

Weights Of Building Materials, Agricultural Commodities, and Floor Loads For Buildings

The loads considered for a building are divided into two major categories; dead loads and live loads. Dead loads are associated with the building and do not change magnitude or location. It includes the weight of the building components, structural parts, and also any fixed equipment such as plumbing, electric, heating, ventilating, refrigeration, and sprinkler systems. Live loads change with time and include loads caused by people, animals, grain, potatoes, equipment, manure, etc.

Table 1 and 2 list estimated weights of selected materials. Known values should be used when available.

Table 1. Weights of common building materials.

<u>Building material</u>	<u>Unit weight</u>
Aluminum ¹	171 pounds per cubic foot
Cast Iron ¹	450 pounds per cubic foot
Cement ²	94 pounds per cubic foot
Concrete ²	150 pounds per cubic foot
Crushed Stone ²	2,500 pounds per cubic yard
Gravel ²	2,700 pounds per cubic yard
Gypsum or plaster board ³	
3/8 inch	1.56 pounds per square foot
1/2 inch	2.08 pounds per square foot
5/8 inch	2.60 pounds per square foot
Insulation ³	
Mineral fiber (fiberglass)	2 pounds per cubic foot
Extruded polystyrene	1.8 pounds per cubic foot
Expanded polystyrene	1.5 pounds per cubic foot
Polyurethane	1.5 pounds per cubic foot
Vermiculite	40 pounds per cubic foot
Limestone	171 pounds per cubic foot
Lumber (@ 35 pounds per cubic foot, Douglas Fir) ⁴	
2X4	1.28 pounds per foot
2X6	2.00 pounds per foot
2X8	2.64 pounds per foot
2X10	3.37 pounds per foot
2X12	4.10 pounds per foot
4X4	2.98 pounds per foot
6X6	7.35 pounds per foot
6X8	10.03 pounds per foot

Masonry Walls ⁵	4 inch brick	42 pounds per square foot
	8 inch concrete block	55 pounds per square foot
	12 inch concrete block	80 pounds per square foot
Plywood ³	1/4 inch	0.71 pounds per square foot
	3/8 inch	1.06 pounds per square foot
	1/2 inch	1.42 pounds per square foot
	5/8 inch	1.77 pounds per square foot
	3/4 inch	2.13 pounds per square foot
Roofing ⁵	Asphalt shingles	3 pounds per square foot
	1/4 in. slate	10 pounds per square foot
	Aluminum (26 gauge)	0.3 pounds per square foot
	Steel (29 gauge)	0.8 pounds per square foot
	Built-up 3 ply & gravel	5.5 pounds per square foot
Sand ²	Bank sand	2,500 pounds per cubic yard
	Torpedo Sand	2,700 pounds per cubic yard
Steel ¹		490 pounds per cubic foot

Table 2. Bulk density of selected products⁶

<u>Product</u>	<u>Unit density</u>
Baled hay or straw	8-14 pounds per cubic foot
Shelled corn	45 pounds per cubic foot
Ear corn	28 pounds per cubic foot
Feed Grains & supplement	32 pounds per cubic foot
High protein supplement	50 pounds per cubic foot
Potatoes	43 pounds per cubic foot
Fruits and vegetables	30-40 pounds per cubic foot
Soil	2,500 pounds per cubic yard
Manure	60 pounds per cubic foot
Water	62.4 pounds per cubic foot

Tables 3 and 4 list distributed floor live loads from the BOCA code and a standard from ASAE. Live loads for design are usually estimated based on code requirements or standards of practice. By code definition, the design live load is the greatest load by the intended use or occupancy but not less than the minimum uniformly distributed load outlined in the codes.

