WEIGHT OF MATERIALS (continued)
A.90

Ice	57.2
Gasoline	75
Snow	8
Water, fresh	62.4
Water, sea	64
GLASS	**PSF**
Polished plate, 1/4"	3.28
Polished plate, 1/2"	6.56
Double strength, 1/8"	26 oz
Sheet A, B, 1/32"	45 oz
Sheet A, B, 1/4"	52 oz
Insulated glazing 5/8" plate with air space	3.25
Wire glass, 1/4"	3.5
Glass block	18
INSULATION AND WATERPROOFING	**PSF**
Blanket per 1" thickness	0.1-0.4
Corkboard per 1" thickness	0.58
Foamed board insulation per 1" thickness	2.6 oz
Five-ply membrane	5
Board insulation	0.75
LIGHTWEIGHT CONCRETE	PSF
Concrete, aerocrete	50–80
Concrete, cinder fill	60
Concrete, expanded clay	85–100
Concrete, expanded shale-sand	105-120
Concrete, perlite	35–50
Concrete, pumice	60–90
METALS	**PCF**
Aluminum, cast	165
Brass, cast, rolled	534
Bronze, commercial	552
Bronze, statuary	509
Copper, cast or rolled	556
Gold, cast, solid	1205
Gold coin in bags	509
Iron, cast gray, pig	450
Iron, wrought	480
Lead	710
Nickel	565
Silver, cast, solid	656
Silver, coin in bags	590
Tin	459
Stainless steel, rolled	492–510
Steel, rolled, cold drawn	490
Zinc, rolled, cast or sheet	449
MORTAR AND PLASTER	**PCF**
Mortar, masonry	116
Plaster, gypsum, sand	104–120
PARTITIONS	**PSF**
2 × 4 wood stud, gypsum board , two sides	8
4" metal stud, gypsum board, two sides	6
4" concrete block, lightweight, gypsum board	26
6" concrete block, lightweight, gypsum board	35

2" solid plaster	20
4" solid plaster	32
ROOFING MATERIALS	**PSF**
Built up	6.5
Concrete roof tile	9.5
Copper	1.5–2.5
Corrugated iron	2
Deck, steel without roofing or insulation	2.2–3.6
Fiberglass panels (2 1/2" corrugated)	5–8 oz
Galvanized iron	1.2–1.7
Lead, 1/8"	6.8
Plastic sandwich panel, 2 1/2" thick	2.6
Shingles, asphalt	1.7–2.8
Shingles, wood	2–3
Slate, 3/16" to 1/4"	7–9.5
Slate, 3/8" to 1/2"	14–18
Stainless steel	2.5
Tile, cement flat	13
Tile, cement ribbed	16
Tile, clay shingle type	8–16
Tile, clay flat with setting bed	15–20
Wood sheathing per inch	3
SOIL, SAND, AND GRAVEL	**PCF**
Ashes or cinder	40–50
Clay, damp and plastic	110
Clay, dry	63
Clay and gravel, dry	100
Earth, dry and loose	76
Earth, dry and packed	95
Earth, moist and loose	78
Earth, moist and packed	96
Earth, mud, packed	115
Sand or gravel, dry and loose	90–105
Sand or gravel, dry and packed	100–120
Sand or gravel, dry and wet	118–120
Silt, moist, loose	78
Silt, moist, packed	98
STONE (ASHLAR)	**PCF**
Granite, limestone, crystalline	165
Limestone, oolitic	136
Marble	173
Sandstone, bluestone	144
Slate	172
STONE VENEER	**PSF**
2" granite, 1/2" parging	30
4" granite, 1/2" parging	59
6" limestone facing, 1/2" parging	55
4" sandstone or bluestone, 1/2" parging	49
1" marble	13
1" slate	14
STRUCTURAL CLAY TILE	**PSF**
4" hollow	23
6" hollow	38
8" hollow	45

