BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE, INDIA

CONCRETE BUILDING BLOCKS AND BLOCK MASONRY

Introduction

The use of solid or hollow concrete blocks in place of traditional bricks and stone in building construction is currently advocated in India for meeting the demands on speed in construction and economy. In order to ensure satisfactory performance of the concrete block masonry, it is necessary that only good quality concrete blocks conforming to the relevant Indian Standard specification (Table I) are used. Considering that a variety of materials is used in making concrete blocks, a strict quality control in the selection, proportioning, batching and mixing of the materials and compaction, curing and drying of the blocks is essential in concrete block production. The quality control requirements and measures needed to prevent cracking in block masonry and rain penetration through it are discussed below.

Selection of Materials

1. CEMENT—The cement used in the production of blocks should conform to the requirements of either of the following Indian Standards.

IS: 269-1967, 'Specification for ordinary, rapid-hardening and low heat portland cement (third revision)'.

IS: 455-1967, 'Specification for portland blast furnace slag cement (second revision)'.

IS: 1489-1967, 'Specification for portland pozzolana cement (first revision)'.

2. AGGREGATES—One of the following aggregates is recommended for use in the production of concrete blocks.

(a) Dense aggregates (natural sand and gravel or crushed stone) complying with the requirements of IS: 383-1963, 'Specification for coarse and fine aggregates from natural sources for concrete (revised)'.

TABLE—1

Indian Standard Specifications for Concrete Building Blocks

Physical Requirements	IS: 2185-1967*			IS: 3590-1966†		
	Length (cm)	Breadth (cm)	Height (cm)	Length (cm)	Breadth (cm)	Height (cm)
1. Size of block (Nominal/Actual)						
Designation A	40/39	30/30	20/19	40/39	30/30	20/19
Designation B	40/39	20/20	20/19	40/39	20/20	20/19
Designation C	40/39	10/10	20/19	40/39	10/10	20/19
2. Density, kg/m³	More than 1600			Less than 1600		
3. Compressive strength (gross area), kg/cm²	50 minimum			28 minimum		
4. Drying shrinkage, per cent	0.04 maximum			0.06 maximum		
5. Moisture movement, per cent	0.03 maximum			0.05 maximum		
6. Water absorption, kg/m³	240 maximum			250 maximum		
7. Moisture content, per cent of the total water absorption	40 maximum			40 maximum		

* IS: 2185-1967, 'Specification for hollow cement concrete blocks (first revision)'.

† IS: 3590-1966, 'Specification for load bearing lightweight concrete blocks'.

(b) Granulated blast furnace slag of under 1250 kg/m³ bulk density made by rapid cooling of iron slag and containing not more than 50 per cent of lime (CaO).

(c) Foamed blast furnace slag.

(d) Cinder conforming to class C of IS: 2686-1964, 'Specification for cinder aggregates for use in lime concrete'.

(e) Lightweight aggregates manufactured by bloating of suitable slates, shales or clays, or by sintering of fly ash.

(f) Any suitable mixtures of the aggregates given above.

The aggregates always contain varying amount of deleterious matter such as dust, silt, clay and organic matter in dense aggregates and combustible matter in cinder. It is imperative, therefore, that the aggregates are frequently tested to ensure their quality according to the relevant Indian Standard. The frequency of testing depends largely on the rate of consumption and reliability of the source of supply.

3. WATER—The water used in the production of blocks should conform to the requirements of clause 4.3 of IS: 456-1964, 'Code of practice for plain and reinforced concrete (second revision)'.

4. ADMIXTURE—Admixtures which do not have deleterious effects and which do not adversely affect the durability of the blocks with the passage of time may be used, if required.

Grading of Aggregates

According to Indian Standards, IS: 2185-1967 and IS: 3590-1966 all aggregates (dense or light-weight) should pass through IS sieve 12.5 mm and not more than 10 per cent should pass through IS sieve 300 micron. In addition, at least 15 per cent should be retained on IS sieve 10 mm and 40 per cent on IS sieve 4.75 mm.

Experience of producing blocks using different aggregates, however, shows that not only considerable amount of time and labour has to be spent in maintaining this grading but it is difficult to produce blocks having adequate green strength when mixes leaner than 1:6 cement-aggregate, by volume, are used. It has been observed that adequate green strength can be attained only by increasing the proportion of fines passing IS seive 300 micron. At times, even 5 to 10 per cent fines passing IS sieve 150 micron may have to be used. Therefore it would be desirable to work out the appropriate grading suiting mix proportion and type of aggregates to be used.

