser revenue for the city. The process of building rehabilitation to achieve revitalization brings in new population, which sequentially increases the rate of usage of the available resources. This not only increases the revenue of the city, but also culminates in an overall revitalized successful urban center. Thus rehabilitating the existing vacant buildings creates a "Snow Ball Effect" on the overall process of urban revitalization.

6.3.1 RECOMMENDATIONS FOR URBAN REVITALIZATION THROUGH BUILDING REHABILITATION

Based on the in-and-out migration trends experienced by the City of Detroit, revitalization is the strategy most vital to regenerating the lost pride and value of this historically famous automotive city. Amongst various revitalization activities discussed earlier, building rehabilitation plays a significant role in achieving successful urban revitalization. Some of the recommendations for urban revitalization through building rehabilitation are:

- Restoration and preservation of the existing built environment by creating an adaptive new re-use for the deteriorating structures in relation to the available market potential

- Creation of incentives for rehabilitating the existing building stock, thereby encouraging building owners to define new markets for the abandoned properties that stand as symbols of hopelessness along in the majestic downtowns

- Development and implementation of innovations related to cost-effective rehabilitation processes and related technologies. One important rehabilitation innovation that was rewarded for its success was the rehabilitation subcode or ***"rehab code"*** developed by the State of New

Jersey, Department of Community Affairs that earned them the national "Innovations in American Government" award in 1999 and a $100,000 prize [NY GORR 2003].

- Planning and phasing of the building rehabilitation projects based on the existing demand and the condition of the abandoned structures (accommodating developer interest)

- Active participation by various private, public, and non-profit organizations at various levels such as planning, development, execution and maintenance of the rehabilitation of structures that are growing old and lying vacant without any proper use. In addition, commitment by these groups to strengthen the local economic system with the impetus created by the growing building stock in relation to the market dynamics and demand.

- Information dissemination to the target groups holding the control over the aging building stock, primarily the building owners, encouraging them to rehabilitate their vacant, abandoned buildings by providing them support and flexible options.

6.4 LIMITATIONS OF THE RESEARCH

One of the major limitations faced in this research was the insufficient information available about the old buildings' components and materials. A series of assumptions was made during the code analysis of the case study building for some of the important parameters that depend upon the properties of the building materials and assembly systems that were originally used in the existing buildings, which were usually built in the late 1800's and the early 1900's. For example, the Fire-Resistance Rating (FRR) value of building materials and assembly components varies based on the type and system of the respective element. When checking the building for fire-resistance compliance requirements, there was no documentation available to show the fire-resistance parameters of the existing building components. Hence, the author ended up using standard fire-resistance rating values as stated for the buildings that were built in the same region, of the similar kind and during the same period of historical significance. Based on this assumption, in the case study building analysis, the author assumed the FRR for all the wall components to be one hour. The author, in places where there was no specific information available for the case study building analysis, used similar reasonable assumptions that were validated by his discussions with many Detroit-area professionals.

Secondly, the load carrying strengths of the building were assumed to be within the permissible limits in the code analysis based on the author's experience and not based on any standard structural testing results. Since there were no standard test results available to be readily used by the researcher, assumptions were made for structural stability as the case study building is converted from higher load requirement (100 psf for Class B) to lower requirements (50 to 60 psf for Class R).

The third important limitation in the research is related to the urban revitalization components. The author did not attempt to explore social, economic, political and cultural parameters from the literature beyond a certain level and as a result, in the urban revitalization model developed, only the interaction between the new component, built environment, and the existing components was shown, whereas the interaction between the existing components was not discussed. In addition, only one major subcomponent of the built environment, existing vacant buildings, was explored in detail, and this opens up scope for future research.

6.5 AREAS OF FUTURE RESEARCH

6.5.1 Validation of the expanded urban revitalization model:

One of the most significant areas of future research based on this work is validation of the expanded urban revitalization model. The built environment factor that is defined as one of the primary components in this research work needs to be validated in coherence with the other primary components in the revitalization model. This validation can be performed as a case study using the input, process and output urban revitalization model. The qualitative analysis performed in this research to develop a expanded model can be used as a base for validating the model quantitatively in a real-time situation in the process of revitalizing a city like Detroit. The effects of the model could be studied and the results that are different from the predicted outcome of revitalization should be documented.

6.5.2 Investigation and Expansion of the Built Environment Component:

The built environment component that is defined by the researcher in the expanded urban revitalization model was investigated to define three primary sub-components:

- *Existing old, vacant and underutilized buildings and dilapidated infrastructure*
- *Design and construction of new buildings and infrastructure*
- *Urban land use management*

Out of these three subcomponents, the first was investigated in detail by the researcher, and its interactions with the four identified primary revitalization components were illustrated. Similarly, future research can investigate the other two components; the design and construction of new buildings and infrastructure and urban land use planning and management can be expanded further, and detailed interactions between these elements can be brought out, which can facilitate a faultless urban revitalization model incorporating the built environment factor. The following are some of the possible areas for future research under these two subcomponents:

- Design and Construction of New Buildings and Infrastructure:

    - Innovative building materials and methods that can save money and increase structures' usage capacities
    - Adopting improved construction management techniques such as proper management of projects and having clear control over construction of buildings and infrastructure.

- Urban Land Use Planning and Management:

    - Land use patterns that will address the social, economic, and cultural issues on a higher scale of importance than what is currently followed
    - Environmental impact assessment of the land use pattern on the urban setting, incorporating the built environment aspect of land use

6.6 CONCLUSIONS

The cycles of peak growth and sudden declines are characterized by the natural law of stability and sustainability. Urban growth and decline is not unique as part of this natural phenomenon. Detroit, which had a swift urban growth during the early 1900's geared by the automotive development, faced its declining stages between the 1960's and the 1980's. The reasons for this decline were numerous and constantly investigated by various groups of urban scientists. This work is an outcome of one such research group that is clustered under the term the "Built Environment."

In this research, the author viewed the urban growth and decline factors from a built environment perspective and investigated if this component called the built environment would have any significant impact on the process of urban revitalization. One of the subcomponents of the built environment factor (the existing old, vacant and underutilized building stock) was explored in depth and the results obtained were used as the primary stepping stone to define the new built environment component as a the vital entity that can be defined as at a similar level of importance to the existing components of urban revitalization (social, economic, political and cultural factors).

The following section presents the major conclusions from this research work:

- The author strongly believes that the code-based cost savings achieved in the process of rehabilitation adopting the new rehabilitation code can have a substantial impact in terms of creating interest and excitement among the building owners in rehabilitating and revitalizing old and vacant buildings in the urban centers.

- The process of rehabilitation not only saves money but also helps to create an increased economic momentum. The cost saved by rehabilitating existing buildings and infrastructure could be used more effectively for other developmental activities. For example, the 18% savings that rehabilitation of the case study building under the rehabilitation code would achieve amounts to almost $1.7 million. Based on the existing vacant building stock data compiled in chapter 4, overall rehabilitation savings for the entire city can be over $1.5 Billion which is very significant in on a large scale for the entire City of Detroit.

- Declining urban centers in other states will be informed by and made aware of the success achieved in terms of cost savings and the impact of rehabilitation on urban growth. The documented cost savings serves as a tool for inspiring thought about rehabilitation over demolition and reconstruction.

- The expanded urban revitalization model developed in this research work opens up a new platform for research to investigate and incorporate new components into the urban revitalization model, similar to how the built environment was incorporated. This research can significantly impact the overall success of the revitalization process.

This research provides insight into and an understanding of a critical component and the overall urban revitalization model. Urban scientists can use this expanded revitalization model to identify various parameters that define success of a revitalization project, which in turn leads to successful urban rebirth.

REFERENCE PAGES

APPENDIX A

CODE ANALYSIS OF CASE STUDY PROJECT`

The code analysis performed in this research work is based on the

International Existing Building Code 2003 (IEBC)

The analysis report attached in this appendix starts at the eight chapter of the IEBC and this is based on the procedure of using this code. The related chapters as required by Chapter 8 of IEBC are continued following Chapter 8 of IEBC analysis

CODE ANALYSIS WORK SHEET - IEBC 2002

CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
CHAPTER 8: CHANGE OF OCCUPANCY			
SECTION 801 GENERAL			
801.1 Repair and alteration with no change of occupancy classification	Any repair or alteration work undertaken in connection with a change of occupancy that does not involve a change of occupancy classification as described in the International building code shall conform to the requirements of Chapters 4, 5, 6 and 7 respectively for the applicable occupancy group and the requirements of Sections 802 through 811.	This case study project is undergoing a change of occupancy from Group "B" Business use group to Group R-2 Residential use with more than four dwelling units. Hence the rehabilitation process need to comply to all the requirements of this Chapter.	Check for compliance as mentioned in each of the sections of this Chapter, Change of Occupancy as there is a change of occupancy in the case study project. Need to Comply to all the Sections 801 though 812.
Exceptions:	1. Compliance with all the provisions of Chapter 7 is not required where the change of occupancy classification complies with the requirements of Section 812.3.	**Exception 1 Not Applicable** (FOLLOW SECTION: 812.3 here)	Exception not applicable as the change in occupancy is not complying with Sec 812.3
	2. As modified in Section 1004.0 for historic buildings.	**$$$$$$$$$$$$$** *VERY IMPORTANT EXCEPTION* **FOLLOW SECTION: 1004.0**	**APPLICABLE EXCEPTION** As the case study building is a designated Historic structure all provisions in Section 1004.0 is applicable(Follow 1004 here)
801.2 Part change of occupancy group.	Where a portion of an existing building is changed to a new occupancy group, Section 812 shall apply.	**APPLICABLE SECTION**	**Follow Section 812 (apply)**
801.3 Certificate of occupancy required.	Change of use to one classified in a different occupancy group shall require a new certificate of occupancy regardless of whether any repair or alteration work is required by these provisions.	**APPLICABLE SECTION**	Certificate of Occupancy is required for this change from Group B to Group R-2
SECTION 802 SPECIAL USE AND OCCUPANCY 802.1 Compliance with the building code.	Where the character of use of an existing building or part of an existing building is changed to one of the following special use or occupancy categories as defined in Chapter 4 of the International Building Code, the building	Not applicable	**NOT APPLICABLE** Case study building is to be converted to Use group R-2 and not to any of the specified special use as per this section

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
	shall comply with all the applicable requirements of the International Building Code regardless of whether a change of occupancy group is involved: *1. Covered mall buildings,* *2. Atriums,* *3. Motor vehicle related occupancies* *4. Aircraft Related occupancies* *5. Motion picture projection rooms,* *6. Stages and platforms,* *7. Special amusement buildings,* *8. Specific use areas* *9. Hazardous materials.*	None of this going to be the new use and hence not applicable	**NOT APPLICABLE**
802.2 Underground buildings.	An underground building in which there is a change of use shall comply with the requirements of the International Building Code applicable to underground structures.	Not applicable	**NOT APPLICABLE** As there is no change of use is made in underground existing structure.
SECTION 803 BUILDING ELEMENTS AND MATERIALS 803.1 General.	Building elements and materials in portions of buildings undergoing a change of occupancy classification shall comply with Section 812.	**APPLICABLE SECTION**	**Follow Section 812 (apply)** As there is a change in use check for compliance with Section 812 of IEBC
SECTION 804 FIRE PROTECTION 804.1 General	Fire protection requirements of Section 812 shall apply where a building or portions thereof undergoes a change of occupancy classification.	**$$$$$$$$$$$$$$** **APPLICABLE SECTION**	**Follow Section 812 (apply)** As there is a change in use check for compliance with Section 812 of IEBC
SECTION 805 EGRESS 805.1 General.	Means of egress in portions of buildings undergoing a change of occupancy classification shall comply with Section 812.	**$$$$$$$$$$$$$$** **APPLICABLE SECTION**	**Follow Section 812 (apply)** As there is a change in use check for compliance with Section 812 of IEBC
SECTION 806 ACCESSIBILITY 806.1 General	. Accessibility in portions of buildings undergoing a change of occupancy classification shall comply with Section 812.	**APPLICABLE SECTION**	**Follow Section 812 (apply)** check for compliance with Section 812 of IEBC

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
SECTION 807 STRUCTURAL 807.1 Gravity loads.	Buildings or portions thereof subject to a change of occupancy where such change in the nature of occupancy results in higher uniform or concentrated loads based on International Building Code Tables 1607.1 and 1607.6, shall comply with the gravity load provisions of the International Building Code.	**As per Section 1607 of IBC** **TABLE 1607.1 Design Loads** MINIMUM UNIFOMLY DISTRIBUTED LIVE LOADS AND MINIMUM CONCENTRATED LIVE LOADS Residential - multifamily dwellings *Private rooms -- 40 psf* *Public rooms and corridors -- 100 psf*	Important factor in this project as the existing use was "B" designed for 100 psf is to be converted to use group R-2 and hence the load compliance is met and no need for any improvement for the new use
Exceptions:	Structural elements whose force stress is not increased by more than 5 percent.	APPLICABLE UNDER ASSUMPTION	Need to check with the structural analysis tests and assumed to comply for this research purpose
807.2 Snow and wind loads.	Buildings and structures subject to a change of occupancy where such change in the nature of occupancy results in higher wind or snow importance factors based on International Building Code Table 1604.5, shall be analyzed and shall comply with the applicable wind or snow load provisions of the International Building Code.	**1604.5 Importance factors.** The value for snow load, wind load and seismic load importance factors shall be determined in accordance with T1604.5.	**APPLICABLE REQUIREMNT** The change from Group B to R-2 doesn't impose any change in Imporatnt factors (Seismic, Snoe and wind) and hence complied in this case study project.
Exception :	Where the new occupancy with higher importance factor is less than or equal to 10% of the total building floor area. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.	Change B to R-2, I-factors are same: **SEISMIC FACTOR (IE) - 1.00** **SNOW FACTOR (IE) - 1.0** **WIND FACTOR (IE) - 1.00**	
807.3 Seismic loads.	Existing buildings with a change of occupancy shall comply with the seismic provisions of Sections 807.3.1 and 807.3.2.		Check for Compliance with 807.3.1 and 807.3.2
807.3.1 Compliance with the International Building Code.	When a building or portion thereof is subject to change of occupancy where such a change in the nature of the occupancy results in a higher Seismic Factor based on Table 1604.5 of the International Building Code or when a change of occupancy results in a building being reclassified to a higher Hazard Category as shown in Table 812.4.1, and for M occupancy being changed to A, E, I-1 R-1 ,R-2 or R-4 occupancies with two-thirds or more of the floors involved in Alteration-level 3 type of work,	Change from B to R-2, the Importance Factor for both uses are same and there is no change in Seismic Factor based on Table 1604.5 **SEISMIC FACTOR IE - 1.00 (B & R-2)**	**Complied in Existing Structure**

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
	the building shall conform to the seismic requirements of the International Building Code for the new Seismic Use Group.		
Exceptions:	1. Group M occupancies being changed to A, E, I-1, R-1, R-2 or R-4 occupancies for buildings less than six stories in height and in Seismic Design Category A, B and C.	Exception Not applicable	**NOT APPLICABLE** As Section 807.3.1 Complied in Existing Structure
2	Specific detailing provisions required for a new structure are not required to be met where it can be shown an acceptable level of performance and seismic safety is obtained for the applicable seismic use group using reduced International Building Code level seismic forces as specified in Section 407.1.1.3. : The rehabilitation procedures shall be approved by the code official and shall consider the regularity, over-strength, redundancy and ductility of the lateral load resisting system within the context of the existing detailing of the system.	Exception Not applicable	**NOT APPLICABLE** As Section 807.3.1 Complied in Existing Structure
3	Where the area of the new occupancy with higher Hazard Category is less than or equal to 10% of the total building floor area and the new occupancy is not classified as Seismic Use Group III. For the purposes of this exception where a structure is occupied for two or more occupancies not included in the same seismic use group, the structure shall be assigned the classification of the highest seismic use group corresponding to the various occupancies. Where structures have two or more portions that are structurally separated in accordance with the International Building Code Section 1620, each portion shall be separately classified. Where a structurally separated portion of a structure provides	Exception Not applicable	**NOT APPLICABLE** As Section 807.3.1 Complied in Existing Structure

