Masonry to Steel: Technology Changes

Skyscraper Museum, New York

September 29, 2020

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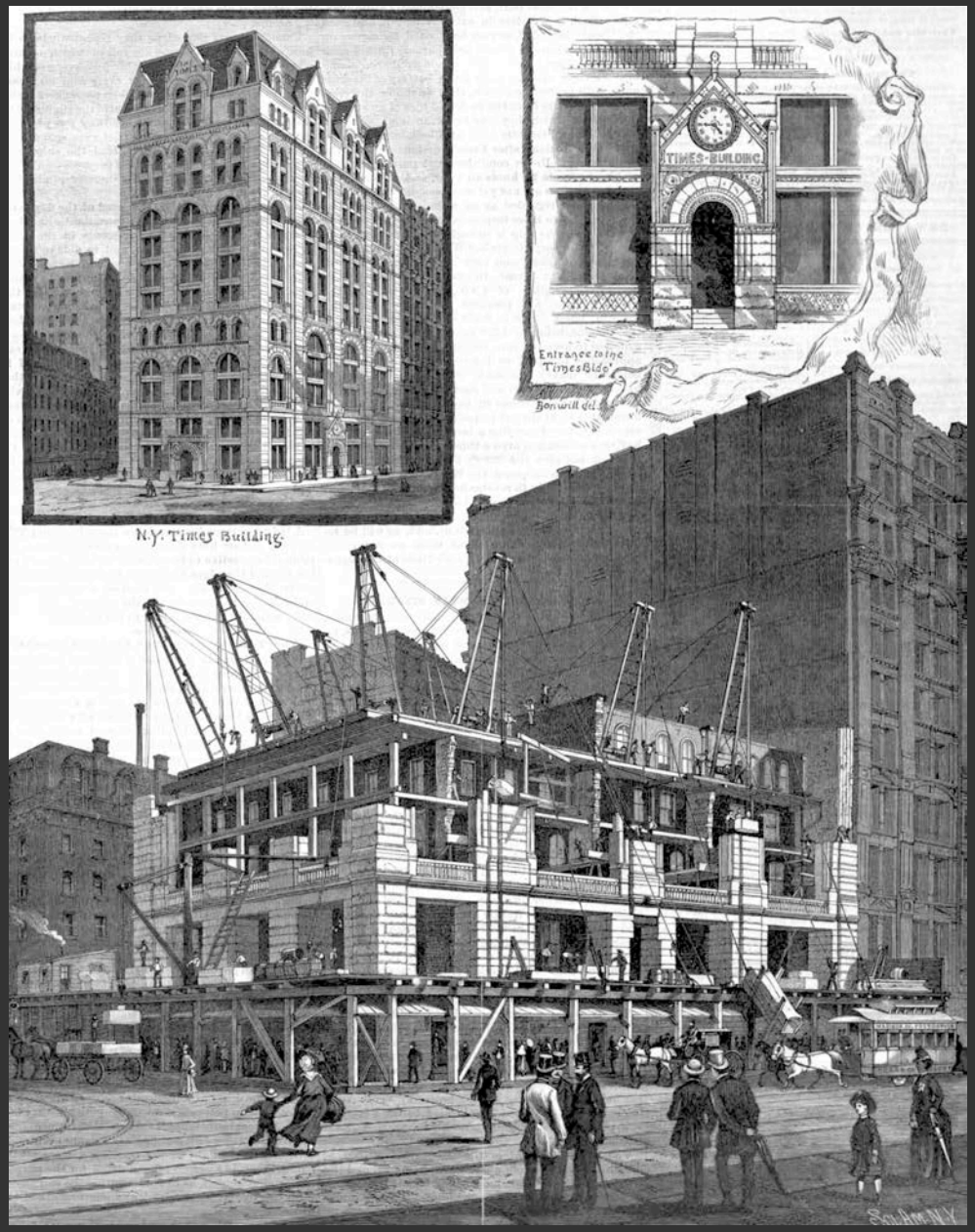
Construction As It Had Been



The masonry walls carry gravity and wind load at all times, so the pace of floor construction is linked to the pace of wall construction.

