C3.2 Weights of Materials and Constructions. 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 for only a few building materials, and in other instances no guide whatsoever is furnished on this subject. In some cases the codes are so drawn up as to leave the question of what weights to use to the discretion of the building official, without providing any authoritative guide. This practice, as well as the use of incomplete lists, has been subjected to much criticism. The solution chosen has been to present, in this commentary, an extended list that will be useful to designer and official alike. However, special cases will unavoidably arise, and authority is therefore granted in the standard for the building official to deal with them.

For ease of computation, most values are given in terms of pounds per square foot (lb/ft^2) (kN/m^2) of given thickness (see Table C3-1). Pounds-per-cubic-foot (lb/ft^3) (kN/m^3) values, consistent with the pounds-per-square foot (kilonewtons per square meter) values, are also presented in some cases (see Table C3-2). Some constructions for which a single figure is given actually have a considerable range in weight. The average figure given is suitable for general use, but when there is reason to suspect a considerable deviation from this, the actual weight should be determined.

Engineers, architects, and building owners are advised to consider factors that result in differences between actual and calculated loads.

Engineers and architects cannot be responsible for circumstances beyond their control. Experience has shown, however, that conditions are encountered which, if not considered in design, may reduce the future utility of a building or reduce its margin of safety. Among them are:

1. Dead Loads. There have been numerous instances in which the actual weights of members and construction materials have exceeded the values used in design. Care is advised in the use of tabular values. Also, allowances should be made for such factors as the influence of formwork and support deflections on the actual thickness of a concrete slab of prescribed nominal thickness.

2. Future Installations. Allowance should be made for the weight of future wearing or protective surfaces where there is a good possibility that such may be applied. Special consideration should be given to the likely types and position of partitions, as insufficient provision for partitioning may reduce the future utility of the building.

Attention is directed also to the possibility of temporary changes in the use of a building, as in the case of clearing dormitory for a dance or other recreational purpose

Table C 3-1: Minimum Design Dead Loads*

Component	Load (psf)
CEILINGS	
Acoustical Fiber Board	1
Gypsum board (per mm thickness)	0.55
Mechanical duct allowance	4
Plaster on tile or concrete	5
Plaster on wood lath	8
Suspended steel channel system	2
Suspended metal lath and cement plaster	15
Suspended metal lath and gypsum plaster	10
Wood furring suspension system	2.5
COVERINGS, ROOF, AND WALL	
Asbestos-cement shingles	4
Asphalt shingles	2
Cement tile	16
Clay tile (for mortar add 10 psf)	
Book tile, 2-in.	12
Book tile, 3-in	20
Ludowici	10
Roman	12
Spanish	19
Composition:	
Three-ply ready roofing	1
Four-ply felt and gravel	5.5
Five-ply felt and gravel	6
Copper or tin	1
Corrugated asbestos-cement roofing	4
Deck, metal, 20 gage	2.5
Deck, metal, 18 gage	3
Decking, 2-in. wood (Douglas fir)	5
Decking, 3-in. wood (Douglas fir)	8
Fiberboard, 1/2-in	0.75
Gypsum sheathing, 1/2-in.	2
Insulation, roof boards (per inch thickness)	
Cellular glass	0.7
Fibrous glass	1.1
Fiberboard	1.5
Perlite	0.8
Polystyrene foam	0.2
Urethane foam with skin	0.5
Plywood (per 1/8-in thickness)	0.4
Rigid insulation, 1/2-in	0.75
Skylight, metal frame, 3/8-in. wire glass	8
Slate, 3/16-in.	7
Slate, 1/4-in.	10
Waterproofing membranes:	
Bituminous, gravel-covered	5.5
Bituminous, smooth surface	1.5
Liquid applied	1
Single-ply, sheet	0.7
Wood sheathing (per inch thickness)	3
Wood shingles	3

