

RESEARCH REPORT



Log House Construction Requirements



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LOG HOUSE CONSTRUCTION REQUIREMENTS

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**Canada Mortgage
and Housing Corporation**

**Société canadienne
d'hypothèques et de logement**

**Honourable Paul Cosgrove
Minister**

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PREFACE

In view of the increasing interest in log construction for houses, the many requests for information, and indeed requests for financing for homes of log construction, Canada Mortgage and Housing Corporation (CMHC) has prepared these Log House Construction Requirements.

This document is largely taken from *Interim Log House Construction Guideline*, developed in the Prince George Office of CMHC in 1978, which drew heavily on the log building experience and expertise of that district.

The document does not supersede the *Residential Standards*. Rather, it should be regarded as an extension to *Residential Standards* to deal with the special construction details of log house structures. All other aspects of the house will be governed by *Residential Standards*.

Neither is this document a guide on how to build log houses. The prospective log builder should read carefully the available publications on the subject.

Log house designs or systems, which do not conform to these requirements may be acceptable to Canada Mortgage and Housing Corporation once the design or system has been reviewed and found to be acceptable by Canada Mortgage and Housing Corporation. Canada Mortgage and Housing Corporation publishes a manual of acceptable building materials, systems and equipment which contains a listing of the manufactured log house systems which Canada Mortgage and Housing Corporation has reviewed and found to be acceptable.

Log construction requires careful attention to certain features, notably potential shrinkage, resistance to heat loss, and log jointing. Before building a log house, the uninitiated is advised to acquaint himself with these features, as well as with the nature and characteristics of available native woods.

CMHC welcomes comments and suggestions for improving these standards. Communications should be addressed to the Director, Technical Research Division, National Office, Canada Mortgage and Housing Corporation, Ottawa, Ontario.

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Part 1. Introduction

1.1 Organization

1.1.1 Each requirement is followed by a commentary, which outlines the various factors, ideas, and objectives that were considered in developing this document; the commentary is in coloured type to distinguish it from the requirements.

1.1.2 The numbering system used in this document is as follows:

- 4. Part
- 4.3 Section
- 4.3.2 Sub-section

1.1.3 Throughout this document Canada Mortgage and Housing Corporation is referred to as CMHC or "the Corporation".

1.2 General Requirements

1.2.1 Housing being financed under the National Housing Act must comply with the requirements contained in this document, except as follows: variations may be employed if they can be shown to be suitable on the basis of past performance or good engineering practice, or on the basis of tests, as provided for in Section 3A of *Residential Standards*.

1.2.2 All applications for the financing of log houses under the National Housing Act shall be supported by documents required by *Administrative Requirements NHA 5062*, having sufficient detail to permit CMHC to determine that the log house proposed is in accordance with these requirements.

1.3 Residential Standards

1.3.1 Unless specifically modified by this document, the requirements of *Residential Standards* shall be complied with in the design and construction of a log house.

1.3.2 Where higher standards than those contained in *Residential Standards* and the Builders' Bulletins published by the Corporation are required by municipal bylaws or provincial legislation, such higher standards shall govern.

1.3.3 For log houses built under CMHC's Rural and Native Housing Program, consideration may be given to relaxing the requirements of both *Residential Standards* and these requirements. Written approval must be obtained from CMHC for any departures from *Residential Standards* or these requirements prior to construction.

1.4 Other Reference Documents

1.4.1 The following documents are either mentioned in the text of this document or were used as resource material in its preparation; the applicant may wish to consult these documents when designing and building a log house.

(A) Canada Mortgage and Housing Corporation publications:

The following Builders' Bulletins:

282 *Thermal Resistance Values for Various Materials*

279 *Solid Fuel Burning Equipment*

270 *Standards of Construction Prescribed by CMHC*

267 *Further Measures to Conserve Energy*

263 *Lightweight Cellular Plastic Insulation Applied to the Outside of Walls*

262 *Requirements for Acceptance of Wood Roof Trusses and Metal Truss Connector Plates*

258 *Standards of Construction Prescribed by CMHC*

250 *1975 Standard "W" Truss Designs with Nailed Plywood Gussets*

- (B) Associate Committee on the National Building Code publications, National Research Council of Canada, Ottawa, Ontario:

Residential Standards, Canada
National Building Code of Canada
Climatic Information for Building Design in
Canada *Supplement No. 1 to the National Building Code of Canada.*

- (C) Other Publications:

Building with Logs, B. Allan Mackie
Notches of All Kinds, B. Allan Mackie
Vols. 1-4, *The Canadian Log House*
(Magazine)
Various publications on log construction,
University of Alaska
The Canadian Log Builders' Association
Building Standards
Construction Guide for Preserved Wood Foundations, PWF-1, 1977. Canadian Wood Council

The listing of publications in this document, other than those published by CMHC and the Associate Committee on the National Building Code, must not be taken as an explicit or implied endorsement of the information contained in these publications. The comments and recommendations they contain are those of the authors and do not necessarily represent the views of CMHC.

Commentary

This document is not a fully self-sufficient standard for the complete construction of a house. Rather, it extends *Residential Standards* to deal only with the log aspect of a log house, which in all other respects conforms to *Residential Standards*.

Certain features are mentioned that must be specially adapted for log construction, such as windows, doors and plumbing.

Residential Standards must be consulted for all other requirements.

Residential Standards generally reflect conditions in an urban setting. Materials and expertise may be less readily accessible in rural or remote locations, and CMHC has made provision in its Rural and Native Housing Program for relaxing some requirements, subject to the Corporation's approval.

Part 2. Scope and Definitions

2.1 Scope

2.1.1 These requirements apply to log houses of one storey, one storey with attic, one storey with basement, or one storey with developed basement or attic.

Crack a lengthwise separation in the wood across the grain

CSA Canadian Standards Association

2.1.2 Log houses other than as described in Sub-section 2.1.1 must be designed by an architect or engineer and are subject to individual acceptance by CMHC; the drawings for these log houses shall bear the seal of the designer.

Decay a decomposition of the wood substance due to action of wood-destroying fungi

Developed Attic a space between a sloping roof and the ceiling of the storey below used as a habitable area with rooms and spaces conforming to *Residential Standards*

2.2 Definitions

2.2.1 Definitions and phrases used in this document that are not included in the list of definitions shall have the meanings that are commonly assigned to them in the context in which they are used.

Developed Basement a space between the foundation and the floor of the storey above used as a habitable area with rooms and spaces conforming to *Residential Standards*

2.2.2 The words and terms used herein have the following meanings:

Dowels pins of wood or metal used to hold two or more logs together

Architect a person registered in a province or territory to practise architecture

Engineer a person registered in a province or territory to practise engineering

ASTM American Society for Testing Materials

Finished Grade the elevation of the ground surface around the foundation when the house is complete

Attic a space between a sloping roof and the ceiling of the storey below

Basement a space between a foundation and the floor of the storey above

Fire-kill standing timber where growth has ceased as a result of forest fires

Bird-pecks holes and damage in logs caused by woodpeckers and other species of birds

Flatted logs which are sawn or hewn on the top and bottom and on one side if desired

Bow a deviation flat-wise from a straight line drawn from end to end of a squared or flatted log

Gable Wall the upper triangular-shaped portion of the end wall of a house

Hollow Heart a void in the heart wood caused by decay or insect attack

Check a lengthwise separation of the wood, normally extending across the rings of annual growth and usually caused by seasoning; medium checks are not over 1 mm (1/32") wide and not over 250 mm (10") long.

Incremental Thermal Resistance the resistance to heat flow per unit of thickness

Lintels horizontal structural members that support the loads over openings such as doors and windows

Pinholes	holes that extend partially through a log and may be from any cause: pinholes shall not exceed 2 mm (1/16") in diameter	Shrinkage	dimensional changes in wood caused by a decrease in moisture content to below fibre saturation (approximately 30%)
Pith	a small soft core in the centre of a log	Sill Log	a structural log anchored to the top of a foundation, on which the floor joists rest
Plugged Holes	wood plugs and fillers are inserted into logs to fill knot or inspection holes. Such inserts may be in the form of splines 200 mm (8") or less in length, or in oval or circular shapes, and are set in waterproof glue in such a manner as to remain in the log	Spiral Grain	a type of grain pattern in which the fibres take a spiral course around the bole of a tree instead of a vertical course
Pockets	well-defined openings between the rings of annual growth, which develop during the growth of the tree. They usually contain pitch or bark	Spline	a rectangular strip of wood that fits the grooves cut into logs
Sap Stain	a deterioration of the sap wood caused by the action of fungi that is not accompanied by softening or other disintegration of the wood	Split	a lengthwise separation of the wood caused by the tearing apart of wood cells
Scars	depressions in the surface of a log resulting from wounds where healing has not re-established the normal cross-section of the log	Storey	that portion of a house between the top of any floor and the ceiling above it
Scribing	fitting logs to the irregular surface of other logs by means of a metal scriber	Sweep	the deviation of a log from straightness
Seasoning	the act of drying logs, either naturally, or artificially in a kiln; the removal of moisture from wood to improve its serviceability	ULC	Underwriters' Laboratories of Canada
Shakes	separations of wood along the grain, usually occurring between the rings of annual growth	Wane	bark or lack of wood from any cause on the edge or corner of a squared or flatted log
Short Crook	a localized deviation from straightness that, within any section 1500 mm (5'-0") or less in length, is more than one half the mean diameter of the crooked section	Warp	any form of deviation of a squared or flatted log about its longitudinal axis
		Commentary	CMHC has chosen to limit the application of these requirements to modest housing as defined in Sub-section 2.1.1. It was considered useful to include a list of definitions to establish the meaning of certain words and terms in the context of the requirements. This has been done in the interests of clarity and to avoid confusion both within CMHC and on the job site.

Part 3. Space Requirements

3.1 Room and Space Dimensions

3.1.1 Rooms and spaces within log houses shall conform to the requirements of *Residential Standards*.

3.1.2 In areas where an adequate supply of fuel other than oil, gas, or electricity is available and the homeowner applicant proposes to use this fuel for domestic purposes, details of the fuel storage facilities and of any measures necessary to protect the fuel against accidental combustion shall be provided.

3.2 Site Requirements

3.2.1 The site requirements of *Residential Standards* shall be complied with.

3.2.2 All log houses in remote locations, or where a municipal fire-fighting service is not available, shall be equipped with a supply of water for emergency fire-fighting and a type ABC fire extinguisher.

Commentary

Although the construction technique for log houses differs somewhat from that for conventional housing, the space and area requirements of the occupants of log houses are in general similar to those of the occupants of frame housing. Therefore the area and dimensional requirements of *Residential Standards* are referenced. In recognition of the fact that in rural or remote areas the homeowner may wish to use wood rather than gas, oil, or electricity as his primary heating and cooking fuel, the requirements permit this alternative, but requires information on storage and on measures taken to prevent accidental combustion of the wood or coal.

In addition to the requirements of *Residential Standards*, CMHC feels that because many of the log houses built under the log house requirements will be in rural or remote locations, some additional considerations with regard to fire safety should be included. It is also recommended that an area within at least 15 m (50') around the house be cleared of all brush and undergrowth; this is to permit the burning of rubbish and to provide a minimum spatial separation between combustible material and the house. However, it must be recognized that a forest fire sweeping through any standing timber in the vicinity of a log house, or frame house for that matter, poses a very serious hazard. The provisions and recommendations of this document are designed to increase the margin of safety should forest or brush fires occur.

Part 4. Log Materials

4.1 Species

4.1.1 Logs used in the construction of log houses shall be obtained from the following species:

a) Softwoods

white pine
red pine
douglas fir
western larch
amabilis fir
white spruce
engelmann spruce
black spruce
red spruce
lodgepole pine
jack pine
alpine fir
tamarack
pacific coast yellow cedar
western red cedar
hemlock

b) Hardwoods

beech
maple
ash
oak
birch
largetooth aspen
trembling aspen

4.2 Seasoning Considerations

4.2.1 Best log performance will be achieved if cutting takes place in winter or late fall.

4.2.2 Logs should be peeled as soon as possible after cutting. The outer bark shall be completely removed from the logs; no patch of inner bark more than 25 mm (1") wide and 150 mm (6") long shall be left on the log surface.

4.2.3 Completely overgrown knots rising more than 25 mm (1") above the log surface, branch stubs, and partially overgrown knots shall be trimmed close. Completely overgrown knots less than 25 mm (1") high need not be trimmed.

4.2.4 In the following sections allowances for shrinkage are recommended, based on 62 millimetres per metre ($3/4$ " per foot) of wall height.

This figure may be reduced depending on drying time and species, and on whether the applicant has experience with drying of the species being used.

Generally, drying for 3-4 months should permit the allowance to be reduced to about 40 millimetres per metre ($1/2$ " per foot).

4.3 Physical Characteristics of Manufactured and Natural Round Logs

4.3.1 The following conditions are prohibited:

- a) Bird-pecks
- b) Cracks
- c) Decay
- d) Double or reverse sweep
- e) Hollow heart butts or tops
- f) Plugged holes; other than holes for test purposes, which shall be plugged
- g) Short crook
- h) Splits or through checks
- i) Damage resulting from boring by insects or insect larvae

4.3.2 The following conditions are permitted:

- a) Fire-killed logs, provided all charred material is removed
- b) Sap stain not accompanied by decay
- c) Checks resulting from normal seasoning

4.3.3 The following conditions are permitted to the extent indicated:

- a) Hollow in the butt caused by "splinter pulling" in felling the tree, provided that the area of such hollow is less than 10 per cent of the butt area and the remainder of the butt is sound.
- b) Scoring and channelling of log surfaces by insects and insect larvae.
- c) Sound, tight-fitting knots.

- d) Sound scars on log surfaces provided that:
 - (I) they are smoothly trimmed
 - (II) the depth of the trimmed scar is not more than 25 mm (1")
 - (III) the width of the trimmed scar is not more than $\frac{1}{10}$ of the log's circumference at that point.
- e) Shakes in the butt and top surfaces extending through an arc of not more than 90 degrees and having a width of less than 2 mm ($\frac{1}{16}$ ").
- f) Sweep or crook in logs provided that a straight line connecting the midpoint of the butt with the midpoint of the top shall not at any intermediate point pass through the surface of the log.
- g) Spiral grain, providing the spiral does not exceed one complete twist in any 5 m (15')

4.4 Physical Characteristics of Squared and Flatted Logs

- 4.4.1 Squared logs shall be sawn or hewn on the top, bottom, and sides.
- 4.4.2 Flatted logs shall be sawn or hewn on the top and bottom, and on one side if desired.
- 4.4.3 All logs shall be sawn or hewn smooth, free from score hacks, with top and bottom faces straight and parallel.
- 4.4.4 Logs manufactured by quartering and halving large trees and that have the heart exposed shall not be accepted.
- 4.4.5 The following conditions are prohibited:
 - a) Decay
 - b) Unsound knots
 - c) Shakes
 - d) Bark seams
 - e) Worm holes
 - f) Warp
 - g) Pith (exposed heart)

4.4.6 The following conditions are permitted:

- a) Fire-killed logs, provided all charred material is removed
- b) Sap stain not accompanied by decay
- c) Checks resulting from normal seasoning
- d) Pockets

4.4.7 The following conditions are permitted to the extent indicated:

- a) Bow 12 mm ($\frac{1}{2}$ ") in 150 mm (6") thickness
25 mm (1") in 175 mm (7") thickness
- b) Sweep 25 mm (1") in 200 mm (8") width
38 mm ($1\frac{1}{2}$ ") in 225 mm (9") width
- c) Checks medium, not through
- d) Holes pin limited, not through
- e) Knots sound and tight, a quarter of the width
- f) Wane wane restrictions shall apply over the full length of the log:
 - (I) logs may have 25 mm (1") wane on one corner on one side only, or
 - (II) 12 mm ($\frac{1}{2}$ ") wane on each corner of one face only

Commentary

Having examined a number of log houses that have been constructed recently, CMHC feels it is necessary to outline some of the requirements for the logs used. Therefore acceptable species and physical characteristics of logs have been outlined. Both natural and round log requirements are based on CSA (Canadian Standards Association) standards 015.3 and 015.4 for Poles and Re-inforcing Stubs. The squared or flatted log requirements are modelled after the Sawn Railway Tie Grading Rule contained in the *Standard Grade Rules for Canadian Lumber* as published by the National Lumber Grades Authority.

Part 5. Foundations

5.1 General Requirements

- 5.1.1 All foundation requirements of *Residential Standards* shall be complied with unless specifically modified in this section.
- 5.1.2 Log house foundations shall consist of one of the following:
- a) Natural stone
 - b) Poured-in-place concrete
 - c) Concrete blocks
 - d) Preserved wood foundations
 - e) Wood piles, preservative-treated
 - f) Wood piers, preservative-treated
- 5.1.3 The top of the foundation shall be a minimum of 150 mm (6") above finished grade.
- 5.1.4 If a pier or pile and beam foundation is used, any space between the underside of the beam and finished grade shall be closed off with a suitable material such as preservative-treated wood or chain-link skirting. Where solid skirting is used, adjustable vents should be installed so they may be opened in the summer and early fall to minimize the formation of excessive condensation and rotting of wood members.
- In permafrost areas where the soil has a high silt content, floors should be constructed over open crawl spaces and insulated to minimize melting of the permafrost and to avoid uneven settlement of the building.
- 5.1.5 Steel strapping used to tie timbers together shall have a zinc coating at least equal to the G-90 designation in ASTM A525-79 *Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, General Requirements*.

5.2 Preserved Wood Foundations

- 5.2.1 Preserved wood foundations shall conform to the *Construction Guide for Preserved Wood Foundations, PWF-1, 1977* as published by the Canadian Wood Council, except as modified in Sub-section 5.1.1. of this document, and shall be designed by an architect or engineer.

Commentary

Although preserved wood foundations are now being used with low-rise housing of wood-frame construction, they have been designed for specific maximum loads. Depending on the size and density of the logs, log construction may impose loads that exceed those for which the standard preserved wood foundations are designed.

If this type of foundation is proposed it must be designed by a competent professional.

Part 6. Walls

6.1 Wall Systems

- 6.1.1 The walls of log houses shall consist only of logs laid horizontally, except as provided in Sub-section 6.1.5.
- 6.1.2 All manufactured or natural round logs shall be scribed and grooved longitudinally on the underside and notched at their ends so that each fits snugly on top of the log below.
- 6.1.3 The longitudinal grooves on the underside of manufactured or natural round logs shall have a minimum width of 75 mm (3") and a maximum depth of 50 mm (2").
- 6.1.4 All squared and flatted logs shall be joined by either a single 38 x 89 mm (2" x 4") wood spline on both the top and the bottom surfaces or by two equal tongue and groove joints on both the top and the bottom surfaces, having a combined width at least equal to the width of the spline. The tongue and groove and the spline shall run the full length of the wall. All squared and flatted logs shall be notched at the ends so that each fits snugly on top of the log below.
- 6.1.5 Log house designs or systems that do not conform to these requirements may be acceptable to CMHC if the design or system has been reviewed and found acceptable by the Corporation. CMHC publishes a manual of acceptable building materials, systems and equipment containing a list of manufactured log house systems that the Corporation has reviewed and found acceptable.

