

A COMPARISON BETWEEN
CONVENTIONAL BRICK
AND TIMBER-FRAME
BRICK VENEER HOUSING

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SECTION 1

INTRODUCTION

INTRODUCTION.

Timber-frame brick veneer construction originated in countries in which houses were traditionally constructed with loadbearing timber frames which were clad with non-loadbearing weather boarding or similar light-weight materials. Timber-frame house construction is extensively used in countries such as Canada, Scandinavia, Australia and North America. With the Canadian system, buildings of up to three storeys can be erected with loadbearing timber frames. This particular system was also adopted in France - the Igny project, and in England - the Harlow project. In most of these cases, basements or crawl-spaces underneath the house were incorporated in the design.

In these countries there have been a trend towards the use of a brick cladding (veneer) for timber-frame structures. This is a comparatively recent introduction in these countries, but it has already been extensively used. This trend is primarily related to the appearance and other advantages (for example durability and ease of maintenance in the case of a face-brick cladding) of a masonry exterior, while largely retaining the low cost benefits of timber-frame construction.

In South Africa, timber-frame construction has only been used on a very limited scale, although, during the past 8 to 9 years, there has been a noticeable increase in the use of this type of construction. At the beginning of this decade, there was a steady demand for this type of construction. A survey conducted under building societies showed that very few bonds were extended for timber-frame brick

vener houses during the past 2 to 3 years. This is not because of bonds not being available for this type of construction, but rather due to the lack of interest on the part of the future homeowners.

At present Australia is the leader in the field of timber-frame brick veneer construction. Their system can easily be adapted to suit the South African circumstances. The South African Lumber Millers' Association is therefore investigating their technique of timber-frame brick veneer construction for possible use in South Africa.

The situation in South Africa.

The three primary essentials for the building of a satisfactory house are:

- (i) An efficient design;
- (ii) Suitable materials; and
- (iii) Sound construction.

The house may be large or small, elaborate or unpretentious, modern or traditional in style, yet without all three of these essentials, it may be neither permanent nor satisfactory. The traditional masonry construction has proved to be permanent and satisfactory, and therefore it satisfies this three primary essentials. Timber-frame construction is a relatively recent introduction compared to traditional masonry construction and has therefore not yet proved itself to be permanent nor satisfactory in South Africa.

Against a background of a long tradition of masonry construction, as well as our complex economic and labour factors, there has been in South Africa a prejudice on the part of home owners and local authorities against non-traditional building methods, of which the timber-frame construction forms part of. At the present time there is a greater awareness within the Building Industry of the potential benefits to be obtained from the use of timber-frame construction. Circumstances are demanding a reduction of on-site artisan labour skills to keep building costs and productivity at a healthy level relative to the economy as a whole. With correct design, planning, etc., it can be achieved by timber-frame construction. The ultimate acceptance of timber-frame construction by home-owners and building societies will be related to factors such as cost, performance-in-use and the resale value of the house. S.J. Richards, Assistant Director of the National Building Research Institute, stresses in his paper "Performance aspects of brick veneer construction and their relation to legislation and codes" the importance of price. "Finally, although the average house buyer in South Africa looks for value for money in terms of suitability of performance and standard of construction and appearance, his overriding consideration is price. It is therefore likely that timber-frame brick veneer housing will not get a significant share of the housing market unless its price is attractively lower than that of traditional housing. Although much has been said about the possibilities of it being lower, only convincing proof of this in actual practice will impress the house buyer.

To many potential purchasers, speed of erection is not such an important consideration." 1

Availability of bonds.

A survey conducted by a local newspaper found that bonds for timber-frame brick veneer houses are as easily obtainable as those for brick houses, but there are still traces of conservatism in attitudes towards these types of construction among building societies. The building societies are also reluctant to extend bonds beyond 20 years as opposed to 30 years for conventional masonry construction. The building societies were also of the opinion that timber-frame brick veneer houses will be no cheaper than the conventional brick houses. This showed that the building societies do not believe that the timber-frame brick veneer house will be as permanent as a solid brick house. Their attitude towards cost showed that they are still ignorant about the timber-frame brick veneer system. On the average the building societies had no objection to granting bonds for brick veneer houses, provided that the usual building safeguards were maintained. Their policy towards solid timber houses would, however, be very conservative.

Requirements of the Local Authorities:

In 1976, the South African Lumber Millers' Association conducted a survey under Local Authorities to establish whether they would per-

1. S.J. Richards: "Municipal Engineer", Vol. 4, No. 6,
Nov./Dec. 1973, p. 75.

mit the timber-frame brick veneer building system in the areas under their jurisdiction. A questionnaire, containing four questions, was drawn up and sent to 45 Local Authorities. The questions were:

Question 1: Is your Council conversant with the Timber Frame Brick Veneer Building System?

Question 2: Is this building system accepted by your Council for construction in the areas under its jurisdiction?

Question 3: Will your Council be prepared to co-operate with the Department of Forestry and this Association in developing this building system within the areas under its jurisdiction?

Question 4: Does your Council accept the principle of agrément, in other words, does your Council accept building methods that are covered by an agrément certificate as suitable for erection of residential housing?

The following is a summary of the replies received:

<u>Question number</u>	<u>Yes</u>	<u>No</u>	<u>Undecided</u>
Question 1	75%	20%	5%
Question 2	56%	37%	7%
Question 3	64%	9%	27%
Question 4	80%	7%	13%

It should be noted that the most larger Local Authorities, for example Alberton, Kempton Park, Potchefstroom, Divisional Council of the Cape, Bellville, East London, etc., accept the whole system of timber-frame brick veneer construction. Of the 37% who do not accept timber-frame brick veneer construction, 23% will accept it if it is accompanied by an agrément certificate. The 7% who was undecided on the same question, indicated that they have never received an application for this type of construction. If this building method complies with their local building regulations, it will be accepted.

Acceptance of this system by the Local Authorities implies that it complies with their respective building regulations, in other words, their fire regulations, etc. As stated before, most larger Local Authorities accept this building system. Due to lack of knowledge and experience, the small Local Authorities do not accept this building system.

Object of Treatise.

Timber-frame brick veneer construction is a relatively recent introduction in South Africa. When it was originally introduced in South Africa, it was expected that it would capture a considerable percentage of the market. This, however, did not happen, mainly because people looked at it as a particular method of industrialized building, and not as an alternative to traditional masonry construction.

People are also uninformed about the performance and feasibility of this type of construction. It is the object of this treatise to

show that the performance characteristics of a timber-frame brick veneer house compare favourably with that of an all-brick house, and that it will present better value for money for the average family. Brick veneer construction do have performance characteristics which are not up to the standard of all-brick construction, but none would be so serious that it cannot be either accepted or overcome.

SECTION 2

CONSTRUCTION PROCEDURE

CONSTRUCTION PROCEDURE.

General requirements.

Light-weight timber frames form the carcass for the external and internal walls and are erected on a sub-structure (foundations and sub-floor). The foundations and sub-floor are basically a conventional operation. The roof structure is supported on and anchored to the external wall framing and is also basically conventional.

The external wall frames, in which the doors and windows are mounted, are clad externally with a single leaf of brickwork which is non-loadbearing and which protects the structure against weather and gives the appearance of a brick building. It is very important to recognize the fact that the brick veneer is regarded as a non-structural cladding and the timber frames must therefore be designed to fulfil the loadbearing function. The timber-framed walls should be so constructed as to provide adequate lateral stability and resistance to horizontal (wind and impact) forces. Since the timber-frame brick veneer construction is relatively light, it is particularly important that the walls be firmly anchored to an adequate concrete foundation in order to resist wind forces. Internally, gypsum plasterboard is generally used to clad the external wall frames and both sides of the internal wall frames. The wall frames should be rigid and the cladding material should possess a satisfactory measure of resistance to damage.

Conventional roof covering and ceiling materials are used. The roof should be tied to the walls in such a manner as to resist wind uplift forces, and the walls in turn should be constructed so that they and

their anchorages are strong enough to withstand the resulting vertical tensile stresses. Plumbing and electrical services are traditional, and pipes and conduits are generally housed in the wall cavities.

CONSTRUCTION PROCEDURE.

The six main operations in the construction of a timber-frame brick veneer house are normally carried out in the following sequence:

- (a) Foundations and floor platform;
- (b) Timber wall framing (including window and door frames);
- (c) Roof structure and covering;
- (d) Plumbing and electrical services;
- (e) Brickwork cladding to external walls;
- (f) Ceiling and cladding to internal wall framing (including insulation, if required).

These operations are not necessarily carried out separately, but may overlap.

(a) FOUNDATIONS AND SUB-FLOOR.

The weight of a brick veneer house is significantly less than that of a conventional brick house and the foundation can therefore be correspondingly lower.

The sub-structure generally comprises concrete strip footings, brick foundation walling below loadbearing timber-frame external walls and a concrete surface bed. Since the internal partitions are non-loadbearing and very light,

no special foundations are required for these walls, and the partitions may generally bear directly onto the concrete surface bed. The strip footings for the loadbearing external walls are required to provide bearing for the timber wall-framing as well as the brick cladding. As mentioned before, the loading is relatively light. In normal stable soils, the width of the footing is therefore dictated more by the practical problems of trench excavations and the laying of brick foundation walls in trenches than by problems of bearing capacity.

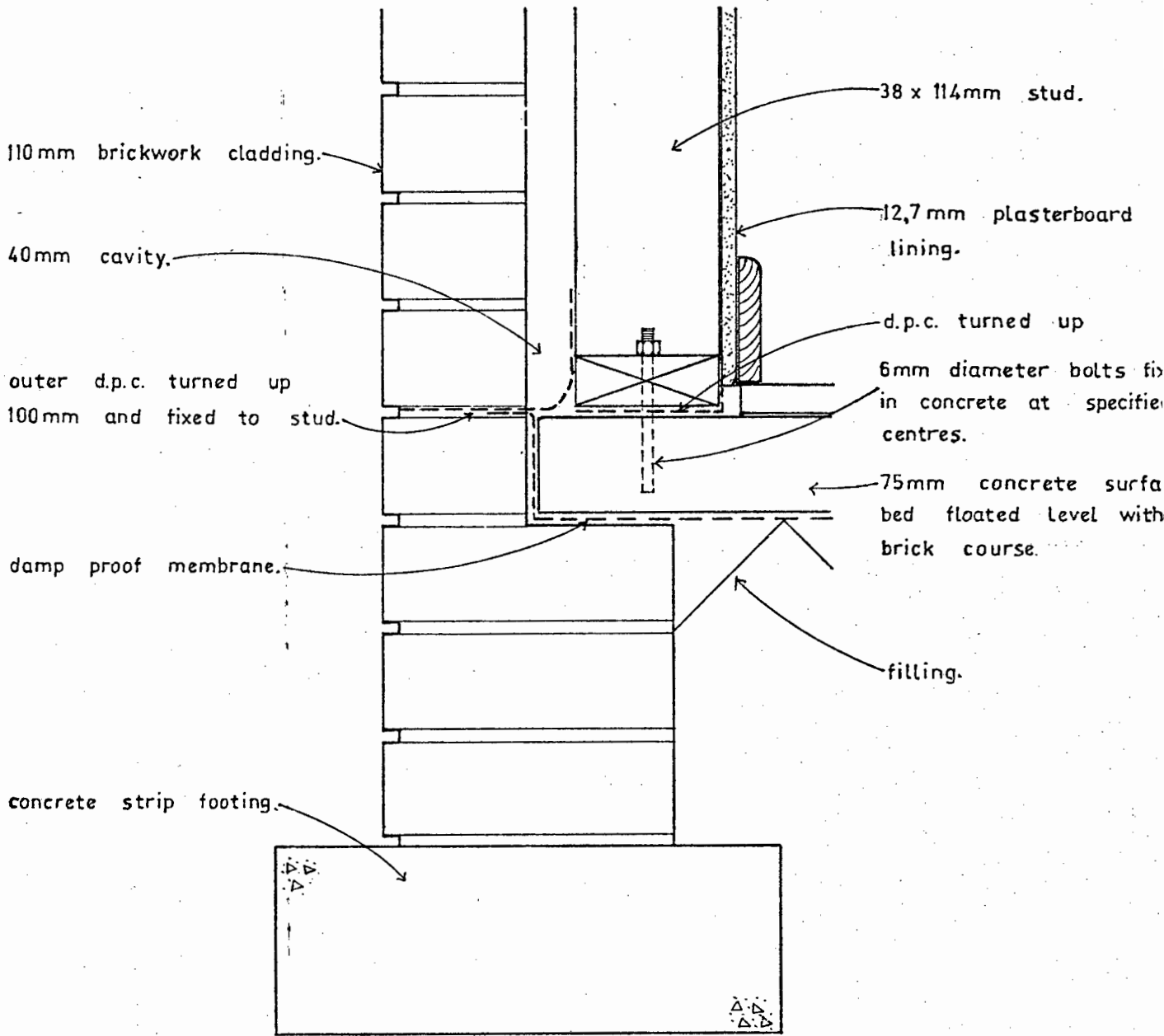
There are two types of footing which may be used:

- (i) The conventional concrete strip footing supporting a double skin brick foundation wall (inner skin under the wall frame and outer skin under the brick veneer). (See drawing 1);
- (ii) A concrete perimeter beam cast as an integral thickening out of the concrete surface bed and serving as both footing and foundation wall. (See drawing 2). This has the advantage of limiting all bricklaying work to the one operation of cladding the external walls at a later stage. This method is not generally used with the conventional brick construction as the foundations can sometimes be very deep.

The concrete surface bed can also be done in one of two ways:

- (i) It can be cast level with and up against the inner

DRAWING NO. 1



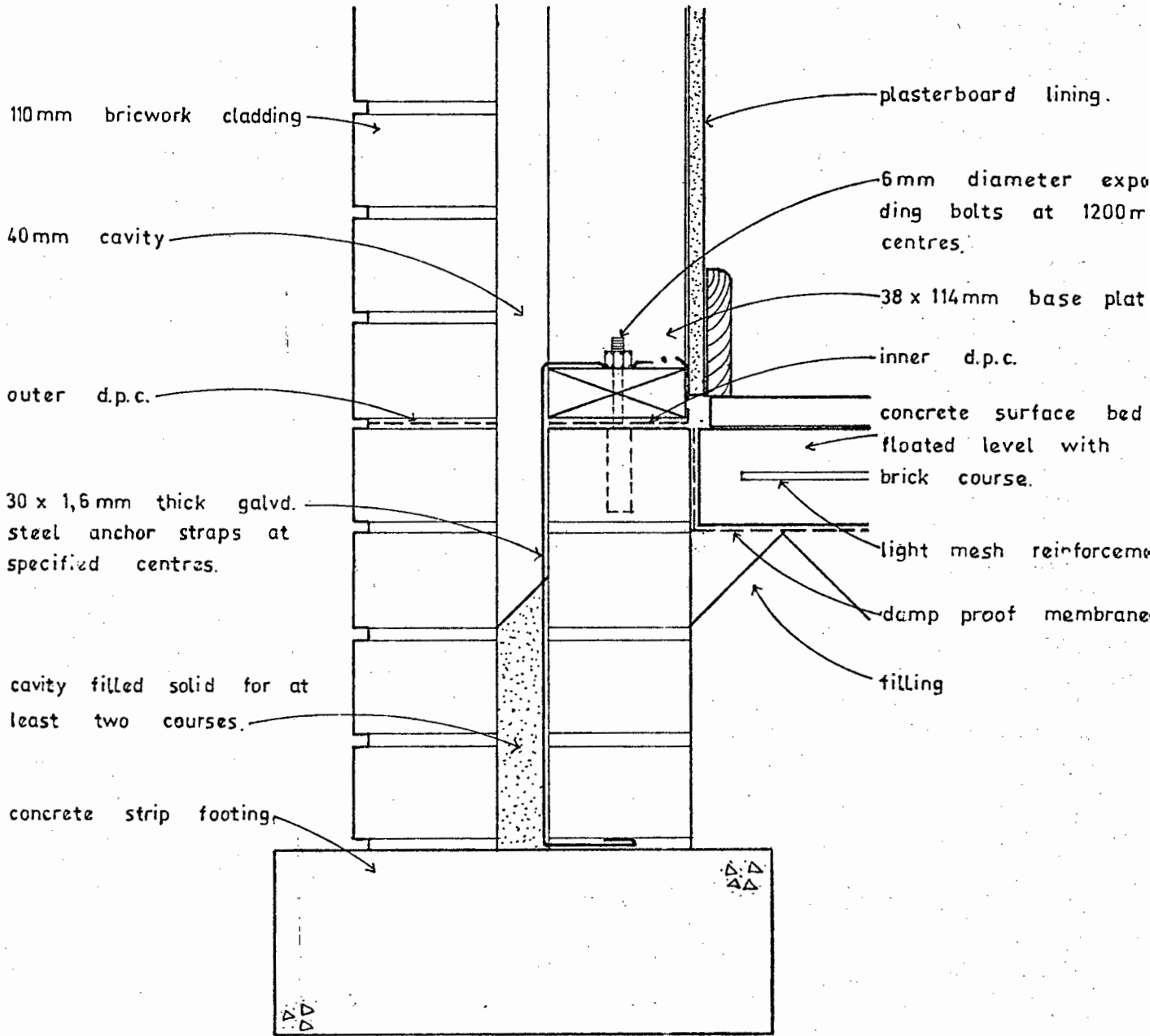
TYPICAL DETAIL USING BOLT ANCHORS.