In this case, the new New York Times Building was being constructed around the existing building, but the existing building was quite short.

Building Costs

Material production: casting iron, firing bricks.

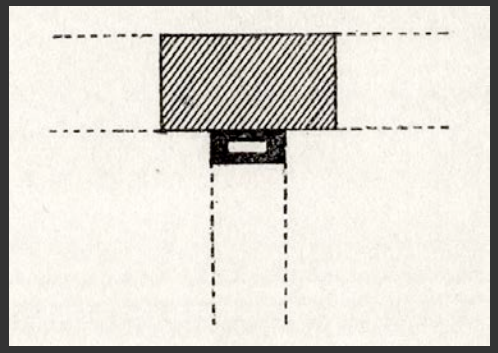
Fabrication: cutting steel to length, punching rivet holes.

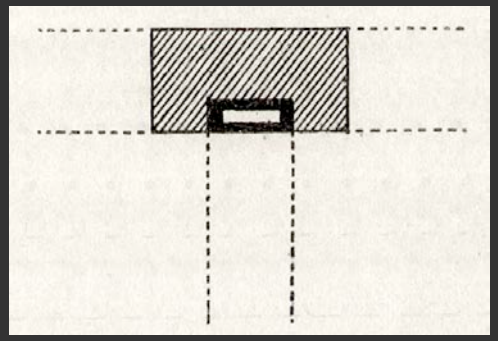
Shipping to destination city: steel to NYC, cement to Boston.

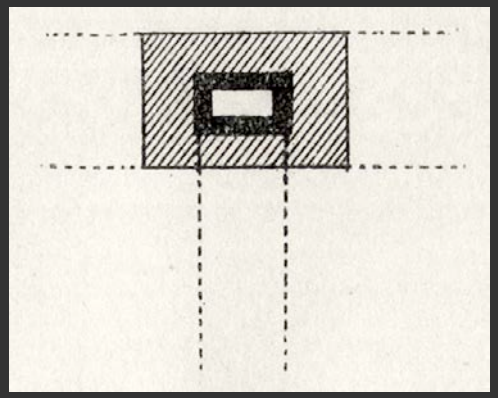
Hauling to site: steel from railroad terminal to building site.

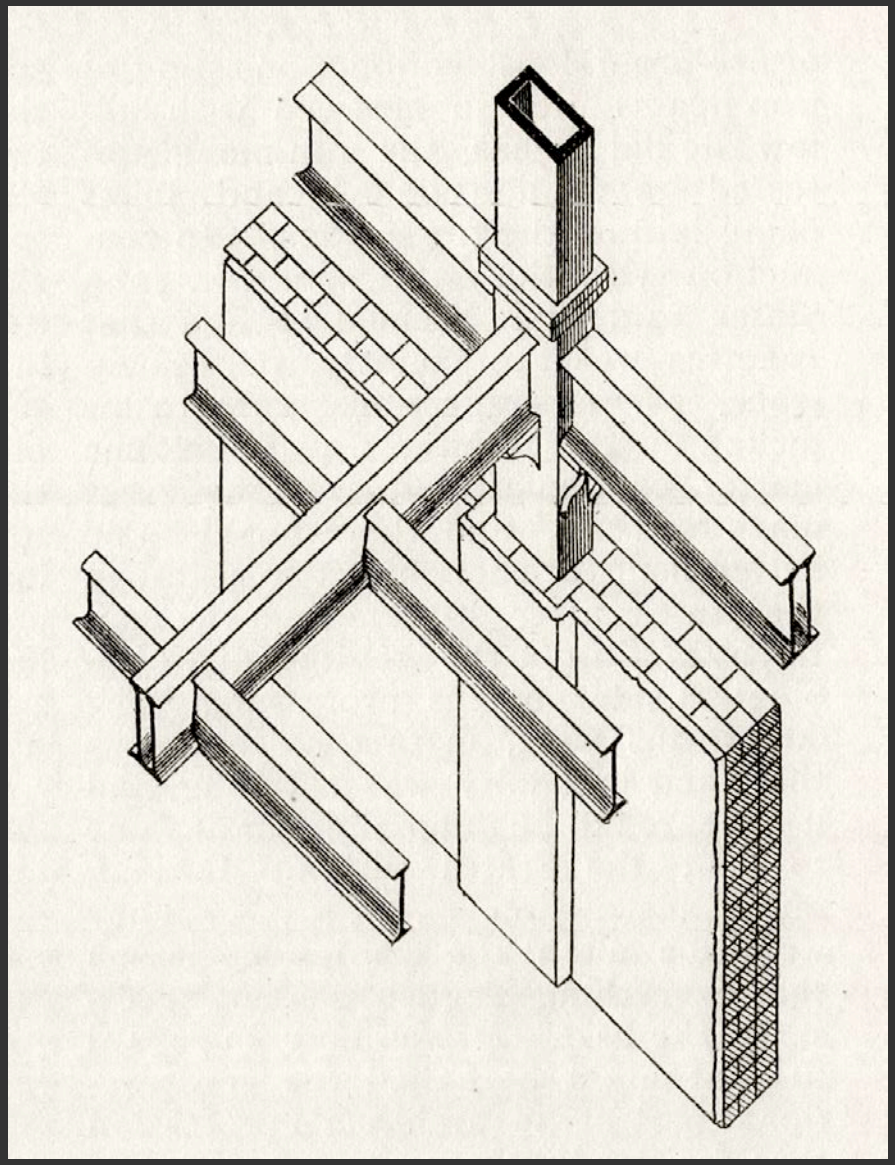
Placing: steel erection, brick laying.

