TECHNICAL REQUIREMENTS FOR HOUSEHOLD SHELTERS 2008

SINGAPORE CIVIL DEFENCE FORCE

BUILDING & CONSTRUCTION AUTHORITY

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May 2008

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INTRODUCTION

CHAPTER 1: INTRODUCTION

1.1 GENERAL

A household shelter (HS) is designed and constructed for the protection of people against weapon effects during a war emergency. It should not be used for protection during other emergency situations such as a fire in a building. For the convenience of the occupants, HS is located inside the individual dwelling unit.

HS shall be incorporated as part of the dwelling unit. This can be achieved by efficient space planning as well as optimal integration of the HS location with other spaces in a dwelling unit.

1.2 APPLICATION OF HS TECHNICAL REQUIREMENTS

The Technical Requirements for HS are applicable to all forms of dwelling units, which are intended as complete and separate units for purpose of private dwelling.

1.3 PEACETIME USE

Every HS shall be designed to a specific peacetime use. The other statutory requirements governing the design and use of the HS space shall also be complied with.

1.4 ABBREVIATIONS

Clause	Description	Abbreviation
1.1	Household Shelter*	HS
2.1	Non-Shelter	NS
2.2	Gross Floor Area	GFA
2.3.1	External Building Line	EBL
2.5.2	Finished Floor Level	FFL

*Under the Civil Defence Shelter Act (CDSA), a household shelter would be required in a "new building" which means a building – **"which is constructed on a vacant land or in place of a building which has been demolished;"** the building covers houses/flats that are constructed as new erection developments as well as existing houses/flats that are completely demolished and rebuilt. However, proposals for addition-and-alteration works (A & A Works)/ reconstruction still need to seek Authority (SCDF/BCA) for approval.

1.5 DEFINITIONS

Clause	Definition	Term
2.1	The space in the HS tower that is not intended for use as a shelter.	Non-Shelter
2.1.2	Height of HS measured from its FFL to the soffit of the HS ceiling slab.	HS Clear Height
2.1.2	Height of NS measured from its FFL to the soffit of the NS ceiling slab.	NS Clear Height
2.2	Relevant Authority means the Commissioner of Singapore Civil Defence Force and includes officers authorised by him generally or specifically to exercise the powers, functions and duties conferred by the Civil Defence Shelter Act.	Relevant Authority
2.3.1	HS located in the basement storey of a landed dwelling unit.	Basement HS
2.3.1	A storey which is below the first storey and the floor of which is situated at such a level that more than half the height of the storey is below the level of the ground adjoining its perimeter walls for more than half the length of the perimeter walls.	Basement Storey
2.3.1	The edge line of the ceiling slab above the HS wall under consideration.	External Building Line
2.3.1	Distance from external face of a HS wall to the nearest EBL.	Setback Distance

CHAPTER 2

ARCHITECTURAL REQUIREMENTS

CHAPTER 2: ARCHITECTURAL REQUIREMENTS

2.1 HS OR NS FORM

2.1.1 Plan

The configuration of a HS or NS on plan shall be rectangular, square, trapezoidal or L-shaped (See Clause 2.2).

2.1.2 Dimensions

The maximum internal length of any floor and roof slab of a HS shall be 3700 mm. The minimum internal width of a HS shall be 1200 mm. The minimum and maximum HS clear height shall be 2400 mm and 3900 mm respectively (See FIGURE 2.1.2). The maximum NS clear height shall be 3900 mm.

2.2 SIZE OF HS - AREA AND VOLUME

If the configuration of HS on plan is rectangular or square, the minimum internal floor area and minimum internal volume of a HS shall be in accordance with TABLE 2.2(a).

If the configuration of HS on plan is trapezoidal or L-shaped, the minimum internal floor area and minimum internal volume of a HS shall contain the number of 0.6 m x 0.6 m square units as specified in TABLE 2.2(b) and as illustrated in FIGURE 2.2.

The maximum internal floor area of a HS shall be 4.8 m^2. Internal floor area exceeding 4.8 m^2 may be allowed subject to the approval from the relevant authority.

2.3 LOCATION OF HS

2.3.1 HS Position

A HS has to be positioned such that the setback distance of each HS wall shall be as large as is practical, and shall not be less than the minimum specified setback distance.

A pair of adjacent HS can share an internal common wall for both non-landed and landed dwelling units respectively (See FIGURE 2.3.1(a)).

A HS in a landed dwelling unit may have one of its walls (on which the HS door is not located) abutting an air well (See FIGURE 2.3.1(b)). The air well, has to be located such that it abuts a party wall and/ or is surrounded by habitable space

at that same level of the HS, belonging to that dwelling unit. The air well edge line shall not be regarded as EBL for the purpose of determining the minimum setback distance.

A HS can also be located in the basement storey of a landed dwelling unit. It is termed as a basement HS. Access to the basement HS shall be from the basement storey and the access route to the HS door shall have a reinforced concrete ceiling slab of minimum thickness 125 mm.

2.3.2 HS Tower

In a building of more than one-storey, the HS (or NS, where applicable) on every storey shall be located one on top of the other to form a vertical tower with its walls continuing to the foundation (See FIGURE 2.3.2(a)).

Up to 2 larger HS are allowed to be located at the top of the HS tower. Only one wall of the larger HS is allowed to be projected beyond the HS walls below it. The minimum thickness of the projected slab shall follow the wall thickness of the larger HS (See FIGURE 2.3.2(b)).

The space within a NS is not intended for protection of occupants during a war emergency.

2.3.3 Setback Distances of HS Walls (Without Reinforced Concrete Down-hang Beams along EBL)

(a) The HS walls shall be located at minimum setback distances from the EBL (See FIGURE 2.3.3(a) and FIGURE 2.3.3(b)). The setback distances of the HS in a dwelling unit shall comply with TABLE 2.3.3.

(b) Where the storey height of a HS on the first storey is greater than the storey heights of other HS above it, the minimum setback distances of the HS on the first storey shall be at least the same as the setback distances of the HS above it.

(c) For HS walls (where the HS door is not located), trellis constructed of RC or steel hollow section may be used to make up for the shortfall in setback distance. However, a minimum 1000 mm RC ceiling slab from the HS wall shall be provided (See FIGURE 2.3.3(c)). A perpendicular or parallel trellis arrangement, or a combination of both, with respect to the HS wall concerned, shall comply with the geometrical configuration as shown in FIGURE 2.3.3(c).

2.3.4 Setback Distances of HS Walls (With Reinforced Concrete Down-hang Beams along EBL)

(a) Where a down-hang beam is provided along the EBL in front of HS walls, the minimum setback distance of that HS wall can be reduced based on the effective storey height and in accordance with TABLE 2.3.4(a). The effective storey height is determined by the storey height less the depth 'd' of the down-hang beam (See FIGURE 2.3.4(a)). If a down-hang beam is also provided along the EBL in front of the HS wall with HS door, the setback distance of this wall shall be in accordance with TABLE 2.3.4(b). Otherwise, it shall be in accordance with TABLE 2.3.3.

(b) For HS walls (where the HS door is not located), trellis constructed of RC or steel hollow section may be used to make up for the shortfall in setback distance. However, a minimum 1000 mm RC ceiling slab from the HS wall shall be provided (See FIGURE 2.3.3(c) and FIGURE 2.3.4(b)). A perpendicular or parallel trellis arrangement, or a combination of both, with respect to the HS wall concerned, shall comply with the geometrical configuration as shown in FIGURE 2.3.3(c).

(c) The setback distances of the HS on the first storey (where its storey height is greater than the storey height of the HS directly above it) shall be at least the same as the setback distances of the HS directly above it provided a down-hang beam of dimensions not less than those provided at the 2nd storey ceiling slab is provided at the 1st storey ceiling slab.

(d) Clause 2.3.4 shall apply only if the width of the reinforced concrete down-hang beam is at least 125 mm.

2.3.5 Setback Distances of Basement HS Walls

(a) There is no setback distance requirement for basement HS wall (See FIGURE 2.3.5(a), FIGURE 2.3.5(b) and FIGURE 2.3.5(c)) if the wall is:

(i) in direct contact with earth throughout its full height and the earth extends out by a minimum distance of 1000 mm from the external face of the HS wall; or

(ii) facing a reinforced concrete basement storey wall in direct contact with earth throughout its full height; or

(iii) facing a reinforced concrete basement storey wall and the distance between them is at least 800 mm (with no openings within the influence zone).

(b) The minimum setback distances for the basement HS wall (See FIGURE 2.3.5(a) and FIGURE 2.3.5(b)) shall be in accordance with TABLE 2.3.5 if

the HS wall faces a reinforced concrete basement storey wall with opening within the influence zone.

2.4 THICKNESS OF HS WALL

The thickness of HS wall depends on HS clear height and the setback distance. The thickness shall comply with the following requirements:

(a) The minimum HS wall thickness shall be in accordance with TABLE 2.4(a) and TABLE 2.4(b).

(b) The wall thickness of any HS or NS within the HS tower shall not be less than that of the HS or NS above.

(c) The minimum thickness of an internal HS wall, which is common to two adjacent HS in dwelling units, shall be 200 mm.

(d) The minimum thickness of the basement HS wall which is in direct contact with earth throughout its entire height shall be 250 mm thick.

(e) The minimum thickness of the basement HS wall facing a reinforced concrete basement storey wall without any opening within the influence zone shall be 200 mm.

(f) The minimum thickness of the basement HS wall facing a reinforced concrete basement storey wall with opening within the influence zone shall be in accordance with TABLE 2.4(a).

2.5 HS DOOR

2.5.1 Opening Dimensions

The opening dimensions of HS door shall be:

Width = 700 mm

Height = 1900 mm

2.5.2 Location

The HS door shall be located on a HS wall with the minimum setback distance in accordance with the following (whichever is applicable) and subject to a minimum 2750 mm:

(a) Column (2) of TABLE 2.3.3: Minimum setback distances of HS walls without reinforced concrete down-hang beam along EBL

(b) Column (2) of TABLE 2.3.4(b): Minimum setback distances of HS walls with HS door and reinforced concrete down-hang beam along EBL

(c) Column (2) of TABLE 2.3.5: Minimum setback distances of basement HS walls (facing reinforced concrete basement storey walls with opening)

The HS door of the basement HS is also allowed on the HS wall facing a reinforced concrete basement storey wall with no opening within the influence zone.

The vertical edge of the HS door frame shall have a minimum 150 mm nib for cast in-situ construction (See FIGURE 2.5.2(a)) and pre-cast door frame panel Type 1 (See FIGURE 3.5.4(i)).

The FFL of the floor slab outside the HS shall be done such that the HS door can be opened adequately for the peacetime use of the HS (See FIGURE 2.5.2(b)).

2.5.3 Strengthened Ceiling Slab Outside HS Door and HS Walls

The minimum thickness of the reinforced concrete ceiling slab immediately outside the HS door and HS walls shall be 125 mm and structurally connected to HS tower (See FIGURE 2.5.3.). This requirement shall only apply to HS in non-landed dwelling units.

2.6 FIXTURES IN HS

2.6.1 General

The following fixtures (See FIGURE 2.6.1) in conduit form shall be provided inside the HS to provide adequate communication and basis stay-in facilities:

a) 13A switched socket outlets;

b) telephone outlet;

c) light point and switch and

d) TV/radio outlet.

The fixtures shall be designed and installed in accordance with the relevant Codes of Practice and statutory requirements for peacetime usage.

Other fixtures, such as cabinets and shelves, which are required for peacetime use, are allowed provided they are easily dismantled and removed.

2.6.2 Power Points

One 13A switched socket outlet shall be provided in the vicinity of the TV/radio point. Additional 13A switched socket outlet shall be provided for other appliances such as fan.

2.6.3 Lighting Point

Luminaries shall be mounted on the soffit of HS ceiling slab with screws, by using non-metallic inserts. Wall-mounted luminaries are not permitted.

2.6.4 Cable Entries and Openings

All cable entries shall be fully sealed for air-tightness as required under Clause 3.6.

2.7 NS IN HS TOWER

2.7.1 Aggregate Wall Heights of NS

Several NS can be stacked one on top of the other within an HS tower, without the need for NS floor slab to be connected to external floor slab, provided that the aggregate wall height of the NS does not exceed 12 m (See FIGURE 2.7.1).

Aggregate wall height of NS refers to the sum of the height(s) of NS between two levels of the HS tower where the full external perimeters of the HS tower at those levels are structurally connected by floor slabs to the structural frame of the building.

The minimum thickness of all the intermediate slabs between each NS shall be 175 mm. Where an NS is located above an HS, the minimum thickness of that intermediate slab between the NS and HS shall be 300 mm (See FIGURE 2.7.1).

2.7.2 NS Walls/Columns

The relevant architectural technical requirements of the NS Walls/Columns as stipulated in Chapter 3 Clause 3.3.2 shall be complied with.

2.8 TRANSFER STRUCTURE SUPPORTING HS TOWER

2.8.1 General

If loads from walls of HS towers cannot be carried directly to the foundation, transfer structure can be used to carry loads indirectly to the foundation. The transfer structure could take the form of slab, beams, columns, walls or any of its

combination. When transfer structure is provided to carry HS tower, additional technical requirements described herein shall be complied with. Please note the following conditions in the HS tower design supported by transfer structure:

a) The use of trellis or/and the adjacent building structure as shielding element of the transfer structure of HS is not allowed.

b) Only one transfer of HS loads in each tower is allowed. Multiple transfers in the same HS tower is not allowed.

c) The use of prestressed concrete for the transfer structure is not permitted.

2.8.2 Transfer Structure

Additional design checks on transfer structure supporting HS tower is required (See Chapter 3 Clause 3.3.3).

2.9 HS BENEATH AN INTERNAL STAIRCASE

If a HS is located beneath an internal staircase, the following requirements shall apply (See FIGURE 2.9):

(a) For the purpose of determining the minimum internal floor area of the HS in accordance with TABLE 2.2, only the portion of the space with clear height of at least 1500 mm shall be taken into account.

(b) For the purpose of determining the minimum internal volume of the HS in accordance with TABLE 2.2, the entire enclosed space may be used.

(c) The minimum thickness of the HS ceiling slab and waist of the staircase shall be 300 mm.

(d) The minimum clear distance between any two opposite HS walls with ventilation sleeves shall be at least 1000 mm apart. This is to facilitate the installation of the ancillaries to the ventilation sleeves.

2.10 FINISHES IN HS

Finishes within a HS shall comply with the following:

(a) The walls and the ceiling slab shall be cast with a smooth concrete finish.

(b) The walls and ceiling slab may be finished with a skim coat of not thicker than 2 mm.

(c) No plastering or tiling shall be permitted on the walls and ceiling slab.

(d) Floor tiles or floor finishes, which are laid on wet cement mortar, are permitted.

(e) Skirting tiles laid on wet cement mortar are permitted up to a maximum 100 mm high above the FFL.

2.11 EXIT STAIRCASE

Where there is only one exit staircase or exit scissors-staircase serving the non-landed dwelling units, the minimum waist of exit staircase and the thickness of the intermediate landing slab shall be 150 mm. The staircase shall be constructed of reinforced concrete.

2.12 DOOR RECESS ON HS WALL

A door recess on HS wall to accommodate the protrusion of the HS door handle when the HS door is fully open, is allowed provided that (See FIGURE 2.12):

a) the dimensions are not larger than 160 mm (length) x 80 mm (height) x 40 mm (depth) for HS wall of minimum 250 mm thickness.

b) the spacing between the HS door handle recess and the external/ or internal socket points shall be at least 300 mm apart.

TABLE 2.2(a): MINIMUM INTERNAL HS FLOOR AREA AND VOLUME

GFA* of Dwelling Unit (m^2)	HS Floor Area** (m^2)	HS Volume (m^3)
GFA ≤ 45	1.6	3.6
45 < GFA ≤ 75	2.2	5.4
75 < GFA ≤ 140	2.8	7.2
GFA > 140	3.4	9.0

* The GFA of the dwelling unit excludes the area of balconies that are open on at least two sides to make the balconies conducive for sky-rise gardening in accordance with URA guidelines. Service balconies, which are commonly provided at the utility areas for the purpose of drying clothes, would therefore not qualify for exclusion.

** Whenever possible a larger HS internal floor area (up to a maximum size of 4.8 m^2) should be provided to enable a relatively more comfortable stay during a war emergency.

TABLE 2.2(b): NUMBER OF SQUARE UNITS (0.6 m x 0.6 m) USED FOR THE ASSESSMENT OF TRAPEZOIDAL OR L-SHAPED HS

GFA* of Dwelling Unit (m^2)	HS Floor Area** (m^2)	HS Volume (m^3)	Number of Square Units
GFA ≤ 45	1.6	3.6	3
45 < GFA ≤ 75	2.2	5.4	4
75 < GFA ≤ 140	2.8	7.2	5
GFA > 140	3.4	9.0	6

TABLE 2.3.3: MINIMUM SETBACK DISTANCES OF HS WALLS WITHOUT REINFORCED CONCRETE DOWN-HANG BEAM ALONG EBL

Storey Height (mm) Column (1)	Setback Distance of HS Wall with HS Door (mm) Column (2)	Setback Distance of HS Walls without HS Door (mm) Column (3)
$2500 \leq Ht \leq 2800$	2750	2000
$2800 < Ht \leq 3100$	2900	2200
$3100 < Ht \leq 3500$	3100	2500
$3500 < Ht \leq 4000$	3300	2700
$4000 < Ht \leq 4500$	3600	2900
$4500 < Ht \leq 5000$	3850	3150
$5000 < Ht \leq 5500$	4100	3400
$5500 < Ht \leq 6000$	4300	3600
$6000 < Ht \leq 6500$	4550	3850
$6500 < Ht \leq 7000$	4800	4100
$7000 < Ht \leq 7500$	5000	4300
$7500 < Ht \leq 8000$	5250	4550

TABLE 2.3.4(a): MINIMUM SETBACK DISTANCES OF HS WALLS WITH REINFORCED CONCRETE DOWN-HANG BEAM ALONG EBL

Effective Storey Height* (mm) Column (1)	Setback Distance of HS Walls without HS Door (mm) Column (2)
Ht ≤ 2200	1800
2200 < Ht ≤ 2800	2000
2800 < Ht ≤ 3100	2200
3100 < Ht ≤ 3500	2500
3500 < Ht ≤ 4000	2700
4000 < Ht ≤ 4500	2900
4500 < Ht ≤ 5000	3150
5000 < Ht ≤ 5500	3400
5500 < Ht ≤ 6000	3600
6000 < Ht ≤ 6500	3850
6500 < Ht ≤ 7000	4100
7000 < Ht ≤ 7500	4300
7500 < Ht ≤ 8000	4550

*Effective Storey Height = Storey Height – Depth 'd' of Down-hang Beam

TABLE 2.3.4(b): MINIMUM SETBACK DISTANCES OF HS WALL WITH HS DOOR AND REINFORCED CONCRETE DOWN-HANG BEAM ALONG EBL

Effective Storey Height (mm) Column (1)	Setback Distance of HS Wall With HS Door (mm) Column (2)
Ht ≤ 2800	2750
2800 < Ht ≤ 3100	2900
3100 < Ht ≤ 3500	3100
3500 < Ht ≤ 4000	3300
4000 < Ht ≤ 4500	3600
4500 < Ht ≤ 5000	3850
5000 < Ht ≤ 5500	4100
5500 < Ht ≤ 6000	4300
6000 < Ht ≤ 6500	4550
6500 < Ht ≤ 7000	4800
7000 < Ht ≤ 7500	5000
7500 < Ht ≤ 8000	5250

*Effective Storey Height = Storey Height – Depth 'd' of Down-hang Beam

TABLE 2.3.5: MINIMUM SETBACK DISTANCES OF BASEMENT HS WALLS (FACING REINFORCED CONCRETE BASEMENT STOREY WALLS WITH OPENING)

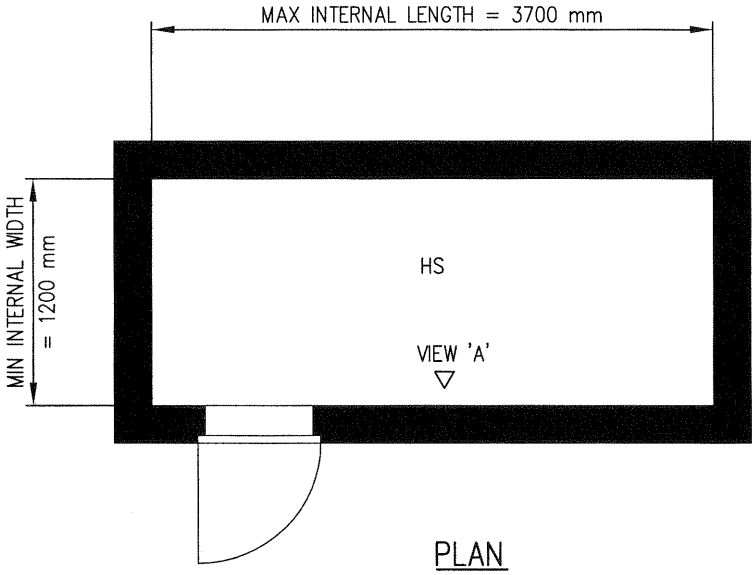
Storey Height (mm) Column (1)	Setback Distance of HS Walls with HS Door (mm) Column (2)	Setback Distance of HS Walls without HS Door (mm) Column (3)
$2500 \leq Ht \leq 2800$	2750	2000
$2800 < Ht \leq 3100$	2900	2200
$3100 < Ht \leq 3500$	3100	2500
$3500 < Ht \leq 4000$	3300	2700
$4000 < Ht \leq 4500$	3600	2900
$4500 < Ht \leq 5000$	3850	3150
$5000 < Ht \leq 5500$	4100	3400
$5500 < Ht \leq 6000$	4300	3600
$6000 < Ht \leq 6500$	4550	3850
$6500 < Ht \leq 7000$	4800	4100
$7000 < Ht \leq 7500$	5000	4300
$7500 < Ht \leq 8000$	5250	4550

TABLE 2.4(a): MINIMUM HS WALL THICKNESS (FOR LANDED DWELLING UNIT)

HS Clear Height (mm)	Setback Distance of HS Wall (mm)	HS Wall Thickness (mm)
2400 ≤ Ht ≤ 3900	≤ 6000	250
	> 6000	200

TABLE 2.4(b): MINIMUM HS WALL THICKNESS (FOR NON-LANDED DWELLING UNIT)

HS Clear Height (mm)	Setback Distance of HS Wall (mm)	HS Wall Thickness (mm)
2400 ≤ Ht ≤ 2700	≤ 6000	250
	> 6000	200
2700 < Ht ≤ 2900	≤ 6000	275
	> 6000	225
2900 < Ht ≤ 3900	≤ 6000	300
	> 6000	250



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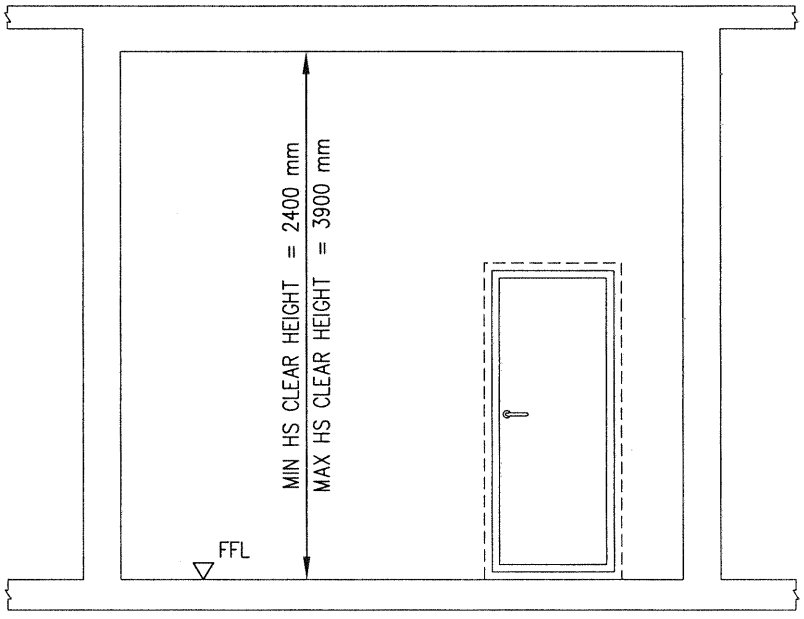
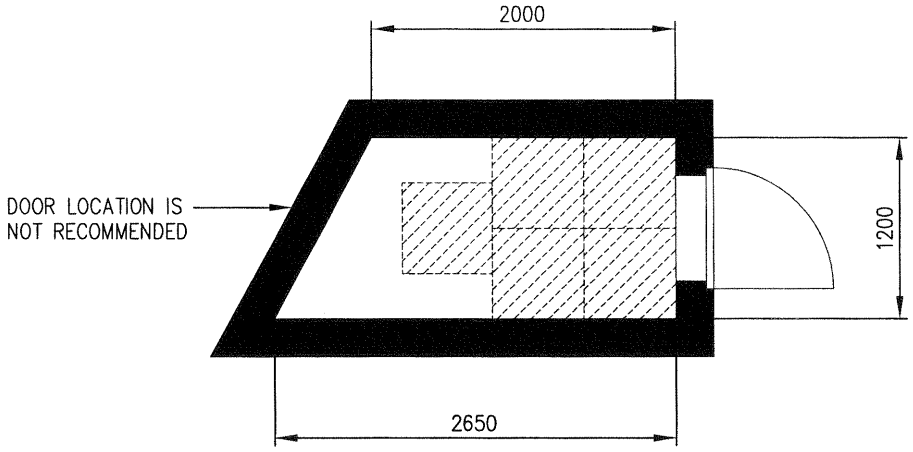
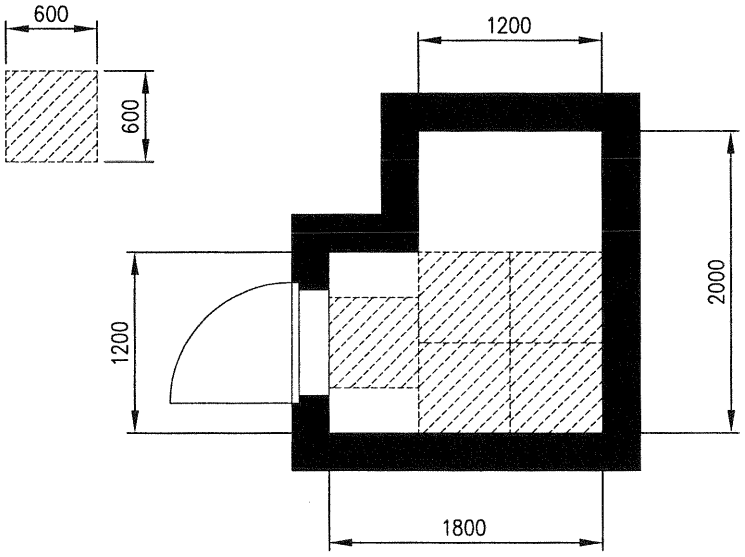


VIEW 'A'

FIGURE 2.1.2 TYPICAL LAYOUT OF HS



TRAPEZOIDAL



L-SHAPED

FIGURE 2.2 EXAMPLES OF HS OF DIFFERENT SHAPES

(FOR GFA = 100 m^2, HS SIZE = 2.8 m^2, NUMBER OF SQUARE UNITS = 5)