Component				Load (psf)
FLOOR FILL				
Cinder concrete, per inch				9
Lightweight concrete, per inch				8
Sand, per inch				8
Stone concrete, per inch				12
FLOORS AND FLOOR FINISHES				
Asphalt block (2-in.), 1/2-in. mortar				30
Cement finish (1-in.) on stone-concrete fill				32
Ceramic or quarry tile (3/4-in.) on 1/2-in. mortar bed				16
Ceramic or quarry tile (3/4-in.) on 1-in. mortar bed				23
Concrete fill finish (per inch thickness)				12
Hardwood flooring, 7/8-in.				4
Linoleum or asphalt tile, 1/4-in				1
Marble and mortar on stone-concrete fill				33
Slate (per mm thickness)				15
Solid flat tile on 1-in. mortar base				23
Subflooring, 3/4-in.				3
Terrazzo (1-1/2-in.) directly on slab				19
Terrazzo (1-in.) on stone-concrete fill				32
Terrazzo (1-in.), 2-in. stone concrete				32
Wood block (3-in.) on mastic, no fill				10
Wood block (3-in.) on 1/2-in. mortar base				16
FLOORS, WOOD-JOIST (NO PLASTER)				
DOUBLE WOOD FLOOR				
Joist sizes (inches)	12-in spacing (lb/ft²)	16-in. spacing (lb/ft²)	24-in. spacing (lb/ft²)	
2 x 6	6	5	5	
2 x 8	6	6	5	
2 x 10	7	6	6	
2 x 12	8	7	6	
FRAME PARTITIONS				
Movable steel partitions				4
Wood or steel studs, 1/2-in. gypsum board each side				8
Wood studs, 2 x 4, unplastered				4
Wood studs, 2 x 4, plastered one side				12
Wood studs, 2 x 4, plastered two sides				20
FRAME WALLS				
Exterior stud walls:				
2 x 4 @ 16-in., 5/8-in. gypsum, insulated, 3/8-in. siding				11
2 x 6 @ 16-in., 5/8-in. gypsum, insulated, 3/8-in. siding				12
Exterior stud walls with brick veneer				48
Windows, glass, frame and sash				8
				3
				3

Component					Load (psf)
Clay brick wythes					
4 in.					39
8 in.					79
12 in.					115
16 in.					155
Hollow concrete masonry unit wythes:					
Wythe thickness (in inches)	4	6	8	10	12
Density of unit (16.49 kN/m³)					
No grout	22	24	31	37	43
48" o.c.		29	38	47	55
40" o.c. grout		30	40	49	57
32" o.c. spacing		32	42	52	61
24" o.c.		34	46	57	67
16" o.c.		40	53	66	79
Full Grout		55	75	95	115
Density of unit (125 pcf):					
No grout	26	28	36	44	50
48" o.c.		33	44	54	62
40" o.c. grout		34	45	56	65
32" o.c. spacing		36	47	58	68
24" o.c.		39	51	63	75
16" o.c.		44	59	73	87
Full Grout		59	81	102	123
Density of unit (21.21 kN/m³)					
No grout	29	30	39	47	54
48" o.c.		36	47	57	66
40" o.c. grout		37	48	59	69
32" o.c. spacing		38	50	62	72
24" o.c.		41	54	67	78
16" o.c.		46	61	76	90
Full Grout		62	83	105	127
Solid concrete masonry unit wythes (incl.					
Wythe thickness (in mm)	4	6	8	10	12
Density of unit (105 pcg).	32	51	69	87	105
Density of unit (125 pcf):	38	60	81	102	124
Density of unit (135 pcf):	41	64	87	110	133

* Weights of masonry include mortar but not plaster. For plaster, add 5 lb/ft² for each face plastered. Values given represent averages. *In some cases there is a considerable range of weight for the same construction.*

Table C 3-1: Minimum Design Dead Loads*

Component	Load (kN/m²)
CEILINGS	
Acoustical Fiber Board	0.05
Gypsum board (per mm thickness)	0.008
Mechanical duct allowance	0.19
Plaster on tile or concrete	0.24
Plaster on wood lath	0.38
Suspended steel channel system	0.10
Suspended metal lath and cement plaster	0.72
Suspended metal lath and gypsum plaster	0.48
Wood furring suspension system	0.12
COVERINGS, ROOF, AND WALL	
Asbestos-cement shingles	0.19
Asphalt shingles	0.10
Cement tile	0.77
Clay tile (for mortar add 0.48 kN/m²)	
Book tile, 51 mm	0.57
Book tile, 76 mm	0.96
Ludowici	0.48
Roman	0.57
Spanish	0.91
Composition	
Three-ply ready roofing	0.05
Four-ply felt and gravel	0.26
Five-ply felt and gravel	0.29
Copper or tin	0.05
Corrugated asbestos-cement roofing	0.19
Deck, metal, 20 gage	0.12
Deck, metal, 18 gage	0.14
Decking, 51 mm wood (Douglas fir)	0.24
Decking, 76 mm wood (Douglas fir)	0.38
Fiberboard, 13 mm	0.04
Gypsum sheathing, 13 mm	0.10
Insulation, roof boards (per mm thickness)	
Cellular glass	0.0013
Fibrous glass	0.0021
Fiberboard	0.0028
Perlite	0.0015
Polystyrene foam	0.0004
Urethane foam with skin	0.0009
Plywood (per mm thickness)	0.006
Rigid insulation, 13 mm	0.04
Skylight metal frame, 10 mm wire glass	0.38
Slate, 5 mm	0.34
Slate 6 mm	0.48
Waterproofing membranes	
Bituminous, gravel-covered	0.76
Bituminous smooth surface	0.07
[illegible]	0.05

