"TECHNO ECONOMIC FEASIBILITY REPORT ON CONCRETE HOLLOW & SOLID BLOCK"

Building Materials & Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation
Government of India
New Delhi

TO THE USERS

This Techno-Economic Feasibility Report has been prepared on the basis of information available. The intention here is to provide preliminary information to the prospective entrepreneur. Prior to making a firm decision for investment in the project the entrepreneur must verify the various feasibility aspects together along with the addresses for the procurement of plant and machinery and raw materials independently. The information supplied in this report is obtained from the reliable sources.

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1.0 INTRODUCTION

Now days, hollow concrete blocks and bricks are becoming very popular. These blocks are being widely used in construction of residential buildings, factories and multi-storied buildings. These hollow blocks are commonly used in compound walls due to its low cost. These hollow blocks are more useful due to its lightweight and ease of ventilation. The blocks and bricks are made out of mixture of cement, sand and stone chips. Hollow blocks construction provides facilities for concealing electrical conduit, water and soil pipes. It saves cement in masonry work, bringing down cost of construction considerably.

Background

A concrete block is primarily used as a building material in the construction of walls. It is sometimes called a concrete masonry unit (CMU). A concrete block is one of several precast concrete products used in construction. The term precast refers to the fact that the blocks are formed and hardened before they are brought to the job site. Most concrete blocks have one or more hollow cavities, and their sides may be cast smooth or with a design. In use, concrete blocks are stacked one at a time and held together with fresh concrete mortar to form the desired length and height of the wall.

Concrete mortar was used by the Romans as early as 200 B.C. to bind shaped stones together in the construction of buildings. During the reign of the Roman emperor Caligula, in 37-41 A.D., small blocks of precast concrete were used as a construction material in the region around present-day Naples, Italy. Much of the concrete technology developed by the Romans was lost after the fall of the Roman Empire in the fifth century. It was not until 1824 that the English

stonemason Joseph Aspdin developed Portland cement, which became one of the key components of modern concrete.

The first hollow concrete block was designed in 1890 by Harmon S. Palmer in the United States. After 10 years of experimenting, Palmer patented the design in 1900. Palmer's blocks were 8 in (20.3 cm) by 10 in (25.4 cm) by 30 in (76.2 cm), and they were so heavy they had to be lifted into place with a small crane. By 1905, an estimated 1,500 companies were manufacturing concrete blocks in the United States. These early blocks were usually cast by hand, and the average output was about 10 blocks per person per hour. Today, concrete block manufacturing is a highly automated process that can produce up to 2,000 blocks per hour.

Concrete blocks were first used in the United States as a substitute for stone or wood in the building of homes. The earliest known example of a house built in this country entirely of concrete block was in 1837 on Staten Island, New York. The homes built of concrete blocks showed a creative use of common inexpensive materials made to look like the more expensive and traditional wood-framed stone masonry building. This new type of construction became a popular form of house building in the early 1900s through the 1920s. House styles, often referred to as "modern" at the time, ranged from Tudor to Foursquare, Colonial Revival to Bungalow. While many houses used the concrete blocks as the structure as well as the outer wall surface, other houses used stucco or other coatings over the block structure. Hundreds of thousands of these houses were built especially in the Midwestern states, probably because the raw materials needed to make concrete blocks were in abundant supply in sand banks and gravel pits throughout this region. The concrete blocks were made with face designs to simulate stone textures: rock-faced, granite-faced, or rusticated. At first considered an experimental material, houses built of concrete blocks were advertised in many Portland cement manufacturers' catalogs as "fireproof, vermin proof, and weatherproof" and as an inexpensive replacement for the ever-scarcer supply of wood. Many other types of buildings such as garages, silos, and post offices were built and continue to be built today using this construction method because of these qualities.

Market Survey And Strategies

Housing is a big & complex problem in India. It has two major facts - urban & rural. More attention is paid to urban housing due to the growing pressure of population & the need to meet the requirements of slum & pavement dwellers

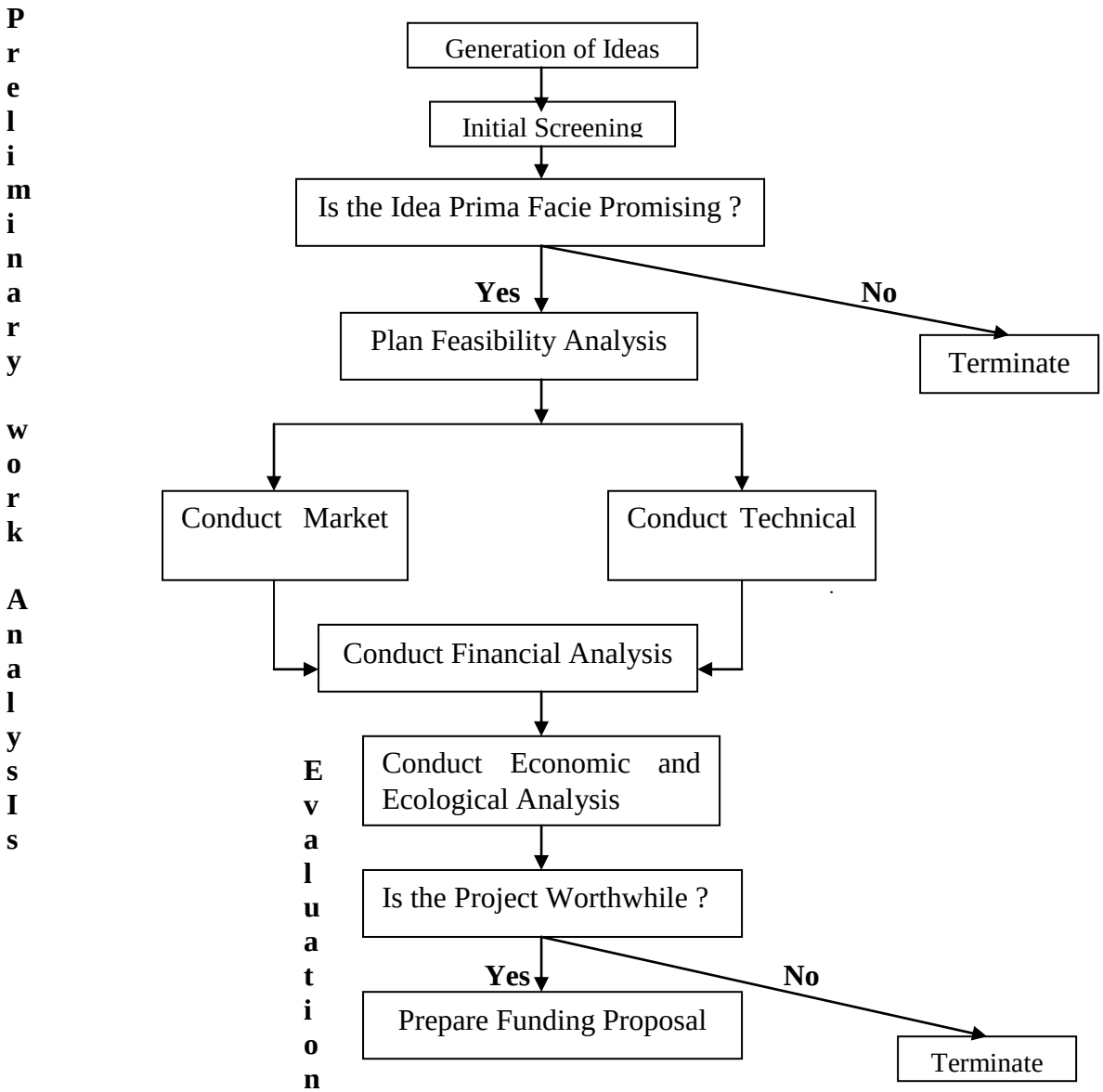
and urban renewal. In the process, rural housing gets neglected. A great majority of Indian population lives in rural areas. The influx of population from villages to metropolis has become a burning problem of the day. Rural & small town housings may slow down an excessive country - to - town movement of people and hence the housing problems of major cities may be controlled. Lack of housing in rural areas pushes the population to cities, there by creating additional housing problems.

The housing shortage in the country was estimated over 20 million units in 1982 out of which 15 millions in rural areas & 5 million in urban areas. Housing is an economic activity & an important part of construction activities, sharing 50 to 60% of total capital formation & employment generation. Residential & non - residential constructions together are capable of swinging the national economy in any direction and to any extent. According to data available, non-residential construction has a very high share in total investment for buildings. Almost 80% of total resources are invested in constructions for non-residential purposes.

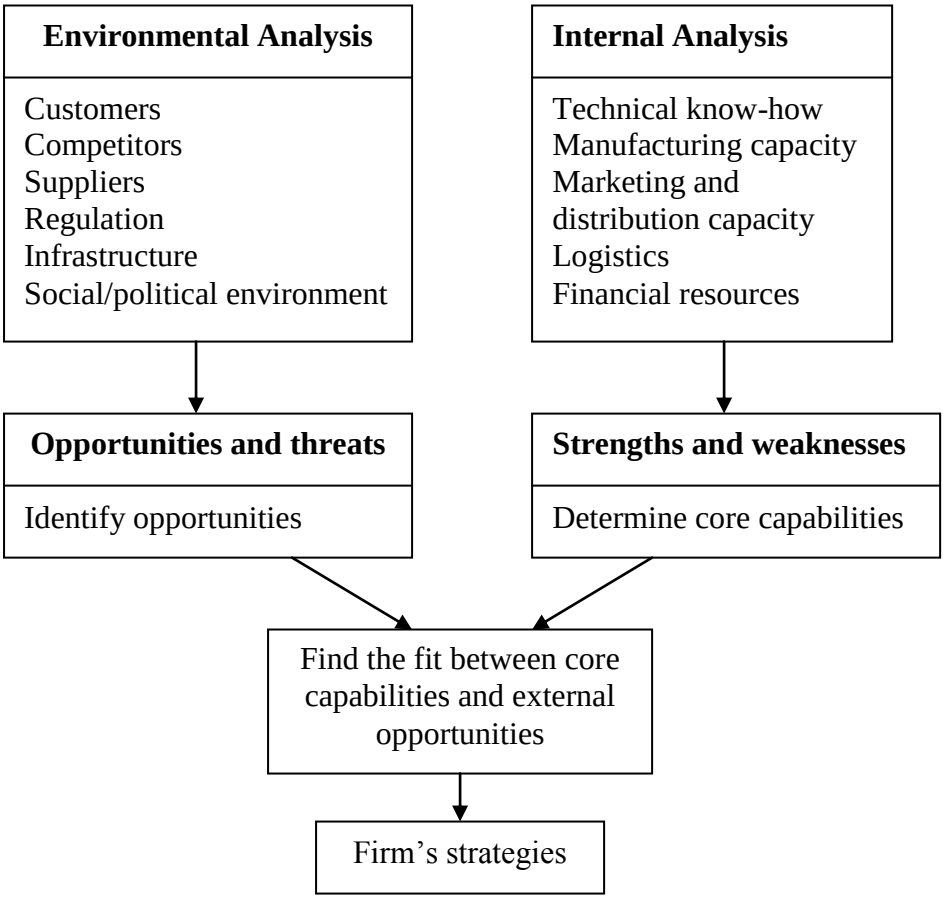
All the above close studies reveal the need and scope for building construction in rural and urban areas for residential & non-residential purposes.

Feasibility Study: A Schematic Diagram

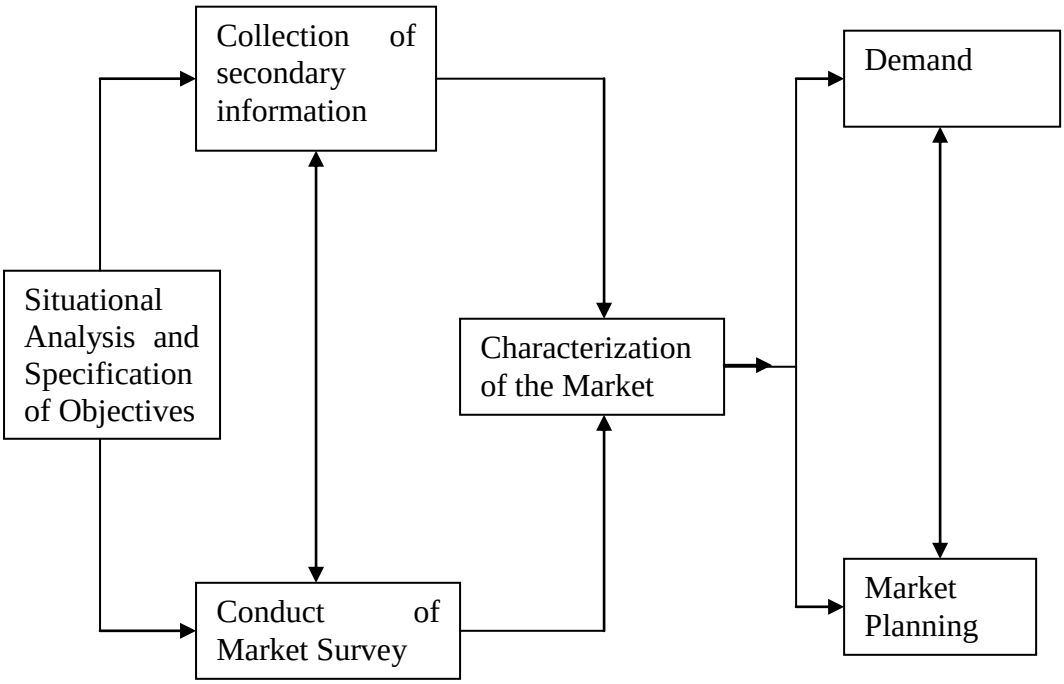
The feasibility study is concerned with the first four phases of capital budgeting, viz., planning, analysis, selection (evaluation), and financing, and involves market technical, financial, economic and ecological analysis. The schematic diagram of the feasibility study.



Formulation of Strategies



Key steps in Market and Demand Analysis and their Inter-relationships



Housing Data & Demand Requirement

The Housing and Building statistics are necessary for the formulation, execution and evaluation of housing policies and building programmes which constitute an integral part of the overall social and economic plans of the country. At the central level, the authentic date on housing and related infrastructure statistics. It also caters to the need of the planners, policy makers and researchers in the field of housing statistics. The housing and building statistics are also necessary for national accounts purposes. In the context of National Housing Policy, the availability of varied details has become all the more important.

The data on urban households and housing stock from various Population Censuses are presented in the table given below. It may be noted that the

decadal growth rate in the number of households has been modest 38 per cent only during eighties and nineties. This is significantly below the figure of 54 per cent recorded during seventies. The decline in the growth during the past two decades can be attributed to deceleration in the rate of urbanization which was phenomenally high during seventies, the corresponding rate being 48 per cent.

Census years	**Households (Million) Mn**	**Total Housing Stock (Mn)**	**Pucca (Mn)**	**Semi Pucca (Mn)**	**Kutcha service able (Mn)**
1961	14.9	13.30	6.44	4.90	1.96
1971	19.1	18.50	11.80	4.35	2.35
1981	29.3	28.00	18.09	6.80	3.11
1991	40.7	39.30	29.79	6.21	3.30
2001	55.8	50.95	41.17	8.08	1.70

The decadal growth rate in pucca housing has come down from 53.30 per cent and 64.68 percent during seventies and eighties to 38.20 per cent only during nineties. As far as semi pucca and kutcha houses are concerned, the growth rates were very high during seventies, similar to that of the pucca houses, the rates being 56 per cent and 32 per cent respectively. The absolute number of semi pucca houses came down by 0.59 million units during 1981-1991 while it registered a jump of 1.87 million i.e. 30.11 % in the following decade. Interestingly the growth in kutcha dwelling units was as low as 6 per cent during eighties while the number came down to fifty per cent during 1991-01. In case we decide to combine semi pucca and kutcha houses, the growth rate has gone down from 48 per cent during 1971-81 to (-) 4.0 per cent during 1981-91 and then to 2.8 per cent during 1991-01. It is possible to argue that a large number of

kutcha houses have been converted into (or reported as) semi pucca houses during 1991-2001 which would explain the spurt in the growth of semi pucca houses compared to the previous decade. The decline in the number of kutcha houses an also attributed to that.

It has also been noted that as per the Census of India, 2001, 9.01 % of census houses are lying vacant. These vacant houses are not available for residential purposes and may not be accessible for the EWS (Economical Weaker Section) and LIG category of households.

Taking all these factors into consideration, it is evident that the growth in the total housing stock during the 1991-2001 decade is much less than the preceding two decades. This could be due to limited withdrawal of public agencies like Housing Boards, and Development Authorities from house construction activities. The fiscal benefits provided in the housing sector during the last 5 to 10 years do not seem to have led to a boost in housing activities. The drastic reduction in the number of kutcha houses may be due to the impact of various housing schemes such as VAMBAY, JNNURM etc. being implemented by the Central Government.

2. CONCRETE BLOCK MAKING

1) Materials

Many types of aggregates have been used with success for making concrete blocks. These include crushed stone, gravel, sand coral, volcanic cinders, slag, foamed slag, furnace clinker etc. In humid areas, cement must be carefully stored so as to prevent its deterioration through premature hydration. Water free from

impurities such as oils, acids, organic matter must be used. Where sulphate-bearing water is liable to attack underground concrete work, it is probably advisable to use stone or brick for foundations together with a sulphate resisting Portland cement mortar.

2) Mixes :

The mix will vary according to the type of aggregate used; but it should not be richer than one part (by volume) of cement to six parts of mixed fine and coarse aggregates. For making blocks in which no coarse aggregate is used, a mix consisting of one part of cement to six or seven parts of well graded sand is satisfactory; some users employ mixes up to one cement to eight or nine sand depending on the end use of the blocks. For dense blocks aggregates should be well graded to ensure that the small particles occupy the spaces between the larger ones and leave a minimum of voids. Well-graded sand will produce a much denser block of greater strength and lower moisture movement (although of higher thermal conductivity), than a block made from poorly graded aggregate and sand. When a block of high strength is required, as much large aggregate as possible, using a proper range of gradation, should be included in the mix.

NOTE: Limiting factors are the coarseness of the block (the use of large aggregate makes it difficult to produce a block with good arises) and the ability of the block-making machine to handle mixes with a large aggregate content. It is best to make several trial batch mixes before determining the one required for strength, yield and texture. There is no satisfactory way of deciding the correct mix before hand. It is possible to measure the materials by weigh batching; this

should be done as it is more accurate than measuring by volume. When working on a 'by volume' basis, allowance should be made for bulking of sand if necessary. Dry material should be well mixed before adding water.

3) Mixing :

As much water should be added to the mix as will produce water sheen on the surface of the block, and still not cause the block to slump. The length of time in mixing is important. A mechanical mixer is worthwhile.

4) Operating the Machine :

A few trial blocks will have to be made to arrive at (a) the correct consistency or wetness of the mix, (b) the total volume of ready-mix to be charged into the mould box for tamping. Once this volume is determined it should be fixed. The worker will then onwards dump the same fixed volume each time, in the machine-loading tray.

TAMPING : 3" to 6" deep blocks-automatically tamped. The tamper plate (which enters the mould box) is adjustable. For instance, when making 3" slabs it enters to a depth of 1" compressing 4" of concrete into 3" and when making 4-1/2 slabs, to a depth of 1-1/2, compressing 6" of concrete in 4-1/2" thus ensures a uniform compression irrespective of the height of slab. No Hand-tamping whatsoever is needed, as the tamper plate adjusted to the proper compression actually enters the mould box. This makes the operation an exceedingly quick one (i.e. fill the box right up to the top, level off, tamp and eject-the work of few seconds only). Blocks greater than 6" height are partly hand and plate tamped.

Plain Blocks upto 6” height. Fill mould to the top and strike off the surplus above the top horizontal plane of the mould. No hand or other tamping being done to this stage. Bring down the lid a few sharp blows on top of the mould and the block is tamped to its required density. The tamper lid should level up with the top of mould at around the last few tamping blows. The block is ejected and picked off on the wooden pallet and taken for curing. The operation is repeated. Plain or Hollow Blocks greater than 6” height These blocks, because of their increased height, are party hand tamped with wooden rammer and finished off with the machine tamper lid. Fill the mould to half its depth and ram the mix well around especially at the four corners of the mould box and in between the two cores forming the hollows. Avoid air pockets or spaces.

Hint; Use a suitable wooden rammer say 4-1/2” X 1-1/2” timber about 15” long, tapered and shaped for about half its length for convenience of grip. The square end shod with a piece of flat sheet iron fastened to the broad faces of the wood. Now fill the mould completely level with the top. Bring the tamper lid down swiftly and tamp down the mix in the mould until the tamper lid levels up.

The most force is required to overcome initial friction and commence upward movement. Pull up the ejection handle with a littler jerk and then onwards there is no further exertion. The block is picked off on the plain or hollow wooden pallet and taken for curing.

5) General :

The complete operation being the work of a few seconds only for a practiced operator, provided he is kept supplied with mix, can be expected to produce approx. 90 solid blocks of size 18”x9”x4-1/2” per hour. As the mould box is only filled up once, the same amount of concrete is used for each slab of any one thickness – a great help when working up estimates. A huge daily output could be realized when five or six machines are run in co-operation with a motor – mixer.

6) Curing :

Shelter the blocks from sun and draying winds. After 24 hours they should be watered and kept damp. Once moulded blocks have sufficiently hardened to permit removal of the supporting wooden pallet they may be carefully turned on side or edge and the pallet removed, the pallet oiled and reused. Keep blocks damp for several days to permit the cement to hydrate completely. The longer the curing time the better is the strength. The blocks should thereafter be completely dried prior to placing in the wall.

7) Mortar for Laying Cement Blocks :

When building in concrete blocks a weak mortar is preferable to one rich in cement. Rich or strong mortars are usually inadvisable as they make the wall to rigid, localizing the effects of minor movement. If these movements are not taken up and distributed in the joints they may eventually lead to cracking of the blocks, thus creating a path for termites and entrance for driving rain. A 1 part cement 1 part lime, and six parts sand by volume mortar should be adequate.

8) Work Cycle :

(i) In the absence of a concrete mixer-for hand mixing and filling of scoops and keeping them ready for transfer of mix to machine hopper tray.

(ii) Dumping ready-for-use mix into hopper tray-taking back emptied scoop and returning to machine with a filled one.

(iii) Feeding mix from hopper tray to mould box, filling mould complete (i.e. level to top of mould) and tamping with the mould tamper lid.

Note : 1 For blocks greater than 6” height, the mix is partly hand-tamped with the mould-half filled and then finished off with the tamper lid.

2. During tamping the lid-plate progressively enters the mould box on each successive tamping blow, Normally the tamper lid should level up with the top of mould box on the fourth or fifth tamping blow.

(iv) Ejecting the block, returning slide to loading position (only after the moulded block has been removed from the machine), cleaning the mould box walls and slide top when necessary and placing a fresh wooden pallet each time into the mould box from a pallet-stack kept nearby the machine.

(v) Picking off the ejected block on the supporting wooden pallet as ejected from the mould and carrying it away to the curing place.

(vi) The use of a concrete mixer will be a great facility when operating a number of machines simultaneously, depending on daily output desired.

Some labour will be required for removing the pallets from the underside of blocks previously moulded and now sufficiently hardened to permit separation of pallet, cleaning the pallets, giving them cleaned pallets a wipe with an oily rag and stacking them near the block making machine. Thus to keep the block making operation going, there must always be sufficient number of ready-for-use pallets on hand stacked near the machine.

9) Making Plain Blocks :

Remove the hollow forming twin cores by unfastening them from the bed of the machine, from below. Use plain pallets – insert the two rectangular plugs into the two windows of the tamper lid and bolt them to the tamper lid. The machine is now set to produce plain blocks.

10) Pallets :

Sample wooden pallets are supplied. Users have to get these made locally in quantity, depending on the daily output desired. It is imperative to have a stack of ready for use pallets always on hand near the machine to keep the blockmaking in continuous operation.

11) Output :

Solid blocks upto 6” height approx 600 blocks per day.

- Solid blocks greater than 6” height approx. 500 blocks per day.
- Hollow blocks upto 6” height approx. 500 blocks per day.
- Hollow blocks greater than 6” height approx. 400 blocks per day.

- Blocks greater than 6” height are partly hand tamped with the mould half filled and finished with the tamper lid.

12) Maintenance :

The machine should be kept lubricated at all points where grease cups have been provided (in all there are six cups.) The check nuts provided on the spring turnbuckles should be kept tight. The bearings of the pin under the slide should be kept lubricated by oiling. The said pin connects the slide to the link. The pin connecting the link to the bifurcated short link at bottom should also be kept lubricated.

