Common Design Loads in Building Codes

= name for area R = rainwater load or ice water load AASHTO = American Association of State symbol Highway and Transportation S = snow load symbol SEI = Structural Engineering Institute Officials *ASCE* = American Society of Civil = name for thickness T**Engineers** = effect of material & temperature ASD = allowable stress design symbol = dead load symbol V= name for volume D

E = earthquake load symbol E = hydraulic loads from fluids

F = hydraulic loads from fluids symbol
 H = hydraulic loads from soil symbol

L = live load symbol L_r = live roof load symbol

LRFD = load and resistance factor design

w =name for distributed load

W = wind load symbol = force due to a weight

= name for total force due to

distributed load

 γ = density or unit weight

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

Notation:

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 = tA; so the calculation becomes:

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

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

 $w = (weight/unit\ volume) \cdot A$ which is a weight per unit <u>length</u>

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

Location	Concentrated load lb (kN)
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	
Skeleton structure with fabric	300 (1.33)
Support frame with screen enclosure	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. When wind loads are involved, the allowable stresses are typically allowed to increase by 1/3. The allowed stresses are some fraction of limit stresses.

ASCE-7 (2010) combinations of loads:

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

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
2. $1.2D + 1.6L + 0.5(L_r \ or \ S \ or \ R)$	included with the same load factor as
3. $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$	dead load D in 1 through 5 and 7.
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
6. $0.9D + 1.0W$	a load factor of 1.6 when adding to load
7. $0.9D + 1.0E$	effect, or 0.9 when resisting the load when
	permanent.

Minimum Uniformly Distributed Live Loads

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

Location	Uniform load psf (kN/m²)
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 and theaters	
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)
- -	

Location	Uniform load psf (kN/m^2)
Balconies and decks	1.5 times the live load for th
	occupancy served. Not
	required`to exceed 100 psf
	(4.79 kN/m2)
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.	300 (1.33)
(50 mm by 50 mm))	
Finish light floor plate construction (on area of 1 in. by 1 in.	200 (0.89)
(25 mm by 25 mm))	200 (0.05)
Fire escapes	100 (4.79)
On single-family dwellings only	40 (1.92)
Garages	40 (1.72)
	40 (1.02)
Passenger vehicles only	40 (1.92)
Helipads	60 (2.87)
Hospitals	60 (2.87)
Operating rooms, laboratories	60 (2.87)
Patient rooms	40 (1.92)
Corridors above first floor	80 (3.83)
Hotels (see Residential)	
Libraries	10 (2 07)
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)
	10 (1.72)
	i e e e e e e e e e e e e e e e e e e e
All other residential occupancies	40 (1.92)
	40 (1.92) 100 (4.79)

Location	Uniform load psf (kN/m^2)
Roofs	
Ordinary flat, pitched, and curved roofs	20 (0.96n
Roofs used for roof gardens	100 (4.79)
Roofs used for assembly purposes	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 applied to the roof frame
	members only, not the screen
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.

