

THESIS

copy 2

**SUPPLEMENTARY
MATERIAL**
IN BACK OF BOOK

Design of a Reinforced
Concrete Apartment
House

A THESIS

Submitted to the Faculty of
THE MICHIGAN AGRICULTURAL COLLEGE

By

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Candidate for the

Degree of Bachelor of Science

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The author desires to acknowledge his indebtedness to Associate Prof. C. A. Miller for his many helpful suggestions.

1. The first part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \int_0^x f(t) dt$. It is shown that $f(x)$ is a constant function, and its value is determined by the initial condition $f(0)$.

DEFINITION OF SYMBOLS

- f_s -- tensile unit stress in longitudinal reinforcement.
- f_c -- compressive unit stress in extreme fiber of concrete in flexure.
- E_s -- modulus of elasticity of steel in tension or compression
(= 30,000,000 p.s.i.)
- E_c -- modulus of elasticity of concrete in compression.
- n -- E_s/E_c
- M -- bending moment or moment of resistance in general.
- A_s -- effective area of reinforcement in tension in beams and slabs.
- b -- width of rectangular beam or width of flange of T-beam.
- d -- depth from compression surface of beam or slab to center of longitudinal tensile reinforcement.
- d' -- depth from compressive surface of beam to center of longitudinal compressive reinforcement.
- b' -- width of web in T-beams.
- k -- ratio of depth of neutral axis to depth d .
- j -- ratio of lever arm of resisting couple to depth d .
- p -- ratio of effective area of tensile reinforcement to effective area of concrete in beams or slabs = A_s/bd .
- p' -- ratio of effective area of compressive reinforcement to effective area of beam.
- V -- total shear.
- v -- shear by unit stress.
- Σo -- sum of perimeters of a group of bars.
- u -- bond unit stress.
- l -- clear span length of beam or slab.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial matters. The text suggests that organizations should implement robust systems to track every aspect of their operations, from procurement to sales, to ensure that all data is captured and stored securely.

2. The second part of the document addresses the challenges of data management in a rapidly changing environment. It highlights the need for flexible and scalable solutions that can adapt to new technologies and evolving business requirements. The author argues that organizations must invest in training and development to ensure their staff are equipped with the skills necessary to manage complex data systems effectively.

3. The third part of the document focuses on the importance of data security and privacy. It discusses the various risks associated with data breaches and the potential consequences for an organization's reputation and financial stability. The text provides a comprehensive overview of best practices for data protection, including the implementation of strong encryption protocols and regular security audits.

4. The fourth part of the document explores the role of data in decision-making and strategic planning. It argues that organizations that leverage their data effectively can gain a significant competitive advantage. The text provides examples of how data analysis can be used to identify trends, forecast future performance, and optimize resource allocation.

5. The fifth part of the document discusses the importance of data governance and compliance. It outlines the various regulations and standards that organizations must adhere to, such as the General Data Protection Regulation (GDPR) and the California Consumer Privacy Act (CCPA). The text emphasizes the need for a clear data governance framework that defines roles, responsibilities, and processes for managing data across the organization.

6. The sixth part of the document addresses the issue of data integration and interoperability. It discusses the challenges of connecting different data sources and systems, and the importance of ensuring that data is consistent and accessible across the organization. The text suggests that organizations should consider adopting a data lake architecture to facilitate seamless integration of data from various sources.

7. The seventh part of the document discusses the importance of data quality and accuracy. It argues that poor data quality can lead to incorrect conclusions and decisions, which can have serious consequences for an organization. The text provides a detailed overview of data quality management practices, including the use of data profiling tools and the implementation of data quality checks.

8. The eighth part of the document discusses the importance of data ethics and responsible data use. It outlines the various ethical considerations that organizations must take into account when collecting, processing, and using data, such as transparency, fairness, and accountability. The text suggests that organizations should develop a data ethics framework that guides their data practices and ensures that they are aligned with societal values and expectations.

9. The ninth part of the document discusses the importance of data literacy and skills development. It argues that organizations must ensure that their staff have the necessary skills and knowledge to work with data effectively. The text provides a comprehensive overview of data literacy training programs and the importance of ongoing learning and development in this field.

10. The tenth part of the document discusses the importance of data innovation and research. It outlines the various ways in which organizations can use data to drive innovation and create new products and services. The text suggests that organizations should invest in research and development to explore new data-driven business models and technologies.

STRENGTHS (continued)

- w -- uniformly distributed load per unit of length of beam or slab.
- P -- concentrated load.
- K -- I/l or I/h
- I -- moment of inertia.
- h -- height of beam.

Preface

The purpose of this thesis is to design a reinforced concrete structure from a floor plan and front elevation such as might be given an engineer by an architect.

The floor plan was drawn up more from an architect's point of view than from an engineer's, that is why there is so little symmetry between the various members.

The building is of three stories, outside stair type which lends itself admirably to group or block organizations, which may be developed either parallel to, or at an angle with, the surrounding street lines. The apartments are of four and five rooms.

The live roof load was so near the live floor load, that the same slab beams and girders were used throughout.

It was found that no steel was needed for diagonal bracing in the short beams of 14ft. - 6in. These beams being made the same size as the large span beams.

It would be interesting to re-design this building using bearing walls and cantilever floor sections. The building being only three stories in height makes bearing walls possible, as the basement wall would not, in the authors mind, be so large as to be out of consideration.

The floor slabs were figured with a total depth of 5in. and an effective depth of 4in. In this way the forms would be of a uniform thickness while the steel required in the different slabs would vary with the length of slab in question.

The beams and girders were kept at a maximum width of 12in. The purpose in so doing was to conceal as many beams and girders as possible in the partitions.

The columns offered quite another problem, and this is the strongest reason for wanting to try a design of bearing walls. It was found that the columns would not remain hidden in the partitions but would in some cases protrude into the rooms giving some an unsightly appearance. In using bearing walls not only would an unbroken wall surface be presented to the prospective tenant, but the building expenses would be cut down.

I regret to say that time did not permit me to make what I think would have been a very interesting investigation. I have little doubt in my own mind but that the bearing wall constructed type of house would prove more economical than the beam and girder type for three and four story houses of this type where appearances play a most important part.

Computation for Slab, Beam and Girder Floor

Slab-Beam-Girder Floor

Live load $40^{\#}/\text{sq.ft.}$

Floors Oak

Materials:

Steel: Intermediate grade: deformed bars

Concrete: Maximum size of aggregate $3/4\text{in.}$

Ultimate strength 23 days: $2000^{\#}/\text{sq.in.}$

Specifications: Lansing Building Code 1937

Stresses:

$$f_s = 20,000^{\#}/\text{sq.in.}$$

$$f_c = 750^{\#}/\text{sq.in. bending}$$

$$= 850 \quad \text{" supports}$$

$$u = 120 \quad \text{"}$$

$$v = 40 \quad \text{" no web reinforcement}$$

$$= 120 \quad \text{" with " "}$$

$$\text{Constants: } 20,000 \quad 750 \quad n = 15$$

$$R \text{ or } K = f_s p j = 118.8$$

$$P = 0.0063$$

$$k = 0.3600$$

$$j = 0.8800$$

1. The first part of the problem is to find the value of x such that

$$x^2 + 2x + 1 = 0$$

$$(x+1)^2 = 0$$

$$x+1 = 0$$

$$x = -1$$

2. The second part of the problem is to find the value of y such that

$$y^2 - 4y + 4 = 0$$

$$(y-2)^2 = 0$$

3. The third part of the problem is to find the value of z such that

$$z^2 - 6z + 9 = 0$$

$$(z-3)^2 = 0$$

$$z-3 = 0$$

$$z = 3$$

$$z = 3$$

$$z = 3$$

$$z = 3$$

4. The fourth part of the problem is to find the value of w such that

$$w^2 - 8w + 16 = 0$$

$$(w-4)^2 = 0$$

$$w-4 = 0$$

$$w = 4$$

Computation for Floor Slab using $M = \frac{WL}{12}$ ✓

Slab D

Allowable $f_c = 750$ $f_s = 20,000$ $n = 15$ $v = 120$ $u = 120$

Clear Span 12ft. - 00in.	Live load	40
Bearing Span 13ft. - 00in.	Slab 5in.	63
Assume 12in. beam	Plaster metal lath	10
	Flooring	5
	Partitions	$\frac{16}{134} \text{ /sq.ft.}$

$$M = \frac{WL}{12} = \frac{134 \times 12}{12} = 1608 \text{ ft.}^{\#} / \text{ft. strip. Interior Span}$$

$$V = \frac{WL}{2} = \frac{134 \times 12}{2} = 804^{\#}$$

Thickness:

$$d = \sqrt{\frac{M}{K}} = \sqrt{\frac{1608 \times 12}{12 \times 113.8}} = \sqrt{13.5} = 3.68 \text{ say } 4.00 \text{ in.}$$

$$D = \frac{1.00}{5.00}^{\#}$$

Use 5in. Slab

$$d = 4 \text{ in.}$$

Floor Slab Steel

Interior Span:

$$A_s = \frac{M}{f_s p j} = \frac{1608}{20,000 \times .85 \times 4} = .02285 \text{ sq.in./in. or } .27^{\#} \text{ sq. in./lin.ft.}$$

$$1/2 \text{ in. } \phi \text{ @ } 8 \frac{1}{2} \text{ o.c.} = 28 \text{ sq. in./lin.ft.}$$

Bond Stress @ Supports:

$$v = \frac{V}{f_j d} = \frac{804}{12 \times .85 \times 4} = 19.1^{\#} / \text{sq.in.}$$

For $1/2 \text{ in. } \phi$:

$$u = \frac{vb}{20} = \frac{19.1 \times 8.5}{3.142 \times 1/2} = 103^{\#} / \text{sq. in.}$$

Using Depth of Interior Slab Figure Steel Needed in Slab (E)
 18ft. - ooin. Clear Span on the Exterior

Find Moment as the Interior Span

$$M = \frac{wL^2}{12} = \frac{134 \times 18^2}{12} = 3618 \text{ ft.}^2/\text{ft. strip (Int.)} \quad W = 134^{\#}$$

$$V = \frac{wL}{2} = \frac{2412}{2} = 1206^{\#}$$

Exterior Span:

$$R = \frac{M}{bd^2} = \frac{3618 \times 1.2}{4^2} = 271$$

$$K = pf_s j$$

$$271 = 20,000 \times .38 \times p$$

$$p = \frac{271}{20,000 \times .38} = .0154$$

Therefore:

$$A_s = .0154 \times 4 = .0616 \text{ sq.in./in. or } .74 \text{ sq.in./lin.ft.}$$

$$5/8 \text{ in. } \phi \quad 2 \text{ 5 in. o.c. for Ext'r.}$$

Bond Stress @ Supports:

$$v = \frac{V}{b j d} = \frac{1206}{12 \times .38 \times 4} = 28.5^{\#}/\text{sq.in.}$$

For $5/8 \text{ in. } \phi$:

$$u = \frac{vb}{\Sigma o} = \frac{28.5 \times 5}{3.142 \times 5/8} = 72.5^{\#}/\text{sq.in.}$$

Computation for Steel in Steel in Interior Spans

Slab (A)

$$D = 5\text{in.} \quad d = 4\text{in.} \quad w = 134^{\#}$$

Clear Span 8ft. - 6in.

