CANADIAN
FARM BUILDING CODE
1983

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PREFACE

This edition of the Canadian Farm Building Code is published by the National Research Council through its Associate Committee on the National Building Code. It comprises a model set of minimum requirements for farm buildings in matters affecting human health, fire safety and structural sufficiency.

The previous edition of the Canadian Farm Building Code was published in 1977. Although it contained a considerable amount of useful farm information, much of the material from that edition was outside the scope of traditional building code requirements, which are normally concerned with matters affecting fire safety, health and structural sufficiency.

The 1983 edition of the Canadian Farm Building Code has been completely rewritten by a special task group established for this purpose by the Associate Committee on the National Building Code. It is presented in a format that permits its legal adoption by an authority having jurisdiction either directly or by reference.

The rationale for having special requirements for farm buildings, as distinct from other buildings, is based on the low human occupancy load, the remote location of typical farm structures or the special nature of the occupancies involved. Farm buildings that do not qualify as having "low human occupancy," that is an occupant load of not more than 1 person for each 40 m^2, are required to conform to the National Building Code in all respects. Dwelling units located on a farm are also required to conform to the National Building Code.

It is anticipated that material from the previous edition of this Code not related to health, fire safety or structural sufficiency will be available from other agencies serving the farming industry.

A table to convert SI units to imperial units can be found inside the back cover of this document.

Comments on the use of this Code and suggestions for its improvement are welcomed and should be submitted to the Secretary, the Associate Committee on the National Building Code, National Research Council of Canada, Ottawa, Ontario K1A 0R6.

PART 1 APPLICATION AND DEFINITIONS

SECTION 1.1 APPLICATION

SUBSECTION 1.1.1. GENERAL

1.1.1.1. This Code covers structural sufficiency, fire safety and health requirements for the protection of persons in *farm buildings*.

1.1.1.2. This Code shall be administered in conformance with the appropriate provincial or municipal regulations or, in the absence of such regulations, in conformance with the ACNBC "Administrative Requirements for Use with the National Building Code 1980."

1.1.1.3. *Farm buildings* shall conform to the appropriate requirements in the National Building Code of Canada 1980 except as specifically amended or exempted by the provisions of this Code. (See Appendix A.)

SECTION 1.2 DEFINITIONS AND ABBREVIATIONS

SUBSECTION 1.2.1. DEFINITIONS

1.2.1.1. Definitions of words and phrases used in this Code that are not included in Article 1.2.1.2. shall have the meanings which are commonly assigned to them in the context in which they are used, taking into account the specialized use of terms with the various trades and professions to which the terminology applies.

1.2.1.2. The words and terms in italics in this Code shall have the meanings as defined in the National Building Code of Canada 1980 and in the following:

Farm building means a *building* which does not contain a *residential occupancy* and which is (a) associated with and located on land devoted to the practice of farming and (b) used essentially for the housing of equipment or livestock, or the production, storage or processing of agricultural and horticultural produce or feeds, such as barns, produce storage *buildings*, milking centres, piggeries, poultry houses, grain bins, silos, machinery sheds, farm workshops, feed preparation centres, tobacco pack barns, manure storages, greenhouses and garages not attached to the farm residence.

Load-sharing system means a construction composed of 3 or more essentially parallel wood members, spaced at 610 mm centres or less, so arranged or connected that they mutally support the load.

Low human occupancy (as applying to *farm buildings*) means an *occupancy* having an *occupant load* of not more than 1 person per 40 m^2 during normal use.

SUBSECTION 1.2.2. ABBREVIATIONS

1.2.2.1. Abbreviations for the names of organizations or authorities in this Code have the following meanings:

ACNBC.... Associate Committee on the National Building Code
(National Research Council of Canada,
Ottawa, Ontario K1A 0R6)

CSA..... Canadian Standards Association
(178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3)

1.2.2.2. Abbreviations of words and phrases in this Code have the following meanings unless otherwise defined:

°C	degree(s) Celsius
g	gram(s)
h	hour(s)
kg	kilogram(s)
kN	kilonewton(s)
kPa	kilopascal
L	litre(s)
m	metre(s)
min	minute(s)
mm	millimetres
o.c.	on centre
s	second(s)
wt	weight
p	mass density, kg/m^3

PART 2 STRUCTURAL DESIGN

SECTION 2.1 GENERAL

SUBSECTION 2.1.1. MATERIALS

2.1.1.1.(1) Structural wood members in long-term contact with earth, manure or damp poultry litter shall be pressure-treated with a wood preservative in conformance with CSA-O80-1974, "Wood Preservation."

(2) Toxic chemicals such as those based on pentachlorophenol or creosote shall not be used for treating wood in direct contact with food products or animal feeds.

SECTION 2.2 STRUCTURAL LOADS AND PROCEDURES

SUBSECTION 2.2.1. LOADS DUE TO USE

2.2.1.1. Except as provided for in Article 2.2.1.8., the specified *live load* supported on a floor or suspended from a ceiling shall be not less than the values listed in Table 2.2.1.A.

Table 2.2.1.A.
Forming Part of Article 2.2.1.1.

MINIMUM SPECIFIED LOADS DUE TO USE		
Type of Load	Minimum Specified Load	
	kPa	Load Between Adjacent Aisles, kN/m length of aisle
Cattle		
tie stall — cow platforms, feed alleys	3.5	—
cow traffic alleys (e.g. litter alleys)	5.0	—
loose housing	5.0	—
holding areas	5.0	—
milking parlours	3.5	—
milking rooms and milk houses	2.5(1)	—
Sheep	1.5	—
Swine		
solid floors	2.5	—
Horses	5.0	—
Turkeys(2)	2.0	—
Greenhouses	2.5	—
Chickens		
housed without cages(2)	2.0	—
housed in cages(2),(3)		
2 levels of cage equipment		
with dropping boards	—	1.7
without dropping boards(3)	—	1.4
3 levels of cage equipment		
with dropping deflectors	—	2.7
with dropping boards(3)	—	3.0
4 levels of cage equipment		
with dropping deflectors	—	3.0
Column 1	2	3

Notes to Table 2.2.1.A.:
(1) See Article 2.2.1.2.
(2) See Article 2.2.1.3.
(3) See Appendix A.

2.2.1.2. A floor under a bulk milk tank shall be designed to support the load from the tank plus its contents.

2.2.1.3. Spaces designed for the accumulation of poultry manure shall have a minimum specified live load of not less than 1 kPa for each 100 mm depth of manure.

