

Common Design Loads in Building Codes

Notation:

<p>A = name for area</p> <p>$AASHTO$ = American Association of State Highway and Transportation Officials</p> <p>$ASCE$ = American Society of Civil Engineers</p> <p>ASD = allowable stress design</p> <p>D = dead load symbol</p> <p>E = earthquake load symbol</p> <p>F = hydraulic loads from fluids symbol</p> <p>H = hydraulic loads from soil symbol</p> <p>L = live load symbol</p> <p>L_r = live roof load symbol</p> <p>$LRFD$ = load and resistance factor design</p>	<p>R = rainwater load or ice water load symbol</p> <p>S = snow load symbol</p> <p>SEI = Structural Engineering Institute</p> <p>t = name for thickness</p> <p>T = effect of material & temperature symbol</p> <p>V = name for volume</p> <p>w = name for distributed load</p> <p>W = wind load symbol</p> <p>= force due to a weight</p> <p>= name for total force due to distributed load</p> <p>γ = density or unit weight</p>
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Design Codes in General

Design codes are issued by a professional organization interested in insuring safety and standards. They are legally backed by the engineering profession. Different design methods are used, but they typically defined the *load cases or combination*, stress or strength limits, and deflection limits.

Load Types

Loads used in design load equations are given letters by *type*:

D = dead load

L = live load

L_r = live roof load

W = wind load

S = snow load

E = earthquake load

R = rainwater load or ice water load

T = effect of material & temperature

H = hydraulic loads from soil

F = hydraulic loads from fluids

Determining Dead Load from Material Weights

Material density is a measure of how much mass in a unit volume causes a force due to gravity. The common symbol for density is γ . When volume, V , is multiplied by density, a force value results:

$$W = \gamma \cdot V$$

Materials “weight” can also be presented as a weight per unit area or length. This takes into account that the volume is a thickness times an area: $V = t \cdot A$; so the calculation becomes:

$$W = (\text{weight/unit area}) \cdot A$$

$$w = (\text{weight/unit volume}) \cdot t \quad \text{which is a weight per unit area}$$

$$w = (\text{weight/unit volume}) \cdot A \quad \text{which is a weight per unit length}$$

Minimum Concentrated Loads

adapted from SEI/ASCE 7-10: Minimum Design Loads for Buildings and Other Structures

<i>Location</i>	<i>Concentrated load lb (kN)</i>
Catwalks for maintenance access	300 (1.33)
Elevator machine room grating (on area of 2 in. by 2 in. (50 mm by 50 mm))	300 (1.33)
Finish light floor plate construction (on area of 1 in. by 1 in. (25 mm by 25 mm))	200 (0.89)
Hospital floors	1,000 (4.45)
Library floors	1,000 (4.45)
Manufacturing	
Light	2,000 (8.90)
Heavy	3,000 (13.40)
Office floors	2,000 (8.90)
Awnings and canopies	
Screen enclosure support frame	200 (0.89)
Roofs – primary members and subject to maintenance workers	300 (1.33)
School floors	1,000 (4.45)
Sidewalks, vehicular driveways, and yards subject to trucking (over wheel area of 4.5 in. by 4.5 in. (114 mm x 114 mm))	8,000 (35.60)
Stairs and exit ways on area of 2 in. by 2 in. (50 mm by 50 mm) non-concurrent with uniform load	300 (1.33)
Store floors	1,000 (4.45)

Allowable Stress Design (ASD)

Combinations of service (also referred to as *working*) loads are evaluated for maximum stresses and compared to allowable stresses. The allowed stresses are some fraction of limit stresses.

ASCE-7 (2010) combinations of loads:

- | | |
|--|---|
| 1. D | When F loads are present, they shall be included with the same load factor as dead load D in 1 through 6 and 8. |
| 2. $D + L$ | |
| 3. $D + 0.75(L_r \text{ or } S \text{ or } R)$ | |
| 4. $D + 0.75L + 0.75(L_r \text{ or } S \text{ or } R)$ | |
| 5. $D + (0.6W \text{ or } 0.7E)$ | When H loads are present, they shall have a load factor of 1.0 when adding to load effect, or 0.6 when resisting the load when permanent. |
| 6a. $D + 0.75L + 0.75(0.6W) + 0.75(L_r \text{ or } S \text{ or } R)$ | |
| 6b. $D + 0.75L + 0.75(0.7E) + 0.75S$ | |
| 7. $0.6D + 0.6W$ | |
| 8. $0.6D + 0.7E$ | |

Load and Resistance Factor Design – LRFD

Combinations of loads that have been *factored* are evaluated for maximum loads, moments or stresses. These factors take into consideration how likely the load is to happen and how often. This “imaginary” worse case load, moment or stress is compared to a limit value that has been modified by a *resistance* factor. The resistance factor is a function of how “comfortable” the design community is with the type of limit, ie. yielding or rupture...