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
	required access to, required egress from, or shares life safety components with another portion having a higher seismic use group, both portions shall be assigned the higher seismic use group. The cumulative effect of the area of occupancy changes shall be considered for the purposes of this exception.		
	4 When the new occupancy with higher Hazard Category is within only one story of a building or structure, only the lateral force resisting elements in that story and all lateral force resisting elements below that story shall be required to comply with Section 807.3.1 and exception 2. The lateral forces generated by masses of such upper floors shall be included in the analysis and design of the lateral force resisting systems for the strengthened floor. Such forces may be applied to the floor level immediately above the topmost strengthened floor and distributed in that floor in a manner consistent with the construction and layout of the exempted floor.	Exception Not applicable	**NOT APPLICABLE** As Section 807.3.1 Complied in Existing Structure
	5 Unreinforced masonry bearing wall buildings in Seismic Use Group 1 and in Seismic Use Group 1 and 2 when in Seismic Design Categories A, B and C shall be allowed to be strengthened to meet the requirements of Appendix A of the code (GSREB).	Exception Not applicable	**NOT APPLICABLE** As Section 807.3.1 Complied in Existing Structure
807.3.2 Access of seismic use group III.	Where the change of occupancy is such that compliance with Section 807.3.1 is required and the Seismic Use Group is a Category III, the operational access to such a Seismic Use Group III existing structure shall not be through an adjacent structure. Exception: Where the adjacent structure conforms to the requirements for Seismic Use Group III structures.	**As per the IBC** Each structure shall be assigned a seismic use group and a corresponding occupancy importance factor (IE) as indicated in Table 1604.5. Of IBC *1616.2.1 Seismic Use Group I.* *1616.2.2 Seismic Use Group II.* *1616.2.3 Seismic Use Group III.*	The case study project is of Seismic Use Group II and this section is not applicable as it is only for the Seismic Use Group III

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
	Where operational access is less than 10 feet (3048 mm) from an interior lot line or less than 10 feet (3048 mm) from another structure, access protection from potential falling debris shall be provided by the owner of the Seismic Use Group III structure.	Seismic Use Group III structures are those having essential facilities that are required for postearthquake recovery and those containing substantial quantities of hazardous substances, as indicated in Table 1604.5, or as designated by the building official.	Not under Group III
SECTION 808 ELECTRICAL 808.1 Special occupancies	Where the occupancy of an existing building or part of an existing building is changed to one of the following special occupancies as described in the ICC Electrical Code, the electrical wiring and equipment of the building or portion thereof that contains the proposed occupancy shall comply with an applicable requirements of the ICC Electrical Code regardless of whether a change of occupancy group is involved: *1. hazardous locations,* *2. commercial garages, repair and storage,* *3. aircraft hangars,* *4. gasoline dispensing and service stations,* *5. bulk storage plants,* *6. spray application, dipping and coating processes,* *7. health care facilities,* *8. places of assembly,* *9. theaters, audience areas of motion picture and television studios and similar locations,* *10.motion picture and television studios and similar locations,* *11.motion picture projectors, and* *12.agricultural buildings.*	None of this going to be the new use and hence not applicable	**NOT APPLICABLE**

CODE ANALYSIS WORK SHEET - IEBC 2002

CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
808.2 Unsafe conditions.	Where the occupancy of an existing building or part of an existing building is changed all unsafe conditions shall be corrected, without requiring that all parts of the electrical system be up to the current edition of the ICC Electrical Code.	Need to Comply to this section	**APPLICABLE REQUIREMNT** Installed in accordance with International Electrical Code
808.3 Service upgrade.	Where the occupancy of an existing building or part of an existing building is changed electrical service shall be upgraded to meet the requirements of the ICC Electrical Code for the new occupancy.	Need to Comply to this section	**APPLICABLE REQUIREMNT** Installed in accordance with International Electrical Code
808.4 Number of electrical outlets.	Where the occupancy of an existing building or part of an existing building is changed the number of electrical outlets shall comply with the ICC Electrical Code for the new occupancy.	Need to Comply to this section	**APPLICABLE REQUIREMNT** Installed in accordance with International Electrical Code
SECTION 809 MECHANICAL			
809.1 Mechanical requirements.	Where the occupancy of an existing building or part of an existing building is changed such that the new occupancy is subject to different kitchen exhaust requirements or to increased mechanical ventilation requirements in accordance with the International Mechanical Code, the intent of the respective International Mechanical Code provisions shall be complied with.	Check Current CFM of existing HVAC system	APPLICABLE REQUIREMENT Need to Comply to ICC's International Mechanical Code Since existing HVAC system is to be replaced for the new use Group R-2, the minimum mechanical ventilation requirements as per the International Mechanical Code
SECTION 810 PLUMBING			
810.1 Increased demand.	Where the occupancy of an existing building or part of an existing building is changed such that the new occupancy is subject to increased or different plumbing fixture requirements or to increased water supply requirements in accordance with the International Plumbing Code, the intent of the respective International Plumbing Code provisions shall be complied with.	**APPLICABLE REQUIREMENT** Need to Comply to ICC's International Plumbing Code	APPLICABLE REQUIREMENT As the occupant load for the new use is going to be lesser than the existing use, existing fixtures may be used to some extent depending upon the consition and location of the existing plumbing fixtures.

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
810.2 Food handling occupancies.	If the new occupancy is a food handling establishment, all existing sanitary waste lines above the food or drink preparation or storage areas shall be panned or otherwise protected to prevent leaking pipes or condensation on pipes from contaminating food or drink. New drainage lines shall not be installed above such areas, and shall be protected in accordance with the International Plumbing Code.	Not applicable	**NOT APPLICABLE** Case study building is to be converted to Use group R-2
810.3 Interceptor required	If the new occupancy will produce grease or oil laden wastes, interceptors shall be provided as required in the International Plumbing Code.	Not applicable	**NOT APPLICABLE** Case study building is to be converted to Use group R-2
810.4 Chemical wastes.	If the new occupancy will produce chemical wastes, the following shall apply: 1. If the existing piping is not compatible with the chemical waste, the waste shall be neutralized prior to entering the drainage system or the piping shall be changed to a compatible material. 2. No chemical waste shall discharge to a public sewer system without the approval of the sewage authority.	Not applicable	**NOT APPLICABLE** Case study building is to be converted to Use group R-2
810.5 Group I-2.	If the occupancy group is changed to Group I-2, the plumbing system shall comply with the applicable requirements of the International Plumbing Code.	Not applicable	**NOT APPLICABLE** Case study building is to be converted to Use group R-2
SECTION 811 OTHER REQUIREMENTS			
811.1 Health and hygiene		**As per Section 1204 of IBC**	
811.1.1 Light and ventilation.	Light and ventilation shall comply with the requirements of the International Building Code for the new occupancy	**1204.2 Natural light.** The minimum net glazed area shall not be less than 8 percent of the floor area of the room served. **1202.4.1 Ventilation area required.** The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated.	APPLICABLE REQUIREMENT This Light and ventilation requirements are met in the existing building and hence complied to this section.

CODE ANALYSIS WORK SHEET - IEBC 2002

CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
SECTION 812 CHANGE OF OCCUPANCY CLASSIFICATION			
812.1 Compliance with chapter 7	The occupancy classification of an existing building may be changed, provided the building meets all the requirements of Chapter 7 applied throughout the building for the new occupancy group, and complies with the requirements of Sections 802 through 812.	All the requirements of Chapter 7 applied throughout the building for the new occupancy group and requirements of Section 802 through 812 are complied in the existing Structure.	***COMPLIED WITH THIS SECTION AND HENCE CHANGE OF OCCUPANCY FROM GROUP "B" TO GROUP "R-2" IS PERMITTED.***
812.1.1 Change of occupancy group without separation	Where a portion of an existing building is changed to a new occupancy group, and that portion is not separated from the remainder of the building with fire barriers having a fire resistance rating as required in the International Building Code for the separate occupancy, the entire building shall comply with all of the requirements of Chapter 7 applied throughout the building for the most restrictive Use Group in the building and with the requirements of this Chapter.	**Chapter 7: Alterations Level III** The entire building complied with all of the requiremnts of Chapter 7 applied throughout the building for the use Group R-2 and with also with the requirements of this chapter.	**FOLLOW CHAPTER 7** Discussed in detail in Chapter 7 and refer to the compliance and applicable exceptions listed under each subsection.
Exception:	Compliance with all the provisions of Chapter 7 is not required when the change of occupancy group complies with the requirements of Section 812.3.	**Exception Not Applicable** (FOLLOW SECTION: 812.3 here)	Exception not applicable as the change in occupancy is not complying with Sec 812.3
812.1.2 Change of occupancy group with separation.	A portion of an existing building that is changed to a new occupancy group, and is separated from the remainder of the building with fire barriers having a fire resistance rating as required in the International Building Code for the separate occupancy shall comply with all the requirements of Chapter 7 for the new occupancy group, and with the requirements of this Chapter.		Need to comply to the requirements of Chapter 7 Follow analysis in Chapter 7.
Exception:	Compliance with all the provisions of Chapter 7 is not required when the change of use complies with the requirements of Section 812.3.	**Exception Not Applicable** (FOLLOW SECTION: 812.3 here)	Exception not applicable as the change in occupancy is not complying with Sec 812.3

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
812.2 Hazard category classifications.	The relative degree of hazard between different occupancy groups shall be as set forth in the hazard category classifications, Tables A through C of Sections 812.4, 812.4.3 and 812.4.4.	Attach the sheet showing all the three Hazard Catgory Tables A through C	Attach the sheet showing all the three Hazard Catgory Tables A through C
812.2.1 Change of occupancy classification to an equal or lesser hazard.	An existing building or portion thereof may have its use changed to a occupancy group within the same hazard classification category or to a occupancy group in a lesser hazard classification category (higher number) in all four hazard category classifications, provided it complies with the provisions of Chapter 7 for the new occupancy group, applied throughout the building, or portion thereof.	**$$$$$$$$$$$$$$** SECTION NOT - APPLICABLE	**NOT APPLICABLE** In the case study project occupancy group is changed from "B" to "R-2" and this results in the building shooting upto a higher hazard category in two of three tables
Exception:	Compliance with all the provisions of Chapter 7 is not required where the change of occupancy group complies with the requirements of Section 812.3.	**Exception Not Applicable** (FOLLOW SECTION: 812.3 here)	Exception not applicable as the change in occupancy is not complying with Sec 812.3
812.2.2 Change of occupancy classification to a higher hazard.	An existing building shall comply with all the applicable requirements of this Chapter when a change in occupancy group will place it in a higher hazard category or when the occupancy group is changed within Group H.	**$$$$$$$$$$$$$$** **APPLICABLE**	**APPLICABLE** *In the case study project occupancy group is changed from "B" to "R-2" and this results in the building shooting upto a higher hazard category in two of three tables*

Table 812.4.1: (A) : Hazard Categories and Classification based on life Safety and Exits:
Table 812.4.1: (A) : Change of use from Group "B" (**relative hazard level 4 - lower hazard**) to Group "R-2" (**Hazard level 3 - higher**)

Table 812.4.3: (B) : Hazard Categories and Classification based on Heights and Areas:
Table 812.4.3: (B) : Change of use from Group "B" (**relative hazard level 4 - lowest hazard**) to Group "R-2" (**Hazard level 2 - higher**)

Table 812.4.4: (C) : Hazard Categories and Classification based on Exposure of Exterior Walls:
Table 812.4.4: (C) : Change of use from Group "B" (**relative hazard level 3 - Same**) to Group "R-2"(**relative hazard level 3 - Same**)

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
812.3 Change of occupancy classification to an equal or lesser hazard in all three hazard classifications.	A change of use to an occupancy group within the same hazard classification category or to an occupancy group in a lesser hazard classification category (higher number) in the three hazard category classifications addressed by Tables A, B and C shall be permitted in an existing building or portion thereof provided the provisions of Sections 812.3.1 through 812.3.5 are met.	$$$$$$$$$$$$$$ SECTION NOT - APPLICABLE	**NOT APPLICABLE** In the case study project occupancy group is changed from "B" to "R-2" and this results in the building shooting upto a higher hazard category in two of three tables
812.3.1 Minimum requirements.	Regardless of the occupancy group involved, the following requirements shall be met: 1. The capacity of the means of egress shall comply with International Building Code. 2. The interior finish of walls and ceilings shall comply with the requirements of the International Building Code for the new occupancy group.	$$$$$$$$$$$$$$ SECTION NOT - APPLICABLE	**NOT APPLICABLE** As section 812.3 is not applicable
812.3.2 Groups I-1, R-1, R-2, or R-4	Where the new use is classified as Group I-1, R-1 or R-2, or R-4 Occupancy the following requirements shall be met. 1. Corridor doors and transoms shall comply with the requirements of Sections 605.5.1 and 605.5.2. 2. Automatic sprinkler systems shall comply with the requirements of Section 604.2. 3. Fire alarm and detection systems shall comply with the requirements of Section 604.4.	$$$$$$$$$$$$$$ SECTION NOT - APPLICABLE	**NOT APPLICABLE** As section 812.3 is not applicable
812.3.3 Group I-2.	Where the new use is classified as Group I-2 Occupancy, the following requirements shall be met: 1. Egress doorways from patient sleeping rooms shall and suites of rooms shall comply with the requirements of Section 605.4.1.2. 2. Shaft enclosures shall comply with the requirements of Section 703.1. 3. Smoke barriers shall comply with the requirements of Section 603.3.	$$$$$$$$$$$$$$ SECTION NOT - APPLICABLE	**NOT APPLICABLE** As section 812.3 is not applicable

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
	4. Automatic sprinkler systems shall comply with the requirements of Section 604.2. 5. Fire alarm and detection systems shall comply with the requirements of Section 604.4.		
812.3.4 Group I-3.	Where the new use is classified as Group I-3 Occupancy, the following requirements shall be met: 1. Locking of egress doors shall comply with the requirements of Section 605.4.5. 2. Shaft enclosures shall comply with the requirements of Section 703.1. 3. Automatic sprinkler systems shall comply with the requirements of Section 604.2. 4. Fire alarm and detection systems shall comply with the requirements of Section 604.4.	**$$$$$$$$$$$$$$** **SECTION NOT - APPLICABLE**	**NOT APPLICABLE** **As section 812.3 is not applicable and also the new use group is R-2**
812.3.5 Group R-3.	Where the new use is classified as Group R-3 Occupancy, the following requirements shall be met: 1. Dwelling unit separation shall comply with the requirements of Section 703.2.1. 2. The smoke alarm requirements of Section 604.4.3 shall be met.	**$$$$$$$$$$$$$$** **SECTION NOT - APPLICABLE**	**NOT APPLICABLE** **As section 812.3 is not applicable and also the new use group is R-2**
812.4 Fire and life safety			
812.4.1 Means of Egress, **General.**	Hazard categories in regard to life safety and means of egress shall be in accordance with Table 812.4.1.		
	TABLE 812.4.1 HAZARD CATEGORIES AND CLASSIFICATIONS: LIFE SAFETY AND EXITS	Refer to table in Page # 45 of IEBC	

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
812.4.1.1 Means of egress for change to higher hazard category.	When a change of occupancy group is made to a higher hazard category (lower number) as shown in Table 812.4.1, the means of egress shall comply with the requirements of Chapter 10 of the International Building Code.	$$$$$$$$$$$$$$ **APPLICABLE**	**APPLICABLE** *In the case study project occupancy group is changed from "B" to "R-2" and this results in the building shooting upto a higher hazard category in two of three tables*
Exceptions:	1. Stairways shall be enclosed in compliance with applicable provisions of Section 703.1.	$$$$$$$$$$$$$$	**FOLLOW SECTION 703.1**
	2. Existing stairways including handrails and guards complying with the requirements of Chapter 7 shall be permitted for continued use subject to approval of the code official.	$$$$$$$$$$$$$$	**FOLLOW CHAPTER 7** (Also Follow Section 605 Means of Egress)
	3. Any stairway replacing an existing stairway within a space where, because of existing construction, the pitch or slope cannot be reduced, shall not be required to comply with the maximum riser height and minimum tread depth requirements.	$$$$$$$$$$$$$$	**FOLLOW** Section 605.3.1.2.3
	4. Existing corridor walls constructed of wood lath and plaster in good condition or ½-inch-thick (12.7 mm) gypsum wallboard shall be permitted.		
	5. Existing corridor doorways, transoms and other corridor openings shall comply with the requirements in Sections 605.5.1, 605.5.2 and 605.5.3.	$$$$$$$$$$$$$$	**FOLLOW** Section 605.5.1 Section 605.5.2 Section 605.5.3
	6. Existing dead end corridors shall comply with the requirements in Section 605.6.	$$$$$$$$$$$$$$	**FOLLOW** Section 605.6
	7. An existing operable window with clear opening area no less than 4 square feet (0.38 m2), and with minimum opening height and width of 22 inches (559 mm) and 20 inches (508 mm) respectively shall be accepted as an emergency escape and rescue opening.		Existing windows in the building meet the minimum requirements.