FOUNDATION DETAIL —

ALTERNATIVE 1

SCALE 1 : 5

DRAWING NO. 2



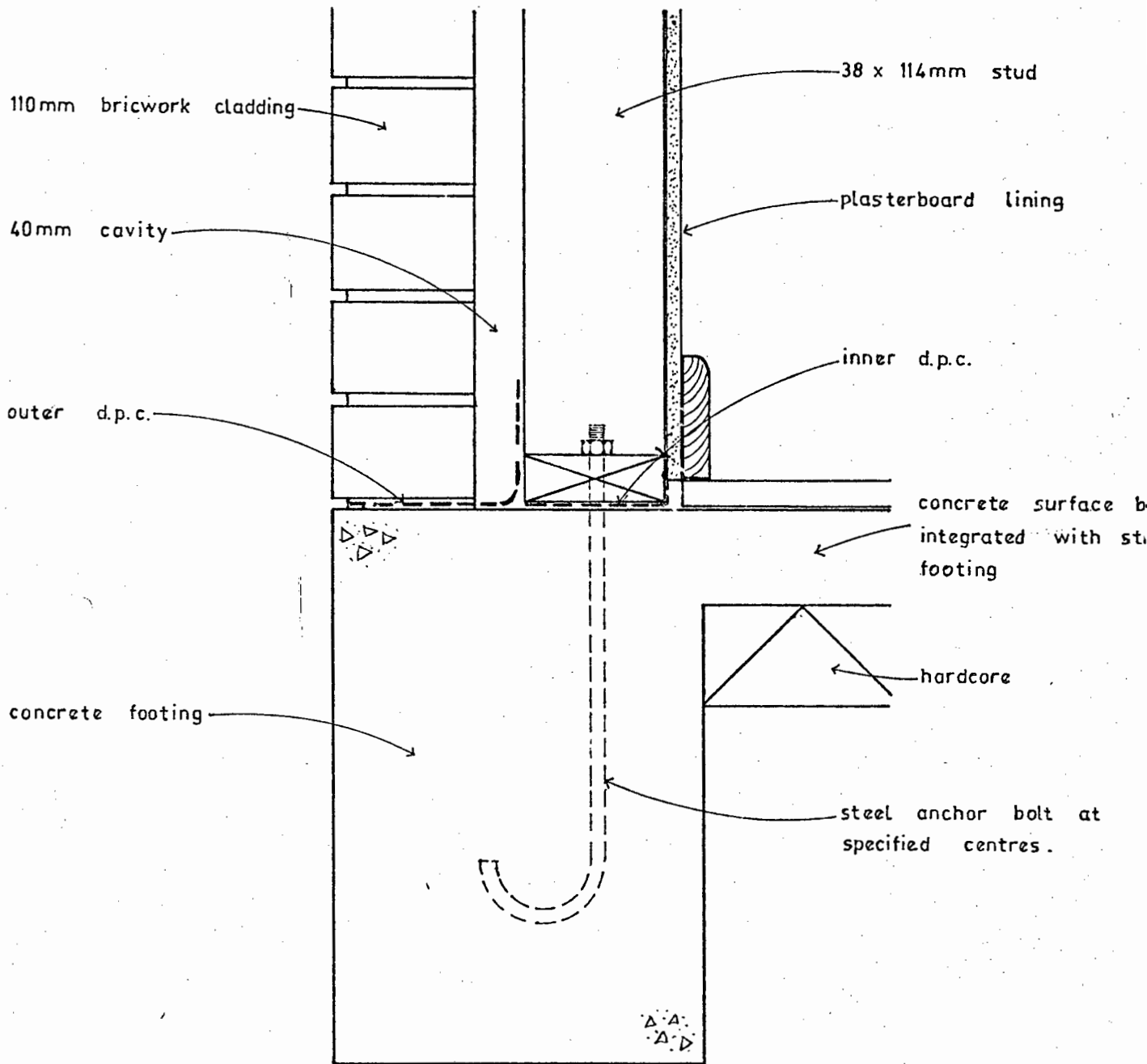
TYPICAL DETAIL USING STRAP ANCHORS.

FOUNDATION DETAIL —

ALTERNATIVE 2

SCALE 1 : 5

DRAWING NO. 3



CONCRETE FOOTING AND SURFACE BED CAST TOGETHER

FOUNDATION DETAIL —

ALTERNATIVE 3

SCALE 1 : 5

leaf of the brick foundation wall. This situation will occur where foundation walls are employed, which will be the case in most instances. (See drawing 1).

- (ii) The inner leaf of the foundation wall may be stopped level with the backfill and the surface bed cast over and up to the outer edge of this leaf. (See drawing 3).

Since there are no internal foundation walls to divide the surface bed into smaller units as in the case with conventional masonry buildings, there is an increased risk of shrinkage cracking of the concrete, leading to damage to floor finishes. The incorporation of light welded steel mesh, which should be at mid-thickness of the concrete slab, will control such cracking. Shrinkage joints can also be formed, preferably under the partition walls.

(b) TIMBER WALL FRAMING.

(i) General:

The term 'wall framing' is applied to the assembled timber frames which form the carcass for the external and internal walls. Each timber frame incorporates vertical studs which are fixed to horizontal top and bottom members (head plates and sole plates) and horizontal intermediate members (noggings).

The timber frames are temporarily braced and erected on the floor platform, to which it is anchored.

Openings are left in the frame in which door and window frames are fixed. If required, these openings will be bridged by timber lintels which transfer the roof loads occurring over the openings to the adjacent frames. The internal and external frames are nailed together. The loadbearing external frames are in addition tied together by a continuous timber wall plate.

(ii) Structural considerations:

There are two types of wall framing to be considered:

- (1) Loadbearing frames (external walls), and
- (2) Non-loadbearing frames (internal walls).

These two types of framing are basically similar. Because they perform different functions, there will be a small difference in the constructional details. This difference will mainly be in the size of the members, spacing of the studs and base and head construction and fixing. Apart from the structural functions of both the internal and external walls, the walls must also be capable of withstanding the forces and wear and tear associated with the use of the house by its occupants. This involves resistance to abrasion and impact forces and the ability to support heavy sanitary fittings, wall shelving, etc. In the loadbearing walls, the loadbearing function will be overriding in the

determination of minimum stud sizes and maximum stud spacing. For the internal non-loadbearing walls they are determined by occupancy forces. (See Tables 1(a) and 1(b) for the sizes of timber members). It should be noted that whether frames are prefabricated or made up on site, it will not affect the constructional details. Individual full height frames should consist of a base plate, studs, close fitting noggings at mid-height and a head plate.

The individual wall frames will be securely jointed to one another by nailing together the end studs of the various frames meeting at the junction. With T- or L-intersections, blocking pieces 300 mm long can be used. (See drawings 4, 5 and 6). The load-bearing external wall frames will in addition be tied together with a continuous wall plate, nailed to the head of the plate. (See drawings 9, 10 and 11). As the wall plate must distribute the roof load to the different frames, it should be long enough to provide continuity across joints between frames and over openings. Joints in wall plates should be directly over a stud, but not over the studs of adjacent wall frames, except at corners. If the wall plate is narrower than the head plate, it should be fixed centrally over the wall framing so as to avoid eccentric loading.

The timber base plates for all loadbearing walls

TABLE 1(a)

ROUGH SAWN DIMENSIONS OF WALL FRAME MEMBERS

Member	For loadbearing walls supporting:				For non-loadbearing walls
	Light roofs with roof span S		Heavy roofs with roof span S		
	$S \leq 6,3 \text{ m}$	$6,3 \text{ m} < S \leq 10 \text{ m}$	$S \leq 7,8 \text{ m}$	$7,8 \text{ m} < S \leq 10 \text{ m}$	
	Dimensions (mm)				
Wall plate if trusses not located directly over studs	114 x 38	114 x 50	114 x 38	114 x 50	Not required
Wall plate if trusses located directly over studs	114 x 38	114 x 38	114 x 38	114 x 38	Not required
Head plate	114 x 38	114 x 38	114 x 38	114 x 38	76 x 38
Studs	114 x 38 at 450 max. centres	114 x 38 at 450 max. centres	114 x 38 at 450 max. centres	114 x 38 at 450 max. centres	76 x 38 at 450 max. centres
Noggings	114 x 38	114 x 38	114 x 38	114 x 38	76 x 38
Base plate	114 x 38	114 x 38	114 x 38	114 x 38	76 x 38

This Table is based on the use of 114 mm wide timber members for all loadbearing walls. The thickness of wall plates is either 38 mm or 50 mm dependent on the roof span. All other members are 38 mm thick.

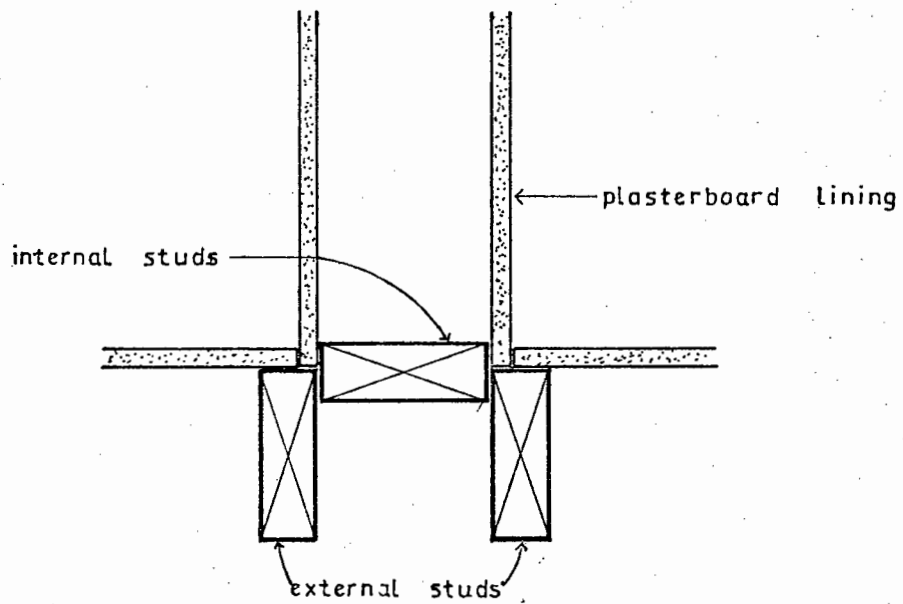
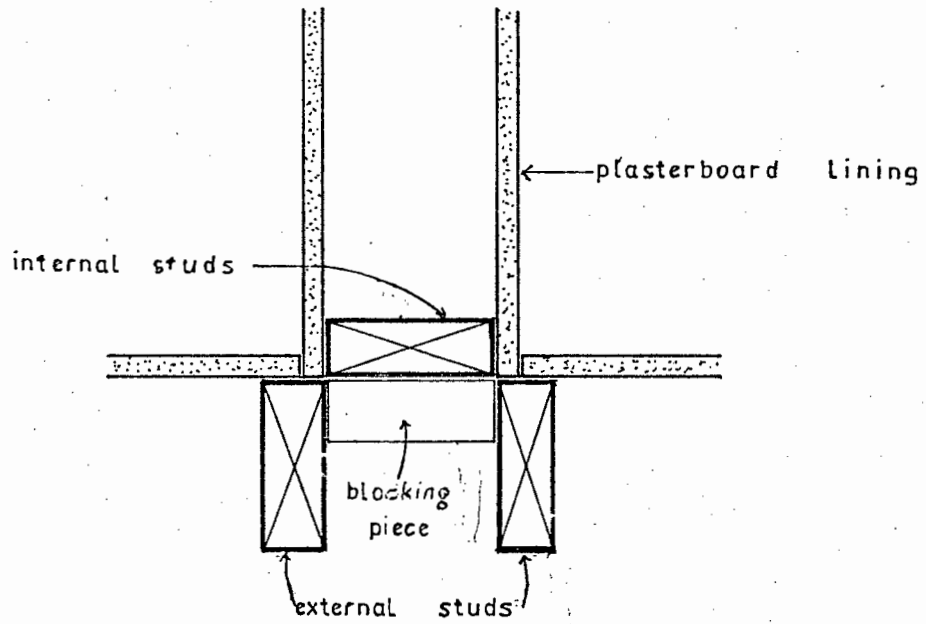
TABLE 1(b)

ROUGH SAWN DIMENSIONS OF WALL FRAME MEMBERS

Member	For loadbearing walls supporting:				For non-loadbearing walls
	Light roofs with roof span S		Heavy roofs with roof span S		
	S ≤ 6 m	6 m < S ≤ 10 m	S ≤ 6 m	6 m < S ≤ 10 m	
Dimensions (mm)					
Wall plate if trusses not located directly over studs	76 x 38	114 x 38	76 x 38	114 x 38	Not required
Wall plate if trusses located directly over studs	76 x 38	114 x 38	76 x 38	114 x 38	Not required
Head plate	76 x 38	114 x 38	76 x 38	114 x 38	76 x 38
Studs	76 x 38 at 450 max. centres	114 x 38 at 450 max. centres	76 x 38 at 450 max. centres	114 x 38 at 450 max. centres	76 x 38 at 600 max. centres
Noggings	76 x 38	114 x 38	76 x 38	114 x 38	76 x 38
Base plate	76 x 38	114 x 38	76 x 38	114 x 38	76 x 38

This table is based on the use of 76 mm wide or 114 mm wide timber members for loadbearing walls dependent on the roof span. All members are 38 mm thick.

DRAWING NO. 4

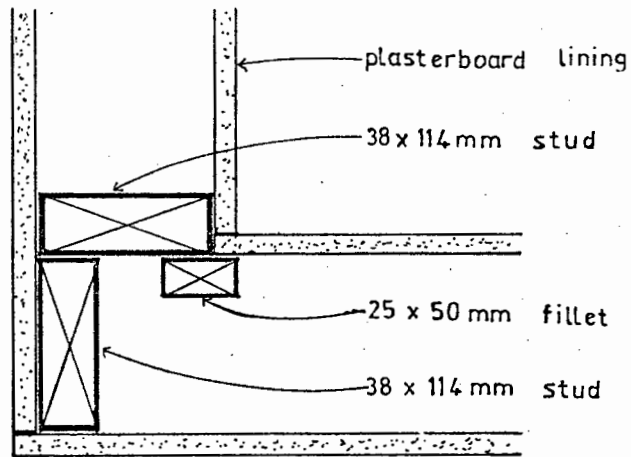


DETAILS -

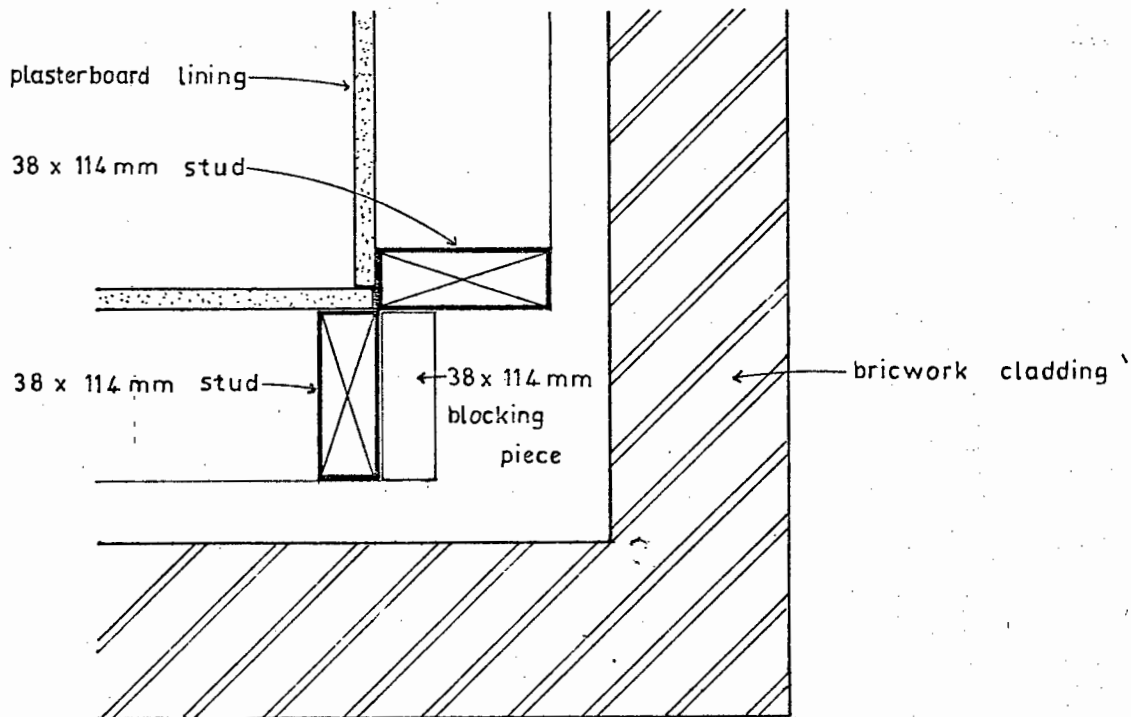
TEE JUNCTIONS

SCALE 1:5

DRAWING NO. 5



(A) INTERNAL CORNER DETAIL



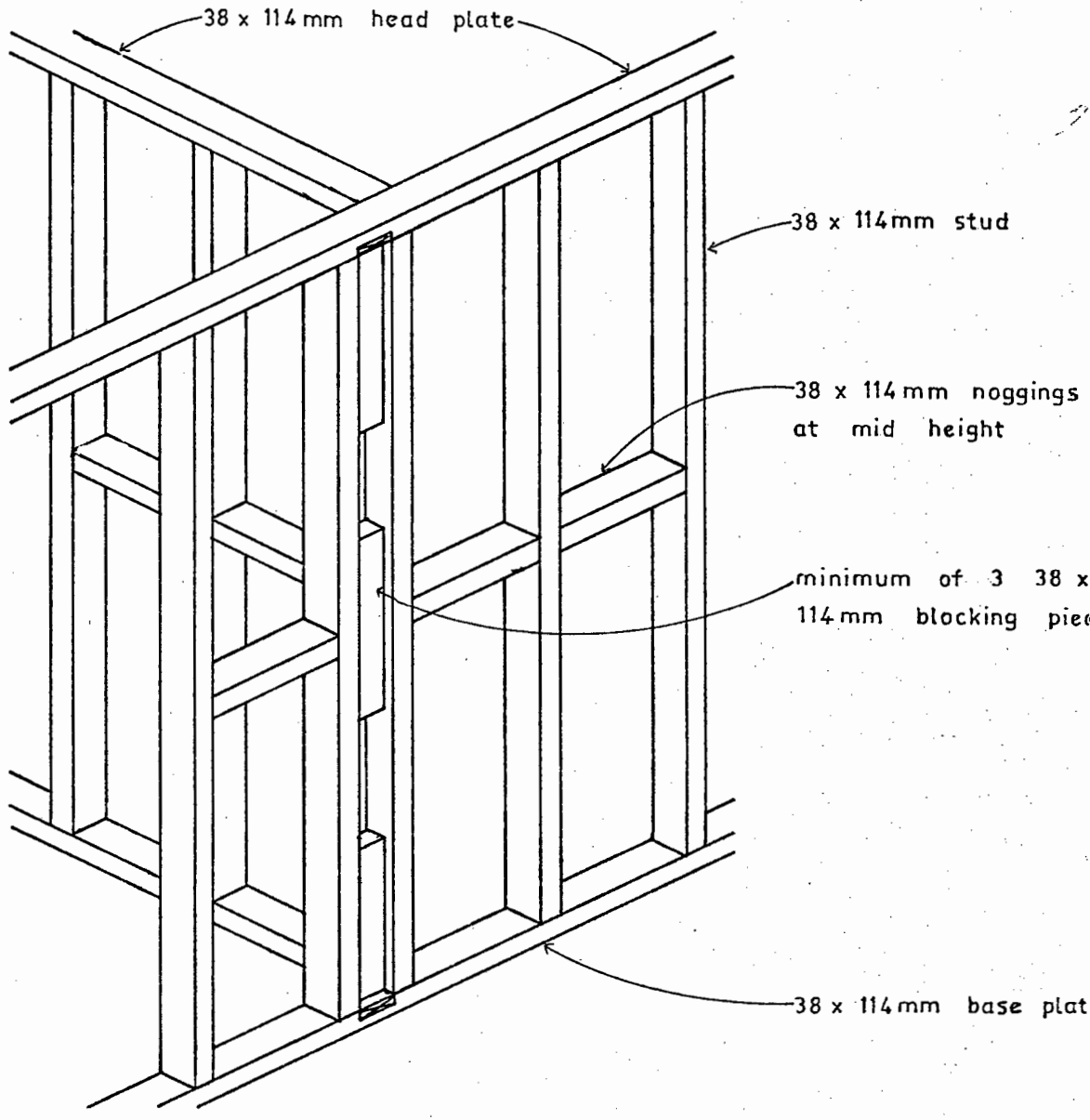
(B) EXTERNAL CORNER DETAIL.

DETAILS -

CORNER JUNCTIONS

SCALE 1 : 5

DRAWING NO. 6



TYPICAL DETAIL

TEE JUNCTION
21

SCALE N.T.S.



