MAJOR THESIS

For The Degree Of Master Of Architecture.
1934-1935.

THE DESIGN OF A PUBLIC LIBRARY FOR THE CITY OF WINNIPEG TO BE LOCATED ON OSBORNE ST. AND YORK AVENUE EXTENDED

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Bachelor of Architecture - 1934.
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Major Thesis for the Degree of

Master of Architecture, 1934 - 1935.

The Design of a Public Library

for the city of Winnipeg to be located on Osborne St and York Ave, extended.

This thesis is divided into the statement of the problem, the solution of the problem, and the conclusion.

The statement is as follows:

Population of Winnipeg -	218,545
Number of books in the libraries -	80,770
Number of books per capita -	.285
Total number of volumes circulated	698,333
Number of new members registered during the year	9,758
Number of books required per capita	1.5
Number of books required in the city	327,820

(The figure of 1.5 books per person, is advanced by Mr. A. F. Jamieson, Librarian, Winnipeg, Canada, and Mr. Hadley, Librarian, Denver, Colorado, U.S.A.)

There is little doubt in the minds both of the library committee and of the citizens of Winnipeg that the library facilities of Winnipeg are inadequate.

Recent controversy in the newspapers proves, that while under the present circumstances, the librarian and his staff are doing well, they are hampered by the lack of proper facilities.

A recent letter to the Editor of the Tribune asks why the small commercial libraries of the cities are patronized to such an extent. To answer this, he claims that looking for a book is a sort of shopping expedition, a lark as well as a search for an interesting book. The service sold by the commercial libraries is better; the interesting books are displayed; there are no grilles and partitions to keep people away from the books; they are made to feel at home.

His answer is incomplete. The main public library is badly located, poorly housed and incompletely stocked. The building is too small and poorly planned. It houses -

(1) A reference library of 21,647 volumes.

(2) A circulation library of approximately 30,000 volumes.

This building is large enough to use as a branch library to serve the district in which it is placed. Winnipeg requires at least 60,000 volumes in a reference library, in a good location.

The building shows an insufficient study of library needs. The newspaper room is located in the same room as the circulation desk and library - an undesirable feature when used by loafers. The offices are inadequate, the librarians office opening on the newspaper room and entered either through the stock room or the other street entrance. It is without a waiting room. The vault is entered from it. The office is also located on the east side and is flooded by the hot sun when it is used the most, in the morning. It is very difficult to expand this building because of the type of plan.

The location is on a minor thoroughfare, that of William Ave. The proximity to the Civic Offices is of no value. The building is in a slum district, six blocks from China town and the soup kitchen. Hence its use is limited to able bodied men, groups of ladies, or people with automobiles, also to the unemployed and vagrants of the district. People are required to make an effort to go to it. They cannot reach it easily, as they can a commercial library.

Librarians claim that the main library should be near the business district, on or near the junction of main thoroughfares; near the people who want to use it; e.g. - the university, the museum, the art gallery and school, the auditorium, the legislative assembly and the business men and women of the city, the musicians, and many others.

The solution of the problem is divided into two parts.

(1) the location of the building.

(2) the requirements of the building or the programme.

(1) The location chosen for this building is on Osborne street, opposite the War Memorial at York Ave extension.

This location is central as shown on the plot plan, situated as follows -

(a) on the new thoroughfare north and south through the city.

(b) opposite the Auditorium and forming a sort of 'civic centre'.

(c) near the Junior University and the Legislative Assembly and Court House.

(d) on the Park Line route, the Westminster bus line and the Suburban bus stop (H.B.Co. parking grounds) and two blocks from Portage Ave. and Broadway, where Portage, North Main, Corydon cars and Ellice bus, and Broadway, Elmwood and Stafford cars pass.

(e) near the Hudson Bay parking grounds.

In this location, the building will provide both a central and dignified location; free, to a degree, from the loafers who hang around public buildings and conveniently located for all the residents of Winnipeg regardless of their place of residence or occupation.

Assuming that the main library at William Ave. be converted to a branch library to serve this district, and a new branch library of 25,000 volumes be built in the West End, say, Portage and Arlington, a new Main Library building for Winnipeg would be required to house -

327,820 - (80,770 plus 25,000) - 222,150 volumes.

No estimate of expansion is required, because the city is under stocked, requiring five times its present facilities. Reading room is required for 300 readers.

In consultation with Mr. Jamieson, librarian of the city of Winnipeg, the following facilities for a main library building were determined: -

(1) A circulation fiction department, on the first floor, to be of the open shelf type, with less popular books in the stock room.

(2) A reference reading room, where quiet will be found, on the second floor.

(3) A music library with a piano in the room.

(4) A fine arts library.

(5) Periodical reading room for current issues.

(6) A browsing room, where people may read and choose their books at leisure.

(7) A rental library, following the present policy on new books which the circulation library does not stock.

(8) A board room for the library board.

(9) The librarian's office.

(10) Secretary's office and waiting room.

(11) Business office.

(12) Catalogue and order room for twelve people.

(13) Registration office for registering readers.

(14) Receiving and shipping.

(15) A bindery, justified by the present expense in re-binding books.

(16) A newspaper room with a separate entrance.

(17) A children's reading room with a separate entrance.

(18) The tower type of book stack.

(19) Staff rooms, small work rooms, wash rooms, etc.

(20) Janitor's room.

(21) Public toilet where they can be easily supervised.

(22) A garage for one car and one light delivery truck.

(23) A branch library room where books of branch libraries are sent.

The conclusion of the thesis is divided into two parts - the drafted solution of the problem and a written explanation thereof.

The art of library design is the art of providing the most perfect accomodations for each of the above requirements, in such relation to each other that the books will be transferred from the shelf to the reader in the shortest possible time, with the fewest steps and the least labor both for readers and attendants.

The type of plan adopted is that of a closed stack room, at the librarian's request, in a tower form, centrally located, with the other rooms around.

The central location is best because:

(a) advantageous position due to ease of communication with both reading rooms and services.

(b) it keeps the natural light for the staff and the readers.

(c) exterior light is not required in the stack room, according to the authorities on library design of today. Improved methods of artificial lighting are not expensive and do not injure the books, as sunlight does. They give a more even intensity of illumination over everything and are not subject to weather conditions and dirt. Forced ventilation is required to keep the books from drying out. Heating costs are also reduced in the central tower type. Expansion can be obtained by adding to the tower like stack. Walls and floors are of concrete, painted white. The stacks are supplied and set by the manufacturer.

The reference reading room, on the second floor for quietness, has a northerly exposure for even lighting. Artificial illumination is supplied by Higby desk lamps and Neon gas lights, indirect lighting. This lighting is carried out through all the public rooms in the building. Common reference books are on shelves around the walls.

The music room is placed so that it will not interfere with other parts of the library, a sound proof wall being used between the Fine Art library and it. Both these reference libraries are conveniently located off the exhibition lobby on the second floor. The periodical reading room is placed next to the reference library, for reference purposes.