Component	Load (kN/m²)
FLOOR FILL	
Cinder concrete, per mm	0.017
Lightweight concrete per mm	0.015
Sand, per mm	0.015
Stone concrete, per mm	0.023
FLOORS AND FLOOR FINISHES	
Asphalt block (51 mm), 13 mm mortar	1.44
Cement finish (25 mm) on stone concrete fill	1.53
Ceramic or quarry tile (19 mm) on 13 mm mortar bed	0.77
Ceramic or quarry tile (19 mm) on 25 mm mortar bed	1.10
Concrete fill finish (per mm thickness)	0.023
Hardwood flooring 22 mm	0.19
Linoleum or asphalt tile, 6 mm	0.05
Marble and mortar on stone-concrete fill	1.58
Slate (per mm thickness)	0.028
Solid flat tile on 25 mm mortar base	1.10
Subflooring, 19 mm	0.14
Terrazzo (38 mm) directly on slab	0.91
Terrazzo (25 mm) on stone-concrete fill	1.53
Terrazzo (25 mm), 51 mm stone concrete	1.53
Wood block (76 mm) on mastic, no fill	0.48
Wood block (76 mm) on 13 mm mortar base	0.77
FLOORS, WOOD-JOIST (NO PLASTER)	
DOUBLE WOOD FLOOR	

Joist sizes (mm)	305 mm spacing (kN/m²)	406 mm spacing (kN/m²)	610 mm spacing (kN/m²)
51 x 152	0.29	0.24	0.24
51 x 203	0.29	0.29	0.24
51 x 254	0.34	0.29	0.29
51 x 305	0.38	0.34	0.29

Component	Load (kN/m²)
FRAME PARTITIONS	
Movable steel partitions	0.19
Wood or steel studs, 13 mm gypsum board each side	0.38
Wood studs, 51 x 102, unplastered	0.19
Wood studs 51 x 102, plastered one side	0.57
Wood studs, 51 x 102, plastered two sides	0.96
FRAME WALLS	
Exterior stud walls	
51mm x 102mm @ 406mm, 16mm gypsum insulated, 10mm siding	0.53
51mm x 152mm @ 406mm, 16mm gypsum insulated, 10mm siding	0.57
Exterior stud walls with brick veneer	2.30
Windows, glass, frame and sash	0.38

Component					Load (kN/m²)
Clay brick wythes					
102 mm					1.87
203 mm					3.78
305 mm					5.51
406 mm					7.42
Hollow concrete masonry unit wythes					
Wythe thickness (in mm)	102	152	203	254	305
Density of unit (16.49 kN/m³)					
No grout	1.05	1.29	1.68	2.01	2.35
1219 mm		1.48	1.92	2.35	2.78
1016 mm grout		1.58	2.06	2.54	3.02
813 mm spacing		1.63	2.15	2.68	3.16
610 mm		1.77	2.35	2.92	3.45
406 mm		2.01	2.68	3.35	4.02
Full Grout		2.73	3.69	4.69	5.70
Density of unit (125 pcf)					
No grout	1.25	1.34	1.72	2.11	2.39
1219 mm		1.58	2.11	2.59	2.97
1016 mm grout		1.63	2.15	2.68	3.11
813 mm spacing		1.72	2.25	2.78	3.26
610 mm		1.87	2.44	3.02	3.59
406 mm		2.11	2.78	3.50	4.17
Full Grout		2.82	3.88	4.88	5.89
Density of unit (21.21 kN/m³)					
No grout	1.39	1.68	2.15	2.59	3.02
1219 mm		1.58	2.39	2.92	3.45
1016 mm grout		1.72	2.54	3.11	3.69
813 mm spacing		1.82	2.63	3.26	3.83
610 mm		1.96	2.82	3.50	4.12
406 mm		2.25	3.16	3.93	4.69
Full Grout		3.06	4.17	5.27	6.37
Solid concrete masonry unit wythes (incl					
Wythe thickness (in mm)	102	152	203	254	305
Density of unit (16.49 kN/m³)	1.53	2.35	3.21	4.02	4.88
Density of unit (19.64 kN/m³)	1.82	2.82	3.78	4.79	5.79
Density of unit (21.21 kN/m³)	1.96	3.02	4.12	5.17	6.27

