Specification for precast concrete blocks

Part 5: Concrete-Polystyrene Sandwich Masonry blocks

Issue Date	Revision	Revision Description
14/08/2011	01	Issue for use This revision superseded DMS 1: Part 5 previous editions which are withdrawn

Title of DMS:
Specification for precast concrete blocks - Part 5: Concrete-polystyrene sandwich masonry blocks

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This Dubai Municipality Standard is:

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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.

The DM Standard Specification for precast concrete blocks falls in five parts as follows:

Part 1: Masonry blocks
Part 2: Filler blocks
Part 3: Autoclaved aerated concrete masonry blocks
Part 4: Paving blocks
Part 5: Concrete-polystyrene sandwich masonry blocks

Amendments issued since publication		
Amd No.	Date	Text affected

1 Scope

This standard specifies minimum performance levels for normal weight and lightweight precast concrete-polystyrene masonry Sandwich-blocks. Annex B of this Standard 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). In case any reference is shown as dated, then that specific edition shall be used. The titles of these references are listed on the last page.

3 Definitions

3.1 Masonry block

a precast concrete masonry block manufactured from cementitious binder, aggregates and water and which may contain admixtures and additions and colouring pigments and other materials incorporated or applied during or subsequent to block manufacture intended for use in the construction of walls.

3.2 Normalweight concrete

concrete having an oven-dry density greater than 2000 kg/m^3 but not exceeding 2600 kg/m^3.

3.3 Lightweight concrete

concrete having an oven-dry net density of not more than 2000 kg/m^3. It is produced using lightweight aggregate with full or partial replacement of the lightweight fines with normal weight sand.

3.4 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.

3.5 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

3.6 Sandwich-block

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

3.7 length

the largest dimension of the horizontal plane of installation.

3.8 width

the smallest dimension of the horizontal plane of installation .

3.9 height

the vertical dimension perpendicular to installation plane.

4 Requirements for materials

4.1 General

Only materials with suitability established in terms of their properties and performance shall be used in the manufacture of concrete masonry blocks.

These materials shall conform to the requirements shown in Annex C.

Where, by conformity with relevant specifications, the properties and performance of materials have been demonstrated, further testing need not be performed.

4.2 Asbestos

Asbestos, or materials containing asbestos, shall not be used.

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.

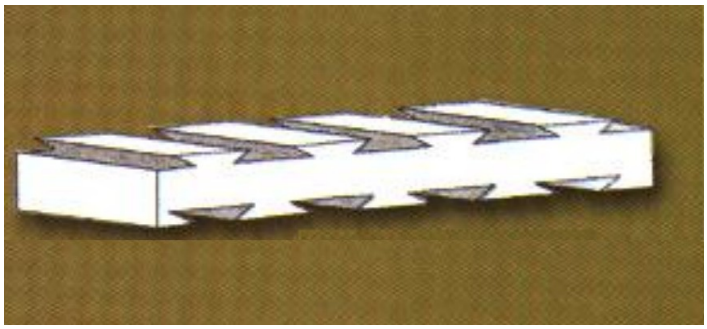

Fig. 1: Example of a polystyrene core

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

5.2 Apparent density

When tested in accordance with BS EN 1602, the average apparent density shall not be less than 25 kg/m^3.

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 ºC and 60% relative humidity (RH).

When tested in accordance with BS EN 12667 or ASTM C 518, at 35 ºC & 60% RH, polystyrene core average thermal conductivity of three specimens 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 not be less than 24% by volume when tested in accordance with ASTM D 2863.

6 Sandwich block properties

6.1 Shape

Blocks shall have regular and uniform shape, free of cracks and defects and have rough surfaces to provide key for plaster.

6.2 Sizes

6.2.1 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

Sandwich-block sizes		
Length (mm)	**Height (mm)**	**Width (mm)**
400	200	200
400	200	250
NOTE Other dimensions can be declared by the manufacturers.		