On the main floor, the main lobby contains all the stairs eliminating slippery steps in the winter time.

In the lobby is the charging desk, keeping book records, and supervising the open shelf room. In the open shelf circulation room, books of current interest are around the walls on shelves. Tables are placed in the centre of the room for those who desire to sit down and read, before taking out their books. This room and the one above are of this long narrow shape for one reason, to get a uniform north light over the whole room, the best possible exterior light.

In the lobby, we also have the information desk, controlling the catalugues, the browsing room and the rental library. The stack room desk, for charging only, of books in the stack room, is along the stack room wall. The walls of the lobby are fitted with cases, where possible, for the display of new books, interesting data, etc. The exhibition lobby on the 2nd floor is to be used for displays of literary character. The browsing room is fitted with wall shelves and easy chairs, carpeted, and with a discriminating selection of books for the reader, who likes to look for himself. The register office is placed next to the main lobby. The business stairs on the side serve the staff and those who wish to see the staff for business reasons. The order and catalogue room is placed next to the work room, and connected with the shipping room by an elevator and passage. The service stairs and work rooms are at the rear. The garage is on a mezzanine floor and serves as a street entrance to the shipping room via the elevator. The children's room is in a waterproof, damp proof basement, well lit on the south side of the building to get the afternoon sun when the room is most used. It is to be decorated with murals depicting a voyage around the world with scenes of interest to a child. The story hour room is partitioned by means of book stacks. By using book stacks as partitions wherever possible, more flexibility is allowed the librarian as the needs of the library vary.

The newspaper room is in the basement, with a separate entrance. This segregates the type of person who uses this room from the other library users. The other minor services are placed as shown, to their best advantage in circulation and lighting.

The offices are placed to avoid the morning light, and are to be equipped with Venetian blinds.

Further explanation of the plans would entail data of the requirements of the city by-laws for public buildings, and also references to data in various books on library planning, management and furniture. The library has been designed to accommodate standard furniture, and fittings, thus reducing the cost.

Windows have been carried high for maximum light. Skylights have been eliminated because -

(1) they leak and the glass cracks,

(2) they get dirty and lose efficiency,

(3) they waste space.

The building will be heated by treated air, preventing deterioration of books and improved atmosphere. Floors are to be of cork tile in public rooms and the walls treated to prevent noise. The heating and ventilating room is placed near the centre of the building for economy.

A telephone exchange will connect all departments. The information desk serves as a centre for the building, for, from it a person may travel to all the rooms without passing through another.

Statistics concerning the building are as follows:

Estimated Cost,

based on comparative costs of other Canadian libraries and present low price building at 35 cents per cubic ft.

549,120 x 35¢ = $192.192

Building cost = 70% - (E.W.Tilton, 1927)

Therefore cost = $\frac{100}{70}$ x 192.192 = $274.560

Therefore total cost estimate - $275.000

Contents,

Reference Room	- 10,000 volumes
Music Room	3,000
Fine Arts	3,000
Periodicals	4,000
Stacks - Reference	81,000
	101,000
Open Shelf Room	12,000
Browsing	4,000
Rental	2,000
Stack	108,000
	227,000 volumes

No. of Readers -

Reference Reading Room	60
Music Room	20
Fine Arts Room	20
Periodical Room	24
Open Shelf Room	60

Browsing Room	20
Rental Room	12
Newspaper Room	31
Children Room	60
	307 Readers

The purpose of planning followed in this library has been -

(1) Efficiency of planning demonstrated by a compact plan, which is well knit together.

(2) Simplicity of design, both in the interiors and exteriors. The exteriors are of a modern classic type, designed simply to fit in harmony with a library spirit and with the architecture of the neighboring buildings. They are designed with dignity, restraint, and beauty.

(3) Economy of building materials. The city by-law requires Tyndal stone facing. Economy demanded a well built structure on secure footings, owing to the fact that the ground beneath is a fill, over a creek which ran here originally.

Reinforced concrete skeleton frame structure, tin pan floors, and concrete piles should give a stable structure with a minimum of repairs.

A concrete pile foundation while more expensive will give security in the knowledge that no settlement will occur in the building to upset the efficiency.

Cork tile floors, metal frame windows, and the use of Class A material throughout will result in an economical building for the slight additional cost will pay for itself ten times in the lack of repair bills. The problem as presented, has been solved by presenting a well planned building, in an excellent location, dignified in appearance, economical, and of good construction.

References

(1) Essentials in Library Planning,
Chalmers Hadley - Librarian, Denver.

(2) The Toronto Public Library,
Geo. H. Locke - Librarian.

(3) College Library Buildings,
Carnegie Endowment.

(4) Architectural Forum, 1932,
E.W.Tilton, Consulting Architect on Libraries.

(5) Library Planning and Equipment,
Sneed and Co.

(6) Architectural Forum, 1927,
E.W.Tilton - Consulting Architect on Library Planning.

(7) Los Angeles Public Library Estimate.

(8) Report of the Winnipeg Public Library, 1933.
(latest available information).

(3) THE OVERHANG SHALL NOT EXCEED 6 × SLAB THICKNESS.

L BEAMS.

FLANGE WIDTH.

(1) SHALL NOT EXCEED $\frac{1}{10}$ OF THE SPAN LENGTH.

(2) THE OVERHANG FROM THE FACE OF THE WEB, SHALL NOT EXCEED 4 × THICKNESS OF THE SLAB, NOR ½ THE CLEAR DISTANCE TO THE NEXT BEAM.

ROOF PLAN.

CONCRETE - 150 #/SQ. IN.
LIVE LOAD . 30 #/ " "

CONSTRUCTION

CINDER CONCRETE OR AEROCRETE.	25 #/SQ.FT.
FELT, TAR, AND GRAVEL ROOFING	6 #/SQ.FT.
PLASTER, ON METAL LATH	8 #/SQ.FT.
TOTAL LOAD	69 #/ " "

ASSUME A LOAD OF 70 #/SQ. FT.

THE FLOOR AND ROOF SLABS ARE DESIGNED. FROM THE TABLES PREPARED UNDER THE HEADING OF "USEFUL DATA" BY THE CORRUGATED BAR CO. INC.

JOISTS.

3A.

SPAN 26'-6" LOAD 70 #/SQ. FT.

MOMENT $\frac{1}{8} w l^2$.

FLOOR #2.

SPAN 2.A. LENGTH 26'-6"

LOAD — $\frac{1}{8}wl^2$.

USE.

14" TYLE — 5" JOIST — 25" c.c.

3" SLAB.

A_s = 2.40 SQ. IN.

FLOOR CONSTRUCTION.

CORK TILE	3#/SQ.FT.
CONCRETE FILL	25#/ " "
PLASTER ON METAL LATH.	8#/ " "
LIVE LOAD.	100#/ " "
TOTAL LOAD	136#/ " "

STEEL

1 — $1\frac{1}{8}$" SQ. ROD—BENT UP.

