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THE DESIGN OF A TWO-STORY  
BUILDING

Thesis for the Degree of B. S.  
MICHIGAN STATE COLLEGE  
Robert N. Rosso, Jr.  
1944

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The Design of a Two-Story  
Building

A Thesis Submitted to

The Faculty of  
MICHIGAN STATE COLLEGE

of

AGRICULTURE AND APPLIED SCIENCE

by

Robert N. Rosso, Jr.

Candidate for the Degree of

Bachelor of Science

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### Acknowledgments

I wish to thank all the members of the Civil Engineering Staff for the aid they have given me in the completion of this design problem. I also wish to thank M. M. Caldwell, Lansing Building Inspector, and O. J. Munson, Lansing Architect, for their assistance on this problem.

I have used several text books to obtain standards, actual construction hints, and design methods. They are as follows: Structural Theory by Hale Sutherland and H. L. Bowman; Structural Design by Carlton T. Bishop; Steel Construction ( A. I. S. C. ); Wood Trusses, a National Lumber Manufacturer's Association Publication; Construction Estimates and Costs by H. R. Pulver; Reinforced Concrete Design by Hale Sutherland and Raymond C. Reese; and The ACI Building Code.



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## Purpose of the Thesis:

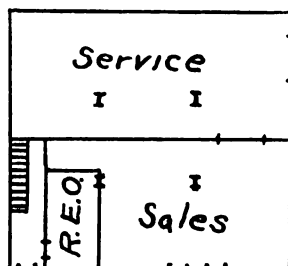
The purpose of this thesis is to design a two-story building, with a sixty foot frontage and fifty-five foot depth. The design is one that involves both an engineering and economic viewpoint and may be regarded as an actual problem that might face an individual with college training.

The building is being designed so that it may be used for many purposes in a town of approximately five to ten thousand population.

The first floor of this building may be used for such purposes as: automobile sales and service, super food market, farm equipment sales and service, or frozen food lockers. It may also be grouped into two or three stores such as: bakery, electrical appliances sales and repairs, auto parts store, and real estate office.

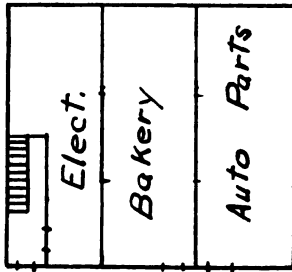
The second floor may be rented or leased as one unit to a lodge or similar organization; or it may be divided into business offices and apartments.

With the above combinations in mind, some of the possible floor plans are: ( Scale 1" equals 40' )



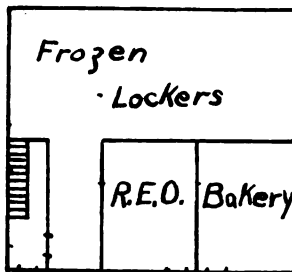
Auto Sales and Service  
Real Estate Office ( R. E. O. )

First Floor



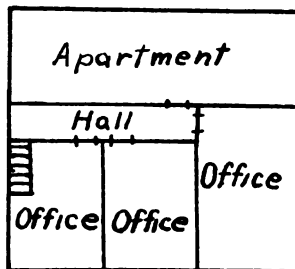
Electrical Appliances  
Auto Parts  
Bakery

First Floor



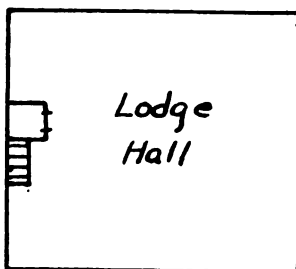
Frozen Food Lockers  
Real Estate Office ( R. E. O. )  
Bakery

First Floor



Apartment  
Business Offices

Second Floor

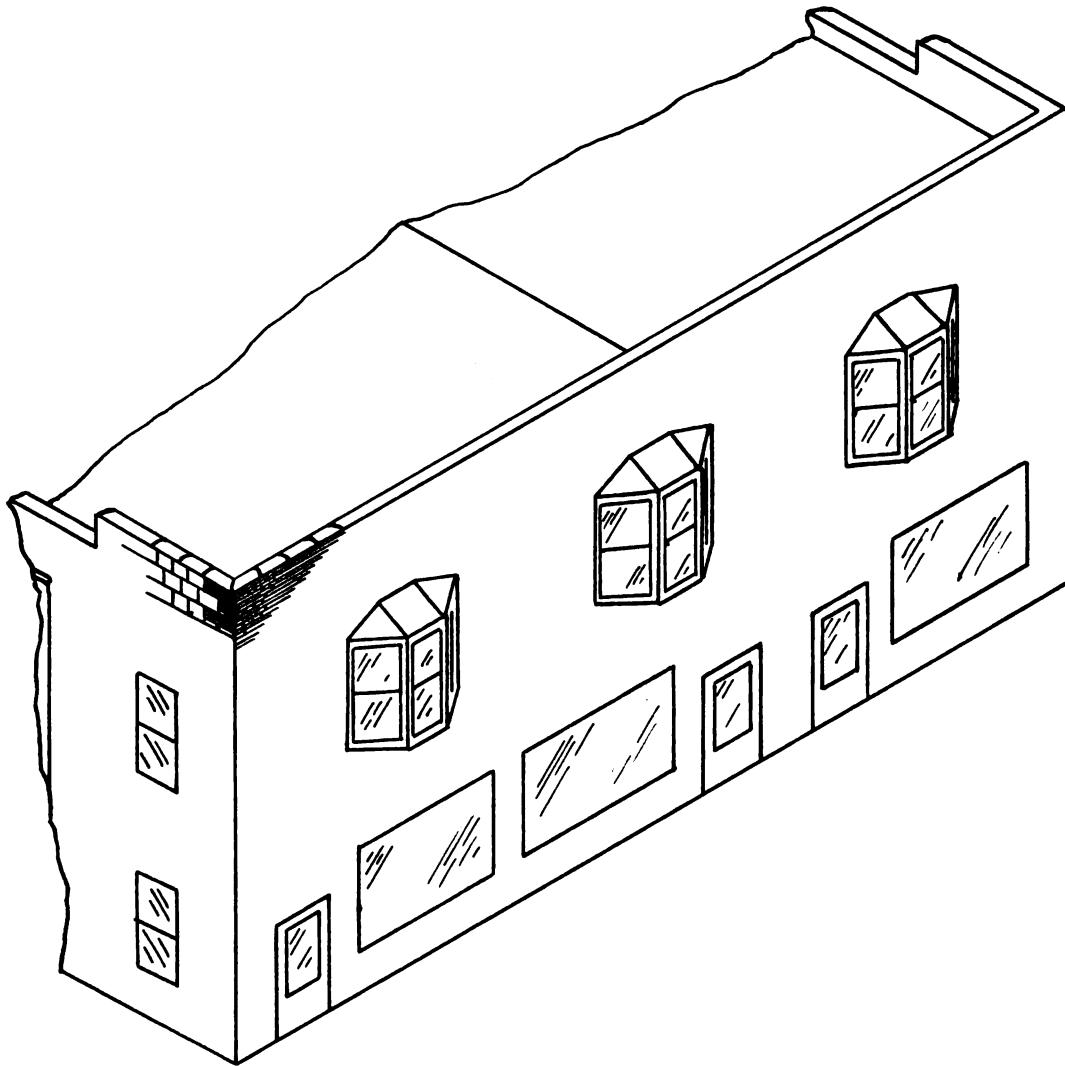


Lodge Hall

Second Floor

The preceding sketches illustrate the type of building to be constructed and also aids in the possible architectural design of the building.

Following the sketch of the proposed building, the thesis will continue with the discussion of the individual design steps taken.



Proposed Building  
( Scale 1" equals 12' )

## Roof Design:

In the roof design, two assumptions were made that will have to be verified before actual construction of the building. One assumption was that the second floor was to be rented as one unit not for living purposes. With this in mind, the window specifications of the locality concerned must be consulted if the second floor is going to be used for apartments. This might necessitate the building of a skylight but it would not effect the truss design due to the fact that the material of the skylight will weigh approximately the same as the roofboards, rafters, and the surfacing of the original design. The second assumption was that the camber of the span would be negligible. This does not mean that it is negligible but, due to the time allotted to the senior problem, it will be impossible to check the truss for camber.

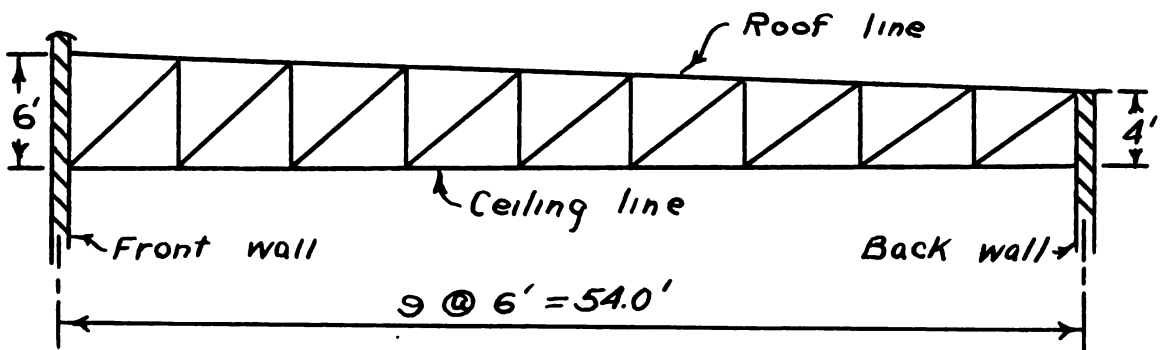
Another assumption was made before the actual computations were started, this being the assumed weight of the roof and truss. The estimated value was fifty pounds per square foot of roof area which was divided up as follows:

L. L.	30#/sq.'	Snow load
D. L.	8#/sq.'	Roofboards, rafters, surfacing
D. L.	7#/sq.'	Steel
D. L.	5#/sq. '	Plaster

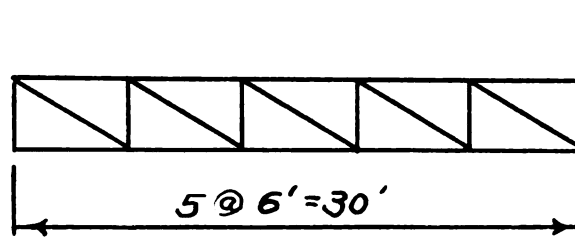
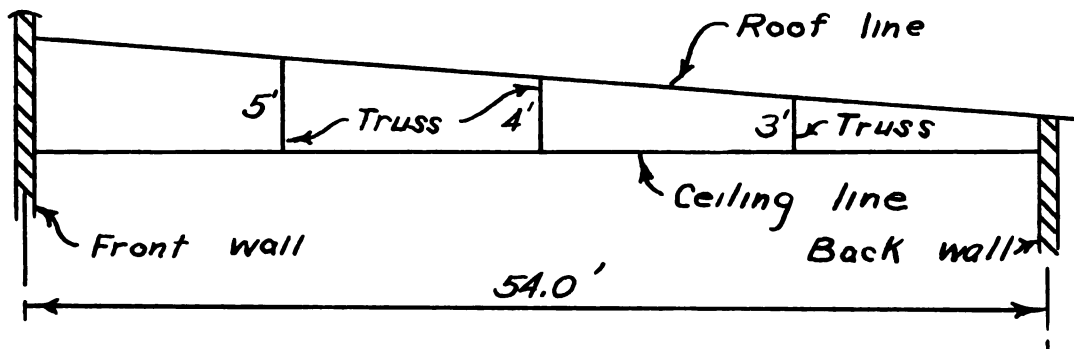
Three different truss systems were designed: the first consisted of two trusses placed at the third points of the building front and running perpendicular to the front; the second is composed of three trusses sixty feet long, but with



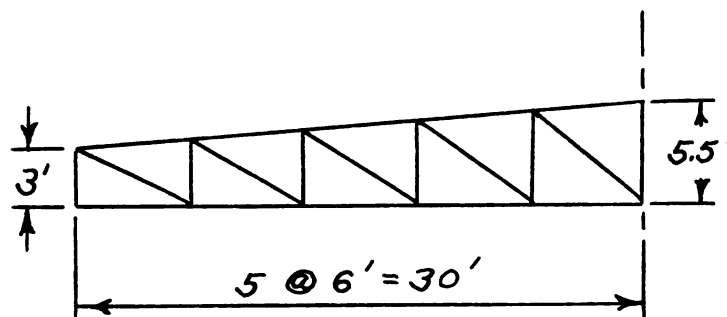
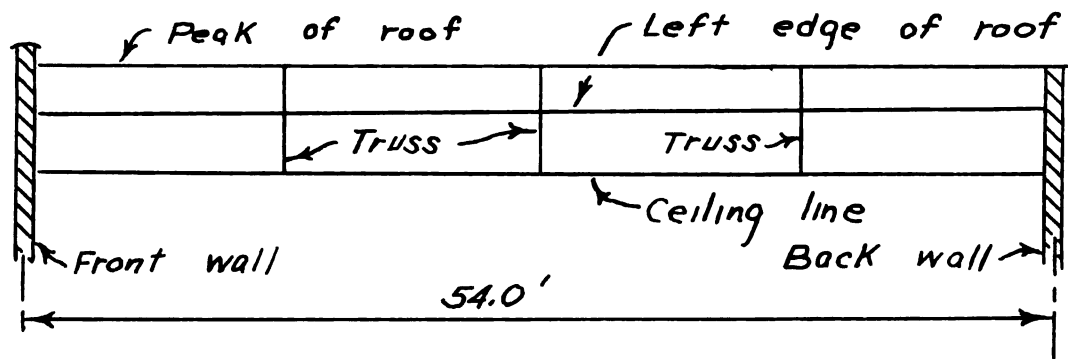
vaying heights of three, four, and five feet which are  
 running parallel to the front of the building; the third  
 consists of three identical trusses running parallel to the  
 store fronts. Sketches of the designs are as follows:  
 ( Scale 1" Equals 10' )



First Design



Second Design



### Third Design

After the three truss systems were completely designed, it was decided that the third design was the one to be used in the construction of the structure. Each design was given due consideration and was analyzed as follows:

Truss design number one was running perpendicular to the building front and, for the proper design of the structure, it is necessary to have the trusses rest on pilasters which would have to be built at the front and back of the building. This would not permit a possible large door opening in the front of the building which might be necessary if floor space be rented for an auto or farm equipment sales-room.

The second truss system was not used because it involved the construction of three different size trusses which would increase the truss cost.

The third and final design was chosen because it ran parallel to the building front which eliminates the pilasters from the front of the building. This truss system also has three identical trusses which will give the cheapest material cost.

The calculation sheet for this truss system will now be discussed. Many of the numerical answers will not be repeated in this section of the thesis but complete details appear in the computation section under Roof Design.

The length of the truss is sixty feet and it is divided into ten panels of six feet each. With the assumed load and the known panel lengths, a total load of 4050 pounds was obtained for each panel.

With the panel load known, the truss was then analyzed for the stress values of its members. The majority of the stress values were obtained by the three main methods used in design work--the summation of moments about a point equals zero, the summation of the horizontal forces equals zero, and the summation of the vertical forces equals zero. The other method used in the analysis was that of the free-body.

After obtaining the stresses in the members, the structural shapes were selected. Two angles were used for every

member, with the angles placed back to back. The angles were selected for members in both tension and compression as specified in "Steel Construction" with three-quarter-inch rivets being assumed.

Next the gusset plates were sketched out. Half-inch material was used for the plates and the details appear on the drawing showing the complete roof design.

The roofboards and roof-rafters were then designed, the rafters being fourteen feet long due to the fact that the trusses are spaced thirteen and one-half feet apart. No length specification for the roofboards was given because they are placed end to end.

The assumed weight was checked next. A one foot section of the truss was taken directly through the center of the truss to determine the weight of the steel to aid in checking the assumed load. As is shown in the computations, the actual load is slightly larger than the assumed load. This is not considered alarming, however, due to the high snow load considered for localities around the central and southern part of the state.

## Floor Design:

The second main design step in the designing of this building was that of computing the second floor slab, its supporting members, columns, its column footings, the first floor slab, and the basement.

The first steps in the design of the second-floor were that of arranging a possible floor-beam and girder plan then assuming a likely live and dead load for the floor. The next step was that of making a floor entry for the stairs that would prove serviceable for a number of occasions such as that of accomodating large crowds and clearance for the moving of office furniture and supplies. (The stairs were designed with the standard seven-and-one-half inch riser with a nine inch tread.)

After that was completed, a four inch floor slab design was computed. The reinforcement steel running from the front to the back of the building was then computed. (This included both positive and negative steel.) Since this steel was running in one direction, it was necessary to use temperature steel. Its calculations are also shown in the computation section.

With the second-floor slab designed, the next step was that of determining the structural sizes of the floor beams and girders. The 12 WF was used throughout to give a uniform thickness to the floor design of the second floor and a uniform first floor ceiling line. Beam connectors were also designed to fasten floor beams and girders.



The columns supporting the second floor were then designed. Their design coming almost directly from the A. I. S. C. tables. The design of the column footings followed, and their design was taken from the method described by Sutherland and Reese. It involves the use of formulas which they developed in their text; for future reference their text should be consulted.

The first-floor slab was then designed by using a concentrated load spread over a six inch square. The proportion of the floor over the basement was computed on a live and dead load basis, however. Reinforced steel was placed in just one direction except over the basement where temperature and negative steel were used. The girder system supporting the slab over the basement was designed similar to that supporting the second-floor slab.

The basement slab was not designed due to the fact that it will act as a wearing surface mainly. The five inch slab will prove sufficient for the basement.

### Store-front Design:

This design was submitted to enable a possible large door opening in the front of the building, if needed.

### Foundation Design:

The foundation was designed with the walls considered as being composed entirely of blocks. The second floor also gives an additional weight to the wall; this was considered by assuming that half the floor beam span was reacting down the wall, with the total floor weight being used.

The proportion of the building over the basement gives a three-story arrangement; therefore, a sixteen-inch wide outer wall must be used for the basement. The rest of the building was considered as a two-story building and only a twelve-inch wall was used. This arrangement conforms with the building specifications of Lansing, Michigan.

No steel was used in the foundation because of the light wall loads.

The basement wall is composed of blocks, and the foundation is of concrete as shown in the computation sketch.

The eight-inch block wall, used for the interior wall of the basement, requires no foundation because there is no wall load. However, the foundation design given for this wall should be used to give security.

The five-inch basement-floor slab should be poured with the foundation around the basement.

### Lintel and Bearing Plate Design:

The problem of designing the lintels was a simple one, and the designs are given in the computation section. The lintels were made of either a channel or angle welded to a plate one-quarter-inches thick and nine-inches wide.

The bearing plate design method used throughout is that prescribed by the A. I. S. C.. The three-quarter-inch plate was used in all cases, because this was the thinnest plate advisable to use from a practical standpoint.

The plates are to be set in poured concrete with anchor bolts. The holes in the blocks supporting these plates should be filled with concrete from the foundation on up. The proportion of the structure resting on these plates will be tack-welded in place.

## Specifications:

The building is one of two-stories and was described in the "Purpose of the Thesis". It was the purpose of the thesis to design the building; such matters as detailing and forming the bill of material were not undertaken, but may be easily obtained by careful analysis of the computations.

The foundation is to be of poured concrete throughout. The front wall is to be made with a brick face and an eight-by-eight back-up block. The other three walls are to be made of eight-by-twelve-by-sixteen standard block. The outer basement wall is to be made sixteen-inches thick, with the inner basement wall eight-inches thick.

All concrete is to have at least three thousand pounds per square inch compressive unit stress in the extreme fiber of concrete in flexure. Three-quarter-inch aggregate will be the maximum allowed in the mix.

All the lumber used in the construction of this building should have at least a twelve thousand pound per square inch bending stress in the extreme fiber.

Steel used should be of the twenty thousand pound per square inch category, except the reinforcement steel, which is to be deformed bars with at least an eighteen thousand pound per square inch value for tension.

The roof is to be made of roofboards, heavy felt--not less than thirty pound felt--, two-ply felt is then to be lain and mopped with asphalt pitch. Next, special mesh is to be laid with asphalt pitch and a cover of crushed slag or

one-quarter to five-eighth-inch well screened gravel. The roof is to be flashed with sixteen ounce copper at the wall boundaries and the peak.

The stairs are to be of concrete with permanent steel forms being used if possible.

Plastering is to be done on metal lath, tack-welded to the steel. ( It is more than likely that small angles will have to be added to give the proper support, but this will be left for the detailer to decide, however. )

Building tile is to be used in partitioning the walls for the separate divisions--four-inch tile will be suitable, but this may vary.

All windows should be of three-foot sash width and may be of wood or steel, but this should be decided upon by the future owner before the building is detailed.

Four-foot doors are to be used in the building front, but three-foot doors may be used in the interior.