6.2 Log Sizes in Exterior Walls

- 6.2.1 When the exterior walls of a log house are built with manufactured or natural round logs, the logs shall have a minimum diameter of 175 mm (7") and a minimum average diameter of 200 mm (8").

- 6.2.2 When the exterior walls of a log house are built of squared or flatted logs, the minimum bearing width of the logs shall be 175 mm (7") and the minimum average bearing width shall be 200 mm (8").

- 6.2.3 The minimum log sizes mentioned in Sub-sections 6.2.1 and 6.2.2 will not necessarily provide the thermal resistance requirements in Part 9. of this document.

6.3 Shrinkage Allowance

- 6.3.1 Log houses shall be designed and built with an allowance, in millimetres (inches), for wood shrinkage in the vertical direction of 62 times the wall height in metres (0.75 multiplied by the wall height in feet).
For example: an allowance of
 $62 \times 2.3 = 143$ mm should be made for a wall 2.3 m in height; (an allowance of $0.75 \times 8 = 6$ " should be made for a wall 8'0" in height).
- 6.3.2 Provision for shrinkage shall be made above any of the following:
- a) Openings in log walls
 - b) Vertical posts
 - c) Chimneys
 - d) Fireplaces
 - e) Frame partitions
 - f) Electrical service entrances
 - g) Stacks
 - h) Plumbing services
 - i) Drains

6.4 Dowelling Requirements

- 6.4.1 Dowels shall be 38 mm (1½") diameter wood, 12 mm (½") diameter steel bars, or 25 mm (1") square wood.
- 6.4.2 Dowels shall have a length of 1½ log diameters and shall pass completely through one log and shall extend half-way into the lower log.

6.4.3 Dowels shall be driven into slightly oversize holes.

6.4.4 Dowels shall be located on the centre line of manufactured or natural round logs; for squared or flatted logs the dowels shall be staggered about the centre line of the logs.

6.4.5 Dowels are required on each side of window and door openings in all log walls; the dowels shall extend at least into the logs immediately above and below the window and door openings.

6.4.6 Walls built of manufactured or natural round logs with unsupported length in excess of 7.3 m (24') shall either have dowels installed for their full height at 1.2 m (4') centres along their length or be supported by cross walls or stub walls notched into the main walls.

6.4.7 Gable walls of manufactured or natural round logs shall have dowels installed for their full height at 1.2 m (4') centres along the length of the wall.

6.4.8 All walls built of squared or flatted logs shall have dowels installed for their full height at 1.2 m (4') centres along the length of the wall.

6.5 Notches, Splices, and Joints in Log Walls

6.5.1 Logs in all walls shall be notched or dovetailed at their intersection with other log walls.

6.5.2 Notches may be round, saddle, square, mitred, sheephead, round sheephead, dove-tail, or box.

6.5.3 Logs may be spliced where necessary and splices in adjacent rows of logs shall be at least 1.2 m (4') apart.

6.5.4 Splices may be mortise and tenon, dovetail, lock, lap or scarf and shall have dowels driven firmly through the splices. (See illustrations on page 23.)

6.6 Gable Walls

6.6.1 Gable walls supporting roof loads shall consist of a load-bearing frame of dimension lumber, interior finish, vapour barrier, insulation, and exterior cladding.

6.6.2 Gable walls that do not support roof loads may be constructed of horizontal logs; provision shall be made at the top of the gable wall for vertical log shrinkage; a suitable cladding shall be attached to the underside of the roof overhang and an insect screen shall also be provided.

6.7 Sill Logs

6.7.1 All log walls shall have a sill log adequately supported on a permanent foundation conforming with Part 5.

6.7.2 Between the top of the foundation and the underside of the sill logs, 25 mm (1") of expanded polystyrene insulation or equivalent shall be provided.

6.7.3 All sill logs shall be anchored to the foundation with anchor bolts or galvanized metal straps conforming to the requirements of *Residential Standards*.

6.7.4 All surfaces of sill logs shall be treated with three brush coats of wood preservative such as copper naphthenate or pentachlorophenol.

6.7.5 The outside edge of sill logs shall overhang the top of the foundation by a minimum of 25 mm (1") and shall be grooved to form a drip, or a suitable metal drip conforming to the requirements of *Residential Standards* shall be provided.

6.8 Interior Partitions

- 6.8.1 Where interior non load-bearing partitions consist of manufactured or natural round logs, they shall be laid horizontally and shall conform to the requirements of Sections 6.1, 6.2, 6.3, 6.4, and 6.5, except that the logs may have a minimum diameter of 100 mm (4").
- 6.8.2 Where interior non load-bearing partitions consist of squared or flatted logs they shall be laid horizontally and shall conform to the requirements of Sections 6.1, 6.2, 6.3, 6.4, and 6.5, except that the logs may have a minimum bearing width of 100 mm (4") and only a single tongue-and-groove joint.
- 6.8.3 Where interior non load-bearing partitions are framed of dimension lumber they shall conform to the requirements of *Residential Standards*.

- 6.8.4 Frame partitions shall have a space at the top the full thickness of the wall to allow for shrinkage. The space shall have a height in millimetres (inches) not less than 62 times the height of the partition in metres (0.75 times the height of the partition in feet). The space shall be covered with a suitable interior finish attached to the ceiling but not attached to the partition.

Commentary

The requirements of this part reflect what CMHC considers to be sound construction details as currently practised by principal log house builders in Canada. These requirements have been established as a result of extensive discussions with knowledgeable people in the forestry and log house building industries, and reflect what CMHC considers to be a reasonable compromise between prohibitively expensive attention to fine details, and slipshod detailing and workmanship.

Where checks become excessive the homeowner or builder may wish to consider filling them with a mixture of waterproof elastomeric glue and dry sawdust from the logs.

Part 7. Roofs

7.1 Roof Support Systems

- 7.1.1 When the roof support system consists of roof joists of dimension lumber, the joists shall conform to the requirements of *Residential Standards*.
- 7.1.2 When the roof support system consists of trusses fabricated from dimension lumber, the trusses shall conform with *Builders' Bulletin No. 250* for trusses with nailed plywood gussets, or with *Builders' Bulletin No. 262* for trusses with metal connector plates.
- 7.1.3 When a roof support system is designed and constructed of logs, the wood-framing practice established for dimension lumber may be adapted by using the following equivalents:
100 mm (4") diam. log equals 38 x 89 mm (2" x 4") or 38 x 114 mm (2" x 5")
125 mm (5") diam. log equals 38 x 140 mm (2" x 6")
150 mm (6") diam. log equals 38 x 184 mm (2" x 8")
175 mm (7") diam. log equals 38 x 235 mm (2" x 10")
200 mm (8") diam. log equals 38 x 286 mm (2" x 12")
If the system is designed in any other manner it shall be designed by an architect or engineer and the drawings shall bear the seal of the designer.
- 7.1.4 When the roof support system consists of log purlins or log trusses they shall be designed by an architect or engineer and the drawings shall bear the seal of the designer.

- 7.1.5 Roof support systems shall be designed for at least the loading shown in *Supplement No. 1* to the *National Building Code of Canada*, and shall be strengthened where local experience indicates that a heavier loading is appropriate.

7.2 Roofs

- 7.2.1 Roofs and roofing materials shall conform to the requirements of *Residential Standards*, except that the minimum slope permitted shall be not less than two in twelve.
- 7.2.2 When a roof system is proposed that is beyond the scope of *Residential Standards*, the system is subject to acceptance by CMHC and shall be designed by an architect or engineer. The drawings for the roof system shall bear the seal of the designer.

Commentary

Conventional roof and roof support systems falling within the scope of *Residential Standards* can be used directly. Roof support systems consisting of log trusses, etc., should be designed by a competent professional to ensure that the size of logs, joints, and connections are adequate. Notwithstanding a desire on the part of the homeowner to have his house designed and built completely of logs, CMHC suggests that the homeowner might investigate the economics of using trusses fabricated from dimension lumber, with nailed plywood gussets or metal connector plates.

Part 8. Floors

8.1 Floor Support Systems

8.1.1 When the floor support system consists of floor joists of dimension lumber, these joists shall conform to the requirements of *Residential Standards*.

8.1.2 When a floor support system is designed and constructed of logs, the wood framing practice established for dimension lumber may be adapted by using the equivalents shown in Sub-section 7.1.3.
If the system is designed in any other manner it shall be designed by an architect or engineer and the drawings shall bear the seal of the designer.

8.1.3 Floor joists shall either be hung from the sill log by joist hangers, or be mortised into the sill log, in which case the mortise shall not exceed $\frac{1}{3}$ the sill log thickness vertically or horizontally.

8.2 Floors

8.2.1 Floors and flooring materials shall conform to the requirements of *Residential Standards*.

8.2.2 When a floor system is proposed that is beyond the scope of *Residential Standards*, the system is subject to acceptance by CMHC and shall be designed by an architect or engineer. The drawings for the floor system shall bear the seal of the designer.

8.3 Stairs

8.3.1 Where a log house contains a developed attic, stairs shall be provided according to the requirements of *Residential Standards*. The design and construction of the stairs shall make provision for the vertical shrinkage in the log walls.

Commentary

Floors and floor support systems falling within the scope of *Residential Standards* may be used directly. Floors and floor support systems beyond the scope of *Residential Standards* should be designed by a competent professional to ensure that the size of materials and other details are adequate.

Part 9. Thermal Resistance, Vapour Barrier, Interior Finishes, and Caulking

9.1 Thermal Resistance

- 9.1.1 All log houses except as noted in Sub-section 9.1.2 shall conform to the thermal resistance requirements of *Builders' Bulletin No. 267, Further Measures to Conserve Energy*.
- 9.1.2 The thermal resistance requirements of Sub-section 9.1.1 may be relaxed for log houses built under CMHC's Rural and Native Housing Program where the principal heating and cooking fuel is locally available wood or coal. This relaxation is at the sole discretion of CMHC's local Branch Manager and must be obtained in writing.
- 9.1.3 For the purpose of calculating the thermal resistance and the required size of manufactured and natural round logs to be used in exterior walls, the effective diameter of the logs shall be assumed to be 0.7 multiplied by the average diameter. The incremental thermal resistance of the wood shall be assumed to be 0.0087 per millimetre (1.25 per inch) with the exception of cedar, which is 0.0092 per millimetre (1.33 per inch); the thermal resistance of the exterior walls shall be the product of the effective diameter multiplied by the incremental thermal resistance.
- 9.1.4 For the purpose of calculating the thermal resistance and the required bearing width of squared logs to be used in exterior walls, the effective bearing width of the logs shall be assumed to be 1.0 multiplied by the average bearing width. The incremental thermal resistance of the wood shall be assumed to be 0.0087 per millimetre (1.25 per inch); the thermal resistance of the exterior walls shall be the product of the effective bearing width multiplied by the incremental thermal resistance.
- 9.1.5 For the purpose of calculating the thermal resistance and the required bearing width of flatted logs to be used in exterior walls, the effective bearing width of the logs shall be assumed to be 1.1 multiplied by the average bearing width. The incremental thermal resistance of the wood shall be assumed to be 0.0087 per millimetre (1.25 per inch); the thermal resistance of the exterior walls shall be the product of the effective bearing width multiplied by the incremental thermal resistance.
- 9.1.6 The required thermal resistance may be achieved solely by a single exterior wall of logs of sufficient diameter, by an exterior double wall of logs, with or without insulation between the walls, or by a single wall of logs backed by insulation and a free-standing internal frame wall recessed into log cross walls and having a shrinkage space at the top.
- 9.1.7 The space allowed for shrinkage at the top of all openings in log walls shall be filled with glass fibre insulation.
- 9.1.8 All longitudinal grooves and notches in exterior log walls shall be filled with glass fibre insulation. Logs shall be bedded completely on the insulation and the insulation shall be trimmed to give a neat and workmanlike appearance.
- 9.1.9 Glass fibre insulation shall be installed at the top of log gable walls immediately under the roof.

9.2 Vapour Barrier

- 9.2.1 Vapour barriers, where required, shall conform to the provisions of *Residential Standards*.
- 9.2.2 When insulation is used to increase the thermal resistance of exterior walls, a vapour barrier shall be provided at the interior face of all insulation.

9.3 Interior Finishes

- 9.3.1 Where interior finishes other than log are to be provided, these shall conform to the requirements of *Residential Standards*.

9.4 Caulking

- 9.4.1 Caulking, where required, shall conform to the provisions of *Residential Standards*.
- 9.4.2 One bead of caulking shall be provided just inside the external edge of all longitudinal grooves and notches in exterior log walls.

Commentary

When oil, gas, or electricity are used for domestic heating and cooking fuels, it is important that log houses should be adequately insulated to prevent waste of these expensive resources. On the other hand, when the heating and cooking fuel is locally available wood or coal that can be obtained at little or no cost, then a lower level of thermal resistance may be justifiable in some situations. The various types of log walls discussed in this document exhibit slightly different characteristics with regard to thermal resistance. This document attempts to clarify the degree of difference associated with each type of wall. The vapour barrier and caulking requirements reflect CMHC's concern for long-term satisfactory performance.

Part 10. Windows and Doors

10.1 Windows

- 10.1.1 Windows shall be provided in the exterior walls in conformity with *Builders' Bulletin No. 267, Further Measures to Conserve Energy*, and *Residential Standards*.
- 10.1.2 All window openings in log walls shall have a vertical spline of 38 x 89 mm (2" x 4") wood set into a slightly oversize chase on each side of every opening and the spline shall extend the full height of the opening less an allowance in millimetres (inches) at the top of the spline for log shrinkage of 62 multiplied by the height of the window in metres (0.75 multiplied by the height of the window in feet).
- 10.1.3 A space the full thickness of the wall shall be provided at the top of all windows for shrinkage allowance; the height of the space in millimetres (inches) shall be 62 multiplied by the height of the windows in metres (0.75 multiplied by the height of the window in feet).
- 10.1.4 The space above the windows shall be covered by a suitable cladding or trim attached either to the log wall above the space or to the window frame, but not attached to both.
- 10.1.5 All wall openings in load-bearing log walls shall have lintels with a minimum depth of 1½ logs.
- 10.1.6 Window openings located in log walls shall be at least 600 mm (2'0") apart and shall not be located within 600 mm (2'0") of a corner.

10.2 Doors

- 10.2.1 Interior and exterior doors shall conform to the requirements of *Residential Standards*.
- 10.2.2 All door openings in log walls shall have a vertical spline of 38 x 89 mm (2" x 4") wood set into a slightly oversize chase on each side of every opening and the spline shall extend the full height of the opening less an allowance in millimetres (inches) at the top of the spline for log shrinkage of 62 multiplied by the height of the opening in metres (0.75 multiplied by the height of the opening in feet).
- 10.2.3 A space the full thickness of the wall shall be provided for shrinkage allowance at the top of all doors in exterior and interior log walls; the height of the space in millimetres (inches) shall be 62 multiplied by the height of the opening in metres (0.75 multiplied by the height of the door in feet).
- 10.2.4 The space above doors shall be covered with a suitable cladding or casement attached either to the log wall above the space or to the door frame below the space, but not to both.
- 10.2.5 All door openings in load-bearing interior and exterior log walls shall have lintels with a minimum depth of 1½ logs.
- 10.2.6 Door openings located in log walls shall be at least 600 mm (2'0") apart and shall not be located within 600 mm (2'0") of a corner.

Commentary

In order to ensure reasonable resistance to heat loss, the requirements of *Residential Standards* for windows and doors have been included. Furthermore, some consideration should be given to providing window and door hardware of a more durable and robust nature than is traditionally provided in urban situations.

Part 11. Building Services

11.1 Electrical Services

- 11.1.1 Where an electrical service is available, a log house shall have all electrical wiring installed in accordance with the requirements of *Residential Standards*.
- 11.1.2 Where an electrical service is not available, the homeowner may choose to have electrical wiring installed in accordance with the requirements of *Residential Standards*, in anticipation of a suitable electrical service being available in the future.
- 11.1.3 Wherever practical, wiring shall be concealed within walls, in which case wiring should run vertically through pre-drilled holes and horizontally in chases cut into the top of the log beneath the longitudinal groove, and switches and receptacles should be recessed flush with the surface of the wall.

11.2 Plumbing Services

- 11.2.1 When plumbing services are to be provided, the piping and fixtures shall be in accordance with the requirements of *Residential Standards*.
- 11.2.2 Piping to plumbing fixtures shall not be buried within log walls; piping shall run within framed-up enclosures on the surface of log walls.
- 11.2.3 Plumbing fixtures shall not be attached to, or supported from, log walls.
- 11.3 Kitchen Cupboards and Counters
 - 11.3.1 Kitchen cupboards and counter tops shall be provided in accordance with the requirements of *Residential Standards*.
 - 11.3.2 Kitchen cupboards and counter tops shall be attached to log walls in such a manner that they will not be damaged by the vertical shrinkage of the logs.

Commentary

The requirements of this part reflect CMHC's concern that services be installed correctly, having due regard for the shrinkage characteristics of log walls and the damage that could be caused to services installed without adequate provision for this shrinkage.

Part 12. Drawings and Diagrams

12.1 General

The sketches that follow illustrate the principal features of the construction of log houses. They illustrate good log building practice, and accord with the preceding requirements.

Precise conformity with the illustrated details is not required provided the requirements are, in general, complied with. Several building and wall cross-sections illustrate basic house designs with alternative foundations, basements, and crawl spaces.

12.2 Conflicts between Text and Drawings

Where a conflict exists between the drawings of this part and the text of other parts of this document, the text of the other parts shall govern.