William Fryer, 1891

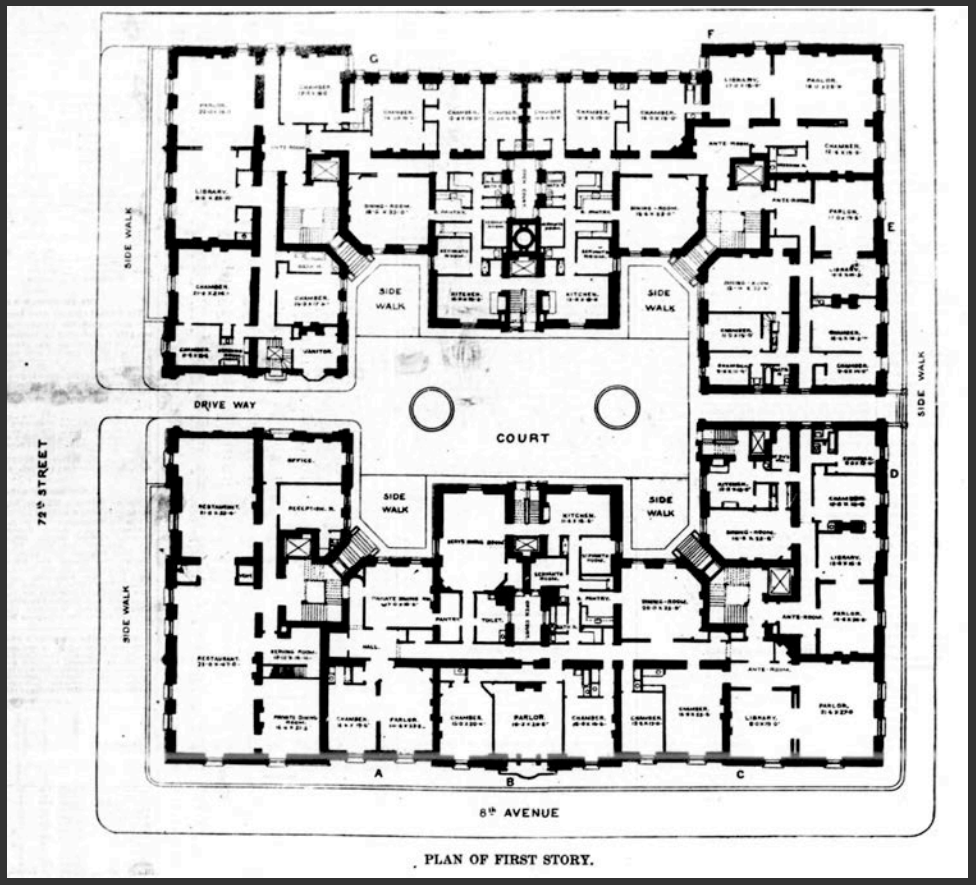