Heating, plumbing, electrical wiring, basement drainage, and any other item that has not been discussed will be left up to the discretion of the owner or contractor, which ever the case may be.

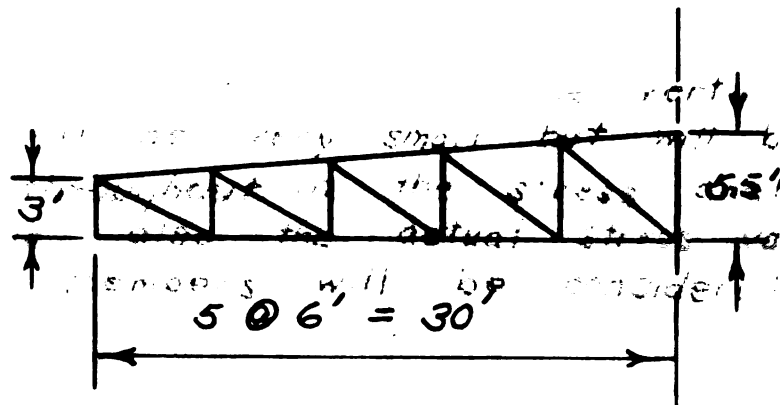
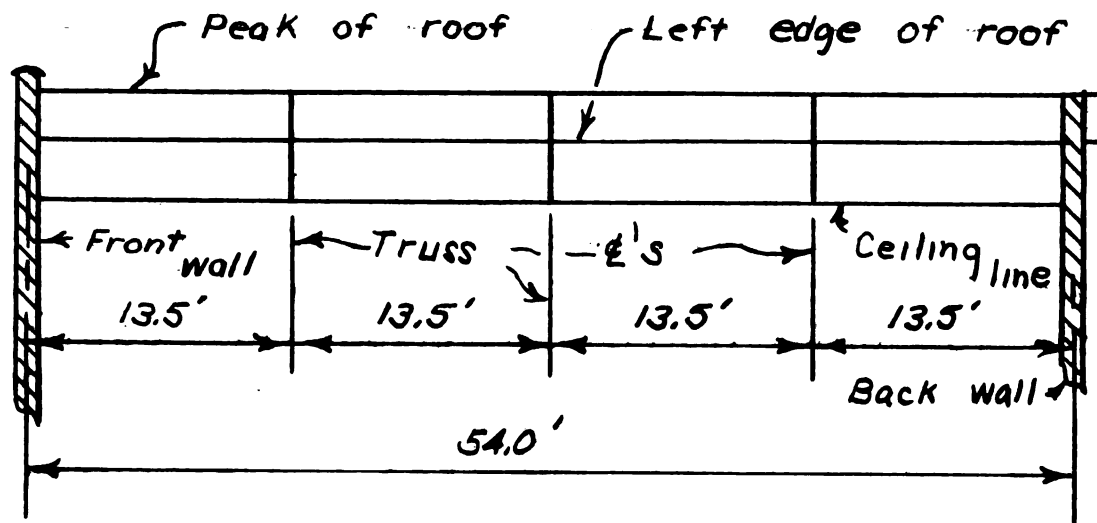
The building specifications for the locality where the building might be erected should be consulted before the complete building arrangements are made.



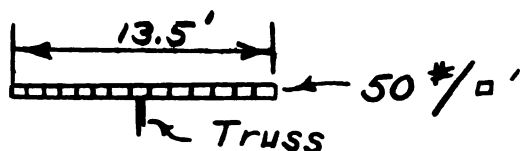
Computations

## ROOF DESIGN :

Three roof trusses running parallel to the store fronts.



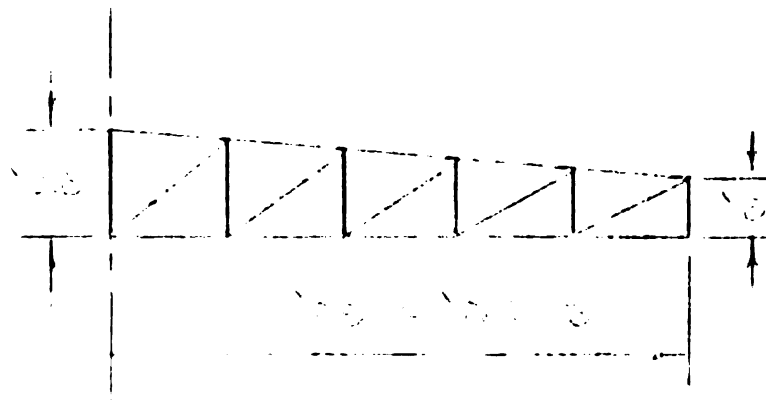
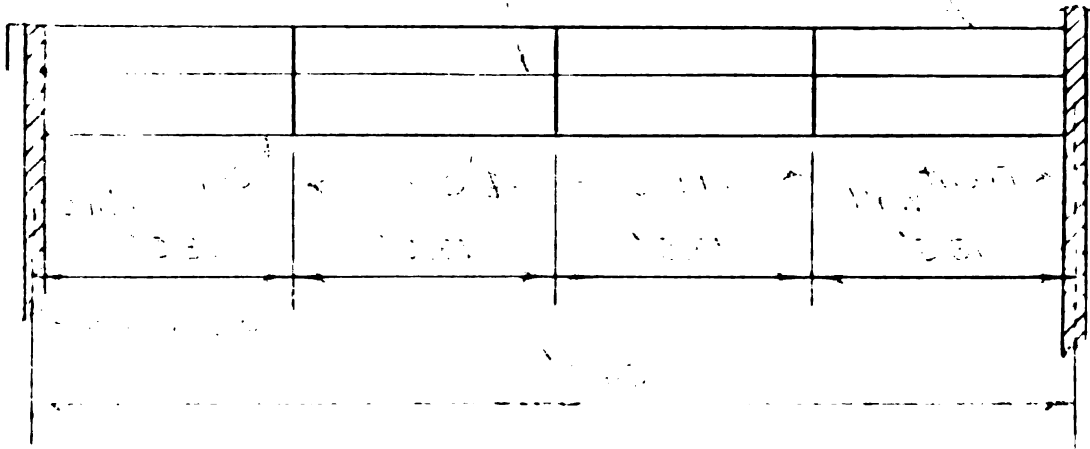
Considering a total Live & Dead load of  $50 \text{ #/sq'}$  of roof area, and a truss with 6' panels; we obtain a total load of 4050 # on each panel.



$$50 (13.5)(6) = 4050 \text{ #}$$

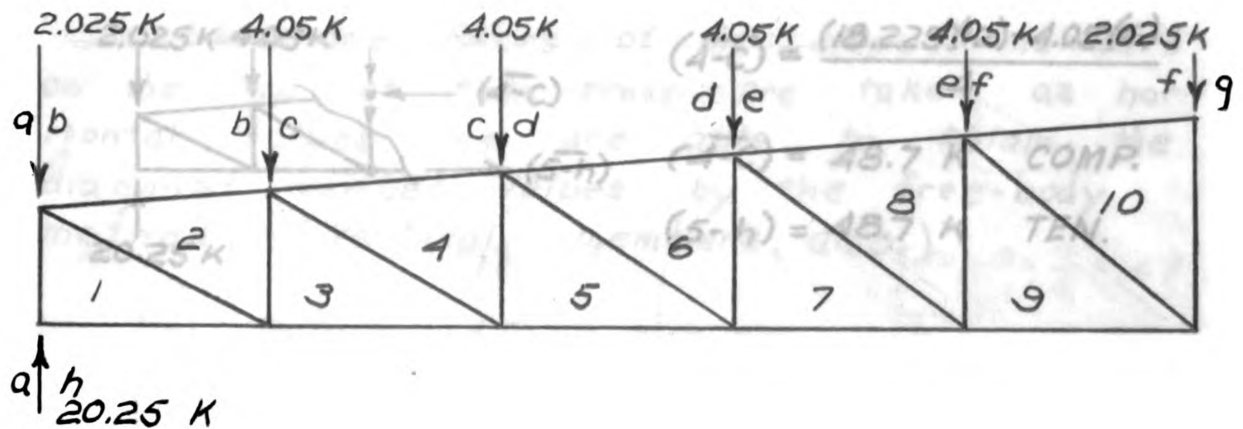
1. The room is to be a vision room for the purpose of the project.

2. The room is to be a vision room for the purpose of the project.



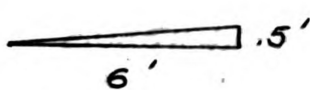
3. The room is to be a vision room for the purpose of the project.

4. The room is to be a vision room for the purpose of the project.



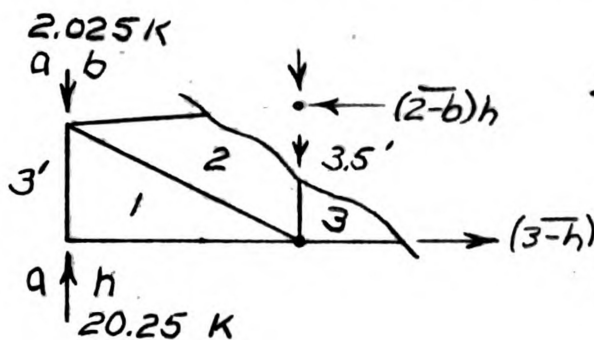
The  $50^{\circ}/\text{ft}$  is considered as acting in a vertical direction to the roof surface, thereby producing a vertical load of  $4050^{\circ}$  on each panel.

.5' rise in each panel gives an  $\angle$  of approximately  $4.8^{\circ}$ .



$$\tan \theta = \frac{.5}{6} \quad \theta = 4.8^{\circ}$$

Due to the small  $\angle$  the vertical load change will be very small but will be considered throughout in the stress analysis of the truss; also the actual stress value of the top members will be considered as having the same value as the horizontal component, because of the natural cos value .997.



$$\sum M = 0$$

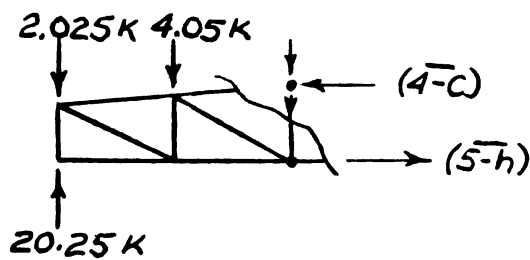
$$(2-b)h = \frac{(18.225)(6)}{3.5}$$

$$(2-b) = 31.2 \text{ K COMP.}$$

$$(3-h) = 31.2 \text{ K TEN.}$$



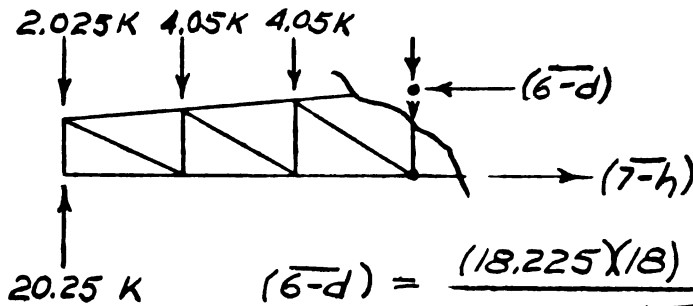




$$(\overline{4-C}) = \frac{(18.225)(12) - 4.05(6)}{4}$$

$$(\overline{4-C}) = 48.7 \text{ K COMP.}$$

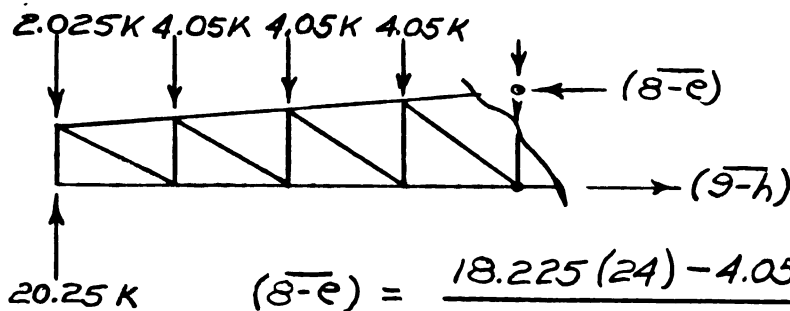
$$(\overline{5-h}) = 48.7 \text{ K TEN.}$$



$$(\overline{6-d}) = \frac{(18.225)(18) - 4.05(6+12)}{4.5}$$

$$(\overline{6-d}) = 56.7 \text{ K COMP.}$$

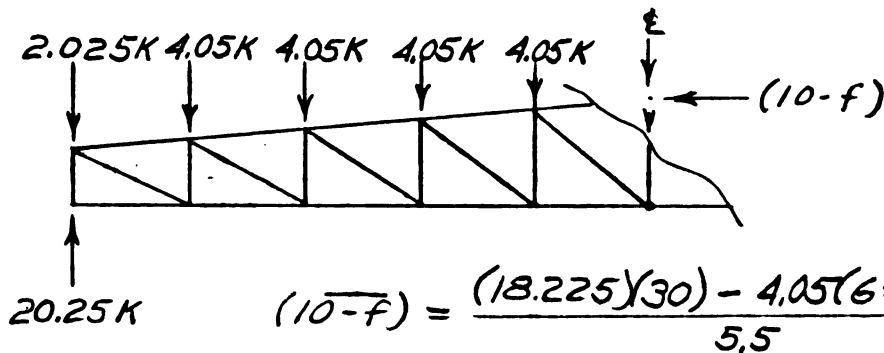
$$(\overline{7-h}) = 56.7 \text{ K TEN.}$$



$$(\overline{8-e}) = \frac{18.225(24) - 4.05(6+12+18)}{5}$$

$$(\overline{8-e}) = 58.5 \text{ K COMP.}$$

$$(\overline{9-h}) = 58.5 \text{ K TEN.}$$



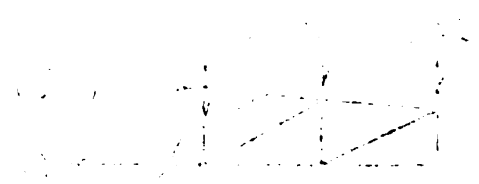
$$(\overline{10-f}) = \frac{(18.225)(30) - 4.05(6+12+18+24)}{5.5}$$

$$(\overline{10-f}) = 55.3 \text{ K COMP.}$$

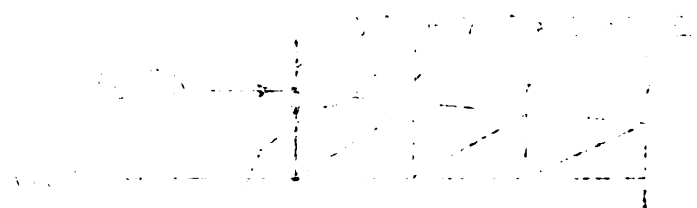
$$2\sqrt{2} \cdot \frac{1}{2} \cdot \frac{1}{2} = (1, 2)$$

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(1, 2)



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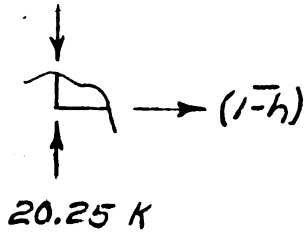


$$2\sqrt{2} \cdot \frac{1}{2} \cdot \frac{1}{2} = (1, 2)$$

$$2\sqrt{2} \cdot \frac{1}{2} \cdot \frac{1}{2} = (1, 2)$$

Since the forces of the sloped members on the top of the truss are taken as horizontal values we are able to obtain the diagonal member values by the free-body method. (Vertical members, also.)

(a-1)



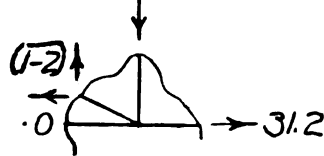
$$\Sigma V = 0$$

$$(a-1) = 20.25 \text{ K COMP.}$$

$$\Sigma H = 0$$

$$(1-h) = 0$$

(2-3)



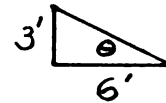
$$\Sigma H = 0$$

$$(1-2)_h = 31.2$$

$$(1-2) = \frac{31.2}{\cos 26.6^\circ}$$

$$(1-2) = 35.0 \text{ K TEN.}$$

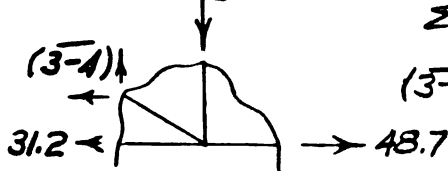
$$(2-3) = 35.0 (\sin 26.6^\circ) = 15.6 \text{ K COMP.}$$



$$\tan \theta = \frac{3}{6} = .5$$

$$\theta = 26.6^\circ$$

(4-5)



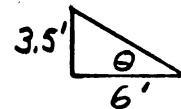
$$\Sigma H = 0$$

$$(3-4)_h = 48.7 - 31.2$$

$$(3-4)_h = 17.5$$

$$(3-4) = \frac{17.5}{\cos 30.2^\circ} = 20.3 \text{ K TEN.}$$

$$(4-5) = 20.3 (\sin 30.2^\circ) = 10.25 \text{ K COMP.}$$



$$\tan \theta = \frac{3.5}{6} = .583$$

$$\theta = 30.2^\circ$$

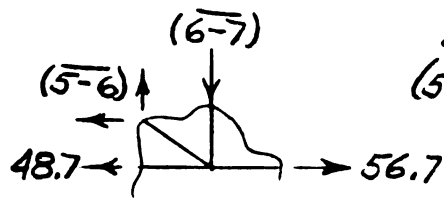
1. The first part of the document is a list of the names of the persons who have been appointed to the various offices of the city of New York.

2. The second part of the document is a list of the names of the persons who have been appointed to the various offices of the city of New York.

3. The third part of the document is a list of the names of the persons who have been appointed to the various offices of the city of New York.

4. The fourth part of the document is a list of the names of the persons who have been appointed to the various offices of the city of New York.

5. The fifth part of the document is a list of the names of the persons who have been appointed to the various offices of the city of New York.



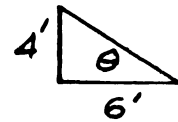
$$\Sigma H = 0$$

$$(5-6)_h = 56.7 - 48.7$$

$$(5-6)_h = 8.0$$

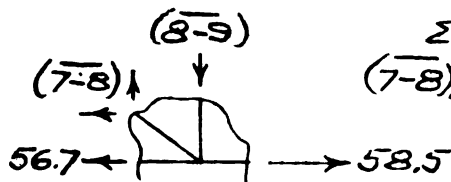
$$(5-6) = \frac{8}{\cos 33.7^\circ} = 9.63 \text{ K TEN.}$$

$$(6-7) = 9.6 (\sin 33.7^\circ) = 5.35 \text{ K COMP.}$$



$$\tan \theta = \frac{4}{6} = .67$$

$$\theta = 33.7^\circ$$



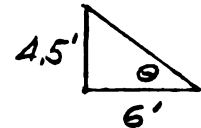
$$\Sigma H = 0$$

$$(7-8)_h = 58.5 - 56.7$$

$$(7-8)_h = 1.8$$

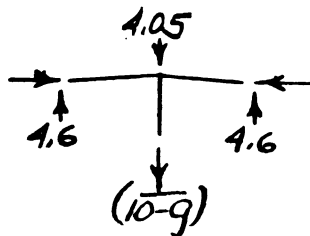
$$(7-8) = \frac{1.8}{\cos 36.9^\circ} = 2.25 \text{ K TEN.}$$

$$(8-9) = 2.25 (\sin 36.9^\circ) = 1.35 \text{ K COMP.}$$



$$\tan \theta = \frac{4.5}{6} = .75$$

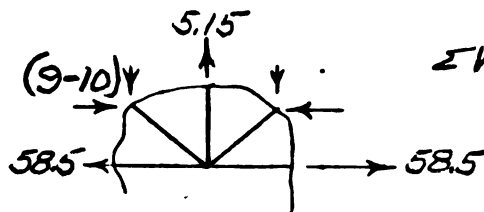
$$\theta = 36.9^\circ$$



$$\frac{6}{55.3} = \frac{.5}{X} \quad X = 4.6$$

$$\Sigma V = 0 \quad 4.6 + 4.6 - 4.05 = (10-9)$$

$$(10-9) = 5.15 \text{ K TEN.}$$

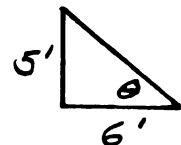


$$\Sigma V = 0$$

$$(9-10)_v = \frac{5.15}{2}$$

$$(9-10)_v = 2.575$$

$$(9-10) = \frac{2.575}{\sin 39.8^\circ} = 4.03 \text{ K COMP.}$$

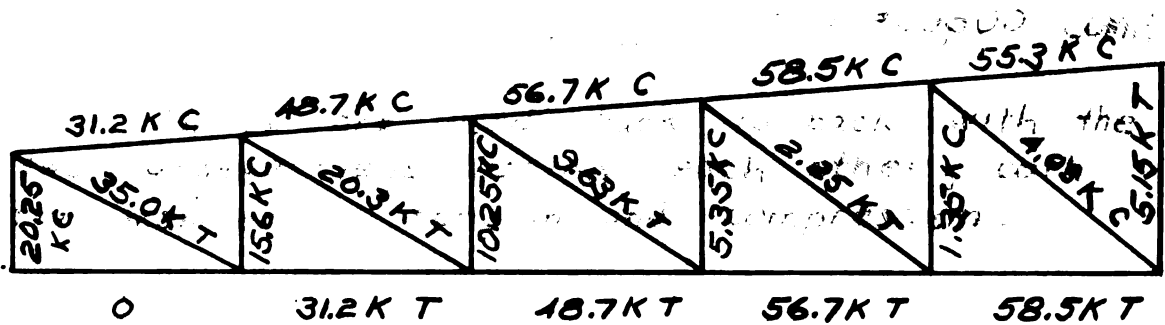


$$\tan \theta = \frac{5}{6} = .833$$

$$\theta = 39.8^\circ$$



Results of the stress analysis :



Material for trusses : (Structural shapes)

Using "Steel Construction" (A.I.S.C.) for the structural shapes, sizes, and specifications.