3. PRODUCT DESCRIPTION : CONCRETE BLOCKS AND BRICKS

DEFINITION:

As per the Indian Standard specification, a hollow block is defined as the block having one or more large holes of cavities which pass through the block and having solid material between 50 and 75 percent of the total volume of block calculated from the over all dimension.

Quality Specifications :

All the different types of cement concrete hollow and rigid bricks are covered by Bureau of Indian Standard (BIS) specification mentioned below:

IS 2185: Specification for Hollow concrete block.

SIZE : Hollow concrete blocks shall be in one of the following size :

	Length	**Breadth**	**Height**
A.	40 Cm	30 Cm	20 Cm
B.	40 Cm	20 Cm	20 Cm
C.	40 Cm	10 Cm	20 Cm

The maximum variation in the dimensions shall not be + 1.5 mm for height and breadth and + 300mm length. The size other than those mentioned above may also be used by mutual agreement between the purchaser and manufacturers/suppliers.

Cavities :

The total width of the cavity in a block right angle to the face of the block as laid in wall (i.e. the bedding surface will be at right angles to the face of the block shall not exceed 65% of the total breadth of the block.

Shell Thickness :

The shell thickness of blocks shall not be less than 40 mm for sizes A & B and 20 mm for other sizes.

Joints ;

The end of the blocks, which form the vertical joints, may be plain rectangle and grooved or double grooved.

Aggregates :

All aggregates shall pass through I.S. sieve 1285mm and not more than 12 per cent shall pass through I.S. sieve 300 micron. In addition at least 15% shall be

retained on I.S. sieve 10mm and 40 per cent on I.S. sieve 4.75mm. The fineness modular of the combined aggregates may be between 3.6 to 40.

Density :

The block density hollow concrete block shall not be richer than 1600 kgs. Per cubic meter of gross volume.

Crushing Strength ;

The average crushing strength of eight blocks that are immersed in water maintaining a temp. of 27^{o} C + 2^{o}C for a period of 24 hrs bedded with cement sand mortar shall be not less than 50 kg per square cm of gross area.

Drying Shrinkage :

The drying shrinkage of average of three blocks when unrestrained shall not exceed 0.004 per cent.

moisture contents :

The moisture content (average of 3 blocks) of the dried blocks on being immersed in water shall not exceed 0.03 %.

Water Absorption :

The water absorption (av. 3 blocks) shall not exceed 240 kg per cu meter.

1.	I.S.2185 (Part) 1979	Hollow and solid concrete blocks
2.	I.S. 2185 (Part-2) 1983	Hollow solid light weight concrete blocks
3.	I.S. 383-1970	Specification for coarse & fine aggregates from natural resources for concrete
4.	I.S. 279-1967	Cement

	I.S. 455-1967 I.S. 1489-1967	
5.	I.S. 2572-1963	Code of practice for construction of hollow concrete block masonry.
6.	I.S. 2250-1981	Code of practice for preparation and use of masonry mortars.

4. TYPES OF CONCRETE BLOCKS

Concrete blocks are produced in a large variety of shapes and sizes, either solid, cellular or hollow, dense or lightweight, air-cured or steam-cured, loadbearing or non-loadbearing, and can be produced manually or with the help of machines.

- Block sizes are usually referred to by their nominal dimensions, which are the actual block length, width and height plus 10 mm of mortar bed thickness added to each dimension. These are normally based on the modular coordination of design with the 10cm module as its basic unit. The most commonly used concrete blocks are the stretcher blocks with a nominal length of 40 cm (half blocks: 20 cm) nominal height of 20 cm, and nominal widths of 8, 10, 15 and 20 cm. In addition, a wide variety of non-modular blocks and special shapes are available, such as corner, jamb, lintel, pilaster and interlocking blocks, to name only a few.

- Solid blocks have no cavities, or - according to US standards - have voids amounting to not more than 25 % of the gross cross-sectional area. Thinner blocks of less than 75 mm (3") width are essentially solid, because of the difficulty of forming cavities.

- Cellular blocks have one or more voids with one bed [ace closed, and are laid with this 'blind end' upwards, preventing wastage of bedding mortar, which would otherwise drop into the cavities.

- Hollow blocks are the most common types of concrete blocks, having one or more holes that are open at both sides. The total void area can amount to 50 % of the gross cross-sectional area, and - according to British Standards - the external wall thickness must be at least 15 mm or 1.75 x nominal maximum size of aggregate, whichever is greater. The use of concrete hollow blocks has several advantages:
    - they can be made larger than solid blocks, and if lightweight aggregate is used, can be very light, without forfeiting much of their load-bearing capacity;
    - they require far less mortar than solid blocks (because of the cavities and less proportion of joints, due to large size), and construction of walls is easier and quicker;
    - the voids can be filled with steel bars and concrete, achieving high seismic resistance;
    - the air-space provides good thermal insulation, which is of advantage in most climatic regions, except warm-humid zones; if desirable, the cavities can also be filled with thermal insulation material;
    - the cavities can be used as ducts for electrical installation and plumbing.

- Dense concretes are normal concretes with a density exceeding 2000 kg/m3, while the densities of lightweight concretes can be as low as 160 kg/m'. The former are produced with well graded aggregates (with a large amount of fines to fill all voids) and full compaction, while the latter comprise lightweight aggregates and/or a high proportion of single-sized particles of coarse aggregate (no-fees concrete) in a lean mix, which is not fully compacted, or comprise a sand-cement mix with a foaming agent to aerate the mixture. Lightweight concrete is generally used for concrete blocks, provided that the ingredients are available and the strengths obtained are acceptable.

- Air curing is the standard procedure for the strength development of concrete, by which the concrete is kept wet for at least 7 days and then allowed to dry at ambient temperature. With steam curing, by which the concrete is exposed to low or high pressure steam (in autoclaves), high early strengths can be achieved (with autoclaving the 28 day strength of air-cured concrete can be obtained in 24 hours). However, in developing countries, steam curing is unlikely to be implemented, because of its high cost and sophistication.

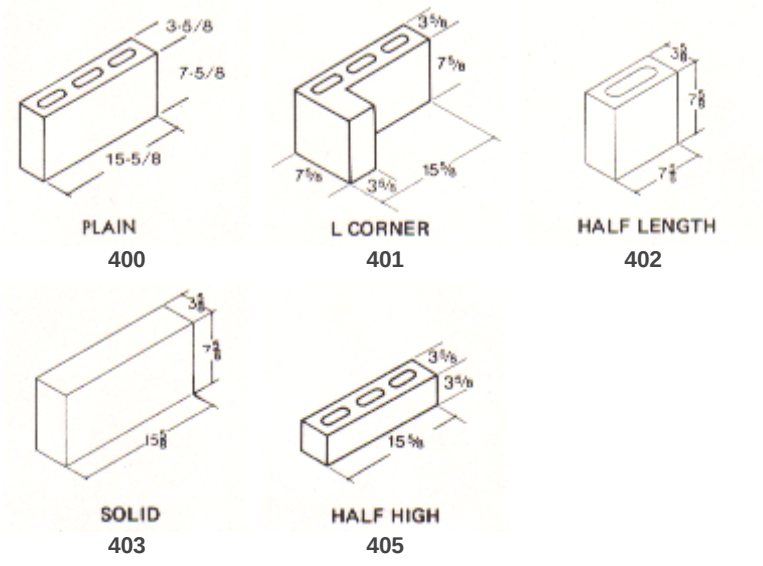
- The definition of loadbearing and non-loadbearing blocks is fairly complex and depends not only on the compressive strengths of the blocks, but also on the ratio of their height to thickness, their density and proportion of voids.

- Manual block production is the cheapest but most laborious method, and the blocks are not likely to attain the superior qualities that are achieved by the far more expensive mechanized production.

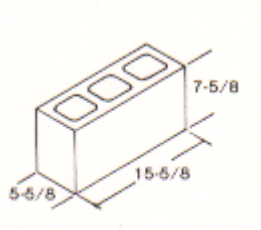
Different Size Concrete Blocks

S.No	Type of Blocks	Size in MM	Purpose
1.	Solid Blocks	100X200X400 200X200X400	Foundation
2.	Closed Cavity Blocks	75X200X400 100X200X400 150X200X400 200X200X200	 Load bearing External works Partition walls
3.	Corner Column Blocks	200X200X400	Corners
4.	Roofing Blocks	410X250X140 530X250X140	Roofs
5.	Bend (U) Blocks	100X200X200 200X200X200	R.C.C. Bend

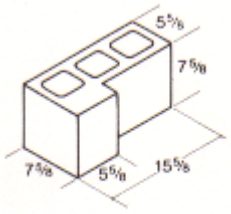
4" Blocks



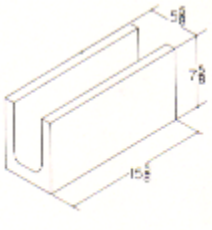
6" Blocks



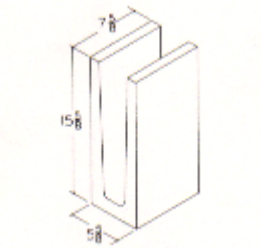
SQUARE CORNER
600



L CORNER
601



BOND BEAM
602



HI LINTEL
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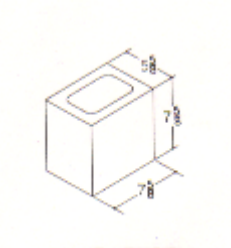

HALF LENGTH
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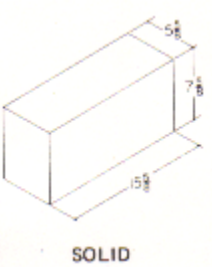

SOLID
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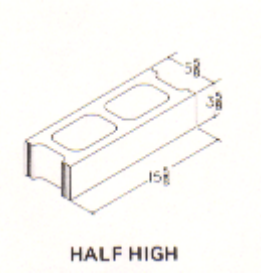
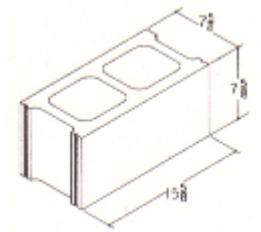
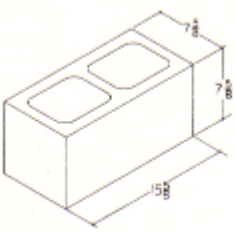


HALF HIGH
606

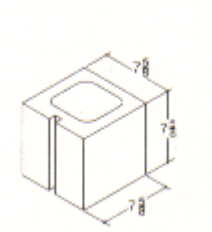
8" Blocks



PLAIN
800



DOUBLE CORNER
801



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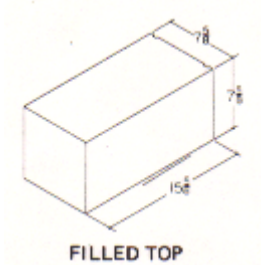

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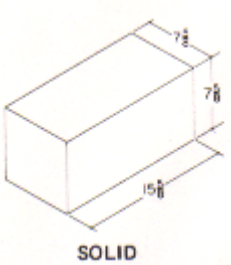

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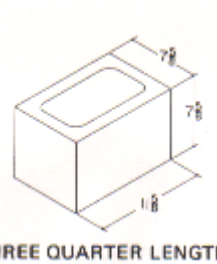

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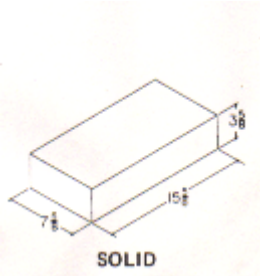

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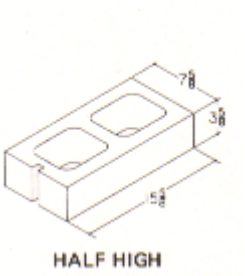

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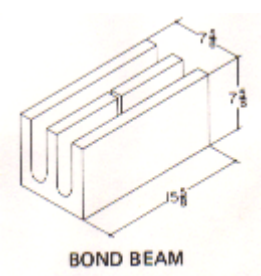

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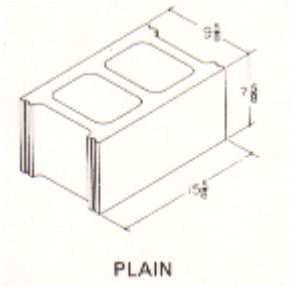
10" Blocks



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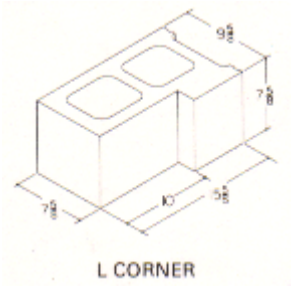

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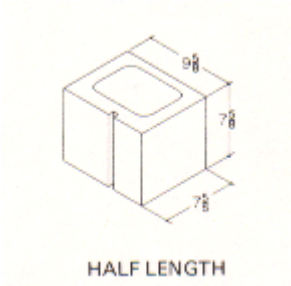

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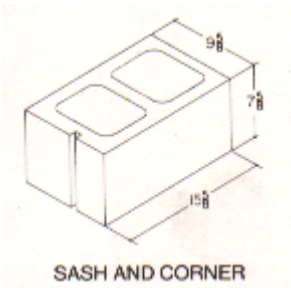

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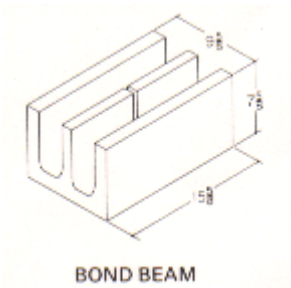

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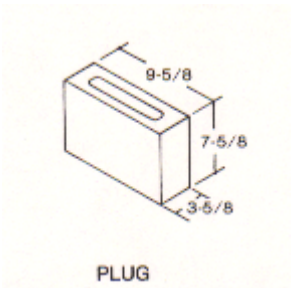

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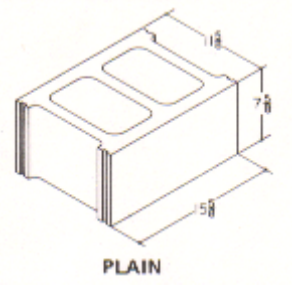
12" Blocks



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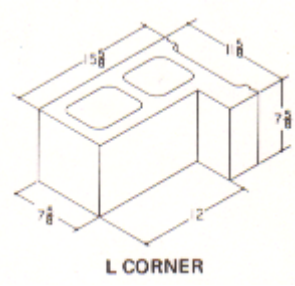

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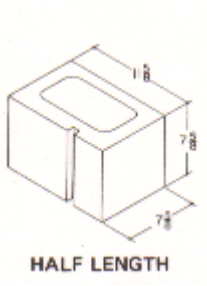

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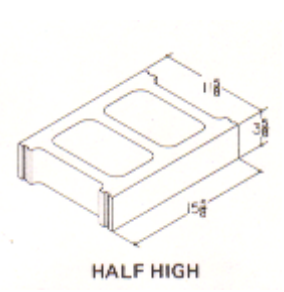

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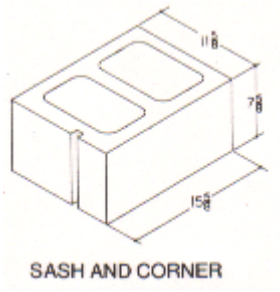

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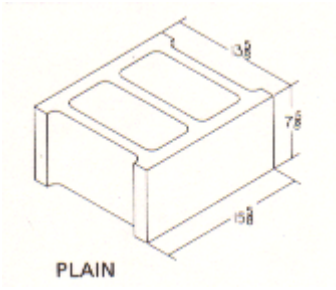
14" Blocks



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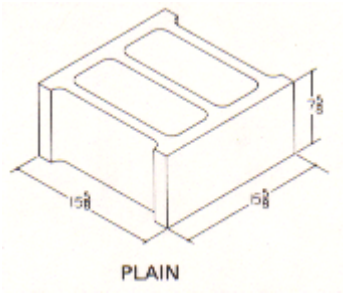
16" Blocks



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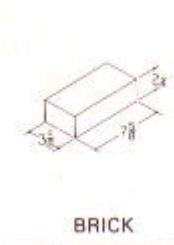
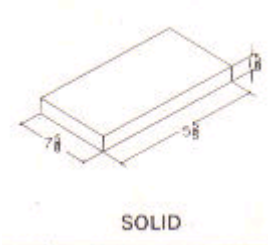
Solid Use



SB-1



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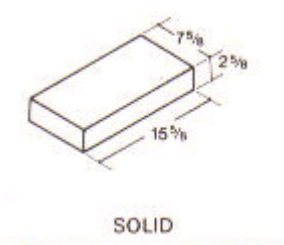

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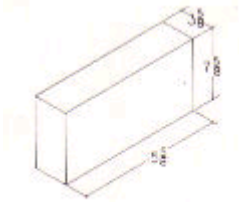

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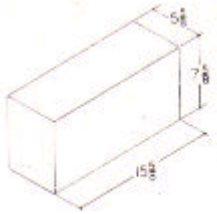

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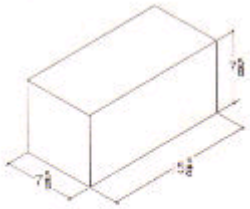

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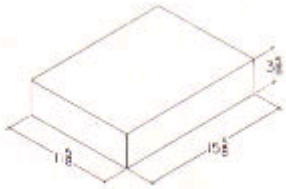
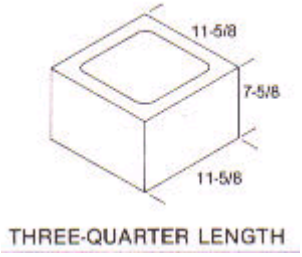


SOLID
SB-7

Special Use



THREE-QUARTER LENGTH
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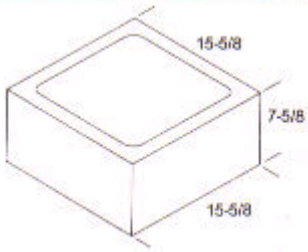

COLUMN BLOCK
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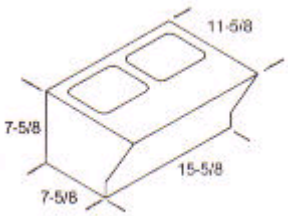

CORBEL BLOCK
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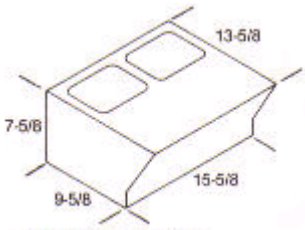

CORBEL BLOCK
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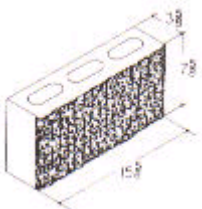
Rock Face Blocks



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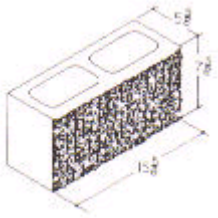

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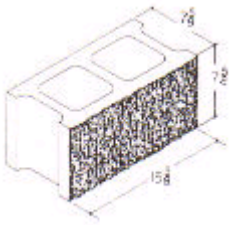
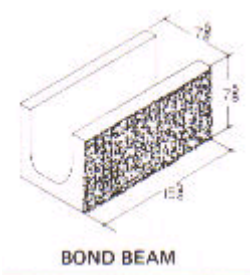
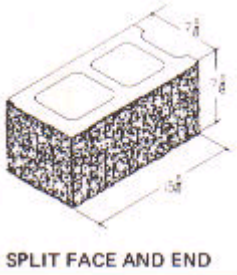


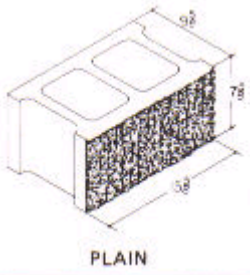
PLAIN



BOND BEAM



SPLIT FACE AND END



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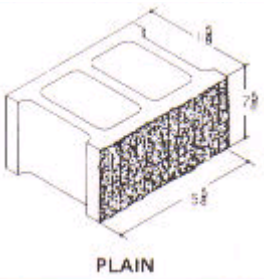
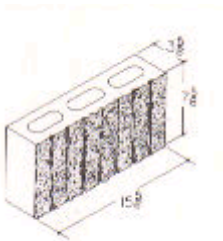


PLAIN

Split Face Blocks



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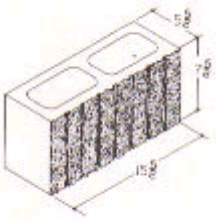

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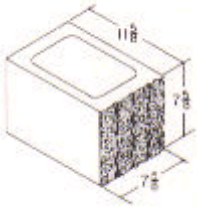
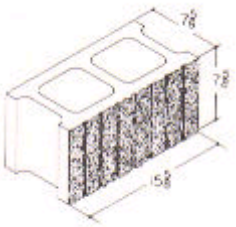


HALF LENGTH



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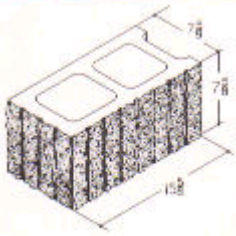
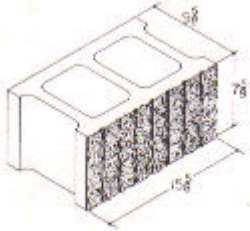


SPLIT FACE AND END



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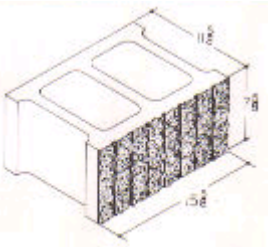

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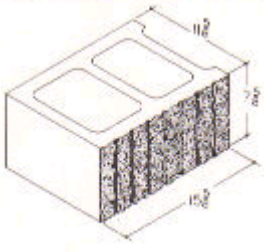
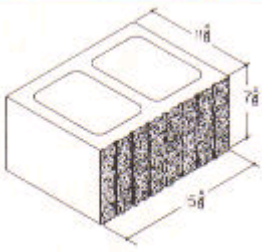
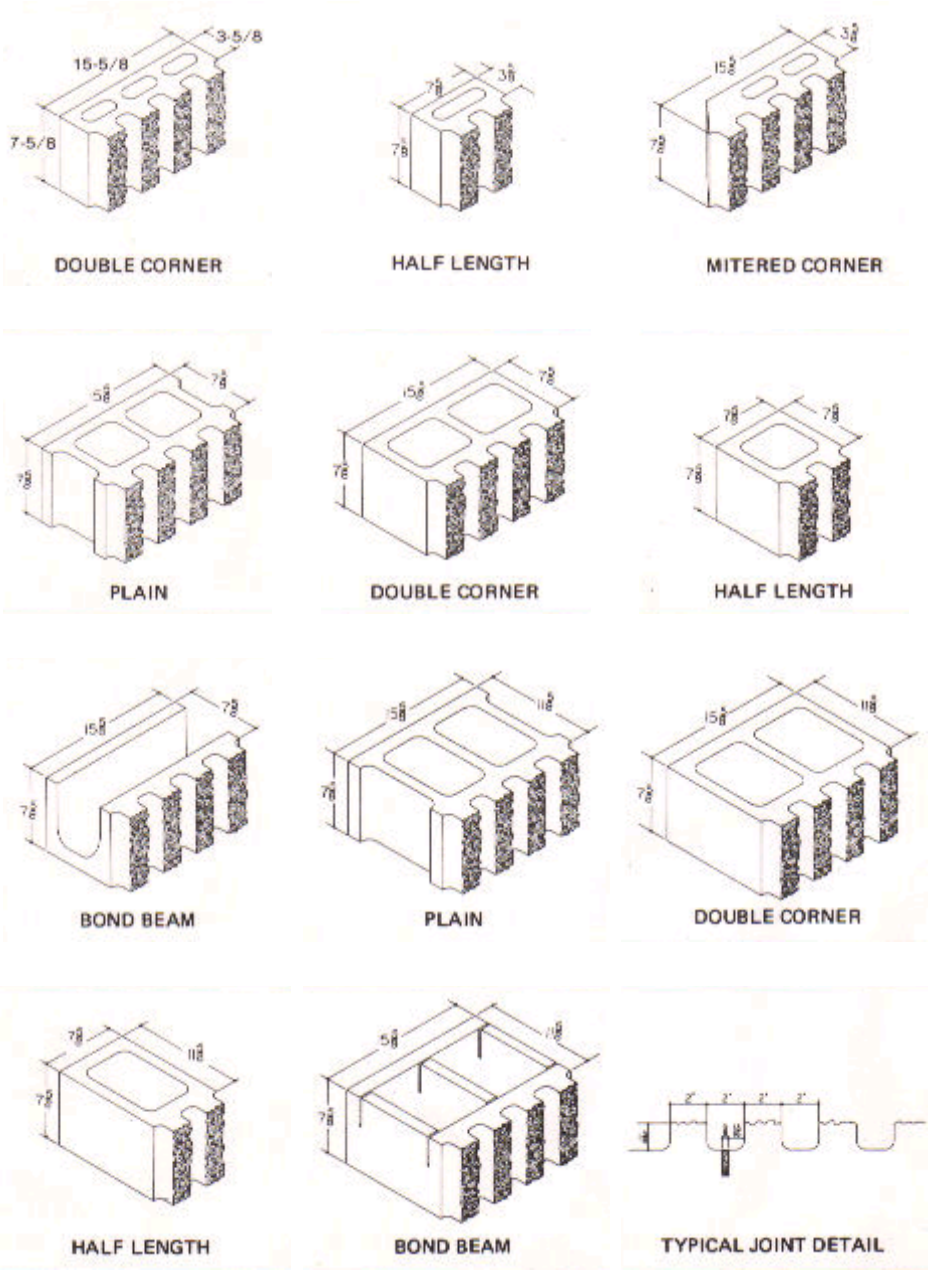


SINGLE CORNER



DOUBLE CORNER

Break-Off Blocks



Materials for Concrete Blocks

Since the ingredients of concrete can be of very different types and qualities, not only depending on their local availability, but also on the desired properties of block, equipment and production method, it is not possible to give detailed recommendations on materials and mix proportions, other than very general guidelines. It is up to the manufacturer to select the most suitable materials and

design of mixes by trial and error, and making tests with the available equipment under the conditions of full-scale production.