2.2.1.4. Floors supporting stored products shall be designed for the loads due to their intended use, but not less than 5.0 kPa. (See Appendix A.)

2.2.1.5.(1) Except as provided in Sentence (2), the uniformly distributed *live load* on an area of floor used for farm machinery traffic shall be not less than 7.0 kPa.

(2) Where it is anticipated that the area will be occupied by either loaded farm trailers and trucks or farm tractors having a mass in excess of 6 000 kg, including the mass of mounted equipment, the *live load* shall be not less than 10 kPa.

(3) Concentrated *live loads* due to tractors and farm machinery shall be not less than 23 kN per wheel, applied over an area of 750 mm by 750 mm, located so as to cause maximum effects.

(4) Where an area serves as a place for vehicle loading, unloading or processing, the minimum *live loads* for such areas shall be increased by 50 per cent to allow for impact or vibration of the machinery or equipment.

2.2.1.6. Except as provided in Article 2.2.1.7., the specified *live load* for livestock penned in groups on slotted floors in which the individual slats are not interconnected shall be not less than the values listed in Table 2.2.1.B.

2.2.1.7. Slotted floors in which the slats are interconnected in grids shall be designed for the *live loads* in both Columns 2 and 3 of Table 2.2.1.B., whichever produces the greatest effect.

Table 2.2.1.B.
Forming Part of Article 2.2.1.6.

FLOOR LOADS FOR GROUPS OF ANIMALS ON SLOTTED FLOORS		
Livestock	*Live Loads* for Design of a Floor Slat, kN/m of slat	Distributed *Live Loads* for Design of Slotted Floors and Their Supports, kPa
Dairy and beef cattle	4.5	5.0
Dairy and beef calves up to 150 kg	2.2	2.5
Sheep	2.0	2.5
Swine weaners up to 25 kg(1) feeders up to 100 kg sows up to 225 kg(1)	 0.7 1.5 2.5	 1.7 2.5 3.5
Column 1	2	3

Note to Table 2.2.1.B.:
(1) See Article 2.2.1.9.

2.2.1.8. Where loads other than those due to livestock may be present, such as from self feeders, they shall be provided for in the design. (See Appendix A.)

2.2.1.9. In addition to the loads in Article 2.2.1.6., slotted and perforated floors in weaner and farrowing pens shall be designed for a concentrated load of 1.1 kN, located so as to produce the greatest effect.

2.2.1.10.(1) Except as provided for in Sentence (2), cylindrical tower silos for whole plant silage of 65 per cent or less moisture content shall be designed for a lateral pressure in conformance with the following formula:

$$L = 4.8 + 0.58\ HD^{0.55}$$

where L = lateral pressure, kPa,
H = vertical distance from top of silo wall, m, and
D = silo diameter, m.

(2) Undrained, watertight cylindrical tower silos intended for storing whole plant silage at greater than 65 per cent moisture content shall be designed to take into account the hydrostatic pressure that may occur in addition to the pressure in Sentence (1). (See Appendix A.)

(3) Walls of tower silos shall be designed for a vertical load equal to the *dead load* of the walls and roof, loads due to suspended equipment and vertical wall friction of the silage in conformance with Sentences (4) and (5).

(4) For bottom-unloading tower silos, the total load of silage shall be assumed to be supported by vertical wall friction.

(5) For top-unloading concrete tower silos, vertical wall load due to friction shall be determined from the following formula:

$$F = \frac{\rho g\ H^2}{18\ 900}\left(1 - \frac{H}{14.2D}\right)$$

where F = vertical silage friction load per unit circumference, kN/m,
ρ = average mass density of the silage at 70 per cent moisture content, kg/m^3 (see Table 3 of the explanation for Sentence 2.2.1.13. in Appendix A),
g = acceleration due to gravity = 9.81 m/s^2,
H = silage depth, m, and
D = silo diameter, m.

(6) Annular ring footings for tower silos shall be designed to support loads due to the silo roof, equipment, wall and footing and the vertical wall friction of the silage.

(7) The total bearing area of soil under the annular ring footing plus floor shall be designed to support the load of the tower silo, foundation and contents.

(8) Concrete footings shall be designed to resist radial and tangential bending moments due to tower silo wall and soil reaction loads.

(9) Where 2 or more tower silos are built in close proximity, the *foundations* shall be designed for the combined effect of the soil pressures.

2.2.1.11.(1) Walls of horizontal silos that are vertical or slope not more than 10° from vertical shall be designed to withstand all anticipated loads due to stored products and superimposed vehicle loads. (See Appendix A.)

2.2.1.12.(1) Manure storage tank tops exposed to vehicular traffic or used as floors in *buildings* shall be designed for the loads due to the intended use.

(2) Outdoor manure storage tank tops not exposed to vehicular traffic shall be designed for *dead load* plus snow load, or *dead load* plus 2.0 kPa, whichever is greater.

(3) Manure storage tank walls and *partitions* shall be designed for an internal horizontal pressure based on a manure equivalent fluid density of 10 kN/m^3.

(4) Vertical external walls of manure tanks below ground level shall be designed to withstand anticipated horizontal soil pressures. (See Appendix A.)

(5) In addition to loads in Sentence (4), where soil within 1.5 m of the manure tank walls is subject to vehicular loads, such as manure tankers or trucks, the walls shall be designed for a horizontal surcharge load of 5.0 kPa, applied uniformly below ground level.

2.2.1.13. Storage for dry grains, ground feeds, fruits and vegetables shall be designed for the loads imposed by stored products. (See Appendix A.)

SUBSECTION 2.2.2. LOADS DUE TO SNOW

2.2.2.1. Simple gable roofs with slopes of 20° or less on *farm buildings* of *low human occupancy* need not be designed for unbalanced loads.

2.2.2.2. Except as provided in Article 2.2.2.3., roof areas of greenhouses of *low human occupancy* shall be designed for snow loads on the same basis as for other *farm buildings*.

2.2.2.3. Where a heating and drainage system is installed to prevent the accumulation of snow and water, the supporting structure for the light-transmitting roof areas of greenhouses of *low human occupancy* shall be designed for a uniform snow load of at least 0.7 kPa.

SUBSECTION 2.2.3. LOADS DUE TO WIND

2.2.3.1. The minimum reference velocity pressure, q, for the design of structural members of *farm buildings* of *low human occupancy* shall be based on a probability of being exceeded once in 10 years.