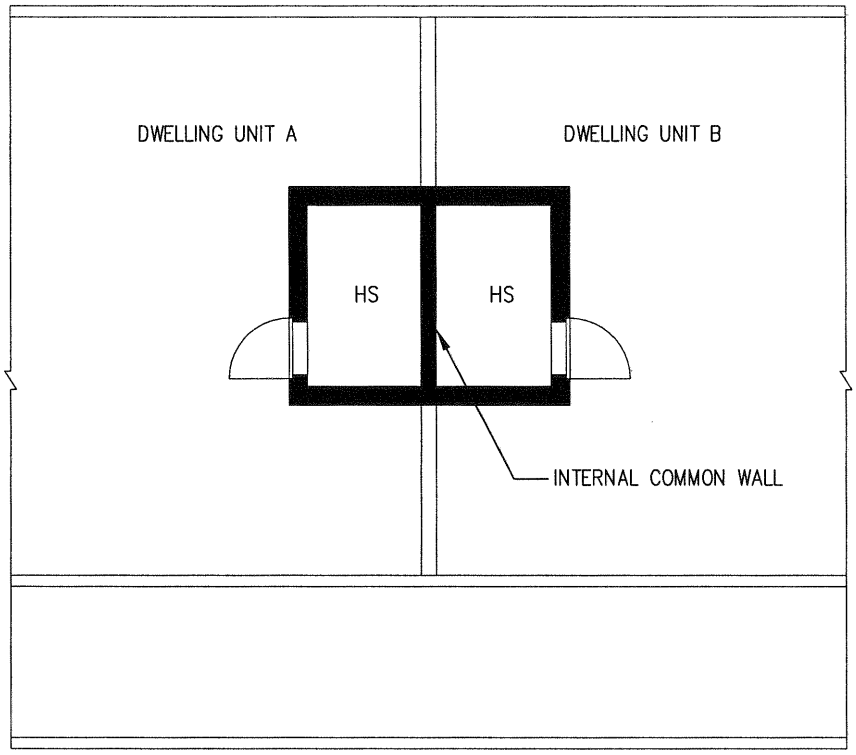


FIGURE 2.3.1(a) INTERNAL COMMON WALL BETWEEN TWO HS IN LANDED AND NON-LANDED DWELLING UNITS

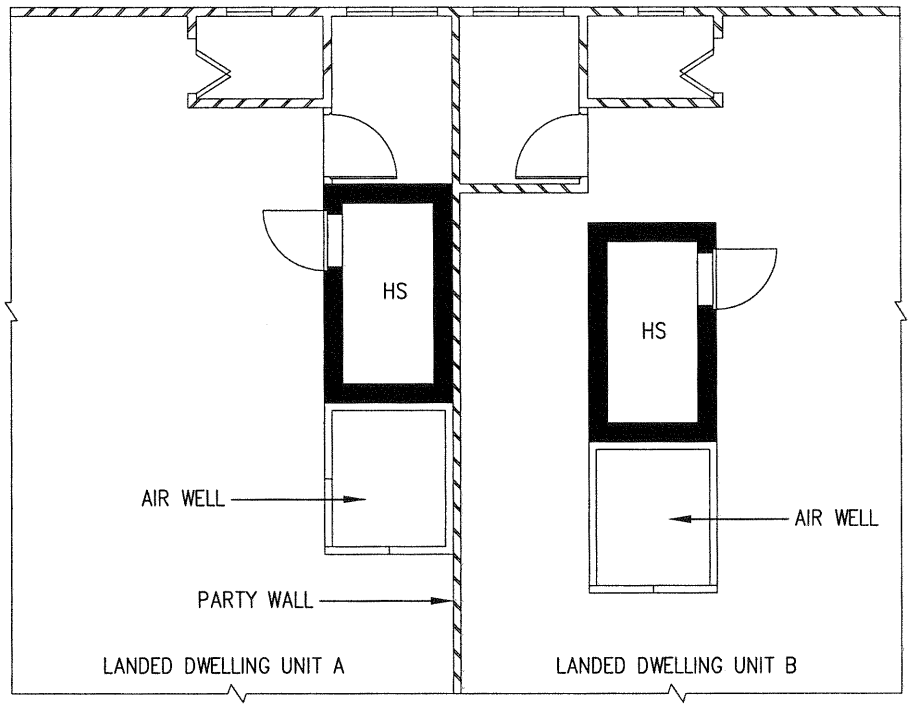
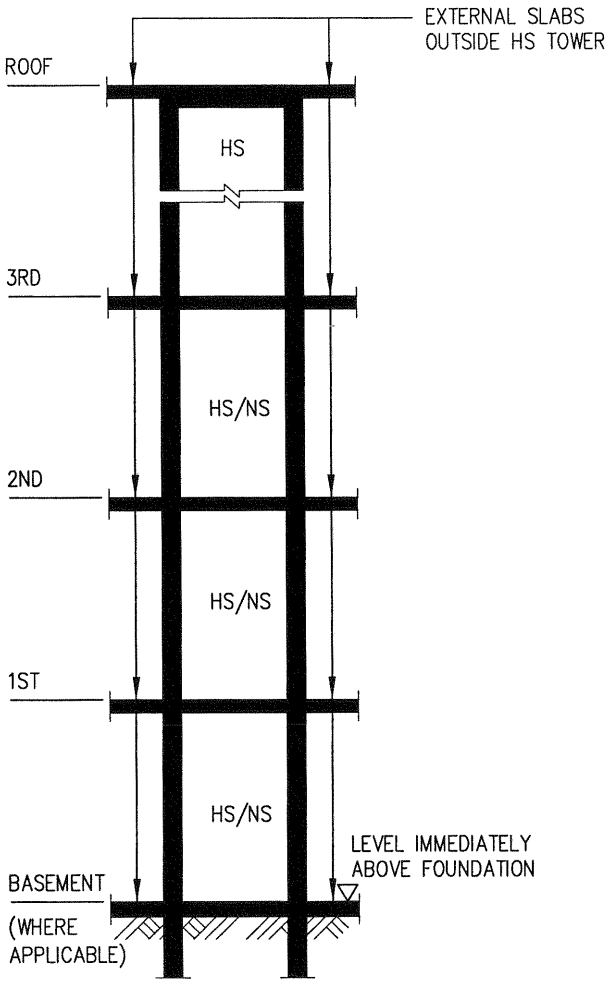


FIGURE 2.3.1(b) HS WALL ABUTTING AN AIR WELL IN A LANDED DWELLING UNIT



NOTES:

1. HS TOWER WITH HS AND NS WHERE APPLICABLE

FIGURE 2.3.2(a) SCHEMATIC SECTION OF HS TOWER

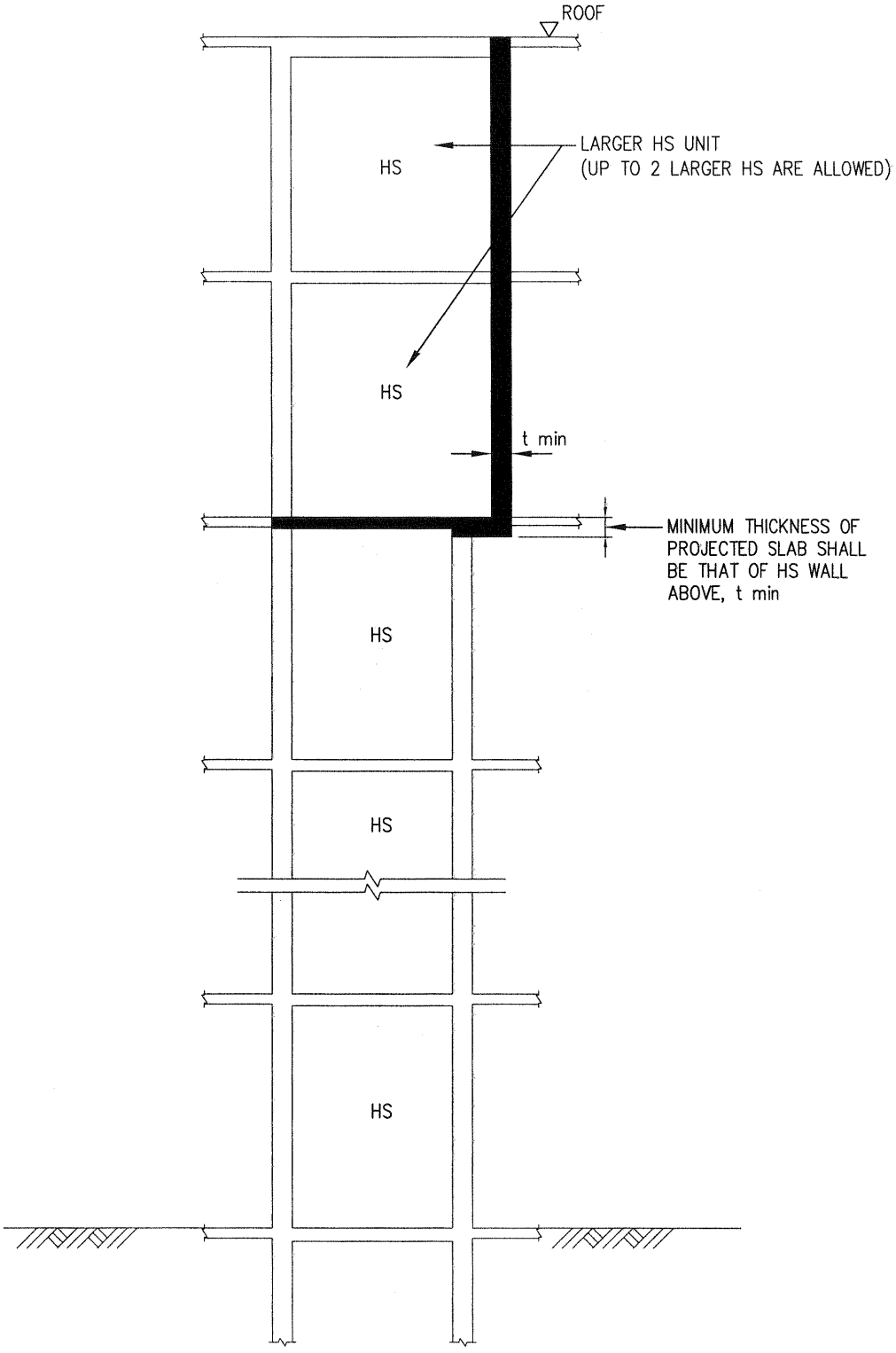
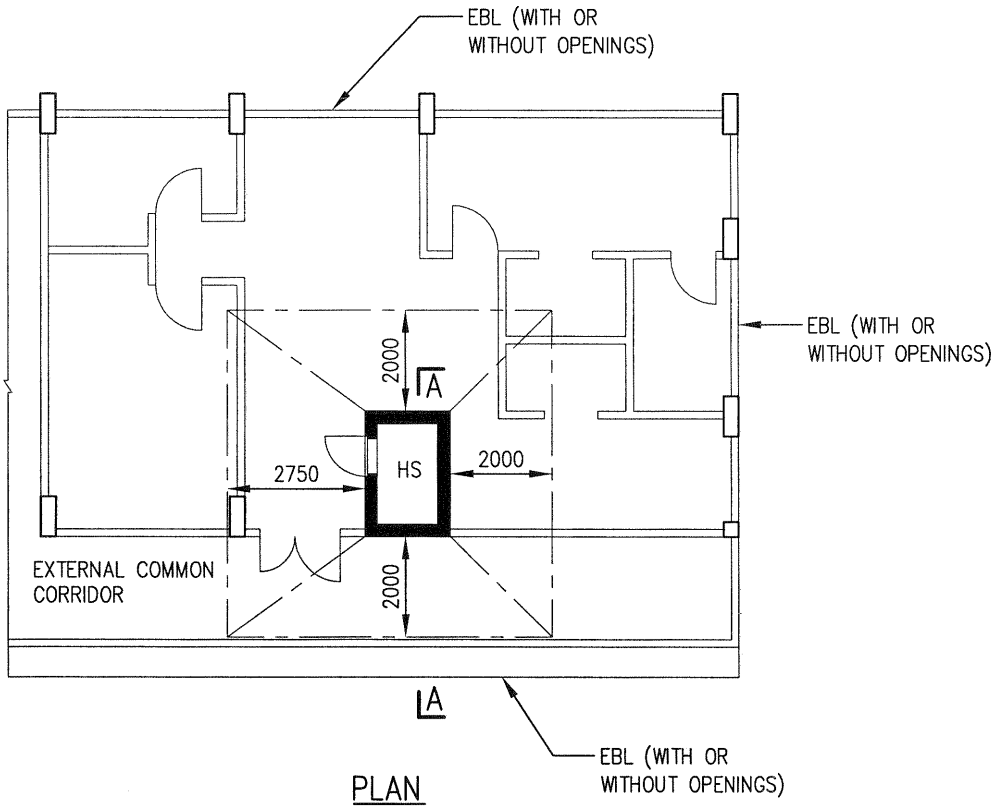


FIGURE 2.3.2(b) PROJECTED HS FLOOR SLAB FOR LARGER HS ABOVE



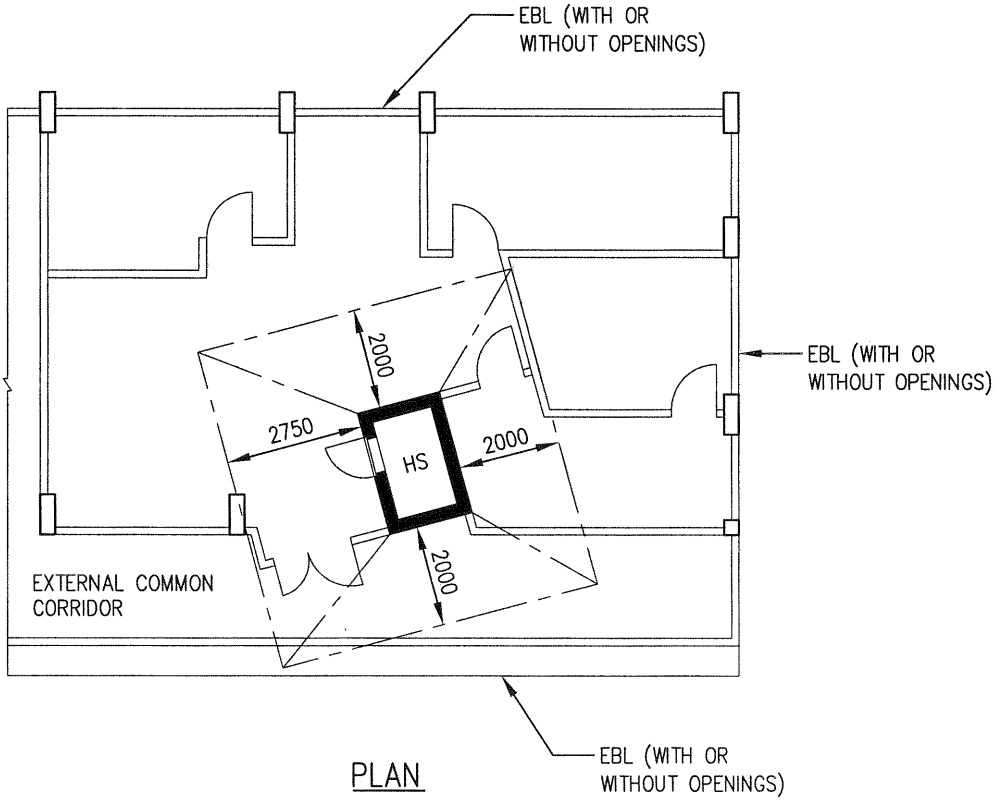
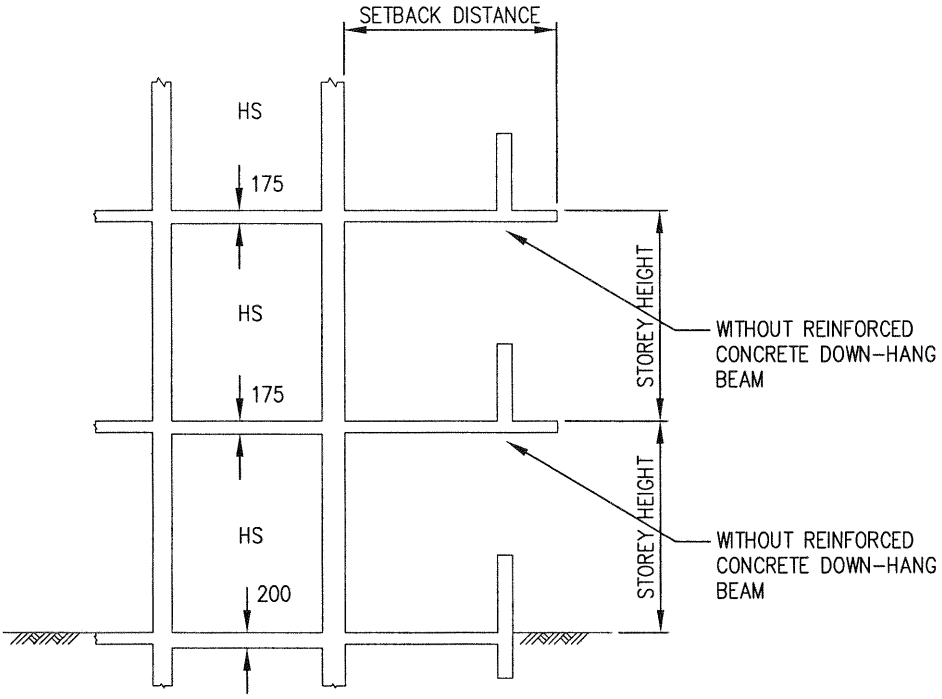


FIGURE 2.3.3(a) REQUIREMENT ON SETBACK DISTANCE OF HS WALLS (WITHOUT DOWN-HANG BEAM)

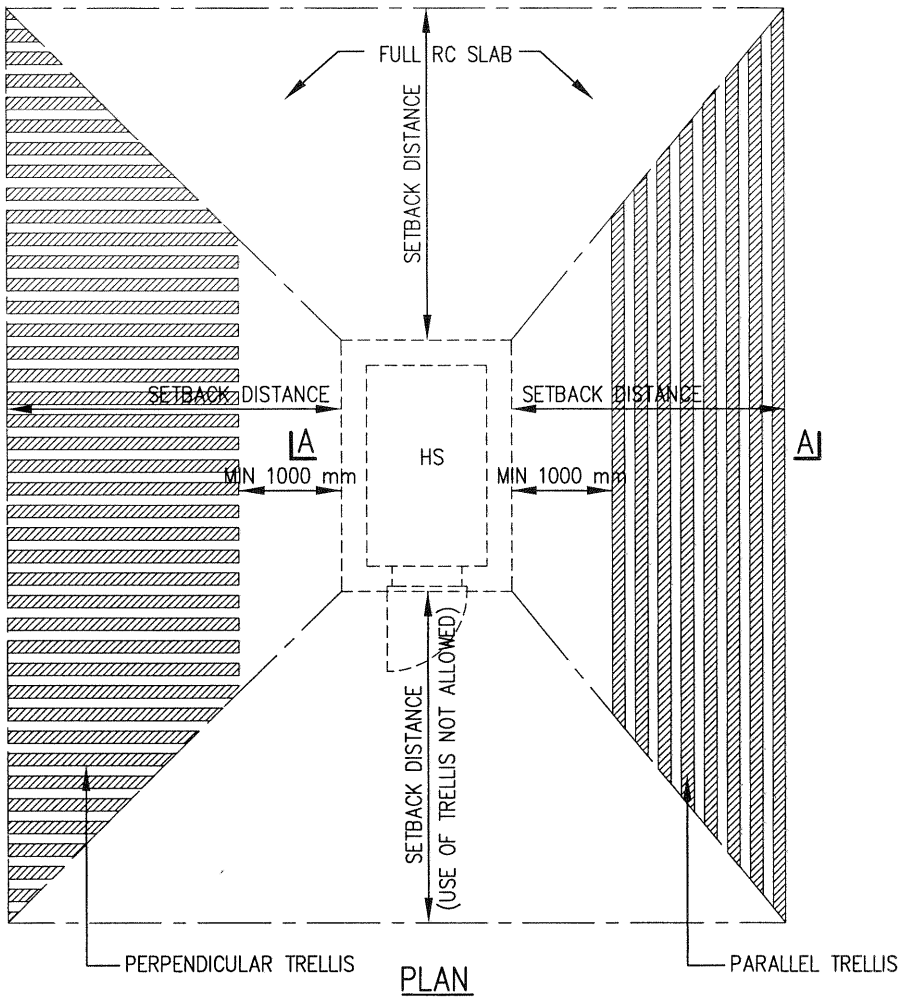
(STOREY HEIGHT ≤ 2800 mm)

(FOR OTHER STOREY HEIGHTS, SEE TABLE 2.3.3)



SECTION A – A

FIGURE 2.3.3(b) SETBACK DISTANCE OF HS WALLS (WITHOUT DOWN-HANG BEAM)



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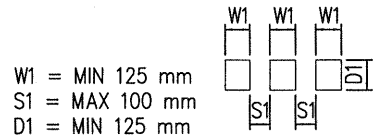
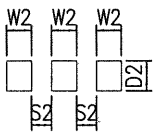


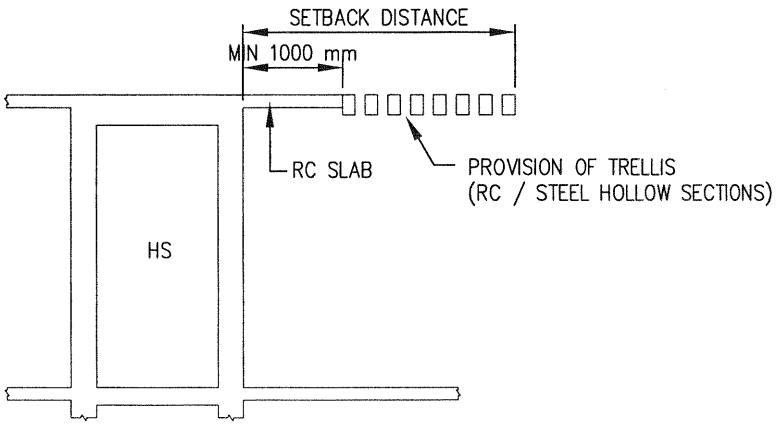
W1 = MIN 125 mm
S1 = MAX 100 mm
D1 = MIN 125 mm

PERPENDICULAR TRELLIS



W2 = MIN 125 mm
S2 = MIN 62.5 mm
D2 = AT LEAST 2 TIMES OF S2

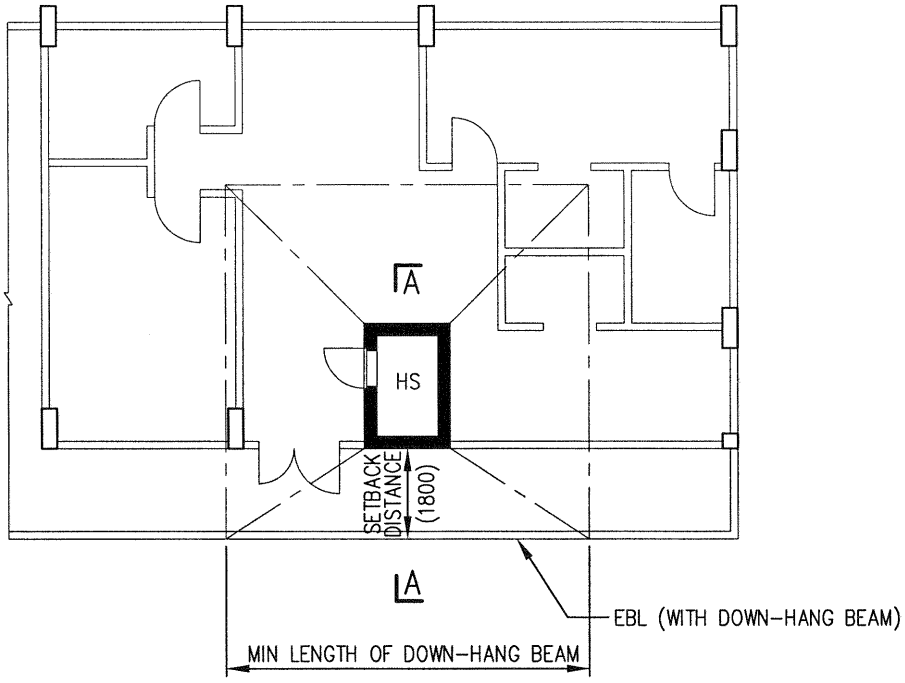
PARALLEL TRELLIS



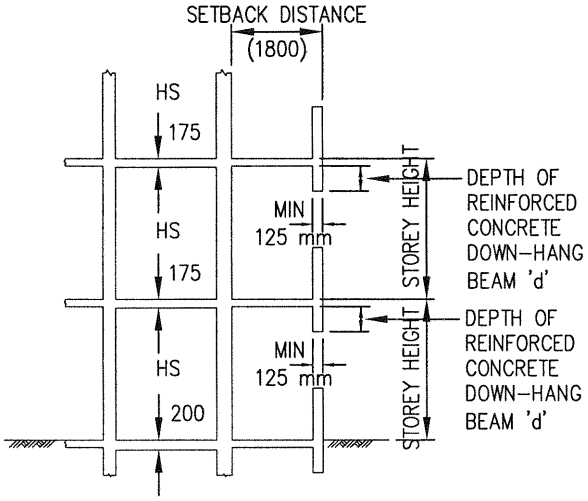
SECTION A – A

NOTE:
THICKNESS OF STEEL HOLLOW SECTIONS SHALL BE AT LEAST 6 mm

FIGURE 2.3.3(c) USAGE OF TRELLIS (RC/STEEL HOLLOW SECTIONS) TO MAKE UP FOR SHORTFALL IN SETBACK DISTANCE



PLAN



SECTION A – A

FIGURE 2.3.4(a) REQUIREMENT ON SETBACK DISTANCE OF HS WALLS (WITH DOWN-HANG BEAM)

(EFFECTIVE STOREY HEIGHT ≤ 2200 mm)

FOR OTHER EFFECTIVE STOREY HEIGHTS, SEE TABLE 2.3.4(a), 2.3.4(b)
(EFFECTIVE STOREY HEIGHT = STOREY HEIGHT – DEPTH 'd' OF DOWN-HANG BEAM)

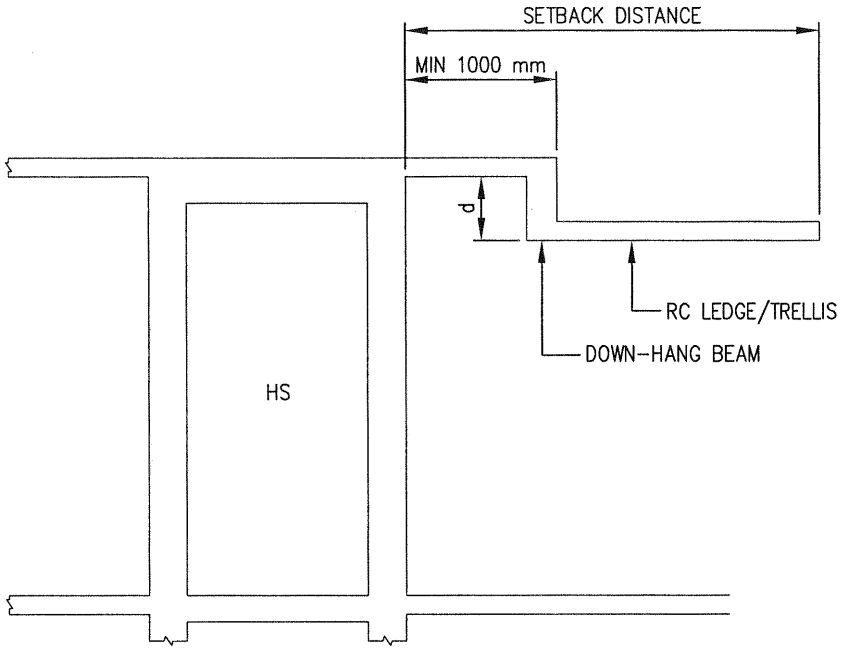


FIGURE 2.3.4(b) DOWN-HANG BEAM NOT LOCATED ALONG EXTERNAL BUILIDING LINE

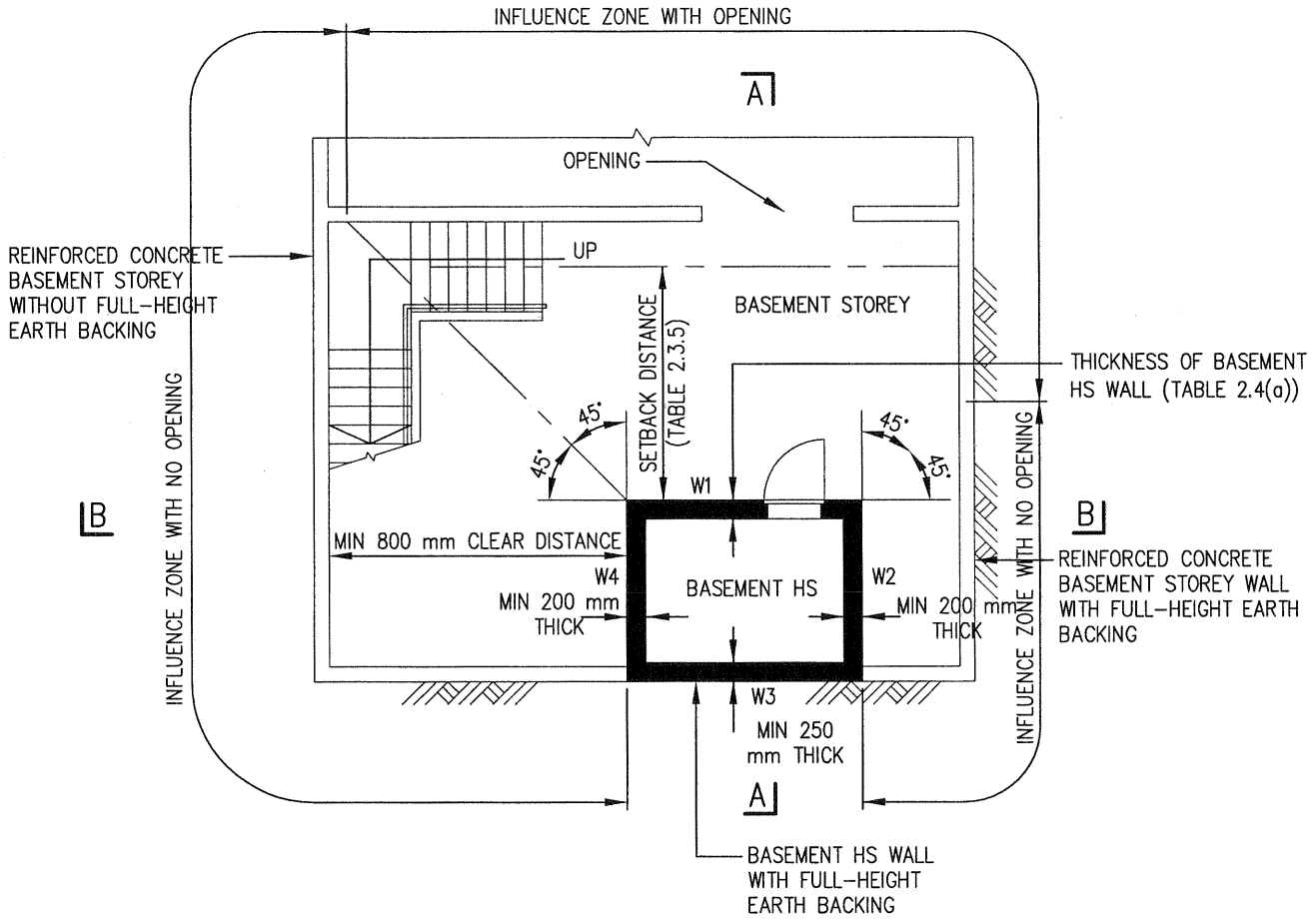
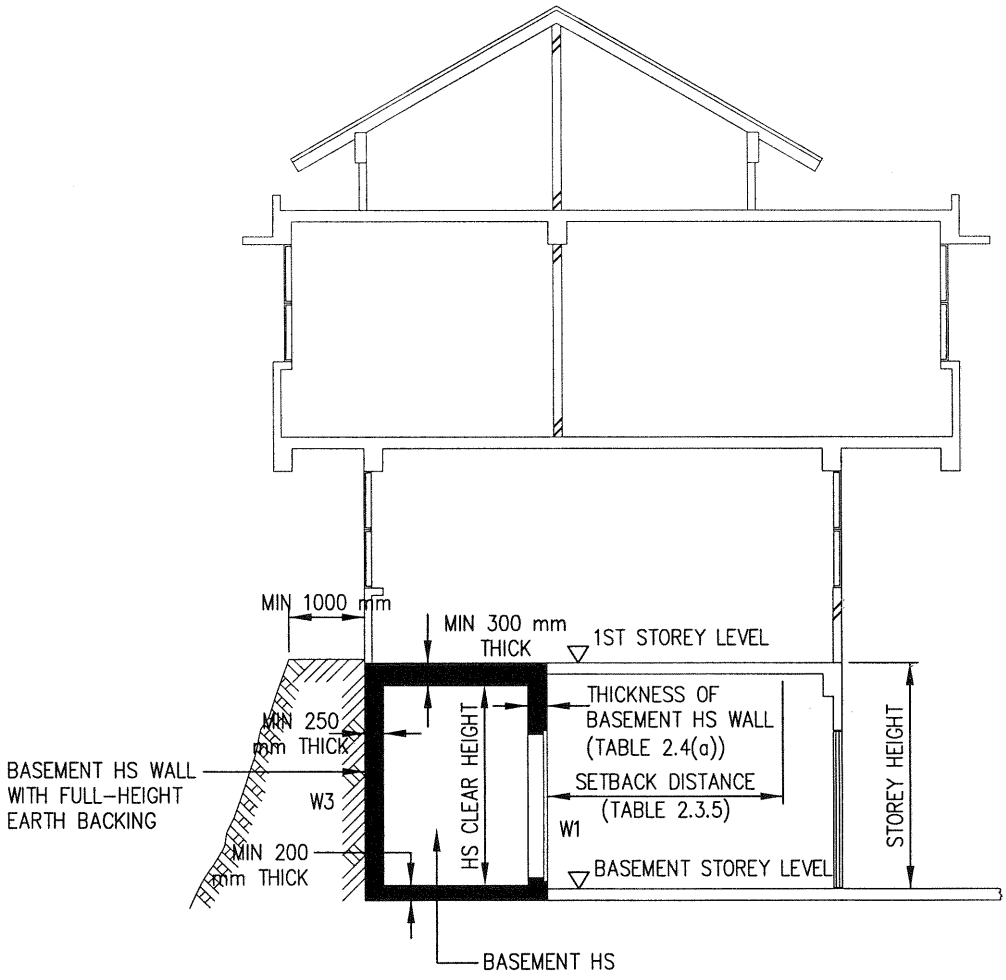
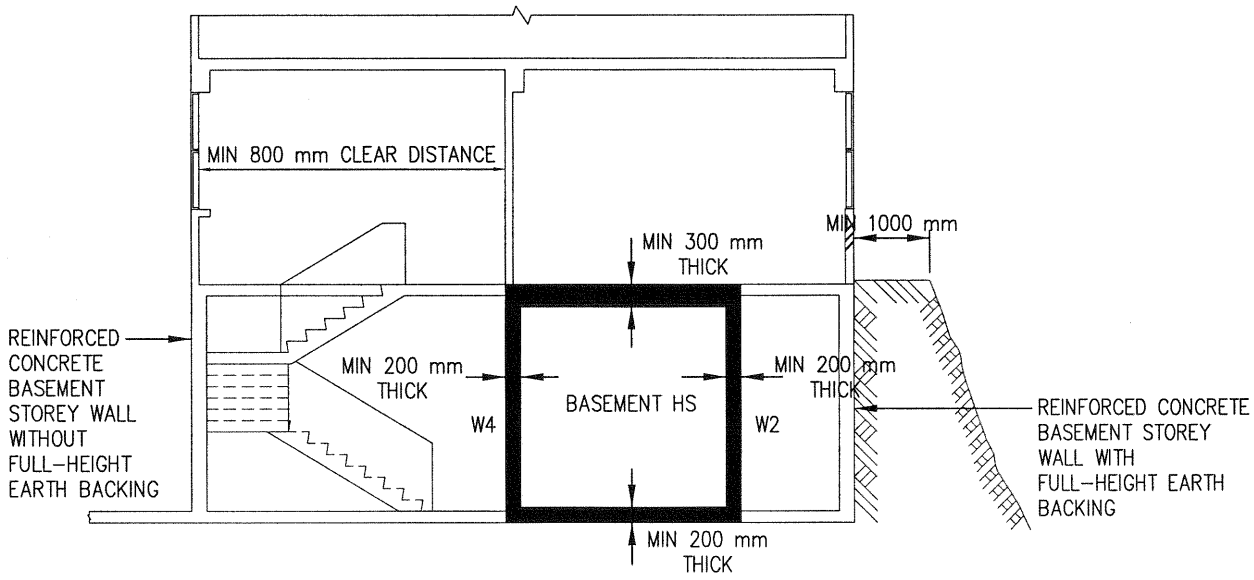


