CAST IRON COLUMNS

Allowable Unit Stresses in Pounds per Square Inch

By Formula of New York Building Law, 1916

9000–40 l/r lbs. per square inch

l/r	Lbs. per Sq. In.	l/r	Lbs. per Sq. In.	l/r	Lbs. per Sq. In.
0	9000	30	7800	51	6960
10	8600	31	7760	52	6920
11	8560	32	7720	53	6880
12	8520	33	7680	54	6840
13	8480	34	7640	55	6800
14	8440	35	7600	56	6760
15	8400	36	7560	57	6720
16	8360	37	7520	58	6680
17	8320	38	7480	59	6640
18	8280	39	7440	60	6600
19	8240	40	7400	61	6560
20	8200	41	7360	62	6520
21	8160	42	7320	63	6480
22	8120	43	7280	64	6440
23	8080	44	7240	65	6400
24	8040	45	7200	66	6360
25	8000	46	7160	67	6320
26	7960	47	7120	68	6280
27	7920	48	7080	69	6240
28	7880	49	7040	70	6200
29	7840	50	7000		

The safe load for a cast iron column of given dimensions is determined from the above table by obtaining the ratio of l/r and multiplying the corresponding unit stress by the sectional area of column.

Example:—Required the safe load of a cast iron column, 15 inches square, ⅞ inch in thickness, and 16 feet long.

From table of Hollow Square Sections, page 199, the radius of gyration is 5.78 inches and the sectional area is 49.44 square inches; hence the ratio of $l/r = 16 \times 12 \div 5.78 = 33.2$, corresponding to a stress of 7672 pounds per square inch, giving a total safe load of $49.44 \times 7672 = 379300$ pounds.

The minimum size of a cast iron column of a certain length to safely support a given load is determined as follows:

Divide the length in inches by 70; the quotient is the minimum allowable radius of gyration required. Divide the total load by 6200 pounds; the quotient is the minimum sectional area.

Example:—Required the minimum size of a round cast iron column, 20 feet long, to support a load of 235000 pounds.

The minimum radius of gyration is $20 \times 12 \div 70 = 3.43$ inches; the minimum area is $235000 \div 6200 = 37.90$ square inches. From table of Hollow Round Sections, page 198, the nearest minimum size for this radius of gyration and this area is found to be a column 11 inches in diameter and 1¼ inches in thickness.

FLOORS AND FLOOR LOADS

Kinds of Loads. Two kinds of loads are carried by structures. Live loads consist of the weight of carriages, cranes or other handling devices and their supported loads, machinery, merchandise, persons or other moving objects, the support of which is the purpose of the structure, including also wind stresses. Dead loads consist of the actual weight of the structure itself with the walls, floors, partitions, roofs, and all other permanent construction and fixtures. The dead loads stress the structure at all times and it must, therefore, be proportioned to sustain them at all times without reduction. The live loads may be taken at their full values or reduced in accordance with the probabilities that the structure as a whole or its principal members will not be subject at all times to the full theoretical live loading.

Dead Loads. The permanent load should be calculated from known weights per unit of the material composing floors, partitions, walls, or other permanent construction. The weight assumed for the steel frame itself should be checked after the sections are determined and then the sizes readjusted if necessary.

Live Loads. Live loads vary with the character of the structures. In buildings they consist of uniform loads per square foot of floor area, concentrated loads, such as heavy safes, which may be applied at any point of the floor, and uniform loads per lineal foot of beams or girders. The load which produces the maximum bending moment or reaction is to be used in proportioning sections. The floor system between beams must of course be of sufficient strength to transmit any concentrated load to the beam.

In cities the minimum live loads to be used on the various classes of buildings are fixed by public ordinances, and are given on page 324 for the principal cities of the United States in accordance with the most recent building laws, which are intended to cover general conditions and do not include machinery or other concentrations. If such concentrations, like safes, armatures, generators, or printing presses, occur on floors, special provision should be made for them in the floor framing. Flat roofs of buildings which may be loaded with people, should be treated the same as floors and the same uniform live loads used as given in the table for dwellings, hotels or assembly rooms.