Cement

- The following cements are commonly used in concrete blockmaking:

Ordinary Portland cement (OPC). most common type used.

Rapid hardening Portland cement (RHPC): more finely ground cement, which hardens much faster than OPC. It is especially useful:

- Where storage space is limited,
- when rapid production is important, and
- to produce good strength blocks despite poor gradation of aggregate.

Block mix cement: marketed especially for block making, but can vary from one manufacturer to another. It has the high early strength qualities of RHPC, but is lower in price.

Special cements: such as Portland blast furnace cement, sulphate-resisting Portland cement and others, used where special properties are of importance. The partial replacement of cement by a pozzolana, eg rice husk ash, fly ash, may be acceptable in certain cases, but should not be implemented without prior laboratory testing.

Aggregates

- In order to facilitate transportation, handling and laying concrete blocks, it is necessary to reduce their density. This is achieved by reducing compaction, ensuring a relatively high proportion of air gaps between the aggregate particles and/or using lightweight aggregates. Hence it is important to have a relatively high proportion of coarser particles, because too much fine aggregate would fill the gaps and increase the density. However, a carefully measured amount of very fine particles is necessary to produce the cement paste required to bind the coarser particles.

- The maximum particle size of coarser aggregates is 13 mm (or 10 mm for hollow blocks). Rounded stones produce a concrete that flows more easily than angular (broken) particles, but the latter give higher 'green strength' to the newly demoulded block, because the particles interlock. This is very important for concrete block production.

- Suitable aggregates are usually obtained from natural sources (eg river beds, gravel pits, stone quarries, volcanic deposits) or from industrial by-processes (eg expanded clay, aircooled, granulated or foamed blast furnace slag, sintered fly ash, etc). All aggregates, whether fine or coarse, must be free from silt, clay, dust, organic matter, salts or other chemical impurities, that could interfere with the bond between cement and aggregate or cause deleterious chemical reactions.

Aggregate-Cement Ratio

- After determining the correct blend of aggregates, the proportion of aggregate to cement must be found by trials with different ratios, eg 6:1, 8:1,10:1, up to 16:1 by weight, end testing the qualities of blocks produced.

- The proportion of fine aggregate to cement is of special importance: if the ratio is too high, the mortar will lack the cohesiveness needed for green strength and will be too weak to impart enough strength to the matured blocks; if the proportion is too low, the mortar will be very cohesive and the mix may not flow easily in handling and filling the mould.

Water-Cement Ratio

- Only water that is fit for drinking should be used to mix the concrete. The correct amount of water to be added to the mix depends on the types and mix proportions of aggregates and cement, the required strength of the block, and the production method and equipment used. The concrete must contain just enough water to facilitate production without any slumping of blocks occuring after demoulding. If the aggregates are dry, they may absorb some of the water (lightweight aggregates may absorb up to 20 % by weight), but if the aggregates are wet, the blocks will take longer to dry out.

- As a simple test for cohesiveness, no excess water should be visible when a lump of concrete is squeezed in the hand, but if the sample is rubbed quickly on a smooth round metal bar or tube (2 to 4 cm in diameter) a slight film or paste should be brought to the surface.

Production Process

Batching and Mixing

- Aggregates can be batched by volume or by weight, but the latter is more accurate. For this reason, cement should only be batched by weight, or preferrably by using only whole bags of 50 kg. In backyard block production, with less stringent quality standards, batching by volume using buckets, tins, wooden boxes or wheelbarrows is quite acceptable, if done with care to ensure uniform proportions of mix.

- Since concretes begin to set within 30 to 60 minutes, depending on the type of cement and ambient temperature, only so much concrete must be prepared as can be used up before that happens. In hot climates, the fresh mix must be shaded from the sun to avoid premature setting.

- In case of hand mixing, it must be done on a level, smooth, hard surface (eg concrete slab or steel plate). Because of the relatively low cement content of the concrete and the need for a cohesive mix, thorough mixing is essential. Thus the best mixes are obtained with mechanically operated mixers.

Moulding

- Concrete blocks can be moulded by several methods, ranging from manually tamping the concrete in wooden or steel mould boxes to large-scale production with 'egg-laying' mobile machines and fully automatic stationary machines. The quality of blocks generally increases with the degree of mechanization, but medium standards are normally adequate for most construction purposes. In all cases, the blocks are demoulded immediately after compaction, so that they have to maintain their shape even before the concrete hardens.

Curing

- The blocks are either left to set and harden where they were moulded, or carried away on pallets to the curing place. In all cases it is important to keep the concrete moist, for example, by regularly spraying with water, until the concrete has obtained sufficient strength. This can take 7 days or more, depending on the type and quality of cement. Quicker strength development is achieved by exposing the blocks to steam, but this is only viable in large scale factory production.

Building with Concrete Blocks

Design

- In order to minimize the need for cutting concrete blocks, all horizontal dimensions of walls should be multiples of nominal half blocks (most commonly 20 cm) and all vertical dimensions should be multiples of nominal full-heights (20 cm). This also applies to the positioning of doors and windows.

- In order to minimize the risk of cracking, the lengths of individual wall sections should not be greater than one-and-a-half times the height.

- Hollow blocks should be specified when good thermal insulation is required. These blocks are also useful when additional structural stability is needed, eg in earthquake areas, because the cavities align vertically and can be filled with reinforcing steel and concrete.

- Blocks with a rough surface (open textured), as in the case of most lightweight blocks, are advantageous, because they

  - provide a better key for bedding mortar and applied finishes,
  - have less capillary attraction for water and dry out more quickly after rains.

Construction

- Concrete blocks must be dried out thoroughly before use, otherwise drying will continue after building the wall and shrinkage cracks may develop.

Only dry blocks should be used and they should not be wetted before laying. Instead the preparation of the mortar must take into consideration that the blocks absorb some of the water.

- Mortars used for bedding should not be too rich in cement. Cement: hydrated lime: sand mixes of 1: 2: 9 or 1: 1: 6 have a high water retention and good workability. It is important that the strength of the mortar does not exceed that of the blocks, so that the joints can absorb a limited amount of movement, preventing the blocks from cracking.

5. ADVANTAGES OF CONCRETE BLOCKS

- Economy in design of sub-structure due to reduction of loads
- Saving in mortar for lying of blocks as compared to ordinary brick work. Saving in mortar for plasterwork. Uniform Plaster thickness of 12 mm can be maintained due to precision of the size of blocks as compared to brick work where plaster thickness of average 20 mm is required to produce uniform and even plastered surface due to variations in the sizes of bricks. Insulation of walls is achieved due to cavity, which provides energy saving for all times. Similarly hollowness results in sound insulation.

- Paint on finished walls can be applied due to cavity, which provides energy saving for all times. Similarly hollowness results in sound insulation.
- No problem of the appearance of salts. Hence great saving in the maintenance of final finishes to the walls.
- Laying of Blocks is much quicker as compared to brickwork hence saving in time.

6. HOLLOW BLOCK AND BRICKWORK

The comparison of materials used for 100 sq-m / 100 sq-ft of 200 mm and 100 mm thick hollow block walls with 9” and 4-1/2” brick wall respectively, is follows :

Width of Wall	Units	200 mm	100 mm	215-225 mm	107-114 mm
Quantity of Hollow Blocks/Bricks required for 100 sq-m of Surface Area	Nos	1161	1161	11365-12120	5926-5435
Quantity of Hollow Blocks/Bricks required for 100 sq-ft of surface area	Nos	108	108	1127-1056	551-505
Mortar for Laying Blocks/Bricks per 100 sq-m	cu-m	1.394	0.679	4.63-4.85	1.80-1.87
Mortar for Laying Blocks/Bricks per 100 sq-ft.	cu-ft	4.571	2.286	15.11-15.93	5.92-6.15
Mortar for plastering both sides of Brick Masonry for 12 mm/20 mm per 100 sq-m	cu-m	2.400	2.400	12.500	12.500
Mortar for plastering both sides of Brick Masonry for 12 mm/20 mm per 100 sq-ft	cu-ft	8.333	8.333	2.500	12.500

7. MANUFACTURING PROCESS

All the three materials – cement, sand, stone chips are mixed in concrete mixture in ratio of 1:3:6 or 1:2:4 depending on the type of construction and required

strength. The water, cement ratio is approx. 0.44:1; the size of the material required is 12 mm and below.

The mixture is fed into the mould of the hydraulic or mechanical tempting machine and vibrated for few seconds with intervals to give complete compactness. The blocks are then placed on the floor for 24 hrs. for initial setting. These blocks are then stacked in layers. Stacking must be in 6 or 8 layers. Curing is done for 21 days by spraying water over stacked blocks.

8. EQUIPMENTS FOR BLOCKS AND BRICK

Concrete block construction is gaining importance in developing countries, even in low-cost housing, and has become a valid alternative to fired clay bricks, stabilized soil, stone, timber and other common constructions, providing the ingredients are available locally, are of good quality and economically viable.

The essential ingredients of concrete are cement, aggregate (sand, gravel) and water, but the physical characteristics of the material can be extremely diverse, depending on the type and relative proportions of these ingredients, the addition of other ingredients and components, and also the production method. Concrete is thus a very versatile material and can be made to satisfy a large variety of requirements, whether it is used for foundations, floor slabs monolithic walls cast in situ, or for prefabricating concrete blocks.

Assuming that the ingredients and workmanship are of average quality, the main characteristics of the most common types of concrete are:

- high compressive strength, resistance to weathering, impact and abrasion;

- low tensile strength (but can be overcome with steel reinforcement)
- capability of being moulded into components of any shape and size
- good fire resistance up to about 400°C.

The main problems, particularly with regard to developing countries, are:

- the need for a relatively large amount of cement, which can be expensive and difficult to obtain
- the need for a relatively large amount of clean water for mixing and curing, which can be a serious problem in dry regions
- the need for special knowledge and experience in the production process
- the risk of deterioration through sulphates in the soil or water to which the concrete is exposed.

Entrepreneurs wishing to start the production of concrete blocks will not only have to consider all these technical and economic aspects, but also a number of environmental, social and administrative factors, in comparison to other alternative building materials, before undertaking further steps towards the establishment of a manufacturing plant.

The information on concrete block production presented on this folder should, however, be regarded only as a brief introduction to the technology and criteria for the selection and purchase of equipment. The reader is advised to refer to the selected Bibliography for detailed information.

Hydraulic Block Laying Machine (Output: 3200 Blocks / 8 hrs)

Type of Machine	**Hydraulic**
Moulding Area	600 x 800 x 250mm
Std. Block Height	200mm
Cycle Time Sec.	90
No. of Cycle / Hours	40
No. of Blocks / Hours	400
Pump Motor (Hp)	3.0
Vibrator Motor (Hp)	2.0
Travel Motor (Hp)	0.5
Power Supply	415 VOLTS 3 PHASE a.c.

Autoramming Block M/C (Output : 800 Blocks / 8 hrs)

Type of Machine	**Autoramming**
Output per shift	800 Blocks
Cycle Hour	50
Vibrator	In Built 1 Hp, 1 Ph/3Ph Motor
Ramming compaction	Automatic 140 Strokes/min in 2 HP, 1 ph
Block Ejection	Blocks are Stationary Moulds slide Down
Weight (Approx)	375 Kg

Vibro Block Machine (Output) : 640 Blocks / 8 Hrs.

Type of Machine	**Vibro**
Output per shift	640 Blocks
Cycle Hour	40
Raming compaction	Manual
Block Ejection	Blocks are Stationary Moulds Slide Down
Weight (Approx)	250 Kg
Vibrator	In-built 1 HP, 1 Ph

Manual Block Machine (Output : 400 Blocks / 8 Hrs.)

Type of Machine	**Manual**
Output per shift	400 Blocks
Cycle Hour	25
Raming compaction	Manual
Block Ejection	Blocks are Stationary Moulds slide Down
Weight (Approx)	225 Kg
Vibrator	

Hyd. Block Laying M/c (Output : 3200 Blocks / 8hrs.)

Type of Machine	Hydraulic
Moulding Area	600 X 800 X 250mm
Std. Block Height	200mm
Cycle Time Sec	90
No.Of Cycle / Hours	40
No Of Blocks / Hours	400
Pump Motor (Hp)	3.0
Vibrator Motor (Hp)	2.0
Travel Motor (Hp)	0.5
Power Supply	415 Volts 3 Phase A.C.

* Only for 300 x 200 x 150mm

Autoramming Block M/C (Output: 800 Blocks/8 Hrs.)

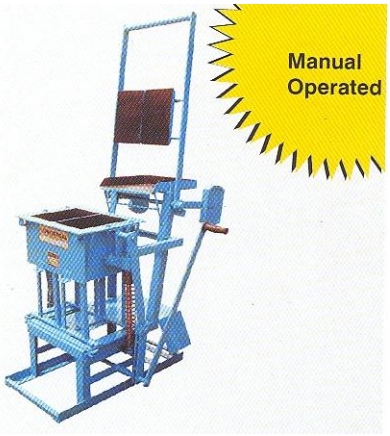
Type of Machine	Autoramming
Output Per Shift	800 Blocks
Cycle Hour	50
Vibrator	In Built 1 Hp , 1 Ph/3Ph Motor
Ramming Compaction	Automatic 140 Strokes/min In 2 HP , 1 Ph
Block Ejection	Blocks are Stationary Moulds Slide Down
Weight (Approx)	375 Kgs

Vibro Block Machine (OUTPUT : 640 Blocks / 8Hrs.)

Type of Machine	Vibro
Output Per Shift	640 Blocks
Cycle Hour	40
Ramming Compaction	Manual
Block Ejection	Blocks Are Stationary Moulds Slide Down
Weight (Approx)	250 Kgs
Vibrator	Inbuilt 1 HP, 1 Ph

Manual Block Machine (OUTPUT : 400 Blocks / 8Hrs.)

Type of Machine	Manual
Output Per Shift	400 Blocks
Cycle Hour	25
Ramming Compaction	Manual
Block Ejection	Blocks Are Stationary Moulds Slide Down
Weight (Approx)	225 Kgs



9. CONCRETE PAVEMENT BLOCK

Concrete pavement blocks, interlocking, has the unique ability to transfer loads and stresses laterally by means of an arching of bridging between units, spreading the load over a large area, reduces the stress thereby allowing heavier loads and traffic over sub-bases which normally would require heavily reinforced concrete. The process of manufacturing these rugged, shapely and beautiful pieces of concrete mouldings involves a unique vibration and hydraulic compaction. This imparts high compressive strength and curability apart from aesthetic beauty to the entire range of products. It's easy to add intriguing design, texture and pattern to monotonous drives and walkways with the versatile paver available. Different systems meet a multitude of high performance tasks and provide exciting design opportunities for Landscape, Architects, Driveways, Sidewalks, Parking areas, Pool decks, Shopping alleys, Canal linings, Industrial floors, Petrol pumps, Loading decks, Ramps etc. are some of the application. The use of paver is limited only by imagination Concrete pavement blocks are ideal for medium traffic roads, sidewalks, garden paths and public areas and it has excellent durability skid resistance, high strength, choice of colours, elegant appearance and factory controlled quality. Concrete pavement block suits

virtually all types of pavements and requires minimum maintenance. The range of concrete pavement block includes Heavy duty, Medium Duty, Light Duty and Decorative Landscape Pavers.

Light Usage	**Medium Usage**	**Heavy Usage**
Sidewalks/Walkways	Hotels-Driveway	Inland container/Depots
Garden Path	Restaurants (Sit-in-Areas)	Industrial Floors
Patios	Farm House-Driveway	Loading Docks/Ramps
Verandahs	Shopping Mall/Plazas	Ports/Maritime Terminals
Swimming Pool Decks	Amusement Parks	Petrol Pump/Service Station
Terraces/Roof tops	Holiday Resorts	Factory Compound
Pavements/Footpaths	Exhibition Grounds	Ware Houses
Jogging Track	Parking Lots	Bus Terminals
Bicycle Path	Embankments/Canal Lining	Street Escapes
Pedestrian Crosswalk	Railway Stations	Airfield runway

Grass Paver Specification

BLOCKS / SQM	4.15
Weight / Block	26 to 28 Kg
Void area on Block	40%
Surface Finish	Semi Coarse
Height of Block	100mm +/- 5mm
Length of Block	600mm +/-5mm
Breadth of Block	400 +/-5mm
Width of Shell (Between Grids)	50 +/-2mm
Distance Between Grids	90 +/-2mm

Regular Block (Heavy Duty)

High compressive strength and consistent quality controlled concrete blocks.

Irregular Block (Medium Duty)

Extremely high stress concrete block with unique interlocking shape

Grass Paver Block

Aesthetic look, It reduces the wastage Rain water and absorb it in the holes. Paver application varies widely and is practically unlimited difference systems satisfy individual taste and meet a multiple of high tasks.

Regular Block (Heavy Duty)

Rectangular pavement blocks are functional, decorative and simple in shape for heavy industrial block pavements, a block shape with straight sides is the appropriate choice for the following reasons:

1. There is a better chance of a constant quality interlock around all sides of the block. The degree of interlock is less than a profiled blocks but its constancy is of greater importance.
2. A rectangular block is less prone to stress concentration than a profiled block under horizontal loads, hence less chance of flexural tensile failure.
3. A rectangular block pavement behaves better when subjected to traffic wave deformations than profiled blocks as horizontal forces will be transferred as line loads rather than points loads.
4. From a practical point of view rectangular blocks are easier to uplift and replace when services need to be installed under the pavement. This happens frequently at an industrial sites.

Uni Regular Block (Medium Duty)

The irregular geometrical shape of uni block provides interlocking capacity significantly higher than conventional rectangular blocks. uni blocks are suitable for almost all paving block applications from pedestrian sidewalks to heavy weight vehicular traffic applications.

An extremely high stress concrete block with the unique interlocking shape :

Uniregular block is a multi-weaved paving block and has a unique “notched” design which allows each individual block to tightly interlock with the surrounding blocks, thus creating an incredibly strong, uniform surface with the beauty of blocks. Their design flexibility makes multi-weaved blocks the perfect modern option.

Interlocking effect :

Every load acting on a natural pavement block outside its center of gravity, causes a tipping motion. This is largely prevented by all around “notching” of the uniregular block Every single block is not only secured against turning by four blocks in the neighboring row but by six surrounding blocks. It is therefore, impossible for one single block to turn without the neighboring block would have to turn because of the “notching” of the block. The herringbone pattern provides the best possible lock effect because of intensive clasping of each single block. The same applies to the six neighboring blocks and every other block in the area.

Grass Paver Block :

The Grass Pavers create a green surface with attractive appearance of grass combined with the strength of concrete.

The grass paver has been designed to suit a hard strong drive way that permits greening and water percolation, provides a safe walking surface and offers all types of slope protection

Advantage Of Pavement Blocsk :

Durable : Superior structural integrity, high strength, Economical Cheaper in price comparing other conventional methods

Practical : Low maintenance, easy to replace/change colour, simplifies subsurface access, skid resistant and immediately useable.

Simple Installation: It can be easily installed on bed of Sand/Mortar

Versatile: Variety of colours and shapes

Flexible : Blends with old and new surroundings, adapts to environmental fluctuations.

Attractive : Adds warmth, human scale and elegance.

Reusable : Easy to replace damaged blocks

Interlocking Pavement Blocks : Are available in any array of colours and patterns, which lend themselves to the creation of interesting designing in paved areas. In addition to breaking the monopoly of a flat paved area, coloured concrete pavement blocks are used to permanently mark such things as Parking Bays, Traffic Lanes and Crossways. Interlocking Pave Blocks are high strength pre-cast concrete elements designed for near medium and heavy-duty uses. They are available in a variety of shapes, designs, colours and thickness.

Concrete Pavement blocks offer ecological solution to man's increasing concern for his environment, the marble of putting the moisture form rainfall back into earth rather than let it run off as waste. The problem of continual repair to streets and sidewalks is simplified. Streets, for example, can be opened for utility line repairs and the pavers replaced to their original appearance without the usually ugly patch.

Advantages Over Conventional Rigid Concrete Pavement Block

Better resistance to wear and tear :

The compressive strength of Interlock concrete block is very high (50 MPa) as compared to 15-20 MPa in case of reinforced concrete, hence the wear and tear of the surface is less compared to conventional concrete floors.

Better thermal resistance :

Interlock concrete block being segmental and due to joint gaps, temperature stresses do not develop in interlock paving unlike the reinforced concrete paving, where temperature stress is an important factor influencing the life of pavement.

Ready to use after laying :

Interlock concrete block paving is ready to use soon after it is laid, no curing time (28 days in case of R.C.C.) is needed at site.

High Limiting deflection :

The elastic deflection limit in rigid concrete paving is very small (2-4 mm) whereas the limit in interlock block paving is high (20-25 mm). This stops the pavement from cracking due to local soil settlement.

All weather construction :

Interlock concrete block paving can be laid in all weathers since there is no risk of work getting hampered, whereas in case of concrete paving it is not possible to cast the concrete in wet and raining conditions.

Easy repair and maintenance :

The compressive strength of block being very high the blocks are not prone to corresponding blocks can be easily replaced without loosing time. Whereas in case of rigid concrete paving repair is not only frequent (due to settlements, cracks, wear and tear etc) but costly, cumbersome also. It requires lot of time (for construction and curing) thereby affecting the normal working.

Facility for post construction underground works :

Interlock concrete blocks paving provides unique facility for any easy underground work for e.g. fire line, cable telephone wire, pipeline repairs etc, which can be done without loosing any time or money as the blocks can be removed and re-laid. Whereas a complete breaking of the pavement is required in case of R.C.C. flooring, which is not only costly and cumbersome but also consumes lot of precious time.

Long term behavior :

The efficiency of interlock increases as the No. of vehicles passes increase and thus the load distribution to the sub grade improves with time. Whereas the rigid concrete pavement, which is subjected, to stress reversal due to vehicular movement gets damaged due to fatigue.

Fatigue :

As stated above in case of conventional concrete paving fatigue is an important criterion for designing. Whereas in the concrete block, paving being segrental fatigue is not the criterion.

Law life cycle cost **:**

The initial cost of installation of interlock concrete block paving is cheaper than that of conventional rigid concrete block paving for the similar soil and load conditions. Moreover since the repair and maintenance cost is almost negligible, the interlock concrete block paving is much cheaper than conventional concrete paving, not to mention about the valuable operation time which is lost due to time consuming repair work in case of conventional paving.

Manufacturing Of Pavement Blocks :

Selection of raw materials **:**

Raw materials like sand and aggregate are carefully selected and tested in govt. approved laboratory before use in commercial production. Sieve analysis and grading check as required for the mix, is done in our site laboratory regularly or the quality control of the material-grading.

Batching and Mixing :

Raw material cement, sand, aggregate, etc are selected in the predetermined proportion (by weight) as per design mix. They are weighted on the weighing scale of the batching plant. Water is directly fed into the mixer and the mix is thoroughly homogeneously mixed in a pan mixer, thereby the green concrete is ready for processing. The above process of weighing and mixing is done in batching plant in order to ensure the consistency of mix proportion a greater degree of quality control.