STRUCTURAL FACING TILE	**PSF**
2" facing tile	14
4" facing tile	24
6" facing tile	34
8" facing tile	44
SUSPENDED CEILINGS	**PSF**
Mineral fiber tile 3/4", 12" * 12"	1.2–1.57
Mineral fiberboard 5/8", 24" * 24"	1.4
Acoustic plaster on gypsum lath base	10–11
WOOD	**PCF**
Ash, commercial white	40.5
Birch, red oak, sweet and yellow	44
Cedar, northern white	22.2
Cedar, western red	24.2
Cypress, southern	33.5
Douglas fir (coast region)	32.7
Fir, commercial white, Idaho white pine	27
Hemlock	28–29
Maple, hard (blacks and sugar)	44.6
Oak, white and red	47.3
Pine, northern white sugar	25
Pine, southern yellow	37.3
Pine, ponderosa, spruce: eastern and sitka	28.6
Poplar, yellow	29.4
Redwood	26
Walnut, black	38

To establish uniform practice among designers, it is desirable to present a list of materials generally used in building construction, together with their proper weights. Many building codes prescribe the minimum weights of only a few building materials. It should be noted that there is a difference of more than 25 percent in some cases.

AREA AND VOLUME CALCULATION

ARCHITECTURAL AREA OF BUILDINGS

The architectural area of a building is the sum of the areas of the floors, measured horizontally in plan to the exterior faces of perimeter walls or to the center line of walls separating buildings. Included are areas occupied by partitions, columns, stairwells, elevator shafts, duck shafts, elevator rooms, pipe spaces, mechanical penthouses, and similar spaces having headroom of 6 ft and over. Areas of sloping surfaces, such as staircases, bleachers, and tiered terraces, should be measured horizontally in plan. Auditoriums, swimming pools, gymnasiums, foyers, and similar spaces extending through two or more floors should be measured once only, taking the largest area in plan at any level.

Mechanical penthouse rooms, pipe spaces, bulkheads, and similar spaces having a headroom less than 6 ft and balconies projecting beyond exterior walls, covered terraces and walkways, porches, and similar spaces shall have the architectural area multiplied by 0.50 in calculating the building gross area.

Exterior staircases and fire escapes, exterior steps, patios, terraces, open courtyards and light wells, roof overhangs, cornices and chimneys, unfinished roof and attic areas, pipe trenches, and similar spaces are excluded from the architectural area calculations. Interstitial space in healthcare facilities is also excluded.

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$$\theta' = \theta_2$$

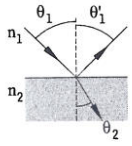
F REFLECTION

OF REFRACTION

light ray traveling through a transparent medium strikes transparent medium, part of the ray is reflected and part cted, entering the second medium. The angle of the d ray depends on the angle of incidence and the index of on of both mediums.

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

F REFRACTION



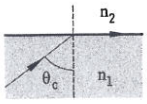
L INTERNAL REFLECTION

ght attempts to move from a medium with a high index of on to a medium with a low index of refraction, there is a ar angle of incidence large enough that the angle of refrac- ches 90°. The transmitted light ray moves parallel to the of the first medium, and no more light is transmitted.

gle of incidence is called the critical angle and depends on exes of refraction of the two mediums. Any angle of inci- arger than the critical angle is reflected back into the first .

$$\sin\theta_c = \frac{n_2}{n_1}$$

INTERNAL REFLECTION



GHT IN MEDIUM

$$C_{medium} = \frac{C_{vac}}{n_{medium}}$$

PANSION OF LENGTH

ngth L_0 at some temperature. With a change Γ, the length increases ΔL. The constant α is coefficient of linear expansion for the given

$$\Delta L = \alpha L_0 \Delta T$$

THERMAL EXPANSION OF AREA

An object of initial area A_0 at some temperature. With a change in temperature of ΔT, the area increases ΔA. The constant γ is the average coefficient of area expansion for the given material.

$$\Delta A = \gamma A_0 \Delta T \qquad \gamma = 2\alpha$$

THERMAL EXPANSION OF VOLUME

A mass of initial volume V_0 at some temperature. With a change in temperature ΔT, the volume increases ΔV. The constant β is called the average coefficient of volume expansion for a given material.

$$\Delta V = \beta V_0 \Delta T \qquad \beta = 3\alpha$$

USEFUL CONSTANTS

INDEXES OF REFRACTION (N)
A.86

Air at 20°c, 1 atm.			1.000
SOLIDS AND LIQUIDS AT 20°C			
Water	1.333	Polystyrene	1.49
Ice (H_2O)	1.309	Glass, crown	1.52
Fused quartz	1.458	Glass, flint	1.66