ASCE-7 (2010) combinations of factored nominal loads:

- | | |
|---|---|
| 1. $1.4D$ | When F loads are present, they shall be included with the same load factor as dead load D in 1 through 5 and 7. |
| 2. $1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$ | |
| 3. $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$ | |
| 4. $1.2D + 1.0W + L + 0.5(L_r \text{ or } S \text{ or } R)$ | |
| 5. $1.2D + 1.0E + L + 0.2S$ | When H loads are present, they shall have a load factor of 1.6 when adding to load effect, or 0.9 when resisting the load when permanent. |
| 6. $0.9D + 1.0W$ | |
| 7. $0.9D + 1.0E$ | |

Minimum Uniformly Distributed Live Loads

adapted from SEI/ASCE 7-10: Minimum Design Loads for Buildings and Other Structures

<i>Location</i>	<i>Uniform load psf (kN/m²)</i>
Apartments (see Residential)	
Access floor systems	
Office use	50 (2.4)
Computer use	100 (4.79)
Armories and drill rooms	150 (7.18)
Assembly areas	
Fixed seats (fastened to floor)	60 (2.87)
Lobbies	100 (4.79)
Movable seats	100 (4.79)
Platforms (assembly)	100 (4.79)
Stage floors	150 (7.18)
Assembly areas (other)	100 (4.79)

<i>Location</i>	<i>Uniform load psf (kN/m²)</i>
Balconies and decks	1.5 times the live load for the area served. Not required to exceed 100 psf (4.79 kN/m ²)
Catwalks for maintenance access	40 (1.92)
Corridors	
First floor	100 (4.79)
Other floors	same as occupancy served except as indicated
Dining rooms and restaurants	100 (4.79)
Dwellings (see Residential)	
Elevator machine room grating (on area of 2 in. by 2 in. (50 mm by 50 mm))	300 (1.33)
Finish light floor plate construction (on area of 1 in. by 1 in. (25 mm by 25 mm))	200 (0.89)
Fire escapes	100 (4.79)
On single-family dwellings only	40 (1.92)
Garages	
Passenger vehicles only	40 (1.92)
Helipads	60 (2.87)
Hospitals	
Operating rooms, laboratories	60 (2.87)
Patient rooms	40 (1.92)
Corridors above first floor	80 (3.83)
Hotels (see Residential)	
Libraries	
Reading rooms	60 (2.87)
Stack rooms	150 (7.18)
Corridors above first floor	80 (3.83)
Manufacturing	
Light	125 (6.00)
Heavy	250 (11.97)
Office buildings	
File and computer rooms shall be designed for heavier loads based on anticipated occupancy	
Lobbies and first floor corridors	100 (4.79)
Offices	50 (2.40)
Corridors above first floor	80 (3.83)
Penal institutions	
Cell blocks	40 (1.92)
Corridors	100 (4.79)
Recreational uses	
Bowling alleys, poolrooms, and similar uses	75 (3.59)
Dance halls and ballrooms	100 (4.79)
Gymnasiums	100 (4.79)
Reviewing stands, grandstands, and bleachers	100 (4.79)
Stadiums and arenas with fixed seats (fastened to the floor)	60 (2.87)
Residential	
One- and two-family dwellings	
Uninhabitable attics without storage	10 (0.48)
Uninhabitable attics with storage	20 (0.96)
Habitable attics and sleeping areas	30 (1.44)
All other areas except stairs	40 (1.92)
All other residential occupancies	
Private rooms and corridors serving them	40 (1.92)
Public rooms and corridors serving them	100 (4.79)