1 — $1\frac{1}{8}$" " " " — STRAIGHT.

WT. OF FLOOR 96#/SQ.FT.

TOTAL LOAD OF FLOOR = 232#/SQ.FT. OF SLAB.

2B.

SPAN 16'-0" MOMENT $\frac{1}{8}wl^2$.

USE 8" JOIST — 5" JOIST — 25" c.c.

STEEL AREA - $A_s = \left(\frac{136 + 55}{170 + 55}\right) 1.37 = 1.01$ SQ. IN.

—1 — $\frac{7}{8}$" DIA. ROD BENT UP.

1 — $\frac{3}{4}$" " " STRAIGHT.

TOTAL LOAD OF FLOOR = 136+55 = 191 #/SQ.FT. OF SLAB.

2C.

SPAN = 26'-0"   MOMENT = $\frac{1}{8} w l^2$.

USE 12" TYLE - 3" SLAB - 5" JOIST - 25" C.C.

STEEL 1 - $1\frac{1}{8}$" SQ. ROD BENT UP.

1 - $1\frac{1}{8}$" " " STRAIGHT.

LOAD OF FLOOR TO GIRDER = 218 #/SQ. FT. OF SLAB.

2E.

SPAN 4'   MOMENT $\frac{1}{8} w l^2$.

USE — 6" TYLE - 5" JOIST - 25" C.C.

2" SLAB.

STEEL — 1 — $\frac{5}{8}$" DIA. BAR BENT UP.

1 - $\frac{1}{2}$" " " STRAIGHT

$$A_s = .76 \times \left(\frac{136+50}{283+50}\right) = .425 \text{ SQ.IN.}$$

TOTAL LOAD TO GIRDER - 184 #/SQ.FT. OF BEAM.

FLOOR #1.

SPAN A1 — SAME AS A2

" B1 — " " B2.

" C1 - " " C2

" D1

LENGTH 9'-6"   MOMENT $\frac{1}{8} w l^2$.

USE - 6" TYLE - 5" JOIST - 25" C.C.

2" SLAB.

$$\text{STEEL } A_s = .76 \times \left(\frac{56+136}{56+283}\right) = .415 \text{ SQ.IN.}$$

USE:

1 — 5/8" DIA. ROD BENT UP.

1 — 1/2" " " STRAIGHT.

∴ LOAD OF SLAB TO GIRDER = 184#/SQ.FT OF SLAB.

SPAN 1E — SAME AS 2E.

BEAMS.

(1) ALL BEAMS FIGURED AS (L) OR (T) BEAMS WHERE EVER POSSIBLE.

(2) IT WAS ASSUMED THAT A LOAD OF 125#/SQ.FT. AT THE SUPPORT, CAUSED BY BOOKS BEING PLACED IN STACKS ALONG THE WALL (STACKS 10" WIDE) WOULD BE TAKEN BY THE CONCRETE BETWEEN THE ENDS OF THE PANS AND THE BEAMS.

BEAM 301.

LOAD	TILE	200#/FT.
	STONE	600#/ "
	STEM	450#/ "
	ROOF	1800#/ "
TOTAL LOAD		3050#/FT.

MAXIMUM MOMENT $\frac{1}{10} wl^2$

$$\frac{3050 \times 25 \times 25 \times 12}{10} = 2,290.000 \text{ IN. LBS.}$$

$$\text{AREA} = \frac{3050 \times 12.5}{100 \times .875} = 363 \text{ SQ. IN.}$$

$b = 30"$ $b' = 14"$ $d = 27"$

$$A_s = \frac{M}{jd} = 6.05 \text{ SQ. IN.}$$

STEEL - 8 - 1" DIA. RODS — AREA - 6.28 SQ. IN.

BEND UP 4 - 1" DIA. RODS.

$\frac{t}{d} = \frac{14}{27} = .55.$

$p = \frac{6.28}{27 \times 30} = .0078. \qquad j = .873.$

THE AXIS IS IN THE FLANGE. ∴ FIGURE AS A RECTANGULAR BEAM.

$SHEAR = v = \frac{V}{bjd} = \frac{3050 \times 12.5}{14 \times 27 \times .873} = 108 \#/SQ.IN.$

$BOND = u = \frac{V}{\Sigma ojd} = \frac{3050 \times 12.5}{3.142 \times 8 \times .873 \times 27} = 64 \#/SQ.IN.$

BEND UP. HALF THE STEEL. AND DESIGN AT 100 #/SQ.IN. SHEAR - TO TAKE CARE OF THE NEGATIVE MOMENT OVER THE SUPPORTS. NO CHECK IS REQUIRED.

STIRRUPS.

$V_1 = 76 \times 14 \times 27 \times .876 = 25.300 \#$

$X' = 12.5 - \frac{40 \times 30 \times .876 \times 27}{3050} = 3.4'$

$S = \frac{.22 \times 16000 \times .876 \times 27}{25,300} = 4.25"$

USE 10 STIRRUPS @ 4¼" O.C.

BEAM 302.

SPAN 12.5'   LOAD 2850 #/FT.

MAXIMUM MOMENT $\frac{1}{12} \times 2850 \times (12.5)^2 \times 12$

445.000 IN. LBS.

DESIGN AT 100 #/SQ.IN SHEAR TO TAKE CARE OF THE NEGATIVE MOMENT OVER THE SUPPORTS.

$$A = \frac{2850 \times 12.5}{2 \times 100 \times .875} = 200 \text{ SQ. IN.}$$

$b = 16''$ $b' = 12''$ $d = 16''$.

$$A_s = \frac{445,000}{.875 \times 16 \times 16000} = 2.0 \text{ SQ. IN.}$$

USE . 6 – 3/4" DIA. RODS – AREA = 2.65 SQ.IN.

$$V = \frac{2850 \times 12.5}{2 \times 16 \times 12 \times .861} = 103 \text{ \#/SQ. IN.}$$

$\frac{t}{d} = .76.$ $p = \frac{2.65}{16 \times 16} = .0103$ $j = .861.$

BEND UP 3 BARS – 3/4" DIA.

$$\text{BOND} - \frac{2850 \times 12.5}{2 \times 6 \times 2.356 \times .861 \times 16} = 89 \text{ \#/SQ.IN.}$$

STIRRUPS.

$$x' = 6.25 - \frac{40 \times 16 \times .861 \times 16}{2850} = 36''.$$

USE 6 STIRRUPS AT 6 1/2" C.C – 3/8" DIA.

BEAM 303.

SPAN 13.5' LOAD - 2850 #/FT.

MOMENT - 515.000 IN. LBS.

$$A = \frac{2850 \times 13.5}{2 \times 100 \times .875} = 220 \text{ SQ. IN.}$$

$b = 16$. $b' = 14''$ $d = 16''$.

$$A_s = \frac{515,000}{.875 \times 16 \times 16000} = 2.28 \text{ SQ. IN.}$$

$$p = \frac{2.65}{16 \times 16} = .0103 \qquad j = .861.$$

USE 6 - 3/4" DIA. BARS — 2.65 SQ. IN.