$S = 20,000 \text{ #/in}^2$  for tension steel

$S = 17,000 - .485 \frac{l^2}{\eta^2}$  for compression steel when  $l/\eta < 120$

Assuming the use of  $3/4$  " rivets.

For members in compression : (2 Ls back to back)

$$l/\eta < 120 \quad l = 6.0'$$

$$\frac{6(12)}{120} = \eta_{\min} = .600"$$

\* Try 2 -  $3\frac{1}{2} \times 3 \times \frac{1}{2}$  Ls

$$\eta = 1.07" \quad A = 6.0 \text{ in}^2$$

$$\left( 17000 - .485 \left( \frac{72}{1.07} \right)^2 \right) = \frac{P}{A}$$

$$\therefore P = 88,700 \text{ *COMP.}$$

\* Try 2 -  $3\frac{1}{2} \times 3 \times \frac{3}{8}$  Ls

$$\eta = 1.09" \quad A = 4.60 \text{ in}^2$$

$$\left( 17000 - .485 \left( \frac{72}{1.09} \right)^2 \right) = \frac{P}{A}$$

$$\therefore P = 68,500 \text{ *COMP.}$$

\* Try 2 -  $3\frac{1}{2} \times 3 \times \frac{1}{4}$  Ls

$$\eta = 1.11" \quad A = 3.12 \text{ in}^2$$

$$\left( 17000 - .485 \left( \frac{72}{1.11} \right)^2 \right) = \frac{P}{A}$$

$$\therefore P = 48,000 \text{ *COMP.}$$

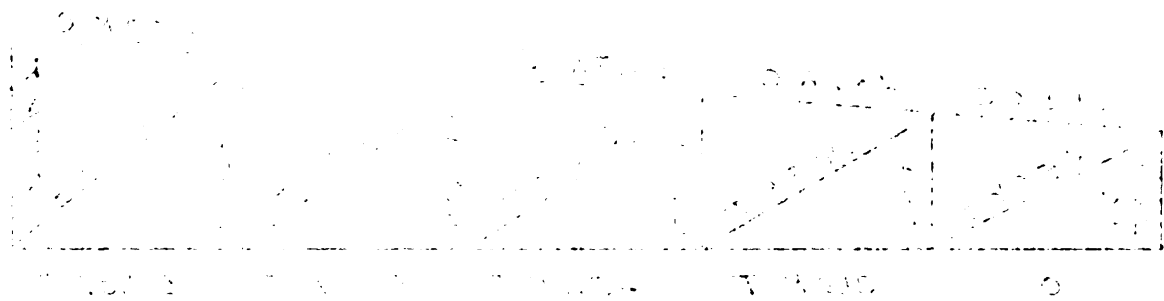
\* Try 2 -  $2\frac{1}{2} \times 2 \times \frac{1}{4}$  Ls

$$\eta = .78" \quad A = 2.12 \text{ in}^2$$

$$\left( 17000 - .485 \left( \frac{72}{.78} \right)^2 \right) = \frac{P}{A}$$

$$\therefore P = 27,200 \text{ *COMP.}$$

# Solving a System of Linear Equations



(Solving a System of Linear Equations)

Given a system of linear equations, find the solution set.

$$\begin{aligned} \text{Line 1: } y &= -\frac{1}{2}x + 1 \\ \text{Line 2: } y &= -x + 2 \\ \text{Line 3: } y &= -x + 3 \end{aligned}$$

Graph the lines on a coordinate plane.

The lines intersect at the point (1, 0).

The solution set is  $\{(1, 0)\}$ .

The lines are not parallel, so there is a unique solution.

The lines are not coincident, so there is a unique solution.

The lines are not vertical, so there is a unique solution.

The lines are not horizontal, so there is a unique solution.

The lines are not vertical, so there is a unique solution.

The lines are not horizontal, so there is a unique solution.

The lines are not vertical, so there is a unique solution.

The lines are not horizontal, so there is a unique solution.

The lines are not vertical, so there is a unique solution.



\*Try 2 -  $2\frac{1}{2} \times 2 \times \frac{3}{8}$  Ls  $\lambda = .77$   $A = 3.10 \text{ in}^2$   
 $\left(17000 - .485 \left(\frac{72}{.77}\right)^2\right) = \frac{P}{A} \quad \therefore P = 39,500 \text{ *COMP.}$

All Ls are used back to back with the two longest legs facing each other, both for member in tension and compression.

For members in tension :

$S = \frac{P}{A}$   $A = \text{Area of the Ls} - \text{the area of the rivet holes.}$

Area of 2 Ls  $3\frac{1}{2} \times 3 \times \frac{3}{8} = 4.60 \text{ in}^2$   
 $3\frac{1}{2} \times 3 \times \frac{1}{4} = 3.12$   
 $2\frac{1}{2} \times 2 \times \frac{3}{8} = 3.10$   
 $2\frac{1}{2} \times 2 \times \frac{1}{4} = 2.12$

Reduction of area for  $\frac{7}{8}$  " rivet hole.

Material thickness of  $\frac{1}{4}$  " =  $.219 \text{ in}^2$   
 $\frac{3}{8}$  " =  $.328 \text{ in}^2$

$S = \frac{P}{A}$  For  $P = 58,500 \text{ \#}$   
 $\frac{58500}{20000} = A = 2.925 \text{ in}^2$

Since  $2.925 + (.219)(2) > 3.12 \text{ in}^2$

$\therefore$  Use 2 Ls  $3\frac{1}{2} \times 3 \times \frac{3}{8}$   $A = 4.60 \text{ in}^2$

The value  $.219 \text{ in}^2$  is multiplied by 2 because 2 Ls are used.

\*For  $P = 48,700 \text{ \#}$   $\frac{48700}{20000} = A = 2.435 \text{ in}^2$

Since  $2.435 + (.219)(2) < 3.12$

$\therefore$  Use 2 Ls  $3\frac{1}{2} \times 3 \times \frac{1}{4}$   $A = 3.12 \text{ in}^2$

1. The first part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

2. The second part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

3. The third part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

4. The fourth part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

5. The fifth part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

6. The sixth part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

7. The seventh part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

8. The eighth part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

9. The ninth part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

10. The tenth part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

11. The eleventh part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

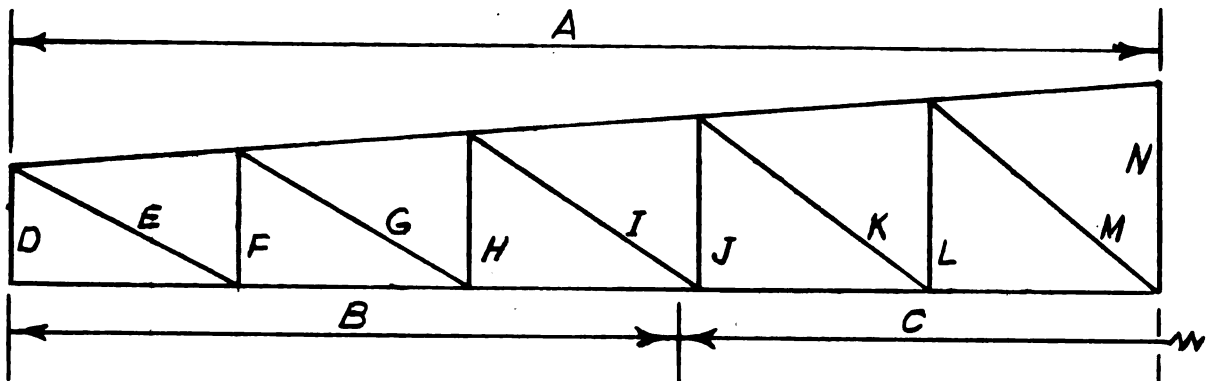
12. The twelfth part of the document is a list of the names of the persons who have been appointed to the various positions of the Board of Directors of the Corporation.

\*For  $P = 35,000$  \*  $\frac{35000}{20000} = A = 1.75$  "

Since  $1.75 + .438 > 2.12$   
 $\therefore$  Use  $2Ls$   $2\frac{1}{2} \times 2 \times \frac{3}{8}$

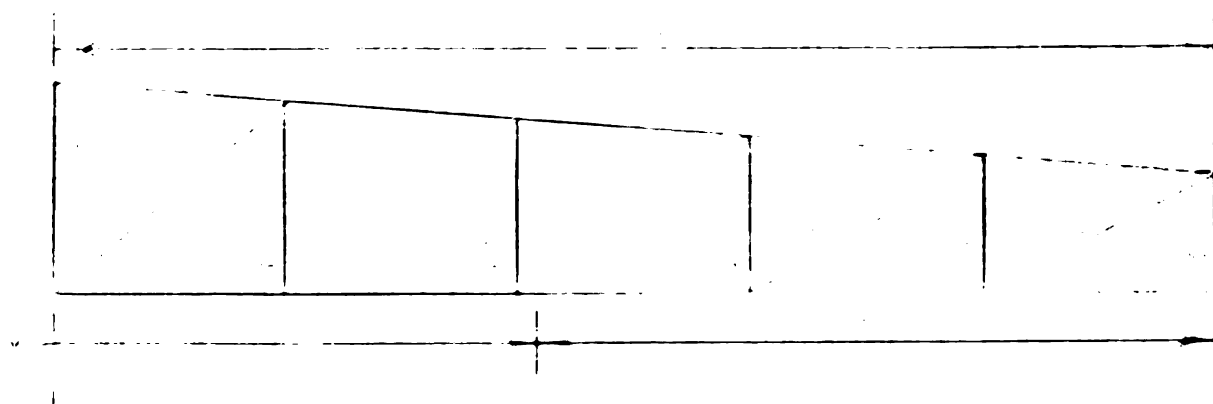
\*For  $P = 20,300$  \*  $\frac{20300}{20000} = A = 1.015$  "

Since  $1.015 + .438 < 2.12$   
 $\therefore$  Use  $2Ls$   $2\frac{1}{2} \times 2 \times \frac{1}{4}$



Bill of material for one truss :

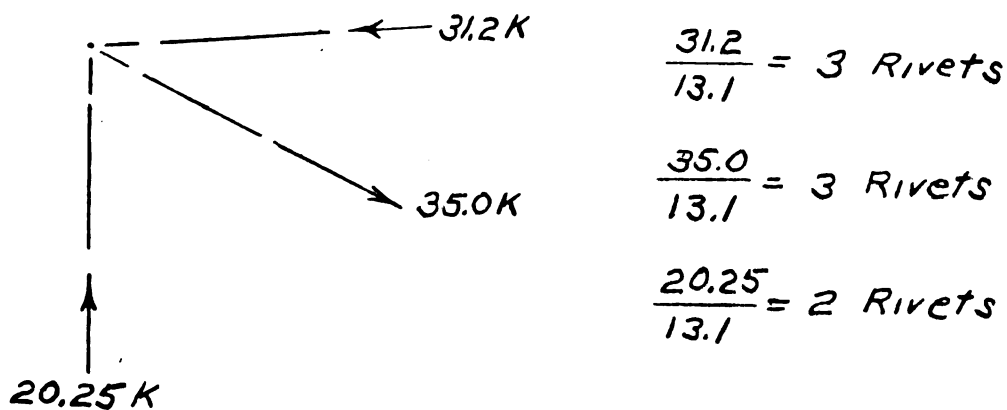
1 Letter	2 No. Req.	3 Size of L	4 Length	1	2	3	4
A	2	$3\frac{1}{2} \times 3 \times \frac{3}{8}$	30'0"	K	2	$2\frac{1}{2} \times 2 \times \frac{1}{4}$	6'6"
B	2	$3\frac{1}{2} \times 3 \times \frac{1}{4}$	17'0"	L	2	$2\frac{1}{2} \times 2 \times \frac{1}{4}$	4'6"
C	1	$3\frac{1}{2} \times 3 \times \frac{3}{8}$	25'10"	M	2	$2\frac{1}{2} \times 2 \times \frac{1}{4}$	6'9"
D	2	$2\frac{1}{2} \times 2 \times \frac{1}{4}$	2'6"	N	1	$2\frac{1}{2} \times 2 \times \frac{1}{4}$	5'0"
E	2	$2\frac{1}{2} \times 2 \times \frac{3}{8}$	5'6"				
F	2	$2\frac{1}{2} \times 2 \times \frac{1}{4}$	3'0"				
G	2	$2\frac{1}{2} \times 2 \times \frac{1}{4}$	5'10"				
H	2	$2\frac{1}{2} \times 2 \times \frac{1}{4}$	3'6"				
I	2	$2\frac{1}{2} \times 2 \times \frac{1}{4}$	6'3"				
J	2	$2\frac{1}{2} \times 2 \times \frac{1}{4}$	4'0"				



## Rivets and Gusset Plates for the Roof Trusses :

Using  $3/4$ " rivets — Shear  $15000 \text{ #/in}^2$   
 Bearing S.S.  $32000 \text{ #/in}^2$   
 D.S.  $40000 \text{ #/in}^2$

Using  $1/2$ " gusset plates — since the smallest  $\Delta$  used are  $1/4$ " thick, the  $1/2$ " thickness will determine the bearing value, which is 13.1 Kip maximum load. (A.I.S.C.)



Minimum rivet spacing (A.I.S.C.) is 3 rivet diameters  $\text{¢}$  to  $\text{¢}$ .

$$(.75)(3) = 2.25" \quad \text{Use } 2.5" \text{ ¢ to ¢}$$

For end spacing use 2.0"

For a  $1/2$ " gusset plate and a tension load of 35.0 K the cross-section area of the gusset plate at the 1<sup>st</sup> rivet should be—

$$s = \frac{P}{A} \quad \frac{35000}{20000} = A = 1.75 \text{ in}^2$$

Sketches are drawn to the scale  $.1" = 1.0"$

Find the area of the shaded region.

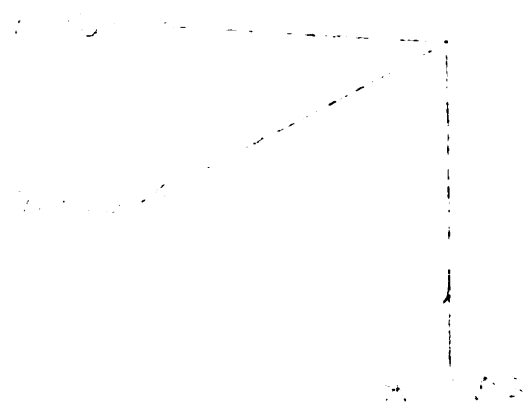
Radius of the circle = 10 cm  
 Length of the chord = 12 cm  
 Angle of the sector = 60°

Let the area of the shaded region be  $A$ .  
 The area of the sector is  $\frac{60}{360} \times \pi \times 10^2$ .  
 The area of the triangle formed by the radii and the chord is  $\frac{1}{2} \times 10 \times 10 \times \sin 60^\circ$ .

$$\text{Area of sector} = \frac{60}{360} \times \pi \times 10^2$$

$$\text{Area of triangle} = \frac{1}{2} \times 10 \times 10 \times \sin 60^\circ$$

$$\text{Area of shaded region} = \text{Area of sector} - \text{Area of triangle}$$



∴ Area of shaded region =  $\frac{60}{360} \times \pi \times 10^2 - \frac{1}{2} \times 10 \times 10 \times \sin 60^\circ$

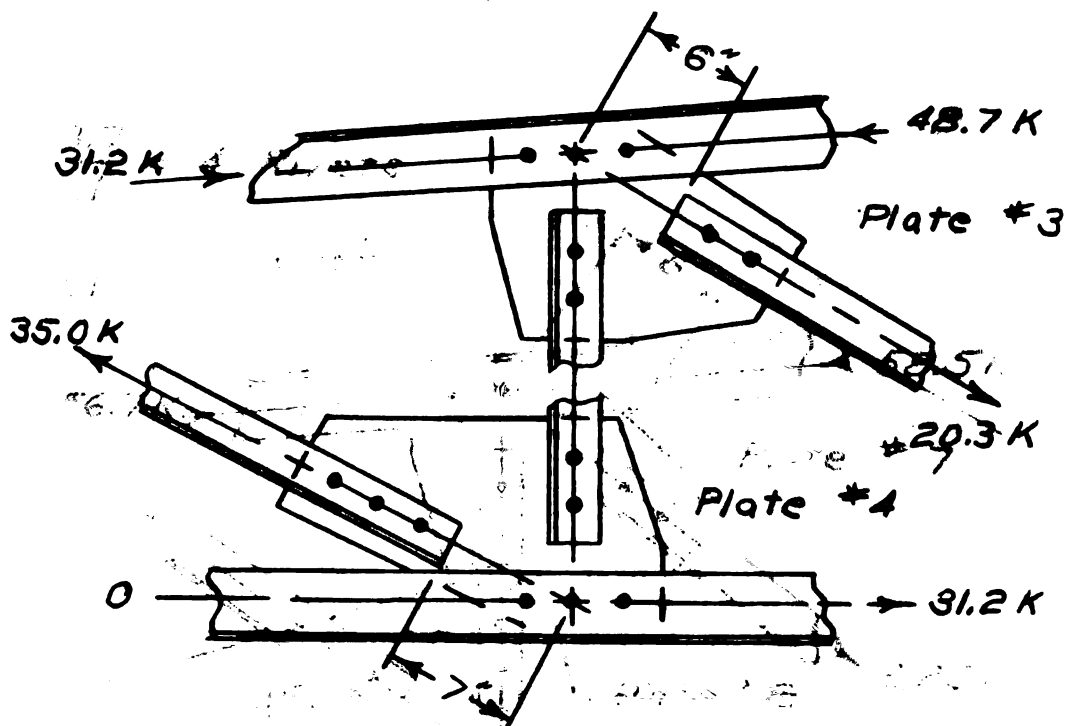
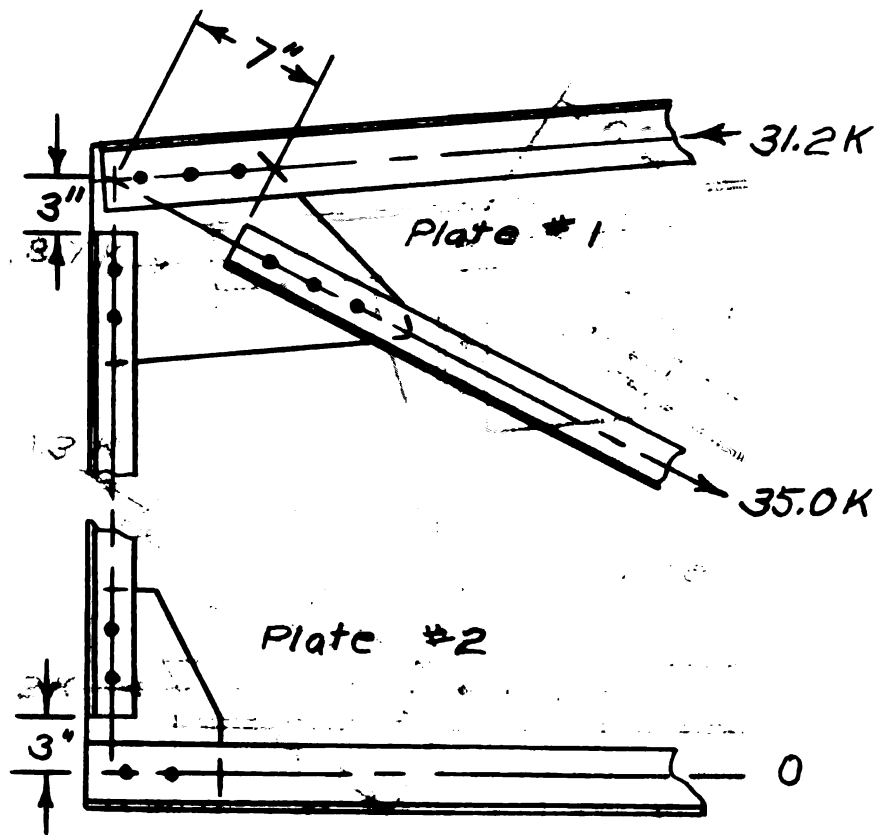
$$= \frac{1}{6} \times \pi \times 100 - \frac{1}{2} \times 100 \times \frac{\sqrt{3}}{2}$$