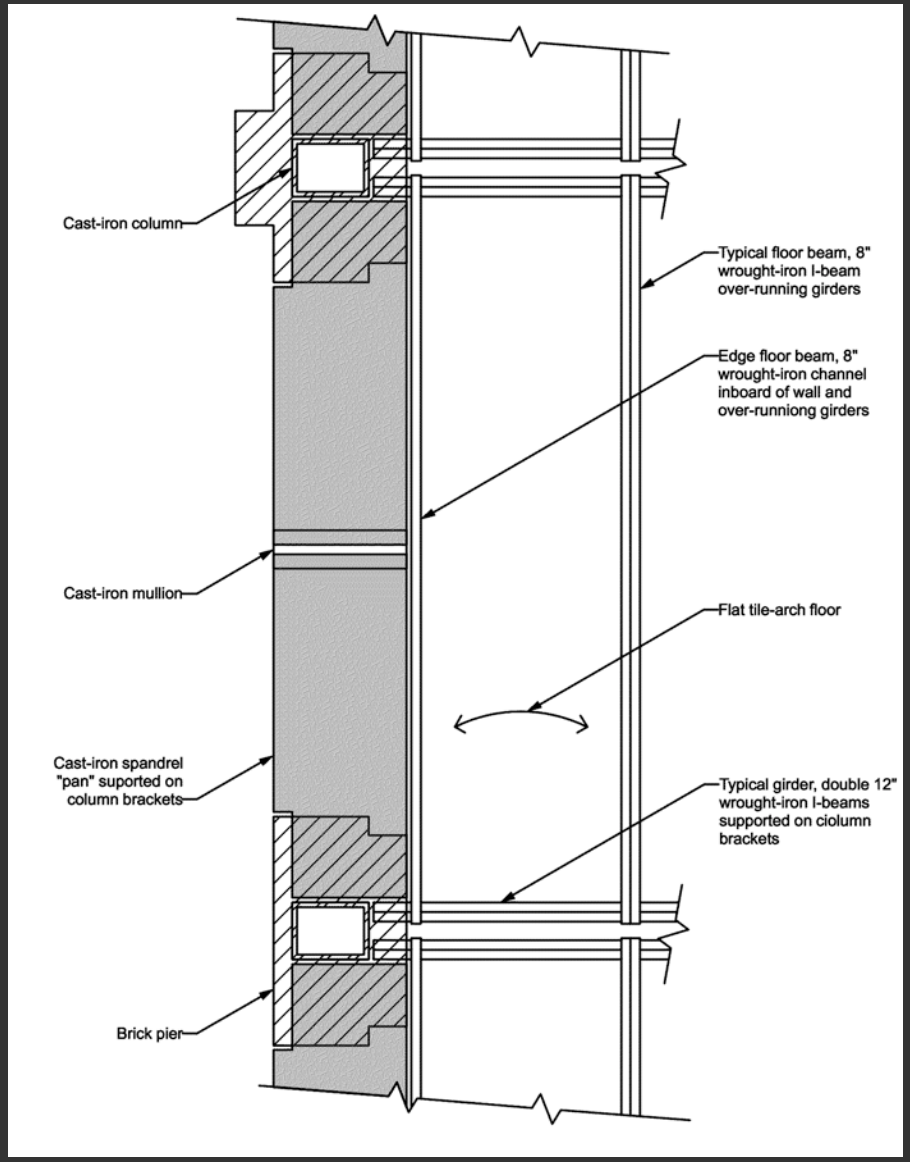


Dakota Apartments, New York



PLAN OF FIRST STORY.