SUBSECTION 2.2.4. LOADS DUE TO EARTHQUAKES

2.2.4.1. *Farm buildings* of *low human occupancy* need not be designed for loads due to earthquakes.

SECTION 2.3 DESIGN PROCEDURES

SUBSECTION 2.3.1. ALLOWABLE STRESSES AND LOAD FACTORS

2.3.1.1.(1) Except as provided for in Sentence (2), where *farm buildings* of *low human occupancy* are designed in conformance with Part 4 of the National Building Code of Canada 1980

(a) the allowable stresses in working stress design are permitted to be increased by 25 per cent,
(b) the importance factor on the effect of factored loads, other than *dead loads*, in limit states design is permitted to be 0.8, and
(c) except for the *dead load* factor, the load factors in reinforced concrete design are permitted to be reduced by 20 per cent.

(2) Sentence (1) does not apply to

(a) the design of circumferential reinforcement in cylindrical tower silos, or
(b) the modulus of elasticity of materials.

2.3.1.2. Allowable unit stresses applicable to wood used in load sharing systems may also be applied to graded lumber used in roof trusses for *farm buildings* of *low human occupancy* provided the trusses are spaced not more than 1 220 mm o.c.

SUBSECTION 2.3.2. DESIGN BASED ON LOAD TESTS

2.3.2.1. Where the load carrying capacity of a structural assembly for a *farm building* of *low human occupancy* is based upon load tests, at least 3 representative sample assemblies selected at random shall be capable of supporting 100 per cent of the specified *dead load* and *live load* for 1 h without exceeding allowable deflection limits as given in Sentence 4.1.1.5.(1) of the National Building Code of Canada 1980 and 100 per cent of the specified *dead load* plus 200 per cent of the specified *live load* for 24 h without structural failure.

PART 3 FIRE SAFETY

SECTION 3.1 GENERAL

SUBSECTION 3.1.1. APPLICATION

3.1.1.1. Unless specifically required, *farm buildings* of *low human occupancy* need not conform to the requirements of Parts 3 and 9 of the National Building Code of Canada 1980 with regard to fire safety or egress, but shall conform to the requirements of this Part. (See Appendix A.)

3.1.1.2.(1) When *farm buildings* of *low human occupancy* other than greenhouses exceed the *floor areas* shown in Table 3.1.1.A. on any one *storey*, they shall be separated into *fire compartments* by *vertical fire separations* of *noncombustible construction*, having a *fire-resistance rating* of at least 1 h, so that each portion so separated has a *floor area* on any one *storey* conforming to Table 3.1.1.A.

Table 3.1.1.A.
Forming Part of Article 3.1.1.2.

Maximum Number of *Storeys*	Maximum *Floor Area* m^2/*Storey*
1	4 800
2	2 400
3	1 600
Column 1	2

SUBSECTION 3.1.2. SPATIAL SEPARATIONS

3.1.2.1. Except for greenhouses, where *exposing building faces* of a *farm building* of *low human occupancy* are located less than 30 m from a property line, the centreline of a public thoroughfare, a residence or a high human *occupancy farm building* on the farm property, the appropriate requirements in Subsection 9.10.15. of the National Building Code of Canada 1980 for *medium hazard industrial occupancies* shall apply to those faces. (See Appendix A.)

SUBSECTION 3.1.3. FIRE STOPPING

3.1.3.1. *Fire stops* shall be provided at floor, ceiling and roof levels to cut off all concealed draft openings occurring between *storeys* and between the top *storey* and roof space, including spaces filled with batt, loose fill or foamed plastic insulation. (See Appendix A.)

3.1.3.2. The maximum dimension of any concealed space in a wall or partition of *combustible construction* shall not exceed 3 m vertically or 6 m horizontally.

3.1.3.3. Every concealed space created by a suspended ceiling, roof space or unoccupied attic space shall be separated into compartments by *fire stops* so that no dimension of such space exceeds 30 m.

3.1.3.4. *Fire stops* shall consist of not less than 0.36 mm sheet steel, 6 mm asbestos board, 12.7 mm gypsum board, 12 mm plywood or waferboard with joints backed with similar material, 2 layers of 19 mm lumber with joints staggered or 38 mm lumber.

3.1.3.5. Where *fire stops* are pierced by pipes, ducts or other elements, the effectiveness of the *fire stops* shall be maintained around such elements.

SUBSECTION 3.1.4. FUEL STORAGE TANKS

3.1.4.1. Except as provided in Article 3.1.4.3., fuels in liquid form in quantities exceeding 100 L shall be stored outdoors or in *buildings* used for that purpose only and shall be separated from other *occupancies*, property lines and centrelines of roads by a distance of at least 30 m.

3.1.4.2. The minimum separation between a flammable or combustible liquid storage tank and a liquified petroleum gas cylinder or tank shall be in conformance with Part 4 of the National Fire Code of Canada 1980.

3.1.4.3. Underground fuel storage tanks shall be separated from *buildings* and from property lines by a distance of 1.5 m.

SUBSECTION 3.1.5. FIRE COMPARTMENTS

3.1.5.1.(1) Except as provided in Articles 3.1.5.2. and 3.1.5.3., fuel-fired *appliances* in *farm buildings* of *low human occupancy* shall be located in a *service room* or *service space* designed for that purpose, and separated from the remainder of the *building* by a *fire separation* having a *fire-resistance rating* of not less than ½ h.

(2) In *farm buildings* of *low human occupancy*, rooms used for crop drying or rooms in which farm machinery is repaired shall be separated from other *occupancies* by *fire separations* having a *fire-resistance rating* of at least ½ h. (See Appendix A.)

3.1.5.2. Fuel-fired *space heating appliances*, space-cooling *appliances* and *service water heaters* that serve only 1 room or serve a *farm building* of *low human occupancy* having a *building area* of not more than 400 m^2 and not more than 2 *storeys* in *building height* need not be separated from the remainder of the *building*, as required in Sentence 3.1.5.1.(1), where the equipment has been designed for such use.

3.1.5.3. *Service rooms* containing incinerators shall be separated from the remainder of the *farm building* of *low human occupancy* by a *fire separation* having a *fire-resistance rating* of not less than 1 h.

SUBSECTION 3.1.6. EXPOSED FOAMED PLASTIC INSULATION

3.1.6.1. Exposed foamed plastic material in *farm buildings* of *low human occupancy* shall be protected on the interior surfaces in conformance with Section 9.30 of the National Building Code of Canada 1980, or by the use of galvanized sheet steel not less than 0.30 mm in thickness on the interior surfaces with no air space between the sheet steel and the protected insulation.