TYPICAL INTERNAL WALL FRAME



TYPICAL TEE-JUNCTION

must be well anchored to the foundation or sub-floor. For fixing to the concrete sub-floor, 6 mm diameter bolts should be used at a maximum spacing of 900 mm for light roofs. For heavy roofs this spacing can be increased to 1 200 mm. The bolts can either be cast in or expanding bolts of the same size and spacing can be used. (See drawings 2 and 3). For anchorage to a brick foundation wall, the base plate must first be secured to the top course of bricks by 6 mm expanding bolts at 1 200 mm centres. A length of 1,6 mm x 30 mm galvanised steel strap should be embedded with a right angle bend under the lowest course of foundation bricks and taken up in the cavity between the two leaves of the foundation wall. The girth of the strap will depend on the depth of the foundations. The cavity will be filled solid with concrete at a later stage. The strap should be bent tightly at right angles over the top of the base plate and nailed to the top of the plate with two 40 mm galvanised clout nails. The straps are required at 900 mm centres for light roofs and 1 200 mm centres for heavy roofs. It is very important that there should be no slack in the strap. (See drawing 1). For houses with light roofs, for example I.B.R., additional ties are required. A 150 mm length of 1,6 mm x 30 mm galvanised steel strap must be nailed to the outer edge of the base plate and to the outer edge of the stud

with two 40 mm galvanised clout nails per member.

These are required at alternate studs.

(iii) Openings in the frame for windows and doors:

There are two ways of providing openings in the wall frame for doors and windows. You can either incorporate the opening within a special wall frame, or by erecting a special window or door frame panel between the two normal wall frame panels. If the opening exceeds 1,5 m wide and is incorporated within the ordinary wall frame, the jamb studs size at each end of the opening must be increased to provide adequate support for the lintel over the opening. This wider jamb stud will then also close the cavity between the brickwork and the timber framework at the window reveal. If a special frame is to be used, the resulting double studs at each end of this frame will be capable of supporting the lintel without requiring the special jamb studs. Here you will require a timber jamb lining to close off the cavity. Pressed steel frames can also be used, but this needs more careful detailing.

There are several forms of lintel construction, the solid timber lintel being the most common. The lintel should be used in conjunction with a wall plate. (See Table 2 for sizes of solid timber lintels and permissible spans). It should be noted that lintel spans exceeding 3 m are not recommended.

TABLE 2

SOLID TIMBER LINTELS USED IN CONJUNCTION WITH A WALL PLATE

Lintel size depth x breadth mm	Roof truss span m	Max. span of lintel	
		Light roofs (1 350 mm max. truss spacing) mm	Heavy roofs (750 mm max. truss spacing) mm
114 x 38	6	800	900
114 x 76	6	1 450	1 550
152 x 38	6	1 250	1 500
152 x 50	6	1 450	1 700
152 x 76	6	2 400	1 950
228 x 50	6	2 800	2 150
228 x 76	6	(3 300)	2 800
304 x 50	5	(3 400)	2 900
304 x 76	6	(4 300)	(3 600)
114 x 38	8	600	750
114 x 76	8	1 100	1 350
152 x 38	8	1 000	1 150
152 x 50	8	1 300	1 500
152 x 76	8	1 900	1 750
228 x 50	8	2 350	1 900
228 x 76	8	3 000	2 400
304 x 50	8	(3 100)	2 500
304 x 76	8	(3 700)	3 200
114 x 76	10	1 100	1 300
152 x 38	10	1 000	1 200
152 x 76	10	1 750	1 650
228 x 50	10	2 000	1 800
228 x 76	10	2 800	2 200
304 x 50	10	2 900	2 300
304 x 76	10	(3 400)	3 000

The values for lintel spans in excess of 3 m are given in brackets because lintel spans larger than 3 m are not recommended.

The ends of the lintel should preferably be notched into the studs. In addition to this, the lintel, jack studs (see drawings 7 and 8) and wall plate should be connected to one another and to the adjoining wall frames to take care of any buckling and twisting effects and for wind uplift forces associated with light-weight roofs. If the lintel is not notched or housed into the studs, metal brackets or straps, bolted or screwed to the ends of large span lintels and the jamb studs, will be necessary. Openings not exceeding 600 mm wide do not require a special lintel as the wall plate or head plate can span this distance.

The following is the nailing requirements recommended by the N.B.R.I. for loadbearing wall frames with 38 mm members. If the members are, for example, 50 mm thick, the nail sizes should be increased proportionately.

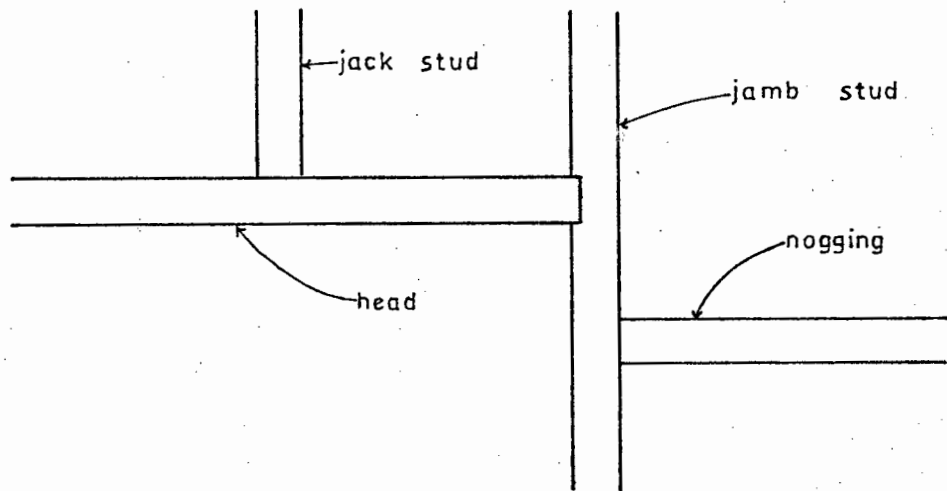
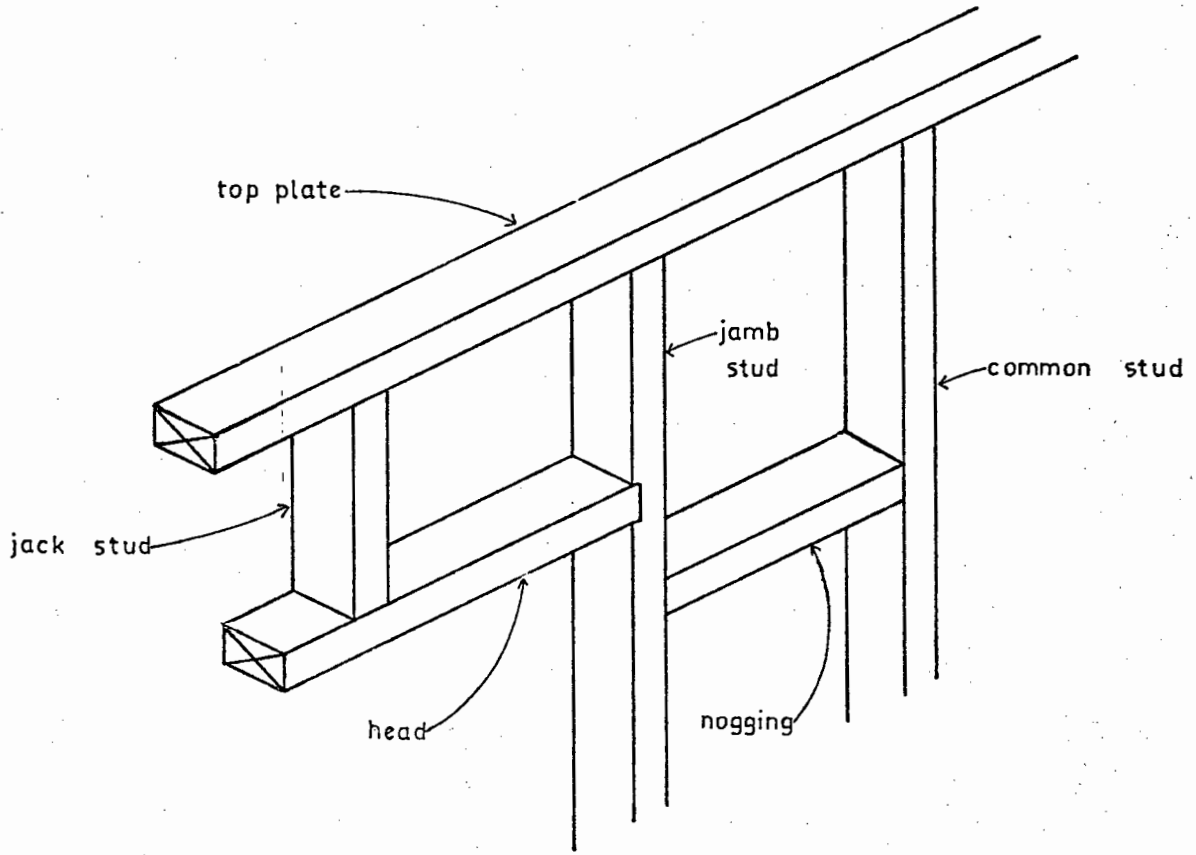
Stud to base plate:

Two 90 mm nails through the plate into the stud, or two 75 mm nails driven skew through the stud into the plate.

Nogging to stud:

Two 75 mm nails through the stud into the nogging, or skew driven through the nogging into the stud where through nailing is impracticable.

DRAWING NO. 7

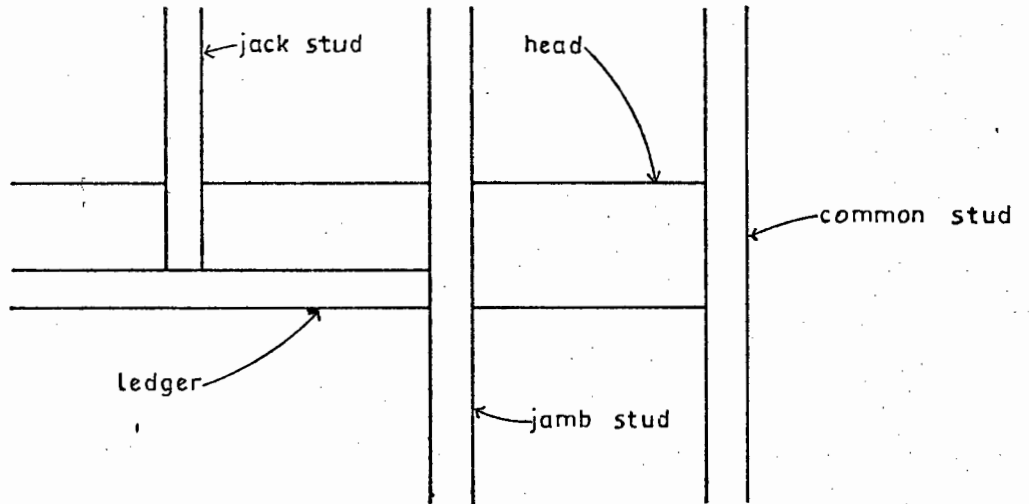
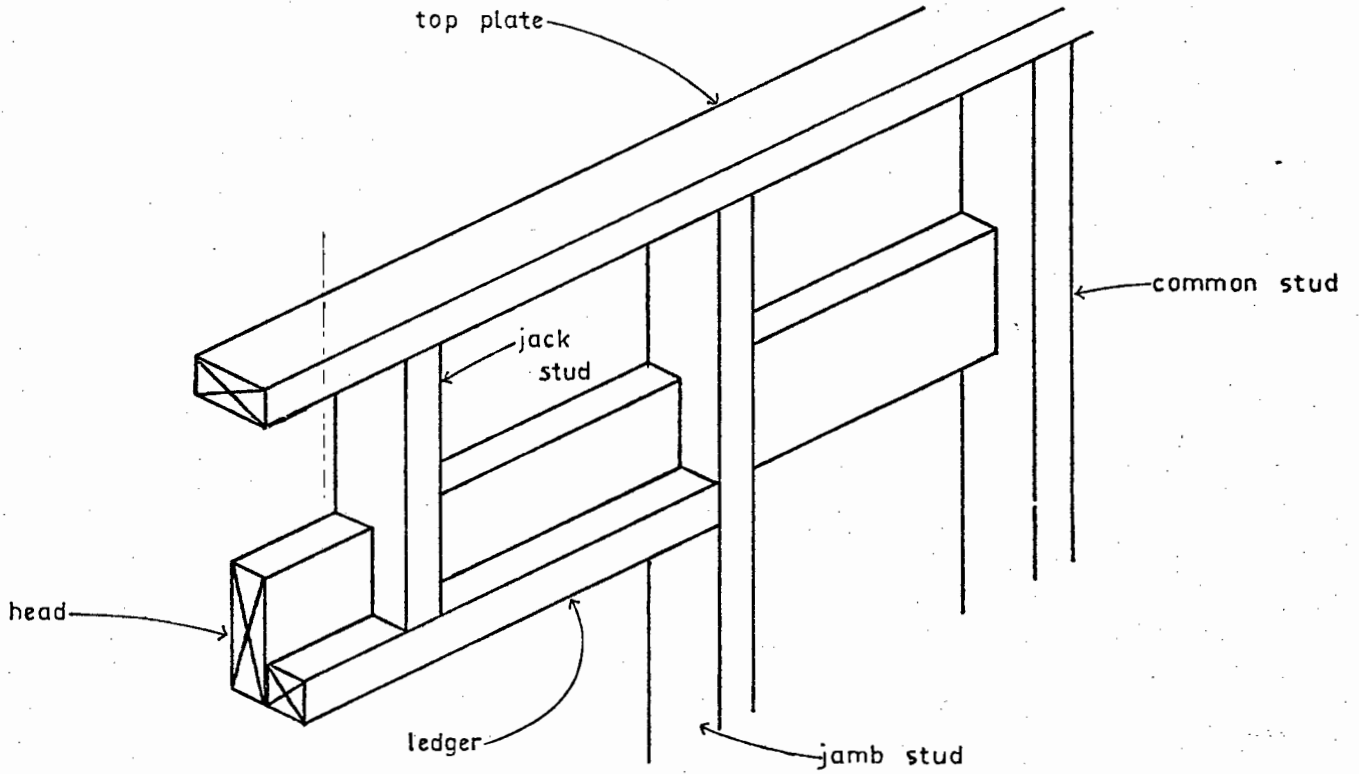


LINTEL DETAIL -

ALTERNATIVE 1

SCALE N.T.S.

DRAWING NO. 8



LINTEL DETAIL -

ALTERNATIVE 2

SCALE N.T.S.



LINTEL DETAIL - SHORT SPAN LINTEL



LINTEL DETAIL - LONG SPAN LINTEL

Double studs (between frames and at openings):

75 mm Nails at 500 mm centres through the face of one stud into the other.

Stud to stud or blocking piece at wall intersections:

75 mm Nails at 500 mm centres or equivalent in three blocking pieces, skewed as necessary.

Head plate to stud:

Two 75 mm nails driven through the plate into the stud.

Wall plate to head plate:

Nails at 600 mm centres driven skew through the wall plate into the head plate. The length of the nail will depend on the thickness of the wall plate. If the trusses are not located directly over the studs in the external walls, the wall plate should be nailed to the head plate at 150 mm centres maximum. The reason for this is to ensure composite beam action between the wall plate and head plate.

(c) ROOF STRUCTURE AND COVERING.

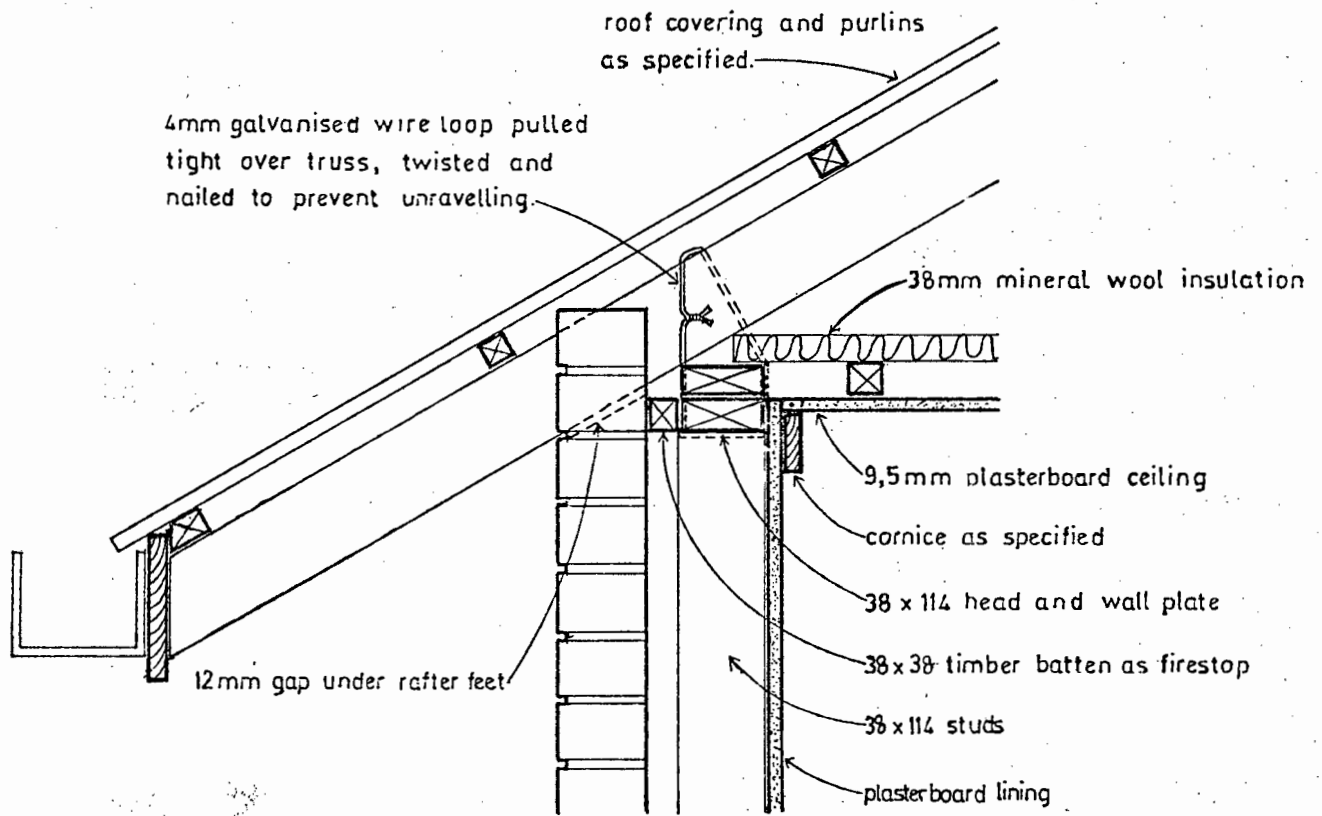
The roof structure does not vary significantly from that used for a conventional masonry house. For the main supporting members, trusses or, in the case of flat roofs, solid timber rafters may be used. These members generally span the full width of the building. For the best result, the trusses or rafters must be so spaced that they coincide

with the studs in the external loadbearing wall-framing. This allows anchorage directly to the vertical studs, and also reduces bending stresses in the wall plates and head plates of the framing.

Roof trusses should be braced against lateral sway by diagonal timber braces nailed to the underside of rafters where the roof covering is not of large sheet form. For heavy roof coverings, the truss spacing should not exceed 750 mm. This is the maximum permissible span for 38 mm x 38 mm battens supporting tiles. For light roof coverings, the truss spacing should not exceed 1 350 mm with 50 mm x 76 mm purlins. Particular attention should be given to the connection between truss members so as to avoid excessive deflection of the trusses. The end support of trusses should be immediately below the rafter/tie beam connection and not under the roof overhang or further along the beam. 'Engineered' trusses with nail plate connectors will be best suited in this instance.