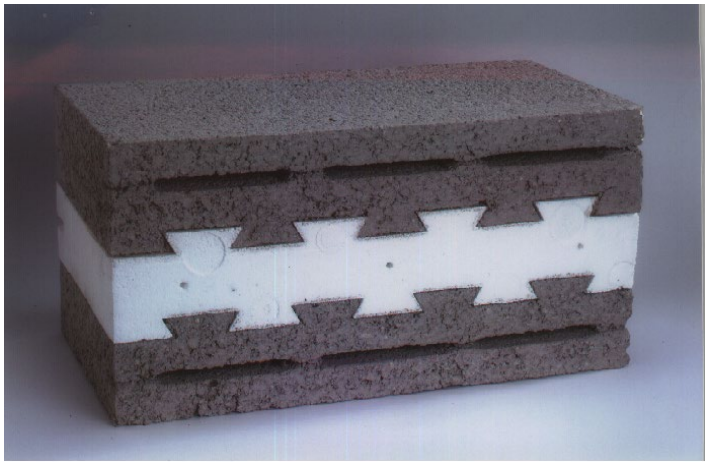

Fig. 2: Example of a Sandwich-block

6.2.2 Tolerances

When measured in the manner described in BS BS EN 772: Part 16, the length, height or width of each block from the sample shall not deviate by more than ± 3 mm from the declared dimensions.

6.3 Manufacturing

Sandwich-blocks are manufactured using 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.

6.4 Chloride and sulfate content

When tested in accordance with BS 1881: Part 124, the acid soluble chloride (Cl) and sulfate (SO_3) content of Sandwich-blocks concrete shall not exceed 0.05% and 0.5% by dry mass of concrete respectively.

6.5 Compressive strength

When tested in accordance with BS EN 772: Part 1 or by using the rapid compressive strength method as per "Annex A" of this DMS, the average compressive strength and that of an individual specimen, based on the gross area, shall not be less than the values given in Table 2:

Table 2 - Minimum compressive strength of masonry blocks based on gross area

Type of masonry blocks	Strength N/mm^2	
	Average	Individual
Normalweight concrete	7.5	6
Lightweight concrete	3.2	2.6
NOTE Designers may specify blocks of higher strengths than those given in this Table if required from design considerations.		

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 considered as not complying with the requirement of this clause.

6.6 Thermal properties

Thermal conductivity of the Sandwich-blocks shall be declared by the block manufacturer according to BS EN ISO 10456 at 35 ºC 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 ºC 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 ºC & 60% RH.

7 Durability aspect

Under normal exposure conditions of use in Arabian Gulf region environment, precast concrete blocks will continue to provide satisfactory strength, provided they conform to clause (6.5) above.

8 Sampling for tests

8.1 For the dimensions and compressive strength the minimum number of test specimens shall conform to BS EN 771 – 3.

8.2 For other tests, the number of specimens shall be:

- Sandwich-block Concrete Chloride and Sulfate content	1 block
- Sandwich-block thermal conductivity or Concrete thermal conductivity	As required by the testing laboratory

9 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.

10 Conformity assessment and certification

10.1 Conformity of the product with this standard shall be assessed in accordance with Dubai Municipality third party product certification system.

10.2 Product delivered to site shall demonstrate compliance with this standard through a Certificate of Conformity or Mark of Conformity issued by Dubai Municipality.

Annex A:

Compressive strength: Rapid testing

A.1 Method of testing

Compressive strength test shall be carried in accordance with BS EN 772 – 1 with the following deviations:

A.1.1 Surface preparation

Rub the bed faces of specimens with a carborundum stone to remove any fins or high spots. Wipe the bearing surfaces of all the platens clean and remove any loose grit or other material from the surfaces of the specimen which are to be in contact with the platens.

A.1.2 Conditioning

Specimens shall be stored in the normal laboratory temperature and humidity for at least 16 h before being used for tests.

A.1.3 Procedure

A.1.3.1 Grinding method

Grind the specimen as per the requirement of BS EN 772 – 1

A1.3.2 Use of fiber board

As an alternative to grinding method and capping method as mentioned in BS EN 772 – 1, fiber boards can be used. Use fiber board (12 ± 1) mm thickness as in parallel contact with the platens. Place the specimen in the machine between two new pieces of 12 mm thick fiber board. Ensure that the board overhangs the specimen by a minimum of 5 mm along each edge and the centre of mass of the specimen coincides with the axis of the machine.

Annex B:

Site application of Sandwich-blocks

B.1 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.2 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.

B.3 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, shall 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.

B.4 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.

B.5 Reinforcement

B.5.1 General

Polystyrene may loose its adhesion with the concrete with time, leaving the two concrete leaves of the Sandwich-block apart without connectivity. To ensure the connectivity of the two

concrete leaves together, a suitable method of those mentioned in clause (B.5.2) shall be applied.

