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THE DESIGN OF A CIVIL ENGINEERING
BUILDING FOR MICHIGAN STATE COLLEGE

Thesis for the Degree of M. S.
MICHIGAN STATE COLLEGE

Milton E. Reeder
1949

This is to certify that the
thesis entitled
**THE DESIGN OF A CIVIL ENGINEERING
BUILDING FOR MICHIGAN STATE COLLEGE**
presented by

Milton E. Reeder

has been accepted towards fulfillment
of the requirements for

M.S. degree in C.E.


Major professor

Date May 27, 1949

THE DESIGN OF A CIVIL ENGINEERING BUILDING
FOR MICHIGAN STATE COLLEGE

by
MILTON E. REEDER

A THESIS

Submitted to the Graduate School of Michigan
State College of Agriculture and Applied
Science in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE

Department of Civil Engineering

1949

INTRODUCTION AND SCOPE

The preparation of this thesis was undertaken with the intention of designing a building to house the Civil Engineering Department of Michigan State College. In so doing it is intended to make this housing unit sufficient within itself so that the Department will not have to rely on any other school or department within the college for teaching facilities.

The design of any type of structure is dependant upon the use to which that structure is to be put. Particularly is this true in the case of a college building where laboratory design is dictated by curriculum. With this knowledge the proposed design herein is based on the existing graduate and undergraduate curriculum. However, the author has taken the liberty to expand and otherwise alter some of the existing laboratory facilities and to include some additional facilities that are desirable, but not available in the present teaching plant.

This treatise is divided into two parts: first, the architectural design and second, the structural design. The architectural design involves the selection of the design module, the apportionment of floor space, the

QUESTION 1

1.1. The following table shows the number of people who visited the National Museum in London in 2018, by age group and gender. The total number of visitors was 1,200,000.

Age Group	Male	Female
0-17	120,000	180,000
18-24	150,000	220,000
25-34	180,000	250,000
35-44	200,000	280,000
45-54	220,000	300,000
55-64	240,000	320,000
65+	260,000	340,000

1.2. The following table shows the number of people who visited the National Museum in London in 2019, by age group and gender. The total number of visitors was 1,300,000.

1.3. The following table shows the number of people who visited the National Museum in London in 2020, by age group and gender. The total number of visitors was 1,400,000.

Age Group	Male	Female
0-17	130,000	190,000
18-24	160,000	230,000
25-34	190,000	260,000
35-44	210,000	290,000
45-54	230,000	310,000
55-64	250,000	330,000
65+	270,000	350,000

1.4. The following table shows the number of people who visited the National Museum in London in 2021, by age group and gender. The total number of visitors was 1,500,000.

Age Group	Male	Female
0-17	140,000	200,000
18-24	170,000	240,000
25-34	200,000	270,000
35-44	220,000	300,000
45-54	240,000	320,000
55-64	260,000	340,000
65+	280,000	360,000

1.5. The following table shows the number of people who visited the National Museum in London in 2022, by age group and gender. The total number of visitors was 1,600,000.

Age Group	Male	Female
0-17	150,000	210,000
18-24	180,000	250,000
25-34	210,000	280,000
35-44	230,000	310,000
45-54	250,000	330,000
55-64	270,000	350,000
65+	290,000	370,000

integration of the individual requirements into building groups,, and the exterior treatment of the building.

The structural design presented in the second part of this thesis is not a complete design,, but is intended as a substantiation of practicability of the overall design. To this end the structural design is limited to those portions of the building frames above ground. Due to the location of the buildings near the river and the danger of flooding, basements have been eliminated excepting for shallow venting tunnels and a small half basement containing venting machinery. Thus it can be seen that while this design is not complete it does contain all the framing constituents other than footings.

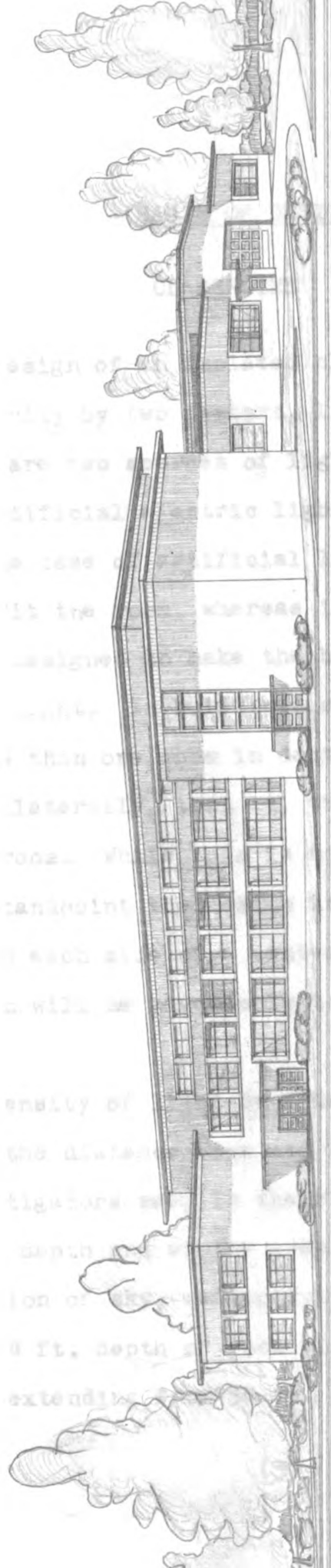
- **Environmenal factors** - factors that can influence the development of a disease, such as diet, exercise, and stress.
- **Genetic factors** - factors that are inherited from one's parents, such as a family history of a disease.
- **Lifestyle factors** - factors that are related to a person's habits and behaviors, such as smoking, drinking, and eating.
- **Age** - the process of growing older, which can increase the risk of certain diseases.
- **Sex** - the biological characteristics that distinguish males and females, which can influence the risk of certain diseases.
- **Race** - the social and cultural characteristics that distinguish different groups of people, which can influence the risk of certain diseases.
- **Ethnicity** - the cultural and social characteristics that distinguish different groups of people, which can influence the risk of certain diseases.
- **Family history** - the medical history of a person's family, which can indicate a higher risk of certain diseases.
- **Medical history** - the medical history of a person, which can indicate a higher risk of certain diseases.
- **Medications** - drugs or substances that are used to treat a disease, which can sometimes increase the risk of other diseases.
- **Chronic diseases** - diseases that last for a long time and often require ongoing treatment, such as diabetes and heart disease.
- **Acute diseases** - diseases that are short-lived and often resolve themselves, such as the flu and a cold.
- **Infectious diseases** - diseases caused by a pathogen, such as a virus or bacteria, which can be spread from one person to another.
- **Non-infectious diseases** - diseases that are not caused by a pathogen, such as cancer and heart disease.
- **Preventable diseases** - diseases that can be avoided by taking certain precautions, such as vaccination and healthy lifestyle choices.
- **Unpreventable diseases** - diseases that cannot be avoided, such as certain genetic diseases and some types of cancer.

PART I

THE

ARCHITECTURAL

DESIGN



— PROPOSED CIVIL ENGINEERING BUILDING —
AND
— LABORATORIES —

- BASIS OF DESIGN -

CLASSROOMS

In the design of an isolated classroom, size is limited primarily by two factors, lighting and acoustics. There are two sources of light available in the classroom, artificial electric light and natural daylight. In the case of artificial lighting this may be designed to fit the room, whereas in daylighting the room must be designed to make the best use of the available natural light. In buildings more than one story high and more than one room in depth daylight is available only unilaterally, that is, through windows on one side of the room. While this is not as desirable from a lighting standpoint the design is much more economical with rooms on each side of a center corridor. Therefore consideration will be given only to unilaterally lighted rooms.

The intensity of light on a desk surface varies directly as the distance from and the area of the windows. Investigators vary in their recommendations of optimum room depth and window area depending upon location, condition of sky, reflectivity of walls, etc. However, a 24 ft. depth of room with a 12 ft. ceiling and windows extending from 30 in. above the floor to

flush with the ceiling are generally accepted as optimum dimensions for good daylighting.

The length of the room running parallel to the windows has no effect on lighting and is a factor of acoustics. A square classroom is considered ideal, acoustically, however variations in the form of rectangles with the length up to twice the width have proved satisfactory.

Application of the preceding limitations results in a basic classroom 24 ft. X 24 ft. X 12 ft. high. An increase in length to 36 ft. may be desirable in some cases where extra large occupancy is expected, but sizes larger than this are not deemed necessary for general classroom use.

While not of importance in classroom size the effect of direct sun light causing excessive brightness differential within the room has effect on window design. Many methods have been devised to control direct sunlight by diffusion. Of these prismatic glass block has proven the most successful, but not necessarily because of better diffusion qualities, but due rather to their permanence and lack of attention required. While the glass block manufacturers advocate their use on all classroom windows regardless of orientation the author does not feel that their advantages are sufficiently proven to

dictate their use as windows other than southern exposures. The usual practice is to include a vision strip of clear glass windows below the glass block. In the case of a 12 ft. ceiling the vision strip extends from 30 in. to 6 ft. above the floor, permitting the average sized person to see out while standing or sitting. The windows of the vision strip open to permit ventilation.

OFFICES

Here again the depth from window to corridor wall is limited by the requirements of good daylighting, however the optimum size for good hearing may be omitted. The length of the room along the windows is therefore governed by the use and arrangement of furniture. Assuming an occupancy of 3 persons per office, each with desk, file, and bookcase, a room of 12 ft. X 24 ft., or approximately 100 sq. ft. per person, should be adequate.

LABORATORIES

Good daylighting is as desirable in the laboratory as in the classroom. Therefore the limitation of depth of room must again be imposed. However, while good hearing is desirable the optimum sized room may not be attainable because of increased area demand imposed by the

specialized equipment. It must also be remembered that the laboratory is essentially a work room and the speaking voice would naturally be drowned out by the work noise. Thus the length of laboratory rooms may be extended to any length dictated by equipment and function.

As was pointed out, laboratories are work areas and noise must be expected, therefore it may be wise to locate all of the laboratories in a separate building sufficiently distant from the classrooms to insure no interference. Another advantage to this separation would be the possible increase in room width due to bilateral daylighting.

LECTURE HALL

Due to the double duty of lecture and motion picture projection the lecture hall is usually windowless. The size therefore is governed by acoustics and good vision with artificial lighting. This is best accomplished by the elevation of each successive row of seats with each row forming an arc about a center at the back of the stage. By so doing the distance from the stage to the most distant seat may be held to a minimum while arranging the maximum number of seats in each row. The

overall dimensions would have a greater width than depth, yet no seat in the room would be farther from the platform than the depth of the room.

CORRIDORS

Little evaluation can be made of corridor dimensions. The available height will depend on the height of the classrooms on either side. It is the general practice not to use the full height available but rather to place a false ceiling about 10 ft. above the floor. This is not only effective in reducing corridor noise but may also furnish space to carry electrical wiring and ducts of the ventilating system.

The width of the corridor is a function of the traffic load. Accurate determination of the traffic load is impossible and an estimate would be nothing more than a wild guess, however, corridor widths of existing structures on campus would be indicative. The new buildings have corridor widths of 10 to 12 ft. while those of older design are somewhat wider.

VENTILATION

Ventilation is usually accomplished either by

• 1990年，中国开始实行“社会主义市场经济”改革，旨在通过引入市场竞争机制来促进经济增长。

- 1992年，邓小平南方谈话进一步推动了改革进程，强调“发展才是硬道理”。
- 1993年，中国正式确立社会主义市场经济体制目标。

（三）2000年代至2010年代

- 2001年，中国加入世界贸易组织（WTO），标志着中国全面融入全球经济体系。

这一时期，中国经济继续保持高速增长，成为全球第二大经济体。同时，中国也面临着日益加剧的环境污染、收入分配不均等问题。2008年爆发的全球金融危机对中国经济产生了深远影响，促使中国政府采取了一系列措施来应对危机，并推动经济结构调整。

- 2012年，中国共产党第十八次全国代表大会召开，提出了“科学发展观”和“中国梦”等重要理念。
- 2013年，中国启动全面深化改革，旨在进一步释放市场活力。

这一时期，中国在经济、科技、文化等领域取得了显著成就，国际影响力不断提升。然而，中国也面临着人口老龄化、环境污染等挑战。

2015年，中国提出“一带一路”倡议，旨在通过加强基础设施建设，促进沿线国家的经济合作与发展。这一倡议得到了国际社会的广泛支持。

2017年，中国共产党第十九次全国代表大会召开，提出了“新时代中国特色社会主义思想”，为中国未来发展指明了方向。

这一时期，中国在经济、科技、文化等领域取得了显著成就，国际影响力不断提升。然而，中国也面临着人口老龄化、环境污染等挑战。

（四）2020年代至今

这一时期，中国面临着新冠疫情等重大挑战，但同时也展现出了强大的韧性和恢复能力。

forcing air into a room, exhausting air from it, or by combinations of both. Regardless of the method used ducts must be provided to conduct air to and from the room.. The arrangement of these ducts may vary greatly, however, one method using a venting tunnel has proven very satisfactory in structures without basements. In this method a shallow tunnel extends the length of the structure directly under the corridors. Ducts extend upward from this, running through the space between double corridor-classroom walls on either side of the corridor. At the desired level the duct is passed through the wall, ending in a screen on the far side just below the ceiling. Fresh air is either forced or drawn through the ducts into the room. This forms the fresh air supply system. The exhaust air system works just in reverse. Stale air is drawn from the the room at floor level into the exhaust ducts, hence through the hollow wall to a main duct in the attic or in the case of flat roofed structures to a duct above the false ceiling in the upper corridor. From here the air is blown or displaced to the outside..

This type of ventilating system is particularly well adapted to one way slabs over building frames perpendicular to the direction of the tunnel. Venting

1. The first step in the process of the scientific method is to make an observation or ask a question. For example, a scientist might observe that a plant grows better in one type of soil than another.

2. Next, the scientist forms a hypothesis, which is a prediction or an educated guess about the outcome of an experiment. For example, the scientist might hypothesize that the plant will grow taller in soil A than in soil B.

3. The third step is to design an experiment to test the hypothesis. This involves setting up a controlled experiment where the only variable that changes is the type of soil.

4. The scientist then conducts the experiment and collects data. For example, they might measure the height of the plant in each type of soil over a period of several weeks.

5. After collecting the data, the scientist analyzes it to see if it supports the hypothesis. If the plant in soil A is significantly taller than the plant in soil B, the hypothesis is supported.

6. If the data does not support the hypothesis, the scientist may need to revise the hypothesis and repeat the experiment.

7. Finally, the scientist communicates the results of the experiment to the scientific community through a publication or presentation.

8. The scientific method is a systematic approach to investigating a question or solving a problem. It involves making observations, forming hypotheses, designing experiments, collecting data, analyzing results, and communicating findings.

9. The scientific method is a process that allows scientists to test their ideas and theories against the natural world. It is a way of thinking that is based on evidence and logic.

10. The scientific method is a fundamental part of science and is used by scientists in all fields of study. It is a way of thinking that is essential for understanding the natural world.

machinery may be placed on the top floor or in a half basement beside the venting tunnel, or in both places depending upon the type of system employed.

MISCELLANEOUS

Doors should be provided for entrance into and exit from the building in all directions from which traffic is anticipated. It is exceedingly difficult to predict patterns of traffic to and from surrounding buildings and the designer may find himself in the embarrassing position of having placed too small a door at a critical opening. Therefore double doors with no constriction of passageway on either side should be minimum requirements. Vestibules should also be provided to reduce the effect of temperature differential between inside and outside.

Stair wells should be located at each end of the main corridor and should be closely accessible to an entrance. One stair well should be near the main entrance.

Toilet facilities for men should be provided on each floor of the main structure. Toilets and lockers should be available on the main floor of the laboratory unit. Separate faculty toilet rooms should be provided

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on the main floor and elsewhere in the building inconjunction with a faculty lounge. As women are not likely to enter the civil engineering field to any great extent in the near future only one toilet room need be provided. This should be located near the lecture hall as other departments may schedule coeducational classes here. These toilet facilities may also serve the secretaries of the faculty members.

Janitor rooms should be provided on each floor for the storage of maintenance materials. An elevator should service all floors of the main building.

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- SOLUTION -

Presented on the subsequent pages of this part of the thesis is the author's solution of the architectural design.

The building site was selected as that which is now the audience area of the college band shell. This would necessitate the razing of the shell and the elimination of this area as an outdoor theater. The tradition value of the band shell notwithstanding, it must be remembered that this area is used only during a small part of the year whereas, the proposed building would be of continuous service to the college.

Furthermore, from a standpoint of convenience it is the only area north of the river of sufficient size to accommodate the proposed structure without crowding. This location would also facilitate the supply of water from the river to the hydraulics laboratory. The band shell could be duplicated elsewhere on the campus having the same desirable attributes as the present site excepting central location.

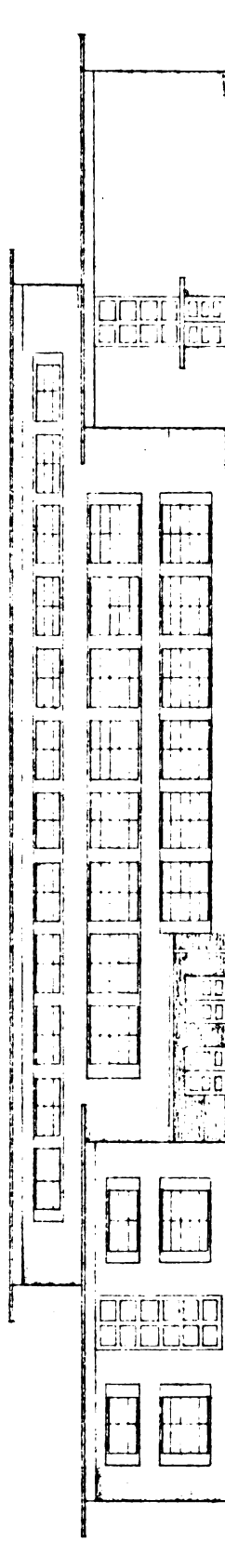
Due to its proximity to the river and the danger of

Flooding all basement areas have been eliminated excepting a shallow venting tunnel and half basement containing venting machinery. The structure is divided into two units, the classroom and administrative building and the laboratory group. The two units are joined by an open breezeway. The classroom building has a main section of three stories containing classrooms, storage and some office space, drafting rooms, library, and ventilating machinery rooms. Two, two story wings are attached to the main section forming a C shaped structure. The right hand wing contains the lecture hall whereas, the left wing houses the major portion of the faculty offices.

The laboratory unit consists of a main two story section housing the hydraulics laboratory, toilets, lockers, and various equipment rooms on the first floor, with the sanitary group, the bituminous testing and photo analysis laboratories on the second floor. Adjoining the main section is a two story general work area with overhead crane. Opening from this on either side are one story laboratories with small glassed-in classrooms and computing rooms. The main work area is bilaterally lighted through clerestory glass block windows on each side above the one story laboratories.

In the developement of these floor plans a design module of 12 ft. was used. It may be noted that the corridors are 12 ft. wide with rooms on either side 24 ft. in depth. The passage of venting ducts through the corridor walls will reduce these dimensions somewhat. Assuming duct widths up to 18 in. with 4 in. cinder block walls on each side would necessitate provision for a 26 in. corridor wall. This would reduce the corridor width to 9 ft. 10 in., and the room width to 22 ft. 11 in.

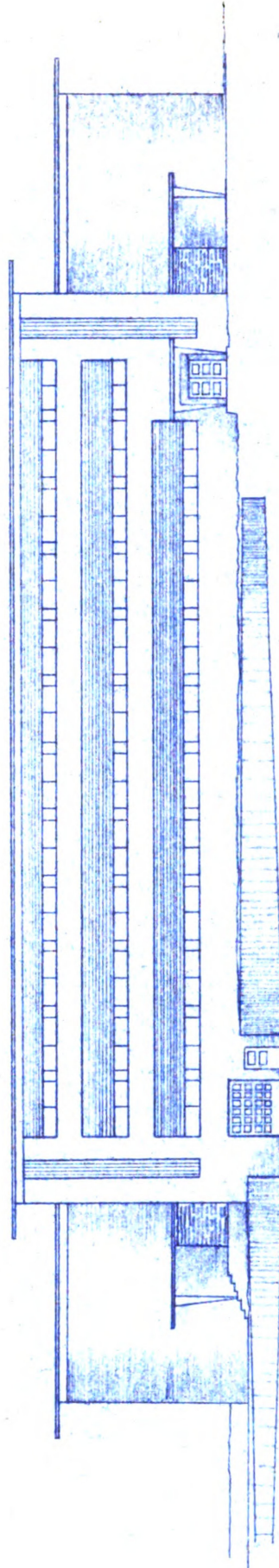
Both units are covered by flat slab roofs. While this is not in keeping with the new college architecture other exterior treatments do much to make the structure blend in with the overall trend. The large glass areas have their parallel in the new Physics Building as does the sand stone facing of the entrance ways. The overall exterior is red face brick with limestone trim around the windows, doors, and a strip under the eaves.