BEND UP 3 · BARS.

$$\text{BOND} \quad \frac{2850 \times 6.75}{6 \times 2.356 \times 16 \times .861} = 97 \text{ \#/SQ. IN.}$$

$$\text{SHEAR} \quad \frac{2850 \times 6.75}{14 \times 16 \times .861} = 98 \text{ \#/SQ. IN}$$

STIRRUPS.

$$X' = 6.75 - \frac{58 \times 16 \times .861 \times 16}{2850} = 39''$$

$$V_1 = 58 \times 14 \times 16 \times .861 = 11.200 \#.$$

$$S = \frac{.22 \times 16000 \times .861 \times 16.}{11.200}$$

$$= 4\tfrac{1}{4}'' \text{ C.C.}$$

USE 9 STIRRUPS - 3/8" DIA - 4 1/4" C.C.

BEAM 304.

LOAD — 2850 #/FT. MAX. MOMENT $\frac{wl^2}{12}$.

MAX. MOMENT = 370.000 IN. LBS.

$A = \frac{2850 \times 11.5}{2 \times 100 \times .875} = 188$ SQ. IN.

$d = 26''$ $b' = 12''$ $b = 12''$.

$A_s = \frac{370.000}{.875 \times 16 \times 16000} = 1.62$ SQ. IN.

USE 2 – 7/8" DIA. RODS. BENT UP.
2 – 7/8" " " STRAIGHT. } AREA = 2.41 SQ. IN.

$p = \frac{2.41}{12 \times 16} = .0122$. $j = .866$.

SHEAR. $\frac{5.75 \times 2850}{12 \times .866 \times 16} = 98$ #/SQ. IN.

BOND $\frac{5.75 \times 2850}{16 \times .866 \times 10.98} = 104$ #/SQ. IN.

STIRRUPS.

$V' = 58 \times 12 \times 16 \times .866 = 9500$ #

$X' = 5.75 - \frac{40 \times 12 \times .866 \times 16}{2850} = 2.9'$

$s = \frac{.22 \times 16000 \times .866 \times 16}{9500} = 5''$

USE 7 STIRRUPS 3/8" DIA – 5" C.C.

BEAM 305.

SPAN 25'-0"

LOAD. — WALL + STEM = 1311 #/FT.

MAXIMUM MOMENT $\frac{1}{10} w(l)^2 = 983{:}000$ IN. LBS.

$A = \frac{1311 \times 12.5}{100 \times .875} = 1.88$ SQ. IN.

$b = 25"$ $b' = 12"$ $d = 16"$

$A_s = \frac{983.000}{16000 \times 16 \times .875} = 4.4$ SQ. IN.

USE 4 - 7/8 "DIA. RODS - BENT UP.
4 - 7/8 " " " - STRAIGHT.

$p = \frac{4.81}{25 \times 16} = .012.$ $j = .851.$

SHEAR $= \frac{16.400}{12 \times .851 \times 16} = 98$ #/SQ. IN.

BOND $= \frac{16.400}{16 \times .851 \times 23.5} = 50$ #/SQ. IN.

$V_1 = 58 \times 12 \times 16 \times .851 = 9500$ #.

$X_1 = 12.5 - \frac{40 \times 25 \times .851 \times 16}{1311 \#} = 3.15'$

$s = .45d = .45 \times 16 = 7"$.

USE 8 STIRRUPS 3/8 "DIA. — 5" C.C.

BEAM 306.

SPAN 9'

LOAD -	FLOOR	1730 #/FT.
	STEM	240 #/FT.
	PARAPET	300 #/FT.
TOTAL LOAD		2270 #/FT.

MAX. MOMENT $\frac{1}{10} wl^2 = \frac{2270 \times 81 \times 12}{10} = 221.000$ IN. LBS.

$A = \frac{2270 \times 4.5}{100 \times .875} = 117$ SQ. IN.

$b = 12''$ $b' = 8''$ $d = 16''$

$A_S = \frac{221.000}{.875 \times 16.000 \times 16} = .88$ SQ. IN.

USE — 2 - 3/4" DIA. BARS – BENT UP.
2 - 3/4" " " - STRAIGHT. } AREA - 1.77 SQ. IN.

$p = \frac{1.77}{12 \times 16} = .0091$ $j = .886$.

SHEAR $\frac{2270 \times 4.5}{8 \times 16 \times .866} = 94$ #/SQ. IN.

BOND $\frac{2270 \times 4.5}{4 \times 2.356 \times .866 \times 16} = 78$ #/SQ. IN.

STIRRUPS

$V_1 = 54 \times .866 \times 8 \times 16 = 5940$ #

$X' = 4.5 - \frac{40 \times 12 \times .866 \times 16}{2270} = 0$

$s = \frac{.22 \times 16000 \times .866 \times 16}{5950} = 8''$

USE - 4 STIRRUPS - 7" C.C. - 3/8" DIA.

TO SIMPLIFY THE STEEL SCHEDULE, THIS SAME BEAM 306 IS USED IN CONTINUOUS SPANS, THE DIFFERENCE IN STEEL AREA REQ.D. IS SO SMALL THAT IT IS DIFFICULT TO USE STOCK SIZE BARS IN A RE-DESIGNED BEAM.

BEAM 307.

SPAN 17'-0" LOAD - 2270 #/FT.

$$A = \frac{2270 \times 17}{2 \times 100 \times .875} = 220 \text{ SQ.IN.}$$

$b = 18"$ $b' = 10"$ $d = 24"$

$$M.\ MAX. = \frac{2270 \times 17 \times 17 \times 12}{12} = 660.000 \text{ IN. LBS.}$$

$$A_s = \frac{660.000}{.875 \times 16000 \times 24} = 1.96 \text{ SQ. IN.}$$

USE — 4 - 5/8" DIA. RODS — BENT UP.
4 - 5/8" " " — STRAIGHT. } AREA = 2.45 SQ.IN.

$$p = \frac{2.45}{18 \times 24} = .0057. \quad j = .889.$$

$$SHEAR = \frac{2270 \times 8.5}{10 \times 24 \times .889} = 90.5 \text{ \#/SQ.IN.}$$

$$BOND = \frac{2270 \times 8.5}{15.68 \times .889 \times 24} = 58 \text{ \#/SQ.IN.}$$

STIRRUPS.

$$V_1 = 50 \times 12 \times 24 \times .889 = 13.000 \#$$

$$X_1 = 8.5 - \frac{40 \times 18 \times .889 \times 24}{2270} = 34"$$

$$S = \frac{.22 \times 16000 \times .889 \times 24}{13000} = 4.25"$$

USE - 8 STIRRUPS - $4\frac{1}{4}$" C.C - 3/8" DIA.

BEAM 308

LOAD —	FLOOR	1730 #/FT.
	STEM	200 #/FT.
	WALL	650 #/FT.
	TOTAL	2480 #/FT.