Figure 1. WOOD POSTS OR PILES WITH CENTRE BEAM AND JOIST ASSEMBLY
(see Figures 2, 3, 4 and 5)

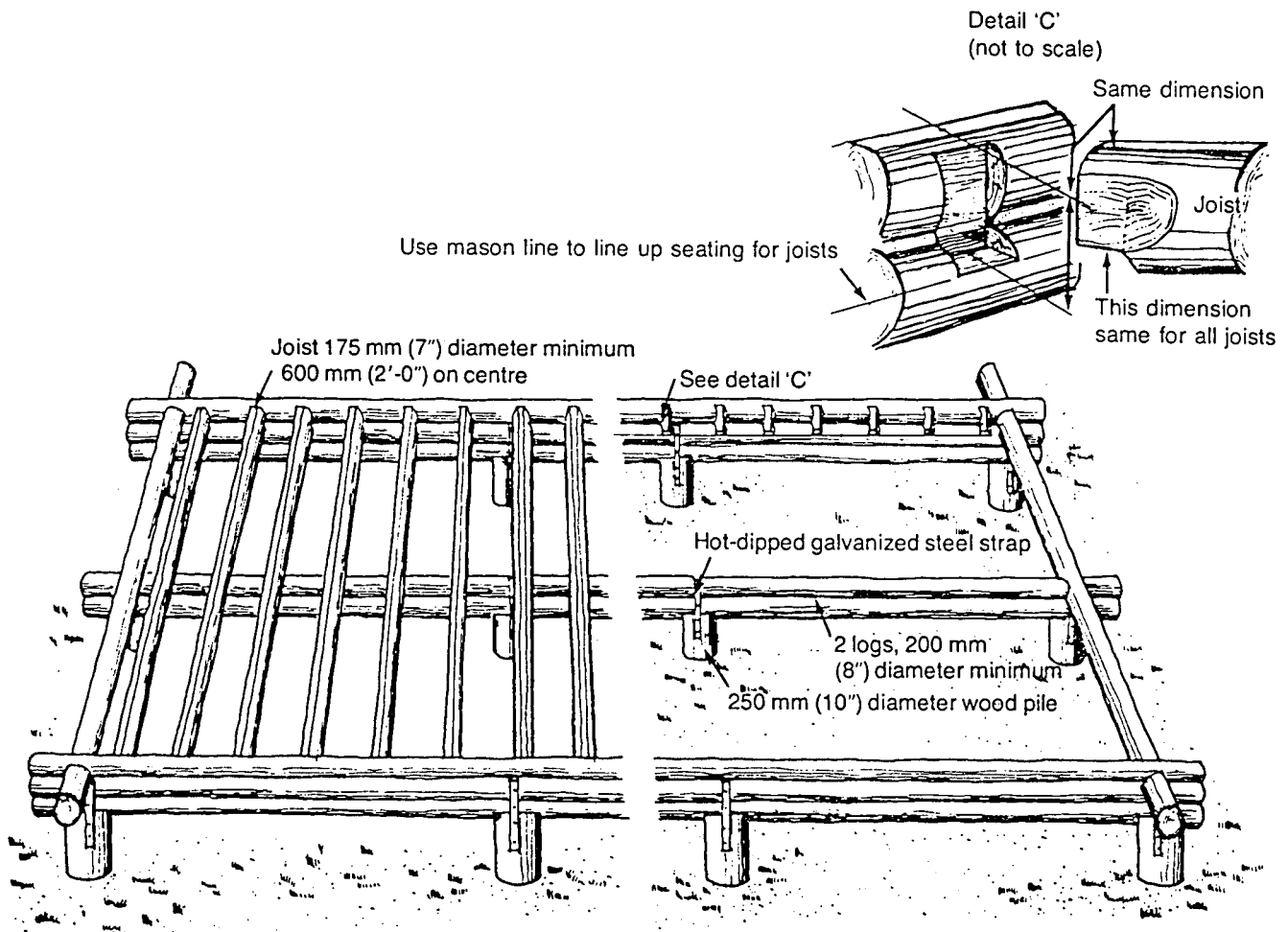


Figure 2. FOUNDATION PLAN (not to scale) (see Figure 1)

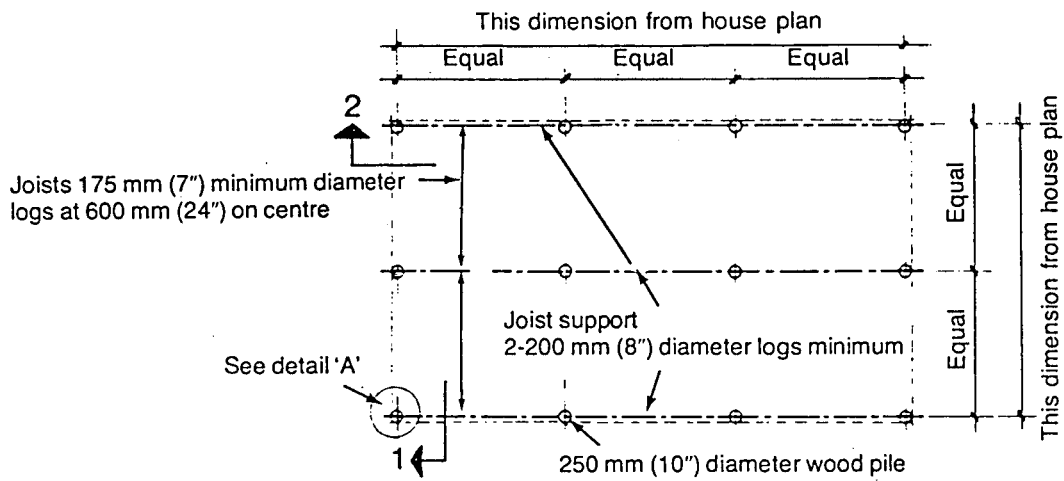


Figure 3. SECTION 1 (see Figure 1)

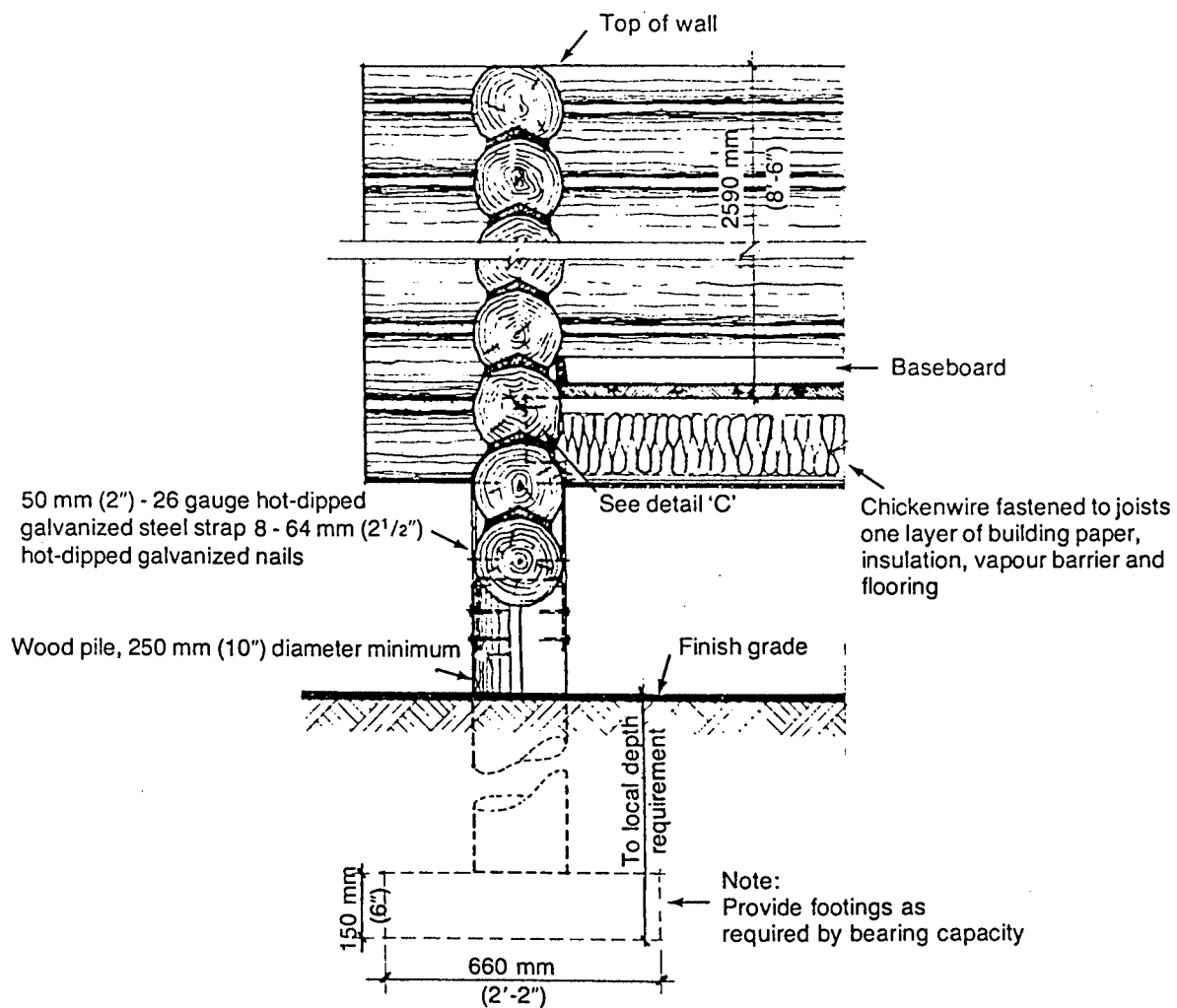


Figure 4. PLAN DETAIL 'A' (see Figure 1 and 2) Note: insulation not shown

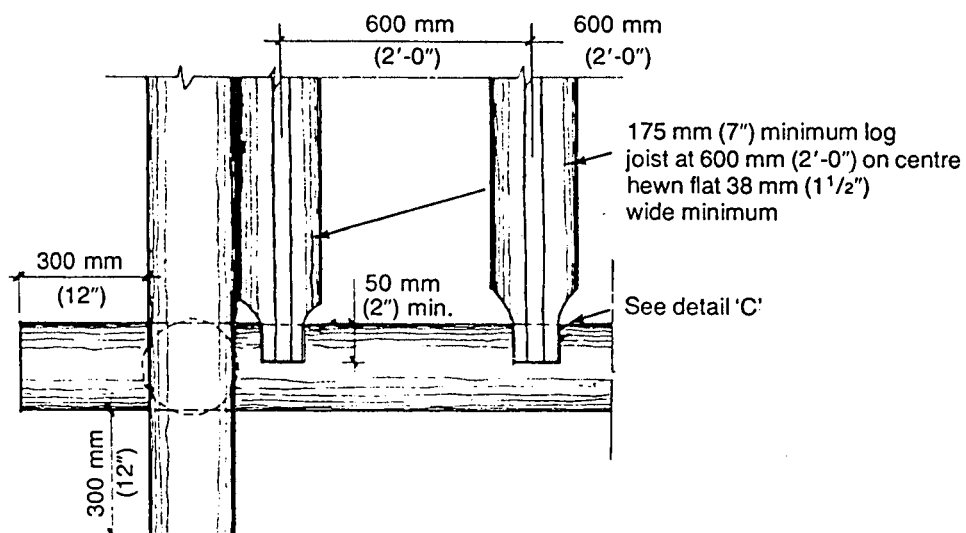


Figure 5. SECTION 2 (see Figures 1, 2, 3 and 4)

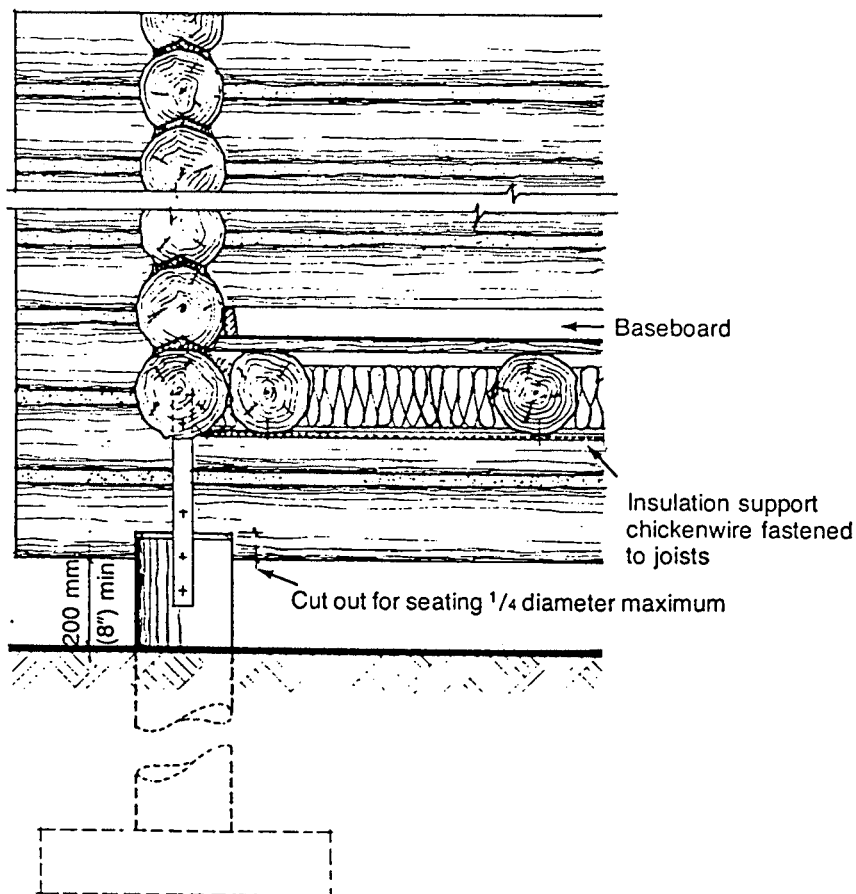


Figure 6. WOOD POSTS OR PILES WITH CROSS BEAMS AND JOISTS

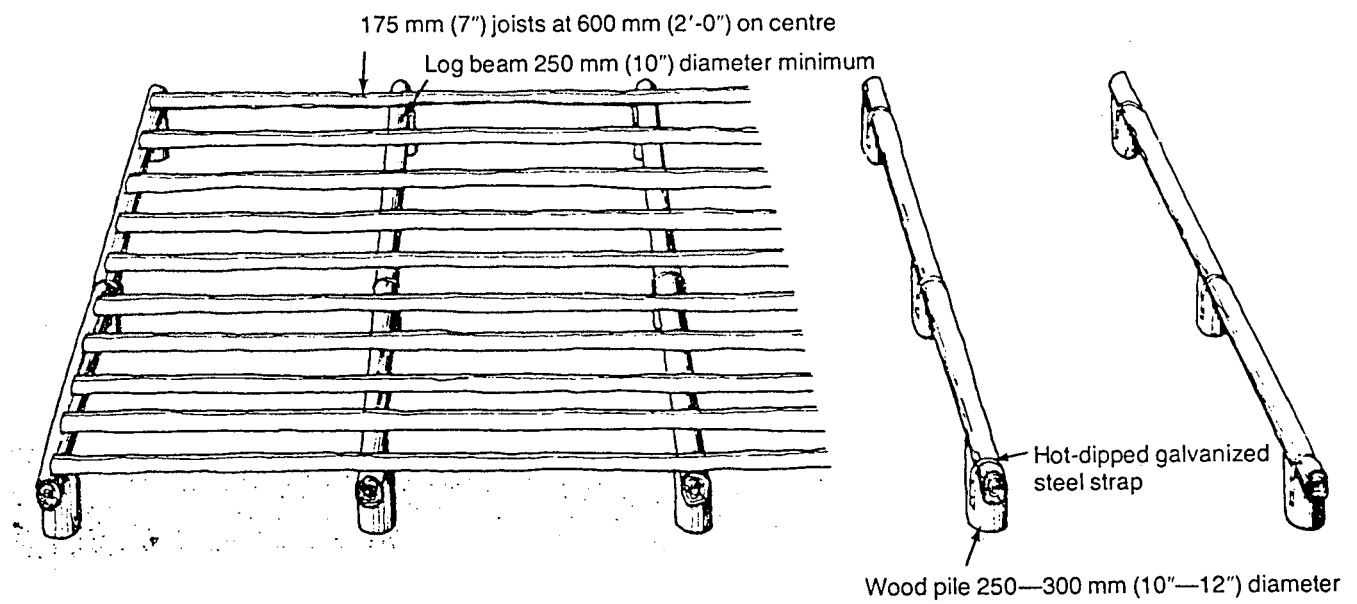


Figure 7. FOUNDATION PLAN (not to scale) (see Figure 6)

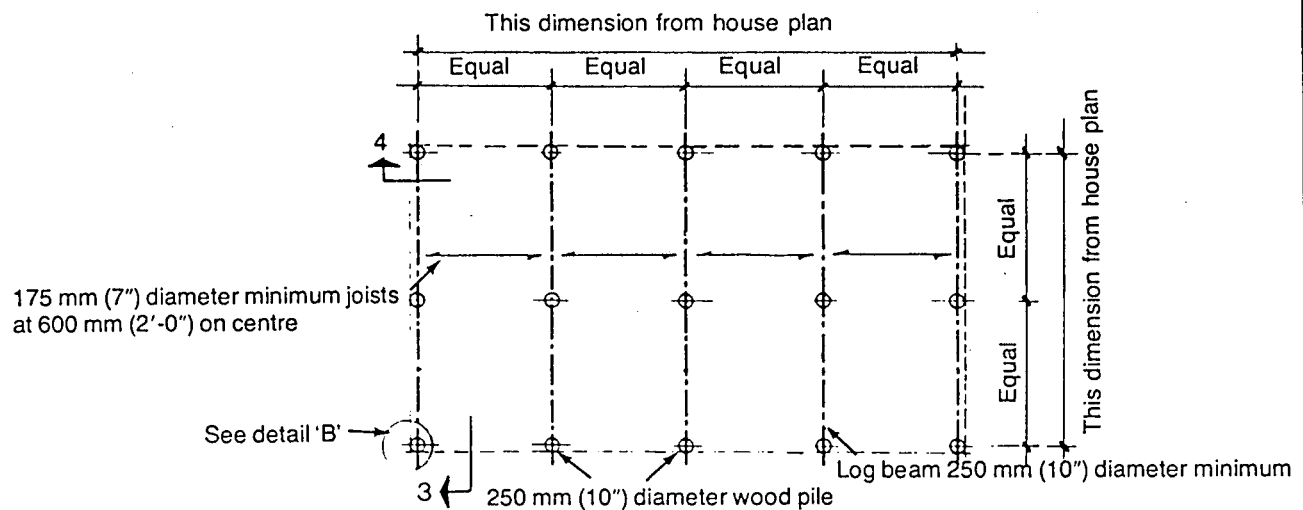


Figure 8. SECTION 3 (see Figure 6)

