



# **Specification for precast concrete blocks**

## **Part 5: Normal-weight concrete-polystyrene sandwich masonry blocks**

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## Foreword

With a view to having a comprehensive set of unified Dubai Municipality Standards which would be consistent and appropriate to local conditions and yet be at par with International Standards, the Dubai Central Laboratory Department is formulating standards taking guidance as much as possible from International and Regional Norms.

This Standard sets the minimum requirements for a new type of precast concrete masonry block that is introduced in the local market to be used as thermal insulating block. Besides the basic requirements of the block, this Standard addresses the connectivity and stability requirements of a wall constructed using this type of block.

This Standard also includes an annex for the site applications of the thermal insulating-blocks.

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### 1 Scope

This standard specifies materials and minimum performance levels for precast concrete-polystyrene masonry Sandwich-blocks. Also addresses the connectivity and stability requirements of a wall constructed using this type of block

### 2 References

This standard incorporates provisions from other references. These references are cited undated at the appropriate points in the text, but latest edition of these references applies (including amendments). The titles of these references are listed on the last page.

### 3 Definitions

#### 3.1 Normal weight concrete

Concrete having an oven-dry density greater than  $2000 \text{ kg/m}^3$  but not exceeding  $2600 \text{ kg/m}^3$ .

#### 3.2 Expanded polystyrene

Rigid cellular plastic material, manufactured by molding beads of expandable polystyrene or one of its copolymers, with an air filled closed cellular structure.

#### 3.3 Extruded polystyrene

Rigid cellular plastics insulation material expanded and extruded with or without a skin, from polystyrene or one of its copolymers and which has a closed cell structure

#### 3.4 Sandwich-block

A precast concrete block consisting of two outer leaves of normal weight concrete sandwiching a polystyrene core.

#### 3.5 Lot

The term "Lot" refers to any number of Sandwich- blocks of a specific configuration or dimension manufactured by the producer using the same materials, concrete mix, manufacturing process, and curing method.

### 4 Materials

#### 4.1 Binders

Precast concrete portion of Sandwich-blocks shall be made using Portland cement of type CEM 1 to BS EN 197 Part 1

#### 4.2 Aggregates

The normal-weight aggregates used shall conform to the requirements of BS EN 12620 and the recommendations of PD 6682 Part 1, except for the grading requirement.

#### 4.3 Admixtures

The admixtures used shall be free from chlorides and conform to BS EN 934: Part 2.

#### 4.4 Water

The water used shall be clean and free from any deleterious and organic matter, and conform to BS EN 1008.



## 4.5 Thermal insulation core

Thermal insulation core of the sandwich block shall be made of either expanded polystyrene or extruded polystyrene that complies with the requirements of clause (5) of this Specification and shall be certified by Dubai Municipality..

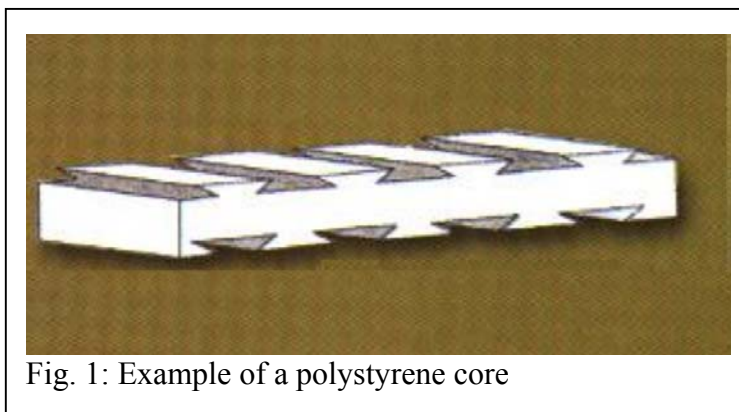
## 5 Polystyrene core properties

### 5.1 Size and shape

Polystyrene core of the Sandwich-block shall have the same length and height of the overall concrete dimensions. Polystyrene core thickness, when measured at any point, shall not be less than 60 mm.

Polystyrene core shall have a dovetailing shape as shown in Fig. 1. Other shapes can also be used.

Polystyrene core shall be either molded or extruded to shape without cutting.



### 5.2 Apparent density

When tested in accordance with BS EN 1602, for a sample of five specimens, the average apparent density shall be not less than 25 kg/m<sup>3</sup>.

### 5.3 Thermal conductivity

Thermal conductivity of the polystyrene core shall be declared by the polystyrene manufacturer according to BS EN ISO 10456 at 35°C and 60% relative humidity (RH).

When tested in accordance with BS EN 12667 or ASTM C 518, at 35°C & 60% RH, polystyrene core thermal conductivity shall not exceed the declared value.

### 5.4 Reaction to fire

Polystyrene shall be of the flame-retardant type. When tested in accordance with BS EN 11925-2, the flame spread shall not exceed 150 mm within 60 s. Alternatively, the Oxygen index shall no be less than 24% by volume when tested in accordance with ASTM D 2863.