$$= \frac{100}{6} \pi - 25\sqrt{3}$$

∴ Area of shaded region =  $\frac{100}{6} \pi - 25\sqrt{3}$  cm<sup>2</sup>

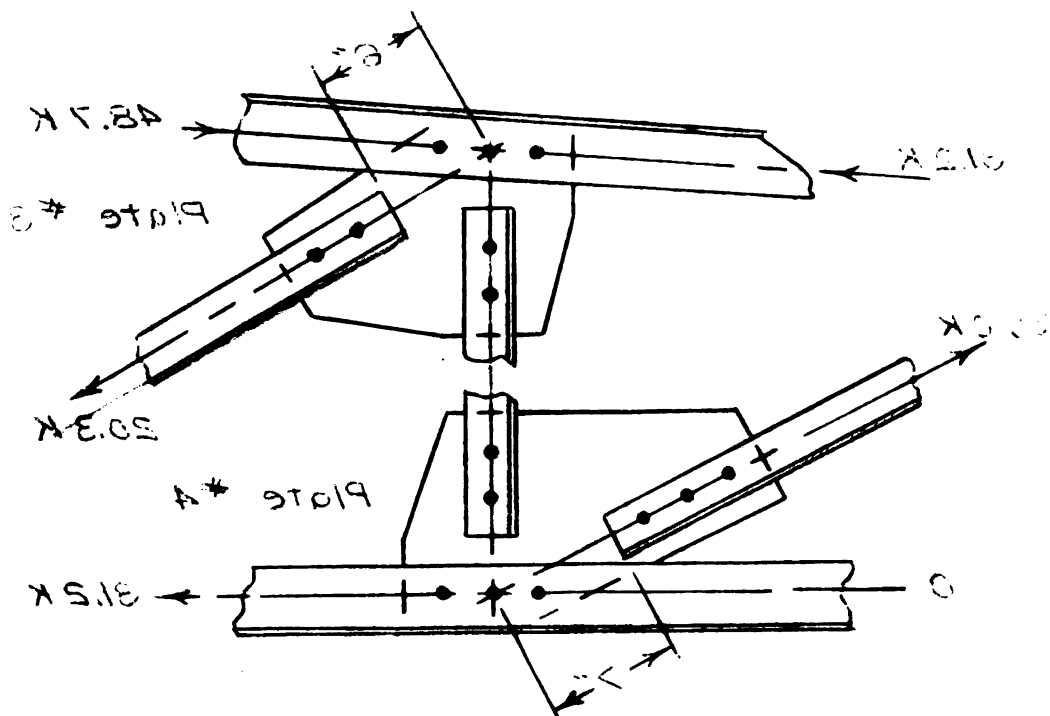
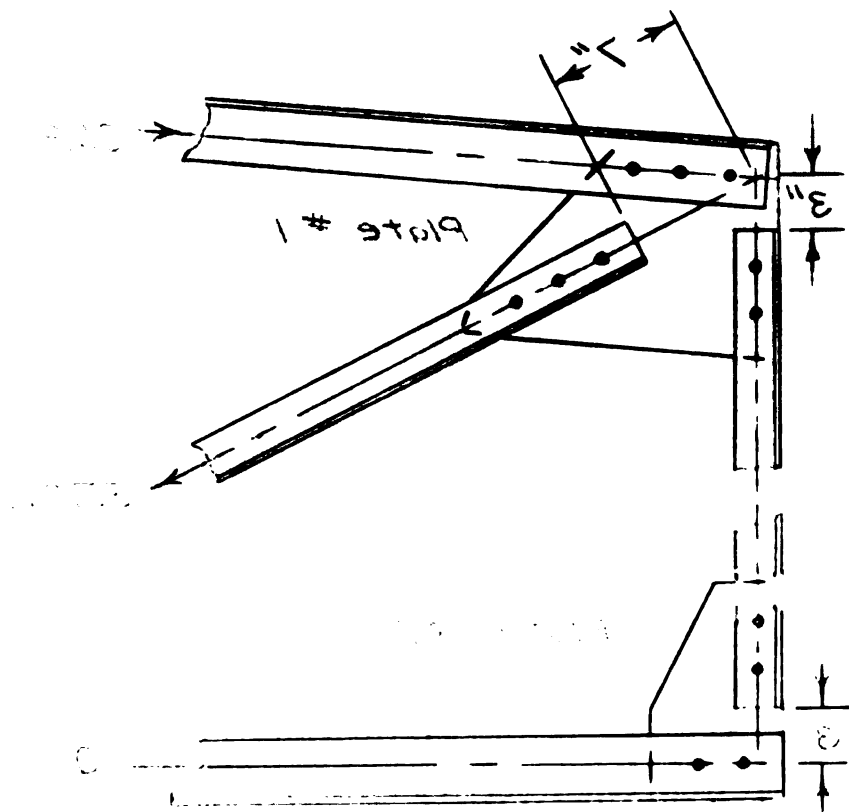
$$= \frac{100}{6} \times \frac{22}{7} - 25 \times 1.732$$

∴ Area of shaded region =  $\frac{100}{6} \times \frac{22}{7} - 25 \times 1.732$



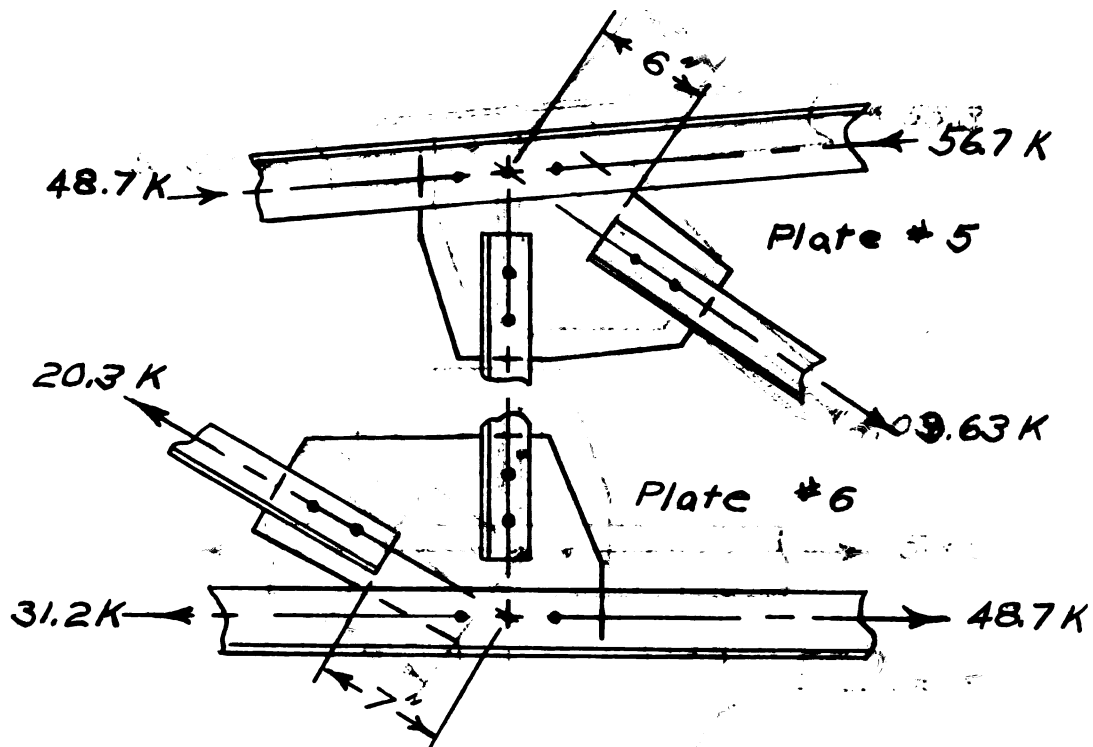
$$\frac{48.7 - 31.2}{13.1} = 2 \text{ Rivets} \quad \text{Use 3 Rivets}$$

$$\frac{20.3}{13.1} = 2 \text{ Rivets} \quad \frac{31.2}{13.1} = 3 \text{ Rivets}$$



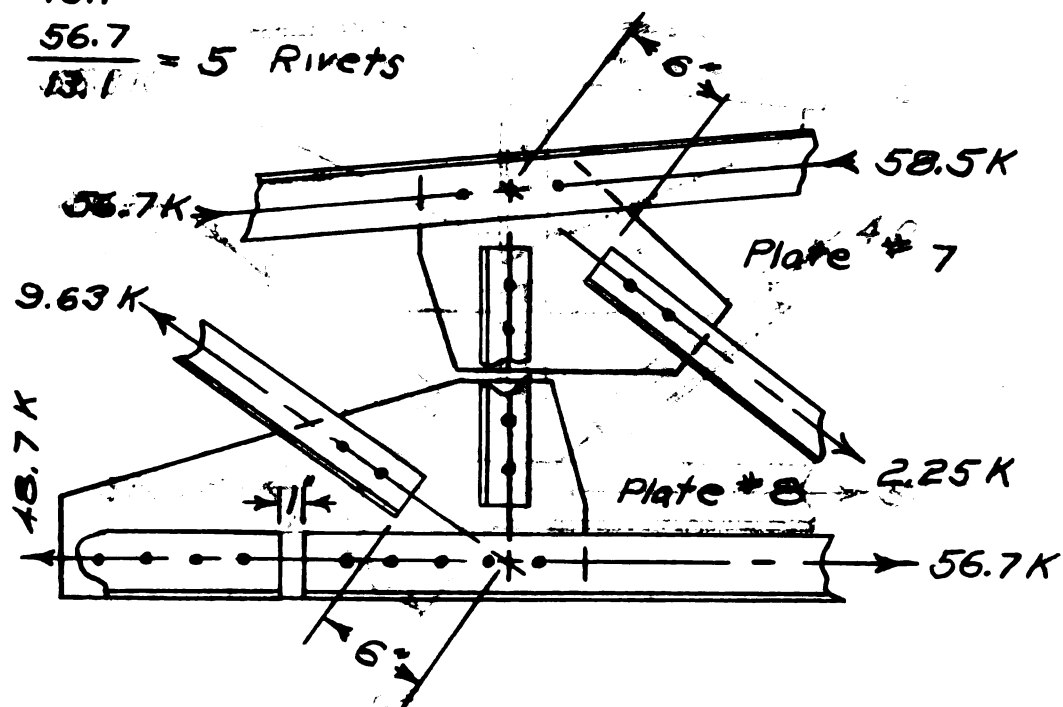
1. The joint is subjected to a horizontal force of 31.5 K and a vertical force of 48.7 K. The joint is supported by a vertical member and two diagonal members, Plate #3 and Plate #4. The joint is shown in two views: a side view and a top view. The side view shows the horizontal member with a vertical dimension of 6" and a horizontal dimension of 4". The top view shows the diagonal members with a horizontal dimension of 3" and a vertical dimension of 3".

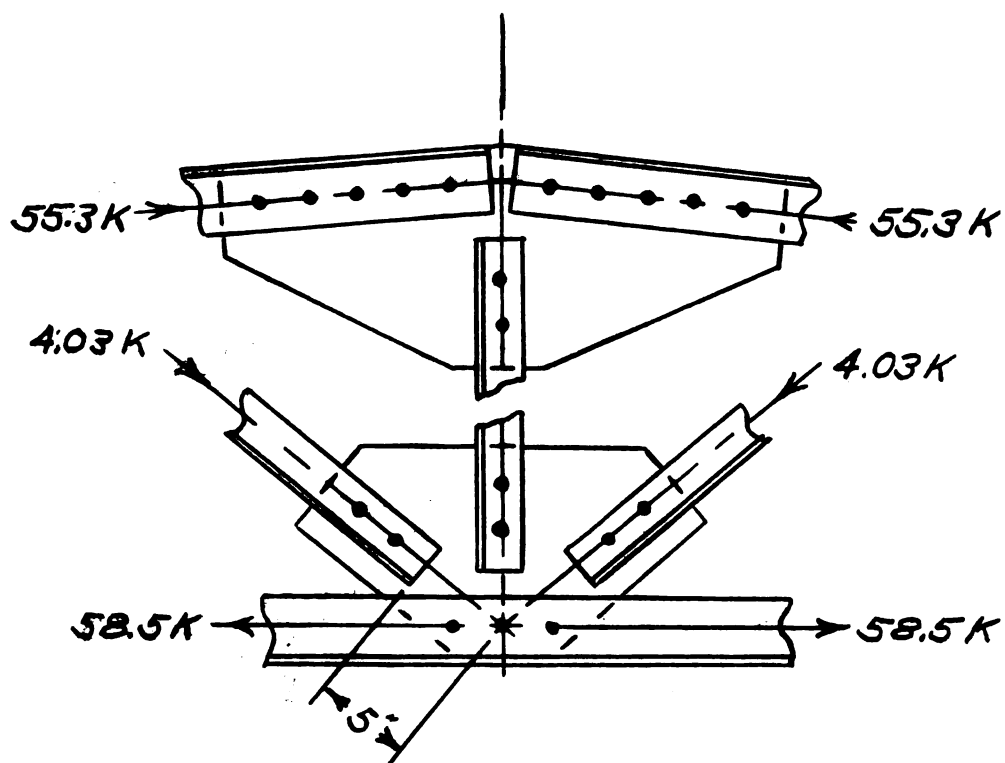
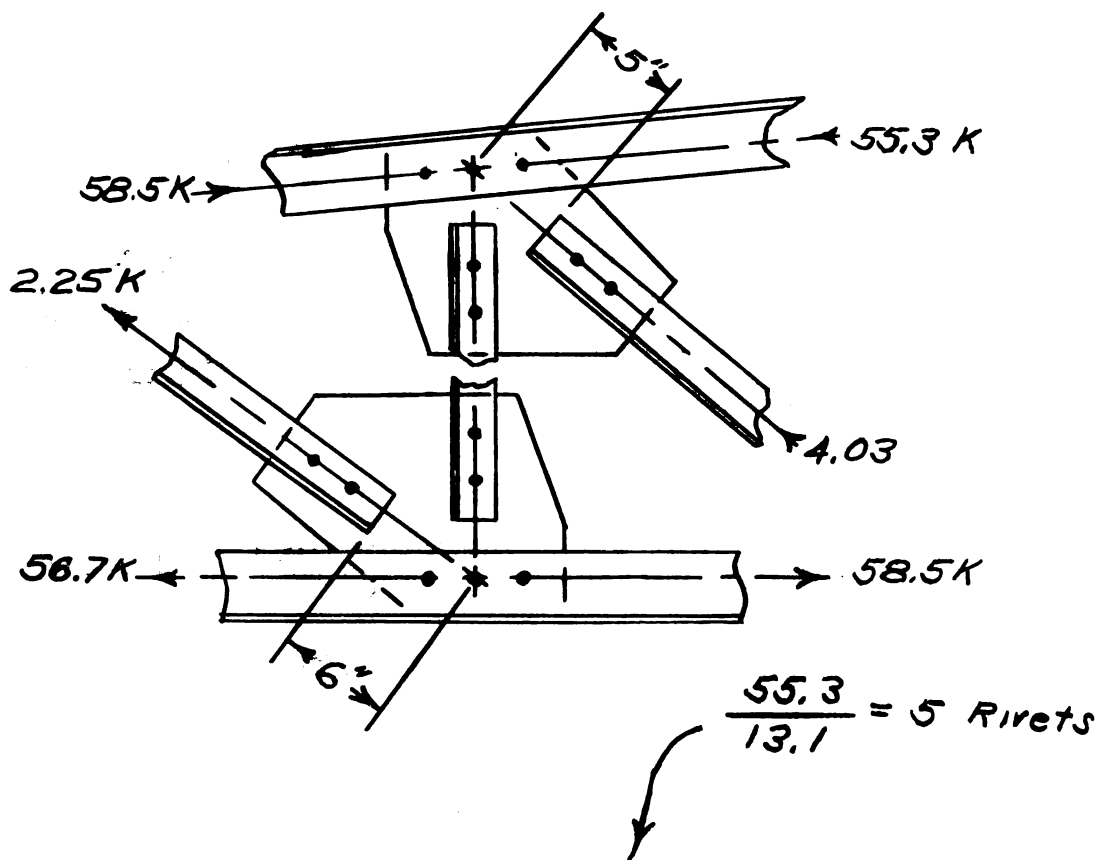




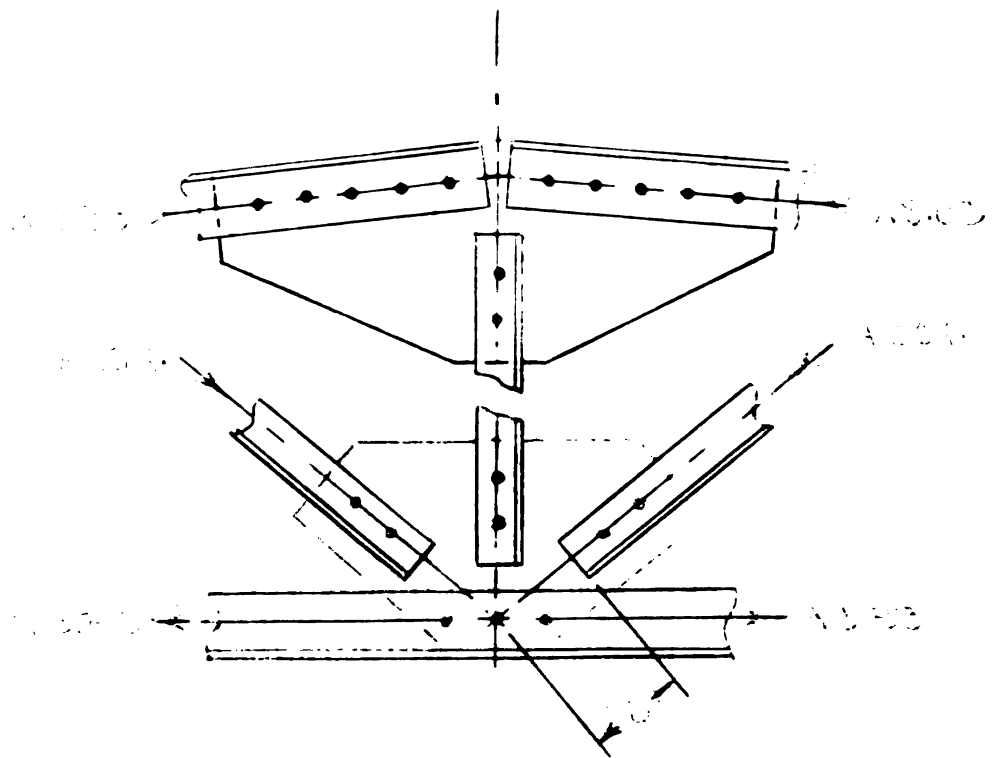
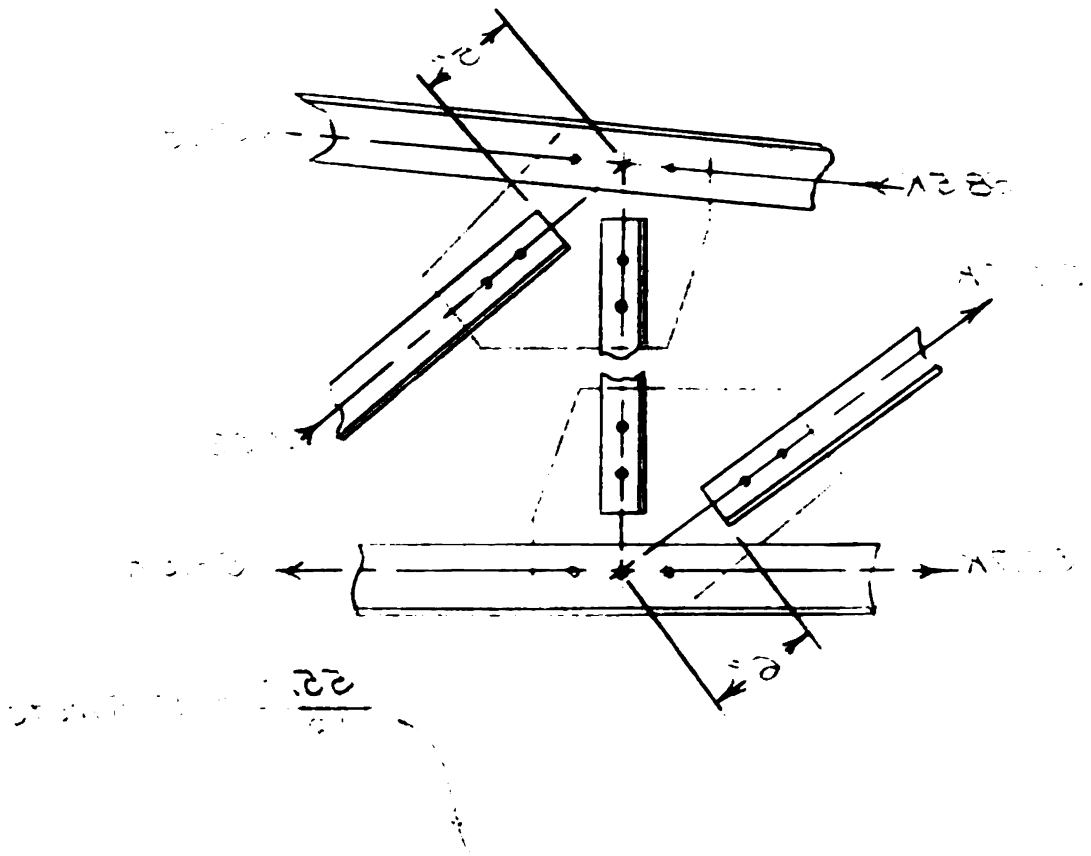
$$\frac{48.7}{13.1} = 4 \text{ Rivets}$$

$$\frac{56.7}{13.1} = 5 \text{ Rivets}$$





Details of these sketches on R.T. Print.