	Weig	hts and Specific Gra	rable 17-12 (cont.). Weights and Specific Gravities		
Substance	Weight Ib per cuft	Specific	Substance	Weight Ib per cu ft	Specific Gravity
METALS, ALLOYS, ORES Aluminum, cast, hammered	165	2.55–2.75	TIMBER, U.S. SEASONED Moisture content by weight:		
Brass, cast, rolled	534	8.4–8.7	Seasoned timber 15 to 20% Green timber up to 50%		
Bronze, aluminum	481	7.7	Ash, white, red	9 6	0.62-0.65
Copper, cast, rolled	556 262	8.8-9.0 4.1-4.3	Cedar, white, red	2 4	0.66
Gold, cast, hammered	1205	19.25-19.3	Cypress	8 3	0.48
:	450	7.2	Fir, Douglas spruce	32	0.51
Iron, wrought	468	7.5	Elm, white	45	0.72
Iron, ferro-silicon	437	6.7-7.3	Hemlock	59	0.42-0.52
Iron ore, hematite	325	5.2	Hickory	49	0.74-0.84
Iron ore, hematite loose	130-160	1 1	Maple, hard	5 4	0.68
Iron ore, limonite	237	3.6-4.0	Maple, white	33	0.53
Iron ore, magnetite	315	4.9–5.2	Oak, chestnut	54	0.86
Iron slag	710	11.37	Oak, live	56 14	0.65
Lead ore, galena	465	7.3–7.6	Oak, white	46	0.74
Magnesium, alloys	112	1.74-1.83	Pine, Oregon	32	0.51
Manganese	475	7.2–8.0	Pine, red	oe 90	0.48
Mangarlese ore, pyrolusing	849	13.6	Pine, vellow, long-leaf	44	0.70
Monel Metal	556	8.8-9.0	Pine, yellow, short-leaf	. 88	0.61
Nickel	565	8.9-9.2	Poplar	30	0.48
Platinum, cast, hammered .	1330	21.1–21.5	Redwood, California	26	0.42
Steel rolled	490	7.85	Spruce, white, plack	38 8	0.61
Tin, cast, hammered	459	7.2–7.5	Walnut, white	26	0.41
Tin ore, cassiterite	418	6.4-7.0			
Zinc, cast, rolled	253	39-42			
	3				
			VARIOUS LIQUIDS		
			Alcohol, 100%	49	0.79
			Acids, muriatic 40%	25	1.20
VARIOUS SOLIDS			Acids, nitric 91%	112	1.80
Cereals, oatsbulk	32		Lve. soda 66%	106	1.70
	39	ı	Oils, vegetable	58	0.91-0.94
:	48	ı	Oils, mineral, lubricants	57	0.90-0.93
Cereals, wheat bulk	84 6		Water, 4°C max. density	59.830	0.9584
emp	3 8	1.47-1.50	Water, ice	26	0.88-0.92
Fats	28	0.90-0.97	Water, snow, fresh fallen	ω ;	.125
Flour, loose	28	0.40-0.50	Water, sea water	40	1.02-1.03
Glass, common	156	2.40-2.60			
Glass, plate or crown	161	2.45–2.72			
Glass, crystal	184	2.90-3.00	SASES		
Paper	28 8	0.70-1.15	Air, 0°C 760 mm	.08071	1.0
Potatoes, piled	45	ı	Ammonia	.0478	0.5920
Rubber, caoutchouc	29	0.92-0.96	Carbon dioxide	.1234	1.5291
Rubber goods	94	1.0-2.0	Carbon monoxide	18/0.	0.96/3
Salt, granulated, piled	84 6		Gas, illuminating	028036	0.35-0.45
Starch	96	1.53	Hydrogen	.00559	0.0693
	125	1.93-2.07	Nitrogen	.0784	0.9714
Wool	85	1.32	Oxygen	.0892	1.1056
			Control Court in the Court in t		1
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The specific gravities of solids and liquids refer to water at 4°C, those of gases to air at 0°C and 760 mm pressi	weights per cubic foot are derived from average specific gravities, except where stated that weights are for bulk,	
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AMERICAN INSTITUTE OF STEEL CONSTRUCTION