B.5.2 Methods of connection:

- 150 mm wide Alkali resistant fiber mesh reinforcement, or galvanized metal mesh or ladder type wire mesh reinforcement, 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.

B.5.3 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.

B.5.4 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.

B.5.5 Concrete stiffeners should be provided around windows and doors openings to allow for stiffening the wall free ends.

B.6 Condensation

To avoid the condensation problem that is expected to happen in walls built with Sandwich-blocks, special coatings having very low water-vapor permeability characteristic (i.e. permeance $\leq$ 57.5 ng/(Pa.s.m^2) [1.0 perm]) shall be applied on the external surface of the walls.

Annex C
Materials properties and limits

Table C.1 – Normal weight aggregate

S.No	Requirements	Test methods	Permissible limits	
			Fine aggregate	Coarse aggregate
Physical Properties				
1	Water absorption	ASTM C 127, or BS EN 1097 Part 6	--	Max.2.0 %
		ASTM C 128, or BS EN 1097 Part 6	Max 2.3 %	--
2	Specific gravity (apparent)	ASTM C 127, or BS EN 1097 Part 6	--	Min. 2.6
		ASTM C 128, or BS EN 1097 Part 6	Min. 2.6	--
3	Clay lumps and friable particles	ASTM C 142	Max. 1%	--
4	Material finer than 0.075 mm • Natural uncrushed • Crushed	ASTM C 117	Max. 3 % Max. 7 %	Max. 1 % Max. 1 %
5	Shell content • Coarser than 10mm • Between 5mm and 10mm	BS EN 933 – 7	-- --	Max. 5 % Max. 15%
6	Particle shape - Flakiness index	BS 812: Part 105.1	--	Max. 25 %
7	Particle shape – Elongation index	BS 812:Part 105.2	--	Max. 25%
8	Soundness – $MgSO_4$ (5 Cycles)	ASTM C 88	Max 12%	Max 12%
Mechanical Properties				
9	Soaked 10% fines value	BS EN 1097 Part 2	--	Min. 100 kN
10	Los angeles abrasion	ASTM C 131 / C 535	--	Max 30%
Chemical Properties				
11	Organic impurities	ASTM C 40	Not darker than the standard solution	--
12	Acid soluble chlorides (Cl)	BS EN 1744 Part 5	0.03%	0.01%
13	Acid soluble sulphates (SO_3)	BS EN 1744 Part 1	0.3%	0.3%

Table C.2 – Cementitious Materials

S. No.	Constituents	Standard specification
1	Portland cements	ASTM C 150, or BS EN 197
2	Fly ash	ASTM C 618, or BS EN 450
3	Ground granulated blastfurrace slag	ASTM C 989, or BS 6699
4	Silica fume	ASTM C 1240, or BS EN 13263
5	Blended hydraulic cement	ASTM C 595
6	Standard performance for hydraulic cement	ASTM C 1157

Table C.3 – Water

S. No	Concentrations	Test method	Limit
1	Chloride as Cl	ASTM D 512	Max.1000 mg/l
2	Sulphates SO_4	ASTM D 516	Max.2000 mg/l
3	Alkali carbonates and bicarbonates	ASTM D 513	Max.1000mg/l
4	Total dissolved solids, including 1,2 & 3 above	BS 1377: Part 3	Max.2000 mg/l
5	pH	ASTM D 1293	$7 \leq pH \leq 9$

Table C.4 – Other materials

S. No.	Constituents	Standard specification
1	Lightweight aggregates	ASTM C 331, or BS 13055: Part 1
2	Admixtures	ASTM C 260, or ASTM C 494, or BS EN 934
3	Thermal insulation core of the sandwich block shall be made of either expanded polystyrene (EPS) or extruded polystyrene (XPS) that complies with the requirements of clause (5) of this Specification and shall be certified by Dubai Municipality.	
4	Any other material, not mentioned in this Annex may be used provided that the material conforms to applicable standard or shall be shown by test or experience that it is not detrimental to the durability of the concrete masonry units or any material customarily used in masonry manufacturing. The suitability requirements of the material used shall be given in the manufacturer's production control documentation.	

Summary of changes

1. Clause 3 new sub clause 3.7, 3.8, and 3.9 are added
2. Table 1 has been revised
3. Clause 6.2.2 has been revised
4. Table C.3 of Annex C has been revised.