Bearing Span 9ft. - 6in.

$$M = \frac{wL^2}{12} = \frac{134 \times 8.5^2}{12} = 806\text{ft.}^{\#}/\text{ft. strip}$$

$$V = \frac{wL}{2} = \frac{134 \times 8.5}{2} = 1139 = 569.5^{\#}$$

$$R = \frac{M}{bd^2} = \frac{806 \times 12}{12 \times 4^2} = 50.4$$

$$R = f_p p_j$$

$$50.4 = 20,000 \times .88 \times p$$

$$p = \frac{50.4}{20,000 \times .88} = .0029$$

Therefore:

$$A_s = .0029 \times 4 = .0116\text{sq.in./in. or } .1322\text{sq.in./lin.ft.}$$

$$3/8\text{in. } @ 8\ 1/2\text{in. o.c.} = .15\text{sq.in./lin.ft.}$$

Bond Stress @ Supports:

$$v = \frac{V}{b_j d} = \frac{569.5}{12 \times .88 \times 4} = 13.45^{\#}/\text{sq.in.}$$

For 3/8in. 8 1/2 in. o.c.:

$$u = \frac{vb}{\phi} = \frac{13.45 \times 8.5}{3.142 \times 3/8} = 97.3^{\#}/\text{sq.in.}$$

1. The first part of the problem is to find the value of x such that

$$(x) = 0$$

$$x^2 + 2x + 1 = 0$$

$$x^2 + 2x + 1 = 0$$

$$x^2 + 2x + 1 = 0$$

$$x^2 + 2x + 1 = 0 \quad \frac{1}{x^2 + 2x + 1} = \frac{1}{x^2 + 2x + 1} =$$

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Computation for Steel in Interior Spans
Slab (B)

$$D = 5\text{in.} \quad d = 4\text{in.} \quad W = 134^{\#}$$

Clear Span 11ft. - 6in.

Bearing Span 12ft. - 6in.

$$K = \frac{WL^2}{12} = \frac{134 \times 11.5^2}{12} = 1475 \text{ft.}^{\#}/\text{ft. strip}$$

$$V = \frac{WL}{2} = \frac{134 \times 11.5}{2} = \frac{1540}{2} = 770^{\#}$$

$$R = \frac{K}{bd} = \frac{1475 \times 12}{12 \times 16} = 92.3$$

$$R = f_s j p$$

$$92.3 = 20,000 \times .38 \times p$$

$$p = \frac{92.3}{20,000 \times .38} = .00523$$

Therefore:

$$A_s = .00523 \times 4 = .02092 \text{sq.in./in. or } .25104 \text{sq.in./lin.ft.}$$

$$3/8\text{in. } \phi \text{ @ } 5\text{in. o.c.} = .26\text{sq.in./lin.ft.}$$

Bond Stress @ Supports

$$v = \frac{V}{b j d} = \frac{770}{12 \times .86 \times 4} = 18.2^{\#}/\text{sq.in.}$$

For 3/8in. ϕ @ 5in. o.c.:

$$u = \frac{vb}{\sum_o} = \frac{18.2 \times 5}{3.142 \times 3/8} = 77.3^{\#}/\text{sq.in.}$$

Computation for Steel in Interior Spans
Slab (C)

$$D = 51\text{in.} \quad d = 41\text{in.} \quad W = 134^{\#}$$

Clear Span 11ft. - 00in.

Bearing Span 12ft. - 00in.

$$M = \frac{WL^2}{12} = \frac{134 \times 11^2}{12} = 1352\text{ft.}^{\#}/\text{ft. strip}$$

$$V = \frac{WL}{2} = \frac{134 \times 11}{2} = 737.5$$

$$R = \frac{M}{bd^2} = \frac{1352.12}{12 \times 16} = 84.6$$

$$R = f_s J P$$

$$84.6 = 20,000 \times .88 \times p$$

$$p = \frac{84.6}{20,000 \times .88} = .00483$$

Therefore:

$$A_s = .00483 \times 4 = .01932\text{sq.in./in. or } .232\text{sq.in./lin.ft.}$$

$$3/8\text{in. } \phi @ 5 \frac{1}{2}\text{in. o.c.} = .24\text{sq.in./lin.ft.}$$

Bond Stress @ Supports:

$$v = \frac{V}{b_j d} = \frac{737.5}{12 \times .88 \times 4} = 17.5^{\#}/\text{sq.in.}$$

For 3/8in. $\phi @ 5 \frac{1}{2}$ in. o.c.:

$$u = \frac{vb}{\sum o} = \frac{17.5 \times 5.5}{3.142 \times 3/8} = 31.5^{\#}/\text{sq.in.}$$

$$A_{11} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \quad A_{12} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{21} = 0$$

$$A_{22} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{31} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2}$$

$$A_{32} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{41} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \quad A_{42} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{51} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \quad A_{52} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{61} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \quad A_{62} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{71} = 0$$

$$A_{81} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2}$$

$$A_{91} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \quad A_{92} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{101} = 0$$

$$A_{11} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \quad A_{12} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{21} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \quad A_{22} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{31} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2}$$

$$A_{41} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \quad A_{42} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{51} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \quad A_{52} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

$$A_{61} = \frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2} \quad A_{62} = \frac{1}{2} \left(\frac{1}{2} - \frac{1}{2} \right) = 0$$

Computation of Steel in Floor Slabs with:

$$D = 5\text{in.} \quad d = 4\text{in.} \quad W = 134^{\frac{1}{2}}$$

Slabs (F), (G), (H), (F)

Clear Span 13ft. - 00in.

Bearing Span 14ft. - 00in.

$$M = \frac{wL^2}{10} = \frac{134 \times 13^2}{10} = 2266 \text{ft.}^{\frac{1}{2}}/\text{ft. strip}$$

$$V = \frac{wL}{2} = \frac{134 \times 13}{2} = 1741 = 870.5^{\frac{1}{2}}$$

$$R = \frac{M}{bd^2} = \frac{2266 \times 12}{12 \times 4^2} = 141.6$$

$$R = f_s p j$$

$$141.6 = 20,000 \times .88 \times p$$

$$p = \frac{141.6}{20,000 \times .88} = .00805$$

Therefore:

$$A_s = .0081 \times 4 = .0324 \text{sq.in./in. or } .328 \text{sq.in./lin.ft.}$$

$$1/2\text{in. } \phi \text{ @ } 6\text{in. o.c.} = 40 \text{sq.in./lin.ft.}$$

Bond Stress @ Supports:

$$v = \frac{V}{b j d} = \frac{870.5}{12 \times .88 \times 4} = 20.6^{\frac{1}{2}}/\text{sq.in.}$$

For $1/2\text{in. } \phi$:

$$u = \frac{v b}{\sum_o} = \frac{20.6 \times 6}{3.14 \times 1/2} = 77.7^{\frac{1}{2}}/\text{sq.in.}$$

$$; \quad \text{for } i = 1, 2, \dots, n, \quad \text{for } j = 1, 2, \dots, n$$

$$x_1 = 0, \quad x_2 = 0, \quad x_3 = 0$$

$$x_1 = 0, \quad x_2 = 0, \quad x_3 = 0$$

$$x_1 = 0, \quad x_2 = 0, \quad x_3 = 0$$

$$x_1 = 0, \quad x_2 = 0, \quad x_3 = 0$$

$$x_1 = 0, \quad x_2 = 0, \quad x_3 = 0$$

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$$x_1 = 0, \quad x_2 = 0, \quad x_3 = 0$$

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$$x_1 = 0, \quad x_2 = 0, \quad x_3 = 0$$

$$x_1 = 0, \quad x_2 = 0, \quad x_3 = 0$$

Stair Slab

From table #23 "Simplified Design of Concrete Floor systems" by the Portland Cement Association.

Horizontal Span of stairs in feet 13ft. - 00in.

Total thickness of slab in inches 10 1/2

Reinforcing steel 3/4in. 6in. o.c.

For temperature reinforcement place a single 3/8in. round bar under each tread.

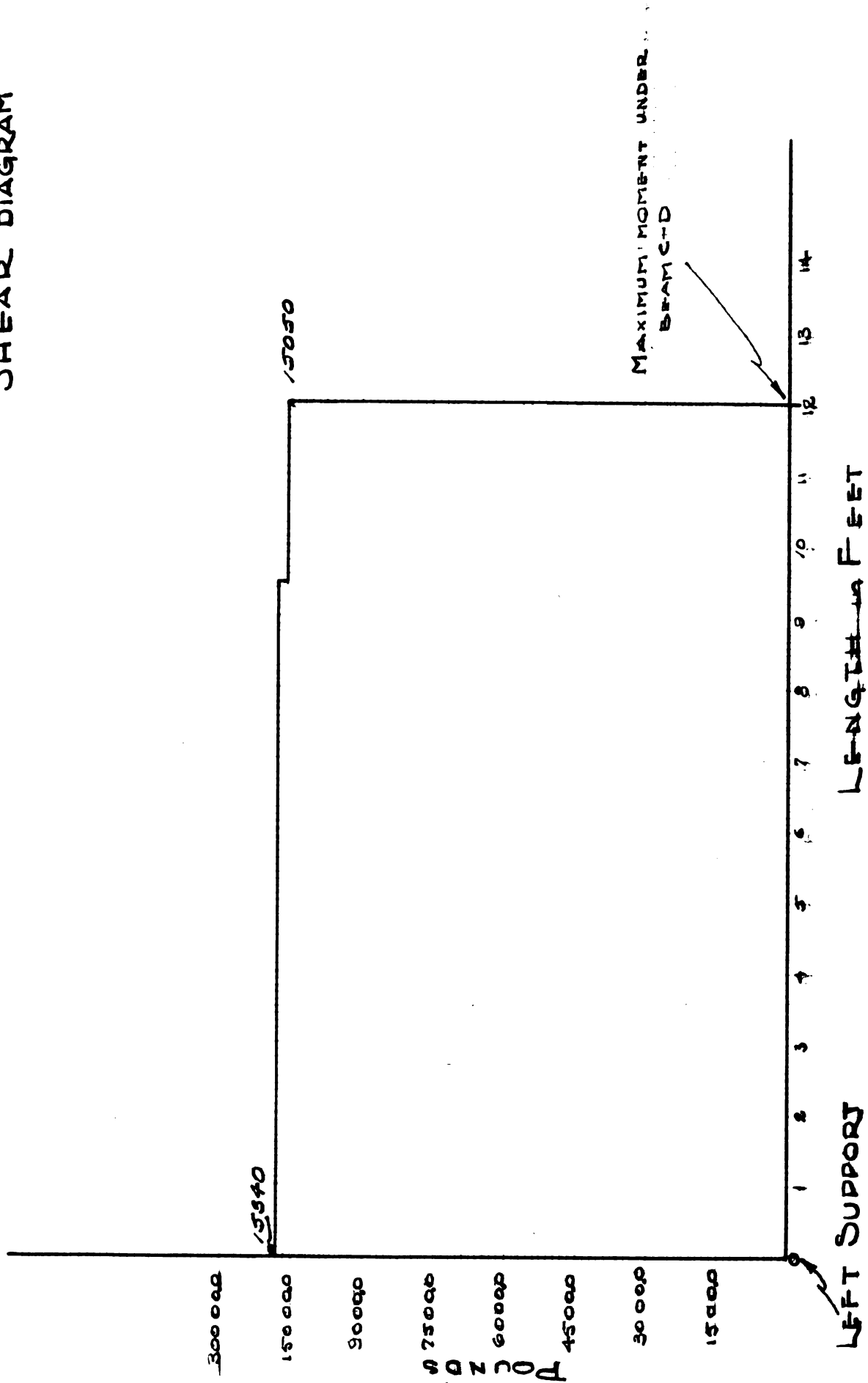
(treads add 45#/horizontal square foot.)