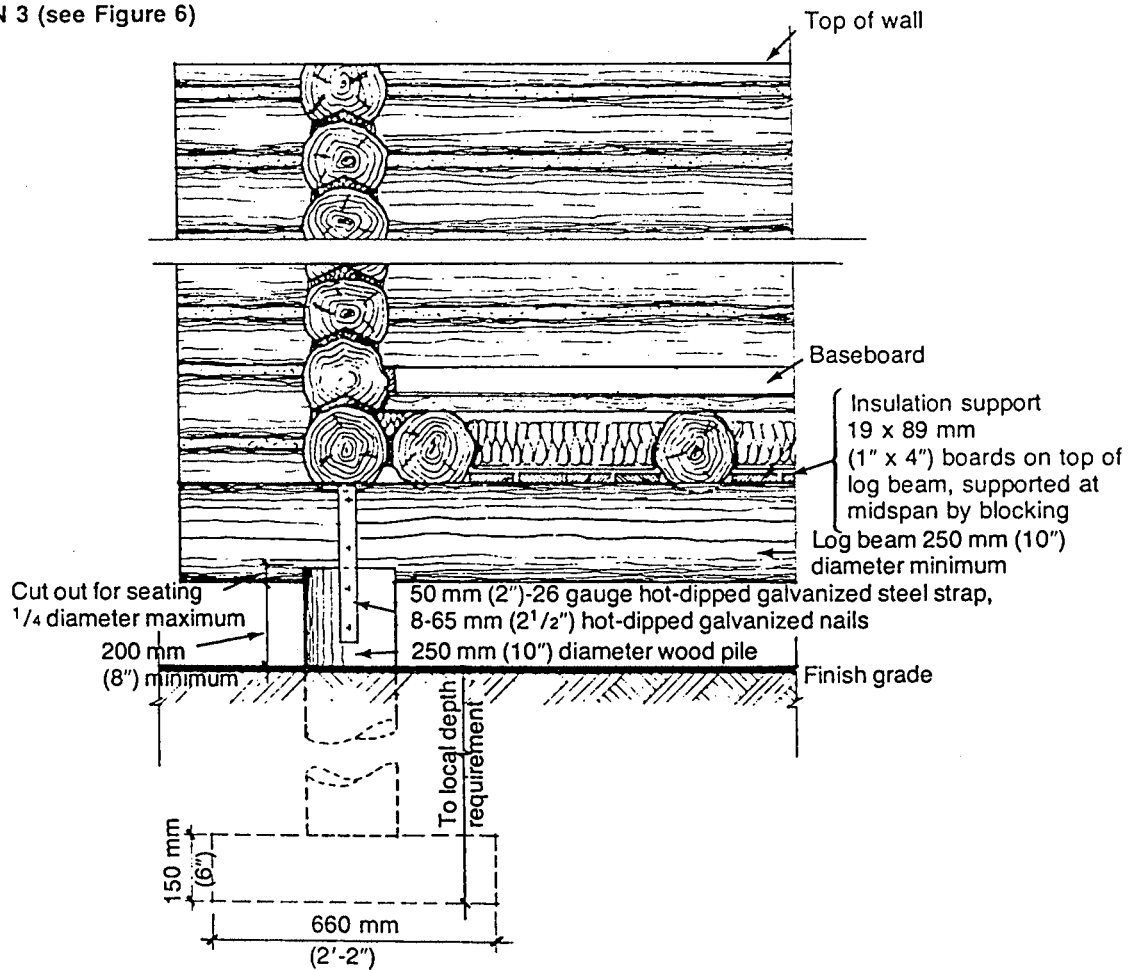


Figure 9. PLAN DETAIL 'B' (see Figure 7) Note: Insulation not shown

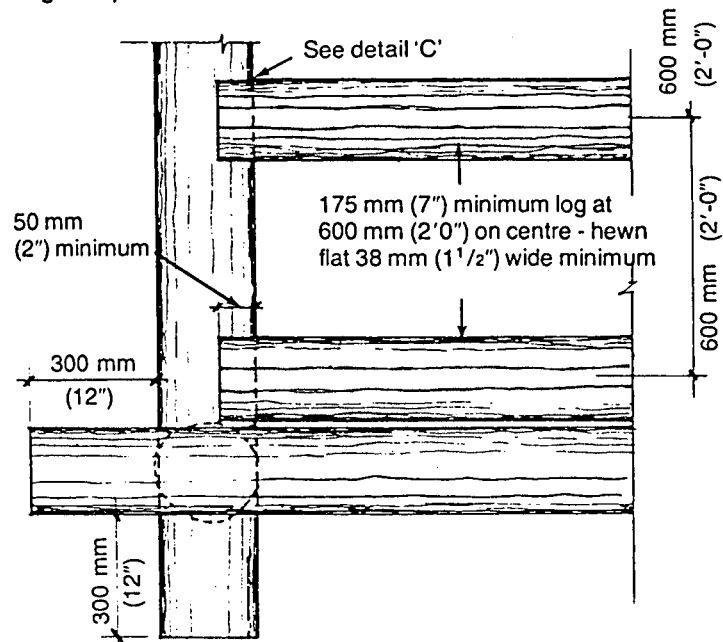


Figure 10. SECTION 4 (see Figures 6, 7 and 8)

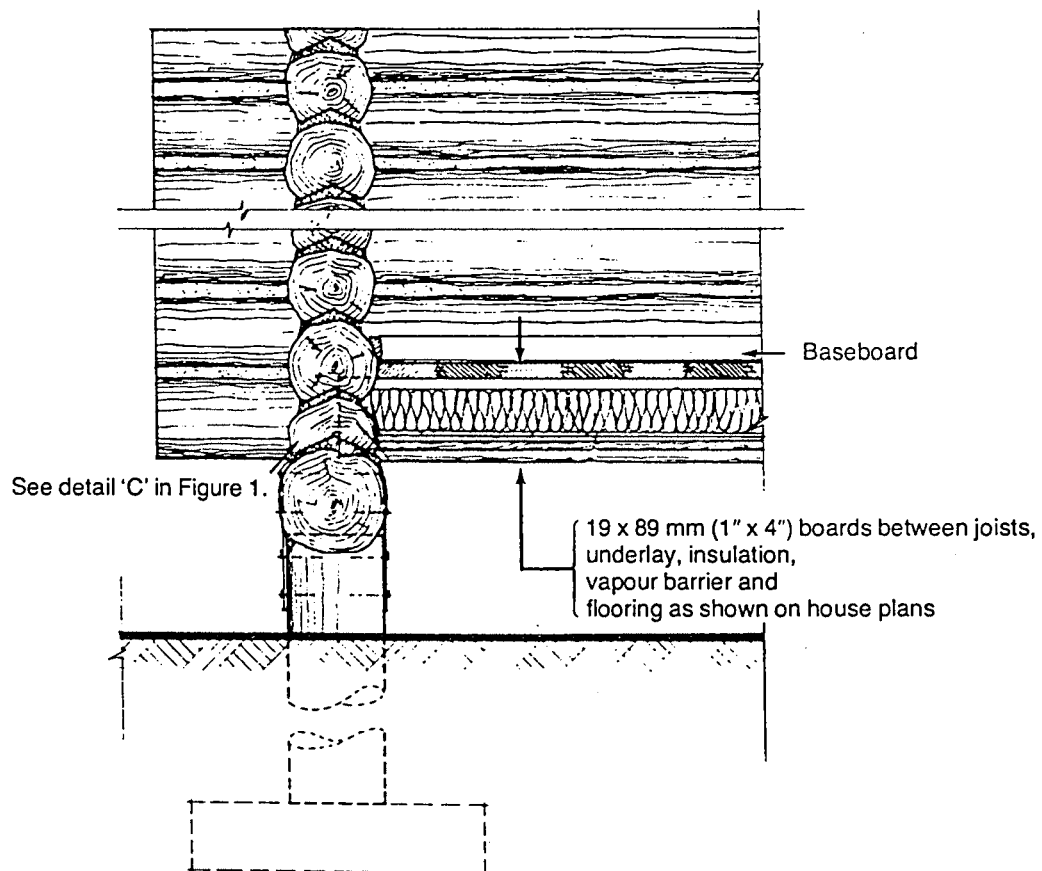


Figure 11. FOUNDATION PLAN (not to scale).

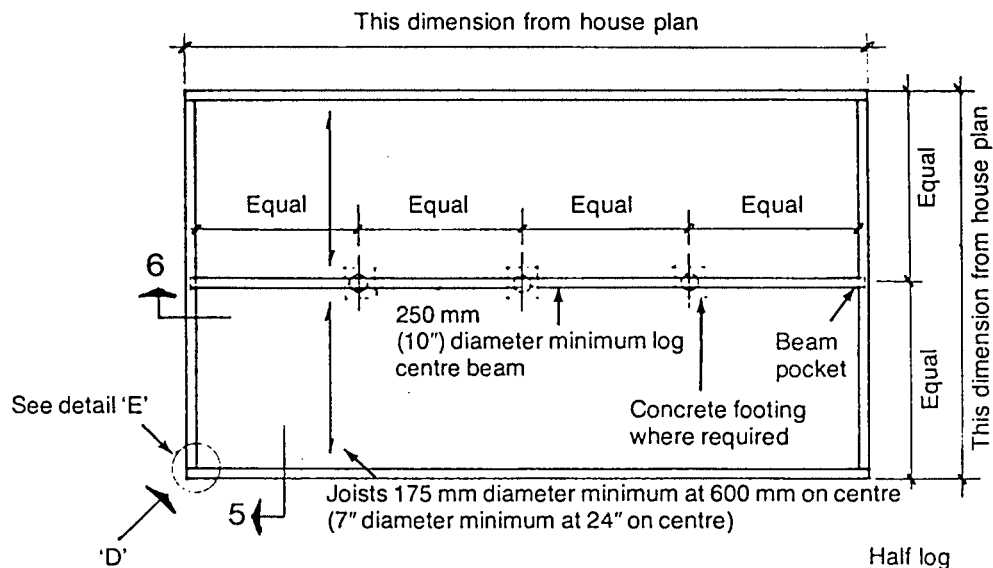


Figure 12. SECTION 5 CONTINUOUS POURED CONCRETE WALL

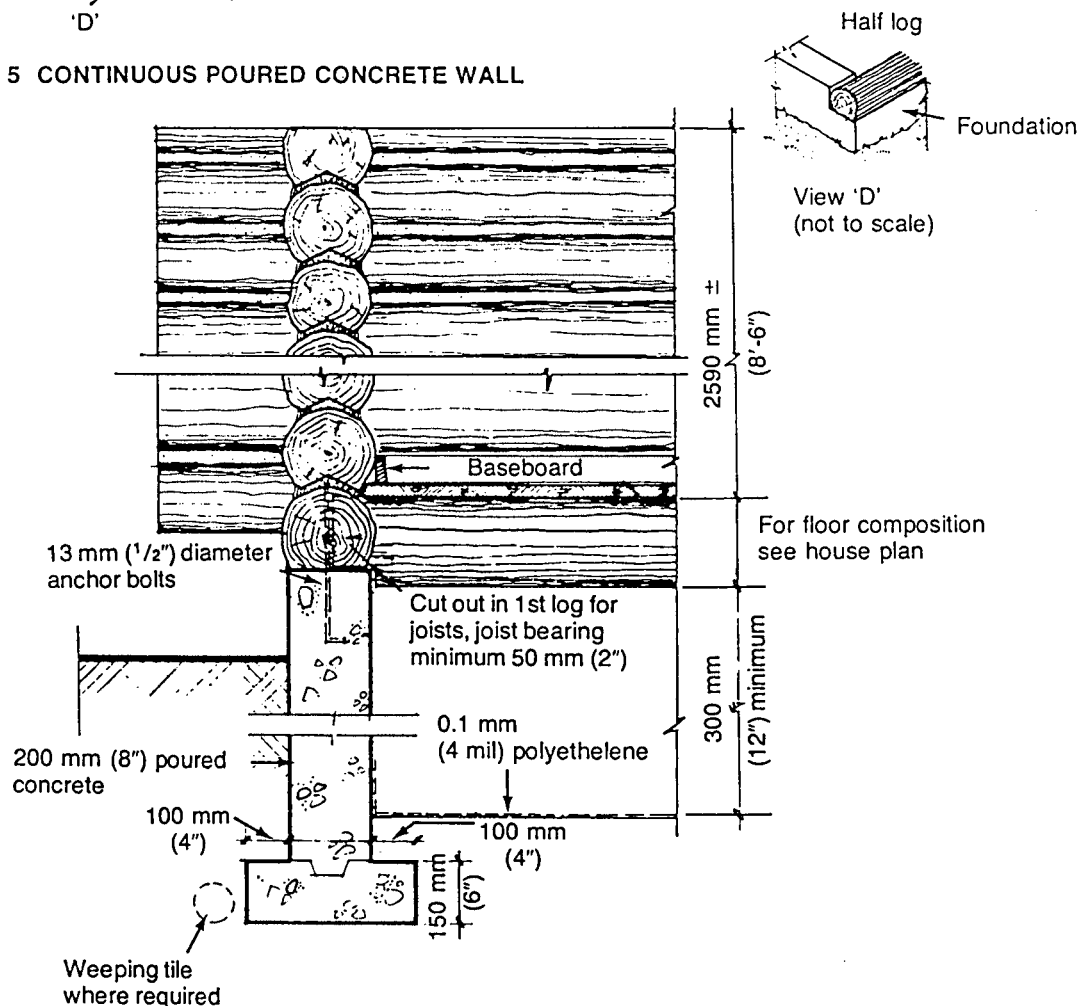


Figure 13. PLAN DETAIL 'E' (see Figure 11)

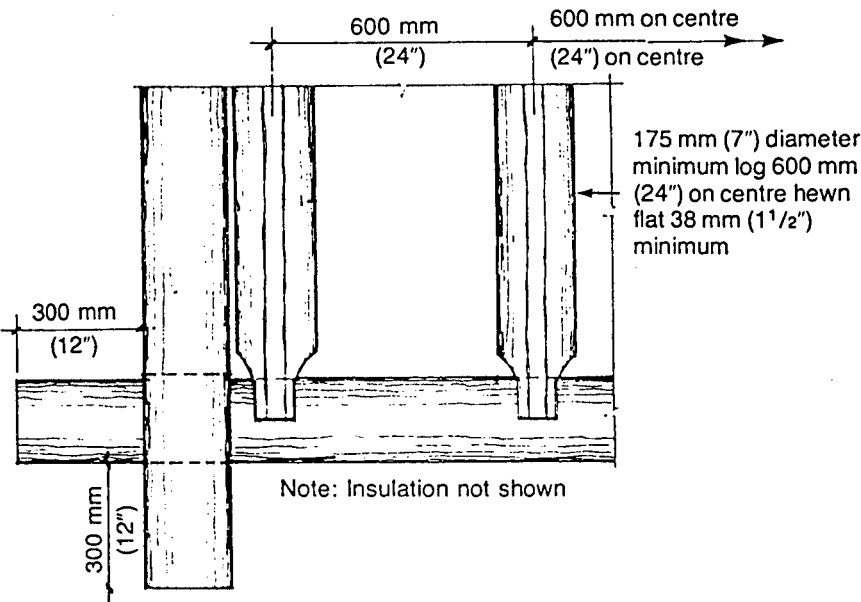


Figure 14. SECTION 6 (see Figures 11 and 12)