100 NORTH ELEVATION

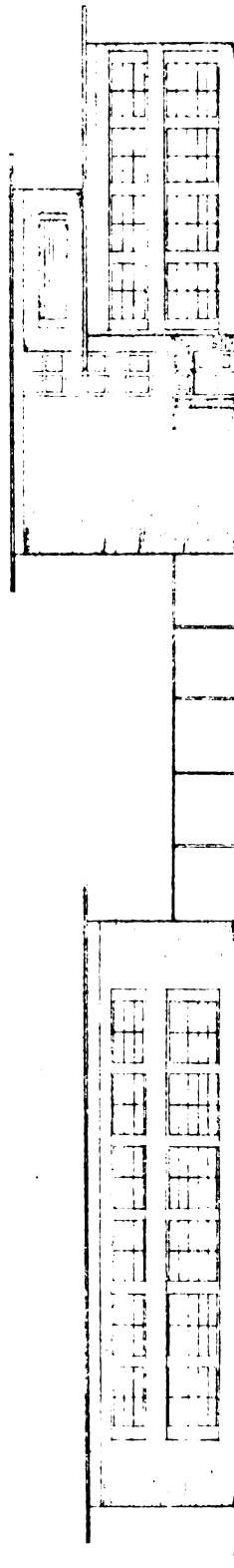
CLASSROOMS

SCALE 1" = 30'



— 60 SOUTH ELEVATION —
CLASSROOMS

SCALE — 1" = 30'

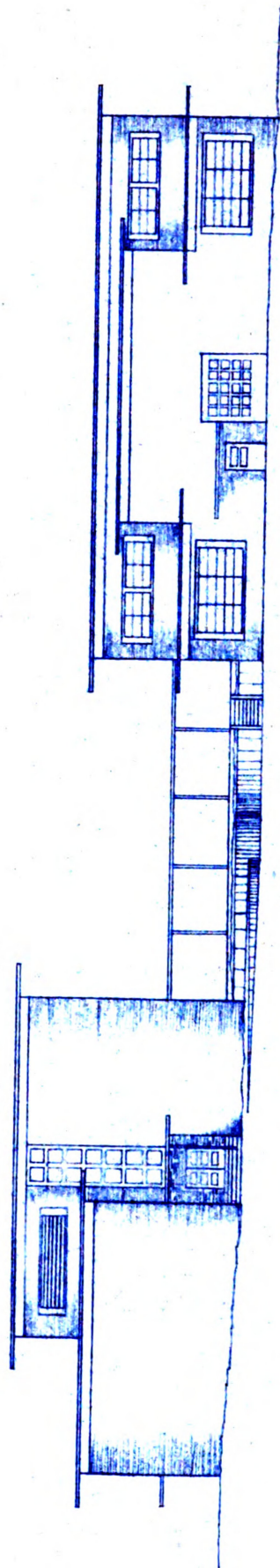


LABORATORIES

8200 S. 4th

EAST ELEVATION

SCALE 1"=30'

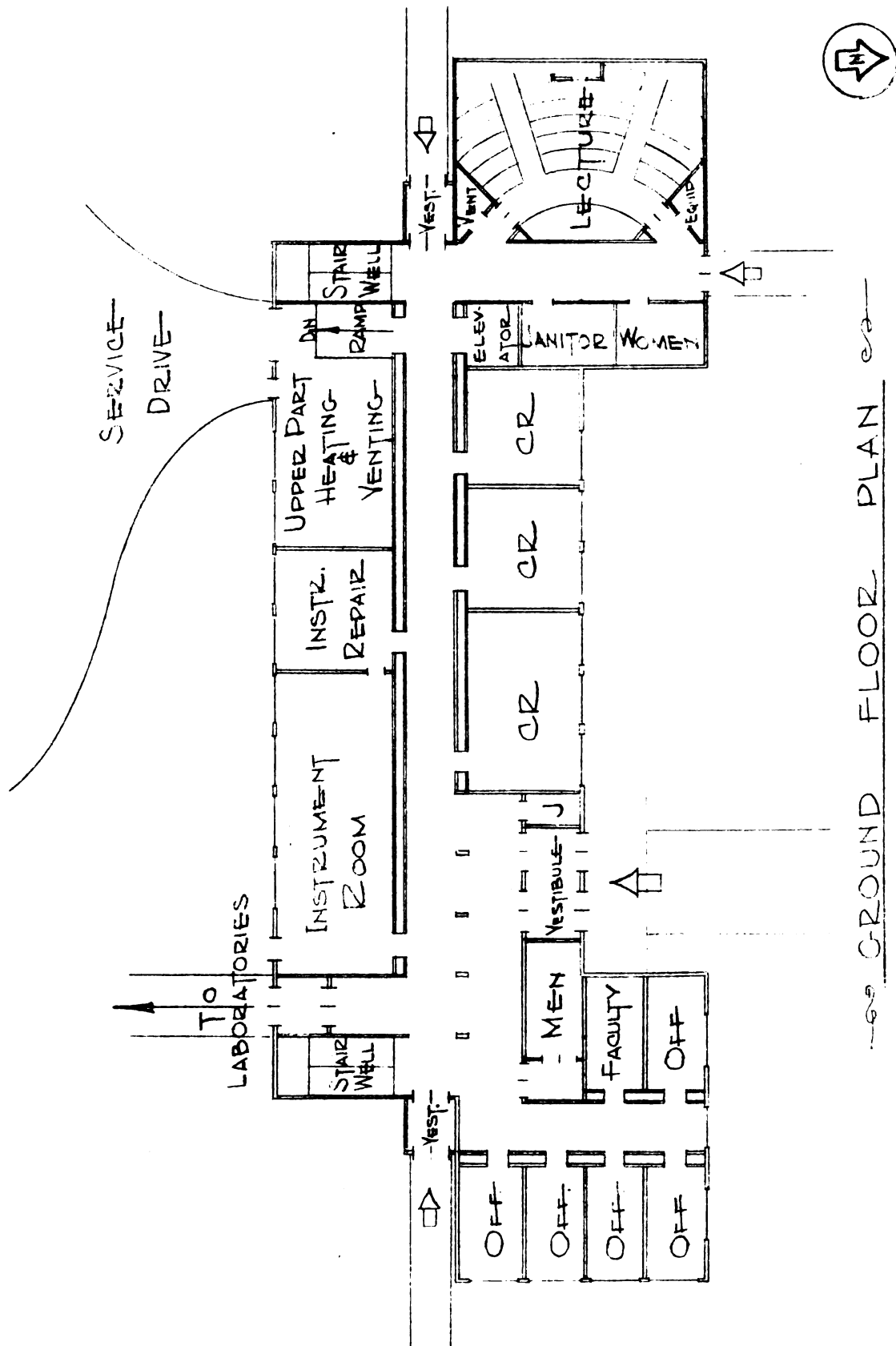


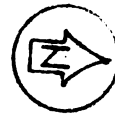
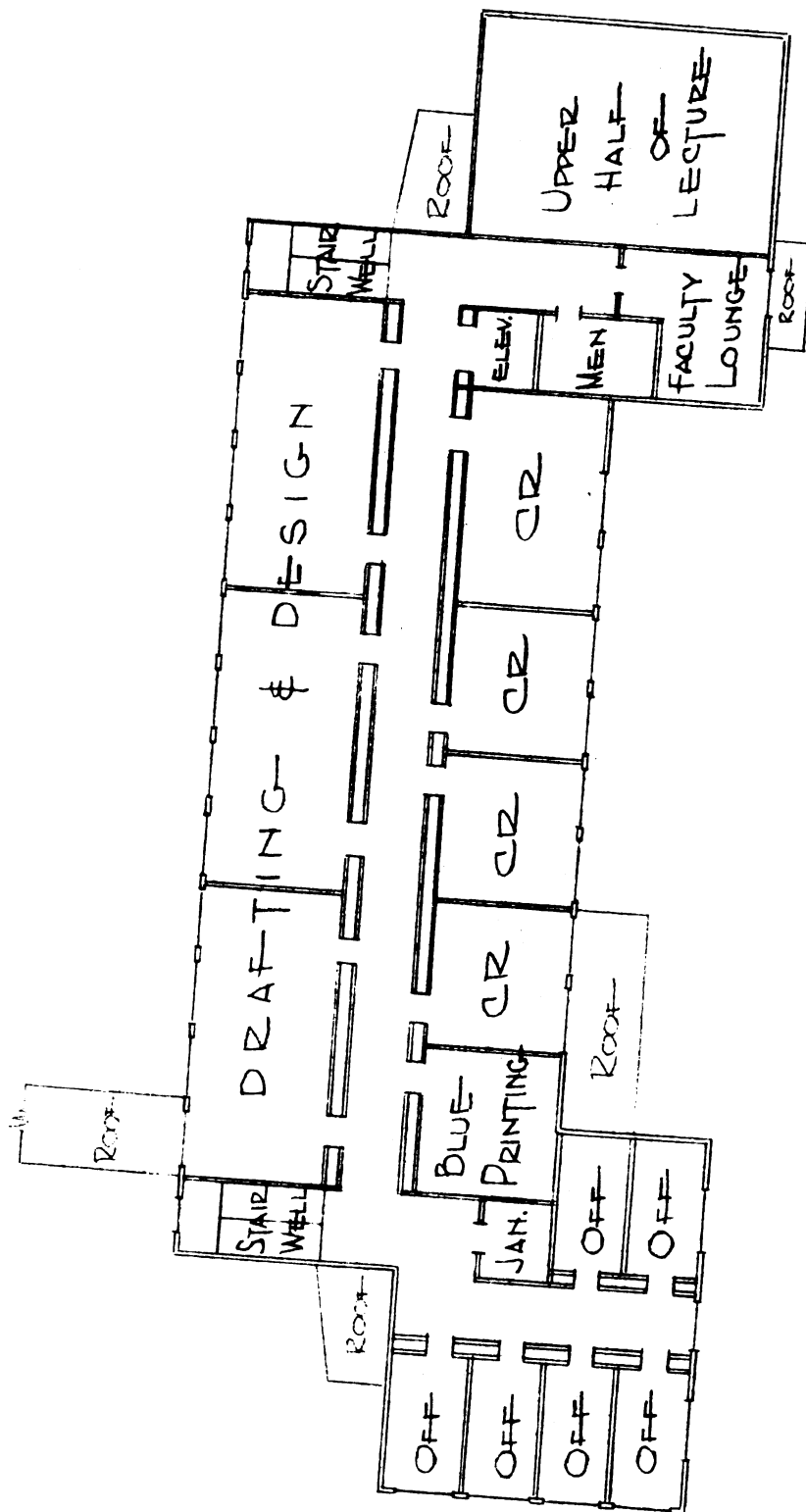
— CLASSROOMS —

— LABORATORIES —

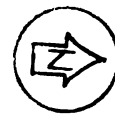
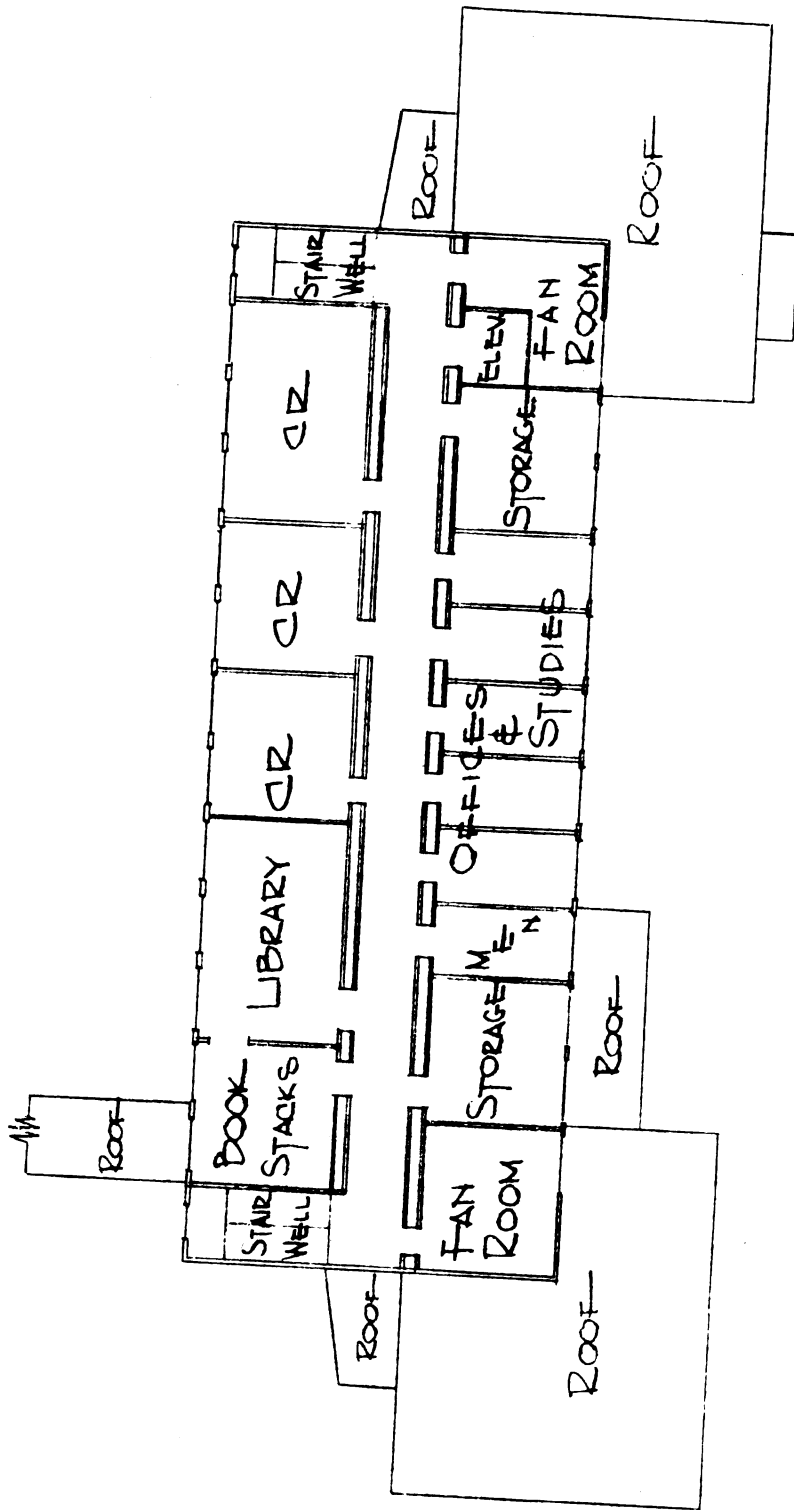
— WEST ELEVATION —

SCALE 1" = 30'





SECOND FLOOR PLAN
 — CLASSROOMS —
 SCALE 1"=30'

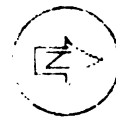
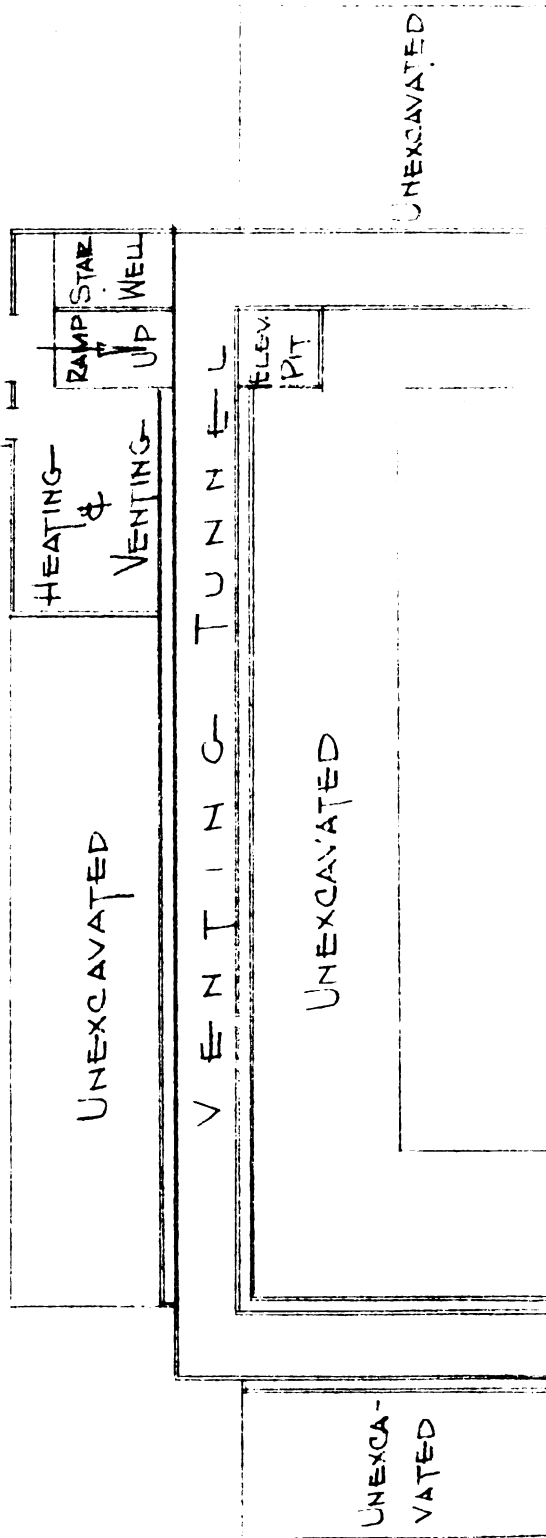


THIRD FLOOR PLAN

CLASSROOMS

SCALE 1" = 30'

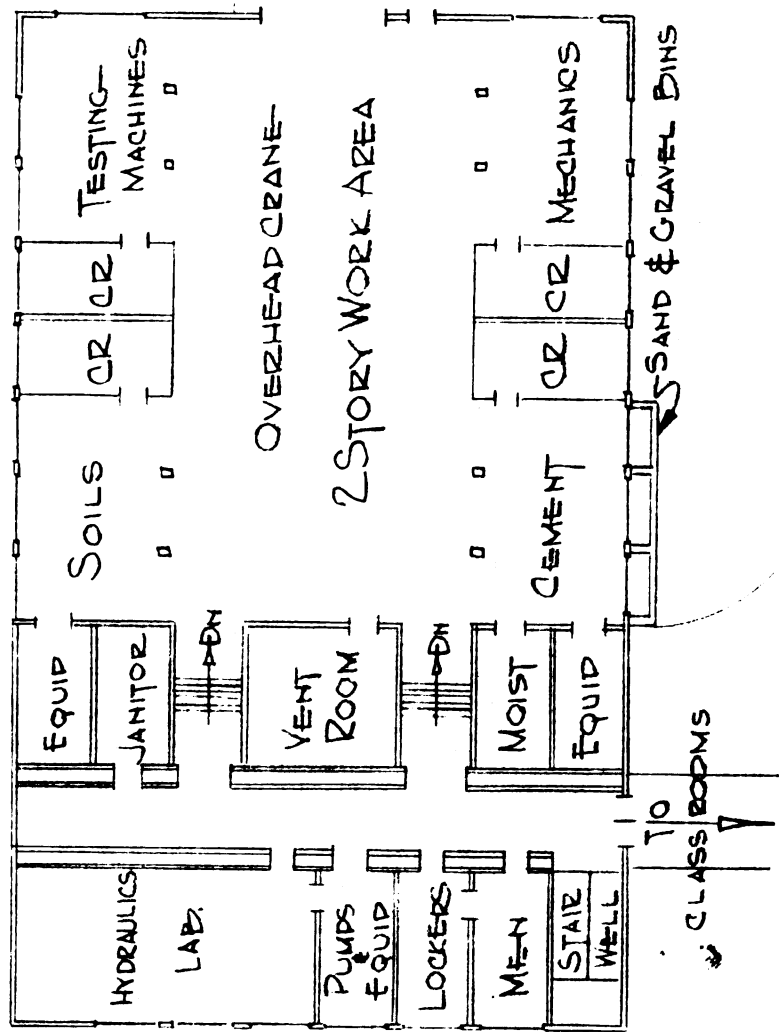
SERVICE-
DRIVE-



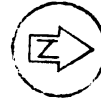
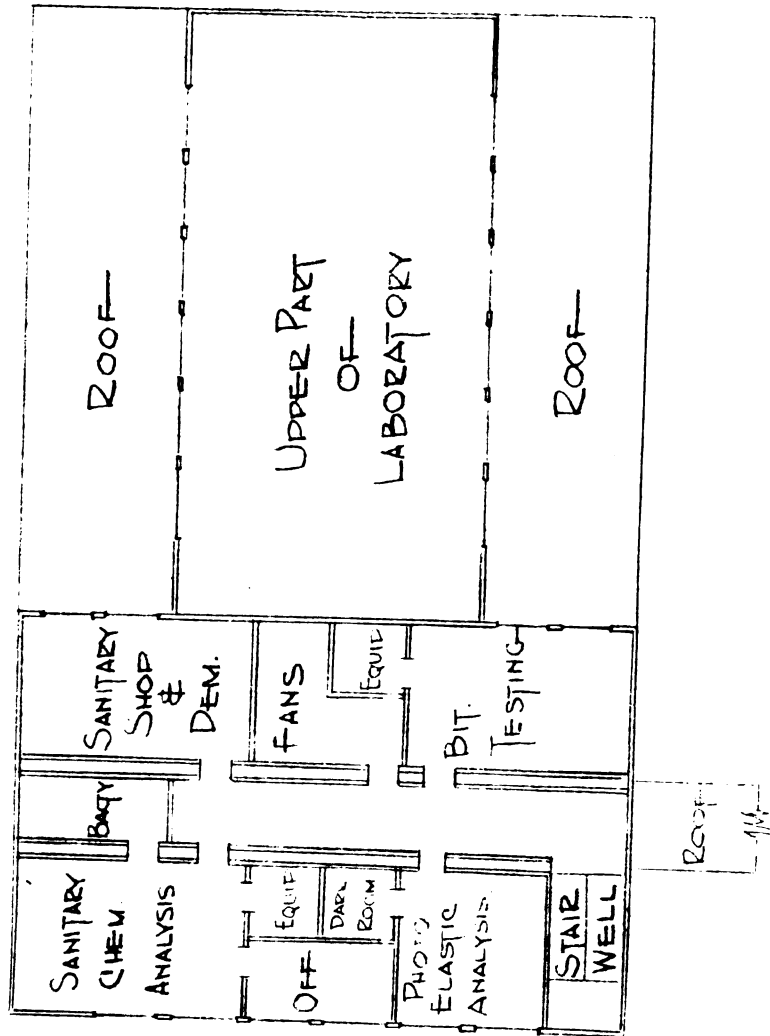
--- BASEMENT PLAN ---

--- CLASSROOMS ---

SCALE 1" = 30'



GROUND FLOOR PLAN
 LABORATORY
 SCALE 1" = 30'



— 65 — SECOND FLOOR PLAN —

— LABORATORY —

SCALE 1"=30'

P A R T I I

T H E

S T R U C T U R A L

D E S I G N

TYPE OF CONSTRUCTION

Reinforced concrete was selected as the construction medium. It is felt that the size and nature of this structure is ideal for this type of design. The tallest part of the building is only three stories high, thus the additional weight of concrete as compared to steel would not cause any unnecessary bulk in columns. The live loading anticipated is moderate to light as all heavy equipment is located on the ground floor. Clear span lengths are not excessive except in the case of the roof beams of the lecture hall and the two story laboratory, and here other provisions have been made. As the building bents run perpendicular to the window surfaces the depth of the beams will not interfere with the diffusion of light or ceiling height. Also venting ducts are carried vertically, again depth of beam is not critical.

