

MODULAR BRICKS: COST EFFECTIVE AND ENVIRONMENT FRIENDLY WALLING MATERIAL

Preamble:

There is a wide gap between housing stocks available and to fill this gap a minimum of million housing units, consuming almost million bricks per year, are required.

Housing has also been identified as an industry, which is responsible for maximum environmental degradation. Every time a house is built tons of non-renew able scarce resources are consumed. Energy is consumed and Green House Gases are also emitted. To ensure sustainable development all these scarce resources need to be conserved.

In the paper, an effort has been made to analytically study Modular brick as a building material, assess its advantages and environment friendliness vis-à-vis traditional bricks.

General:

Environment protection concerns have brought to fore the need for conservation of precious topsoil, utilisation of waste materials, energy conservation in manufacture / creation and adoption of sustainable technology in the brick manufacturing sector.

Bureau of Indian Standard, keeping in view the advantages of modular co-ordination, has specified the dimensions of standard bricks in 100 mm module as basis for all dimensional standardisation with regards to building components. This is also in conformity with the decision of the Government of India to adopt metric system in the country. It will not be out of way to mention that the metric system was in force since 1956 but in building construction industry it has not been followed till now even in departments of Govt. of India. Rapid building activity, to be on rational lines needs a certain degree of uniformity in constructional material and standardisation with regards to quality and dimensions. Government of India through BIS has specified modular size of the brick for general use. Manufacturers and consumer organisation were to gradually switch over to the preferred modular sizes within a period of four years with effect from 1992.

Modular brick is a standard brick with dimensions in 100 mm modules i.e., 190 mm x 90 mm x 90 mm or 190 mm x 90 mm x 40 mm. IS 1077: 1992 (Reaffirmed 1997) for common Burnt Clay Bricks specifications (Fifth revision) covers various aspects of this bricks.

Brick Manufacture:

Brick manufacturing is an energy and resource intensive activity. To maintain sustain ability, it is essential that consumption of energy and raw material should be minimised for a unit area of the wall constructed. The traditional raw material of various types for making bricks i.e., soil / clay is also limited. The problem of various types of waste generated and their safe disposal also needs attention. Soil and mix of various waste materials such as fly ash, coal ash, mining overloads etc also require looking into.

With extensive use of machine moulding technology, it is possible to make bricks of very high strength (up to class 35). However, brick construction industry does not generally require bricks higher than class 20. International, the practice is to use bricks with holes.

Machine Made Modular bricks with holes shall result in increasing the saving in material and energy to the extent of perforations besides further reducing the dead weight of the structure.

Advantages of modular brick

The rapid growth in construction has caused a boom for the demand for bricks, which has led to other problems such as stop soil, air pollution and energy waste. In China where only 7% of the land is cultivable but 22% of the world population lives, there is tremendous shortage of cropland. In order to preserve cropland and reduce energy consumption, Chinese Government introduced a project “ Innovation of Wall material” in 1988. The project proposed use of various types of waste residue such as fly ash, coal gangue, shale and perforation as a means of material and energy conservation. As a result of the project, out of the total 1000 billion bricks being produced, the %age of new material as fraction of total quantity increased from 4.6% in 1989 to 16.2% in 1996 and a share of 40% is expected by the year 2010. In China, most of the cities have banned use of solid clay bricks construction.

Advantage of the modular bricks have been covered in the forward of IS 1077: 1992 on common Burnt Clay Building Brick specifications. A comparison of 10 m² of wall with hand made FPS bricks, vis-à-vis hand made modular is given at Appendix A. Considering the same conversion norms for energy and emissions as for this Appendix the profile of yearly energy saving and reduction in green house gases emissions which can be achieved by use of modular bricks in construction at ‘Delhi National Capital Region’ and on ‘All India’ basis can be made and the same is given in Appendix B. Perusal of these comparisons show the use of Modular bricks results in:

- **Economy in cost of brick masonry:**

Considering 10 m² of un-plastered wall, it is seen that the wall with modular bricks is 17% cheaper than the wall constructed with FPS bricks. This, when translated in terms of cost would imply that a 10 m² wall with class 7.5 modular would be cheaper by Rs. 623/- vis-à-vis class 7.5 FPS bricks at rates given in CPWD DSR 2002.

- **Less Consumption of mortar:**

Mortar saving work out to approximately 27% in case of brickwork by the modular brick rather than the FPS bricks.

- **Reduction in dead weight of the structure:**

Considering the weight of the FPS brick (3.2 kgs) and modular brick (2.5 kgs), use of modular bricks will result in reduction of dead weight of the structure by approx. 22% with consequent impact of generating saving in steel and cement consumption and foundation design in load bearing structure. In framed structures, the safety factor would be enhanced due to less weight on the foundation.

- **Gives more carpet area:**

Municipal by laws state that the width of load bearing walls to be 200 mm thick. Modular bricks give load-bearing wall (200 mm thick) as per municipal byelaws

against 230 mm wall thickness given by FPS bricks. Thus, with modular bricks an additional 2% carpet /floor area is achieved for dwelling with plinth area of 95 m².