<i>Location</i>	<i>Uniform load psf (kN/m²)</i>
Roofs	
Ordinary flat, pitched, and curved roofs	20 (0.96)
Roofs used for roof gardens	100 (4.79)
Roofs used for assembly occupancies	Same as occupancy served
Roofs used for other occupancies	As approved by authority having jurisdiction
Awnings and canopies	
Fabric construction supported by a skeleton structure	5 (0.24) nonreducible
Screen enclosure support frame	5 (0.24) nonreducible and based on the tributary area of the roof supported by the frame
All other construction	20 (0.96)
Schools	
Classrooms	40 (1.92)
Corridors above first floor	80 (3.83)
First-floor corridors	100 (4.79)
Scuttles, skylight ribs, and accessible ceilings	200 (0.89)
Sidewalks, vehicular driveways, and yards subject to trucking	250 (11.97)
Stairs and exit ways	100 (4.79)
One- and two-family dwellings only	40 (1.92)
Storage areas above ceilings	20 (0.96)
Storage warehouses (shall be designed for heavier loads if required for anticipated storage)	
Light	125 (6.00)
Heavy	250 (11.97)
Stores	
Retail	
First floor	100 (4.79)
Upper floors	75 (3.59)
Wholesale, all floors	125 (6.00)
Walkways and elevated platforms (other than exit ways)	60 (2.87)
Yards and terraces, pedestrian	100 (4.79)

Live load reductions are not permitted for specific types (see code).
Some occupancies must be designed for appropriate loads as approved by the authority having jurisdiction.
Library stack room floors have specified limitations (see code)
AASHTO lane loads should also be considered where appropriate.

Building Material Weights-AISC Manual of Load and Resistance Factor Design, 3rd ed.

**Table 17-12 (cont.).
Weights and Specific Gravities**

Substance	Weight lb per cu ft	Specific Gravity	Substance	Weight lb per cu ft	Specific Gravity
METALS, ALLOYS, ORES			TIMBER, U.S. SEASONED		
Aluminum, cast, hammered	165	2.55-2.75	Moisture content by weight:		
Brass, cast, rolled	534	8.4-8.7	Seasoned timber: 15 to 20%		
Bronze, 7.9 to 14% Sn	509	7.4-8.9	Green timber up to 50%		
Bronze, aluminum	481	7.7	Ash, white, red	40	0.62-0.65
Copper, cast, rolled	556	8.8-9.0	Cedar, white, red	22	0.32-.038
Copper ore, pyrites	1205	19.25-19.3	Chestnut	41	0.66
Gold, cast, hammered	485	19.3	Cypress	30	0.51
Iron, cast, pig	450	7.6-7.9	Fir, Douglas spruce	32	0.40
Iron, wrought	468	7.5	Fir, eastern	25	0.40
Iron, speigel-eisen	437	6.7-7.3	Elm, white	45	0.72
Iron, ferro-silicon	325	5.2	Hemlock	29	0.42-0.52
Iron ore, hematite	160-180	—	Hickory	49	0.74-0.84
Iron ore, hematite in bank	130-160	—	Locust	46	0.73
Iron ore, hematite loose	237	3.6-4.0	Maple, hard	43	0.68
Iron ore, limonite	315	4.9-5.2	Maple, white	33	0.53
Iron ore, magnetite	172	2.5-3.0	Oak, chestnut	54	0.86
Iron slag	710	11.37	Oak, live	59	0.95
Lead	465	7.3-7.6	Oak, red, black	41	0.65
Lead ore, galena	112	7.4-1.83	Oak, white	46	0.74
Magnesium, alloys	475	7.2-8.0	Pine, Oregon	32	0.51
Manganese ore, pyrolusite	259	3.7-4.6	Pine, red	30	0.48
Mercury	849	13.6	Pine, white	26	0.41
Monel Metal	556	8.8-9.0	Pine, yellow, long-leaf	44	0.70
Nickel	565	8.9-9.2	Pine, yellow, short-leaf	38	0.61
Platinum, cast, hammered	1330	21.1-21.5	Poplar	30	0.48
Silver, cast, hammered	656	10.4-10.6	Redwood, California	26	0.42
Steel, rolled	490	7.85	Spruce, white, black	27	0.40-0.46
Tin, cast, hammered	459	7.2-7.5	Walnut, black	38	0.61
Tin ore, cassiterite	418	6.4-7.0	Walnut, white	26	0.41
Zinc, cast, rolled	440	6.9-7.2			
Zinc ore, blende	253	3.9-4.2			
			VARIOUS LIQUIDS		
			Alcohol, 100%	49	0.79
			Acids, muriatic 40%	75	1.20
			Acids, nitric 91%	94	1.50
			Acids, sulphuric 87%	112	1.80
			Lye, soda 66%	106	1.70
			Oil, vegetable	58	0.91-0.94
			Oil, mineral, lubricants	57	0.90-0.93
			Water, 4° C max. density	62.428	1.0
			Water, 100° C	59.830	0.9584
			Water, snow, fresh fallen	56	0.88-0.92
			Water, ice	8	0.915
			Water, sea water	64	1.02-1.03
			GASES		
			Air, 0° C 760 mm	0.0071	1.0
			Ammonia	0.478	0.5920
			Carbon dioxide	1.294	1.5291
			Carbon monoxide	0.781	0.9673
			Gas, illuminating	.028-.036	0.35-0.45
			Gas, natural	.038-.039	0.47-0.48
			Hydrogen	0.0559	0.0693
			Nitrogen	0.784	0.9714
			Oxygen	0.892	1.1056