Home Insurance Building, Chicago



Reliance Building, Chicago

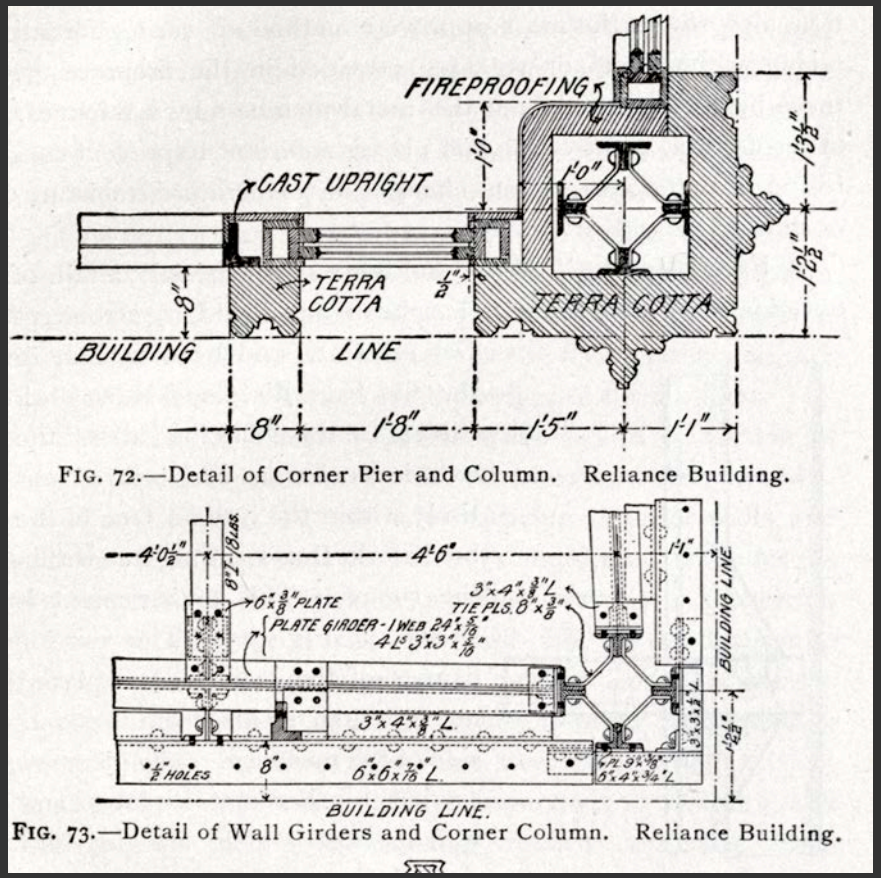


FIG. 72.—Detail of Corner Pier and Column. Reliance Building.

FIG. 73.—Detail of Wall Girders and Corner Column. Reliance Building.

Walls Required By Code

WAREHOUSE WALLS.

(For buildings other than Dwellings, except Churches, Theatres and School-houses.)

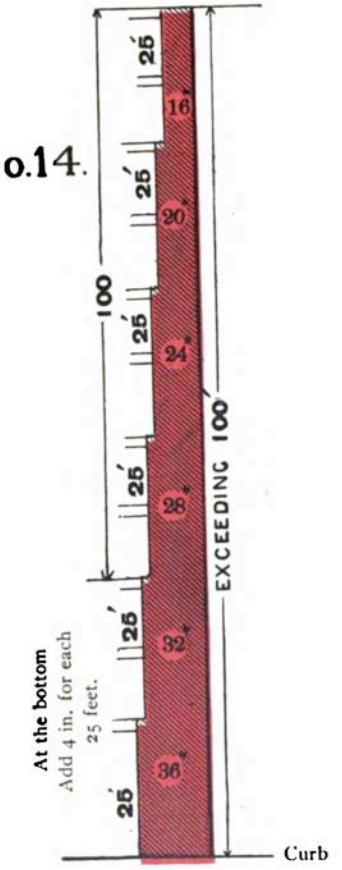
Party and sidewalls have the same thickness.

Front and rear walls and inside bearing walls may be four inches less in thickness.

(If the building be in width more than 25 feet clear span between walls, or more than 105 feet in depth, walls must be made thicker.)