Transit of wet concrete mix :

The green mix is directly released from Batching plant mixer into the block-making hopper by suitable placing the block making machine hopper below the mixer drum of the batching of the plant.

Casting of the block :

Block making machine consists of feed drawers vibrating table, mould (with cavities) temper head hydraulic power pack, control etc. The concrete is fed into the mould cavities (while the mould the rests on vibrator table) once the cavities are filled with green concrete the blocks are pressed and compacted by vibrant compaction

{simultaneously vibrating and applying high hydraulic pressure}. This ensures that blocks are cast in the desired shape as that of mould cavities. Now the fresh Blocks are released on the pallets move forward on conveyor system from where they are taken to the stacking area. {Stacking, handling, etc depends upon the area availability, site layout, and other local site conditions as considered suitable.}

Curing :

The fresh blocks after initial setting are covered by jute rolls/and are continuously moist by sprinkling water in order to retain the initial moisture and to reduce the heat of hydration for a period of minimum 10 days from the casting.

Testing and quality control :

Matured blocks after they are fully cured are tested in our site laboratory for the crushing strength of the blocks as per the BS 6717 by the help of a compression testing machine blocks. Once they are tested and passed as required are ready for dispatch to the concerned laying sites.

Laying Of Pavement Blocks

Step 1 : Levelling of Sub-base

A good base with proper compaction shall be done before the sand bedding Allowing surcharge for compaction. The sand should be screened with guide rods to achieve a uniform thickness of 50mm (average)

Step 2 : Laying of Blocks

Blocks are loosely laid manufacturing joint gap of 2 mm-4mm, alignment is controlled by tightening alignment strings and adjusting the gaps line correction etc by skillful and trained work force.

Step 3 : Compaction of Surface

Compaction is done by vibratory roller for heavy/medium duty paving to ensure uniform acceptable level.

Step 4 : Joint Filling of Blocks

Sweep dry, fine sand over the surface, making sure it fills all the gaps between the pavers.

Step 5 : Final Compaction

Vibrate the area again to give a Strong interlocking bond. Sweep off excess sand and your pavement is now completed and ready to use instantly.

Note :

1. Ensure edge restraint is in position before laying of pavers. Care should be taken to ensure proper grading of base layer to ensure proper surface drain gradient of 1:150 in generally recommended along the x n of the pavement. Suitable weep holes etc should be provided in the kerbs/edge restraints a bedding layer level to ensure drainage of water from sand and layer.
2. Base coarse must be prepared as per the standard code practice and lot of care should be taken for the compacting, level and grade control. It is very important to ensure that proper drainage system is provided to prevent logging etc.

10. PROJECT SIZE AND COST FOR SOLID & INTERLOCKING BLOCKS

This project profile has been finalized for average production of 9,00,000 blocks of different sizes per annum. The machine's daily production is 1500 blocks in one single shift of 8 hours. There will be 300 working days in a year. Total project cost is Rs.35 lakhs.

PROJECT COST ESTIMATION.

S.No.	Particulars	Rs. lakhs
1.	Land	5.00
2.	Building	5.00
3.	Plant and Machinery	4.00
4.	Fixture and furniture	0.20
5.	Total pre-operative expenditure	0.50
6.	Misc. Expenses	0.65
7.	Working capital requirement for 3 months	19.65
	Total	35.00

Land: 500 Sq. meter land is required for the project, the cost of which @ Rs.1,000 will be Rs.5,00,000.

Building: Building requirements for the project are as follows:

S.No.	Particulars	Size (meter)	Area (Sq-m)	Rate (Rs.)	Amount (Rs)
1.	Office	4x3	12	2,500	30,000
2.	Godown for Raw Material	6x5	30	2,000	60,000
3.	Godown for finished material	6x5	30	2,000	60,000
4.	Casting yard	10x10	100	1,000	1,00,000
5.	Open platform	10x10	100	1,000	1,00,000
6.	Tube well with overhead tank	L.S	-	-	70,000
7.	Toilet	L.S	-	-	30,000
	Total				4,50,000
	10% Sanitation and Electrification				50,000
	Total Building cost				5,00,000

Plant and Machinery :

S.No	Particulars	Nos.	Rate (Rs.)	Amount (Rs)
1.	Concrete block & Brick Making machine	2	99,250	1,98,500
2.	Concrete mixer with motor and other accessories	1	42,000	42,000
3.	Rams and Moulds for Diff. Sizes	20	425	85,000
4.	Tipping Barrows 7	2	8,400	16,800

	cu.ft. capacity			
5.	Tipping Barrows 4 cu ft. capacity	2	6,300	12,600
	Total			3,54,900
	15% CST, Cartage & Installation charges etc.			45,100
	Total Cost of Machinery & Equipment			4,00,000

Fixture and Furniture :

S.No	Particulars	Nos	Rate (Rs)	Amount (Rs)
1.	Office table	2	1.200	2,400
2.	Chairs	6	450	2,700
3.	Almirah	1	5,200	5,200
4.	Stools	4	225	900
5.	Fans	2	750	1,500
6.	Type Writer	1	7,300	7,300
	Total Cost of Fixtures & Furniture			20,000

Pre-operative Expenditure Rs.50,000/-

Working capital requirement for one month :

(A) Raw material per month

S.No.	Particulars	Quantity	Rate (Rs)	Amount (Rs.)
1.	Cement	3000 bags	130/-	3,90,000
2.	Sand	12000 cu.ft	2.50	30,000
3.	Stone Chips	27000 cu ft.	5/-	1,35,000
	Total			5,55,000

(B) Salary and wages per month

S.No.	Particulars	No.	Rate (Rs.)	Amount (Rs.)
1.	Manager cum Prod. Incharge	1	7,000/-	7,000
2.	Cashier cum clerk	1	3,500/-	3,500
3.	Typist cum store keeper	1	3,500/-	3,500
4.	Machine Operator	2	4,000/-	8,000
5.	Semi skilled worker	2	3,000/-	6,000
6.	Unskilled worker	12	2,500/-	30,000
7.	Peon	2	2,500/-	5,000
	Total			63,000
	+ 15% perquisites on the salary			9,450
	Total			72,450

(C) Utilities per month (Rs.)

1	Electricity charges for 3000 K W H	12,000
2	Water charges L.S.	500
	Total	12,500

(D) Other expenses per month (Rs.)

1	Postage and Stationery	500
2	Telephone	1,500
3	Traveling expenses	3,000
4	Advertisement and publicity	2,000
5	Repair and Maintenance	700

6	Consumable Stores	600
7	Insurance	3,500
8	Sales expenses	2,500
9	Misc. expenses	700
	Total	15,000

Working capital requirement per month (Rs.)

A	Raw Materials	5,55,000
B	Salary and Wages	72,450
C	Utilities	12,500
D	Other Expenses	15,000
	Total	6,54,950
	Working capital requirement for 3 months	19,64,850

Financial Aspects

(I) Cost of Production per annum	**(Rs.)**
Cost per annum 6,54,950 X 12	78,59,400
Depreciation on Plant & Machinery @ 5% p.a.	22,770
Depreciation on Building @ 10% p.a.	40,814
Depreciation on Furniture & Fixture @ 20% p.a.	3,740
Interest on Investment @ 18% p.a.	6,11,460
Total Cost of Production	85,38,184
Say	85,38,000

(II) Sales return per annum	**(Rs.)**
Average production of Blocks	9,00,000
Rejection @ 2%	18,000
Production of Blocks	8,82,000
Sales cost of blocks & bricks @ Rs.11/- per pc of average size	97,02,000

(III) Profit per annum	**(Rs.)**
Sales return-cost of production	11,63,816

(IV) Profitability on sale

$$\frac{\text{Net Profit X 100}}{\text{Total Sales}} = \frac{\text{11,63m81 X 100}}{\text{97,02,000}} = 12\%$$

(V) Profitability on total investment

$$\frac{\text{Net Profit X 100}}{\text{Total capital investment}} = \frac{\text{11,73,400 X 100}}{\text{33,97,000}} = 35\%$$

(VI) Break even analysis :

(i) Fixed Cost

(a) Total Depreciation	67,324
(b) 40% of Salary	3,47,760
© 40% of Utilities & Other expenses (excluding insurance)	1,12,800
(d) Interest on total capital investment @ 18%	6,02,460
Total	11,30,344
Say	11,30,000

(ii) Break Even Point (BEP)

$$BEP = \frac{\text{Fixed cost X 100}}{\text{Fixed Cost + Profit}} = \frac{11,30,000 \text{ X } 100}{11,30,000 + 11,63,816} = 49.26\%$$

BEP = 49.26 %

11. HOLLOW CONCRETE BLOCKS (BRICKS)

Introduction:

Concrete blocks for building houses were first made in Europe around 1850. The mass-production of concrete blocks underway in step with the development of the cement industry chiefly in Western Countries around 1918. In the United Stated, the concrete blocks industry recorded a major development after the introduction of the vibration process as a new method of compaction around 1930.

During the World War - II, the concrete block industry developed significantly in European countries and the United States. Japan introduced the latest type of block making machine in the past war era. Cavity type or Hollow blocks are mainly made of materials like sand, gravel, and cement. These are used to construct walls of houses and other structures with embedded steel re-enforcement. They are safe & have good durability in earthquake & fire prone areas.

The existence of cavity in concrete blocks helps keep rooms cool in summer and warm in winter, thereby making human living comfortable. On the other hand, it also reduces the cost of construction. The manufacturing

technique is quite simple and concrete block manufacture does not offer many difficulties. Since concrete blocks are heavy, it is advantageous to set-up concrete block making plants near its consumption point rather than transporting them to long distance for use. The major raw material should also be available in the neighborhood of a concrete block plant.

There is no problem and hence no strict recommendation about the scale of production. This project can be set up for any scale of production level does not not make the industry unprofitable. However, a reasonably high production target is always desirable. Concrete hollow blocks are made of major ingredients like sand, gravel, cement, water, reinforcing steel and admixtures and arc used for building walls of houses, fences, partitions and other structures, in large quantities.

Production of concrete blocks or hollow blocks requires neither reinforcement or pre - stressing of concrete. Thus, the plant used for hollow concrete blocks does not have the facilities for pre-stressing nor it is required to have water curing facilities as in the case of concrete pipes/poles plant. Concrete Block making plant is, thus, smaller in size when compared with the same capacity of concrete pole, pile, pipe or railway sleeper plant as far as financial investment is concerned. But, the profitability is not hampered whatsoever. As far as the marketability is concerned, India has not fully switched over to hollow concrete block masonry constructions.

The use of hollow concrete blocks in masonry construction is yet to be established over conventional brick construction & stone wall construction in India. Thus, it is quite premature to say what market scope this item is going to have in future. One thing is quite clear that there is no chance for either exports or imports of hollow concrete blocks. Whatever market is has to enjoy, that will be the indigenous consumption alone. The entire demands created will have to be met, on the other hand, with indigenous production itself. Since, the raw material (eg. cement, aggregates & water) are quite common building materials and are available in abundance in India, alongwith indigenously available simple technical know-how, hence, it is expected that its long term economy, durability, reliability and availability should promote its growth rapidly in future. The manufacture of pre - cast concrete pipes uses centrifugal molding system, one of the pre-tensioning systems for making hollow cylindrical form of even quality & fine finishing. But, these arrangement are not required in the case of concrete hollow blocks mfg. the prestressed spun poles/pipes of 7 to 16 m length are mostly produced in medium & large seats. But, the hollow concrete blocks are quite small in dimensions and use concrete block molding machines, after complete mixing the concrete mix, for their shaping.

Steam curing is common for concrete pipe & hollow concrete blocks but the systems used for steam curing are different. Consumption of wire mesh or iron rods in concrete pipes is a must while the same is not required for load bearing hollow concrete block. Thus, from various points it can be seen that the manufacture of masonry hollow concrete blocks requires a different type

of set-up than the one required for larger concrete products like pipes/piles etc.

Market Survey

Housing is a big & complex problem in India. It has two major facts - urban & rural. More attention is paid to urban housing due to the growing pressure of population & the need to meet the requirements of slum & pavement dwellers and urban renewal. In the process, rural housing gets neglected. A great majority of Indian population lives in rural areas. The influx of population from villages to metropolis has become a burning problem of the day. Rural & small town housings may slow down an excessive country - to - town movement of people and hence the housing problems of major cities may be controlled. Lack of housing in rural areas pushes the population to cities, there by
creating additional housing problems.

The housing shortage in the country was estimated over 20 million units in 1982 out of which 15 millions in rural areas & 5 million in urban areas. Housing is an economic activity & an important part of construction activities, sharing 50 to 60% of total capital formation & employment generation. Residential & non - residential constructions together are capable of swinging the national economy in any direction and to any extent.

According to data available, non-residential construction has a very high share in total investment for buildings. Almost 80% of total resources are invested in constructions for non-residential purposes.

All the above close studies reveal the need and scope for building construction in rural and urban areas for residential & non-residential purposes.

Uses And Applications

The concrete hollow blocks are used for building construction in developed countries. It takes less time in building work when concrete hollow blocks are used for building walls. Several ft. of wall-height can be constructed in a few hours in case of concrete hollow block walls compared with much slower rate of construction with conventional bricks. Thus, the use of concrete hollow blocks guarantee saving on labour expenses and man-hours needed for building a house.

The second major advantage derived by the use of concrete hollow blocks is that the cavities in the blocks are fitted with air column even after completion of the building work. This condition offers a warm room atmosphere during winter and cold during summer. Thus, the occupants of the house made of hollow blocks feel life comfortable in their rooms in both summer & winter seasons.

The cavity firmed in the concrete blocks makes it easy for prompt handling and higher in weight in comparison to the solid blocks of the same

dimensions. Thus, workers engaged in building construction work feel less exhausted even after long stretch of work.

Properties

Concrete is the most widely used man - made construction material and it will continue to be so in the years & decades to come. From common ingredients i.e. cement, aggregate, water & admixture the properties of concrete are tailored in order to meet the construction requirements. Locally available cheap materials are judiciously mixed in required proportion with proper workmanship to result in a concrete satisfying the performance demands.

Concrete is a major entity among building materials. Concrete can be classified as (i) Nominal mix concrete & (ii) Designed mix concrete according to IS: 456 - 1978. This same standard had earlier classified concrete into (a) controlled concrete & (b) ordinary concrete depending upon the levels of control exercised in the works and the method of proportioning concrete mixes. 'Ordinary Concrete' in the one where nominal concrete mixes are adopted while the 'controlled concrete' has mix proportion fixed by designing the concrete mixes with preliminary tests.

Among the many properties of concrete, its compressive strength is considered to be the most important and has been held as an index of its over all quantity. Other concrete properties are related to its compressive strength property. The table below gives the gradation of concrete as laid down by IS: 456 - 1978 and IS: 1343 - 1980 out of these, two grades (i.e. M5 and M7.5) are

used for lean concrete bases and simple foundations for masonry walls. These mixes need not be designed.

Table 1 Grades Of Concrete

(Clause 1.2.1.)

Grade Designation	Specified Characteristic Compressive Strength at 28 Days (N/mm2)
M 5	5
M 7.5	7.5
M 10	10
M 15	15
M 20	20
M 25	25
M 30	30
M 35	35
M 40	40
M 45	45
M 50	50
M 55	55
M 60	60

Note 1 - In the designation of a concrete mix, letter M refers to the mix and the number to the, specified characteristic compressive strength of 15-cm cube at 28 days, expressed in N/mm2

Note 2 - M 5 and M 7.5 grades of concrete may be used for lean concrete bases and simple foundations for masonry walls. These mixes need not be designed.

Note 3 - Grades of concrete lower than M 15 shall not be used in reinforced concrete.

Note 4 - Grades of concrete lower than M 30 shall not be used in prestressed concrete.

The common ingredients of concrete are cement, coarse & fine aggregates, and water. A fourth ingredient called 'admixtures' is used to modify certain specific properties of the concrete mix in fresh & hardened states. By judicious use of available materials & their proportioning, concrete mixes are produced to have the desired properties as the situation demands.

Table 2 Properties of Concrete Influenced By Aggregate Properties

(Clause 2.2.1.2)

Concrete Properties	Relevant Aggregate Property
Strength and workability	Strength
	Surface texture
	Particle shape, flakiness and elongation idices
	Maximum size, grading, deleterious constituents
Shrinkage and creep	Modulus of elasticity

	Particle shape
	Grading
	Cleanliness
	Maximum size
	Presence of clay
	Durability
Resistance to wetting and drying	Pore structure
	Modulus of elasticity
Resistance to heating and cooling	Coefficient of thermal expansion
Abrasion resistance	Hardness
Alkali-aggregate reaction	Presence of particular siliceous constituents
Resistance to freezing & thawing	Soundness
	Porosity
	Pore structure
	Permeability
	Degree of saturation
	Tensile strength
	Texture and structure
	Presence of clay
Co-efficient of thermal expansion	Co-efficient of thermal expansion
	Modulus of elasticity
Thermal conductivity	Thermal conductivity

Specific heat	Specific heat
Unit weight	Specific gravity
	Particle shape
	Grading
	Maximum size
Modulus of elasticity	Modulus of elasticity
	Poisson's ratio
	Tendency to polish
Slipperiness	Particle shape
Economy	Grading
	Maximum size
	Amount of processing required
	Availability

Note: Table 2 is from 'Selection and Use of Aggregates for Concrete' Reported by ACI Committee 621 (ACT Manual of Concrete Practice, Part I. 1979). American Concrete Institute, USA.

BIS Specifications

IS: 2185-1967 Hollow Cement concrete Blocks (I -Revision, with amendment No. 1).

This standard prescribes requirements regarding dimensions, tolerances, materials surface structures, mix, visual examination & other physical requirements for load bearing hollow concrete blocks, made from port land

Cement suitable aggregates & water, for use in the construction of concrete masonry wall.

IS: 2572 - 1963 Code of Practice for construction Hollow Concrete Block masonry.

It covers construction of walls & partitions with precast hollow concrete blocks. Guidance w.r.t. selection of materials, mix proportions of mortars, thickness of walls, finish etc. Details of design & analysis & working stresses for concrete hollow block masonry are covered in appendix. IS: 3590 - 1966 Prescribes dimensions, mix, manufacture, curing, drying & physical requirements along with methods of samplings & tests for load bearing high weight concrete blocks.

Manufacturing Process

Selection, grading and adjustment of the different sizes of grains of aggregates are the first step towards manufacturing concrete hollow blocks. The right sizes of gravels are obtained by sieving/screening. These largest sizes of aggregate grains should not be larger than 10 mm. Aggregates of coarse, medium & fine grades require to be taken in correct proportions by weighing them separately. These computed proportions of different grades of gravels are, then, mixed together dry in such a way that the size distribution in the bulk is as uniform as possible.

With this part of concrete ready the further operations of (1) compounding & weighing of raw materials (2) Mixing of raw materials (3) Block shaping (4) Curing and (5) storage are scheduled.

Cement, aggregate & water are the principal raw materials for concrete hollow blocks production. Some admixtures can be added to the mix as secondary materials.

There are cements available with various qualities. These are Portland cement, Blast furnace slag cement, silica cement & fly ash cement etc.

But, normally Portland cement is used for making concrete blocks.

Sand, gravel etc. are termed aggregates which may be ofcoarse, medium & fine grades and proportioned judiciously for mfg. concrete products.

The water used may be service water, well water or river water. Generally, any water is acceptable if it is drinkable.

The admixtures are the minerals which are mixed for the purpose of providing concrete or mortar with a special property. For example, they may be used for making cement waterproof or making coloured cements etc.

Compounding refers to the process of adjusting the amounts of cement, aggregate & water as well as admixtures. Sand & gravel are mixed in 1:1 proportion by volume or a little larger amount of sand over gravel.

The cement & aggregate proportion is determined according to the force of compaction of the blocks. By volume, cement to aggregate proportion may be 1:5-9.

The number of blocks produced from one bag of cement 50 Kg is approximately as below:-

Thickness (cm)	Nos. per Bag.
10	42
15	32
19	25

Mixing of raw materials is done in a suitable type of concrete mixer with a motor or engine. Water is added to the mixing materials by spray as the mixing proceeds.

Vibration compaction type of machine shapes the blocks. appropriate size of moulds lined with suitable material are used for casting.

This casting process uses concrete mix slurry for pouring into moulds. The cast-slip fills the mould cavity and thus produces the shape of the concrete

block conforming to the inside dimensions & shape of the mould. Also an insert is used to make a cavity in the cast-slip which solidifies in the shape of hollow blocks. This method of casting reduces chinks in the blocks and offers increased density.

Moisture content and temperatures are controlled in curing process to ensure the hardening of cement to the required extent. Block handling is done carefully for about 48 hours after casting. Steam curing of blocks takes place in a curing chamber during this period. The suitable curing temperature is 70oC and relative humidity = 100%. After steam curing the blocks are taken out of the curing chamber and they are stacked outdoors for curing in a highly humid condition. Curing temp x curing hours = 4000 gives the approximate hours for which curing of concrete blocks should be done from the moment the blocks are stored in the curing room. This, of course, varies widely depending upon concrete mix formulation, cement & aggregate qualities & method of manufacturing the blocks.

After completion of curing process, the blocks are stored in dry air for more than 7 days. Moisture reduces in this period and makes blocks suitable for transportation to the site where these are used.

Hollow Interlocking Blocks

A technology using reinforced hollow concrete block has been developed all over the world since a while. Its principle is to reinforce the masonry by grouting a concrete into the holes of the blocks where stands a steel rod at the critical

locations (Corners, ends, near openings, etc.) Horizontal reinforcements are also case in blocks with a U shape.

The technology using Hollow interlocking Compressed Stabilised Earth Blocks (HI CSEB) is based on the same principle: to reinforce horizontally and vertically the masonry with Reinforce Cement Concrete (RCC) members. The advantage of hollow interlocking CSEB, compared to hollow concrete blocks, is that they offer keys, which interlock in the other blocks. Thus these walls offer more resistance to shear and buildings would be even stronger. They would better resist earthquakes and without major damages.

Compressed stabilized earth blocks have another advantage: they are in most cases cheaper and they are always more eco-friendly than concrete blocks.

Particular requirements for hollow interlocking blocks :

Interlocking blocks can resist disasters (Cyclones, earthquakes and floods), provided they are hollow, so as to be reinforced with Reinforced Cement Concrete (RCC), at regular intervals. A hollow interlocking CSEB for earthquake resistance must satisfy these requirements:

- Extreme consistence in height (1 mm difference maximum is allowed).
- Self-aligning to reduce time-wasting adjustments.
- Blocks should be hollow and the vertical holes and U shaped blocks should allow casting RCC, according to requirements: To reinforce regularly the masonry vertically and horizontally.

- The interlocking keys must interlock transversally and longitudinally to the wall. They should interlock especially well in the length of the wall, which is subject to the shear stress of the earthquake.
- Every course must interlock with each other as well as the header of every block in length; to increase the shear strength of the masonry.
- Good seating of the blocks on top of each other for properly transmitting the load bearing; All the block area, including the key, must transmit the load.
- A binder must bind them: they must not be dry stacked, as the aim is to get a homogenous masonry.
- The binder should be a cement-sand mortar of 5 mm thick. It should be quite fluid in order to be workable.
- The mould must allow manufacturing of full size blocks but also ¾ and ½ sizes. The blocks must not be cut to match the bond pattern, which will be detrimental to the accuracy, strength and quality of the masonry.

Compressed stabilized earth blocks have a poor bending strength but this is not so critical because the block itself will not bend but the masonry will do. CSEB have very poor shear strength, which is critical in the case of earthquakes. Interlocking blocks will not have a stronger shear strength compared to ordinary CSEB. But the key effect will increase the shear strength of the masonry if the cohesiveness of the material is high enough to keep the link between the key and the body of the block. (Especially shocks and vibrations of an earthquake).

The Auram hollow Interlocking Blocks.

The accuracy of the Auram press allows a very regular block height: only 0.5 mm difference in height. This allows the block to get the ideal mortar thickness of 5 mm. Therefore, the block modules are:

- 30 x 15 x 10 cm for the rectangular block 295 (29.5 x 14.5 x 9.5 cm)
- 25 x 25 x 10 cm for the square block 245 (24.5 x 24.5 x 9.5 cm)

The holes have been maximized (regarding the size of the block and the press design) at 5 cm diameter to allow a proper concrete cover for the steel.

The area of the key has been maximized at 9 cm diameter to ensure the maximum adhesiveness of the key on to the block body, so as to resist the shear effect. The height of the key as been determined by having the maximum friction area between blocks to resist the shear and by having the minimum friction on the mould while de-moulding the block from the press. The chamfer angle of the key seeks to be optimum.