SUBSECTION 3.1.7. LIGHTNING PROTECTION

3.1.7.1. Lightning protection devices where used shall be installed in conformance with CSA B72-1960, "Code for the Installation of Lightning Rods."

SECTION 3.2 EGRESS

SUBSECTION 3.2.1. GENERAL

3.2.1.1.(1) Except as permitted in Sentence (2), *exits* in *farm buildings* of *low human occupancy* shall consist of an exterior doorway, or an openable window or panel providing an opening measuring at least 550 mm by 900 mm with a stair or ladder as required in Article 3.2.1.2.

(2) An *exit* from a top-unloading tower silo may be an opening not less than 550 mm by 550 mm into the silo chute.

3.2.1.2.(1) Except as provided in Sentence (2), a stair shall be provided where a doorway is more than 300 mm above the adjacent ground level.

(2) If the bottom of a wall opening serving as an *exit* in Article 3.2.1.1. is more than 2.5 m above ground level, a permanently installed outside ladder conforming to Subsection 3.2.2. or a stair shall be provided.

SUBSECTION 3.2.2. LADDERS

3.2.2.1. Permanently installed ladders and their fastenings to the *building* shall be designed for a concentrated load of 1.0 kN, applied so as to produce the most critical stress in the member concerned.

3.2.2.2. Permanently installed ladders serving as *exits* in Article 3.2.1.1.(1) shall terminate not more than 1.5 m and not less than 1.0 m above ground level.

3.2.2.3. A clear space of not less than 175 mm shall be provided behind the rungs, steps or cleats of any permanently installed ladder.

3.2.2.4. The spacing of rungs, steps or cleats of any ladder shall be uniform and shall not exceed 300 mm.

3.2.2.5. The distance between the side rails of any ladder shall be not less than 250 mm.

3.2.2.6. Safety cages shall be provided around permanently installed ladders of more than 6 m in height, starting not more than 3 m from the bottom of the ladder.

SUBSECTION 3.2.3. EXITS

3.2.3.1.(1) *Exits* in Article 3.2.1.1. shall be located and arranged so that they are clearly visible or their locations are clearly indicated.

(2) *Exits* in Article 3.2.1.1. shall be accessible at all times.

3.2.3.2. Except as provided in Article 3.2.3.3., every *farm building* of *low human occupancy* shall be served by at least 2 *exits*, spaced remotely from each other at opposite ends of the *building*.

3.2.3.3. *Farm buildings* of *low human occupancy* of not more than 200 m^2 in *floor area* and *farm buildings* storing bulk crops of low combustibility, such as silage, grain, fruit and vegetables, may be served by 1 *exit*.

3.2.3.4.(1) Except as provided in Sentence (2), the travel distance to an *exit* in a *farm building* of *low human occupancy* shall not exceed

(a) 20 m in *buildings* used for liquid fuel storage in excess of 100 L, and
(b) 45 m in other *buildings*.

(2) Sentence (1) need not apply if *exits* are placed along the perimeter and are not more than 60 m apart, measured along the perimeter.

PART 4 HEALTH

SECTION 4.1 WASTE DISPOSAL

SUBSECTION 4.1.1. LIQUID MANURE STORAGE TANKS

4.1.1.1.(1) Covers providing access to liquid manure storage tanks shall either be designed to prevent them from being dropped through their openings or shall be permanently secured with safety chains.

(2) Liquid manure storage tank tops shall be designed to support loads due to the use and *occupancy* of the area.

4.1.1.2. Where a separate liquid manure storage tank is connected to an animal *building*, traps or valves shall be installed to prevent gases from the manure storage tank from entering the *building*.

4.1.1.3. Ladders shall not be installed in closed liquid manure tanks.

4.1.1.4. Liquid manure tanks without covers shall be provided with a fence at least 1.2 m in height except where the tank walls extend at least 1.2 m above the adjacent ground level.

SUBSECTION 4.1.2. MANURE HOPPER OPENINGS

4.1.2.1. Manure hopper openings at or below floor level shall be fitted with a safety railing or floor grill having an opening of not more than 100 mm in width.

SUBSECTION 4.1.3. MILK CENTRE WASTES

4.1.3.1. A gas trap shall be provided on the delivery pipe for milk centre wastes between the milk centre and the sediment tank or other storage.

SECTION 4.2 VENTILATION

SUBSECTION 4.2.1. GAS PROTECTION AT SILOS AND ATTACHED FEED ROOMS

4.2.1.1. Where a roofed tower silo or an enclosed horizontal silo connects with an adjacent closed feedroom, powered exhaust ventilation of not less than 3 air changes per hour to the exterior shall be provided from the lowest floor level of the feedroom.

4.2.1.2. Where an enclosed silo feedroom connects with a stable, the ventilation system shall be designed to prevent airflow from the feedroom to the stable.

4.2.1.3. A sign indicating the danger of silo gas shall be installed adjacent to the chute or ladder on vertical silos.

SUBSECTION 4.2.2. GREENHOUSES

4.2.2.1. Where fuels are burned in greenhouses, separate combustion air and flue systems shall be provided except where the system is specifically designed as a generator for carbon dioxide enrichment of the greenhouse atmosphere.

SECTION 4.3 ACCESS COVERS

SUBSECTION 4.3.1. GENERAL

4.3.1.1. Manhole covers and liquid manure storage tank access covers of less than 20 kg shall be equipped with locking devices.

APPENDIX A

EXPLANATORY MATERIAL
for the
Canadian Farm Building Code 1983

Article 1.1.1.3. APPLICATION

Part 9 of the National Building Code of Canada 1980 provides detailed requirements for the construction of small buildings up to 600 m^2 per floor and 3 storeys in height which apply to all occupancies except assembly, institutional and high hazard industrial. All other buildings must be designed to satisfy the requirements in the remainder of the National Building Code of Canada 1980.

Table 2.2.1.A. MINIMUM DESIGN FLOOR LOADS DUE TO USE

Chicken cage manufacturers should be consulted for information on the type and spacing of supports (floor stand or suspended type).

Bird mass is based on eight 1.8 kg birds for each 300 mm length of deck. On this basis a 3-deck cage row has 24 birds in 300 mm of cage row length.

Dropping boards used to prevent soiling of the lower level cages are assumed to accummulate 50 mm of wet manure between cleaning operations.