Table C3-2

Minimum Densities for Design Loads from Materials

Material	Load (lb/ft³)
Aluminum	170
Bituminous products	
Asphaltum	81
Graphite	135
Paraffin	56
Petroleum, crude	55
Petroleum, refined	50
Petroleum, benzine	46
Petroleum, gasoline	42
Pitch	69
Tar	75
Brass	526
Bronze	552
Cast-stone masonry (cement, stone, sand)	144
Cement, portland, loose	90
Ceramic tile	150
Charcoal	12
Cinder fill	57
Cinders, dry, in bulk	45
Coal	
Anthracite, piled	52
Bituminous, piled	47
Lignite, piled	47
Peat, dry, piled	23
Concrete, plain	
Cinder	108
Expanded-slag aggregate	100
Haydite (burned-clay aggregate)	90
Slag	132
Stone (including gravel)	144
Vermiculite and perlite aggregate, nonload-bearing	25-50
Other light aggregate, load-bearing	70-105
Concrete, Reinforced	
Cinder	111
Slag	138
Stone (including gravel)	150
Copper	556
Cork, compressed	14
Earth (not submerged)	
Clay, dry	63
Clay, damp	110
Clay and gravel, dry	100
Silt, moist, loose	78
Silt, moist, packed	96
Silt, flowing	108
Sand and gravel, dry, loose	100
Sand and gravel, dry, packed	110
Sand and gravel, wet	120
Earth (submerged)	
Clay	80
Soil	70
River mud	90
Sand or gravel	60
Sand or gravel and clay	65
Glass	160
Gravel, dry	104
Gypsum, loose	70
Gypsum, wallboard	50
Ice	57
Iron	
Cast	450
Wrought	48

Material	Load (lb/ft3)
Lead	710
Lime	
Hydrated, loose	32
Hydrated, compacted	45
Masonry, Ashlar Stone	
Granite	165
Limestone, crystalline	165
Limestone, oolitic	135
Marble	173
Sandstone	144
Masonry, Brick	
Hard (low absorption)	130
Medium (medium absorption)	115
Soft (high absorption)	100
Masonry, Concrete*	
Lightweight units	105
Medium weight units	125
Normal weight units	135
Masonry Grout	140
Masonry, Rubble Stone	
Granite	153
Limestone, crystalline	147
Limestone, oolitic	138
Marble	156
Sandstone	137
Mortar, cement or lime	130
Particleboard	45
Plywood	36
Riprap (Not submerged)	
Limestone	83
Sandstone	90
Sand	
Clean and dry	90
River, dry	106
Slag	
Bank	70
Bank screenings	108
Machine	96
Sand	52
Slate	172
Steel, cold-drawn	492
Stone, Quarried, Piled	
Basalt, granite, gneiss	96
Limestone, marble, quartz	95
Sandstone	82
Shale	92
Greenstone, hornblende	107
Terra Cotta, Architectural	
Voids filled	120
Voids unfilled	72
Tin	459
Water	
Fresh	62
Sea	64
Wood, Seasoned	
Ash, commercial white	41
Cypress, southern	34
Fir, Douglas, coast region	34
Hem fir	28
Oak, commercial reds and whites	47
Pine, southern yellow	37
Redwood	28
Spruce, red, white, and Sitka	29
Western hemlock	32
Zinc, rolled sheet	449

*Tabulated values apply to solid masonry and to the solid portion of hollow masonry

