

Reinforced Hollow Concrete Masonry as Cost-Effective Construction Technology for Affordable Housing in Nepal

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Building a house has become a distant dream for majority of the families due to ever increasing land and housing price in all the major cities of Nepal. Rising prices have been further amplified by the distorted land and housing market controlled by land mafia and brokers, and the land speculators who hold land not for its use value but for sale at a future date when prices are even higher. According to UN Habitat, more than 75 percent of the urban population of Nepal cannot afford the minimum standard 50sq.m house on 80sq.m plot in the outskirts of a city, while 95 percent cannot afford to purchase a readily built property from a real estate developer.

On the other hand, the large influx of population from rural to urban, inadequate infrastructure and a widening housing deficit has resulted in an increasing number of urban residents living in inadequate housing. The housing need of millions of people of low middle income and low income group has not been addressed so far and face serious difficulty in finding affordable housing. In order to improve the supply of affordable housing, the focus should be on policies that promote a wide range of alternative housing options including cooperative solutions and support incremental housing programs. Besides, as architects and engineers, we can make housing more affordable by efficient land planning and using alternative construction technologies.

Approach to Cost Effective Housing:

Cost effective house does not mean cheap house without considering the quality, durability and strength of the house. Cost of a house can be reduced by proper planning and by efficient utilization of land, construction materials and labor. We can achieve 15-to-20% reduction in cost by proper planning of land, while 8-to-10% by efficient planning and design of houses, and further 15-to-20% by using appropriate building material and technology.

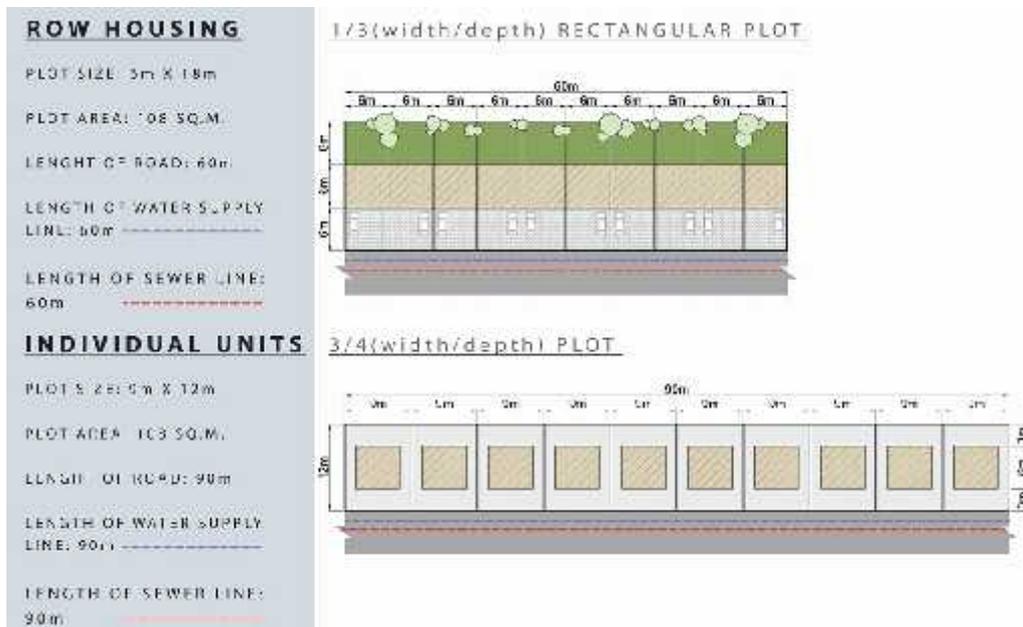
1. Efficient land planning and development

In the current market, cost of land is very high and in some places even more than construction cost. Hence, there is no other alternate than to reduce the land area per housing unit which results in low-rise high density settlements. High density settlement (density as high as 100 units per hectare) with quality environment can be achieved by proper planning. A comparative analysis of two different methods of planning is illustrated in the figure below.