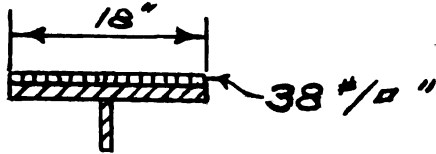


Roof rafters and roof boards :

Rafters :

$$S = \frac{Mc}{I} \quad S = \frac{M}{S} \quad S = \frac{I}{c}$$

Assume  $S = 1200 \text{ in}^3$  for wood.



30 #/ft' L.L. snow  
8 #/ft' D.L. rafters  
38 roof boards  
roofing

$$M = \frac{wl^2}{8} = \frac{(38)(\frac{18}{12})(13.5)^2}{8} = 1300' \text{ in}$$

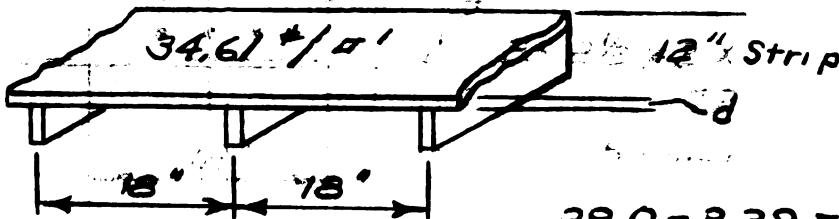
$$1300(12) = 15600' \text{ in}$$

$$S = \frac{15600}{1200} = 13.0 \text{ in}^3$$

Use  $2 \times 8 \times 14'$

$$Wt = 3.39 \text{ #/ft'}$$

Roof boards :



$$38.0 - 3.39 = 34.61 \text{ #/ft'}$$

$$M = \frac{wl^2}{12} = \frac{(34.61)(1.5)^2}{12} = 6.5' \text{ in} \quad S = \frac{6.5(12)}{1200}$$

$$I = \frac{bd^3}{12} \quad c = \frac{d}{2} \quad S = \frac{I}{c} \quad S = .065 \text{ in}^3$$

$$.065 = \frac{\frac{12d^3}{12}}{\frac{d}{2}}$$

$$.065 = 2d^2 \quad d^2 = .0325 \quad d = .18 \text{ in}$$

Use  $1 \times 8$  material

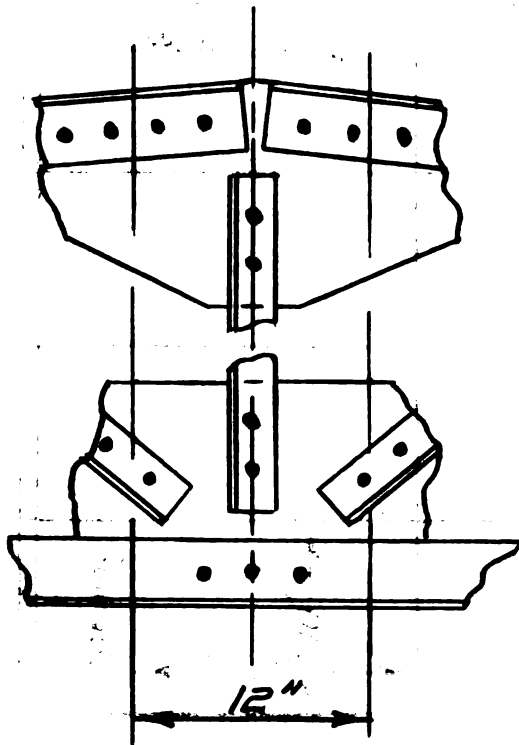


Weight of roof boards based on 40  
#/cu. ft. for wood. (A.I.S.C.)

$$\frac{40}{X} = \frac{12}{1} \quad X = 3.33 \text{ \#/ft'}$$

Check on assumed weights:

Cut a section 1' wide down the  
center of the truss.



Assume G.P. steel to weigh  
10 \#/36 cu \"

$$G.P. = \left( \frac{12 \times 12 \times 1}{36} \right) 10 = 40. \#$$

Rivets = 45 \#/100

$$10 \text{ Rivets} = 4.5 \#$$

$$2 - 3\frac{1}{2} \times 3 \times \frac{3}{8} \\ 15.8 \#/\text{ft'}$$

$$2(15.8) = 31.6 \#$$

$$2 - 2\frac{1}{2} \times 2 \times \frac{1}{4} \\ 7.2 \#/\text{ft'}$$

$$5(7.2) = 36.0 \#$$

$$\text{Total} \quad \frac{112.1}{13.5} = 8.8 \text{ \#/ft'}$$

Snow	30.0 \#/ft'
Steel	8.8
Roof	8.0
Plaster	5.0
	<u>51.8 \#/ft'</u>

The check is 1.8 \#/ft' high but is not  
considered alarming due to the high  
snow load.

1. The first step is to find the area of the base of the cone.

$$A_{\text{base}} = \pi r^2 = \pi (3)^2 = 9\pi$$

2. The next step is to find the area of the lateral surface.

$$A_{\text{lateral}} = \pi r l = \pi (3) (5) = 15\pi$$

3. The total area of the cone is the sum of the base area and the lateral area.

$$A_{\text{total}} = A_{\text{base}} + A_{\text{lateral}} = 9\pi + 15\pi = 24\pi$$

4. The final step is to find the volume of the cone.

$$V = \frac{1}{3} \pi r^2 h = \frac{1}{3} \pi (3)^2 (4) = 12\pi$$

$$V = 12\pi$$

5. The final answer is:

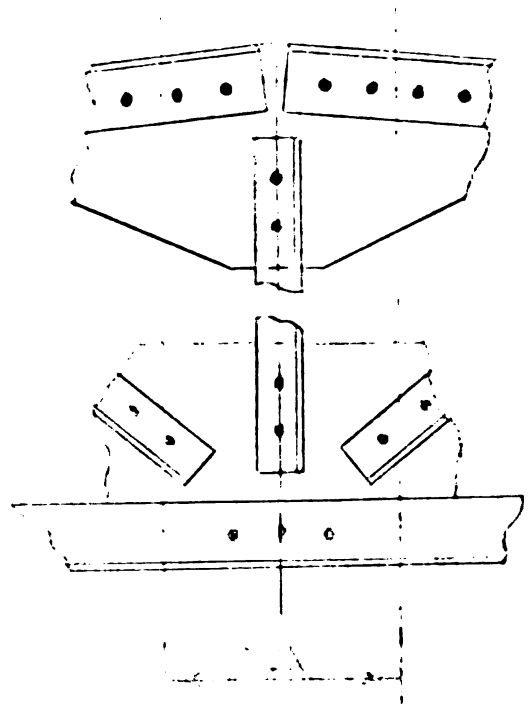
$$A_{\text{total}} = 24\pi$$

$$V = 12\pi$$

6. The final answer is:

$$A_{\text{total}} = 24\pi$$

$$V = 12\pi$$



7. The final answer is:

$$A_{\text{total}} = 24\pi$$

$$V = 12\pi$$

8. The final answer is:

$$A_{\text{total}} = 24\pi$$

9. The final answer is:

$$A_{\text{total}} = 24\pi$$

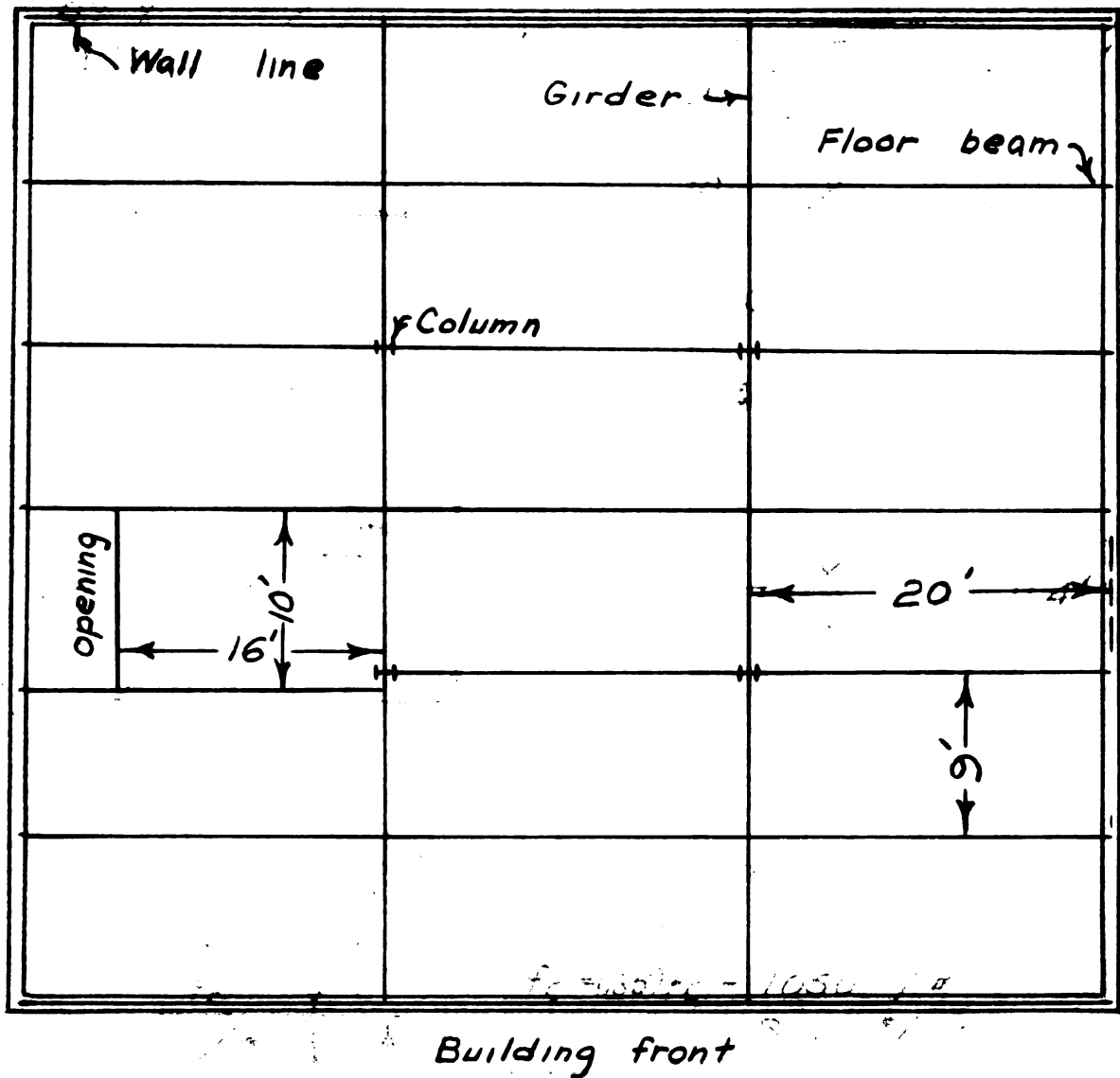
$$V = 12\pi$$

## FLOOR DESIGNS :

Second floor :

Live Load  $100 \text{ \#/ft}^2$

Dead Load  $50 \text{ \#/ft}^2$  4" reinforced slab



Floor beam and girder plan.

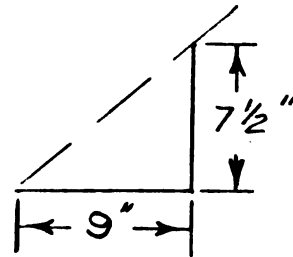
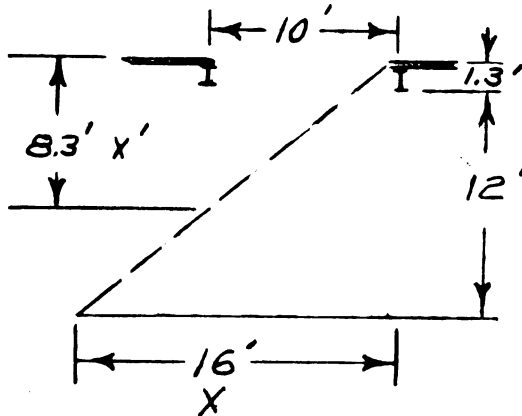




Stairs :

First to second floor :

7 1/2" riser  
9" tread

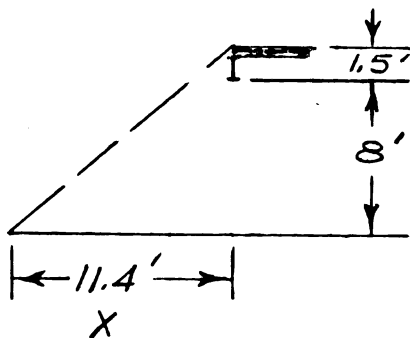


$$\frac{7.5}{9} = \frac{13.3}{X} \quad X = 16.0'$$

$$\frac{10}{16} = \frac{X'}{13.3} \quad X' = 8.3'$$

$$\text{Clearance} \quad \frac{1.3}{7.0'}$$

Basement to first floor :



$$\frac{9}{7.5} = \frac{X}{9.5} \quad X = 11.4'$$

Slab design - second floor :

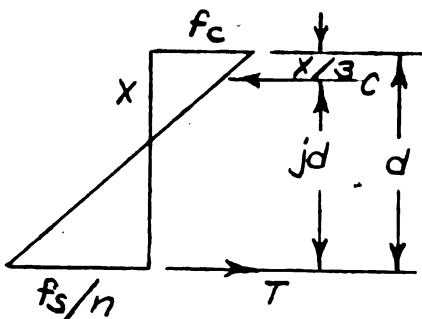
Use :  $n = 12$

$$f'_c = 3000 \text{ psi}$$

$$f_c = (.35)f'_c = 1050 \text{ psi}$$

$$f_s = 18000 \text{ psi}$$

$$f_s/n = 1500 \text{ psi}$$



$$\frac{d}{X} = \frac{1500 + 1050}{1050} \quad X = .412d$$

$$1.0d - \frac{.412d}{3} = jd = .863d$$



$$M = \frac{wl^2}{12} = \frac{150(9)^2}{12} = 1010(12) = 12150 \text{ " #}$$

$$C = (.412d)(12)\left(\frac{1050}{2}\right) = 2590 d$$

$$(C)(jd) = M$$

$$2590 d (.863d) = 12150$$

$$d^2 = \frac{12150}{2235} = 5.45 \quad d = 2.34"$$

Use 2.5"

Total necessary thickness  $2.5" + 1.0" = 3.5"$

$$C = T = 2590 d = 2590(2.5) = 6480 \text{ #}$$

$$\text{Area of steel} = \frac{P}{s} = \frac{6480}{18000} = .36 \text{ " "}$$

$$\text{Area of } 1/2 \phi = .20 \text{ " "}$$

Therefore use 2 -  $1/2 \phi$  / ft. for  $\oplus$  steel.  
 $1/2 \phi @ 6"$

$$\text{Check for bond: } 1/2 \phi \text{ Circumference} = 1.571$$

$$\mu = \frac{V}{\Sigma o jd} = \frac{150(4.5)}{2(1.571)(.863)(2.5)} = 99 \text{ #/ " "}$$

$$\mu < (.05)(f'_c) \quad (.05)(3000) = 150 \text{ #/ " "}$$

Therefore bond is satisfactory.

Check for shear:

$$v = \frac{V}{bjd} = \frac{150(4.5)}{(12)(.863)(2.5)} = 26 \text{ #/ " "}$$

$$v < .03 f'_c \quad (.03)(3000) = 90 \text{ #/ " "}$$

Therefore shear is satisfactory.

Since the steel is running in one direction temperature steel will be used:  $A_s = .002 A_c$   
 Using  $3/8 \phi$  bars:  $.11 = .002(4)(\text{spacing}) \quad 3/8 \phi @ 13.5"$

$$f(x) = \frac{1}{x^2} = x^{-2} \Rightarrow f'(x) = -2x^{-3} = -\frac{2}{x^3}$$

$$f'(1) = -\frac{2}{1^3} = -2$$

$$f'(2) = -\frac{2}{2^3} = -\frac{1}{4}$$

$$f'(3) = -\frac{2}{3^3} = -\frac{2}{27}$$

$$f'(4) = -\frac{2}{4^3} = -\frac{1}{32}$$

$$f'(5) = -\frac{2}{5^3} = -\frac{2}{125}$$

$$f'(6) = -\frac{2}{6^3} = -\frac{1}{108}$$

$$f'(7) = -\frac{2}{7^3} = -\frac{2}{343}$$

$$f'(8) = -\frac{2}{8^3} = -\frac{1}{256}$$

$$f'(9) = -\frac{2}{9^3} = -\frac{2}{729}$$

$$f'(10) = -\frac{2}{10^3} = -\frac{1}{500}$$

$$f'(11) = -\frac{2}{11^3} = -\frac{2}{1331}$$

$$f'(12) = -\frac{2}{12^3} = -\frac{1}{360}$$

$$f'(13) = -\frac{2}{13^3} = -\frac{2}{2197}$$

$$f'(14) = -\frac{2}{14^3} = -\frac{1}{490}$$

$$f'(15) = -\frac{2}{15^3} = -\frac{2}{3375}$$

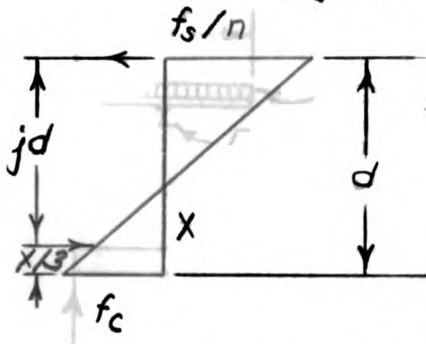
$$f'(16) = -\frac{2}{16^3} = -\frac{1}{640}$$

$$f'(17) = -\frac{2}{17^3} = -\frac{2}{4913}$$

$$f'(18) = -\frac{2}{18^3} = -\frac{1}{810}$$

$$f'(19) = -\frac{2}{19^3} = -\frac{2}{6859}$$

For negative steel :



Using the same values as for + steel.

$$C = 2590d \quad jd = .863d$$

$$14600 \text{ " #} = M = \frac{wl^2}{10} = \frac{150(9)^2(12)}{10}$$

$$14600 = (2590d)(.863d)$$

$$d^2 = 6.52 \text{ " } \quad d = 2.56 \text{ "}$$

$$A_s = \frac{2590(2.56)}{18000} = .37 \text{ "}$$

Use  $\frac{1}{2} \phi @ 6''$  for negative steel

Length of negative steel :

From A.I.S.C. — length of negative moment is  $12/28 \ell$ .

$$\text{length} = \text{length neg. mom.} + (30)(\text{bar dia.})$$

$$\frac{12}{28}(9)(12) + 30(\frac{1}{2}) = 46.3 + 15 = 61.3 \text{ "}$$

Use  $5\frac{1}{2}'$  length. This will allow for the 10' span at the stairs.