**6 Sandwich block properties**

**6.1 Sizes**

**6.1.1 Dimensions**

Sandwich-block overall dimensions shall conform to the requirements of Table 1. If air cavities exist in any of the two concrete leaves of the Sandwich-block, the shell thickness shall not be less than 20mm. A sample block is shown in Fig. 2.

**Table 1 - Dimensions of Sandwich-blocks**

<b>Sandwich-block sizes</b>		
<b>Length (mm)</b>	<b>Height (mm)</b>	<b>Thickness (mm)</b>
400	200	200
400	200	250

Note: Other dimensions can be declared by the manufacturers.

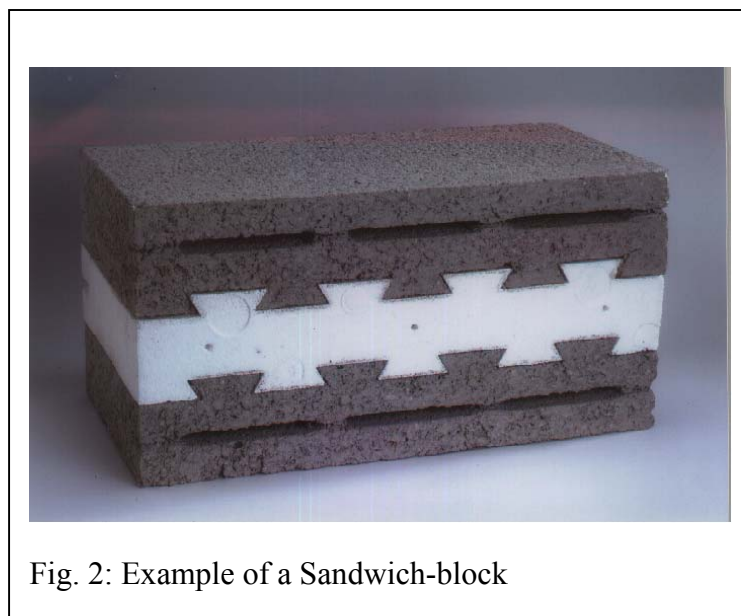


Fig. 2: Example of a Sandwich-block

**6.1.2 Tolerances**

When measured in the manner described in BS 6073: Part 1 appendix A, the length, height or thickness of each block from the sample shall not differ by more than  $\pm 3$  mm from the stated dimensions.

**6.2 Manufacturing**

Sandwich-blocks are manufactured using normal weight concrete cast integrally with the dovetailed polystyrene core placed in the mould and wet concrete poured around it. The



concrete is then compacted and cured. These processes are to be carried out without damage to the polystyrene core.

### 6.3 Chloride and sulfate content

When tested in accordance with BS 1881 : Part 124, the acid soluble chloride (Cl) and sulfate (SO<sub>3</sub>) content of Sandwich-blocks concrete shall not exceed 0.06% and 0.4% by dry mass of concrete respectively.

### 6.4 Compressive strength

When tested in accordance with appendix B of BS 6073: Part 2, for a sample of ten Sandwich-blocks, the average compressive strength and that of an individual specimen, based on the gross area, shall be not less than the following:

Average compressive strength:	7.5 N/mm <sup>2</sup>
Individual compressive strength:	6.0 N/mm <sup>2</sup>

Sandwich-blocks shall maintain their integrity during the compressive strength test i.e. failure pattern during compressive strength test shall not show evidence of separation between the polystyrene core and the outer concrete leaves. Any evidence of separation noticed before or during the test shall be a cause for rejection of the lot represented by the sample.

### 6.5 Thermal properties

Thermal conductivity of the Sandwich-blocks shall be declared by the block manufacturer according to BS EN ISO 10456 at 35°C and 60% relative humidity (RH).

When tested in accordance with BS EN 12664 or BS EN 12667 or BS EN 1934 or BS EN ISO 8990 or ASTM C 1363, at 35°C and 60% RH, Sandwich-block thermal conductivity shall not exceed the declared value.

As an alternative, thermal conductivity of the Sandwich-blocks shall be calculated according to BS EN ISO 6946 taking into consideration the block configuration, concrete and polystyrene thermal conductivities declared by their manufacturers at 35°C & 60% RH.

## 7 Sampling for tests

### 7.1 Number of Specimens

The number of specimens required for each specified test shall be :

- |  |                                       |
|--|---------------------------------------|
| - Sandwich-block dimensions and Compressive strength                   | 10 blocks                             |
| - Sandwich-block Concrete Chloride and Sulfate content                 | 1 block                               |
| - Sandwich-block thermal conductivity or Concrete thermal conductivity | As required by the testing laboratory |
| - Polystyrene core dimensions and apparent density                     | 5 core specimens                      |
| - Polystyrene core thermal conductivity                                | 1 core specimen                       |



### **7.2 Selection of test specimens**

A representative sample of Sandwich-blocks required for test purposes shall be selected at random from every designated lot of 20,000 Sandwich-blocks or fraction thereof. Each specimen shall be marked so that it may be identified at any time.

