# TECHNICAL REQUIREMENTS FOR DESIGN AND CONSTRUCTION OF PRECAST HOLLOW CORE STAIRCASE STOREY SHELTERS (SSS) 2017





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# **Topics**

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## Appendix 1

Figure 1 to 20 Details of Precast Hollow Core Staircase Storey Shelters





# A General

1. Precast hollow core staircase storey shelters shall comply with the latest "Technical Requirements for Storey Shelters" unless otherwise specified in this part of technical requirements for precast hollow core staircase storey shelters.

# **B** Material

2. a) Concrete

The minimum grade of concrete shall be C32/40 for precast hollow core SSS including Concrete for hollow core and joints

b) Steel Reinforcements

The minimum yield stress of steel reinforcements and shear links in structural elements forming the precast hollow cores SSS shall be  $500 \text{ N/mm}^2$ .

## C Dimensions of Precast Hollow Core Staircase Storey Shelters

- 3. Precast hollow core staircase storey shelter (hereafter known as precast SSS) shall be designed to meet the shelter area and volume requirements. The internal length and width of the precast SSS walls shall be modular with an increment of 100mm or 50mm respectively. Precast SSS comprises 3 parts as shown in Figure 1 and 2. Precast SSS, including the dimensions and spacing of modular hollow cores (See Table A & B of Annex A), ventilation sleeves, blast door, blast hatch and electrical fixtures are shown in Figure 1 to 3:
  - a) Figure 1: Plan of 3 Volumetric Components of Precast SSS
  - b) Figure 2: Internal Elevation View 'A' of 3 Volumetric Components of Precast SSS
  - c) Figure 3: Blast Door and Ventilation Sleeve
- 4. To facilitate de-moulding of the precast SSS, the hollow cores shall be tapered all round along its height as shown in Figure 4.
  - a) Figure 4: Hollow Core Shape
- 5. Where possible, hollow core of maximum 500mm long shall be adopted to achieve lighter precast SSS components for ease of handling and achievement of maximum vertical continuity.





## **D** Reinforcement Requirements

- 6. The reinforcements of precast SSS shall be welded steel fabric mesh and hot rolled steel bars. Reinforcements specified for precast slab components, walls and hollow cores of the precast SSS refer to minimum bar diameters and maximum spacing in both directions.
- 7. In the precast SSS walls, reinforcements shall be welded steel fabric mesh of minimum H13 at 100mm c/c spacing or minimum H16 at 100mm c/c spacing depending on the clear height of staircase storey shelter as given in the "Technical Requirements for Storey Shelters".
- 8. The details of reinforcements for precast SSS, the rib of precast SSS, connection between precast SSS components, SSS door frame, blast hatch, electrical fixtures, trimmer bars around ventilation sleeve openings, at door recess and hollow cores are shown in Figure 5 to 15:
  - a) Figure 5A: Plan of Precast SSS (Component 'A')
  - b) Figure 5B: Plan of Precast SSS Wall with Reinforcement Details at Blast Hatch Opening (SSS Component 'A')
  - c) Figure 5C: Plan of Precast SSS Wall with Reinforcement Details above Blast Hatch Opening (SSS Component 'A')
  - d) Figure 5D: Section D-D (SSS Component 'A')
  - e) Figure 5E: Section E-E (SSS Component 'A')
  - f) Figure 5F: Section F-F (SSS Component 'A')
  - g) Figure 5G: Section G-G (SSS Component 'A')
  - h) Figure 5H: Section H-H (SSS Component 'A')
  - i) Figure 6A: Plan of Precast (SSS Component 'B')
  - j) Figure 6B: Plan of Precast SSS Wall with Reinforcement Details (SSS Component 'B')
  - k) Figure 6C: Internal Elevation View 'B' (SSS Component 'B')
  - 1) Figure 6D: Section K1-K1 (SSS Component 'B')
  - m) Figure 6E: Section K2-K2 (SSS Component 'B')
  - n) Figure 6F: Section L-L (SSS Component 'B')
  - o) Figure 7A: Plan of Precast SSS (Component 'C')





- p) Figure 7B: Plan of Precast SSS Wall with Reinforcement Details (SSS Component 'C')
- Figure 7C: Section S-S (SSS Component 'C') q)
- Figure 7D: Section T-T (SSS Component 'C') r)
- Figure 7E: Section U-U at Ventilation Sleeve (SSS Component 'C') s)
- Figure 7F: Section X-X at Ventilation Sleeve (SSS Component 'C') t)
- Figure 7G: Section V-V (SSS Component 'C') u)
- v) Figure 7H: Section W-W (SSS Component 'C')
- w) Figure 8: Reinforcement details of Rib
- x) Figure 9: Details of Reinforcements near Door Frame and at Electrical Fixtures on Internal Face of Precast SSS
- y) Figure 10: Details of Trimmer Bars for Ventilation Sleeve
- z) Figure 11: Details of Trimmer Bars for Wall Recess for Precast SSS Door Handle
- aa) Figure 12: Electrical Fixtures on External Face of Precast SSS
- bb) Figure 13: Reinforcements in Hollow Cores
- cc) Figure 14: Reinforcements in Hollow Cores of Precast SSS