LINEAR EXPANSION COEFFICENTS (A)
A.87

Aluminum	24×10^{-6}	Concrete	12×10^{-6}
Brass and bronze	19×10^{-6}	Lead	29×10^{-6}
Copper	17×10^{-6}	Steel	11×10^{-6}
Glass, ordinary	9×10^{-6}		

VOLUME EXPANSION COEFFICENTS (β) (β = 3α)
A.88

Air	3.67×10^{-3}

NATURAL CONSTANTS
A.89

Speed of light in a vacuum	$C = 3.0 \times 10^8$ m/s
Standard gravity	$g = 9.80$ m/s^2

WEIGHT OF MATERIALS

WEIGHT OF MATERIALS
A.90

BRICK AND BLOCK MASONRY		PSF
4" brickwork		40
4" concrete block, stone or gravel		34
4" concrete block, lightweight		22
4" concrete brick, stone or gravel		46
4" concrete brick, lightweight		33
6" concrete block, stone or gravel		50
6" concrete block, lightweight		31
8" concrete block, stone or gravel		55
8" concrete block, lightweight		35
12" concrete block, stone or gravel		85
12" concrete block, lightweight		55
CONCRETE		**PCF**
Plain	Cinder	108
	Expanded slag aggregate	100
	Expanded clay	90
	Slag	132
	Stone and cast stone	144
Reinforced	Cinder	111
	Slag	138
	Stone	150
FINISH MATERIALS		**PSF**
Acoustical tile unsupported per 1/2"		0.8
Building board, 1/2"		0.8
Cement finish, 1"		12
Fiberboard, 1/2"		0.75
Gypsum board, 1/2"		2
Marble and setting bed		25–30
Plaster, 1/2"		4.5
Plaster on wood lath		8
Plaster suspended with lath		10
Plywood, 1/2"		1.5
Tile, glazed wall 3/8"		3
Tile, ceramic mosaic, 1/4"		2.5
Quarry tile, 1/2"		5.8
Quarry tile, 3/4"		8.6
Terrazzo 1", 2" in stone concrete		25
Vinyl tile, 1/8"		1.33
Hardwood flooring, 25/32"		4
Wood block flooring, 3" on mastic		15
FLOOR AND ROOF (CONCRETE)		**PSF**
Flexicore, 6" precast lightweight concrete		30
Flexicore, 6" precast stone concrete		40
Plank, cinder concrete, 2"		15
Plank, gypsum, 2"		12
Concrete, reinforced, 1"	Stone	12.5
	Slag	11.5
	Lightweight	6–10
Concrete, plain, 1"	Stone	12
	Slag	11
	Lightweight	3–9
FUELS AND LIQUIDS		**PCF**
Coal, piled anthracite		47–58
Coal, piled bituminous		40–54

Table 8 Specific Gravity for Solid Sawn Lumber

Species Combination	Specific Gravity[1], G	Species Combination	Specific Gravity[1], G
Aspen	0.39	Mountain Hemlock	0.47
Balsam Fir	0.36	Northern Pine	0.42
Beech-Birch-Hickory	0.71	Northern Red Oak	0.68
Coast Sitka Spruce	0.39	Northern Species	0.35
Cottonwood	0.41	Northern White Cedar	0.31
Douglas Fir-Larch	0.50	Ponderosa Pine	0.43
Douglas Fir-Larch (North)	0.49	Red Maple	0.58
Douglas Fir-South	0.46	Red Oak	0.67
Eastern Hemlock	0.41	Red Pine	0.44
Eastern Hemlock-Balsam Fir	0.36	Redwood, close grain	0.44
Eastern Hemlock-Tamarack	0.41	Redwood, open grain	0.37
Eastern Hemlock-Tamarack (North)	0.47	Sitka Spruce	0.43
Eastern Softwoods	0.36		
Eastern Spruce	0.41	Southern Pine	0.55
Eastern White Pine	0.36	Spruce-Pine-Fir	0.42
Englemann Spruce-Lodgepole Pine	0.38	Spruce-Pine-Fir ($E \geq 2{,}000{,}000$ psi MSR and MEL)	0.50
Engelmann Spruce-Lodgepole Pine[2] (MSR 1650f and higher grades)	0.46	Spruce-Pine-Fir (South)	0.36
Engelmann Spruce-Lodgepole Pine[2] (MSR 1500f and lower grades)	0.38	Western Cedars	0.36
		Western Cedars (North)	0.35
		Western Hemlock	0.47
Hem-Fir	0.43	Western Hemlock (North)	0.46
Hem-Fir (North)	0.46	Western White Pine	0.40
Mixed Maple	0.55	Western Woods	0.36
Mixed Oak	0.68	White Oak	0.73
Mixed Southern Pine	0.51	Yellow Poplar	0.43

1. Specific gravity based on weight and volume when oven-dry.
2. Applies only to Engelmann Spruce-Lodgepole Pine machine stress rated (MSR) structural lumber.