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
812.4.1.2 Means of egress when change of use to equal or lower hazard category.	When a change of occupancy group is made to an equal or lesser hazard category as shown in Table 812.4.1, existing elements of the means of egress shall comply with the requirements of Section 705 for the new occupancy group. Newly constructed or configured means of egress shall comply with the requirements of Chapter 10 of the International Building Code.	**SECTION NOT - APPLICABLE**	**NOT APPLICABLE** In the case study project occupancy group is changed from "B" to "R-2" and this results in the building shooting upto a higher hazard category as per Table 812.4.1
Exception:	1. Any stairway replacing an existing stairway within a space where, because of existing construction, the pitch or slope cannot be reduced, shall not be required to comply with the maximum riser height and minimum tread depth requirements. 2. Compliance with Section 705 is not required where the change of occupancy group complies with the requirements of Section 812.3.	**Exception Not Applicable**	Exception not applicable as the change in occupancy is not complying with 812.4.1.2
812.4.1.3 Egress capacity.	Egress capacity shall meet or exceed the occupant load as specified in the International Building Code if the change of Occupancy Classification is to an equal or lesser hazard category when evaluated in accordance with Table 812.4.1.	**SECTION NOT - APPLICABLE**	**NOT APPLICABLE** In the case study project occupancy group is changed from "B" to "R-2" and this results in the building shooting upto a higher hazard category as per Table 812.4.1
812.4.1.4 Handrails.	Existing stairways shall comply with the handrail requirements in Section 605.9 in the area of the change of occupancy Classification.	$$$$$$$$$$$$$$	**FOLLOW** Section 605.9
812.4.1.5 Guards.	Existing guards shall comply with the guardrail requirements in Section 605.10 within the area of the change of occupancy classification.	$$$$$$$$$$$$$$	**FOLLOW** Section 605.10

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
812.4.2 Enclosure of vertical shafts.	Enclosure of vertical shafts shall be in accordance with Section 812.4.2.1 through 812.4.2.4.		**FOLLOW** Sections 812.4.2.1 to Sections 812.4.2.4
812.4.2.1 Minimum requirements.	Vertical shafts shall be designed to meet the International Building Code requirements for atriums or the requirements of this Section.		
812.4.2.2 Stairways.	When a change of occupancy group is made to a higher hazard category as shown in Table 812.4.1, interior stairways shall be enclosed as required by the International Building Code.	Applicable in the existing building as the new use is in higher hazard category	**APPLICABLE REQUIREMENT** Need to Comply to IBC
Exceptions:			
	1. In other than Group I Occupancy, an enclosure shall not be required for openings serving only one adjacent floor and not connected with corridors or stairways serving other floors.	**Exception Not Applicable**	Exception not applicable as opening serves many floors
	2. Unenclosed existing stairways need not be enclosed in a continuous vertical shaft if each story is separated from other stories by one-hour fire-resistive construction or approved wired glass set in steel frames and all exit corridors are sprinklered. The openings between the corridor and occupant space shall have at least one sprinkler head above the openings of the tenant side. The sprinkler system shall be permitted to be supplied from the domestic water-supply systems, provided the system is of adequate pressure, capacity and sizing for the combined domestic and sprinkler requirements.	**Exception Not Applicable**	Exception not applicable as building has enclosed stairs
	3. Existing penetrations of stairway enclosures shall be accepted if they are protected in accordance with the International Building Code.	**Exception Not Applicable**	Exception not applicable as the change in occupancy is not complying with Sec 812.3

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
812.4.2.3 Other vertical shafts.	Interior vertical shafts other than stairways, including but not limited to elevator hoistways and service and utility shafts, shall be enclosed as required by the International Building Code when there is a change of use to a higher hazard category in Table 812.4.1.	Applicable in the existing building as the new use is in higher hazard category	**APPLICABLE REQUIREMENT** Need to Comply to IBC
Exceptions:	1. Existing one-hour interior shaft enclosures shall be accepted where a higher rating is required.	$$$$$$$$$$$$$$ **APPLICABLE EXCEPTION**	**Follow Section 604 (apply)** Fire Protection requirements as needed in section 604
	2. Vertical openings, other than stairways, in buildings other than Group I Occupancy and connecting less than 6 stories in height shall not be required to be enclosed if the entire building is provided with an approved automatic sprinkler system.	**Exception Not Applicable**	Exception not applicable as building is more than six stories in height
812.4.2.4 Openings.	All openings into existing vertical shaft enclosures shall be protected by fire assemblies having a fire-protection rating ofnot **less than one hour** and shall be maintained selfclosing or shall be automatic closing by actuation of a smoke detector. All other openings shall be fire protected in an approved manner. Existing fusible link-type automatic door-closing devices shall be permitted in all shafts except stairways if the fusible link rating does not exceed 135oF. (57oC.).	$$$$$$$$$$$$$$ **As per Section 707.4 of IBC** **707.4 Fire-resistance rating.** Shaft enclosures including exit enclosures shall have a fire-resistance rating of **not less than 2 hours** where connecting four stories or more and 1 hour where connecting less than four stories. Shaft enclosures shall have a fire-resistance rating not less than the floor assembly penetrated, but need not exceed 2 hours.	This is an important factor as all the vertical shaft openings in the existing building are one hour rated, whereas for a building of 4 stories or more IBC requires 2 hour fire rating. This provision of IBC is benefitial to save rehab cost by retaining the existing openings of vertical shafts.
812.4.3 Heights and areas.	Hazard categories in regard to height and area shall be in accordance with Table 812.4.3		Follow Sections 812.4.3.1 through 812.4.3.3
	TABLE 812.4.3 HAZARD CATEGORIES AND CLASSIFICATIONS: HEIGHTS AND AREAS	Refer to table in Page # 47 of IEBC	

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
812.4.3.1 Height and area for change to higher hazard category.	When a change of occupancy group is made to a higher hazard category as shown in Table 812.4.3, heights and areas of buildings and structures shall comply with the requirements of Chapter 5 of the International Building Code for the new occupancy group.	SECTION 812.4.3.1 APPLICABLE In the case study project occupancy group is changed from "B" to "R-2" and this results in the building shooting upto a higher hazard category as per Table 812.4.3	**SECTION APPLICABLE** **FOLLOW CHAPTER 5 - IBC** The heights and area (IBC) limitations of the existing building is in compliance with the international Building Code Standards and hence complied
Exception:	A 1-story building changed into Group E shall not be required to meet the area limitations of the International Building Code.	Exception Not Applicable	**Height - 135 ft (code 160 ft)** **Area - 96000 sft (code UL)**
812.4.3.2 Height and area for change to equal/ lesser hazard category.	When a change of use is made to an equal or lesser hazard category as shown in Table 812.4.3, the height and area of the existing building shall be deemed to be acceptable.	SECTION 812.4.3.2 NOT APPLICABLE	**NOT APPLICABLE** In the case study project occupancy group is changed from "B" to "R-2" and this results in the building shooting upto a higher hazard category as per Table 812.4.3
812.4.3.3 Fire barriers .	When a change of occupancy group is made to a higher hazard category as shown in Table 812.4.3, fire barriers in separated mixed use buildings shall comply with the fire resistance requirements in the International Building Code.	Applicable in the existing building as the new use is in higher hazard category	APPLICABLE REQUIREMENT Need to Comply to IBC
Exception:	Where the fire barriers are required to have a one-hour fire resistance rating, existing wood lath and plaster in good condition or existing ½-inch-thick (12.7 mm) gypsum wallboard shall be permitted.	Exception Not Applicable	
812.4.4 Exterior wall fire resistance ratings.	Hazard categories in regard to fire resistance ratings of exterior walls shall be in accordance with Table 812.4.4.		Follow Sections 812.4.4.1 through 812.4.4.3
	TABLE 812.4.4 HAZARD CATEGORIES AND CLASSIFICATIONS: EXPOSURE OF EXTERIOR WALLS	Refer to table in Page # 48 of IEBC	

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
812.4.4.1 Exterior wall rating for change of occupancy classification to a higher hazard category.	Where a change of occupancy group is made to a higher hazard category as shown in Table 812.4.4, exterior walls shall have fire resistance and exterior opening protectives as required by the International Building Code. This provision shall not apply to walls at right angles to the property line.	SECTION 812.4.4.1 NOT APPLICABLE	**NOT APPLICABLE** In the case study project occupancy group is changed from "B" to "R-2" and this results in no change in the relative hazard category as per Table 812.4.4
Exception:	A two hour fire resistance rating shall be allowed where the building does not exceed three stories in height and is classified as one of the following Groups: A-2 and A-3 with an occupant load of less than 300, B, F, M, or S.	Exception Not Applicable	
812.4.4.2 Exterior wall rating for change of occupancy classification to an equal or lesser hazard category.	When a change of occupancy group is made to an equal or lesser hazard category as shown in Table 812.4.4, existing exterior walls, including openings, shall be accepted.	$$$$$$$$$$$$$$ SECTION 812.4.3.1 APPLICABLE In case study project occupancy group is changed from "B" to "R-2" and this results in no change in realtive hazard category as per Table 812.4.4	***All the Existing Exterior Walls, including Openings are allowed under this section***
812.4.4.3 Opening protectives.	Openings in exterior walls shall be protected as required by the International Building Code. When openings in the exterior walls are required to be protected due to distance from the property line, the sum of the area of such openings shall not exceed 50 percent of the total area of the wall in each story.		**FOLLOW EXCEPTION 4 OF THIS SECTION**
Exceptions:	1. Where the International Building Code permits openings in excess of 50 percent.	**Exception Not Applicable**	
	2. Protected openings shall not be required in buildings of occupancy group R which do not exceed three stories in height and which are located not less than 3 feet (914 mm) from the property line.	**Exception Not Applicable**	Exception not applicable as building is more than six stories in height

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
	3. Where exterior opening protectives are required, an automatic sprinkler system throughout may be substituted for opening protection. 4. Exterior opening protectives are not required when the change of occupancy group is to an equal or lower hazard classification in accordance with Table 812.4.4.	$$$$$$$$$$$$$ IMPORTANT APPLICABLE EXCEPT. In case study project occupancy group is changed from "B" to "R-2" and this results in no change in realtive hazard category as per Table 812.4.4	Exterior opening protectives are not required
812.5 Accessibility.	Existing buildings or portions thereof that undergo a change of occupancy classification shall have all of the following accessible features:	When a change in occupancy is made accessibility requirements need to comply with suitable sections in IEBC	APPLICABLE REQUIREMENT
	1. At least one accessible building entrance.	*Important Requirements as Per Code*	Need to Comply to IBC
	2. At least one accessible route from an accessible building entrance to primary function areas.	*Important Requirements as Per Code*	Need to Comply to IBC
	3. Signage complying with Section 1109 of the International Building Code.		*Follow Section 1109 of IBC*
	4. Accessible parking, where parking is being provided.	*Important Requirements as Per Code*	Need to Comply to IBC
	5. At least one accessible passenger loading zone, where loading zones are provided.		
	6. At least one accessible route connecting accessible parking and accessible passenger loading zones to an accessible entrance.	*Important Requirements as Per Code*	Need to Comply to IBC
Exception:	Where it is technically infeasible to comply with the new construction standards for any of these requirements for a change of group or occupancy, the above items shall conform to the requirements to the maximum extent technically feasible. Change of group or occupancy that incorporate any alterations or additions shall comply with this section and Sections 506.1 and 506.2 as applicable.	$$$$$$$$$$$$$ IMPORTANT APPLICABLE EXCEPT.	In the rehabilitation project, whereever it is technically infeasible to comply with new construction standards for accessibility requiremnts, comply with Sections 506.1 and 506.2 as applicable.

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
812. 6 Structural safety 812.6.1 Seismic loads	Existing buildings with a change of Occupancy Classification shall comply with the seismic provisions of Section 807.3	Change from B to R-2, the Importance Factor for both uses are same and there is no change in Seismic Factor based on Table 1604.5 SEISMIC FACTOR IE - 1.00 (B & R-2)	Follow Section 807.3 **Complied in Existing Structure**

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
All these compliance requirements to be checked in Chapter 5, 6 and 7 are based on the references made by the Chapter 8 - Change of Occupancy as this case study project involves a change in Occupancy from Use Group B to Residential Use Group R-2. As per the International Existing Building Code (IEBC), if there is a change in occupancy in a building from a lower hazard category to a higher hazard category as defined in Chapter 8 of the IEBC, then respective compliance requirements from Chapter 5, 6 and 7 as stated by Chapter 8 are to be met. These compliance requirements will be discussed in the forthcoming three chapters (5,6 and 7) that are based on Chapter 8. As this case study project is also an Historical Building, all the applicable Sections of Chapter 10 of IEBC are checked for compliance. This is tabulated in the next sections of this analysis.			
SECTION 501 **GENERAL** 501.1 Scope	**CHAPTER 5** **ALTERATIONS - LEVEL 1** Level 1 alterations, as described in Section 303 shall comply with the requirements of this Chapter. Level 1 alterations to historic buildings shall comply with this chapter, except as modified in Chapter 10.		Since this case study building is a designated Historic Building the Level 1 alterations shall comply with this chapter and in accordance with chapter 10 as required

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
501.2 Conformance.	An existing building or portion thereof shall not be altered such that the building becomes less safe than its existing condition. If, in the alteration the current level of safety or sanitation is to be reduced, the portion altered shall conform to the requirements of the International Building Code.	check for the altered use and condition of the building	**NOT APPLICABLE** As the altered building is not going to be less safer than its existing consition
501.3 Flood hazard areas	. In flood hazard areas, alterations that constitute substantial improvement shall require that the building comply with International Building Code Section 1612.	The altered buildings shall be designed and constructed to resist the effects of flood hazards and flood loads	Need to comply with International Building Code
501.3 Flood hazard areas			
502.1 General	Alteration of buildings, classified as special use and occupancy as described in the International Building Code, shall comply with the requirements of Section 501.1 and the scoping provisions of Chapter 1 where applicable.	Buildings and structures located in flood hazard areas subject to high velocity wave action shall be designed and constructed in accordance with ASCE 24 listed in chapter 35 of IBC	**NOT APPLICABLE** The case study project is not classified as special use and occupancy
SECTION 503 BUILDING ELEMENTS AND MATERIALS			
503.1 Interior finishes.	All newly installed interior finishes shall comply with the flame spread requirements of the International Building Code.	Any material that is subject to an increase in flame spread index or smoke developed index beyond the limits established by IBC shall not be permitted	APPLICABLE AS PER IBC Carpet and similar textile materials shall have a Class A flame and smokespread index accordance with ASTM E 84 and be protected by automatic sprinklers.
503.2 Carpeting.	New carpeting used as an interior floor finish material shall comply with the radiant flux requirements of the International Building Code.	***Class A:*** flame spread 0-25; smoke developed 0-450.	
503.3 Materials and methods:	All new work shall comply with materials and methods requirements in the International Building Code, International Mechanical Code, International Plumbing Code, International Energy Conservation Code and ICC Electrical Code as applicable, that specify material standards, detail of installation and connection, joints, penetrations and continuity of any element, component or system in the building.	New materials and methods used in the rehabilitation work shall comply to the IBC and Materials and methods used for recovering or replacing an existing building elements shall comply with the IBC.	APPLICABLE AS PER IBC For new materials and methods

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
SECTION 504 FIRE PROTECTION 504.1 Smoke detectors in Group R and I-1 occupancies.	In buildings of Use Groups R and I-1, newly installed smoke detectors that are located closer than five feet to a kitchen or bathroom area shall be of photoelectric type only.	Smoke detectors in HVAC systems. The detectors are installed in accordance with the requirements for new buildings in the International Mechanical Code.	APPLICABLE AS PER IBC Case study project is a going to be of Use Group R. Hence need to comply to this requirement.
SECTION 505 MEANS OF EGRESS 505.1 General	Means of egress for buildings undergoing alteration shall comply with the requirements of Section 501.1 and the scoping provisions of Chapter 1 where applicable.	Level 1 alterations to historic buildings shall comply with this chapter, except as modified in Chapter 10.	APPLICABLE AS PER *CHAPTER 5 AND CHAPTER 10 OF THIS CODE (IEBC)*
SECTION 506 ACCESSIBILITY 506.1 Accessibility	A building, facility or element that is altered shall comply with the applicable provisions in Chapter 11 of the International Building Code, Sections 506.1.1 thru 506.1.15 and ICC/ANSI A117.1, unless technically infeasible. Where compliance with this section is technically infeasible, the alteration shall provide access to the maximum extent technically feasible.	The provisions of chapter 11 of IBC shall control the design and construction of facilities for accessibility to physically disabled persons. Buildings and facilities shall be rehabilitated to be accessible in accordance with IBC & ICC/ANSI A117.1	APPLICABLE AS PER IBC AND THE IEBC (*subdivisions in this Section with suitable exceptions described below)*
Exceptions:	1. The altered element or space is not required to be on an accessible route, unless required by Section 506.2.	Where an alteration affects the accessibility to, or contains an area of primary function - Shall be accessible	APPLICABLE AS PER IBC
	2. Accessible means of egress required by Chapter 10 of the International Building Code are not required to be provided in existing buildings and facilities.	**$$$$$$$$$$$$$**	IMPORTANT APPLICABLE EXCEPTION AS THIS IS WORK IN EXISTING BUILDING
	3. Type B dwelling units required by Section 1107.5.4 of the International Building Code are not required to be provided in existing buildings and facilities.	1107.5.4 Group I-2 rehabilitation facilities.	**NOT APPLICABLE** As the builiding is Group R-2