Putra Interlocking Block

The system was designed to satisfy the modular coordination requirement, the typical structural, production and constructional requirements. The system can be used for construction of load bearing walls up to five storeys high. The block received a grant of patent from UK patent office in May 2002 [Certificate]

13 September 2002 : CIDB R&D Award

2nd Research and Development Construction Industry Award, held at Nikko Hotel Kuala Lumpur – the R & D award was given to the group of researchers who demonstrated excellent and creativity in the design development and commercialization of technologically significant.

An Interlocking load bearing hollow block system

The first Malaysian Block with Modular Coordination

Putra Block has been invented by the Housing Research Centre, UPM It gives rise to an interlocking block system

Advantages

- Simple to manufacture, low capital investment
- Light enough to handle manually
- Self-aligning features
- Fast construction, mortar less masonry
- Easy to transport
- No form work
- Plastering optional on the internal walls
- Assured strength
- Sturdiness and stability
- Modular friendly
- Encourages 'open' Industrial Building system.

The main features of the system are its load-bearing and interlocking characteristics while catering to modular co-ordination requirements.

Application

Versatile interlocking block system which can be used in construction of :

- House
- Retaining walls
- Partition walls
- Fences

12.0 MANUFACTURING PROCESS USED GLOBALLY

A concrete block is primarily used as a building material in the construction of walls. It is sometimes called a concrete masonry unit (CMU). A concrete block is one of several precast concrete products used in construction. The term precast refers to the fact that the blocks are formed and hardened before they are brought to the job site. Most concrete blocks have one or more hollow cavities, and their sides may be cast smooth or with a design. In use, concrete blocks are stacked one at a time and held together with fresh concrete mortar to form the desired length and height of the wall.

Concrete mortar was used by the Romans as early as 200 B.C. to bind shaped stones together in the construction of buildings. During the reign of the Roman emperor Caligula, in 37-41 A.D., small blocks of precast concrete were used as a construction material in the region around present-day Naples, Italy. Much of the concrete technology developed by the Romans was lost after the fall of the Roman Empire in the fifth century. It was not until 1824 that the English stonemason Joseph Aspdin developed Portland cement, which became one of the key components of modern concrete.

The first hollow concrete block was designed in 1890 by Harmon S. Palmer in the United States. After 10 years of experimenting, Palmer patented the design in 1900. Palmer's blocks were 8 in (20.3 cm) by 10 in (25.4 cm) by 30 in (76.2 cm), and they were so heavy they had to be lifted into place with a small crane. By 1905, an estimated 1,500 companies were manufacturing concrete blocks in the United States.

These early blocks were usually cast by hand, and the average output was about 10 blocks per person per hour. Today, concrete block manufacturing is a highly automated process that can produce up to 2,000 blocks per hour.

Raw Materials

The concrete commonly used to make concrete blocks is a mixture of powdered Portland cement, water, sand, and gravel. This produces a light gray block with a fine surface texture and a high compressive strength. A typical concrete block weighs 38-43 lb (17.2-19.5 Kg). In general, the concrete mixture used for blocks has a higher percentage of sand and a lower percentage of gravel and water than the concrete mixtures used for general construction purposes. This produces a very dry, stiff mixture that holds its shape when it is removed from the block mold.

If granulated coal or volcanic cinders are used instead of sand and gravel, the resulting block is commonly called a cinder block. This produces a dark gray block with a medium-to-coarse surface texture, good strength, good sound-deadening properties, and a higher thermal insulating value than a concrete block. A typical cinder block weighs 26-33 lb (11.8-15.0 Kg).

Lightweight concrete blocks are made by replacing the sand and gravel with expanded clay, shale, or slate. Expanded clay, shale, and slate are produced by crushing the raw materials and heating them to about 2000°F (1093°C). At this temperature the material bloats, or puffs up, because of the rapid generation of gases caused by the combustion of small quantities of organic material trapped inside. A typical light-weight block weighs 22-28 lb (10.0-12.7 kg) and is used to build non-load-bearing walls and partitions. Expanded blast furnace slag, as well

as natural volcanic materials such as pumice and scoria, are also used to make lightweight blocks.

In addition to the basic components, the concrete mixture used to make blocks may also contain various chemicals, called admixtures, to alter curing time, increase compressive strength, or improve workability. The mixture may have pigments added to give the blocks a uniform color throughout, or the surface of the blocks may be coated with a baked-on glaze to give a decorative effect or to provide protection against chemical attack. The glazes are usually made with a thermosetting resinous binder, silica sand, and color pigments.

Design

The shapes and sizes of most common concrete blocks have been standardized to ensure uniform building construction. The most common block size in the United States is referred to as an 8-by-8-by-16 block, with the nominal measurements of 8 in (20.3 cm) high by 8 in (20.3 cm) deep by 16 in (40.6 cm) wide. This nominal measurement includes room for a bead of mortar, and the block itself actually measures 7.63 in (19.4 cm) high by 7.63 in (19.4 cm) deep by 15.63 in (38.8 cm) wide.

Many progressive block manufacturers offer variations on the basic block to achieve unique visual effects or to provide desirable structural features for specialized applications. For example, one manufacturer offers a block specifically designed to resist water leakage through exterior walls. The block incorporates a water repellent admixture to reduce the concrete's absorption and

permeability, a beveled upper edge to shed water away from the horizontal mortar joint, and a series of internal grooves and channels to direct the flow of any crack-induced leakage away from the interior surface.

Another block design, called a split-faced block, includes a rough, stone-like texture on one face of the block instead of a smooth face. This gives the block the architectural appearance of a cut and dressed stone.

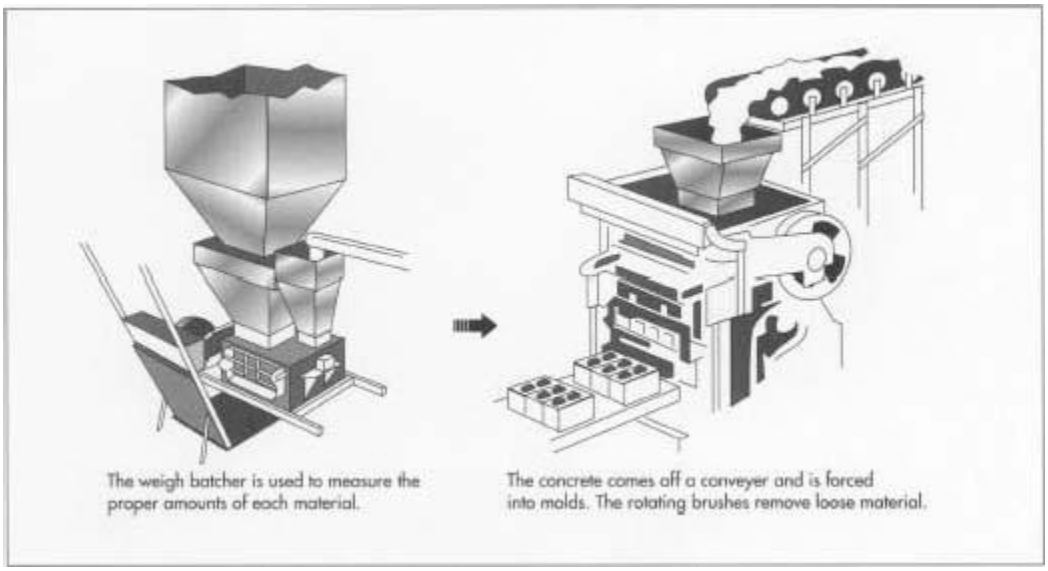
Concrete blocks were first used in the United States as a substitute for stone or wood in the building of homes. The earliest known example of a house built in this country entirely of concrete block was in 1837 on Staten Island, New York. The homes built of concrete blocks showed a creative use of common inexpensive materials made to look like the more expensive and traditional wood-framed stone masonry building. This new type of construction became a popular form of house building in the early 1900s through the 1920s. House styles, often referred to as "modern" at the time, ranged from Tudor to Foursquare, Colonial Revival to Bungalow. While many houses used the concrete blocks as the structure as well as the outer wall surface, other houses used stucco or other coatings over the block structure.

Hundreds of thousands of these houses were built especially in the mid-western states, probably because the raw materials needed to make concrete blocks were in abundant supply in sand banks and gravel pits throughout this region. The concrete blocks were made with face designs to simulate stone textures: rock-faced, granite-faced, or rusticated. At first considered an experimental

material, houses built of concrete blocks were advertised in many Portland cement manufacturers' catalogs as "fireproof, vermin proof, and weatherproof" and as an inexpensive replacement for the ever-scarcer supply of wood. Many other types of buildings such as garages, silos, and post offices were built and continue to be built today using this construction method because of these qualities.

Cynthia Read-Miller

When manufacturers design a new block, they must consider not only the desired shape, but also the manufacturing process required to make that shape. Shapes that require



complex molds or additional steps in the molding process may slow production and result in increased costs. In some cases, these increased costs may offset the benefits of the new design and make the block too expensive.

The Manufacturing Process

The production of concrete blocks consists of four basic processes: mixing, molding, curing, and cubing. Some manufacturing plants produce only concrete blocks, while others may produce a wide variety of precast concrete products including blocks, flat paver stones, and decorative landscaping pieces such as lawn edging. Some plants are capable of producing 2,000 or more blocks per hour.

The following steps are commonly used to manufacture concrete blocks.

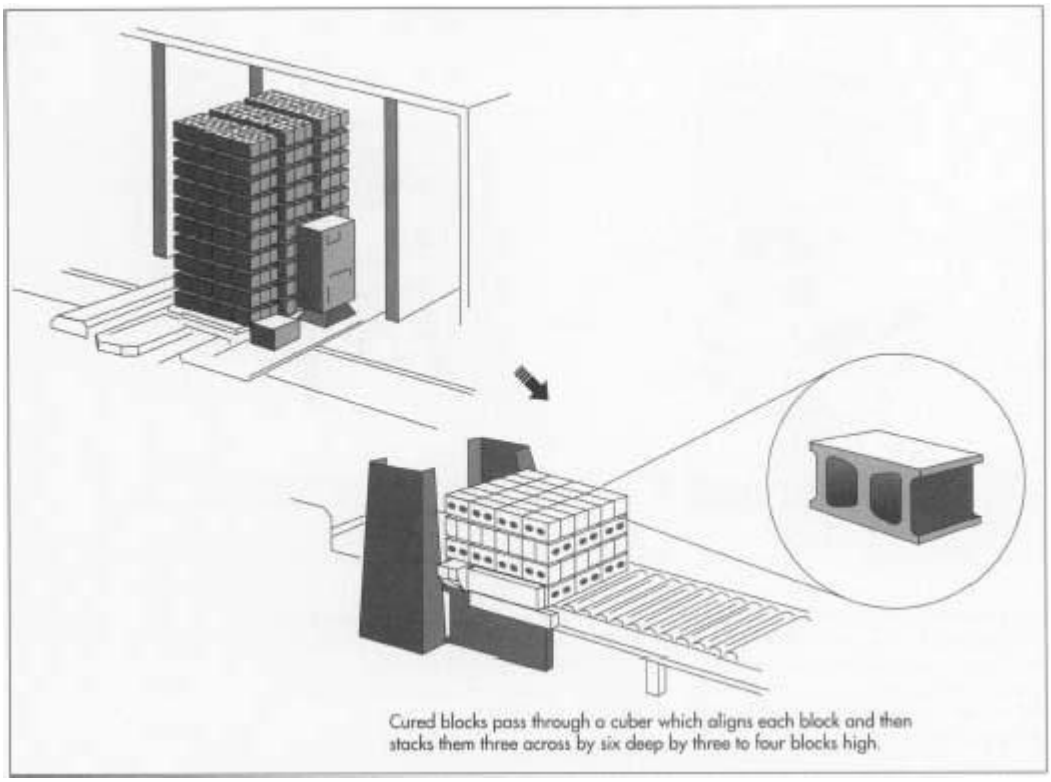
Mixing

- 1 The sand and gravel are stored outside in piles and are transferred into storage bins in the plant by a conveyor belt as they are needed. The Portland cement is stored outside in large vertical silos to protect it from moisture.
- 2 As a production run starts, the required amounts of sand, gravel, and cement are transferred by gravity or by mechanical means to a weigh batcher which measures the proper amounts of each material.
- 3 The dry materials then flow into a stationary mixer where they are blended together for several minutes. There are two types of mixers commonly used. One type, called a planetary or pan mixer, resembles a shallow pan with a lid. Mixing blades are attached to a vertical rotating shaft inside the mixer. The other type is called a horizontal drum mixer. It resembles a coffee can turned on its side and has mixing blades attached to a horizontal rotating shaft inside the mixer.

- 4 After the dry materials are blended, a small amount of water is added to the mixer. If the plant is located in a climate subject to temperature extremes, the water may first pass through a heater or chiller to regulate its temperature. Admixture chemicals and coloring pigments may also be added at this time. The concrete is then mixed for six to eight minutes.

Mouding

- 5 Once the load of concrete is thoroughly mixed, it is dumped into an inclined


Cured blocks pass through a cuber which aligns each block and then stacks them three across by six deep by three to four blocks high.

bucket conveyor and transported to an elevated hopper. The mixing cycle begins again for the next load.

- 6 From the hopper the concrete is conveyed to another hopper on top of the block machine at a measured flow rate. In the block machine, the

concrete is forced downward into molds. The molds consist of an outer mold box containing several mold liners. The liners determine the outer shape of the block and the inner shape of the block cavities. As many as 15 blocks may be molded at one time.

- 7 When the molds are full, the concrete is compacted by the weight of the upper mold head coming down on the mold cavities. This compaction may be supplemented by air or hydraulic pressure cylinders acting on the mold head. Most block machines also use a short burst of mechanical vibration to further aid compaction.
- 8 The compacted blocks are pushed down and out of the molds onto a flat steel pallet. The pallet and blocks are pushed out of the machine and onto a chain conveyor. In some operations the blocks then pass under a rotating brush which removes loose material from the top of the blocks.

Curing

- 9 The pallets of blocks are conveyed to an automated stacker or loader which places them in a curing rack. Each rack holds several hundred blocks. When a rack is full, it is rolled onto a set of rails and moved into a curing kiln.
- 10 The kiln is an enclosed room with the capacity to hold several racks of blocks at a time. There are two basic types of curing kilns. The most common type is a low-pressure steam kiln. In this type, the blocks are held in the kiln for one to three hours at room temperature to allow them to harden slightly. Steam is then gradually introduced to raise the temperature at a controlled rate of not more than 60°F per hour (16°C per

hour). Standard weight blocks are usually cured at a temperature of 150-165°F (66-74°C), while lightweight blocks are cured at 170-185°F (77-85°C). When the curing temperature has been reached, the steam is shut off, and the blocks are allowed to soak in the hot, moist air for 12-18 hours. After soaking, the blocks are dried by exhausting the moist air and further raising the temperature in the kiln. The whole curing cycle takes about 24 hours.

Another type of kiln is the high-pressure steam kiln, sometimes called an autoclave. In this type, the temperature is raised to 300-375°F (149-191°C), and the pressure is raised to 80-185 psi (5.5-12.8 bar). The blocks are allowed to soak for five to 10 hours. The pressure is then rapidly vented, which causes the blocks to quickly release their trapped moisture. The autoclave curing process requires more energy and a more expensive kiln, but it can produce blocks in less time.

Cubing

- 11 The racks of cured blocks are rolled out of the kiln, and the pallets of blocks are unstacked and placed on a chain conveyor. The blocks are pushed off the steel pallets, and the empty pallets are fed back into the block machine to receive a new set of molded blocks.
- 12 If the blocks are to be made into split-face blocks, they are first molded as two blocks joined together. Once these double blocks are cured, they pass through a splitter, which strikes them with a heavy blade along the section between the two halves. This causes the double block to fracture and form a rough, stone-like texture on one face of each piece.

- 13 The blocks pass through a cuber which aligns each block and then stacks them into a cube three blocks across by six blocks deep by three or four blocks high. These cubes are carried outside with a forklift and placed in storage.

Quality Control

The manufacture of concrete blocks requires constant monitoring to produce blocks that have the required properties. The raw materials are weighed electronically before they are placed in the mixer. The trapped water content in the sand and gravel may be measured with ultrasonic sensors, and the amount of water to be added to the mix is automatically adjusted to compensate. In areas with harsh temperature extremes, the water may pass through a chiller or heater before it is used.

As the blocks emerge from the block machine, their height may be checked with laser beam sensors. In the curing kiln, the temperatures, pressures, and cycle times are all controlled and recorded automatically to ensure that the blocks are cured properly, in order to achieve their required strength.

The Future

The simple concrete block will continue to evolve as architects and block manufacturers develop new shapes and sizes. These new blocks promise to make building construction faster and less expensive, as well as result in structures that are more durable and energy efficient. Some of the possible block designs for the future include the biaxial block, which has cavities running horizontally as well as vertically to allow access for plumbing and electrical

conduits; the stacked siding block, which consists of three sections that form both interior and exterior walls; and the heatsoak block, which stores heat to cool the interior rooms in summer and heat them in winter. These designs have been incorporated into a prototype house, called Lifestyle 2000, which is the result of a cooperative effort between the National Association of Home Builders and the National Concrete Masonry Association.

13. PROJECT SIZE AND COST FOR HOLLOW CONCRETE BLOCKS (8000.00 /day)

Rated Plant capacity	=	8000.00 /day
	=	2400000.00 /annum
No. of working days	=	25 days/month
	=	300 days/annum
No. of shifts	=	2 per day
One shift	=	8 hours

Land & Building

1. Total area of land required

3000 sq.mt @ Rs. 600/-per sq.mt Rs. 18,00,000.00

2. Main Working Shed in 150 sq.mt

(Light Iron Structure) @ Rs. 3000/- per sq.mt Rs. 4,50,000.00

3. Curing Chamber in 100 sq.mt

(Concrete Block structure)

@ Rs. 3200/-per sq.mt Rs. 3,20,000.00

4. Aggregate yard in 50 sq.mt

(Light iron frame structure)

@ Rs. 3200/-per sq.mt Rs. 1,60,000.00

5. Cement & general stroes building

(R.C.C. construction) in 50 sq.mt

@ Rs. 3000/-per sq.mt Rs. 1,50,000.00

6. Laboratory, Power House/Pump house

Repair Shop, Security Room etc. in

150 sq.mt @ Rs. 3000/-per sq.mt Rs. 4,50,000.00

7. Office & Rest Room etc in 100 sq.mt

@ Rs. 3500/-per sq.mt Rs. 3,50,000.00

8. Boundry walls, fences, O.H. water

tanks construction etc. Rs. 2,50,000.00

TOTAL Rs. 39,30,000.00

Plant & Machinery

1. Batch Concrete Mixer with 7.5 RW
   Motor, Capacity 1 MT. 4 No. Rs. 2,00,000.00

2. Vibration compaction Machine 2 No.
   with all accessories for pouring
   densification etc with 9 HP motor Rs. 3,60,000.00

3. Steam generating boiler complete
   with all mountings & accessories
   Cap: 400 kg/hr 3 Nos. 3 No. Rs. 3,00,000.00

4. Weighing Machine 1 tonne Capacity
   (Platform type) 1 No. Rs. 30,000.00

5. Weighing Machine 500 kg cap: 1 No Rs. 10,000.00

6. EOT - Cranes 1 ton Cap: 1 No. Rs. 1,50,000.00

7. HOT - Crane 1 ton Capacity 1 No. 1 No. Rs. 50,000.00

8. Curing Chambers covers leak proof type Rs. 1,00,000.00

9. Plain Steel Plates 45 mm x 420 mm x 520 mm with wooden Partitions of
   suitable sizes 1000 Nos. Rs. 7,50,000.00

10. Hydraulic Palled truck (2 ton Cap:)

1 No. Rs. 1,50,000.00

11. Steel racks capable of holding 100 Blocks of 150 mm thickness.

50 Nos. Rs. 1,00,000.00

12. Block Conveyor with all accessories 1 No. Rs. 2,00,000.00

13. Electric/Gas-Welding & cutting Sets Rs. 15,000.00

14. High Speed grinder 1 No. 1 No. Rs. 1,35,000.00

15. Automobile truck 1 No. 1 No. Rs. 2,50,000.00

16. Office Jeep 1 No. Rs. 1,00,000.00

17. Diesel Generating Set 300 KVA rating 1 No. 1 No. Rs. 4,50,000.00

18. Distribution transformer 300 KVA rating 1 No. Rs. 2,50,000.00

19. Other tools & Tackles, Jigs & Fixtures Rs. 2,00,000.00

TOTAL Rs. 38,00,000.00

Other Fixed Assets

1. Office equipment, furniture plus other equipment & accessories

	Rs.	75,000.00
2. Electric arrangement & Installation	Rs.	3,50,000.00
3. Water installation & water lifting pumps	Rs.	1,00,000.00
4. Preliminary & Pre-Operatives	Rs.	1,00,000.00

TOTAL	Rs.	6,25,000.00

Fixed Capital

1. LAND & BUILDING	Rs.	39,30,000.00
2. PLANT & MACHINERY	Rs.	38,00,000.00
3. OTHER FIXED ASSETS	Rs.	6,25,000.00

TOTAL	Rs.	83,55,000.00

Working Capital Requirement/Month

RAW MATERIALS

1. Sand 1800 m3 @ Rs. 520/-per Cu.m	Rs.	9,36,000.00
2. Gravel 900 m3 @ Rs. 520/-per Cu.m	Rs.	4,68,000.00

3. Cement 325 MT @ Rs. 5.5/-Kg		Rs.	17,87,500.00
4. Miscellaneous stores & Contingencies		Rs.	1,25,000.00
	TOTAL	Rs.	33,16,500.00

Salary & Wages / Month

1. Manager	1 No.	Rs.	15,000.00
2. Production Engineer	1 No.	Rs.	10,000.00
3. Maintenance Engr.	1 No.	Rs.	8,500.00
4. Supervisors	2 No.	Rs.	15,000.00
5. Clerks/Typist/Assistants	4 No.	Rs.	22,000.00
6. Peons/Watchman	4 No.	Rs.	15,200.00
7. Skilled Workers	16 No.	Rs.	80,000.00
8. Unskilled Helpers	20 No.	Rs.	90,000.00
	TOTAL	Rs.	2,55,700.00

Plus perks @ 33% p.a.