A 2500 lbs per sq. in. concrete with a extreme fiber stress in compression of 1125 lbs per sq. in. was selected as the basis of the concrete design. Intermediate grade of reinforcing steel with a working stress in tension of 20,00 lbs per sq. in. and in compression of 16,000 lbs per sq. in. is used throughout.

FRAMING DETAILS

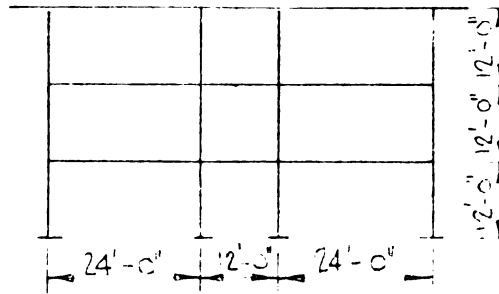
The application of the 12 ft. design module makes possible the selection of a basic building bent to which minor alterations can be made to satisfy the requirements of the major portion of the building frames. To permit an unobstructed two story space as is necessary in the lecture hall and the two story laboratory with craneway an additional bent, combined with a non rigid frame, was selected. The supporting roof beam is a pre-fabricated, commercial type steel joist supported simply at the ends with a clear span of 48 ft. The author selected this type of roof support in this case because the dead weight of a reinforced concrete beam of this length of span would be prohibitive.

Presented on pages 25, 27 and 28 are the elevation views of the bents, and plan views showing their integration into the building frame. Pages 29 and 30 show framing details at critical points.

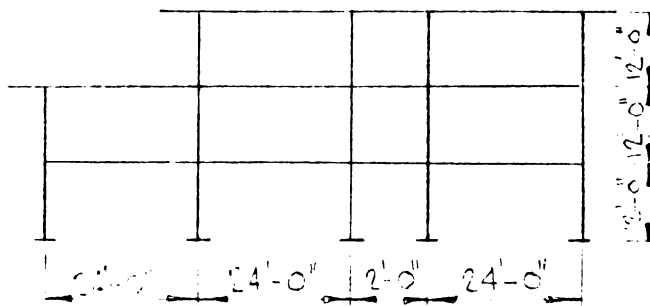
• The first step in the process of creating a new product is to identify a market need. This can be done through market research, which involves gathering information about the target market and its needs. Once a market need has been identified, the next step is to develop a concept for a new product that meets this need. This concept should be based on the market research and should take into account the needs and preferences of the target market. The concept should also be feasible, meaning that it can be developed and produced within the available resources and budget. Once a concept has been developed, the next step is to create a prototype of the product. This can be done using a variety of methods, including 3D printing, computer-aided design (CAD), and traditional manufacturing techniques. The prototype should be used to test the product and to gather feedback from potential customers. This feedback can be used to refine the product and to make any necessary changes. Once the product has been refined, the next step is to develop a marketing plan. This plan should outline the strategies and tactics that will be used to promote the product and to reach the target market. The marketing plan should also include a budget and a timeline for the marketing activities. Once the marketing plan has been developed, the final step in the process is to launch the product. This involves producing the product and distributing it to the target market. The product should be promoted through a variety of channels, including social media, email marketing, and traditional advertising. The success of the product launch will depend on the effectiveness of the marketing plan and on the quality of the product itself.

BUILDING BENTS

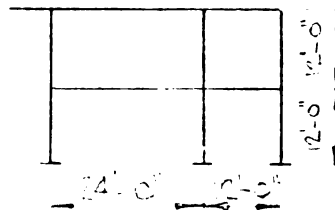
BENTS FORMING
LAB & OFFICE
SECTIONS SAME
AS TOP 2 STORES
OF BENT #1.



BENT #1

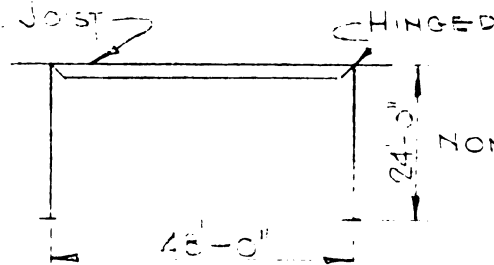


BENT #2



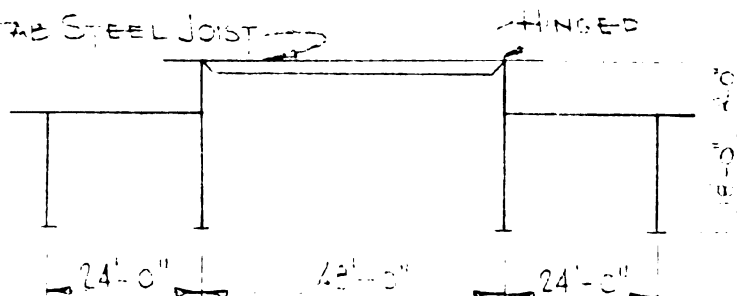
BENT #3

PREFAB STEEL JOIST



NON RIGID FRAME

PREFAB STEEL JOIST



BENT #4

OVERALL LENGTH 240'-0"

102'-0"

15 BENTS @ 12' 7/2"

5 BENTS
@ 12' 7/2"
48'-0"

OVERALL WIDTH
34'-0"

3 BENTS 7 Joists @ 6' 2"
@ 12' 7/2" 4 COL. @ 12' 7/2"
60'-0"

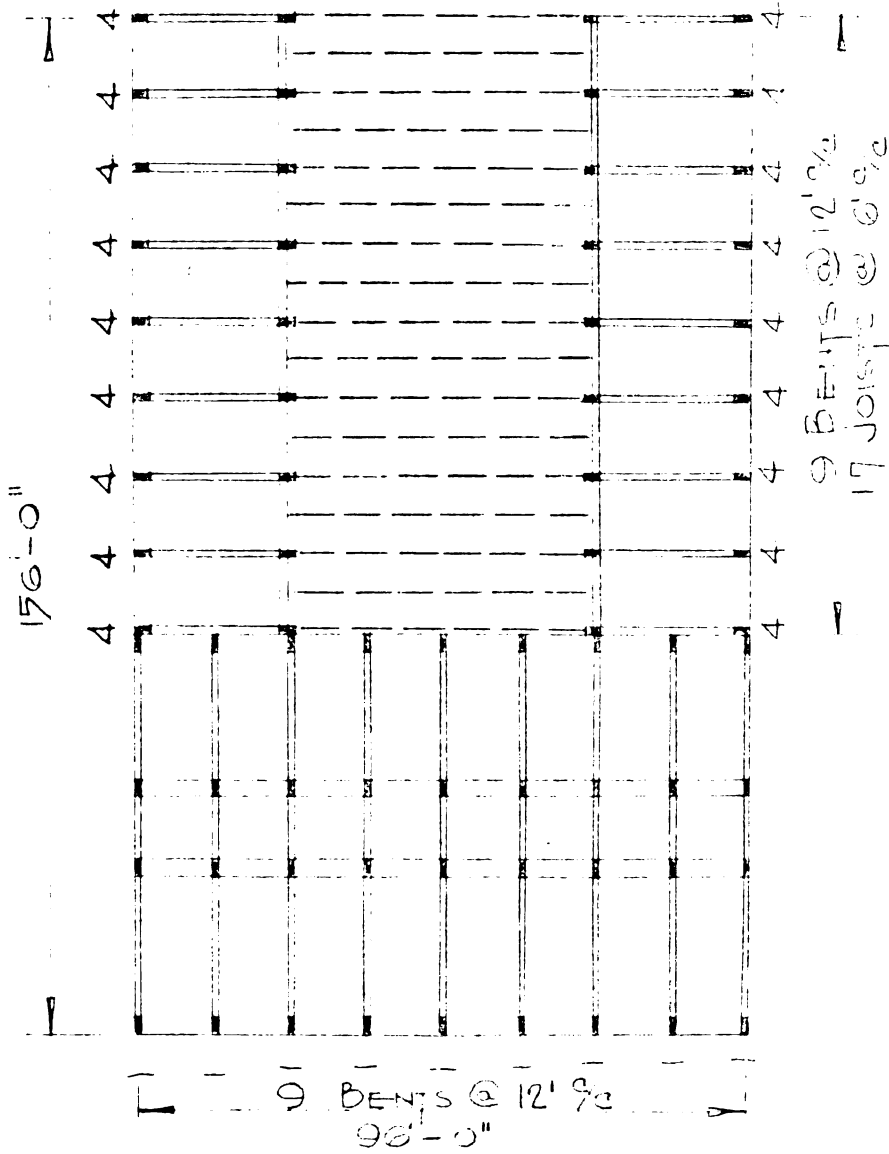
FRAMING DIAGRAM

NUMBERS INDICATE
SIMILAR BENTS

CLASSROOMS

SCALE 1" = 30'

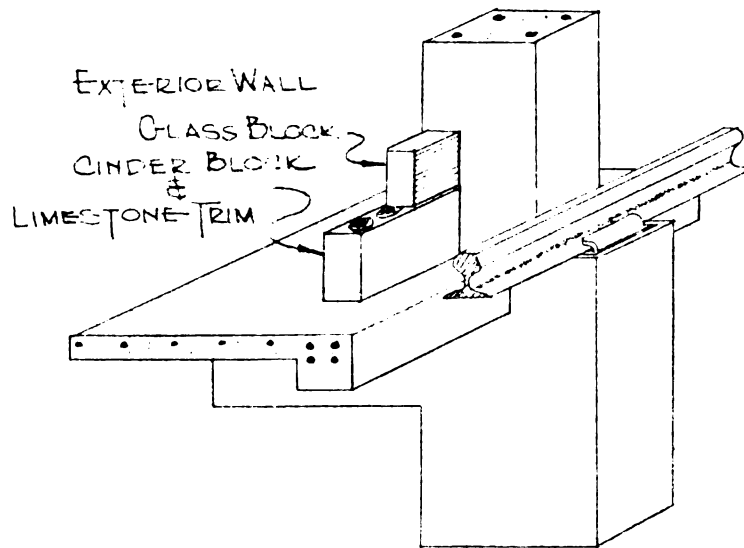
MAIN FRAME-BEAM
SECONDARY WALL BEAM
PREFAB STEEL JOIST
COLUMNS



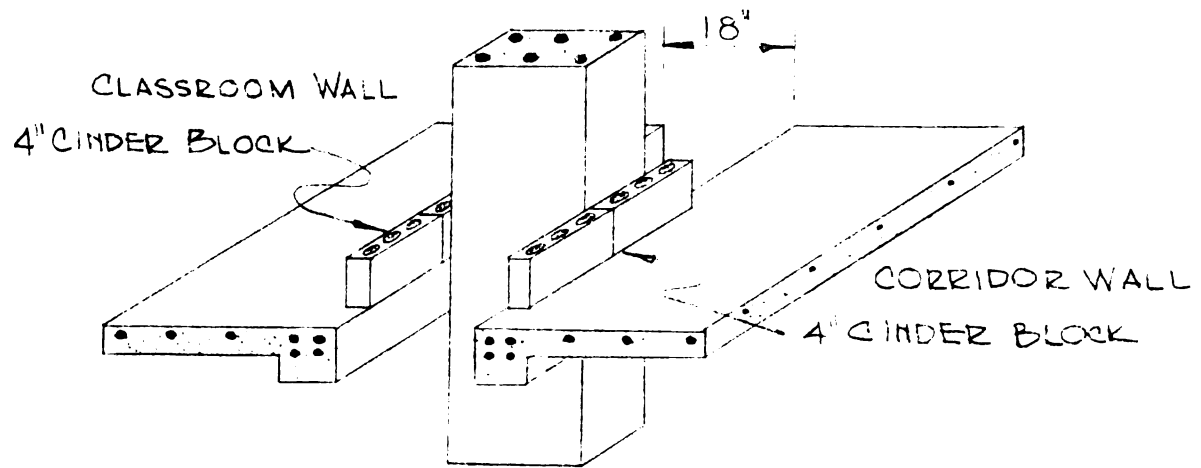
FRAMING DIAGRAM

LABORATORIES

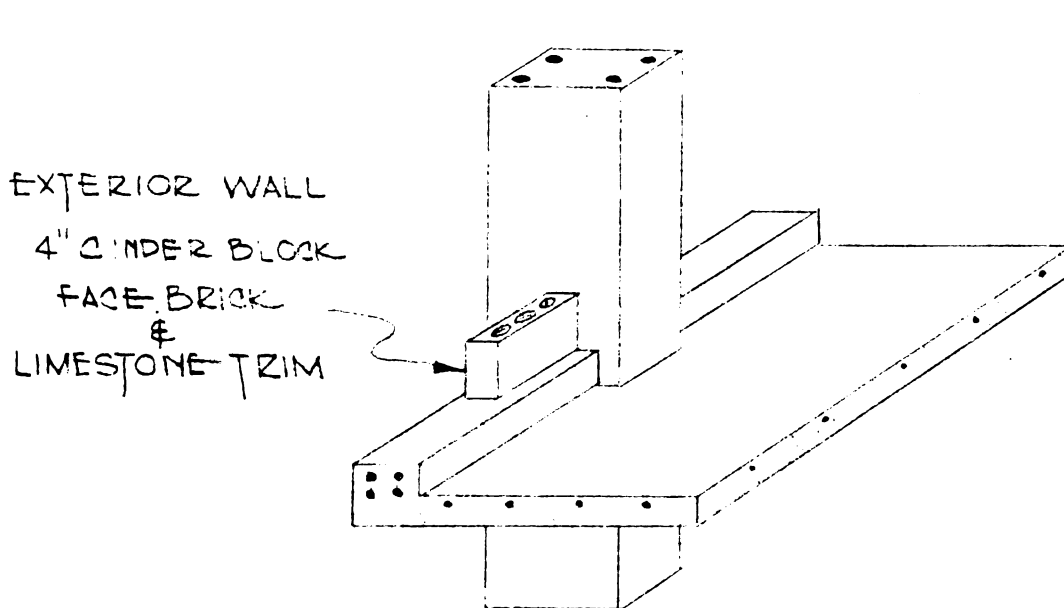
SCALE 1" = 30'



TYPICAL FRAMING AT INTERIOR COLUMN
OF BENT NO. 4 SHOWING PLACEMENT
OF CRANE RAIL ON COLUMN CON-
STRUCTION



— TYPICAL FRAMING AT INTERIOR COLUMN —



— TYPICAL FRAMING AT EXTERIOR COLUMN —
SHOWING INVERTED WALL BEAM

LIVE LOADING

Codes governing snow loads on flat roofs vary greatly depending upon locality. Recommendations vary from 20 to 40 lbs per sq. ft. with an average of 30 lbs per sq. ft. The Manual of the American Institute of Steel Construction sets a minimum snow load of 20 lbs per sq. ft. with provisions to increase the loading in portions of the United States north of the 40th parallel of latitude. As East Lansing is north of this line the adoption of 30 lbs per sq. ft. seems in accord with the above recommendations.

Classroom and corridor floor loadings of 50 and 100 lbs per sq. ft. respectively are accepted as standard by most codes. However this is for general elementary and high school construction and does not include consideration of additional weight of individual and specialized equipment found in the engineering classroom. This would indicate a moderate increase in floor loading. If, for simplicity of design, the allowable combined total of the wall load plus the live load were accepted as 100 lbs per sq. ft., the maximum allowable live load in the smallest sized room, 12 ft. by 24 ft., would be 62 lbs per sq. ft. (see page 32). As the size of the room

QUESTION 1

1. The following table shows the number of people who attended the 2010 World Cup in South Africa, categorized by country and gender.
- | Country | Male | Female | Total |
|--------------|------|--------|-------|
| USA | 120 | 80 | 200 |
| France | 150 | 100 | 250 |
| Germany | 180 | 120 | 300 |
| Spain | 160 | 110 | 270 |
| Italy | 140 | 90 | 230 |
| England | 130 | 85 | 215 |
| South Africa | 110 | 70 | 180 |
2. The following table shows the number of people who attended the 2010 World Cup in South Africa, categorized by country and age group.
- | Country | 18-24 | 25-34 | 35-44 | 45-54 | 55-64 | 65+ |
|--------------|-------|-------|-------|-------|-------|-----|
| USA | 40 | 50 | 60 | 70 | 80 | 90 |
| France | 50 | 60 | 70 | 80 | 90 | 100 |
| Germany | 60 | 70 | 80 | 90 | 100 | 110 |
| Spain | 55 | 65 | 75 | 85 | 95 | 105 |
| Italy | 45 | 55 | 65 | 75 | 85 | 95 |
| England | 40 | 50 | 60 | 70 | 80 | 90 |
| South Africa | 30 | 40 | 50 | 60 | 70 | 80 |

LIVE LOADING

RECOMMENDED:

CORRIDORS: 100 psf

CLASSROOMS: 50 psf.

FOR SIMPLICITY TRY USING 100 psf LOADING, INCLUDING WALL LOADS, OVER ENTIRE FLOOR AREA.

CONSIDER MIN. SIZED ROOM OF 12' x 24' x 12' HIGH

1- SIDE WALL: (ACTUALLY $\frac{1}{2}$ OF 2 SIDE WALLS)

4" CONCRETE BLOCK = 20 psf

$$24 \times 12 \times 20 = 5760^\#$$

1- CURTAIN WALL: 4" CONC BLOCK = 20 psf

4" BRICK = $\frac{38}{58}$ psf

$$2\frac{1}{2} \times 12 \times 58 = 1740^\#$$

$$4 \times 6 \text{ BEAM} = \frac{24}{144} \cdot 12 \cdot 150 = \frac{300^\#}{2040^\#}$$

1- CORRIDOR WALL: (OMIT DOOR OPENING)

4" CONC BLOCK = 20 psf

$$12 \times 12 \times 20 = 2880^\#$$

$$4 \times 6 \text{ BEAM} = \frac{300^\#}{3180^\#}$$

$$\begin{array}{r} \text{SUMATION:} \\ 5760 \\ 2040 \\ 3180 \\ \hline 10,980^\# \end{array}$$

$$\frac{10,980}{12 \times 24} = 38 \text{ psf} = \text{WALL EQUIVALENT OF LL}$$

$$100 - 38 = 62 \text{ psf MIN ALLOWABLE LL}$$

increases the wall load per unit area of floor space would decrease permitting a greater unit live load. In the corridor where there are no transverse walls and the lateral walls are carried at the junction of the beam and column the maximum allowable live load would be the recommended 100 lbs per sq. ft. By this analysis it is apparent that the assumption of an overall load of 100 lbs per sq. ft. is not only permissible but desirable.

Wind loading recommendations vary widely, from city to city, depending upon the height of the building. An average would be difficult to determine but the arbitrary selection of a wind pressure of 20 lbs per sq. ft. on a vertical projection seems to more than satisfy all of the codes.

COMPUTATIONS

Presented on the following pages are the computations relative to the structural design of all slabs, columns and beams of the building frame. Listed below along with short explanations are the calculations in the order of their consideration.

The design of roof and floor slabs. These were designed as continuous one way slabs over supports 12 ft. on centers. Moment analysis was by coefficients recommended in the Joint Committee Report. By this method restraint is only by continuity of one span to the next over the supports. Concrete design is by the usual balanced design method as proposed in the Reinforced Concrete Design Handbook.

Determination of fixed end and midspan moments. Sizes of all members were assumed and dead loads calculated. These combined with the live load determined the fixed end and midspan moments for dead and total loading. Stiffness factors were also determined.

Moment and shear analysis due to wind pressure. This is the method of practical analysis as set forth in Continuity in Concrete Building Frames.

Moment and shear analysis of bents. Moment analysis is by a method of limited moment distribution explained in Continuity of Concrete Building Frames. By this method columns are assumed fixed at the floors above and below the level considered. Distribution of moments involves only two cycles. The method also uses a system of tabulation to speed calculations.

The design of the roof and floor beams. This is accomplished by the usual balanced design method as set forth in the Reinforced Concrete Design Handbook.