FIGURE 2.3.5(a) PLAN OF A BASEMENT HS



SECTION A – A



SECTION B – B

FIGURE 2.3.5(b) SECTIONAL VIEW OF A BASEMENT HS

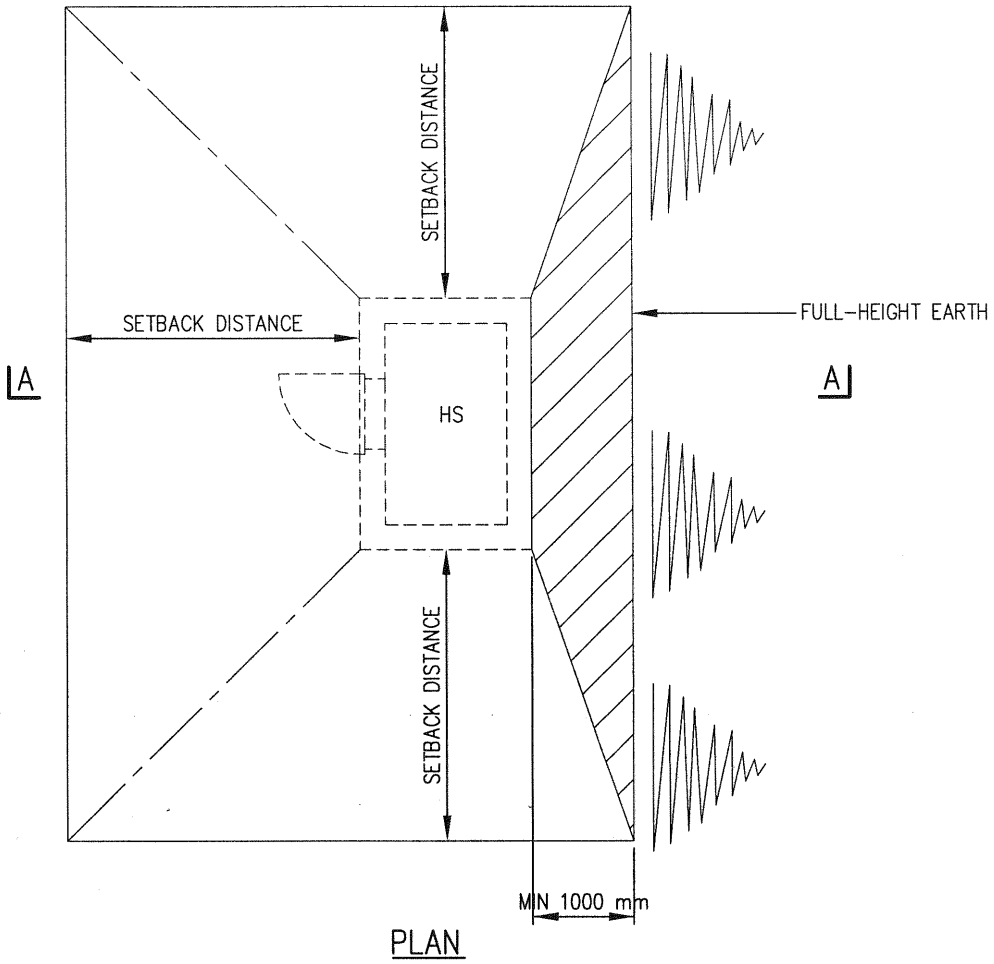


FIGURE 2.3.5(c) HS WALL IN CONTACT WITH EARTH THROUGHOUT ITS FULL HEIGHT

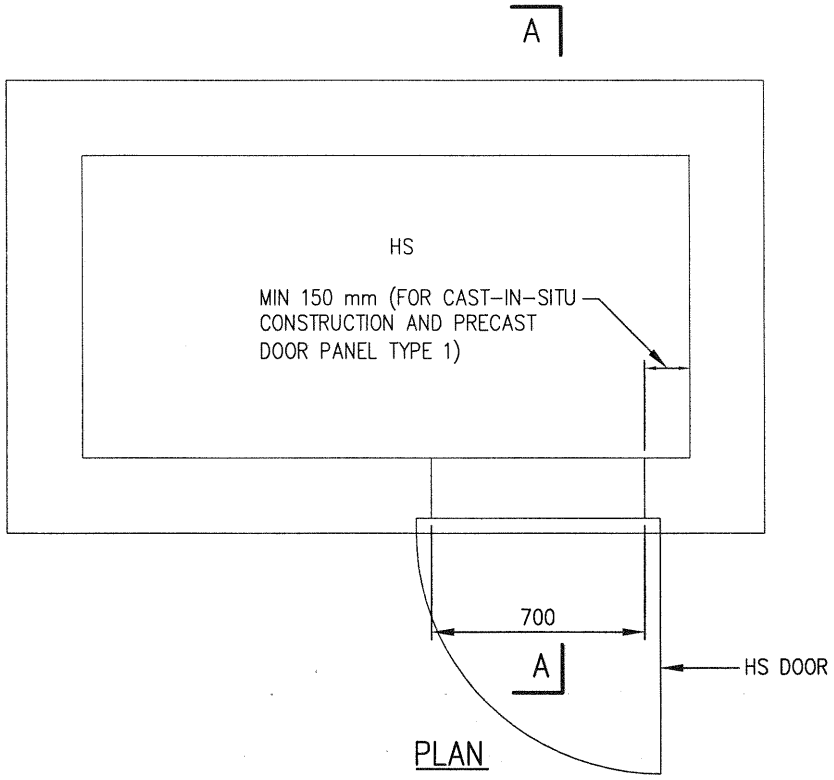
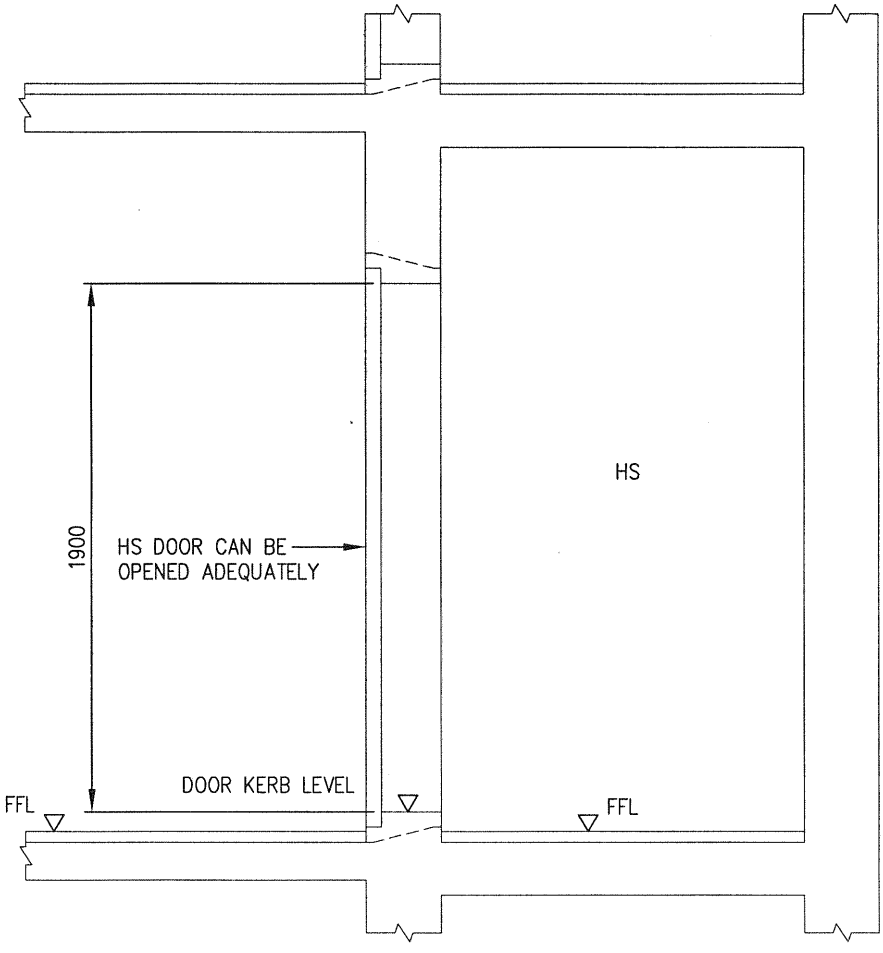


FIGURE 2.5.2(a) CONCRETE WALL SEGMENT AT HS DOOR



SECTION A – A

FIGURE 2.5.2(b) HS DOOR KERB

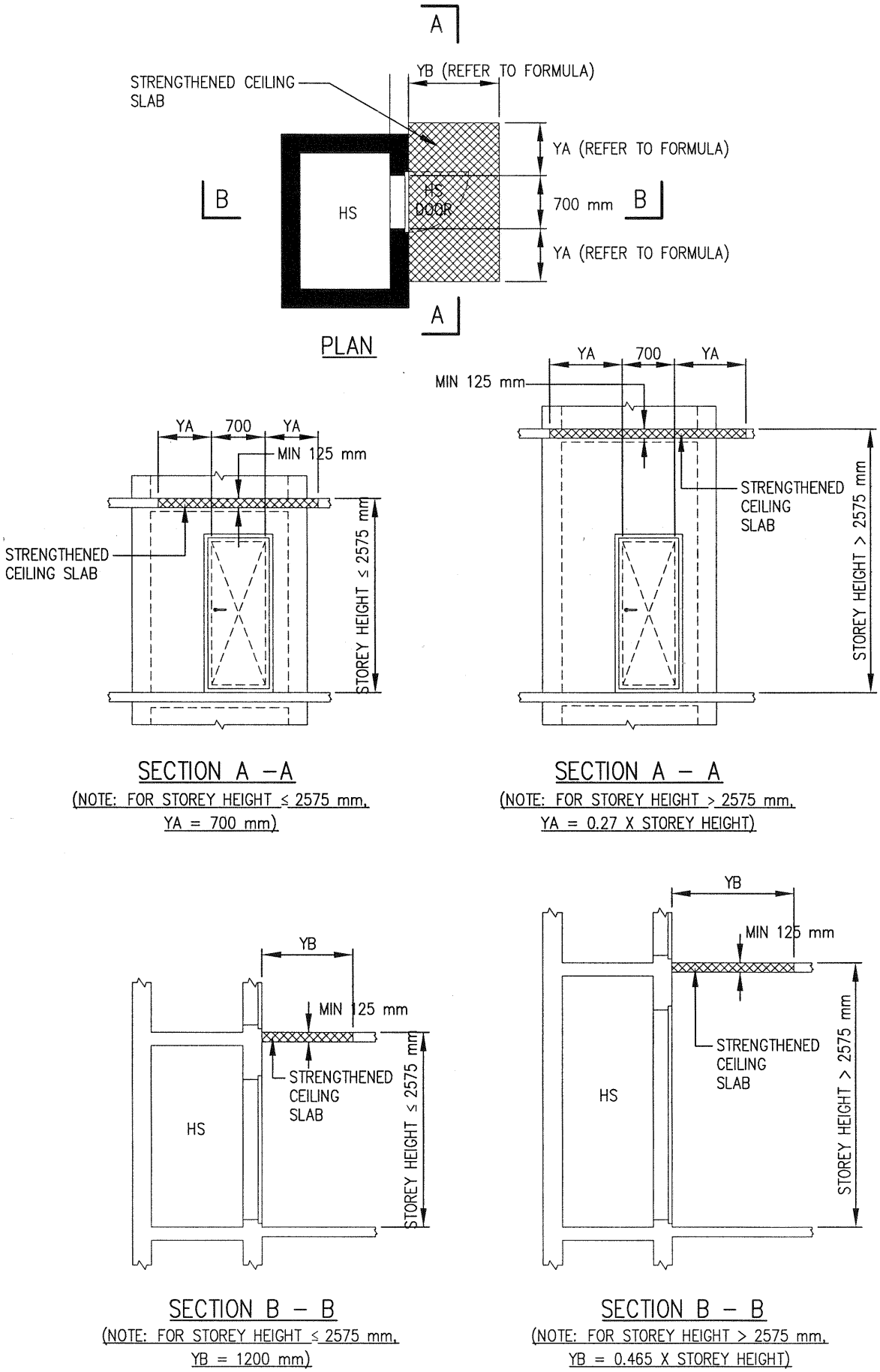


FIGURE 2.5.3 REQUIREMENTS FOR STRENGTHENED CEILING SLAB IN FRONT OF HS DOOR

(APPLICABLE FOR HS IN NON-LANDED DWELLING UNIT)

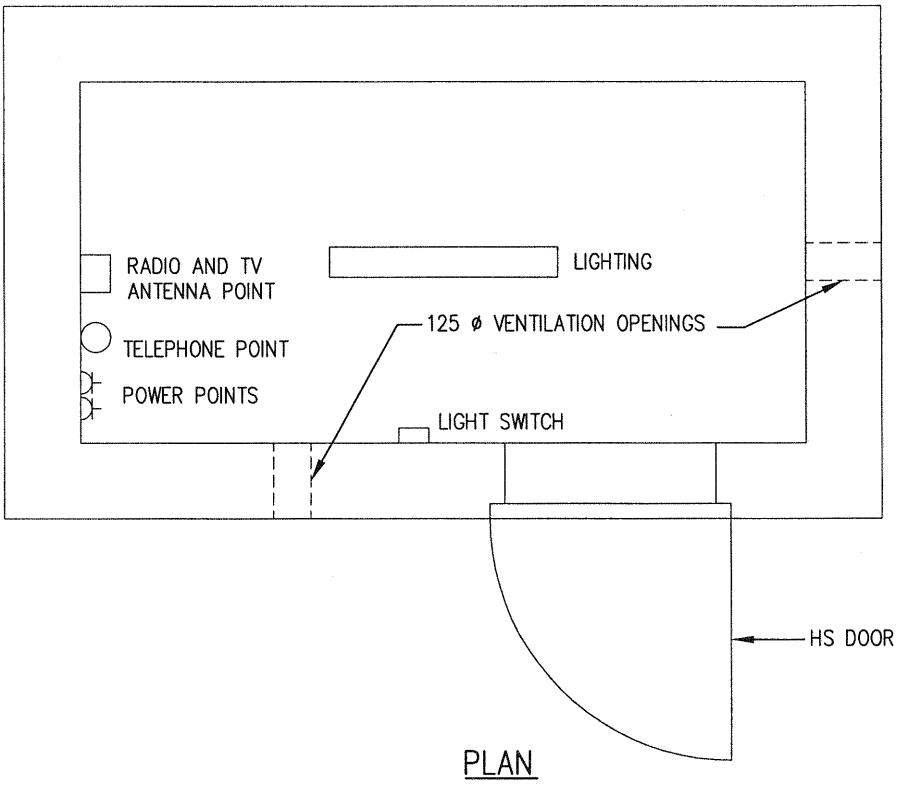
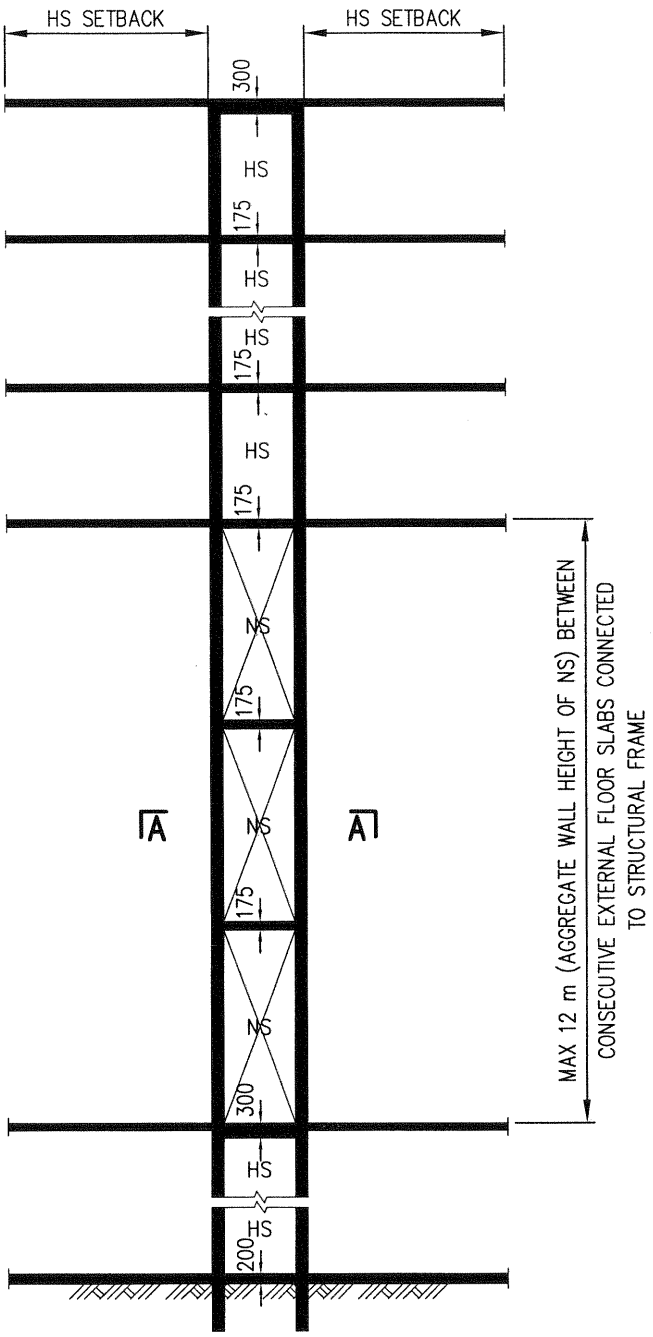
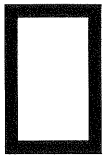


FIGURE 2.6.1 SPECIFIED HS FIXTURES AND OPENINGS

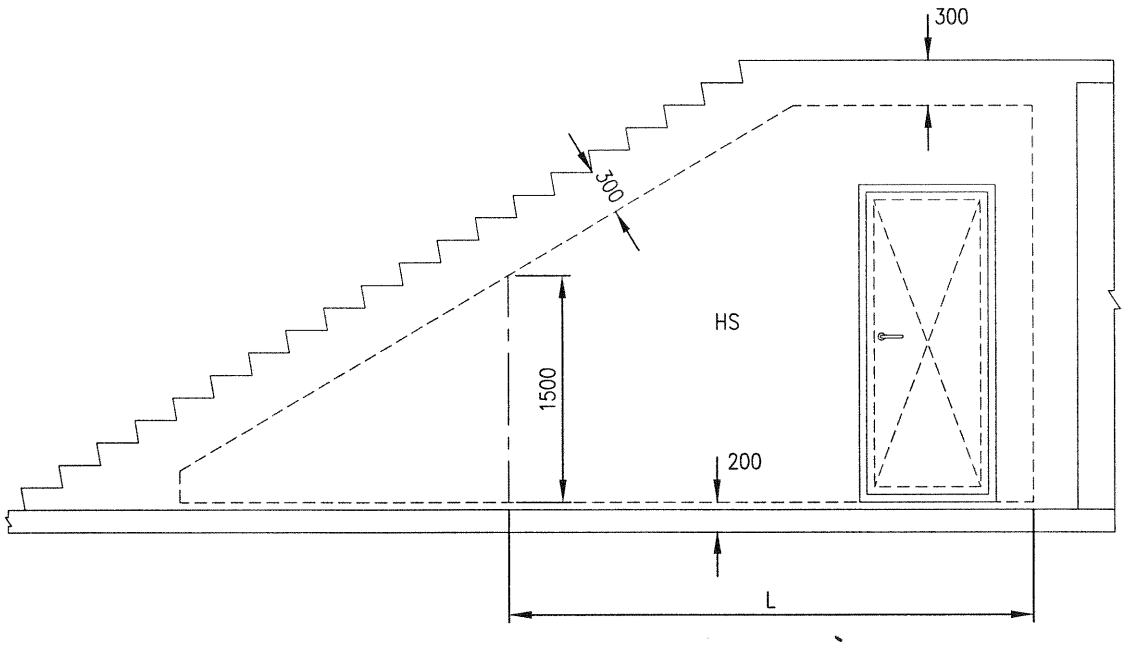


HS TOWER
(HS/NS)



SECTION A – A
PLAN FACADE OF NS WALL

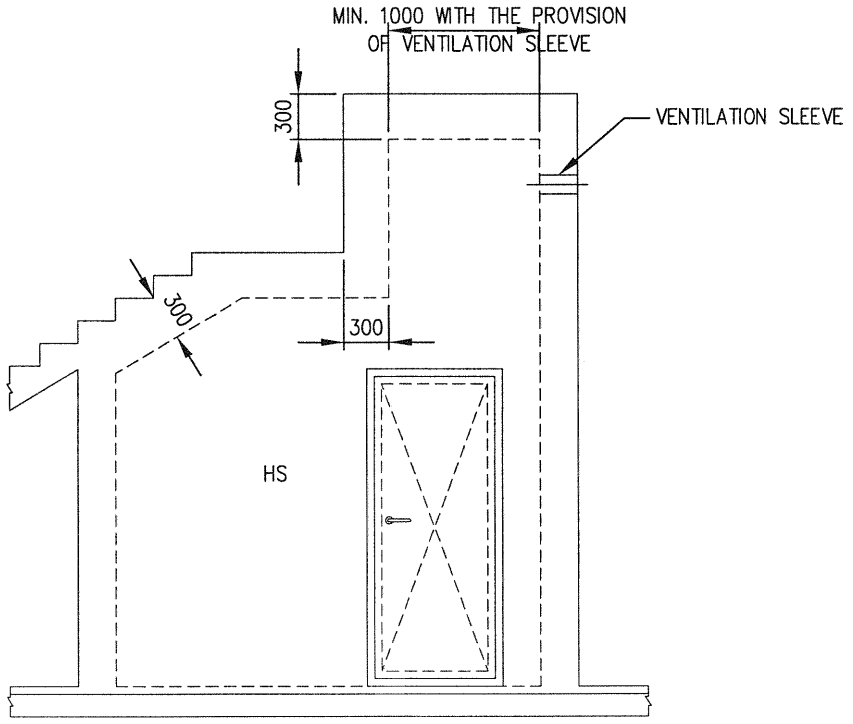
FIGURE 2.7.1 HS TOWER



SECTIONAL ELEVATION
(TYPE A)

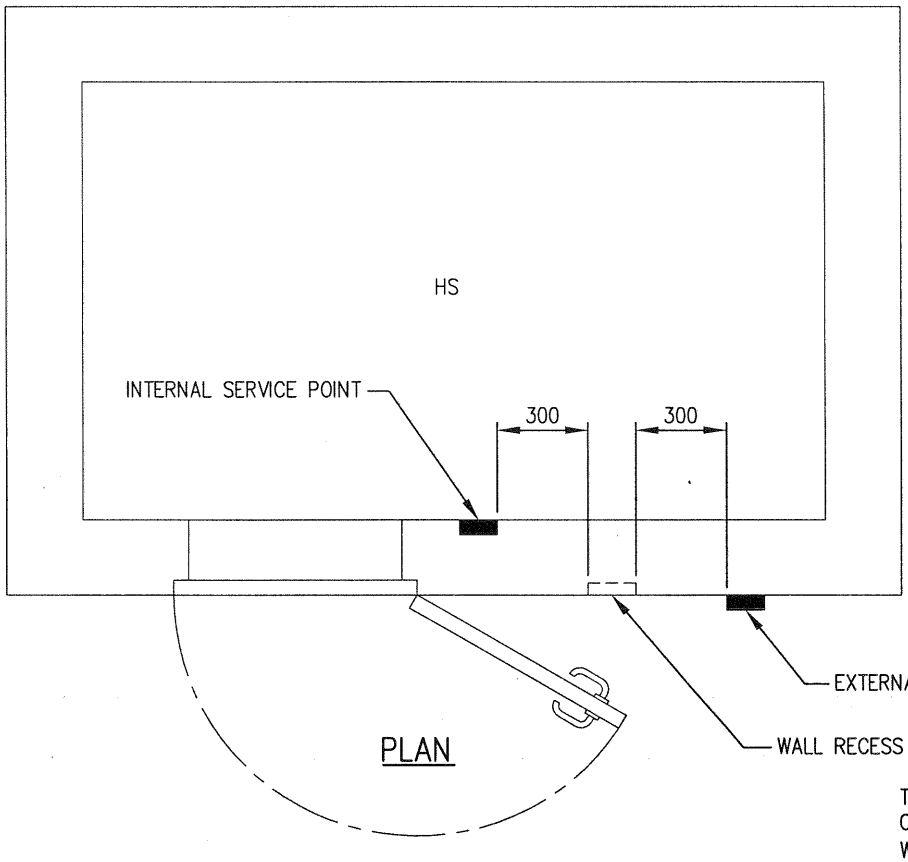
NOTE:

THE DIMENSION, L OF THE FLOOR SHALL BE USED FOR COMPUTING THE INTERNAL HS FLOOR AREA FOR THE PURPOSE OF TABLE 2.2.