Appendix A -- Weight Of Materials

All weights are pounds per square foot (psf) unless otherwise shown.

DECKING AND INSULATION

3/8 inch thick Plywood / OSB	1.2
1/2 inch thick Plywood / OSB	1.7
5/8 inch thick Plywood / OSB	2.1
3/4 inch thick plywood / OSB	2.5
1-1/8 inch thick plywood / OSB	3.6
1 inch nominal wood	2.3
2 inch nominal wood decking	4.3
16 ga. Corrugated Steel	2.5
20 ga. Corrugated Steel	1.8
22 ga. Corrugated Steel	1.5
24 ga. Corrugated Steel	1.3
28 ga. Corrugated Steel	1.0
Rigid Fiberglass - 1 inch thick	1.5
Styrofoam - 1 inch thick	0.2
Insulrock - 1 inch thick	2.7
Poured gypsum - 1 inch thick	6.5
Rock Wool - per 1 inch of thickness	0.4
Glass Wool - per 1 inch of thickness	0.2
Vermiculite - per 1 inch of thickness	2.6

WALLS AND PARTITIONS

Masonry, per 4 inches of thickness:	
Brick	38.0
Concrete Block	30.0
Stucco - 7/8 inch thick	10.0
2x4 Framing @ 16" oc with ½ inch Thick gypsum each side	6.0
2x6 Framing @ 16" oc with ½ inch Thick gypsum each side	7.0

CEILINGS

1/2 inch thick Gypsum board	2.2
5/8 inch thick Gypsum board	2.8
5/8 inch thick Type X Gypsum bd	3.0
Acoustical Fiber Tile	1.0
Metal Grid Ceiling	0.8
Plaster - 1 inch thick	8.0
Plaster on Metal Lath	8.5

ROOFING

Asphalt Shingles - Minimum (1 Layer)	2.5
Clay Tile Shingles	12.0
1/4 inch Slate Shingles	10.0
Wood Shakes - 5/8 inch thick	3.0
3 Ply & Gravel	5.6
4 Ply & Gravel	6.0
5 Ply & Gravel	6.5

FLOORING

Hardwood - 1 inch nominal	4.0
Quarry Tile 3/4 inch thick	10.0
Linoleum or Soft Tile	1.5
Vinyl Tile - 1/8 inch thick	1.4
Concrete:	
Reinforced 1 ½ inch thick	17.5
Lightweight 1 ½ inch thick	12.5
Terrazzo 1 ½ inch thick	19.0

LUMBER (32 pcf)

Nominal Size:	@ 12" oc	@ 16" oc	@ 24" oc
2x4	1.4	1.1	0.7
2x6	2.2	1.7	1.1
2x8	2.9	2.2	1.5
2x10	3.7	2.8	1.9
2x12	4.4	3.3	2.2

WOOD TRUSSES - (APPROXIMATE)

Based on Southern Pine

Top Chord	Bottom Chord	PLF	24" oc.
2x4	2x4	5.2	2.6
2x6	2x4	6.1	3.1
2x6	2x6	6.9	3.5
2x8	2x6	7.8	3.9
2x8	2x8	8.5	4.3
2x10	2x8	9.3	4.7
2x10	2x10	10.1	5.2
2x12	2x10	10.9	5.5
2x12	2x12	11.6	5.8

We suggest the addition of 1.5 psf for misc. dead loads

FLOOR TRUSSES - (APPROXIMATE)

Based on Southern Pine
All members 2x4 - Weights are PLF

Depth in inches	Single Chord	Double Chord
12	5.0	
14	5.25	
16	5.5	8.4
18	5.75	8.6
20		8.9
24		9.4

SPRINKLER SYSTEMS

Pipe Size	Dry (PLF)	Wet (PLF)
1	1.7	2.1
1 1/4	2.3	3.0
1 ½	2.7	3.6
2	3.7	5.2
2 ½	5.8	7.9
3	7.6	10.8
3 ½	9.2	13.5
4	10.9	16.4
5	14.8	23.5
6	19.2	31.7
8	28.6	50.8

NOTE: The weight of wood and wood products will vary as the moisture content varies and as density of grain varies. Code of jurisdiction should be consulted for live load requirements. Weight of manufactured products should be verified with manufacturers.