There are several methods of anchoring the trusses or rafters to the supporting wall frames. (See drawings 9, 10 and 11). Where the roof trusses are located directly over the studs, the trusses may be fixed to the wall plate with two 90 mm skew driven nails and then tied down directly to the stud by means of a length of 1,6 mm x 30 mm galvanised hoop iron. This should be of inverted U-form, placed over the truss and nailed to it on either side so that the lower ends of the U-form can be taken down through

DRAWING NO. 9



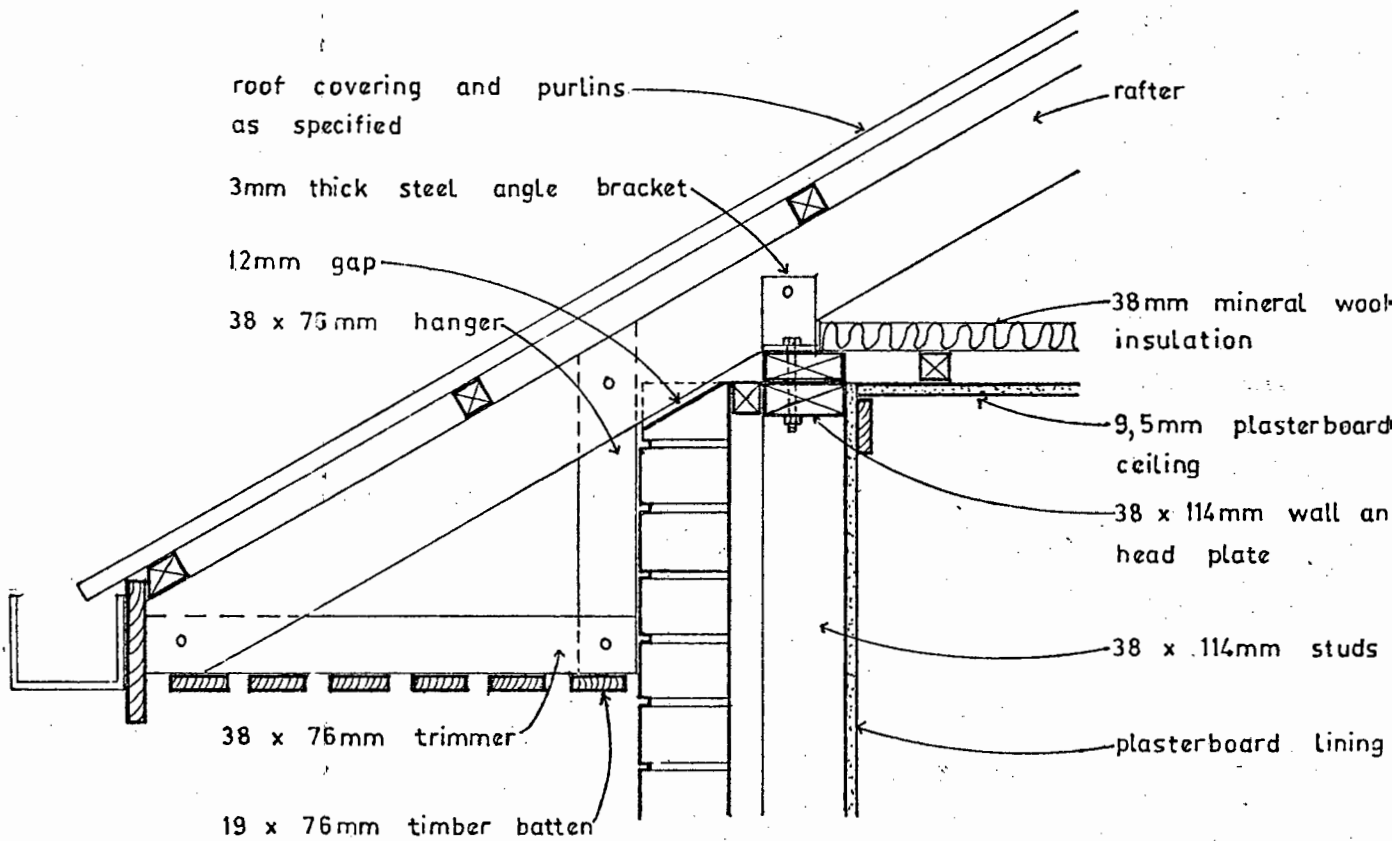
EAVES DETAIL -

OPEN EAVES

34

SCALE 1:10

DRAWING NO. 10

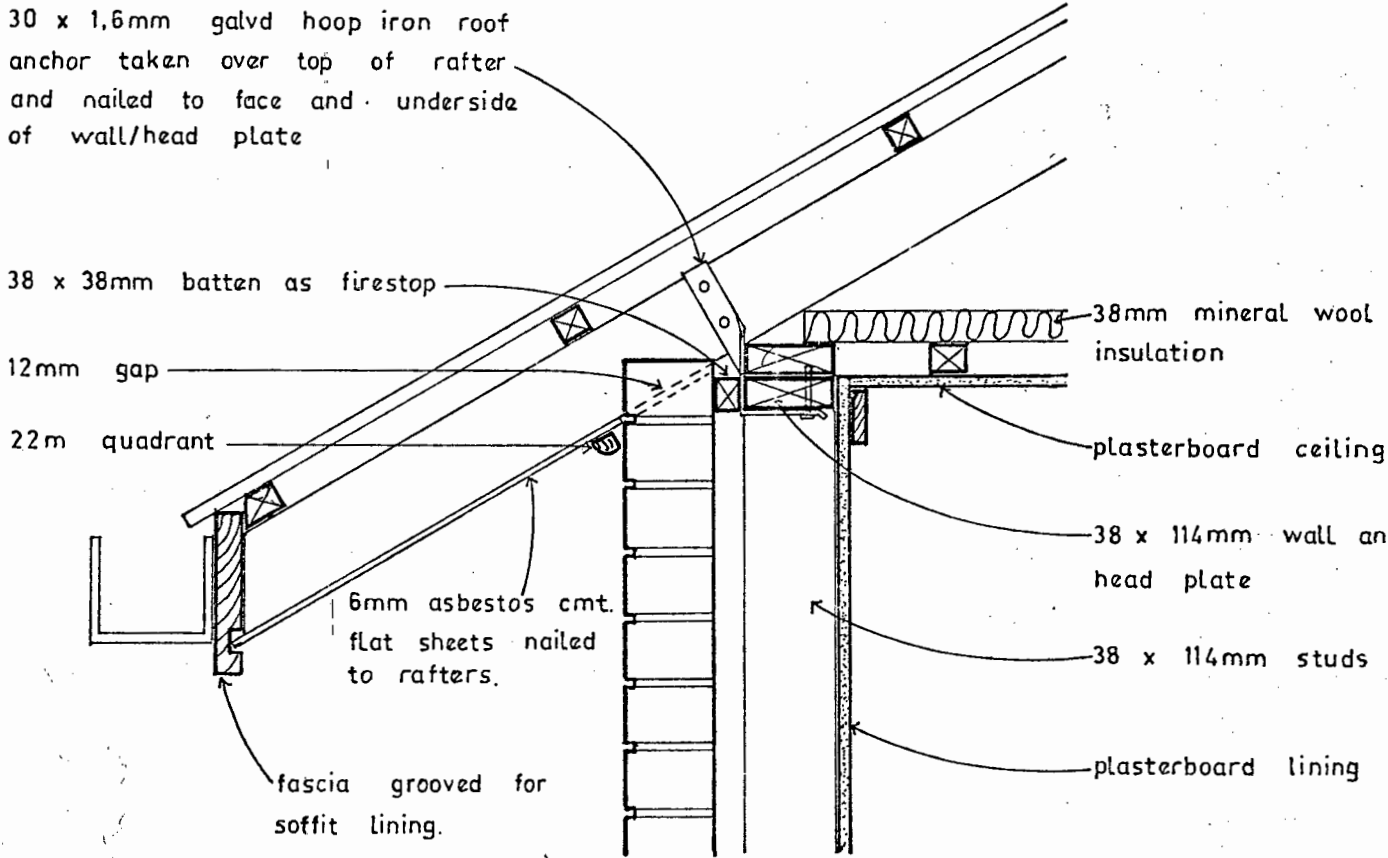


EAVES DETAIL —

CLOSED EAVES

SCALE 1 : 10

DRAWING NO. 11



EAVES DETAIL -

CLOSED EAVES

SCALE 1 : 10

ALTERNATIVE 2

the cavity and nailed to either broad face of the stud. Three 40 mm galvanised clout nails on each side will be sufficient. Where the trusses do not coincide with the studs, the ends of the straps should be nailed to the outer face of the head plate, or wall plate, with one 40 mm clout nail and then bent under the plate and nailed to its underside with a similar nail. An alternative solution is that the trusses may be bolted to the head or wall plate with a suitable angle bracket. The trusses can also be tied to the plates with a loop of 4 mm galvanised wire, pulled tight over the truss, twisted and nailed down to the truss to prevent unravelling. On the inside edges of the plates the wire should be let into the wood to avoid foiling the internal cladding.

It should be noted that any roof covering used for conventional masonry construction, can also be used for the timber-frame construction, provided that the correct anchorage methods are employed.

(d) PLUMBING AND ELECTRICAL SERVICES.

The plumbing and electrical services do not vary considerably from that of a conventional house. Both the plumbing and electrical piping will be housed in the wall cavity, as well as in the roof space. Holes will be made in the internal cladding where piping, etc. protrudes the cladding. This cuts out chasing of walls completely, except for minor chasing which may be required in the external brick skin. Care should be taken with sanitary

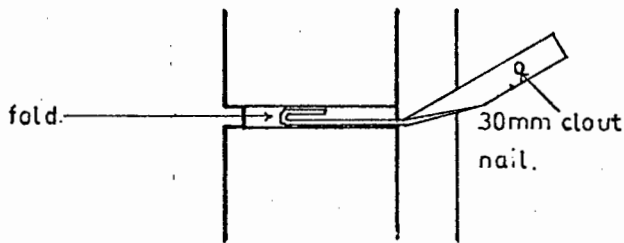
fittings, but with the correct detailing and pre-planning no problems should arise.

(e) BRICKWORK CLADDING TO EXTERNAL WALL FRAMING.

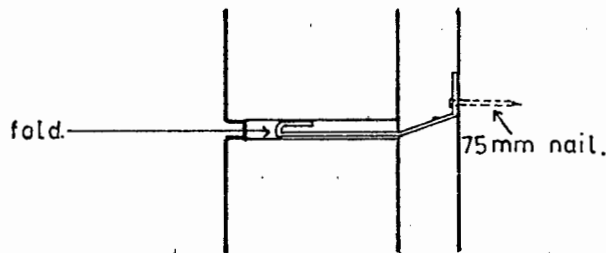
A single skin of brickwork is built up and tied to the outer face of the external wall framing by galvanised steel ties. A gap of at least 40 mm is maintained between the brick cladding and the wall framing. This gap can be used to house plumbing pipes and electrical conduiting. The gap is fire-stopped at ceiling level around the perimeter of the house to prevent any fire which may develop in or penetrate the wall cavity, from spreading into the roof space. To ensure that loads from primary roof supporting members which pass through the brick cladding are not transferred to the brick cladding, gaps of at least 12 mm and 6 mm are necessary between the brickwork and the undersides and sides of roof members.

The brick cladding should be connected to the studs in the external walls by means of galvanised steel ties, which should be provided every fourth course at alternate studs in a staggered pattern. The ties can be formed either from flat galvanised steel, which should be at least 25 mm wide and 1,25 mm thick, or from galvanised wire at least 4 mm diameter. (See drawing 12). 1,6 mm Thick x 30 mm wide galvanised hoop iron ties are ideal for the purpose if flat ties are to be used. Flat ties can be formed and connected to the studs in one of the following ways:

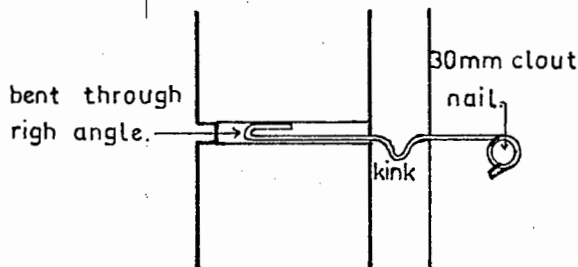
DRAWING NO. 12



1. GALVANISED HOOP IRON-SIDE FIXING
 25x1,2mm galvanised hoop iron ties with a 90° twist, predrilled to take a 30mm clout nail at one end and folded over to anchor in mortar at other end.



2. GALVANISED HOOP IRON-FACE FIXING
 30x1,65mm galvanised hoop iron bent up through a right angle for fixing to face of stud.



3. GALVANISED WIRE TIES
 4mm galvanised steel wire ties nailed to side of stud.

ALTERNATIVE

WALL TIES

SCALE 1:5



DETAIL OF HOOP IRON TIES AND
D.P.C. UNDER BASE PLATES

- (i) For connection to the side of the stud, the tie should be made up with a 90° twist in the portion which is in the cavity, a pre-drilled hole in the vertical end to receive a 30 mm galvanised clout nail for securing the tie to the stud and a ragged, crimped or folded back portion on the other end for securing proper anchorage in the mortar bed joint;
- (ii) For connection to the outer face of the stud, the tie should have a right angle bend with a pre-drilled hole, close to the bend and in the upstanding leg, through which a 75 mm nail is driven to secure the vertical leg to the outer face of the stud. The other end of the tie is ragged, crimped or folded back (for mortar bed joint anchorage), and the tie should be fixed to slope slightly upwards to the stud or it may have a kink to act as a drip in the cavity.

If galvanised wire ties are to be used, they can be made up with a kink in the portion which is in the cavity, a right angle bend at the end to be embedded in the mortar joint and a tight double loop through which the tie is nailed to the side of the stud with a 30 mm galvanised clout nail.

Lintels over openings in the brick veneer may either be prestressed concrete lintel units, or they may be of reinforced brick masonry. In this case, conventional brick

TABLE 3

CONSTRUCTION REQUIREMENTS FOR BRICK MASONRY LINTELS

Spans (S) of lintel (mm)	Depth (D) of lintel in courses of brickwork	Lintel reinforcement if conventional brick reinforcement is used	Lintel reinforcement if reinforcing rods are used
$S \leq 2500$	$D \geq 4$	A single layer of brick reinforcement in the lowest bed joint of the lintel	A single 6 mm diameter mild/high tensile rod in the lowest bed joint of the lintel
$2500 < S \leq 2800$	$D \geq 5$		
$2800 < S \leq 3000$	$D \geq 6$	Single layers of brick reinforcement in the lowest and second lowest bed joints of the lintel	A single 6 mm diameter mild/high tensile rod in the lowest bed joint of the lintel

- (1) To control cracking, an additional layer of brick reinforcement or a 6 mm diameter rod should be provided in the topmost bed joint of lintels with spans exceeding 2 000.
- (2) All reinforcement should project at least 300 mm beyond the edge of the opening. Where the opening is closer than 300 mm to a corner, the reinforcement should be taken around the corner with a right-angle bend for at least 300 mm.



DETAIL OF PRESTRESSED CONCRETE LINTEL

reinforcement or reinforcing rods may be used. The requirements of brick masonry lintels are set out in Table 3.

(f) CEILING AND CLADDING TO INTERNAL WALL FRAMING.

(i) Cladding to internal wall framing:

Only one type of cladding is considered here, namely gypsum plasterboard. This is the most popular cladding material, and has been recommended by the N.B.R.I.

The gypsum plasterboard is fixed to the wall framing either by nails or screws. The boards can be fixed either horizontally, i.e. the length of the board is at right angles to the vertical timber frame members, or vertically. With horizontal application, the provision of noggings at the level of the horizontal joints between joints will improve the resistance to impact at the joint between the boards. With vertical board application there will generally be no horizontal joints since the boards will generally be of wall height. Vertical joints in both vertical and horizontal application should occur on the studs. Joints between the adjacent boards are finished with a paper tape and flush jointed with the board surfaces with a gypsum-based compound. This surface will have an appearance virtually the same as that of conventional plastered masonry.

In addition to its space enclosing and dividing function, the gypsum plasterboard fulfils a structural bracing function. To do this, it must be adequately fixed to the timber framing. The nailing requirements for the plasterboard to the framing are as follows:

40 mm Galvanised clout nails at 200 mm centres into every support, horizontal and vertical, or;

Power driven drywall screws at the same spacing;

Overdriving of the nails or screws and consequent crushing of the gypsum core of the board should be avoided. In Australia a special glue has been developed which are used to fix the boarding to the framing. It is a quick-setting glue, which will ultimately reduce the fixing time of the cladding to the frames.

This jointing technique is as effective as the normal nailing recommended by the N.B.R.I.

This is a recent introduction in Australia, and will require thorough investigation before it will be introduced in South Africa.

Tests have shown that to achieve satisfactory durability against impact damage, the plasterboard should not be thinner than 12,7 mm. This is also the thickness recommended by the N.B.R.I. At places where

there is a high possibility of impact damage, for example garages, two layers of plasterboard can be used. This is a very common solution to the problem, and, in addition, provides a higher degree of sound insulation and fire resistance. In North America, a glass-fibre reinforced gypsum wall board was developed which could be used where exposure to impact is higher than normal. Alternatively, a hardboard backing could be used for additional strength.