SECTIONAL ELEVATION
(TYPE B)

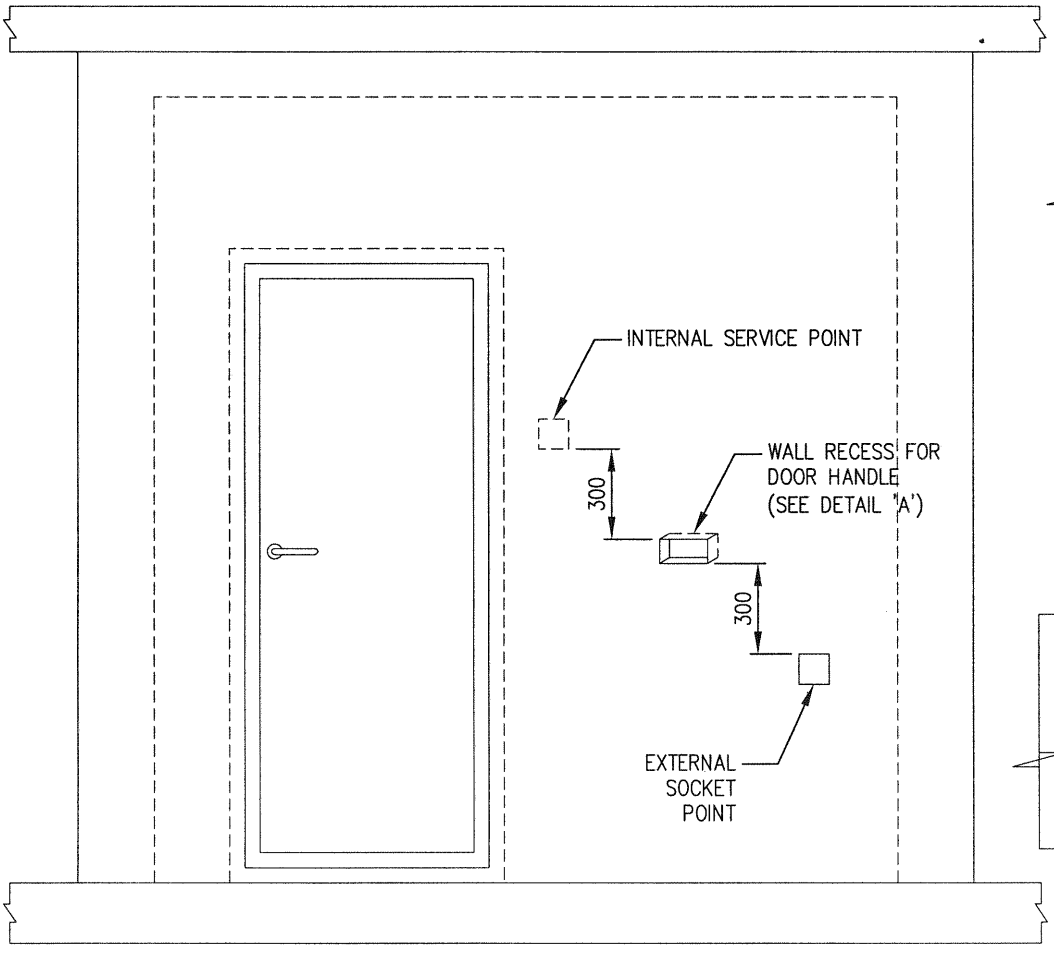
FIGURE 2.9 HS BENEATH AN INTERNAL STAIRCASE



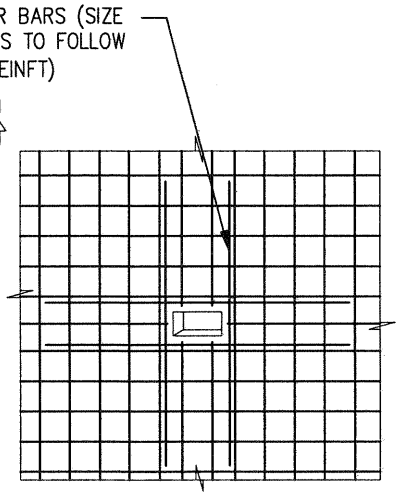
PLAN

NOTES:

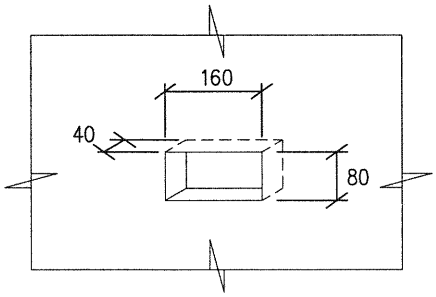
1) APPLICABLE FOR HS WALL OF THICKNESS 250 mm OR MORE
2) BOTH INTERNAL AND EXTERNAL SERVICE POINTS SHALL BE AT LEAST 300 mm APART FROM THE WALL RECESS
3) PROVISION OF WALL RECESS AT THE HS WALL BY HACKING / CUTTING IS NOT ALLOWED



ELEVATION



TRIMMER BARS DETAILS FOR WALL RECESS



DETAIL 'A'

FIGURE 2.12 DETAILS OF WALL RECESS FOR HS DOOR HANDLE

CHAPTER 3

STRUCTURAL REQUIREMENTS

CHAPTER 3: STRUCTURAL REQUIREMENTS

3.1 GENERAL

The structural design of the HS tower shall take into account both the vertical and lateral loads, where applicable.

The HS tower shall be designed for maximum degrees of redundancy in the structural system against weapon effects.

3.2 MATERIALS

3.2.1 Concrete

The minimum grade of concrete for all HS elements shall be Grade 30. The use of prestressed concrete for the HS tower is not permitted.

3.2.2 Steel Reinforcement

The minimum yield stress for the main reinforcements and shear links in the structural elements forming the HS or NS shall be 460 N/mm^2 and 250 N/mm^2 respectively.

3.3 ANALYSIS

3.3.1 General

In a building of more than one-storey, the HS (or NS, where applicable) on every storey shall be located one on top of the other to form a vertical tower with its walls structurally continuous to the foundation.

3.3.2 NS Walls/Columns

A HS or NS on each storey of a building shall be designed one on top of the other, to form a continuous structural HS tower.

3.3.2.1 Shielded NS walls and/or NS columns

No additional design checks on HS tower is required if its supporting NS elements, either wall(s), column(s) or any of its combination, are shielded. These structural elements are deemed adequately shielded if reinforced concrete slab or other equivalent structural forms provided above them is extended beyond their edges by

a minimum length of 0.5H, where H is the aggregate wall height of NS (See FIGURE 3.3.2.1).

3.3.2.2 Unshielded NS Wall(s) and/or NS Columns

The following requirements are to be complied with if the design adopts:

(a) Unshielded NS Wall(s)

The minimum thickness of each NS wall shall be 300 mm. The HS tower shall be designed against the most severe effects as the result of the removal of a portion of the NS wall equivalent to an opening of 1500 mm diameter on the NS wall at its most critical location (See FIGURE 3.3.2.2(a)).

(b) Unshielded NS Column(s)

The minimums size (either its diameter or the shorter dimension) of each NS column shall be 500 mm. The HS tower shall be designed against the most severe effects as the result of the removal of any one NS column (See FIGURE 3.3.2.2(b)).

(c) Combination of Unshielded NS Wall(s) and NS Column(s)

The minimum thickness of each NS wall and minimum size (either its diameter or the shorter dimension) of each NS column shall be 300 mm and 500 mm respectively. The HS tower shall be designed against the most severe effects as the result of the following (See FIGURE 3.3.2.2(c)):

(i) Removal of a portion of the NS wall equivalent to an opening of 1500 mm diameter at its most critical location and

(ii) Removal of any one NS column

The above items (i) and (ii) shall be considered mutually exclusive.

(d) The following are the criteria to be used when performing design checks for Clause 3.3.2.2(a), 3.3.2.2(b) or 3.3.2.2(c):

(i) The design loads shall be based on the load combination and values of partial safety factors for loads (γ_f) in accordance with TABLE 3.3.2.2.

(ii) The design strength for a given material is derived from the characteristic strength divided by the partial safety factor for strength

of material (γ_m), which shall be 1.3 for concrete and 1.0 for reinforcement.

3.3.3 Transfer Structure Supporting HS Tower

3.3.3.1 Design Against Collapse Load

The design loads for the transfer structure shall include a collapse load of 20kN/m^2 acting on transfer slab/beam. An additional load combination in the design, incorporating the collapse load, shall be considered with partial safety factors for loads (γ_f) given in Table 3.3.3.1.

3.3.3.2 Shielded Transfer Structure

No additional design checks on transfer structure are required, besides the requirement in Clause 3.3.3.1, if the transfer structures are shielded by RC slab or other equivalent structural forms. The transfer structure is deemed adequately shielded if Clause 3.3.3.2(a) and 3.3.3.2(b) are complied with:

(a) Shielding of Transfer slab/beams

The transfer slab/beams are deemed to be shielded if RC shielding slab or other equivalent structural forms is provided directly above the transfer slab/beams and is extended beyond their external edges by a minimum length of $0.5H_1$, where H_1 is the vertical distance between the top level of the RC shielding slab and that of the transfer slab/beams (See FIGURE 3.3.3.2).

(b) Shielding of Exterior Columns

The transfer columns are deemed to be shielded if RC shielding slab or other equivalent structural forms is provided above the exterior columns and is extended beyond their exterior edges by a minimum length of $0.5H_2$, where H_2 is the vertical distance between the top level of the RC shielding slab and the base of the exterior columns (See FIGURE 3.3.3.2).

3.3.3.3 Unshielded Transfer Structure

Besides the requirement in Clause 3.3.3.1, additional design checks on unshielded transfer structure shall be carried out in accordance with the following requirements:

(a) Unshielded Transfer Slab/Beams

The transfer structure shall be designed against the most severe effects as

the result of the removal of a portion of the transfer slab/beam equivalent to an opening of 1500 mm diameter on the transfer slab/beams at its most critical location (See FIGURE 3.3.3.3).

(b) Unshielded Exterior Columns

The minimum size (either its diameter or shorter dimension) of the exterior columns shall be 500 mm. The transfer structure shall be designed against the most severe effects as the result of the removal of any one exterior column (See FIGURE 3.3.3.3).

(c) The following are the criteria to be used when performing design checks for Clause 3.3.3.3(a) and 3.3.3.3(b):

(i) The design loads including collapse load, shall be based on the load combination and values of partial safety factors for loads (γ_f) in accordance with Table 3.3.3.3.

(ii) The design strength for a given material is derived from the characteristic strength divided by the partial safety factor for strength of material (γ_m), which shall be 1.3 for concrete and 1.0 for reinforcement.

3.3.4 Exit Staircase

Where there is only one exit staircase or exit scissors-staircase serving non-landed dwelling units, the minimum waist and the thickness of the landing slab of the staircase shall be 150 mm. The staircase shall be constructed of reinforced concrete. Where a pre-cast concrete exit staircase is used, the support connections shall be designed for a load equal to 1.25 times its characteristic dead weight, which are acting in 2 lateral directions.

3.4 MEMBER DIMENSIONS AND REINFORCEMENT AMOUNTS

3.4.1 Member Dimensions

The minimum dimensions of members forming part of the HS tower shall be as follows:

(a) HS wall - refer to Clause 2.4.

(b) Internal common wall between two adjacent HS - 200 mm.

(c) Intermediate slabs - 175 mm.

(d) Ceiling slab of top-most HS - 300 mm.

(e) Ceiling slab of top-most HS in landed dwelling unit – 250mm (if there is a roof or another ceiling slab above the HS that extend beyond the required setback distance of that HS wall (See FIGURE 3.4.1)).

(f) Floor slab of bottom-most HS or NS - 200 mm.

(g) Floor slab of NS located above HS - 300 mm.

(h) Wall thickness of any HS or NS within the HS tower shall not be less than the wall thickness of the HS or NS above it.

3.4.2 Amount of Reinforcement

All diameters of reinforcement specified hereinafter shall refer to minimum bar diameters. All spacing of reinforcement specified hereinafter shall refer to maximum spacing of reinforcement in both directions.

(a) Minimum Reinforcement in HS walls in landed dwelling units – refer to TABLE 3.4.2(a).

(b) Minimum Reinforcement in HS or NS walls in non-landed dwelling units – refer to TABLE 3.4.2(b).

(c) Internal common wall between two adjacent HS:

Two layers of reinforcements (at both internal and external faces) shall be T10-100 c/c in both directions. The shear links shall be R6-600 c/c in both directions.

(d) Intermediate slabs:

Two layers of reinforcements (top and bottom) shall be T10-100 c/c in both directions. The shear links shall be R6-600 c/c in both directions.

(e) Ceiling slab of top-most HS, floor slab of bottom-most HS or NS, and floor slab of NS located above an HS:

Two layers of reinforcements (top and bottom) shall be T10-100 c/c in both directions. The shear links shall be R6-600 c/c in both directions.

(f) Ceiling slab outside the HS tower which is immediately above HS door:

The ceiling slab shall be constructed of reinforced concrete. If the ceiling slab is 125 mm thick, the reinforcement shall consist of two layers of reinforcement (top and bottom) at T10-100 c/c in both directions. If the ceiling slab is 150 mm thick, the reinforcement shall consist of two layers of reinforcement (top and bottom) at T10-200 c/c in both directions.

(g) Floor slab outside HS tower:

The reinforcements of every floor slab immediately outside HS tower walls shall be structurally connected to HS tower.

(h) Exit Staircase:

The reinforcement of the waist and landing slab of exit staircase shall consist of two layers of reinforcement (top and bottom) at T10–200 c/c in both directions. The shear links connecting the two layers of main reinforcements shall be R6-600 c/c in both directions.

(i) HS slab which is integrated with pile-cap/footing:

For HS slab integrated with the pile-cap or footing of more than 500 mm thick, shear links is not required. The maximum spacing of main reinforcement shall be 200 mm c/c.

3.5 DETAILING OF HS TOWER

3.5.1 General

The HS tower is to be detailed to allow for the installation of services and fixtures in HS and to resist spalling of the internal face of HS walls, soffit of ceiling slabs and/or finishes on HS floor slab.

3.5.2 Lap and Anchorage Length

Requirements for lap and anchorage length of reinforcement bars are as follows:

(a) For slabs and walls, full tension lap length shall be provided at all laps. The lap length shall be at least equal to the design tension length necessary to develop the full tensile capacity of the reinforcement. The lap length shall take into account the minimum cover, location and strength of the lapped reinforcement and the concrete grade.

(b) Welding of reinforcement is not permitted.

(c) Bundled bars are not permitted.

3.5.3 Concrete Cover

The concrete cover to the main reinforcement shall not exceed 40 mm.

3.5.4 Cast-In-Situ and Precast Elements

Cast-In-Situ HS elements shall comply with the dimensions and detailed requirements as shown in the following figures:

- FIGURE 3.5.4(a) - Plan of HS wall
- FIGURE 3.5.4(b) - Typical details of HS slabs/walls
- FIGURE 3.5.4(c) - Plan of two HS with an internal common wall
- FIGURE 3.5.4(d) - Typical details of two HS with an internal common wall
- FIGURE 3.5.4(e) - Details of HS wall reinforcement near HS door
- FIGURE 3.5.4(f) - Typical details of embedded conduit in HS wall
- FIGURE 3.5.4(g) - Plan of HS wall reinforcement details near HS door
- FIGURE 3.5.4(h) - Typical details of trimmer bars for ventilation sleeve

Pre-cast HS elements shall comply with the dimensions and detailed requirements as shown in the following figures:

- FIGURE 3.5.4(i) - Details of pre-cast HS door frame panel (Type 1)
- FIGURE 3.5.4(j) - Details of pre-cast HS door frame panel (Type 1)
- FIGURE 3.5.4(k) - Plan of HS walls with pre-cast HS door frame panel (Type 1)
- FIGURE 3.5.4(l) - Details of pre-cast HS door frame panel (Type 2)
- FIGURE 3.5.4(m) - Details of pre-cast HS door frame panel (Type 2)
- FIGURE 3.5.4(n) Details of pre-cast HS door frame panel (Type 2)
- FIGURE 3.5.4(o) - Plan of HS wall with pre-cast HS door frame panel (Type 2)
- FIGURE 3.5.4(p) - Details of pre-cast HS door frame panel (Type 3)
- FIGURE 3.5.4(q) - Details of pre-cast HS door frame panel (Type 3)
- FIGURE 3.5.4(r) - Plan of HS wall with pre-cast HS door frame panel (Type 3)

3.5.5 Joints

(a) Construction joints in an HS tower shall be properly executed to ensure that the strength and the integrity of the HS are not impaired. The type and location of joints shall be specified in the design after taking into account the following:

(i) A concrete kicker, if provided, shall not be more than 100 mm high.

(ii) All HS walls located within each storey shall be cast in one operation.

(b) Expansion joints or contraction joints in the HS tower are not permitted.

3.6 PENETRATION OF SERVICES

3.6.1 Electrical Services

All service cables which do not serve the HS directly shall not penetrate the walls and slabs of the HS and shall not be embedded within the HS walls and slabs. However, service cables for other fixture which is mounted on the external face of HS can be embedded in the HS wall.

Two embedded fixtures mounted one behind the other (i.e. back to back mounting) on the internal and external faces of the HS wall are not permitted (See FIGURE 3.6.1(a)). Where fixtures are to be mounted on both the internal and external faces of an HS wall, they shall be mounted at least 300 mm apart from each other, measured between their clear edges.

Risers for electrical services can be mounted on the external face of HS tower walls.

Where service cables and fixtures in the HS are exposed on internal walls, non-metallic inserts are to be used for their mounting. For embedded service cables and fixtures serving the HS, the details as shown in FIGURE 3.5.4(f) shall be followed. The encasement for the switch, 13A switched socket outlet, TV/radio and telephone outlets of Clause 2.6 shall be hot-dipped galvanised steel construction (See FIGURE 3.6.1(b)).

A maximum of three numbers of 25 mm diameter holes to accommodate service conduits for electrical cables serving the HS are allowed to penetrate and be embedded within the HS walls. Both ends of the conduits on the internal and the external of the HS shall be fully sealed with approved sealing material of up to a depth of not less than 100 mm into the conduits to ensure air-tightness of HS. For exposed or surface conduit crossing at the wall, the penetration at the wall shall also be fully sealed.

Where an HS or NS and lift core share a common wall, mounting of services on the lift core side of the HS wall shall be made of stainless steel material. For the purpose of installing M&E equipment within the lift core, all anchor bolts to be fixed onto this common wall shall be made of stainless steel and embedded up to a maximum penetration depth of 75 mm. They shall also be cast in place with the structural wall. If non-cast in place method is used on this common wall for the installing of M&E equipment, then the thickness of this common wall shall be increase by 50 mm. The spacing of the anchor bolts measured between their centerlines shall not be less than 300 mm for both methods.

3.6.2 Water and Gas Services

Service pipes for water or gas are allowed to pass through the HS walls provided that they are laid within a stainless steel conduit encased by 150 mm reinforced concrete all round (See FIGURE 3.6.2). Joints in water pipe, gas pipe or the stainless steel conduit shall be located outside the HS.

Risers for water and gas services can be mounted on the external face of HS tower walls.

TABLE 3.3.2.2: LOAD COMBINATION AND VALUES OF PARTIAL SAFETY FACTORS (γ_f) FOR ULTIMATE LIMIT STATE

(Unshielded NS Walls, Unshielded NS Columns or a Combination of Unshielded NS Walls and NS Columns)

Load Combination	Load Types					
	Dead		Imposed		Earth and Water Pressure	Wind
	Adverse	Beneficial	Adverse	Beneficial		
Dead and imposed and wind (and earth and water pressure)	1.05	1.05	1.05	1.05	1.05	1.05

TABLE 3.3.3.1: LOAD COMBINATION AND VALUES OF PARTIAL SAFETY FACTORS (γ_f) FOR ULTIMATE LIMIT STATE

(Design against Collapse Load and Unshielded/Shielded Transfer Structure)

Load Combination	Load Types						
	Dead		Imposed		Earth and Water Pressure	Wind	Collapse
	Adverse	Beneficial	Adverse	Beneficial			
Dead and imposed and wind and collapse load (and earth and water pressure)	1.2	1.2	1.2	1.2	1.2	1.2	1.05

TABLE 3.3.3.3: LOAD COMBINATION AND VALUES OF PARTIAL SAFETY FACTORS (γ_f) FOR ULTIMATE LIMIT STATE

(Unshielded Transfer Structure)

Load Combination	Load Types						
	Dead		Imposed		Earth and Water Pressure	Wind	Collapse
	Adverse	Beneficial	Adverse	Beneficial			
Dead and imposed and wind and collapse load (and earth and water pressure)	1.05	1.05	1.05	1.05	1.05	1.05	1.05

TABLE 3.4.2(a): MINIMUM REINFORCEMENT OF HS WALLS FOR LANDED DWELLING UNITS

HS Clear Height (mm)	Reinforcements at both internal and external faces of wall (both directions)	Shear Links (both directions)
$2400 \leq Ht \leq 3900$	T10 - 100	R6 - 600

TABLE 3.4.2(b): MINIMUM REINFORCEMENT OF HS OR NS WALLS FOR NON-LANDED DWELLING UNITS

HS Clear Height (mm)	Reinforcements at both internal and external faces of wall (both directions)	Shear Links (both directions)
$2400 \leq Ht \leq 2700$	T10 - 100	R6 - 600
$2700 < Ht \leq 3900$	T13 - 100	R6 - 600

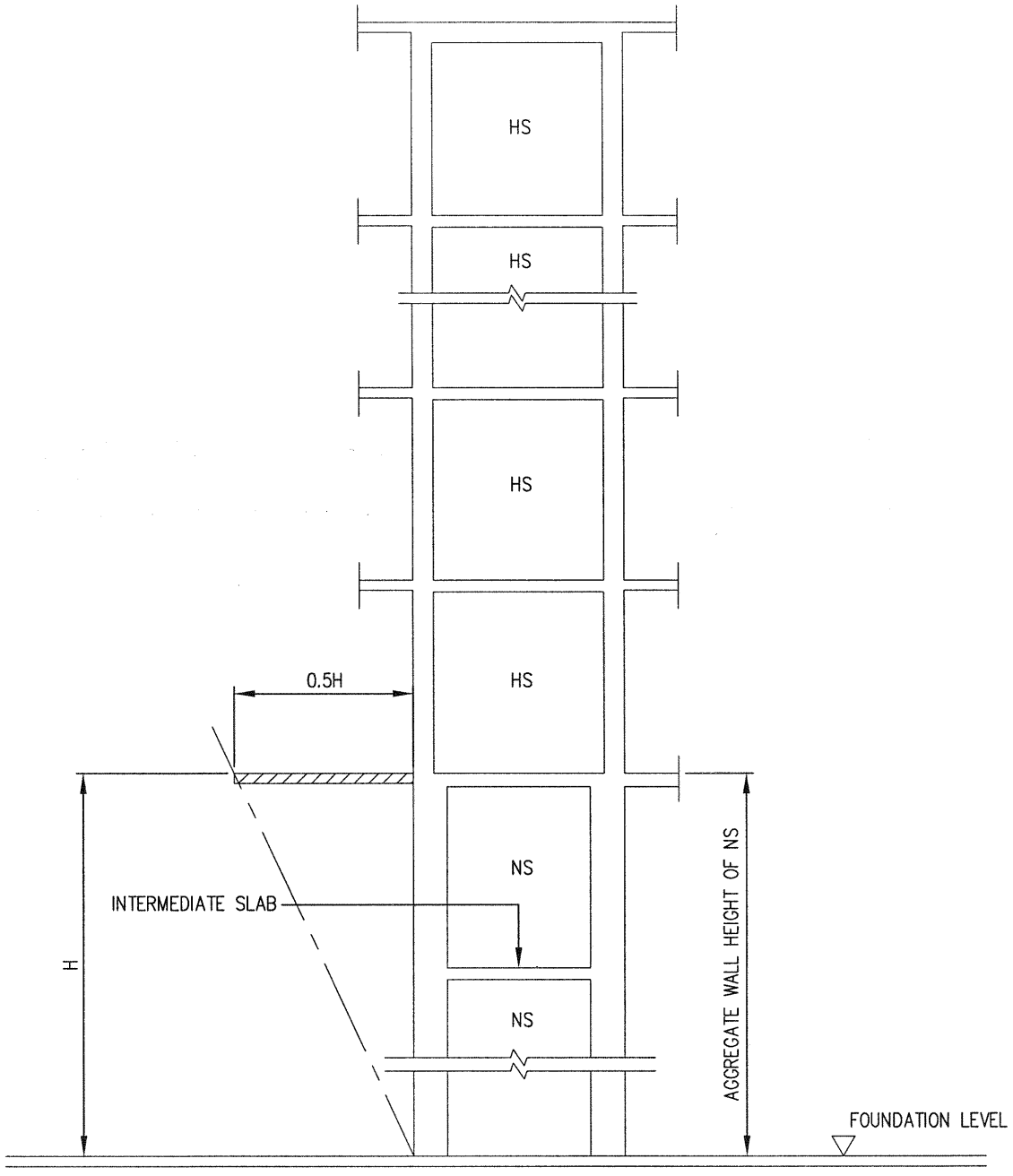


FIGURE 3.3.2.1 SHIELDED NS WALLS AND/OR NS COLUMNS

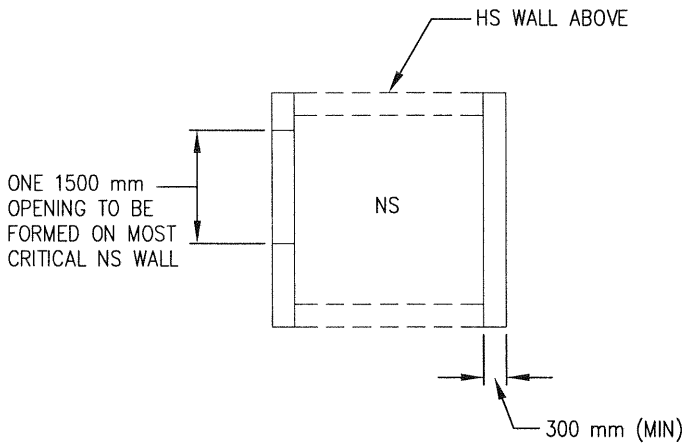


FIGURE 3.3.2.2(a) UNSHIELDED NS WALLS

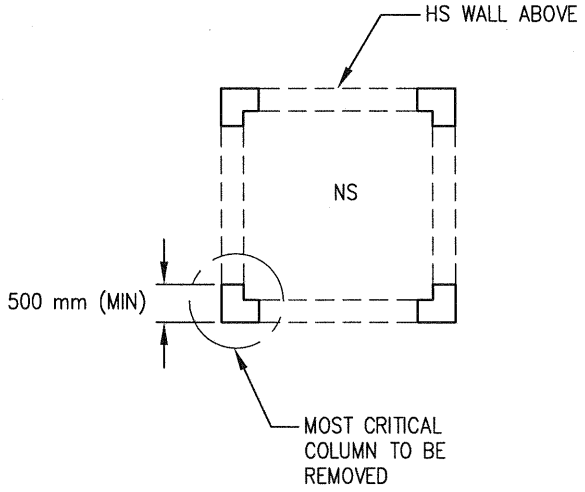


FIGURE 3.3.2.2(b) UNSHIELDED NS COLUMN(S)