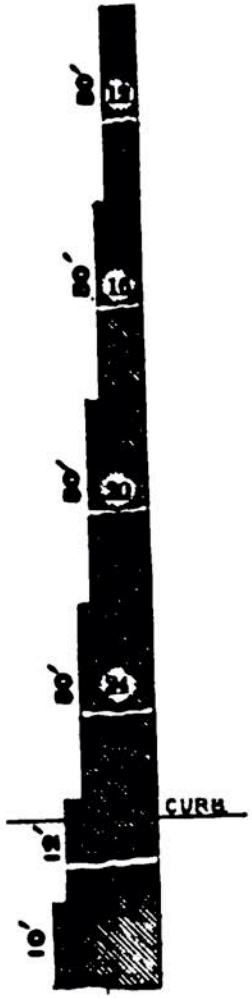
(Fire-proof Building.)

No. 14.



CURTAIN WALLS FOR SKELETON STRUCTURES.

Curtain walls of brick built in between iron or steel columns, and supported wholly or in part on iron or steel girders, shall not be less than twelve inches thick for fifty feet of the uppermost height thereof, or to the nearest tier of beams to that measurement, in any building so constructed, and every lower section of fifty feet or to the nearest tier of beams to such vertical measurement, or part thereof, shall have a thickness of four inches more than is required for the section next above it, down to the tier of beams nearest to the curb level; and thence downwardly the thickness of walls shall increase in the ratio prescribed in section four hundred and seventy-four of this title for the thickness of foundation walls.



Steel Analysis

of section is two rivet-holes opposite each other, connecting the angles with the plates of the bottom flange.

Using $\frac{7}{8}$-inch-diameter rivets, and allowing $\frac{1}{8}$ of an inch more for any injury to the metal in the process of punching, we have the area of a rivet-hole equal to $\frac{1}{2}'' + \frac{1}{2}'' + \frac{1}{2}'' + \frac{8}{8}'' \times 1'' = 1\frac{7}{8}$ square inches, for two rivet-holes $2 \times 1\frac{7}{8}'' = 3\frac{3}{4}$ square inches, to be added to the bottom flange, or $25'' + 3\frac{3}{4}'' = 28\frac{3}{4}$ square inches. Then

Bottom flange = 2 angles $5'' \times 4'' \times \frac{1}{2}''$	=	8.50	square inches.
1 plate $12'' \times \frac{5}{8}''$	=	7.50	" "
1 " $12'' \times \frac{5}{8}''$	=	7.50	" "
1 " $12'' \times \frac{7}{16}''$	=	5.25	" "
Total,		28.75	" "

Flanges reduced in Area towards the Supports.—To reduce the area of the flanges as the ends are approached, draw the diagram Fig. 15, making R and R' equal to the span of 30

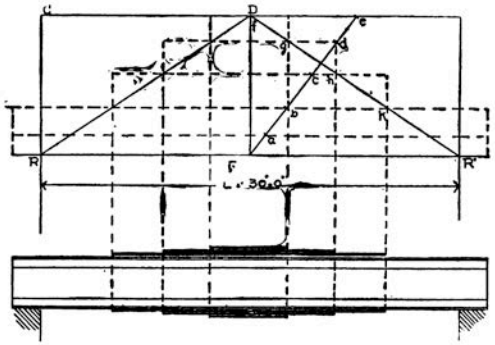


Fig. 15.

feet, and set off FD at centre of span equal to the bending moment at that point, or equal to DF, Fig. 14. Connect RD and DR'. Draw the rectangle $RCER'$.

The angles to extend from end to end of girder, and the adjoining plates are required to extend in like manner for practical reasons, which will be readily seen in all box girders.

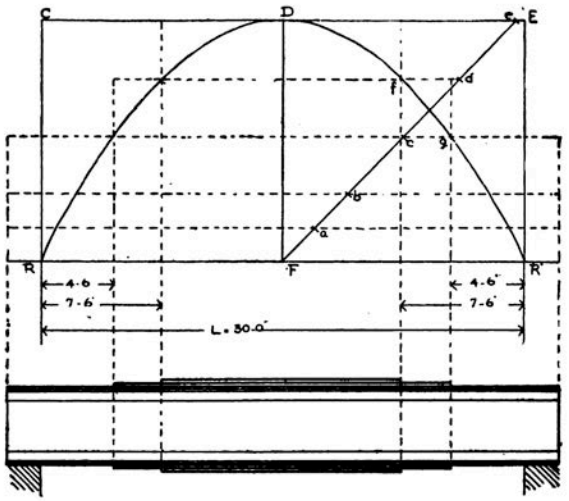


Fig. 25.