M. MAX. $\frac{2480 \times 81 \times 12}{10} = 242.000$ IN.LBS.

$A = \frac{2480 \times 9}{2 \times 100 \times .875} = 129$ SQ. IN.

$b = 12''$ $b' = 10''$ $d = 14''$.

$As = \frac{242.000}{.875 \times 16000 \times 14} = 1.23$ SQ.IN.

USE — 2 - 3/4" DIA. RODS BENT UP } AREA = 1.77 SQ. IN.
2 - 3/4" " " STRAIGHT }

BOND $= \frac{2480 \times 4.5}{4 \times 2.356 \times .86 \times 14} = 97$ #/SQ.IN.

SHEAR $= \frac{2480 \times 4.5}{10 \times 14 \times .861} = 92$ #/SQ.IN.

STIRRUPS. $V_1 = 63 \times 12 \times 16 \times .861 = 10.200$ #.
$S = \frac{.22 \times 16000 \times .861 \times 16}{10.200} = 6.5''$

USE 6 - 3/8" DIA. STIRRUPS - 6.5" c.c.

THIS BEAM IS ALSO USED FOR CONTINUOUS SPANS, BECAUSE SMALLER STEEL BARS ARE NOT GENERALLY USED IN PRACTISE.

BEAM 309.

SPAN 17' LOAD = 2480 #/FT.

$$M.\ MAX. = \frac{2480 \times 17^2 \times 12}{12} = 718{,}000 \text{ IN.LBS.}$$

$$A = \frac{2480 \times 8.5}{100 \times .875} = 242 \text{ SQ. IN.}$$

$b = 20''$ $b' = 14''$ $d = 18''$

$$A_s = \frac{718.000}{16000 \times 18 \times .875} = 2.82 \text{ SQ.IN.}$$

USE – 4 – 3/4" DIA. RODS BENT UP.
4 – 3/4" " " STRAIGHT.

AREA = 3.53 SQ. IN.

$$p = \frac{3.53}{18 \times 20} = .0098 \qquad j = .836$$

$$\text{SHEAR} \quad \frac{2480 \times 8.5}{.836 \times 18 \times 14} = 99 \text{ \#/SQ.IN.}$$

$$\text{BOND} \quad \frac{2480 \times 8.5}{.836 \times 18 \times 8 \times 2.35} = 73.5 \text{ \#/SQ.IN.}$$

STIRRUPS.

$V_1 = 59 \times 16 \times .836 \times 18 = 10.600$ #.

$$X' = 8.5 - \frac{40 \times 20 \times .836 \times 18}{2480} = 4.5''$$

$$S = \frac{.22 \times 16000 \times .836 \times 18}{10.600} = 5.3''$$

SPACE. 9 STIRRUPS – 3/8" DIA – 5 1/4" C.C.

BEAM 310.

SPAN 25'-0" LOAD – 2700#/FT.

$$M.MAX. - \frac{1}{10} wl^2 = \frac{1}{10} \times 2700 \times 25 \times 25 \times 12.$$
$$= 2.020.000 \text{ IN. LBS.}$$

$$A = \frac{2700 \times 12.}{100 \times .875} = 370 \text{ SQ. IN.}$$

$b = 25"$ $b' = 14"$ $d = 26"$

$$A_S = \frac{2.020.000}{26 \times .875 \times 16000} = 5.5 \text{ SQ. IN.}$$

USE 4 – 7/8" DIA. BARS BENT UP.
4 – 1" " . " STRAIGHT.

AREA = 5.55 SQ. IN.

$$p = \frac{5.55}{25 \times 26} = .0085 \qquad j = .870.$$

$$SHEAR = \frac{2700 \times 4.5}{26 \times 14 \times .87} = 105 \text{ \#/SQ. IN.}$$

$$BOND = \frac{2700 \times 4.5}{23.6 \times .87 \times 26} = 63.3 \text{ \#/SQ. IN.}$$

STIRRUPS.

$$V_1 = 65 \times .87 \times 14 \times 26 = 20.600 \#.$$

$$X' = 12 - \frac{40 \times 25 \times .87 \times 26}{2700} = 44"$$

$$S = \frac{.22 \times 16000 \times .87 \times 26}{20.600} = 4"$$

USE – 11 STIRRUPS – 3/8" DIA – 4" C.C.

BEAM 311.

SPAN 12'-0"

LOAD	117 (7.5) =	875#
WALL		800
STEM		225
TOTAL		1900#/FT.

$M.\ MAX. = \frac{1}{10} \times 1900 \times 144 \times 12 = 327.500$ IN. LBS.

$A = \frac{1900 \times 6}{100 \times .875} = 131$ SQ. IN.

$b = 18"$ $b' = 9"$ $d = 16"$ AREA = 144 SQ. IN.

$A_S = \frac{327.500}{16000 \times .875 \times 16} = 1.46$ SQ. IN.

USE — 2 - 3/4" DIA. BARS BENT UP.
2 - 3/4" " " STRAIGHT.
AREA = 1.77 SQ. IN.

$p = \frac{1.77}{18 \times 16} = .00615$ $j = .884$.

$= \frac{1900 \times 6}{9.4 \times .87 \times 16} = 87$ #/SQ. IN.

$SHEAR = \frac{1900 \times 6}{16 \times 9 \times .884} = 90$ #/SQ. IN.

STIRRUPS. $V_1 = 50 \times 16 \times 9 \times .884 = 6350$#

$X_1 = 6 - \frac{40 \times 18 \times .884 \times 16}{1900} = 2'4"$

$S = \frac{.2208 \times 16000 \times .884 \times 16}{6350} = 7.7"$

USE 4 — 3/8" DIA. STIRRUPS — 1/4" C.C.

TYPICAL FLOOR PLAN.

BEAM 01.

CLEAR SPAN 24'-0" — DUE TO INCREASED COLUMN SIZE.

LOAD

FLOOR - 232 × 12.5.	=	2900 #/FT.
WALL - 12" TILE - (30 × 15)	=	450 #/"
4" STONE (50 × 15)	=	750 #/"
PILASTERS	=	100 #/"
STEM OF BEAM		240 #/"
WINDOW ALLOWANCE	-	280 #/"
TOTAL LOAD		4430 #/FT.

MAXIMUM MOMENT — $\frac{1}{10} w l^2 = \frac{4430 \times (24)^2 \times 12}{10}$

$= 3,050.000$ IN. LBS.

$A = \frac{4430 \times 12.}{100 \times .875} = 610$ SQ. IN.

$b = 30"$ $b' = 19"$ $d = 32"$.

$A_s = \frac{3.050.000}{.875 \times 32 \times 16.000} = 6.72$ SQ. IN

STEEL — 4 - 1" DIA. BARS BENT UP.

4 - 1" SQ. " STRAIGHT.

AREA = 7.14 SQ. IN.

$p = \frac{7.14}{32 \times 30} = .0074$ $j = .878.$

SHEAR = $\frac{4430 \times 12.}{32 \times 19 \times .878} = 99$ #/SQ. IN.