Check on the 10' span :

$$M = \frac{wl^2}{12} = \frac{150(10)^2}{12} = 1250(12) = 15000 \text{ " #}$$

$$(2590d)(.863d) = 15000 \quad d^2 = 6.70 \quad d = 2.59 \text{ "}$$

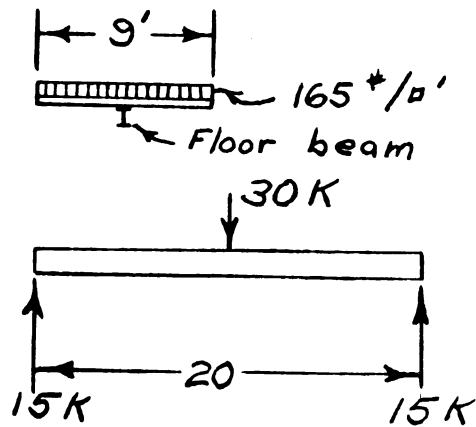
$$A_s = \frac{2590(2.59)}{18000} = 3.73 \text{ "}$$

Therefore the 10' span will not cause a change in the slab design.

\* Use  $d = 3''$  and  $t = 4''$  for actual design of the slab.



### Floor beams and girders :



Floor beam :

L.L.	100 #/ft'
(concrete) D.L.	50
(plaster) D.L.	5
(beam steel) D.L.	10
	<hr/>
	165 #/ft'

$$9(165)(20) = 29700 \# = 30 K$$

The deflection of floor beams carrying plaster ceilings should be limited to not more than  $1/360$  of the span length.

$$(1/360)(20)(12) = .67"$$

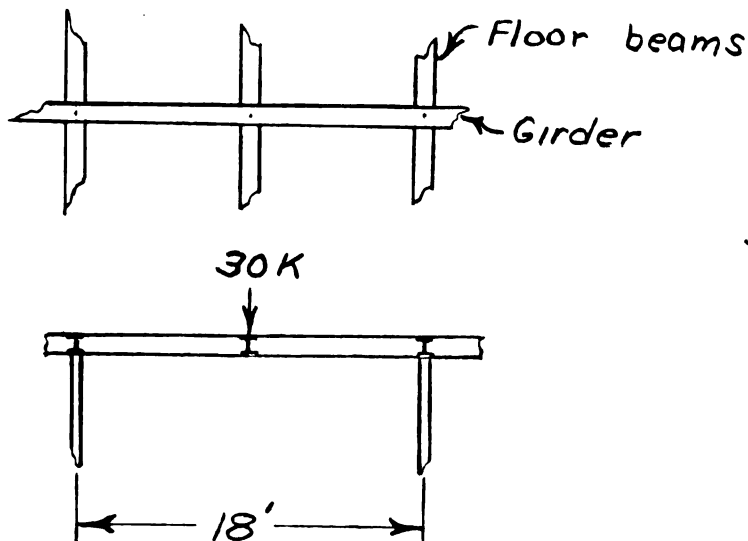
From A.I.S.C. :

12 WF 36 I  
20' Long

deflection = .69"  
load = 31 K

$$\frac{30 K}{31 K} = \frac{X}{.69"} \quad X = .67" \quad \text{Therefore 12 WF 36 may be used.}$$

Girders :



From A.I.S.C.

12 WF 65  
54' Long



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To check the steel weight assumed:

$$\begin{array}{rcl} \text{Floor beams} & (36)(20) & = 720 \text{ \#} \\ \text{Girder} & (65)(9) & = 585 \\ & & \hline & & 1305 \text{ \#} \end{array}$$

Surface area:  $9 \times 20 = 180 \text{ sq'}$

$$\frac{1305}{180} = 7.25 \text{ \#/sq' } \quad \text{Which checks.}$$

Beam connectors to be used throughout:

A.I.S.C. Method:

$3/4"$  Rivets

Use 2  $\angle$  4x4x $3/8$

Double Shear  $t = 5/16$  9.38K

Double Shear  $t = 3/8$  11.30K

Shear = 15.0K

Enclosed bearing on the web 30.0t

12 WF 36  $t = .305"$

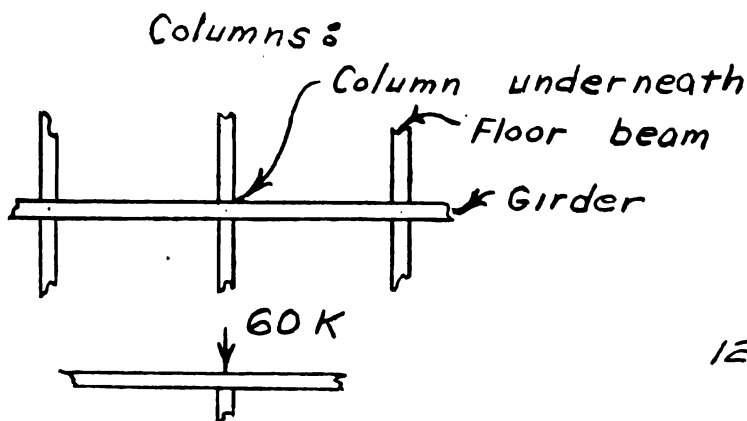
12 WF 65  $t = .390"$

O.S. Legs (4 Rivets)

$$(4)(11.30) = 45.2 \text{ K}$$

Web Legs

$$\frac{15}{(30)(.3125)} = 1.6 \text{ Rivets} \quad \text{— use 2}$$



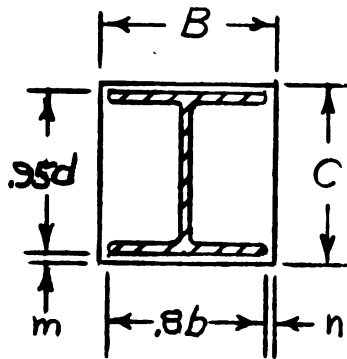
From A.I.S.C.

8 WF 31 \#

12 1/2' Long



Column Base Plates : A. I. S. C. Method



Bearing on concrete  $= .375 f'_c$

$$(.375)(3000) = 1125 \text{ #/sq"} "$$

$$p = 1125 \text{ #/sq"} "$$

$$L = 60K$$

$$b \times d = 8 \text{"} "$$

$$A = \frac{L}{p} = \frac{60000}{1125} = 53.4 \text{ sq"} "$$

$$\text{Assume } B \times C = 9 \text{"} "$$

$$A = 81 \text{ sq"} "$$

$$p = \frac{60000}{81} = 740 \text{ #/sq"} "$$

$$.80b = (.80)(8) = 6.4 \text{"} "$$

$$n = \frac{9 - 6.4}{2} = 1.3 \text{"} "$$

$$t^2 = .15pn^2 = .15(.75)(1.3)^2 = .191 \text{ sq"} "$$

$$t = .438 \text{"} "$$

$$.95d = (.95)(8) = 7.6 \text{"} "$$

$$m = \frac{9 - 7.6}{2} = .7 \text{"} "$$

$$t^2 = .15pm^2$$

$t$  is governed by  $.15pn^2$   
since  $n > m$

Use a 1" plate 9x9 because a plate under 1" is not used in actual practice for a base plate.

Column footing : Sutherland & Reese Method

$$f'_c = 3000 \text{ #/sq"} "$$

$$\text{Use } \nu_c = .02 f'_c$$

$$f_c = 1050 \text{ #/sq"} "$$

$$\text{Soil pressure} = 2000 \text{ #/sq'}$$

$$60.0K \text{ Load}$$

$$j = 7/8$$

$$.5 \text{ (D.L. Column)}$$

$$f_s = 18000 \text{ #/sq"} "$$

$$6.0 \text{ (Footing D.L.)}$$

$$66.5K \text{ Total Load}$$



$$- \frac{1}{2} \frac{d}{dt} \left( \frac{1}{2} \frac{d}{dt} \right) = - \frac{1}{2} \frac{d^2}{dt^2}$$

$$\frac{d}{dt} \left( \frac{1}{2} \frac{d}{dt} \right) = \frac{1}{2} \frac{d^2}{dt^2}$$

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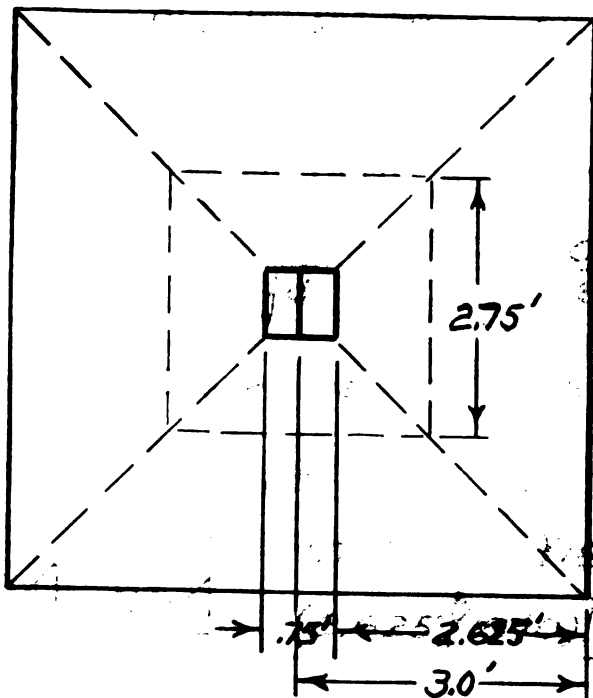
$$\frac{d}{dt} \left( \frac{1}{2} \frac{d}{dt} \right) = \frac{1}{2} \frac{d^2}{dt^2}$$

$$\frac{d}{dt} \left( \frac{1}{2} \frac{d}{dt} \right) = \frac{1}{2} \frac{d^2}{dt^2}$$

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$$\frac{d}{dt} \left( \frac{1}{2} \frac{d}{dt} \right) = \frac{1}{2} \frac{d^2}{dt^2}$$



$$\frac{66500}{20000} = 33.25 \text{ "}$$

Therefore use a 6X6 footing.

$$v_c = .02(3000) = 60 \text{ #/sq"}$$

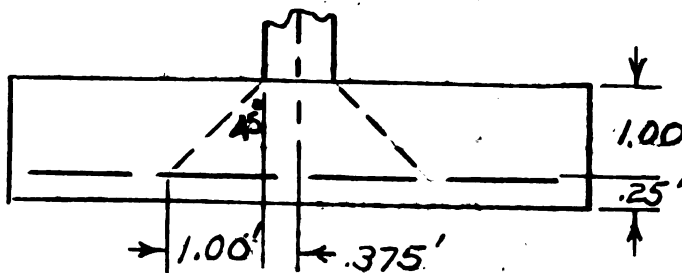
$$j = 7/8 \quad K = a/L$$

$$a = .75' \quad L = 6.0'$$

$$K = \frac{.75}{6} = .125$$

$$C = \frac{w}{504 v_c} = \frac{2000}{504(60)}$$

$$C = .066$$



(Sketch out of scale.)

$$\frac{d}{L} = \frac{\sqrt{2C + 4C^2 + \frac{K^2}{4}} - \frac{K}{2}(1 + 4C)}{2 + 4C}$$

$$d = 6 \left( \frac{\sqrt{2(.066) + 4(.066)^2 + \frac{(.125)^2}{4}} - \frac{.125}{2}[1 + 4(.066)]}{2 + 4(.066)} \right)$$

$$d = 2.65 \sqrt{.0774} = 2.65(.279) = .74'$$

$$\text{Actual weight } 150(6)(6)(1.25) = 6750 \text{ #}$$

$$\text{Other load} = 60500$$

$$36 \boxed{67250 \text{ #}}$$

$$\text{net soil pres.} = 1870 \text{ #/sq'}$$

\* d used as 1' because .74' would be too low a value.

1. The first part of the document is a list of names and addresses of the members of the committee.

2. The second part of the document is a list of the names and addresses of the members of the committee.

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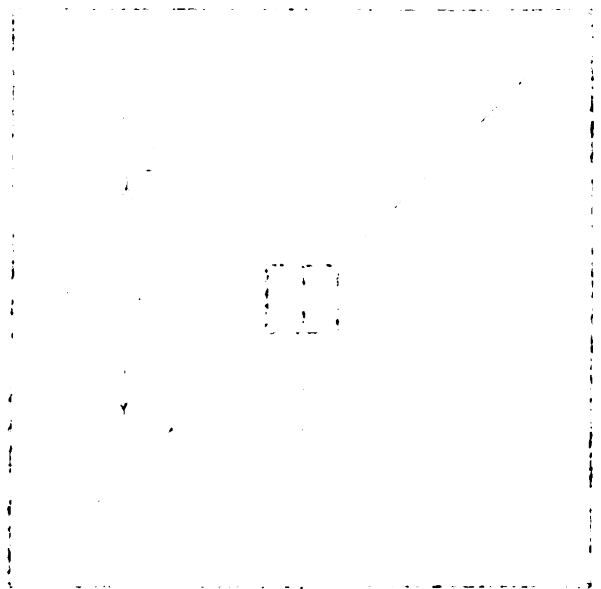
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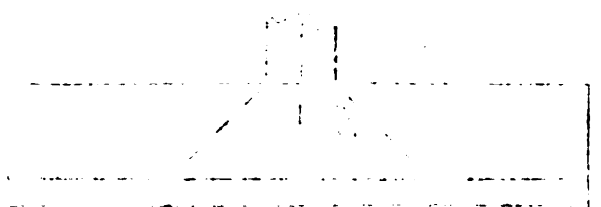
6. The sixth part of the document is a list of the names and addresses of the members of the committee.

7. The seventh part of the document is a list of the names and addresses of the members of the committee.

8. The eighth part of the document is a list of the names and addresses of the members of the committee.



9. The ninth part of the document is a list of the names and addresses of the members of the committee.



10. The tenth part of the document is a list of the names and addresses of the members of the committee.

11. The eleventh part of the document is a list of the names and addresses of the members of the committee.

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15. The fifteenth part of the document is a list of the names and addresses of the members of the committee.

16. The sixteenth part of the document is a list of the names and addresses of the members of the committee.

17. The seventeenth part of the document is a list of the names and addresses of the members of the committee.

Check on shear :

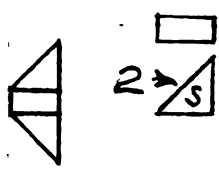
$$(6^2 - 2.75^2) = 36.0 - 7.55 = 28.45 \text{ ft}^2$$

$$28.45(1870) = 53200 \text{ #} = V$$

$$v_c = \frac{V}{b_j d} = \frac{53200}{4(33.0)(8.75)(12)} = 38.5 \text{ #/ft}^2$$

Shear is all right since  $38.5 \text{ #/ft}^2 < 60.0 \text{ #/ft}^2$

Moment at the edge of cap :



$$\begin{aligned} & (.75)(2.625)(1870) \frac{2.625}{2} = 4830 \text{ #} \\ & (2.625^2)(1870) \left[ \left( \frac{2}{3} \right) (2.625) \right] = \frac{22600}{27430 \text{ #}} \end{aligned}$$

$$M = 27430(12) = 329,000 \text{ #ft}$$

Effective width :

$$.75 + 2.00 + 1.625 = 4.375 \text{ ft}$$

$$R = \frac{329000}{(4.375)(12)(12)^2} = 43.5$$

From the tables in Sutherland & Reese's text for  $f'_c = 3000 \text{ #/ft}^2$   $R < 236$  — this checks.

$$\text{Area of steel} = \frac{329000}{(18000)(7/8)(12)} = 1.46 \text{ #ft}^2 \text{ in } 4.375 \text{ ft}$$

$$A_s = \frac{M}{f_s j d}$$

$$\frac{1.46}{A_s} = \frac{4.375}{6.0} \quad A_s = 2.0 \text{ #ft}^2$$

Use 8- $\frac{1}{2}$  # @ 9"


$$A \text{ of } \frac{1}{2} \# = .25 \text{ #ft}^2$$

$$n = \frac{V}{0.4 j d}$$

$$\mu = .062 f'_c = .062(3000)$$

$$\mu = 186 \text{ #/ft}^2$$

0 = perimeter



$$\begin{aligned} & V = \frac{.75 + 6}{2} (1870) 2.63 \\ & V = 16600 \text{ #} \end{aligned}$$



The first part of the document  
 describes the general situation  
 and the results of the  
 investigation. The second part  
 contains the detailed description  
 of the experiments and the  
 results of the calculations.  
 The third part contains the  
 conclusions and the  
 recommendations.

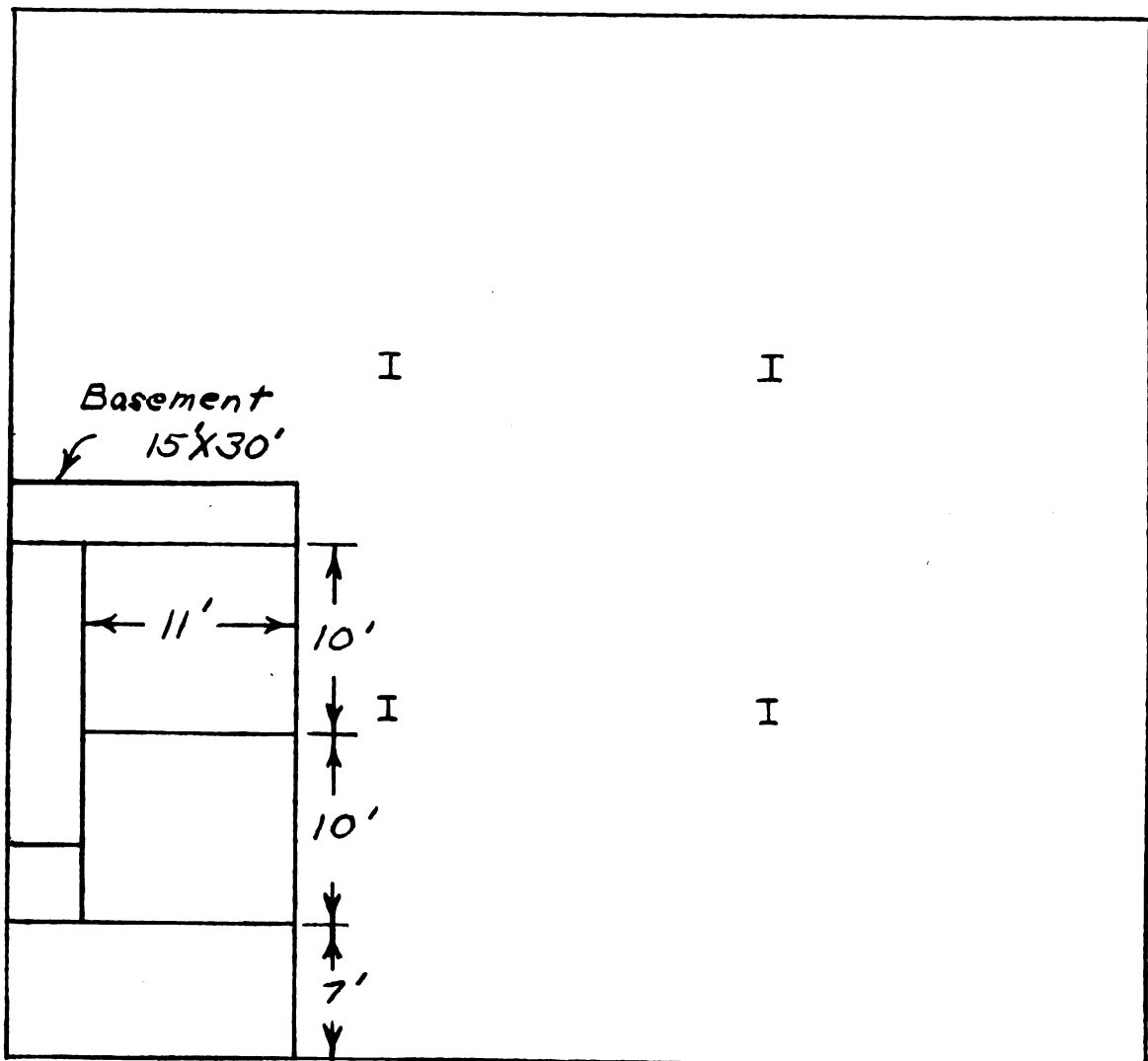
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 recommendations.

$$n = \frac{16600}{(2.0)(186)(7/8)(12)} = 4.25 \text{ rods}$$

Since 8 rods were used the design is all right for bond.