Table C3-2
Minimum Densities for Design Loads from Materials

Material	Load (kN/m³)	Material
Aluminum	17.0	Lead
Bituminous products		Lime
Asphaltum	12.7	Hydrated, loose
Graphite	21.2	Hydrated, compacted
Parafin	8.8	Masonry, Ashlar Stone
Petroleum, crude	8.6	Granite
Petroleum, refined	7.9	Limestone, crystalline
Petroleum, benzine	7.2	Limestone oolitic
Petroleum, gasoline	6.6	Marble
Pitch	10.8	Sandstone
Tar	11.8	Masonry, Brick
Brass	82.6	Hard (low absorption)
Bronze	86.7	Medium (medium absorption)
Cast-stone masonry (cement, stone, sand)	22.6	Soft (high absorption)
Cement, portland, loose	14.1	Masonry, Concrete*
Ceramic tile	23.6	Lightweight units
Charcoal	1.9	Medium weight units
Cinder fill	9.0	Normal weight units
Cinders, dry, in bulk	7.1	Masonry Grout
Coal		Masonry, Rubble Stone
Anthracite, piled	8.2	Granite
Bituminous, piled	7.4	Limestone, crystalline
Lignite, piled	7.4	Limestone, oolitic
Peat, dry, piled	3.6	Marble
Concrete, plain		Sandstone
Cinder	17.0	Mortar, cement or lime
Expanded-slag aggregate	15.7	Particleboard
Haydite (burned-clay aggregate)	14.1	Plywood
Slag	20.7	Riprap (Not submerged)
Stone (including gravel)	22.6	Limestone
Vermiculite and perlite aggregate, nonload-bearing	3.9-7.9	Sandstone
Other light aggregate, load-bearing	11.0-16.5	Sand
Concrete, Reinforced		Clean and dry
Cinder	17.4	River, dry
Slag	21.7	Slag
Stone (including gravel)	23.6	Bank
Copper	87.3	Bank screenings
Cork, compressed	2.2	Machine
Earth (not submerged)		Sand
Clay, dry	9.9	Slate
Clay, damp	17.3	Steel, cold-drawn
Clay and gravel dry	15.7	Stone, Quarried, Piled
Silt, moist, loose	12.3	Basalt, granite, gneiss
Silt, moist, packed	15.1	Limestone, marble, quartz
Silt, flowing	17.0	Sandstone
Sand and gravel, dry, loose	15.7	Shale
Sand and gravel dry, packed	17.3	Greenstone, hornblende
Sand and gravel, wet	18.9	Terra Cotta, Architectural
Earth (submerged)		Voids filled
Clay	12.6	Voids unfilled
Soil	11.0	Tin
River mud	14.1	Water
Sand or gravel	9.4	Fresh
Sand or gravel and clay	10.2	Sea
Glass	25.1	Wood, Seasoned
Gravel, dry	16.3	Ash, commercial white
Gypsum, loose	11.0	Cypress, southern
Gypsum, wallboard	7.9	Fir, Douglas, coast region
Ice	9.0	Hem fir
Iron		Oak, commercial reds and whites
Cast	70.7	Pine, southern yellow
Wrought	75.4	Redwood
		Spruce, red, white, and Sitka
		Western hemlock
		Zinc, rolled sheet

*Tabulated values apply to solid masonry and to the solid portion of hollow masonry

C4. Live Loads

C4.2 Uniformly Distributed Loads

C4.2.1 Required Live Loads. A selected list of loads for occupancies and uses more commonly encountered is given in 4.2.1, and the authority having jurisdiction should approve on occupancies not mentioned. Tables C4-1 and C4-2 are offered as a guide in the exercise of such authority.

In selecting the occupancy and use for the design of a building or a structure, the building owner should consider the possibility of later changes of occupancy involving loads heavier than originally contemplated. The lighter loading appropriate to the first occupancy should not necessarily be selected. The building owner should ensure that a live load greater than that for which a floor or roof is approved by the authority having jurisdiction is not placed, or caused or permitted to be placed, on any floor or roof of a building or other structure.

In order to solicit specific informed opinion regarding the design loads in Table 4-1, a panel of 25 distinguished structural engineers was selected. A Delphi [1] was conducted with this panel in which design values and supporting reasons were requested for each occupancy type. The information was summarized and recirculated back to the panel members for a second round of responses; those occupancies for which previous design loads were reaffirmed, as well as those for which there was consensus for change, were included.