(ii) Internal fittings:

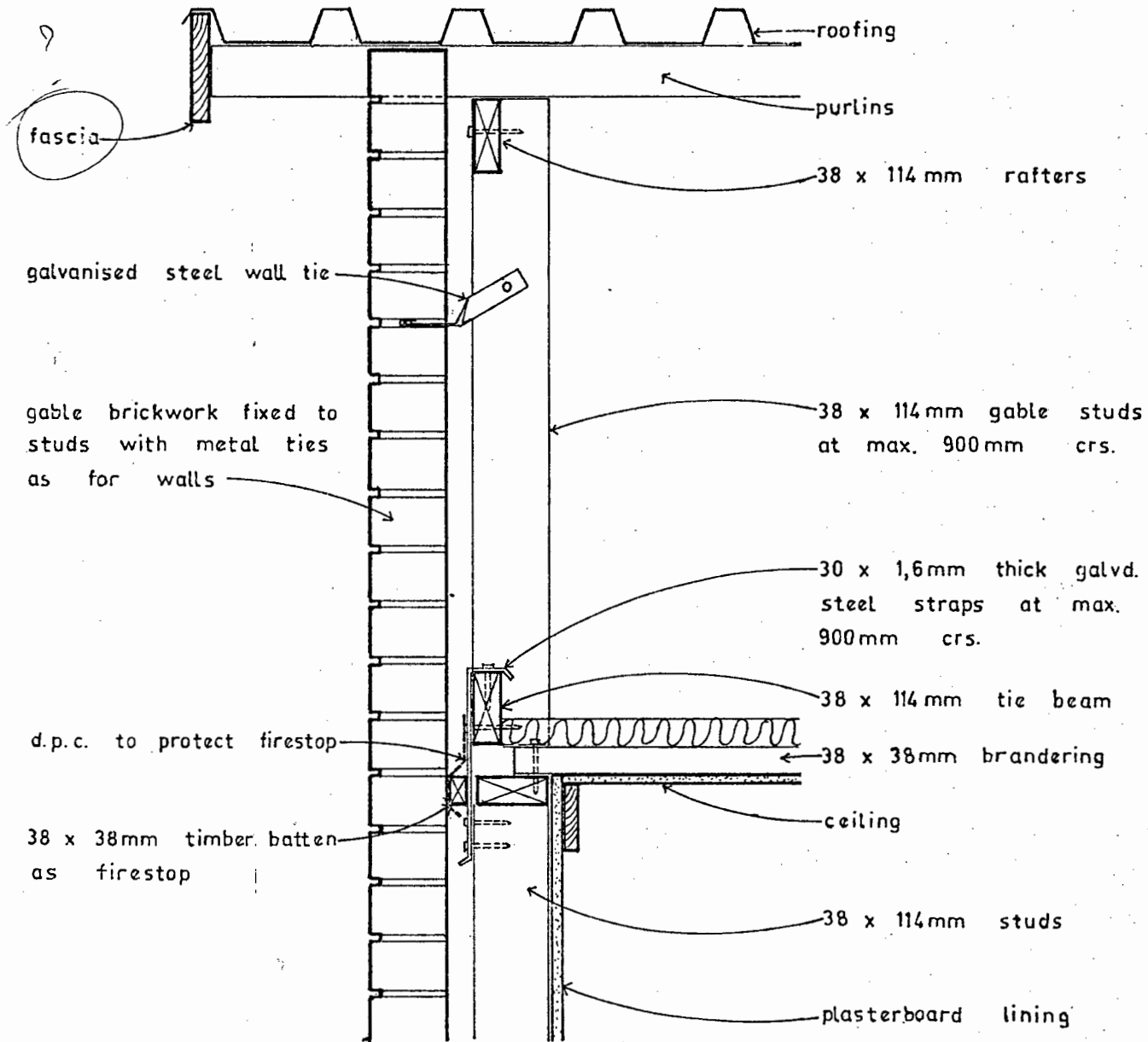
Heavy sanitary fittings such as W.C. cisterns, wash-hand basins, sinks, etc., which are to be fixed to and supported by the walls, will require stout nogging pieces incorporated in the timber framing. It is therefore important that the sanitary fittings are properly designed for at an early stage. Support for plumbing work in the wall cavities will also be required. Kitchen sink units and draining boards must be provided with upstands against wall surfaces so that wall tiling or other wall finishes may be dressed over the upstand. Light-weight fittings such as single coat hooks may be fixed to the plasterboard with special toggle or expanding type screw anchors.

(iii) Ceilings:

For the ceiling to fulfil its structural function

as horizontal stiffener diaphragm for the tops of the walls, it should be of nailed in-situ construction and not of the loose panel type. The bracing should be at right angles to the trusses and will generally be at 450 mm centres. It should be securely nailed to the underside of each truss with one 90 mm or two 75 mm nails (for 38 mm thick bracing). To ensure that the top of gable-end wall framing is adequately braced, the ceiling bracing should be securely nailed to the head plate so that lateral forces on the wall can be submitted to the ceiling structure. (See drawing 13).

DRAWING NO. 13



GABLE END DETAIL —

BRICKWORK CLADDING

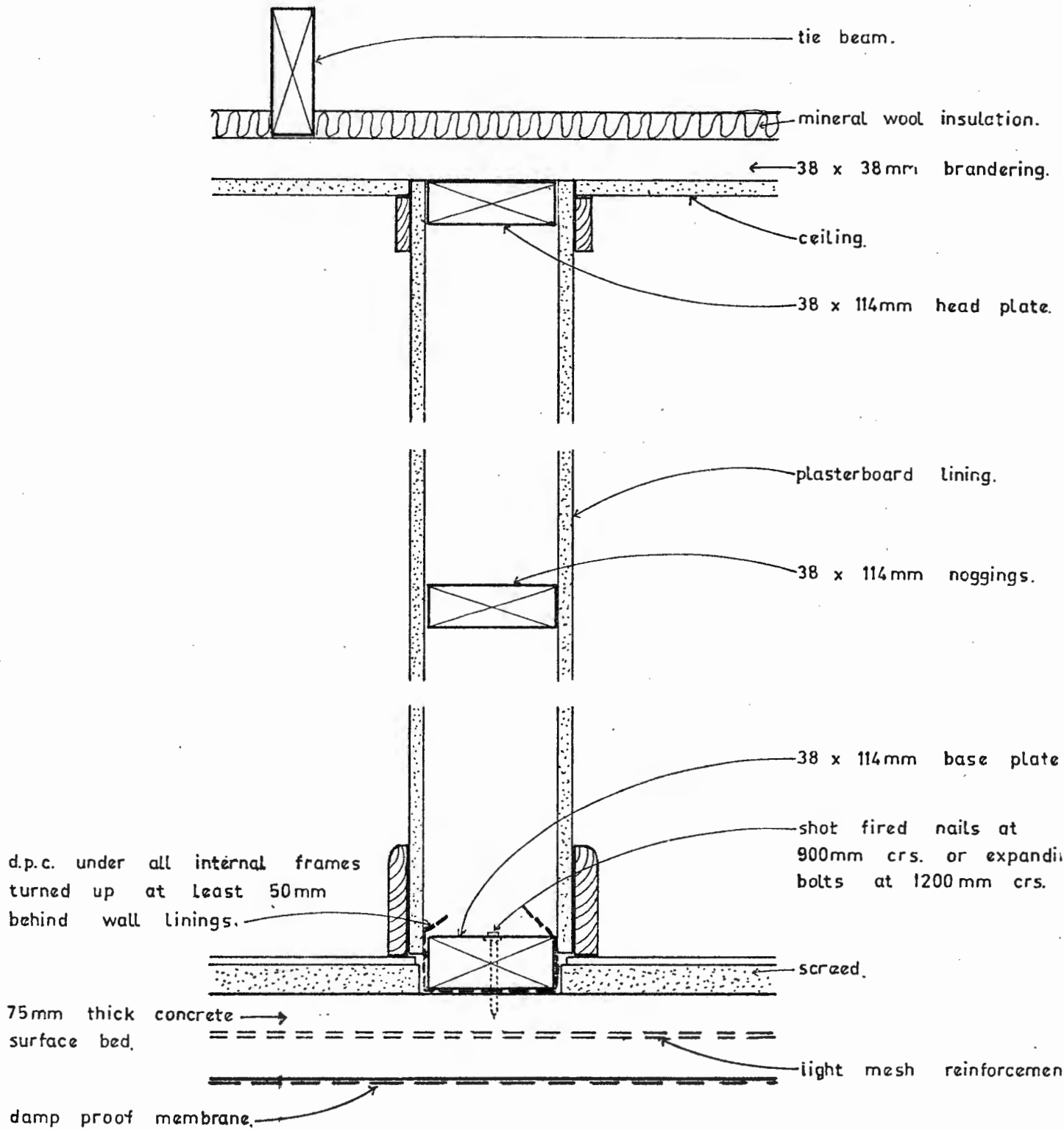
48

SCALE 1 : 10



GABLE END DETAIL

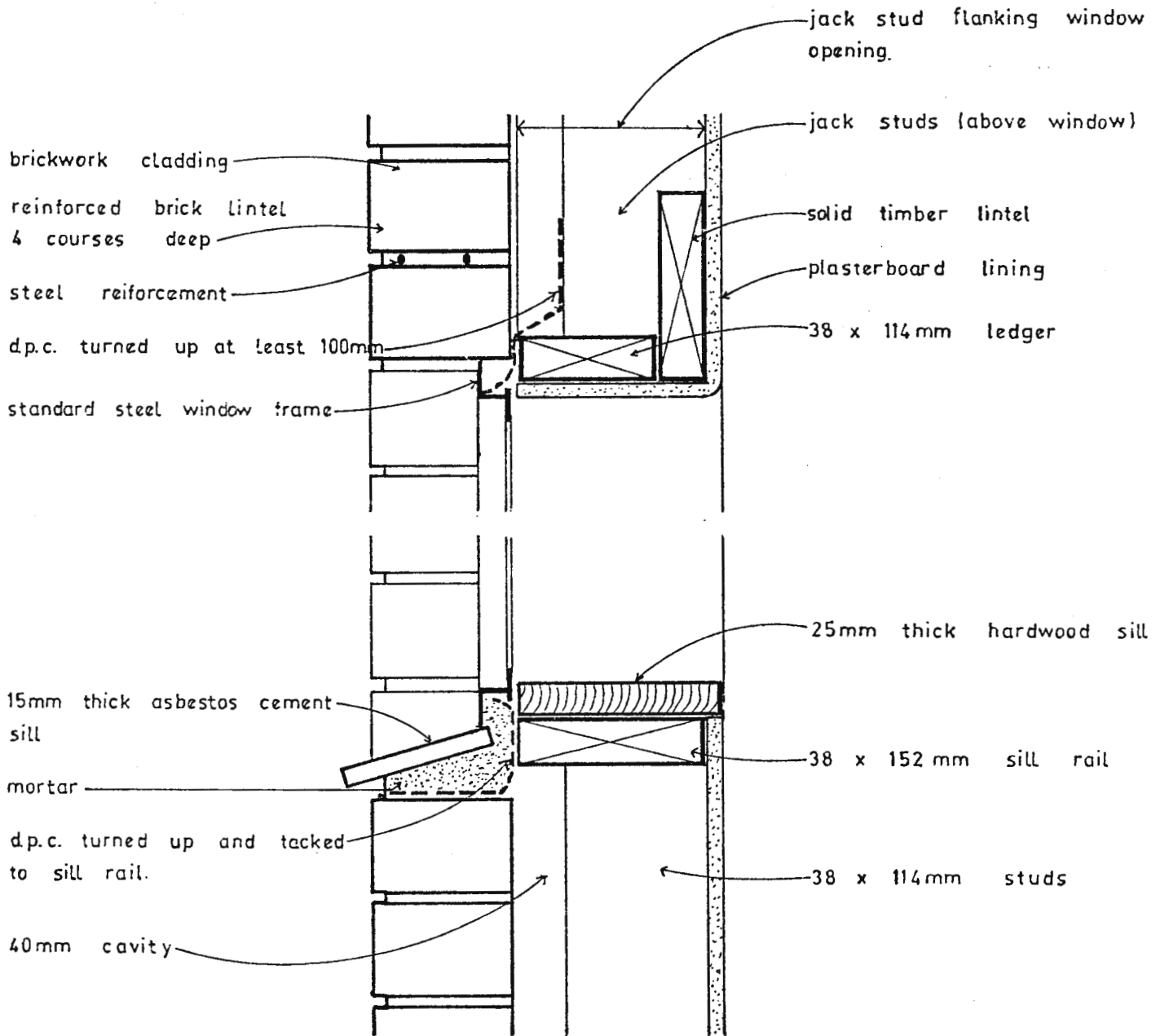
DRAWING NO. 14



TYPICAL INTERNAL
PARTITION DETAILS

SCALE 1 : 5

DRAWING NO. 15



WINDOW DETAIL -

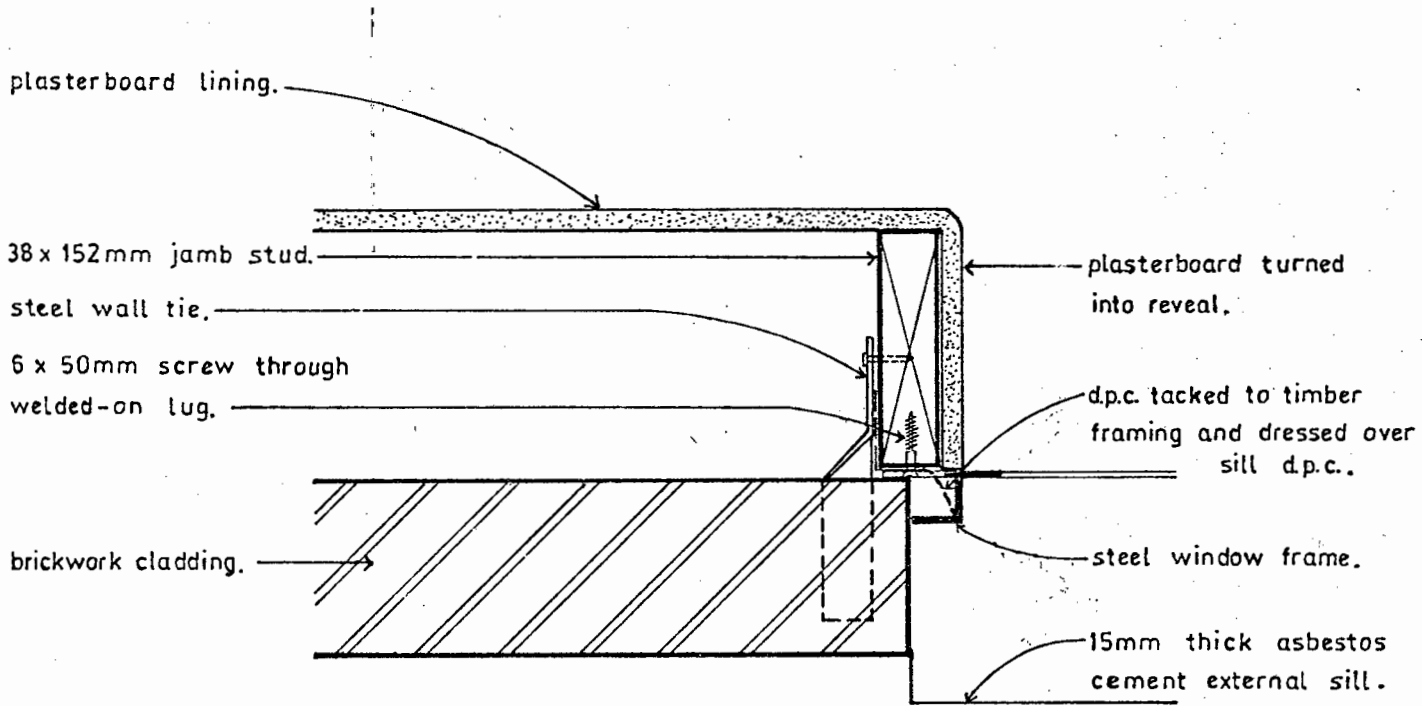
STEEL FRAME

SCALE 1 : 5



DETAIL AT WINDOW CILL

DRAWING NO. 16



PLAN

WINDOW REVEAL -

STEEL FRAME

SCALE 1:5

SECTION 3

PERFORMANCE ASPECTS

MOISTURE RESISTANCE.

General.

Moisture penetration in buildings is frequently the cause of deterioration that is difficult and costly to rectify. Rain penetration, rising damp and condensation can significantly affect the durability, thermal performance and appearance of a building.

Good design and detailing, correct choice of materials and careful supervision will generally eliminate the problems associated with moisture penetration.

1. Rain penetration.

External walls in brick veneer construction will be just as effective in preventing rain penetration as a brick cavity wall, and even more effective than a solid 220 mm brick wall. The air space within the wall prevents water which may penetrate the external brick cladding from bridging the gap between the brickwork and the timber framing and external cladding. To prevent rain penetration, the following measures should be adopted:

- (i) Damp-proof membranes should be provided to isolate the timber framing, i.e. the base plate members, from water which may penetrate the brick cladding after severe exposure to rain. (See drawing 14). A damp-proofing membrane at the foot of the external brick cladding will prevent any water that may find its way into the cavity and accumulate, to transfer across the membrane. The damp-proofing should be turned up into the cavity for

about 150 mm and secured to the framing. (See drawing 3). Weep holes at regular intervals should be provided in the brick veneer leaf immediately above the damp-proof course to allow water to escape to the outside. There have been experiments to produce a waterproofing treatment for application to the outside surface of the brickwork, but non showed to be effective in the long term.

- (ii) Good quality, dense bricks should be used. Although rain penetration through brick walls generally occur through the mortar joints or through cracks at the mortar and brick interface, water can also penetrate through low density, porous bricks.
- (iii) All mortar joints should be well filled in and sealed.
- (iv) The galvanized steel ties between the brickwork and the studs should either be kinked so as to provide a drip, or be fixed so as to slope slightly upwards to the stud. (See drawing 12).

Window and door reveals.

A suitable damp-proofing membrane should be incorporated between the jamb lining and the brickwork at the head and sides of the reveal. Windows will have an additional damp-proofing membrane underneath the sill which will be turned into the cavity. (See drawings 15 and 16).

Roof construction.

With regard to rain penetration, roof construction in brick

veneer houses is essentially similar to that used for conventional masonry construction

2. Rising damp.

Problems associated with rising damp in buildings are characterized by the persistence at or near floor level and are generally difficult to counter. Rising damp can cause the failure of paint finishes on walls, failure of floor finishes and efflorescence in brickwork. In addition, rising damp in brick veneer houses could have a detrimental effect on the long term behaviour and durability of the framing and cladding. To prevent this form of moisture penetration, the following measures should be adopted:

- (i) A moisture barrier should be provided below the concrete surface bed. This can either be a continuous damp-proof or a 150 mm thick layer of compacted concrete aggregate, of which the nominal diameter should not be less than 25 mm.
- (ii) Damp-proof membranes should be provided below the base plates for all external and internal wall frames and should be turned up and stapled to the vertical edges of the base plates. (See drawings 3 and 14). Suitable mastic caulking should be used where the damp-proofing has been pierced by anchor bolts.
- (iii) Damp-proof membranes should be provided in the external brick cladding at the level of the top of the foundation brickwork. Where the brick veneer is started at


a lower level, a stepped damp-proof course can be used. The damp-proof membrane should be turned up against the cavity face of the timber framing.

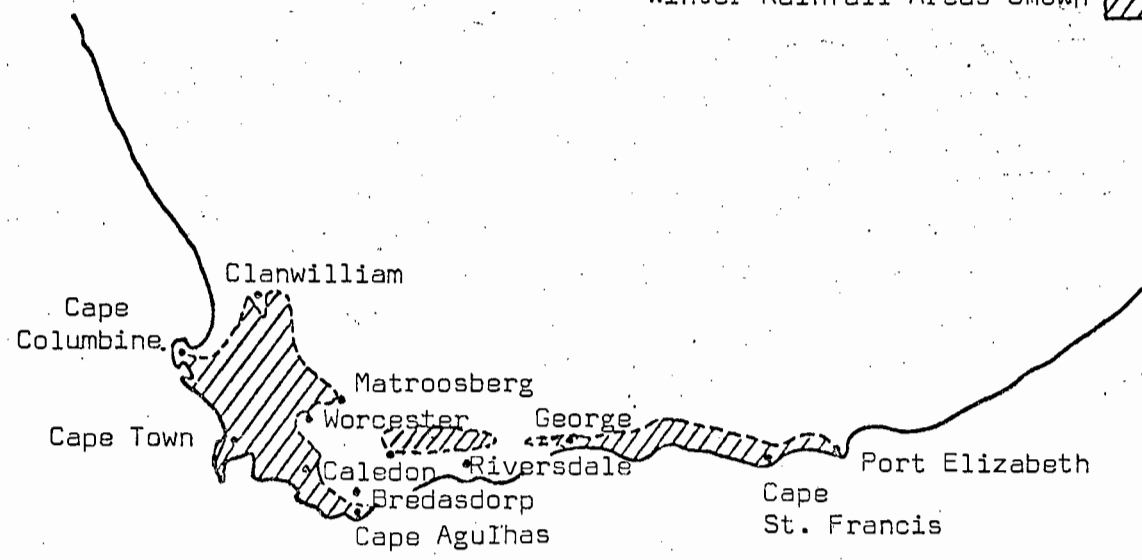
3. Condensation.