- The first step in the process of identifying a problem is to define the problem clearly.
- The second step is to identify the causes of the problem.
- The third step is to identify the effects of the problem.
- The fourth step is to identify the stakeholders involved in the problem.
- The fifth step is to identify the resources available to solve the problem.
- The sixth step is to identify the constraints on the solution.
- The seventh step is to identify the potential solutions.
- The eighth step is to evaluate the potential solutions.
- The ninth step is to select the best solution.
- The tenth step is to implement the solution.
- The eleventh step is to monitor the solution.
- The twelfth step is to evaluate the solution.

The original floor system lay out called for two beams, 2 ft. - 6 in. apart and running into the girder from opposite sides. One of the beams was a floor beam and the other was part of the stair well framing. In order to figure the maximum moment it was necessary to find the point where the shear was zero, this gave the location of the maximum moment. After a preliminary investigation it was found that it would be better to enlarge the stair well, running the beams together over a column. This was done in the final design.

1. The first step in the process of creating a new product is to identify a market need. This involves conducting market research to determine what consumers are looking for and what problems they are trying to solve. Once a need is identified, the next step is to develop a concept for a product that addresses that need. This often involves brainstorming and sketching out ideas. The third step is to create a prototype, which is a preliminary model of the product. This can be done using various materials and techniques, depending on the nature of the product. The fourth step is to test the prototype, which involves showing it to a group of people and gathering their feedback. This feedback is used to make improvements to the product. The fifth step is to create a business plan, which outlines the costs of production, the pricing strategy, and the marketing plan. Finally, the product is manufactured and distributed to the market.

SHEAR DIAGRAM



Computation for Floor Beams (1-10) (5-5)

Allowable $750^{\#}/\text{sq.in.}$ $f_3 = 20,000^{\#}/\text{sq.in.}$ $n = 15$

$v = 120^{\#}/\text{sq.in.}$ $u = 120^{\#}/\text{sq.in.}$

$850^{\#}/\text{sq.in.}$ at supports

Clear Span 28ft. - 00in.

Live load 40

Bearing Span 29ft. - 00in.

Dead " $\frac{24}{134}$

Panel width 19ft. - 6in.

Assume 12in. girders

Loads: Live + dead

$$\frac{134 \times 19.5}{2} = 1306$$

$$\text{stem} = 250$$

$$M = \frac{wL^2}{10} = \frac{1555 \times 29.5^2}{10} = 135,500 \text{ ft.}^{\#}/\text{ft. strip}$$

$$V = \frac{wL}{2} = \frac{1555 \times 29.5}{2} = 22,950^{\#}$$

Assume $j = .88$ 3 supports .02 at center of span

$v = 120$ with web reinforcement

Determination of beam section to care for shear

$$b^1 b = \frac{V}{jv} = \frac{22950}{.88 \times 120} = 217$$

$b = 12\text{in.}$ $d = 13.1\text{in.}$ say 13.5in.

Total depth 20.5in.

Check wt. of stem

$$\frac{(20.5-2)(12)(150)}{144} = 231^{\#}$$

Steel area Assume $j = .92$

$$A_s = \frac{135,500 \times 12}{20,000 \times .92 \times 13.5} = 4.77 \text{ sq.in.}$$

Use 4-1 1/8 in. sq. bars - 5.08 sq.ft.

Spaced 2 1/2 a. o.c.

Check Shear

$$v = \frac{22950}{12 \times .88 \times 18.5} = 117.4^{\#}/\text{sq.in.}$$

Bond

$$u = \frac{22950}{4 \times 4.5 \times .88 \times 18.5} = 48^{\#}/\text{sq.in.}$$

At supports

$$\frac{d^1}{a} = \frac{2}{13.5} = .193 \quad p' = p \frac{4.77}{12 \times 13.5} = .0215$$

From Diagram 10 Vol. 1 "Reinforced Concrete Construction"

by Hool

$$k = .415 \quad j = .833$$

$$f_s = \frac{135,500 \times 12}{5.08 \times .88 \times 18.5} = 19,500^{\#}/\text{sq.in.}$$

$$f_c = \frac{12,500 \times .42}{15(1-.42)} = 943^{\#}/\text{sq.in.}$$

Stirrup Spacing

From Fig. 17 "Simplified Design of Concrete Floor Systems"

by the Portland Cement Association

$$v = 117^{\#}/\text{sq.in.}$$

$$v - v_c = v^1$$

$$117 - 40 = 77$$

$$v^1 b = (77)(12) = 925$$

$$\begin{aligned} a &= \frac{1}{2} \left(\frac{v^1}{v} \right) \\ &= 29.5 \left(\frac{77}{117} \right) \\ &= 9.7\text{ft.} \end{aligned}$$

$$\text{Maximum allowable spacing} \quad \frac{1}{2} d = .5(13.5) = 9.7$$

Use 1/2in. v stirrups

12 @ 9in.

of stirrups in each end of beam = 12

This beam is run through building for construction. The stirrups were fig. for the longest span.

Computation for Floor Beam (2-9)

Allowable $750^{\#}/\text{sq.in.}$ $f_y = 20,000^{\#}/\text{sq.in.}$ $n = 15$

$v = 120^{\#}/\text{sq.in.}$ $u = 120^{\#}/\text{sq.in.}$

$850^{\#}/\text{sq.in.}$ supports

Live load 40

Clear Span 20ft. - 00in.

Dead " $\frac{94}{134}$

Bearing Span 29ft. - 00in.

Panel widths 1 9ft. - 6in. 9ft. - 6in.

Assume 12in. girders

Loads: Live + dead

$$134 \times \left(\frac{19.5}{2} + \frac{9.5}{2} \right) = 1941$$

$$\text{stem} = 350$$

$$M = \frac{wL^2}{10} = \frac{2291 \times 29.5^2}{10} = 199,500 \text{ ft.}^{\#}/\text{ft. strip}$$

$$V = \frac{wL}{2} = \frac{2291 \times 29.5}{2} = 33,800^{\#}$$

Assume $j = .83$ @ support $.92$ @ center of span

$v = 120^{\#}/\text{sq.in.}$ with web reinforcement

Determination of beam section to care for shear

$$b^1d = \frac{V}{jv} = \frac{33800}{.83 \times 120} = 320.0$$

$$b = 12\text{in. } d = 26.7\text{in. say } 27\text{in.}$$

Total depth 29.01in.

Check wt. of stem

$$\frac{(29-2)(12)(150)}{144} = 337.5^{\#}$$

Steel area Assume $j = .92$

$$A_s = \frac{19,9500 \times 12}{20,000 \times .92 \times 27} = 4.83 \text{ sq.in.}$$

Use 4 - 1 1/8in. sq. bars = 5.03 sq.in.

Spaced 2 1/2 d o.o.

Check Shear

$$v = \frac{33,800}{12 \times .88 \times 27} = 118.5^{\#}/\text{sq.in.}$$

Bond

$$u = \frac{33,800}{4 \times 4.5 \times 27 \times .88} = 43.0^{\#}/\text{sq.in.}$$

At Supports

$$\frac{d^1}{d} = \frac{2}{27} = .0742 \quad p = p^1 = \frac{5.03}{12 \times 27} = .0157$$

From diagram 10, Vol. 1 "Reinforced Concrete Construction"

by Hool

$$k = .39 \quad j = .37$$

$$f_s = \frac{192,500 \times 12}{5.03 \times .37 \times 27} = 20,050^{\#}/\text{sq.in.}$$

$$f_c = \frac{20,050 \times .39}{15(1-.39)} = 855^{\#}/\text{sq.in.}$$

Stirrup Spacing

From Fig. 17 "Simplified Design of Concrete Floor Systems"

by the Portland Cement Association

$$v = 119^{\#}/\text{sq.in.}$$

$$v - v_c = v^1$$

$$119 - 40 = 79$$

$$v^1 b = (79)(12) = 948$$

$$a = \frac{1}{2} \left(\frac{v^1}{v} \right) \\ = \frac{29.5(79)}{2 \times 119} \\ = 9.8\text{ft.}$$

$$\text{Maximum allowable spacing} \quad 1/2d = (.5)(27) = 13.5\text{in.}$$

$$\text{Use } 1/2\text{in. } \bigcirc \text{ Stirrups} \quad 2 - 9\text{in.} \quad 8 - 12\text{in.}$$

$$\# \text{ of Stirrups in each end of beam} = 10$$

This beam is run through the building for construction economy.

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Computation for Floor Beam (A-B)

Allowable $f_c = 750^{\#}/\text{sq.in.}$ $f_s = 20,000^{\#}/\text{sq.in.}$ $n = 15$

$v = 120^{\#}/\text{sq.in.}$ $u = 120^{\#}/\text{sq.in.}$

$850^{\#}/\text{sq.in.}$ 2 supports

Clear Span 28ft.-00in.	Live Load	40
Bearing Span 29ft.-6in.	Slab 5in.	63
Panel Widths 9ft.-6in. 12ft.-6in.	Plaster metal lath	10
Assume 12in. girders	Flooring	5
	Partitions	$\frac{16}{134}^{\#}$

Loads: Live+dead

$$134 \times \frac{(9.5 + 12.5)}{2} = 1474$$

$$\text{Stem} = \frac{200}{10}$$

$$M = \frac{WL^2}{10} = \frac{1674 \times 29.5^2}{10} = 145,700 \text{ft.}^{\#}/\text{ft. strip}$$

$$V = \frac{WL}{2} = \frac{1674 \times 29.5}{2} = 24,700^{\#}$$

Assume $j = .88$ @ support $.92$ @ center of span

$v = 120^{\#}/\text{sq.in.}$ with web reinforcement

Determination of beam section to care for shear:

$$b^1 d = \frac{V}{jv} = \frac{24,700}{.88 \times 120} = 233.7 \text{sq.in.}$$

$$b^1 = 12\text{in. } d = 19.5\text{in. say } d = 19.5\text{in.}$$

Total depth 21.5in.

Check Wt. of Stem

$$\frac{(21.5 - 2)(12)(150)}{144} = 239^{\#}$$

Wt. assumed ~~to~~ far off re-check

Live + dead load 1474

New stem wt. $\frac{250}{1724}^{\#}$

$$M = \frac{wL^2}{10} = \frac{1.224 \times 20.5^2}{10} = 150,000 \text{ ft.}^2/\text{ft. at top}$$

$$V = \frac{wL}{2} = \frac{1.724 \times 20.5}{2} = 25,400^{\#}$$

$$b^1d = \frac{25,400}{.88 \times 120} = 241 \text{ sq.in.}$$

$$b^1 = 12 \text{ in. } d = 20.5 \text{ in.}$$

Total depth 22.5 in.

Check new wt. of stem

$$\frac{(22.5-2)(12)(150)}{144} = 251^{\#}$$

New wt. of stem assumed

Steel area Assume $j = .92$

$$A_s = \frac{150,000 \times 12}{20,000 \times .92 \times 20.5} = 4.91 \text{ sq.in.}$$

Use 4 - 1 1/3 in. sq. bars 5.03 sq.in.