Various advantages of row housing over individual units are as follows:

- With no set-back at the left and right sides of buildings, smaller plot size becomes more feasible

- Row housing helps reduce the installation as well as maintenance cost of infrastructures like road, side drains, electric cables, water supply lines and sewer lines.
- Privacy between neighboring houses



2. Optimum design of housing unit

For economization, simple planning and designing is preferable. Regular-shaped floor plans with centrally located staircase, smaller openings and lower storey height helps reduce the cost of a house significantly. In addition, shared walls between housing units, optimum size of rooms and semi-finished incremental units also help reduce the construction cost.

3. Appropriate building materials and construction technology

Appropriate building materials and construction technology are indispensable for reducing the cost of a house. Studies have shown that it is cost-effective and safe to build one-to-three storey house with masonry structure. Reinforced Hollow Concrete Block Masonry is one of the cost-effective and earthquake-resistant masonry constructions.

Reinforced Hollow Concrete Block Masonry as Cost-Effective Construction Technology

Hollow concrete blocks are precast concrete blocks with two large holes (40-50% cavity) which are open at top and bottom. Normally, the mix of 1:3:6 (cement: sand: stone chips) is used to get a minimum required strength of 50kg/sq.cm. These blocks are lighter than bricks, easier to place and also confer economics in foundation cost and consumption of cement. In comparison to conventional bricks, they offer the advantages of uniform quality, faster construction, less labor intensive and longer durability.

Hollow concrete blocks can be used for

- a. Exterior load bearing wall
- b. Partition walls
- c. Column
- d. Retaining wall
- e. Compound wall

Dimensions of Hollow Concrete blocks are

- a. Length: 400mm
- b. Height: 200mm
- c. Length: 100mm, 150mm and 200mm



What are the Benefits of Hollow Concrete Block (HCB) Masonry?

1. Dimensional Accuracy

Hollow concrete blocks are batch-produced in moulds which means size can vary in only one plane, usually the height, as opposed to other products on the market that can vary in length, width and height. Permissible variation is +/-1.5mm on length and +/- 3mm on height.

2. Energy efficiency

R.C.C frame structure and brick masonry consume 3 and 2 times more energy respectively as compared to hollow concrete masonry structure. Hollow blocks are also naturally energy efficient. The air gaps or the voids in blocks act as barrier between outside and inside environment. This effect of ensuring that buildings stay warm in winter and cool in summer lessens the need for artificial energy for heating and cooling.

3. Modular system

Hollow concrete block masonry is a modular system which allows for efficient design and standardization of building components, such as door and window frames which then leads to cost efficiency. Modular co-ordination enables components to be built on site without modification, as well as reducing the range of sizes required.

4. Fire resistant

Hollow concrete block masonry is fire resistant.

5. Cost Effective

Hollow concrete block masonry is 18-to-20% cheaper than brick masonry. Hollow block masonry consumes lesser mortar as compared to conventional brick masonry because volume of joints. Amount of mortar is 25% of the total volume in brick masonry while only 10% in HCB masonry construction. In addition, the amount of plaster required for hollow block masonry is also lesser due to the evenness in the surface as compared to undulated brick masonry wall. Also, the speed of hollow block masonry is faster than brick masonry which also makes the construction economic.