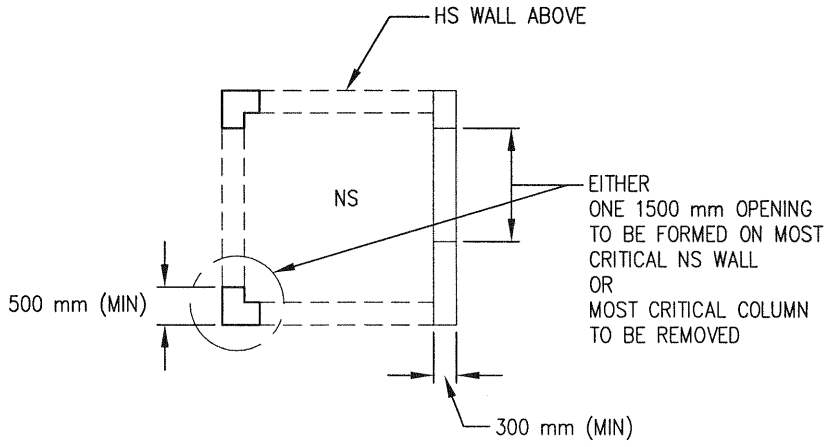
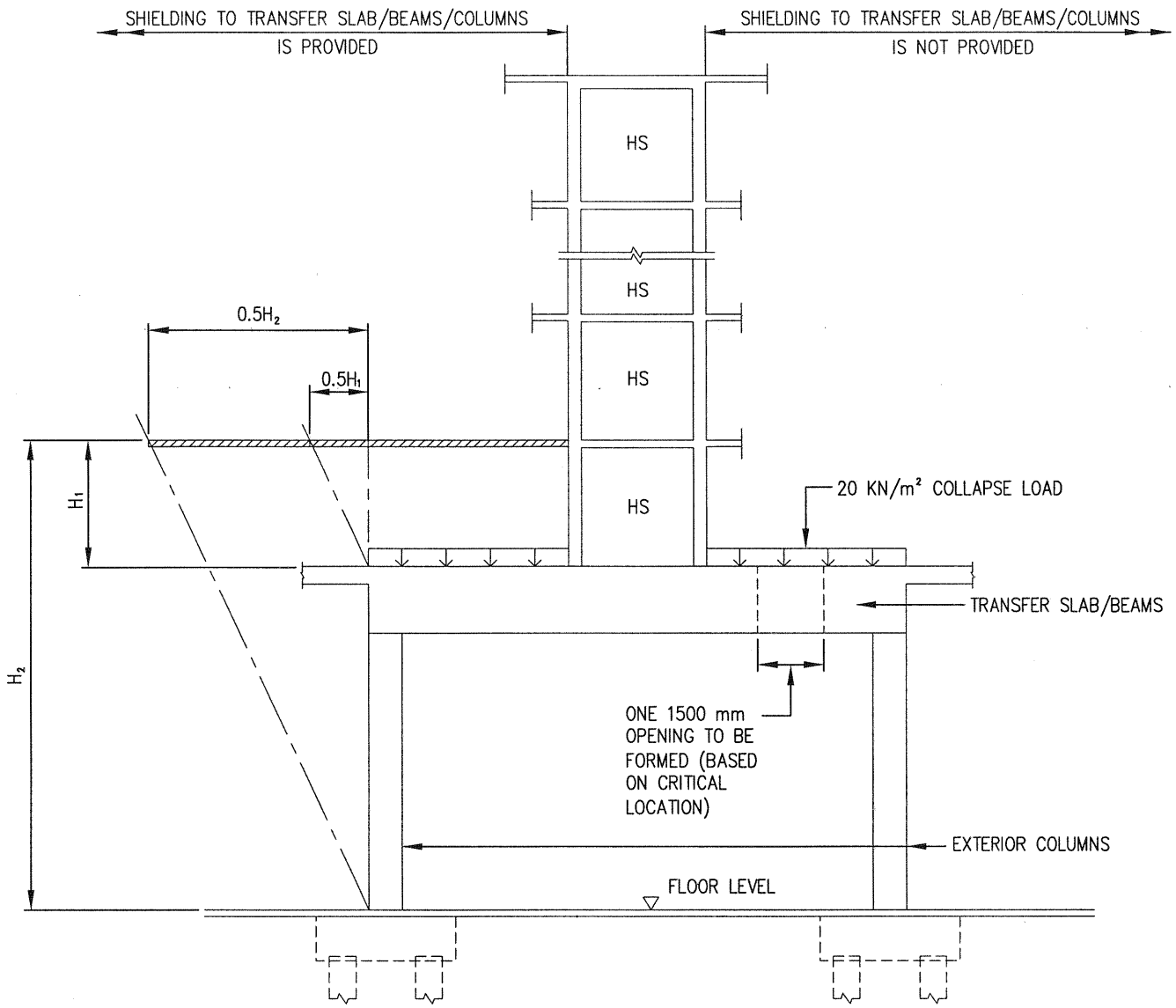
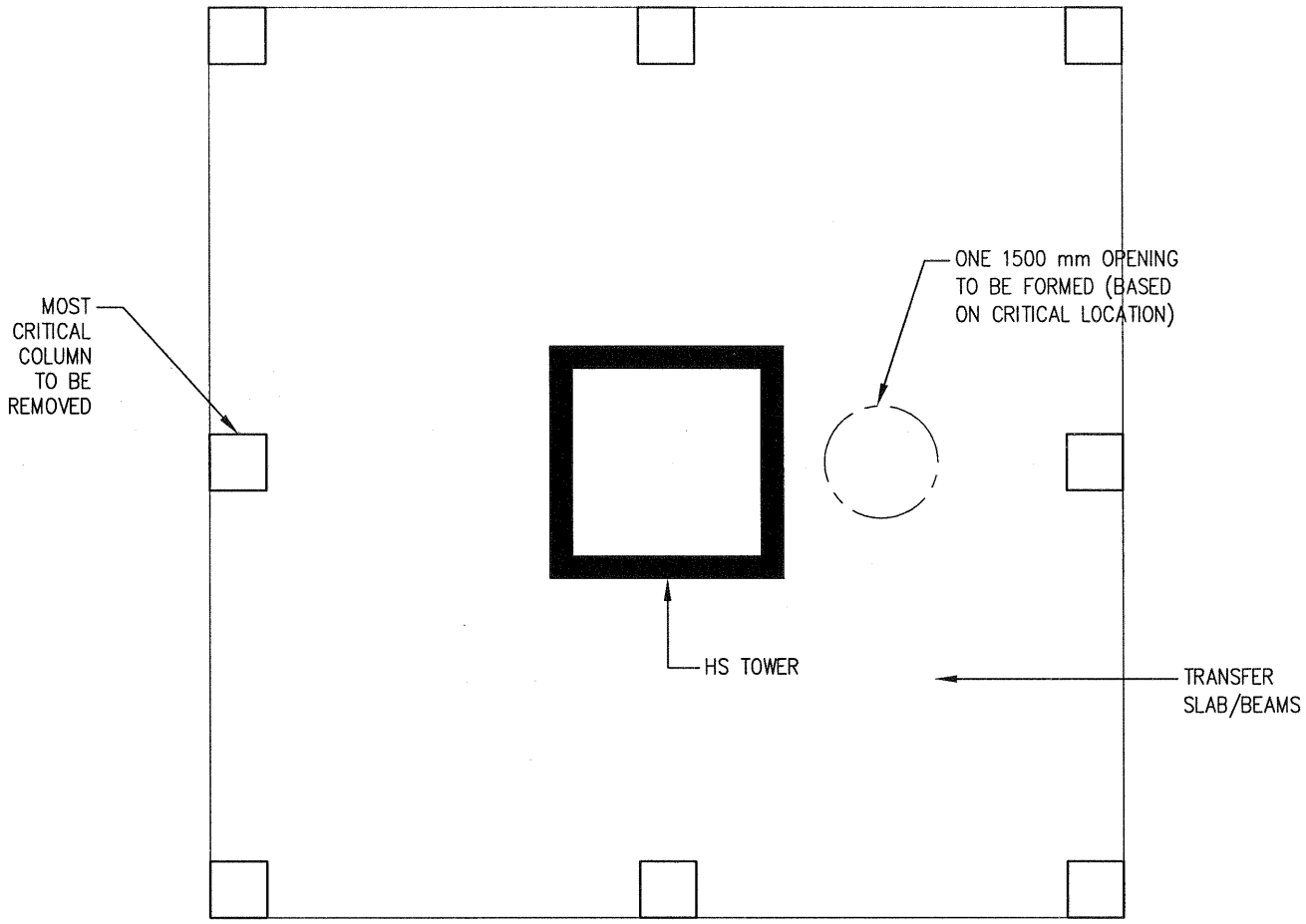


FIGURE 3.3.2.2(c) COMBINATION OF UNSHIELDED NS WALL(S) AND/OR NS COLUMN(S)



SECTION

FIGURE 3.3.3.2 SHIELDING OF TRANSFER SLAB/BEAMS/EXTERIOR COLUMNS



PLAN

FIGURE 3.3.3.3 UNSHIELDED TRANSFER SLAB/BEAMS

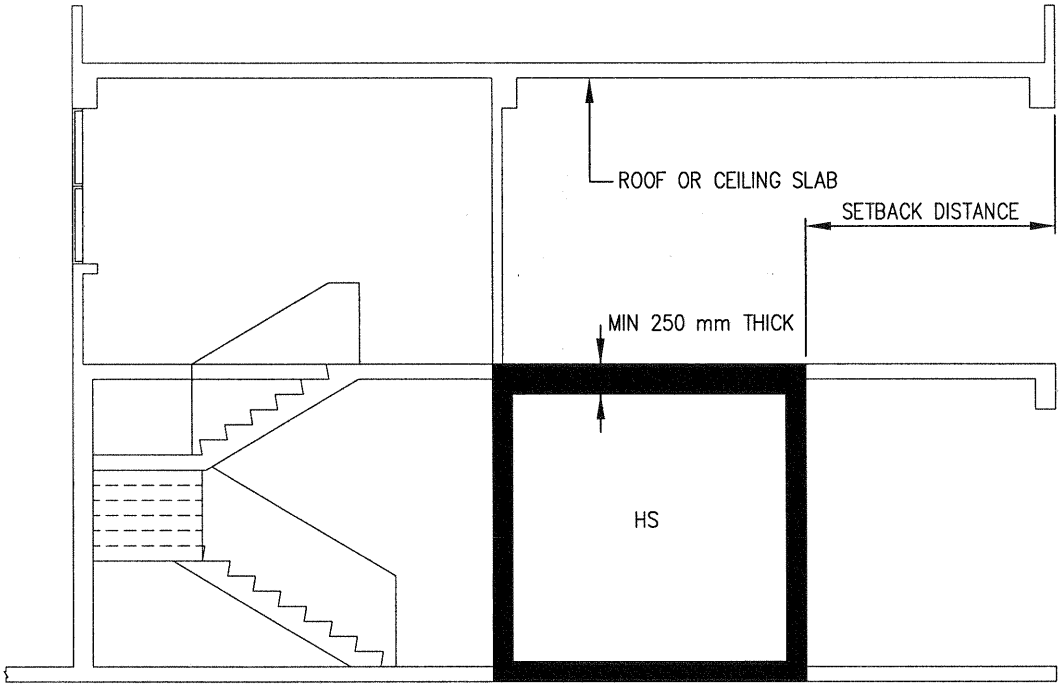
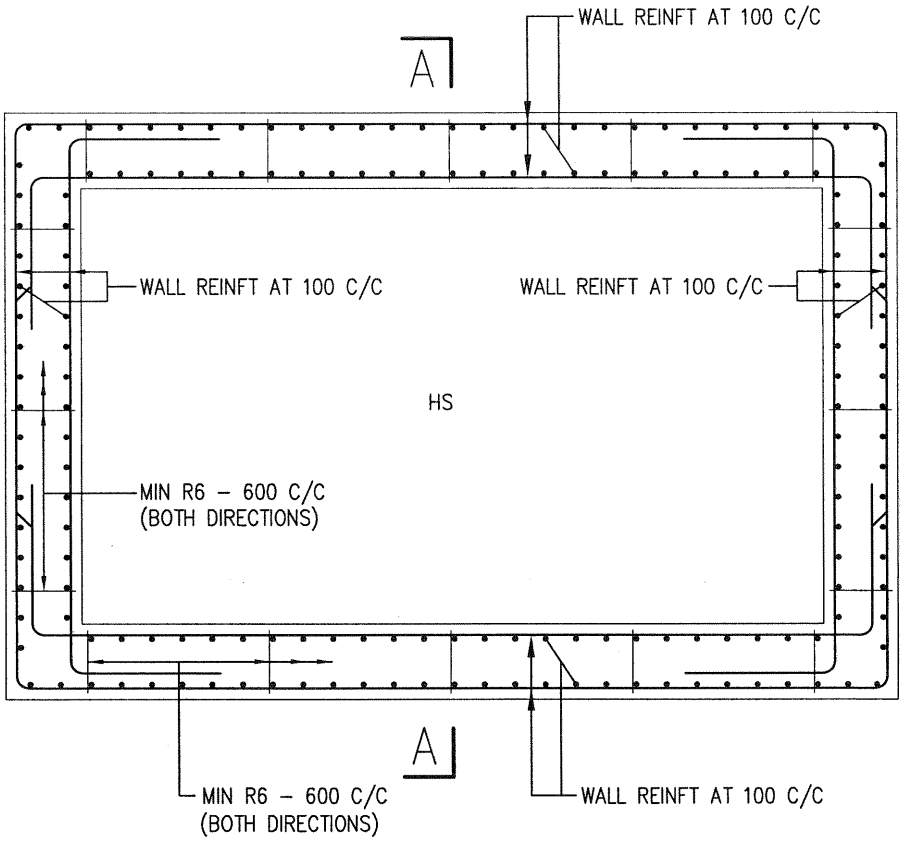
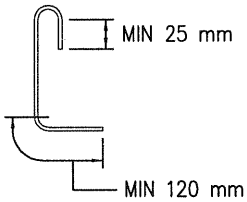


FIGURE 3.4.1 MINIMUM DIMENSIONS OF CEILING SLAB FOR HS IN LANDED DWELLING UNIT





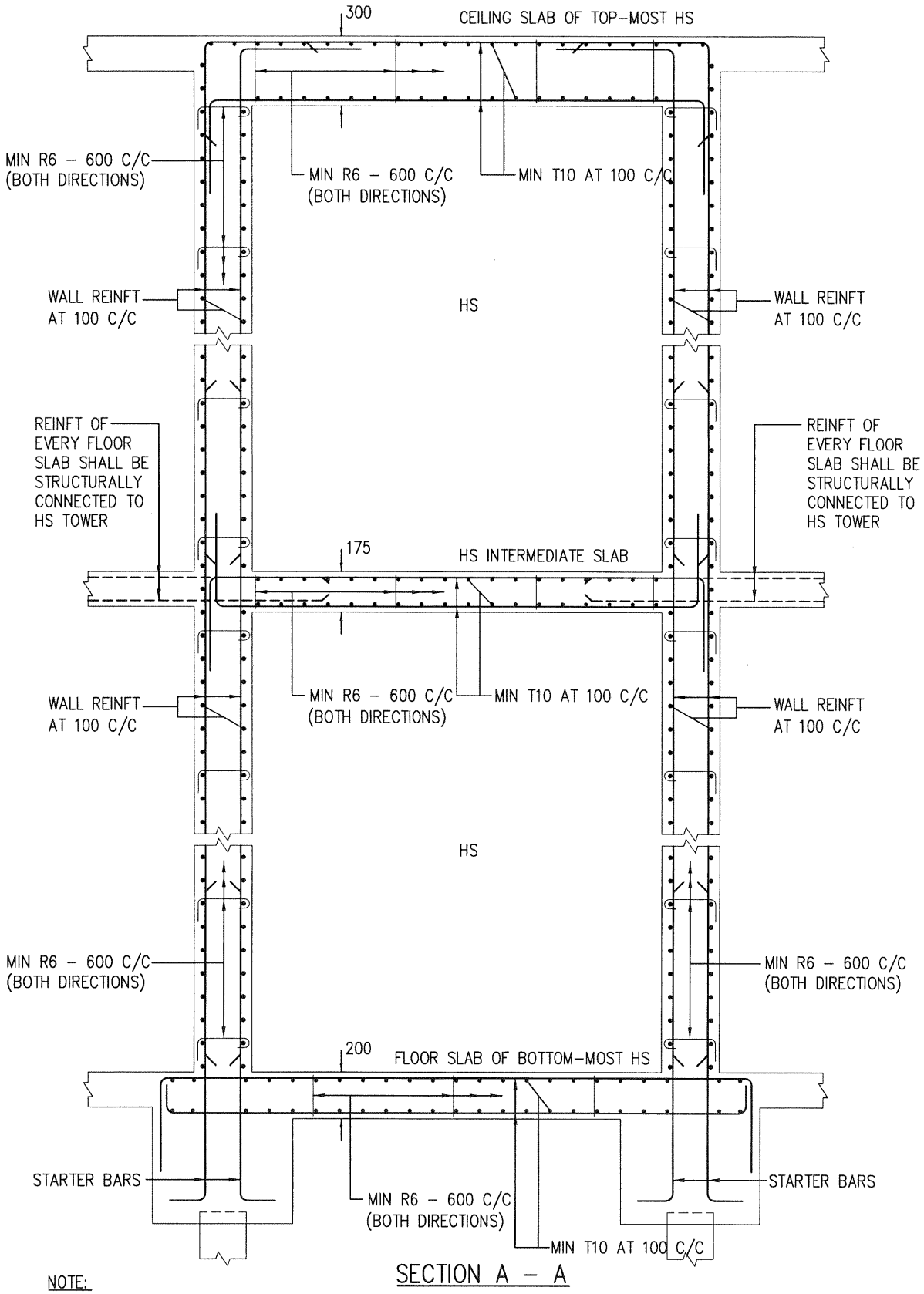
MINIMUM HOOK AND BEND ALLOWANCE
FOR SHEAR LINK

NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT

2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm^2 (CP65 1999)

FIGURE 3.5.4(a) PLAN OF HS WALL

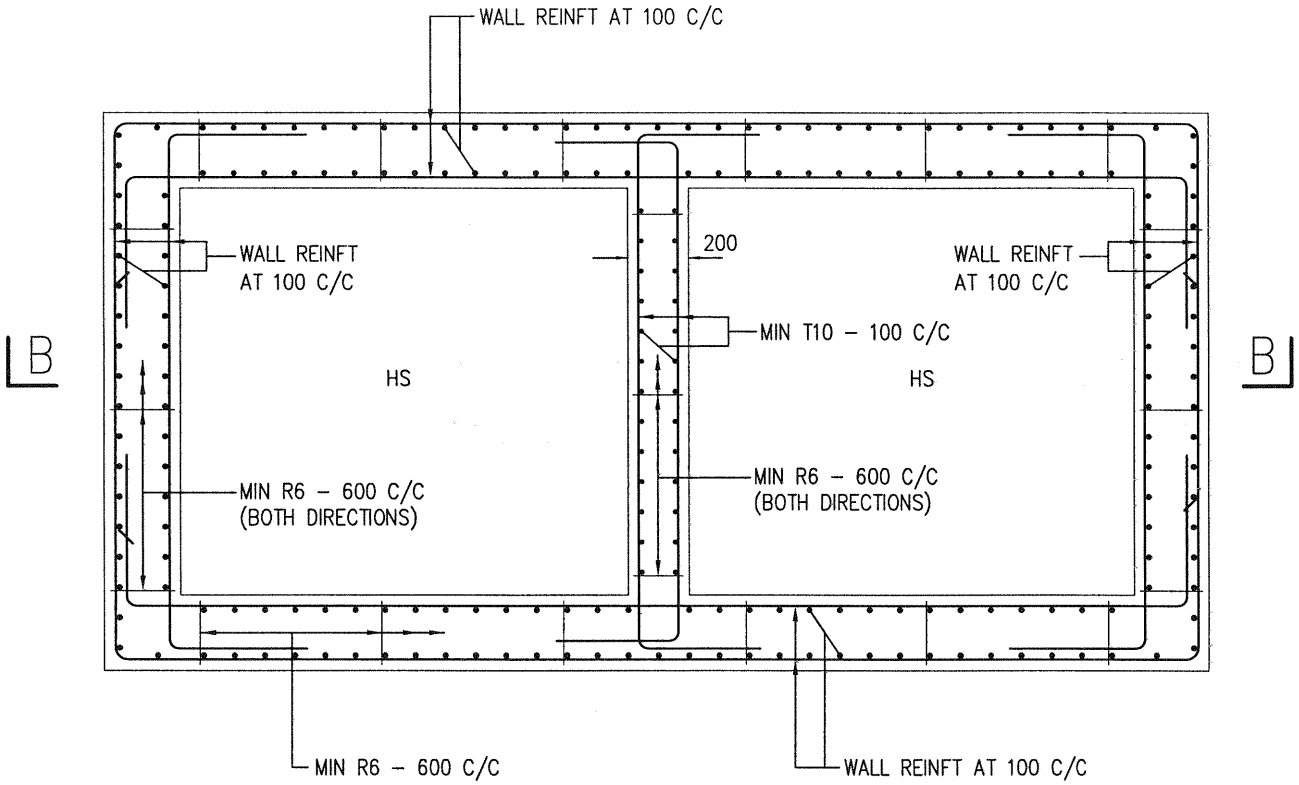


SECTION A - A

NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm^2 (CP65 1999)

FIGURE 3.5.4(b) TYPICAL DETAILS OF HS SLABS / WALLS

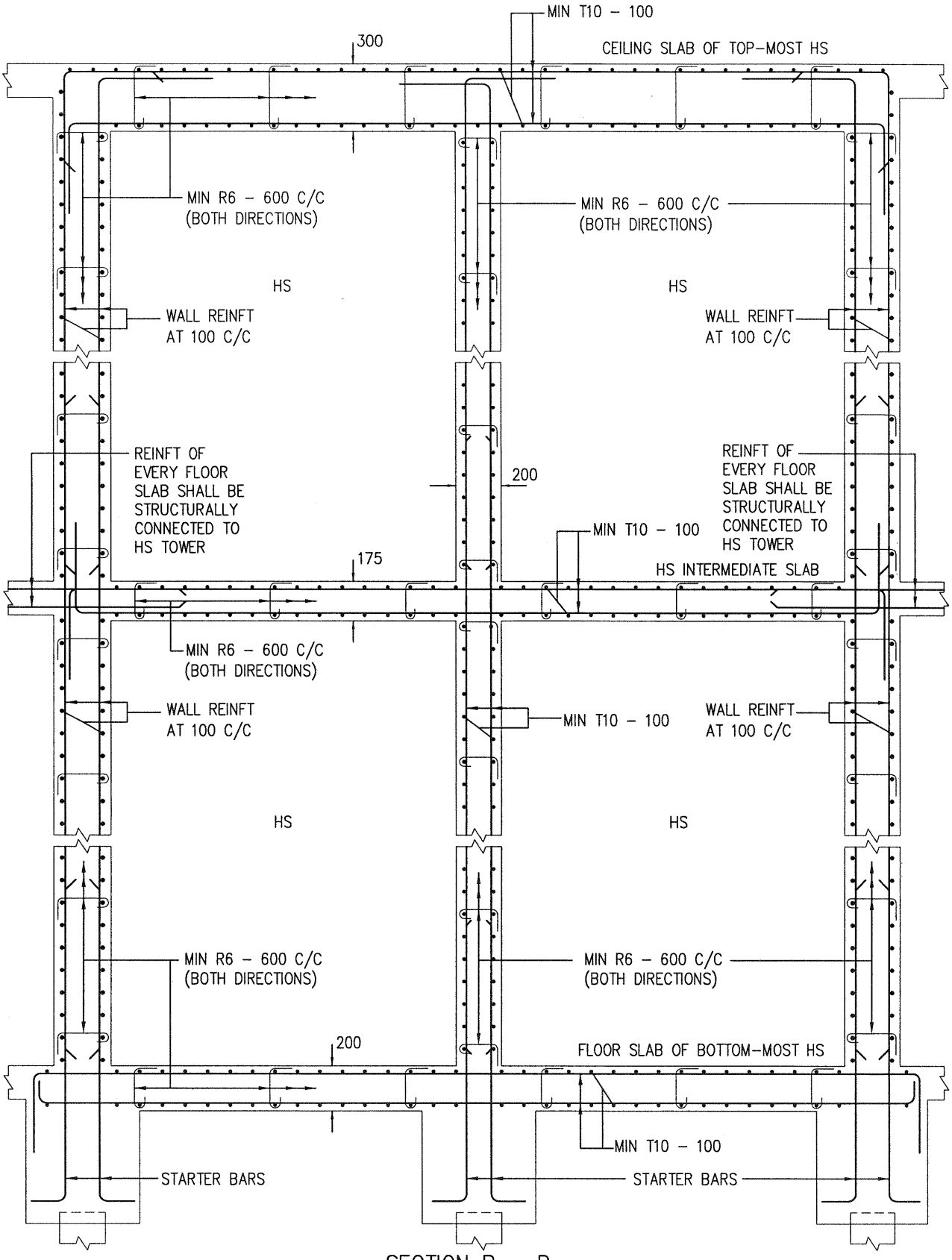


NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT

2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm^2 (CP65 1999)

FIGURE 3.5.4(c) PLAN OF TWO HS WITH AN INTERNAL COMMON WALL

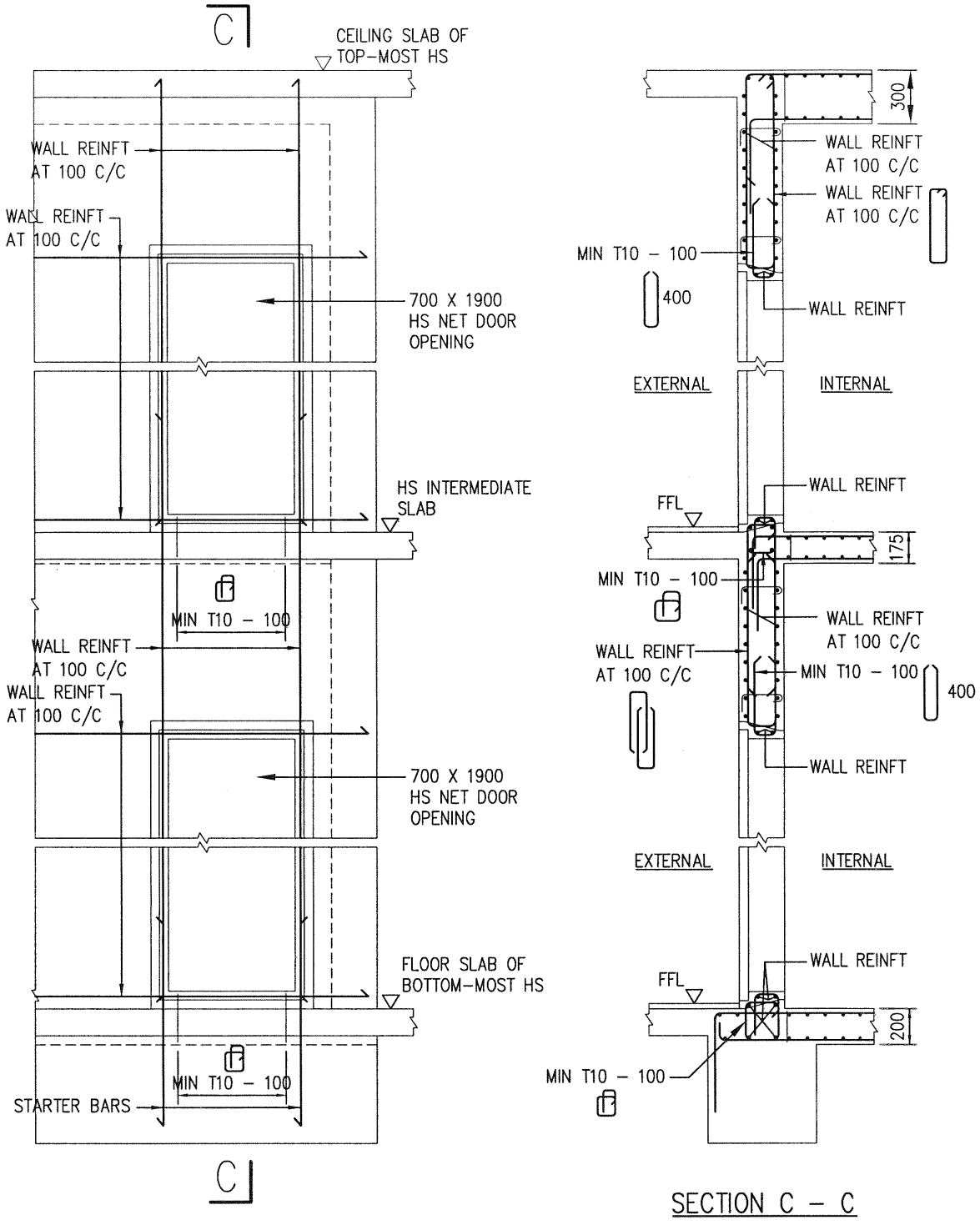


SECTION B – B

NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON–LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm² (CP65 1999)

FIGURE 3.5.4(d) TYPICAL DETAILS OF TWO HS WITH AN INTERNAL COMMON WALL



ELEVATION

SECTION C - C

NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm² (CP65 1999)

FIGURE 3.5.4(e) DETAILS OF HS WALL REINFORCEMENT NEAR HS DOOR

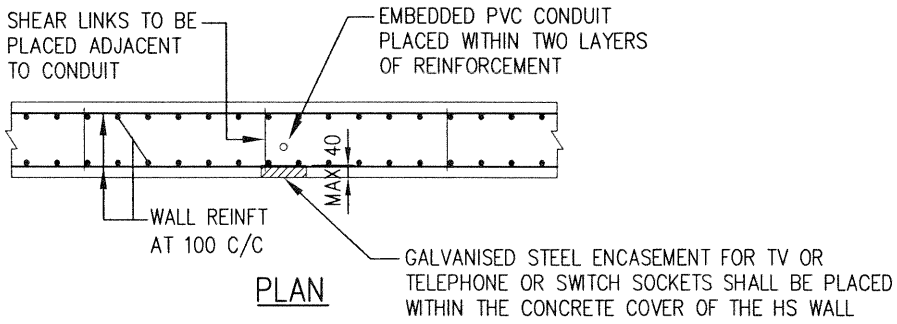


FIGURE 3.5.4(f) TYPICAL DETAILS OF EMBEDDED CONDUIT IN HS WALL

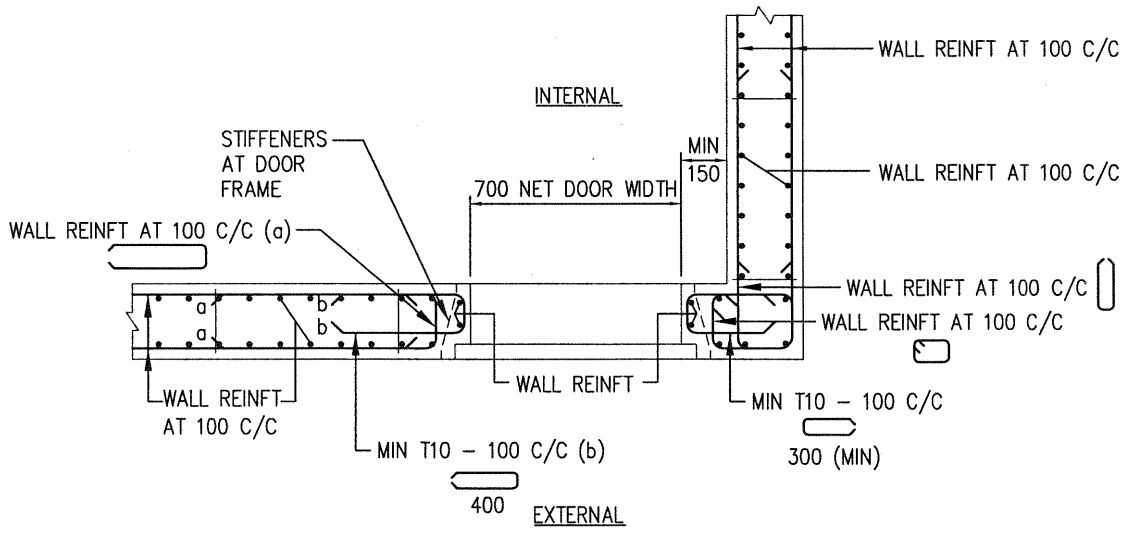
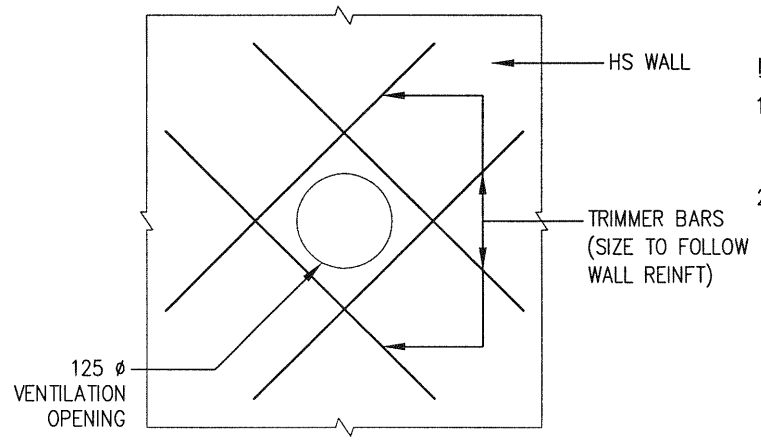