Because of the undesirable effect of moisture accumulation within the walls as a result of condensation within the wall thickness, it is necessary to incorporate measures designed to control vapour movement into them. Condensation in the external walls will not create problems provided that moisture which enters the wall cavity can drain out and does not accumulate. The minimum requirement is that provision must be made for ventilation of the cavity. In damp situations, such as bathrooms and kitchens, a vapour barrier may be required in addition, preferably as part of the inside cladding. (See drawing 17). Weepholes would still be required at the bottom of the external cladding.

To eliminate potential condensation problems in the roof space, especially in winter rainfall areas (see Table 4), a vapour barrier should be installed immediately above and in close contact with the ceiling. Polyethylene sheeting or aluminium foil can be used. The provision of thermal insulation above the ceiling, which is intended primarily to improve the thermal performance of the house, is essential if a vapour barrier is installed, as otherwise any condensation occurring on the underside of the vapour barrier will drip onto the ceiling itself.

TABLE 4

Winter Rainfall Areas Shown 



Winter Rainfall Areas

FIRE RESISTANCE.

Assuming adequate design precautions are taken with the electrical system, fireplaces and flues, fires are equally likely to start in any type of house construction and therefore the main purpose of behaviour requirements in fire is to ensure against rapid and heavy smoke production and to control or delay the spread of fire to allow ample opportunity for the occupants to make an easy and safe escape. If a fire breaks out in a properly designed and well constructed brick veneer house, it will pose no greater hazard than in a traditional masonry house. It will also represent no greater risk with regard to possible spread of fire between adjacent houses, provided that regular fire protection requirements are adhered to. For fire insurance purposes, brick veneer houses are grouped with all-brick construction, rather than with timber.

Although timber-frame walls clad with gypsum plasterboard can be designed to provide the necessary resistance to fire to ensure safe evacuation of the occupants of a house, it can be expected that, in the event of a burnout, a brick veneer house would probably suffer greater physical damage than a traditional masonry house. It would, however, consume far less time to rebuild the damaged part of the house than in the case of a conventional masonry house. The occupants of the house will then also suffer less inconvenience.

Fire protection requirements.

(i) Walls:

The minimum requirements for housing is that all structural walls and frames should have a fire resistance of at least

30 minutes and internal partition walls at least 20 minutes. As in the case of some of the other performance requirements these are also not difficult to meet in timber-framed brick veneer construction when careful consideration is given to choice of materials and design detailing. It is important to avoid heat bridges across walls, to obviate the possibility of gaps developing between wall elements during a fire or early failure at fastening points of wall linings, and to be sure of the effectiveness of any fire retarding treatments.

(ii) Ceilings:

It has been found that most ceilings represent a weak point as regards fire-spread in houses, since the ceiling collapses at an early stage in the fire and permits it to spread to adjacent rooms via the roof space. This largely nullifies the fire-resisting characteristics of the partition walls. Ceiling materials that will prevent a possible rapid spread of fire via the roof/ceiling space should therefore be used. Suitable materials for this purpose are, for example, 9 mm thick gypsum plasterboard or 12 mm thick tongued and grooved timber boarding. Because the lightweight internal walls of a timber-framed brick veneer house have relative low heat sink properties, heat build up in these houses is likely to be more rapid than in traditional masonry houses. It is therefore important to employ ceiling materials which offer sufficient resistance to fire. If the ceiling material offers in-

Sufficient resistance to fire and properly constructed fire barriers should be provided in the roof/ceiling space at appropriate positions.

(iii) Fire stopping in wall cavities:

In external walls, the gap between the brick cladding and the top of the timber framing must be fire-stopped by bridging the gap with a suitable material to prevent an early flow of hot gasses and flames into the roof space. (See drawings 9, 10 and 11).

(iv) Insulation materials for thermal or sound insulation:

If thermal or sound insulation materials are required above ceilings or in wall cavities, incombustible materials which will not give off large quantities of smoke when exposed to elevated temperatures should be used. In so far as behaviour in fire is concerned, mineral or glass wool and reflective aluminium foil are typical examples of suitable materials.

(v) Roof cladding materials:

Combustible roof claddings should not be used, particularly if there are a number of houses in close proximity. The danger of setting several houses alight via the roof cladding is just as applicable to traditional masonry houses clad with combustible roof materials.

THERMAL PERFORMANCE.

The thermal performance of a building determines the indoor thermal conditions that will prevail under any specific climatic conditions in the absence of artificial heating or cooling. It also affects thermal conditions in those instances where artificial heating or cooling is used.

In general terms, in any specific zone, the thermal performance of a building is largely determined by the mass of the external and internal walls, the thermal resistance of the walls, roof and ceiling, the mass and thermal conductance of the floor and floor finishes, the predominant orientation of the building, the orientation and size of windows and the colour of the external wall and roof surfaces.

In many areas in South Africa the lack of mass in veneer and frame construction results in its thermal performance being less favourable in some respects compared with that achieved by traditional brick construction. The reason is that the elements of heavy mass can absorb or give off a considerable amount of heat, while the temperature of their interior surfaces change very slowly. Thus, during the hot part of a day they have a cooling effect on the interior of the house and during the night, a warming effect. Because of their lower mass, the external and internal walls of a brick veneer house have a lower heat storing capacity than those of a traditional masonry house. This in turn means that a brick veneer house will be warmer during the warmest part of the day and colder during the coldest part of the day. The rapid response to

variation in outdoor temperature may be, in some cases, advantageous. In hot, humid areas a more rapid response to a comparatively small decrease in temperature at night will result in cooler, more acceptable sleeping conditions than in a traditional house.

The following aspects should be borne in mind when designing a timber-frame brick veneer house:

(i) Floor finishing materials:

In areas where there are large fluctuations in temperature during day-time, preference should be given to materials such as burnt clay tiles or materials less than 3 mm thick, for example vinyl tiles, linoleum, cork, etc. Concrete floors finished with these materials will be thermally conductive and will act as a heat storer during the day and a heat source at night. This will reduce the effects of large temperature fluctuations.

(ii) Thermal insulation of ceilings:

It is considered essential that a 38 mm thick mineral wool insulation, or equivalent, should be incorporated above the ceiling of brick veneer houses. The reason for this is that conventional roofing and ceiling materials do not normally provide satisfactory insulation against excessive heat gains or losses. Additional ceiling insulation is therefore necessary to reduce the effect which heat gains and losses through the roof structure can have on the thermal environment within a house.

Reflective metal foil, fixed in the roof space in such a way that its bottom surface is separated from the ceiling material by a gap of at least 40 mm, is basically as effective as 38 mm thick mineral wool insulation. This is only as far as downward heat transfer is concerned, because its thermal resistance against upward heat transfer is significantly inferior to that of mineral wool.

(iii) Thermal insulation in external walls:

Insulation in the external walls of a brick veneer house will reduce excessive night time cooling during winter, as well as excessive heating by solar radiation through the walls during summer. Recommended insulation in external walls is 25 mm thick mineral wool mats fixed between the timber framing members of the external walls and hard up against the outer face of the gypsum plasterboard lining.

(iv) Orientation of houses and size of glazed areas:

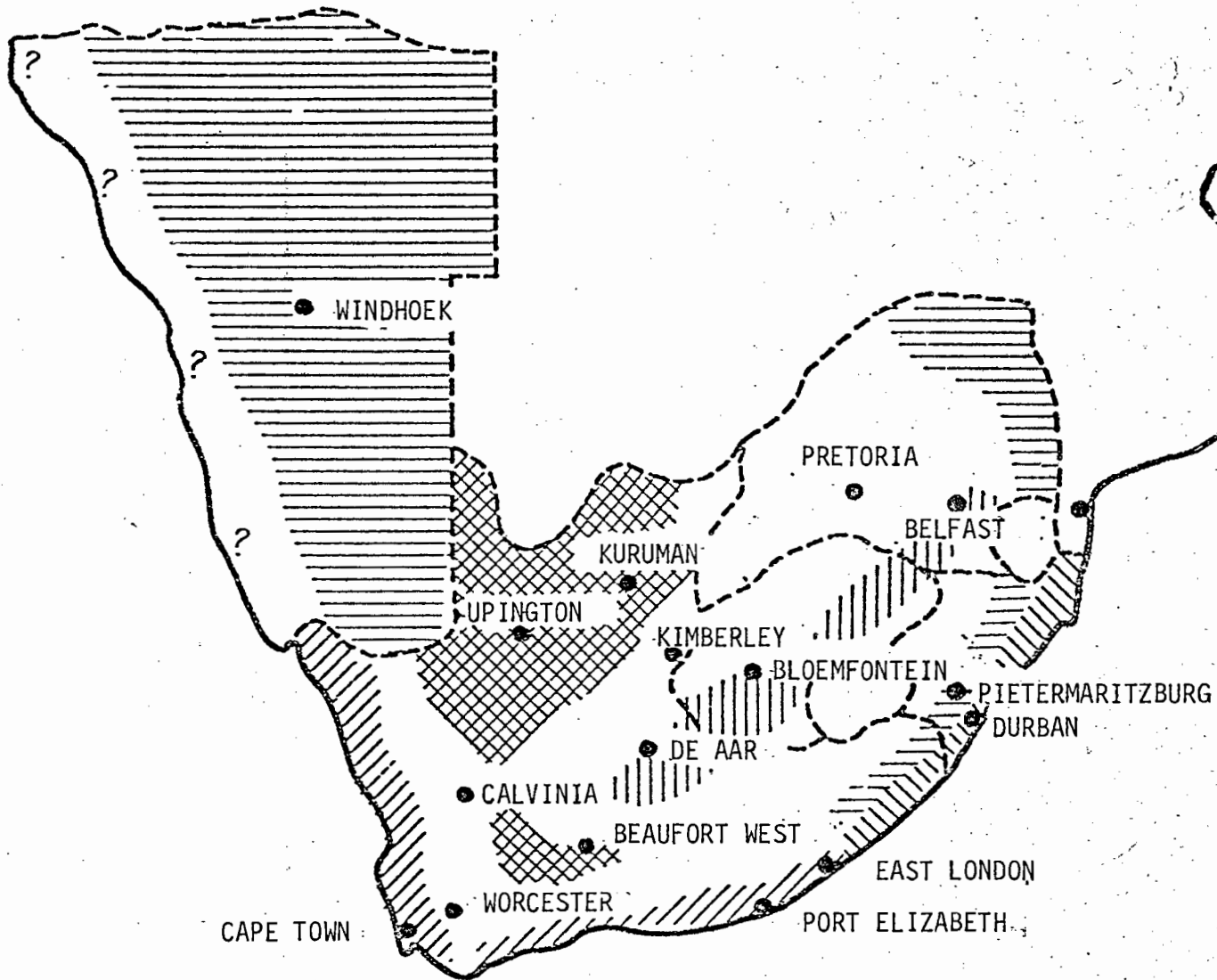
The following recommendations do not apply only to a brick veneer construction, but are equally applicable to conventional masonry construction. Houses should be orientated to face north, with the shorter side of the house facing west. Glazed areas should be as small as possible, especially if they receive direct solar radiation in summer. Windows facing east and west should be confined in area to the minimum required for lighting and ventilation. When this cannot be adhered to, special glass can be used.

The following is an assessment of the thermal performance of a brick veneer house, according to experiments carried out by the N.B.R.I. The assessment is based on the calculated ranges of corrected effective temperature (CET) conditions that will theoretically prevail in brick veneer houses in the six climatic zones shown in Table 5. The contribution to the indoor thermal environment by any particular artificial aid or activity is not taken into account in the assessment. The assessment is divided into two categories:

1. Probable thermal performance of brick veneer houses;
and,
 2. Comparison of the thermal performance of brick veneer and conventional masonry houses.
1. Probable thermal performance of brick veneer houses.
 - (a) For each of the six climatic zones, Tables 6, 7, 8 and 9 indicate the theoretically calculated ranges of indoor corrected effective temperatures and the corresponding subjective sensations that will probably be experienced by occupants of brick veneer houses in which the total window area does not exceed 20 percent of the floor area and ceilings are insulated with 40 mm thick mineral wool (or equivalent).
 - (b) Each of the diagrams represents a different combination of the following 'variables' which

TABLE 5

ZONE	CLIMATIC CONDITIONS
1	COLD INTERIOR
2	TEMPERATE INTERIOR
3	HOT INTERIOR
4	TEMPERATE COASTAL
5	SUB-TROPICAL COASTAL
6	ARID INTERIOR



Climatic zones of South Africa and South West Africa

affect the thermal performance of brick veneer houses:

- (i) Orientation of the predominant unshaded windows either within or more than 30° of/from true north/south;
- (ii) external walls either uninsulated or insulated with 25 mm thick mineral wool (or equivalent);
- (iii) Floors (i.e. concrete surface bed plus finishes) either thermally conductive or thermally insulative.

From the Tables it can be seen that, for brick veneer houses, the best thermal performance is obtained in any particular climatic zone when the 'variables' listed are combined as shown on Table 6, i.e. with:

- (i) orientation of predominant unshaded windows within 30° of true north;
- (ii) external walls insulated with 25 mm thick mineral wool (or equivalent);
- (iii) concrete surface beds with thermally conductive flooring materials.

(a) Houses in which:

- (i) Predominant window orientation is within 30° of true north/south;
- (ii) External walls are insulated with 25 mm thick mineral wool (or equivalent);
- (iii) Ceilings are insulated with 38 mm thick mineral wool (or equivalent); and
- (iv) Total window area does not exceed 20% of floor area;

Then the following will apply:

TABLE 6

APPROX. INDOOR CET RANGE IN CLIMATIC ZONE INDI- CATED FOR A HOUSE WITH:												THERMAL COMFORT SCALE FOR HOUSES	
A THERMALLY CONDUCTIVE FLOOR						A THERMALLY INSULATIVE FLOOR						CORRECTED EFFECTIVE TEMP. °C	REMARKS
1	2	3	4	5	6	1	2	3	4	5	6	30	UPPER HEALTH LIMIT
								UNCOMFORTABLY HOT					
								THRESHOLD DEFINITE DISCOMFORT					
								WARM BUT COMFORTABLE					
								OPTIMUM SUMMER COMFORT					
								OPTIMUM WINTER COMFORT					
								COOL BUT COMFORTABLE					
								THRESHOLD DEFINITE DISCOMFORT					
								UNCOMFORTABLY COLD					
								LIMIT FOR UNDISTURBED SLEEP					

RECOMMENDED
UPPER LIMIT

RECOMMENDED
LOWER LIMIT

NOTE: IF THE CET IS ABOVE/BELOW
THESE RECOMMENDED LIMITS, ARTIFICIAL
COOLING/HEATING AIDS MAY BE ESSENTIAL

(b) Houses in which:

- (i) Predominant window orientation is within 30° of true north/south;
- (ii) External walls are not insulated;
- (iii) Ceilings are insulated with 38 mm thick mineral wool (or equivalent); and
- (iv) Total window area does not exceed 20% of floor area;

Then the following will apply:

TABLE 7

APPROX. INDOOR CET RANGE IN CLIMATIC ZONE INDICATED FOR A HOUSE WITH:												THERMAL COMFORT SCALE FOR HOUSES	
A THERMALLY CONDUCTIVE FLOOR						A THERMALLY INSULATIVE FLOOR						CORRECTED EFFECTIVE TEMP. °C	REMARKS
1	2	3	4	5	6	1	2	3	4	5	6	30	UPPER HEALTH LIMIT
RECOMMENDED UPPER LIMIT						RECOMMENDED LOWER LIMIT							
												25	UNCOMFORTABLY HOT
													THRESHOLD DEFINITE DISCOMFORT
													WARM BUT COMFORTABLE
												20	OPTIMUM SUMMER COMFORT
													OPTIMUM WINTER COMFORT
												15	COOL BUT COMFORTABLE
													THRESHOLD DEFINITE DISCOMFORT
												10	UNCOMFORTABLY COLD
												5	LIMIT FOR UNDISTURBED SLEEP

NOTE: IF THE CET IS ABOVE/BELOW THESE RECOMMENDED LIMITS, ARTIFICIAL COOLING/HEATING AIDS MAY BE ESSENTIAL

(c) Houses in which:

- (i) Predominant window orientation is more than 30° from true north/south;
- (ii) External walls are insulated with 25 mm thick mineral wool (or equivalent);
- (iii) Ceilings are insulated with 38 mm thick mineral wool (or equivalent); and
- (iv) Total window area does not exceed 20% of floor area;

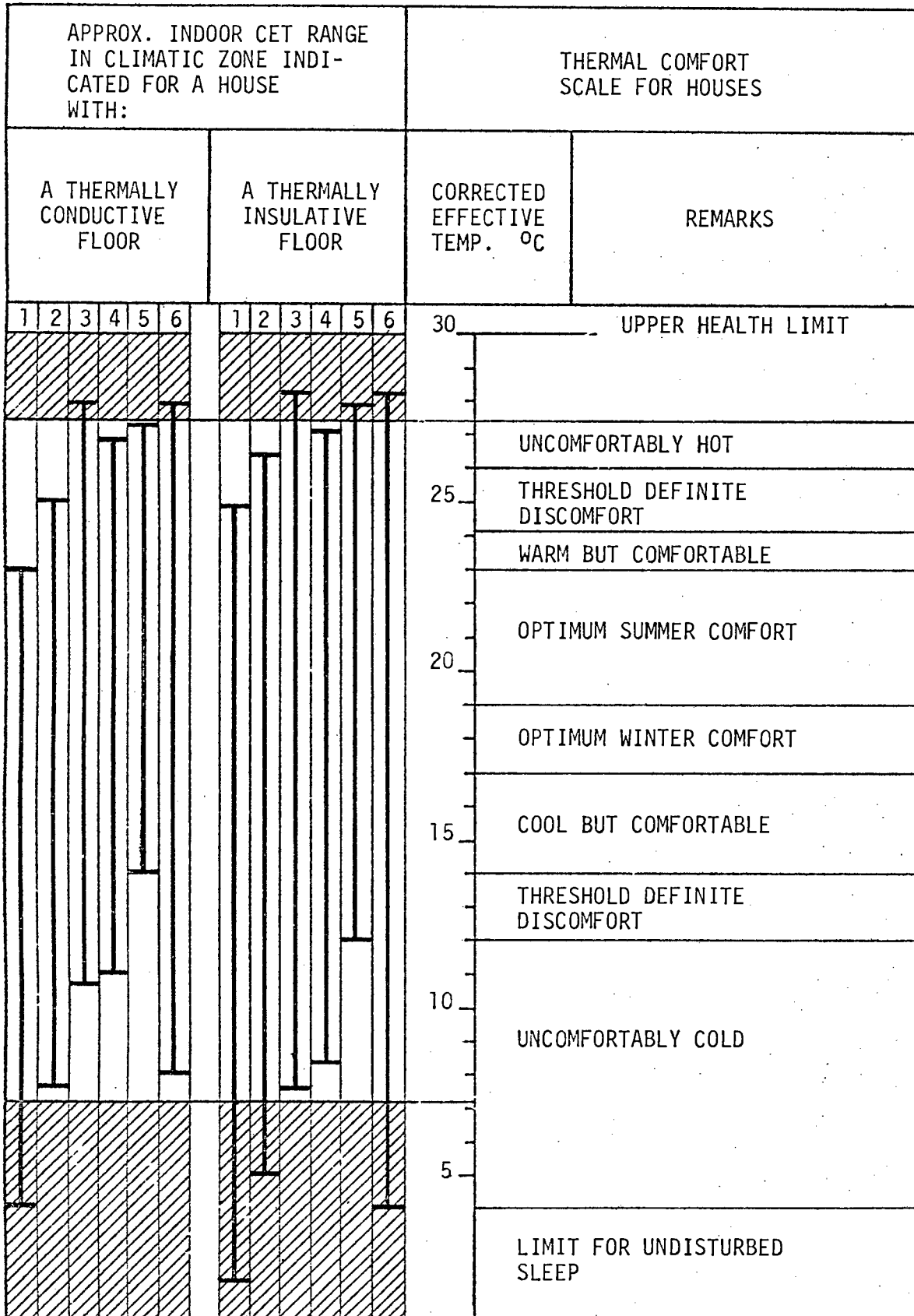
Then the following will apply:

(d) Houses in which:

- (i) Predominant window orientation is more than 30° from true north/south;
- (ii) External walls are not insulated;
- (iii) Ceilings are insulated with 38 mm thick mineral wool (or equivalent); and
- (iv) Total window area does not exceed 20% of floor area;

Then the following will apply:

TABLE 9



RECOMMENDED
UPPER LIMIT

RECOMMENDED
LOWER LIMIT

NOTE: IF THE CET IS ABOVE/BELOW
THESE RECOMMENDED LIMITS, ARTIFICIAL
COOLING/HEATING AIDS MAY BE ESSENTIAL

2. Comparison of the thermal performance of brick veneer and conventional masonry houses.

Table 10 indicates the average calculated difference in indoor corrected effective temperature of brick veneer and conventional masonry houses.