Spaced 3 in. o.c. 1 in. in the clear on sides

Check Shear

$$v = \frac{V}{bjd} = \frac{25,400}{12 \times (.88)(20.5)} = 117.3^{\#}/\text{sq.in.}$$

Bond

$$u = \frac{25,400}{4 \times 4.5 \times .88 \times 20.5} = 73.2^{\#}/\text{sq.in.}$$

At supports

$$\frac{d^1}{d} = \frac{2}{20.5} = .0976 \quad p = p^1 - \frac{A_s}{bd} = \frac{5.03}{12 \times 20.5} = .0206$$

From diagram 10, Vol. 1 "Reinforced Concrete Construction"

by Hool

$$k = 0.33 \quad j = 0.885$$

$$f_s = \frac{M}{A_s j d} = \frac{150,000 \times 12}{5.03 \times .885 \times 20.5} = 19,500^{\#}/\text{sq.in.}$$

$$f_c = \frac{f_s k}{1(1-k)} = \frac{19,500(.33)}{1(1-.33)} = 793^{\#}/\text{sq.in.}$$

Stirrup Spacing

From Fig. 17 "Simplified Design of Concrete Floor Systems"

by the Portland Cement Association

$$v = 117 \text{#/sq.in.}$$

$$v - v_c = v^1$$

$$117 - 40 = 77$$

$$v^1 b = (77)(12) = 925$$

$$a = \frac{d}{2} \left(\frac{v'}{v} \right)$$

$$= \frac{29.5}{2} \left(\frac{77}{117} \right)$$

$$= 2.7 \text{ft.}$$

Maximum allowable spacing

$$1/2d = .5(20.5) = 10.25 \text{in.}$$

Use $1/2 \text{in. } \phi$ stirrups

$$13 @ 9 \text{in.}$$

of stirrups in each end of beam = 13

Computation for Floor Beam (7-8)

Allowable $f_c = 750^{\#}/\text{sq.in.}$ $f_s = 20,000^{\#}/\text{sq.in.}$ $n = 15$

$v = 120^{\#}/\text{sq.in.}$ $u = 120^{\#}/\text{sq.in.}$

$850^{\#}/\text{sq.in.}$ @ supports

Clear Span 28ft. - 00in.

Live load 40

Bearing Span 29ft. - 00in.

Dead load $\frac{94}{134}^{\#}$

Panel widths 12ft. - 6in. 12ft. - 00in.

Assume 12in. girders

Loads: Live dead

$$134 \times \left(\frac{12.5}{2} + \frac{12.0}{2} \right) = 1640$$

$$\text{stem} = 300$$

$$M = \frac{wL^2}{10} = \frac{1940 \times 29.5^2}{10} = 169,000 \text{ ft.}^{\#}/\text{ft. strip}$$

$$V = \frac{wL}{2} = \frac{1940 \times 29.5}{2} = 28650^{\#}$$

Assume $j = .88$ @ support $.92$ @ center of span

$v = 120^{\#}/\text{sq.in.}$ with web reinforcement

Determination of beam section to care for shear

$$b^1 d = \frac{V}{jv} = \frac{28650}{.88 \times 120} = 271.0 \text{ sq.in.}$$

$$b^1 = 12\text{in. } d = 22.6\text{in. say } 23\text{in.}$$

Total depth 25in.

Check wt. of stem

$$\frac{(25-2)(12)(150)}{144} = 287.5^{\#}$$

Steel area Assume $j = .92$

$$A_s = \frac{169,000 \times 12}{20,000 \times .92 \times 23} = 4.79 \text{ sq.in.}$$

Use 4 - 1 1/8" sq. bars = 5.03 sq.in.

Spaced 2 1/2 d o.c.

Check Shear

$$v = \frac{23650}{2.75 \times 3 \times .88 \times 23} = 64.4^{\#}/\text{sq.in.}$$

At supports

$$\frac{d^1}{d} = \frac{2}{23} = .087 \quad p = p^1 = \frac{5.93}{12 \times 23} = .0134$$

From diagram 13. Vol. 1 "Reinforced Concrete Construction"

by Hool

$$k = .40 \quad j = .384$$

$$f_s = \frac{160,000 \times 12}{5.03 \times .384 \times 23} = 19,650^{\#}/\text{sq.in.}$$

$$f_c = \frac{19650 \times .40}{15(1-.40)} = 874^{\#}/\text{sq.in.}$$

Stirrup Spacing

From Fig. 17 "Simplified Design of Concrete Floor Systems"

by the Portland Cement Association

$$v = 113^{\#}/\text{sq.in.}$$

$$v - v_c = v^1$$

$$113 - 40 = 73$$

$$v^1 b = (73)(12) = 936$$

$$a = \frac{8(v^1)}{2v}$$

$$= \frac{29.5(73)}{113}$$

$$= 9.75\text{ft.}$$

Maximum allowable spacing

$$1/8d = .5)(23) = 11.5\text{in.}$$

Use 1/2in. ϕ stirrups

$$12 @ 9\text{in.}$$

of stirrups in each end of beam = 12

This beam is run through building for construction economy.

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Computation for Floor Beam (C-D)

Allowable $f_c = 750^{\#}/\text{sq.in.}$ $f_s = 20,000^{\#}/\text{sq.in.}$ $n = 15$

$v = 120^{\#}/\text{sq.in.}$ $u = 120^{\#}/\text{sq.in.}$

$350^{\#}/\text{sq.in.}$ 2 supports

Clear Span 23ft. - 00in.

Live load 40

Bearing Span 22ft. - 00in.

Dead " $\frac{94}{134}^{\#}$

Panel widths 12ft. - 00in. & 13ft. - 00in.

Assume 12in. girders

Loads: Live + dead

$$134\left(\frac{12}{2} + \frac{13}{2}\right) = 1975$$

$$\text{stem} = 300$$

$$W = \frac{WL}{15} = \frac{1975 \times 29.5}{15} = 172,000^{\#}/\text{ft. strip}$$

$$V = \frac{VL}{2} = \frac{1975 \times 29.5}{2} = 29,100^{\#}$$

Assume $j = .83$ @ support $.92$ @ center of span

$v = 120^{\#}/\text{sq.in.}$ with web reinforcement

Determination of beam section to care for shear

$$b^1d = \frac{v}{jv} = \frac{29,100}{.83 \times 120} = 276.2 \text{ sq.in.}$$

$$b = 12\text{in.} \quad d = 23.0\text{in.}$$

Total depth 25in.

Check wt. of stem

$$\frac{(25-2)(12)(150)}{144} = 223^{\#}$$

Steel area Assume $j = .92$

$$A_s = \frac{172,000 \times 12}{20,000 \times .92 \times 23} = 4.38 \text{ sq.in.}$$

Use 4 - 1 1/8in. sq. bars = 5.03sq.in.

Spaced 2 1/2 d c.c.

Check Shear

$$v = \frac{29,100}{12 \times .88 \times 23} = 119.9^{\circ}/\text{sq.in.}$$

Bond

$$u = \frac{29,100}{4 \times 4.5 \times .88 \times 23} = 50^{\circ}/\text{sq.in.}$$

At supports

$$\frac{d^1}{d} = \frac{2}{23} = .0369 \quad p = p^1 = \frac{52.3}{12 \times 23} = .0134$$

From diagram 10 Vol. 1 "Reinforced Concrete Construction"

$$k = .40 \quad j = .884 \quad \text{by Hook}$$

$$f_s = \frac{172,000 \times 12}{5.88 \times .884 \times 23} = 19,950^{\circ}/\text{sq.in.}$$

$$f_c = \frac{19,950 \times .40}{15(1-.43)} = 833^{\circ}/\text{sq.in.}$$

Stirrup Spacing

From Fig. 17 "Simplified Design of Concrete Floor Systems"

$$v = 120^{\circ}/\text{sq.in.} \quad \text{by the Portland Cement Association}$$

$$v - v_c = v^1$$

$$120 - 40 = 80$$

$$v^1 b = (80)(12) = 960$$

$$a = \frac{l}{2} \left(\frac{v^1}{v} \right)$$

$$= \frac{22.5}{2} \left(\frac{80}{120} \right)$$

$$= 9.85$$

$$\text{Maximum allowable spacing: } l/23 = .5(23) = 11.51\text{in.}$$

$$\text{Use } l/21\text{in.}^{\circ} \text{ stirrups } 13^{\circ} \text{ 9in.}$$

$$\frac{1}{2} \text{ of stirrups in each end of beam } = 13$$

This beam is to be run through the building for construction economy.

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Computation for Floor Beam (4-7)

Allowable $f_c = 750^{\#}/\text{sq.in.}$ $f_s = 20,000^{\#}/\text{sq.in.}$ $n = 15$

$v = 120^{\#}/\text{sq.in.}$ $u = 120^{\#}/\text{sq.in.}$

$330^{\#}/\text{sq.in.}$ supports

Clear Span 23ft. - 00in.

Live Load 40

Bearing Span 20ft. - 6in.

Dead " $\frac{94}{134}^{\#}$

Panel widths 19ft. - 6in. 13ft. - 00in.

Assume 12in. girders

Loads: Live + dead

$$134 \times \left(\frac{19.5}{2} + \frac{13.0}{2} \right) = 2177.5$$

$$\text{stem} = 400$$

$$M = \frac{wL^2}{10} = \frac{2577.5 \times 29.5^2}{10} = 224,500 \text{ ft.}^{\#}/\text{ft. strip}$$

$$V = \frac{wL}{2} = \frac{2577.5 \times 29.5}{2} = 38,000^{\#}$$

Assume $j = .88$ supports $.92$ center of span

$v = 120^{\#}/\text{sq.in.}$ with web reinforcement

Determination of beam to care for shear

$$b'd = \frac{V}{jv} = \frac{38,000}{.88 \times 120} = 360$$

$$b = 12\text{in. } d = 30\text{in.}$$

Total depth = 32in.

Check wt. of stem

$$\frac{(32-2)(12)(150)}{144} = 375^{\#}$$

Steel area Assume $j = .92$

$$A_s = \frac{224,500 \times 12}{20,000 \times .92 \times 30} = 4.39 \text{ sq.in.}$$

Use 4 - 1 1/8in. sq. bars = 5.06 sq.in.

Spaced 2 1/2d c.c.

1. $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$
 2. $\frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$
 3. $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$
 4. $\frac{1}{2} \times \frac{1}{8} = \frac{1}{16}$
 5. $\frac{1}{4} \times \frac{1}{8} = \frac{1}{32}$
 6. $\frac{1}{8} \times \frac{1}{8} = \frac{1}{64}$

7. $\frac{1}{2} \times \frac{1}{16} = \frac{1}{32}$
 8. $\frac{1}{4} \times \frac{1}{16} = \frac{1}{64}$
 9. $\frac{1}{8} \times \frac{1}{16} = \frac{1}{128}$
 10. $\frac{1}{16} \times \frac{1}{16} = \frac{1}{256}$

11. $\frac{1}{2} \times \frac{1}{32} = \frac{1}{64}$
 12. $\frac{1}{4} \times \frac{1}{32} = \frac{1}{128}$
 13. $\frac{1}{8} \times \frac{1}{32} = \frac{1}{256}$
 14. $\frac{1}{16} \times \frac{1}{32} = \frac{1}{512}$

15. $\frac{1}{2} \times \frac{1}{64} = \frac{1}{128}$
 16. $\frac{1}{4} \times \frac{1}{64} = \frac{1}{256}$
 17. $\frac{1}{8} \times \frac{1}{64} = \frac{1}{512}$
 18. $\frac{1}{16} \times \frac{1}{64} = \frac{1}{1024}$

19. $\frac{1}{2} \times \frac{1}{128} = \frac{1}{256}$
 20. $\frac{1}{4} \times \frac{1}{128} = \frac{1}{512}$
 21. $\frac{1}{8} \times \frac{1}{128} = \frac{1}{1024}$
 22. $\frac{1}{16} \times \frac{1}{128} = \frac{1}{2048}$