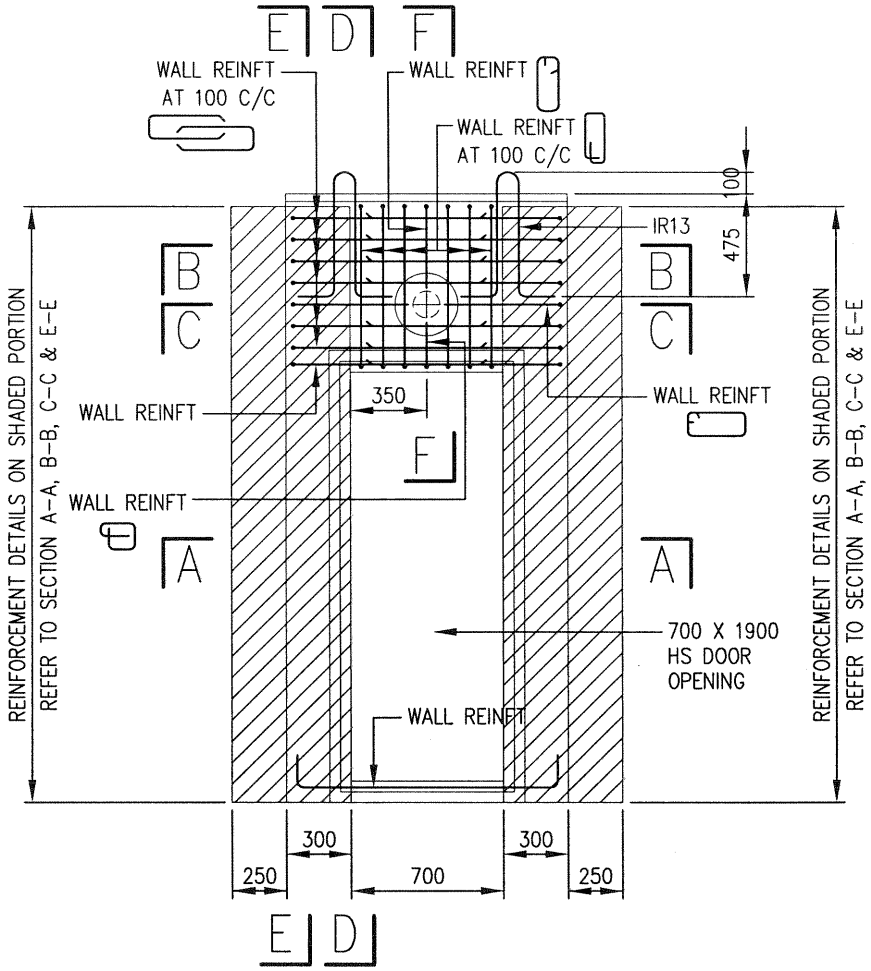
FIGURE 3.5.4(g) PLAN OF HS WALL REINFORCEMENT DETAILS NEAR HS DOOR



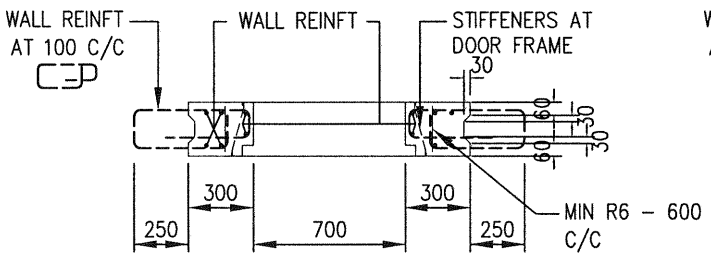
NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm² (CP65 1999)

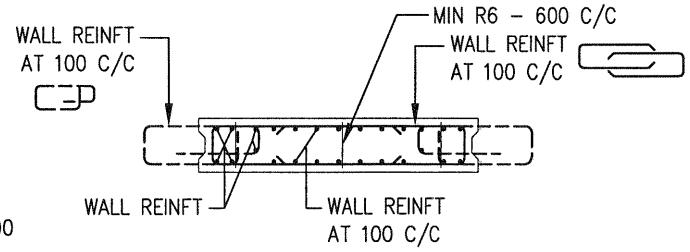
FIGURE 3.5.4(h) TYPICAL DETAILS OF TRIMMER BARS FOR VENTILATION SLEEVE



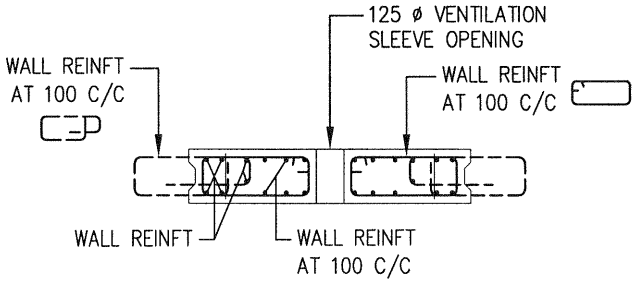
ELEVATION



SECTION A - A



SECTION B - B

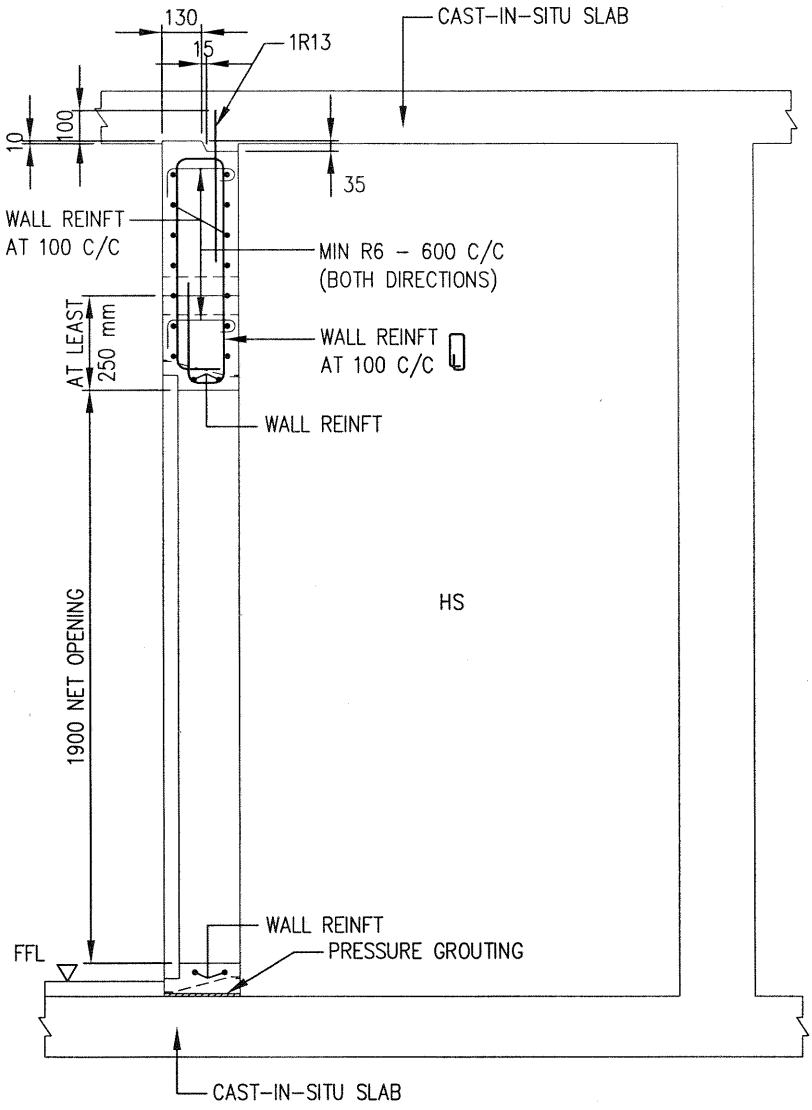


SECTION C - C

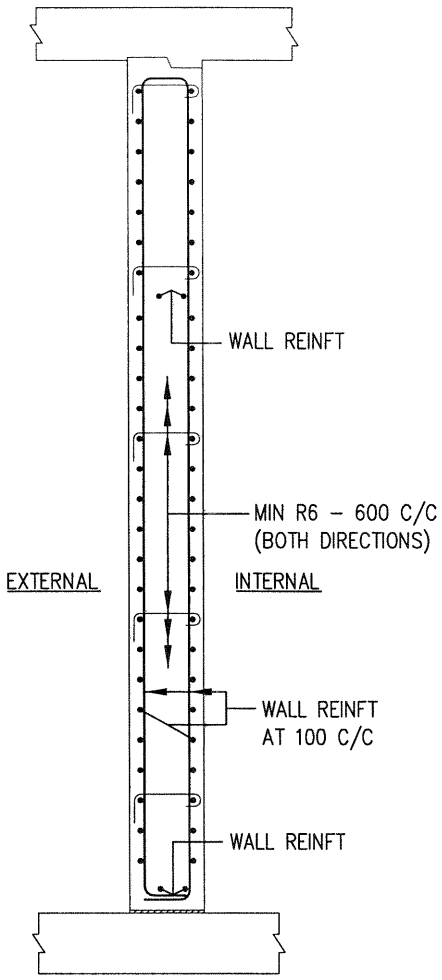
NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm² (CP65 1999)

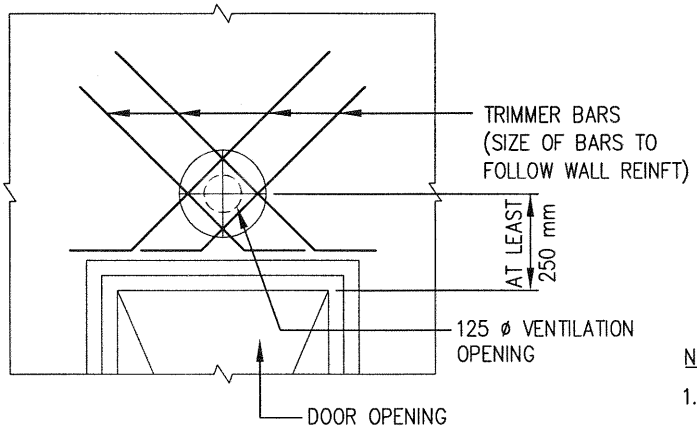
FIGURE 3.5.4(i) DETAILS OF PRECAST HS DOOR FRAME PANEL (TYPE 1)



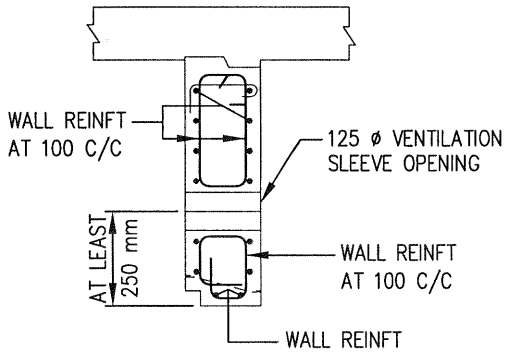
SECTION D - D



SECTION E - E



TYPICAL DETAILS OF TRIMMER BARS
FOR VENTIALTION SLEEVE

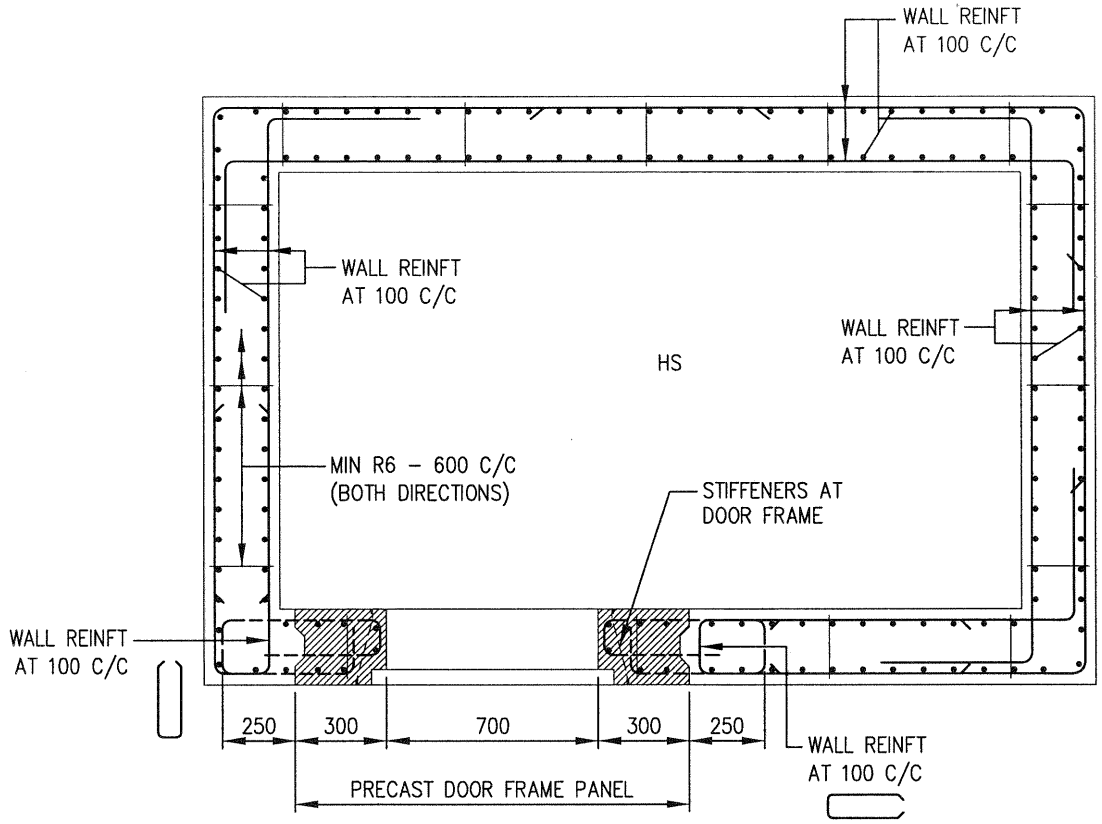


SECTION F -F

NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm² (CP65 1999)

FIGURE 3.5.4(j) DETAILS OF PRECAST HS DOOR FRAME PANEL (TYPE 1)

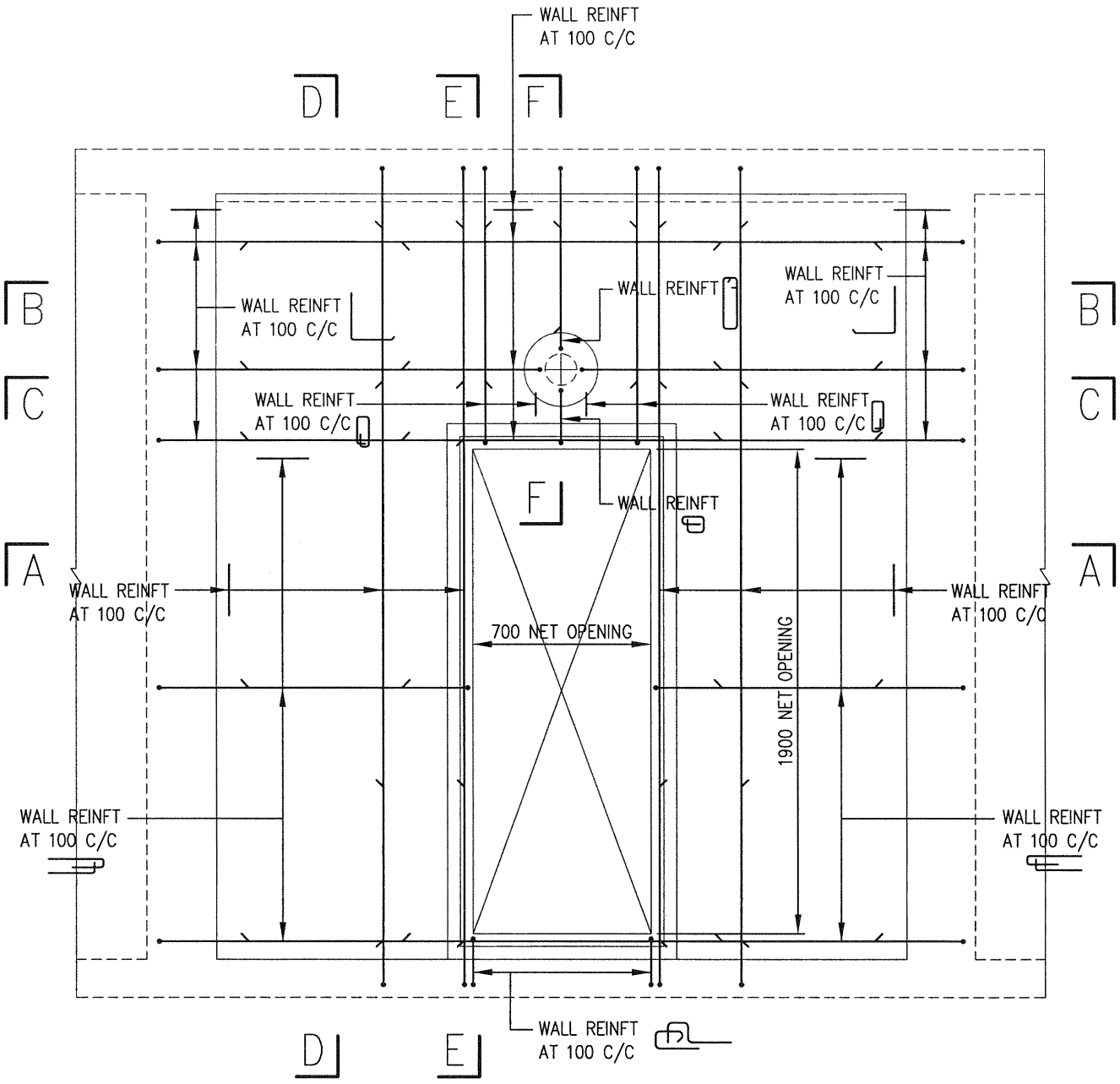


PLAN

NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm^2 (CP65 1999)

FIGURE 3.5.4(k) PLAN OF HS WALLS WITH PRECAST HS DOOR FRAME PANEL (TYPE 1)

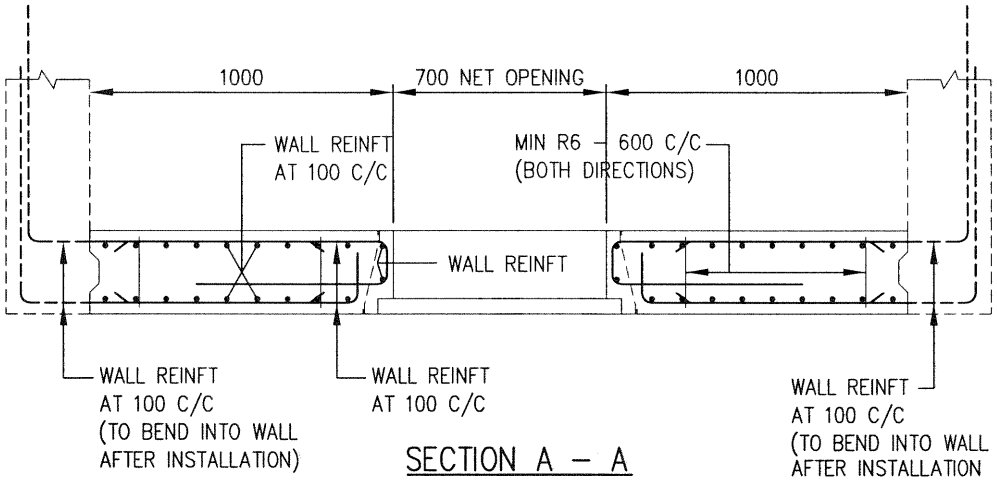


ELEVATION

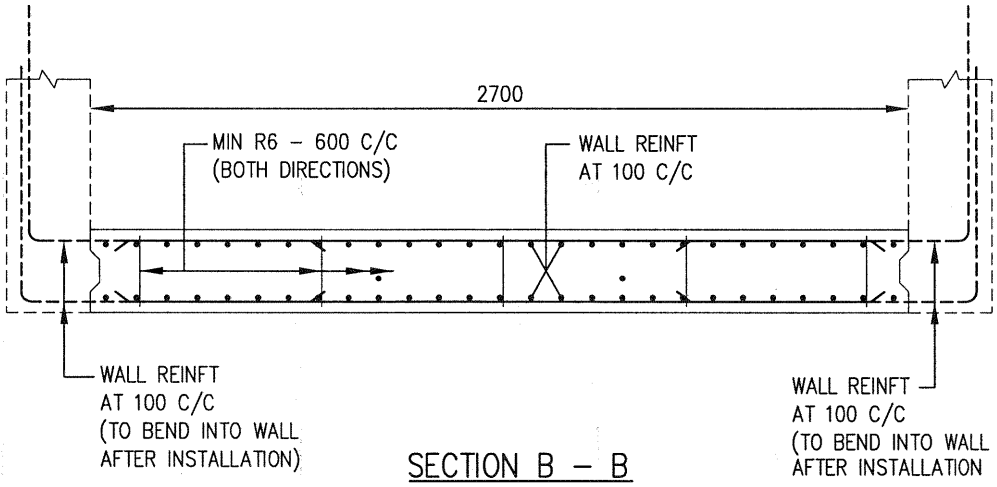
NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm² (CP65 1999)

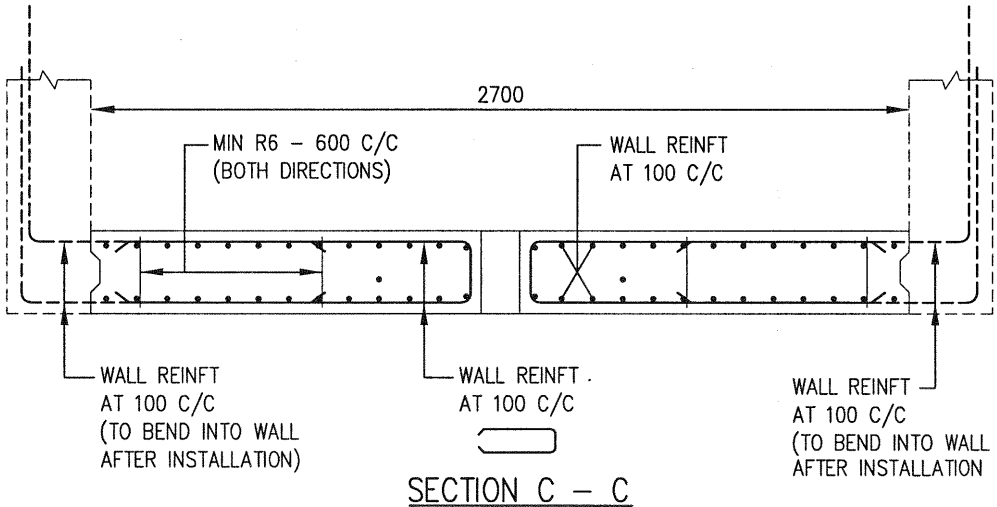
FIGURE 3.5.4(I) DETAILS OF PRECAST HS DOOR FRAME PANEL (TYPE 2)



SECTION A – A



SECTION B – B

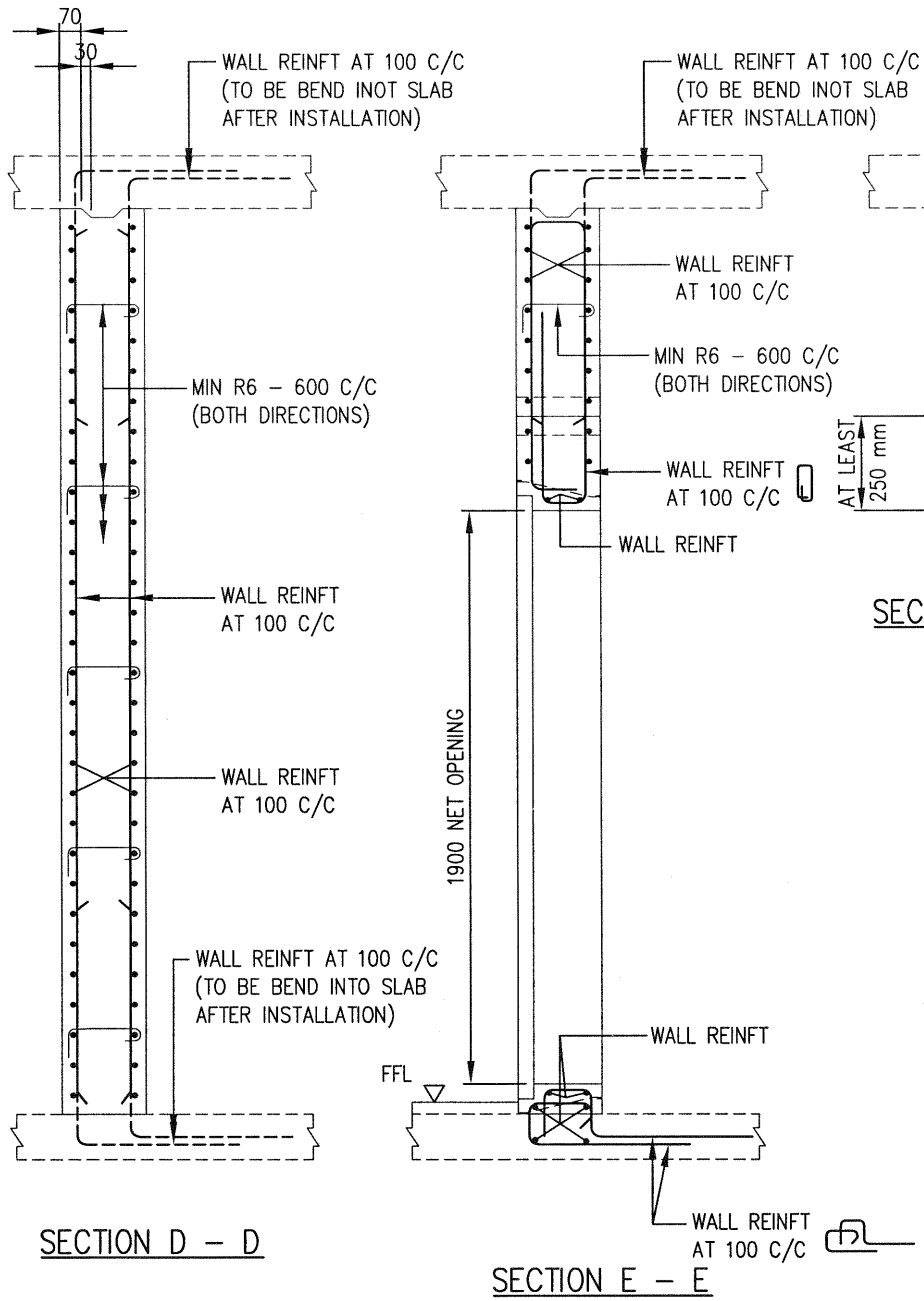


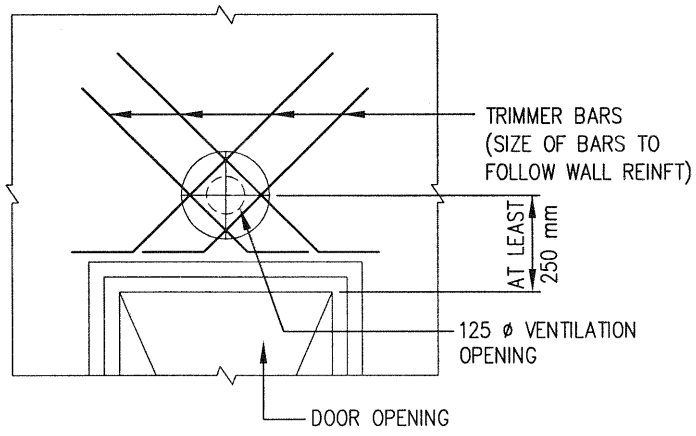
SECTION C – C

NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm^2 (CP65 1999)

FIGURE 3.5.4(m) DETAILS OF PRECAST HS DOOR FRAME PANEL (TYPE 2)



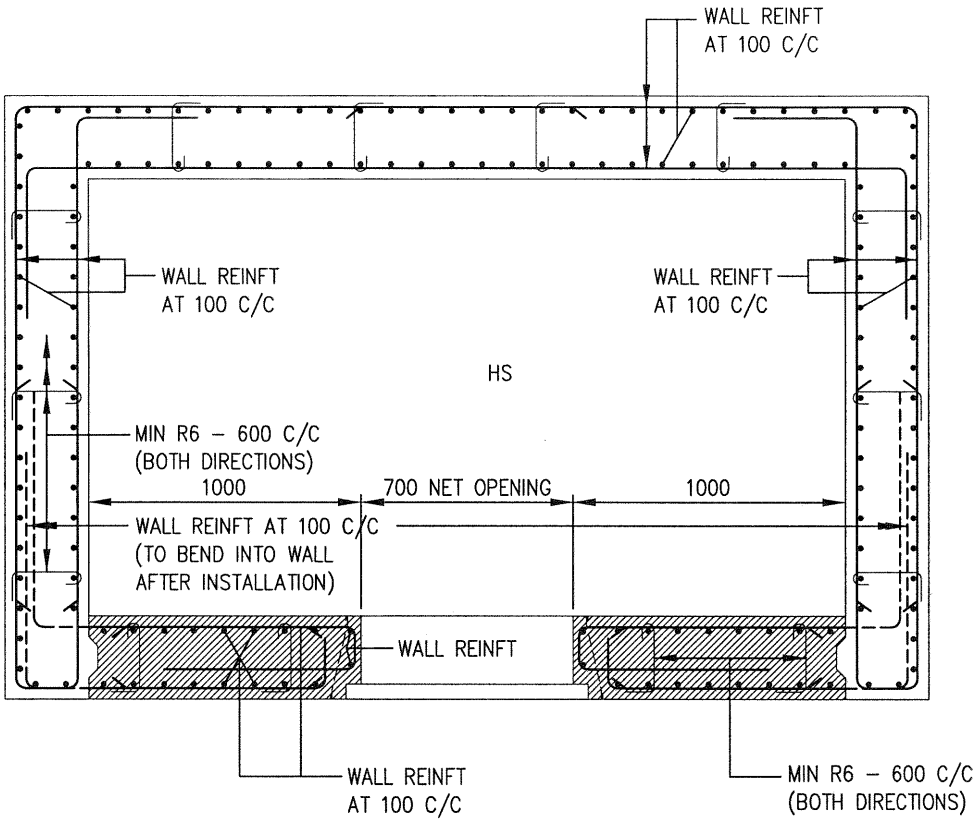


TYPICAL DETAILS OF TRIMMER BARS
FOR VENTIALTION SLEEVE

NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm² (CP65 1999)