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155 22-28 Bauxile 159	Sandstone bluestone	140	0 1-0 4		107	4.50
155 2.2-2.8 Clay, mart 197			i		104	2.7-3.2
155 2.2-2.8 Chaik 137 150 150 2.2-2.6 Chaik 130 2.0-2.2 Chaik 137 150 2.0-2.2 Chaik 130 2.0-2.2 Chaik 130 1.9-2.3 Chaiks, serpentine 159 150 1.9-2.1 Chaiks, serpentine 175 17	IORTAR RUBBLE				000	2.55
155 22-2.8 Clay, mat 157 150 22-2.8 Clay, mat 157 150 20-2.2 Gravis, serpentine 181 151 19-2.3 Gravitis, serpentine 185 152 19-2.1 Gravitis, serpentine 187 153 19-2.3 Gravitis, serpentine 187 140 22-2.3 Phosphate rock, apatite 187 150 18-2.0 Phorphyry 172 150 18-2.0 Phorphyry 172 150 15-1.7 Phorise, hat will 140 15-1.7 Phorise, hat will 140 15-1.7 Phorise, hat will 141 150 15-2.3 Shale, siate 175 150 15-1.7 Shale, siate 175 150 16-1.0 Shale, siate 175 160 16-1.0 Shale, siate 175 170 170 Shale, siate 175 181 192 Shale, siate 175 198 14-1.0 Greenstone, harringer 181 100	MASONRY			Chalk	137	1.7-1.8
150 2.2-2.6 Polomite 181	Granite, syenite, gneiss	155	2.2-2.8	Clay. marl	137	1.8-2.6
130 2.0-2.2 Greatest, seprentine 159 130 1.9-2.3 Grande, spentine 159 150 1.9-2.1 Grande, spentine 159 151 1.9-2.1 Grande, spentine 159 152 1.9-2.1 Gypsum, alabaster 187 140 1.8-2.0 Principhyry 172 150 1.5-1.7 Pumice natural 40 1.5-1.7 Pumice natural 40 1.5-1.7 Pumice natural 40 1.5-1.7 Pumice natural 40 1.5-1.7 Shale, state 175 130 1.5-1.7 Shale, state 175 141 2.2-2.4 Shale, state 175 150 1.5-1.7 Shale, state 175 150 1.5-1.7 Shale, state 175 160 1.5-1.7 Shale, state 107 161 1.5-1.7 Shale, state 107 162 1.5-1.7 Shale, state 107 163 1.5-1.7 Shale, state 107 164 1.5-1.7 Shale 107 165 1.5-1.7 Shale 107 166 1.5-1.7 Shale 107 167 1.5-1.7 Shale 107 168 1.5-1.7 Shale 107 170 1.5-1.7 Sha	Limestone, marble	150	2.2-2.6	Dolomite	181	8-2.6
130 1.9-2.3 Graetis, serpentine 159 130 1.9-2.3 Graenis, syeride 175 140 1.8-2.0 Hornbende 159 140 2.2-2.3 Hornbende 155 150 1.8-2.0 Hornbende 155 150 1.8-2.0 Hornbende 155 150 1.9-2.3 Phosphate rock, apatite 155 141 2.2-2.4 Shale, siate 175 150 1.5-1.7 Phomice, natural 140 150 1.5-1.7 Phomice, natural 140 150 1.5-1.7 Shale, siate 175 160 1.5-1.7 Shale, siate 175 170 1.5-1.7 Shale, siate 175 180 1.5-1.7 Shale, siate 175 190 1.5-1.7 Shale, siate 175 100 1.5-1.7 Shale, siate 175 100 1.5-1.7 Shale, siate 175 110 1.5-1.7 Shale, siate 175 111 1.5-1.7 Shale, siate 175 112 1.5-1.7 Shale, siate 175 113 1.5-1.7 Shale, siate 175 114 1.5 1.5 1.5 1.5 115 1.5 1.5 1.5 1.5 115 1.5	Sandstone, bluestone	130	2.0-2.2	Feldspar, orthoclase	159	6.5
130 13-2.3 Granife, syenife 175 125 1.9-2.1 Granife, syenife 175 126 1.9-2.1 Granife, syenife 187 140 1.8-2.0 Porphy, and sibaster 187 150 1.8-2.0 Porphy or cox, apatie 187 150 1.5-1.7 Pumice, natural 165 150 1.9-2.3 Porphy, and a cox, apatie 175 150 1.9-2.3 Pomice, natural 147 150 1.9-2.3 Shale, siate 175 150 1.9-2.3 Shale, siate 175 150 1.5-1.7 Sandstone, indestone 147 150 1.5-1.7 Sandstone 169 150 1.5-1.7 Sandstone 169 160 1.5-1.7 Sandstone 169 170 1.4-1.9 Greenstone, indeed 169 171				Gneiss, serpentine	159	97-5.6