It is well known that the floor loads measured in a live-load survey usually are well below present design values [2,3,4,5]. However, buildings must be designed to resist the maximum loads they are likely to be subjected to during some reference period T, frequently taken as 50 years. Table C4-2 briefly summarizes how load survey data are combined with a theoretical analysis of the load process for some common occupancy types and illustrates how a design load might be selected for an occupancy not specified in Table 4-1 [6]. The floor load normally present for the intended functions of a given occupancy is referred to as the sustained load. This load is modeled as constant until a change in tenant or occupancy type occurs. A live-load survey provides the statistics of the sustained load. Table C4-2 gives the mean, m_s, and standard deviation, σ_x, for particular reference areas. In addition to the sustained load, a building is likely to be subjected to a number of relatively short-duration, high-intensity, extraordinary or transient loading events (due to crowding in special or emergency circumstances, concentrations during remodeling, and the like). Limited survey information and theoretical considerations lead to the means, m_t, and standard deviations, σ_t, of single transient loads shown in Table C4-2.

Combination of the sustained load and transient load processes, with due regard for the probabilities of occurrence, leads to statistics of the maximum total load during a specified reference period T. The statistics of the maximum total load depend on the average duration of an individual tenancy, τ, the mean rate of occurrence of the transient load, v_e, and the reference period, T. Mean values are given in Table C4-2. The mean of the maximum load is similar, in most cases, to the Table 4-1 values of minimum uniformly distributed live loads and, in general, is a suitable design value.

C4.3 Concentrated Loads

C4.3.1 Accessible Roof-Supporting Members. The provision regarding concentrated loads supported by roof trusses or other primary roof members is intended to provide for a common situation for which specific requirements are generally lacking.

C4.4 Loads on Handrails, Guardrail Systems, Grab Bar Systems and Vehicle Barrier Systems

C4.4.2 Loads

(a) Loads that can be expected to occur on handrail and guardrail systems are highly dependent on the use and occupancy of the protected area. For cases in which extreme loads can be anticipated, such as long straight runs of guardrail systems against which crowds can surge, appropriate increases in loading shall be considered.

(b) When grab bars are provided for use by persons with physical disabilities the design is governed by CABO A117 Accessible and Usable Buildings and Facilities.

(c) Vehicle barrier systems may be subjected to horizontal loads from moving vehicles. These horizontal loads may be applied normal to the plane of the barrier system, parallel to the plane of the barrier system, or at any intermediate angle. Loads in garages accommodating trucks and buses may be obtained from the provisions contained in Standard Specifications for Highway Bridges, 1989, The American Association of State Highway and Transportation Officials.

(d) This provision is introduced to the standard in 1998 and is consistent with the provisions for stairs.

(e) Side rail extensions of fixed ladders are often flexible and weak in the lateral direction. OSHA (CFR 1910) requires side rail extensions, with specific geometric requirements only. The load provided is introduced to the standard in 1998, and has been determined on the basis of a 250 lb. person standing on a rung of the ladder, and accounting for reasonable angles of pull on the rail extension.

C4.6 Partial Loading. It is intended that the full intensity of the appropriately reduced live load over portions of the structure or member be considered, as well as a live load of the same intensity over the full length of the structure or member.

Partial-length loads on a simple beam or truss will produce higher shear on a portion of the span than a full-length load 'Checkerboard' loadings on multistoried, multipanel bents will produce higher positive moments than full loads, while loads on either side of a support will produce greater negative moments. Loads on the half span of arches and domes or on the two central quarters can be critical. For roofs, all probable load patterns should be considered. Cantilevers cannot rely on a possible live load on the anchor span for equilibrium.