23. $\frac{1}{2} \times \frac{1}{256} = \frac{1}{512}$
 24. $\frac{1}{4} \times \frac{1}{256} = \frac{1}{1024}$
 25. $\frac{1}{8} \times \frac{1}{256} = \frac{1}{2048}$
 26. $\frac{1}{16} \times \frac{1}{256} = \frac{1}{4096}$

27. $\frac{1}{2} \times \frac{1}{512} = \frac{1}{1024}$
 28. $\frac{1}{4} \times \frac{1}{512} = \frac{1}{2048}$
 29. $\frac{1}{8} \times \frac{1}{512} = \frac{1}{4096}$
 30. $\frac{1}{16} \times \frac{1}{512} = \frac{1}{8192}$

31. $\frac{1}{2} \times \frac{1}{1024} = \frac{1}{2048}$
 32. $\frac{1}{4} \times \frac{1}{1024} = \frac{1}{4096}$
 33. $\frac{1}{8} \times \frac{1}{1024} = \frac{1}{8192}$
 34. $\frac{1}{16} \times \frac{1}{1024} = \frac{1}{16384}$

35. $\frac{1}{2} \times \frac{1}{2048} = \frac{1}{4096}$
 36. $\frac{1}{4} \times \frac{1}{2048} = \frac{1}{8192}$
 37. $\frac{1}{8} \times \frac{1}{2048} = \frac{1}{16384}$
 38. $\frac{1}{16} \times \frac{1}{2048} = \frac{1}{32768}$

39. $\frac{1}{2} \times \frac{1}{4096} = \frac{1}{8192}$
 40. $\frac{1}{4} \times \frac{1}{4096} = \frac{1}{16384}$
 41. $\frac{1}{8} \times \frac{1}{4096} = \frac{1}{32768}$
 42. $\frac{1}{16} \times \frac{1}{4096} = \frac{1}{65536}$

43. $\frac{1}{2} \times \frac{1}{8192} = \frac{1}{16384}$
 44. $\frac{1}{4} \times \frac{1}{8192} = \frac{1}{32768}$
 45. $\frac{1}{8} \times \frac{1}{8192} = \frac{1}{65536}$
 46. $\frac{1}{16} \times \frac{1}{8192} = \frac{1}{131072}$

47. $\frac{1}{2} \times \frac{1}{16384} = \frac{1}{32768}$
 48. $\frac{1}{4} \times \frac{1}{16384} = \frac{1}{65536}$
 49. $\frac{1}{8} \times \frac{1}{16384} = \frac{1}{131072}$
 50. $\frac{1}{16} \times \frac{1}{16384} = \frac{1}{262144}$

51. $\frac{1}{2} \times \frac{1}{32768} = \frac{1}{65536}$
 52. $\frac{1}{4} \times \frac{1}{32768} = \frac{1}{131072}$
 53. $\frac{1}{8} \times \frac{1}{32768} = \frac{1}{262144}$
 54. $\frac{1}{16} \times \frac{1}{32768} = \frac{1}{524288}$

55. $\frac{1}{2} \times \frac{1}{65536} = \frac{1}{131072}$
 56. $\frac{1}{4} \times \frac{1}{65536} = \frac{1}{262144}$
 57. $\frac{1}{8} \times \frac{1}{65536} = \frac{1}{524288}$
 58. $\frac{1}{16} \times \frac{1}{65536} = \frac{1}{1048576}$

59. $\frac{1}{2} \times \frac{1}{131072} = \frac{1}{262144}$
 60. $\frac{1}{4} \times \frac{1}{131072} = \frac{1}{524288}$
 61. $\frac{1}{8} \times \frac{1}{131072} = \frac{1}{1048576}$
 62. $\frac{1}{16} \times \frac{1}{131072} = \frac{1}{2097152}$

63. $\frac{1}{2} \times \frac{1}{262144} = \frac{1}{524288}$
 64. $\frac{1}{4} \times \frac{1}{262144} = \frac{1}{1048576}$
 65. $\frac{1}{8} \times \frac{1}{262144} = \frac{1}{2097152}$
 66. $\frac{1}{16} \times \frac{1}{262144} = \frac{1}{4194304}$

Check Shear

$$v = \frac{73,000}{12 \times 30 \times 30} = 120^{\#}/sq.in.$$

Bond

$$u = \frac{73,000}{4 \times 3.14 \times 1.5 \times 30} = 60^{\#}/sq.in.$$

At supports

$$\frac{d'}{d} = \frac{12}{30} = .4 \quad p = p' = \frac{3.14}{12 \times 70} = .0041$$

From diagram 10 Vol. 1 "Reinforced Concrete Construction"
by Hool

$$k = .373 \quad j = .385$$

$$f_s = \frac{22' \times 500 \times 12}{5 \times 14 \times 30 \times 30} = 19,900^{\#}/sq.in.$$

$$f_c = \frac{19,900 \times .373}{15(1 - .373)} = 806^{\#}/sq.in.$$

Stirrup Spacing

From Fig. 17 "Simplified Design of Concrete Floor Systems"
by the Portland Cement Association

$$v = 120^{\#}/sq.in.$$

$$v - v_s = v'$$

$$120 - 40 = 80$$
$$v'b = (80)(12) = 960$$

$$a = \frac{(v')}{v}$$

$$= \frac{20.5}{2} \times \frac{(30)}{120}$$

$$= 9.85 ft.$$

Maximum allowable spacing

$$1/2d = .5(30) = 15 in.$$

Use 1/21 ft. ~~2~~ stirrups

$$2 \times 9 in. \quad 1 \times 12 in. \quad 5 \times 15 in.$$

of stirrups in each end of beam = 8

This beam is to be run through the building for construction economy.

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Computation for Floor Girder (6-7-8-9-10)

These girder dimensions are to be used for floor girders:

(1-2-3-4-5-) (11-12-13-14-15-16)

Allowable $f_c = 750^{\#}/\text{sq.in.}$ $f_s = 20,000^{\#}/\text{sq.in.}$ $n = 15$

$v = 120^{\#}/\text{sq.in.}$ $u = 120^{\#}/\text{sq.in.}$

$350^{\#}/\text{sq.in.}$ supports

Clear Span 21ft. - 00in.

Bearing Span 22ft. - 00in.

Panel widths 9ft. - 6in. 12ft. - 6in.

Loads: V from beam (AB) 25,400

Stem = 400

Floor Slab (H) $= \frac{134 \times 14.5}{2} = \underline{971}$

$\frac{1371 \times 22}{2} = \underline{15081}$

Total V = 40,481[#]

Maximum bending moment

$$M = \frac{Pab}{22} - \frac{(25,400)(9.5)(12.5)}{22} \times \frac{8}{10} = 109,200\text{ft.}^{\#}$$

$$1371 \times 22 \times \frac{1}{10} = 66,400\text{ft.}^{\#}$$

Total M = 176,300ft.[#]

Stem shear

$$b'd = \frac{40,481}{155 \times 120} = 383\text{sq.in.}$$

$b' = 12\text{in.}$ $d = 32\text{in.}$

Total depth 34in.

Check wt. of stem

$$\frac{(34-2)(12)(150)}{144} = 401$$

Steel area assumed $j = .92$

$$A_s = \frac{176,300 \times 12}{20,000 \times 9 \times 32} = 3.59 \text{ sq. in.}$$

Use 4 - 1 in. sq. bars = 4.00 sq. in.

Spaced 2 1/2 in. c.c.

Check Shear

$$v = \frac{40,401}{12 \times 9 \times 32} = 112.9' / \text{sq. in.}$$

Bond

$$u = \frac{40,401}{4 \times 4 \times 9 \times 32} = 89.3' / \text{sq. in.}$$

At supports

$$\frac{d'}{d} = \frac{2}{32} = .0625 \quad p = p' = \frac{1.00}{12 \times 32} = .0104$$

From diagram 19, Vol. 1 "Reinforced Concrete Construction"

by Hool

$$k = .35 \quad j = .69$$

$$f_s = \frac{176,300}{3.14 \times 9 \times 32} = 19,610' / \text{sq. in.}$$

$$f_c = \frac{19,610 \times 12}{16(1-.69)} = 773' / \text{sq. in.}$$

1. The first part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation

$$f(x) = \int_0^x \frac{1}{1+t^2} dt, \quad (1)$$

where x is a real number.

It is well known that

$$f(x) = \arctan x, \quad (2)$$

and

$$f'(x) = \frac{1}{1+x^2}. \quad (3)$$

From (2) and (3) it follows that the function $f(x)$ is an odd function and that its graph is a curve passing through the origin and having a horizontal asymptote at $y = \frac{\pi}{2}$.

$$\lim_{x \rightarrow \infty} f(x) = \frac{\pi}{2}, \quad \lim_{x \rightarrow -\infty} f(x) = -\frac{\pi}{2}. \quad (4)$$

It is also known that the function $f(x)$ is concave down for $x > 0$ and concave up for $x < 0$.

$$f(x) = \arctan x, \quad (5)$$

$$f'(x) = \frac{1}{1+x^2}, \quad (6)$$

$$f''(x) = -\frac{2x}{(1+x^2)^2}. \quad (7)$$

Typical Column Design

by using Table 13 page 43 in "Reinforced Concrete Design" by Sutherland and Clifford

Column #9 $n = 15$

Third Floor

Load: live dead = 39,043"

Size of column = 14in.

$A_s = .98\text{sq.in.}$ Use 4 - 1/2in.sq. $A_g = 1.90\text{sq.in.}$

Second Floor

Load: live dead = 173,096"

Size of column = 20in.

$A_s = 2.30\text{sq.in.}$ Use 4 - 3/4in.sq. $A_g = 2.25\text{sq.in.}$

First floor

Load: live dead = 267,144"

Size of column = 24in.

$A_s = 2.88\text{sq.in.}$ Use 4 - 7/8in.sq. $A_g = 3.06\text{sq.in.}$

Basement

Load: live dead = 356,192"

Size of column = 28in.

$A_s = 3.92\text{sq.in.}$ Use 4 - 1 in. sq. $A_g = 4.36\text{sq.in.}$

For lateral ties use 1/4in. round bars. Spaced 7.5in. apart.

Design of a Footing for an Interior Column

Use 2,000#/sq.in. concrete and 20,000#/sq.in. steel

Column load 356,192

Soil pressure - 2,000#/sq.ft. (Sandy Clay)

Select two-way reinforcement

Assume wt. of footing = 33,000

$$\begin{array}{r} \text{Footing base area required } 356,192 \\ \quad \quad \quad 33,000 \\ \hline 389,192 = 194.5 \text{ sq.ft.} \\ \quad \quad \quad 2,000 \end{array}$$

Base of footing 14ft. sq.

$$W = 2,000 \text{#/sq.ft.}$$

$$a = 28 \text{in.} = 2.4 \text{ft.}$$

$$c = 1/2(14 - 2.4) = 5.8 \text{ft.}$$

$$M = \frac{W}{2}(a + 1.2c)c^2 = \frac{2,000(2.4 + 1.2)(5.8)}{2} 33.6$$

$$= 316,100 \text{ft.}^2 = 3,769,200 \text{in.}^2$$

$$\text{Try } d = 40 \text{in.} \quad \text{a total depth} = 44 \text{in.}$$

Shear

$$V = W L^2 - (a + 2d)^2 = 2,000 \overline{14} - (2.4 + 6.67)^2$$

$$= 2,000 \overline{196} - 82.2$$

$$= 227,600$$

$$d = 12 \quad j = .87$$

$$v = \frac{227,600}{4(2.4 + 6.67)(12)(.87)(13)} = 45.7 \text{ sq.in.}$$

Allowable shear $v = .06 \quad f_c = 120 \text{#/sq.ft.}$ with ordinary anchorage.

$$A_s = \frac{M}{f_s j d} = \frac{3,769,200}{20,000(.87)(40)} = 5.35 \text{ sq.in.}$$

Use 14- 5/8in. sq. bars for each band, giving a steel area of 5.47 sq.in.