The plates of the bottom flange are, for the reasons explained in the previous example, practically the same length as those of the top flange, and should extend 12 inches beyond the calculated length.

Webs.—The reactions on the supports of a girder sustaining a uniformly distributed load are each equal to one half the total load, and the shearing force on the webs at each end of the girder is equal to $\frac{400{,}000}{2} = 200{,}000$ pounds.

Then $t = \frac{20{,}0000}{36 \times 6000} = .92$, nearly $\frac{15}{16}$ of an inch;

Model Buildings

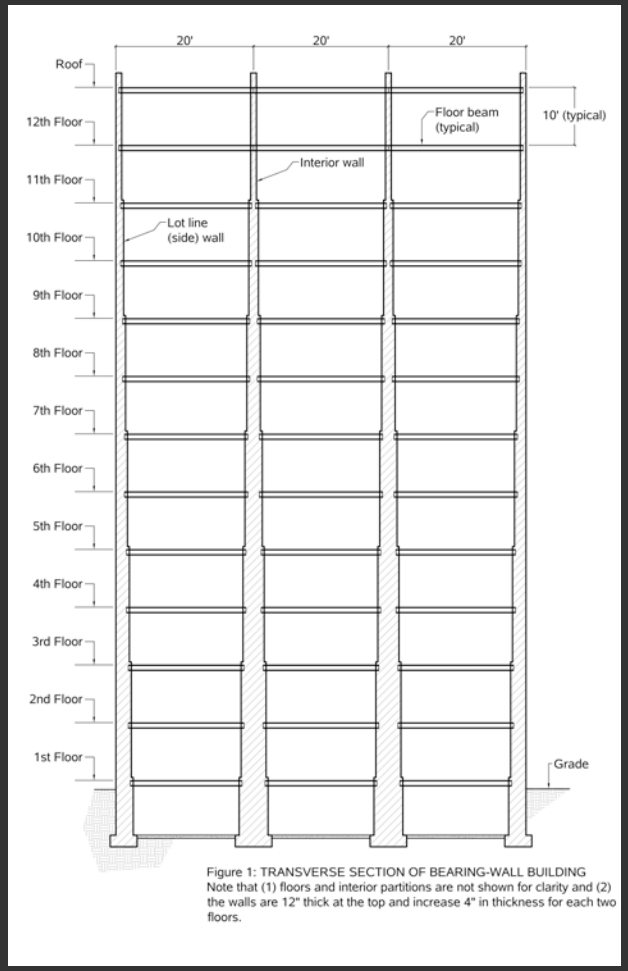


Figure 1: TRANSVERSE SECTION OF BEARING-WALL BUILDING
Note that (1) floors and interior partitions are not shown for clarity and (2) the walls are 12" thick at the top and increase 4" in thickness for each two floors.