Column design. Columns were proportioned by the abbreviated form discussed in Continuity in Concrete Building Frames.

Design of wall beam. Moment analysis is by coefficient and concrete design by balanced design method.

4. The fourth part of the document discusses the challenges and limitations of the research process. It identifies the various factors that can affect the quality and reliability of the data, and provides suggestions for how to overcome these challenges. The text also mentions the importance of being transparent about the limitations of the study and the potential for bias.

5. The fifth part of the document provides a summary of the key findings and conclusions of the study. It reiterates the importance of accurate record-keeping and the use of reliable data sources, and emphasizes the need for transparency and accountability in the organization's operations. The text also provides a final recommendation for how the findings can be used to improve the organization's performance.

— FLOOR SLAB —

$$LL = 100 \text{ psf}$$

$$DL = 70$$

(ASSUME 5" SLAB)

$$TL = 170 \text{ psf}$$

$$V = \frac{170 \cdot 12}{2} = 1020 \#$$

$$V_{\text{CLEAR SPAN}} = \frac{170 \cdot 11}{2} = 935 \#$$

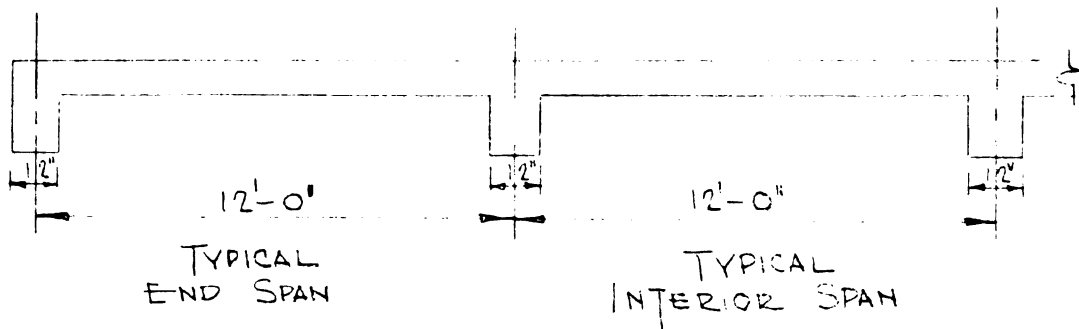
USE MOMENT COEFFICIENTS FOR ONE-WAY SLABS, JC-1940
COEFFICIENTS OF $w_{DL}L^2 + w_{LL}L^2$

	END SPAN				INTERIOR SPAN				
	END SUPPORT	MIDSPAN		1ST INT. SUPPORT	MIDSPAN		TYPICAL SUPP.		
	-	+	-	+	-	+	-	+	-
COEF. OF DL	.04	.08			.110	.046			.03
COEF. OF LL	.04	.105	.02	.015	.120	.085	.045	.036	.115
$w_{DL}L^2 = 70 \cdot 12^2$	10080				10080				10080
$w_{LL}L^2 = 100 \cdot 12^2$	14400				14400				14400
COEF. X $w_{DL}L^2$	403	805			1110	434			805
COEF. X $w_{LL}L^2$	576	1510	258	216	1730	1220	645	518	1660
MOM (ft. lbs.)	979	2315	0	0	2840	1624	184	0	2465
$\frac{1}{3}V_L = \frac{1020 \cdot 1}{3}$	340	-	-	-	340	-	-	-	340
$\frac{1}{6}V_L = \frac{1020 \cdot 1}{6}$	-	170	-	-	-	170	-	-	-
MOM (ft. lbs.)	639	2145	-	-	2500	1514	-	-	2125
" (K.N.)	768	2552	-	-	30.0	18.15	-	-	25.5

ALL CALCULATIONS ARE PER FT. OF WIDTH OF SLAB.

DESIGN OF FLOOR SLAB

FOR ALL 2ND & 3RD FLOOR AREAS & 1ST FLOOR CORRIDOR, OVER VENTILATING TUNNEL.



EFFECTIVE DEPTH:

$$M = K b d^2$$

$$d = \sqrt{\frac{2500}{196}} = 3.57"$$

$$h = 3.57 + \frac{1}{4} + \frac{3}{4} = 4.57" \quad \text{TRY } 5"$$

$$d = 5 - \frac{1}{4} - \frac{3}{4} = 4"$$

$$d = \sqrt{\frac{2145}{196}} = 3.3"$$

$$h = 3.3 + \frac{1}{4} + \frac{3}{4} = 4.3" \quad \text{TRY } 5" \text{ SLAB}$$

SHEAR:

$$V = \frac{V}{b j d} = \frac{935}{12.3664} = 22.5 < 40 \text{ psi}$$

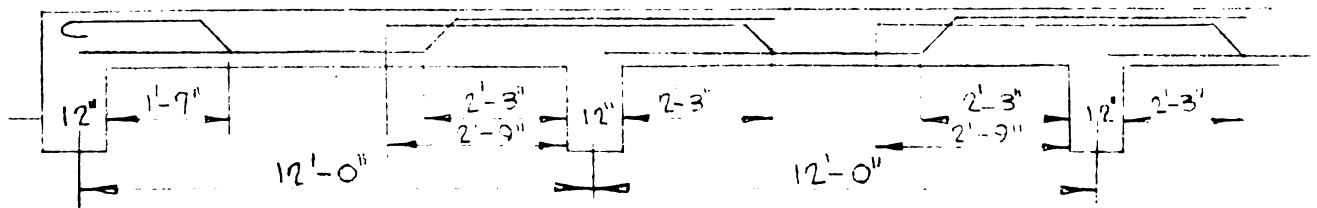
ADOPT 5" SLAB

$$V_{\text{COL FACE}} = 935 \#$$

$$V_{\text{PT OF INEL}} = .6 \cdot 935 = 560 \#$$

DESIGN OF FLOOR SLAB

	END SPAN		INTERIOR SPAN					
	END SUPPORT	MID-SPAN	1ST INT. SUPPORT	MID-SPAN	TYPICAL SUPPORT			
	-	+	-	+	-			
MOMENT (KIP.IN.)	7.63	25.80	30.00	18.15	25.50			
DEPTH, D (IN)	40	40	40	40	40			
$A_s = \frac{M}{f_s j d} = \frac{M}{69,300}$ (SQ.IN)	.11		.43		.37			
		.37		.26				
USE 1/2" ϕ -SPACING (IN)	12	6 1/2	5 1/2	9	6 1/2			
BENT UP-BARS/ft	17		1.85	.67	133	.67		
STRAIGHT-BARS/ft	.65	1.65	0	.67	133	0	.67	
ΣO (IN)	1.6		2.9	1.0		2.1	1.0	
	1.3	2.9	0	1.1	2.1	0	1.1	
REQ'D $\Sigma O = \frac{V}{\mu j d}$	1.5*	-	1.3	2.2	.9*	1.3	2.2	.9*
$\frac{935}{125 \cdot 666.4} = 2.2$	1.3	-	0	-	.9*	0		.9*
$\frac{560}{125 \cdot 666.4} = 1.3$								
$\frac{2}{3} \cdot 2.2 = 1.5^* \text{ SP. ANCH}$								
$\frac{2}{3} \cdot 1.3 = .9^* \text{ " "}$								



USE $\frac{1}{2}$ " ϕ BARS THRU OUT
 TEMP. STEEL $\frac{3}{8}$ " ϕ @ 12"
 CLEAR COVER: $\frac{3}{4}$ " TOP, $\frac{3}{4}$ " EXT.
 5" SLAB

— DESIGN OF ROOF SLAB —

$$\begin{array}{l} LL = 30 \text{ psf} \\ DL = 50 \text{ psf} \\ TL = 80 \text{ psf} \end{array} \quad \left\{ \begin{array}{l} \text{ASSUME } 3\frac{1}{2}" \text{ SLAB} = 44 \text{ psf} \\ \text{BUILT UP ROOF} = \frac{6}{50 \text{ psf}} \end{array} \right.$$

$$V = \frac{12 \cdot 80}{2} = 480 \text{ #}$$

$$V_{\text{CLEAR SPAN}} = \frac{11\frac{1}{3} \cdot 80}{2} = 450 \text{ #}$$

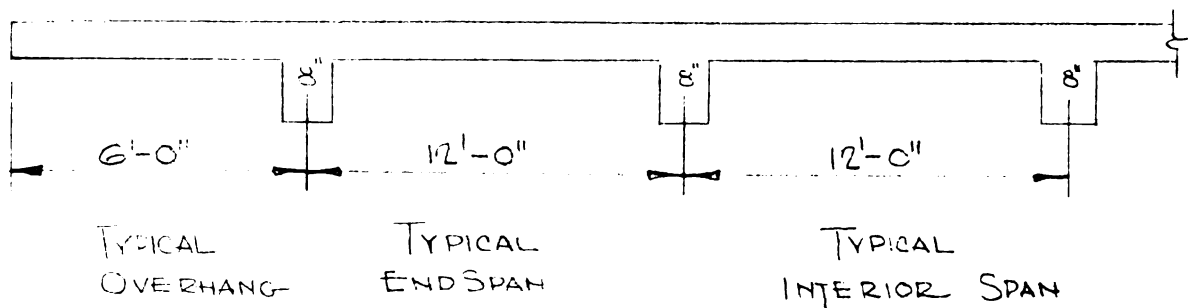
USE MOMENT COEFF., JC-1940, AS THE OVERHANG ADDS RESTRAINT TO OUTER END OF EXTERIOR SPAN EQUIVALENT TO INTERIOR SPAN, USE INTERIOR COEFF. FOR BOTH INT & EXT. SPANS
AS LOADING IS DUE TO SNOW, LOADING WILL BE UNIFORM OVER ENTIRE ROOF. THEREFORE ONLY TL NEED BE CONSIDERED.

COEFFICIENTS OF $w_{DL}L^2 + w_{LL}L^2$

	OVER- HANG	ENDSPAN		INTERIORSPAN		
	RT	LT	MID	LT	MID	RT
	-	-	+	-	+	-
COEF OF DL		.110	.046	.110	.046	.08
COEF. OF LL		.120	.055	.120	.055	.115
$w_{DL}L^2=50 \cdot 12^2$		—	7,200	—	—	—
$w_{LL}L^2=30 \cdot 12^2$		—	4,320	—	—	—
COEF $\times w_{DL}L^2$		790	330	790	330	575
COEF $\times w_{LL}L^2$		520	370	520	370	500
MOM. (ft lbs)	1440	1310	700	1310	700	1075
$\frac{1}{3}V_a = \frac{480}{3}$	160	160		160		160
$\frac{1}{6}V_a = \frac{480}{6}$			80		80	
MOM (ft lbs)	1280	1150	620	1150	620	915
MOM (KIP IN.)	15.35	13.80	7.45	13.80	7.45	11.0

DESIGN OF ROOF SLAB

FOR ALL ROOF AREAS EXCEPTING THOSE PORTIONS OF LECTURE HALL WING & LABORATORY SPANED BY PRE-FABRICATED STEEL JOISTS & ROOFED WITH STEEL DECK.



EFFECTIVE DEPTH:

$$M = K b d^2$$

$$d = \sqrt{\frac{1280}{196}} = 2.56"$$

$$h = 2.56 + .19 + .75 = 3.50", \text{ TRY } 3\frac{1}{2}"$$

$$d = \sqrt{\frac{1150}{196}} = 2.42"$$

$$h = 2.42 + .19 + .75 = 3.36" \text{ TRY } 3\frac{1}{2}" \text{ SLAB}$$

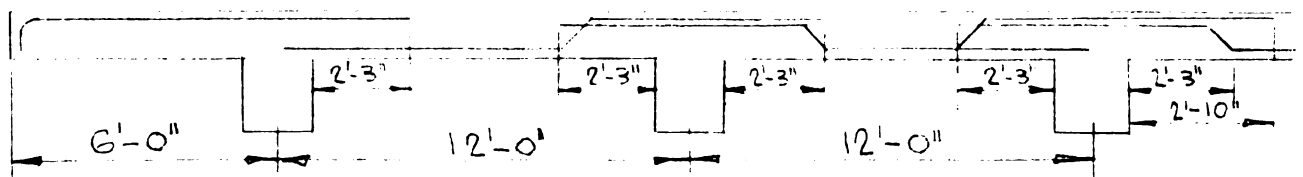
UNIT SHEAR:

$$V = \frac{V}{b_j d} = \frac{450}{12 \cdot .866 \cdot 3\frac{1}{2}} = 12.4 < 40 \text{ PSI}$$

ADOPT $3\frac{1}{2}"$ SLAB

DESIGN OF EDGE SLAB

	OVER-HANG	END SPAN		INTERIOR SPAN		
		END SUPPORT	MIDSPAN	1ST INT. SUPPORT	MIDSPAN	TYPICAL SUPPORT
		-	+	-	+	-
MOMENT (KID.IN.)	15.35	13.80	7.45	13.80	7.45	11.0
DEPTH, D (IN.)	256	256	256	256	256	256
$A_s = \frac{M}{f_{s,d}} = \frac{M}{44,400}$ (SQ IN.)	.35	.31		.31		.25
			.17		.17	
USE $\frac{3}{8}" \phi$ - SPACING (IN.)	$3\frac{3}{4}$	$4\frac{1}{4}$	8	$4\frac{1}{4}$	8	$5\frac{1}{4}$
BENT UP - BARS/ft.	3.2	3.2		1.5	1.5	1.5
STRAIGHT - BARS/ft.		1.5	1.5	0	0	1.5
ΣO (IN.)	3.8	3.8		1.8	1.8	.9
		1.8	1.8	0	0	1.8
REQD $\Sigma O = \frac{V}{\phi V_d}$	1.6	1.0		1.0	1.6	1.0
$\frac{450}{125 \cdot 266 \cdot 256} = 1.6$		1.0		0	0	1.0
$.6 \cdot 1.6 = 1.0$						
$\frac{2}{3} \cdot 1.0 = .7$ * (END ANCH.)						



USE $\frac{3}{8}" \phi$ BARS THRU OUT
 TEMP STEEL: $\frac{3}{8}" \phi @ 12"$
 CLEAR COVER, $\frac{3}{4}"$ T.C.P, $\frac{3}{4}"$ BOT.
 $3\frac{1}{2}"$ SLAB

TOTAL LOADING —

= ROOF =

USE: 3 1/2" SLAB

8" x 13" TEE BEAMS

12" x 12" COLUMNS

K = 32 for 24'-0" TEE BEAMS

K = 85 for 12'-0" TEE BEAMS

K = 14 for 12" x 12" COL.

LOADING PER LINEAL FT. OF TEE BEAM (ROOF)

$$3\frac{1}{2}" \text{ SLAB} = 50 \text{ psf} \cdot 12 = 600 \text{ plf}$$

$$\text{T BEAM} = \frac{6.15}{144} \cdot 150 = \frac{150}{750 \text{ plf. SAY } .85 \text{ k/ft}}$$

$$\text{LL} = 30 \text{ psf} \cdot 12 = \frac{360}{1110 \text{ plf, } \frac{.35 \text{ k/ft}}{1.20 \text{ k/ft}}}$$

$$\text{ROOF OVERHANG} = \frac{4}{12} \cdot 12 \cdot 150 = 600 \text{ plf, SAY } .65 \text{ k/ft}$$

$$\text{LL} = 30 \cdot 12 = \frac{360}{960 \text{ plf } \frac{.35 \text{ k/ft}}{1.00 \text{ k/ft}}}$$

= FLOOR =

USE: 5" SLAB

12" x 24" TEE BEAMS

12" x 18" COLUMNS

K = 110 for 24'-0" TEE BEAMS

K = 220 for 12'-0" TEE BEAMS

K = 49 for 12" x 18" COLUMN

TOTAL LOADING

LOADING PER LINEAL FT. OF TEE BEAM (FLOOR)

$$5" \text{ SLAB} = 63 \text{ psf} \cdot 12 = 755 \text{ plf}$$

$$\text{T BEAM} = \frac{19.12}{144} \cdot 150 = \underline{240}$$

395 plf, SAY 1.0K/ft

$$\text{LL + WALL LOAD} = 100 \text{ psf} \cdot 12 = 1200 \text{ plf} = 1.2 \text{K/ft}$$

FIXED END & MIDSPAN MOVEMENTS:

ROOM

	TEE BEAMS					
	END	TL	DL	MIDSPAN	TL	DL
LL = .35K/ft DL = .85K/ft 12'-0"	$\frac{1}{2} w L^2$	-15	-10	$\frac{1}{24} w L^2$	+9	+5
24'-0"	$\frac{1}{2} w L^2$	-58	-41	$\frac{1}{24} w L^2$	+20	+12
LL = .35K/ft DL = .85	OVERHANG					
END	TL	DL				
6'-0"	$\frac{1}{2} w L^2$	-22	-2			

FLOOR

	TEE BEAMS					
	END	TL	DL	MIDSPAN	TL	DL
LL = 1.2K/ft DL = 1.0K/ft 12'-0"	$\frac{1}{2} w L^2$	-106	-48	$\frac{1}{24} w L^2$	+53	+24
24'-0"	$\frac{1}{2} w L^2$	-27	-12	$\frac{1}{24} w L^2$	+14	+6

MOMENT & SHEAR ANALYSIS

- PENT #1 -

	0	32	65	32	0	
	14	110	14	220	14	110
	49	110	49	220	49	110
	49		49		49	
	A	B	C	D		

ROOF
 3RD
 2ND
 1ST

WIND FORCE = 20 PSF

AT 1ST FLOOR: $20 \cdot 12 \cdot 36 = 8.65^k$

" 2ND " : $20 \cdot 12 \cdot 24 = 5.75^k$

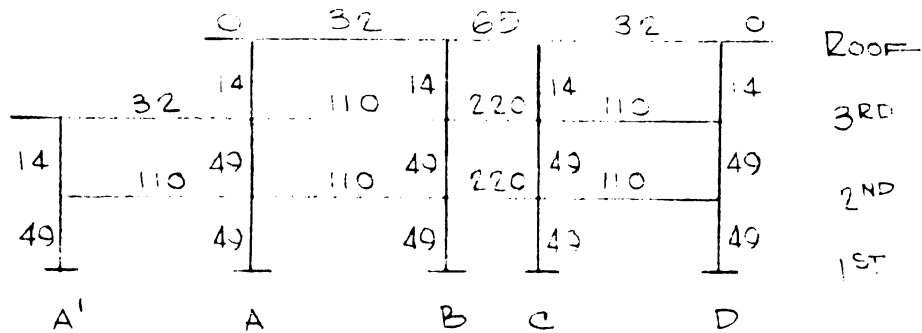
" 3RD " : $20 \cdot 12 \cdot 12 = 2.90^k$

COL	K ^{BEAMS} K ^{ALL}	C ^{BEAMS} C ^{ALL}	COLUMN ABOVE		SUM OF COL MOM ABOVE + C ^{BEAM}	BEAMS AB & CD		BEAM BC		C ^{BEAM}
			FOR SHEAR	MOM		MOM	SHEAR	MOM	SHEAR	
R-A										
R-D			No COL. ABOVE		$\frac{3.7}{2} = 1.9$	$\frac{3.7}{4} = .9$	1.3	0		
R-B			"		$\frac{5.0}{2} = 2.5$	$\frac{3.7}{11} = .34$	7	15	.3	$\frac{6.5}{11} = .59$
R-C			"							
3-A	14	$\frac{110}{173}$	8.9	$\frac{8.9}{41.4} = .22$	$\frac{12}{2} = 6$	3.7	$\frac{3.7 + 3.6}{1.3} = 7.3$	4.7	0	
3-B	14	$\frac{330}{393}$	11.8	$\frac{11.8}{4.4} = 2.7$	5.3	"	5.0	$\frac{5 + 5}{10} = 1.0$	2.8	.3
3-C									5.6	.9
2-A	49	$\frac{110}{208}$	26.0	$\frac{26}{128} = .21$	1.2	$\frac{12}{2} = 6$	7.2	$\frac{7.2 + 6.3}{1.3} = 13.5$	5.3	7.3
2-D										0
2-B	49	$\frac{330}{428}$	38.0	$\frac{38}{128} = .30$	1.7	"	10.0	$\frac{10 + 6.3}{6.2} = 2.6$	4.3	5
2-C									5.5	1.4
1-A	49									
1-B	49									
1-C	49									
1-D	49									

— WIND LOADINGS —

MOMENT & SHEAR ANALYSIS

= BENT #2 =



SAME LOADINGS AS BENT #1

J_c N_T				$K \frac{K_{BEAMS}}{K_{ALL}} = C$	$\frac{C}{C_{ALL}}$ FORCE	COLUMN ABOVE	SHEAR	M-M ARM	MOM	SUM OF COLUMN ABOVE C BEAM $\frac{1}{2}$ BEAM	LT END MOM	LT END SHEAR	RT END MOM	RT END SHEAR	C BEAMS
Roof															
SAME AS BENT #1															
3-A'	←			No COL	ABOVE	→	$\frac{24}{2} = 12$	$\frac{32}{48} = .7$	0		8				
3-A		14	$\frac{142}{205}$	9.7	$\frac{27}{422}$	28	.7	$1\frac{1}{2}$	4.2	$42+39 = \frac{81}{305} = .26$	1.3	4.4			$\frac{110}{205} = .54$
3-B				11.8	$\frac{11.2}{422}$	29	.8	"	4.8	$48+45 = \frac{93}{393} = .24$	2.6	5.2	.3		$\frac{220}{393} = .56$
3-C				11.5	$\frac{11.8}{422}$	29	.8	"	4.8	$48+45 = \frac{93}{393} = .24$	5.2	2.6	.9		$\frac{110}{393} = .28$
3-D				8.9	$\frac{8.9}{422}$	29	.6	"	3.6	$3.6+30 = \frac{66}{73} = .9$	4.2	0	.3		
2-A'		3-D		8.9	$\frac{8.9}{1447}$	575	.4	$1\frac{1}{2}$	2.4	$24+51 = \frac{75}{173} = .43$	0	4.8			
2-A		49	$\frac{220}{318}$	33.8	$\frac{33.8}{447}$	575	1.3	"	7.8	$7.8+51 = \frac{58.8}{318} = .18$	4.5	4.5	.4		$\frac{110}{318} = .35$
2-B				38.0	$\frac{38}{1447}$	575	1.5	"	9.0	$9.0+51 = \frac{60}{428} = .14$	2.7	7.2	.3		$\frac{220}{428} = .51$
2-C				38.0	"		1.5	"	9.0	"	7.2	3.7	1.2		$\frac{110}{428} = .26$
2-D				26.0	$\frac{26}{447}$	575	1.0	"	6.0	$6+51 = \frac{57}{111} = .51$	5.6	0	1.4		
1-A THRU D				1	$\frac{1}{5}$	365	.7	$1\frac{1}{2}$	10.2						NO BEAMS

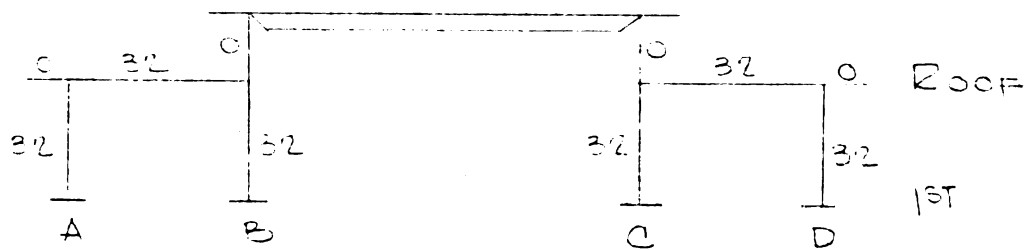
— WIND LOADING —

— MOMENT & SHEAR ANALYSIS —

- BENT #3 -

BENT #3 FRAMES INTO A ROW OF 14 COLUMNS, AND AS ANY WIND LOADING MUST BE DISTRIBUTED TO THESE IN ADDITION TO THE THREE IN THE BENT THE EFFECT OF SUCH LOADING MAY BE NEGLECTED.