### **8 Intended use**

Sandwich-blocks are intended to be used as thermal insulating blocks for the construction of infill, non-load bearing, masonry walls in buildings.

Sandwich-blocks shall be used in superstructures only and shall not be used in substructures.



## Annex A: Site application of Sandwich-blocks

### A- Site storage

Ultra-Violet light adversely affects the polystyrene properties. Therefore, polystyrene cores should be stored or kept in closed places unexposed to solar radiation. Also, Sandwich-blocks need to be protected from exposure to solar radiation during their storage and handling until the time of erection where the polystyrene is then fully protected.

### B- Handling

Sandwich-blocks need to be handled with care to avoid damage such as chipping of edges and corners, splitting between the polystyrene core and the outer concrete layers, ...etc.

### C- Thermal bridging

Mortar joints in masonry walls built with Sandwich-blocks will act as a thermal bridge due to the high thermal conductivity of the mortar compared to the polystyrene core. To avoid this thermal bridge, 45 mm wide Polystyrene strips, having a thickness equal to the mortar joints thickness, may be included in the horizontal and vertical mortar joints to provide continuity for the Polystyrene thermal insulation layer.

As an alternative, light weight aggregate concrete mortar with low thermal conductivity can be used as full bed mortar joints without any polystyrene strips.

Other alternatives can also be used.

### D- Installation

Care should be taken to align the blocks both horizontally and vertically in a way that the polystyrene cores of adjacent blocks are not staggered. This is of great importance so as to avoid forming thermal bridges inside the walls.

### E- Reinforcement

**E/1-** Polystyrene may lose its adhesion with the concrete with time leaving the two concrete leaves of the Sandwich-block apart without any connection. To ensure the connectivity of the two concrete parts together, the methods discussed in clause (E/2) can be applied.

**E/2-** Methods of connection:

- Alkali resistant fiber mesh reinforcement 150 mm wide, or galvanized metal mesh or ladder type wire mesh reinforcement 150 mm wide, embedded in the mortar joints at every third course.
- 150 mm long ties complying with the requirements of BS EN 845: Part 1 shall be placed in mortar joints at a rate not less than 4.9 ties per one square meter of wall area.
- Other methods for ensuring connectivity may be used.



**E/3-** Column-masonry junctions shall be connected by galvanized wall ties, 2.5 mm x20 mm x 150 mm, complying with the requirements of BS EN 845: Part 1, at every third course.

**E/4-** If the wall height is more than 3.5 m, galvanized beam-masonry wall ties of 2.5 mm x 20 mm x 75 mm, complying with the requirements of BS EN 845: Part 1, shall be fixed at 1.2 m c/c approximately.

**E/5-** Concrete stiffeners should be provided around windows and doors openings to allow for stiffening the wall free ends.

### **F-** Condensation

To avoid the condensation problem that is expected to happen in walls built with Sandwich-blocks, special coatings that have very low water-vapor permeability characteristic shall be applied on the external surface of the walls.



**G- Publications referred to:**

BS 1881: Part 124	Method for analysis of hardened concrete
BS 4027	Specification for sulfate-resisting Portland cement
BS 6073: Part 1	Specification for precast concrete masonry units
BS 6073: Part 2	Method for specifying precast concrete masonry units
BS EN 197: Part 1	Cement Part 1: Composition, specifications and conformity criteria for common cements
BS EN 845: Part 1	Specification for ancillary components for masonry Part 1: Ties, tension straps, hangers and brackets
BS EN 934: Part 2	Admixtures for concrete, mortar and grout Part 2: Concrete admixtures – Definitions, requirements, conformity, marking and labeling
BS EN 1008	Mixing water for concrete
BS EN 1602	Thermal insulation products for building applications – determination of apparent density
BS EN 1934	Thermal Performance of Buildings - Determination of Thermal Resistance by Hot Box Method Using Heat Flow Meter - Masonry
BS EN 11925: Part 2	Reaction to fire tests – Ignitability of building products subjected to direct impingement of flame – Part 2: Single flame source test
BS EN 12620	Aggregates for concrete
BS EN 12664	Thermal performance of building materials and products – Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – dry and moist products of medium and low thermal resistance
BS EN 12667	Thermal performance of building materials and products – Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – products of high and medium thermal resistance
BS EN ISO 6946	Building components and building elements – Thermal resistance and thermal transmittance – Calculation method
BS EN ISO 10456	Building materials and products – Procedures for determining declared design thermal values
BS EN ISO 8990	Thermal insulation — Determination of steady-state thermal transmission properties — Calibrated and guarded hot box



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ASTM C 518	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 1363	Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus
ASTM D 2863	Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)