The specific gravities of solids and liquids refer to water at 4° C, those of gases to air at 0° C and 760 mm pressure. The weights per cubic foot are derived from average specific gravities, except where stated that weights are for bulk, heaped, or loose material, etc.

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**Table 17-12.
Weights and Specific Gravities**

Substance	Weight lb per cu ft	Specific Gravity	Substance	Weight lb per cu ft	Specific Gravity
ASHLAR, MASONRY			MINERALS		
Granite, syenite, gneiss	165	2.3-3.0	Asbestos	153	2.1-2.8
Limestone, marble	160	2.3-2.8	Barytes	281	4.50
Sandstone, bluestone	140	2.1-2.4	Basalt	184	2.7-3.2
			Bauxite	159	2.55
MORTAR RUBBLE			Borax	109	1.7-1.8
Granite, syenite, gneiss	155	2.2-2.8	Chalk	137	1.8-2.6
Limestone, marble	150	2.2-2.6	Clay, marl	181	2.9
Sandstone, bluestone	130	2.0-2.2	Dolomite	159	2.5-2.6
			Feldspar, orthoclase	175	2.4-2.7
DRY RUBBLE MASONRY			Gneiss, serpentine	175	2.5-3.1
Granite, syenite, gneiss	130	1.9-2.3	Granite, syenite	187	3.0
Limestone, marble	125	1.9-2.1	Greenstone, trap	187	2.5-3.1
Sandstone, bluestone	110	1.8-1.9	Gypsum, alabaster	159	2.3-2.8
			Hornblende	187	3.0
BRICK MASONRY			Limestone, marble	165	2.5-2.8
Pressed brick	140	2.2-2.3	Magnetite	187	3.0
Common brick	120	1.8-2.0	Phosphate rock, apatite	200	3.2
Soft brick	100	1.5-1.7	Porphyry	172	2.6-2.9
			Pumice, natural	40	0.37-0.90
CONCRETE MASONRY			Quartz, flint	165	2.5-2.8
Cement, stone, sand	144	2.2-2.4	Sandstone, bluestone	147	2.2-2.5
Cement, slag, etc.	130	1.9-2.3	Shale, slate	175	2.7-2.9
Cement, cinder, etc.	100	1.5-1.7	Soapstone, talc	169	2.6-2.8
VARIOUS BUILDING MATERIALS			STONE, QUARRIED, PILED		
Ashes, cinders	40-45	—	Basalt, granite, gneiss	96	—
Cement, portland, loose	90	—	Limestone, marble, quartz	95	—
Cement, portland, set	183	2.7-3.2	Sandstone	92	—
Lime, gypsum, loose	53-64	—	Shale	92	—
Mortar, set	103	1.4-1.9	Greenstone, hornblende	107	—
Slags, bank slag	67-72	—			
Slags, bank screenings	98-117	—	BITUMINOUS SUBSTANCES		
Slags, machine slag	96	—	Asphaltum	81	1.1-1.5
Slags, slag sand	49-55	—	Coal, anthracite	97	1.4-1.7
			Coal, bituminous	84	1.2-1.5
EARTH, ETC., EXCAVATED			Coal, lignite	78	1.1-1.4
Clay, dry	63	—	Coal, peat, turf, dry	47	0.65-0.85
Clay, damp, plastic	110	—	Coal, charcoal, pine	23	0.28-0.44
Clay and gravel, dry	100	—	Coal, charcoal, oak	33	0.47-0.57
Earth, dry, loose	76	—	Coal, coke	75	1.0-1.4
Earth, dry, packed	95	—	Graphite	131	1.9-2.3
Earth, moist, loose	78	—	Paraffin	56	0.87-0.91
Earth, moist, packed	96	—	Petroleum	54	0.87
Earth, mud, flowing	108	—	Petroleum, refined	50	0.79-0.82
Earth, mud, packed	115	—	Petroleum, benzine	46	0.73-0.75
Riprap, limestone	80-85	—	Petroleum, gasoline	42	0.66-0.69
Riprap, sandstone	90	—	Pitch	69	1.07-1.15
Riprap, shale	105	—	Tar, bituminous	75	1.20
Sand, gravel, dry, loose	90-105	—			
Sand, gravel, dry, packed	100-120	—	COAL AND COKE, PILED		
Sand, gravel, wet	118-120	—	Coal, anthracite	47-58	—
			Coal, bituminous, lignite	40-54	—
EXCAVATIONS IN WATER			Coal, peat, turf	20-26	—
Sand or gravel	60	—	Coal charcoal	10-14	—
Sand and gravel and clay	65	—	Coal coke	23-32	—
Clay	80	—			
River mud	90	—			
Soil	70	—			
Stone riprap	65	—			