130 19-23 Greenstone, trap 187 110 18-21 Gypsum, alabaster 189 110 18-20 Hondlende 187 110 18-20 Phosphate rock, apatite 187 120 18-20 Phosphate rock, apatite 200 15-17 Pumies intural 117 144 22-24 Shale, side 175 150 15-23 Soapstone, tac 175 150 15-13 Soapstone, tac 188 150 15-13 Soapstone, tac 189 160 15-17 Shale, side 175 161 162 163 162 163 164 175 163 164 165 165 164 165 165 165 165 165 165 165 166 167 167 165 167 168 167 167 168 169 160 167 168 169 160 167 169 160 160 160 160	RY RUBBLE MASONRY			Granite, syenite	175	25.20
125 19-2.1 Gypsum, alabaster 159 140 1.8-1.2 Hornberde 155 140 2.2-2.3 Phorsphete rock, apatter 155 150 1.8-2.0 Prorphyry 172 150 1.9-2.3 Phorsphete rock, apatter 175 151 144 2.2-2.4 Shade, side 147 152 1.9-2.3 Sandstone, bluestone 147 153 1.9-2.3 Sandstone, talc 165 154 2.2-2.4 Shade, side 175 150 1.5-1.7 Shade, side 175 150 1.5-1.7 Shade, side 175 150 1.4-1.9 Greenstone, talc 169 157 169 175 160 1.5-1.7 Shade, side 175 160 1.5-1.7 Shade, side 175 161 162 Sandstone 175 162 1.4-1.9 Greenstone, talc 169 163 2.7-3. Shade, side 169 164 165 Shade 175 165	Granite, syenite, gneiss	130	1.9-2.3	Greenstone, trap	187	28-33
110 18-19 Horblende 165	Limestone, marble	125	1.9-2.1	Gypsum, alabaster	159	23-28
140 22-23 Priosphale marble 155 120 18-20 Priosphale rock, apatite 167 120 18-20 Priosphale rock, apatite 167 144 22-24 Priosphale rock, apatite 200 15-17 Pumice, natural 40 15-18 Pumice, natural 40 15-19 Pumice, natural 40 15-17 Pumice, natural 40 15-18 Sandstone 175 100 15-17 Shale, siate 175 113 27-32 Shale, siate 175 103 14-19 Srower 166 175 104 -2 Shale 107 105 -2 Shale 107 106 -2 Shale 107 110 -2 Shale 107 110 -3 Shale 107 110 -3 Shale 107 110 -4 Coal, lightle 107 110 -5 Coal, charcoal, oak 23 111 Patroleum, inclined 131 112 -4 Petroleum, perzine 46 100-120 Petroleum, merrine 46 100-120 Petroleum, merrine 46 100-120 Coal, bituminous 107 118-120 Coal, bituminous 107 119-120 Coal, bituminous 107 119-120 Coal (oke 107 110-120 Coal (oke 107 110-120 Coal (oke 107 110-1	Sandstone, bluestone	011	9.1–8.1	Hornblende	187	3.0
140 2.2-2.3 Phosphate rock, apatite 187 120 1.8-2.0 Prosphyty 172 141 2.2-2.4 Sandstone, bluestone 147 152 1.9-2.3 Sandstone, bluestone 147 153 1.9-2.3 Sandstone, bluestone 147 154 2.2-2.4 Shale, slate 175 156 1.9-2.3 Sandstone, pluestone 147 157 1.9-1.7 Shale, slate 175 158 2.7-3.2 Sandstone, marble, quartz 169 159 1.4-1.9 Greenstone, marble, quartz 169 159 1.4-1.9 Greenstone, marble, quartz 107 150 1.4-1.9 Greenstone, hornblende 107 150 1.9-5 Sandstone 107 150 1.9-5 Shale 107 150 1.9-5 Shale 107 150 1.9-5 Shale 107 150 1.9-5 Shale 117 150 1.9-5 118	200			Limestone, marble	165	2.5-2.8