Article 2.2.1.4. FLOORS SUPPORTING STORED PRODUCT

Densities of agricultural materials are given in Table 3 under the explanation for Article 2.2.1.13. in this Appendix.

Article 2.2.1.8. FLOOR LOADS DUE TO FEEDING EQUIPMENT

In the absence of specific information, floors supporting feeding equipment should be designed for the following concentrated loads, located so as to produce the most critical effects:

Feeding equipment for weaner pigs — 2.5 kPa over an area of 750 mm by 300 mm.

Feeding equipment for growing and finishing pigs — 5.0 kPa over an area of 1 200 mm by 1 000 mm.

Sentence 2.2.1.10.(2) STORAGE OF WHOLE PLANT SILAGE AT A MOISTURE CONTENT GREATER THAN 65 PER CENT

Sentence 2.2.1.10.(1) gives a formula for lateral pressure in concrete tower silos intended for whole-plant silages of 65 per cent or less moisture content (wet basis). Tall silos filled with excessively wet silage can develop sufficient compaction pressure in the bottom part to squeeze almost all of the gases out of the silage. At this point, the silage is essentially saturated and silage juice starts to drain out of any wall or floor openings. However, if the silo is made relatively water tight, the silage juice in the saturated zone can produce hydrostatic pressure, in addition to the pressure of the silage material. There is no precise guideline for determining the saturation depth. Rough estimates of the H_s for alfalfa silage are 30 m for 65 per cent, 16 m for 70 per cent and 11 m for 75 per cent moisture. Where farming practices are likely to produce excessively wet silage, the designer should assume a silage depth, H_s, at which saturation can occur, then calculate the silage lateral pressure, L_s, at the top of the saturated zone and the lateral pressure, L_w, within the saturated zone from the following formulas:

$$L_s = 4.8 + 0.58\, H_s D^{0.55} \qquad (1)$$

$$L_w = L_s + (9.81 - L_s/D)\,(H-H_s) \qquad (2)$$

Figure 1 shows an example pressure versus depth diagram for 70 per cent moisture silage. Saturated conditions are assumed to be reached at H_s = 16 m. In this example, formula (1) above gives a lateral pressure L_s = 29.9 kPa at 16 m depth. At greater depths, silage pressure is assumed to remain constant at 29.9 kPa, but the hydrostatic pressure (adjusted for silage friction) is added to give saturated pressure L_w. (See formula (2).)

Sentence 2.2.1.10.(2) (Cont'd)

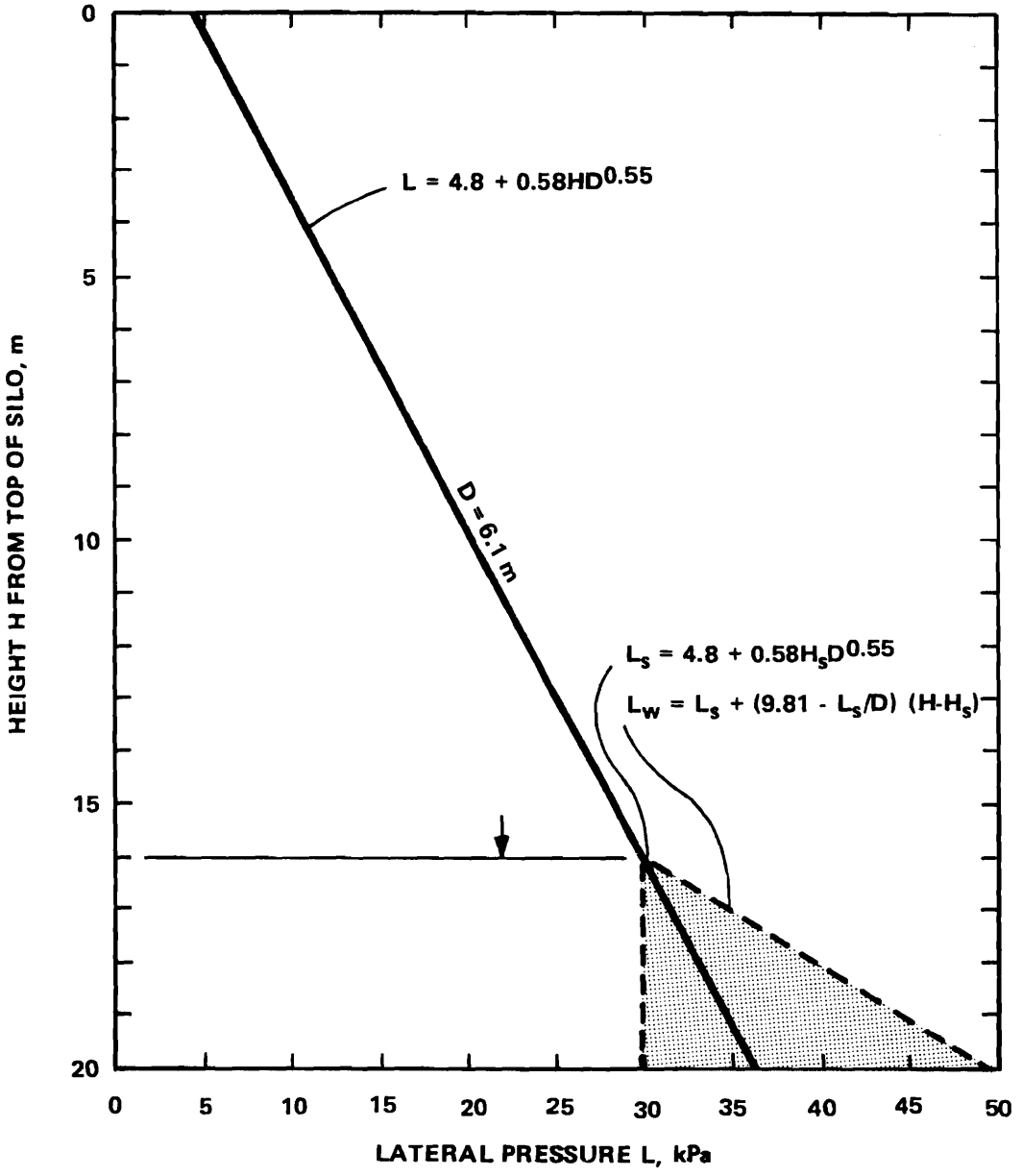

Figure 1 Lateral pressure in a 6.1 m diam cylindrical concrete tower silo for whole plant silage

Sentence 2.2.1.11.(1) Loads on the Walls of Horizontal Silos

Walls of horizontal silos that are vertical or slope not more than 10° from the vertical shall be designed

(a) for a pressure of 6.7 kPa applied normally and uniformly to the area below a line 0.6 m from the top of the wall, and
(b) for a triangular pressure distribution beginning at 0.0 kPa at the top edge and increasing to 6.7 kPa at 0.6 m from the top as shown in Figure 2.