The specific gravities of solids and liquids refer to water at 4° C, those of gases to air at 0° C and 760 mm pressure. The weights per cubic foot are derived from average specific gravities, except where stated that weights are for bulk, heaped, or loose material, etc.

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Table 17-13.
Weights of Building Materials

Materials	Weight lb per sq ft	Materials	Weight lb per sq ft
CEILING		PARTITIONS	
Channel suspended system	1	Clay tile	17
Lathing and plastering	See Partitions	3 in.	18
Acoustical fiber tile	1	4 in.	28
		6 in.	34
		8 in.	40
		10 in.	
FLOORS		Gypsum block	
Steel deck	See Manufacturer	2 in.	9 1/2
		3 in.	10 1/2
Concrete-Reinforced 1 in.		4 in.	12 1/2
Stone	12 1/2	5 in.	14
Slag	11 1/2	6 in.	18 1/2
Lightweight	6 to 10	Wood studs 2x4	
		12-16 in. o.c.	
Concrete-Plain 1 in.		Steel partitions	
Stone	12	Plaster 1 in.	
Slag	11	Cement	
Lightweight	3 to 9	Gypsum	
		Lathing	
Fills 1 inch		Metal	
Gypsum	6	Gypsum board 1/2 in.	1/2
Sand	8		2
Cinders	4		
Finishes			
Terrazzo 1 in.	13	WALLS	
Ceramic or Quarry Tile 3/4-in.	10	Brick	40
Linoleum 1/4-in.	1	4 in.	80
Mastic 3/4-in.	9	8 in.	120
Hardwood 7/8 in.	4	12 in.	
Softwood 3/4-in.	2 1/2	Hollow concrete block	
		(Heavy aggregate)	
ROOFS		4 in.	30
Copper or tin	1	6 in.	43
Corrugated steel	See Manufacturer	8 in.	55
3-ply ready roofing	1	12 1/2 in.	80
3-ply felt and gravel	5 1/2	Hollow concrete block	
5-ply felt and gravel	6	(Light aggregate)	
		4 in.	21
Shingles		6 in.	30
Wood	2	8 in.	38
Asphalt	3	12 in.	55
Clay tile	9 to 14	Clay tile (Load bearing)	
Slate 1/4 in.	10	4 in.	25
		6 in.	30
Sheathing		8 in.	33
Wood 3/4 in.	3	12 in.	45
Gypsum 1 in.	4	Stone 4 in.	55
		Glass block 4 in.	18
Insulation 1 in.		Window, Glass, Frame, & Sash	
Loose	1/2	Curtain walls	8
Poured	2	Structural glass 1 in.	15
Rigid	1 1/2	Corrugated Cement Asbestos 1/4 in.	3

For weights of other materials used in building construction, see Table 17-12.

Table 17-14.
Weights and Measures
United States System

LINEAR MEASURE			
Inches	Feet	Yards	Miles
1.0 =	.08333 =	.02778 =	.0001578 =
12.0 =	1.0 =	.33333 =	.0011939 =
36.0 =	3.0 =	1.0 =	.0035818 =
198.0 =	16.5 =	5.5 =	.003125 =
7,920.0 =	660.0 =	220.0 =	1.0 =
63,360.0 =	5,280.0 =	1,760.0 =	8.0 =
		320.0 =	1.0 =