BOND. $\dfrac{12 \times 4430}{28.56 \times 32 \times .878} = 66\ \#/\text{SQ.IN.}$

SINCE WE HAVE DESIGNED FOR 100 #/SQ.IN. SHEAR, IT WILL NOT BE NECESSARY TO CHECK. FOR NEGATIVE MOMENT. OVER THE SUPPORTS.

STIRRUPS.

$V_1 = (99-40)\ 19 \times 32 \times .878 = 31.500\ \#$

$x' = 12 - \dfrac{40 \times 30 \times .878 \times 32.}{4430.}$

$= 4.5'$

$s = \dfrac{.196 \times 2 \times 16000 \times .875 \times 32}{31.500} = 5\frac{1}{2}''$

USE 10 — 1/2" DIA. STIRRUPS — 5 1/2" C.C.

BEAM. 02.

SPAN 12'-0" LOAD – 4330 #/FT.

$$\text{MAX. MOMENT} = \frac{wl^2}{12} = \frac{4330 \times 144 \times 12}{12}$$

$$= 640{,}000 \text{ IN.LBS.}$$

$$A = \frac{4330 \times 6}{100 \times .875} = 297 \text{ SQ.IN.}$$

$b = 16"$ $b' = 12"$ $d = 26"$.

$$A_s = \frac{640.000}{.875 \times 26 \times 16000} = 1.78 \text{ SQ.IN.}$$

$$p = \frac{2.65}{16 \times 26} = .00575 \qquad j = .888.$$

USE 6 – 3/4" DIA. BARS – AREA = 2.41 SQ.IN.
BEND UP 3 "

$$\text{SHEAR} = \frac{4430 \times 6}{26 \times 12 \times .888} = 94 \text{ \#/SQ.IN.}$$

$$\text{BOND} = \frac{4330 \times 6.}{11.0 \times 26 \times .888} = 103 \text{ \#/SQ.IN.}$$

STIRRUPS.

$$V' = 54 \times 12 \times 26 \times .888 = 19.050 \text{ \#}.$$

$$x' = 6 - \frac{40 \times 16 \times .888 \times 26}{4330} = 34"$$

$$S = \frac{.22 \times 16000 \times .888 \times 26}{19{,}050} = 5"$$

USE – 7 – 3/8" DIA. STIRRUPS – 5" O.C.

BEAM 03.

SPAN 13'-0" LOAD = 4330 #/FT.

MAX. MOMENT. $= \frac{4330 \times 13 \times 13 \times 12.}{12} = 731.000$ IN. LBS.

$A = \frac{4330 \times 6.5}{100 \times .875} = 322.5$ SQ. IN.

$A_s = \frac{731.000}{16000 \times .875 \times 26.} = 2.01$ SQ. IN.

$b = 16"$ $b' = 13"$ $d = 26"$.

USE - 4 - 7/8" DIA. BARS. AREA = 2.41 SQ. IN.

BEND UP 2 BARS.

$P = \frac{2.41}{16 \times 26} = .0058.$ $j = .888.$

SHEAR $= \frac{6.5 \times 4330}{.888 \times 13 \times 26} = 102$ #/SQ. IN.

BOND $= \frac{6.5 \times 4330}{.888 \times 4 \times 2.75 \times 26} = 102$ #/SQ. IN.

STIRRUPS.

$V' = 28.800 - 15.400 = 13.400$ #

$X' = 6'6" - 3.16 = 3.34'$

$S = \frac{A_s f_s j d.}{}$

$= \frac{.2208 \times 16000 \times .888 \times 26}{(7 \times 4330) - (16 \times 26)40}$

$= 6"$.

USE 8 STIRRUPS — 3/8" DIA - 6" C.C.

BEAM 04.

SPAN 11.5'. LOAD = 4330 #/FT.

MAX. MOMENT. $= \frac{1}{12} \times (11.5)^2 \times 4330 \times 12$

$= 570,000$ IN. LBS.

$A = \frac{4330 \times 5.75}{100 \times .875} = 285$ SQ. IN.

$b = 12''$ $b' = 12''$ $d = 26''$

$As = \frac{570.000}{.875 \times 16000 \times 26} = 1.58$ SQ. IN.

USE — 2 — 7/8"DIA. BARS STRAIGHT.
2 - 3/4" " " BENT UP.

AREA = 2.2 SQ. IN.

$p = \frac{2.2}{12 \times 26} = .007.$ $j = .878.$

SHEAR $= \frac{5.75 \times 4330}{.878 \times 12 \times 26} = 90$ #/SQ.FT.

BOND $= \frac{5.75 \times 4330}{.878 \times 26 \times 5.10 \times 2} = 104$ #/SQ.FT.

STIRRUPS.

$x' = 5.75 - \frac{40 \times 12 \times .878 \times 26}{4330}$

$= 30''$

$s = \frac{A_s f_s j d}{V'} = \frac{.22 \times 16000 \times .878 \times 26}{50 \times 12 \times 26 \times .878}$

$= 5.9''$

USE — 6 — 3/8"DIA. STIRRUPS — 5½" C.C.

BEAM O5.

SPAN 25′ LOAD.

FLOOR AND STEM	219 #/FT.
TILE	540 #/FT.
STONE	1000 #/FT.
WINDOW ALLOWANCE	−289 #/FT.
TOTAL LOAD.	1470 #/FT.

t = 14″ d = 15″.

$$A = \frac{1470 \times 12.5}{100 \times .875} = 210 \text{ SQ. IN.}$$

b′ = 10″ d = 22″.

$$\text{MAX. MOMENT} = \frac{1470 \times 25 \times 25 \times 12}{10} = 1.100.000 \text{ IN.LBS.}$$

$$A_s = \frac{1.100.000}{16000 \times .875 \times 22} = 3.55 \text{ SQ. IN.}$$

USE — 4 – 3/4″ DIA. BARS BENT UP.
4 – 7/8″ " " " STRAIGHT.

$$p = \frac{4.4}{22 \times 15} = .0133 \qquad j = .845.$$

$$\text{BOND.} = \frac{1470 \times 12.5}{20.4 \times .845 \times 22} = 49 \text{ \#/SQ. IN.}$$

$$\text{SHEAR.} = \frac{1470 \times 12.5}{10 \times 22 \times .845} = 97 \text{ \#/SQ. IN.}$$

STIRRUPS. $V' = 47 \times 10 \times 22 \times .845 =$

$$X' = 12.5 - \frac{40 \times 15 \times .845 \times 22}{1470} = 54''$$

$$S = \frac{.22 \times 16000 \times .845 \times 22}{47 \times 10 \times 22 \times .845} = 7.5''$$

USE 8 STIRRUPS — 7″ C.C. — 3/8″ DIA.

BEAM 06.

SPAN 9'

LOAD = 212 × 12.25 = 2620 #/FT.

TILE AND FACING, LESS.