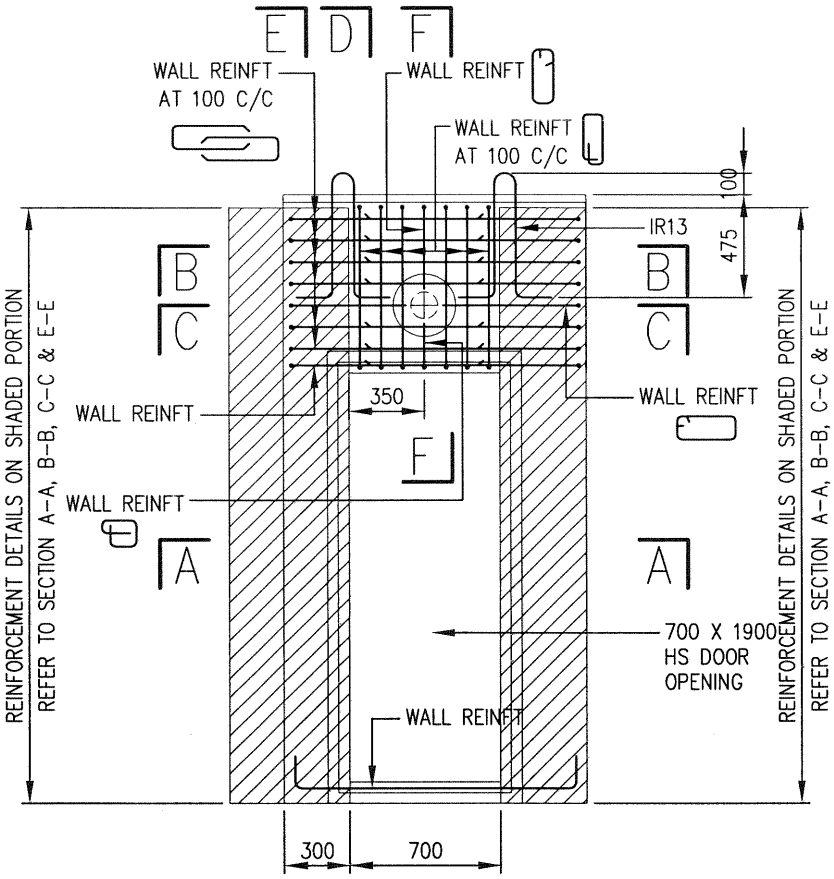
FIGURE 3.5.4(n) DETAILS OF PRECAST HS DOOR FRAME PANEL (TYPE 2)



NOTE:

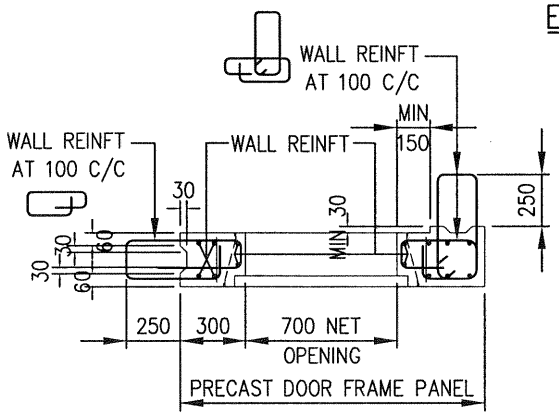
1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm^2 (CP65 1999)

FIGURE 3.5.4(o) PLAN OF HS WALLS WITH PRECAST HS DOOR FRAME PANEL (TYPE 2)

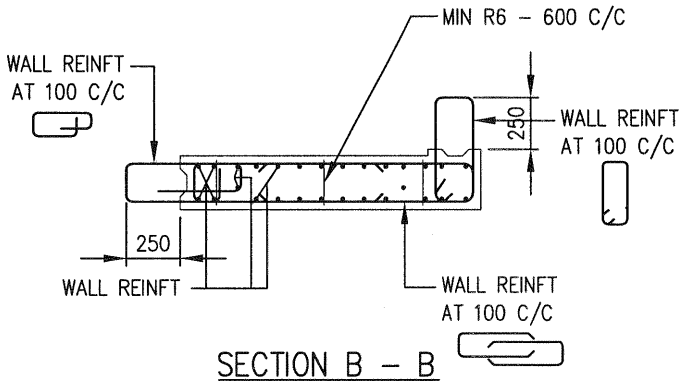


E D

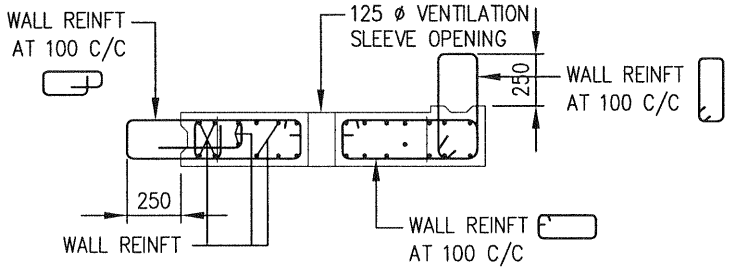
ELEVATION



SECTION A – A

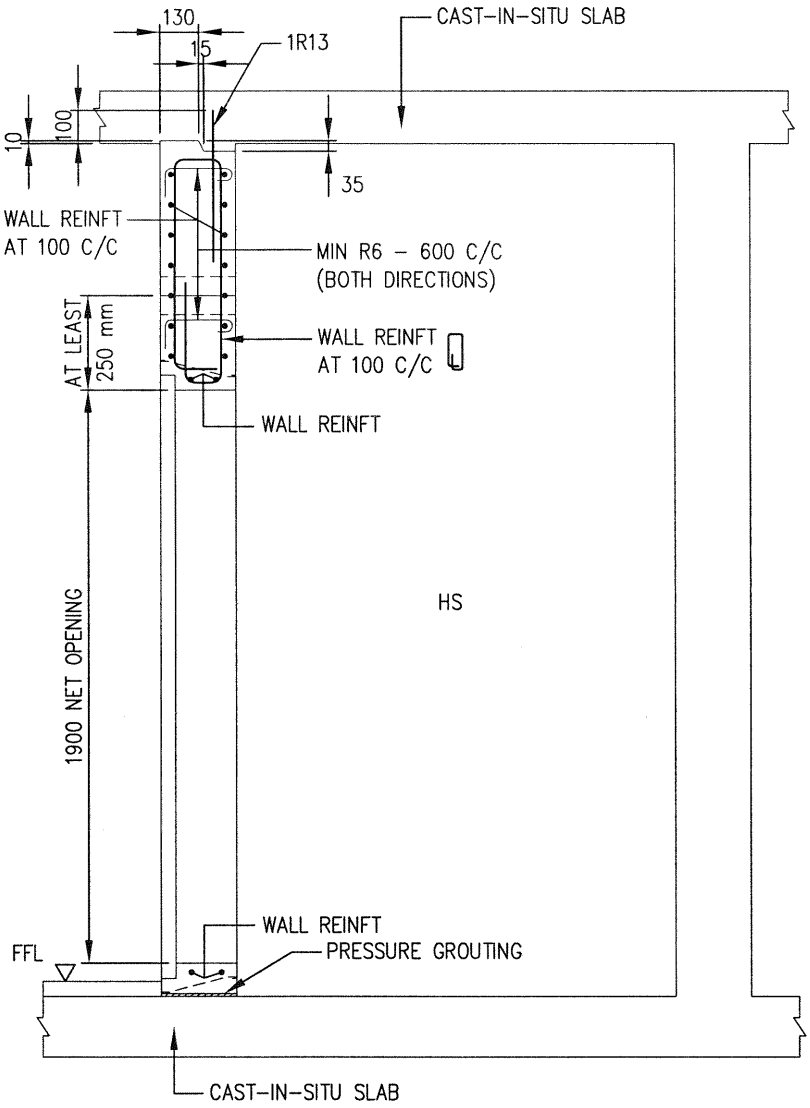


SECTION B – B

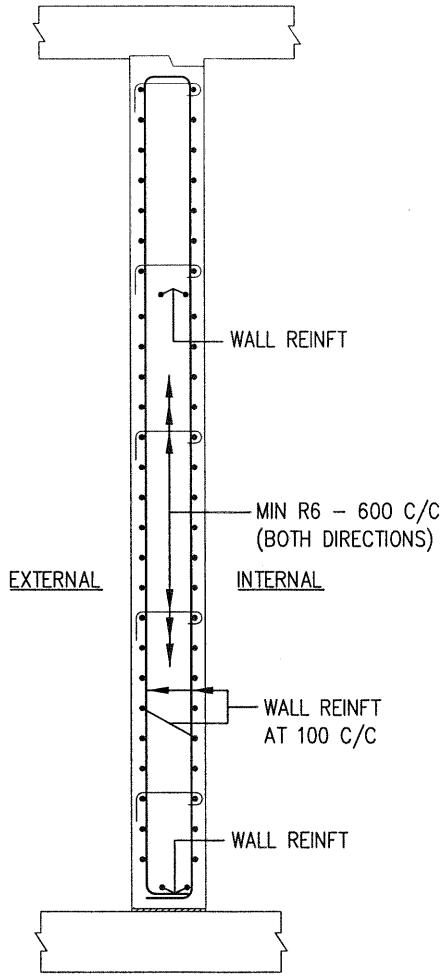


SECTION C – C

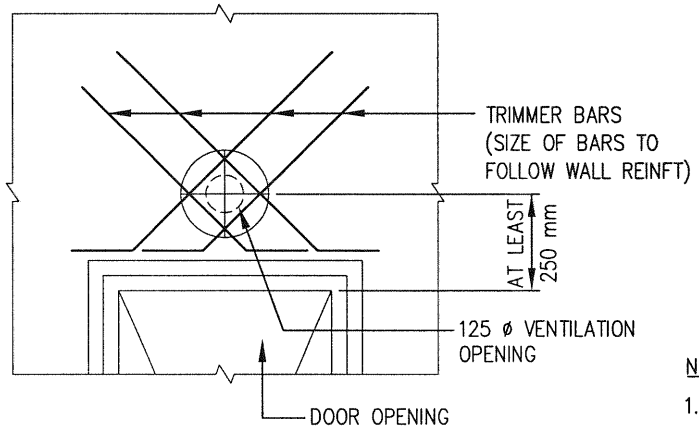
FIGURE 3.5.4(p) DETAILS OF PRECAST HS DOOR FRAME PANEL (TYPE 3)



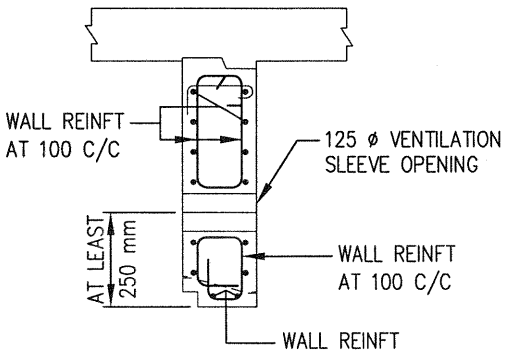
SECTION D – D



SECTION E – E



TYPICAL DETAILS OF TRIMMER BARS
FOR VENTIALTION SLEEVE



SECTION F –F

NOTE:

1. WALL REINFORCEMENT REFER TO TABLE 3.4.2(a) FOR LANDED DWELLING UNIT OR TABLE 3.4.2(b) FOR NON-LANDED DWELLING UNIT
2. TENSION LAP LENGTH AND TENSION ANCHORAGE LENGTH TO BE 37 TIMES THE DIAMETER OF THE REINFORCEMENT FOR CONCRETE GRADE = 30 N/mm² (CP65 1999)

FIGURE 3.5.4(q) DETAILS OF PRECAST HS DOOR FRAME PANEL (TYPE 3)

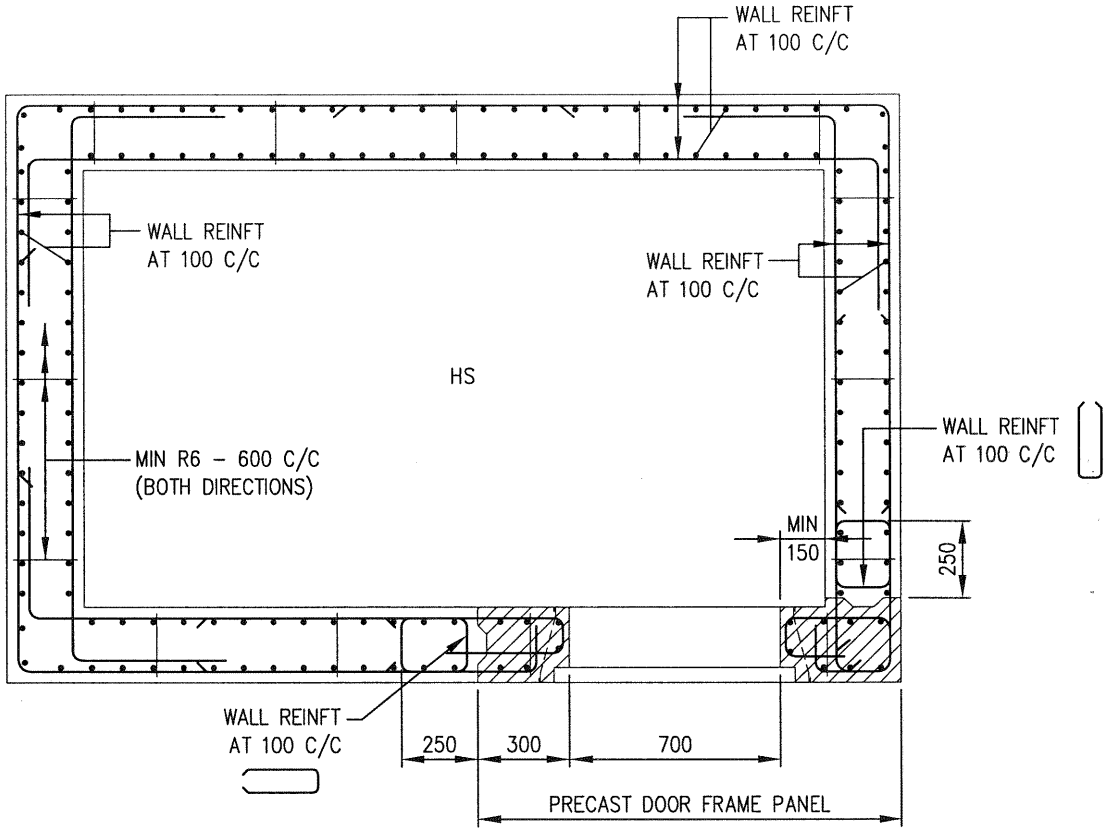
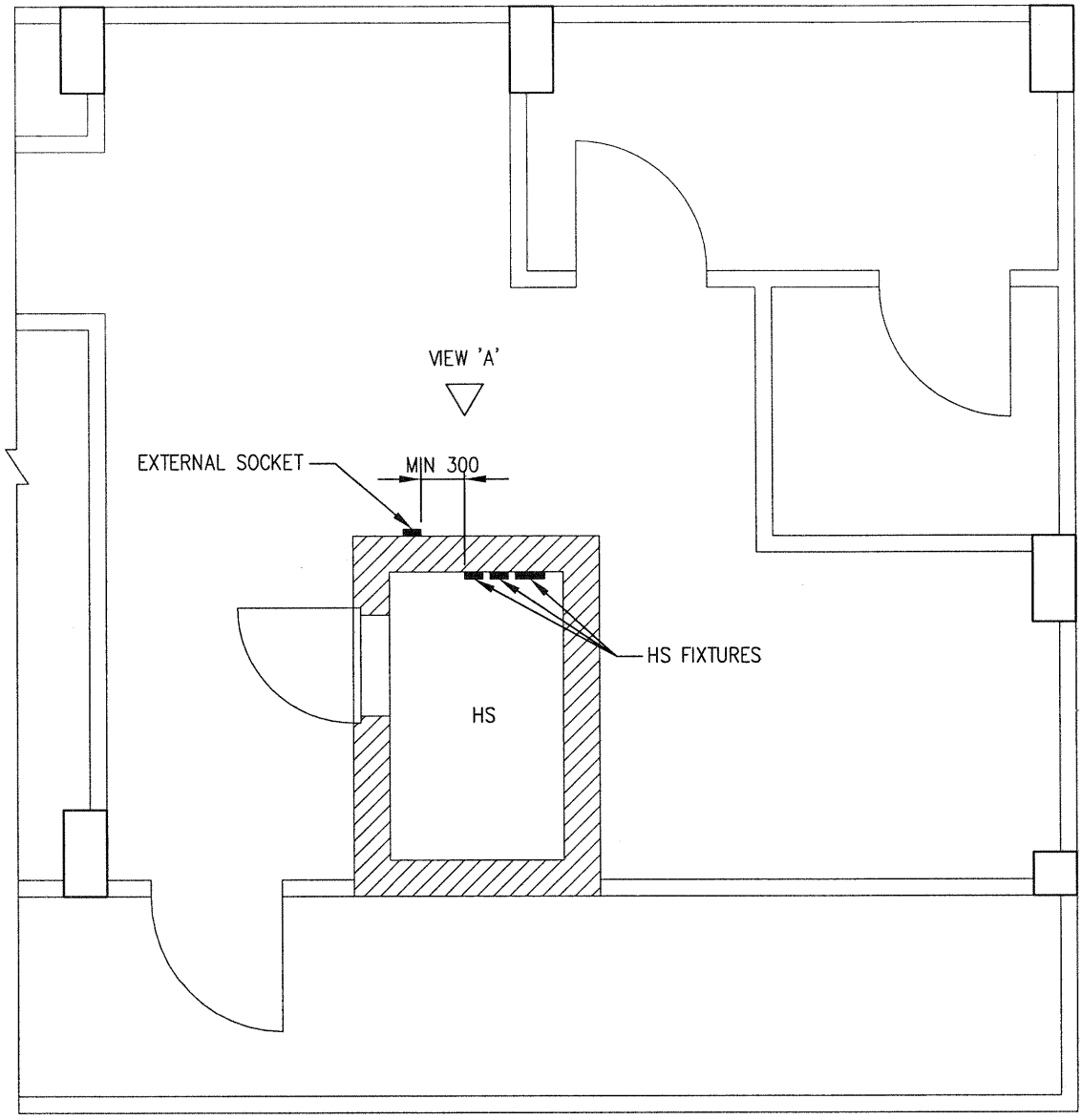
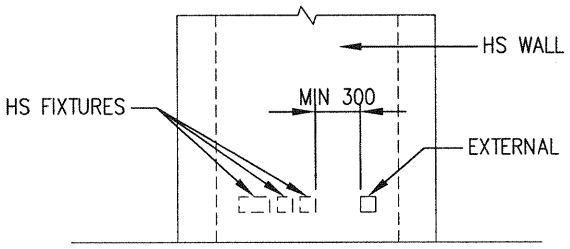


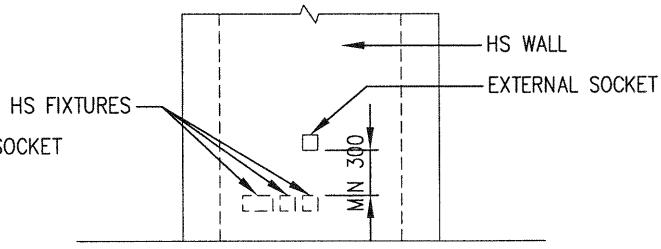
FIGURE 3.5.4(r) PLAN OF HS WALLS WITH PRECAST HS DOOR FRAME PANEL (TYPE 3)



PLAN

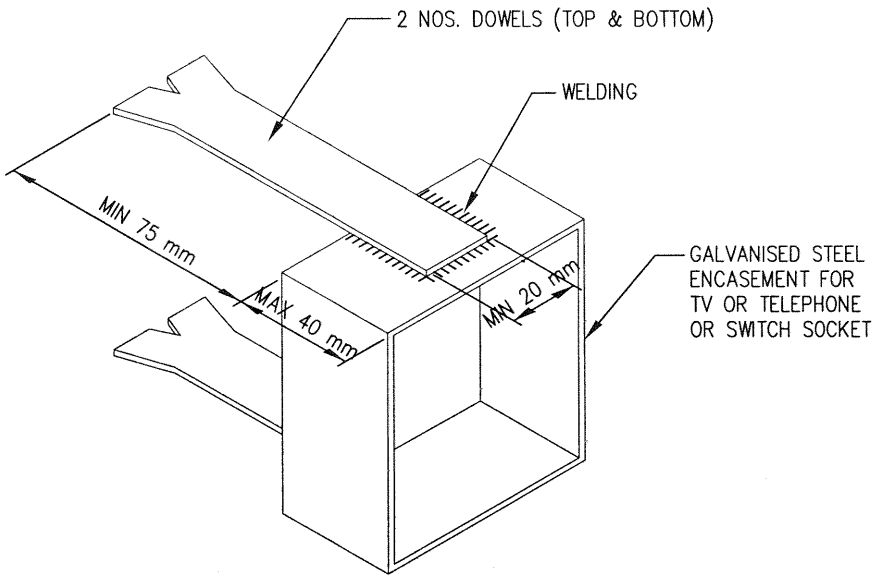


VIEW 'A'
(ALTERNATIVE 1)



VIEW 'A'
(ALTERNATIVE 2)

FIGURE 3.6.1(a) MOUNTING OF SERVICES ON EXTERNAL WALL OF A HS



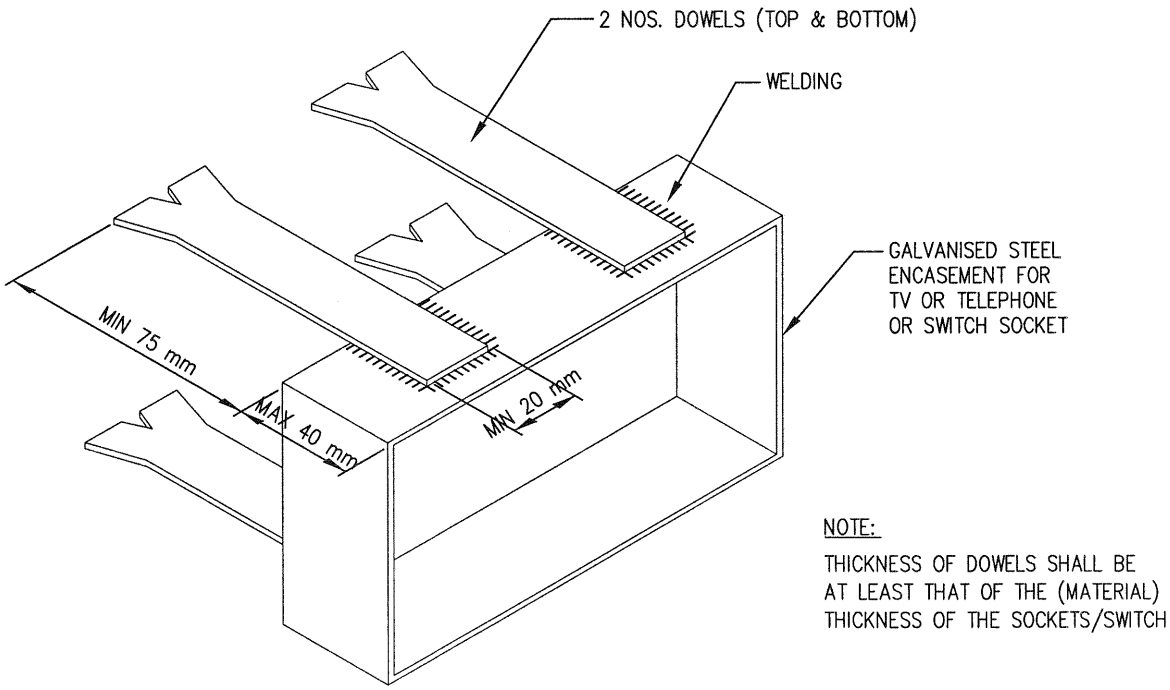
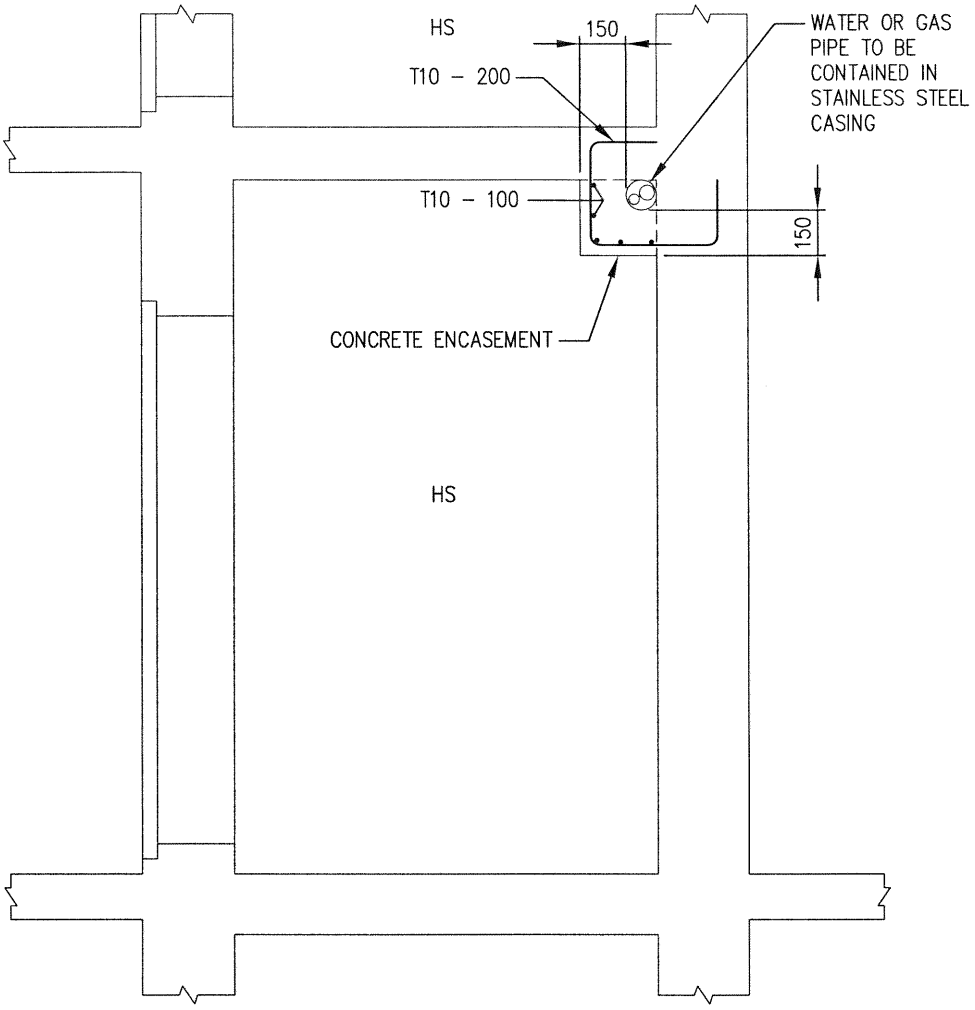
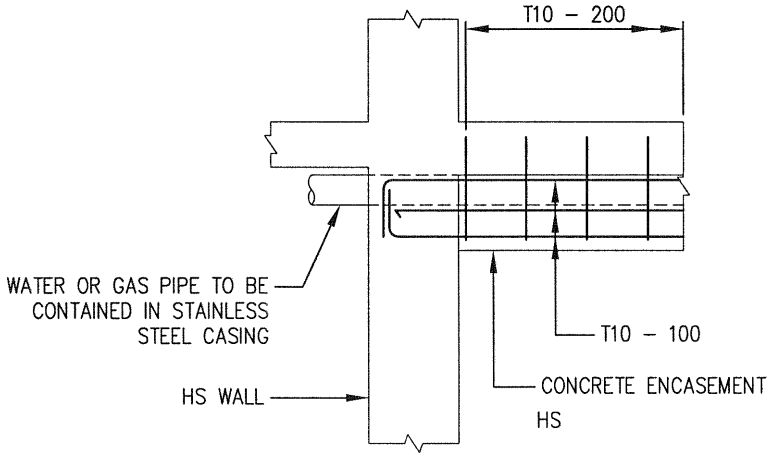


FIGURE 3.6.1(b) TYPICAL DETAILS OF EMBEDDED SOCKET/SWITCH



SECTION OF HS



END CONNECTION DETAILS

FIGURE 3.6.2 ENCASEMENT DETAILS OF WATER / GAS SERVICE PIPES PENETRATING THROUGH HS WALLS

CHAPTER 4

VENTILATION SLEEVES

CHAPTER 4: VENTILATION SLEEVES

4.1 GENERAL

Two 125 mm diameter ventilation sleeves shall be cast into the wall/s of each HS.

4.2 POSITION

(a) The two ventilation sleeves may be positioned on different walls or on the same wall of the HS.

(b) The position of each ventilation sleeve shall comply with the following (See FIGURE 4.2(a), 4.2(b), and 4.2(c)):

(i) The height of each opening, measured from the centre of the opening to internal FFL of the HS shall be between 1900 mm and 2600 mm;

(ii) The ventilation sleeve shall be positioned such that there is sufficient clear space around it. The clear space around it shall be of an area of at least 600 mm diameter (or 300 mm radius), measured concentrically from the centre of the opening to any structural elements within the HS,

(iii) Where the ventilation sleeve is placed above or adjacent to the HS door, the centre of the opening shall be at least 250 mm from the nearest edge of the door frame ;

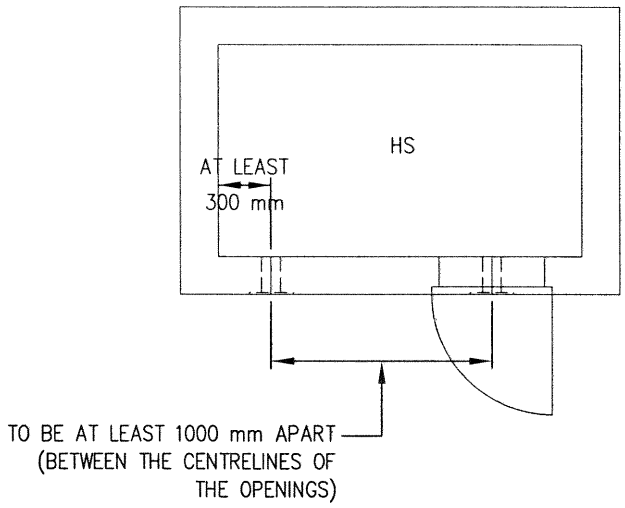
(iv) The shortest distance between the centres of the two ventilation sleeves shall be at least 1000 mm.