Effective width of footing

$$= a + 1/2(L-a-2d) = 2.4 + 6.67 + 1/2(14-2.4-6.67)$$

$$= 11.83\text{ft.} = 138.3\text{in.}$$

Space the 14 bars equally over 138in. about 9.86in. c.c.

Two ways

Bond

$$u = \frac{\pi(ac+c^2)}{2jd} = \frac{2,000(13.83+33.65)}{(14)(2.5)(.88)(40)} = 76.5''/\text{sq.in.}$$

1. The first part of the document is a letter from the

author to the editor of the journal, in which he

states that he is submitting the enclosed

manuscript for consideration for publication in the

journal.

2. The

second part of the document is a letter from the

The following computations were made ~~of~~
the original lay out but as there was a change
made in the continuity they had to be discarded.

J. E. B.

Computation for Floor Slab: (A) using $M = \frac{wL^2}{10}$

Allowable $f_c = 750$ $f_s = 20,000$ $n = 15$ $v = 120$ $u = 120$

Clear Span 8ft. - 6in.	Live load	40
Bearing Span 9ft. - 6in.	Slab 4in.	50
Assume 12in. beams	Plaster metal lath 10	
	Flooring	5
	Partitions	$\frac{16}{121} \text{ /sq.ft.}$

$$M = \frac{wL^2}{10} = \frac{121 \times 3.6^2}{10} = 894.92 \text{ ft./ft. strip. Interior Span}$$

$$V = \frac{wL}{2} = \frac{121 \times 3.6}{2} = 520.3$$

Thickness:

$$d = \sqrt{\frac{M}{bR}} = \sqrt{\frac{894.92 \times 12}{12 \times 113.8}} = \sqrt{7.54} = 2.65 \text{ say } 3.00$$

$$D = \frac{1.00 \text{ in.}}{4.00 \text{ in.}}$$

Use 4in. Slab

$$d = 3 \text{ in.}$$

Floor Slab: Steel

$$\text{Interior Span: } A_s = pbd = .0058 \times 12 \times 3 = .2348 \text{ sq. in.}$$

ϕ 3/8 in. ϕ 5 1/2 in. o.c. for Interior

Bond Stress at Supports:

$$v = \frac{V}{bjd} = \frac{520.3}{12 \times .38 \times 3} = 16.42 \text{ /sq.in.}$$

For 3/8 in. ϕ :

$$u = \frac{vb}{\sum o} = \frac{16.42 \times 5.5}{3.142 \times 3/8} = 76.7 \text{ /sq.in.}$$

$$f_1(x) = f_2(x) = \dots = f_n(x) = 0 \quad (1)$$

$$f_1(x) = f_2(x) = \dots = f_n(x) = 0 \quad (2)$$

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$$f_1(x) = f_2(x) = \dots = f_n(x) = 0 \quad (4)$$

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Computation for Floor Slab (B) using $M = \frac{WL}{10}$

Allowable $f_c = 750$ $f_s = 20,000$ $n = 15$ $v = 120$ $u = 120$

Clear Span 11ft. - 6in.	Live load	40
Bearing Span 12ft. - 6in.	Slab 5in.	63
Assume 12in. beams	Plaster metal lath	10
	Flooring	5
	Partitions	$\frac{16}{134} \text{#/sq.ft.}$

$$M = \frac{WL}{10} = \frac{134 \times 11.5}{10} = 177 \text{ ft.}^2 \text{/ft. strip. Interior Span}$$

$$V = \frac{WL}{2} = \frac{134 \times 11.5}{2} = 770.5$$

Thickness:

$$d = \frac{M}{bR} = \sqrt{\frac{1771 \times 12}{12 \times 118.8}} = \sqrt{14.92} = 3.86 \text{ say } 4.00$$

$$D = \frac{1.00 \text{ in.}}{5.00 \text{ in.}}$$

Use 5in. Slab

$$d = 4 \text{ in.}$$

Floor Slab: Steel

Interior Span:

$$A_s = p d b = .0068 \times 12 \times 4 = .326$$

$3/8 \text{ in. } \phi$ 4in. o.c. for Intr.

Bond Stress @ Supports:

$$v = \frac{V}{b j d} = \frac{770.5}{12 \times .38 \times 4} = 18.28 \text{ \#/sq. in.}$$

For $3/8 \text{ in. } \phi$:

$$u = \frac{v b}{\sum o} = \frac{18.28 \times 4}{3.142 \times 3/8} = 62.0 \text{ \#/sq. in.}$$

$$\frac{1}{\sqrt{1-\beta^2}} = \gamma$$

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$$\frac{1}{\sqrt{1-\beta^2}} = \gamma$$

Computation for Floor Slab (C) using $M = \frac{WL^2}{10}$

Allowable $f_c = 750$ $f_s = 20,000$ $n = 15$ $v = 120$ $u = 120$

Clear Span 11ft. - 00in.	Live load	40
Bearing Span 12ft. - 00in.	Slab 5in.	50
Assume 12in. beams	Plaster metal lath	10
	Flooring	5
	Partitions	$\frac{16}{134}^{\#}/\text{sq.ft.}$

$$M = \frac{WL^2}{10} = \frac{134 \times 11^2}{10} = 1621^{\#}/\text{ft. strip. Interior span}$$

$$V = \frac{WL}{2} = \frac{134 \times 11}{2} = 737.5^{\#}$$

Thickness:

$$d = \sqrt{\frac{M}{bR}} = \sqrt{\frac{1621 \times 12}{12 \times 118.8}} = \sqrt{13.68} = 3.7 \text{ say } 4.0$$

$$D = \frac{1.0\text{in.}}{5.0\text{in.}}$$

Use 5in. Slab

$$d = 4\text{in.}$$

Floor Slab: Steel

Interior Span:

$$A_s = p d b = .0068 \times 12 \times 4 = .326 \text{ sq.in.}$$

$\frac{3}{8}$ ft. ϕ @ 4in. o.c. for Int.

Bond Stress @ Supports:

$$v = \frac{V}{b j d} = \frac{737.5}{12 \times .88 \times 4} = 17.47^{\#}/\text{sq.in.}$$

For $\frac{3}{8}$ in. ϕ :

$$u = \frac{v b}{\sum o} = \frac{17.47 \times 4}{3.142 \times \frac{3}{8}} = 55.9^{\#}/\text{sq.in.}$$

Computation for Floor Slab (D) using $M = \frac{WL^2}{10}$

Allowable $f_c = 750$ $f_s = 20,000$ $n = 15$ $v = 120$ $u = 120$

Clear Span 12 ft. - 00in. Live load 40

Bearing Span 13ft. - 00in. Slab 5in. 63

Assume 12in. beam. Plaster metal lath 10

Flooring 5

Partitions $\frac{16}{134} \#/\text{sq.ft.}$

$$M = \frac{WL^2}{10} = \frac{134 \times 12^2}{10} = 1930 \#/\text{ft. strip. Interior span}$$

$$V = \frac{WL}{2} = \frac{134 \times 12}{2} = 804 \#$$

Thickness:

$$d = \sqrt{\frac{M}{bR}} = \sqrt{\frac{1930 \times 12}{12 \times 118.8}} = \sqrt{16.23} = 4.03 \text{ say } 4.00$$

$$D = \frac{1.00 \text{ in.}}{4.00 \text{ in.}}$$

Use 5in. Slab

$$d = 4 \text{ in.}$$

Floor Slab: Steel

Interior Span:

$$A_s = p d b = .0068 \times 12 \times 4 = .326$$

$3/8 \text{ in. } \phi @ 4 \text{ in. o.c. for Int.}$

Bond Stress @ Supports:

$$v = \frac{V}{b j d} = \frac{804}{12 \times .38 \times 4} = 19.1 \#/\text{sq.in.}$$

For $3/8 \text{ in. } \phi$:

$$u = \frac{v b}{\sum o} = \frac{19.1 \times 4}{3.142 \times 3/8} = 64.5 \#/\text{sq.in.}$$

Computation for Floor Slab (A) using $M = \frac{WL^2}{8}$

Allowable $f_c = 750$ $f_s = 20,000$ $n = 15$ $v = 120$ $u = 120$

Clear Span 8 ft. - 6in. Live load 40

Bearing Span 9ft. - 6in. Slab 4in. 50

Assume 12in. beams Plaster metal lath 10

Flooring 5

Partitions $\frac{16}{121}$ /sq.ft.

$$M = \frac{WL^2}{8} = \frac{121 \times 5.5^2}{8} = 1119 \text{ ft.}^2 / \text{ft. strip. Interior Span}$$

$$V = \frac{WL}{2} = \frac{121 \times 5.5}{2} = 520.3$$

Thickness:

$$d = \sqrt{\frac{M}{bR}} = \sqrt{\frac{1119 \times 12}{12 \times 118.8}} = \sqrt{9.44} = 3.04 \text{ say } 3.00$$

$$D = \frac{1.00 \text{ in.}}{4.00 \text{ in.}}$$

Use 4in. Slab

$$d = 3 \text{ in.}$$

Floor Slab: Steel

Interior Span:

$$A_s = \rho b d = .0068 \times 3 \times 12 = .2348 \text{ sq.in.}$$

ϕ 3/8 in. @ 5 1/2 in. o.c. Intr.

Bond Stress @ Support:

$$v = \frac{V}{b j d} = \frac{520.3}{12 \times .83 \times 3} = 16.42 \text{ /sq.in.}$$

For 3/8 in. ϕ :

$$u = \frac{v b}{\sum} = \frac{16.42 \times 5.5}{3.142 \times 3/8} = 76.7 \text{ /sq.in.}$$

1. The first part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation

$$f(x) = \frac{1}{2} \left(f\left(\frac{x}{2}\right) + f\left(\frac{x+1}{2}\right) \right)$$

where $f(x)$ is a function defined on the interval $[0, 1]$ and satisfying the condition

$$f(0) = 0, \quad f(1) = 1.$$

It is shown that the function $f(x)$ is continuous on the interval $[0, 1]$ and that it is differentiable at the point $x = \frac{1}{2}$.

2. In the second part of the paper, the function $f(x)$ is studied in more detail. It is shown that the function $f(x)$ is a fractal function and that it has a self-similar structure.

3. The third part of the paper is devoted to the study of the properties of the function $f(x)$ in the case when the function $f(x)$ is defined on the interval $[0, 1]$ and satisfies the condition

$$f(x) = \frac{1}{2} \left(f\left(\frac{x}{2}\right) + f\left(\frac{x+1}{2}\right) \right) + \frac{1}{2} \left(f\left(\frac{x}{2}\right) - f\left(\frac{x+1}{2}\right) \right) x.$$

$$f(0) = 0, \quad f(1) = 1.$$

It is shown that the function $f(x)$ is a fractal function and that it has a self-similar structure.

$$f(x) = \frac{1}{2} \left(f\left(\frac{x}{2}\right) + f\left(\frac{x+1}{2}\right) \right) + \frac{1}{2} \left(f\left(\frac{x}{2}\right) - f\left(\frac{x+1}{2}\right) \right) x.$$

$$f(0) = 0, \quad f(1) = 1.$$

It is shown that the function $f(x)$ is a fractal function and that it has a self-similar structure.

$$f(0) = 0, \quad f(1) = 1.$$

4. The fourth part of the paper is devoted to the study of the properties of the function $f(x)$ in the case when the function $f(x)$ is defined on the interval $[0, 1]$ and satisfies the condition

$$f(x) = \frac{1}{2} \left(f\left(\frac{x}{2}\right) + f\left(\frac{x+1}{2}\right) \right) + \frac{1}{2} \left(f\left(\frac{x}{2}\right) - f\left(\frac{x+1}{2}\right) \right) x.$$

$$f(0) = 0, \quad f(1) = 1.$$

It is shown that the function $f(x)$ is a fractal function and that it has a self-similar structure.