- BENT #4 -



$$A_{\text{Roof}}: 8 \cdot 12 \cdot 20 = 1.92^k$$

$$A_{\text{1ST FLOOR}}: 20 \cdot 12 \cdot 20 = 5.75^k$$

JOINT	CALC	COLUMNS			CALC	BEAM	
		SHEAR	MOM ARM	MOM		MOM	SHEAR
R-B&C	$\frac{1}{2} 1.92$	.96	$\frac{8}{2}$	3.84	HINGED	0	0
1-A&E/D	$\frac{1}{4} 5.75$	1.44	$\frac{12}{2}$	13.0	$\frac{12}{2}$	6.5	.5

— NON RIGID FRAME —

$$A_{\text{1ST FLOOR}}: 24 \cdot 12 \cdot 20 = 5.75$$

$$\text{COL SHEAR} = \frac{5.75}{2} = 2.88^k$$

$$\text{COL MOM.} = 2.88 \cdot 12 = 27.4^k$$

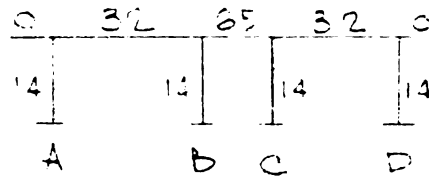
— BENT #1 —
— MOMENT & SHEAR ANALYSIS —

= ROOF SPANS =

JOINTS A & D

$$\frac{14}{46} = .30$$

$$\frac{32}{46} = .70$$



JOINTS B & C

$$\frac{14}{111} = .13$$

$$\frac{32}{111} = .29$$

$$\frac{65}{111} = .58$$

	A			B				C			D
COL MOM	0									0	
COL COEF.	0									0	
BEAM COEF	.70			.29	.58			.58	.29		.70
FEM DL	-12			-41	-10			-10	-41		-12
FEM TL	-58	+29	-58	-15	+7	-15	-58	+29	-58		
	-7	+6	-16	+8	-6	+8	-16	+6	-7		
	-65	+10	-74	-7	-6	-7	-74	+10	-65		
	+46		+19	-39		-39	+19		+46		
MAX BEAM MOM	-19	+45	-55	-46	-5	-46	-55	-45	-19		
COL COEF	.30									.30	
COL MOM	19									19	
COL MOM				0				0			
COL COEF		TL		0		DL		0		TL	
FEM TL or DL	-22			-58	-10	+5	-10	-58		-58	-22
	-7			-13	+14	-11	+14	-13		-7	
				-71	+4	-11	+4	-71			
				+22	-44		-44	+22			
MIN BEAM MOM				-49	-40	-17	-40	-40			
COL COEF				.13				.13			
COL MOM				0				0			

BENT #1
MOMENT & SHEAR ANALYSIS

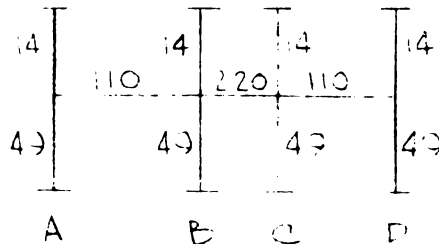
THIRD FLOOR SPAN =

JOINTS A & D

$$\frac{14}{173} = .08$$

$$\frac{49}{173} = .28$$

$$\frac{110}{173} = .64$$



JOINTS B & C

$$\frac{14}{173} = .04$$

$$\frac{42}{173} = .24$$

$$\frac{110}{173} = .64$$

$$\frac{220}{173} = .56$$

	A		B		C		D
COL MOM	8						8
COL COEF	.08						.08
BEAM COEF	.64		.28	.56	.56	.28	.64
FEM, DL			-48	-12	-12	-48	
FEM, TL	-106	+53	-106	-27	+14	-27	-106
	-13	+11	-34	+6	+5	+6	-34
	-119	+22	-140	-21	-5	-21	-140
	+76		+33	-67		-67	+33
MAX BEAM MOM	-43	+86	-107	-83	+4	-88	-107
COL COEF	.28						.28
COL MOM	33						33
COL MOM			8		8		
COL COEF		TL	.04	DL	.04	TL	
FEM, TL OR DL	-106		-106	-12	+6	-12	-106
			-34	+23	-20	+23	-34
			-140	+14	-20	+14	-140
				-71		-71	
MIN BEAM MOM			-57	-34	-57		
COL COEF			.12		.12		
COL MOM			15		15		

BENT #1

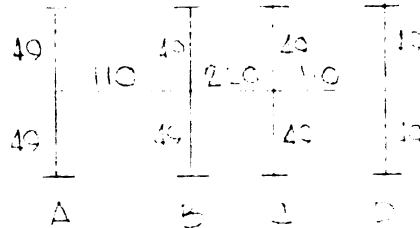
MOMENT & SHEAR ANALYSIS

SECOND FLOOR SPAN

JOINTS A & D

$$\frac{49}{208} = .24$$

$$\frac{110}{208} = .53$$



JOINTS B & C

$$\frac{49}{428} = .11$$

$$\frac{110}{428} = .26$$

$$\frac{220}{428} = .51$$

	A		B		C		D
COL MOM	28						28
COL COEF	.24						.24
BEAM COEF	.53		.26	.51		.51	.26
FEM, DL			-48	-12		-1	
FEM, TL	-106	+53	-106	-27	+14	-27	-106
	-12	+9	-28	+5	-4	+5	-28
	-118	+12	-134	-22	-4	-22	-134
	+63		+29	-57		-57	+29
MAX BEAM MOM	-55	+80	-105	-79	+8	-79	-105
COL COEF	.24						.24
COL MOM	28						28
COL MOM							
COL COEF							
FEM, TL OR DL	-106		-106	-12	+8	-12	-106
			-28	+24	-18	+24	-28
			-134	-12	-18	+12	-134
				-75		-75	
MIN BEAM MOM				-51	-30	-51	
COL COEF			.11			.11	
COL MOM			16			16	

--- 2ND FLOOR ---

--- TABULATION OF SHEAR DATA ---

2ND FLOOR BEAMS

	14'-0" A-B & C-D			12'-0" B-C	
	CALC	LT END	R. END	CALC	LT & R. END
SIMPLE FIXED END SHEAR	$\frac{24 \cdot 12}{2} =$	14.4	14.4	$\frac{12 \cdot 12}{2} =$	7.2
FIXED END CORRECTIONS	$\frac{55-19}{24} =$	-1.5	+1.5	$\frac{46-40}{12} =$	+1.5
WIND SHEAR		+1	+1		+1.3
SHEAR AT C. OF COL	SUM	13.0	16.0	SUM	8.0
SHEAR AT COL FACE	$\frac{10}{12.5} \times 13 =$ $\frac{13.75 \times 12}{12} =$	12.1	15.1	$\frac{5.25}{6} \times 8 =$	7.0

3RD FLOOR BEAMS

SIMPLE FIXED END SHEAR	$\frac{24 \cdot 2.2}{2} =$	26.4	26.4	$\frac{12 \cdot 2.2}{2} =$	13.2
FIXED END CORRECTIONS	$\frac{107-43}{24} =$	-2.7	+2.7	$\frac{56-71}{12} =$	+1.4
WIND SHEAR		+1.3	+1.3		+1.9
SHEAR AT C. OF COL	SUM	24.0	29.4	SUM	15.5
SHEAR AT COL FACE	$\frac{0.05 \times 24}{10.5} \times 24 =$ $\frac{10.5 \times 24}{10.5} =$	22.4	27.8	$\frac{4.65}{5.4} \times 5.5 =$	13.7

2ND FLOOR BEAMS

SIMPLE FIXED END SHEAR	$\frac{24 \cdot 2.2}{2} =$	26.4	26.4	$\frac{12 \cdot 2.2}{2} =$	13.2
FIXED END CORRECTIONS	$\frac{105-55}{24} =$	-2.1	+2.1	$\frac{79-51}{12} =$	+2.3
WIND SHEAR		+1.5	+1.5		+1.4
SHEAR AT C. OF COL	SUM	24.5	29.0	SUM	16.9
SHEAR AT COL FACE	$\frac{10.3 \times 24.8}{11.05 \times 29.0} =$	23.1	27.3	$\frac{4.3 \times 16.9}{5.65} =$	15.1

— BENT #1 —

— TABULATION OF MOMENT DATA —

○ ROOF BEAMS ○

24'-0" A-B & C-D				12'-0" B-C		
ENDS	LT	MID	RT	LT & RT	MID	MIDSPAN
MAX MOM	-19	+45	-55	-46	-17	MAX(±) MOM
WIND MOM	-1.3	—	-.7	-1.5	—	—
SUM	-20.3	—	-55.7	-47.5	—	—
$\frac{1}{3}V_a = V \frac{1.5}{3}$	+6.1	-3.4	+7.6	+3.5	+1.8	$\frac{1}{6}V_a = V_{AVER} \frac{1.5}{6}$
DESIGN MOM	-14.2	+41.6	-48.1	-44.0	-17	DESIGN MOM

3RD FLOOR BEAMS

MAX MOM	-43	+86	-107	-88	+4 / -34	MAX(±) MOM
WIND MOM	-4.7	—	-2.8	-5.6	—	—
SUM	-47.7	—	-109.8	-93.6	—	—
$\frac{1}{3}V_a$	+11.2	-6.3	+13.7	+6.9	-3.1 / 0	$\frac{1}{6}V_a$
DESIGN MOM	-36.5	+79.7	-95.9	-86.7	+9 / -34	DESIGN MOM

2ND FLOOR BEAMS

MAX MOM	-55	+80	-105	-79	+6 / -30	MAX(±) MOM
WIND MOM	-7.3	—	-4.3	-8.5	—	—
SUM	-62.3	—	-109.3	-87.5	—	—
$\frac{1}{3}V_a$	+11.6	-6.3	+13.7	+7.6	-3.2 / 0	$\frac{1}{6}V_a$
DESIGN MOM	-50.7	+73.7	-95.6	-79.9	+2.8 / -30	DESIGN MOM

BENT #1

TABULATION OF COLUMN DATA

COL STACK	A & D			B & C	
LEVEL R-3	3-2	2-	2-3	3-2	2-1
SIZE 12"x12"	12"x18"	12"x15"	12"x12"	12"x13"	12"x18"
MAX MOM 19	33	28	10	19	16
WIND MOM 1.9	3.7	7.2	2.5	5.0	10.0
DESIGN MOM 20.9 ^K	36.7	35.2	12.5	24.0	26.0
AXIAL LOAD 14.5 ^K	41.5 ^K	69.0	25.3	90.6	114.6
WIND SHEAR 6	1.2	2.2	.8	1.7	2.2

--- BENT #2 ---

--- MOMENT & SHEAR ANALYSIS ---

o ROOF SPAN o

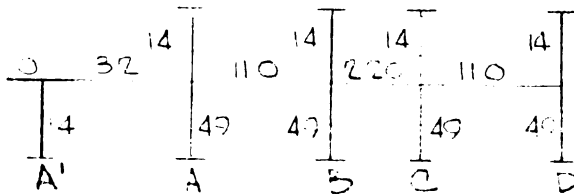
ROOF SPAN IDENTICAL TO BENT #1

o THIRD FLOOR SPAN o

JOINT A

$$\frac{14}{46} = .30$$

$$\frac{32}{46} = .70$$



JOINT A

$$\frac{14}{205} = .06$$

$$\frac{32}{205} = .16$$

$$\frac{42}{205} = .24$$

$$\frac{25}{205} = .12$$

JOINTS B, C & D
SAME AS BENT #1

	A'			A			B			C			D
COL MOM	0												10
COL COEF	0												.08
BEAM COEF	70			.16	.54		.28	.56		.56	.28		.64
FEM DL 1-12				-41	-43		-43	-12		-12	-48		
FEM, TL	-58	+29		-52	-106	+53	-106	-27	+14	-27	-106	+53	-106
	-1	0		-16	-13	+10	-18	+6	-5	+6	-34	+11	-13
	-59	+9		-74	-119	+12	-124	-2	-5	-21	-140	+22	-119
	+41			-9	+24		+29	-55		-67	+33		+76
MAX BEAM MOM	-18	+32		-81	-95	+75	-95	-77	+4	-83	-107	+86	-43
COL COEF	.30												.25
COL MOM	18												33

COL MOM	8				5				6			
COL COEF	.08				.04				.04			
FEM, TL or DL-22	-41	+21	-41	-106	-106	-12	+6	-12	-106			-106
	+5	-4	-7	-13	-18	+3	-2	+13	-34			-13
	-36	-4	-45	-119	-124	-9	-10	+1	-140			-119
	+25		-11	+38	+32	-35		-78	+39			+76
MIN BEAM MOM	-11	+13	-59	31	-92	-74	-8	-77	-101			-43
COL COEF			.24			.12			.12			
COL MOM			34			14			17			

BENT #2

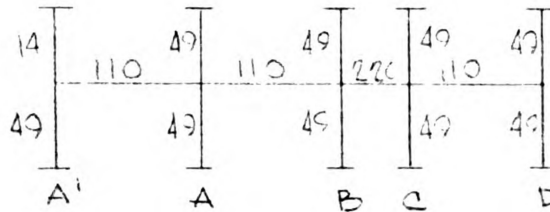
MOMENT & SHEAR ANALYSIS

= SECOND FLOOR SPAN =

JOINT A

$$\frac{49}{318} = .15$$

$$\frac{110}{318} = .35$$



JOINTS A', B, C, D
SAME AS BENT #1

	A'		A		B		C		D			
COL MOM	9								28			
COL COEF	.08								.24			
BEAM COEF	.64		.35	.35		.26	.51		.53			
FEM, DL			-48	-48		-48	-12		-48			
FEM, LL	-106	+53	-106	-106	+53	-106	-27	+14	-27	-106	+53	-106
	-10	+23	-34	-13	+9	-10	+5	-4	+5	-28	+9	-12
	-116	+8	-140	-119	+6	-116	-22	-4	-22	-134	+18	-118
	+74		+7	-7		+24	-48		-57	+29		+63
MAX BEAM MOM	-42	+84	-133	-126	+68	-92	-70	+6	-79	-105	+80	-55
COL COEF	.28											.24
COL MOM	32											28
COL MOM			8			11			16			
COL COEF			.15			.11			.11			
FEM, L or DL	-48	+24	-48	-106		-106	-12	+6	-12	-106		-106
	+10	-8	-15	-12		-10	+24	-18	+24	-28		
	-38	+10	-63	-118		-116	+12	-18	+12	-134		
	+24		-19	+19		+27	-53		-74	+37		
MIN BEAM MOM	-14	+26	-82	-99		-89	-41	-30	-62	-97		
COL COEF			.15			.11			.11			
COL MOM			8			11			16			

BENT #2

TABULATION OF SHEAR DATA

0 ROOF BEAMS 0

	24'-0" A-A	12'-0" B-C	24'-0" A-B & C-D
	CALC	CALC	CALC
SIMPLE FIXED			
END SHEAR	$\frac{24 \cdot 1.2}{2} =$		
FIXED END			
CORRECTIONS	$\frac{81-15}{24} =$		
WIND SHEAR			
SHEAR AT			
¢ OF COL	SUM		
SHEAR AT	$\frac{21}{955} \cdot 11.9 =$		
COL FACE	$\frac{11.9}{17.1} =$		

1ST FLOOR BEAMS

	24'-0" A-B	B-C	C-D
SIMPLE FIXED			
END SHEAR	$\frac{24 \cdot 2.2}{2} =$		
FIXED END			
CORRECTIONS	$\frac{95-95}{24} =$		
WIND SHEAR			
SHEAR AT			
¢ OF COL	SUM		
SHEAR AT	$\frac{11.25}{12.3} \cdot 26.7 =$		
COL FACE			

2ND FLOOR BEAMS

	24'-0" A-A	24'-0" A-B	B-C	C-D
SIMPLE FIXED				
END SHEAR	$\frac{24 \cdot 2.2}{2} =$			
FIXED END				
CORRECTIONS	$\frac{133-42}{24} =$			
WIND SHEAR				
SHEAR AT				
¢ OF COL	SUM			
SHEAR AT	$\frac{9.55}{103} \cdot 23.0 =$			
COL FACE	$\frac{23.0}{30.6} =$			

BENT #2

TABULATION OF MOMENT DATA

ROOF BEAMS

ENDS	21'-0" A'-A			12'-0" B-C		24'-0" A-B & C-D			MIDSPAN
	LT	MID	RT	LT & RT	MID	LT	MID	RT	
MAX MOM	-13	+33	-31						MAX (±) MOM
WIND MOM	-8	—	-13	SAME AS BENT #1		SAME AS BENT #1			—
SUM	-183	—	-823						—
$\frac{1}{2} V_L = \frac{V_L}{2}$	+55	-34	+51						$\frac{1}{2} V_L = \frac{V_L}{2}$
DESIGN MOM	-133	+346	-742						DESIGN MOM

THIRD FLOOR BEAMS

	A-B			B-C		C-D			
MAX MOM	-95	+95	-95						MAX (±) MOM
WIND MOM	-44	—	-26	SAME AS BENT #1		SAME AS BENT #1			—
SUM	-394	—	-376						—
$\frac{1}{2} V_L$	+123	-63	+125						$\frac{1}{2} V_L$
DESIGN MOM	-86	+627	-851						DESIGN MOM

SECOND FLOOR BEAMS

	A'-A			B-C & C-D		A-B			
MAX MOM	-42	+84	-123			-126	+88	-92	MAX (±) MOM
WIND MOM	-48	—	-45	SAME AS BENT #1		-45	—	-37	—
SUM	-432	—	-135			-1305	—	-957	—
$\frac{1}{2} V_L$	+107	-63	+145			+131	-63	+117	$\frac{1}{2} V_L$
DESIGN MOM	-32	+777	-1230			-1174	+817	-840	DESIGN MOM

--- BENT #2 ---

--- TABULATION OF DATA ---

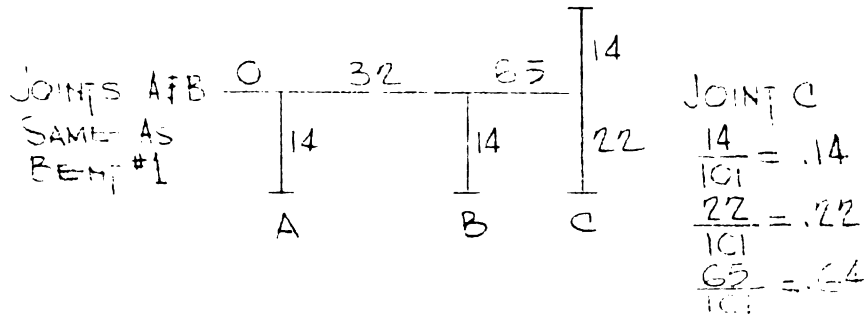
= COLUMNS =

STACK	A'		A			B & C			D		
SIZE	12x12	12x18	12x12	12x18	12x18	12x12	12x18	12x18	12x12	12x18	12x18
MAX MOM	18	32	19	34	3	19	17	16	19	33	28
WIND MOM	1.2	2.4	4.2	7.8	10.2	4.8	9.0	10.2	3.6	6.0	10.2
DESIGN MOM	19.2	34.4	23.2	41.8	18.2	23.8	26.0	26.2	22.6	39.0	35.2
AXIAL LOAD	13.7	25.7	14.8	31.3	122.7	25.8	63.1	112.9	14.5	46.9	75.3
WIND SHEAR	.4	1.7	.7	1.3	1.7	.8	1.5	1.7	.6	1.0	1.7
LEVEL	2-2	2-1	2-3	2-2	2-1	2-3	2-2	2-1	2-3	2-2	2-1