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
506.1.1 Elevators.	Altered elements of existing elevators shall comply with ASME A17.1 and ICC/ANSI A117.1. Such elements shall also be altered in elevators programmed to respond to the same hall call control as the altered elevator.	An elevator to be considered part of an accessible means of egress shall comply with the emergency operation and signaling devices requirements of Section 211 of ASME A17.1.	**APPLICABLE AS PER IBC** 1003.2.13.3 Elevators (IBC)
506.1.2 Platform lifts	Platform (wheelchair) lifts complying with ICC/ANSI A117.1 and installed in accordance with ASME A17.1 shall be permitted as a component of an accessible route.	**1104.4 Multilevel buildings and facilities.** At least 1 accessible route shall connect each accessible level, including mezzanines	**NOT AVAILABLE IN THE EXISTING BUILDING** (Existing elevators will suffice this need)
506.1.3 Stairs and escalators in existing buildings.	In alterations where an escalator or stair is added where none existed previously an accessible route shall be provided in accordance with Sections 1104.4 and 1104.5 of the International Building Code.	**1104.5 Location.** Accessible routes shall coincide with or be located in the same area as a general circulation path.	**NOT APPLICABLE** As the existing builiding has escalators and stairs
506.1.4 Ramps.	Where steeper slopes than allowed by Section 1003.3.4.1 are necessitated by space limitations, the slope of ramps in or providing access to existing buildings or facilities shall comply with Table 506.1.4.	**1003.3.4.1 Ramp Slope.** Ramps used as part of a means of egress shall have a running slope not steeper than one unit vertical in 12 units horizontal (8-percent slope).	**REFER TO SECTION 605.3.1.2.3**
506.1.5 Dining areas.	An accessible route to raised or sunken dining areas, or to outdoor seating areas is not required provided that the same services and decor are provided in an accessible space usable by any occupant and not restricted to use by people with a disability.		**NOT AVAILABLE IN THE EXISTING BUILDING**
506.1.6 Performance area	Where it is technically infeasible to alter performance areas to be on an accessible route, at least one of each type of performance area shall be made accessible.		**NOT AVAILABLE IN THE EXISTING BUILDING**

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
506.1.7 Assembly areas.	Seating shall adjoin an accessible route that also serves as a means of egress. Where it is technically infeasible to disperse accessible seating throughout an altered assembly area, the minimum required number of wheelchair space clusters shall be one-half of that required by Section 1107.2.2.1 of the International Building Code. In existing assembly seating areas with a mezzanine, where the main level provides three-fourths or more of the total seating capacity, wheelchair space clusters are permitted to be dispersed on the main level. Each accessible seating area shall have provisions for companion seating.		NOT AVAILABLE IN THE EXISTING BUILDING Case study project is a going to be of Use Group R. Hence need to comply to this requirement.
506.1.8 Sleeping rooms . and accommodations	Where I-1 sleeping rooms, I-2 sleeping rooms or patient rooms, I-3 residential units, or R-1 and R-2 sleeping accommodations are being altered or added, the requirements of Section 1107 of the International Building Code for accessible rooms and Chapter 9 for accessible alarms apply only to the quantity of spaces being altered or added.	Not applicable in existing businedd use and needed in new residential use	NOT NECESSARY IN THE EXISTING BUILDING (Since Group R-2 is going to be the new use, the new change or additions made will comply to IBC)
506.1.9 Toilet rooms.	Where it is technically infeasible to alter existing toilet and bathing facilities to be accessible, an accessible unisex toilet or bathing facility is permitted. The unisex facility shall be located on the same floor and in the same area as the existing facilities.	Not available in existing businedd use and needed in new residential use	NOT APPLICABLE
506.1.10 Dressing, fitting and locker rooms.	Where it is technically infeasible to provide accessible dressing, fitting or locker rooms at the same location as similar types of rooms, one accessible room on the same level shall be provided. Where separate sex facilities are provided, accessible rooms for each sex shall be provided. Separate sex facilities are not required where only unisex rooms are provided.	Not applicable in existing business use and needed in new residential use	NOT NECESSARY IN THE EXISTING BUILDING (Since Group R-2 is going to be the new use, the new change or additions made will comply to IBC)

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
506.1.11 Check-out aisles	. Where check-out aisles are altered in facilities having a selling space of 5,000 square feet (465 m2) or more, at least one check-out aisle serving each function shall be made accessible.	Not applicable in residential use buildings	**NOT APPLICABLE**
506.1.12 Dispersion of seating at fixed or built-in tables, counters, or work surfaces.	Accessible seating at fixed or built-in tables, counters or work surfaces shall be distributed throughout the space or facility as much as technically feasible.	Not applicable in residential use buildings	**NOT APPLICABLE**
506.1.13 Sales and servic counters.	Where it is technically infeasible for existing counters for sales or distribution of goods or services to be made accessible, an accessible auxiliary counter shall be provided.	Not applicable in residential use buildings	**NOT APPLICABLE**
506.1.14 Thresholds.	The maximum height of thresholds at doorways shall be 3/4 inch (19.1 mm). Such threshold shall have beveled edges on each side.		
506.1.15 Extent of application.	An alteration of an existing element, space, or area of a building or facility shall not impose a requirement for greater accessibility than that which would be required for new construction. Alterations shall not reduce or have the effect of reducing accessibility of a building, portion of a building, or facility.	Chapter 34 of IBC states: 3408.5.1 Extent of application. Alterations shall not reduce or have the effect of reducing accessibility of a building, portion of a building, or facility.	**Checked for compliance** Checked for compliance in the rehabilitation project and no change is imposed by the new change in occupancy

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
506.2 Alterations affecting an area containing a primary function.	Where an alteration affects the accessibility to, or contains an area of primary function, the route to the primary function area shall be accessible. The accessible route to the primary function area shall include toilet facilities or drinking fountains serving the area of primary function. For the purposes of complying with Section 506.2, an area of primary function shall be defined by applicable provisions of 49 CFR Part 37.43(c) or 28 CFR Part 36.403.	Where an alteration affects the accessibility to, or contains an area of primary function - Shall be accessible	**NOT APPLICABLE** Not Applicable as the new use of R-2 is going to determine this requiremnts and as this is new change it will comply to IBC
Exceptions:	1. The costs of providing the accessible route is not required to exceed 20 percent of the costs of the alterations affecting the area of primary function.		**NOT APPLICABLE**
	2. This provision does not apply to alterations limited solely to windows, hardware, operating controls, electrical outlets and signs.		**NOT APPLICABLE**
	3. This provision does not apply to alterations limited solely to mechanical systems, electrical systems, installation or alteration of fire-protection systems, and abatement of hazardous materials.		**NOT APPLICABLE**
	4.This provision does not apply to alterations undertaken for the primary purpose of increasing the accessibility of an existing building, facility or element.		**NOT APPLICABLE**
SECTION 507 STRUCTURAL 507.1 General.	Where alteration work includes replacement of equipment that is supported by the building or where a re-roofing permit is required, the structural provisions of this section shall apply.	Check with the Compliance requirements of Section 707.5 Structural Alteration for details	As this case study project involves a Change of Occupancy from Group B to Group R-2, all comnpliance requirtements are as per Chapter 8 of IEBC and Section 707 Structural

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
507.2 Design criteria .	Existing structural components supporting alteration work shall comply with this section.		
507.2.1 Replacement of roofing or equipment.	Where replacement of roofing or equipment results in additional dead loads, structural components supporting such re-roofing or equipment shall comply with the vertical load requirements of the International Building Code.	Check with the Compliance requirements of Section 707.5 Structural Alteration for details	As this case study project involves a Change of Occupancy from Group B to Group R-2, all comnpliance requirtements are as per Chapter 8 of IEBC and Section 707 Structural
Exceptions :	1. Structural elements whose stress is not increased by more than 5 percent. 2. Buildings constructed in accordance with the International Residential Code or the conventional construction methods of the International Building Code and where the additional dead load from the equipment is not increased by more than 5 percent.		
507.2.2 Parapet bracing and wall anchors for re-roof permits	. Unreinforced masonry bearing wall buildings classified as Seismic Design Category D, E or F shall have parapet bracing and wall anchors installed at the roof line whenever a re-roofing permit is issued. Such parapet bracing and wall anchors shall be designed in accordance with the reduced International Building Code level seismic forces as specified in Section 407.1.1.3 and design procedures of Section 407.1.1.1.	Check with the Compliance requirements of Section 707.5 Structural Alteration for details	As this case study project involves a Change of Occupancy from Group B to Group R-2, all comnpliance requirtements are as per Chapter 8 of IEBC and Section 707 Structural
507.3 Roof diaphragm	. Where roofing materials are removed from more than 50% of the roof diaphragm of a building or section of a building where the roof diaphragm is a part of the main wind force resisting system the integrity of the roof diaphragm shall be evaluated and if found deficient due to insufficient or deteriorated connections such connections shall be provided or replaced.	Check with the Compliance requirements of Section 707.5 Structural Alteration for details	As this case study project involves a Change of Occupancy from Group B to Group R-2, all comnpliance requirtements are as per Chapter 8 of IEBC and Section 707 Structural
	[illegible]		

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
CHAPTER 6 ALTERATIONS - LEVEL 2			
SECTION 601 GENERAL			
601.1 Scope.	Level 2 alterations, as described in Section 304 shall comply with the requirements of this Chapter.		The requirements initiated by Chapter 8 - Change of Occupancy for compliance requirements with Chapter 7 are discussed in these sections
Exception:	Buildings in which the reconfiguration is exclusively the result of compliance with the accessibility requirements of Section 506.2 shall be permitted to comply with Chapter 5.		
601.2 Alteration level 1 compliance	. In addition to the requirements of this chapter, all work shall comply with the requirements of Chapter 5.		Applicable requirements are complied in the previous chapter 5
601.3 Compliance.	All new construction elements, components and systems and spaces shall comply with the requirements of the International Building Code.		
Exception:	1. Openable windows may be added without requiring compliance with the light and ventilation requirements of the International Building Code.	As per IBC, minimum openable area to outdoors shall be 4 percent of the floor area being ventilated. The minimum net glazed area shall not be less than 8 percent of the floor area of the room served.	The existing windows in the case study building meets both the light and ventilation requiremnts (8 and 4 percent respectively)
	2. Newly installed electrical equipment shall comply with the requirements of Section 608.0.		
	3. Dead end corridors in newly constructed spaces need only comply with the provisions of Section 705.	Not Applicable	Not applicable (Since Group R-2 is going to be the new use, the new change or additions made will comply to IBC)
	4. The minimum ceiling height of the newly created habitable and occupiable spaces and corridors shall be 7 feet.	**$$$$$$$$$$$$$** As per IBC Occupiable spaces, habitable spaces and corridors shall have a ceiling height of not less than 7 feet 6 inches (2286 mm).	IMPORTANT & APPLICABLE *In the existing building there are two stories (less than 7'6") that do not meet IBC, but are permitted & stay as per IEBC*
SECTION 602 SPECIAL USE AND OCCUPANCY			

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
602.1 General.	Alteration of buildings, classified as special use and occupancy as described in the International Building Code, shall comply with the requirements of Section 601.1 and the scoping provisions of Chapter 1 where applicable.		**NOT APPLICABLE** The case study project is not classified as special use and occupancy
SECTION 603 BUILDING ELEMENTS AND MATERIALS			
603.1 Scope.	The requirements of this section are limited to work areas in which Level 2 alterations are being performed, and shall apply beyond the work area where specified.		The requirements initiated by Chapter 8 - Change of Occupancy for compliance requirements with Chapter 6 and Ch 7 are discussed in these sections
603.2 Vertical openings.	Existing vertical openings shall comply with the provisions of Sections 603.2.1, 603.2.2 and 603.2.2.	603.2.1 Existing Vertical Openings 603.2.2 Supplemental shaft and floor opening enclosure requirements 603.2.3 Opening enclosure requirements	
603.2.1 Existing Vertical Openings	All existing interior vertical openings connecting two or more floors shall be enclosed with approved assemblies having a fire resistance rating of not less than one hour with approved opening protectives.	**$$$$$$$$$$$$$$** **As Per IBC** 707.4 Fire-resistance rating (FRR) Shaft enclosures including exit enclosures shall have a fire-resistance rating of not less than 2 hours where connecting four stories or more and 1 hour where connecting less than four stories. Shaft enclosures shall have a fire-resistance rating not less than the floor assembly penetrated, but need not exceed 2 hours.	*Most of the existing vertical openings in the case study building are of one hour FRR As per the IBC all the existing enclosures need to improve to Two Hour FRR. But IEBC prevents the additional costs for improving the FRR from One to Two hours, there by saving cost of rehabilitation to make the building comply with code.*
Exceptions for Group R-2:			
603.2.1.11	11. **In Group R-2 Occupancies**, a minimum 30 minute enclosure shall be provided to protect all vertical openings not exceeding three stories. This enclosure, or the enclosure specified in Section 603.2.1, shall not be required under the following conditions:	Check for compliance as our new proposed change in use is to Group R-2	**NOT APPLICABLE** The case study project is more than three stories. (It is a Nine story building)

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
	11.1. Vertical openings not exceeding two stories with not more than four dwelling units per floor; or		**NOT APPLICABLE**
	11.2. In buildings which are protected throughout by an approved automatic sprinkler system; or	Check for compliance as our new proposed change in use is to Group R-2	
	11.3. In buildings with not more than four dwelling units per floor where every sleeping room above the second floor is provided with direct access to a fire escape or other approved second exit by means having a sill height of not greater than 44 inches		**NOT APPLICABLE** The case study project is planned to have over 10 dwelling units per floor
603.2.2 Supplemental shaft and floor opening enclosure requirements.	Where the work area on any floor exceeds 50 percent of that floor area, the enclosure requirements of Section 603.2 shall apply to vertical openings other than stairways throughout the floor:		As the work area in the rehab project is exceeding 50 percent the shaft and floor opening encl. shall comply with the section 603.2 Vertical Openings
Exception:	Vertical openings located in tenant spaces that are entirely outside the work area.		**NOT APPLICABLE**
603.2.3 Supplemental stairway enclosure requirements.	Where the work area on any floor exceeds 50 percent of that floor area, stairways that are part of the means of egress serving the work area shall at a minimum be enclosed with smoke tight construction on the highest work area floor & flrs below.	**As Per IBC** Doors of the means of egress required to be smoke tight as per Section 408.7 of the IBC, shall be substantial doors, of construction that will resist the passage of smoke.	As the work area in the rehab project is exceeding 50 percent the supplemental stairway enclosure requirements need to be met as per this Fire code
Exception:	Where stairway enclosure is not required by the International Building Code or the International Fire Code.		
603.3 Smoke barriers.	Smoke barriers in Group I-2 shall be installed where required by Sections 603.3.1 and the travel distance from any point to reach a door in the required smoke barrier shall not exceed 200 feet (60 960 mm).		**NOT APPLICABLE** As the builiding is Group R-2
Exception:	Where neither the length nor width of the smoke compartment exceeds 150 feet (45 720 mm), the travel distance to reach the smoke barrier door shall not be limited.		**NOT APPLICABLE** As the builiding is Group R-2

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
603.3.2 Fire-resistance rating.	The smoke barriers shall be fire resistance rated for 30 minutes and constructed in accordance with the International Building Code.		
603.4 Interior finish.	The interior finish of walls and ceilings in exits and corridors in any work area shall comply with the requirements of the International Building Code.	$$$$$$$$$$$$$$ As per Section 803 of IBC (Finishes) ***Class A finish materials*** shall be used for exposed interior surfaces of buildings including, but not limited to: fixed or movable walls and partitions; columns; ceilings; and interior wainscotting, paneling, or other finish applied structurally or for decoration, acoustical correction, surface insulation, structural fire resistance or similar purposes.	APPLICABLE REQUIREMNT As per the exception offered by section of IEBC, if the existing Interior finish is of a Class other than Class A (Since the existing building was a Group B, it is expected to have a Class B or C flame spread index) then instead of changing the finishes, an approved fire retardent coating can be used.
Exception:	Existing interior finish materials which do not comply with the interior finish requirements of the International Building Code shall be permitted to be treated with an approved fire retardant coating in accordance with the manufacturer's instructions to achieve the required rating.		
603.4.1 Supplemental interior finish requirements	Where the work area on any floor exceeds 50 percent of the floor area, Section 603.4 shall also apply to the interior finish in exits and corridors serving the work area throughout the floor.	Class A: flame spread 0-25; Class B: flame spread 26-75; Class C: flame spread 76-200 For all the above classes, the smoke developed index is 0-450.	APPLICABLE REQUIREMENT comply as per explaination in Section 603.4
603.5 Guards	. The requirements of Sections 603.5.1 and 603.5.2 shall apply in all work areas.		
603.5.1 Minimum requirement.	Every portion of a floor, such as a balcony or a loading dock that is more than 30 inches (762 mm) above the floor or grade below and not provided with guards, or those in which the existing guards are judged to be in danger of collapsing, shall be provided with guards.	Section 1003.2.12 Guards. (IBC) Guards shall be located along open-sided walking surfaces, mezzanines, industrial equipment platforms, stairways, ramps and landings which are located more than 30 inches (762 mm) above the floor or grade below	APPLICABLE REQUIREMENT (requiremnts similar to IBC, so No cost Impact) The case study building meets the Guard requiremnts of IBC
603.5.2 Design.	Where there are no guards or existing guards must be replaced, the guards shall be designed and installed in accordance with the International Building Code.		