	Rs.	84,381.00

TOTAL	Rs.	3,40,081.00

Utilities And Overheads

1. Power Consumption of 32000 Kwatt hrs @ Rs. 4.50 per Kwatt hr.	Rs.	1,44,000.00
2. Water Consumption of 1000 Kls @ Rs. 3.00 per KL	Rs.	3,000.00
3. Diesel 5000 lits @ Rs. 20/- Litres	Rs.	1,00,000.00
4. L.D. Oil/K-oil 7500 litres @ Rs. 26/per litres	Rs.	1,95,000.00
5. Telephone & Conveyance	Rs.	5,000.00
6. Transportation	Rs.	30,000.00

TOTAL	Rs.	4,77,000.00

Total load is 88 Kwatts

Total Working Capital/Month

1. RAW MATERIAL	Rs.	33,16,500.00
2. SALARY & WAGES	Rs.	3,40,081.00
3. UTILITIES & OVERHEADS	Rs.	4,77,000.00
TOTAL	Rs.	41,33,581.00

1. WORKING CAPITAL FOR 1 MONTHS	Rs.	41,33,581.00
2. MARGIN MONEY FOR W/C LOAN	Rs.	10,33,395.25

Project Cost

TOTAL FIXED CAPITAL	Rs.	83,55,000.00
MARGIN MONEY	Rs.	10,33,395.25
TOTAL	Rs.	93,88,395.25

Total Capital Investment

TOTAL FIXED CAPITAL Rs. 83,55,000.00

TOTAL WORKING CAPITAL FOR 1 MONTHS

Rs. 41,33,581.00

TOTAL Rs. 1,24,88,581.00

Cost of Production/Annum

1. Working Capital for 1 year Rs. 4,96,02,972.00

2. Interest @ 13.50% on T.C.I Rs. 16,85,958.44

3. Depreciation @ 10.00% on buildings Rs. 2,13,000.00

4. Depreciation @ 20.00% on Plant and Machinery Rs. 7,60,000.00

5. Depreciation @ 20.00% on office equipment & furnitures Rs. 15,000.00

TOTAL Rs. 5,22,76,930.44

Turn Over/Annum

1. By sale of 100 mm Hollow Concrete

   Blocks 9,60,000 Pcs @ Rs.25/-per Block Rs. 2,40,00,000.00

2. 7,20,000 Nos. Hollow Concrete Block

   150 mm @ Rs. 30/-each Rs. 2,16,00,000.00

3. 190 mm Hollow Concrete Blocks

   7,20,000 Nos. @ Rs. 30/-per each Rs. 2,16,00,000.00

TOTAL Rs. 6,72,00,000.00

Profit = Receipts - Cost Of Production

= 6,72,00,000.00 - 5,22,76,930.44

= 1,49,23,069.57

PROFIT SALES RATIO = Profit / Sales x 100

$$= \frac{1,49,23,069.57}{6,72,00,000.00} \times 100$$

= 22.21 %

RATE OF RETURN = Operating profit / T.C.I x 100

$$= \frac{1,49,23,069.57}{1,24,88,581.00} \times 100$$

= 119.49 %

BREAK EVEN POINT (B.E.P)

Fixed Costs of the plant are as under -

1. Interests	Rs.	16,85,958.44
2. Depreciation	Rs.	9,88,000.00
3. 40.00% of salaries	Rs.	16,32,388.80
4. 40.00% of overheads	Rs.	22,89,600.00
TOTAL	Rs.	65,95,947.24

$$B.E.P. = \frac{\text{FIXED COSTS}}{\text{FIXED COSTS + PROFIT}} \times 100$$

65,95,947.24

= ---------- X 100

65,95,947.24 + 1,49,23,069.57

= 30.65 %

LAND MAN RATIO = Total land / Manpower

3000 : 49 :: 61 : 1

Resources For Finance

1. Term loans from Financial institutions
   (80.00 % of fixed capital)
   at @13.50% p.a rate of interest Rs. 66,84,000.00
2. Bank loans for 3 months
   (75.00 % of working capital)
   at @ 13.50% p.a rate of interest Rs. 31,00,185.75
3. Self raised capital from even
   funds & loans from close ones to
   meet the margin money needs at a
   @ 13.50% p.a rate of interest Rs. 27,04,395.25

TOTAL Rs. 1,24,88,581.00

13.0 MARKET POTENTIAL

The Global construction industry today stands at US$ 3.4 trillion, of which India's share is approximately 1.7%. Construction sector is the second highest employer, after agriculture and accounts for 5% of GDP and 38% of the gross domestic investment. The sector has direct linkages with cement and steel sectors as almost 100% cement and 50% of the steel goes into the construction. Thus even a moderate growth in the construction sector can bring about positive impact on the core industries such as Cement, Steel, Mining and many other industries such as Fixtures / Fittings, Paints and Chemicals, Bricks / Tiles, Aluminum, Glass Plastics, Timber, Capital Goods, etc.

Construction also accounts for 60-70 % of the infrastructure project cost and the quality, reliability and efficiency of infrastructure, to a large extent, is laid on the efficiency and quality of construction sector. However, despite tremendous significance, the sector has so far been neglected and there is no particular ministry responsible for the development of the sector.

To build world-class construction industry and to enhance India's share in the Global market, the challenge for the Indian Construction Industry is to increasingly modernize, adopt new technologies and use cost effective building materials.

The shortage of housing units in India is estimated to be 22.90 million. More than 90% of this shortage is in low cost housing sector intended for economically weaker sections.

The Government of India has committed to providing housing for all in the "National Agenda for Governance." Towards this end, the Government has pledged to facilitate construction of 20 lakh additional housing units annually and has started various schemes for poor and economically weaker sections.

Concrete Hollow Bricks and Pavement Blocks are extensively used all over the world. The major applications of concrete hollow bricks and pavement blocks include wall units – load bearing and non-load bearing, structural units, pierced units as well as special applications such as decorative/architectural facades. The market for concrete blocks would, therefore, be a big chunk of the building industry, because its applications are very wide and varied.

The market for concrete hollow bricks and pavement blocks is indirectly related to the total building activities such as housing, commercial complex, office premises, entertainment-recreation-sports complex, municipal corporation, street and road construction and development and industrial units.

Though the market is wide spread an individual unit manufacturing concrete hollow bricks and pavement blocks can target the market closer to its proximity due to cost advantage.

Individual unit has to define geographically its reach and can consider mobile units to manufacture and paving of concrete hollow bricks and pavement blocks on site in order to gain wider market.

However, it is necessary to assess the market potential, as it is specific to geographic area of operation. In addition to retail customers, bulk customers

requirements have to be assessed. The bulk customers such as builders & contractors, municipal corporations, metropolitan development authorities, public works department, port-railway-highway authorities, architects and exterior designers and consultants etc would play major role in developing market for concrete hollow bricks and pavement blocks.

15.0 INSTITUTIONS PROVIDING TERM LOANS

Institutions that provide term loans in India may be divided into three broad categories as follows:

All India Financial institutions These include IFCIP ICICI, and IDBI, the three oldest general term-lending institutions (ICICI and IDBI have been transformed into banks in recent years)1 specialised institutions like Exim Bank, IL&FS, Power Finance Corporation, IDFC, and SIDBI, and insurance companies (TIC and GIC) with marginal exposure to term-lending.

State Level Financial Institutions Most of the states have a State Industrial Development Corporation(SIDC) and a State Financial Corporation (SFC) which are refinanced by IDBI.

Commercial Banks Historically1 commercial banks were marginal players in the term- lending arena, as their main thrust was on providing working capital finance. In recent years, commercial banks have stepped up their term-lending activities.

ANNEXURE

CONSTRUCTION OF HOLLOW AND SOLID CONCRETE BLOCK MASONRY

CODE OF PRACTICE

1. SCOPE

This standard covers the construction of walls and partitions with pre-cast hollow and solid concrete blocks as per IS 2185 (Part 1) : 2004 ‘Specification for concrete masonry units: Part 1 Hollow and solid concrete blocks (Second revision)’.

2. REFERENCES

The Indian Standards listed in Annexure-A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the edition indicated were valid. All standards are subject to revision and parties to agreements based on these standards are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3. TERMINOLOGY

For general terms with regard to masonry works, reference may be made to IS 2185 (Part 1) and IS 2212.

4. NECESSARY INFORMATION

4.1 For efficient planning, design and execution of the work, detailed information with regard to the following shall be furnished to those responsible for work:

a) Layout plans showing the walls, position of doors, windows and other openings, stairs, columns, etc.

b) Detailed dimensions of the structure with details of sections, showing reinforced bands, ties, etc.

c) Full details of architectural features, mouldings and other special work such as fittings attached to or embedded in the masonry.

d) Details of fixing of door and window frames to masonry wall.

e) Location and other details of service lines, such as for water supply, drainage, sewerage, electrical installations, telephone, cable TV, etc.

f) The grade of blocks.

4.2 All information as given in 4.1 shall be made available to those who are responsible for the masonry work. Necessary drawings and instructions for planning the work shall be furnished.

4.3 Arrangements shall also be made for the proper exchange of information between those engaed in masonry work and all trhose whose work will effect or will be affected.

5. PROGRAMMING OF THE WORK

5.1. In preparing a time schedule, the masonry work shall be considered in relation to other works and so ordered that the work of the various tradesmen do not interfere with each other.

5.2 Particular attention shall be paid to the following items:

a) Timing of the erection of adjacent structural work should correspond to the erection of the walls and partitions where the various operations are interdependent.

b) Installation of conduits and services within on the face of or through the walls and partitions.

c) Application of finishes to adjacent walls, floors and ceilings which may be required to be finished, before the application of finishes to the walls and partitions concerned.

d) Time intervals as and when necessary, to allow parts of the masonry work and finishes to dry out and mature before the commencement of subsequent operation.

5.3 The time schedule shall include dates for the following :

a) Supply of drawings and specifications for materials to be used;

b) Delivery of materials, masonry units and accessories; and

c) Commencement and completion of the various operations involved in the construction and finish of the walls and partitions.

5.4 Internal walls and partitions, if non-load-bearing and bonded or tied to the flanking framework, shall preferably be erected simultaneously with it, but where it is not practicable to do so, they may be erected afterwards, the necessary provision for their support and for bonding or tying their ends to the main structure being made at the appropriate time.

6. MATERIALS

6.1 Masonry Units

Hollow and solid concrete blocks used as masonry units shall conform to IS 2185 (Part 1)

6.2 Cement

Cement shall conform to IS 269 or IS 455 or IS 489 (Part 1) or IS 1489 (Part 2) or IS 3466 or IS 8041 or IS 8043 or IS 8112 or IS 12269.

6.3 Lime:

Lime shall conform to IS 712. The lime shall be of Class C, unless otherwise specified.

6.4 Water

Water shall be clean and free from injurious amounts of deleterious materials. Potable water is generally considered satisfactory for use in masonry mortar. For further requirements regarding limits of deleterious materials permitted in water, reference may be made to IS 456.

6.5 Sand

Sand for masonry work shall conform to IS 2116. Sand for concrete work shall conform for the requirements of IS 383.

6.6. Coarse Aggregate

Coarse aggregate, where used shall conform to IS 383.

6.7 Fly Ash

Fly ash conforming to IS 3812 (Part 1) may be used as part replacement of ordinary Portland cement up to a maximum of 20 percent, provided homogeneous mixing is ensured.

6.8 Additives

Additives used, if any, shall conform to IS 9103.

6.9 Mortar

6.9.1 Mortar shall be composed of cement, lime and sand, unless otherwise specified. All lime other than dry hydrated lime shall be fully slaked in accordance with IS 1635.

6.9.2 Hollow concrete blocks shall be embedded with a mortar which is relatively weaker than the mix used for making blocks in order to avoid the formation of cracks. A rich or strong mortar tends to make a wall too rigid thus localizing the effects of minor movements due to temperature and moisture variations resulting in cracking of the blocks. The recommended proportions of mortar measured by volume are given in Table 1.

6.9.3 All mortar shall be prepared in accordance with IS 2250.

Concrete.

Concrete used for filling cells in hollow concrete block masonry when reinforced, shall be composed of one part of cement, two parts of sand, three parts of coarse aggregate and when un-reinforced it shall be composed of one part of cement,

three parts of sand, six parts of coarse aggregate. The cell containing reinforcement bars may alternatively be filled using cement coarse sand mortar 1:3. The mortar or concrete shall be properly pumped or rodded or vibrated for compaction.

Table 1 Mix Proportions of Mortar for Hollow and Solid concrete Block Masonry

S.No.	Type of Work	Normal Masonry without Reinforcement			Masonry where reinforcement is used.	
		Cement	Lime	Sand	Cement	Sand
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(i)	Normal Work	1	1	9-10	1	7-8
(ii)	When exposed to severe conditions or where the intensity of load is high such as in foundations, plasters or portions of wall directly below heavily loaded lintels and beams.	1	1	6-7	1	4-5
(iii)	Partitions of 100 mm nominal thickness	1	1	7-8	1	5-6

Note: Alternative sand proportions are given for the mortar mixes in the table so that where the sand is well graded between the maximum and minimum particle sizes specified in 6.5 the higher figure should be adopted, but where the sand is not graded and is rather fine, the lower sand content should be used.

DESIGN CONSIDERATIONS

Strength and Stability

Unless otherwise specified, the design and construction of concrete block masonry walls shall conform to the requirements of IS 1905. The earthquake Resistant Design and Construction of Buildings shall be as per IS 4326.

The nominal thickness of load bearing masonry built with hollow concrete blocks shall be not less than 200 mm. The designer shall make assessment about the thickness of wall required based on level of wall (floor and number of storey) compressive strength of blocks, mortar, reinforcement etc.

The minimum nominal thickness of non-load-bearing internal partitions shall be 100 mm.

The minimum nominal thickness of external panel walls in framed construction shall preferably be not less than 200 mm. However, depending upon the local conditions and the desired effect of thermal transmission and sound reduction, 150 mm thick panel walls may be used provided they are suitably braced and reinforced by lateral or vertical supports.

Parapet Walls : Unless adequately braced at intervals not exceeding 3 m the height of the wall shall be limited to five times its thickness.

Lateral supports:

Lateral supports shall be as per 4.2 of IS 1905.

Modular Co-ordination

Hollow concrete block walls shall preferably be planned on the basis of modular co-ordination with a view to making the maximum use of full and half-length units.

The cutting of units at the site shall be restricted to the minimum. Attention shall be paid to modular co-ordination while fixing the overall length and height of the wall; width and height of door, window and other openings; and wall dimensions between doors, window and corners. All horizontal dimensions shall be in multiples of nominal half-length of the units and all vertical dimensions shall be multiples of full-height units.

Avoidance of Crack Formation

The major causes of cracks in the structure of hollow concrete block wall or partition and measures for their preventions are described as above.

Structural Movements:

Cracks may arise from alterations in length, curvature or orientation of the structural members enclosing a wall or partition due to load settlement, thermal expansion or changes in moisture content. The precautions to be taken for prevention shall be as mentioned previously.

In the case of framed structure, erection of partitions and panel walls shall be delayed wherever possible until the frame has taken up as much as possible any deformation occurring due to structural loads.

For floor deformation and movement:

The floor upon which a partition is built may deflect under load brought upon it after the partition is built. Where such deflections tend to create non-continuous bearing, the partition shall be strong enough to span between the points of least floor deflection or shall be capable of adapting itself to the altered conditions of support without cracking. This may be achieved by embedding horizontal reinforcement such as 6 mm diameter bars or any other suitable reinforcement or, if possible by providing a reinforced concrete band at every 400 mm height. This can also be achieved by using joint reinforcement as per of IS 6042.

Operation for Laying Block Masonry

First Course.

The first course of concrete masonry, shall be laid with great care, making sure that it is properly aligned, leveled and plumbed, as this will assist the mason in laying succeeding courses to obtain a straight and truly vertical wall. Tools used for laying masonry are given in IS 2572: 2005. For laying hollow block concrete masonry, figures are given for general guidance (see Fig. 2, 3, 4, 5, 6 and 7).

Before laying the first course, the alignment of the wall shall be marked on the foundation footings. The blocks for this course shall first be laid dry, that is without mortar over the footing, along a string lightly stretched between properly located corners of the wall in order to determine the correct position of the blocks including those of the cross-walls joining it and also adjust their spacing. When the blocks are set in proper position, the two corner blocks should be removed, a full mortar bed spread on the footing and these blocks laid back in place truly

level and plumb. The string shall then be stretched tightly along the faces of two corner blocks and the faces of intermediate one adjusted to coincide with the line. Thereafter each block shall be removed and re-laid over a bed of mortar. After every three or four blocks have been laid, their correct alignment, level and vertically shall be carefully checked.

The construction of the walls may be started either at corners first or started from one end proceeding in other direction. If the corners of the wall are built first, they shall be built four or five courses higher than the center of the wall. As each course is laid at the corner, it shall be checked for alignment and level and for each plumb. Each block shall be carefully checked with a level or straight-edge to make certain that the faces of the block are all in the same plane. This precaution is necessary to ensure truly straight and vertical walls.

The use of a storey-rod or course-pole, which is simply a board with makings 200 mm apart, provides an accurate method of finding the top of the masonry for each course. All mortar joints shall be 1 cm thick. Each course, in building the corners, shall be stepped back by a half-block and the horizontal spacing on the block shall be checked by placing a mason’s level diagonally across the corners of the block.

When filling the wall between the corners, a mason’s line shall be stretched from corner to corner for each course and the top outside edge of each block shall be laid to this line. The manner of handling or gripping the block shall be such as to position the block properly with minimum adjustment.

To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block or it will stiffen and lose its plasticity. As each block is laid, excess mortar extruding from the joints shall be cut off with the trowel and thrown back on the mortar bed to be reworked into fresh mortar. If the work is progressing rapidly, the extruded mortar cut from the joints may be applied to the vertical face-shells of the block just laid. Should there be any delay long enough for the mortar to stiffen on the block, the mortar shall be removed to the mortar board and reworked. Dead mortar that has been picked up from the scaffold or from the floor shall not be used.

Closure Block :

When installing the closure block, all edges of the opening and all four vertical edges of the closure block shall be buttered with mortar. The closure block shall be carefully lowered into place. If any of the mortar falls out leaving an open joint, the closure block shall be removed, fresh mortar applied and the operation repeated.

The special blocks like U-block, J-block and C-block shall be appropriately used. U-blocks shall be used at DPC level and on cross walls just below the slabs. J-blocks shall be used below the slabs on outer walls so that the longer shell is on the outside face of the masonry wall. C-blocks may be used to encase the concrete columns to give the same aesthetic look as wall masonry.

Since chase can not be cut in hollow block masonry parapet wall the cement concrete 'gola' should be provided after making chase. First a low height block of 390mm X 190mmX90 mm shall be placed flat with 90 mm height. On it another partition block of 390mm x 190mm x 90 mm shall be placed vertically at the outer edge with 190 mm height and 190 mm width. A fluted block with 190 mm height and 10mm width shall be placed over it so as to create a cavity of 190mm height and 100mm width between the flat laid down block and the fluted block. The cavity shall be the filled up with cement concrete 1:2;4 and tapered at 45^{o} from top to bottom at the open end to form the required 'gola' (see Fig. 8).

Provision for Lintels

Lintels may consist of either a single precise unit or a number of units. They shall be appropriately reinforced. In-situ concrete used for forming a composite lintel with the use of a number of units shall preferably be of the same mix as of the concrete that is used in the pre-cast units and the composite unit shall also be appropriately reinforced (see Note). When opening occur close to one another a continuous lintel shall be provided (see Fig. 8 for typical construction detail).

Note: A convenient method of construction of composite lintel is to form it with precast U-shaped units and providing the required reinforced bars in the hollow and filling the hollows with 1:2:3 concrete mix.

Provision for Roof

The course immediately below the roof slabs shall be built with appropriate grade of solid blocks of U-shaped units may be used which shall be filled in with 1:2:4

concrete. If a reinforced roof band is required appropriate reinforcement shall be placed in U-blocks and 1:2:4 concrete laid.

The top of the roof course shall be finished smooth with a thin layer of 1:3 cement mortar and covered with a coat of crude oil, or craft or oil paper to ensure free movement of the roof.

Where J-blocks are used just below the slabs, concrete should first be filled up to the top of the shorter shell wall and the top surface plastered with 1:3 cement mortar and finished with a coat of neat cement punning and white washed with lime. The slab should then be cast after a Kraft paper is placed along the longer shell of the J-block.

Where the roof slab projects beyond the external wall face, it shall be provided with a drip.