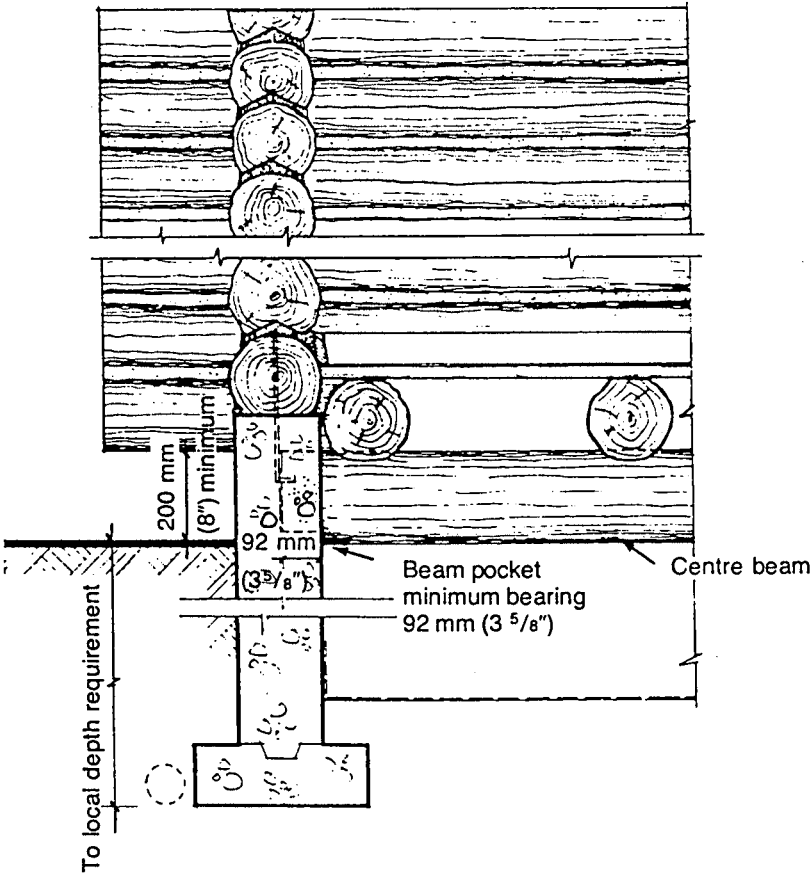


Figure 15. SECTION 7

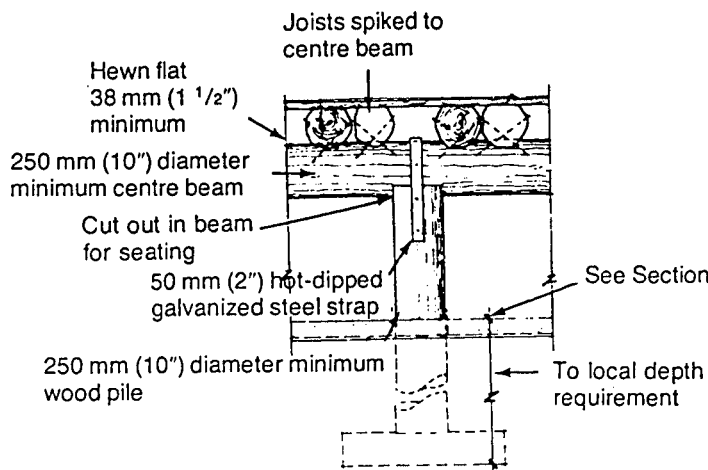


Figure 16. SECTION 8

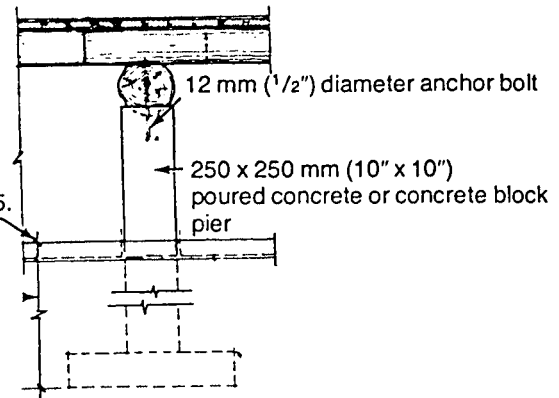


Figure 17. PART PLAN, (centre floor beam) TYPICAL CENTRE BEAM DETAILS

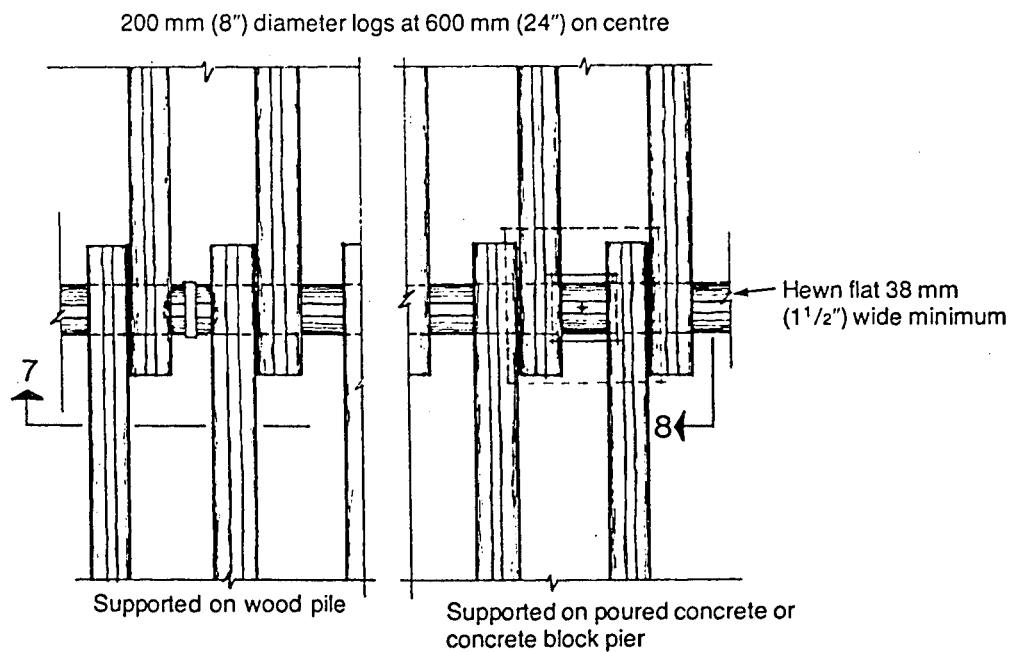


Figure 18. LAP JOINT

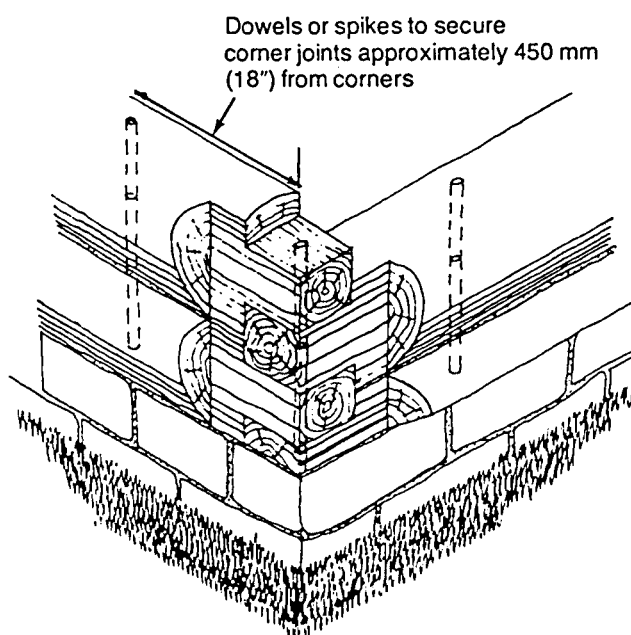


Figure 19. BUTT JOINT

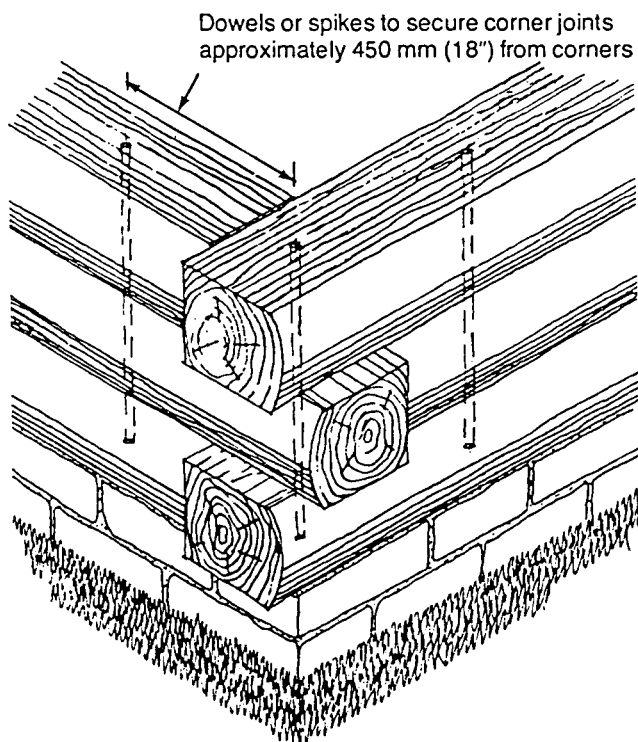


Figure 20. LOG PARTITION INTERNAL CORNER DETAIL

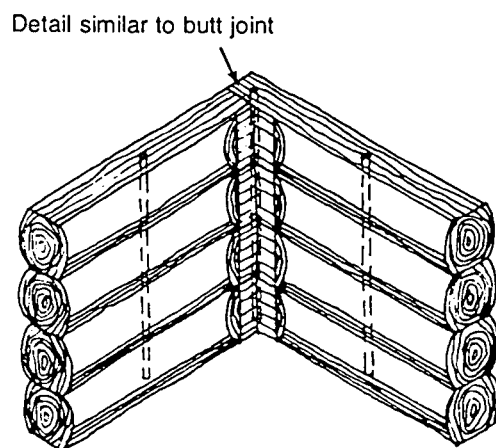


Figure 21. NOTCH JOINT

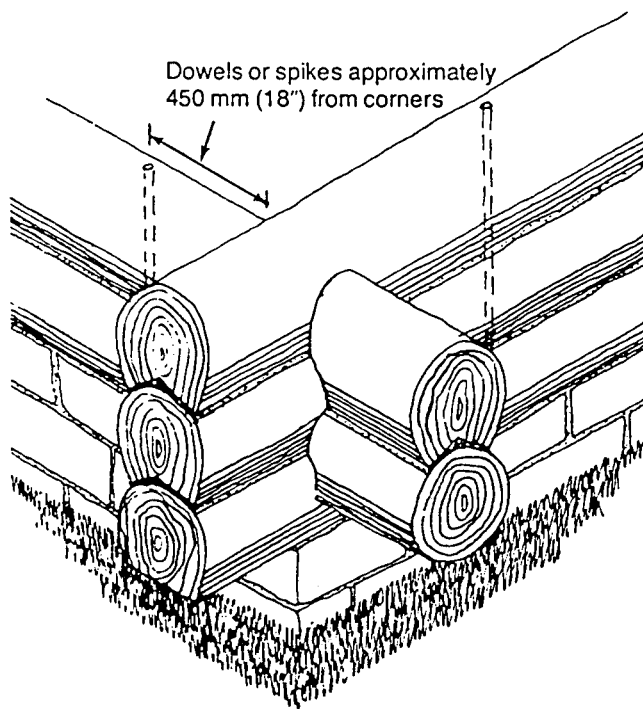


Figure 22. LOG PARTITION SLIP JOINT

90 x 65 mm (4" x 2 1/2") approximate slot cut in exterior walls to receive log partitions. Log partitions should be secured at floor level *only* to allow for shrinkage.

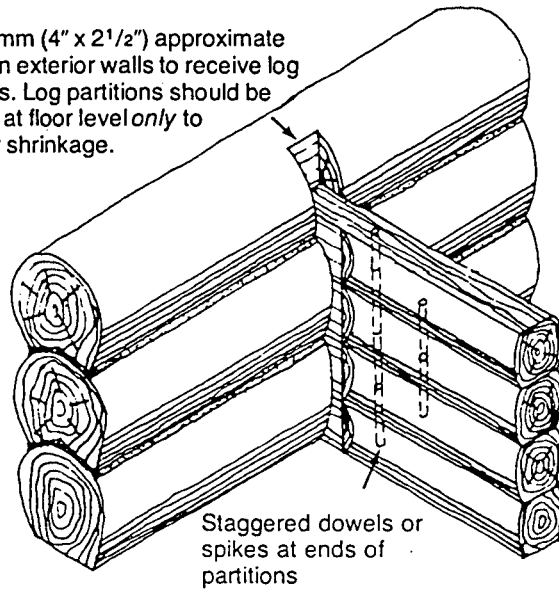


Figure 23. FRAME PARTITION SLIP JOINT

90 x 65 mm (4" x 2 1/2") approximate slot cut in exterior walls to receive the partitions and the interior wall cladding. Frame partitions should be secured at floor level *only* to allow for shrinkage.

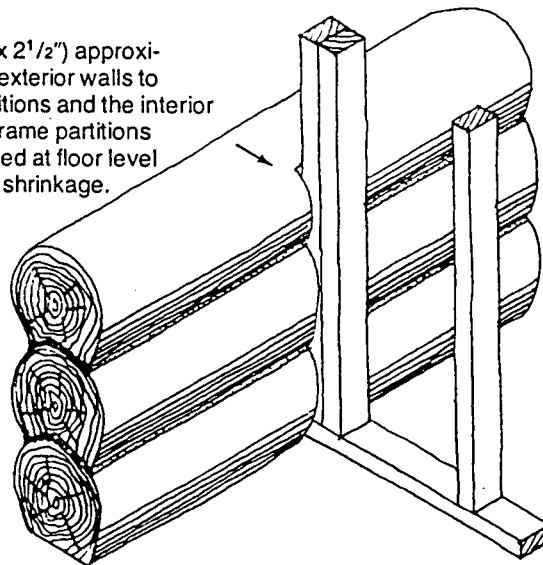


Figure 24. DETAIL OF JOINT BETWEEN LOGS

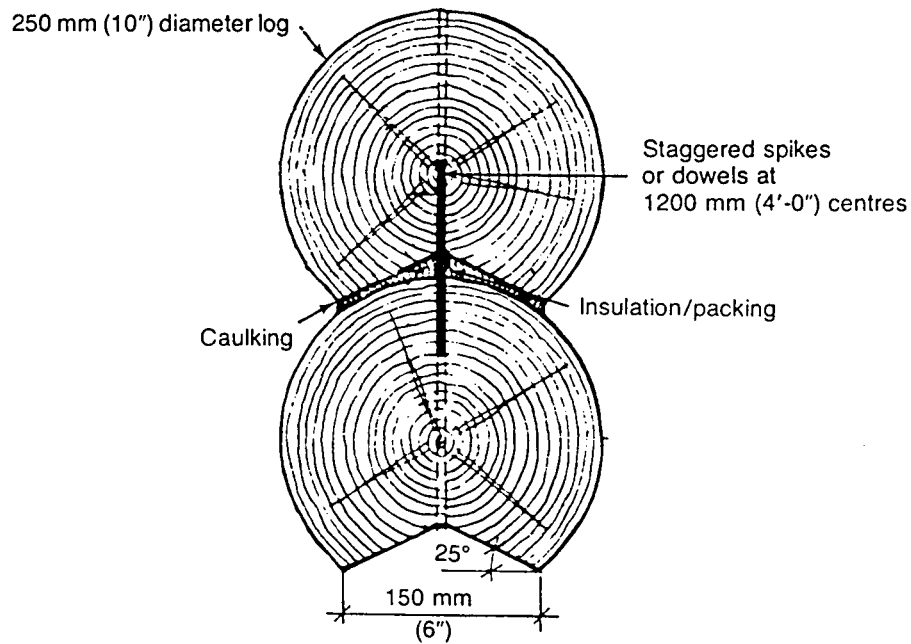


Figure 25. SMALL LOGS USED TO REDUCE HEAT LOSS

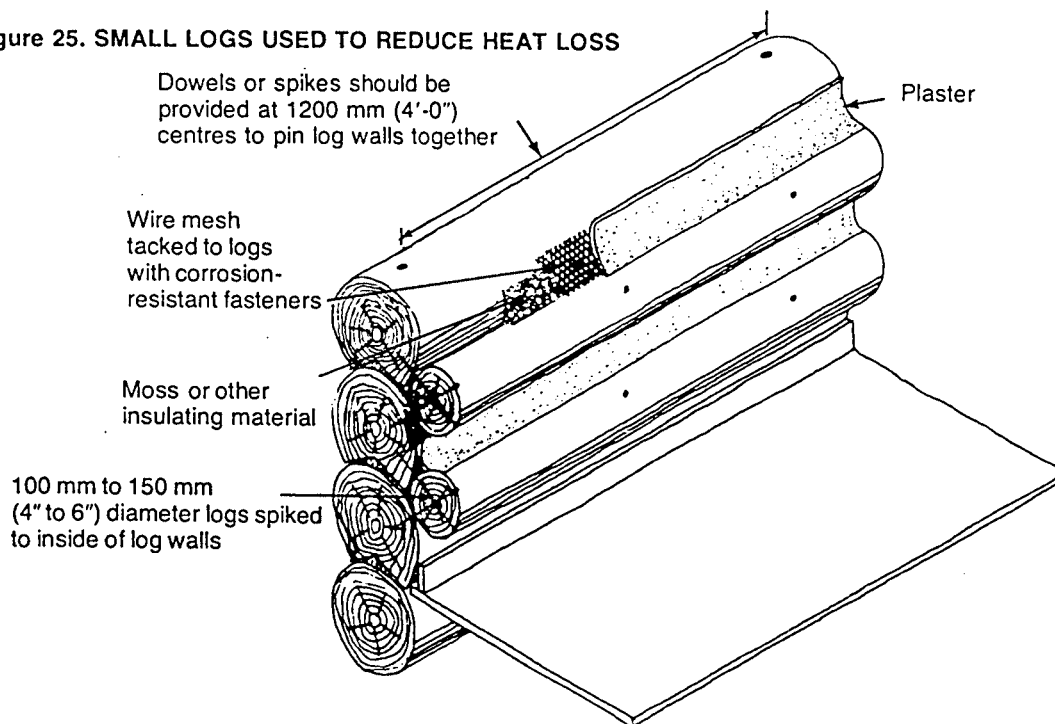


Figure 26. WINDOW AND DOOR OPENINGS

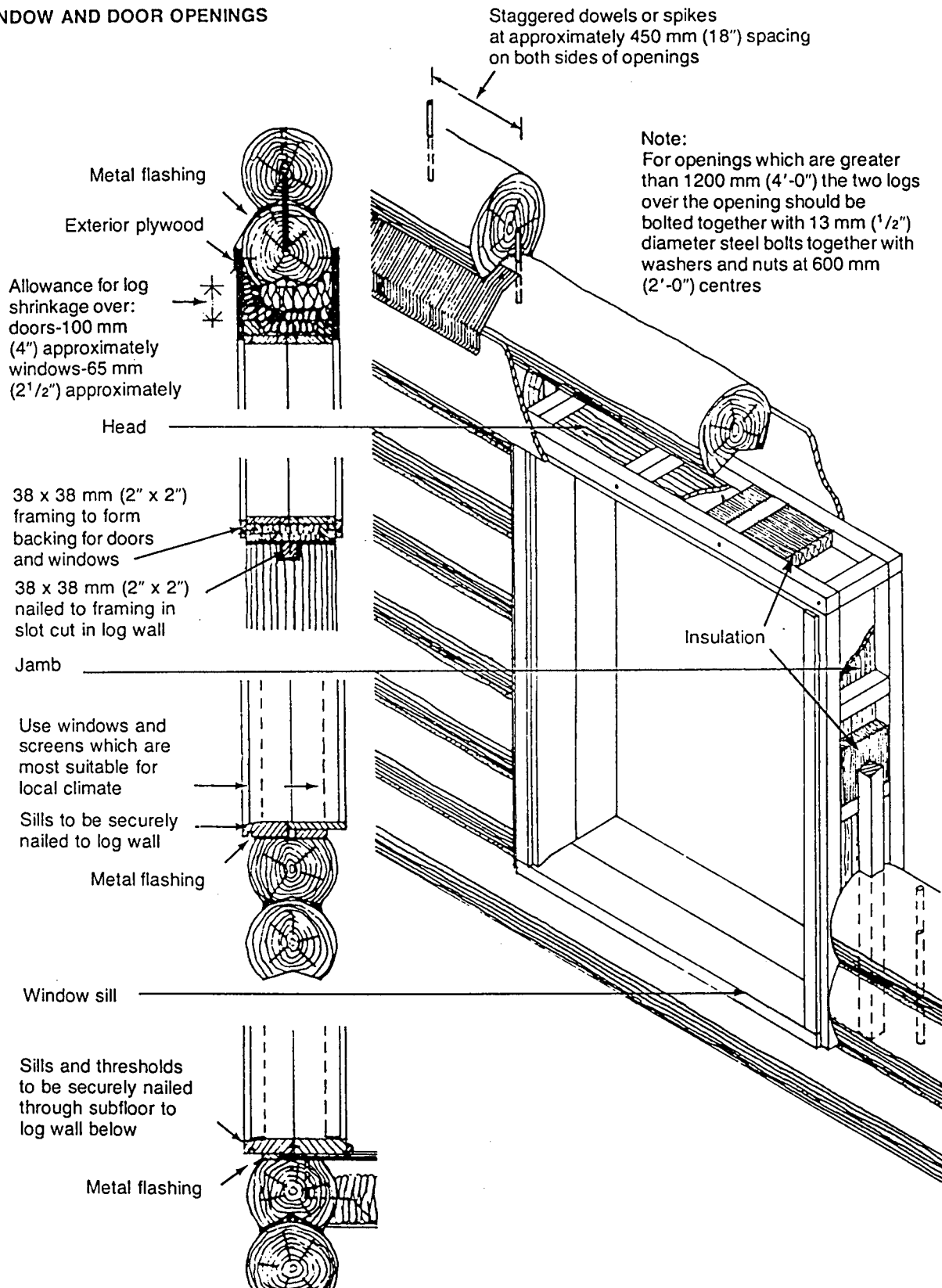
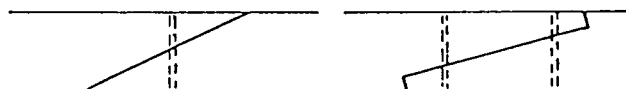