Conservation in Resource Consumption

Top Soil: It takes 1000 years to make an inch of Topsoil. Developed countries have established brick manufacture technologies, which are environment friendly and conserve the scarce resources of farmland and energy. It can be seen that in Delhi NCR yearly consumption of bricks if considered in terms of walls constructed, top soil to the extend of 17.75 million tons can be saved by the use of modular bricks.

Energy: The saving in weight of brick will effect the specific energy consumption in production of bricks. Considering energy to weight conversion as 1.4 GJ/ton, a saving of 98 GJ of energy can be achieved for production of one lakh modular bricks (2.5 kg each) instead of FPS (3.2 kgs each). This works out to be 4.82 tons of coal equivalent (0.0492 ton/GJ). This saving can be further increased in case we take into account the reductions in cement (utilised in mortar) and steel due to reduction in dead weight of structure. Energy conservation up to 40% can be achieved.

Reduction in Green House Gas emissions: Brick kilns chimneys releases smoke and gases into the atmosphere, which ought to be minimised to acceptable levels. Green house gas is also released at the rate of 0.103 ton per ton of bricks manufactured. The saving in weight by use of modular bricks vis-à-vis FPF bricks also leas to reduction of CO₂ emissions by 7.21 tons or 40% in case one lakh bricks are considered.

Environmental Impact and Economy in a Medium sized project

The saving in energy consumption and reduction in CO₂ emission quantified in respect of 10 m² wall may appear to be small but when construction projects are evaluated, energy savings due to reductions weight of bricks, cement and steel utilised as also reduction in CO₂ emissions becomes significant. This can best be illustrated by case studies. Study on contraction of 386 type II quarters for CRPF by CPWD at an estimated cost of Rs. 13.05 crores was evaluated. Use of modular bricks in construction of walls has resulted in saving both in cost and energy and reduction in CO₂ emissions as below:-

Economy:

Saving in cost ranging from 6.42% to 22.10% can be used by considering various options given in Appendix C.

Energy saving

Item	Saving in Weight	Energy req. to produce	Reduction in Energy Consumption.
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1. Cement	2438 Ton	5.65 GJ/Ton	13774.7 GJ
2. Bricks	7853 Ton	1.4 GJ / Ton	10994.2 GJ
3. Steel	352 Ton	24.7 GJ / Ton	8712.00 GJ
		Total	33480.9 Ton
Cost equivalent saving	@ 0.0492 T/GJ		1647.26 Ton

Reduction in CO2 emission

□ For 2438 ton of cement @ 0.3 Ton/Ton of cement	2194.20 Ton
□ For 7853 Ton of bricks @ 0.103 Ton/Ton of bricks	808.56 Ton
□ for 352 Ton of steel @ 1.82 Ton/Ton of steel	640.64 Ton
	Total 3643.70 Ton

Details of similar studies based on brick consumption in national capital Region and All India basis for brick masonry indicate:-

All India	<i>Annual brick consumption</i>	140 billions
National capital Region Delhi	<i>Annual brick consumption</i>	16 billions

Annual savings*		All India	Delhi
Top Soil	<i>hectares of land</i>	11823	1359
Energy (Coal equivalent)	<i>million tons</i>	14.0574	1.606
Cement	<i>million tons</i>	4.83	0.5
Sand	<i>million tons</i>	28.98	3.31

CASE STUDY

Delhi State Industrial Development Corporation (DSIDC) carried out study on FAL-G and modular bricks as walling material for their housing project of constructing dwelling units for industrial workers at Bawana. For DSIDC, quality, cost and regular maintenance were concerns to be addressed. Being dwelling for lower status low cost housing was the prime motto. To get maximum dwelling in the budget was the target. After due studies and exploring various options, they are now constructing the dwelling units with clay modular bricks. Saving generated and environment friendliness of the modular bricks can be gauged from the salient features of the project given below:-

Project details:

1. Number of dwelling units (DU) 3164
2. Number of DU in four storey blocks 16
3. Type of Construction Load bearing brick structure with seismic reinf.
4. Clay modular bricks used Modular bricks of class designation 12.5

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|--|----------------------------|
| 5. Plinth area per DU | 32 sqm & 36 sqm |
| 6. Aprox cost per DU | Rs. 1.66 and Rs. 1.92 lacs |
| 7. Cost per sqmt | Rs. 4370.00 |
| 8. Total number of clay modular bricks | 2.5 crores. |

Saving (Load bearing structure being made)

Monetary: 18% saving in cost of construction totalling to Rs. 8.10 crores.

Material: Dead Weight	117000 Tons
Cement	11000 Tons
Steel	1600 Tons
Sand	21000 Tons

Environment: CO2 emission	16000 Ton
Energy Consumption	150000 Tons
(Coal equivalent)	

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