Proportioning of Materials

Indian Standards, IS: 2185-1967, 'Specification for hollow cement concrete blocks (first revision)' and IS: 3590-1966, 'Specification for load bearing lightweight concrete blocks', do not permit the use of concrete mix of proportions richer than 1:6 cement-aggregate, by volume for producing concrete blocks. While complying with this requirement, the proportions of concrete mix should be so chosen as to obtain the required workability during the manufacture and strength and durability in the finished block, with minimum amount of cement and using the lowest possible water/cement ratio. This can be achieved by proper grading of the combined aggregates. The grading should be so chosen as to provide in the coarse aggregate the smallest amount of voids to be filled by the fine aggregate, and in the fine aggregate to provide the smallest amount of voids to be filled by the cement.

Batching and Mixing of Materials

The batching of different materials should be done by weight. The weighing equipment should be periodically checked using standard weights. It is necessary to determine moisture content of the aggregates frequently to enable control over quantities of the aggregates and water used. When dry lightweight aggregate is used, it is important that the aggregate is first wetted in the concrete mixer with a portion of the mixing water. If this is not done, then some amount of cement is sucked in with water by the dry aggregate resulting in less strength in the blocks.

Mixing of the materials in the concrete mixer should be continued until concrete of uniform colour and consistency is obtained.

Compaction of Concrete

Good compaction of concrete in producing blocks is as important as the design of concrete mix itself. The concrete should preferably be compacted by vibration in a block making machine. In case of manual compaction, the concrete mix should be placed into the mould in layers of about 50 to 75 mm and each layer thoroughly tamped with a tamper until the whole mould is filled up. It is then struck off level with a trowel and finished smooth.

Curing of Blocks

The volume change characteristics of concrete blocks are largely influenced by the curing conditions under which the blocks are cured. In India, due to econmic considerations, concrete blocks are generally cured either by submerging them under water or by sprinkling water over them. Since the rate of strength development in cold winter is slower than in hot summer, the blocks should be cured for longer periods in winter to ensure good strength. If water cured blocks are found to show higher drying shrinkage and wetting expansion than the specified requirements, then the blocks should be cured using steam at atmospheric pressure. In certain cases, high pressure (7 to 11 kg/cm^2) steam curing may be used. It is essential to keep the blocks at ambient temperature for about 3 hours after casting and before starting steam curing. The rapid rise in temperature has been found to reduce strength of the blocks put under steam curing soon after casting.

Drying of Blocks

The dimensional stability of concrete blocks is greatly affected by variation in their moisture content. Since the shrinkage of the block is much greater at the time it dries for the first time than due to subsequent wetting and redrying, it is necessary to ensure that the blocks are dried so that their initial shrinkage is completed before they are delivered for use. Further, their moisture content should not exceed 25 per cent of their maximum water absorption capacity, if the blocks are to be used in situation where the relative humidity of air averages less than 60 per cent. When the relative humidity averages more than 60 per cent, the blocks can be dried to a moisture content of 40 per cent of their maximum water absorption capacity.

Strength of Block Masonry

In general, the design and construction of hollow concrete block masonry should conform to the requirements of IS : 1905-1969 'Code of practice for structural safety of buildings-masonry walls'. It should however be ensured that no tension is allowed in the design of block masonry as the bond between block and mortar is weaker than that between brick and mortar. The minimum thickness of the external wall should not be less than 20 cm to avoid appearance of dampness inside. For internal non-load bearing walls and under situations where the rainfall is scanty the wall thickness can be reduced to 10 cm.

Measures to Prevent Cracking in Block Masonry

Cracks in block masonry may appear due to (i) load settlement, thermal expansion or changes in moisture content in the structural members enclosing the block walls and (ii) from shrinkage or expansion of the block walls as a whole or of the blocks due to changes in moisture content, thermal effects or unsoundness of the materials. Indian Standard (IS : 2572-1965 'Code of practice for construction of hollow concrete block masonry') recommends certain measures to prevent formation of cracks in block masonry. These are summerised below and should be adopted as far as possible.

1. In framed structures, erection of partition and panel walls should be delayed to take care of deformations due to structural loads.

2. The partition walls should be suitably reinforced in the lower courses to strengthen them against any excessive deflection that may occur in the floor slabs supporting them.

3. The walls should be separated from the ceiling by a layer of resilient material. Where this cannot be done, the joint between the ceiling and the wall should be properly reinforced or a cut be formed between the ceiling plaster and the wall plaster.