In addition, walls of horizontal silos intended for packing by the use of tractors should be designed for a single load of 5.0 kN, applied normally to an area 0.6 m by 0.6 m, centred 0.6 m below the silage surface and located to produce the most critical design condition.

The silo wall surcharge load due to packing by the use of tractors is based on a maximum wheel load of 1 600 kg (gross tractor mass 4 600 kg, 4 wheels). The surcharge load normal to the silo wall is assumed to be 30 per cent of the wheel load.

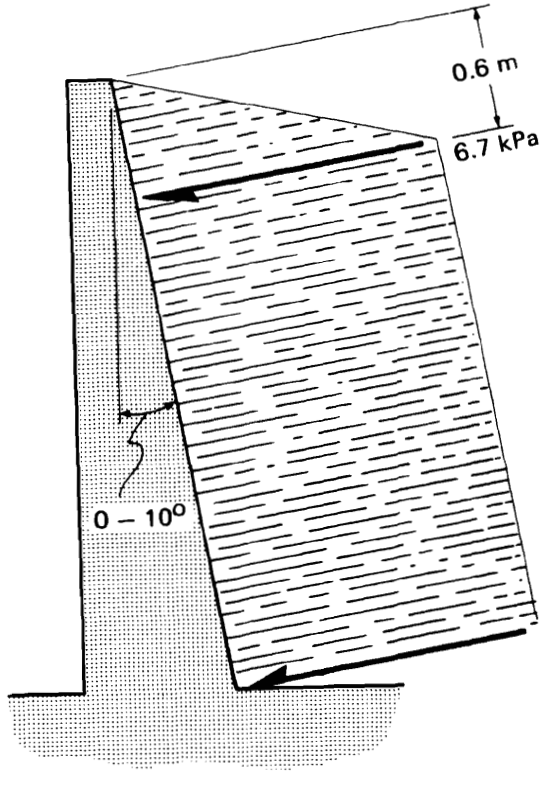

Figure 2 Pressure due to silage on walls of horizontal silos

Article 2.2.1.12.(4)

Vertical external walls of manure tanks below grade should be designed for external horizontal soil pressures based on the following soil equivalent fluid densities:

clean sand and gravel, well drained — 4.7 kN/m^3,
sand and gravel with fines, restricted permeability — 5.7 kN/m^3,
stiff residual silts and clays — 7.0 kN/m^3, and
soft silts and clays, poorly drained — 16.0 kN/m^3.

Article 2.2.1.13. DESIGN OF PRODUCE STORAGE FACILITIES

PRESSURES IN GRAIN AND GROUND FEED STORAGE

Symbols used in calculating grain and feed storage pressures are as follows:

F = maximum vertical load per unit of wall perimeter due to friction, kN/m,
L = horizontal pressure against the bin wall, kPa,
V = L/K = vertical pressure on the bin floor or within the grain mass, kPa,
μ = $\tan \emptyset_1$ = coefficient of friction between the fill material and the bin wall as given in Table 1,
k = ratio of horizontal to vertical pressure as given in Table 2,
H = depth below surface of fill or where surface would be if fill was levelled, m,
D = bin diameter, m,
R = hydraulic radius for circular bins = ¼ diam,

$$\text{for rectangular bins} = \frac{2ab-a^2}{4b} \text{ (long side)}$$

$$= \frac{a}{4} \text{ (short side)}$$

where a = length of short side, and
b = length of long side,

ρ = bulk density, kg/m^3 as given in Table 3,
g = acceleration due to gravity, 9.81 m/s^2,
ϕ = angle of internal friction,
e = natural log base = 2.71828.

Table 1

COEFFICIENTS OF FRICTION FOR GRAIN

Kind of Grain	Moisture Content, per cent (wet basis) (3)	Coefficient of Friction of Grain on			Internal Friction Within the Grain, (2) tan ϕ
		Smooth Steel, μ	Plywood, μ	Concrete, (1) μ	
Wheat, Barley, Shelled Corn	13.5	0.3	0.4	0.6	0.5
Soybean	11.0	0.2	0.35	0.5	0.5
Flaxseed	9.0	0.2	0.35	0.4	0.25
Canola (Rapeseed)	9.0	0.2	0.35	0.4	0.5
Column 1	2	3	4	5	6

Notes to Table 1:

(1) Values are for rough textured concrete. Where concrete is placed against smooth forms and polished by the repeated flow of grain, values will be approximately 2/3 of those shown.

(2) For very rough surfaces, sliding may occur within the grain mass rather than on the surface.

(3) The moisture content of grain on the wet basis is the weight of water in the grain divided by the weight of the wet grain. For higher moisture contents, the values of friction coefficients will be appreciably higher, but maximum pressures will occur with clean, dry grain as given in Table 1.

Article 2.2.1.13. (Cont'd)

Table 2

RATIO OF HORIZONTAL TO VERTICAL PRESSURES		
Type of Grain	Values of k	
	Smooth Wall	Rough Wall
Wheat Barley Corn Soybeans	0.4	0.6
Durum Wheat	0.42	0.65
Oats	0.55	0.8
Flaxseed	0.55	0.8
Canola (Rapeseed)	0.45	0.65
Column 1	2	3

Article 2.2.1.13. (Con't)

Table 3

APPARENT DENSITIES OF AGRICULTURAL MATERIALS IN STORAGE	
Material	Apparent Density, ρ, kg/m^3
Grains and Seeds (1)	
Barley	650
Buckweat	670
Corn	
shelled, 15.5 per cent moisture	800
28 per cent moisture	830
ground shelled	850
husked ear corn	450
ground ear corn	600
Flax seed	700
Lentils	780
Mustard seed	770
Oats	500
Ground or rolled oats	300–400
Peas	820
Rapeseed	
argentine	770
turnip rape	670
Rice, rough	600
Rye	750
Soybeans	780
Sunflowers	320–420
Wheat	
Red Spring	840
Durum	840
Concentrated Feeds	
Alfalfa meal, dehydrated	250–350
Alfalfa pellets	650–700
Beet pulp, dried	175–250
Brewers grains	
dried	240
wet	900–960
Bone meal	800–850
Column 1	2