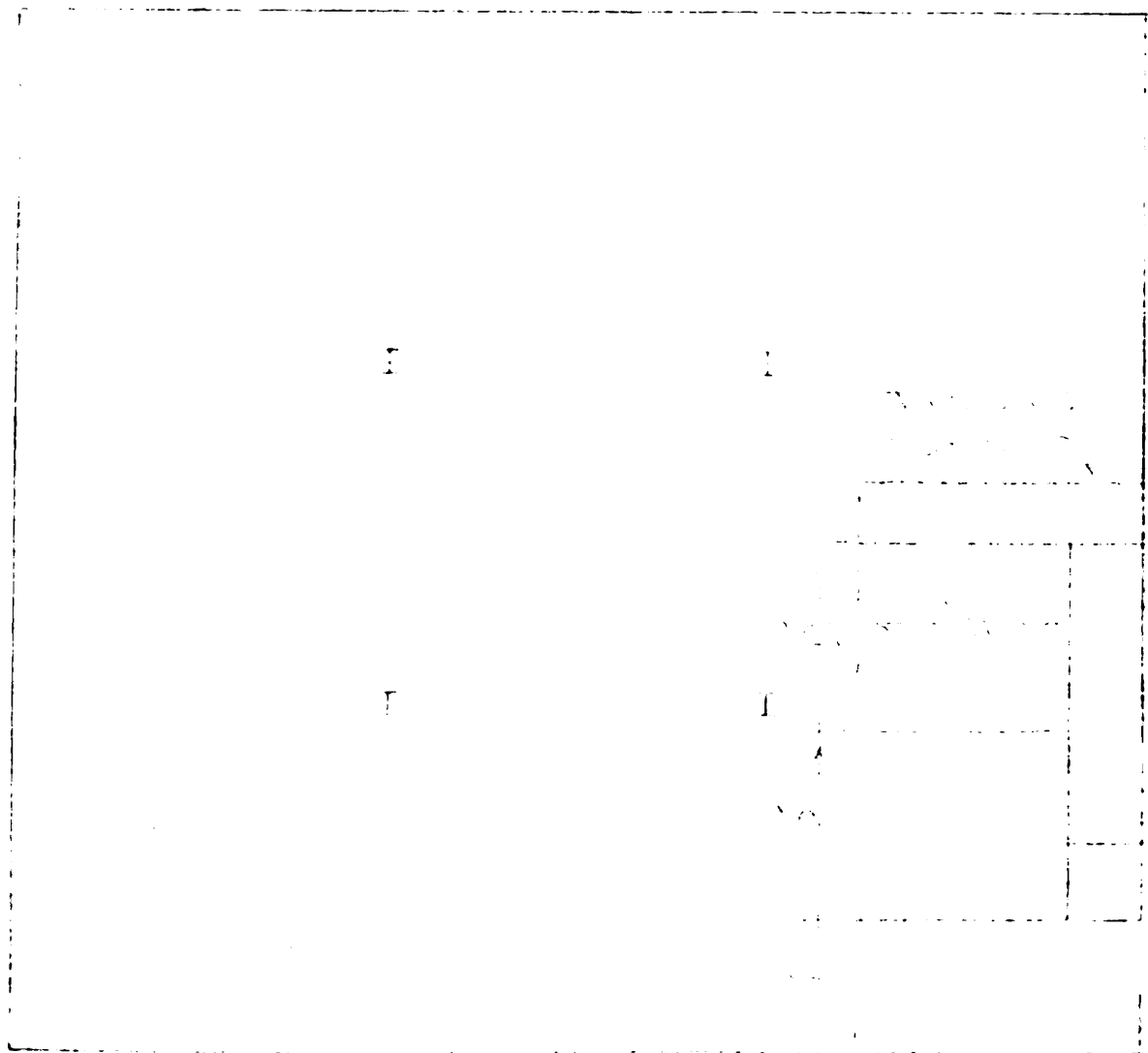
The steel is to be laid in both directions and is to be 5.5' long.

First floor concrete slab :



First floor and basement plan

The first of these is the fact that the  
 system is not a simple one. It is a  
 complex one, and it is not possible to  
 describe it in a simple way. It is a  
 system of many parts, and it is not  
 possible to describe it in a simple way.  
 It is a system of many parts, and it is  
 not possible to describe it in a simple way.  
 It is a system of many parts, and it is  
 not possible to describe it in a simple way.



Assume a concentrated load of 2500 # on a square 6" on a side.

$$f'_c = 3000 \text{ #/sq"} \quad n = 12$$

$$f_c = 1050 \text{ #/sq"} \quad v_c = .03 f'_c$$

$$f_s = 18000 \text{ #/sq"} \quad j = .863$$

$$v_c = .03 f'_c$$

$$j = .863$$

Assume :

$$d = 5"$$

$$\text{total thickness} = 1 + 5 = 6"$$

Perimeter around the square = 36"

$$v_c = \frac{P}{A}$$

$$P = 2500 \text{ #}$$

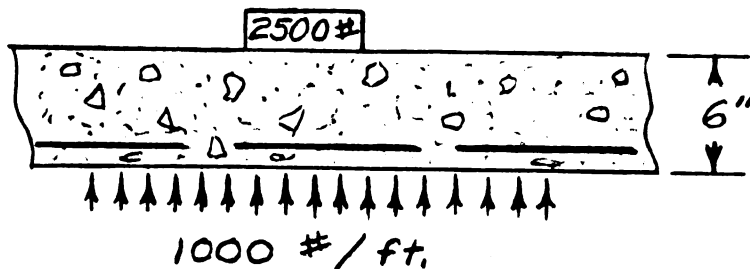
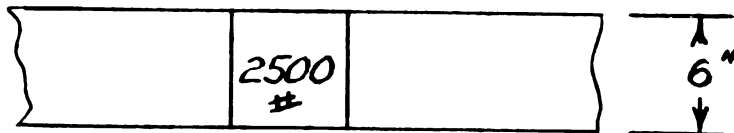
$$A = (\text{perimeter} \times \text{thickness})$$

$$v_c = \frac{2500}{(36 \times 6)} = 11.6 \text{ #/sq"} \quad \text{}$$

This value indicates a safe range for shear since the maximum  $v_c = 90 \text{ #/sq"}.$

Check for moment:

Assume a 6" slab section and bearing pressure of 2000 #/sq' for soil.



$$\frac{2000}{6/12} = 1000 \text{ #/ft.}$$

THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT

PHYSICS 311

LECTURE 1

LECTURE 1: INTRODUCTION

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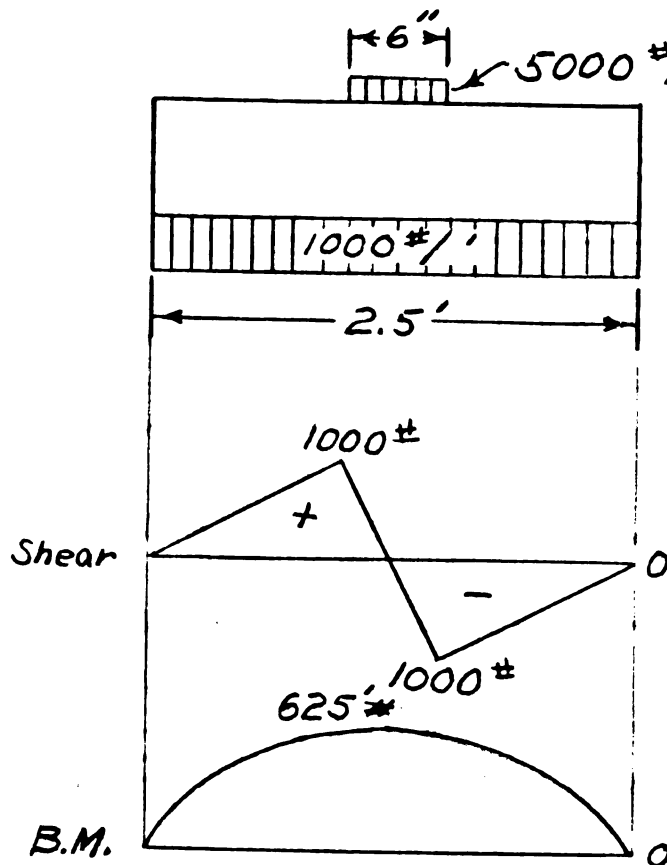
LECTURE 1: INTRODUCTION

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LECTURE 1: INTRODUCTION

2500 # load = 5000 #/' for 6"



$$\frac{2500}{1000} = 2.5'$$

$$\frac{1.25(1000)}{2} = 625' \#$$

$$625(12) = 7500" \#$$

$$M = Cjd$$

$$C = \frac{M}{jd}$$

$$C = \frac{7500}{(.863)(5)} = 1740 \#$$

$$A_s = \frac{1740}{18000} = .097 \text{ sq"} \text{ "}$$

$$A \text{ of } 3/8 \phi = .11 \text{ sq"} \text{ "}$$

Use  $3/8 \phi @ 6"$

The above design will be poured over properly graded subsoil.

For the area over the basement use the following data and computations:

L.L.	150 #/sq'
D.L.	75 #/sq'
total	225 #/sq'

Use  $C = 2590(d)$  from the second floor design.

1. The first part of the paper is devoted to a discussion of the general principles of the theory of the structure of the atom. It is shown that the structure of the atom is determined by the laws of quantum mechanics, which are based on the principle of the uncertainty of the position and momentum of the particles.

2. The second part of the paper is devoted to a discussion of the specific properties of the structure of the atom. It is shown that the structure of the atom is determined by the laws of quantum mechanics, which are based on the principle of the uncertainty of the position and momentum of the particles.

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8. The eighth part of the paper is devoted to a discussion of the specific properties of the structure of the atom. It is shown that the structure of the atom is determined by the laws of quantum mechanics, which are based on the principle of the uncertainty of the position and momentum of the particles.

$$M = \frac{wL^2}{12} = \frac{225(10)^2}{12} = \frac{22500}{12} (\cancel{12}) = 22500 \text{ " \#}$$

$$Cjd = 22500$$

$$(2590d)(.863d) = 22500$$

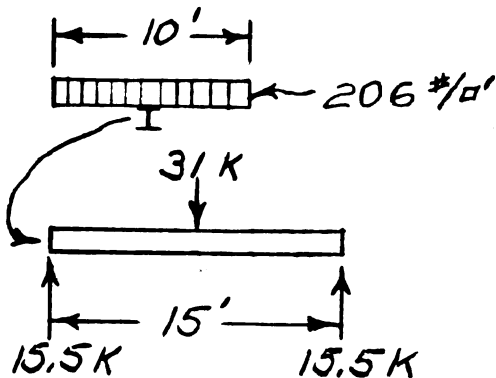
$$d^2 = \frac{22500}{2235} = 10.1$$

$$d = 3.18" \quad \text{Use } 3.5" \quad t = 4.5"$$

$$A_s = \frac{2590(3.5)}{18000} = .503 \text{ " "}$$

$$\text{Use } 1/2 \text{ \# bars} \quad A = .25 \text{ " "} \quad 1/2 \text{ \# @ } 6"$$

WF beams to be used in the basement:



$$\begin{aligned} L.L. &= 150 \text{ #/ft} \\ \left(\frac{4.5}{12}\right) 150 \text{ D.L.} &= 56 \text{ #/ft} \\ &= 206 \text{ #/ft} \end{aligned}$$

$$(10)(15)(206) = 30900 \text{ \#}$$

Use 31 K

From A. I. S. C.

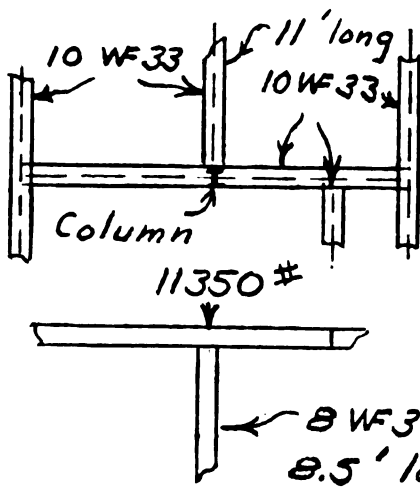
10 WF 33

Column :

$$(10)(11)(206) = 22700 \text{ \#}$$

$$\frac{22700}{2} = \text{Reaction on column}$$

$$R = 11350 \text{ \#}$$



Column 8 WF 31

Use same size base plates as before.



1. The first step is to identify the problem.

2. The second step is to define the problem.

3. The third step is to analyze the problem.

4. The fourth step is to develop a solution.

5. The fifth step is to implement the solution.

6. The sixth step is to evaluate the solution.

7. The seventh step is to monitor the solution.

8. The eighth step is to maintain the solution.

9. The ninth step is to improve the solution.

10. The tenth step is to document the solution.

11. The eleventh step is to review the solution.

12. The twelfth step is to conclude the solution.

13. The thirteenth step is to reflect on the solution.

14. The fourteenth step is to learn from the solution.

15. The fifteenth step is to share the solution.

16. The sixteenth step is to apply the solution.

17. The seventeenth step is to evaluate the results.

18. The eighteenth step is to monitor the progress.

19. The nineteenth step is to maintain the results.

20. The twentieth step is to improve the results.

21. The twenty-first step is to document the results.

No negative steel will be use on the first floor slab — except over the basement.

Negative steel :

$$C = 2590 \quad jd = .863d$$

$$M = \frac{wl^2}{10} = \frac{206(10)^2}{10} = 2060(12) = 24720 \text{ " \#}$$

$$Cjd = M \quad \frac{24720}{(2590)(.863)} = d^2 = 11.1 \quad d = 3.34" \quad \text{Use } d = 3.5"$$

$$A_s = \frac{(2590)(3.5)}{18000} = .501 \text{ " "}$$

$$\text{Use } 1/2 \text{ " } @ 6" \quad A = .25 \text{ " "}$$

$$\text{Length of negative steel : } A = \frac{\pi d^2}{4}$$

$$\frac{12}{28} (l") + 30(\text{bar dia.}) = l \text{ of steel}$$

$$\frac{12}{28} (10)(12) + 30\left(\sqrt{\frac{4(.25)}{3.14}}\right) = 52" + 17" = 69"$$

$$l = 5.75'$$

Temperature steel :

$$A_s = .002 A_c \quad \text{Use } 3/8 \text{ " bars } A = .11 \text{ " "}$$

$$.11 = .002 (4.5)(\text{spacing}) \quad s = 12 \text{ "}$$

$$\text{Use } 3/8 \text{ " } @ 12"$$

Both the temperature and negative steel were designed the same as that used in the second floor slab.

Footing for basement column : —

Assume a possible load of 30K to include everything except the footing D. L. .

1. The first part of the document is a list of names and addresses of the members of the committee. The names are written in a cursive hand, and the addresses are written in a more formal, printed hand. The list is organized in a table-like format with columns for names and addresses.

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7. The seventh part of the document is a list of names and addresses of the members of the committee. The names are written in a cursive hand, and the addresses are written in a more formal, printed hand. The list is organized in a table-like format with columns for names and addresses.

8. The eighth part of the document is a list of names and addresses of the members of the committee. The names are written in a cursive hand, and the addresses are written in a more formal, printed hand. The list is organized in a table-like format with columns for names and addresses.

9. The ninth part of the document is a list of names and addresses of the members of the committee. The names are written in a cursive hand, and the addresses are written in a more formal, printed hand. The list is organized in a table-like format with columns for names and addresses.

10. The tenth part of the document is a list of names and addresses of the members of the committee. The names are written in a cursive hand, and the addresses are written in a more formal, printed hand. The list is organized in a table-like format with columns for names and addresses.

$$f'_c = 3000 \text{ #/sq"} \quad \text{soil} = 2000 \text{ #/sq'}$$

$$\text{L.L.} \quad 30.0 \text{ K}$$

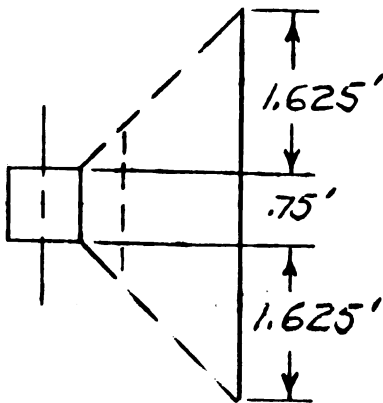
$$j = 7/8$$

$$\text{D.L.} \quad \frac{1.5}{31.5 \text{ K}} \quad (\text{Assumed footing wt.})$$

$$\frac{31500}{2000} = 15.75 \text{ sq'}$$

$$4' \times 4' = 16 \text{ sq'}$$

Assume a "d" value of 6" or .5'



$$\text{D.L.} = (150 \times 16 \times .75) = 1800 \text{ #/sq'}$$

$$\begin{array}{r} 30000 \text{ #/sq' } \\ 16 \overline{) 31800} \\ \underline{1990 \text{ #/sq' }} \end{array}$$

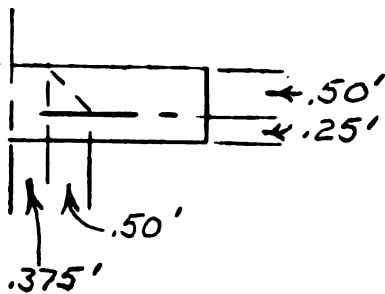
Check on shear :

$$(4^2 - 1.75^2) = 16 - 3.06 = 12.94 \text{ sq'}$$

$$(12.94 \times 1990) = V = 25700 \text{ #}$$

$$v_c = \frac{V}{b j d} = \frac{25700}{4(21) \times .875 \times (6)}$$

$$v_c = 58.3 \text{ #/sq"} < 60 \text{ #/sq"}$$



Moment at the edge of cap :

$$\square \quad (1.625 \times .75 \times 1990 \times \frac{1.625}{2}) = 1975 \text{ #}$$

$$2 \rightarrow \nabla \quad (1.625)^2 \left( \frac{2}{3} \right) (1.625 \times 1990) = 5700 \text{ #}$$

$$M = (7675 \times 12) = 92000 \text{ #"} \quad \underline{7675 \text{ #}}$$

Effective width :

$$.75 + 1.00 + 1.125 = 2.875 \text{ '}$$

1. 1970-1971

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1971-1972

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1990-1991

1991-1992

1992-1993

1993-1994

1994-1995

1995-1996

$$R = \frac{92000}{(2.875)(12)(6)^2} = \frac{92000}{1240} = 74.2 < 236$$

$$\text{Area of steel} = \frac{92000}{(18000)(7/8)(6)} = .975 \text{ in } 2.875'$$

$$\frac{.975}{2.875} = \frac{A_s}{4}$$

$$A_s = 1.36 \text{ in } 4.0'$$

Use 6 -  $\frac{1}{2}$  # @ 8"

Check on bond :

$$n = \frac{V}{0.44jd} = \frac{(1990)(\frac{4.0+.75}{2})(1.625)}{(2)(.875)(6)(186)} = \frac{7680}{1955}$$

$$n = 3.93 \text{ rods}$$

Since 6 rods were used this checks satisfactory.

The method used in designing this footing was the same method used earlier in the design.

1. The first part of the paper is devoted to a discussion of the general principles of the theory of the structure of the atom.

2. In the second part, we shall consider the question of the influence of the external magnetic field on the structure of the atom.

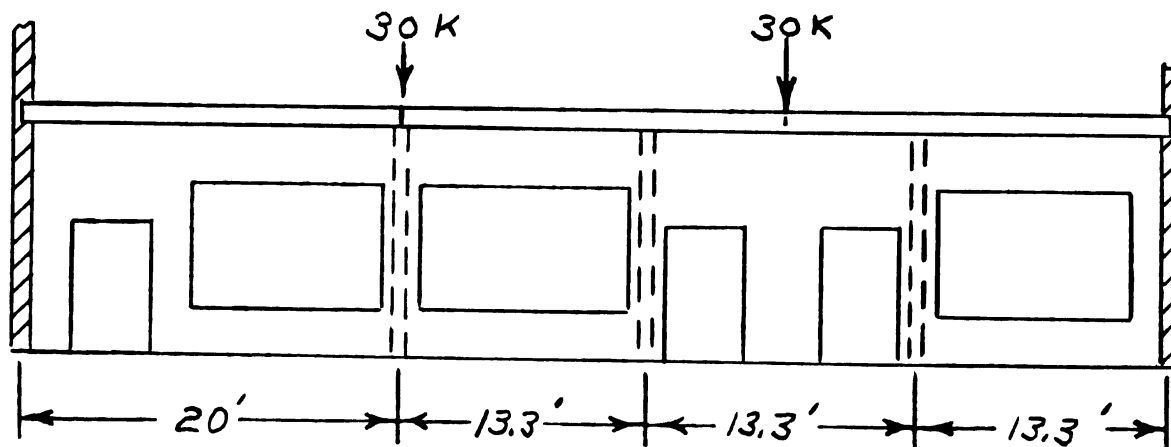
3. The third part of the paper is devoted to a discussion of the question of the influence of the external electric field on the structure of the atom.

4. In the fourth part, we shall consider the question of the influence of the external magnetic field on the structure of the atom.

5. The fifth part of the paper is devoted to a discussion of the question of the influence of the external electric field on the structure of the atom.

6. In the sixth part, we shall consider the question of the influence of the external magnetic field on the structure of the atom.