WINDOW ALLOWANCE 1000 #/FT.

TOTAL LOAD 3620 #/FT.

$$\text{MAX. MOMENT.} = \frac{3620 \times 81 \times 12}{10} = 348{,}000 \text{ IN. LBS.}$$

$$A = \frac{3620 \times 4.5}{100 \times .875} = 186 \text{ SQ. IN.}$$

$b' = 10''$ $b = 10''$ $d = 18''$

$$A_s = \frac{348.000}{.875 \times 16000 \times 18} = 1.38 \text{ SQ. IN.}$$

USE — 4 - 7/8" DIA. BARS — 1.77 SQ. IN.

BEND UP 2 BARS.

$$p = \frac{1.77}{10 \times 18} = .00975 \qquad j = .862.$$

$$\text{SHEAR} \quad \frac{3620 \times 4.5}{18 \times .862} = 104 \text{ \#/SQ. IN.}$$

$$\text{BOND} \quad \frac{3620 \times 4.5}{18 \times 11.04 \times .862} = 94 \text{ \#/SQ. IN.}$$

STIRRUPS.

$$V_1 = 64 \times 18 \times 10 \times .862. = 8400 \#.$$

$$X' = 4.5 - \left(\frac{40 \times 10 \times .862 \times 18}{3620}\right) = 34''$$

$$s = \frac{A_s f_s j d}{V'} = \frac{.22 \times 16000 \times .862 \times 18}{8400} = 6.5''$$

USE 6 STIRRUPS — 3/8" DIA — 6 1/2" C.C.

BEAM 07.

SPAN 17'-0" LOAD 3620#/FT.

MAXIMUM MOMENT. $\frac{3620 \times 17 \times 17 \times 12}{12} = 1.050.000$ IN. LBS.

AREA, REQ'D. IN SHEAR.

$\frac{3620 \times 8.5}{100 \times .875} = 3.52$ SQ. IN.

$b = 18"$ $b' = 13"$ $d = 28"$.

$A_s = \frac{1.050.000}{.875 \times 16000 \times 28} = 2.68$ SQ. IN.

USE 4 – 1" DIA. BARS – 3.14 SQ. IN.

BEND UP 2 BARS.

$p = \frac{3.14}{28 \times 18} = .0062.$ $j = .884.$

SHEAR $\frac{3620 \times 8.5}{13.5 \times 28 \times .884} = 95$ #/SQ. IN.

BOND. $\frac{3620 \times 8.5}{12.5 \times 28 \times .884} = 99$ #/SQ. IN.

STIRRUPS.

$X_1 = 8.5 - \left(\frac{40 \times 18 \times .884 \times 28}{3620}\right) = 50"$

$s = \frac{A_s f_s j d}{V'} = \frac{.22 \times 16000 \times .884 \times 28}{30.800 - 12.000}$

$= 5.17"$

USE 10 – 3/8" DIA. STIRRUPS – 5" C.C.

BEAM 08.

SPAN 25'-0"

LOAD – FLOOR.

12.75 × 212 = 2700 #/FT.

– STEM 350 #/FT.

TOTAL LOAD 3050 #/FT.

MAX. MOMENT – $\frac{1}{10} wl^2$ (FOR CONTINUOUS SPANS ALSO AS THE CHANGE VARIES THE STIRRUPS ONLY, DUE TO THE DIFFICULTY IN SELECTING STANDARD STEEL)

MAX. MOMENT. = $M = \frac{3050 \times 25 \times 25 \times 12}{10}$ = 2.300.000 IN. LBS.

$A = \frac{3050 \times 12.5}{100 \times .875} = 434$ SQ. IN.

$b = 28"$, $b' = 17"$. $d = 25"$

$A_s = \frac{2.300.000}{16000 \times 25 \times .875} = 6.5$ SQ. IN.

USE – 6 – $1\frac{1}{8}$" SQ. BARS — AREA = 7.59. SQ. IN.

BEND UP 3 BARS.

$p = \frac{7.59}{425} = .0178$ $j = .831.$

BOND = $\frac{12.5 \times 3050}{4.5 \times 6 \times .831 \times 25}$ = 68 #/SQ. IN.

SHEAR = $\frac{12.5 \times 3050}{17 \times .831 \times 25}$ = 105 #/SQ. IN.

STIRRUPS. $x' = 12.5 - \frac{40 \times 28 \times .831 \times 25}{3050} = 53"$

$S = \frac{A_s f_s j d}{V'} = \frac{.391 \times 16000 \times .831 \times 25}{65 \times 25 \times 17 \times .831} = 5.65"$

USE 10 – 1/2" ⌀ STIRRUPS – $5\frac{1}{2}$" C.C.

BEAM O-10.

SPAN — 15'-0"

LOAD = 2900 + 240 = 3140 #/FT.

MAX. MOMENT $= \frac{1}{10} wl^2 = \frac{1}{10} \times 225 \times 12 \times 3140 =$

$= 850.000$ IN. LBS.

$A = \frac{3140 \times 7.5}{100 \times .875} = 270$ SQ. IN.

$b = 18''$ $b' = 12''$ $d = 22''$.

$A_s = \frac{850.000}{16000 \times .875 \times 22} = 276$ SQ. IN.

$P = \frac{3.61}{18 \times 22} = .0091.$ $J = .866.$

USE 6 – 7/8" DIA. BARS — AREA = 3.61 SQ. IN.

SHEAR $= \frac{7.5 \times 3.140}{12 \times 22 \times .866} = 103$ #/SQ. IN.

BOND $= \frac{7.5 \times 3140}{16.56 \times 22 \times 866} = 75$ #/SQ. IN.

STIRRUPS.

$V_1 = 63 \times 12 \times 22 \times .866 = 14.400$ #.

$x' = 7.5 - \left(\frac{40 \times 18 \times .866 \times 22}{3140}\right) = 1.75'$

$S = \frac{.2208 \times 16000 \times .866 \times 22}{14.400} = 4.5''$

USE 6 STIRRUPS — 3/8" DIA. — 4½" C.C.

BEAM 0-11.

A CONTINUOUS BEAM; IN PRACTISE THE SAME AS BEAM 0-12; DUE TO THE DIFFICULTY IN SELECTING THE STEEL.

$$M = \frac{1}{12} wl^2 = \frac{1}{12} \times 2930 \times (11.5)^2 \times 12 =$$
$$= 387.500 \text{ IN. LBS.}$$

$$A_s = \frac{387.500}{16000 \times .875 \times 20} = 1.375 \text{ SQ. IN.}$$

USE 4 - 3/4" DIA. RODS - AREA = 1.77 SQ. IN.

∴ USE THE SAME STIRRUPS AS IN 0-12.

4 STIRRUPS - 3/8" DIA. - 6" C.C.

BEAM O-12.

SPAN – 11.5'

LOAD	1430 #/FT.
WALL AND STEM	1520 #/FT.
	2950 #/FT.