120 1.5-7.3 Prosphale rock, spatile 120 1.5-7.7 Pumice, natural 140 1.5-1.7 Pumice, natural 141 12.2-2.4 Shale, siate 147 147 150 1.5-1.7 Shale, siate 147 147 150 1.5-1.7 Shale, siate 175 169 15-1.7 Shale, siate 175 169 15-1.7 Shale, siate 175 169 175 169 177 170	THE PROPERTY OF	,	0	iviagresite	18/	3.0
120 18-20 Purplyy, 172 18-20 18-20 Purplyy, 175 144 2.2-2.4 Shale, share blestone 147 190 1.9-23 Sandstone, bluestone 147 149 1.9-23 Sandstone, bluestone 147 140 1.9-23 Sandstone, bluestone 147 140 1.9-23 Sandstone, bluestone 147 140	Pressed brick	140	2.2-2.3	Phosphate rock, apatite	200	3.2
100 1,2-1,7	Common brick	120	1.8-2.0	Porphyry	172	2.6-2.9
144 2.2.2.4 Sandstrone 147 190 1.9-2.3 Sandstrone 147 190 1.9-2.3 Sandstrone 147 190 1.9-2.3 Sandstrone 147 177 190 1.4-1.9 Sandstrone 147 178 183 2.7-3.2 Shale, siate 175 183 2.7-3.2 Shale 14-1.9 Greenstrone, hornblende 107 103 1.4-1.9 Greenstrone, hornblende 107 108 100		3	7.1-6.	Pumice, natural	040	0.37-0.90
144 2.2-2.4 Shale state 175 179 190 1.9-2.3 Soapstone, talc 175 175 190 1.5-1.7 190 1.5-1.7 190 1.5-1.7 190 1.5-1.7 190 1.5-1.7 190 1.4-1.9 190 1.4-1.9 190 19	ONCRETE MASONRY			Sandstone bliestone	24	2.5-2.8
130 1.9-2.3 Soapstone, talc 169	Cement stone sand	144	2 2-2 4	Shale slate	175	6.2-2.5
100 1,5-1,7 STONE, CUARRIED, PILED Basals, grante, greess 96 16-9,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16-1,7 163 16	Cement, slag, etc.	130	19-23	Soapstone talc	169	0.7-7-2
STONE_GUARRIED, PILED 96 90 90 90 90 90 90 90	Cement, cinder, etc.	100	1.5-1.7			0.3
STONE, GUARRIED, PILED 96						
State Stat	ARIOUS BUILDING					
183 27-32 Sandstin, galanting and the part of th	MAIERIALS	ļ		STONE, QUARRIED, PILED		
183 2.7-3 Characterin marble, quartz 53-64 53-64 1.4-1.9 Greenstone, hornblende 92 67-72 1.4-1.9 Greenstone, hornblende 107 96 49-55	Asnes, cinders	£ 65	i i	Basalt, granite, gneiss	96	ı
14-19 Greenstone, homblende 107	Compart portland set	183	0 1 0	Sandstone, marbie, quartz	000	ı
103	lime cureum loces	8 6	4.0	2	200	ı
Section Sect	Mortar set	103	1 4-1 0	Greenstone hornhlande	307	1
BITUMINOUS SUBSTANCES 96-117	Slads, bank slad	67-72			}	
Second S	Slads, bank screenings	98-117	1			
49-55	Slags, machine slag	96	1			
Asphaltum 81 63 - Coal, anthracite 97 100 - Coal, ignile 78 100 - Coal, clart unf dry 78 76 - Coal, chart unf dry 77 78 - Coal, charcoal, pine 23 95 - Coal, charcoal, oak 33 78 - Coal, charcoal, oak 35 80 - Graphite 131 115 - Parriellem 54 80 - Petroleum, refined 50 90 - Petroleum, penzine 42 105 - Petroleum, penzine 46 106 - Petroleum, gasoline 42 106 - Pitch Pitch 69 100-105 - Pitch 69 100-120 - Tar, bituminous 75 118-120 - Coal, bituminous, lightle 40-54 90 - Coal, bituminous, lightle 20-26 70 - Coal, coal, petrocoal 10-14 80 - Coal, coal, petrocoal 10-14	Slags, slag sand	49-55	1	BITUMINOUS SUBSTANCES		