5. The fifth part of the paper is devoted to the study of the properties of the function $f(x)$ in the case when the function $f(x)$ is defined on the interval $[0, 1]$ and satisfies the condition

$$f(x) = \frac{1}{2} \left(f\left(\frac{x}{2}\right) + f\left(\frac{x+1}{2}\right) \right) + \frac{1}{2} \left(f\left(\frac{x}{2}\right) - f\left(\frac{x+1}{2}\right) \right) x.$$

$$f(0) = 0, \quad f(1) = 1.$$

$$f(x) = \frac{1}{2} \left(f\left(\frac{x}{2}\right) + f\left(\frac{x+1}{2}\right) \right) + \frac{1}{2} \left(f\left(\frac{x}{2}\right) - f\left(\frac{x+1}{2}\right) \right) x.$$

Computation for Floor Slab (B) using $M = \frac{WL^2}{8}$

Allowable $f_c = 750$ $f_s = 20,000$ $n = 15$ $v = 120$ $u = 120$

Clear Span 11ft. - 6in.	Live load	40
Bearing Span 12ft. - 6in.	Slab 6in.	75
	Plaster metal lath	10
	Flooring	5
	Partitions	$\frac{16}{176} \#/\text{sq.ft.}$

$$M = \frac{WL^2}{8} = \frac{146 \times 11.5^2}{8} = 2415 \text{ ft.}^2/\text{ft. strip}$$

$$V = \frac{WL}{2} = \frac{146 \times 11.5}{2} = 1680 = 840 \#$$

Thickness:

$$d = \sqrt{\frac{M}{bR}} = \sqrt{\frac{2415 \times 12}{12 \times 118.8}} = \sqrt{20.35} = 4.52 \text{ say } 5.00$$

$$D = \frac{1.00 \text{ in.}}{6.00 \text{ in.}}$$

Use 6in. Slab

$$d = 5 \text{ in.}$$

Floor Slab: Steel

Interior Span:

$$A_s = p d b = .0068 \times 12 \times 5 = .408$$

$$1/2 \text{ in. } \phi = 5 \text{ } 1/2 \text{ o.c. for Intr.}$$

Bond Stress @ Supports:

$$v = \frac{V}{b j d} = \frac{840}{12 \times .88 \times 5} = 15.9 \#/\text{sq.in.}$$

For $1/2 \text{ in. } \phi$:

$$u = \frac{v b}{\Sigma_o} = \frac{15.9 \times 5.5}{3.142 \times 1/2} = 55.5 \#/\text{sq.in.}$$

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Computation for Floor Slab (C) using $M = \frac{WL^2}{8}$

Allowable $f_c = 750$ $f_s = 20,000$ $n = 15$ $v = 120$ $u = 120$

Clear Span 11ft. - 00in. Live load 40

Bearing Span 12ft. - 00in. Slab 5 1/2in. 69

Assume 12in. beam Plaster metal lath 10

Flooring 5

Partitions $\frac{16}{140} \text{ #/sq.ft.}$

$$M = \frac{WL^2}{8} = \frac{140 \times 3.142^2}{8} = 2120 \text{ ft. #/ft. strip. Interior Span}$$

$$V = \frac{WL}{2} = \frac{1530}{2} = 765 \text{ #}$$

Thickness:

$$d = \sqrt{\frac{M}{bR}} = \sqrt{\frac{2120 \times 12}{12 \times 118.8}} = \sqrt{17.7} = 4.21 \text{ say } 4.50$$

$$D = \frac{1.00 \text{ in.}}{5.50 \text{ in.}}$$

Use 5.5in. Slab

$$d = 4.5 \text{ in.}$$

Floor Slab: Steel

Interior Span:

$$A_s = p d b = .0068 \times 12 \times 4.5 = .367$$

$$1/2 \text{ in. } \phi @ 6 \text{ 1/2 in. o. c. Intr.}$$

Bond Stress @ Supports:

$$v = \frac{V}{b j d} = \frac{765 \text{ #}}{12 \times .88 \times 4.5} = 16.1 \text{ #/sq. in.}$$

For 12 in. ϕ :

$$u = \frac{v b}{\sum o} = \frac{16.1 \times 6.5}{3.142 \times 1/2} = 66.5 \text{ #/sq. in.}$$

1. $\frac{1}{x^2} = x^{-2}$ $\frac{d}{dx} x^{-2} = -2x^{-3} = -\frac{2}{x^3}$

$$\frac{d}{dx} \frac{1}{x^2} = -\frac{2}{x^3}$$

2. $\frac{1}{x^3} = x^{-3}$ $\frac{d}{dx} x^{-3} = -3x^{-4} = -\frac{3}{x^4}$

3. $\frac{1}{x^4} = x^{-4}$ $\frac{d}{dx} x^{-4} = -4x^{-5} = -\frac{4}{x^5}$

4. $\frac{1}{x^5} = x^{-5}$ $\frac{d}{dx} x^{-5} = -5x^{-6} = -\frac{5}{x^6}$

$$\frac{d}{dx} \frac{1}{x^n} = -\frac{n}{x^{n+1}}$$

$$\frac{d}{dx} x^{-n} = -n x^{-n-1}$$

5. $\frac{1}{x^6} = x^{-6}$

$$\frac{d}{dx} \frac{1}{x^6} = -\frac{6}{x^7} = -\frac{6}{x^7}$$

$$\frac{d}{dx} \frac{1}{x^6} = -\frac{6}{x^7}$$

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Computation for Floor Slab (D) using $M = \frac{WL^2}{8}$

Allowable $f_c = 750$ $f_s = 20,000$ $n = 15$ $v = 120$ $u = 120$

Clear Span 12ft. - 00in. Live load 40

Bearing Span 13ft. - 00in. Slab 6in. 75

Assume 12in. beam Plaster metal lath 10

Flooring 5

Partitions $\frac{16}{146} \#/\text{sq. ft.}$

$$M = \frac{WL^2}{8} = \frac{146 \times 12^2}{8} = 2630 \text{ ft.}^2/\text{ft. strip. Interior Span}$$

$$V = \frac{WL}{2} = \frac{1751}{2} = 875.5 \#$$

Thickness:

$$d = \sqrt{\frac{M}{LR}} = \sqrt{\frac{2630 \times 12}{12 \times 118.8}} = \sqrt{22.3} = 4.72 \text{ say } 5.00$$

$$D = \frac{1.00 \text{ in.}}{6.00 \text{ in.}}$$

Use 6in. Slab

$d = 5 \text{ in.}$

Floor Slab: Steel

Interior Span:

$$A_s = p d b = .0068 \times 5 \times 12 = .407$$

$1/2 \text{ in.} \phi \approx 5 \text{ } 1/2 \text{ in. o.c. for Intr.}$

Bond Stress @ Supports:

$$v = \frac{V}{b j d} = \frac{875.5}{12 \times .88 \times 5} = 16.63 \#/\text{sq. in.}$$

For $1/2 \text{ in.} \phi$:

$$u = \frac{r b}{\Sigma o} = \frac{16.63 \times 5.5}{3.142 \times 1/2} = 58.3 \#/\text{sq. in.}$$

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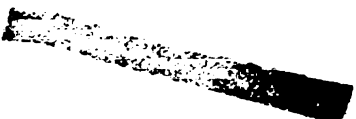
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[REDACTED]

