Dear Sir/Mdm,

AMENDMENT TO TECHNICAL REQUIREMENTS FOR DESIGN AND CONSTRUCTION OF PRECAST HOLLOW CORE HOUSEHOLD SHELTERS 2013

A circular dated 25 Jan 2013 was issued by SCDF on the permissible variations for technical requirements for precast household shelter designs. SCDF and BCA have gathered feedback from the building industry and made amendments to the precast household shelter technical requirements for greater clarity and design flexibility.

2 The amendments to the technical requirements include a common modular increase in the length and width of the precast HS; dimensions between the core and the nearest fixtures; details of closed link at the starter bar level for the cast in-situ joint between two HS; shear key design on HS for precast plank or cast in-situ slab construction and the details of tapered hollow cores for ease of production; etc. The key amendments are summarised in Annex A. The amended technical requirements for design and construction of the precast hollow core household shelters are attached in Annex B for easy reference.
3   The amended technical requirements shall take immediate effect. Please convey the contents of this circular to members of your Institution/Association/ Board. The circular is also available in CORENET-e-Info: [http://www.corenet.gov.sg/einfo](http://www.corenet.gov.sg/einfo). For any inquiry or clarification, please contact the undersigned at 68481478.

Yours faithfully,

MAJ ANG GUAN HOCK  
SSO SHELTER DEVELOPMENT  
FIRE SAFETY & SHELTER DEPARTMENT  
FOR COMMISSIONER  
SINGAPORE CIVIL DEFENCE FORCE

cc  
CEO, BCA  
CEO, URA  
CEO, HDB  
President, IFE  
President, SISV  
FSSD Standing Committee
<table>
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<th>S/No</th>
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<th>Amendment</th>
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<tr>
<td>1</td>
<td>Dimensions of Precast Hollow Core Household Shelters. Refer to page B-8 to B-11, figure 1 to 9.</td>
<td>Modular increment in length and width of the precast hollow core HS for all the 7 types of the precast HS designs to allow for more flexibility in terms of dimensions between the hollow core and the nearest fixtures.</td>
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<tr>
<td>2</td>
<td>Reinforcement Bar Requirements. (a) Refer to page B-12, figure 10. (b) Refer to page B-13 to B-15, figure 11 to 16. (c) Refer to page B-17, figure 18. (d) Refer to page B-19, figure 22.</td>
<td>Additional information on the hollow core dimensions with 15mm tapering all round from the bottom to the top of the core to provide clarity on the dimensions and the required clearance for the tapering design. Additional details on the shear link and starter bar for cast-in-situ joint between two HS. Additional details for the shear key designs and the dimensions for precast plank or cast-in-situ joint construction. Additional notes to reinforce the requirements of rebar size; no. of rebar and its clear space arrangement.</td>
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<td>3</td>
<td>Connection Between Precast Hollow Core Household Shelters. Refer to page B-20, figure 23.</td>
<td>Additional notes on the requirements of structural safety and technical requirements for HS to be fulfilled and designed by qualified person.</td>
</tr>
<tr>
<td>4</td>
<td>Blocked-Out at Precast Hollow Core Household Shelters. Refer to page B-24 and B-25, figure 29 and 30 respectively.</td>
<td>Additional notes on the shear key requirements between two precast hollow core HS.</td>
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TECHNICAL REQUIREMENTS FOR DESIGN AND CONSTRUCTION OF PRECAST HOLLOW CORE HOUSEHOLD SHELTERS 2013

(AMENDED ON 25 NOVEMBER 2013)
## Annex B

### Contents

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Figures 1 to 30 : Details of Precast Hollow Core Household Shelters ..............B-8 to B-25
Technical Requirements for the Design and Construction of Precast Hollow Core Household Shelters (HS)

A  General

1. Precast hollow core household shelter shall comply with the latest Technical Requirements for Household Shelters unless otherwise specified in this part of technical requirements for precast hollow core household shelters.