C4.7 Impact Loads. Grandstands, stadiums, and similar assembly structures may be subjected to loads caused by crowds swaying in unison, jumping to its feet, or stomping. Designers are cautioned that the possibility of such loads should be considered

C4.8 Reduction in Live Loads

C4.8.1General. The concept of, and methods for, determining member live load reductions as a function of a loaded member's influence area, A_I, was first introduced into this standard in 1982 and was the first such change since the concept of live load reduction was introduced over 40 years ago The revised formula is a result of more extensive survey data and theoretical analysis [7]. The change in format to a reduction multiplier results in a formula that is simple and more convenient to use. The use of influence area , now defined as a function of the tributary area, A_T , in a single equation has been shown to give more consistent reliability for the various structural effects The influence area is defined as that floor area over which the influence surface for structural effects is significantly different from zero

The factor K_{LL} is the ratio of the influence area (A_I) of a member to its tributary area (A_T), i e · $K_{LL} = A_I/A_T$, and is used to better define the influence area of a member as a function of its tributary area Fig C4 illustrates typical influence areas and tributary areas for a structure with regular bay spacings Table 4-2 has established K_{LL} values (derived from calculated K_{LL} values) to be used in Eq 4-1 for a variety of structural members and configurations. Calculated K_{LL} values vary for column and beam members having adjacent cantilever construction, as is shown in Fig. C4, and the Table 4-2 values have been set for these cases to result in live load reductions which are slightly conservative. For unusual shapes, the concept of significant influence effect should be applied

An example of a member without provisions for continuous shear transfer normal to its span would be a precast T-beam or double-T beam which may have an expansion joint along one or both flanges, or which may have only intermittent weld tabs along the edges of the flanges. Such members do not have the ability to share loads located within their tributary areas with adjacent members, thus resulting in K_{LL} = 1 for these types of members.

Reductions are permissible for two-way slabs and for beams, but care should be taken in defining the appropria influence area. For multiple floors, areas for members supporting more than one floor are summed.

The formula provides a continuous transition from unreduced to reduced loads. The smallest allowed value c the reduction multiplier is 0.4 (providing a maximum 60% reduction), but there is a minimum of 0.5 (providing a 50 reduction) for members with a contributory load from jus one floor.

C4.8.2 Heavy Live Loads. In the case of occupancies involving relatively heavy basic live loads, such as storag buildings, several adjacent floor panels may be fully loaded However, data obtained in actual buildings indica that rarely is any story loaded with an average actual live load of more than 80% of the average rated live load. It appears that the basic live load should not be reduced for the floor-and-beam design, but that it could be reduced a flat 20% for the design of members supporting more than one floor Accordingly, this principle has been incorporated in the recommended requirement.

C4.9 Minimum Roof Live Loads

C4.9.1 Flat, Pitched, and Curved Roofs. The values specified in Eq.4-1 that act vertically upon the projected area have been selected as minimum roof live loads, even in localities where little or no snowfall occurs This is because it is considered necessary to provide for occasion loading due to the presence of workers and materials during repair operations

C4.9.2 Special Purpose Roofs. Designers should consid any additional dead loads that may be imposed by saturat landscaping materials. Special purpose or occupancy roo live loads may be reduced in accordance with the requirements of Section 4.8

C4.10 Crane Loads. All support components of moving bridge cranes and monorail cranes, including runway beams, brackets, bracing, and connections, shall be designed to support the maximum wheel load of the crane and the vertical impact, lateral, and longitudinal forces induced by the moving crane. Also, the runway beams shall be designed for crane stop forces The methods for determining these loads vary depending on the type of crane system and support. References [8 through 11] describe types of bridge cranes and monorail cranes. Cranes described in these references include top running bridge cranes with top running trolley, underhung bridge cranes, and underhung monorail cranes. Reference [12] gives more stringent requirements for crane runway design that are more appropriate for higher capacity or higher speed crane systems.

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[9] Specifications for Electric Overhead Traveling Cranes, No. 70, 1994, Material Handling Industry, Charlotte NC.

[10] Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes, No. 74, 1994, Material Handling Industry, Charlotte NC.

[11] Metal Building Manufacturers Association. Low Rise Building Systems Manual, 1986, MBMA, Inc., Cleveland OH.

[12] Association of Iron and Steel Engineers, Technical Report No. 13, 1979, Pittsburgh PA.