Article 2.2.1.13. (Cont'd)

Table 3 (Cont'd)

APPARENT DENSITIES OF AGRICULTURAL MATERIALS IN STORAGE	
Material	Apparent Density, ρ, kg/m^3
Concentrated Feeds	
Fish meal	500–550
Meat meal	600
Linseed oil meal	525
Soya bean oil meal	550–650
Salt	1 000–1 100
Wheat, bran	250
Wheat middlings	300–400
Pelleted ration	600
Crumbled ration	550
Roughage Feeds and Bedding	
Hay (air-dried)	
long	80
chopped	160
baled	160
wafered	325
Silage, 70 per cent moisture content, wet basis[2]	
stored 3 m deep, average	550
" 10 m " "	685
" 12 m " "	745
" 14 m " "	795
" 16 m " "	845
" 18 m " "	890
" 20 m " "	940
" 22 m " "	980
" 24 m " "	1 015
" 26 m " "	1 055
Straw	
long	60
chopped	100–130
field baled	130
Wood shavings, baled	320
Column 1	2

Article 2.2.1.13. (Cont'd)

Table 3 (Cont'd)

APPARENT DENSITIES OF AGRICULTURAL MATERIALS IN STORAGE	
Material	Apparent Density, ρ, kg/m^3
Fruits and Vegetables	
Apples (bulk)	600
Apples (stacked in bushel boxes)	500
Beans	
unshelled	400
shelled	800
Cabbage	450
Carrots	650
Cherries	650
with stems	700
without stems	800
Cranberries	500
Onions, dry	650–740
Potatoes	670
Miscellaneous Products	
Eggs in cases	200
Tobacco	550
Wool	
compressed bales	775
uncompressed bales	200
Fertilizer	950–1 100
Fresh manure (feces and urine mixed)	1 000
Column 1	2

Notes to Table 3:

(1) The tabulated values for grains and seeds are slightly higher than those used in grading grain, because grain dropped into a storage is denser than grain poured into a standard sampling container.

(2) The moisture content of silage on the wet basis is the mass of water in the silage divided by the mass of the wet silage. The apparent density, D, in kg/m^3 of silage at a moisture content other than 70 per cent is equal to

$$30\ (D_{70})/(100\text{-}M)$$

where D_{70} = apparent density at 70 per cent wet basis
M = moisture content of silage, wet basis.

Article 2.2.1.13. (Cont'd)

SHALLOW BINS (bins in which the depth does not exceed 0.75 times the diameter or width)

Horizontal pressure, L, against the walls is equal to

$$\frac{C\rho gH}{1\,000} \text{ for level fill, and}$$

$$\frac{1.33\ C\rho gH}{1\,000} \text{ for heaped fill}$$

where C = 0.4 for cereal grains,
= 0.5 for oilseeds, and
= 0.3 for ground grain.

Vertical pressure, V, in a shallow bin is equal to

$$\frac{\rho gH}{1\,000}$$

For bins with sloping walls, Coulomb's equation may be used as follows:

$$P = \frac{\rho gH}{1\,000}\left[\frac{\sin^2(\beta - \phi)}{\sin^2\beta\ \sin(\beta + \phi_1)\left(1 + \sqrt{\frac{\sin(\phi + \phi_1)\sin(\phi - i)}{\sin(\beta - i)\sin(\beta + \phi_1)}}\right)^2}\right]$$

where P = unit pressure of stored product on bin wall, kPa,
ϕ_1 = angle of friction of material on bin wall (See Table 1, μ = Tan ϕ_1), and
i and β are angles as shown in Figure 3.

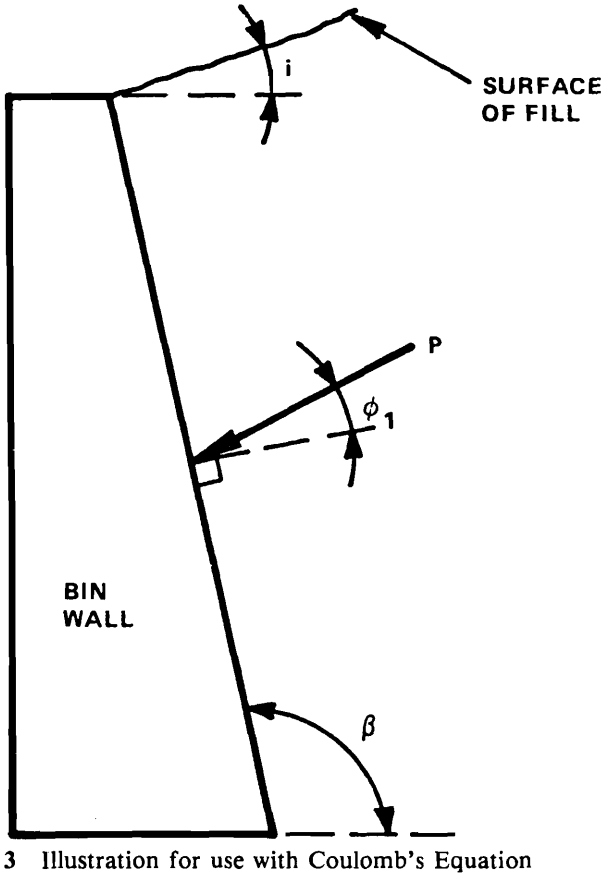

Figure 3 Illustration for use with Coulomb's Equation

Article 2.2.1.13. (Cont'd)

DEEP BINS (bins in which the depth exceeds 0.75 times the diameter or width)

The horizontal pressure, L, against the wall during filling is equal to

$$\frac{\rho g R}{1\,000\,\mu}\left[1 - e^{\left(\frac{-k\mu H}{R}\right)}\right]$$

At a depth equal to $\frac{2.5R}{\mu k}$, the maximum pressure, L_{max}, will be equal to

$$\frac{\rho g R}{1\,000\,\mu}$$

and will be constant to the bottom of the bin.

The maximum vertical load per unit of wall perimeter due to friction from contents, F, is equal to

$$\frac{\rho g R}{1\,000}\left[H - \frac{R}{k\mu} + \frac{R}{k\mu}e^{\left(\frac{-k\mu H}{R}\right)}\right]$$

In deep bins having a ratio of height to diameter of more than 2, horizontal pressures increase substantially during emptying if walls are smooth and slippery.