B  Dimensions of Precast Hollow Core Household Shelters

2. Precast hollow core household shelters (hereafter known as precast household shelters) must be designed to meet the area and volume requirements. The internal length and width of the household shelter (HS) walls shall be modular in size with an increment of 50mm. Precast household shelters including the dimensions and spacing of modular hollow cores (See Tables A & B, Annex B), location of shear key on wall above HS door, ventilation sleeves, blast door and electrical fixtures are shown in Figures 1 to 10 of Annex B:

   a) Figure 1 : Precast HS with HS door on longer wall and one of ventilation sleeve above the door (Type 1).

   b) Figure 2 : Precast HS with HS door on shorter wall and one of ventilation sleeve above the door (Type 2).

   c) Figure 3 : Precast HS showing ventilation sleeve and internal electrical fixtures on the same wall (Type 3).

   d) Figure 4 : Precast HS and C-shaped Precast HS connected at the shorter wall and with HS Doors on long walls (Type 4).

   e) Figure 5 : Precast HS and C-shaped Precast HS connected at the longer wall and with HS doors on long walls (Type 5).

   f) Figure 5A : Precast HS and C-shaped Precast HS connected at the longer wall and with HS door each on long wall and short wall (Type 5A).

   g) Figure 6 : Precast HS and C-shaped Precast HS with connection between longer and shorter walls respectively and with HS doors on long walls (Type 6).

   h) Figure 6A : Precast HS and C-shaped Precast HS with connection between longer and shorter walls respectively and with HS door each on long wall and short wall (Type 6A).

   i) Figure 7 : Precast HS adjoining Cast in-situ Walls/ Columns (Type 7).
3. To facilitate de-moulding of the precast household shelter, the hollow cores shall be tapered all round throughout its height as shown in Figure 10.

4. Where possible, hollow core of maximum 500mm long shall be adopted to achieve lighter precast household shelter for ease of handling.

C Reinforcement Bar Requirements

5. The reinforcement of precast household shelter shall be welded steel fabric mesh and hot rolled steel bars. Reinforcement bars specified for precast slab, walls and hollow cores of the precast household shelter refer to minimum bar diameters and maximum spacing in both directions.

6. In the precast HS walls, reinforcement bars shall be welded steel fabric mesh of minimum T10 at 100mm spacing or minimum T13 at 100mm spacing depending on the clear height of household shelter as given in the Technical Requirements for Household Shelters.

7. The details of reinforcement bars for precast HS, C-shaped Precast HS, the rib of precast HS, connection to precast HS, door frame, electrical fixtures, trimmer bars around ventilation sleeve and at door recess, and hollow cores are shown in Figures 11-23 of Annex B:

   a) Figure 11 : Reinforcement Bar Details of Wall and Rib for Precast HS (Type 1).

   b) Figure 11A : Plan and Section of Rib with Shear Links.

   c) Figure 12 : Reinforcement Bar Details of Wall and Rib for Precast HS (Type 2).

   d) Figure 13 : Reinforcement Bar Details of Wall and Rib for C-Shaped Precast HS (Type 5).

   e) Figure 14 : Reinforcement Bar Details of Wall and Rib for C-Shaped Precast HS (Type 6).

   f) Figure 15 : Connection Details Between Two-Precast HS.

   g) Figure 16 : Connection Details Between Precast HS and Cast in-Situ Wall/Column.

   h) Figure 17 : Reinforcement Bar Details of Rib.
i) Figure 18 : Details of Reinforcement Bars near Door Frame and at Electrical Fixtures on Internal Face of Precast HS.

j) Figure 19 : Details of Trimmer Bars for Ventilation Sleeve.

k) Figure 20 : Details of Trimmer Bars for Wall Recess for HS Door Handle.

l) Figure 21 : Cage Reinforcement Bars in Hollow Cores.

m) Figure 22 : Reinforcement Bars in Hollow Cores of Precast HS with and without adjacent Ventilation Sleeve, Door and Internal Electrical Fixtures.

n) Figure 23 : Reinforcement Bars Lapping in Hollow Cores.

8. For the rib between two hollow cores, its top and bottom portion shall be provided with closer shear links of at least 6 number of R6 at 100mm spacing. For area between these top and bottom portions, minimum shear link of at least R6 at 600mm spacing shall be provided. (See Figure 17). The hook of the shear link must be anchored around the outermost bars of the internal face of precast HS wall.

9. The reinforcement bars for the HS door frame, ventilation sleeves and wall recess for electrical fixtures on internal face of HS wall are shown in Figures 18 to 20. As shown in the Figures, the wall recess for electrical fixtures on internal face of HS wall shall be located next or near to the HS door.

10. The modular length of the hollow cores shall vary from minimum 200mm to maximum 500mm with increment of 100mm whereas the modular width of hollow cores shall be minimum 150mm and maximum 200mm with increment of 25mm as shown in Table C. In these hollow cores, minimum cage reinforcement bars and links shall be provided and installed as shown in Figures 21 and 22, Tables D and E. Higher reinforcement bars and links shall be provided if they are required to meet the structural safety and stability requirements.

11. All reinforcement bars must be designed and detailed with tension anchorage or lapped length. The cage reinforcement bars for hollow cores of precast household shelter wall shall be cranked at their upper parts to facilitate placing of the reinforcement bars at lapping level (See Figure 23).