Table C4-1

Minimum Uniformly Distributed Live Loads

Occupancy or use	Live Load lb/ft² (kN/m²)	Occupancy or use	Live Load lb/ft² (kN/m²)
Air-conditioning (machine space)	200* (9 58)	Laboratories, scientific	100 (4 79
Amusement park structure	100* (4 79)	Laundries	150* (7 1[illegible]
Attic Nonresidential		Libraries, corridors	80* (3 83
Nonstorage	25 (1 20)	Manufacturing, ice	300 (14 3[illegible]
Storage	80* (3 83)	Morgue	125 (6.00
Bakery	150 (7 18)	Office Buildings	
Exterior	100 (4 79)	Business machine equipment	100* (4.7[illegible]
Interior (fixed seats)	60 (2 87)	Files (see file room)	
Interior (movable seats	100 (4.79)	Printing Plants	
Boathouse, floors	100* (4.79)	Composing rooms	100 (4.79
Boiler room, framed	300* (14 36)	Linotype rooms	100 (4.79
Broadcasting studio	100 (4 79)	Paper storage	**
Catwalks	25 (1 20)	Press rooms	150* (7 1[illegible]
Ceiling, accessible furred	10# (0 48)	Public rooms	100 (4 79
Cold Storage		Railroad tracks	‡‡
No overhead system	250‡ (11 97)	Ramps	
Overhead system		Driveway (see garages)	
Floor	150 (7 18)	Pedestrian (see sidewalks and corridors in Table 2)	-
Roof	250 (11 97)	Seaplane (see hangars)	
Computer equipment	150* (7 18)	Rest rooms	60 (2.87)
Courtrooms	50 - 100 (2 40 - 4 79)	Rinks	
Dormitories		Ice Skating	250 (11 9[illegible]
Nonpartitioned	80 (3 83)	Roller skating	100 (4 79
Partitioned	40 (1 92)	Storage, hay or grain	300* (14 3
Elevator machine room	150* (7 18)	Telephone exchange	150* (7 1[illegible]
Fan room	150* (7 18)	Theaters	
File room		Dressing rooms	40 (1 92)
Duplicating equipment	150* (7 18)	Grid-iron floor or fly gallery	
Card	125* (6 00)	Grating	60 (2.87)
Letter	80* (3 83)	Well beams 250 lb/ft per pair	
Foundries	600* (28 73)	Header beams, 1000 lb/ft	
Fuel rooms, framed	400 (19 15)	Pin rail, 250 lb/ft	
Garages - trucks	§	Projection room	100 (4 79
Greenhouses	150 (7 18)	Toilet rooms	60 (2 87)
Hangars	150§ (7 18)	Transformer rooms	200* (9.5[illegible]
Incinerator charging floor	100 (4 79)	Vaults, in offices	250* (11 9
Kitchens, other than domestic	150* (7 18)		

* Use weight of actual equipment or stored material when greater

‡ Plus 150 lb/ft² (7 18 kN/m²) for trucks.

§ Use American Association of State Highway and Transportation Officials lane loads. Also subject to not less than 100% maximum axle load.

** Paper storage 50 lb/ft (2 40 kN/m²) of clear story height

‡‡ As required by railroad company.

\# Accessible ceilings normally are not designed to support persons. The value in this table is intended to account for occasional light storage or suspension of items. If it necessary to support the weight of maintenance personnel, this shall be provided for.

Table C4-2
Typical Live Load Statistics

Occupancy or use	Survey Load m_s lb/ft² (kN/m²)	Survey Load σ_s* lb/ft² (kN/m²)	Transient Load m_t* lb/ft² (kN/m²)	Transient Load σ* lb/ft² (kN/m²)	Temporal Constants τ_s† (years)	Temporal Constants v_e‡ (per year)	Temporal Constants T§ (years	Mean maximum load* lb/ft² (kN/m²)
Office buildings								
offices	10 9 (0 52)	5 9 (0 28)	8.0 (0 38)	8 2 (0 39)	8	1	50	55 (2 63)
Residential								
renter occupied	6 0 (0 29)	2.6 (0 12)	6.0 (0 29)	6 6 (0 32)	2	1	50	36 (1.72)
owner occupied	6.0 (0 29)	2.6 (0 12)	6 0 (0 29)	6 6 (0.32)	10	1	50	38 (1 82)
Hotels								
guest rooms	4 5 (0 22)	1 2 (0 06)	6 0 (0 29)	5 8 (0 28)	5	20	50	46 (2 2)
Schools								
classrooms	12 0 (0 57)	2.7 (0 13)	6 9 (0 33)	3 4 (0 16)	1	1	100	34 (1 63)

* For 200-ft² (18 58 m²) area except 1000 ft² (92 9 m²) for schools
† Duration of average sustained load occupancy
‡ Mean rate of occurrence of transient load
§ Reference period.