TABLE 10
ASSESSMENT OF THE THERMAL PERFORMANCE
OF BRICK VENEER HOUSES

Brick veneer houses with insulated ceilings			
External wall insulation	Floor	Season	Average CET difference
25 mm-thick mineral wool (or equivalent)	Thermally conductive floor	Summer	0,6°C warmer than conventional house
		Winter	1,7°C cooler than conventional house
	Thermally insulative floor	Summer	2,0°C warmer than conventional house
		Winter	4,5°C cooler than conventional house
No insulation	Thermally conductive floor	Summer	1,2°C warmer than conventional house
		Winter	2,5°C cooler than conventional house
	Thermally insulative floor	Summer	1,6°C warmer than conventional house
		Winter	5,0°C cooler than conventional house

The following should be noted:

- (i) The CET scale is based on the fact that different combinations of air temperature, humidity, radiation from surrounding surfaces and rate of air movement can induce similar sensations of heat and cold. A small CET difference can correspond to a significantly large air temperature difference.
- (ii) A floor will be 'thermally conductive' if the concrete surface bed has a weight not less than 122 kg/m^2 and it is left uncovered, or either covered with a material having a thermal conductivity greater than $0,72 \text{ W/m}^\circ\text{C}$ (e.g. burnt clay tiles) or a material less than 3 mm thick (e.g. vinyl tiles, linoleum, cork).
- (iii) A floor will be 'thermally insulative' if the concrete surface bed is covered with any material more than 3 mm thick and with a thermal conductivity less than $0,72 \text{ W/m}^\circ\text{C}$ (e.g. wood blocks, full-floor carpeting).

Veneer construction does have advantages over heavy weight construction in two respects. The one is that indoor temperature respond fairly quickly when heating is turned on and less heat is required during the relatively short period when heating is needed. The other advantage is that indoor temperature drop relatively quickly in the evenings in summer. This advantage is particularly appreciated in the coastal areas of Natal.

SOUND INSULATION.

Sound insulation is the reduction of transmitted sound from one room to the next via the barriers separating the rooms. The effectiveness of these barriers depends on a number of factors:

- (i) The mass of the barrier - a heavy-weight wall is a more effective sound insulator than a light-weight wall.
- (ii) The rigidity of the barrier - with light-weight walls, the sound insulation can be improved by reducing the rigidity of the wall.
- (iii) The uniformity of the barrier - if a door with a low insulation index, is incorporated in a wall with a high sound insulation index the performance of the composite barrier is severely affected.
- (iv) The completeness of the barrier - gaps between a wall and a floor can cause a significant loss in sound insulation across the barrier.
- (v) The site location and acoustic environment surrounding the house.
- (vi) The orientation of the house on the site.
- (vii) The layout and internal planning of the house.

With brick veneer construction, the problem is not considered serious as far as insulation from external noise is concerned, because, even in the traditional type of house, most of this noise is transmitted into a house through elements other than walling,

such as the roof, windows and doors. The problem is significant as far as sound transmission between rooms in dwellings is concerned. A well-constructed brick veneer house, however, should provide sufficient sound insulation between adjoining rooms to ensure a satisfactory degree of privacy to the occupants. The sound insulation will definitely not be on the same level as that of a traditional masonry constructed house, but it still falls within the category prescribed by the Agrément Board. The present policy of the Agrément Board is that the sound reduction value between different rooms in the same dwelling should be about 37 decibels. (See Table 11 for typical noise levels). A well-constructed partition wall of timber and gypsum plasterboard complies with this requirement.

To improve the sound insulation between rooms in a brick veneer house, the following planning and design principles should be adopted:

- (i) Rooms between which a higher degree of sound insulation is required should not share a common separating wall. Bathrooms and toilets, for example, should not directly adjoin bedrooms or living rooms, but should, where possible, be separated from these rooms by other utility rooms or a passage.
- (ii) Where it is difficult to effect separation between rooms by means of 'buffer' rooms, sound transmission can be reduced if built-in cupboards are located on the wall separating the rooms between which higher sound insulation is required.

In this instance a full wall width and wall height cupboard will be more effective than a cupboard which only partially cover the wall.

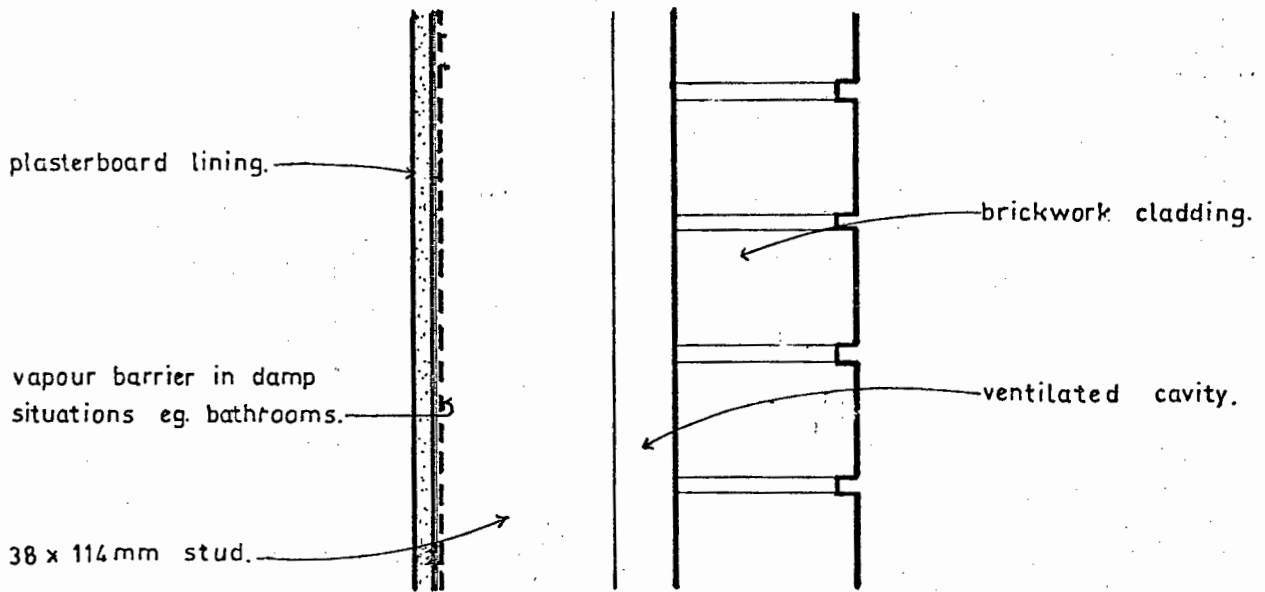
The biggest problem is that a sound, once it has been born, is determined to live out its life. It should be noted that absorbing materials generally do not improve insulation appreciably.

If a thick layer of glass or mineral wool is fastened to the surface of the wall on the side where the sound is generated, the person on the other side of the wall will still hear the same sound almost as loud as he would have if there was no glass or mineral wool. The difference, however, will be that the person who made the sound will hardly hear the echo, because it will be absorbed by the glass wool and not reflected.

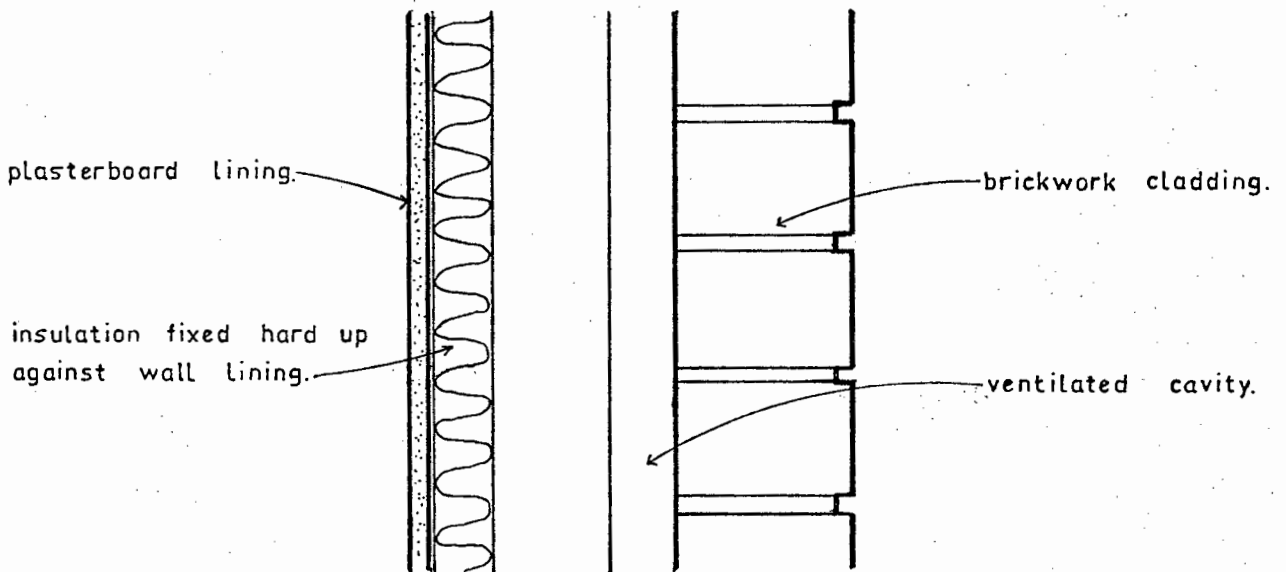
TYPICAL NOISE LEVELS MEASURED IN DECIBELS

JET PLANE PASSING LOW OVERHEAD	125	
	120	THRESHOLD OF PAIN
INSIDE A MACHINE SHOP	115	
	105	PASSING CLOSE TO A JACK HAMMER
AT A POP CONCERT	95	
	90	INSIDE A BUS
VERY LOUD TRAFFIC NOISE	85	
	75	A BUSY STREET CORNER
TWO PEOPLE TALKING	65	
	55	BACKGROUND NOISE IN A BUSINESS OFFICE
BACKGROUND NOISE IN A LIVING ROOM	50	
	40	BACKGROUND NOISE IN A PUBLIC LIBRARY
THE TICKING OF A WATCH A METRE AWAY	30	
	25	BACKGROUND NOISE IN A BROADCASTING STUDIO
THE RUSTLE OF LEAVES	10	
	0	THRESHOLD OF HEARING

DRAWING NO. 17



(A) ADDITIONAL VAPOUR BARRIER.



(B) ADDITIONAL INSULATION

ALTERNATIVE
SOLUTIONS

SCALE 1:5

STRUCTURAL FLEXIBILITY.

Timber-frame brick veneer construction is extensively used in areas where there are a danger of earthquakes or where heaving soils are a problem. Brick veneer construction has been found to be more suitable than all-brick construction because of its greater flexibility.

In 1968, the small town of Meckering near Perth had been badly damaged by an earthquake which reached force 6,8 on the Richter scale. It was seen that the brick veneer houses withstood the earthquake better than the all-masonry ones did. The exteriors of the brick veneer showed hardly any cracking although inside there were cracks along the joints between the light-weight linings but nothing that could not be easily repaired and redecorated.

At the request of the South Australian Division of the Institution of Engineers, Adelaide University carried out a study of the behaviour of house structures when subject to foundation movement. The following is an extract from their findings: "The study showed conclusively that the cheapest, and probably most effective house on expansive clay is one with a flexible or at least an articulated superstructure. If for some special and unavoidable reason an inflexible and brittle structure must be built, the foundations of adequate depth and stiffness must be provided; such foundations are invariably expensive. A large number of houses in Adelaide crack and become unsightly. It is less expensive to build a house that permits foundation movements, yet still remains aesthetically satisfactory. Masonry structures are generally brittle and crack

easily as a result of small movements in their supports. For a typical 9 foot high one brick wall, the critical movement is about 1/4" in 20 feet. Four house units were constructed and tested during this investigation. Apart from minor blemishes at points where good construction practice had not been followed, the timber-framed brick veneer unit showed no internal defects or cracking. The only visible cracking was in the external brick cladding. This was in contrast to, the behaviour of the double brick construction".

From the extract above it can be seen that because of the greater flexibility of the timber-frame brick veneer construction, it will be more suitable in areas where there are a problem with expansive clays and where there are a possibility of earthquakes.

RODENT INFESTATION.

Although the regulations published under the Public Health Act exclude dwellings from their scope, health authorities may require the shell of every building to be completely of Class A construction. However, for domestic buildings, dependent on the area and environment, they generally permit Class B construction.

In terms of the definitions given in Section 2 of S.A.B.S. Code of Practice 080, the rodent-proofing of buildings, the walls of a brick veneer house can be classified as follows:

- (a) Brick cladding to external walls: Class A material and construction;
- (b) Gypsum plasterboard cladding to external and internal walls: Class B material and construction.

WEATHERING AND DURABILITY.

Most home owners have come to expect that their houses should give satisfactory performance in all aspects they hope for and be free of serious defects or heavy maintenance for a period of at least 30 years, but preferably very much longer. Due cognizance must be taken of the fact that rising costs and the shortage of labour, particularly skilled labour, are forcing house owners to harden their attitude on the question of repair and maintenance. The problem of predicting the long-term behaviour of unorthodox materials or methods of construction is, however, complicated because experience has shown that actual performance that has been adequately demonstrated in other parts of the world, or the test methods that they use, are frequently of little validity for indicating suitability to the climatic and other conditions of this country. Timber houses have proved, in South Africa as well as overseas countries, that it can withstand the test of time, although it requires frequent maintenance. The biggest problem here was termite and fungal attack of timber members. If well-treated timber is used, this possibility does not exist. Timber-frame brick veneer construction is a more sound type of construction, and a life-expectancy of 30 to 40 years is anticipated.

Precautions against termite and fungal attack of timber members should cause no problems as local research has provided adequate information on timber treatment and soil poisoning. However, the following are other important aspects requiring careful consideration:

- (i) Precautions against corrosion of metal items that play a key role in structural stability and/or are in positions hidden from view. An example here is the ties which tie back the brick cladding to the timber framing. This is a very significant factor in coastal areas.
- (ii) Precautions to adequately cater for the inevitable dimensional changes of materials that result from temperature and moisture variations. Of particular importance is the relative movement between different materials and the movement at joints. Problems to avoid due to dimensional changes are, for instance, excessive shrinkage of the timber-frame that may transfer the roof load to the brick veneer, crack formation and distortion at window and door frames and window sills, nail popping and cracks at joints in wall linings.
- (iii) Detailing at the bottom of walls and between walls and fittings in bathrooms and kitchens to obviate the effects of water spillage.
- (iv) Wall panelling should allow quick and easy repairs to be carried out when holes or breaks occur in them. Health authorities take a very serious view on this because if not repaired for some time, there is the danger of vermin entering and harbouring the wall cavity.
- (v) It should not be assumed that all brickwork will be free from problems. Apart from taking the normal precautions to ensure good brickwork, the possible need to allow for

the long-term moisture expansion of brickwork should not be overlooked, particularly in the Cape coastal area.

SECTION 4

ECONOMIC APPRAISAL

ECONOMIC APPRAISAL.

Introduction.

It has been estimated by Local Authorities that the Building Industry will be required to erect more dwelling units in the next 30 years than it has erected in the past 300 years. It is therefore necessary to use a construction method that will reduce the erection time of dwellings to meet this enormous challenge. This is the main advantage of timber-frame brick veneer - the time saving. Saving in time not only means earlier occupation of the dwelling by the home-owner, with its resultant savings for the home-owner, but it also means tremendous cost savings to the contractor. Speed of erection is the critical factor. The more dwellings the contractor can complete in a certain specified time, the higher his turnover and profits will be. Because a brick veneer house can be erected in far less time than a conventional brick house, the contractor will save on his Preliminary and General and overhead costs. Items that will be effected are the following: foreman, insurances, plant and equipment, water, lighting and watching, etc.

In order to compare the cost of these two different building methods, a complete analysis of cost is given. A simple building has been designed to suit the requirements of both the conventional brick and timber-frame brick veneer construction. Elements which are likely to differ between the two systems are analysed and a comparison drawn up.

Utilization of skilled labour.

A very important advantage offered by brick veneer construction is the saving in labour costs for skilled bricklayers, who are always in short supply in this country.

A conventional 280 mm cavity wall uses 110 bricks per square metre as against 55 bricks required for a half brick wall, as used in brick veneer. Assuming the same output of bricks per day, this would result in an astronomical saving of 100% in the labour content and costs of a wet trade. This would result in the most effective use of skilled bricklayers. !!!

During rainy days all work is stopped when building the walls of a conventional brick building. In a brick veneer construction, because the roof is carried by a timber frame and therefore in position after a few days, the roof overhang affords protection against rain. No delay in building operations can therefore be caused by rain after the roof is in position.

The delaying effect of rain can be a serious factor in the erection of a conventional brick building when one considers that the mean annual number of rainy days for the Western Cape area is 108 days and for the Southern Cape area 124 days.

Cost and time saving.

(1) Preliminary and General.

If one considers that a luxury four-bedroomed house in brick veneer can be built in only 40 days as opposed to between 3 and 4 months if built in conventional brick, savings in the Preliminary and General can be considerable.

Items which run for the duration of the contract, for example foreman, insurances, etc., can be reduced by as much as 40%. The timber frames can be factory made. This allows for very much faster production while the detrimental effects of the weather cannot influence production. Closer supervision and quality control is afforded by this in-wall production process.

(2) Foundations.

The brick veneer method is considered as a light weight construction. The foundation strip footing sizes will, therefore, be less than that required for conventional brick.

General accepted sizes.