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
SECTION 604 FIRE PROTECTION			
604.1 Scope.	The requirements of this section shall be limited to work areas in which Level 2 alterations are being performed, and where specified they shall apply throughout the floor on which the work areas are located, or otherwise beyond the work area.		APPLICABLE REQUIREMENT
604.2 Automatic sprinkler systems.	Automatic sprinkler systems shall be provided in accordance with the requirements of Sections 604.2.1 through 604.2.5. Installation requirements shall be in accordance with the International Building Code.	*Follow Section 604.2.1 through 604.2.5*	
604.2.1 High rise buildings	In high rise buildings, work areas that include exits or corridors shared by more than one tenant or serving an occupant load greater than 30 shall be provided with automatic sprinkler protection where the work area is located on a floor which has a sufficient existing sprinkler water supply system to the floor.	As per Section 403 of IBC, any building having the occupied floors located more than 55 feet (16 764 mm) above the lowest level of fire department vehicle access is designated as High-Rise building as need to comply to this requirement.	The case study building is a High-rise building with total height of 135 feet. Hence Automatic Sprinkler System is needed and the existing system need to be modified to suit the Group R-2 sprinkler requiremnts
604.2.1.1 Supplemental automatic sprinkler	system requirements. Where the work area on any floor exceeds 50 percent of that floor area, Section 604.2.2 shall apply to the entire floor on which the work area is located.		Applicable Requirement as the work area exceeds 50 percent of floor area and need to comply with section 604.2.2
Exception:	Tenant spaces that are entirely outside the work area.	Not applicable exception	
604.2.2 Groups A, E, F-1, H, I, M, R-1, R-2, R-4, S-1 and S-2.	In buildings with occupancies in Groups A, E, F-1, H, I, M, R-1, R-2, R-4, S-1 and S-2, work areas that include exits or corridors shared by more than one tenant or serving an occupant load greater than 30 shall be provided with automatic sprinkler protection where all of the following conditions occur:		

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	1. The work area would be required to be provided with automatic sprinkler protection in accordance with the International Building Code applicable to new construction; 2. The work area exceeds 50% of the floor area; and 3. The building has sufficient municipal water supply for design of a fire sprinkler system available to the floor.		**Applicable Requirement** as the work area exceeds 50 percent of floor area automatic sprinkler protection in accordance with the IBC should be provided
Exception:	Work areas in Group R Occupancies 3 stories or less in height.	Not applicable exception	
604.2.2.1 Mixed uses	. In work areas containing mixed uses, one or more of which requires automatic sprinkler protection in accordance with Section 604.2.2, such protection shall not be required throughout the work area provided that the uses requiring such protection are separated from those not requiring protection by fire resistive construction having a minimum two-hour rating for Use Group H, and a minimum one-hour rating for all other use groups.	$$$$$$$$$$$$$$ As per 302.3 Mixed occupancies (IBC) As per the the fire-resistance ratings in Table 302.3.3 of IBC, the mixed use with Groups R-2 and Group M (Mercantile) a fire separation of 2 hours is needed	APPLICABLE REQUIREMNT The required 2 hour separation as per IBC is reduced to 1 hour as per the IEBC for the case study building as there is Group M retail shops are present in the first floor of the existing building with Group R-2 from secong hrough ninth floor.
604.2.3 Windowless stories.	Work located in a windowless story as determined in accordance with the International Building Code shall be sprinklered where the work area would be required to be sprinklered under the provisions of the International Building Code as a newly constructed building, and the building has sufficient municipal water supply available to the floor.		**NOT APPLICABLE** As all the floors in the existing building has windows

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604.3 Standpipes	Where the work area includes exits or corridors shared by more than one tenant and is located more than 50 feet (15240 mm) above or below the lowest level of fire department access, a standpipe system shall be provided. Standpipes shall have an approved fire department connection with hose connections at each floor level above or below the lowest level of fire department access. Standpipe systems shall be installed in accordance with the International Building Code.	***Class I system.*** A system providing 2.5-inch (64 mm) hose ***Class II system.*** A system providing 1.5-inch(38 mm) hose ***Class III system.*** system providing 1.5-inch (38 mm) hose stations to supply water for use by building occupants and 2.5-inch (64 mm) hose connections to supply a larger volume of water for use by fire departmnts	Existing Standpipes comply to this requirement of IBC and additional costs to just improve the quality as per latest standards In case of replacement of existing standpipes, Class I systems can be used as this is a high rise building.
604.4 Fire alarm and detection.	An approved fire alarm system shall be installed in accordance with Sections 604.4.1 through 604.4.1.9. *Where automatic sprinkler protection is provided in accordance with Section 604.2 and connected to the building fire alarm system, automatic heat detection required by this section shall not be required.*	As per Section 907.2.9 of IBC (R-2) A fire alarm system shall be installed in Group R-2 occupancies where: 1. Any dwelling unit is located three or more stories above the lowest level of exit discharge; 2. Any dwelling unit is located more than one story below the highest level of exit discharge of exits serving the dwelling unit; or 3. The building contains more than 16 dwelling units.	APPLICABLE REQUIREMNT
604.4.1.6 Group R-2	A fire alarm system shall be installed in work areas of Group R-2 apartment buildings as required by the International Fire Code for existing Group R-2 occupancies. 604.4.1.7 Group R-4. A fire alarm system shall be installed in work areas of Group R-4 residential care/assisted living facilities as required by the International Fire Code for existing Group R-4 occupancies.		Installed in accordance with the International Fire Code
604.4.3 Smoke Alarms.	Individual guestrooms and individual dwelling units in any work area in Group R-1, R-2, R-3, R-4 and I-1 shall be provided with smoke alarms in accordance with the International Fire Code.	As per Section 907.2.10.1.2 of IBC In Groups R-2, R-3, R-4 and I-1, Single- or multiple-station smoke alarms shall be installed and maintained in Groups R-2, R-3, R-4 and I-1, regardless of occupant load and need to be interconnected	APPLICABLE REQUIREMNT Installed in accordance with the International Fire Code
Exception:	Interconnection of smoke alarms outside of the rehabilitation work area shall not be required.		Applicable exception and no need for interconnection as this is rehab work

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SECTION 605 MEANS OF EGRESS			
605.1 Scope.	The requirements of this section shall be limited to work areas that include exits or corridors shared by more than one tenant within the work area in which Level 2 alterations are being performed, and where specified they shall apply throughout the floor on which the work areas are located, or otherwise beyond the work area.	As per the IBC, It shall be unlawful to alter a building or structure in a manner that will reduce the number of exits or the capacity of the means of egress to less than required by IBC.	*All existing Means of Egress is checked for compliance with this Chapter and this is based on the Means of Egress requirements set-forh by Sectns 805 and 812 - Egress of Change of Occupancy chapter of IEBC.*
605.2 General.	The means of egress shall comply with the requirements of this section.		
Exception:	1. Where the work area and the means of egress serving it complies with NFPA 101.	NFPA 101—97 - Code for Safety to Life from Fire in Buildings and Structures	Existing Building Not complying Not an applicable exception
	2. Means of egress conforming to the requirements of the International Building Code under which the building was constructed shall be considered as complying means of egress if, in the opinion of the code official, they do not constitute a distinct hazard to life.		Existing Building Not complying Not an applicable exception
605.3 Number of exits.	The number of exits shall be in accordance with Sections 605.3.1 through 605.3.3.		
605.3.1 Minimum number of exits	Every story utilized for human occupancy on which there is a work area that includes exits or corridors shared by more than one tenant within the work area shall be provided with the minimum number of exits based on the occupancy and the occupant load in accordance with the International Building Code. In addition, the exits shall comply with Sections 605.3.1.1 and 605.3.1.2.	**As per Section 1005.2.1 of IBC** 1005.2.1 Minimum number of exits. Every floor area shall be provided with the minimum number of approved independent exits as required by Table 1005.2.1(IBC) based on the occupant load: For OCCUPANT LOAD of 1-500 MINIMUM NUMBER OF EXITS - 2	Check for Section 605.3.1.1 Single exit Buildings The case study project is planned to have over 10 dwelling units per floor
605.3.1.1 Single exit buildings.	Only one exit is required from buildings and spaces with the following occupancies	Check for Compliance with section relevant to Group R-2 occupancy in the sections 605.3.1.1.1 through 605.3.1.1.10	
605.3.1.1.9	In buildings of Group R-2 Occupancy of any height with not more than four dwelling units per floor, with a smokeproof enclosure.		**NOT APPLICABLE** As the case study project is planned to have over 10 dwelling units per floor

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605.3.1.2 Fire escapes required.	When more than one exit is required, an existing or newly constructed fire escape complying with Section 605.3.1.2.1 shall be accepted as providing one of the required means of egress.	**As per Section 1005.2.1 of IBC** 1004.2.2.1 Two exit or exit access doorways: Where two exits or exit access doorways are required, from any portion of the exit access, the exit doors or exit access doorways shall be placed a distance apart equal to not less than one-half of the length of the maximum o verall diagonal dimension of the building or area to be served measured in a straight line between exit doors or exit access doorways.	Based on the minimum placing requiremnts set-forth by Section 1004.2.2.1 of the IBC and also considering the applicability of the exception defined by IBC (as Sprinkler system is present) Section 605.3.1.2 of IEBC is applicable and the existing fire escape stair can be used to meet the requiremnts of the minimum number of egress requirements in the building.
605.3.1.2.1 Fire escape access and details.	Fire escapes shall comply with all of the following requirements: 1. Occupants shall have unobstructed access to the fire escape without having to pass through a room subject to locking. 2. Access to a new fire escape shall be through a door, except that windows shall be permitted to provide access from single dwelling units or guest rooms in Groups R-1, R-2 and I-I Occupancies or when providing access from spaces having a maximum occupant load of 10 in other occupancy classifications. 3. Newly constructed fire escapes shall be permitted only where exterior stairs cannot be utilized due to lot lines limiting stair size or due to the sidewalks, alleys, or roads at grade level. 4. Openings within 10 feet (3048 mm) of fire escape stairs shall be protected by fire assemblies having a minimum of ¾-hour fire-resistance ratings.	Exception for above section of IBC: Where a building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2, the separation distance of the exit doors or exit access doorways shall not be less than one-third of the length of the maximum overall diagonal dimension of the area served.	**Option1:** Adopting this section, the existing second staiway can be removed for accomodating more dwelling units in new R-2 use, or **Option 2:** Adopting this section, the existing second staiway can be used as a location for new fire escape.
Exception:	Buildings equipped throughout with an approved automatic sprinkler system, opening protection is not required.	Important Exception for Opening Protectiveness	The existing openings within 10 feet of the fire escape stairs excempted from minimum of ¾-hour fire-resistance ratings.

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
605.3.1.2.2 Construction.	Fire escape shall be designed to support a live load of 100 pounds per square foot (4788 Pa) and shall be constructed of steel or other approved noncombustible materials.		APPLICABLE REQUIREMNT Existing Fire escape need to be checked for load carrying capacity based on load analysis.
605.3.1.2.3 Dimensions.	Stairs shall be atleast 22 inches (559 mm) wide with risers not more than, and treads not less than, 8 inches (203 mm) and landings at the foot of stairs not less than 40 inches (1016 mm) wide by 36 inches (914 mm) long, located not more than 8 inches (203 mm) below the door. **Key Numbers based on IEBC:** * Stair width: atleast 22 inches (559 mm) * Risers Not more than: 8 inches (203 mm) * Treads Not less than: 8 inches (203 mm) * Landings at the foot of stairs not less than 40 inches (1016 mm) wide by 36 inches (914 mm) long. * Landing not more than 8" below the door * Stair Slope: Maxixmum of 1:1	**$$$$$$$$$$$$$** **As per Section 1003.2 of IBC** *1003.2 EgressSystem design requirmnts* **1003.2.3 Egress width**: Total width of means of egress in inches (mm) shall not be less than the total occupant load served by the means of egress multiplied by the factors in Table 1003.2.3 (as per table required width is 50" for 500 Occup), but such width shall not be less than 44 inches (1118 mm) **1003.3.3.3 Stair treads and risers.** Stair riser heights shall be 7" (178 mm) maximum and 4" (102 mm) minimum. Stair tread depths shall be 11" minimum. **1003.3.3.4 Stairway landings:** Shall not be less than 44" X 44" (width of stairs) * Stair Slope: Maximum of 1:1.5	APPLICABLE REQUIREMNT This is the most important relaxation offered by the IEBC over the IBC. The means of egress stairways built in early 1900s were of different dimensions and when required to comply with IBC, most of the stairs were pulled down as they didn't meet the requirements. In this case study building, the existing stairway width is 42", the riser is 8" high, and the tread is 9" long and Slope 1:1.2, which are not in compliance as per IBC and need to be rebuilt. But the IEBC allows these stairs to exist without demolition ** Cost savings are discussed in Chapter 4 of this report.*
605.3.2 Mezzanines	Mezzanines in the work area and with an occupant load of more than 50 or in which the travel distance to an exit exceeds 75 feet (22 860 mm) shall have access to at least two independent means of egress.		APPLICABLE REQUIREMENT Existing Mezzanine have access to two (see drawing) independent means of egress.
Exception:	Two independent means of egress are not required where the travel distance to an exit does not exceed 100 feet (30 480 mm) and the building is protected throughout with an automatic sprinkler system.	Important Cost Saving exception for Mezzanine means of egress compliance. Not useful in this case study project as there are 2 independent means of egress.	

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
605.4 Egress doorways	Egress doorways in any work area shall comply with Sections 605.4.1 through 605.4.5.	As per IBC Section 1003.3.1.1 The minimum width of each door opening shall be sufficient for the occupant load thereof and shall provide a clear width of not less than 32 inches (813 mm).	
605.4.1 Two egress doorways required	Work areas shall be provided with two egress doorways in accordance with the requirements of Sections 605.4.1.1 and 605.4.1.2.		Check for compliance with Sections 605.4.1.1 to 605.4.1.3
605.4.1.1 Occupant load and travel distance	In any work area, all rooms and spaces having an occupant load greater than 50 or in which the travel distance exceeds 75 feet (22 860 mm) shall have a minimum of two egress doorways.	Applicable in the existing building as the occupant load is more than 50	Requirement met as there are two egress doorways in the existing building
605.4.2 Door swing.	In the work area and in the egress path from any work area to the exit discharge, all egress doors serving an occupant load greater than 50 shall swing in the direction of exit travel. This provision shall apply to the entire floor where the work area exceeds 50 percent of the floor area.	Applicable in the existing building as the occupant load is more than 50 and also the work area exceeds 50 percent of the floor area.	Requirement met as the door swing is in the direction of exit travel in the existing building
Exception:	Means of egress within a tenant space that is entirely outside the work area.		Exception Not Applicable
605.4.3 Door closing.	In any work area, all doors opening onto an exit passageway at grade or exit stair shall be self-closing or automatically closing by listed closing devices. This provision shall apply throughout the exit stair from the work area floor to the level of exit discharge where the work area exceeds 50 percent of the floor area.	Applicable in the existing building as the work area exceeds 50 percent of the floor area.	APPLICABLE REQUIREMENT Need to Comply
Exceptions:	1. Where exit enclosure is not required by the International Building Code. 2. Means of egress within a tenant space that is entirely outside the work area.		Exception Not Applicable

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
605.5 Openings in corridor walls	Openings in corridor walls in any work area shall comply with Sections 605.5.1 through 605.5.4.	**NOT APPLICABLE** As there are no corridor walls in the existing building	As there is no corridors in the existing building (existing group B building is pretty open and there are no partition walls) and the new use group R-2 that is to be built will comply to IBC as it is anyways built new.
Exception:	Openings in corridors where such corridors are not required to be rated in accordance with the International Building Code.		
605.5.1 Corridor doors.	Corridor doors in the work area shall not be constructed of hollow core wood and shall not contain louvers. All dwelling units, guest room or rooming unit corridor doors in work areas in buildings of Groups R-1, R-2, and I-I shall be at least 1 3/8 inch (35 mm) solid core wood or approved equal with approved door closers and shall not have any glass panels, other than approved wired glass or other approved glazing material in metal frames. All replacement doors shall be 1 ¾ inch (45mm) solid bonded wood core or approved equal, unless the existing frame will accommodate only a 1" door.	**NOT APPLICABLE** As there are no corridor doors in the existing building	The new corridors that will be placed for new R-2 construction will comply to IBC as there is no corridor and corridor doors at present as the building is open and vacant.
605.5.2 Transoms.	In all buildings of Group I- 1, R-1 and R-2 Occupancy all transoms in corridor walls in work areas shall be either glazed with ¼-inch (6.4 mm) wired glass set in metal frames or other glazing assemblies having a fire protection rating as required for the door and permanently secured in the closed position or sealed with materials consistent with the corridor construction.	**NOT APPLICABLE** As there are no ctransoms in corridor walls in the existing building	This is applicable in existing buildings where there is an existing corridor wall
605.6 Dead end corridors.	Dead end corridors in any work area shall not exceed 35 feet (10 670 mm).	**$$$$$$$$$$$$$** **As per Section 1003.2 of IBC** 1004.3.2.3 Dead ends: Where more than one exit or exit access doorway is required, the exit access shall be arranged such that there are no dead ends in corridors more than 20 feet (6096 mm) in length.	Even though this is not applicable in this case study building as there are no existing dead end corridor, the difference in IEBC (35 feet) over the IBC (20 feet) is considerable. This is applicable in existing buildings where there is an existing Dead end corridor.