BENT #3

MOMENT & SHEAR ANALYSIS

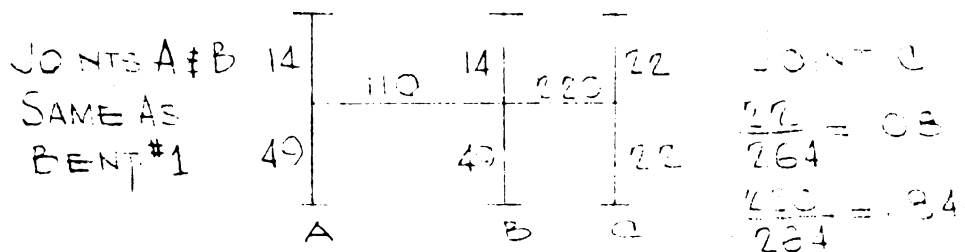
o ROOF SPAN o



	A			B			C
COL MOM	0						1
COL COEF	0						.14
BEAM COEF	.70		.29	.58			.64
FEM, DL 1-12			-41	-10			
FEM, TL	-58	+29	-58	-15	+7	-15	
	-7	+6	-16	-5	+4	+8	
	-65	+10	-74	-20	-7	-7	
	+45		+16	-31		+4	
MAX BEAM MOM	-20	+45	-53	-51	+4	-3	
COL COEF	30						.22
COL MOM	20						2
COL MOM				0			
COL COEF				0			
FEM, TL CRDL	-22	-58	+29	-58	-10	+5	-10
				-13	-3	+2	+14
				-91	-13	-12	+4
				+17	-34		-3
MIN BEAM MOM				-54	-47	-5	+1
COL COEF				.13			
COL MOM				7			

BENT #3
MOMENT & SHEAR ANALYSIS

○ 2ND FLOOR SPANS ○



A			B			C		
CCL MOM	10							1
COL COEF	.08							.08
BEAM COEF	.64			.28	.56			.84
FEM, DL				-48	-12			
FEM, TL	-106	+53		106	-27	+14		-27
	-13	+11		-34	-11	+9		+6
	-119	+22		-143	-33	-6		-21
	+76			+29	-51			+18
MAX BEAM MOM	-43	+86		-111	-95	+17		-3
COL COEF	.28							.08
COL MOM	33							2

CCL MOM			4		
COL COEF		TL	.04		DL
FEM, TL & DL	-106	+53	-106	-12	+6
			-34	-5	+4
			-143	-33	-6
			+34	-62	+12
MIN BEAM MOM				-83	-14
COL COEF				.12	
COL MOM				12	

BENT #3

TABULATION OF SHEAR DATA

- ROOF BEAMS -

	CALC	24'-0" A-B		CALC	12'-0" B-C	
		LT	RT		LT	RT
SIMPLE-FIXED END SHEAR	$\frac{24 \cdot 1.2}{2} =$	14.4	14.4	$\frac{12 \cdot 1.2}{2} =$	7.2	7.2
FIXED END CORRECTION	$\frac{58-20}{24} =$	-1.7	+1.7	$\frac{54-3}{12} =$	+4.3	-4.3
WIND SHEAR	—	0	0	—	0	0
SHEAR AT C OF COL	SUM	12.7	16.1	SUM	11.5	2.9
SHEAR AT COL FACE	$\frac{9.85}{10.6} \times \frac{12.7}{16.1} =$	11.8	15.2	$\frac{8.85}{9.60} \times \frac{11.5}{2.9} =$	10.6	2.0

2ND FLOOR BEAMS

SIMPLE-FIXED END SHEAR	$\frac{24 \cdot 2.2}{2} =$	26.4	26.4	$\frac{12 \cdot 2.2}{2} =$	13.2	13.2
FIXED END CORRECTION	$\frac{111-43}{24} =$	-2.8	+2.8	$\frac{3-95}{12} =$	+7.7	-7.7
WIND SHEAR	—	0	0	—	0	0
SHEAR AT C OF COL	SUM	23.6	29.2	SUM	20.9	5.5
SHEAR AT COL FACE	$\frac{10.0}{10.75} \times \frac{23.6}{29.2} =$	21.9	27.5	$\frac{8.75}{9.5} \times \frac{20.9}{5.5} =$	19.3	3.9

BENT #3

TABULATION OF MOMENT DATA

ROOF BEAMS

ENDS	24'-0" A-B			12'-0" B-C			MIDSPAN
	LT	MID	RT	LT	MID	RT	
MAX(-) MOM	-20	+48	-58	-51	+4 -5	-3	MAX(±) MOM
WIND MOM	0	—	0	0	—	0	—
SUM	-20	—	-58	-51	—	-3	—
$\frac{1}{3}V_L = V \frac{15}{3}$	+5.9	-3.4	+7.6	+5.3	-1.6 0	+1.0	$\frac{1}{6}V_L = V_{AVER} \frac{12}{6}$
DESIGN MOM	-14.1	+44.6	-50.4	-45.7	+2.4 -5	-20	DESIGN MOM

2ND FLOOR BEAMS

MAX(-) MOM	-43	+86	-111	-95	+17 -14	-3	MAX(±) MOM
WIND MOM	0	—	0	0	—	0	—
SUM	-43	—	-111	-95	—	-3	—
$\frac{1}{3}V_L = V \frac{15}{3}$	+11.0	-6.3	+13.8	+9.7	-2.9 0	+2.0	$\frac{1}{6}V_L$
DESIGN MOM	-32.0	+79.7	-97.2	-85.3	+14.1 -14	-1.0	DESIGN MOM

BENT #3

TABULATION OF DATA

○ COLUMNS ○

STACK	A		B		C	
LEVEL	R-2	2-1	R-2	2-1	R-2	2-1
SIZE	12x12	12x18	12x12	12x18	12x18	12x18
MAX MOM	20	33	7	12	2	2
WIND MOM	0	0	0	0	0	0
DESIGN MOM	20	33	7	12	2	2
AXIAL LOAD	14.5	40.9	29.4	82.2	5.6	13.8
WIND SHEAR	0	0	0	0	0	0

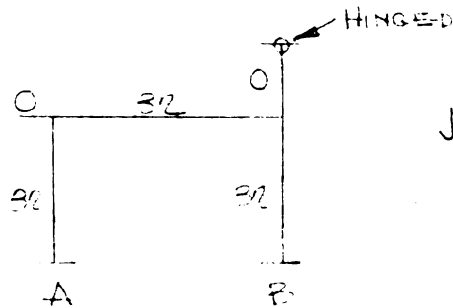
BENT #4

MOMENT & SHEAR ANALYSIS

- ROOF SLAB -

JOINT A

$$\frac{32}{64} = .5$$



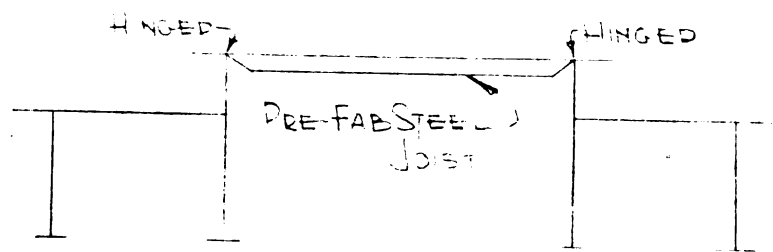
JOINT K-2

$$\frac{22}{88} = .25$$

$$\frac{32}{88} = .36$$

COL MOM	0		0
COL QEFF	0		0
BEAM QEFF	.5		.5
FEM, D-	-12		
FEM, L-	-58	+29	-58
	-14	+11	-12
	-72	+9	-40
	+33		+55
MAX BEAM MOM	-58	+49	-58
COL QEFF	.5		.5
COL MOM	33		35
COL MOM	0		0
COL QEFF	0	D-	0
FEM, L-D-	-2	-1	-41
	-10	+3	-5
	-51	+4	-46
	+25		+23
MIN BEAM MOM	-26	+33	-23
COL QEFF	.5		.5
COL MOM	25		23

— BENT #4 —
— MOMENT & SHEAR ANALYSIS —
 ◁ ROOF-SPAN ▷



USE PRE-FABRICATED ROOF-TRUSS SUCH AS "TRUSSCON CLEARSPAN ROOF JOIST" WITH "TRUSSCON STEEL-DECK ROOF".

ROOF DECK: SPAN = 6'-0"

DL: DECK-INSULATION + FLOORING = 5 psf · 6 = 30 pif

LL:

30 psf · 6 = 180

210 pif

ROOF-JOISTS: 45'-0" SPAN, 6'-0" OVERHANG
 6'-0" 2/2

TYPE "24G" SAFE-LOADING = 222 pif

WT.

= 19 pif

WT OF JOIST = 60 · 19 = 1140 #

ROOF-LOADING = 60 · 210 = 12600 #

13740 #, SAY 14,000 #

COL LOAD:

2 JOISTS = 14,000 · 1/2 · 2 = 14K

6"X12"X12' BEAM = 1/2 · 12 · 150 = 9K

14.9K, SAY 15K

BENT #4

TABULATION OF DATA

SHEAR

SIMPLE FIXED END SHEAR	FIXED END CORRECTION	WIND SHEAR	SHEAR @ COL		SHEAR COLFACE		CALC
			LT	RT	LT	RT	
14.4	$\frac{36-23}{24} = +.5$	+5	14.4	15.4	13.5	14.5	$\frac{10.5}{11.25} \times 14.4 = 15.4 =$

MOMENTS

MAX (-) MOM		WIND MOM		SUM		$\frac{1}{3}V_a$		DESIGN (-) MOM		MAX (+) MOM	$\frac{1}{6}V_a$	DESIGN (+) MOM
LT	RT	LT	RT	LT	RT	LT	RT	LT	RT	MOM		MOM
-36	-35	-6.5	-6.5	-42.5	-41.5	+6.5	+7.4	-36	-34.1	+49	-3.5	+45.5

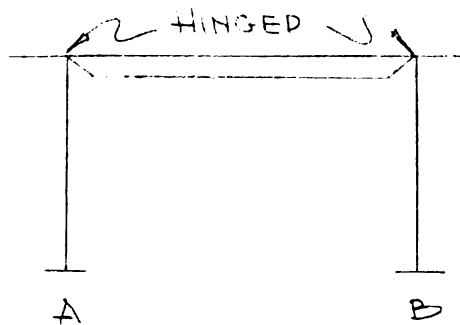
COLUMNS

COL	SIZE	MAX MOM	WIND MOM	SUM	AXIAL LOAD	COL SHEAR
A&D	12x18	36	13.0	49.0	23.4	1.44 ^K
B&C	12x12	0	3.8	3.8	16.2	.96
B&C	12x18	35	13.0	48.0	48.1	1.44

NON RIGID FRAME

TABULATION OF DATA

USE SAME PRE-FABRICATED STEEL JOISTS AS FOR BENT #4.



COL. LOAD:

$$2 \text{ JOISTS} = 14 \cdot \frac{1}{2} \cdot 12 = 14^k$$

$$6" \times 12' \times 12' \text{ BEAM} = \frac{1}{2} \cdot 12 \cdot 150 = .9$$

$$W_T \text{ COL} = \frac{1}{2} \times 24 \times 150 = \frac{5.25}{20.15}, \text{ SAY } 20.2^k$$

~ COLUMNS ~

COL	SIZE	MAX MOM	WIND MOM	SUM	AXIAL LOAD	COL SHEAR
A & B	12x18	0	27.4	27.4	20.2	1.88

— ROOF BEAM DESIGN —

— COMPILATION OF DATA — MOMENT & SHEAR, ALL BENTS

BENT	24'-0"							12'-0"						
	BEAM	NO.	MOMENT			SHEAR		BEAM	NO.	MOMENT			SHEAR	
			-	+	-					-	+	-		
1	A-B	23						B-C	23	44.0	-17	44.0	7.0	7.0
	C-D	23	14.2	41.6	48.1	12.1	15.1							
2	A-B	3						B-C	3	44.0	-17	44.0	7.0	7.0
	C-D	3	14.2	41.6	48.1	12.1	15.1							
2	A'-A	3	13.3	34.6	74.2	11.0	16.2							
3	A-B	3	14.1	44.6	50.4	11.8	15.2	B-C	3	45.7	+2.4 -50	2.0	10.6	2.0
4	A-B	9												
	C-D	9	36.0	45.5	34.1	13.5	14.5							

ROOF BEAM DESIGN

EFFECTIVE DEPTH:

$$d = \frac{35}{b_j v} = \frac{16200}{8 \cdot 300 \cdot 150} = 15.6"$$

$$h = 15.6 + 1.5 + 1.5 + 2.5 = 21.1" \quad \text{TRY } 18"$$

$$d = 18 - 2.25 = 15.75" \quad (\text{1 ROW STEEL, POS MOM})$$

$$d = 18 - 3\frac{1}{8} - 3\frac{1}{2} - \frac{1}{2} - 1 = 15" \quad (\text{2 ROWS STEEL, NEG MOM})$$

$$d = 18 - 3\frac{1}{8} - 3\frac{1}{8} - 3\frac{1}{8} = 16.5" \quad (\text{1 ROW STEEL, NEG MOM})$$

WIDTH OF TIE, MAX

24'-0" SPAN

$$\frac{1}{4} \cdot 24 \cdot 12 = 72"$$

$$8 + 16 \cdot 3\frac{1}{2} = 61"$$

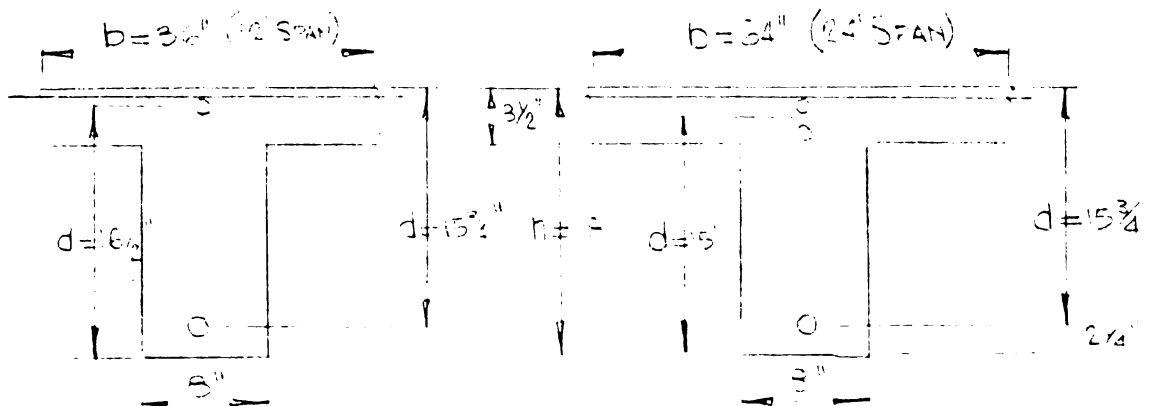
$$12 \times 12 = 144"$$

$$\text{MAX } b = 64"$$

12'-0" SPAN

$$\frac{1}{4} \cdot 12 \cdot 12 = 36"$$

$$\text{MAX } b = 36"$$



STEEL AREA

24'-0" ROOF SPAN

	K	F	KE	M	M-KF	$M_{max} = \frac{W L^2}{8}$	$A_s = \frac{M}{f_y}$	V	$\Sigma O = \frac{S}{7.48}$
MID-SPAN	155	155	152	310	-	0	145		
+ $\frac{1}{4}$ SPAN				340	-	0	145		
				440	-	0	157		
				455	-	0	157		
END	196	160	152	142	-	0	60	12.1	6.7
				133	-	0	58	11.0	6.1
				141	-	0	60	11.8	6.4
END	196	155	152	366	155	0	167	13.5	8.0
				421	157	2.26	2.22	15.1	9.2
				742	140	5.42	3.43	16.0	9.0
				504	210	2.54	2.33		
				340	211	.59	1.58	4.5	

$$\frac{T}{C} = \frac{T}{C} \quad \frac{T}{C} = \frac{343}{542} \quad 2 \quad A-A$$

$$\frac{62}{C} = \frac{222}{226} \quad \frac{222}{226} \quad 1 \quad A-B$$

$$\frac{1.75}{C} = \frac{222}{226} \quad \frac{222}{226} \quad 1 \quad A-B$$

STEEL AREA

12'-0" ROOF SPAN

	K	F	KF	M	M-KF	A _s ' = $\frac{M-KF}{C_d}$	A _s = $\frac{M}{C_d}$	V	$\Sigma O = \frac{8 \text{ sec. } f}{7 \mu d}$
MID-SPAN +	155	.745	115	2.4	—	0	.10		
MID-SPAN —	196	.166	32.6	5.0 17.0	— —	0 0	.21 .72		
END —	196	.166	32.6	2.0	—	0	.03	2.0	1.1
END —	196	.15	29.4	44.0 45.7	14.6 16.3	1.77 1.98	2.04 2.11	7.0 10.6	4.3 6.4

I C T T I C O D E —

2.04 .172 2.04 1 B-C
1.77 0 1.77

SAME 2 B-C

2.11 .21 .08
1.98 .10 0 3 B-C

OF FRAME

OF FRAME

AD	OVERHANG	24'-0"	12'-0"	12'-0"
Roof Spans, Bents 1 & 2				
Top Steel Area	.35/ft	0	2.22	2.04
Bottom Steel Area	0	1.15	2.26	1.77
Top Steel Bars	3/8" ϕ 3/4" ϕ	3-1/2"	5-3/4" ϕ	2-3/4" ϕ
Bottom Steel Bars	—	2-1" ϕ	1-5/8" ϕ 2-1" ϕ	2-1" ϕ
Top Steel Area & ΣO Provided	.35 3.8	.75 6.0	2.22 11.8	.88 4.7
Bot " " "	"	2.0 8.0	2.31 10.0	2.0 8.0
V	K	.5	12.1 7.3	9.4 15.1
ΣO REQ'D = $\frac{V}{\mu_j d} = \frac{V}{125.866 \cdot 15} = \frac{V}{1825}$				
SPEC. ANCH = $\frac{V}{3} \frac{V}{1825} = \frac{V}{7440}$				

WEB REINFORCEMENT $V = \frac{V}{b_j d} = \frac{V}{8.866 \cdot 15} = \frac{V}{109}$

V = 111 PSI 138 64
V ALLOW = 75 75 75
V EXCESS = 36 63 0

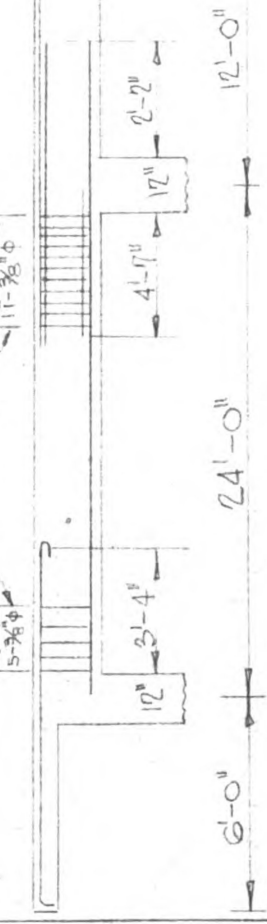
TL $b_j d = \frac{1200}{8.866 \cdot 15} = .92$ PSI/IN

Q (N) = 39 68
A_s = $\frac{36 \cdot 39 \cdot 8}{2 \cdot 16000} = .35$ in² 1.06 = 2.16000

STEEL: 4-3/8" ϕ = .44 in² 1.10 in² = 10-3/8" ϕ
EMBEDMENT: $\frac{1}{2} d - \frac{1}{4} = \frac{15.75}{2} - 1.25 = 6.61$
REQ'D: $\frac{A_s}{\mu_j d} = \frac{68 \cdot 39}{125.118} = 4.5$ OK

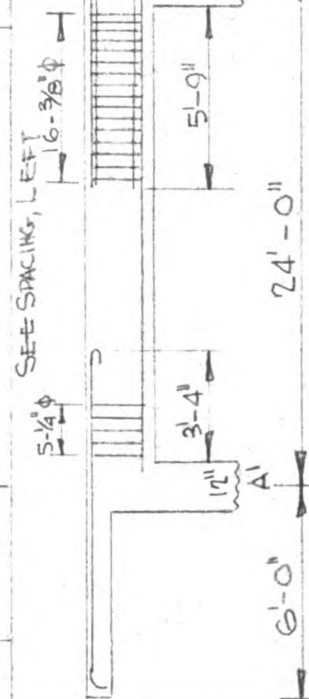
SPACING: 24'-5"-8" 8'-8"-6"-5"-4'-4"-3'-2"