Figure 27. SPLICES (not to scale)



MORTISE AND TENON

DOVETAIL



SCARF

BUTT SCARF

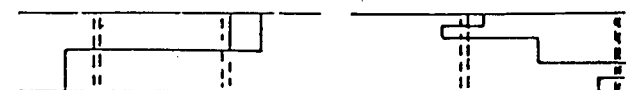


WEDGED SCARF

LOCKED SCARF



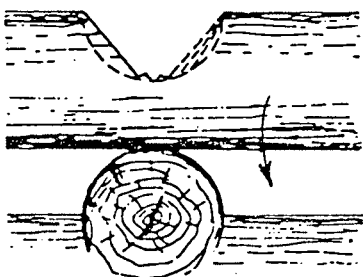
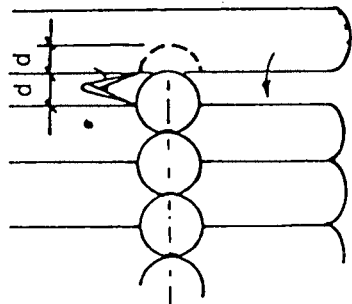
TENONED SCARF



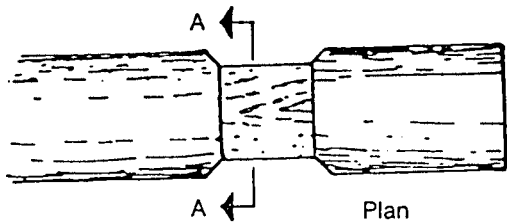
LAPPED

SHOULDERED

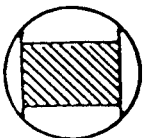
Figure 28. NOTCHES (not to scale)



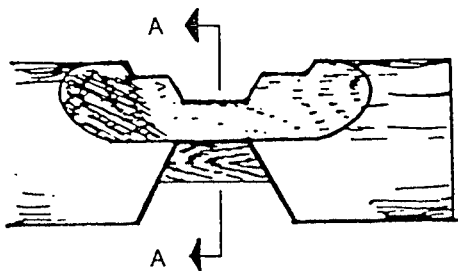
ROUND NOTCH



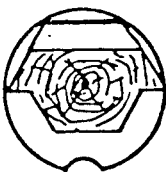
MITRED NOTCH



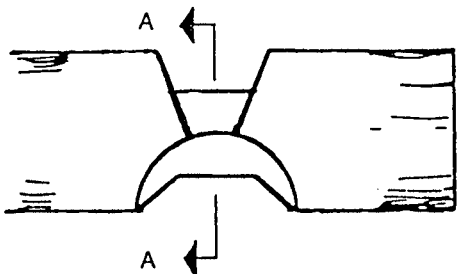
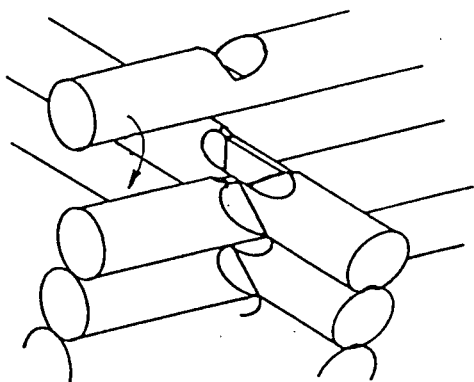
A-A



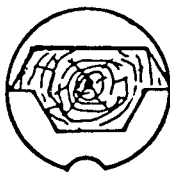
ELEVATION
SHEEPSHEAD NOTCH



A-A

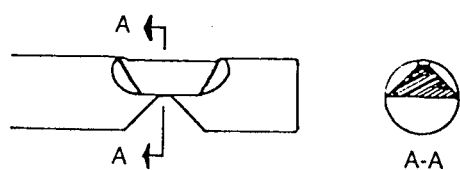


ROUND SHEEPSHEAD NOTCH

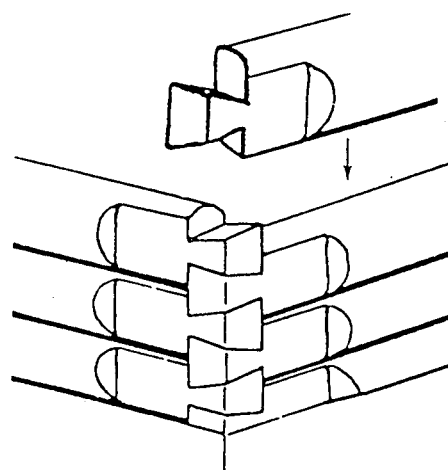


A-A

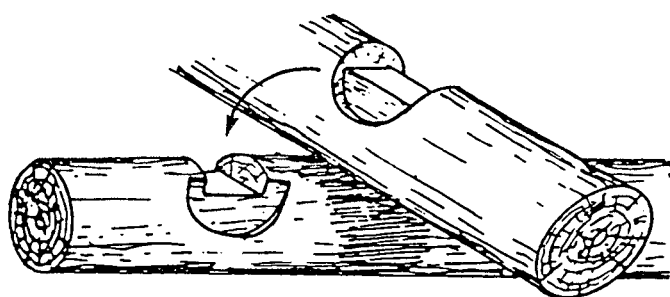
Figure 28. NOTCHES (continued)



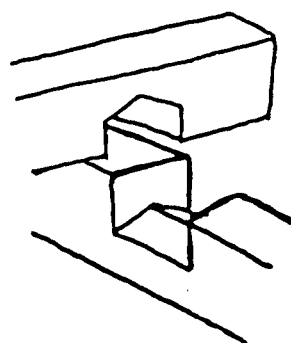
SADDLE NOTCH



DOVETAIL NOTCH



SQUARE NOTCH



BOX NOTCH

Figure 29. SQUARED AND FLATTED LOGS (not to scale)

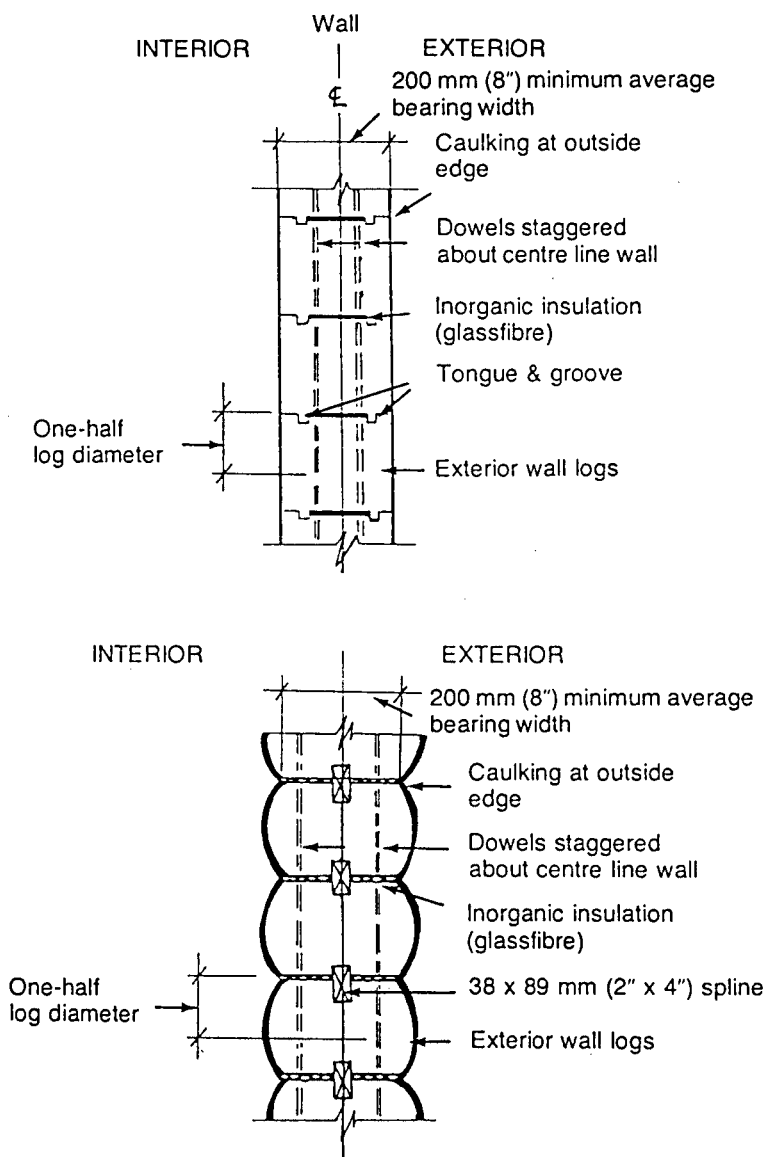


Figure 30. ROOF DETAILS CROSS-SECTION

Notes:

1. Underlay beneath shingles is not mandatory but when used should be asphalt-saturated sheathing paper weighing not less than 0.195 kg/m^2 (4 lbs per square), or No. 15 plain or perforated asphalt saturated felt or 0.05 mm (2 mil) polyethylene, except that underlayment beneath wood shingles should be a breather type.
2. For the successful application of gypsum board the log rafters or strapping attached to them should present an even surface.