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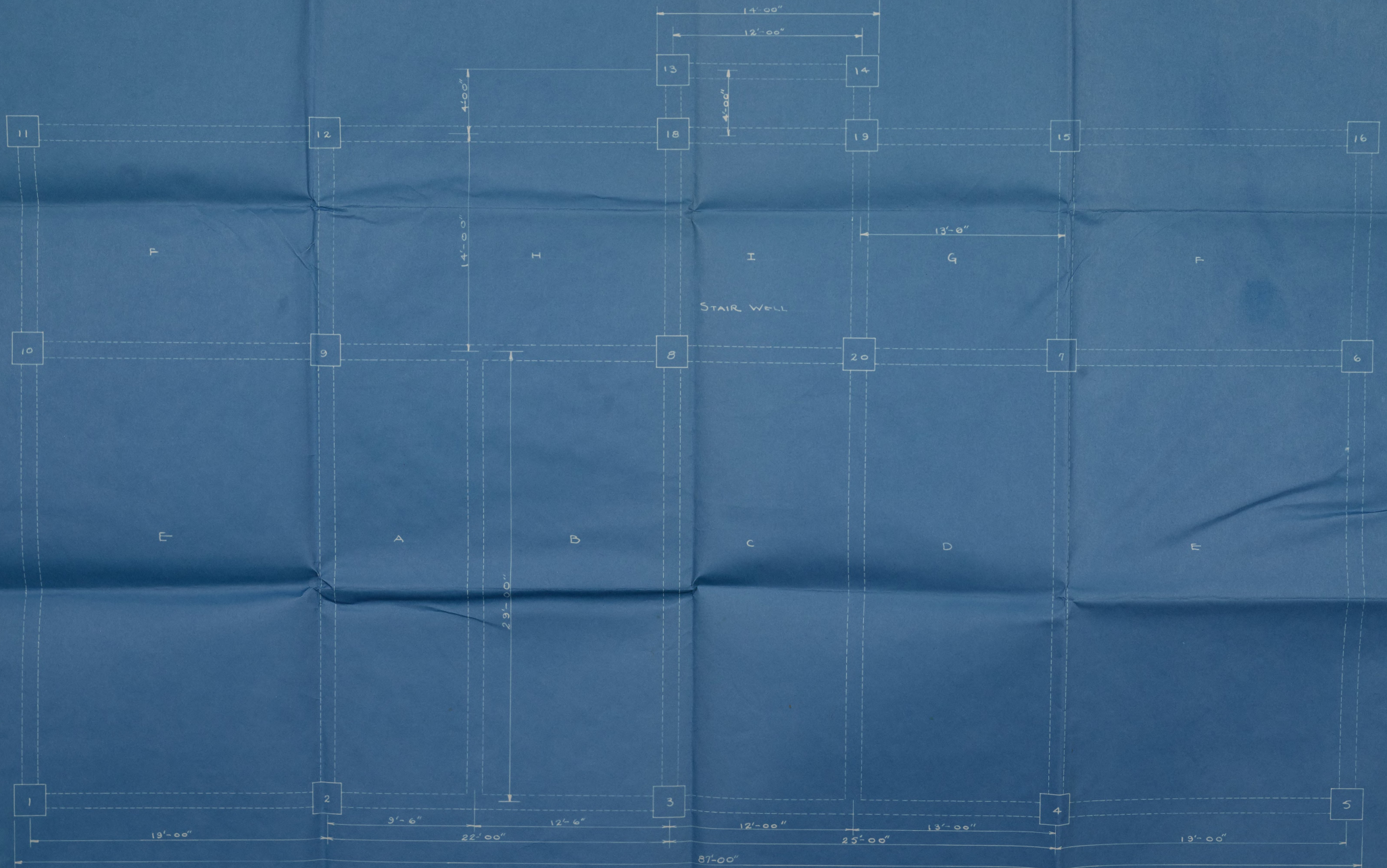
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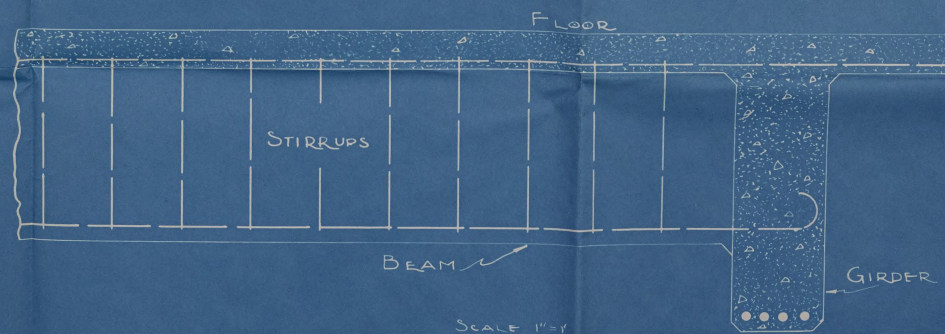
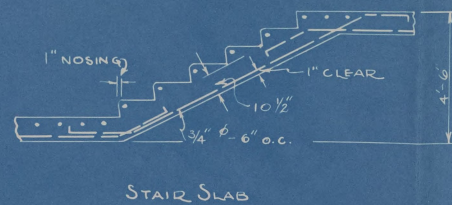
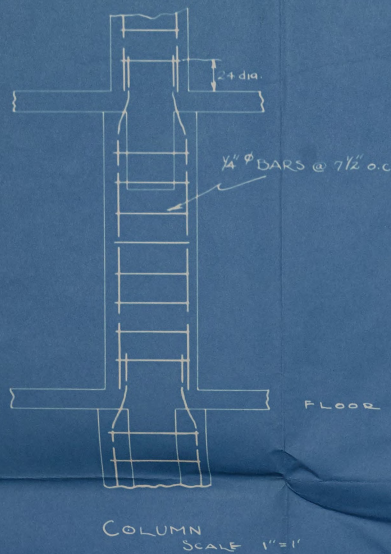
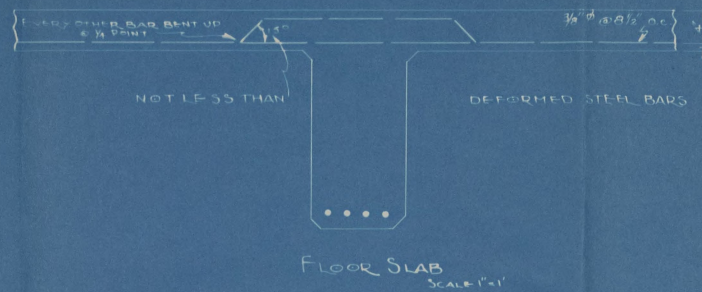
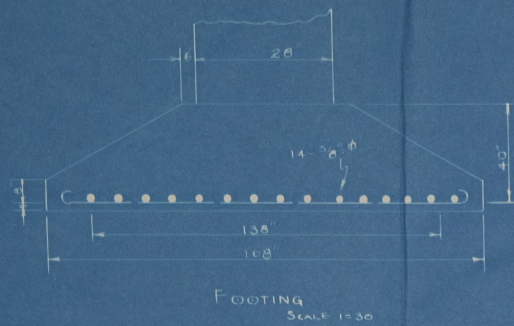
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BEAM-GIRDER-FLOOR SLAB COLUMN LAYOUT

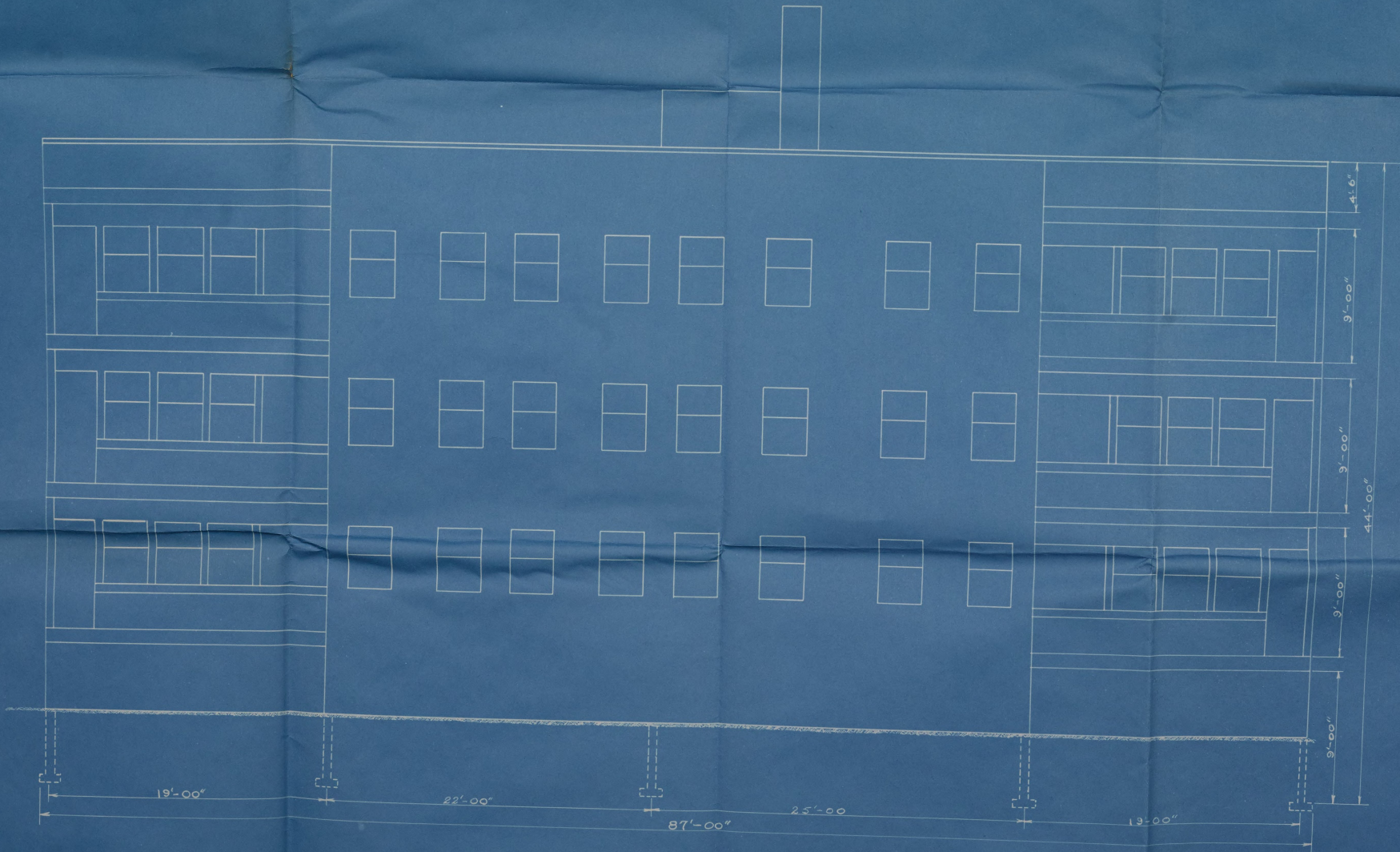
SCALE 1"=40'



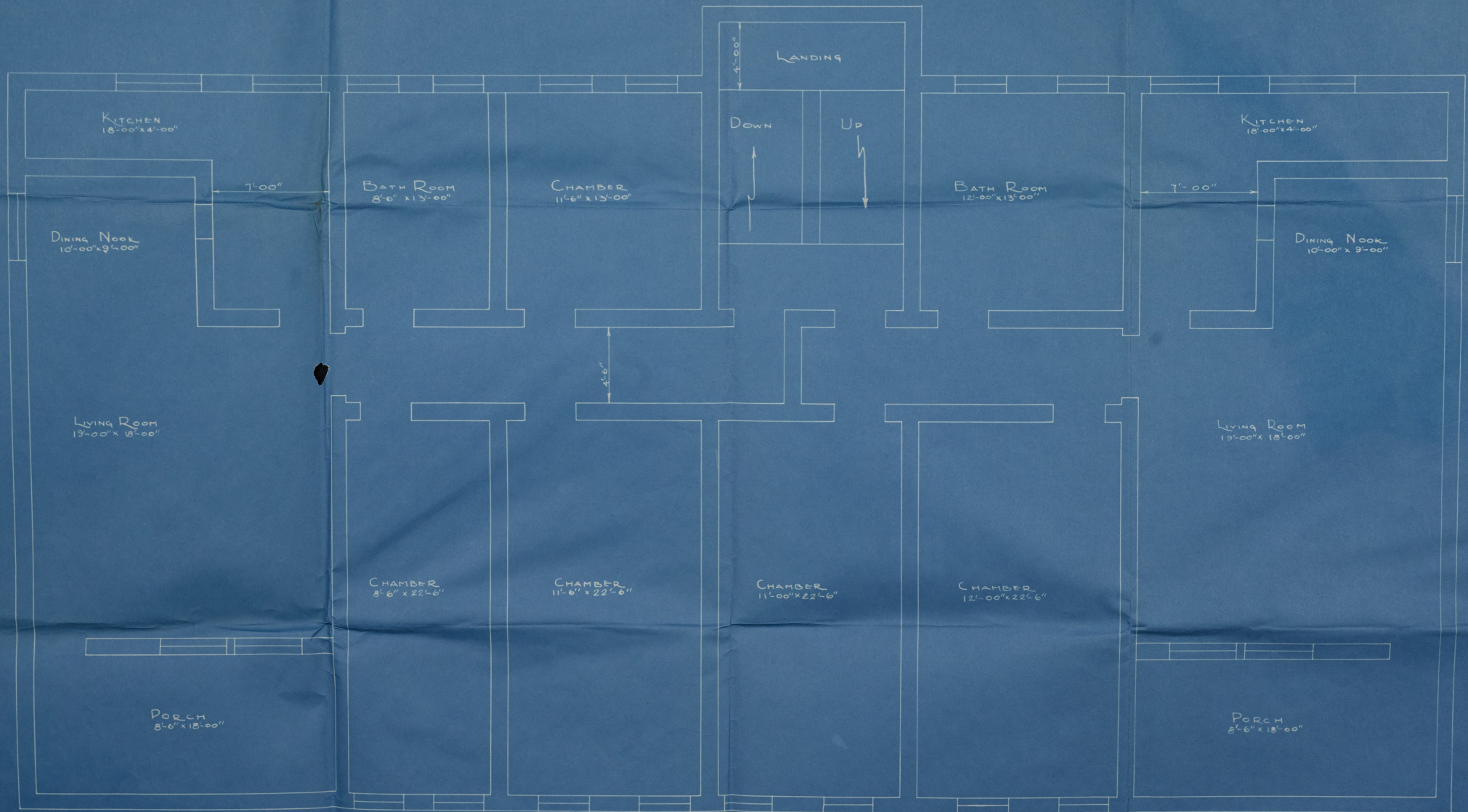


TYPICAL STEEL PLACEMENT
SCALE NOTED

FRONT ELEVATION
SCALE 1/8" = 1'-0"



FLOOR PLAN
SCALE 1"=40'



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