MAX. MOMENT – $\frac{2930 \times (11.5)^2 \times 12}{10} = 465,000$ IN. LBS.

$A = \frac{2930 \times 5.75}{100 \times .875} = 194$ SQ. IN.

$b = 14''$ $b' = 10''$ $d = 20''$

$A_S = \frac{465.000}{16000 \times 20 \times .875} = 1.66$ SQ. IN.

USE 4 – 3/4" DIA. BARS – AREA = 1.77 SQ. IN.

$p = \frac{1.77}{14 \times 20} = .006325.$ $j = .883.$

BEND UP 2 – 3/4" DIA. RODS.

SHEAR – $\frac{5.75 \times 2930}{10 \times 20 \times .883} = 95$ #/SQ. IN.

BOND – $\frac{5.75 \times 2930}{9.43 \times .883 \times 20} = 101$ #/SQ. IN.

STIRRUPS.

$V_1 = 55 \times 10 \times 20 \times .883 = 9750$#.

$X' = 6 - \left(\frac{40 \times 14 \times .883 \times 20}{2930}\right) = 1.7'$

$s = \frac{.22 \times 16000 \times .883 \times 20}{9750} = 6.35''$

USE – 4 STIRRUPS – 3/8" DIA – 6" C.C.

BEAM 113.

LENGTH 24'-0"

LOAD $\frac{218 \times 9'6}{2}$ = 1040 #/FT.

STEM OF BEAM = 180 #/FT.

TOTAL LOAD 1220 #/FT.

MAX-MOMENT. $= \frac{wl^2}{10} = \frac{1220 \times 24 \times 24 \times 12}{10}$

= 842.000 IN. LBS.

$A = \frac{1220 \times 12}{100 \times .875} = 167$ SQ. IN.

$b = 28"$. $b' = 12"$ $d = 24"$

$A_s = \frac{824.000}{.875 \times 16000 \times 14} = 4.28$ SQ. IN.

$p = \frac{4.28}{14 \times 28} = .0123$ $j = .850.$

SHEAR = $\frac{12 \times 1220}{14 \times 12 \times .85} = 102$ #/SQ. IN.

BOND = $\frac{12 \times 1220}{.85 \times 20.9 \times 14} = 59$ #/SQ. IN.

STIRRUPS.

$V' = 62 \times 14 \times 12 \times .85 = 8.800$ #

$X' = 12 - \frac{40 \times 12 \times 14 \times 85}{1220} = 87"$

$S = \frac{.22 \times 16000 \times .85 \times 14}{8800} = 4.75"$

∴ USE 18 STIRRUPS 3/8" ϕ @ 4 3/4" C.C.

BEAM 209.

SPAN 9'

LOADS 2700#/FT - WALL SPAN.
2700#/" - OTHER "
325#/" - STEM OF BEAM.

TOTAL LOAD: 5725#/FT.

THIS IS A 'T' BEAM.

MAX. MOMENT - $\frac{1}{10} w l^2 = \frac{1}{10} \times 5725 \times 81 \times 12$
= 560.000 IN. LBS.

AREA REQ'D FOR SHEAR.

$\frac{5725 \times 4.5}{100 \times .875} = 295$ SQ. IN.

b = 28" b' = 12" d = 26".

$A_s = \frac{560.000}{16000 \times .875 \times 26} = 1.54$ SQ. IN.

USE - 6 - 3/4" DIA. BARS - AREA = 2.65 SQ. IN.

BEND UP 3 BARS.

$p = \frac{2.65}{28 \times 26} = .00365.$ $j = .907.$

BOND = OK (.908 > .875).

$X' = \frac{.22 \times 16000 \times .908 \times 26}{15251} = 5.4"$

USE 5 - 3/8" DIA. STIRRUPS - 5" C.C.

BEAM 114.

CLEAR SPAN 9'-0"

LOAD – 12" TILE	450 #/FT.
4" STONE	150 #/FT.
FLOOR AND STEM	300 #/FT.
WINDOW ALLOWANCE	280 #/FT.
TOTAL LOAD	1320 #/FT.

MAX. MOMENT $= \frac{1}{12} w l^2 = \frac{1320 \times 81 \times 12}{12} = 106900$ IN. LBS.

$A = \frac{1320 \times 4.5}{100 \times .875} = 67.9$ SQ. IN.

$b = 12''$ $b' = 8''$ $d = 10''$

$A_s = \frac{106.900}{.875 \times 16000 \times 10} = .755$ SQ. IN.

USE – 4 – 3/4" DIA. BARS – AREA – 1.77 SQ. IN.

$p = \frac{1.77}{12 \times 10} = .01475$ $j = .847$

SHEAR $= \frac{1320 \times 4.5}{8 \times 10 \times .847} = 87.6$ #/SQ.

BOND $= \frac{1320 \times 4.5}{4 \times 2.356 \times 10 \times .847} = 74.5$ #/SQ. IN.

STIRRUPS.

$V' = 47.6 \times .847 \times 8 \times 10 = 3225$ #.

$X' = 4.5 - \left(\frac{40 \times 12 \times .847 \times 10}{3225}\right) = 18''$

$S = \frac{.22 \times 16000 \times .847 \times 10}{3225} = 5''$

USE 4 STIRRUPS – 5" C.C – 3/8" DIA.

COLUMN L1

	BEAM	LOAD	COL. WT.	TOTAL	CORE SIZE	COL.	f.c	As	BARS	SPIRAL
ROOF	301	38100			12"	16"			4-3/4" DIA.	
	305.	16.350	2000							
				54.450			2000#/SQ.IN	1.70		1/4" #3-3" C.C.
2ND.	201	45540			12"	16"			7-3/4" DIA.	
FLOOR.	205.	18.810	2750							
				67.100			2000#/SQ.IN.	3.96		3/8" #3-3" C.C.
1ST	101	46,980	3080		14"	18"			7-7/8" DIA.	
FLOOR.	105.	18,810								
				65,790			2500#/SQ.IN.	5.39		5/16" DIA-2 3/4" C.C.
	BASEMENT WALL			7.000						

TOTAL — 194.340 #

ASSUMED. WT. OF CAP — 13.600

$$\text{No. of Piles Reqd} = \frac{207.940}{60.000} = \underline{\underline{\text{4 Piles — 16" Dia.}}}$$

CAP.

PUNCHING SHEAR

$$\frac{194.340}{4 \times 16 \times 120} = 25''$$

TOTAL THICKNESS = 35".

SPACING OF PILES = 3'-0" c.c.

SIZE OF FOOTING – 5'-4" SQ.

LOAD PER PILE $\frac{194,340}{4} = 48.725$#/

B.M. AROUND PERIMETER OF COLUMN

$48.725 \times 25\frac{1}{2}'' = 1,205.000$ IN.LBS.

$$A_s = \frac{\frac{1}{4} \times 1,205,000}{16000 \times .875 \times 25} = 8.75 \text{ SQ.IN.}$$

USE 2 ROWS – 8 BARS – ½" DIA. HOOKED.