Coal, anthractie 97 110 Coal, bituminous 84 110 Coal, peat, furf, dry 47 76 Coal, charcoal, oine 23 95 Coal, charcoal, oine 33 78 Coal, charcoal, oine 33 96 Coal, charcoal, oine 75 90 Pardin 131 90 Pardin 56 90 Petroleum, perzine 46 90 Petroleum, perzine 46 90 Petroleum, gascline 46 90 Petroleum, gascline 46 100 Petroleum, gascline 46 90 Petroleum, gascline 46 100 Petroleum, gascline 46 100 Petroleum, gascline 46 100 Petroleum, gascline 46 90 Coal, chartiminous				Asphaltum	81	1.1-1.5
100	ARTH, ETC., EXCAVATED				26	1.4-1.7
100	Clay, dry	63	1	Coal, bituminous	84	1.2-1.5
100	Clay, damp, plastic	110	1	Coal, lignite	78	1.1-1.4
76	Clay and gravel, dry	100	ı	Coal, peat, turf, dry	47	0.65-0.85
78	Earth, dry, loose	9/	1.308.1	Coal, charcoal, pine	23	0.28-0.44
78 - Coal, coke 75 108 - Graphite 131 115 - Petroleum 54 80-85 - Petroleum, petroleum 54 90-105 - Petroleum, pascline 46 100-120 - Petroleum, pascline 46 100-120 - Petroleum, pascline 46 100-120 - Petroleum, pascline 46 118-120 - Petroleum, pascline 46 118-120 - Petroleum, pascline 47 118-120 - Tar, bituminous 77 118-120 - Coal, anthiractie 47-58 65 - Coal, anthiractie 40-54 90 - Coal, bituminous, lightle 20-26 70 - Coal, coal, turi 190-14 80 - Coal, peat, turi 190-14 80 - Coal, peat, turi 190-14 80 - Coal, peat, turi 190-14 80 - Coal charcoal 190-14	Earth, dry, packed	92	1	Coal, charcoal, oak	33	0.47-0.57
196	Earth, moist, loose	78	,	Coal, coke	75	1.0-1.4
118	Earth, moist, packed	96	1	Graphite	131	1.9-2.3
115	Earth, mud, flowing	108	ı	Paraffin	26	0.87-0.91
80-85	Earth, mud, packed	115	1	Petroleum	54	0.87
105	Riprap, limestone	80-85	ı	Petroleum, refined	20	0.79-0.82
105	Riprap, sandstone	06	1	Petroleum, benzine	46	0.73-0.75
90–105 – Plitch 69 110–120 – Tar, bituminous 75 118–120 – COAL AND COKE, PILED 75 COAL AND COKE, PILED 47–58 65 – COAI, bituminous, lignite 40–54 90 – COAI, peat, tuf 20–26 70 – COAI charroal 10–14 65 – COAI charroal 23–32	Riprap, shale	105	1	Petroleum, gasoline	42	0.66-0.69
100-120	Sand, gravel, dry, loose	90-105	ı	Pitch	69	1.07-1.15
60 - COAL AND COKE, PILED 65 - Coal, anthracite 47–58 70 - Coal operaturinous, lignite 20–26 70 - Coal operaturi 10–14 70 - Coal operaturi 10–14 65 - Coal oracose 23–32	Sand, gravel, dry, packed	100-120	ı	Tar, bituminous	75	1.20
60 COAL AND COKE, PILED 65 Coal, anthracite 40-54 80 Coal, bituminous, lignite 40-54 90 Coal, peat, furf 20-26 70 Coal charcoal 10-14 70 Coal coke 23-32		118-120	ı			
60 - COAL AND COKE, PILED 65 - Coal, anthracite	CAVATIONS IN WATER					
or gravel and clay 65 - Coal, anthraction 47–58 (20-26) - Coal, bituminous, lightle 20–26 (20-26) - Coal charcost 10–14 (20–26) - Coal coal coal coal coal coal coal coal c	Sand or grave	09		COAL AND COKE BILED		
Coal bituminous, lignite 40-54 Audition Auditio	Sand or gravel and clay	65	ı	Coal, anthracite	47-58	1
mud	Clay	80	ı	Coal, bituminous, lignite	40-54	١
riprisp. 70 - Coal charcoal 10–14 10–14 55 - Coal coke 23–32	River mud	06	,	Coal, peat, turf	20-26	١
	Soil	70	1	Coal charcoal	10-14	ı
	Stone riprap	92	,	Coal coke	23-32	1