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
605.7 Means of egress lighting.	Means of egress lighting shall be in accordance with this section, as applicable.	**As per IBC Section 403.10.2** 403.10.2 Separate circuits and fixtures. shall be required to provide sufficient light with an intensity of not less than 1 foot-candle (10.76 lux) measured at floor level in means of egress corridors, stairways, lobbies, and other areas that are clearly a part of the escape route.	
605.7.1 Artificial lighting required	. Means of egress in all work areas shall be provided with artificial lighting in accordance with the requirements of the International Building Code.		APPLICABLE REQUIREMENT Need to Comply
605.7.2 Supplemental requirements for means of egress lighting.	Where the work area on any floor exceeds 50 percent of that floor area, means of egress throughout the floor shall comply with Section 605.7.1.		Applicable in the existing bldg as the work area exceeds 50 percent of the floor area. Need to Comply to Sec 605.7.1
Exception:	Means of egress within a tenant space that is entirely outside the work area.	Exception Not Applicable	
605.8 Exit signs.	Exit signs shall be in accordance with this section, as applicable.	As per 1003.2.10 Exit signs (IBC) Exits and exit access doors shall be marked by an approved exit sign readily visible from any direction of egress travel. Exit sign placement shall be such that no point in an exit access corridor is more than 100 feet (30 480 mm) from the nearest visible exit sign.	APPLICABLE REQUIREMENT Need to Comply
605.8.1 Work areas.	Means of egress in all work areas shall be provided with exit signs in accordance with the requirements of the International Building Code.		
605.8.2 Supplemental requirements for exit signs	Where the work area on any floor exceeds 50 percent of that floor area, means of egress throughout the floor shall comply with Section 605.8.1.		Applicable in the existing bldg as the work area exceeds 50 percent of the floor area.
Exception:	Means of egress within a tenant space that is entirely outside the work area.	Exception Not Applicable	
605.9 Handrails	The requirements of Sections 605.9.1 and 605.9.2 shall apply to handrails from work area floor to the level of exit discharge.		Shall comply as per sections specified

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
605.9.1 Minimum requirement.	Every required exit stairway that is part of the means of egress for any work area and that has three or more risers and is not provided with at least one handrail, or in which the existing handrails are judged to be in danger of collapsing, shall be provided with handrails for the full length of the run of steps on at least one side. All exit stairways with a required egress width of more than 66 inches shall have handrails on both sides.	**As per IBC** 1003.3.3.11.1 Handrail Height. Handrail height, measured above stair tread nosings, or finish surface of ramp slope, shall be uniform, not less than 34 inches (864 mm) and not more than 38 inches (965 mm).	APPLICABLE REQUIREMENT Need to Comply to IBC
605.9.2 Design.	Handrails required in accordance with Section 605.9.1, shall be designed and installed in accordance with the provisions of the International Building Code.	**As per IBC** 1003.3.3.11.6 Handrail Clearance. Clear space between a handrail and a wall or other surface shall be a minimum of 1.5 inches (38 mm).	
605.10 Guards.	The requirements of Sections 605.10.1 and 605.10.2 shall apply to guards from work area floor to the level of exit discharge, but shall be confined to the egress path of any work area.	**As per IBC** 1003.2.12.1 Guard Height. Guards shall form a protective barrier not less than 42 inches (1067 mm) high, measured vertically above the leading edge of the tread, adjacent walking surface or adjacent seatboard.	APPLICABLE REQUIREMENT Need to Comply to IBC
605.10.1 Minimum requirement	Every open portion of a stair, landing, or balcony that is more than 30 inches (762 mm) above the floor or grade below and not provided with guards, or those in which the existing guards are judged to be in danger of collapsing, shall be provided with guards as per IBC.	Minimum requirement is same as the IBC	
SECTION 606 ACCESSIBILITY	606.1 General. A building, facility or element that altered shall comply with Section 506.		APPLICABLE REQUIREMENT Discussed in Section 506
SECTION 607 STRUCTURAL 607.1 General	Where alteration work includes installation of additional equipment that is structurally supported by the building or reconfiguration of space such that portions of the building become subjected to higher gravity loads as required by Tables 1607.1 and 1607.6 of the International Building Code, the provisions of this section shall apply.	Discussed in section 707	Based on Chapter 8 (IEBC) Change in Occupancy, Section 807 compliance requirements structural compliance is as per Chapter 7, Section 707. Discussed in section 707.

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
SECTION 608 ELECTRICAL			
608.1 New installations.	All newly-installed electrical equipment and wiring relating to work done in any work area shall comply with the materials and methods requirements of Chapter 5.		APPLICABLE REQUIREMENT Need to Comply to ICC's Electrical Code
Exception:	Electrical equipment and wiring in newly installed partitions and ceilings shall comply with all applicable requirements of the ICC Electrical Code.		
608. 3 Residential occupancies.	In Groups R-2, R-3, R-4 Occupancies and buildings regulated by the International Residential Code, the requirements of Sections 608.3.1 through 608.3.7 shall be applicable only to work areas located within a dwelling unit.		As there are no enclosed areas the existing building (existing group B building is pretty open and there are no enclosed area) and the new use group R-2 that is to be built will comply to IBC as it is anyways built new.
608.3.1 Enclosed areas	. All enclosed areas, other than closets, kitchens, basements, garages, hallways, laundry areas, utility areas, storage areas and bathrooms shall have a minimum of two duplex receptacle outlets or one duplex receptacle outlet and one ceiling or wall type lighting outlet.	**NOT APPLICABLE** As there are no enclosed areas in the existing building	
608.3.2 Kitchens.	Kitchen areas shall have a minimum of two duplex receptacle outlets.	**NOT APPLICABLE** As there are no Kitchens/ laundry areas in the existing building	The new Kitchens/ laundry areas placed for new R-2 construction will comply to IBC.
608.3.3 Laundry areas	. Laundry areas shall have a minimum of one duplex receptacle outlet located near the laundry equipment and installed on an independent circuit.		
608.3.4 Ground fault circuit interruption.	Ground fault circuit interruption shall be provided on newly installed receptacle outlets if required by the Electrical Code.		APPLICABLE REQUIREMENT Need to Comply to ICC's Electrical Code
608.3.5 Minimum lighting outlets.	At least one lighting outlet shall be provided in every bathroom, hallway, stairway, attached garage and detached garage with electric power, and to illuminate outdoor entrances and exits.	All the existing lighting outlets need to be changed as they are damaged and old changed as they are damaged and old	APPLICABLE REQUIREMENT Need to Comply to ICC's Electrical Code

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
SECTION 609 MECHANICAL			
609.1 Reconfigured or converted spaces	All reconfigured spaces intended for occupancy and all spaces converted to habitable or occupiable space in any work area shall be provided with either natural or mechanical ventilation in accordance with the International Mechanical Code		APPLICABLE REQUIREMENT Need to Comply to ICC's International Mechanical Code
Exception:	Existing mechanical ventilation systems shall comply with the requirements of Section 609.2.		
609.2 Altered existing systems	. In mechanically ventilated spaces, existing mechanical ventilation systems that are altered, reconfigured or extended shall provide not less than 5 cubic feet per minute (cfm) (0.0024 m3/s) per person of outdoor air and not less than 15 cfm (0.0071 m3/s) of ventilation air per person; or not less than the amount of ventilation air determined by the Indoor Air Quality Procedure of ASHRAE 62- 99.	Check Current CFM of existing HVAC system	Since existing HVAC system is to be replaced for the new use Group R-2, the minimum CFM of air per person and ventilation air per person is determined as per the International Mechanical code
609.3 Local exhaust.	All newly-introduced devices, equipment or operations that produce airborne particulate matter, odors, fumes, vapor, combustion products, gaseous contaminants, pathogenic and allergenic organisms, and microbial contaminants in such quantities to adversely affect or impair health, or cause discomfort to occupants shall be provided with local exhaust as per Mechanical Code		APPLICABLE REQUIREMENT Need to Comply to ICC's International Mechanical Code
SECTION 610 PLUMBING			
610.1 Minimum fixtures.	Where the occupant load of the story is increased by more than 20 percent, plumbing fixtures for the story shall be provided in quantities specified in the Interntl. Plumbing Code based on the increased occupant load.	This project conversion is from Group B to Group R-2. So the occupant load for Group B is almost twice that of Group R-2 (Occupant load for B- 100 sf/person and for R2 - 200 sf/person). Hence no increase in the occupant load of the story	*Need to Comply with Section 810 Plumbing of Change of Occupancy Chapter of IEBC as this case study building has proposed change from Group B to Group R-2*

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
CHAPTER 7: ALTERATIONS - LEVEL 3			
SECTION 701 GENERAL			
701.1 Scope.	Alterations classified as Level 3 alterations as described in Section 305 shall comply with the requirements of this Chapter.	See descriptions detailed in sections mentioned below of IEBC :	The requirements initiated by Chapter 8 - Change of Occupancy for compliance requirements with Chapter 7 are discussed in these sections
701.2 Compliance.	In addition to the provisions of this chapter work shall comply with all the requirements of Chapters 5 and 6. The requirements of Sections 603, 604, and 605 shall apply within all work areas regardless of whether or not they include exits and corridors shared by more than one tenant and regardless of the occupant load.	***Section 603: Building Elements and Materials*** ***Section 603: Fire Protection*** ***Section 605: Means of Egress*** All the compliance requirements detailed in above sections shall be complied in the rehabilitation work.	Applicable requirements are complied in the previous Chapters 5 and 6
Exceptions:	1. Buildings in which the reconfiguration of space affecting exits or shared egress access is exclusively the result of compliance with the accessibility requirements of Section 506.2 shall not be required to comply with this Chapter.	**NOT APPLICABLE** Not Applicable as the new use of R-2 is going to determine this requiremnts and as this is new change it will comply to IBC	Not applicable exception
	2. Existing dead end corridors may be extended and new dead end corridors may be added in accordance with Section 605.6.	See Section 605.6 in previous chapter	Even though this is not applicable in this case study building as there are no existing dead end corridor.
SECTION 702 SPECIAL USE AND OCCUPANCY			
702.1 High rise buildings	Any building having one or more floors more than 75 feet (22 860 mm) above the lowest level accessible to a fire department vehicle shall comply with the requirements of Sections 702.1.1 through 702.1.3.	As per Section 403 of IBC, any building having the occupied floors located more than 55 feet (16 764 mm) above the lowest level of fire department vehicle access is designated as High-Rise building as need to comply to this requirement.	The IEBC defined the same height as 75 feet over 55 feet as defined by IBC. But as the case study building is a High-rise building with total height of 135 feet, as per both IEBC and IBC compliance to this section is needed.
702.1.1 Re-circulating air or exhaust systems	When a floor is served by a re-circulating air or exhaust system with a capacity greater than 15,000 cfm (701 m3/s), that system shall be equipped with approved smoke and heat detection devices installed in accordance with the International Mechanical Code.	Check for the new exhaust systems that are to be installed for the new use group R-2	**APPLICABLE REQUIREMNT** Installed in accordance with International Mechanical Code

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702.1.2 Elevators.	Where there is an elevator or elevators for use by the public, at least one elevator serving the work area shall comply with Section 607.1 of the International Fire Code.	*Section 607.1 International Fire Code* 607.1 Elevator Recall & Maintenance	**APPLICABLE REQUIREMNT** Installed in accordance with the International Fire Code
702.2 Boiler and Furnace equipment rooms	Boiler and furnace equipment rooms adjacent to or within the following facilities shall be enclosed by one-hour fire rated construction: day nurseries, children's shelter facilities, residential child care facilities and similar facilities with children below the age of 2-½ years, or which are classified as Group I-2 Occupancy, shelter facilities, residences for the developmentally disabled, group homes, teaching family homes, transitional living homes, rooming and boarding houses, hotels and multiple dwellings.	**As per Section 1007.1 of IBC** 1007.1 Boiler, incinerator/furnace rooms. Two exit access doorways are required in boiler, incinerator and furnace rooms where the area is over 500 square feet (46 m2) and any fuel-fired equipment exceeds 400,000 British thermal unit (Btu) (422 000 KJ) input capacity.	This section requirement is applicable to the case study project as the conversion is to Group R-2 with multiple dwelling units (more than 90 dwelling units)
Exceptions:			
	1. Furnace and boiler equipment of low pressure type, operating at pressures of 15 psig (103.4 KPa) or less for steam equipment or 170 psig (1171 KPa) or less for hot water equipment, when installed in accordance with manufacturer recommendations.	Not applicable exception	Applicable only based on the newly installed furnace and boiler equipment
	2. Furnace and boiler equipment of residential R-3 type with 200,000 BTU (211,000 KJ) per hour input rating or less is not required to be enclosed.	Not applicable exception	Case study building is to be converted to Use group R-2
	3. Furnace rooms protected with automatic sprinkler protection.	**APPLICABLE EXCEPTION**	The entire building is protected with automatic sprinkler system
702.2.1 Emergency controls.	Emergency controls for boilers and furnace equipment shall be provided in accordance with the International Mechanical Code in all buildings classified as day nurseries, children's shelter facilities, residential child care facilities and similar facilities with children below the age of 2-½ years, or which are classified as Group I-2 Occupancy, and in group homes, teaching family	Not applicable for R-2	**NOT APPLICABLE** Case study building is to be converted to Use group R-2 and not to any of the specified categories of this section.

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	homes, and supervised transitional living homes in accordance with the following: 1. Emergency shutoff switches for furnaces and boilers in basements shall be located at the top of the stairs leading to the basement; and 2. Emergency shutoff switches for furnaces and boilers in other enclosed rooms shall be located outside of such room.	Not applicable exception	Case study building is to be converted to Use group R-2
SECTION 703 BUILDING ELEMENTS AND MATERIALS 703.1 Existing shafts and vertical openings.	Existing stairways that are part of the means of egress shall be enclosed in accordance with Section 603.2.1 between highest work area floor and the level of exit discharge and all floors below.	603.2.1 Existing Vertical Openings (IEBC) ***(FRR required is 1 Hour)***	**FOLLOW SECTION 603.2.1** Discussed in detail in Section 603.2.1 and refer to that Sec and applicable exceptions
703. 2 Fire partitions in Group R-3.	Fire separation in Group R-3 Occupancies shall be in accordance with Section 703.2.1.	Not applicable	**NOT APPLICABLE** Case study building is to be converted to Use group R-2
703.2.1 Separation required.	Where the work area is in any attached dwelling unit in Group R-3, or any multiple single family (Townhouse) constructed in accordance with the International residential Code, walls separating the dwelling units which are not continuous from the foundation to the underside of the roof sheathing shall be constructed to provide a continuous fire separation using construction materials consistent with the existing wall or complying with the requirements for new structures. All work shall be performed on the side of the wall of the dwelling unit that is part of the work area. Exception: Walls are not required to be continuous through concealed floor spaces.	Not applicable	**NOT APPLICABLE** Case study building is to be converted to Use group R-2
703.3 Interior finish.	Interior finish in exits serving the work area shall comply with Section 603.4 between the highest floor on which there is a work area to the floor of exit discharge.	603.4 Interior finish (IEBC)	**FOLLOW SECTION 603.4** Discussed in detail in Section 603.4 and refer to that Sec and applicable exceptions

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SECTION 704 FIRE PROTECTION			
704.1 Automatic sprinkler systems	Automatic sprinkler systems in accordance with Section 604.2 shall be provided in all work areas.	604.2 Automatic sprinkler systems (IEBC)	**FOLLOW SECTION 604.2** Discussed in detail in Section 604.2 and refer to that Sec and applicable exceptions
704.1.1 High rise buildings	. In high rise buildings, work areas shall be provided with automatic sprinkler protection where the building has a sufficient municipal water supply system to the site. Where the work area exceeds 50 percent of floor area, sprinklers shall be provided in the specified areas where sufficient municipal water supply for design and installation of a fire sprinkler system is available at the site.	As per Section 403 of IBC, any building having the occupied floors located more than 55 feet (16 764 mm) above the lowest level of fire department vehicle access is designated as High-Rise building as need to comply to this requirement.	The case study building is a High-rise building with total height of 135 feet. Hence Automatic Sprinkler System is needed and the existing systm need to be modified to suit the Group R-2 sprinkler reqr.mnts
704.1.2 Rubbish and linen chutes.	Rubbish and linen chutes located in the work area shall be provied with sprinklered protection where protection of the rubbish and linen chute would be required under the provisions of the International Building Code for new construction, and the building has sufficient municipal water supply available to the site.	Not applicable	**NOT APPLICABLE**
704.2 Fire alarm and detection.	Fire alarm and detection systems complying with Sections 604.4.1 and 604.4.3 shall be provided throughout the building in accordance with the International Building Code.	**FOLLOW SECTION 604.4.1 & 604.4.3** 604.4.1 Fire alarm and detection. 604.4.3 Smoke Alarms.	**APPLICABLE REQUIREMNT** Installed in accordance with International Fire Code **APPLICABLE REQUIREMNT** Installed in accordance with International Fire Code
704.2.1 Manual fire alarm systems.	In Groups A, B, E, F, H, I, M, R-1 and R-2 Occupancies a manual fire alarm system shall be provided on all floors in the work area. Alarm notification appliances shall be provided on such floors and shall be automatically activated as required by the International Building Code.	**As per Section 907.3 of IBC** Manual fire alarm boxes shall be located not more than 5 feet (1524 mm) from the entrance to each exit. Additional manual fire alarm boxes shall be located so that travel distance to the nearest box does not exceed 200 feet (60 960 mm).	**APPLICABLE REQUIREMNT** Installed in accordance with International Building Code
Exceptions:	1. Where the International Building Code does not require a manual fire alarm system.		