4.3 FALSE CEILING BELOW VENTILATION SLEEVES

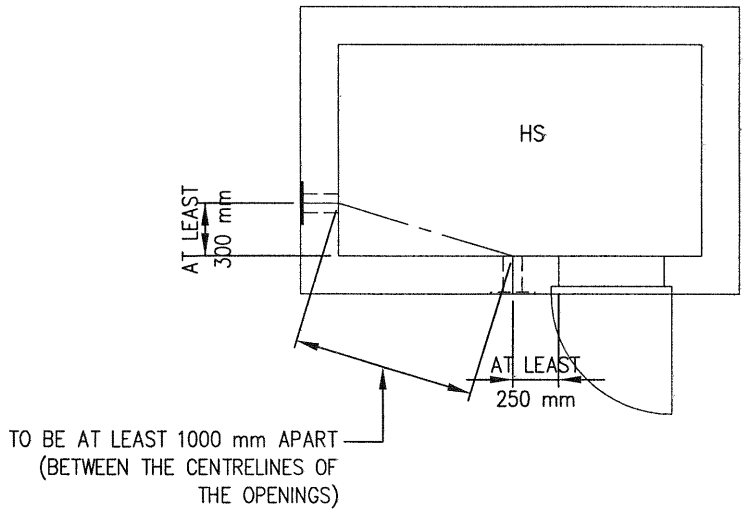
Where false ceilings are provided outside the HS and below the ventilation sleeves, there shall be one access panel of a minimum size of 600 mm x 600 mm positioned directly below each ventilation sleeve.

4.4 FRAGMENTATION PLATE

Each ventilation sleeve shall have a 6 mm thick stainless steel fragmentation plate mounted on the external face using 10 mm stainless steel bolts (See FIGURE 4.2(c)).

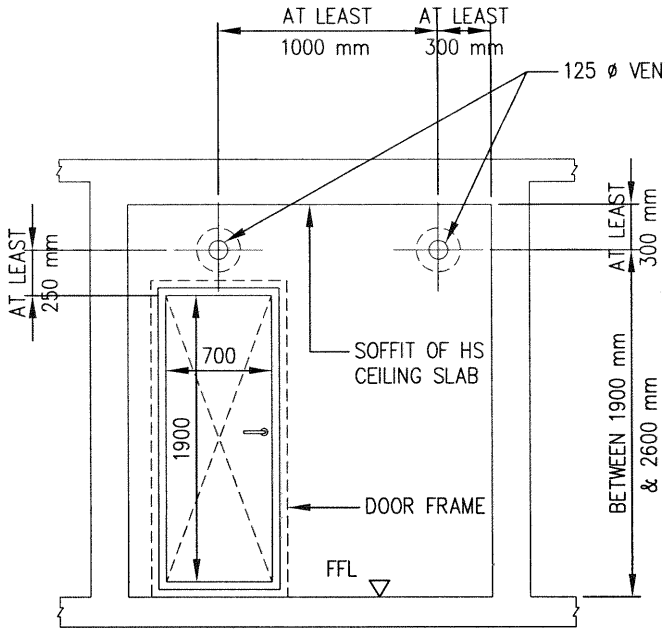


PLAN
(DWELLING UNIT A)

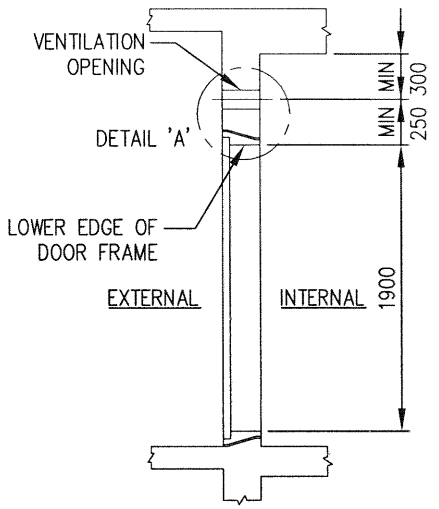


PLAN
(DWELLING UNIT B)

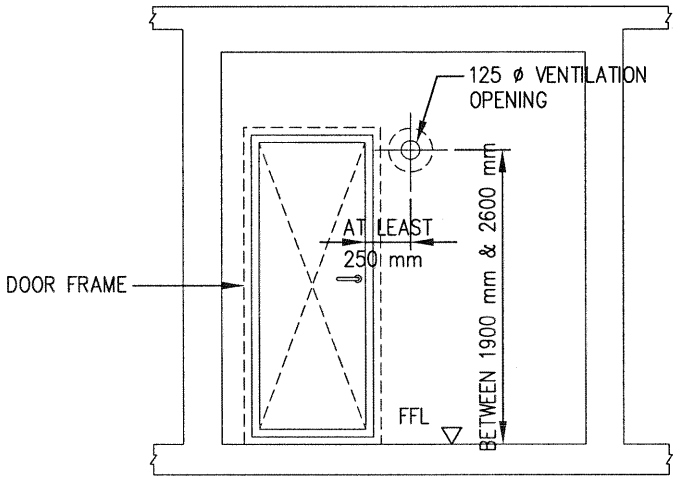
FIGURE 4.2(a) POSITION OF VENTILATION SLEEVES



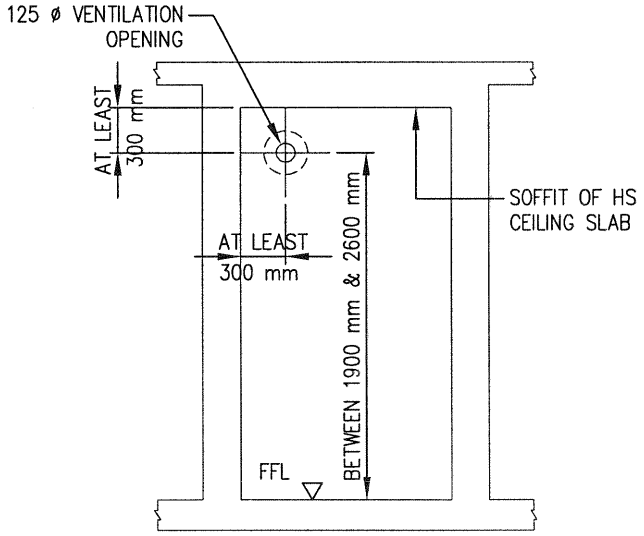
SECTION A – A



SECTION B – B

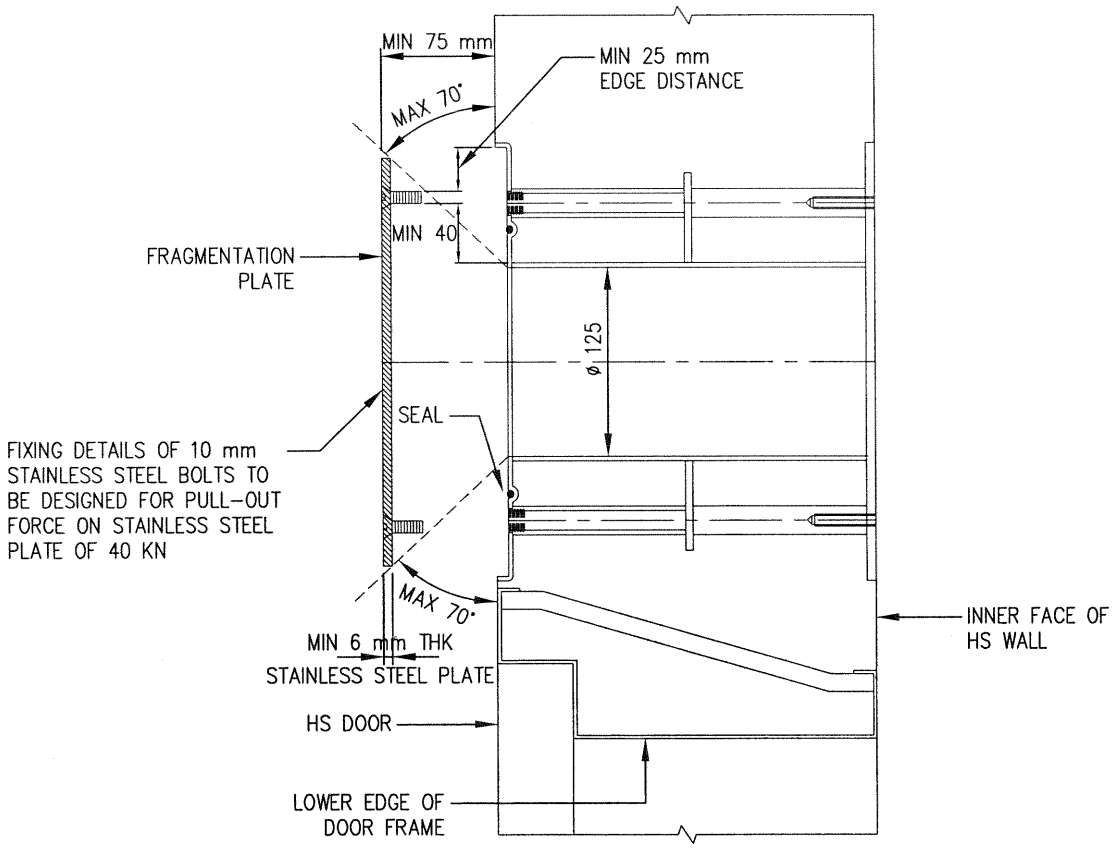


SECTION C – C

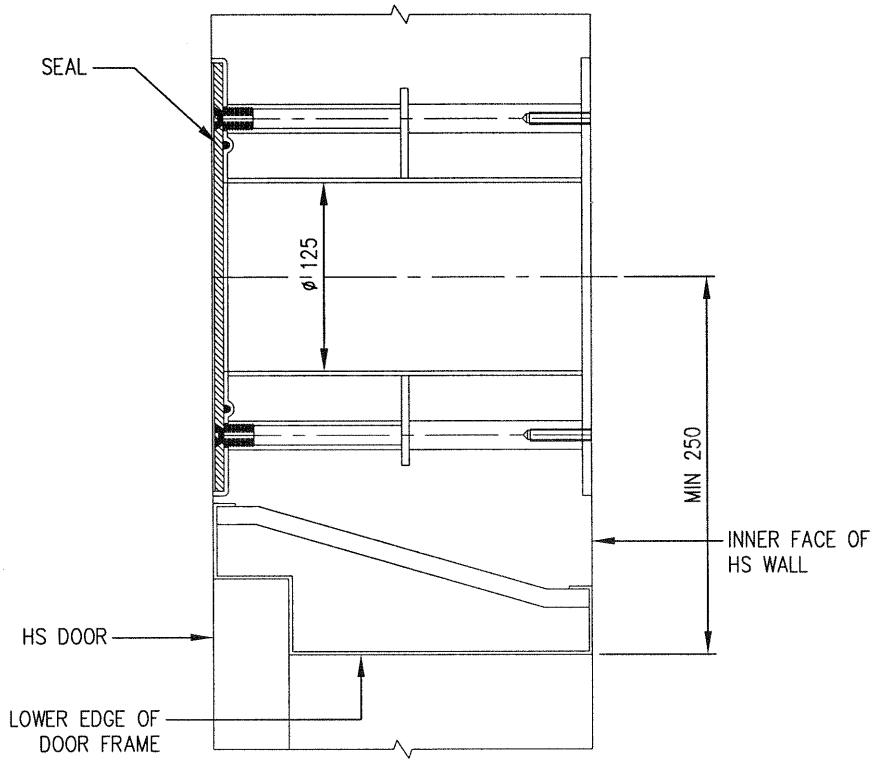


SECTION D – D

FIGURE 4.2(b) SECTIONAL VIEW OF VENTILATION SLEEVES



VENTILATION SLEEVE AT OPEN POSITION
(DETAIL 'A')



VENTILATION SLEEVE AT CLOSED POSITION
(DETAIL 'A')

FIGURE 4.2(c) DETAILS OF VENTILATION SLEEVE

CHAPTER 5

HS DOOR

CHAPTER 5: HS DOOR

5.1 GENERAL

The HS door shall provide an airtight closure to the HS, and shall be designed to open outwards from the HS.

Door frame/jambs with two rebates is allowed subject to consultation with Relevant Authority on the reinforcement detailing before fabrication.

5.2 APPROVED HS DOOR

Only HS doors of an approved design, and which have been certified and listed under the Product Listing Scheme to the test standards and specifications shall be used.

5.3 HS DOOR NOTICE

Every HS door shall have a HS door notice affixed on its internal face (See FIGURE 5.3(a)). A sample notice is shown in FIGURE 5.3(b).

5.4 SPECIFICATION OF HS DOOR NOTICE

(a)	Manner of Application	:	For affixing onto painted steel door
(b)	Application Surface	:	Flat
(c)	Application Procedure	:	Hand applied
(d)	Adhesive	:	Pressure sensitive and strong adhesive
(e)	Special Features	:	Non-brittle, rub and mar resistant, storage stability and colour fastness under light
(f)	Text, Lettering, Layout	:	Conform to sample notice
(g)	Colours	:	Background is light yellow, lettering is black, subheadings, border and triangular logo area are red

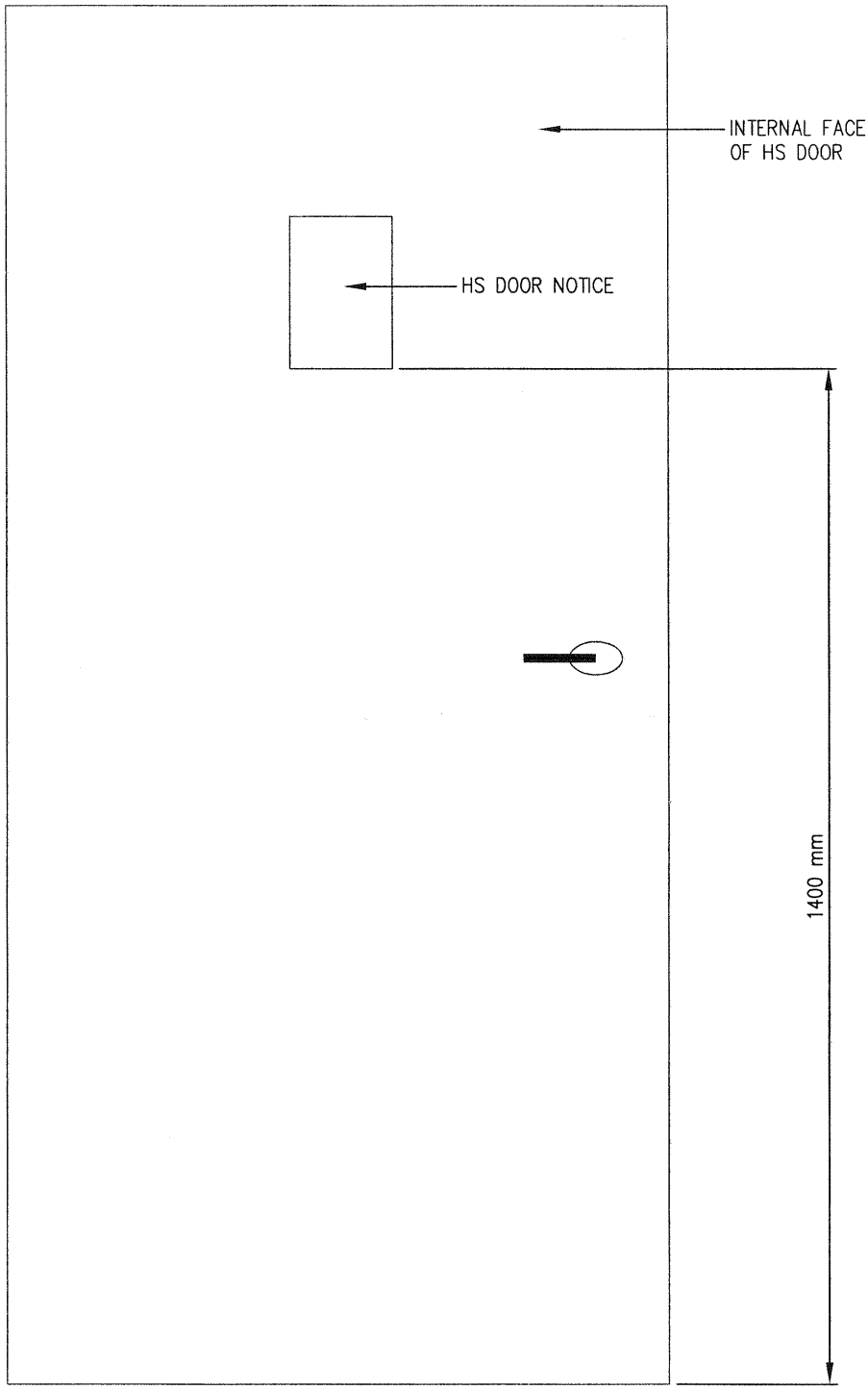


FIGURE 5.3(a) LOCATION OF NOTICE ON HS DOOR

NOTICE

This room is also a civil defence shelter provided under the Civil Defence Shelter Act 1997.

For your safety and protection,

- *In the event of a fire, do not stay in the shelter. Leave the building.*
- *Keep every fixture installed in the shelter in good working condition at all times.*
- *Keep at least one of the 2 ventilation holes open to ventilate the shelter at all times.*

For renovation works in the shelter,

- *If this is an HDB apartment, consult the HDB branch office. If this is a private house or apartment, consult your building management corporation or the Singapore Civil Defence Force (SCDF).*

During an emergency,

- *Follow SCDF instructions or guidelines on what to do. These will be issued when the need arises.*

Please refer to the diagram below on how to operate the door to the shelter

- *Civil Defence Mode*
- *Normal Mode*

通 告

在一九九七年民防防空所法令下，这是一间受管制的室内防空所。

为了保障您的安全，

- 屋内发生火患时，立刻离开您的住所。
- 时刻确保室内防空所的设备及系统正常操作。
- 其中的一个通风窗应时刻开着。

室内防空所装修准则，

- 如住所是建屋发展局的组屋，应向建屋发展分局询问。若是私人产业则向其管理委员会或新加坡民防部队查询。

当紧急事故发生时，

- 请遵循新加坡民防部队在紧急事故发生时所发出的通告。

请参阅下列图表以了解防空门的操作，

- 民防操作法。
- 普通操作法。

NOTIS

Bilik ini adalah sebuah kubu pertahanan awam. Ini adalah di bawah Akta Kubu Pertahanan Awam 1997.

Untuk keselamatan dan perlindungan anda,

- *Jika berlaku kebakaran, jangan mengambil perlindungan di dalam kubu. Tetapi keluar dari bangunan itu.*
- *Pastikan setiap alat yang dipasang di dalam kubu perlindungan dijaga dengan rapi setiap masa.*
- *Pastikan salah satu daripada dua saluran udara di dalam kubu perlindungan tidak ditutup.*

Untuk kerja ubah elok di tempat perlindungan,

- *Jika anda tinggal di perumahan HDB, runding dengan pejabat daerah HDB bila anda ingin menjalankan ubah elok rumah. Untuk mengubah elok rumah privet, rundinglah dengan majlis bangunan atau hubungi Pasukan Pertahanan Awam Singapura.*

Di waktu kecemasan,

- *Patuhi arahan atau panduan Pasukan Pertahanan Awam. Keterangan lanjut akan diumumkan bila perlu.*

Sila rujuk pada gambar rajah yang tertera di bawah untuk mengetahui cara menggunakan pintu untuk ke bilik perlindungan

- Kaedah kecemasan
- Kaedah biasa

அறிவிப்பு

இந்த அறையை குடிமைத் தற்காப்பு காப்பறையாகவும் பயன்படுத்தலாம். இது குடிமைத் தற்காப்பு காப்பறை சட்டம் 1997ல் வழங்கப்பட்டுள்ளது.

உங்கள் பாதுகாப்புக்கு நீங்கள் செய்யவேண்டியவை,

- தீ ஏற்பட்டால், காப்பறையில் இருக்காதீர்கள். கட்டிடத்திலிருந்து வெளியேறுங்கள்.
- காப்பறையின் ஒவ்வொரு பகுதிகளையும் நல்ல சீர் நிலையில் வைத்திருங்கள்.
- எந்த நேரத்திலும், காப்பறையில் உள்ள இரண்டு காற்றோட்ட திறப்புகளில் ஏதேனும் ஒன்றை மூடாமல் வைத்திருங்கள்.

காப்பறை புதுப்பிப்பு வேளைக்கு செய்யவேண்டியவை,

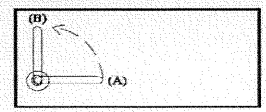
- உங்கள் வீடு ஓர் HDB வீடாக இருப்பின், அதன் கிளை அலுவலகத்தை அலுவலக தொடர்பு கொள்ளுங்கள். அதே ஓர் தனியார் வீடாக இருக்குமானால், உங்கள் கட்டட நிர்வாக கழகத்தையோ அல்லது சிங்கப்பூர் குடிமைத் தற்காப்புப் படையை தொடர்பு கொள்ளுங்கள்.

அவசரக்காலத்தின்போது,

- சிங்கப்பூர் குடிமைத் தற்காப்பு படையின் குறிப்புகளை அல்லது விதி முறைகளைப் பின்பற்றுங்கள். இவை தேவை ஏற்படும்போது வழங்கப்படும்.

கீழே கொடுக்கப்பட்டிருக்கும் படத்தில் காணப்படும் விதிமுறைப்படி காப்பறைகளின் முறையை கையாளுங்கள்.

- குடிமைத் தற்காப்பு முறை
- இயல்பான முறை



(A) Normal Mode
普通操作法
Kaedah biasa
இயல்பான முறை

(B) Civil Defence Mode
民防操作法
Kaedah kecemasan
குடிமைத் தற்காப்பு முறை

CIVIL DEFENCE
READINESS IS YOUR ONLY PROTECTION

FIGURE 5.3(b) SAMPLE HS DOOR NOTICE

CHAPTER 6

CONSTRUCTION AND COMMISSIONING

CHAPTER 6: CONSTRUCTION AND COMMISSIONING

6.1 GENERAL

As the HS is designed to resist weapon effects, good workmanship is essential to achieve the designed protection level.

6.2 STRUCTURAL WORKS

The following shall be observed:

(a) Only the non-removable type of form-tie (form-tie without through opening) to secure formwork before casting of HS wall is permitted. Upon the removal of every recessible type of plastic cones from the form-tie, the void shall be sealed with non-shrink grout. The use of reinforcement bar as form-tie is not permitted.

(b) All embedded items shall be placed in their planned location. They are to be tightly secured to ensure their stability during casting. Indiscriminate hacking and drilling of HS tower walls, ceiling slabs or floor slabs are not permitted.

(c) To avoid bending, warping or displacement of HS door frame and honeycombing due to inadequate compaction or leakage of cementitious grout, additional precaution shall be taken while casting the concrete near the HS door frame.

(d) The exposed surfaces of HS walls and soffit of HS ceiling slabs shall be cast with smooth concrete finish. A maximum of 2 mm thick skim coat on the internal face of the HS walls and ceiling slabs of HS is allowed.

(e) The concrete structural elements shall be adequately compacted to ensure air-tightness. Concrete areas with segregation or honeycombing shall not be accepted without acceptable rectification.

(f) Irregularities of exposed surfaces shall not be indiscriminately hacked and plastered back.

(g) Method statement of the remedial work on structural elements, including HS door frame, shall be approved by the relevant authority

6.3 HS DOOR

The following shall be observed:

(a) Allowing an opening in the HS wall and later erecting the HS door frame and door leaf in this opening, followed by casting concrete around it is not permitted.

(b) When casting the HS wall with HS door frame, a dummy door leaf of adequate design shall be placed to ensure the stability and prevent the bending, warping or displacement of the HS door frame during concreting.

(c) The FFL of the floor slab outside the HS shall be done such that the HS door can be opened adequately for the peacetime use of the HS.

6.4 PEACETIME REQUIREMENT OF VENTILATION SLEEVES

For ventilation purposes during peacetime, at least 25% of total area of the two ventilation openings shall be kept uncovered.

6.5 COMMISSIONING REQUIREMENTS

All fixtures such as HS door notice, TV/ radio point, telephone points and electrical points shall be provided inside the completed HS. The service conduits with electrical cables serving the HS shall be provided prior to commissioning.

A HS is considered commissioned only if the HS passes all the following tests in one inspection:

(a) Light penetration test of HS door – an acceptable test method to check on light penetration into the HS is to use a torchlight from the exterior of HS door. The test is considered to have passed if no light could be seen from the inside of HS.

(b) Chalk mark test on the HS door – an acceptable test method is to apply chalk to the part of the door frame where the door seal will come into contact with when the door is closed. The test is considered to have passed if there is an unbroken and uniform transfer of the chalk markings onto the door seal when the door is closed and re-opened.

(c) Air-tightness test of the HS – an acceptable test method is to pressurise the HS and measure the rate of pressure drop. A water manometer is required to measure the pressure difference between the interior and exterior of the HS. The HS is pressurised to a manometer level difference of 25 mm. The HS is considered to have passed the test if the manometer level difference is not less than 5 mm after 45 seconds.

The ventilation sleeves of the HS, which have been closed for the commissioning tests, shall be opened after the tests to comply with Clause 6.4 for ventilation during peacetime.

CHAPTER 7

PERMITTED AND NOT PERMITTED WORKS IN HS TOWER

CHAPTER 7: PERMITTED AND NOT PERMITTED WORKS IN HS TOWER

7.1 GENERAL

Any repair or alteration or renovation works, which are likely to weaken or damage any structural elements of the HS or NS, is not permitted.

7.2 PERMITTED AND NOT PERMITTED WORKS

7.2.1 Permitted Works in HS

(a) Laying of floor tiles bonded to wet cement mortar. The total thickness of floor finishes and screed is not to exceed 50mm.

(b) Laying of vinyl or linoleum flooring.

(c) Laying of floor skirting tiles (up to a maximum of 100 mm high) by bonding them with wet cement mortar to HS walls.

(d) Applying splatterdash or equivalent to the external face of HS walls only to provide rough surface for feature wall panels or wall tiles installation.

(e) Painting of walls, ceiling or door. In the case of HS door, owners shall not cover up or paint over the HS door notice (See Clause 5.3), locking bolts or door seal. The old paint coat on door and door frame is to be removed prior to repainting to avoid increase paint thickness resulting in difficulty in closing and opening of the door. The new paint coat must be dried up completely before closing the door as wet or damp paint will cause the door/ rubber gasket to stick onto the door frame resulting in opening the door.

(f) Painting on only the exterior face of the 6mm fragmentation stainless steel plate of the ventilation sleeves.

(g) Fixing of removable screws with non-metallic inserts not exceeding 50 mm deep for fixtures and equipment e.g. pictures, posters, cabinets or shelves etc. Such fixtures that are installed inside the HS will have to be removed by the owners within 48 hours upon notification. There is no restriction to the diameter of the non-metallic insert as long as it does not exceed 50mm in length. It is the owner's responsibility to ensure that the strength of the insert is adequately provided for the intended purpose.

(h) Removal of the fragmentation plates (Clause 4.4) covering the ventilation openings shall be carried out subject to the following conditions:

(i) The plates (after removal) shall be securely mounted with removable screws on non-metallic inserts not exceeding 50 mm deep on one of the internal face of HS walls.

(ii) After the removal of plates, the bolts and nuts shall be installed back to their original positions on the ventilation sleeves.

(iii) Closing or covering up of ventilation openings by removable aesthetic or architectural finishes is allowed, provided that at least 25% of the total area of the two openings shall be left uncovered for ventilation purposes during peacetime.

(i) Power driven nails are allowed only on external face of the HS walls to facilitate flexibility in mounting of features/ fixtures by owners.

(j) Where false ceilings, which are provided on the exterior of the HS, are to be installed at a level below the ventilation sleeves, there shall be one access panel of a minimum size of 600 mm x 600 mm to be provided directly below each ventilation sleeve.

7.2.2 Not Permitted Works in HS

(a) Laying of wall tiles or spray of rock tone finish, cement sand finish and gypsum plastering for on the internal faces of HS walls.

(b) Laying of floor tiles using adhesive materials.

(c) Laying of 2nd layer of tiles on floor or skirting tiles.

(d) Installation of cornices within the HS.

(e) Installation works with fixings using power driven nails into the internal HS walls.

(f) Tampering with, removing or covering up of the HS door notice. The HS door notice provides important information to the occupants on the use of the HS.

(g) Indiscriminate hacking and drilling of HS walls, floor slabs, and ceiling slabs, other than drilling into HS walls and ceiling slabs to affix removable screws on inserts, provided the depth of the insert shall not exceed 50 mm.

(h) Hacking to both internal and external face of the household shelter walls to form key for tiling.

(i) Hacking or indiscriminate drilling on external face of HS wall for mounting of feature wall panels or wall tiles installation.

(j) Modifying, changing, removing or tampering of HS door.

(k) Modifying, altering or tampering with any part of the ventilation openings, plates and the mounting devices such as bolts and nuts.

(l) Painting to the interior face of the 6mm fragmentation stainless steel plate of the ventilation sleeves, the ventilation sleeves, "O" ring rubber gaskets and the four or eight numbers of stainless steel bolts which hold the steel plate to the sleeves.

7.2.3 Not Permitted Works in NS

Indiscriminate hacking and drilling of NS walls, floor slabs, and ceiling slabs, other than drilling into NS walls and ceiling slab to affix removable screws on inserts, provided the depth of the insert shall not exceed 50 mm.