SEE SPACING, LEFT



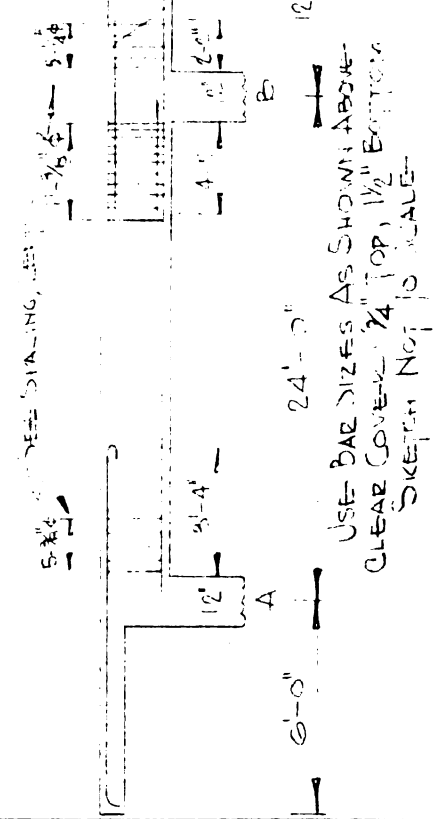
USE BAR SIZES AS SHOWN ABOVE
CLEAR COVER: 3/4" TOP, 1/2" BOTTOM
SKETCH NOT TO SCALE

A'	OVERHANG	A		ADJACENT 3RD FLOOR BEAM
		24'-0"	24'-0"	
ROOF SPAN, BENT #2				
TOP STEEL AREA	□" 35/ft	.56	3.43	2.90
BOT STEEL AREA	□" 0	0	5.42	2.29
TOP STEEL	3/8" φ 3 3/4" o/c	3-1/2" □	—	6-7/8" φ
BOT STEEL	—	2-1" φ	2-1" φ	3-7/8" φ
TOP STEEL AREA & Σ O PROVIDED	□" .35 3.3	.75 6.0	3.60 16.5	4-7/8" φ
BOT " " " "	□" —	1.58 6.3	5.43 19.8	3-7/8" φ
Σ O REQ'D = $\frac{V}{\mu_{jd}} = \frac{V}{16.5}$	K .5	11.0	6.6	9.7
SPEC ANCH. = $\frac{V}{2440}$	1.6	4.5	4.1	6.0
WEB REINFORCEMENT: $V = \frac{V}{109}$				
$V = 101$				
$V_{ALLOW} = \frac{75}{74}$				
$a = 28"$				
$A_s = \frac{2628 \times 8}{21500} = .18"$				
$A_s = \frac{14800 \times 8}{32000} = .148"$				
STEEL: 4-1/4" φ = .20"				
14-3/8" φ = 1.54				
EMBEDMENT: OK				
SPACING:				
2-4-5-8-8				
8-8-8-7-6-5-5-4-4-4-3-3-3-2				

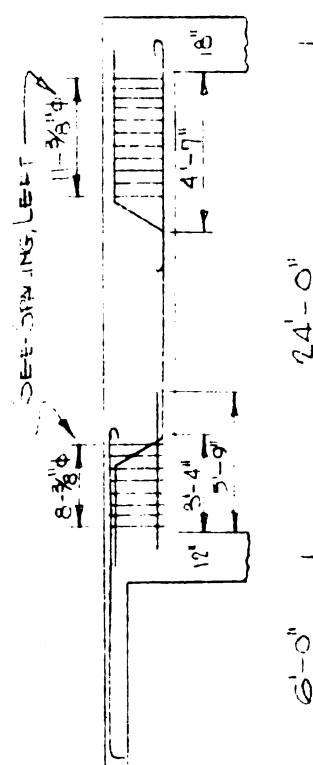


USE BAR SIZES AS SHOWN ABOVE—
CLEAR COVER 3/4" TOP, 1 1/2" BOT.
SKETCH NOT TO SCALE

A		B		C	
OVERHANG		24'-0"		12'-0"	
0"	35/4	.60	2.38	.21	.02
0"	35/4	0	1.54	.10	0
0"	35/4	3-1/2"	6-3/4"	1-3/4"	1-3/4"
0"	35/4	2-1"	2-1"	1-3/4"	1-3/4"
0"	35/4	.75	2.64	.31	.21
0"	35/4	2.0	14.1	2.0	2.0
0"	35/4	2.0	3.0	3.0	3.0
0"	35/4	11.8	9.1	15.2	12.2
0"	35/4	4.9	4.4	5.5	3.9
0"	35/4	1.6			
Σ REQD = $\frac{V}{1625}$					
SPEC ANCH = $\frac{V}{2440}$					
WEAR REINFORCEMENT: $V = \frac{V}{100}$					
V = 108	130	97	18	75	0
VALU = 75	75	75	75	75	75
V EXCH = 33	64	22	22	22	22
USE SAME SIZE & SPACING AS BENT #1					
SPACING:					
2-5-7-8-8	5-5-5-5-4-4-4-3-1/2-2	2-4-5-8-8	2-4-5-8-8	2-4-5-8-8	2-4-5-8-8
5-9/8"	11-3/4"	5-9/8"	5-9/8"	5-9/8"	5-9/8"



USE BAR SIZES AS SHOWN ABOVE
 CLEAR COVER 3/4" TOP, 1 1/2" BOTTOM
 SKETCH NOT TO SCALE

Roof Spans, Bent #4		AD		BC	
		OVERHANG	24'-0"		
TOP STEEL AREA		0"	.35/ft	1.67	1.58
BOT STEEL AREA		0"	—	.80	.57
TOP STEEL			$\frac{3}{4}" \phi$ $3 \frac{3}{4} \phi$	2-1" ϕ	2-1" ϕ
BOT STEEL			—	3- $\frac{3}{8}" \phi$	3- $\frac{1}{2}" \phi$
TOP STEEL AREA $\phi \leq 0$ PROVIDED		0"	.35	2.0	2.0
BOT " " " " "		0"	3.8	8.0	8.0
V		K	.5	13.5	8.1
Σ REQ'D = $\frac{V}{1625}$			1.6	8.3	5.4
SPEC ANCH = $\frac{V}{2440}$			* 5.5	* 3.6	* 5.9
WE-B REINFORCEMENT: $V = \frac{V}{100}$		 DEF. DRAWING, LEFT USE BAR SIZES AS SHOWN CLEAR COVER: $\frac{3}{4}"$ TOP, $1\frac{1}{2}"$ BOT. SKETCH NOT TO SCALE			
V = 124 PSI V ALLOW = $\frac{75}{49}$ V CHECK = 53" A_s = $\frac{53 \times 12.5}{2.16 \times 1000} = .65 \text{ in}^2$ STEEL: 6-$\frac{3}{8}" \phi$ = .65 in² EMBEDMENT: OK SPACING: 0 1/2'-4 1/2'-5 1/2'-6'-8'-8'-8'-5 5'-8'-4'-6'-5'-5'-4'-4'-3 1/2'-3 1/2'-2		133 58 USE SAME SIZE & SPACING AS BENT #1 11-$\frac{3}{8}" \phi$			

FLOOR BEAM DESIGN

COMPILATION OF DATA MOMENT & SHEAR, ALL BENTS

FLOOR	BENT	24'-0"							12'-0"						
		BEAM	NO	MOMENT			SHEAR		BEAM	NO	MOMENT			SHEAR	
				-	+	-					-	+	-		
3 RD	1	A-B	23						B-2	23	86.7	+9.34	86.7	13.7	13.7
	2	C-D	3	36.5	77.7	95.9	22.4	27.8	B-C	3	86.7	+9.34	86.7	13.7	13.7
	2	A-B	3	56.9	68.7	85.1	25.0	25.0	—	—	—	—	—	—	—
2 ND	1	A-B	23	50.7	73.7	95.6	23.1	27.3	B-C	23	79.9	+28.30	79.9	15.1	15.1
	2	C-D	3	50.7	73.7	95.6	23.1	27.3	B-C	3	79.9	+28.30	79.9	15.1	15.1
	2	A-B	3	117.4	81.7	84.0	23.2	23.4	—	—	—	—	—	—	—
	2	A-A	3	36.1	77.7	23.0	21.3	25.9	—	—	—	—	—	—	—
	3	A-B	3	32.0	72.9	97.2	21.9	27.5	B-C	3	85.3	+4.14	-1.0	19.3	3.9

DESIGN OF FLOOR BEAMS

EFFECTIVE DEPTH:

$$d = \frac{25}{b_j v} = \frac{28.9}{12 \cdot 868 \cdot 150} = 18.5"$$

$$n = 18.5 + 1.5 + .5 + 1.0 + 1.0 = 22.5"; \text{ TRY } 24"$$

$$d = 24 - 1.5 - 5 - .5 = 21.5" \text{ (POS MOM, 1 ROW STEEL)}$$

$$d = 24 - 1.5 - .5 - 1.0 - 1.0 = 20.0" \text{ (POS MOM, 2 ROWS STEEL)}$$

$$d = 24 - .75 - .5 - 5 = 22.25" \text{ (NEG MOM, 1 ROW STEEL)}$$

$$d = 24 - .75 - .5 - 1.0 - 1.0 = 20.75" \text{ (NEG MOM, 2 ROWS STEEL)}$$

WIDTH OF TEE, MAX:

$$24' - 0" \text{ SPAN}$$

$$\frac{1}{4} \cdot 24 \cdot 12 = 72"$$

$$12 + 16.5 = 32"$$

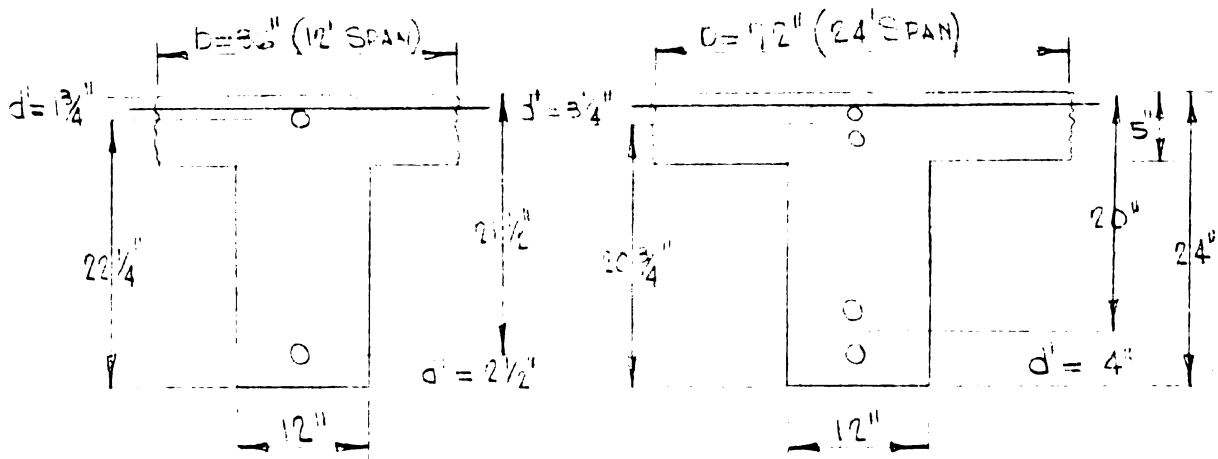
$$12 \times 12 = 144"$$

$$\text{MAX } b = 72"$$

$$12' - 0" \text{ SPAN}$$

$$\frac{1}{4} \cdot 12 \cdot 12 = 36"$$

$$\text{MAX } b = 36"$$



STEEL AREA

24'-0" FLOOR SPANS

		K	F	KF	M	M-KF	$A_s' = \frac{M-KF}{\phi d}$	$A_s = \frac{M}{\phi d}$
MID SPAN	$d=20$ $b=12$ $\frac{t}{d}=.25$	173	1.60	276	79.7	—	0	2.68
+	$\alpha = 1.50$ $d'/d = —$ $\alpha = —$				83.7	—	0	2.29
					73.7	—	0	2.46
					61.7	—	0	2.06
					77.7	—	0	2.59
END	$d=20\frac{3}{4}$ $b=12$	120	.43	54	30.5	—	0	1.22
	$\alpha = 1.44$ $d'/d = .16$ $\alpha = .52$				50.7	—	0	1.70
					30.1	—	0	1.16
					32.0	—	0	1.07
					84.0	—	0	2.82
					86.9	2.9	.27	2.90
					117.4	33.4	3.10	3.93
					95.9	11.9	1.10	3.21
					85.1	1.1	.10	2.85
					95.6	11.6	1.10	3.21
					123.0	37.0	3.60	4.12
					97.2	13.2	1.22	3.25

	T	T	T	CODE
C	C	T	C	
3RD	1.22 0	2.66	3.21 1.10	A-B 2C-D 1C-D
			2ND 3.93 3.10	2.82 0
2ND	2.90 .27	2.29	2.95 .10	2 A-B 2 A-A
			2ND 1.18 0	4.12 3.05
1ND	1.70 0	2.46	3.21 1.10	A-B 2C-D 1C-D
			2ND 1.07 0	3.25 1.22

STEEL AREA

12'-0" FLOOR SPAN

	K	F	KF	M	M-KF	A _s = $\frac{M-KF}{C_u}$	A _s = $\frac{M}{u}$
MID-SPAN	173	1.10	203	0.9	—	0	.03
+				2.8	—	0	.10
				14.1	—	0	.47
MID-SPAN	196	.441	87	30	—	0	1.00
—				34	—	0	1.14
				14	—	0	.05
END	192	.441	87	23.1	—	0	2.20
—				79.3	—	0	2.03
				59.5	—	0	2.66
				1.0	—	0	.03

$d = 20$
 $b = 36$
 $t/d = .25$
 $\alpha = 1.50$
 $d'/d = —$
 $C = —$
 $\alpha = 1.44$
 $d'/d = —$
 $C = —$

T T T CODE—

3RD 2.90 1.14 2.03 1 B-C, 2 B-C

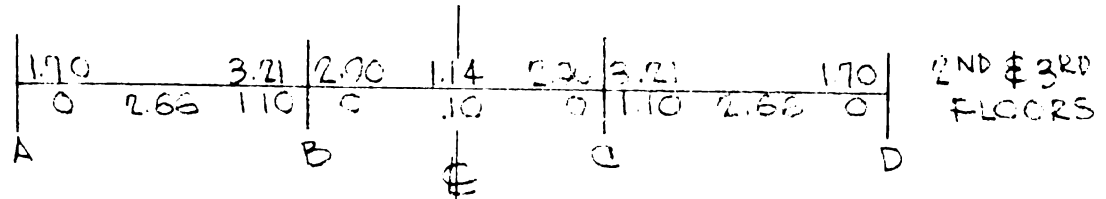
2ND 2.68 1.00 2.68 1 B-C, 2 B-C

2ND 2.38 .05 .03 3 B-C

STEEL AREA

- BENT #1 -

AS DIFFERENCES IN STEEL AREAS ARE VERY SMALL,
USE THE SAME BEAMS FOR BOTH 2ND & 3RD FLOORS

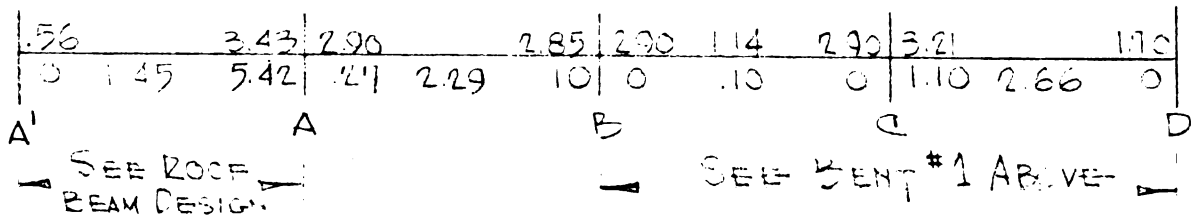


SYMMETRICAL ABOUT C

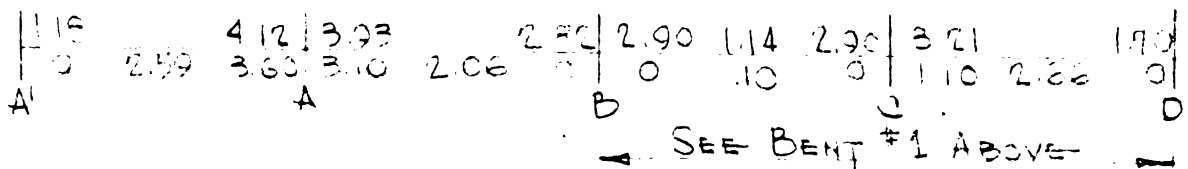
- BENT #2 -

BEAMS B-C & C-D, BOTH FLOORS ARE IDENTICAL TO BEAMS
B-C & C-D OF BENT #1. ROOF BEAM A'-A IS DESIGNED
UNDER ROOF BEAMS. THEREFORE DESIGN ONLY BEAM A-B
(3RD FLOOR) & A'-A, A-B (2ND FLOOR) UNDER THIS SECTION.

3RD FLOOR

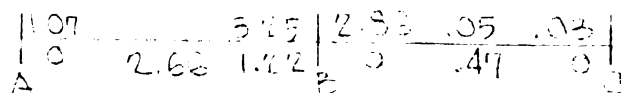


2ND FLOOR



- BENT #3 -

DESIGN BOTH BEAMS A-B & B-C, SECOND FLOOR, UNDER
THIS SECTION.



OF FRAME—

BC

AD

UNITS

2 ND FLOOR SPANS BENT #1	24'-0"	12'-0"	12'-0"
TOP STEEL AREA	1.70	3.21	2.90
BOT STEEL AREA	—	1.10	—
TOP STEEL	4-3/4"φ	3-1"φ	3-1"φ
BOT STEEL	2-3/4"φ	3-3/4"φ	3-3/4"φ
TOP STEEL AREA & Ø PROVIDED	1.76	3.69	3.60
BOT. " " " "	1.85	1.32	1.58
V	22.4	16.7	13.9
ΣO REQD = $\frac{V}{\mu_j d} = \frac{125,000 \times 20}{2170} = \frac{V}{2170}$	10.3	7.7	6.3
SPEC. ANCH = $\frac{1}{2} \frac{V}{2170} = \frac{V}{4340}$	* 6.9	* 4.1	* 5.1

WEB REINFORCEMENT: $V = \frac{V}{b_j d} = \frac{V}{16.86 \times 20} = \frac{V}{208}$

V	=	108 PSI	134	106
V ALLOW	=	75	75	75
V EXCESS	=	33	59	C

$\frac{V}{b_j d} = \frac{22,400}{16.86 \times 20} = 66.5 \text{ PSI/IN}$

$A_c = \frac{33 \times 16.86 \times 20}{2,150} = .51 \text{ IN}^2$

1.47" = $\frac{50,000 \times .6}{2,150 \times 20} = A_s$

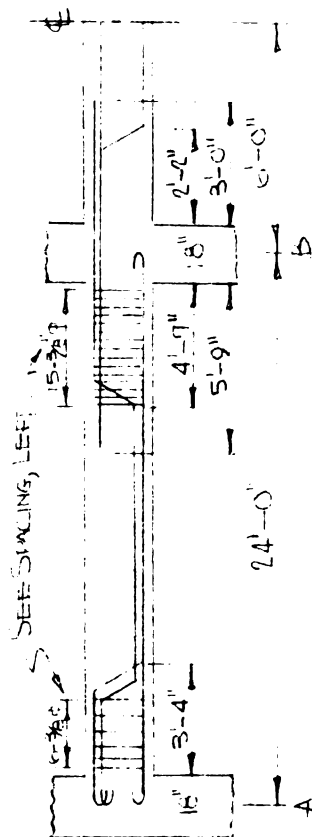
STEEL: 5-3/8"φ = 5.50"

EMBEDMENT: $\frac{1}{2} d - \frac{1}{4} = \frac{20}{2} - \frac{1}{4} = 9.75"$

" REBAR: $\frac{1.5 A_v}{1.23} = \frac{60 \times .11}{1.23} = 4.5"$ O.K.