Design Value Comparisons for 2x10

Values are given in pounds per square inch (psi)

These tables compare design values for Southern Pine lumber and other major commercial species U.S. The tables are based on results of the North American In-Grade Testing Program completed in These tests confirmed that **Southern Pine is the Strongest Species** for engineered and framing applications.

Tabulated design values are based on normal loading conditions. Because the strength of wood vari conditions under which it is used, these design values should only be applied in conjunction with ap design and service recommendations from the *NDS*. Tabulated design values must be multiplied by applicable adjustment factors to determine allowable design values.

2x10	Property	Southern Pine	Douglas Fir-Larch	Hem-Fir	Spruce-Pine-Fir
Select Structural	Extreme Fiber Stress in Bending, F_b	2,050	1,595	1,540	1,375
	Tension parallel-to-grain, F_t	1,100	1,100	990	740
	Compression parallel-to-grain, F_c	1,850	1,700	1,500	1,400
	Modulus of Elasticity, E	1,800,000	1,900,000	1,600,000	1,500,000
No. 1	Extreme Fiber Stress in Bending, F_b	1,300	1,100	1,045	960
	Tension parallel-to-grain, F_t	725	745	660	470
	Compression parallel-to-grain, F_c	1,600	1,450	1,300	1,100
	Modulus of Elasticity, E	1,700,000	1,700,000	1,500,000	1,400,000
No. 2	Extreme Fiber Stress in Bending, F_b	1,050	965	935	960
	Tension parallel-to-grain, F_t	575	635	550	470
	Compression parallel-to-grain, F_c	1,500	1,300	1,250	1,100
	Modulus of Elasticity, E	1,600,000	1,600,000	1,300,000	1,400,000
No. 3	Extreme Fiber Stress in Bending, F_b	600	550	550	550
	Tension parallel-to-grain, F_t	325	360	330	275
	Compression parallel-to-grain, F_c	850	750	725	625
	Modulus of Elasticity, E	1,400,000	1,400,000	1,200,000	1,200,000

SOURCES

These tables are for comparison purposes only, and do not provide complete design information. Fc design details, see the *National Design Specification® (NDS®) for Wood Construction* published by American Forest & Paper association, the *Southern Pine Use Guide* published by the Southern Pine and the following sources used for this publication:

Southern Pine
Southern Pine Council: *Maximum Spans for Southern Pine Joists & Rafters*, 5/93.
Southern Pine Inspection Bureau: *Standard Grading Rules for Southern Pine Lumber*, 1994 Edition.

Douglas Fir-Larch, Hem-Fir and Spruce-Pine-Fir (South)
Western Wood Products Association: *Western Lumber Size-Adjusted Values*, 2/92, and *Western Lur Tables*, 2/94.

VERAGE WEIGHTS OF MATERIALS :

OIL, SAND & GRAVEL	LBS. PER CU. FT.
ıders or Ashes	40–45
ıy, damp & plastic	110
ıy, dry	63
ay & gravel, dry	100
rth, dry & loose	76
rth, dry & packed	95
rth, moist & loose	78
rth, moist & packed	96
rth, mud, packed	115
nd or gravel, dry & loose	90–105
nd or gravel, dry & packed	100–120
nd or gravel, dry & wet	118–120

STONE	LBS. PER CU. FT.
Granite	175
Limestone	165
Marble	165
Sandstone, bluestone	147
Slate (See also stone veneer)	175

BRICK & BLOCK MASONRY (INCL. MORTAR)	LBS. PER SQ. FT.
4" brickwork	35
4" concrete block stone or gravel	34
4" concrete block lightwt. aggregate (avg.)	22
6" concrete block stone or gravel	50
6" concrete block lightwt. aggregate (avg.)	31
8" concrete block stone or gravel	58
8" concrete block lightwt. aggregate (avg.)	36
12" concrete block stone or gravel	90
12" concrete block lightwt. aggregate (avg.)	58