D Connection Between Precast Hollow Core Household Shelters

12. The connections between hollow cores are shown in Figures 24, 24A and 25 of Annex B :

a) Figure 24 : Splice Sleeve Connection Details Between Precast HS and Cast In-Situ Element and Bolt Connection Details Between Two Precast HS.

b) Figure 24A : Splice Sleeve Connection Details for Precast HS Tower
c) Figure 25 : Connection Details Between Lower and Upper Precast HS.

13. Where precast household shelter is supported on cast in-situ elements (beam, or wall), T28 dowel bars shall be cast in the in-situ elements for splice sleeve connection between the precast household shelter and the cast in-situ elements. These dowel bars must be properly secured in position such that they are in line with the splice sleeve of the precast hollow core household shelter as shown in Figure 24 and Figure 24A. The splice sleeve shall be pressure-grouted with minimum Grade 70 grout to design and manufacturer’s specification.

14. The lower and upper precast household shelters can be connected by bolt and steel plate connection or splice sleeve connection as shown in Figure 25 of Annex B. To facilitate installation, T28 bars required for these two types of connection shall be properly secured in position at 4 top corners of lower precast household shelter wall with a template such that they are aligned with the bolt holes or splice sleeve provided at the base or lower part of the upper precast household shelter respectively.

E Precast Slab of Household Shelter

15. The minimum reinforcement bars to be provided for precast plank and structural concrete topping shall be as shown in Figure 26, Annex B. Table E shows the thickness of slab, precast plank and in-situ concrete topping.

   a) Figure 26 : Details of Precast Plank (marked as PS) and Concrete Topping.

16. The shear links shall be cast in the precast plank. The hook of the shear link must be anchored around outermost layer of bottom reinforcement bars of the precast plank. The bend of the shear link shall be anchored round the outermost layer of top reinforcement bars in the concrete topping.

F External Electrical Fixtures

17. Where there are electrical fixtures on external face of HS wall, a recess shall be formed on the rib of the precast household shelter wall. The reinforcement bars around the recess shall be as shown in Figure 27 of Annex B.

   a) Figure 27 : Electrical Fixtures on External Face of Precast HS.

G Ventilation Sleeves

18. One of the two ventilation sleeves shall be located above the shelter door.

19. Ventilation sleeve shall not be located at the connection joint between two precast shelter walls.
H  Door Recess on HS Wall

20. A recess shall be formed on the external face of the precast HS wall to accommodate the HS door handle when the HS door is open in 180°. The recess shall not be larger than 160 mm (length) x 80 mm (height) x 40 mm (depth).

I  Blocked-Out at Precast Hollow Core Household Shelters

21. Reinforcement bar details for the blocked out at the bottom part of the outer wall of hollow cores are shown in Figures 17 and 23. In the blocked-out area where the cast in vertical reinforcement bars are exposed, horizontal reinforcement bars and shear links are to be installed at site.

22. Where the blocked-out is required for supporting in-situ beam, it shall be limited to outer wall of hollow core or outer part of precast household shelter wall. Blocking out any part of the inner wall of the hollow core for in-situ construction works is not allowed. The isometric views of precast HS showing blocked-out areas and exposed reinforcement bars are in Figures 28 and 29 of Annex B.

   a) Figure 28  :  Isometric View of Precast HS with bolt and steel plate connection (without blocked out for Beam).

   b) Figure 29  :  Isometric View of Precast HS with bolt and steel plate connection (with blocked out for Beam).

23. For a beam with more than one support, the end of a beam that is supported on the household shelter wall shall be designed and detailed as simply support.

24. Figure 30 shows Isometric View of Precast HS with Splice Sleeve Connection (Reinforcement Bar Details)
**Annex B**

**Figure 1:** Precast HS with HS door on longer wall and one of ventilation sleeve above the door (Type 1)

(HS denotes Household Shelter and CS denotes Precast Panels)

**Figure 2:** Precast HS with HS door on shorter wall and one of ventilation sleeve above the door (Type 2)

**Figure 3:** Precast HS showing ventilation sleeve and internal electrical fixtures on the same wall (Type 3)

**Figure 4:** Precast HS and C-shaped precast HS connected at the shorter wall and with HS doors on longer walls (Type 4)

(Under joint details "A", refer to Figure 15)

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**Table A**

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<td>d</td>
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<td>w</td>
<td>300 150</td>
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*Dimensions with increments of 100 mm