Table 3. Minimum Uniformly Distributed Live Loads (BOCA, Building Officials and Code Administrators)⁷

Occupancy or Use	Live Load (psf)
Garages	
Passenger Cars	50
Trucks and Buses	50
Manufacturing	
Light	100
Heavy	150
Office Buildings	
Offices	50
Lobbies	100
Residential	
Attics	20
Dwelling units	40
Sleeping rooms	30
Sidewalks	250
Storage Areas	
Light	125
Heavy	250
Yards and terraces, pedestrians	100

Table 4. Design Floor Live Load (American Society of Agricultural Engineers EP378.3)⁸

Occupancy or Use	Live Load, Solid Floor(psf)
Beef Cattle	
Calves to 300 lb.	50
Feeders, breeders	100
Dairy Cattle	
Calves to 300 lb.	50
Mature cows	100
Stall area	60
maternity or hospital pen	50
Swine	
to 50 lb.	35
200 lb.	50
400 lb.	65
500 lb.	70
Sheep	
Feeders	40
Ewes, rams	50
Horses	100
Turkeys	30
Chickens (floor houses)	20
Greenhouses	50

The above loadings are for uniformly distributed loads. Loads that are considered concentrated at one point should be handled differently than distributed loads. For example, the thickness of a concrete slab should be greater when a load such as a jack base is considered. Table 5 lists some minimum concentrated loads from the BOCA code. Unless otherwise specified the load is assumed to occupy an area of 2.5 feet square and located to produce the maximum stress in the structural members.

Table 5. Minimum concentrated loads (BOCA)⁷

Location	Pounds
Garages	
Passenger cars (20 square inches)	2,000
Trucks or buses (20 square inches)	Maximum axle load
Greenhouse roof bars, purlins, rafters	100
Manufacturing and storage	2,000
Office	2,000
Sidewalks or driveways	8,000

Tractors and other equipment can be treated similar to trucks or buses. The maximum axle load of the equipment should be taken as the concentrated load.

EXAMPLE 1.

What is the distributed floor load under baled hay 16 feet high?

From table 2. baled hay weighs 8 to 14 pounds per cubic foot.

For each square foot of floor area the maximum loading for 16 feet of baled hay is:

$$16 \text{ feet} \times 14 \text{ pounds per cubic foot} = 224 \text{ pounds per square foot.}$$

EXAMPLE 2.

How much does a wall of 8 inch concrete block weigh that is 10 feet high and 40 feet long?

From Table 1, a 8 inch concrete block wall weighs 55 pounds per square foot.

For each running foot, the wall would weigh,

$$10 \text{ feet} \times 55 \text{ pounds per square foot} = 550 \text{ pounds per foot. and}$$

$$550 \text{ pounds per foot} \times 40 \text{ feet} = 22,000 \text{ pounds}$$

EXAMPLE 3.

According to the specifications for a tractor, the front axle load is 5,000 pounds and the rear axle load is 7,000 pounds. For loading considerations the minimum concentrated load is 7,000 pounds over 20 square inches or 350 pounds per square inch.

PSU/89

“This fact sheet was developed by Jon Carson and originally published in 1989. It was reviewed in 1995 by Robert Graves and found suitable for continued use.”

¹ Mazria, Edward. 1979. The Passive Solar Energy Book. Rodale Press, Emmaus, PA.

² 1986. The Building Estimator's Reference Book. Frank R. Walker Company. Chicago, IL.

³ 1985. Fundamentals, ASHRAE Handbook. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Atlanta, GA.

⁴ 1977. National Design Specification for Wood Construction. National Forest Products Association. Washington, D.C.

⁵ Muller, Edward J. 1967. Architectural Drawing and Light Construction. Prentice-Hall, Inc. Englewood Cliffs, NJ.

⁶ Hall, Carl W. 1980. Drying and Storage of Agricultural Crops. AVI Publishing Company, Inc. Westport, CN.

⁷ 1987. The BOCA National Building Code. Building Officials and Code Administrators, Inc. Country Club Hills, IL.

⁸ ASAE Standards 1988. American Society of Agricultural Engineers. St. Joseph MI.