CONCRETE	LBS. PER CU. FT.
Stone, reinforced	150
Stone, plain	144
Slag, plain	130
Cinder, reinforced	100–115

ETALS	LBS. PER CU. FT.
uminum, cast	165
ass, red	546
ass, yellow, extruded bronze	528
onze, commercial	552
onze, statuary	509
pper, cast or rolled	556
on, cast gray	450
on, wrought	485
ead	710
onel metal	552
ickel	555
tainless steel, rolled	492–510
teel, rolled	490
inc, rolled or cast	440

LIGHT WEIGHT CONCRETE	LBS. PER CU. FT.
Concrete, Aerocrete	50–80
Concrete, cinder fill	60
Concrete, Haydite	85–100
Concrete, Nailcode	75
Concrete, Perlite	35–50
Concrete, Pumice	60–90
Concrete, Vermiculite	25–60

TILE—STRUCTURAL CLAY (INCL. MORTAR)	LBS. PER SQ. FT.
4" hollow	23
6" hollow	33
8" hollow, 5" unit ht.	42
8" hollow, 8" unit ht.	38
8" hollow, 12" unit ht.	34
12" hollow, 5" unit ht.	66
12" hollow, 8" unit ht.	55
12" hollow, 12" unit ht.	49

VOOD 12% MOISTURE CONTENT)	LBS. PER CU. FT.
irch, red oak	44
edar, northern white	22
edar, western red	23
ypress, southern	32
ouglas Fir (coast region)	34
ir, commercial, white; Idaho white pine	27
lemlock	28–29
Maple, hard (black & sugar)	42
Oak, white	47
ine, northern white sugar	25
ine, long leaf southern	29
ine, ponderosa; Spruce: eastern & sitka	28
ine, short leaf southern	36
oplar, yellow	28
Redwood	28
Walnut, black	38

MORTAR & PLASTER	LBS. PER CU. FT.
Mortar, masonry	116
Plaster, gypsum, sand	104–120
Plaster, gypsum, perlite	50–55
Plaster, Portland Cement, sand	104–120
Plaster, Portland Cement, perlite	50–55
Plaster, Portland Cement, vermiculite	50–55

TILE—STRUCTURAL FACING (INCL. MORTAR)	LBS. PER SQ. FT.
2" facing tile	16
4" facing tile	30
6" facing tile	41

FUELS & LIQUIDS	LBS. PER CU. FT.
Coal, piled anthracite	47–58
Coal, piled bituminous	40–54
Gasoline	75
Water at 4°C	62.4
Water, ice	56

STONE VENEER (NO MORTAR)	LBS. PER SQ. FT.
2" granite, 1/2" parging	30
4" granite, 1/2" parging	59
6" limestone facing, 1/2" parging	55
4" sandstone or bluestone, 1/2" parging	49
1" marble	13
1" slate	14

MacKnight, Kirmmse, French & Sizing; Syracuse, New York

AVERAGE WEIGHTS OF MATERIALS:

PARTITIONS	LBS. PER SQ. FT.
2x4 wood stud, lath & plaster 2S	14–16
4" metal stud, lath & plaster 2S	18
4" conc. part'n. block lightweight, plaster 2S	34
6" conc. part'n. block lightweight, plaster 2S	43
3" gypsum block, plaster 2S	21
4" gypsum block, plaster 2S	25
6" gypsum block, plaster 2S	31
2" solid plaster	18
3" solid plaster	27
Moveable steel (office type)	4–8

ROOFING MATERIALS	LBS. PER SQ. FT.
Built-up	6.5
Cemesto roof deck 1 9/16"	4.8
Copper	1.5–2.5
Corrugated Asbestos	4
Corrugated glass	6.3
Corrugated iron	1.2–1.7
Deck, steel without roofing or insulation	2.2–3.6
Fiberglass panels (2 1/2" corr.)	5–8 oz.
Galvanized iron	1.2–1.7
Gypsum tile, 3"	17
Lead 1/8"	6–8
Monel metal	1.2–1.5
Plank, cinder conc. 2"	15
Plastic sandwich panel, 2 1/2" thick	2.6
Shingles, asbestos cement	2.6
Shingles, asphalt	1.7–2.8
Shingles, wood	2–3
Slate, 3/16" to 1/4"	7–9.5
Slate, 3/8" to 1/2"	14–18
Stainless steel	2.5
Tile, cement flat	13.0
Tile, cement ribbed	16
Tile, clay mission	13.5
Tile, clay shingle type	8–16
Tile, clay flat with setting bed	15–20