4. A slip joint should be provided where the walls abut against other structural walls or columns.

5. The block should be laid dry using composite mortars of mix proportions 1:1:6, or 1:2:9 or 1:3:12 cement-lime-sand by volume. In hot climate, the blocks can be slightly wetted at the surface before laying.

6. For curing the block masonry should be moistened lightly and not made excessively wet as done in brick masonry.

7. To accommodate the changes in length due to shrinkage of blocks, joints called control joints should be provided at suitable places e.g. at 8 to 10 metres intervals in free standing walls, at 15 to 18 metres intervals in walls which are connected by cross walls at longer or closer intervals and at junctions of load and non-load bearing walls, etc.

8. To accomodate changes due to temperature, provision for expansion and contraction, particularly in long walls exceeding 30 m or walls arou-

nd cold rooms, boiler houses, should be made in the form of expansion joints.

In addition to these measures, the following measures may also be adopted where possible.

1. The block work should be split into solid rectangular panels without any openings. The length of a panel should not exceed 1½ to 2 times its height. The areas above doors and above and below windows should be treated as separate panels (Fig. 1).

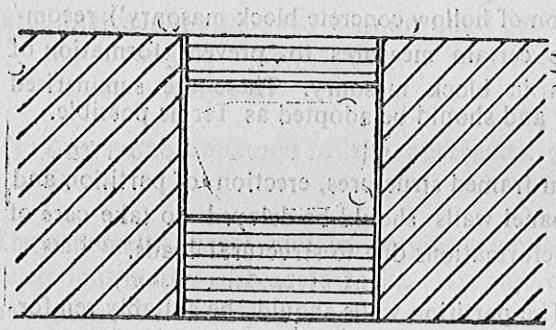

Fig. 1. Blockwork broken into rectangular panels by separate panels above and below window.

2. The rendering applied over the block masonry should form a clear break at the panel joints and the visual effects of these should be carefully considered and integrated into the overall design of the block wall.

3. If it is not practicable to sub-divide the wall into panels, then reinforcement should be provided above and below windows and above doors in order to distribute concentration of the shrinkage stresses occurring at the corners more uniformly throughout the wall (Fig. 2).

Measures against Rain Penetration through Block Masonry

Rain water passes through the cracks and measures suggested above to avoide cracking shall go a long way in preventing rain penetration through block masonry. In addition the following measures are suggested to prevent rain penetration, if any.

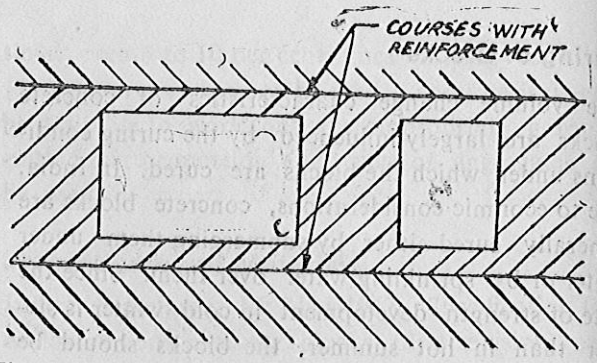

Fig. 2. Position of reinforcement to control cracking in traditional design.

1. Use face-shell bedding i.e. putting mortar in two separate strips both for horizontal and vertical joints for laying blocks.

2. Firmly press down the mortar joints after they have stiffened somewhat with a jointing tool.

3. Render the external face of the block wall using a composite mortar. The rendering should be done after the wall has fully dried.

4. Proper flashings or drip courses should be provided over the openings.

Provision for Services

Proper care should be taken during planning and construction for the installations of service lines. Services may run on the wall surface or in shallow chases so that they are embedded in the plaster, chases may be chiselled. Chases should not be cut in hollow blocks, but services may be taken through the cavities and apertures cut through the face of the block at the appropriate points. The drainage and sanitary pipes may be fixed on the face of wall with the help of clamps fixed at the joints. Where large openings are required to be made for taking out the sanitary fittings, the holes be either left during construction or the full block be removed and the hole be plugged with concrete after placing the fittings in position.

There is a demand for short notes summarising available information on selected building topics for the use of Engineers and Architects in India. To meet the need, this Institute is bringing out a series of Building Digests from time to time and the present one is the 122nd in the series. Readers are requested to send to the Institute their experience of adopting the suggestions given in this Digest.

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