# STORE-FRONT DESIGN :

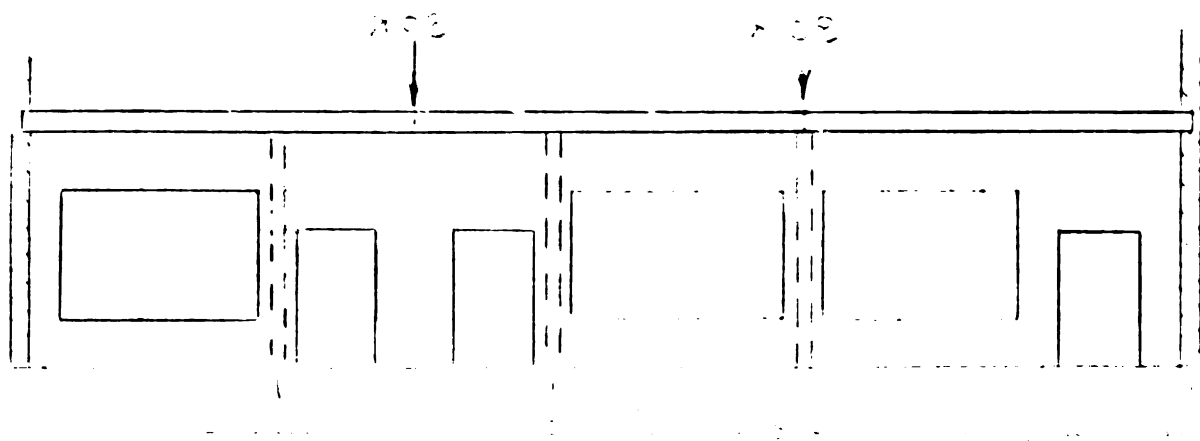


Columns are set on a 9'x9" base plate — the base plate is set in the foundation then welded construction is used. The foundation is spread as shown on the print showing the area needed to build building.

From A.I.S.C. use 8 WF24 for columns

Base plate 1'x9'x9"

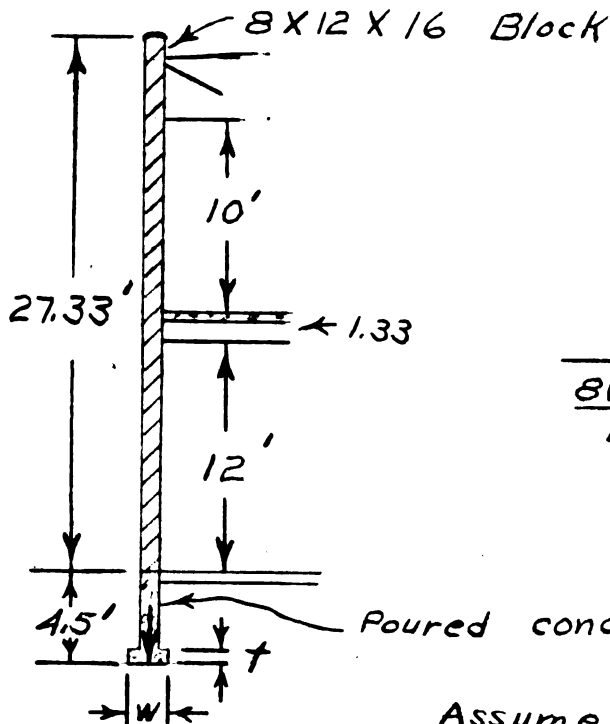




## FOUNDATION DESIGN :

For the foundation sections not around the basement :

Assume a 4' frost line.



$$\text{Concrete} = 150 \text{ \#/cu. ft.}$$

$$8 \times 12 \times 16 = 65 \text{ \#}$$

Take 1' strip

$$\frac{1 \text{ cu. ft.}}{8(12)(16)} = \frac{X}{65} \quad X = 73 \text{ \#/cu. ft.}$$

$$\frac{1728}{1728}$$

$$\text{Block} = 73 \text{ \#/cu. ft.}$$

$$\text{Use } 75 \text{ \#/cu. ft.}$$

Assume 10' of the second floor to be included in wall weight. Second floor = 165 \#/sq'.

$$\text{Approximate } P = (75)(27.33) + 10(165) + 4.5(150)$$

$$P = 2050 + 1650 + 675 = 4375 \text{ \#}$$

Assume bearing pressure = 2000 \#/sq' soil.

$$s = \frac{P}{A}$$

$$(1) W = \frac{4375}{2000} = 2.187' \text{ use } 2.25'$$

$P$  acting directly vertical on a 12" square  
 $\tau_c = 90 \text{ \#/sq"}$   
 $2.25'$   
 $+ (12)(4) = \frac{4375}{90} \quad t = 1.01''$

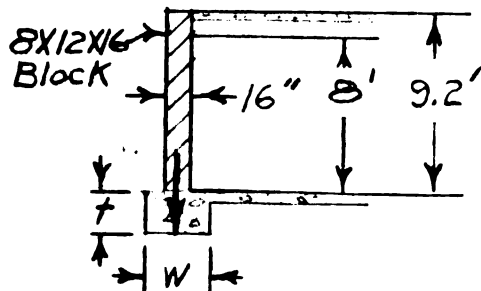
$$t = 0.5' \quad \& \quad W = 2.25'$$



For the section around the basement —  
outer wall :

Same loading above earth as before —

$$\text{Assume } W = 3' \text{ \& } t = 2'$$



$$P = 2050 + 1650 + \left(\frac{16}{12}\right)(9.2)(75) + (2)(3)(150)$$

$$2050$$

$$1650$$

$$918$$

$$900$$

$$P = 5518 \#$$

$$\text{Actual } W = \frac{5518}{2000} = 2.759'$$

$$t = \frac{5518}{(90)(48)} = 1.2''$$

Use  $W = 2.75'$  \&  $t = 1.0'$  for  
practical reasons.

Use  $W = 1.0'$  and  $t = 1.0'$  for the  
foundation under the 8X8X16 block wall  
which forms the inner walls.

Where pilasters are in the walls  
the foundation swings out around it with  
the same additional width added to it.  
(This is shown in the print showing the  
area needed to build this building.)



## LINTEL and BEARING PLATE DESIGNS :

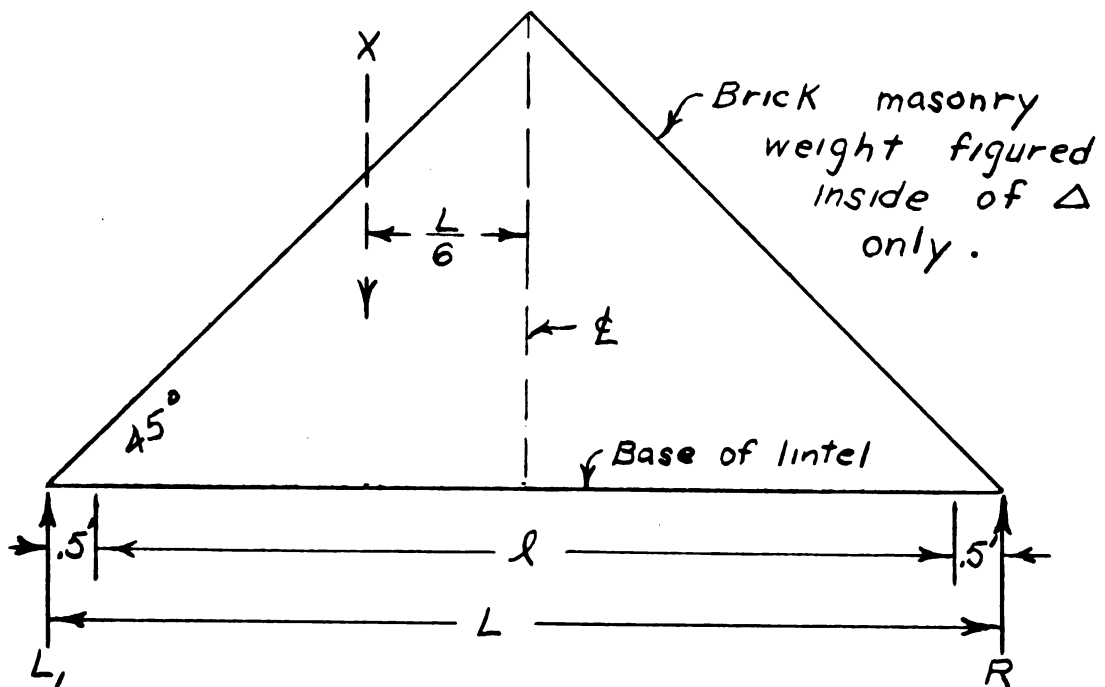
Lintels :

12" Brick masonry wall

Common brick = 120 #/ cu. ft.

$S = 20000 \text{ #/in}^2$  for steel.

All lintel designs will refer to the following sketch :



$l$  = opening in wall

$L$  = total lintel length

$X$  = total weight of left  $\Delta$

1. The first part of the paper is devoted to the study of the

properties of the function  $f(x)$  defined by the equation

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

for  $x \in \mathbb{R}$ . It is shown that  $f(x)$  is an odd function and

that it satisfies the functional equation

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

for  $x \neq 0$ . The second part of the paper is devoted to the study of the

properties of the function  $g(x)$  defined by the equation

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

for  $x \in \mathbb{R}$ . It is shown that  $g(x)$  is an even function and

that it satisfies the functional equation

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

for  $x \neq 0$ . The third part of the paper is devoted to the study of the

properties of the function  $h(x)$  defined by the equation

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

for  $x \in \mathbb{R}$ . It is shown that  $h(x)$  is an odd function and

that it satisfies the functional equation

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

for  $x \neq 0$ . The fourth part of the paper is devoted to the study of the

properties of the function  $i(x)$  defined by the equation

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

for  $x \in \mathbb{R}$ . It is shown that  $i(x)$  is an even function and

For  $l = 11'$  :

$$L = 12'$$

$$L_1 = R = \frac{6(12)}{2} (120) = 2160 \#$$

B.M.

$$2160(6) - \frac{6(6)}{2} (120)(2) = 12960 - 4320$$

$$B.M. = 8640' \#$$

$$S = \frac{M}{S} = \frac{(8640)(12)}{20000} = 5.2''^3$$

From A.I.S.C. use 7 L 9.8 with a  $\frac{1}{4}'' \times 9''$  plate welded to the L.



Drop bolts through the plate to fasten the window-sash.

For  $l = 10'$  use the same structural shapes as those used when  $l = 11'$ .  $L = 11'$  for  $l = 10'$ .

For  $l = 3'$  :

$$L = 4'$$

$$L_1 = R = \frac{4(2)}{2} (120) = 240 \#$$

B.M.

$$2(240) - 240\left(\frac{2}{3}\right) = 320' \#$$

$$S = \frac{M}{S} = \frac{320(12)}{20000} = .192''^3$$

Use a  $2\frac{1}{2} \times 2 \times \frac{1}{4}$  L with a  $\frac{1}{4}'' \times 9''$  plate welded to the L.



1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the transparency and accountability of the organization. This section also outlines the various methods used to collect and analyze data, ensuring that the information is reliable and up-to-date.

2. The second part of the document focuses on the implementation of the proposed changes. It details the steps involved in the rollout process, from initial planning to final execution. This section also addresses potential challenges and provides strategies to overcome them, ensuring a smooth transition for all stakeholders.

3. The third part of the document discusses the long-term impact of the changes. It highlights the expected benefits, such as improved efficiency and cost savings, and provides a timeline for when these benefits are anticipated to be realized. This section also includes a summary of the key findings and recommendations for future action.

4. The final part of the document is a conclusion that summarizes the overall findings and provides a final recommendation. It reiterates the importance of the changes and encourages all stakeholders to support the implementation process. This section also includes a list of references and a bibliography for further reading.

For  $l = 4'$

$L = 5'$

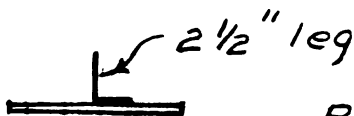
$$L_1 = R = \frac{(2.5)(5)(120)}{2} = 375 \#$$

B.M.

$$(375)(2.5) - 375\left(\frac{5}{6}\right) = 625' \#$$

$$S = \frac{M}{S} = \frac{(625)(12)}{20000} = .375''^3$$

Use a  $2\frac{1}{2} \times 2 \times \frac{1}{4}$   $\angle$  with a  $\frac{1}{4}'' \times 9''$  plate welded to the  $\angle$ . ( $2\frac{1}{2}''$  leg is in the vertical position.)



Position of  $\angle$  the same for  $l = 3'$  and  $l = 4'$  lintel.

For  $l = 12'$

$L = 13'$

$$L_1 = R = \frac{13(6.5)(120)}{2} = 2540 \#$$

B.M.

$$(2540)(6.5) - 2540\left(\frac{13}{6}\right) = 11000' \#$$

$$S = \frac{M}{S} = \frac{11000(12)}{20000} = 6.05''^3$$

Use 7  $\angle$  12.25 with  $\frac{1}{4}'' \times 9''$  plate.

Bearing Plates :

For lintels :

No actual bearing plate is needed, but the  $\frac{1}{4}''$  plate will act as such, and the length of the lintels overlap the masonry a  $\frac{1}{2}'$  at each end of the opening.

The first part of the document is a list of names and dates, which appears to be a record of some kind. The names are written in a cursive script, and the dates are in a more formal, printed style. The list is organized into columns, with names on the left and dates on the right.

The second part of the document is a series of paragraphs of text, also written in cursive. The text is somewhat difficult to read due to the handwriting, but it appears to be a narrative or a report of some kind. The paragraphs are separated by small gaps, and the overall layout is somewhat irregular.

The third part of the document is a list of names and dates, similar to the first part. This list is also organized into columns, with names on the left and dates on the right. The handwriting is consistent with the first part, suggesting it was written by the same person or in the same context.

The fourth part of the document is another series of paragraphs of text, written in cursive. This section continues the narrative or report from the second part, with similar formatting and layout.

The fifth part of the document is a final list of names and dates, organized into columns. This list is the last of its kind in the document, and it follows the same format as the previous lists.

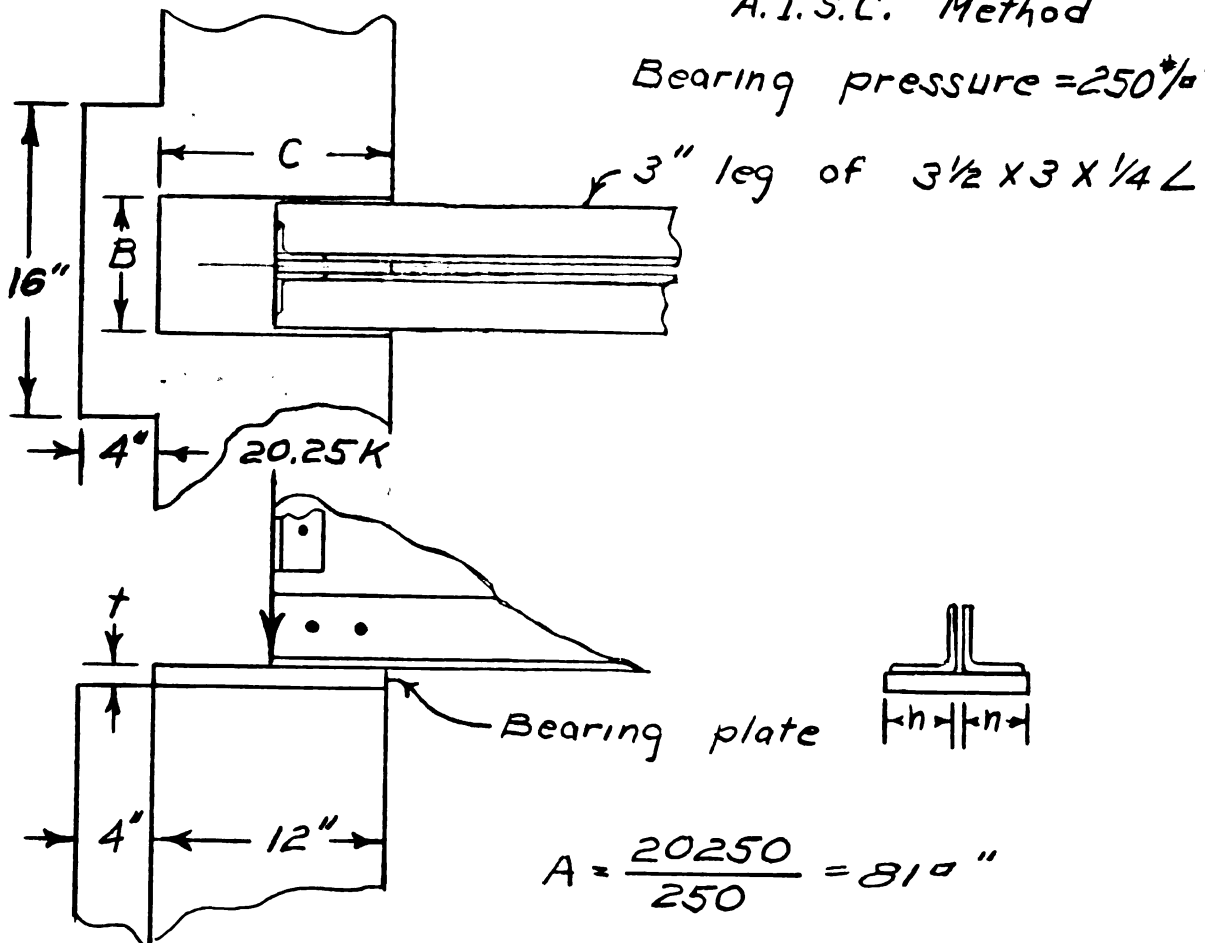
Taking the maximum lintel reaction of 2540# and a bearing pressure for a masonry wall of 250#/in<sup>2</sup> we get:

$$S = \frac{P}{A} \quad A = \frac{2540}{250} = 10.2 \text{ in}^2$$

Since the walls are 12" wide — a 1" strip would prove a satisfactory bearing area. Therefore no bearing plate is needed.

Bearing plates for the roof truss:  
A.I.S.C. Method

Bearing pressure = 250#/in<sup>2</sup>



$$A = \frac{20250}{250} = 81 \text{ in}^2$$

Assume  $C = 12''$   $12B = 81$   
Let  $B = 7''$

$$\text{net } p = \frac{20250}{12(7)} = 241 \text{ \#/in}^2 \quad n = \frac{B}{2} - 1 = \frac{7}{2} - 1 = 2.5''$$

$$t^2 = .15 p n^2 = (.15) \times 241 \times (2.5)^2 = 2260 \quad t = 47.6''$$

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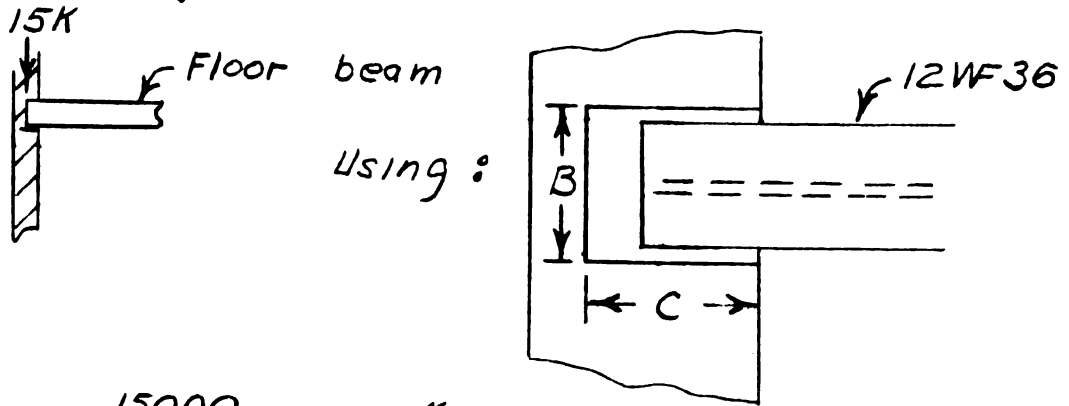
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Use  $3/4"$  plate because this is the thinnest used in actual practice. Welded construction is used along with anchor bolts.

Bearing plates for the floor beams:



$$A = \frac{15000}{250} = 60 \text{ in}$$

$$\text{Assume } B = 8 \text{ in } C = 9 \text{ in}$$

$$\text{net } p = \frac{15000}{(8 \times 9)} = 208 \text{ #/in} \quad n = \frac{8}{2} - 1 = 3$$

$$t^2 = (.15 \times 208 \times 3)^2 = .281 \quad t = .53$$

Use  $3/4"$  plate  $8 \times 9$  — Use welded construction and anchor bolts.

1. The first part of the document is a letter from the President of the United States to the Congress, dated January 3, 1862. It is a very important document, as it contains the President's annual message to Congress. The letter is written in a formal, dignified style, and it is one of the most important documents in the history of the United States.

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rocket res. Drawing 2.1

Drawing no. 2

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