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RICAN
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Table 17-14. Weights and Measures United States System	LINEAR MEASURE	Inches Feet Yards Rods Fullongs Miles 1.0 0.8333 0.2778 0.005656 0.0001828 0.0001578 1.2.0 1 0 3.3333 0.060661 0.001839 36.0 3.0 1 0 1.0 0.001839 36.0 1 0 1.0 0.001839 0.001839 36.0 1 0 1.0 0.001829 0.001839 7.920.0 1 0 2.2 0.0 0 0.001829 7.920.0 5.280.0 2.2 0 0 0 0.00182 63.360.0 5.280.0 1.760.0 8.0 1.0 0 1.15	SQUARE AND LAND MEASURE Sq. Inches Square Feet Square Yards Square Rods Acres Sq. Miles	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	AVOIRDUPOIS WEIGHTS	Grains Drams Ounces Pounds Tons 1.0 1.0 .00657 = .002286 = .000143 = .000000714 27.34375 = 1.0 1.0 = .06256 = .00306 = .00000195 437.5 1.0 = 1.0 = .0625 = .00000195 7.000.0 = 256.0 = 16.0 = 1.0 = .0005 14,000,000.0 = 512,000.0 = 22,000.0 = 2.000.0 = 1.0	DRY MEASURE	Oubic Pints Quarts Pecks Feet Bushels	1.0 = .5 = .0625 = .01945 = .01563 2.0 = 1.0 = .125 = .03891 = .03125 16.0 = 8.0 = 1.0 = .31112 = .25 51.42627 = 25.71314 = 3.21414 = 1.0 64.0 = 32.0 = 4.0 = 1.2445 = 1.0		CAOLD MEASURE CAOLD CABC Gills Prins Quarts Gallons Feet	= .25 = .125 = .03125 = = 1.0 = .5 = .125 = = 2.0 = 1.0 = .250 = = 8.0 = 4.0 = 1.0 = 7.48052 = 1.
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Materials	Weight Ib per sq ft	Materials	Weight b per se 4
CEILINGS		PARTITIONS	F 52
Channel suspended system	- ;	Clay tile	, i
Latning and plastering	See Partitions	3in.	17
Acoustical liber tile	_	4 ID.	18
			28
		101	34
FLOORS		Gvosum block	40
Steel deck	See Manufacturer	2 in.	ī
		3 in.	101/2
Concrete-Reinforced 1 in.		4 in.	121/2
Stone	121/2	5 in.	14
Slag	111/2	6 in.	181/2
Lightweight	6 to 10	Wood studs 2×4	
		12-16 in. o.c.	2
Concrete-Plain 1 in.		Steel partitions	4
Stone	12	Plaster 1 in.	
Slag	F	Cement	10
Lightweight	3 to 9	Gypsum	2
		Lathing	
Fills 1 inch		Metal	1/2
Gypsum	9	Gypsum board 1/2 in.	2
Sand	80		
Cinders	4		
Finishes			
Terrazzo 1 in.	13		
Ceramic or Quarry Tile 3/4-in.	10	WALLS	
Linoleum 1/4-in.	-	Brick	
Mastic 3/4-in.	6	4 in.	40
Hardwood 7/8-in.	4	8 in.	80
Softwood 3/4-in.	21/2	12 in.	120
		Hollow concrete block	
		(Heavy aggregate)	;
STOOM STOOM	•		Q. S
Comment of the	Con Manufacture	. I.	5 1
3-ply ready roofing	See Mariulactuer	0 III.	o 6
3-ply felt and gravel	. 15	Hollow concrete block	3
5-ply felt and gravel	7 9	(Light aggregate)	
		4 in.	21
Shingles		6 in.	30
Wood	2	8 in.	38
Asphalt	က	12 in.	92
Clay tile	9 to 14	Clay tile (Load bearing)	
Slate 1/4 in.	9	4 in.	25
		6 in.	30
Sheathing	4	8 in.	
Wood 3/4 In.	m ·	12 in.	£ 1
Gypsum I In.	4	Stone 4 in.	22
Insulation 1 in		Mindow Glace Frame & Seeh	o «
Loose	1/2	Curtain walls	See Manufacturer
Poured	2 2	Structural class 1 in	15
7			•
pille	11/2	Corrugated Cement Asbestos 1/4 in.	ဇ