Publications referred to

ASTM C 40	Standard test method for organic impurities in fine aggregates for concrete
ASTM C 88	Standard test method for soundness of aggregates by use of sodium sulfate or magnesium sulfate
ASTM C 117	Standard test method for materials finer than 75-µm (No. 200) sieve in mineral aggregates by washing
ASTM C 127	Standard test method for density, relative density (specific gravity), and absorption of coarse aggregate
ASTM C 128	Standard test method for density, relative density (specific gravity), and absorption of fine aggregate
ASTM C 131	Standard test method for resistance to degradation of small-size coarse aggregate by abrasion and impact in the los angeles machine
ASTM C 142	Standard test method for clay lumps and friable particles in aggregates
ASTM C 150	Standard specification for portland cement
ASTM C 260	Standard specification for air-entraining admixtures for concrete
ASTM C331	Standard specification for lightweight aggregates for concrete masonry units
ASTM C 494	Standard specification for chemical admixtures for concrete
ASTM C 518	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 535	Standard test method for resistance to degradation of large-size coarse aggregate by abrasion and impact in the los angeles machine
ASTM C 595	Standard specification for blended hydraulic cements
ASTM C 618	Standard specification for coal fly ash and raw or calcined natural pozzolan for use in concrete
ASTM C 989	Standard specification for slag cement for use in concrete and mortars
ASTM C 1157	Standard performance specification for hydraulic cement
ASTM C 1240	Standard specification for silica fume used in cementitious mixtures
ASTM C 1363	Standard test method for the thermal performance of building assemblies by means of a hot box apparatus
ASTM D 512	Standard Test Methods for Chloride Ion in Water
ASTM D 513	Standard Test Methods for Total and Dissolved Carbon Dioxide in Water
ASTM D 516	Standard Test Method for Sulfate Ion in Water
ASTM D 1293	Standard Test Methods for pH of Water

ASTM D 2863	Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
BS 812: Part 105.1	Testing aggregates — Part105: Methods for determination of particle shape section 105.1 Flakiness index
BS 812: Part 105.2	Testing aggregates —Part 105.2: Elongation index of coarse aggregate
BS 1881: Part 124	Method for analysis of hardened concrete
BS 1377: Part 3	Methods of test for soils for civil engineering purposes — Part 3: Chemical and electro-chemical tests
BS 6699	Specification for ground granulated blastfurnace slag for use with portland cement
BS EN 197	Cement — Part 1: Composition, specifications and conformity criteria for common cements
BS EN 450	Fly ash for concrete — Part 1: Definition, specifications and conformity criteria
BS EN 771: Part 3	Specification for masonry units — Part 3: Aggregate concrete masonry units (dense and light-weight aggregates)
BS EN 772: Part 1	Methods of test for masonry units - Part 1: Determination of Compressive Strength
BS EN 772: Part 16	Methods of test for masonry units Part 16: Determination of dimensions
BS EN 845: Part 1	Specification for ancillary components for masonry — Part 1: Ties, tension straps, hangers and brackets
BS EN 933: Part 7	Tests for geometrical properties of aggregates - Part 7: Determination of shell content - percentage of shells in coarse aggregates
BS EN 934	Admixtures for concrete, mortar and grout
BS EN 1097: Part 2	Tests for mechanical and physical properties of aggregates — Part 2: Methods for the determination of resistance to fragmentation
BS EN 1097: Part 6	Tests for mechanical and physical properties of aggregates —Part 6: Determination of particle density and water absorption
BS EN 1602	Thermal insulation products for building applications – determination of apparent density
BS EN 1744: Part 1	Tests for chemical properties of aggregates — Part 1: Chemical analysis
BS EN 1744: Part 5	Tests for chemical properties of aggregates — Part 5: Determination of acid soluble chloride salts
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 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 13055: Part 1	Lightweight aggregates— Part 1: Lightweight aggregates for concrete, mortar and grout
BS EN 13263	Silica fume for concrete
BS EN ISO 6946	Building components and building elements – Thermal resistance and thermal transmittance – Calculation method
BS EN ISO 8990	Thermal insulation — Determination of steady-state thermal transmission properties — Calibrated and guarded hot box
BS EN ISO 10456	Building materials and products – Procedures for determining declared design thermal values