6. Durability

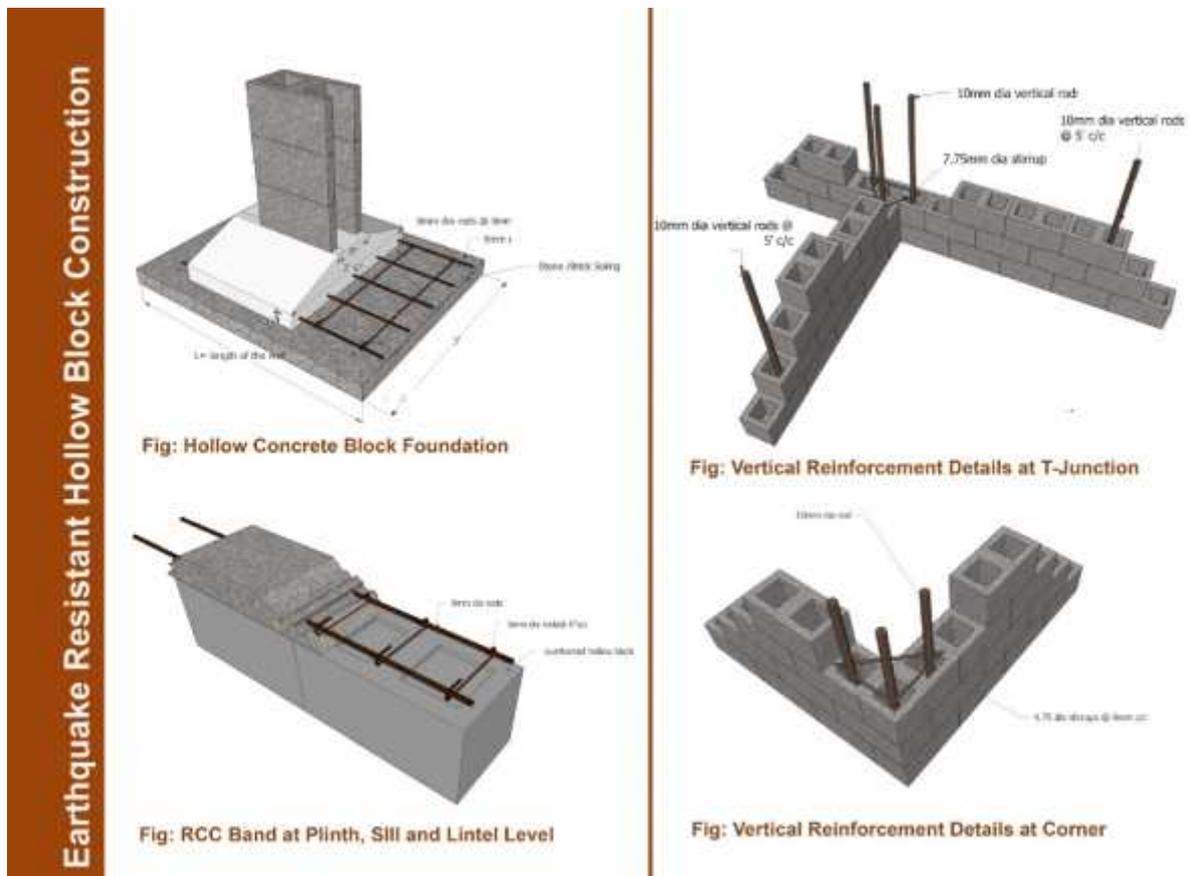
Hollow concrete block is highly durable material and is manufactured to resist local exposure conditions for the intended life of the building. Durability is generally related to compressive strength, which in turn is related to density. Surface protection such as paint and plaster adds tremendously to the durability of any walling material.

7. Environmentally friendly

The production of brick consumes fertile soil that is valuable for cultivation. Large amount of firewood is required to bake the bricks which in turn lead to destruction of forest and the smoke emitted during the production leads to air pollution. None of these exist in the production of hollow concrete blocks.

Structural System of Reinforced Hollow Concrete Block Masonry:

Hollow concrete block masonry structures can be easily made strong to resist earthquake and other vertical and lateral forces. The main property of hollow concrete block is that reinforcement can be easily placed at any position and make all the parts of the building function as structural members. Normally, the direct vertical force is not a problem as masonry can itself resist it. On the other hand, to resist lateral force like earthquake or eccentric forces (which produces tensile stress), steel reinforcements must be provided at the necessary positions and hollow blocks are the best for this purpose.



In this construction system, each wall and slab structurally behaves as a shear wall and a diaphragm respectively, reducing the vulnerability of disastrous damage to the building, during natural hazards. Due to uniform distribution of reinforcement in both vertical and horizontal directions, through each masonry element, increased tensile resistance and ductile behavior of elements could be achieved.

Hence, this construction system can safely resist lateral or cyclic loading, when compared to other conventional masonry construction systems. This construction system has also been proved to offer better resistance under dynamic loading, when compared to other conventional systems of construction. Some construction photos of hollow concrete block masonry are illustrated below:



Following are some of the projects constructed using hollow concrete block masonry:

1. Sanchayakosh Housing Project, Pokhara
2. Balambu Housing project
3. Lumanti Housing Project, Pokhara
4. Sewa Homes-I , Gaishar, Itahari
5. Green Valley Homes, Lamatar, Lalitpur