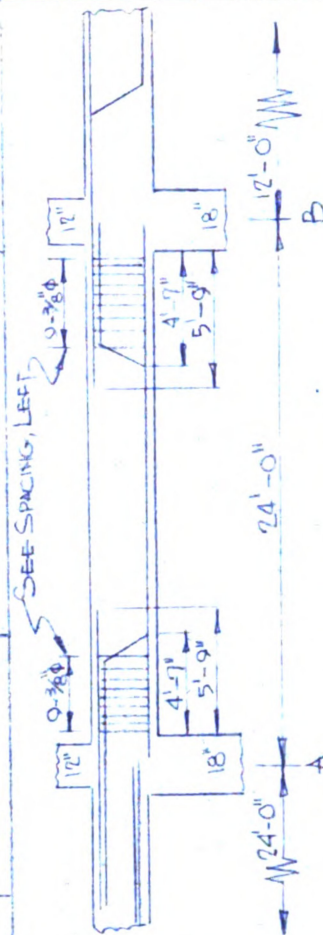
SPACING:

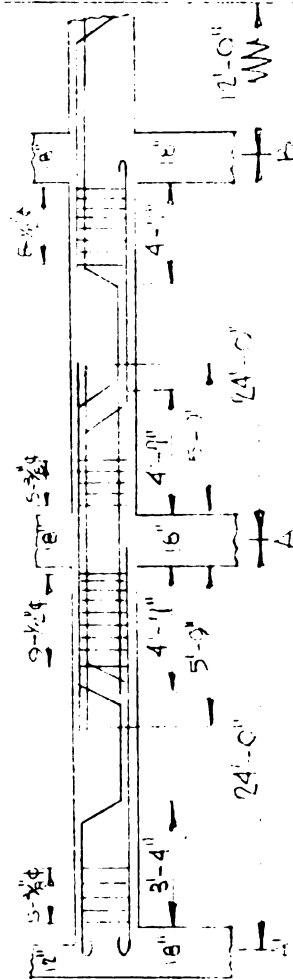
2-4-5-6-10-10 10-10 6-2-4-4-4-4-3-3-2-2-1/2



USE BAR SIZES AS SHOWN ABOVE
CLEAR COVER: 3/4" TOP, 1/2" BOT.
DEF. REBAR NOT SHOWN

3RD FLOOR SPAN, BENT #2	A		B	
	UNIT	ADJACENT SPAN (A'-A)	24'-0"	ADJACENT SPAN (B-B)
TOP STEEL AREA	sq"	—	2.90	2.85
BOT STEEL AREA	sq"	1.45	2.71	1.10
TOP STEEL		—	6-7/8" ϕ	3-1" ϕ — 3-1" ϕ — 2-1" ϕ
BOT STEEL		2-1" ϕ	3-7/8" ϕ — 4-7/8" ϕ — 5-1/8" ϕ	1-7/8" ϕ — 1-1" ϕ
TOP STEEL AREA $\leq$ 0 PROVIDED	sq"	—	3.60	2.91
BOT " " " "	sq"	—	16.5	12.2
V	K	—	1.80 8.2	1.80 8.2
Σ REQD = $\frac{V}{2170}$		25.0	15.0	15.0
SPEC. ANCH. = $\frac{V}{31250}$		11.5	6.9	6.9
WEB REINFORCEMENT: $V = \frac{V}{208}$				
$V = 120 \text{ PSI}$ $V_{\text{ALLOW}} = \frac{75}{45}$ $V_{\text{EXCESS}} = 517$ $\alpha = 45.51 \cdot 12 = .86 \text{ in}$ $A_s = 2.16000$ STEEL: B-7/8" $\phi = .88 \text{ in}$ EMBEDMENT: O.K. SPACING: 2-3-4-4-4-5-7-10-10 SAME—				
USE BAR SIZE AS SHOWN ABOVE CLEAR COVER: 3/4" TOP, 1 1/2" BOTTOM. SKETCH NOT TO SCALE				





USE BAR SIZES AS SHOWN ABOVE.
CLEAR COVER: $\frac{3}{4}$ " TOP, $1\frac{1}{2}$ " BOTTOM.
DESIGN NOT TO SCALE—

WEB REINFORCEMENT: $V = \frac{V_u}{200}$

$V =$	102	133	105	133
$V_{ALLOW} =$	75	75	75	75
$V_{EXCESS} =$	27 PSI	64	30	58
$a =$	31"	73"	34"	66"
$A_s =$	31"	175"	38"	1.43"
$STEEL =$	4- $\frac{3}{8}\phi$	9- $\frac{1}{2}\phi$	4- $\frac{3}{8}\phi$	8- $\frac{1}{2}\phi$

EMBLEMENT: 6.15.

RECEIVED
JUN 10 1967

SPACING:

2-4-6-8-10

2-4-6-8-10

10-10-10-8-5-7-7-4-2

2ND FLOOR SPANS, BENT #3		A		B		C	
		UNITS	24'-0"	12'-0"	12'-0"		
TOP STEEL AREA		sq"	1.07	3.25	2.55	.05	.03
BOT STEEL AREA		sq"	—	2.66	1.22	.47	—
TOP STEEL			3-3/4"	5-3/4"	5-3/4"	1-3/4"	1-3/4"
BOT STEEL			3-3/4"	3-3/4"	3-3/4"	2-3/4"	2-3/4"
TOP STEEL - AREA & ΣO PROVIDED		sq"	13.2	3.52	3.52	44	44
BOT "		sq"	13.2	13.2	15.2	2.4	2.4
V			7.1	14.1	7.1	8.5	4.7
ΣO REQ'D = $\frac{V}{2170}$			21.9	13.2	16.5	22.5	19.3
SPEC ANCH = $\frac{V}{3250}$			10.1	6.1	7.6	12.7	9.4
			* 6.1	*	5.1		

WEB REINFORCEMENT: $V = \frac{V}{208}$

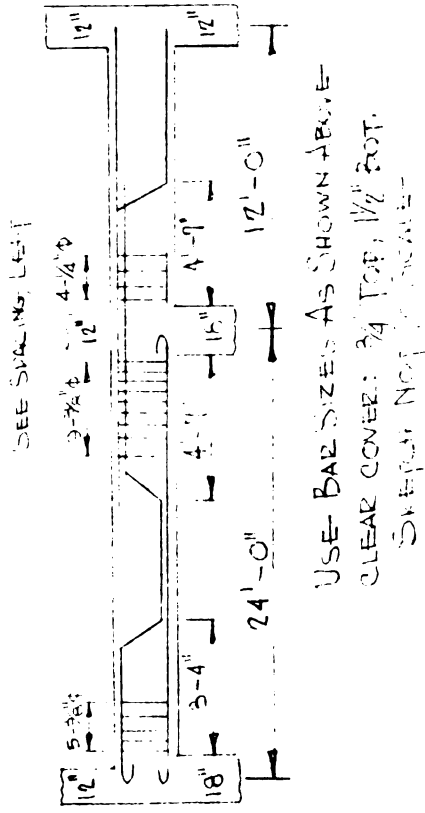
V = 105.75	133	93	19
V ALLOW = 75	75	75	75
V EXCESS = 30	58	18	0

USE SAME AS # SPACING
AS IN BENT #1.

5-3/8" 9-3/8"

STEEL: 3-1/4" φ = 15
EMBEDMENT OK

SPACING:
2-4-6-8-10
10-12-14-16-18-20-22-24-26-28-30-32-34-36-38-40-42-44-46-48-50-52-54-56-58-60-62-64-66-68-70-72-74-76-78-80-82-84-86-88-90-92-94-96-98-100

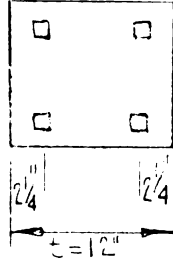


— COLUMN DESIGN —

— COMPILATION OF DATA —

LEVEL	SIZE	EXTERIOR				INTERIOR		
		MOM	LOAD	COL		MOM	LOAD	COL
R-3	12"x12" 12'	20.9	14.8	1A, 1D		12.5	25.8	1B, 1C
		19.2	13.7	2A'		5.6	13.8	3C
		23.2	14.8	2A		23.8	25.8	2B, 2C
		22.6	14.8	2D		7.0	29.4	3B
		20.0	14.5	3A		2.0	5.6	3C
		MAX:	23.2	14.8	①	23.8	29.4	②
3-2	12"x18" 12'	35.7	41.5	1A, 1D		23.0	40.6	1B, 1C
		34.4	25.7	2A'		41.8	61.3	2A
		22.6	14.8	2D		26.0	68.1	2B, 2C
		33.0	40.0	3A		12.0	82.2	3B
		MAX:	36.1	41.5	④	41.8	82.2	⑤
2-1	12"x18" 12'	35.2	69.0	1A, 1D		26.0	114.6	1B, 1C
		38.2	78.6	2D		18.2	122.7	2A
						26.2	112.9	2B, 2C
		MAX:	38.2	78.6	⑥	26.2	122.7	⑦
R-1	12"x12" 8'	3.8	16.2	4B, 4C ③				
R-1	12"x18" 18'	49.0	23.4	4A, 4D ③		48.0	48.1	4B, 4C ③
R-1	12"x18" 24'	27.4	20.2	NON RIG'D FRAME A 42 ⑩				

— DESIGN OF 12" x 12" COLUMNS —



$$gt = 12 - 4 \times \frac{1}{2} = 7 \frac{1}{2}''$$

$$g = \frac{7 \frac{1}{2}}{12} = .625$$

① 12' EXTERIOR ROOF COL: $M = 23.2 \text{ k} \cdot 12 = 278 \text{ k}''$ $N' = 148 \text{ k}$

$$\frac{l}{t} = \frac{12 \cdot 12}{12} = 12 > 10 \quad \text{LONG COL.}$$

$$N' = N(1 - .03 \frac{l}{t}) = 148$$

$$N = 15.75$$

TRY: $P = .01$ $C = .46$ $D = 6.0$

$$CD \frac{M}{t} = 46 \cdot 6.0 \cdot \frac{278}{12} = 64.0$$

$$N = \underline{15.75}$$

$$P = \underline{79.95}$$

$$\text{CONC} = \underline{65.0}$$

$$\text{STEEL} = \underline{14.75}$$

TRY: $4 - \frac{5}{8}'' \phi = 1.24 \text{ in}^2$

$$\text{MIN } A_s = .01 \cdot 144 = 1.44 \text{ in}^2$$

USE: $4 - \frac{3}{4}'' \phi = 1.76 \text{ in}^2$

$$\frac{1}{4}'' \text{ c TIES @ } 12''$$

② 12' INTERIOR ROOF COL: $M = 23.8 \cdot 12 = 285.6 \text{ K}$ $N' = 29.4 \text{ K}$

$$29.4 = N \cdot 94$$

$$N = 31.3 \text{ K}$$

$$\text{TRY: } p = .02 \quad c = .51 \quad D = 5.8$$

$$CD \frac{M}{L} = .51 \cdot 5.8 \frac{285.6}{12} = 71.0$$

$$N = 31.3$$

$$P = 102.3$$

$$CONC = 65.0$$

$$\text{STEEL} = 37.3$$

$$\text{USE } 4 - 1" \phi = 31.6$$

$$p = \frac{31.6}{142} = .222 \quad \text{OK}$$

$$\text{USE } \frac{1}{4}" \text{ TIES @ } 12"$$

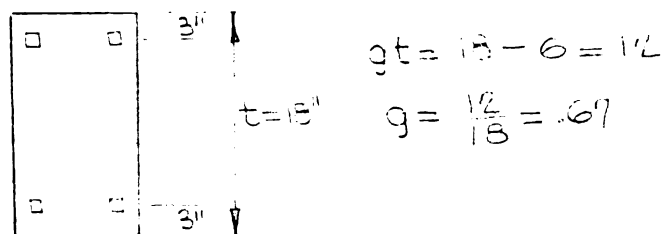
③ 8' EXTERIOR ROOF COL: $M = 3.3 \cdot 12 = 40 \text{ K}$ $N = 16 \text{ K}$

STEEL REQD IN THIS CASE IS OBVIOUSLY
BELOW MIN ALLOWABLE AND $p = .01$.

$$\text{USE: } 4 - \frac{3}{8}" \phi$$

$$\frac{1}{4}" \text{ TIES @ } 12"$$

DESIGN OF 12" x 13" COLUMNS



④ 12' EXTERIOR THIRD FLOOR COL: $M = 38.7 \cdot 12 = 440 \text{ K}$ $N' = 415 \text{ K}$

$$l/t = \frac{12 \cdot 12}{12} = 12 > 10 \text{ LONG COL.}$$

$$N' = N (1.3 - 0.3 \frac{h}{l}) = 415 \text{ K}$$

$$N' = 440$$

$$\text{TRY: } p = .01 \quad c = .48 \quad D = 5.3$$

$$CD \frac{M}{F} = .48 \cdot 5.3 \frac{440}{13} = 650 \text{ K}$$

$$N = \underline{440}$$

$$P = 1090$$

$$\text{CONC} = \underline{9"}$$

$$\text{STEEL} = \underline{12 \text{ O}^K}$$

$$\text{TRY: } 4 - \frac{5}{8} \text{ } \phi = 1.24 \text{ O}^K$$

$$\text{MIN } A_s = .01 \cdot 216 = 2.16 \text{ O}^K$$

$$\text{USE: } 4 - \frac{7}{8} \text{ } \phi = 2.40 \text{ O}^K$$

$$\frac{l}{4} \text{ TIES } @ 12"$$

⑤ 12' INTERIOR THIRD FLOOR COL: $M = 41.8 \cdot 12 = 502 \text{ k''}$ $N' = 82.2 \text{ k}$

$$82.2 = N \cdot 94$$

$$N = 87.5 \text{ k}$$

$$\text{TRY: } p = .035 \quad c = .515 \quad D = 5.5$$

$$CD \frac{M}{t} = .515 \cdot 5.5 \frac{502}{18} = 38.5 \text{ k}$$

$$N = \frac{87.5}{1}$$

$$P = 176.0$$

$$\text{CONC} = \frac{97.0}{1}$$

$$\text{STEEL} = \frac{79.0}{1}$$

$$\text{TRY: } 6 - 1\frac{1}{8}'' \square = 762$$

$$P = \frac{762}{216} = .035 \quad \text{OK}$$

$$\text{USE: } 6 - 1\frac{1}{8}'' \square$$

$$\frac{1}{4}'' \phi \text{ TIES @ } 12''$$

⑥ 12' EXTERIOR SECOND FLOOR COL: $M = 38.2 \cdot 12 = 458 \text{ k''}$
 $N' = 78.6 \text{ k}$

$$78.6 = N \cdot 94$$

$$N = 83.5 \text{ k}$$

$$\text{TRY: } p = .0275 \quad c = .55 \quad D = 5.6$$

$$CD \frac{M}{t} = .55 \cdot 5.6 \frac{458}{18} = 78.5$$

$$N = \frac{83.5}{1}$$

$$P = 162.0$$

$$\text{CONC} = \frac{97.0}{1}$$

$$\text{STEEL} = \frac{65.0}{1}$$

$$\text{TRY: } 6 - 1'' \square = 600$$

$$P = \frac{60}{216} = .0275 \quad \text{OK}$$

$$\text{USE: } 6 - 1'' \square$$

$$\frac{1}{4}'' \phi \text{ TIES @ } 12''$$

⑦ 12' INTERIOR SECOND FLOOR COL: $M = 26.2 \cdot 12 = 314 \text{ K}$
 $N' = 122.7$

$$122.7 = N \cdot 94$$

$$N = 135.0 \text{ K}$$

TRY: $p = .035$ $c = .575$ $D = 5.5$

$$CD \frac{M}{t} = .575 \cdot 5.5 \frac{314}{18} = 59.0$$

$$N = \frac{135.0}{p} = 190.0$$

$$CONC = 97.0$$

$$STEEL = 93.0$$

TRY: $6 - 1\frac{1}{8}'' \square = 762 \text{ mm}$

$$p = \frac{762}{216} = .035 \quad \text{OK}$$

USE: $6 - 1\frac{1}{8}'' \square$

$\frac{1}{4}'' \phi$ TIES @ 12"

⑧ 18' EXTERIOR ROOF COL: $M = 49.0 \cdot 12 = 590 \text{ K}$
 $N' = 23.4 \text{ K}$

$$h/t = \frac{18 \cdot 12}{12} = 18 > 10$$

$$23.4 = N' (1.3 - .03 \cdot 18)$$

$$N = 30.8 \text{ K}$$

TRY: $p = .015$ $c = .49$ $D = 5.7$

$$CD \frac{M}{t} = .49 \cdot 5.7 \frac{590}{18} = 91.5$$

$$N = \frac{30.8}{p} = 205.3$$

$$p = 122.3$$

$$CONC = 97.0$$

$$STEEL = 25.3$$

TRY: $4 - 1'' \phi = 316 \text{ mm}$

$$p = \frac{316}{216} = .015 \quad \text{OK}$$

USE: $4 - 1'' \phi$

$\frac{1}{4}'' \phi$ TIES @ 12"

⑨ 18' INTERIOR ROOF COL: $M = 48.0 \cdot 12 = 575 \text{ K}'$ $N' = 48.1$

$$48.1 = N \cdot 1.6$$

$$N = 30.1$$

TRY $p = .02$ $c = .51$ $D = 5.7$

$$CD \frac{M}{t} = .51 \cdot 5.7 \frac{575}{18} = 93.0 \text{ K}$$

$$N = \underline{63.3}$$

$$P = 156.3$$

$$\text{CONC} = \underline{97.0}$$

$$\text{STEEL} = 59.3$$

TRY: 6-1" $\phi = 474 \text{ mm}^2$

$$p = \frac{474}{216} = .022 \text{ OK}$$

USE: 6-1" ϕ

$\frac{1}{4}$ " ϕ TIES @ 12"

⑩ 24' EXTERIOR ROOF COL: $M = 27.4 \cdot 12 = 330 \text{ K}'$ $N' = 20.2$

$$\eta/t = \frac{24 \cdot 12}{12} = 24$$

$$20.2 = N(1.3 - .03 \cdot 24)$$

$$N = 34.8 \text{ K}$$

TRY: $p = .01$ $c = .46$ $D = 5.8$

$$CD \frac{M}{t} = .46 \cdot 5.8 \frac{330}{18} = 47.0$$

$$N = \underline{34.8}$$

$$P = 83.8$$

$$\text{CONC} = \underline{97.0}$$

$$\text{STEEL} = 0$$

$$\text{MIN } A_s = .01 \cdot 216 = 2.16 \text{ in}^2$$

USE: 4- $\frac{7}{8}$ " $\phi = 2.40 \text{ in}^2$

$\frac{1}{4}$ " ϕ TIES @ 12"

— WALL BEAM DESIGN —

LOADING:

INTERIOR WALL (NO OPENINGS) 4" CONCRETE BLOCK.

$$\frac{12 \times 12 \times 20}{12} = 240 \text{ #/ft}$$

EXTERIOR WALL: 4" CONCRETE BLOCK + 4" FACE BRICK
WINDOWS—

$$\frac{2 \frac{1}{2} \times 12 \times 50}{12} = 145 \text{ #/ft}$$

NO OPENINGS—

$$\frac{12 \times 12 \times 50}{12} = 600 \text{ #/ft}$$

EFFECTIVE DEPTH:

$$bd = \frac{V}{jv} = \frac{11(680+75)}{.866 \times 150} = 63.0 \text{ in}$$

$$b = 8 \text{ in}$$

$$d = 8 \text{ in}$$

$$h = 8 + \frac{1}{2} + \frac{1}{2} = 10 \text{ in}$$

USE: TYPICAL 8" x 10" WALL BEAM THRU OUT.

MOMENTS: BY CORR.

$$\text{POS MOM} = .049(680+75)11^2 = 4.5 \text{ K'}^1$$

$$\text{NEG. MOM} = .091(680+75)11^2 = 8.3 \text{ K'}^1$$

SHEAR:

$$\frac{680+75}{2}11 = 4.2 \text{ K}$$

$$K = 196, F = .043, a = 1.44$$

$$M = 8.3$$

$$KF = 8.4$$

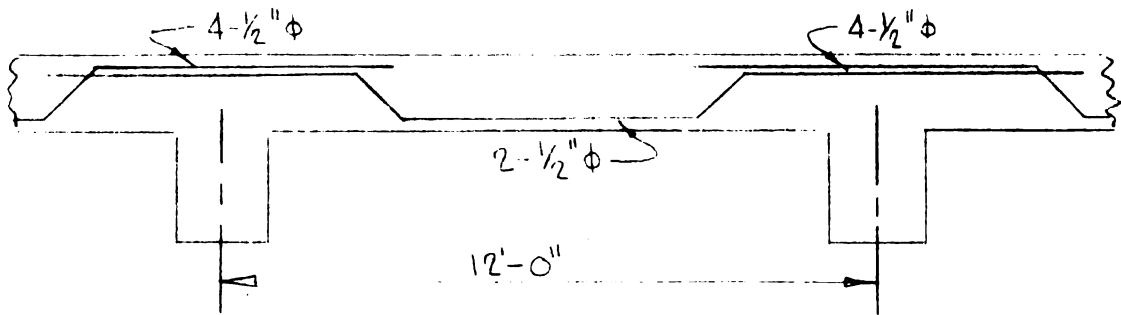
$$M - KF = -.1 \quad \text{No COMP STEEL REQ'D}$$

$$A_s = \frac{M}{ad} = \frac{8.3}{1.44 \cdot 8} = .73 \text{ in}^2 \quad 4 - \frac{1}{2} \text{ in } \phi = .80 \text{ in}^2$$

$$A_s = \frac{4.5}{1.44 \cdot 8} = .39 \text{ in}^2 \quad 2 - \frac{1}{2} \text{ in } \phi = .40 \text{ in}^2$$

$$V = \frac{V}{b_j d} = \frac{4,200}{8 \cdot 866.5} = 74 \text{ psi}$$

$$V_{\text{ALLOW}} = 75 \text{ psi} \quad \text{No WE-B REINFORCEMENT REQ'D}$$



BOND:

$$\mu = \frac{V}{\Sigma o_j d} = \frac{4200}{6.3 \cdot 866.5} = 76 < 125 \text{ PSI ALLOWABLE}$$

$$\mu = \frac{.6 \cdot 4200}{3.1 \cdot 866.5} = 118 < 125 \text{ PSI} \quad \text{OK}$$

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Simplified Design of Concrete Floor Systems.....Ibid

Introduction

The purpose of this study is to investigate the effects of the proposed system on the performance of the participants. The study was conducted in a laboratory setting with a sample of 30 participants. The participants were divided into two groups: a control group and an experimental group. The control group used a standard system, while the experimental group used the proposed system. The performance of the participants was measured using a series of tasks. The results of the study show that the proposed system significantly improved the performance of the participants compared to the control group. The improvement was observed in all tasks, with the most significant improvement in the task of data entry. The results also show that the proposed system was easy to use and did not require a long learning curve. The study concludes that the proposed system is a viable solution for improving the performance of participants in data entry tasks. The study also suggests that the proposed system could be used in other settings where data entry is a key task.

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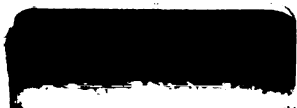
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