PORCELAIN ENAMEL PANELS	LBS. PER SQ. FT.
Porcelain on alum. lam to 1/8" cem. asb. & backed with aluminum foil	2.25–2.5
Porcelain on alum. unbacked "pan-type"	1.0
Porcelain on steel panel, double faced, lam. to 1 1/8" insulating core	4–6.5
Porcelain on steel panel, unbacked "pan-type"	2.5–3

FINISH MATERIALS FLOOR, WALL, CEILING	LBS. PER SQ. FT.
Acoustical tile unsupported per 1/2" thickness	.8
Building board, 1/2"	.8
Cement finish, 1"	12
Gypsum board 1/2"	2.1
Marble & setting bed	25–30
Plaster, 1/2"	4.5
Plaster, suspended w/lath	10
Plywood, 1/2"	1.5
Tile, glazed wall 3/8"	3
Tile, ceramic mosaic 1/4"	2.5
Quarry tile, 1/2"	5.8
Quarry tile, 3/4"	8.6
Terrazzo, 2"	25
Terrazzo, 3"	38
Vinyl asbestos tile, 1/8"	1.33
Hardwood flooring 25/32"	4
Wood block flooring 3"	15

SUSPENDED CEILING MATERIALS	LBS. PER SQ. FT.
Mineral fiber tile 3/4", 12" x 12"	1.2–1.57
Wood fiber tile 3/4", 12" x 12" or 12" x 24"	.78–1.07
Mineral fiber board 5/8", 24" x 24"	1.4
Wood fiber board 5/8", 24" x 48"	.87
1", 24" x 48"	1.18
Acoustic plaster on gyp. lath base	10–11

INSULATION	LBS. PER SQ. FT.
Bat, blankets, per 1" thickness	.1–.4
Boards, vegetable fiber	1.5–2
Cork board per 1" thickness	.58
Foamed board insulation per 1" thickness	2.6 oz.

FLOOR & ROOF CONSTRUCTION	LBS. PER SQ. FT.
Flexicore, 6" pre-cast lightwt. conc.	30
Flexicore, 6" pre-cast stone concrete	40
Plank, cinder conc. 2"	15
Plank, Durisol roof 3 1/4" & 4 1/4"	14, 17
Plank, gypsum 2"	12
Concrete, reinforced 1"	
stone	12.5
slag	11.5
lightweight	6–10
Concrete, plain 1"	
stone	12
slag	11
lightweight	3–9

GLASS	LBS. PER SQ. FT.
Polished plate 1/4"	3.28
Polished plate 1/2"	6.56
Double strength 1/8"	26 oz.
Sheet A, B, 1/32"	45 oz.
Sheet A, B, 1/4"	52 oz.
Spandrel glass app. same as window glass	
Insulating glass 1/8" plate with air space	3.25
1/4" wire, glass	3.5
Glass block, 4"	20

LIVE LOADS	LBS. PER SQ. FT.
In general see building codes for specific requirements	
Dwellings, apartments, hotels, clubs, hospitals, prisons	40
Factories, workshops–variable	
Office buildings:	
office space	50
corridors, public space	100
Schools:	
classrooms	40, 50, or 60
corridors	100
Sidewalks	250 & 300
Theater lobbies, gyms, grandstands, stages, places of assembly with no fixed seats	100
Theaters, auditoriums with fixed seats	50–100
Stairs & fire escapes, except private residences	100