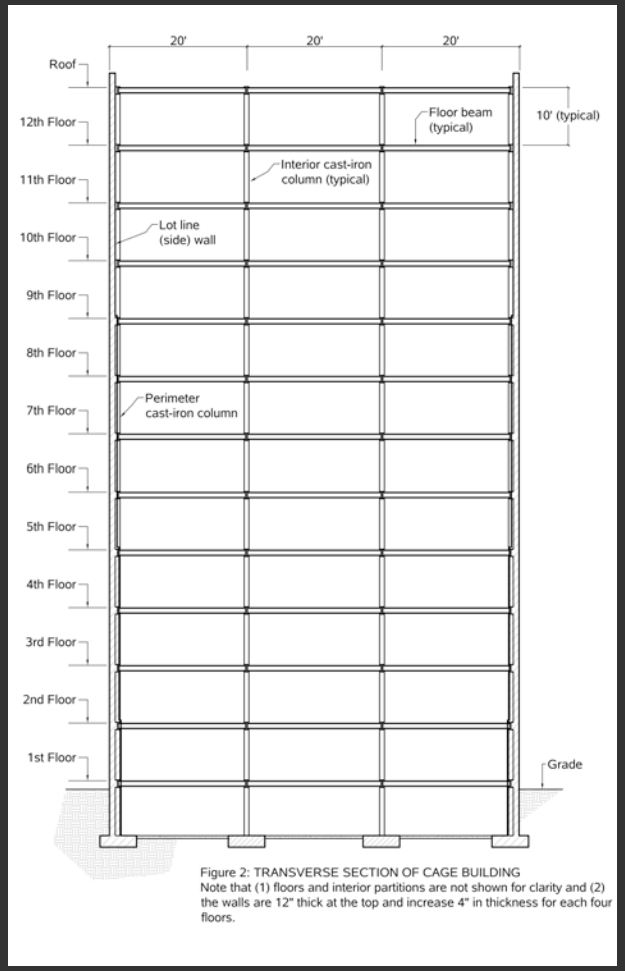


Figure 2: TRANSVERSE SECTION OF CAGE BUILDING
Note that (1) floors and interior partitions are not shown for clarity and (2) the walls are 12" thick at the top and increase 4" in thickness for each four floors.

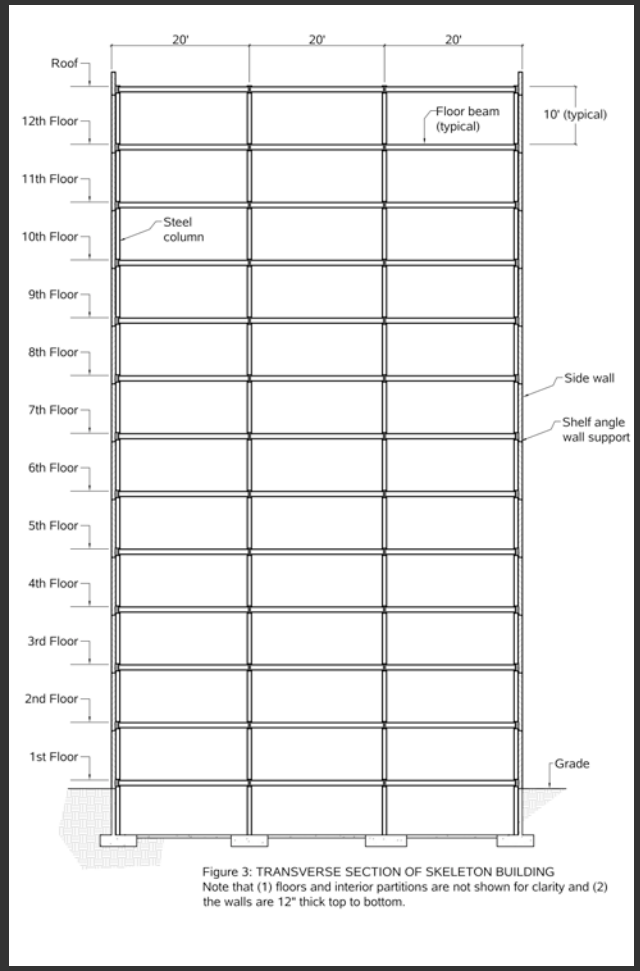


Figure 3: TRANSVERSE SECTION OF SKELETON BUILDING
Note that (1) floors and interior partitions are not shown for clarity and (2) the walls are 12" thick top to bottom.

Materials And Cost

	Bearing-Wall Building	Cage-Frame Building	Skeleton Frame Building
Weight of brick (tons)	4900	2600	1800
Weight of cast iron (tons)	0	82	0
Weight of steel (tons)	180	250	520
Cost of brick ($)	111,000	59,000	41,000
Cost of cast iron ($)	0	6,000	0
Cost of steel ($)	11,000	15,000	33,000
Total structural cost ($)	122,000	80,000	74,000
Structural cost ($/s.f.)	2.11	1.39	1.28

Dime Savings Bank, Detroit, 1912

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