SQUARE AND LAND MEASURE			
Sq. Inches	Square Feet	Square Yards	Square Rods
1.0 =	.006944 =	.000772 =	
144.0 =	1.0 =	1.11111 =	
1,296.0 =	9.0 =	1.0 =	.03306 =
39,204.0 =	272.25 =	30.25 =	1.0 =
	43,560.0 =	4,840.0 =	160.0 =
		3,097,600.0 =	102,400.0 =
			640.0 =
			1.0 =
			.000098 =
			.0015625 =
			1.0 =

AVOIRDUPOIS WEIGHTS			
Grains	Drams	Ounces	Tons
1.0 =	.06657 =	.002286 =	.0000000714 =
27.34375 =	1.0 =	.0625 =	.0000195 =
437.5 =	16.0 =	1.0 =	.0625 =
7,000.0 =	256.0 =	16.0 =	1.0 =
14,000,000.0 =	512,000.0 =	32,000.0 =	2,000.0 =
			1.0 =

DRY MEASURE			
Pints	Quarts	Pecks	Bushels
1.0 =	.5 =	.0625 =	.01945 =
2.0 =	1.0 =	.125 =	.03125 =
16.0 =	8.0 =	1.0 =	.3112 =
51.42827 =	25.71314 =	3.21414 =	1.0 =
64.0 =	32.0 =	4.0 =	1.2445 =
			1.0 =

LIQUID MEASURE			
Gills	Pints	Quarts	U.S. Gallons
1.0 =	.25 =	.125 =	.03125 =
4.0 =	1.0 =	.5 =	.125 =
8.0 =	2.0 =	1.0 =	.250 =
32.0 =	8.0 =	4.0 =	1.0 =
			7.48052 =
			1.0 =

Example 1

Determine the controlling load combinations(s) using AISC-LRFD for a building column subject to the following service or nominal (unfactored) axial compressive loads: $D = 30$ k, $L = 50$ k, $L_r = 10$ k, $W = 25$ k, $E = 40$ k

Using a spreadsheet analysis:

LRFD (ASCE-7)	FACTORED LOAD
$1.4D$	
$1.4D$	= 42 kips
$1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$	
$1.2D + 1.6L + 0.5L_r$	= 121
$1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$	
$1.2D + 1.6L_r + L$	= 102
$1.2D + 1.6L_r + 0.5W$	= 64.5
$1.2D + 1.6L_r - 0.5W$	= 39.5
$1.2D + 1.0W + L + 0.5(L_r \text{ or } S \text{ or } R)$	
$1.2D + 1.0W + L + 0.5L_r$	= 116
$1.2D - 1.0W + L + 0.5L_r$	= 66
$1.2D + 1.0E + L + 0.2S$	
$1.2D + 1.0E + L$	= 126
$1.2D - 1.0E + L$	= 46
$0.9D + 1.0W$	
$0.9D + 1.0W$	= 52
$0.9D - 1.0W$	= 2
$0.9D + 1.0E$	
$0.9D + 1.0E$	= 67
$0.9D - 1.0E$	= -13
Critical Factored Load	126 kips (C) -13 kips (T)

Example 2

EXAMPLE 2-4

Determine factored loads for the beam shown in Figure 2-16.

Solution

For the left half of the beam:

$$w_{u1} = 1.2w_D + 1.6w_L$$

$$w_{u1} = 1.2 \times 1.0 + 1.6 \times 2.0 = 4.4 \text{ kip/ft}$$

For the right half of the beam:

$$w_{u2} = 1.2w_D + 1.6w_L$$

$$w_{u2} = 1.2 \times 1.0 + 1.6 \times 0 = 1.2 \text{ kip/ft}$$

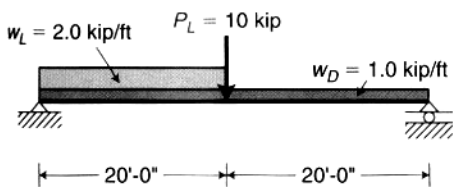


FIGURE 2-16 Example 2-4 (service loads).

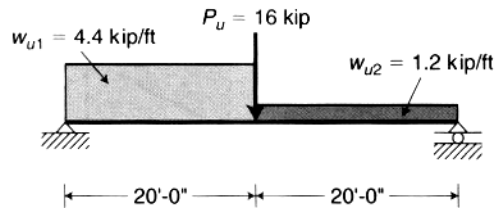


FIGURE 2-17 Example 2-4 (factored loads).

The concentrated load is a live load only:

$$P_u = 1.2P_D + 1.6P_L$$

$$P_u = 1.2 \times 0 + 1.6 \times 10 = 16 \text{ kip}$$

The factored loads on the beam are shown in Figure 2-17.