FLOORS AND ROOFS

Minimum Live Loads, Pounds per Square Foot

By Building Laws of Various Cities

Description of Building	Baltimore, 1908	Boston, 1912	Chicago, 1911	Cleveland, 1911	New York, 1916	Philadelphia, 1913	Pittsburgh, 1914	St. Louis, 1910	San Francisco 1910
Apartment Houses, etc.:									
Floors	60	50	40	50	40	70	50	60	60
Hospitals, Asylums:									
Floors			50	60		70	70		60
Assembly Rooms, etc.			100	80		120	125		125
Hotels:									
Floors	60	50	50	50	40	70	70	60	60
Assembly Rooms, etc.	125	100	100	80	100	120	125	100	75
Factories:									
Floors, light manufacture	125a	125a	100a	125a	120a	120a	125a	150a	125a
" heavier	175a			200a		150a			250a
Mercantile Buildings:									
Stores, light goods	125	125	100	100b	120	120	125	150	125
" heavier goods	175	250		200		150	200	150	250
Warehouse floors	250	250		200		150	200	150	250
Office Buildings:									
Floors	75	100	50	60	60	100	70	70	60
Assembly Rooms, etc.	125	125	100	100	100	120	125	100	125
Public Assembly Halls:									
Auditoriums, fixed seats	75	125	100	80	100	120	125	100	75
" movable seats	125	125	100	100	100	120	125	100	125
Churches	75	125	100	80	100	120	125	100	75
Dance and Drill Halls		200	100	150			150		
Theaters	75	125	100	80	100	120	125	100	75
Schools:									
Class Rooms	75	60	40	60	75	70	70	100	75
Assembly Rooms, etc.	75	125	75	80	100	120	125	100	125
Sidewalks	200			200	300				150
Stables, Garages, etc.	100		100	80			125		75
Stairways, Fire Escapes		70	100	80					
Roofs:									
Flat, slope under 20°	40	40	25	40	40	30	50c	40	30
Steep, slope over 20°	20		25d	40d	30	30d	50c		20
Wind Pressure	30		20	30e	30	30e	25	30	20

a Floor loads do not include weight or impact load of machinery.
b Ground or First Floor: Baltimore 150, Cleveland 125, St. Louis 150 pounds.
c Dead and live load; snow load 25 pounds, reduced 1 pound for each degree between 20° and 45°.
d Load per square foot of superficial roof area; other roof loads are for the projected area.
e Wind pressure for high buildings in built-up districts 35 pounds; buildings 14 stories high or over: 25 pounds at tenth story, 2½ pounds less each story below.

Reduced Live Loads. Floor beams in buildings should be computed to sustain floor by floor the full live and dead loads. It is not probable that all the floors will be fully loaded at all times, and, therefore, good practice permits a reduction of the theoretical live load in the computations of column sections. The New York and Pittsburgh building laws do not permit any reduction on columns supporting the roof and top floor. These building laws permit for buildings more than five stories in height on columns supporting each succeeding floor a reduction of 5 per cent of the total live floor load until 50 per cent is reached, which reduced load is to be used for the columns supporting the remaining floors. Pittsburgh building law, however, does not permit any reduction of live floor loads over 150 pounds per square foot (bulk storage). The Chicago building law requires columns to sustain the full live load on roofs, 85 per cent of the full live floor load on the top floor with a 5 per cent reduction on each succeeding floor down to 50 per cent.

When the character of the loading will permit, it is also considered good practice to reduce the live load on the main girders to which the primary supporting beams are framed. The amount of the reduction will depend on the probable distribution of the loads.

Foundation Loads. Footings should be so designed that the loads they sustain per unit of area shall be as nearly uniform as possible, and the dead loads carried by the footings should include the actual weight of the superstructure and foundations down to the bottom of the footing. The live load should be assumed to be the same as the live load in the lowest tier of columns or in the footings under walls. According to the proposed New York building law, the area of the footing which has the largest percentage of live load to total load shall be determined by dividing the total load by the unit working stress. From the area thus calculated all the other footings of the building shall be proportioned according to the ratios of their respective dead loads only. In no case shall the load per square foot under any portion of any footing due to the combined dead, live, and wind loads, exceed the safe sustaining power of the soil upon which the footing rests.

Fireproof Floor Systems. A modern office or mercantile building is essentially a steel framed structure which supports the dead load of the building and its contents and is itself protected on all sides by refractory materials. The floors are made fireproof by the use of terra cotta tiles or arches or of a composite flooring made of concrete or reinforced concrete. While brick arches may still be used in special locations where great floor strength is needed, and concrete arches are sometimes thrown between the beams,