MacKnight, Kirmmse, French & Sizing; Syracuse, New York

CONVERSION FACTORS (continued)
A.81

QUANTITY	FROM INCH-POUND UNITS	TO METRIC UNITS	MULTIPLY BY
Thermal conductivity (k value)	Btu/ft • h • °F	W/m/K	1.73073
Thermal conductance (U value)	Btu/ft^2/h/°F	W/m^2/K	5.678263
Thermal resistance (R value)	ft^2/h/°F/Btu	m^2/K/W	0.176110
Heat capacity, entrophy	Btu/°F	kJ/K	1.8991
Specific heat capacity, specific entrophy	Btu/lb/°F	kJ/kg/K	4.1868[a]
Specific energy, latent heat	Btu/lb	kJ/kg	2.326[a]
Vapor permeance	perm (23 °C)	ng/(Pa/s/m^2)	57.4525
Vapor permeability	perm/in	ng/(Pa/s/m)	1.45929
Volume rate of flow	ft^3/s	m^3/s	0.028316 8
	cfm	m^3/s	0.0004719474
	cfm	L/s	0.4719474
Velocity, speed	ft/s	m/s	0.3048[a]
Acceleration	ft/s^2	m/s^2	0.3048[a]
Momentum	lb.ft/s	kg/m/s	0.1382550
Angular momentum	lb/ft^2/s	kg/m^2/s	0.04214011
Plane angle	degree	rad	0.0174533
Power, radiant flux	W	W	1 (same unit)
Radiant intensity	W/sr	W/sr	1 (same unit)
Radiance	W/(sr/m^2)	W/(sr/m^2)	1 (same unit)
Irradiance	W/m^2	W/m^2	1 (same unit)
Frequency	Hz	Hz	1 (same unit)
Electric current	A	A	1 (same unit)
Electric charge	A/hr	C	3600[a]
Electric potential	V	V	1 (same unit)
Capacitance	F	F	1 (same unit)
Inductance	H	H	1 (same unit)
Resistance	W	W	1 (same unit)
Conductance	mho	S	100[a]
Magnetic flux	maxwell	Wb	10-8[a]
Magnetic flux density	gamma	T	10-9[a]
Luminous intensity	cd	cd	1 (same unit)
Luminance	lambert	kcd/m^2	3.18301
	cd/ft^2	cd/m^2	10.7639
	footlambert	cd/m^2	3.42626
Luminous flux	lm	lm	1 (same unit)
Illuminance	footcandle	lx	10.7639

SELECTED EQUATIONS AND CONSTANTS

SCIENTIFIC NOTATION

Scientific notation is used to abbreviate large numerical values in order to simplify calculations.

$4.2 \times 10^4 = 4.2 \times (10 \times 10 \times 10 \times 10) = 42{,}000$

$1.0 \times 10^1 = 1 \times 10 = 10$

$6.0 \times 10^{-4} = 6.0 \times (1 / 10 \times 10 \times 10 \times 10) = 0.0006$

MULTIPLYING AND DIVIDING POWERS

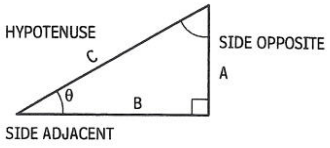
$$x^n x^m = x^{nm} \qquad (x^n)^m = x^{nm}$$

$$\frac{x^n}{x^m} = x^{n-m} \qquad \frac{1}{x^n} = \sqrt[n]{x}$$

PYTHAGOREAN THEOREM

$$c^2 = a^2 + b^2$$

PYTHAGOREAN THEOREM
A.82



BASIC TRIGONOMETRY FUNCTIONS

$$\sin\theta \frac{\text{opposite}}{\text{hypotenuse}} = \frac{a}{c}$$

$$\cos\theta \frac{\text{adjacent}}{\text{hypotenuse}} = \frac{b}{c}$$

$$\tan\theta \frac{\text{opposite}}{\text{adjacenet}} = \frac{a}{b}$$

$$\cot\theta \frac{\text{adjacent}}{\text{opposite}} = \frac{b}{a}$$

RADIANS AND DEGREES

A radian is a way of measuring angles in addition to degrees. Radians are the primary unit of angular measurement used in calculations.

$$1 \text{ rad} = \frac{180^\circ}{\pi} = 57.3 \quad \text{(approx)}$$

$$1^\circ = \frac{\pi}{180^\circ} = 0.01745 \text{ rad} \quad \text{(approx)}$$

LINEAR DISTANCE

The distance s that a point p on the rim of a rotating wheel covers is called linear distance. The angle θ, the intercepting angle, is measured in radians.

$$s = r\theta$$

LINEAR SPEED

The linear speed v, of the point p around the rim of a rotating wheel, is the time taken t for a point to travel the distance s.

$$v = \frac{s}{t}$$

NOTE

A.81[a] Denotes an exact conversion.