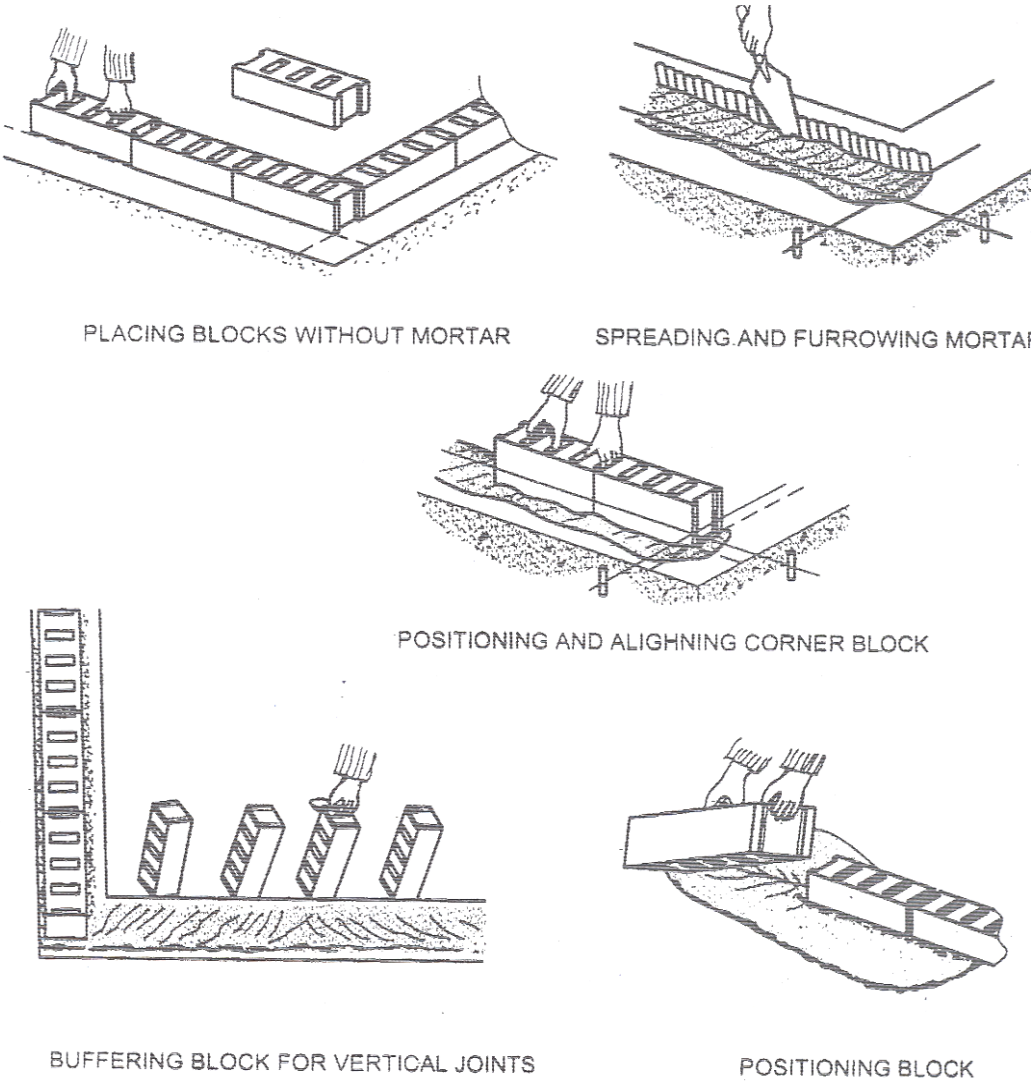


Fig. 1 Laying First Course of Blocks For A Wall

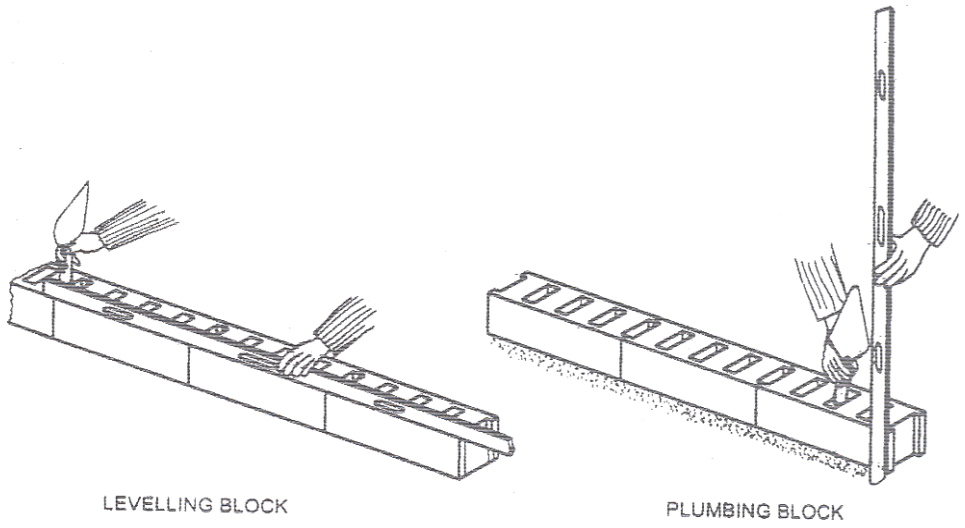


Fig. 2 Leveling & Plumbing First Course of Blocks For A Wall

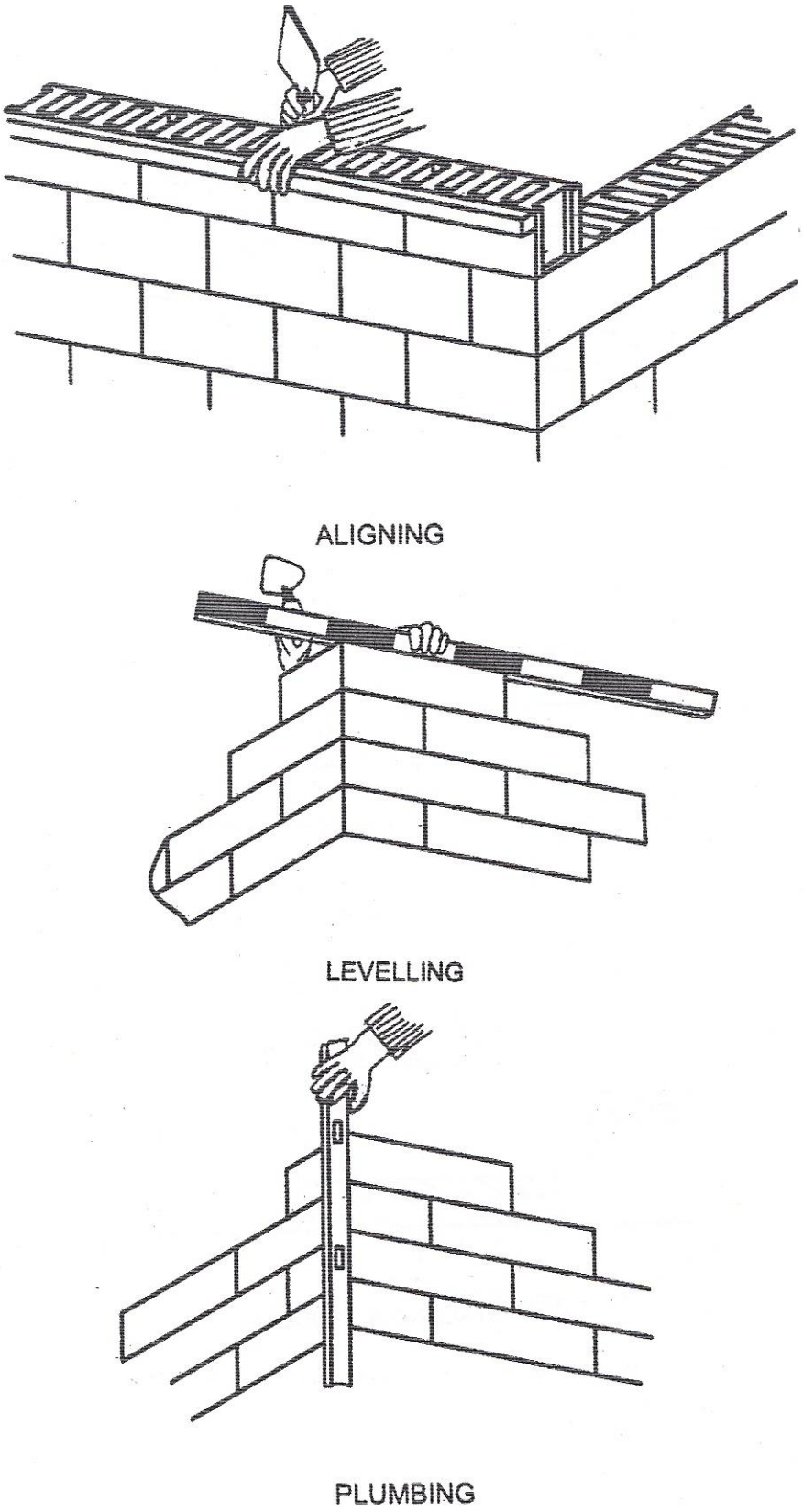
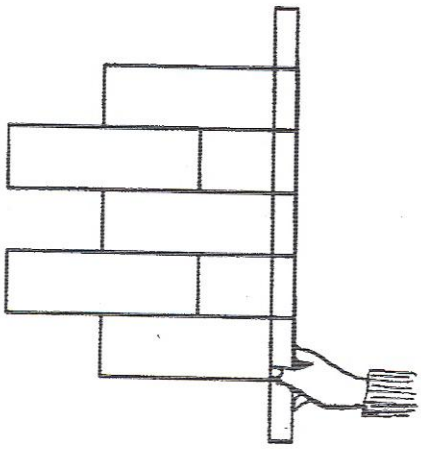
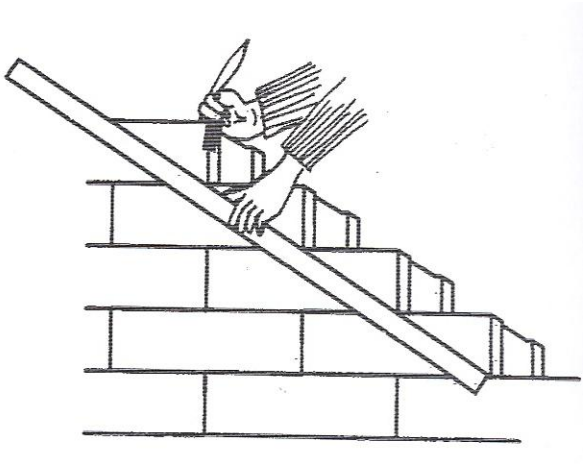


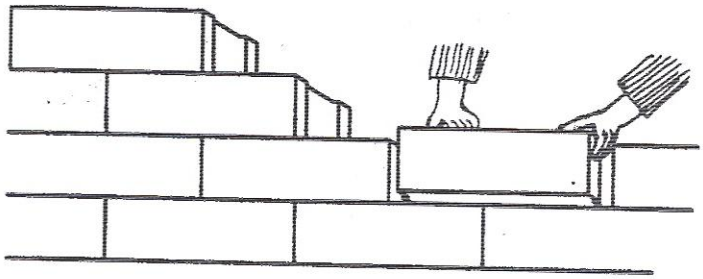
Fig. 3 Checking Each Course At The Corner



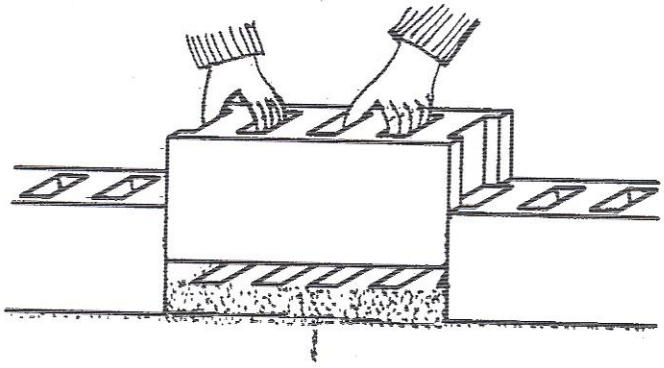
USING A STORY OR COURSE POLE



CHECKING HORIZONTAL BLOCK SPACING



FILLING IN THE WALL BETWEEN CORNERS



INSTALLING A CLOSURE BLOCK

Fig. 4 Concrete Masonry Laying Details

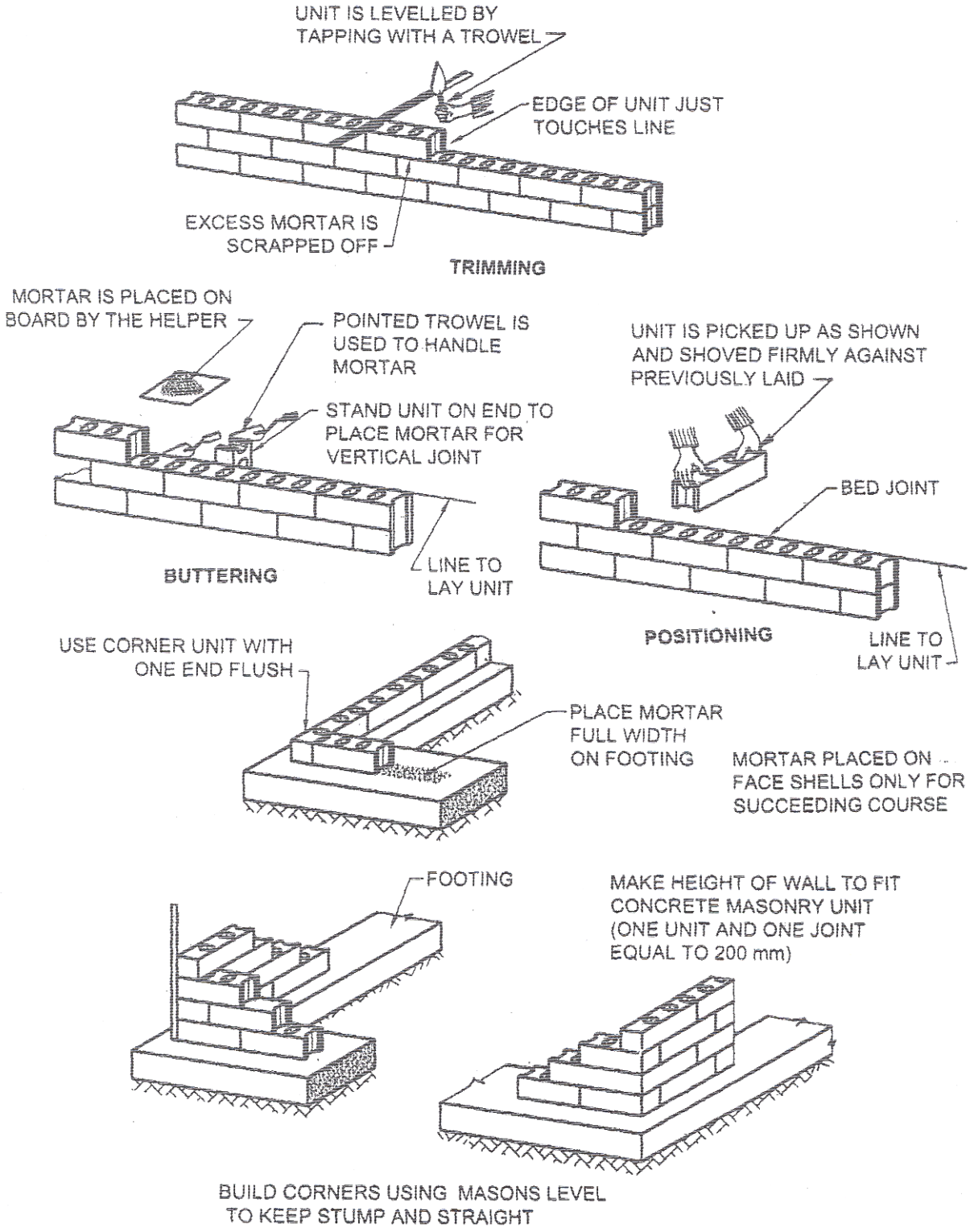


Fig. 5 Concrete Masonry Laying Details

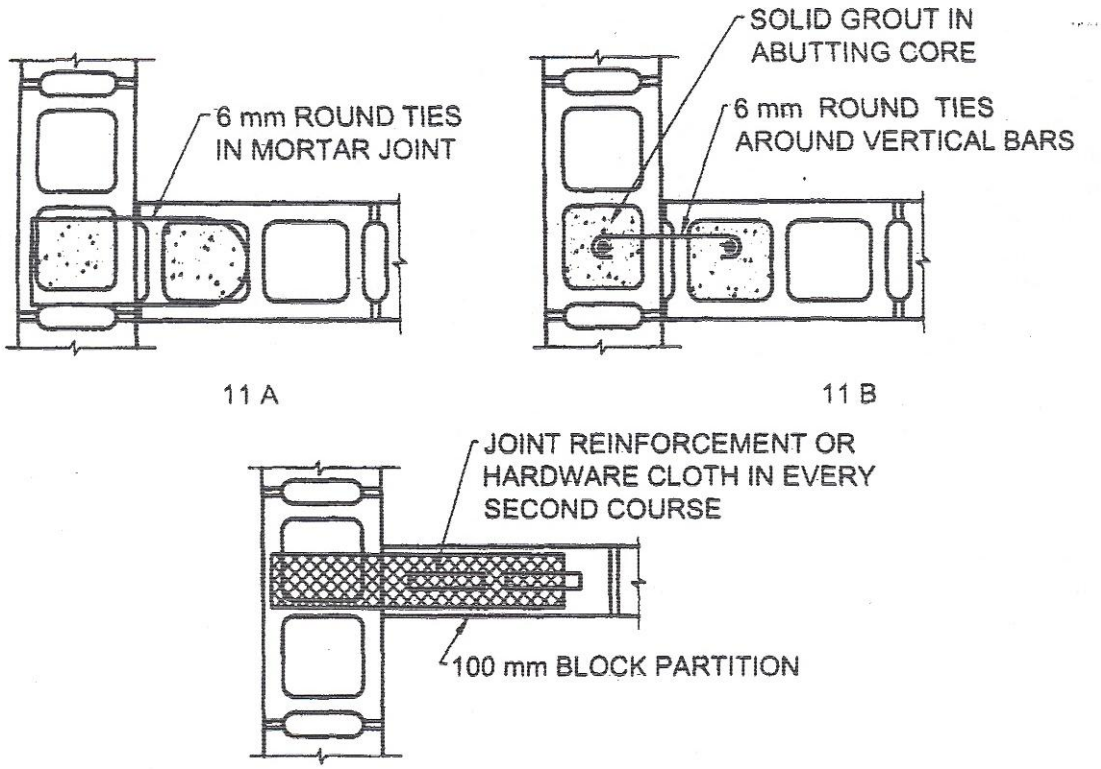


Fig. 6 Rigid Connections For Intersecting Walls

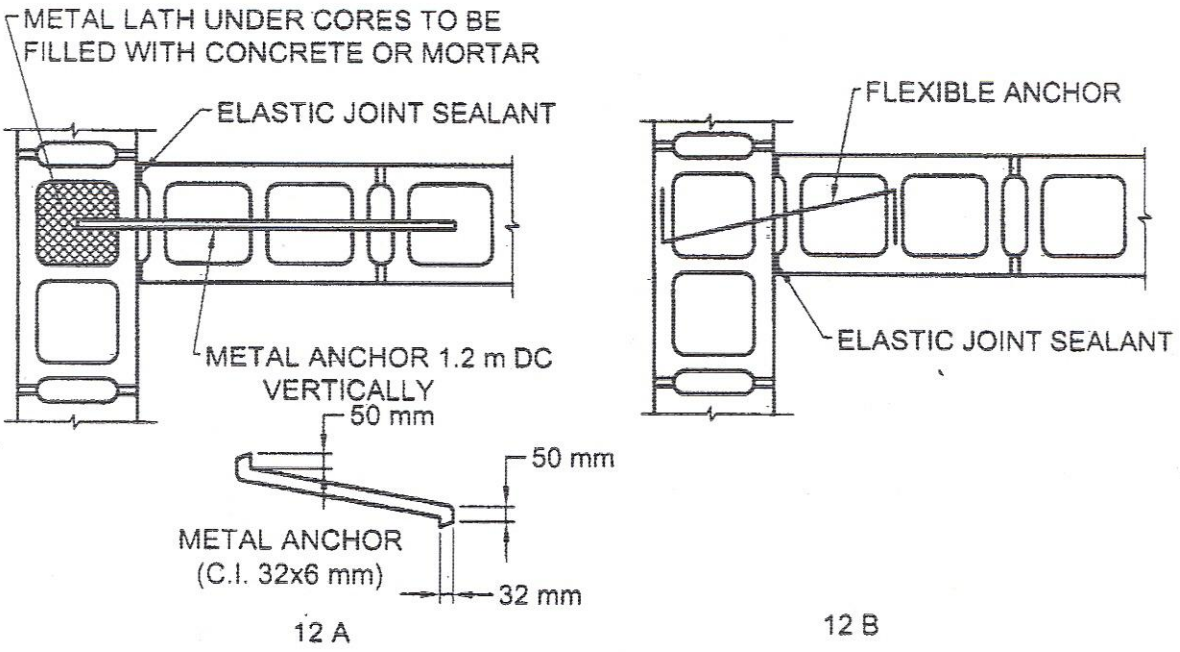
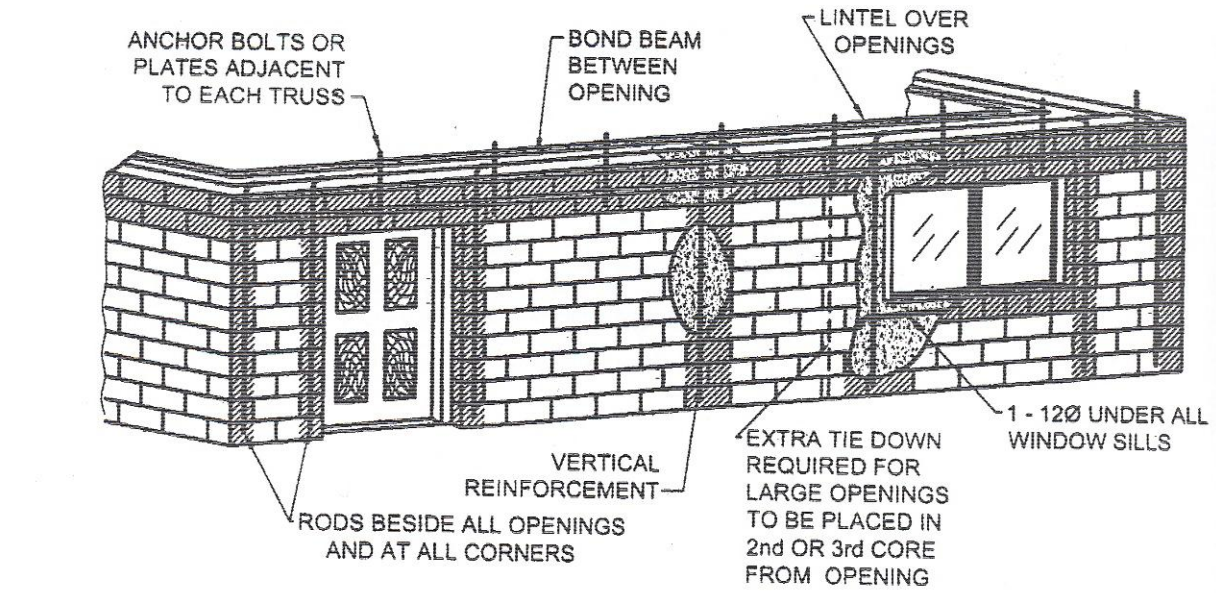


Fig. 7 Flexible Connections For Intersecting Walls



TYPICAL CONSTRUCTION DETAILS FOR REINFORCED SINGLE-LEAF MASONRY WALLING SYSTEM

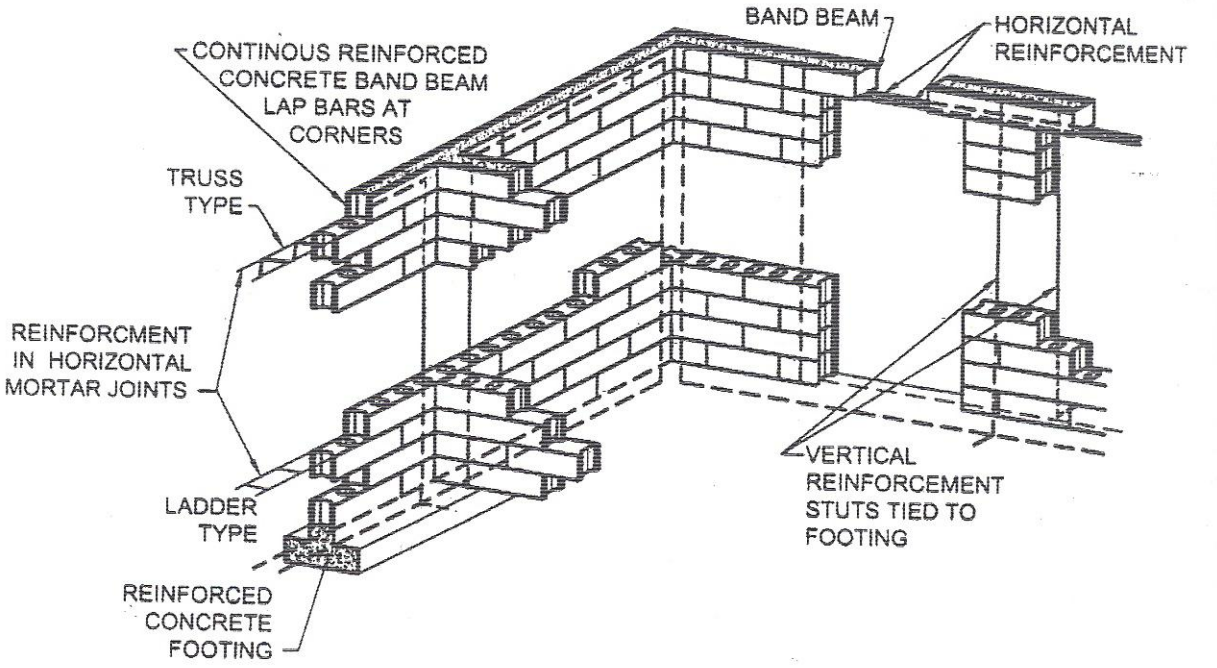


Fig. 8 Reinforcement Typical Details

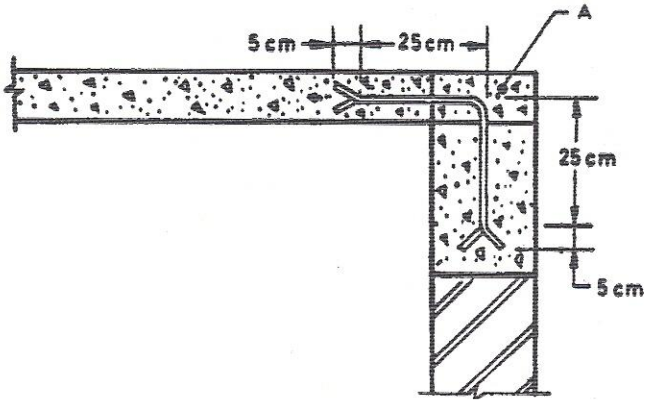


Fig. 9 Anchoring of RCC Slab with Masonry Wall

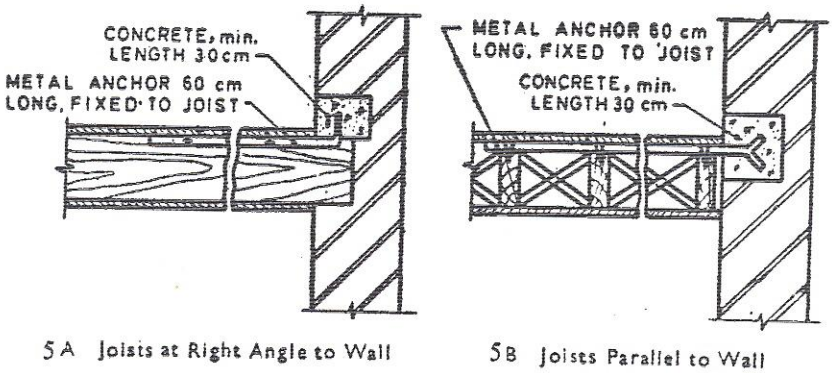
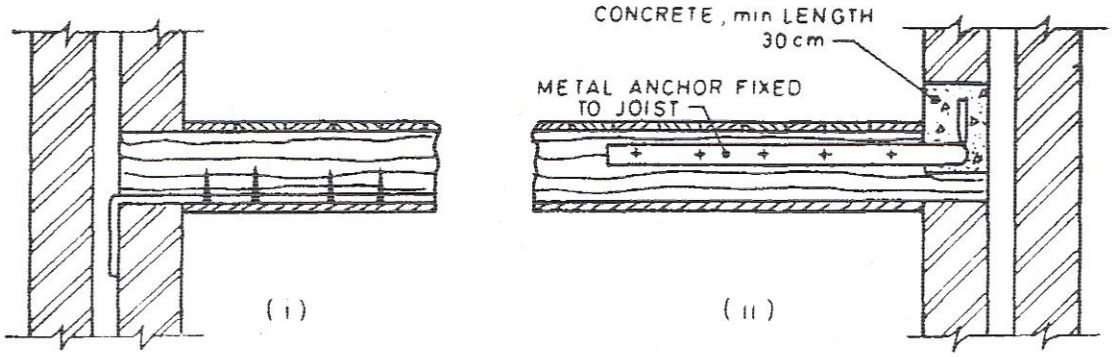
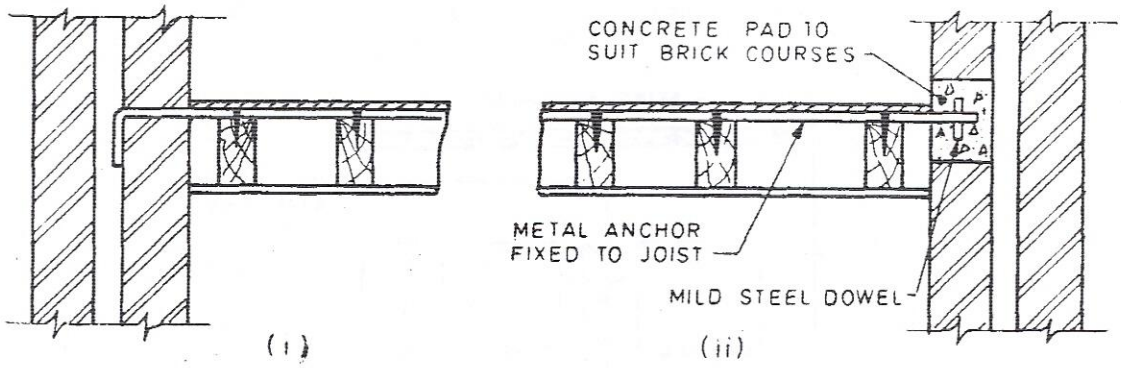