Centric Emptying

Where a flat-bottom bin is emptied through a central opening, the fill material forms a hopper of stationary material to a depth equal to the width or diameter of the bin. Increased horizontal pressures during emptying will be cushioned within this hopper and will be reduced to the filling pressure at floor level. For a hopper-bottomed bin the maximum pressure will occur at the junction of the hopper and the wall. The increased horizontal pressure in a smooth-wall bin during emptying is equal to

1.4 times the filling pressures for cereal grains, soybeans and canola, and

1.6 times the filling pressures for flaxseed and canary seed.

Eccentric Emptying

Where a bin is emptied from an opening near a wall, the cushioning effect of grain is not obtained, so the horizontal pressure increases that build up during emptying are of greater magnitude than for centric emptying and extend to near the opening.

The increased horizontal pressure which occurs at depths greater than $\frac{1.75R}{\mu k}$ is equal to

2.0 times the filling pressures for cereal grains, soybeans and canola, and

2.5 times the filling pressures for flaxseed and canary seed.

At depths less than $\frac{1.75R}{\mu k}$, the increase in horizontal pressure during emptying is in proportion to the depth.

PRESSURES DUE TO INCREASED MOISTURE

Moisture added to grain during storage causes it to swell and can produce lateral pressures equal to 3 to 4 times the filling pressures.

Article 2.2.1.13. (Cont'd)

PRESSURES IN BULK FRUIT AND VEGETABLE STORAGE

Symbols used in calculating fruit and vegetable storage pressures are as follows:

L = horizontal pressure against the bin wall, kPa,

V = vertical pressure on the bin floor or within the stored mass, kPa,

H = depth below surface of fill or where surface would be if fill was leveled, m,

ρ = bulk density, kg/m^3, as given in Table 3,

g = acceleration due to gravity, 9.81 m/s^2, and

θ = assumed angle of repose (32° for potatoes). For other vegetables, such as onions, carrots, turnips, θ is not readily available, however, the use of 32° for these vegetables will result in a safe design.

SHALLOW BINS (bins in which the depth is less than the diameter or width)

Horizontal pressure, L, against the vertical walls of a shallow bin is equal to

$$\frac{\rho g H}{1\,000}\left(\frac{1-\text{Sin}\,\theta}{1+\text{Sin}\,\theta}\right)$$

For potato storage, horizontal pressures for conservative design of vertical walls in shallow bins may be calculated, based upon equivalent fluid density of 2.00 kN/m^3.

Vertical pressure, V, on the floor of a shallow bin is equal to

$$\frac{\rho g H}{1\,000}$$

DEEP BINS (bins in which the depth is equal to or greater than the diameter or width)

Horizontal pressure, L, against the vertical walls of a deep bin is equal to

$$\frac{C\rho g H}{1\,000}\left(\frac{1-\text{Sin}\,\theta}{1+\text{Sin}\,\theta}\right)$$

where C = 1.0 where H is less than D,
= 0.8 where H is less than 1.5D but not less than D,
= 0.7 where H is less than 2D but not less than 1.5D, and
= 0.6 where H is not less than 2D.

Vertical pressure, V, on the floor of a deep bin is equal to

$$\frac{\rho g H}{1\,000}$$

Article 3.1.1.1. Fire Safety Requirements

The fire safety requirements in Part 6 of the National Building Code of Canada 1980 apply by virtue of Sentence 1.1.1.3.

Article 3.1.2.1. Definition of Exposing Building Face

The Canadian Farm Building Code 1983 regulates only the building under construction. The concern of the Code, therefore, is the exposure offered by that building (i.e. the exposing building) to an adjacent building (i.e. the exposed building) or property line.

Article 3.1.3.1. Fire Stopping

This requirement is not intended to prohibit concealed roof spaces being used as fresh air supply plenums for air distribution through porous ceilings or slotted inlets to rooms below.

Article 3.1.5.1. ESTIMATED FIRE-RESISTANCE RATINGS FOR ASSEMBLIES[1],[2]

Structure	Membranes	Fire Resistance, min
38 mm × 89 mm wood studs 400 mm o.c.	11.0 mm Douglas Fir plywood or waferboard (both faces)	30
	14.0 mm Douglas Fir plywood or 15.6 mm waferboard (both faces)	35
	4.5 mm asbestos cement board over 9.5 mm gypsum wallboard (both faces)	60
	12.7 mm gypsum wallboard (both faces)	35
	8.0 mm Douglas Fir plywood or 9.4 mm waferboard (both faces) with stud spaces filled with mineral wool batts	40
38 mm × 89 mm wood studs 600 mm o.c.	11.0 mm Douglas Fir plywood or waferboard (both faces) with stud spaces filled with mineral wool batts	30
	4.5 mm asbestos cement board over 9.5 mm gypsum wallboard (both faces)	30
Steel studs 400 mm o.c.	12.7 mm Type X gypsum wallboard (both faces)	35
	4.5 mm asbestos cement board over 9.5 mm gypsum wallboard (both faces)	50
Wood floor and roof joists (38 mm thickness) 400 mm o.c. or Open web steel joist floors and roofs with ceiling supports 400 mm o.c.	12.7 Type X gypsum wallboard ceiling	35
	4.5 mm asbestos cement board on 9.5 mm gypsum wallboard ceiling	50
	26 mm portland cement and sand or lime and sand plaster on metal lath ceiling	40
Column 1	2	3

Article 3.1.5.1. (Cont'd)

Structure	Membranes	Fire Resistance, min
90 mm hollow concrete blocks (normal weight aggregate)	—	45
140 mm hollow concrete blocks (normal weight aggregate)	—	60
190 mm hollow concrete blocks (normal weight aggregate)	—	90
Column 1	2	3

Notes to Table:

(1) Additional information on *fire-resistance ratings* for assemblies is given in Chapter 2, "Fire Performance Ratings" of the Supplement to the National Building Code 1980 and Article 9.10.4.1. of the National Building Code 1980.

(2) Interior walls are rated from both sides whereas floors and roofs are rated from below.

CONVERSION FACTORS		
To Convert	To	Multiply By
kg	lb	2.20462
kg/m^3	lb/cu ft	0.062428
kN	kip	0.224809
kPa	lbf/sq in	0.145038
L	gal.	0.219969
m	ft	3.28084
m^2	sq ft	10.7639
m^3	cu ft	35.3147
mm	in.	0.039370