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 = 10 k, W = 25 k, E = 40 k

Using a spreadsheet analysis:

LRFD (ASCE-7) 1.4D 1.4D 1.2D + 1.6L + 0.5(L_r or S or R) 1.2D + 1.6L + 0.5L _r 1.2D + 1.6(L_r or S or R) + (L or 0.5W) 1.2D + 1.6(L_r or S or S) = 102
$ \begin{array}{rcl} 1.4D & = & 42 \text{ kips} \\ 1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R) & = & 121 \\ 1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W) & = & 121 \end{array} $
$1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$ $1.2D + 1.6L + 0.5L_r = 121$ $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (L \text{ or } 0.5W)$
$1.2D + 1.6L + 0.5L_r = 121$ $1.2D + 1.6(L_r or S or R) + (L or 0.5W)$
$1.2D + 1.6(L_r \ or \ S \ or \ R) + (L \ or \ 0.5W)$
1.2D + 1.6I + I - 102
$-1.2D + 1.0L_f + L = -102$
$1.2D + 1.6L_r + 0.5W = 64.5$
$1.2D + 1.6L_r - 0.5W = 39.5$
$1.2D + 1.0W + L + 0.5(L_r \ or \ S \ or \ R)$
$1.2D + 1.0W + L + 0.5L_r = 116$
$1.2D - 1.0W + L + 0.5L_r = 66$
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:

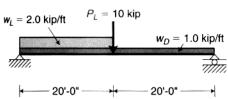
$$w_{u1} = 1.2w_D + 1.6w_L$$

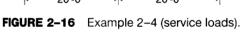
 $w_{u1} = 1.2 \times 1.0 + 1.6 \times 2.0 = 4.4 \text{ kip/ft}$

For the right half of the beam:

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

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





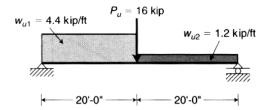


FIGURE 2-17 Example 2-4 (factored loads).

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.