**Table B**

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**N.B.**

1. Internal length (L) and width (W) of the HS walls shall be modular in size with an increment of 50 mm.
2. Arrangement of hollow cores shown are indicative only.
3. Building plan shall indicate precast HS layout showing arrangement of hollow cores with dimensions and spacing.
4. Hollow cores shall be modular in size with increment of 100 mm for length (L) and 25 mm for width (W).
5. Hollow cores shall be 500 mm long where possible to achieve a lighter precast HS for ease of handling.
6. Other sizes of hollow core can be used to fill up the wall area where possible. 300 mm long hollow core cannot be formed.
**Annex B**

**Figure 5:** Precast HS and C-shaped Precast HS connected at the longer wall and with HS doors on long walls (Type 5)

*(For joint details, refer to Figure 10)*

**Figure 5A:** Precast HS and C-shaped Precast HS connected at the longer wall and with HS door each on long wall and short wall (Type 5A)

*(For joint details, refer to Figure 10)*

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**Table A**

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<td>D***</td>
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*DIMENSIONS WITH INCREMENT OF 50 mm
**DIMENSIONS WITH INCREMENT OF 50 mm
***DIMENSIONS WITH INCREMENT OF 25 mm

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**Table B**

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**Notes:**

1. THE INTERNAL LENGTH (L) AND WIDTH (W) OF THE HS WALLS SHALL BE MODULAR IN SIZE WITH AN INCREMENT OF 50 mm.

2. FOR ILLUSTRATION, MODULAR SIZE AND ARRANGEMENT OF HOLLOW CORES SHOWN ARE INDICATIVE ONLY.

3. BUILDING PLAN SHALL INDICATE PRECAST HS LAYOUT SHOWING ARRANGEMENT OF HOLLOW CORES WITH DIMENSION AND SPACING.

4. HOLLOW CORES SHALL BE MODULAR IN SIZE WITH INCREMENT OF 100 mm FOR LENGTH (L) AND 25 mm FOR WIDTH (W).

5. HOLLOW CORES SHALL BE NO LESS THAN 100 mm LONG WHERE POSSIBLE TO ACHIEVE A LIGHTER PRECAST HS FOR EASE OF HANDLING.

6. OTHER SIZES OF HOLLOW CORE CAN BE USED TO FILL UP THE WALL AREA WHERE 500 mm LONG HOLLOW CORE CANNOT BE FORMED.
FIGURE 6: PRECAST HS AND C-SHAPED PRECAST HS WITH CONNECTION BETWEEN LONGER AND SHORTER WALLS RESPECTIVELY AND WITH HS DOORS ON LONG WALLS (TYPE 6)

(For joint details A and W, refer to Figure 15)

FIGURE 6A: PRECAST HS AND C-SHAPED PRECAST HS WITH CONNECTION BETWEEN LONGER AND SHORTER WALLS RESPECTIVELY AND WITH HS DOOR EACH ON LONG WALL AND SHORT WALL (TYPE 6A)

(For joint details A and W, refer to Figure 15)
Annex B

FIGURE 7: PRECAST HS ADJOINING CAST-IN-SITU WALLS/COLUMNS (TYPE 7)

FOR DOOR DETAILS C' AND D', REFER TO FIGURE 10

FIGURE 8: SHEAR KEY FORMED ON WALL ABOVE HS DOOR

FIGURE 9: BLOCKED-OUT AT PRECAST HS FOR BEAM CONNECTION

NOTES:
1. FOR ILLUSTRATION, SIZE AND ARRANGEMENT OF HOLLOW CORES SHOWN ARE INDICATING ONLY.
2. FOR BEAM WITH MORE THAN ONE SUPPORTS, ONE END OF THE BEAM THAT IS SUPPORTED ON THE HS WALL SHALL BE DESIGNED AND DETAILED AS SIMPLY SUPPORT.
FIGURE 10: HOLLOW CORE SHAPE
Annex B

Figure 13: Reinforcement Bar Details of Wall and Rib for C-Shaped Precast HS (Type 5)

Figure 14: Reinforcement Bar Details of Wall and Rib for C-Shaped Precast HS (Type 6)
Annex B

Figure 15: Connection Details Between Two Precast HS

Figure 16: Connection Details Between Precast HS and Cast-in-Situ Wall/Column

Notes:
1. Pre-bent Z-shape bars (6) shall be bent at site to form a close link (L2) as shown in Detail 'A' at starter reinforcement bar level.