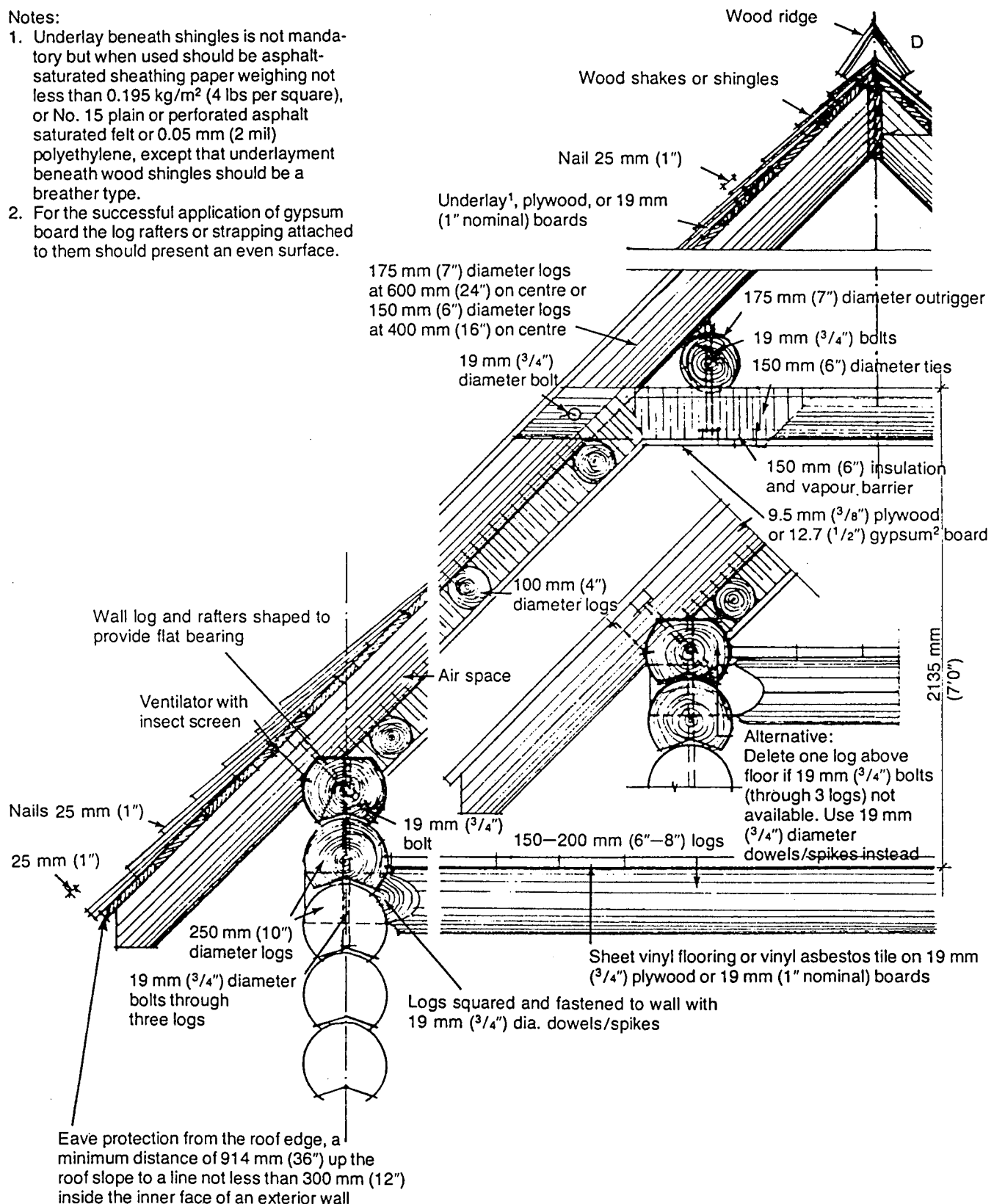


Figure 31. ROOF DETAILS. PART ELEVATION

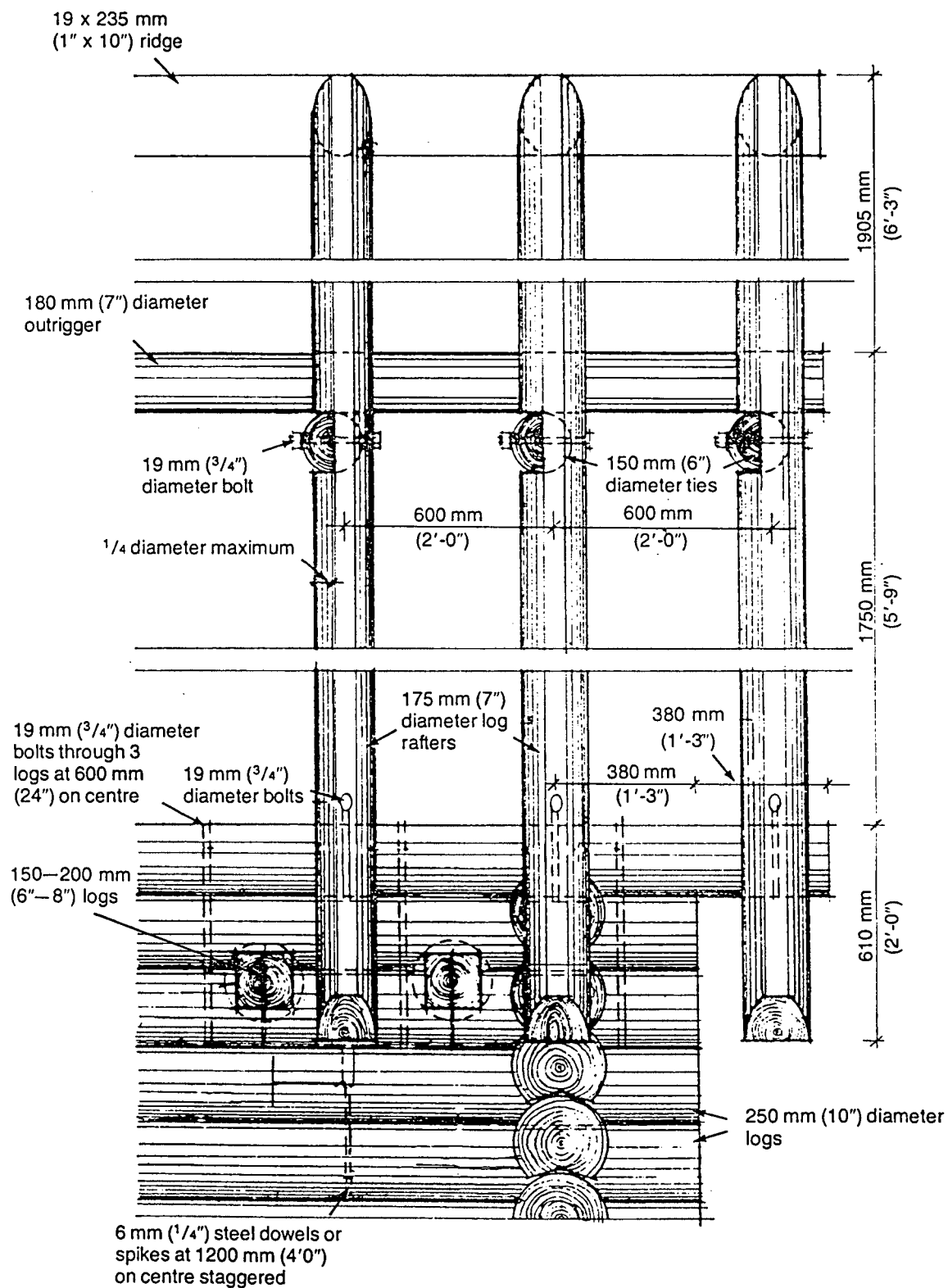


Figure 32. ROOF DETAILS. PERSPECTIVE VIEW OF CORNER

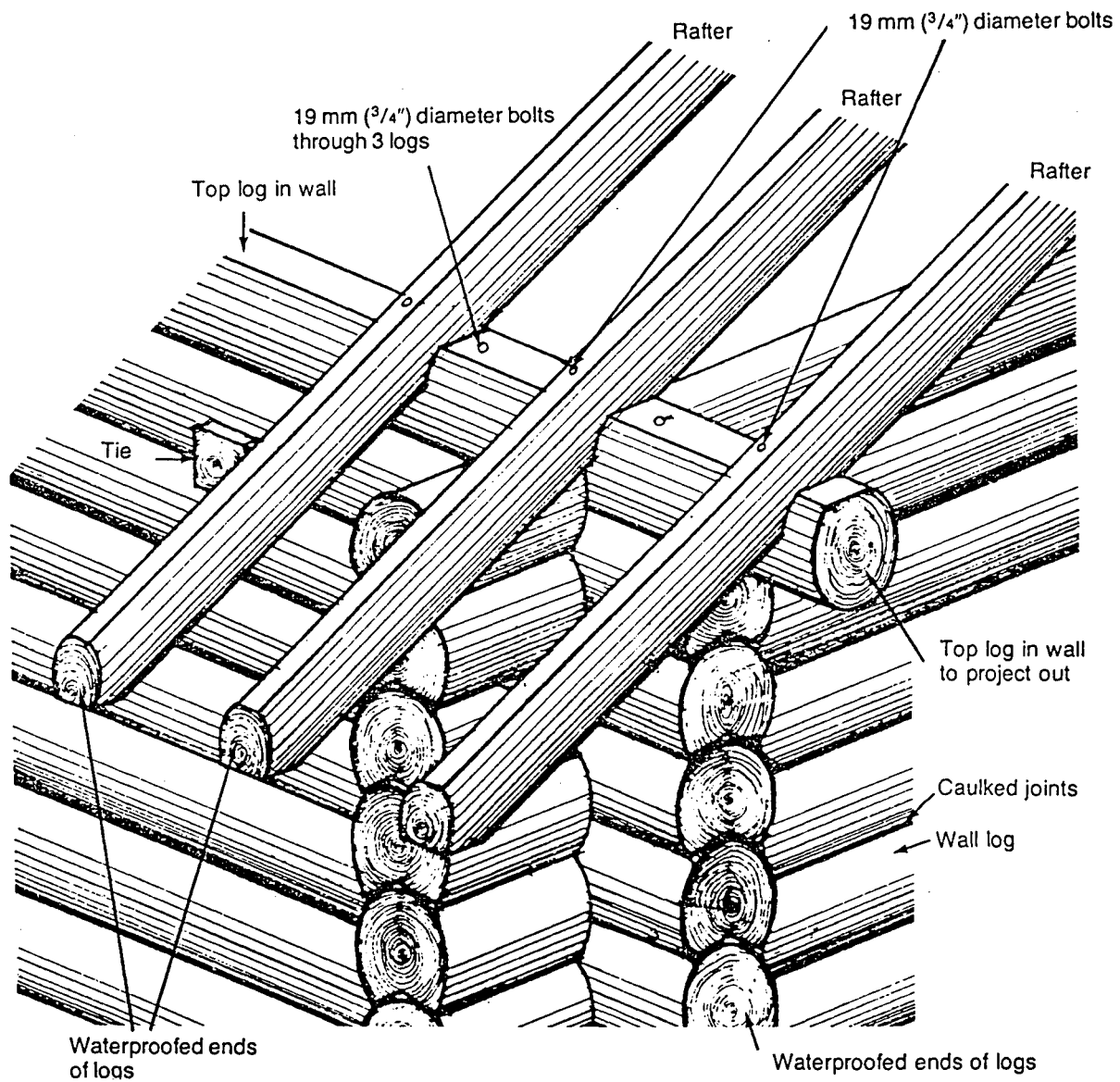


Figure 33. ROOF DETAILS

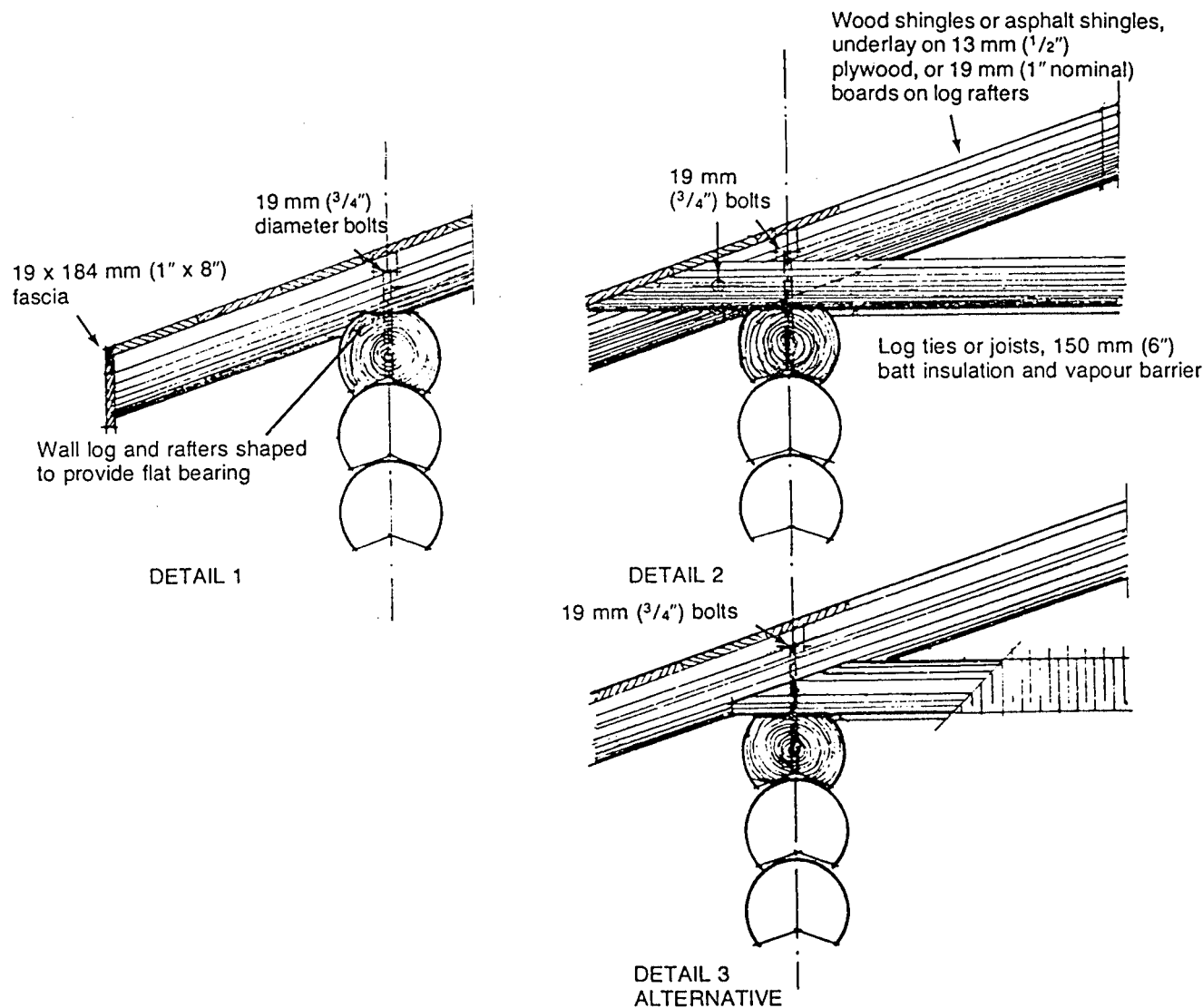


Figure 33. ROOF DETAILS (continued)