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	2. Alarm-initiating and notification appliances shall not be required to be installed in tenant spaces outside of the work area.	Exception Not Applicable	**Exception Not Applicable**
SECTION 705 MEANS OF EGRESS 705.1 General.	The means of egress shall comply with the requirements of Section 605 except as specifically required in Sections 705.2 and 705.3.	**SECTION 605: Means of Egress (IEBC)** This is very important section to check as it details complete means of egress requiremnts in existing buidings, some of which include design and dimensions	**FOLLOW SECTION 605** Discussed in detail in Section 605 and refer to that Sec and applicable exceptions The requirements are initiated by Chapter 8 (IEBC) Change of Occupancy.
705. 2 Means of egress lighting.	Means of egress from the highest work area floor to the floor of exit discharge shall be provided with artificial lighting within the exit enclosure in accordance with the requirements of the International Building Code.	**As per Section 1003.2.10 of IBC** **1003.2.10 Exit signs.**	
705.3 Exit signs.	Means of egress from the highest work area floor to the floor of exit discharge shall be provided with exit signs in accordance with the requirements of the International Building Code.	Exits and exit access doors shall be marked by an approved exit sign readily visible from any direction of egress travel Exit sign placement shall be such that no point in an exit access corridor is more than 100 feet (30 480 mm) from the nearest visible exit sign.	**APPLICABLE REQUIREMNT** Installed in accordance with International Building Code
SECTION 706 ACCESSIBILITY 706.1 General.	A building, facility or element that is altered shall comply with Section 506.	SECTION 506: Accessibility (IEBC)	**FOLLOW SECTION: 506** Discussed in detail in Section 506 and refer to that Sec and applicable exceptions
SECTION 707 STRUCTURAL 707.1 General.	Where buildings are undergoing Level 3 Alterations including structural alterations, the provisions of this section shall apply.	**As per Section 1616.6 of IBC** 1616.6 Structural Analysis procedures.	Comply to 707.2 through 707.7
707.2 Reduction of streng	Alterations shall not reduce the structural strength or stability of the building, structure or any individual member thereof. Exception: Such reduction shall be allowed provided that the structural strength and the stability of the building are not reduced to below the International Building Code levels.	A structural analysis shall be made for all structures in accordance with the requirements of this section. The analysis shall form the basis for determining the seismic forces, and Em (Maximum seismic load effect), to be applied in the load combinations of Section 1605 and is used for analyzing reduction of strength	**APPLICABLE REQUIREMNT** Structural Analysis as per International Building Code
707.3 New structural members.	New structural members in alterations, including connections and anchorage, shall comply with the International Building Code.	Not Applicable as there is no new structural addition in this project	**NOT APPLICABLE**

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707.4 Minimum design loads.	The minimum design loads for the structure shall be the loads applicable at the time the building was constructed, provided that no overstressed condition is created.	**As per Section 1605 to 1610 (IBC)** **TABLE 1607.1Design Loads** MINIMUM UNIFOMLY DISTRIBUTED LIVE LOADS AND MINIMUM CONCENTRATED LIVE LOADS **Residential - multifamily dwellings** ***Private rooms -- 40 psf*** ***Public rooms and corridors -- 100 psf***	Important factor in this project as the existing use was "B" designed for 100 psf is to be converted to use group R-2 and hence the load compliance is met and no need for any improvement for the new use
707.5 Structural alterations.	Buildings and structures undergoing structural alterations shall comply with this section.		
707.5.1 Evaluation and analysis.	An engineering evaluation and analysis which establishes the structural adequacy of the altered structure shall be prepared by a registered design professional and submitted to the code official where more than 30 percent, within a 12 months period, of the floor and roof areas of the building or structure have been or are proposed to be involved in structural alteration. The evaluation and analysis shall demonstrate that the building or the buildings' structural system once altered complies with the International Building Code for wind loading and with reduced International Building Code level seismic forces as specified in Section 407.1.1.3 for seismic loading. For seismic considerations the analysis shall be based upon one of the procedures specified in Section 407.1.1.1 The areas to be counted towards the 30 percent shall be those areas tributary to the vertical load carrying components such as joists, beams, columns, walls and other structural components that have been or will be removed, added or altered, as well as areas such as mezzanines, penthouses, roof structures and infilled courts and shafts.	**As per Section 1905.6.5.5 (IBC)** 1905.6.5.5 Structural Strength evaluation If the criteria of **Section 1905.6.5.4** are not met and if the structural adequacy remains in doubt, the building official is permitted to order a strength evaluation in accordance with ACI 318, Chapter 20, for the questionable portion of the structure, or take other appropriate action. **1905.6.5.4** Test results. Concrete in an area represented by core tests shall be considered structurally adequate if the average of three cores is equal to at least 85 percent of f ¢ c and if no single core is less than 75 percent of f ¢ c. Additional testing of cores extracted from locations represented by erratic core strength results is permitted. ***f ¢ c - Compressive Strength of Concrete*** used in design and evaluated in accordance with the provisions of Sec 1905, expressed in pounds per square inch (psi)	Engineering analysis need to be performed for the existing building. For this research, it is assumed that the structural requirements are met in the existing structure (conversion from load use ("B") category to lower use "R-2") Based on the structural analysis results it is needed to check for the over stressed conditions in the existing sructure ***Assumption is made for this research purpose***

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
Exceptions:	1. Buildings of Group R Occupancy with no more than 5 dwelling units or guest rooms used solely for residential purposes altered based on the Conventional Light-Frame Construction methods of the International Building Code or in compliance with the provisions of the International Residential Code.	Exception Not Applicable	**Exception Not Applicable**
	2. Where such alterations involve only the lowest story of a building and Change of Occupancy Provisions of Chapter 8 do not apply, only the lateral force resisting components in and below that story need comply with this Section.	Exception Not Applicable	**Exception Not Applicable**
707.6 Additional vertical loads.	Where gravity loading is increased on the roof or floor of a building or structure, all structural members affected by such increase in loading shall meet the gravity load requirements of International Building Code.	**As per the IBC** Complete calculations for the deformation compatibility of the gravity load-carrying system shall be made in accordance with Section 1617.6.4.3 of the International Building Code using cracked section stiffness in the lateral-force-resisting system of the existing structure	**APPLICABLE AS PER IBC** Gravity loading conditions shall be investigated. Local uplift of individual elements is permitted provided the resulting deflections do not cause overstress or instability of the isolator units or other structural elements.
Exceptions:	1. Structural elements whose stress is not increased by more than 5 percent.	**APPLICABLE UNDER ASSUMPTION**	Need to check with the structural analysis tests and assumed to comply for this research purpose
	2. Buildings of Group R Occupancy with no more than 5 dwelling units or guest rooms used solely for residential purposes altered based on the Conventional Light-Frame Construction methods of the International Building Code or in compliance with the provisions of the International Residential Code.	Exception Not Applicable	**Exception Not Applicable**

CODE ANALYSIS WORK SHEET - IEBC 2002

CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
707.7 Voluntary lateral force resisting system alterations.	Alterations of existing structural elements that are initiated for the purpose of increasing the lateral force-resisting strength or stiffness of an existing structure, and are not required by other sections of this code, shall not be required to be designed for forces conforming to the International Building Code provided that an engineering analysis is submitted to show that : 1. The capacity of existing structural elements required to resist forces is not reduced. 2. The lateral loading to existing structural elements is not increased beyond their capacity. 3. New structural elements are detailed and connected to the existing structural elements as required by the International Building Code. 4. New or relocated non-structural elements are detailed and connected to existing or new structural elements as required by the International Building Code and 5. A dangerous condition as defined in this code is not created. Voluntary alterations to lateral force resisting systems conducted in accordance with Appendix A and the referenced standards of this code shall be permitted.	**As per Section 1616.1 of IBC** ***1616.1 Structural design criteria*** Each structure shall be provided with complete lateral- and vertical-force-resisting systems capable of providing adequate strength, stiffness and energy dissipation capacity to withstand the design earthquake ground motions determined in accordance with Section 1615 within the prescribed deformation limits of Section 1617.3. TABLE 1617.3 of IBC ALLOWABLE STORY DRIFT, Da (inches) Masonry wall frame buildings 0.013 hSX (SEISMIC USE GROUP 1) 0.013 hSX (SEISMIC USE GROUP 2) 0.010 hSX (SEISMIC USE GROUP 3) 1616.1 Structural design criteria	Not Applicable in this case study project, but this is a valid section for general discussion on rehab code for existing buildings during the process of rehabilitation. Structural analysis should be performed and following criterias must be checked: * Reduction in capacity * Increase in lateral loading * Connection between new and existing structural elements * No danger is created as per the structurtal stability requir.

All these compliance requirements checked in Chapter 5, 6 and 7 are based on the references made by the Chapter 8 - Change of Occupancy as this case study project involves a change in Occupancy from Use Group B to Residential Use Group R-2. As per the International Existing Building Code (IEBC), if there is a change in occupancy in a building from a lower hazard category to a higher hazard category as defined in Chapter 8 of the IEBC, then respective compliance requirements from Chapter 5, 6 and 7 as stated by Chapter 8 are to be met. These compliance requirements were discussed in the previos three chapters (5,6 and 7) that are based on Chapter 8. As this case study project is also an Historical Building, all the applicable Sections of Chapter 10 of IEBC are checked for compliance. This is tabulated in the next sections of this analysis.

CODE ANALYSIS WORK SHEET - IEBC 2002

CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
CHAPTER 10 HISTORIC BUILDINGS			
SECTION 1001 GENERAL			
1001.1 Scope.	It is the intent of this chapter to provide means for the preservation of historic buildings. Historical buildings shall comply with the provisions of this chapter relating to their repair, alteration, relocation and change of occupancy.	This case study project is undergoing a change of occupancy from Group "B" Business use group to Group R-2 Residential use with new use having nearly 90 market rate residential units. As this building is designated as a hoistoric structure, provisions under this chapter are to be met.	The case study building is designated under the Lower Woodward National Register Historic District. This building is listed as the structure that contribute to the historic character of the district *This case study building is eligible for Federal Investment Tax Credits for rehabilitation of historic buildings*
1001.2 Report.	A historic building undergoing repair, alteration, or change of occupancy shall be investigated and evaluated. If it is intended that the building meet the requirements of this chapter, a written report shall be prepared and filed with the code official by a registered design professional when in the opinion of the official, such a report is necessary. Such report shall be in accordance with Chapter 1 and shall identify each required safety feature in compliance with this chapter and where compliance with other chapters of these provisions would be damaging to the contributing historic features. In high seismic zones, a structural evaluation, describing, as a minimum, a complete load path and other earthquake–resistant features shall be prepared. In addition, the report shall describe each feature not in compliance with these provisions and demonstrate how the intent of these provisions is complied with in providing an equivalent level of safety.	**APPLICABLE REQUIREMENT** Historic structure evaluation report needed to be submitted by design professional for approval by the code official.	For the case study building it is essential to investigate and evaluate the safety status of the structure based on the requirements setforth by this chapter and Chapter 1. This evaluation need to be performed a registered design professional and should get the approval of the code official.
1001.3 Special occupancy exceptions - museums.	When a building that is in Use Group R–3 is also used for Group A, B or M purposes such as museum tours, exhibits and other public assembly activities, or for museums less than 3000 s.f. (279 m2) the code official may make a determination that the Use Group is B when life–safety conditions can be demonstrated in	Not applicable	**NOT APPLICABLE** Case study building is to be converted to Use group R-2, from use Group B (80 years) and do not have any specified special use as per this section

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
	accordance with Section 1001.2. Adequate means of egress in such buildings, which may include a means of maintaining doors in an open position to permit egress, a limit on building occupancy to an occupant load permitted by the means of egress capacity, a limit on occupancy of certain areas or floors, and/or supervision by a person knowledgeable in the emergency exiting procedures, shall be provided.		**NOT APPLICABLE**
1001.4 Flood hazard areas.	*In flood hazard areas:* 1. If a historic building will continue to be listed or eligible for listing as a historic building, then work proposed to be undertaken is not considered to be a substantial improvement. 2. If all work proposed constitutes substantial improvement, including repairs, work required due to a change of occupancy, and alterations, then the existing building shall comply with International Building Code Section 1612.	For buildings in flood hazard areas as established in Section 1612.3, interior finishes, trim and decorative materials below the design flood elevation shall be flood-damage-resistant materials. As per Section 1612: Flood Loads *FLOOD HAZARD AREA.* The greater of the following two areas: 1. The area within a floodplain subject to 1-percent or greater chance of flooding in any year. 2. The area designated as a flood hazard area on a community's flood hazard map, or otherwise legally designated.	Check for the flood hazard status of the existing building from the flood hazard area as defined in sction 1612 of the International Building Code. It is essential for the existing building undergoing rehab need to comply with the flood hazard requirements.
SECTION 1002 REPAIRS 1002.1 Requirements.	Repairs to any portion of a historic building or structure shall be permitted with original or like materials and original methods of construction, subject to the provisions of this chapter.		APPLICABLE REQUIREMENT
1002.2 Dangerous buildings.	When a historic building is determined to be dangerous no work shall be required except as necessary to correct identified unsafe conditions.	Important benefit for correcting the unsafe parts of the existing building	In the case study building no area is dangerous to work and only issue may be the time over which it has been vacant with out any occupants
1002.3 Relocated buildings.	Foundations of relocated historic buildings and structures shall comply with the International Building Code. Relocated historic bldgs shall otherwise be considered a historic building for the purposes of this code. Relocated historic buildings and structures shall be so sited that exterior wall and openg requirements comply with the International Building Code or the compliance alternatives of this code.	SECTION NOT - APPLICABLE	**NOT APPLICABLE** As there is no relocation of the existing structure

CODE ANALYSIS WORK SHEET - IEBC 2002

CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
1002.4 Repairs and alterations, general.	Historic buildings undergoing repairs or alterations shall comply with all of the applicable requirements of Chapter 4 except as specifically permitted in this chapter.		**FOLLOW CHAPTER 6 & 7 BASED ON SECTION 100.4 OF THIS CHAPTER**
1002.5 Replacement.	Replacement of existing or missing features using original materials shall be permitted. Partial replacement for repairs that match the original in configuration, height and size shall be permitted. Such replacements shall not be required to meet the materials and methods requirements in Section 401.2.		**FOLLOW CHAPTER 6 & 7 BASED ON SECTION 100.4 OF THIS CHAPTER**
Exception:	Replacement glazing in hazardous locations shall comply with the safety glazing requirements of Chapter 24 of the International Building Code.	**Exception Not Applicable**	Exception not applicable as in the new use no area is designated as hazardous
SECTION 1003 FIRE SAFETY			
1003.1 General.	Every historic building that does not conform to the construction requirements specified in this code for the occupancy or use and that constitutes a distinct fire hazard as defined herein shall be provided with an approved automatic fire–extinguishing system as determined appropriate by the code official. However, an automatic fire–extinguishing system shall not be used to substitute for, or act as an alternate to, the required number of exits from any facility.	As per Section 403 of IBC, any building having the occupied floors located more than 55 feet (16 764 mm) above the lowest level of fire department vehicle access is designated as High-Rise building as need to comply to this requirement.	The case study building is a High-rise building with total height of 135 feet. Hence Automatic Sprinkler System is needed and the existing system need to be modified to suit the Group R-2 sprinkler requiremnts
1003.2 Means of egress.	Existing door openings and corridor and stairway widths of less than that specified elsewhere in this code may be approved, provided that in the opinion of the code official there is sufficient width and height for a person to pass through the opening or traverse the means of egress. When approved by the code official, the front or main exit doors need not swing in the direction of the path of exit travel, provided other approved means of egress having sufficient capacity to serve the total occupant load are provided.	SECTION 605: Means of Egress (IEBC) This is very important section to check as it details complete means of egress requiremnts in existing buidings, some of which include design and dimensions Follow: 605.3.1.2.3 Dimensions.	**FOLLOW SECTION 605** Discussed in detail in Section 605 and refer to that Sec and applicable exceptions The requirements are initiated by Chapter 8 (IEBC) Change of Occupancy and Chapter 10