2. Pre-bent Z-shape bars (5) shall be bent to form precast loop bars (L2) with anchorage length as shown in Detail 'C'.

3. Minimum bar size of the link shall be the same as the wall reinforcement of the HS.
FIGURE 17: REINFORCEMENT BAR DETAILS OF RIB
Figure 18: Details of reinforcement bars near door frame and at electrical fixtures on internal face of precast HS.
**Annex B**

**FIGURE 19: DETAILS OF TRIMMER BARS FOR VENTILATION SLEEVE**

**FIGURE 20: DETAILS OF TRIMMER BARS FOR WALL RECESS FOR HS DOOR HANDLE**
Figure 21: Cage reinforcement bars in hollow cores

Figure 22: Reinforcement bars in hollow cores of precast HS with and without adjacent ventilation sleeve, door and internal electrical fixtures.
FIGURE 23: REINFORCEMENT BARS LAPPING IN HOLLOW CORES
Annex B

NOTES:

1. The 1st or lowest precast household shelter must be connected by splice sleeve (Detail A, Figure 25) at 4 corners of shelter wall. Minimum 125 bar (6 mm) for splice sleeve shall be cast in the cast-in-situ supporting elements (wall, column, beam, transformed structures or foundation).

2. The upper precast household shelters shall be joined by bolt connection (see Figure 24, Detail A, Detail B, Section 1-1 and 2-2) at their 4 corners of shelter wall.

3. Alternatively, splice sleeve connector can be used for precast HS tower (see Figure 24A, Detail A, Detail B and Section 3-3).

4. Hot rolled steel section or plate shall be of grade 43 (MN).

5. 125 bars required for these two types of connection shall be properly recessed in position at 4 top corners of lower precast household shelter wall with template such that they are aligned with the bolt holes of splice sleeve provided at the base of lower part of the upper precast household shelter respectively.

Figure 24: Splice sleeve connection details between precast HS and cast-in-situ element and bolt connection details between two precast HS.

Figure 24A: Splice sleeve connection details for precast HS tower.
Annex B

NOTES:
1. RUBBER STOPPERS SHALL BE USED TO PLUG THE OUTLET AND CROSSING INLET TUBE IMMEDIATELY AFTER SLEEVE HAVE BEEN FILLED WITH GROUT.
2. MINIMUM 6 mm TELTIT I MOL ALL ROUND SHALL BE USED.
3. CAST-IN-SITU ELEMENTS SUPPORTING THE LOADS FROM HS WALLS AS SHOWN IN DETAIL "A" SHALL BE DESIGNED BY QUALIFIED FUSION [P] TO SATISFY STRUCTURAL, SAFETY REQUIREMENTS AND TECHNICAL REQUIREMENTS OF HS.

SECTION 2 - 2

DETAIL "B"

SECTION 3 - 3

DETAIL "C"

FIGURE 25: CONNECTION DETAILS BETWEEN LOWER AND UPPER PRECAST HS
TABLE E: THICKNESS OF SLAB AND CONCRETE TOPPING

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<tr>
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<tr>
<td>HS ROOF SLAB</td>
<td>300 mm</td>
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<td>MIN 230 mm</td>
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<td>HS INTEGRATED SLAB</td>
<td>175 mm</td>
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SECTION A - A

FIGURE 26: DETAILS OF PRECAST PLANK (MARKED AS PS) AND CONCRETE TOPPING

SECTION B - B

FIGURE 27: ELECTRICAL FIXTURES ON EXTERNAL FACE OF PRECAST HS
Annex B

NOTES:

1. WHERE TOP CORNER OF PRECAST HOUSEHOLD SHELTER IS BLOCKED-OUT FOR IN-SITI BEAM, THE EXPOSED CAST-IN-TOP DOWEL BAR WITH THREADED END SHALL BE SECURED BY A TEMPLATE So AS TO ALIGN IT WITH BOLT HOLES PROVIDED IN THE CONNECTION PLATE AT THE BASE OF THE UPPER PRECAST HOUSEHOLD SHELTER. THIS IS ESSENTIAL FOR EASE OF INSTALLING THE UPPER HOUSEHOLD SHELTER.

FIGURE 28: ISOMETRIC VIEW OF PRECAST HS WITH BOLTS AND STEEL PLATE CONNECTION (WITHOUT BLOCKED-OUT FOR BEAM)

(For illustration, size, and arrangement of hollow cores shown are indicative only)

FIGURE 29: ISOMETRIC VIEW OF PRECAST HS WITH BOLTS AND STEEL PLATE CONNECTION (WITH BLOCKED-OUT FOR BEAM)

(For illustration, size, and arrangement of hollow cores shown are indicative only)
FIGURE 30: ISOMETRIC VIEW OF PRECAST HS WITH SLEEVE SLEEVE CONNECTION
(REINFORCEMENT BAR DETAILS)