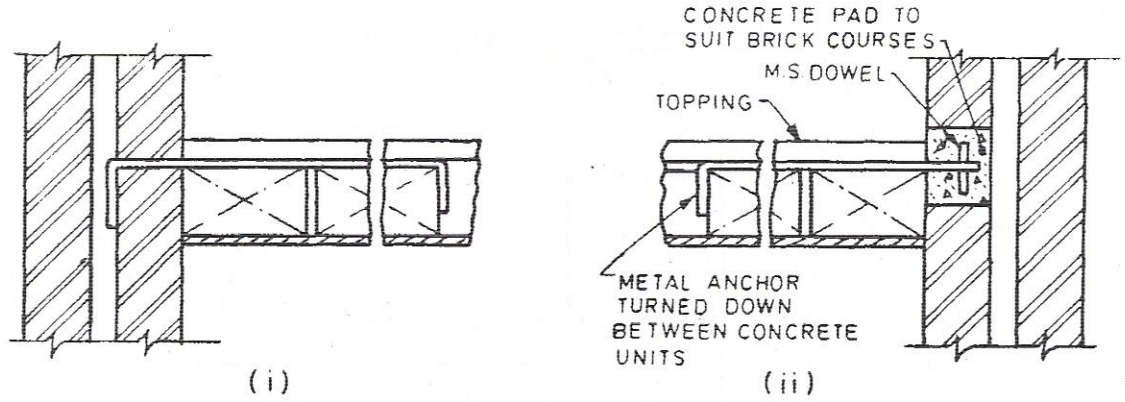
Fig. 10 Typical Details For Anchoring of Solid Walls



6A Timber Joists at Right Angles to Wall



6B Timber Joists Parallel to Wall



6C Precast Concrete Floor Units Parallel to Wall

Fig. 11 Typical Details For Anchoring of Cavity Walls

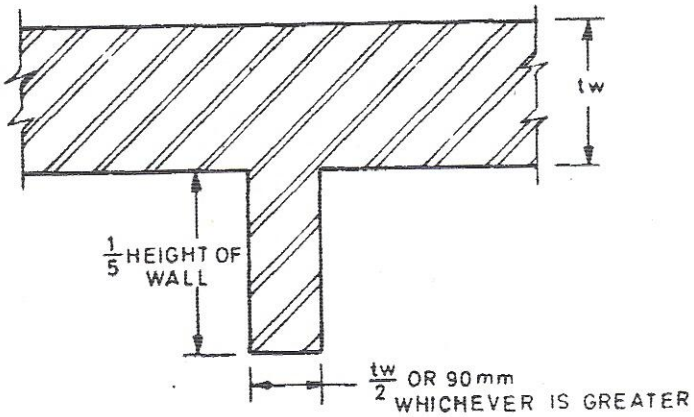


Fig. 12 Minimum Dimensions For Masonry Walls or Buttress Providing Effective Lateral Support

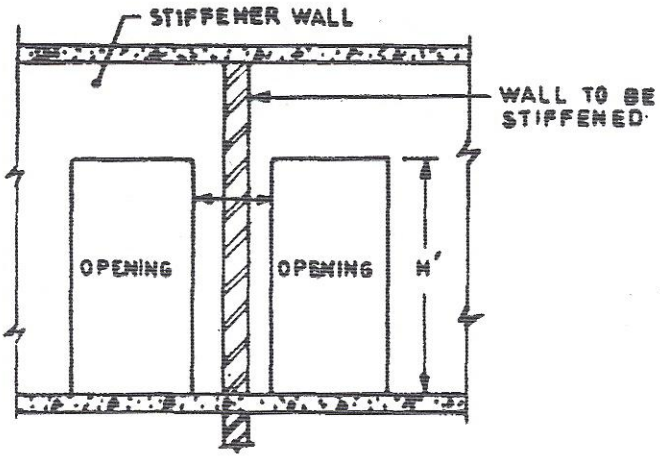


Fig. 13 Opening In Stiffening Wall

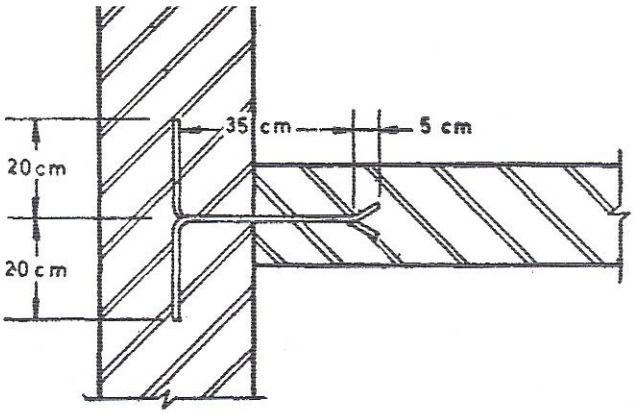


Fig. 14 Anchoring of Stiffening Wall With Supported Wall

(Clause 2)

List of Referred Indian Standards

IS No.	Title	IS No.	Title
269 : 1989	Specification for 33 grade ordinary Portland cement (fourth revision)	875 : 1987	Code of practice for design loads (Other than earthquake) for building and structures.
383 : 1970	Specification for coarse and fine aggregates from natural sources for concrete (second revision)	456 : 2000	Code of practice for plain and reinforced concrete (fourth revision)
(Part 1) : 1991	Fly ash based (third revision)	712 : 1984	Specification for building limes (third revision)
(Part 2): 1991	Calcined clay based (third revision)	1893 : 1984	Criteria for earthquake resistant design of structures (fourth revision)
4326 : 1993	Code of practice for earthquake resistant design and construction of buildings (second revision)	2185 (Part 1) : 1979	Specification for concrete masonry units: Part 1 Hollow and solid concrete blocks (second regision)

(Clause 7.2.1)

DESIGN ANALYSIS AND WORKING STRESSES FOR CONCRETE HOLLOW BLOCK MASONRY

Module of elasticity and of rigidity of masonry – For masonry made of concrete hollow blocks, the modulus of elasticity in tension and compression shall be taken as 10.5 x 10 kg/cm^2 and the shear modulus shall be taken 4 x 10 kg/cm^2. Alternatively, the engineer may either require or permit the use of moduli of rigidity for calculation purposes as determined by standard tests conducted under his supervision and approval.

B-2 WORKING STRESSES :

B.2.1 The applied and the induced stresses, calculated on net area, and in un-reinforced

concrete masonry, with or without continuous inspection, shall not exceed the following

values:

Compression		4.2 Kg/cm^2
With continuous	+ tension	0.7 Kg/cm^2
Inspection	+ shear	0.7 Kg/cm^2
Compression		2.8 Kg/cm^2
With continuous	+ Tension	0.4 Kg/cm^2

Inspection + shear 0.4 Kg/cm^2

B.2.4 Stresses under Concentrated Loads

B.2.4.1 Local stresses resulting from concentrated loads and the maximum combined stresses resulting from these or other loadings shall not exceed the allowable stresses for that part of the structure by more than 50 per cent.

B.2.4.2. Concentrated loads shall not be considered as being distributed by metal ties, nor across continuous vertical joints.

B.3 ASSESSMENT OF STRENGTH

B.3.1 Limitation on Strength of Un-reinforced Masonry

A building incorporating reinforced masonry framing or other structural framing shall have its basic structure able to resist all applied loadings without any contribution to strength from un-reinforced masonry.

B.3.2 Stresses shall be computed on the basis of the net thickness of the masonry, with considerations from reduction such as raked joints.

B.3.3. Combined Stresses :

Masonry subject to combined axial and flexural stresses shall be designed so that the quality

$f_a/F_a + f_a/F_b$ does not exceed 1.

Where f_a = direct stress computed on net area;

F_a = direct stress computed value of f_a permitted, multiplied by slenderness factors for axial loads;

f_a = actual stress due to bending; and

F_a = permissible stress in bending

APPENDIX -I

Association and Institutions

1. Builders Association of India,
   6, Casa Major Road, Egmore,
   CHENNAI – 600 008
   Phone: 28191874

2. Indian Earth Moving & Construction Industry Association
   23-26, Institutional Area,
   Lodhi Road, NEW DELHI- 110 003

3. Confederation of Industry,
   4th Floor, Core 4-A,
   India Habitat Centre, Lodi Road,
   New Delhi
   Phone 011-24662225

4. Indian Building Congress,
   Delhi.

5. National council for Cement & Building Materials,
   New Delhi.

6. Construction Federation of India,
   New Delhi.

7. Building Materials & Technology Promotion Council,
   (BMTPC)
   Ministry of Housing & Urban Poverty Alleviation,
   Govt. of India,
   India Habitat Centre, Lodhi Road,
   New Delhi.

8. CBRI, ROORKEY, UTTRA ANCHAL

9. HUDCO, NEW DELHI

10. Jamia Millia Islamia
    Maulana Mohd Ali Jauhar Marg,
    New Delhi-110025.

APPENDIX -II

Indicative list of Manufacturers of Machineries

MANEKLAL GLOBAL EXPORTS
237 / 239 Perin Nariman Street, Fort,
Mumbai – 400 001, INDIA
Tel: (+91 22) 22618951 / 22618962
Fax: (+91 22) 22618903 / 22679573
e-mail: sales@maneklalexports.com

ESPEE ENGINEERS
Ground Floor Express Towers,
Lokmanya Tilak Road,
Borivili West, Mumbai – 400 092
Tel: 022 8981984

JAYEM MANUFACTURING COMPANY
C-99, Sector IV, NOIDA
PIN: 201 301 (U.P.)
Tel: 0118 4520242

SABIN ENTERPRISES
28, third floor, Sucheta Niwas,
285, Shahid Bhagat Singh Road,
Fort, MUMBAI-400 001
Tel: 022-2317787

SEVAK INDUSTRIES
419, Narayak Peth Mulay Chambers,
1st floor, Umbrya Ganpati Chowk,
Laxmi Road, PUNE-411 030
Tel: 020-4451185

ENGINEERS ENTERPRISES
189, Bharathiyar Road
(Maniyakaranpalayam Road)
Ganpathy, COIMBATORE-641 006
Tel: 530639, 530788, 532260
Fax: 531893
e-mail: engineer@md3.vsnl.net.in

ASHOK ENGINEERING & CONSTRUCTION CO.
14, Ganesh Chander Avenue,
(Kent House), KOLKATA - 700 013.

MINTO SHIRKE CONCRETE MACHINE PVT. LTD.
72-76, Industrial Estate,
Mundhwa,

PUNE – 411 036

BARODA ROLLING MILLS PVT. LTD.
Chilani Road,
BARODA – 2 (Gujarat)

SAYAJI IRON & ENGG. CO.
Chilani Road,
BARODA – 2 (Gujarat)

ELSON VIBRO CONCRETE BLOCK MACHINE,
Kathiawar Metal and Tin Works Pvt. Ltd.
Ihati Plot, Sunder Nagar,
RAJKOT – 360 003.

Indicative list of Manufacturers of Concrete Hollow Blocks and Pavement Blocks

TECHNIC TILES & PAVERS PVT. LTD.
324/1. Hosur Road, Madivala,
BANGALORE –560 068
Tel: 5533361

HYDERABAD INDUSTRIES LTD
Sanat Nagar,
HYDERABAD – 18
Tel: 040-3700601

VIJAY HOLLOW BRICKS
85, Tass Industrial Est.
CHENNAI – 600 098
Tel: 044-26243656

NIRMAN CONCRETE BLOCKS
14, 3rd Main RPC Lay Out,
Vijay Nagar, BANGALORE – 40
Tel: 080-3302350

THE BALLIAPATAM TILE WORKS LTD
P.O. Pappinisseri,
Cannanore Dist.
PAPPINISERRI – 670 561 (Ker.)
Tel: 778432
FAX: 78436

VIKRAM CLAY INDUSTRY
No.573, “Super Bricks”.

XI Main Road, V Block, Jayanagar,
BANGALORE – 560 041
Tel: 641383 / 6651710
FAX: 664429

SAND PLAST INDIA LTD
B-77, Raman Marg, Tilak Nagar,
JAIPUR – 302 004
Tel: 620520. 621287
FAX: 620773

SREE SAI TILES PVT. LTD.
1075/G, "Naline", 10th Main Road,
HAL II Stage, Indiranagar
BANGALORE – 560c 008 (Kar)
Tel: 5254577
FAX: 5272182

TATANAGAR BRICKS LTD.
28, Circuit House Area,
Bungalow No.1,
JAMSHEDPUR – 831 001
Tel: 423214
FAX: 423251

RAIPUR BRICK INDUSTRIES,
413, Laxman Gunj, Khurja,
BULANDSHAHAR – 203 131
Tel: 22307 / 20005

ROHINI FLYASH BRICK WORKS,
Plot No.28, SIDCO Industrial Estate,
Parvathipuram, Vadalur,
Distt. CUDDALORE – 607 303
Tel: 59643

PERFECT sanitary pipes
1292, Hanumantal,
JABALPUR-482 002 (M.P.)
Tel: 343287 / 342489

RANKA BLOCKS MANUFACTURING PVT. LTD.
III Floor, Ranka chambers,
31, Cunningham Road,
BANGALORE – 560 053 (Kar)
Tel: 2262351 / 2260426 / 2265554
FAX : 2260952

PIONEER BRICKS PVT. LTD.
Bahadurgarh Village,
P.O. Rampur Sanian, Dera Bassi
PATIALA Distt. (Pun)
Tel: 70285 / 70655

NISSHOW IWAI CORPORATION
No.120, II Floor, Cunningham Road,
Hoodi Apartments,
BANGALORE – 560 052
Tel: 2255823
FAX: 2257096

ORISSA INDUSTRIES LTD.
2322, Lakshmi Narayan Street,
Paharganj,
NEW DELHI – 110 055
Tel: 2526814 / 27779532

NAGARJUNA BRICKS
Ameena Complex,
Opposite Survey of India,
Uppal,
HYDERABAD (A.P.)
Tel: 853511 / 85463

NAMHA FLY-ASH BRICK MFG. & CONSTN. TECH. P.LTD.
RS No.44/1, Mattur post,
SHIMOGA TALUKA & DISTTT. 577 203 (Kar)
Tel: 37891

MARUTHI BRICKS WORKS PVT. LTD.
19/7, V. Floor, Maruthi Mansion,
Cunningham Road,
BANGALORE-560 052
Tel: 2266576 / 2267507 / 2203876
FAX; 2200022.

MECHNO BRICKS PVT. LTD.
307-308m Magnum House II,
B-3, Karampura Complex
NEW DELHI-1100015.
Tel: 25453208 / 25419570

M..J. BRICKS COMPANY
10/26, East Punjabi Bagh,
NEW DELHI – 110017 (India)

Tel: 011-25422355
Mobile No. 9811094361

KANCHANA STRUCTURALS PVT. LTD.
No.9, Nagammai Street,
Raja Annamalaipuram,
CHENNAI-600 028
Tel: 4939543 / 4939555 / 4957108

M. SIVAKUMAR TILE WORKS
Krishnagari Road,
Dharamapuri Distt.
HOSUR – 635 109 (TN)

KALINGA CONCRETES
Subodh K.U.Sahoo,
Mansingh Patna
CUTTACK – 753 008
Tel: 30790.

HYDRATECH PROJECTS INDIA PVT. LTD.
8/3, Gandhi Park,
Opp. Modi Hospital, Hauz Rani,
NEW DELHI-110 017
Tel: 5552139
FAX: 5532528

JAGAN SELVE BRICK WORKS
90, Appavoo Nagar, II Cross,
Thally Road
HOSUR-635 109
Tel: 22258 / 23360

HINDUSTAN TILES
3rd Street, Shukla Colony,
Hinoo,
RANCHI – 834 002
Tel: 501134 / 503134 / 501132

HIMALAYAN SALES PVT. LTD.
Wadia Building, 17/19
Dalal Street,
MUMBAI – 400 023
Tel: 2674186
FAX: 267813

Dual fabs pvt. Ltd.
7, 3RD street, Nehru Nagar,
CHENNAI – 600 020
Tel: 4422701 to 4422705
FAX: 4422707

CON-BOX
14, Dungarshi Nagar – 1,
Opposite Anjali Theatre,
Bhatha-Paldi,
AHMEDABAD – 380 007
Tel: 416558 / 414355
FAX: 6637742 / 414355

CALCUTTA MECH. BRICKS PVT. LTD
I.C. Heysham Road,
KOLKATTA – 700 020
Tel: 4756404 / 4756047 / 4756955
FAX: 4753594

AUROVILLE BUILDING CENTRE (AV-BC)
SR-Auroshilpam
AUROVILLE – 605 101 (Pon)
Tel: 862168 / 862274
FAX: 62057

BASANT BRICKS
99, Jakkasandra,
Sarjapur Road,
BANGALORE – 560 034
Tel: 531703 / 5533694

BAWA ENTERPRISES
Ashok Nagar
MANGALORE – 575006 (Kar)
Tel: 458158
FAX: 420293

ARORA FIRE BRICKS
404, B Vrindawan,
Goregaon Mulund Link Road (W)
MUMBAI-400 080
Tel: 5602387

AMBAL BRICK WORKS
Room No.10, Gayatri Mansion,
60, Sannadhi Street,

Thiruvottiyur
CHENNAI – 600 019
Tel: 543224

ANUTONE BOARDSS PVT. LTD.
3-A, Visvesvaraya Industrial Area,
BANGALORE – 560048
Tel: 8510814 / 85213539
FAX: 2212586 / 8516991
e-mail: anutone@blr.vsnl.net.in

AEC CEMENTS & CONSTRUCTION LTD.
I Floor, Electricity,
Lal Darwaja,
AHMEDABAD – 380 001
Tel: 354417

SINGH BRICKS & ALLOYED CORP.
II Floor, Room No.10,
Shanti Bhawan,
DHANBAD – 826 001 (Bhr)
Tel: 456086 / 406774

ALLVA PLAST
105, Mission Street,
PONDICHERRY – 605 001
Tel: 23473 / 25469

CONCRETE BLOCK MAKING MACHINES

M/S Shri Engineering Enterprises
Tower Hoist, Concrete Mixer, Hydraulic Concrete Block Machines,
13, Sukhnivas, Survey No.102/2/al, s.b. Road, Behind Hsg. Soc.,
Shivaji Nagar, PUNE-411016 (Maharashtra)
PH: 91-20-25651611

M/s Sabin Enterprises,
Machine Materials, Plastic Processinginks, Rivets, Rivets, Washers Screws etc.
28, 3rd Floor, Sucheta Niwas,
285, Shahid Bhagat Singh Road, Fort,
Mumbai-400 001
PH: 91-022-56317787

M/s Balachandra Granites & Pu Foams Pvt. Lotd.
Bricks & Pavers concrete Block Making machines,
Earth moving Equipments.
Plot No.13-A, Ida Phase III, Jeedimetla,
Hyderabad-500 855
Ph: 91-040-23095262

M/S Bajaj Tempo Ltd.
Concrete Block Making Machines, Engines, Machine Parts
Mumbai-Pune Road, Akurdi, PUNE-411 035.
PH: 91-020-7476380

M/S Bharat Floorings & Tiles (Mumbai) P.Ltd.
Bricks & Pavers, Concrete Block Making Machines,
32, Mumbai Samachar Marg,
Next to Stock Exchange, Fort,
Mumbai-400 023.
Ph. 91-22-22654837

M/s Ramasu Hydraulics Pvt. Ltd.

Concrete Block Making Machines,
362. Fie Patparganj Delhi-110092.
PH: 91-11-2140345

M/s B.G. Shirke Construction Technology P.Ltd.,
Gricultural Products, Bricks & Pavers,
72-76, Mundhwa, PUNE-411 036 (Mah)
PH: 91-020-671612.

PRESENT MANUFACTURES OF CONCRETE BRICKS & TILES

Sir Venkateswar Brick & Tiles Industries,

Unnava, Kurnool, A.P.

Esskay Industries,

Vill - Jonapur, Mehrauli, New Delhi.

Mehta Tiles Factory,

775/1, Behind Cellulose Pdts,

Kathwada (Guj.)

Vijay Tiles Industries,

30, New Industrial Estate,

Naroda, Ahmedabad.

Ravi Concrete Pipe Co.,

Kathua, Jammu & Kashmir.

United Brick & Co.,

Durwani Nagar, Banglore - 16.

Anant Laxmi Brick & Tiles works,

Whitfield Main Road, Hoodi, Banglore - 16.

St. Mary;s Production & Sales,

Nagampadam, Kottayam, Kerala.

KC Concrete Molding,

Chittoor, Palghat, Kerala.

Nav Nirman Pvt. Ltd.,

Indl. Estate, Bhopal (M.P.)

Italica Pvt. Ltd.,

Chhoti Khajarini, Indore, M.P.

Concrete fabrications Pvt. Ltd.,

Barthora, Lucknow (U.P.)

BOILERS AND STEAM GENERATION PLANT:

Chem Engineering Co.

Plot 517, Sector 25, Nigdi,

Pune 411044.

Phone :(020)-784792,782605

Fax : (020)-782605,789822

Chemtex Engineering Enterprises,

Plot No. 277-278.,

Opp. Shed No- L-1, G.I.D.C. Industrial Estate,

Odhav, Ahmedabad-382415,

Gujarat.

Phone : (079)-2871180,2871280,

Email : chemtex@vsnl.net.in

Fluidtech Boilers P.Ltd.

2703, Phase-IV, G.I.D.C. Vatva,

Ahmedabad-382445 Gujarat

Phone - (079)-5830105, 5830106

Fax : (079)-5830041.

Email : fluidltd@vsnl.com

Website : http://www.infoquestindia.com/fluidtech.

Double Ace Engineers

1/3, Siddharth Nagar-3,

Next to Siddhi Vinayak Temple,

S.V.Road, Goregaon (West),

Mumbai-104.

Tel : 91-22-8728436,8771948

Fac : 91-22-8740466

Wesite : www.doubleaceboiler.com

Email : dblace@bom5.vsnl.net.in

Maxima Boilers Pvt. Ltd.

G-14, Meghal Service Industrial Estate

Devidayal Road Mulund (W),

Mumbai - 400080

Tel : 5646815,5612759

Fax : 5670030

Email : maxima@bom8.vsnl.net.in

Indcon Boilers Ltd.

D-170, Okhla Indl.Area, Phase-1,

New Delhi - 110020

Ph. 6811440,6811441,6811442

Fax : 011-6812425

Email : pnmpsa@del2.vsnl.net.in

CONCRETE MIXERS

Enkay Testing Machines Corp.

B-143/1

Phase-I

Mayapuri Indl. Area

New Delhi, NCT of Delhi-110064

India

TEL : +91 (0) 11 5140811

FAX : +91 (0) 11 5131209

E-mail: enkayenterprises@vsnl.net

Gian Singh & Sons

Phase-II, C-75

Mayapuri Indl. Area

New Delhi, NCT of Delhi-110064

India

TEL : +91 (0) 11 5404262

Karnavati Road Equipment Pvt. Ltd.

86/3/A

GIDC, Phase-I

Vatva

Ahmedabad, Gujarat-382445

India

TEL : +91 (0) 79 5830414

FAX : +91 (0) 79 5893014

E-mail: contact@karnavatipathmaker.com

Shree Ram Engg. & Manufacturing Industries

Opp. Narsinh Est.

Pratapnagar

Vadodara, Gujarat-390004

India

TEL : +91 (0) 265 580925

FAX : +91 (0) 265 581616

E-mail: shreeram@aahura.com

Vaibhav Road Equipment

2 Shree Ram Est., Nr. Mony Hotel

Isanpur-Narol Rd.

Isanpur

Ahmedabad, Gujarat-382443

India

TEL : +91 (0) 79 5342008

FAX : +91 (0) 79 5710208

E-mail: vaibhavlaxmi@satyam.net.in

Crushers, Conveyors, Bucket Elevators etc.

Sayaji Mfg. Pvt. Ltd.,

1-A, Peenya Indl. Area,

Phase - II,

Tumkur Road, Banglore.

KSB Pumps Ltd.,

Pimpri, Pune, Maharashtra.

Conveyor Equipment Co. Ltd.,

Race Course Road, Guindy, Madras - 32.

WEIGHING MACHINE

Avery India Ltd.,

Guntur, Andhra Pradesh.

Precision Machinery Co. Pvt. Ltd.,

27, Laxmibai Nagar, Indore.

(M.P.)