CODE ANALYSIS WORK SHEET - IEBC 2002

CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
1003.3 Transoms.	In fully sprinklered buildings of Groups R–1, R–2 or R–3 Occupancy existing transoms in corridors and other fire–rated walls may be maintained if fixed in the closed position. A sprinkler shall be installed on each side of the transom.	**NOT APPLICABLE** As there are no transoms in corridor walls in the existing building	This is applicable in existing buildings where there is an existing corridor wall
1003.4 Interior finishes.	The existing finishes of walls and ceilings shall be accepted when it is demonstrated that they are the historic finishes.	603.4 Interior finish (IEBC)	**FOLLOW SECTION 603.4** Discussed in detail in Section 603.4 and refer to that Sec and applicable exceptions
1003.5 Stairway enclosure.	In buildings of three stories or less, exit enclosure construction shall limit the spread of smoke by the use of tight–fitting doors and solid elements. Such elements are not required to have a fire rating.	**$$$$$$$$$$$$$$** **APPLICABLE SECTION**	**Follow Section 604 (apply)** Fire Protection requirements as needed in section 604
1003.6 One–hour fire resistant assemblies.	Where one–hour fire–resistive construction is required by these provisions, it need not be provided regardless of construction or occupancy when the existing wall and ceiling finish is wood or metal lath and plaster.	**$$$$$$$$$$$$$$** **APPLICABLE SECTION**	**Follow Section 812 (apply)** As there is a change in use check for compliance with Section 812 of IEBC **Also, Follow Section 604** Fire Protection requirements as needed in section 604
1003.7 Glazing in fire–rated systems.	Historic glazing materials in interior walls required to have one-hour fire rating may be permitted when provided with approved smoke seals and when the area affected is provided with an automatic sprinkler system.	**As per IBC** 1003.3.3.11.1 Handrail Height. Handrail height, measured above stair tread nosings, or finish surface of ramp slope, shall be uniform, not less than 34 inches (864 mm) and not more than 38 inches (965 mm).	
1003.8 Stairway railings.	Grand stairways shall be accepted without complying with the handrail and guardrail requirements. Existing handrails and guards at all stairs shall be permitted to remain, provided they are not structurally dangerous.		**Follow Sections: (apply)** 605.9 Handrails 605.9.1 Minimum requirement 605.9.2 Design. 605.10 Guards.
1003.9 Guards.	Guards shall comply with Sections 1003.9.1 and 1003.9.2.	**$$$$$$$$$$$$$$**	**FOLLOW** Section 605.9
1003.9.1 Height.	Existing guards shall comply with the requirements of Section 405.	**As per IBC** 1003.2.12.1 Guard Height.	**FOLLOW** Section 605.10
1003.9.2 Guard openings.	The spacing between existing intermediate railings or openings in existing ornamental patterns shall be accepted. Missing elements or members of a guard may be replaced in a manner that will preserve the historic appearance of the building or structure.	Guards shall form protective barrier not less than 42 inches (1067 mm) high, measured vertically above the leading edge of the tread, adjacent walking surface or adjacent seatboard.	

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
1003.10 Exit signs.	Where exit sign or egress path marking location would damage the historic character of the building, alternate exit signs are permitted with approval of the code official. Alternative signs shall identify the exits and egress path.	**As per Section 1003.2.10 of IBC** **1003.2.10 Exit signs.** Exits and exit access doors shall be marked by an approved exit sign readily visible from any direction of egress travel Exit sign placement shall be such that no point in an exit access corridor is more than 100 feet (30 480 mm) from the nearest visible exit sign.	**APPLICABLE REQUIREMNT** Installed in accordance with International Building Code
1003.11 Automatic fire–extinguishing systems.	Every historical building which cannot be made to conform to the construction requirements specified in the International Building Code for the occupancy or use, and which constitutes a distinct fire hazard shall be deemed to be in compliance if provided with an approved automatic fire extinguishing system.	604.2 Automatic sprinkler systems (IEBC)	**FOLLOW SECTION 604.2** Discussed in detail in Section 604.2 and refer to that Sec and applicable exceptions
Exception:	When an alternative life–safety system is approved by the code official.	Exception Not applicable	Automatic sprinkler system presence in the building
SECTION 1004 CHANGE OF OCCUPANCY			
1004.1 General.	Historic buildings undergoing a change of occupancy shall comply with the applicable provisions of Chapter 3, except as specifically permitted in this chapter. When Chapter 3 requires compliance with specific requirements of Chapter 4, Chapter 5, or Chapter 6 and when those requirements are subject to the exceptions in Section 1002, the same exceptions shall apply in this section.	This case study project is undergoing a change of occupancy from Group "B" Business use group to Group R-2 Residential use with more than four dwelling units. Hence the rehabilitation process need to comply to all the requirements of this section as this is a historical building designated by the Lower Woodward National Register Historic District.	Check for compliance as mentioned in each of the sections of this section 1004 Change of Occupancy as there is a change of occupancy in the case study project. Also follow to Comply to all the Sections 801 though 812.
1004.2 Building area.	The allowable floor area for historic buildings undergoing a change of occupancy shall be permitted to exceed the allowable areas specified in Chapter 5 of the International Building Code by 20 percent.		

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
1004.3 Location on property.	Historic structures undergoing a change of use to a higher hazard category, in accordance with Section 812.4.4 may use alternative methods to comply with the fire–resistance and exterior opening protective requirements. Such alternatives shall comply with Section 1001.2.	SECTION 1004.3 NOT APPLICABLE $$$$$$$$$$$$$	**NOT APPLICABLE** In the case study project occupancy group is changed from "B" to "R-2" and this results in no change in the relative hazard category as per Table 812.4.4
1004.4	Required occupancy separations of one–hour may be omitted when the building is provided with an approved automatic sprinkler system throughout. 1004.5 Roof covering. Regardless of occupancy or Use Group, roof–covering materials not less than Class C shall be permitted where a fire–retardant roof covering is required.	**APPLICABLE SECTION** The case study building is a High-rise building with total height of 135 feet. Hence Automatic Sprinkler System is needed and the existing system need to be modified to suit the Group R-2 sprinkler requiremnts	**APPLICABLE SECTION** As the complete building is provided with an approved automatic sprinkler system
1004.6 Means of egress.	Existing door openings and corridor and stairway widths less than those that would be acceptable for nonhistoric buildings under these provisions shall be approved, provided that in the opinion of the code official, there is sufficient width and height for a person to pass through the opening or traverse the exit and that the capacity of the exit system is adequate for the occupant load, or where other operational controls to limit occupancy are approved by the code official.	**Key Numbers based on IEBC:** *IEBC Section 605.3.1.2.3 Dimensions.* **Stair width:** atleast 22 inches (559mm) **Risers** Not more than: 8 inches (203mm) **Treads** Not less than: 8 inches (203mm) **Landings** at the foot of stairs not less than 40 inches wide by 36 inches long. Landing not more than 8" below the door **Stair Slope:** Maxixmum of 1:1	**APPLICABLE REQUIREMNT** In this case study building, the existing stairway width is 42", the riser is 8" high, and the tread is 9" long and Slope 1:1.2, which are not in compliance as per IBC and need to be rebuilt. But the IEBC allows these stairs to exist without demolition
1004.7 Door swing.	When approved by the code official, existing front doors need not swing in the direction of exit travel, provided other approved exits having sufficient capacity to serve the total occupant load are provided.	Follow Sec: 605.4.2 Door swing.	Requirement met as the door swing is in the direction of exit travel in the existing building
1004.8 Transoms.	In corridor walls required to be fire rated by these provisions, existing transoms may be maintained if fixed in the closed position and fixed wired glass set in a steel frame or other approved glazing shall be installed on one side of the transom.	**NOT APPLICABLE** As there are no ctransoms in corridor walls in the existing building	This is applicable in existing buildings where there is an existing corridor wall
Exception:	Transoms conforming to Section 1003.4 shall be accepted.		
1004.9 Finishes.	Where finish materials are required to have a flame–spread classification of Class III or better, existing nonconforming materials shall be surfaced with an approved fire–retardant paint or finish.		**APPLICABLE REQUIREMENT** comply as per explaination in Section 603.4

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
Exception:	Existing nonconforming materials need not be surfaced with an approved fire–retardant paint or finish when the building is equipped throughout with an automatic fire–suppression system installed in accordance with the International Building Code and the nonconforming materials can be substantiated as being historic in character.	**\$\$\$\$\$\$\$\$\$\$\$\$\$** **APPLICABLE EXCEPTION**	This exception facilitates the existing nonconforming materials to be treated with fire-retardent instead of completely changing it and this will save considerable cost for making finishes comply to the flame–spread requiremnts
1004.10 One–hour fire resistant assemblies.	Where one–hour fire resistant construction is required by these provisions, it need not be provided regardless of construction or occupancy where the existing wall and ceiling finish is wood lath and plaster.		
1004.11 Stairs and railing.	Existing stairways shall comply with the requirements of these provisions. The code official shall grant alternatives for stairways and railings if alternative stairways are found to be acceptable or if judged as meeting the intent of these provisions. Existing stairways shall comply with Section 1003		**FOLLOW SECTION 605** Discussed in detail in Section 605 and refer to that Section and applicable exceptions
Exception:	For buildings less than 3000 s.f. (279 m2), existing conditions permitted to remain at all stairs and rails.	**NOT APPLICABLE EXCEPTION** As there are no ctransoms in corridor	This is applicable in existing buildings where there is an existing corridor wall
1004.12 Exit signs.	The code official may accept alternate exit sign locations where such signs would damage the historic character of the building or structure. Such signs shall identify the exits and exit path.		
1004.13 Exit stair live load.	Existing historic stairways in buildings changed to Use Groups R-1 and R-2 shall be accepted where it can be shown that the stairway can support a 75 pounds per square foot (366 kg/m2) live load.	**\$\$\$\$\$\$\$\$\$\$\$\$\$** IMPORTANT APPLICABLE SECTION	Since the existing building is changed to occupancy group R-2, this section is applicable and hence the existing historic stairs shall be accepted (Need to show the load carrying with an evaluation as per1001.2
1004.14 Natural light.	When it is determined by the code official that compliance with the natural light requirements of Section 811.1.1 will lead to loss of historic character or historic materials in the building, the existing level of natural lighting shall be considered acceptable.	**\$\$\$\$\$\$\$\$\$\$\$\$\$** **APPLICABLE SECTION**	But in the existing building as requirements of Sec 811.1.1 are met, not applicable in this case.

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
1004.15 Accessibility requirements.	The provisions of Section 812.5 shall apply to buildings and facilities designated as historic structures that undergo a change of occupancy, unless technically infeasible. Where compliance with the requirements for accessible routes, ramps, entrances, or toilet facilities would threaten or destroy the historic significance of the building or facility, as determined by the authority having jurisdiction, the alternative requirements of Sections 1005.1.1 through 1005.1.5 of the International Building Code for that element shall be permitted.	**FOLLOW SECTION 812.5** When a change in occupancy is made accessibility requirements need to comply with suitable sections in IEBC	In the rehabilitation project, whereever it is technically infeasible to comply with new construction standards for accessibility requiremnts, comply with Sections 506.1 and 506.2 as applicable.
SECTION 1005 ALTERATIONS			
1005.1 Accessibility requirements.	The provisions of Section 506 shall apply to buildings and facilities designated as historic structures that undergo alterations, unless technically infeasible. Where compliance with the requirements for accessible routes, ramps, entrances, or toilet facilities would threaten or destroy the historic significance of the building or facility, as determined by the code official, the alternative requirements of Sections 1005.1.1 through 1005.1.5 of this code for that element shall be permitted.	The provisions of chapter 11 of IBC shall control the design and construction of facilities for accessibility to physically disabled persons. Buildings and facilities shall be rehabilitated to be accessible in accordance with IBC & ICC/ANSI A117.1	FOLLOW SECTION 506 (IEBC) *As per Excep. 2 of Sec 506.1 Accessible means of egress required by Chapter 10 of the International Building Code are not required to be provided in existing buildings and facilities.*
1005.1.1 Site arrival points	At least one main entrance shall be accessible.		
1005.1.2 Multilevel buildings and facilities.	An accessible route from an accessible entrance to public spaces on the level of the accessible entrance shall be provided.	1104.4 Multilevel buildings and facilities. At least 1 accessible route shall connect each accessible level, including mezzanines	**NOT AVAILABLE IN THE EXISTING BUILDING** (Existing elevators will suffice this need)
1005.1.3 Entrances.	At least one main entrance shall be accessible.		

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CODE Section / No.	DESCRIPTION OF ITEM	ALLOWABLE / REQUIRED LIMITS	NOTES / REMARKS
1005.1.4 Toilet and bathing facilities.	Where toilet rooms are provided at least one accessible toilet room complying with Section 1108.2.1 of the International Building Code shall be provided.	Not applicable in existing business use and needed in new residential use **$$$$$$$$$$$$$**	**NOT NECESSARY IN THE EXISTING BUILDING** (Since Group R-2 is going to be the new use, the new change made will comply to IBC)
1005.1.5 Ramps.	The slope of a ramp run of 24 inches (610 mm) maximum shall not be steeper than one unit vertical eight units horizontal (12-percent slope).	**As per IBC Section 1003.3.4.1** **1003.3.4.1 Ramp Slope:** Ramps used as part of a means of egress shall have a running slope not steeper than one unit vertical in 12 units horizontal (8-percent slope).	If there is a existing ramp then the rehab code permits a slope of 1 in 8 (12%) over 1 in 12 (8%) requirements as per IBC. This is not applicable in the case study building as there is no ramp.
SECTION 1006 STRUCTURAL 1006.1 General.	Historic Buildings shall comply with the structural provisions of this code.		
Exception :	The code official shall be authorized to accept existing floors and approve operational controls that limit the live load on any such floor.	Check with the Compliance requirements of Section 707.5 Structural Alteration for details	As this case study project involves a Change of Occupancy from Group B to Group R-2, all comnpliance requirtements are as per Chapter 8 of IEBC and Section 707 Structural
1006.2 Unsafe structural elements.	Where determination is made by the code official that a component or a portion of a building or structure is dangerous, as defined in this code, and is in need of repair, strengthening or replacement by provisions of this code, only that specific component or portion shall be required to be repaired, strengthened or replaced.	Engineering analysis need to be performed for the existing building. For this research, it is assumed that the structural requirements are met in the e xisting structure. Based on the structural analysis results it is needed to check for the over stressed conditions in the existing sructure.	*Assumption is made for this research purpose*

APPENDIX B

METROPOLITAN STATISTICAL AREA OF DETROIT

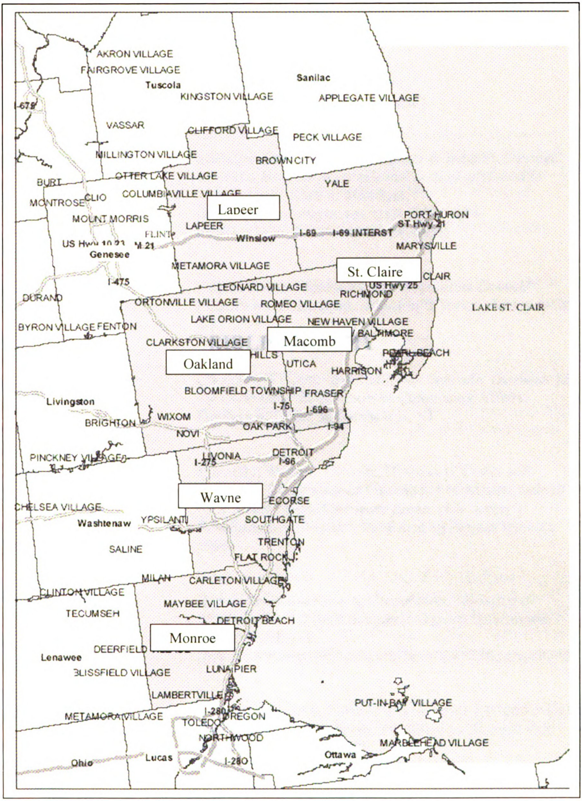

Figure 29: Metropolitan Statistical Area of City of Detroit [FRBC 1998]

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