	<u>Conventional brick</u>	<u>Brick veneer</u>
External walls	610 mm x 380 mm	460 mm x 380 mm
Internal walls	460 mm x 230 mm	Nil

No internal foundation walls are required for brick veneer because of its light weight. This results in tremendous savings in excavations, concrete in strip footings and foundation brickwork. Savings in foundation costs of up to 45% can be expected. Because fewer footings are required, there will also be a saving in time. In the event of a sloping site, an even greater saving can result, depending on the degree of the slope.

(3) Ground floor construction.

The construction of the ground floor is basically similar for both building methods. A damp proof membrane or

hardcore must be provided under the surface bed. A sand bed may be required in addition. Because a brick veneer house has no foundation division walls, the surface bed will be cast as one flat slab. Mesh reinforcement will be required at mid-thickness in the surface bed to prevent shrinkage cracking. This results in the cost of a solid floor of a conventional brick house being approximately 5% cheaper than that of a brick veneer house.

(4) External walls.

A saving of about 1% can be effected in the cost of the external walls of a conventional brick building as against brick veneer. The gypsum plasterboard makes up the bulk of the cost of a timber-framed wall. The external frames are only clad on one side with gypsum plasterboard and therefore it will be cheaper than the internal wall frames. The timber-framed brick veneer external walls can thus compare favourably with a conventional 280 mm cavity wall. Another factor is that the outer skin of the 280 mm cavity wall must be carried up to the full height in order to support the roof trusses irrespective of whether the eaves are closed in or not.

(5) Internal walls.

A timber-framed wall with gypsum plasterboard both sides is more expensive than a half brick wall, but cheaper than an one brick wall. If, however, the half brick wall is plastered and painted both sides, the timber-framed wall will be approximately 3% cheaper. This part of the construction produces the biggest time saving as no wet trades

are involved. Immediately the timber frames are placed in position and the roof has been erected, the plasterboard cladding can be fixed. This allows further finishing work inside the building to be done. Skilled labour in other trades for example carpentry, plumbing, etc., can thus be employed simultaneously. A saving in transport costs of labour to and from the site is thus effected.

(6) Plastering.

If plastering is considered as an element on its own, there is an astronomical saving of about 60% in favour of brick veneer in the cost of plastering. This is a substantial saving especially when considering that plastering is done by skilled labour.

(7) Roof construction and covering.

Although generally accepted that "engineered" trusses should be used with brick veneer construction, conventional trusses made up on site can also be used. It is therefore generally considered that the cost of the roof construction and covering will be identical for a brick veneer and conventional brick house.

(8) Floor finishes.

If screeds for floor finishes are incorporated in both instances, there will be no cost difference.

(9) Ceilings.

There is no cost difference between the ceiling of a conventional brick house and a timber-frame brick veneer house.

(10) Door and window frames.

The cost of these operations will be basically similar for both construction methods. The advantage of the brick veneer is that the frames do not have to be ordered in advance and stored on site. The frames are not required at the early stages of the project. It can be fixed in position after all the walls have been erected. The major saving here is in time, which will also reflect a cost saving.

(11) Electrical and plumbing installation.

The time taken to install these services in a brick veneer structure is very much less because of the hollow timber frame. This work can be done simultaneously with the outer brick skin. Chasing of walls is reduced to the minimum. Holes in the plasterboard for plugs, pipes, etc., can easily be made, and making good of the lining should produce no problem. Electrical and plumbing sub-contractors are, however, unfamiliar with this building method and will generally make no allowance for these advantages. For all practical purposes it can be assumed that the cost of the electrical and plumbing installation will be the same for both building methods.

(12) External work.

External work bears no relation to what building method is adopted and is therefore not considered here.

ELEMENTAL ANALYSIS OF CERTAIN ELEMENTS OF A CONVENTIONAL
BRICK BUILDING.

General specification.

Floor area	=	126 m ²
Wall height	=	2,5 m
Perimeter of building	=	46 m
External wall area	=	130 m ²
Length of internal walls	=	50 m
Internal wall area	=	125 m ²

ELEMENT: Foundations (126 m²).

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
1. Excavate 700 mm deep for external walls.	20 m ³	3,00	60,00	
2. Ditto, for internal walls.	16 m ³	3,00	<u>48,00</u>	108

Concrete.

1. 20 MPa concrete for external wall footings.	11 m ³	25,00	275,00	
2. Ditto, for internal one brick walls.	4 m ³	25,00	100,00	
3. Ditto, for internal half brick walls.	3 m ³	25,00	<u>75,00</u>	450

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
<u>Foundation walls.</u>				
1. 280 mm Cavity walls 500 mm high.	23 m ²	13,30	305,90	
2. One brick ditto.	11 m ²	11,90	130,90	
3. Half brick ditto.	14 m ²	6,60	92,40	
4. Plaster on external foundation walls	12 m ²	2,50	<u>30,00</u>	559

Sundries

1. Includes risk of collapse, keeping excavations free from water, etc.	126 m ²	1,00	<u>126,00</u>	<u>126</u>
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TOTAL FOR FOUNDATIONS R1 243

RATE PER M² OF FLOOR AREA R 9,87

ELEMENT: Ground floor construction (126 m²)

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
1. Mass concrete in surface beds.	13 m ³	25,00	325,00	
2. Striking off surface beds.	126 m ²	0,40	50,40	
3. 25 mm Cement screed.	126 m ²	2,00	252,00	
4. Damp proof course under surface beds.	126 m ²	1,30	163,80	
5. Earth filling under floors.	10 m ³	1,50	<u>15,00</u>	<u>806</u>
TOTAL FOR GROUND FLOOR CONSTRUCTION				R <u>806</u>
RATE PER M ² OF FLOOR AREA				R <u>6,40</u>

ELEMENT: External walling (130 m²)

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
<u>Walling.</u>				
1. 280 mm Cavity wall.	130 m ²	13,30	<u>1729,00</u>	1 729
<u>Finishes.</u>				
1. Plaster on external brick walls.	130 m ²	2,50	325,00	
2. Paint on plastered external walls.	130 m ²	1,50	<u>195,00</u>	<u>520</u>
TOTAL FOR EXTERNAL WALLING				<u>R2 249</u>
RATE PER M ² OF WALL AREA				R <u>17,30</u>

ELEMENT: Internal divisions (125 m²)

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
1. One brick wall.	55 m ²	11,90	654,50	
2. Half brick wall.	70 m ²	6,60	<u>462,00</u>	<u>1 117</u>
TOTAL FOR INTERNAL DIVISIONS				<u>R1 117</u>
RATE PER M ² OF WALL AREA				R <u>8,94</u>

ELEMENT: Internal wall finishes (365 m²)

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
1. Plaster on internal brick walls.	365 m ²	2,30	839,50	
2. Paint on ditto.	365 m ²	1,40	<u>511,00</u>	<u>1 351</u>
TOTAL FOR INTERNAL WALL FINISHES				<u>R1 351</u>
RATE PER M ² OF INTERNAL WALL AREA				R <u>3,70</u>

ELEMENTAL ANALYSIS OF CERTAIN ELEMENTS OF A BRICK VENEER BUILDING

General specification.

Floor area	=	126 m ²
Wall height	=	2,5 m
Perimeter of building	=	46 m
External wall area	=	130 m ²
Length of internal walls	=	50 m
Internal wall area	=	125 m ²

ELEMENT: Foundations (126 m²).

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
<u>Excavations.</u>				
1. Excavate 700 mm deep for external walls.	15 m ³	3,00	<u>45,00</u>	45
<u>Concrete.</u>				
1. 20 MPa concrete for external wall footings.	8 m ³	25,00	<u>200,00</u>	200
<u>Foundation walls.</u>				
1. 280 mm Cavity walls 500 mm high.	23 m ²	13,30	305,90	
2. Plaster on external foundation walls.	12 m ²	2,50	<u>30,00</u>	336

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
<u>Sundries.</u>				
1. Includes risk of collapse, keep excavations free from water, etc.	126 m ²	1,00	<u>126,00</u>	<u>126</u>
TOTAL FOR FOUNDATIONS				R <u>707</u>
RATE PER M ² OF FLOOR AREA				R <u>5,61</u>

ELEMENT: Ground floor construction (126 m²).

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
1. Reinforced concrete in surface beds.	13 m ³	28,00	364,00	
2. Power floating.	126 m ²	1,20	151,20	
3. Mesh reinforcement in surface beds.	126 m ²	1,20	151,20	
4. Damp proof course under surface beds.	126 m ²	1,30	163,80	
5. Earth filling under floors	10 m ³	1,50	15,00	<u>845</u>
TOTAL FOR GROUND FLOOR CONSTRUCTION				R <u>845</u>
RATE PER M ² OF FLOOR AREA				R <u>6,71</u>

ELEMENT: External walling (130 m²).

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
<u>Walling.</u>				
1. Half brick cladding tied to timber framing.	130 m ²	6,65	864,50	

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
2. Timber framed walls with gypsum plasterboard one side. *	115 m ²	7,74	<u>890,10</u>	1 755
<u>Finishes.</u>				
1. Plaster to external walls.	130 m ²	2,50	325,00	
2. Paint on plastered external walls.	130 m ²	1,50	<u>195,00</u>	<u>520</u>
TOTAL FOR EXTERNAL WALLING				<u>R2 275</u>
RATE PER M ² OF WALL AREA				R <u>17,50</u>

* See schedule 1 for calculation of rate.

ELEMENT: Internal divisions (125 m²).

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
1. Timber framed partition walls with gypsum plasterboard both sides. *	125 m ²	10,73	<u>1341,25</u>	<u>1 341</u>
TOTAL FOR INTERNAL DIVISIONS				<u>R1 341</u>
RATE PER M ² OF WALL AREA				R <u>10,73</u>

* See schedule 2 for calculation of rate.

ELEMENT: Internal wall finishes (365 m²).

<u>Item</u>	<u>Quantity</u>	<u>Rate</u>	<u>Extension</u>	<u>Total</u>
1. Paint on gypsum plasterboard cladding.	365 m ²	1,50	<u>547,50</u>	<u>548</u>
TOTAL FOR INTERNAL WALL FINISHES				R <u>548</u>
RATE PER M ² OF INTERNAL WALL AREA				R <u>1,50</u>

COMPARATIVE COSTS.

<u>Element</u>	<u>Conventional brick</u>	<u>Brick vener</u>
1. Foundations	R1 243	R 707
Saving:		<u>43%</u>
2. Ground floor construction	R 806	R 845
Saving:	<u>5%</u>	
3. External walling	R2 249	R2 275
Saving:	<u>1%</u>	
4. Internal divisions	R1 117	R1 341
Saving:	<u>17%</u>	
5. Internal wall finishes	R1 351	R 548
Saving:		<u>59%</u>

SUMMARY OF COSTS.

<u>Element</u>	<u>Conventional brick</u>	<u>Brick vener</u>
1. Foundations	R1 243	R 707
2. Ground floor construction	R 806	R 845
3. External walling	R2 249	R2 275
4. Internal divisions	R1 117	R1 341
5. Internal wall finishes	<u>R1 351</u>	<u>R 548</u>
TOTAL COSTS:	<u>R6 766</u>	<u>R5 716</u>
OVERALL SAVING:		<u>15,5%</u>

15,5%
Part Cost
of Bldg
Only!

SCHEDULE 1.

COST ANALYSIS OF TIMBER-FRAME EXTERNAL WALL

Size of wall panel: 3,0 m x 2,45 m = 7,35 m²

MATERIALS.

Note:

All timber to be sawn S.A. Pine

1. 38 mm x 76 mm Studs
7/2,5 m + 12,5% waste = 19,7 m
38 mm x 76 mm Top and bottom rail
2/3,0 m + 12,5% waste = 6,8 m
38 mm x 76 mm Noggings
1/3,0 m + 12,5% waste = 3,4 m
29,9 m @ 57c/m = 17,04
2. Wire nails (100 mm)
56 + 10% waste = 62 @ R1,93/1000 = 0,12
3. 12,7 mm Rhinoboard lining
7,35 m² + 11,5% waste = 8,2 m² @ R1,29/m² = 10,58
4. Galvanised clout nails (32 mm)
140 + 10% waste = 154 @ 45c/1000 = 0,07
5. Galvanised hoop iron ties incl. nails 28 @ 0,06 = 1,68
R29,49

LABOUR.

1. 1 Artisan @ R4,11/hr.
1 Labourer @ R1,54/hr.
2. Cost to manufacture and clad panel
3,35 hours @ R4,11/hr = 13,77
2,7 hours @ R1,54/hr = 4,16
R17,93

TOTAL COST.

1. Materials	=	29,49
2. Labour	=	<u>17,93</u>
		R47,42
3. 20% Gross profit		<u>9,48</u>
		<u>R56,90</u>

COST PER M².

$$7,35 \text{ m}^2 = \text{R}56,90$$
$$= \text{R } 7,74/\text{m}^2$$

SCHEDULE 2

COST ANALYSIS OF TIMBER-FRAME INTERNAL WALL

Size of wall panel: $3,0 \text{ m} \times 2,45 \text{ m} = 7,35 \text{ m}^2$

MATERIALS.

1. 38 mm x 76 mm Studs
 $7/2,5 \text{ m} + 12,5\% \text{ waste} = 19,7 \text{ m}$
38 mm x 76 mm Bottom and top rail
 $2/3,0 \text{ m} + 12,5\% \text{ waste} = 6,8 \text{ m}$
38 mm x 76 mm Noggings
 $1/3,0 \text{ m} + 12,5\% \text{ waste} = \underline{3,4 \text{ m}}$
 $29,9 \text{ m} @ 57\text{c}/\text{m} = 17,04$
2. Wire nails (100 mm)
 $56 + 10\% \text{ waste} = 62 @ R1,93/1000 = 0,12$
3. 12,7 mm Rhinoboard lining
 $(7,35 \text{ m}^2 \times 2) + 11,5\% \text{ waste} = 16,4 \text{ m}^2 @ R1,29/\text{m}^2$
 $= 21,16$
4. Galvanised clout nails (32 mm)
 $280 + 10\% \text{ waste} = 301 @ 45\text{c}/1000 = \underline{0,14}$
 R38,46

LABOUR.

1. 1 Artisan @ R4,11/hr.
 1 Labourer @ R1,54/hr.
2. Cost to manufacture and clad panel
 $5,2 \text{ hours} @ R4,11/\text{hr} = 21,37$
 $3,8 \text{ hours} @ R1,54/\text{hr} = \underline{5,85}$
 R27,22

TOTAL COST.

1. Materials	=	38,46
2. Labour	=	<u>27,22</u>
		65,68
3. 20% Gross profit		<u>13,14</u>
		<u>R78,82</u>

COST PER M².

$$7,35 \text{ m}^2 = R78,82$$
$$= R10,73/\text{m}^2$$

SCHEDULE 3.

CALCULATION OF LABOUR RATES

Artisans (Carpenters)

Average actual wage rate per hour	=	2,24
Statutory cost of labour	=	<u>0,50</u>
		R2,74
Plus 50% overheads		<u>1,37</u>
		<u>R4,11 / hr.</u>

Labourers

Average actual wage rate per hour	=	0,86
Statutory cost of labour	=	<u>0,17</u>
		R1,03
Plus 50% overheads		<u>0,51</u>
		<u>R1,54 / hr.</u>

NOTE:

The 50% added to the direct labour cost for overheads provides for the following expenses, which are not priced in the Preliminary and General for any contract:

- Salaries : Directors, administrative and service staff, etc.
- Rentals : Office space, yards, stores, etc.
- Services : Light, water, advertising signs, research and publication, etc.
- Insurances : Buildings, burglary, fire, vehicles, loss of profits, etc.
- Motor : Drivers and cars, licenses, etc.
- General : Gifts, bank charges, legal fees, bad debts, stationery, telephone, etc.

The relationship between the costs of the different walls.

(i) External walling.

280 mm Cavity wall, plastered and painted
both sides:

280 mm Cavity wall	=	R13,30 / m ²
External plaster	=	R 2,50 / m ²
Internal plaster	=	R 2,30 / m ²
External paint	=	R 1,50 / m ²
Internal paint	=	<u>R 1,40 / m²</u>
<u>TOTAL</u>	=	<u>R21,00 / m²</u>

Timber-frame brick veneer wall, plastered
one side and painted both sides:

Timber partition	=	R 7,74 / m ²
Brick cladding	=	R 6,65 / m ²
External plaster	=	R 2,50 / m ²
External paint	=	R 1,50 / m ²
Internal paint	=	<u>R 1,50 / m²</u>
<u>TOTAL</u>	=	<u>R19,89 / m²</u>

A 280 mm cavity wall, without any finishes to it, is about 8% cheaper than a timber-frame brick veneer wall. When finishes are applied, the brick veneer wall is about 5% cheaper than a 280 mm cavity wall.

(ii) Internal walling.

Half brick internal wall plastered and painted
both sides:

Half brick wall = R 6,60 / m²

Internal plaster (b/s) = R 4,60 / m²

Internal paint (b/s) = R 2,80 / m²

TOTAL R14,00 / m²

Timber-frame internal partition wall painted
both sides:

Timber-frame wall = R10,73 / m²

Internal paint (b/s) = R 3,00 / m²

TOTAL R13,73 / m²

A half brick wall, without any finishes to it, is about 38% cheaper than a timber-frame wall. When finishes are applied, the timber-frame wall is about 2% cheaper.

Comments.

From the cost comparison it appears as if the brick veneer construction is approximately 15,5% cheaper than a conventional building. This large saving will only be achieved if the building is erected by a specialist contractor. It has been found that if an ordinary contractor is given the opportunity of submitting two tenders, one for a conventional brick building and the other for a brick veneer building, there will only be a saving of about 5%. It is therefore generally accepted that a saving of up to 20% will only be achieved by a specialist firm.

~~Part of
the only~~

From the cost analysis it can be seen that the ratio of labour: material for a brick veneer building is about 1 : 1,5, or 40% : 60%, while the ratio for a conventional brick building is vice versa.

If there is a steep increase in the cost of timber, the brick veneer building may not be as feasible as before. If, on the other hand, there is a sudden increase in the cost of bricks, it will affect the conventional brick building more and it will not be able to compete with a timber-frame brick veneer building.

The cost analysis only applies to level sites, the soil being pickable material. Timber-frame brick veneer construction only really comes into its own with sloping or rocky sites.

SECTION 5

CONCLUSION

CONCLUSION.

A house that is built well, with adequate attention to construction details and the use of suitable materials, will obviously be more sound than a house that is not well built. If suitable materials are used, far less maintenance will be required and the house will most probably last longer. In brick veneer, a smaller capital outlay will be required compared to a conventional brick building. With many other non-conventional building methods, an even smaller capital outlay may be required, but other costs, for example maintenance, will be higher. In the end the extra costs incurred through maintenance will cancel the saving in the initial cost, and the building will no longer be economical. A timber-frame brick veneer building has a smaller initial cost than the conventional brick building. With maintenance costs being virtually the same, a house built on this system must be more feasible and present better value for money for the average family.

In several respects a brick veneer building has performance characteristics similar to those of a light-weight timber-framed building, sharing numerous of its advantages and disadvantages. Its most important advantage over the latter is the fact that it enjoys the same good appearance of a brick building, with little maintenance over a long life. There are other performance characteristics that are not on the same level as the solid masonry construction, but with correct planning, this can be virtually overcome. Those that cannot be overcome, can easily be accepted. Planning is the key word.

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