dd) Figure 15: Reinforcements Lapping in Hollow Cores

- 9. For the rib between two hollow cores of precast SSS, its top and bottom portion shall be provided with closer shear links of at least 6 numbers of H8 at maximum 100mm c/c spacing as shown in Figure 8. For area between these top and bottom portions, minimum shear links of at least H8 at maximum 600mm c/c spacing shall be provided as shown in Figure 8. The hook of the shear links must be anchored around the outermost reinforcements of the internal face of precast SSS wall.
- 10. The reinforcements for the precast SSS door frame, ventilation sleeves, wall recess for electrical fixtures on internal face of precast SSS wall and wall recess for the external SSS door handle are shown in Figure 10 to 12.
- The modular length of the hollow cores of precast SSS shall vary between minimum 11. 200mm and maximum 500mm with increment of 100mm whereas the modular width of the hollow cores of precast SSS shall be 165mm and 190mm for SSS wall thickness of 300mm and 325mm respectively as shown in Table C and Figure 13. In these hollow cores, minimum reinforcements and links shall be provided and installed as shown in Table D, Figure 13 and 14. Higher reinforcements and links shall be provided if they are required to meet the structural safety and stability requirements.





- 12. All reinforcement bars must be designed and detailed with full tension anchorage or lap length. The reinforcements for hollow cores of precast SSS wall shall be cranked at their upper part to facilitate placing of the reinforcements at lapping level as shown in Figure 15.
- 13. Full lap and anchorage length of reinforcements in SSS walls and slabs shall be provided. The lap length shall take into account good or poor bond condition, steel bar diameter, shape of steel bar, concrete cover, steel strength and location where reinforcement bar laps and confinement of transverse bars. Minimum tension lap and anchorage length of reinforcement bars for minimum concrete grade C32/40 with good bond condition shall be as shown in TABLE 1. Longer tension lap and anchorage length shall be provided if they are required to meet poor bond condition and/or the structural load and safety requirements.

Trans	Reinforcement Bar Diameter Ø (mm)		
Гуре	$10 \le \emptyset \le 16$	$16 < \emptyset \leq 32$	
Tension Lap Length	47Ø	52Ø	
Tension Anchorage Length	37Ø	37Ø	

# TABLE 1: MINIMUM TENSION LAP AND ANCHORAGE LENGTH

## E Connection between Precast Hollow Core Staircase Storey Shelters

- 14. The connection between Precast SSS hollow cores are shown in Figure 16 to 18:
  - a) Figure 16: Splice Sleeve Connection Details between Precast SSS and Cast In-Situ Element and Bolt Connection Details between Two Precast SSS
  - b) Figure 17: Splice Sleeve Connection Details for Precast SSS Tower
  - c) Figure 18: Connection Details between Lower and Upper Precast SSS
- 15. Where precast SSS is supported on cast in-situ elements (beam or wall), H28 dowel bars shall be cast in the in-situ elements for bolt and steel plate connection or splice sleeve connection between the precast SSS and the cast in-situ elements. These dowel bars must be properly secured in position with temporary template such that they are in line with bolt hole or splice sleeve of the upper precast SSS hollow core as shown in Figure 16 to 18. In case of the splice sleeve, it shall be pressure-grouted with minimum Grade 70 N/mm<sup>2</sup> grout to design and manufacturer's specification.
- 16. The lower and upper precast SSS can be connected by bolt and steel plate connection or splice sleeve connection as shown in Figure 18. To facilitate installation, H28 bars required for these two types of connection shall be properly secured in position at 4 top corners or other locations (if any) of lower precast SSS wall with a temporary template such that they are aligned with the bolt holes or splice sleeve provided at the base or lower part of the upper precast SSS respectively.





#### F Precast Slab

- 17. 90mm thick precast slab is cast as integrated part of the precast SSS component.
- 18. The minimum reinforcements to be provided for precast slab and structural concrete topping for the slab shall be as shown in Figure 19. The details show the thickness of precast slab and in-situ concrete topping.

Figure 19: Detailed Reinforcements of Precast Slab and Cast In-Situ Concrete Topping

Figure 20: Connection Details between Precast SSS and Cast In-Situ Wall

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

## **G** External Electrical Fixtures

20. Where there are electrical fixtures on external face of SSS precast wall, a recess shall be formed on the rib of the precast SSS wall as shown in Figure 12.

## H Ventilation Sleeves

- 21. One of the two ventilation sleeves shall be located above the precast SSS door at the entrance.
- 22. Ventilation sleeve shall not be located at the connection joint between two precast SSS walls.

## I Door Recess on Precast SSS Wall

23. A recess shall be formed on the external face of the precast SSS wall to accommodate the SSS door handle when the SSS door is open in 180°. The recess shall not be larger than 160mm (length) x 80mm (height) x 40mm (depth). The reinforcement bars for the recess is shown in Figure 11.













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