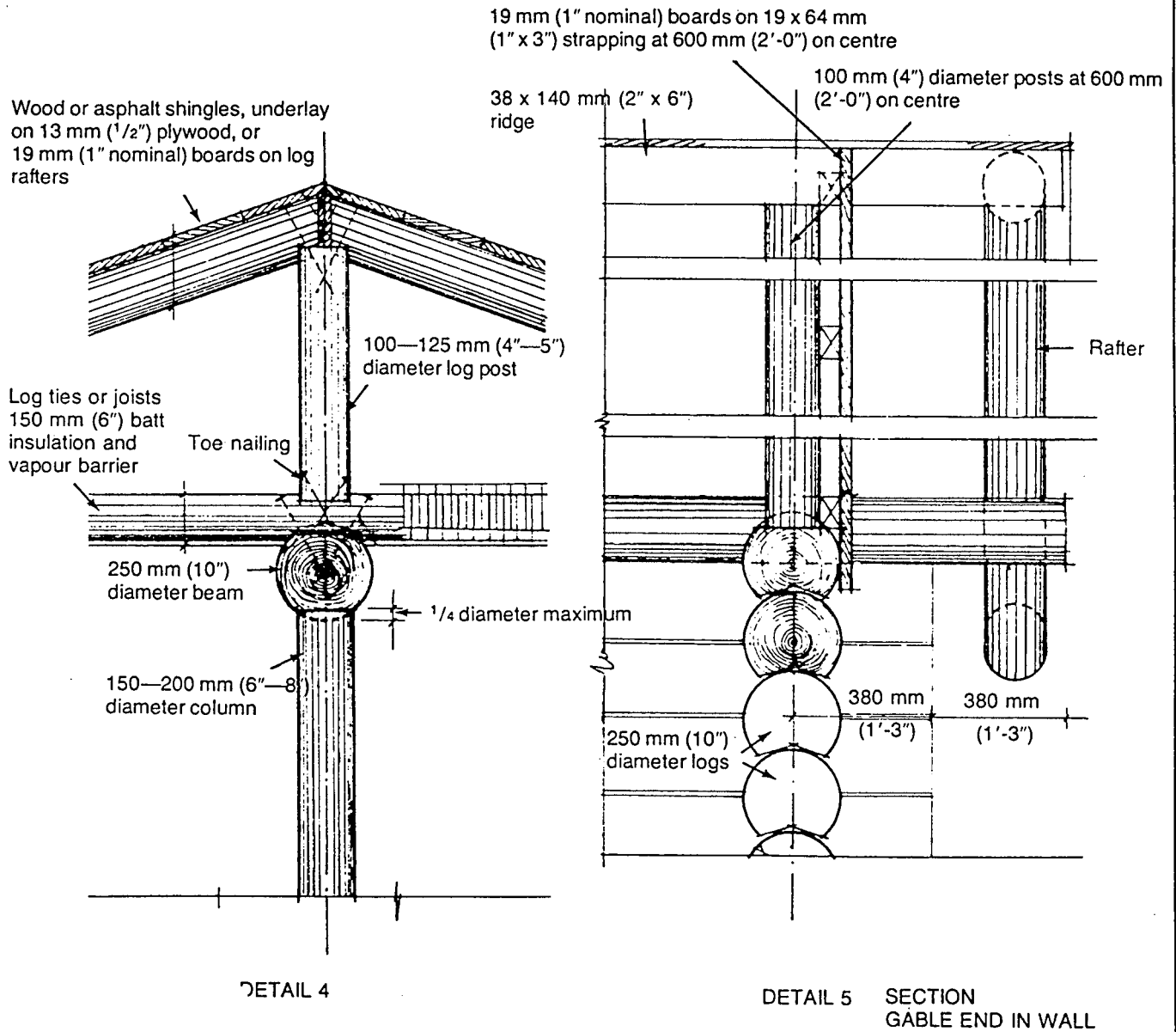


Figure 34. TYPICAL CROSS-SECTION

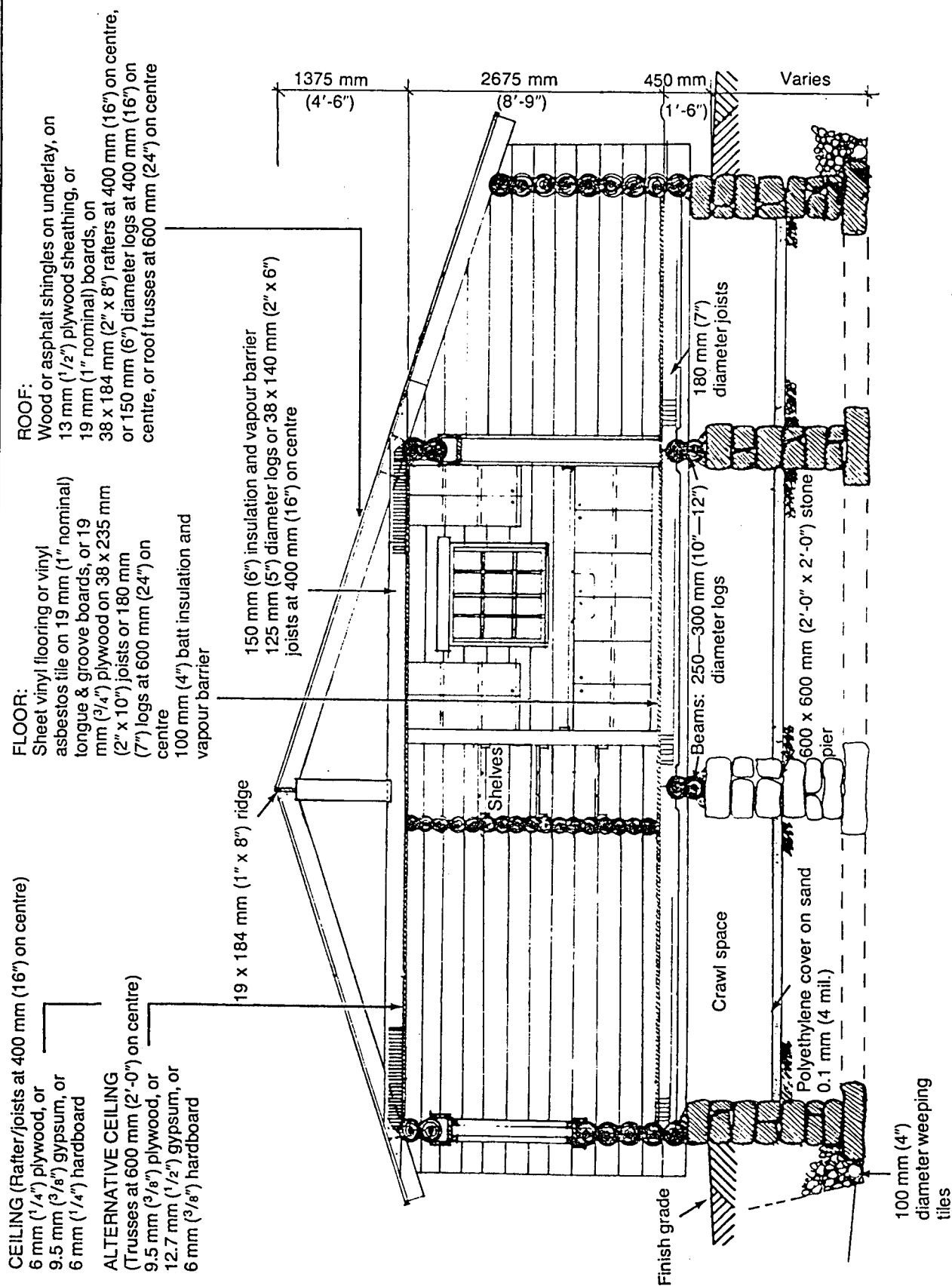


Figure 35. TYPICAL WALL SECTION

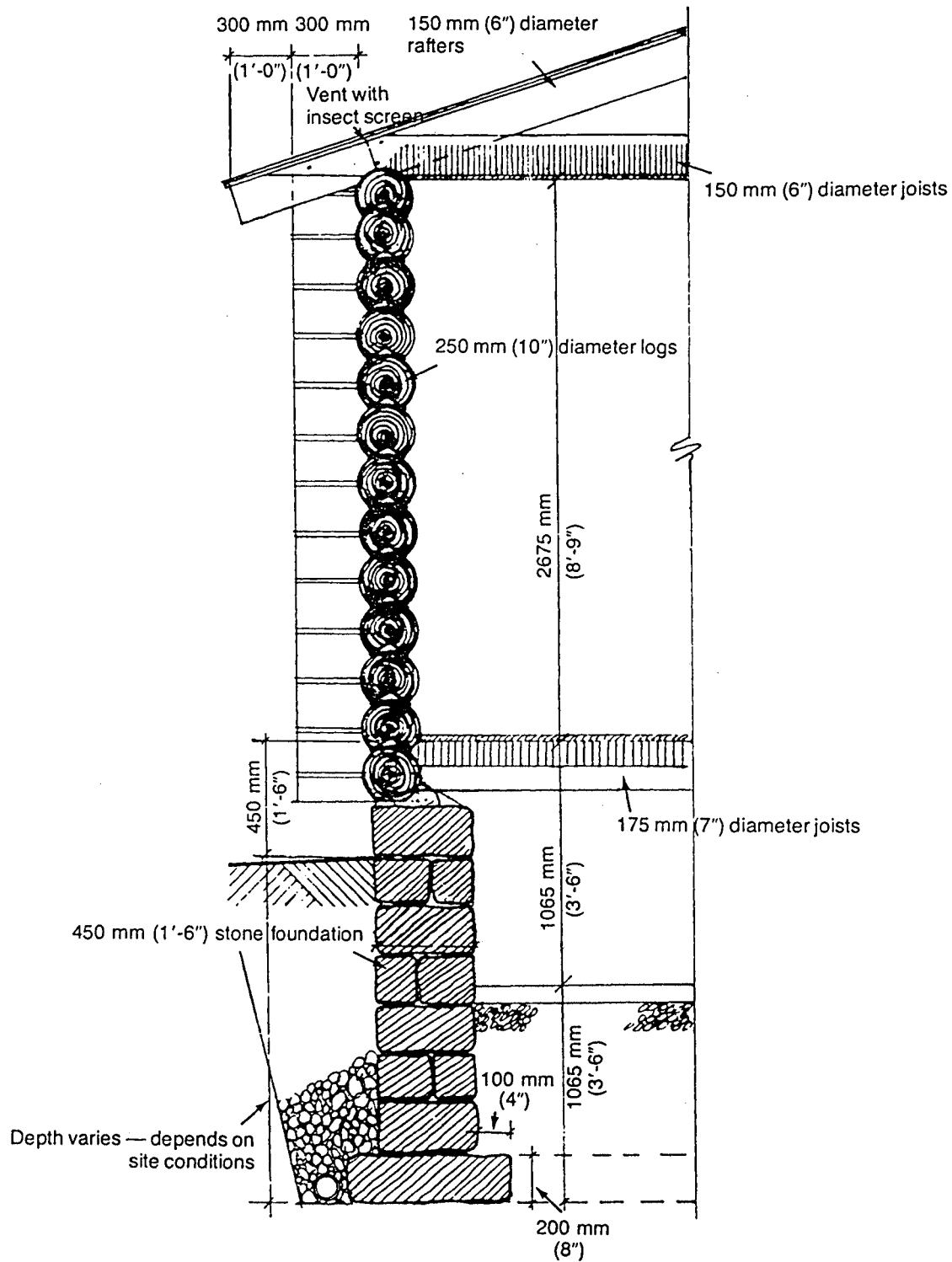


Figure 36. TYPICAL CROSS-SECTION

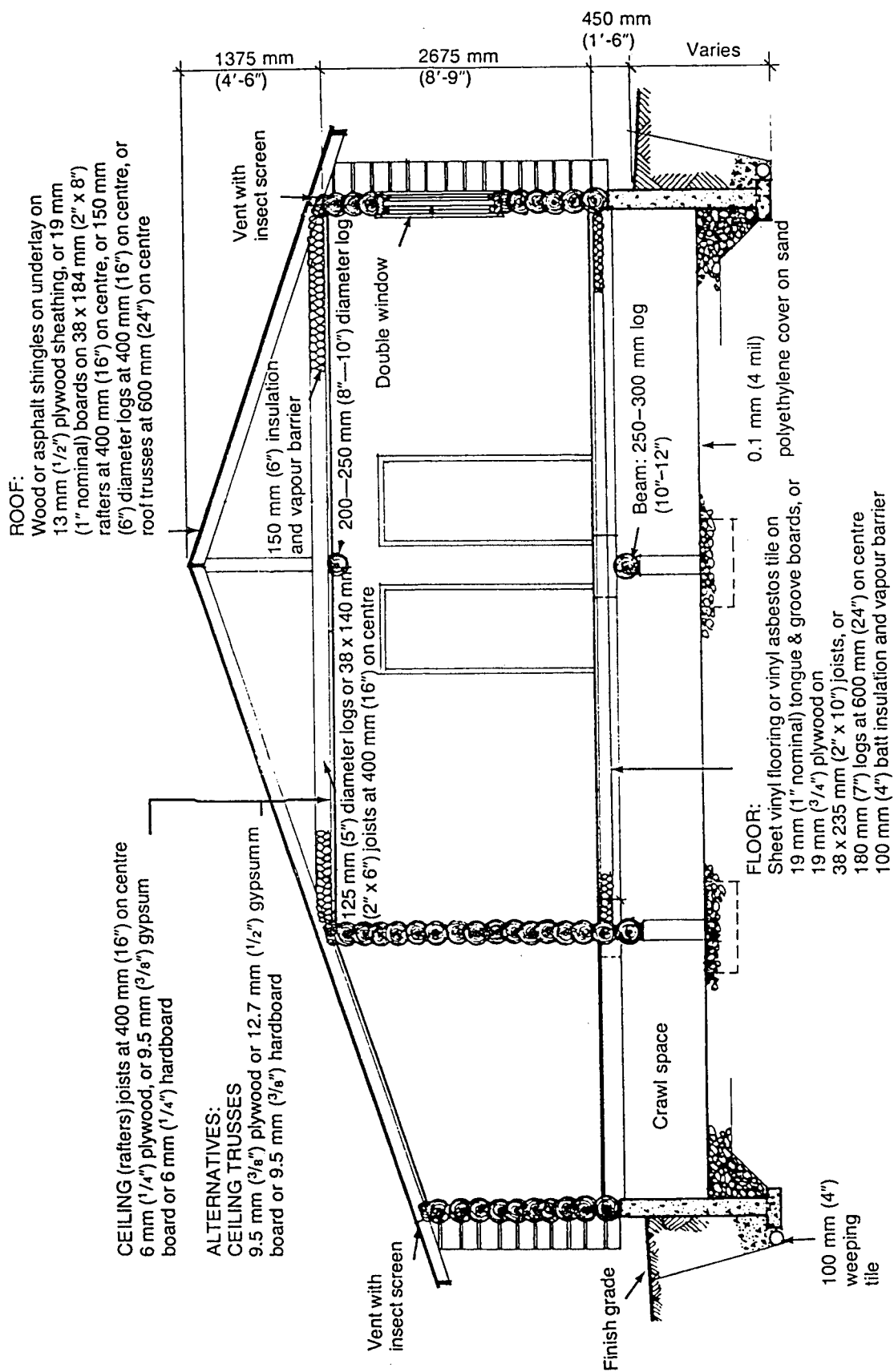


Figure 37. TYPICAL WALL SECTION

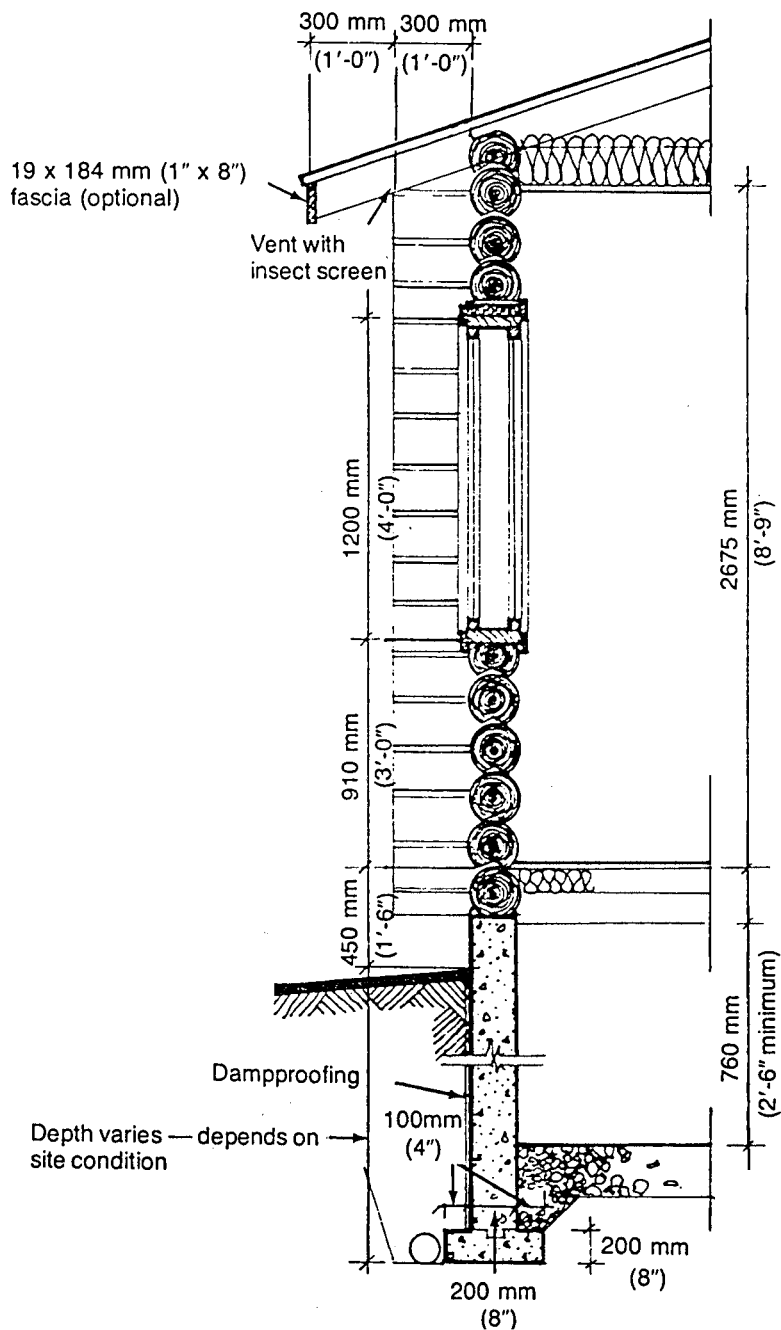


Figure 38. TYPICAL CROSS-SECTION

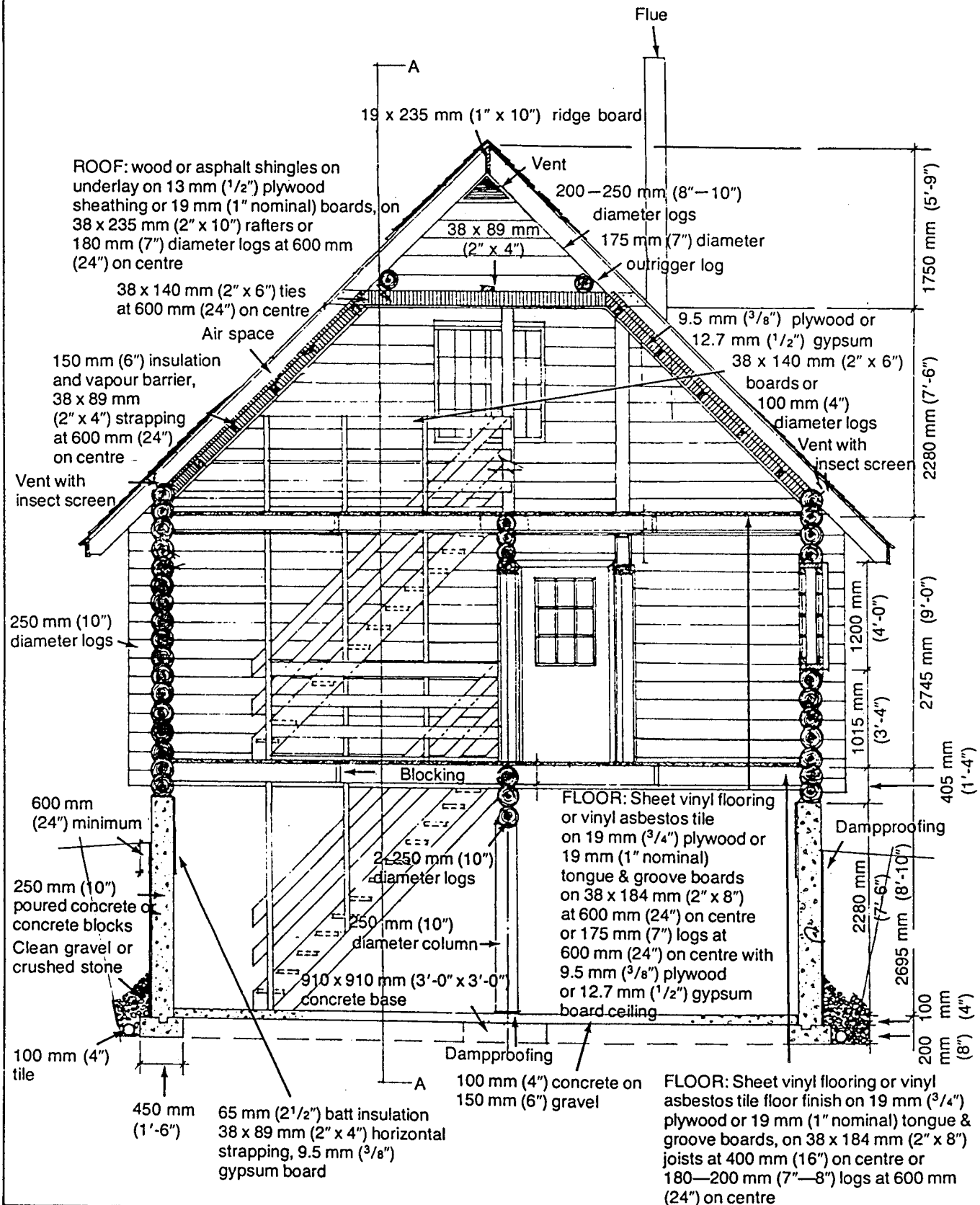


Figure 39. TYPICAL CROSS-SECTION

CEILING (rafters/joists at 400 mm (16") on centre)
6 mm (1/4") plywood, or 9.5 mm (3/8")
gypsum, or 6 mm (1/4") hardboard

ALTERNATIVE:
CEILING (trusses at 600 mm (24") on centre)
9.5 mm (3/8") plywood, or 12.7 mm
(1/2") gypsum board, or 9.5 mm (3/8")
hardboard

ROOF:
Wood or asphalt shingles on underlay on
13 mm (1/2") plywood sheathing or 19 mm (1" nominal)
boards on 38 x 184 mm (2" x 8") rafters at
400 mm (16") on centre or 150 mm (6") diameter logs
at 400 mm (16") on centre of roof trusses at
600 mm (24") on centre

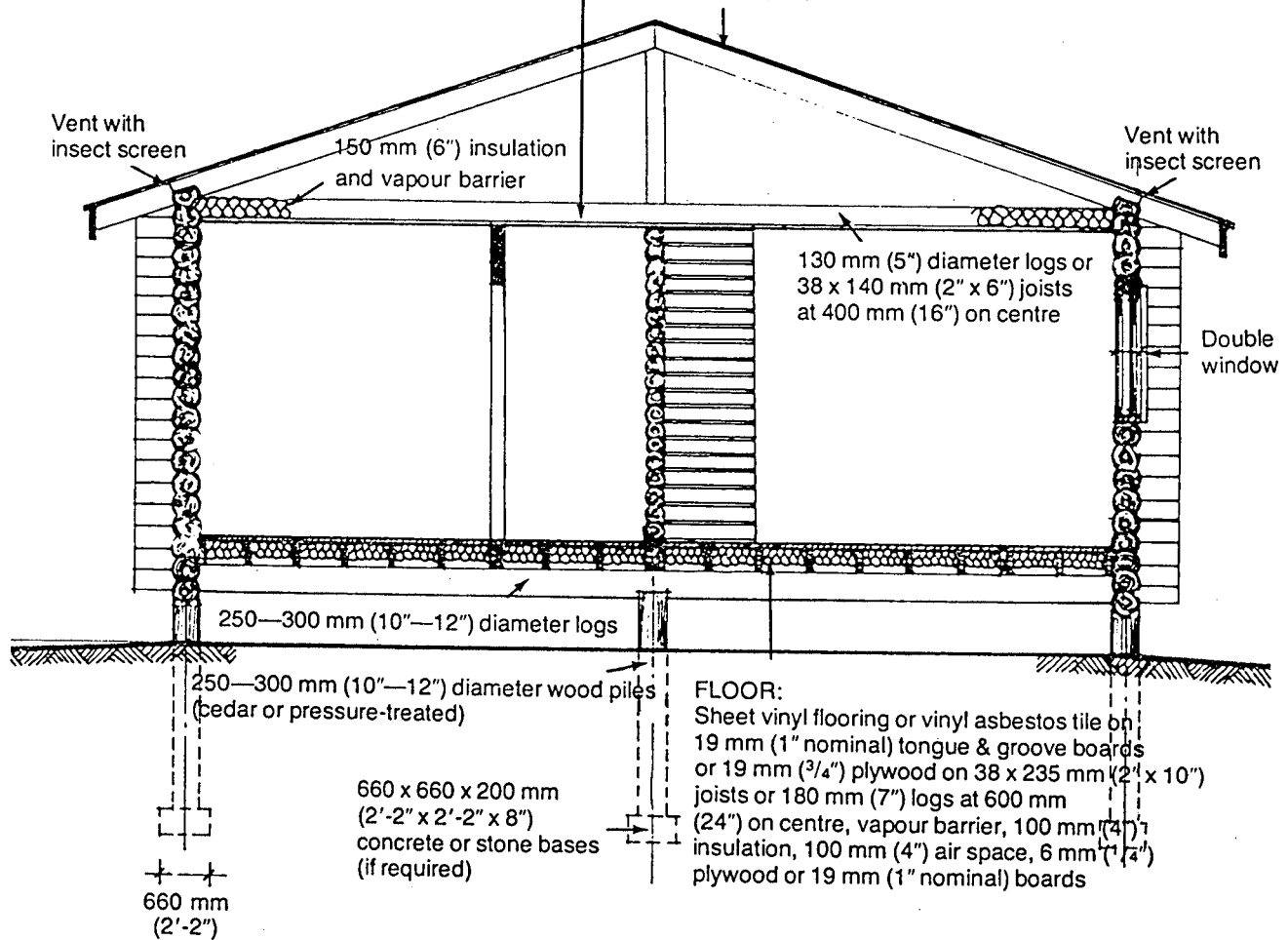


Figure 40. TYPICAL WALL SECTION

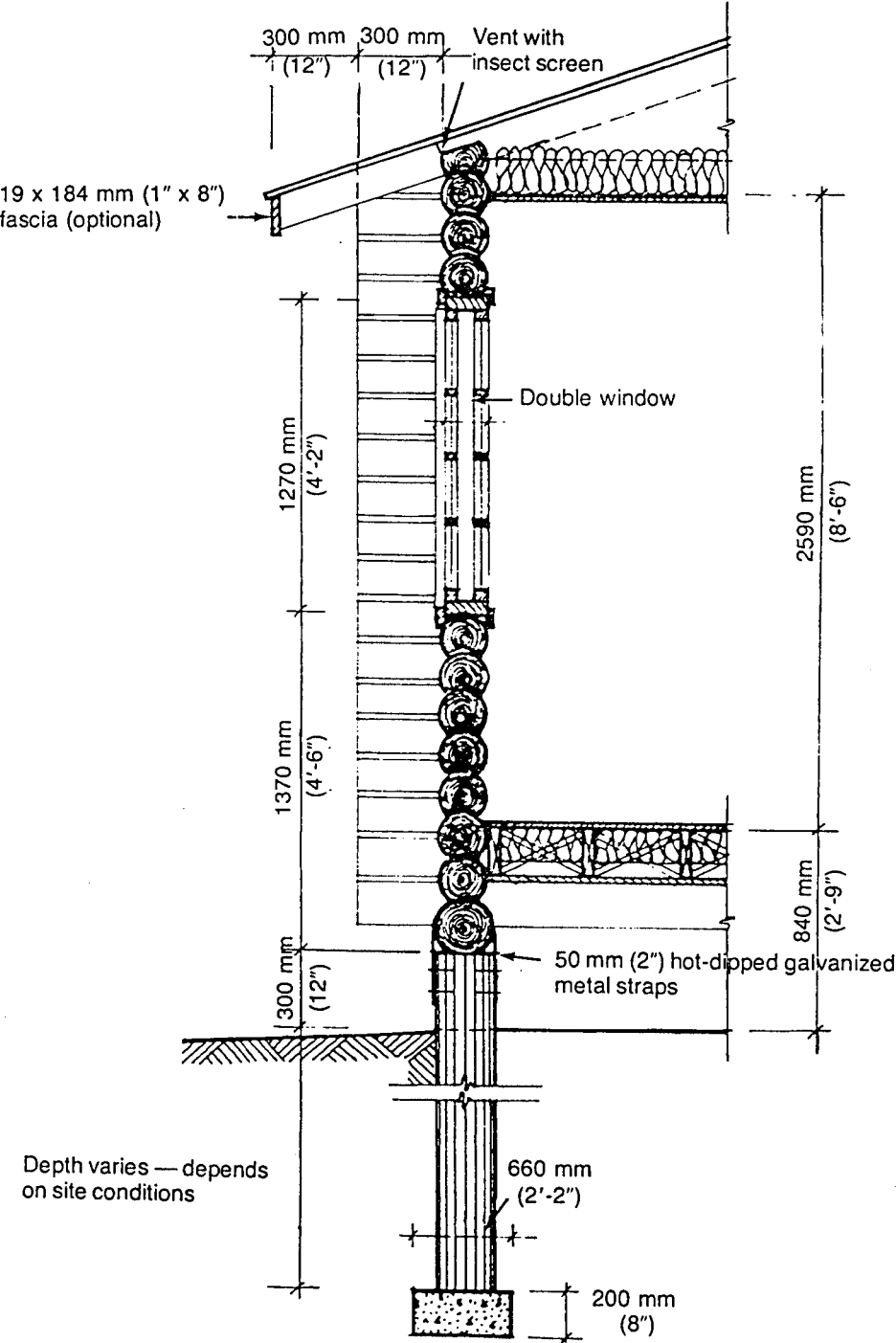


Figure 41. SECTION SHOWING TYPICAL INSTALLATION OF HEATER (not to scale)

