

Advanced Construction Materials

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ABSTRACT

Building material is any material which is used for a construction purpose. Many naturally occurring substances, such as clay, sand wood and rocks, even twigs and leaves have been used to construct buildings. Apart from naturally occurring materials, many man-made products are in use, some more and some less synthetic. Light weight construction materials can be a great choice when it comes to building a home. New technology has also made building with metal more practical than in previous human history. Most high rise buildings and sky scrapers are built with steel or other metal frames. Plastics are another widely used modern building material. Formed of polymers, plastics are easily molded while in the liquid state. Compared to metal and many other materials, plastic is very light in weight and relatively low in cost. Plastic is often used to make pipes and to decorate the interior of buildings. Many modern buildings use glass, not only for windows, but often as the primary exterior building material. Glass skyscrapers and other structures have become quite popular due to their aesthetic appeal.

Technology continues to create new building materials with exceptional properties. For example, sea-cretion is a construction material made from minerals found in sea water. Composite materials are made by combining different types of building materials together. These materials combine organic and inorganic components. One material acts as a type of “adhesive” that binds the other components together. The “hard” components are usually glass, carbon or boron fiber. Composites are known for combining light weight with strength and durability. Cement composites bind together wood or similar materials like paper, fiberglass and natural fibers in a cement paste. These composites can be placed into molds to create pre-shaped building components. With the increase interest in green technology, many builders are moving back to older building materials in an effort to increase sustainability. Thus, one can find modern homes or other structures built of mud and straw, or other archaic materials, in green living communities.

Keywords: *Stabilized Adobe, Lato Blocks, Rat Trap Bond, Pyramidal Brick Roof, Filler Slab.*

1. INTRODUCTION

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1. **Under Reamed Pile Foundation:** Such type of foundations is ideally suitable in the areas where the black cotton soil or expansive soil is beyond 2.50 meter. The basic principle of under reamed pile is to anchor the structure at a depth where ground movement is negligible due to moisture variation or other reasons. Simple tools are required for construction of under-reamed piles like spiral auger, under reaming tool, and boring guide. This is a well proven and established technology for construction of foundation in expansive soils. For speeding up the construction bore and under ream for large diameter and deeper pile a mechanical rig can be used. The construction and design of such foundation can be done in accordance with Indian Standard Code of Practice IS 2911-Part III.
2. **Brick Arch Foundation:** Construction of arches is an old technology. Such type of foundation is of much use where the bearing capacity of soil is good and there exist some loose/filled up soil pockets in between. The arches can be built by avoiding the pressure on such loose pockets and transfer the load to the isolated footings built to support the arches. For construction of such foundation the use of available material like brick or concrete blocks can be made. In order to resist the lateral forces buttresses at the corner or at the end are built. With the use of such foundation there is a considerable saving in the masonry and concrete between the two footings.

3. WALLING

1. **Stabilized, Compressed earth Blocks:** are made of mud stabilized with 5% cement/lime etc. and compacted in block making machine with no burning. A good walling material as burnt bricks and is economical, stronger, energy saving and simple to manufacture. The soil to be used for the blocks should have the requisite component of clay and silt and sand etc. Soil stabilized hollow and interlocking blocks can provide better thermal insulation.
2. **Stabilized Adobe:** is an improvement over traditional adobe or hand moulded and sun dried mud block in which mud is mixed with a small proportion of cement or lime or broken or cut dry grass as reinforcing media to impart added strength and lower the permeability. It is appropriate in dry climates.

3. **Clay Fly ash Burnt Bricks:** produced from fly ash and clay, are stronger than conventional burnt clay bricks, consume less energy, provide better thermal insulation and solve the environmental problem through utilization of the fly ash, an industrial waste.
4. **Fly ash/ Sand-Lime Bricks:** produced from fly ash or sand with lime as binder, are strong, superior in water absorption and crushing strength. However this needs autoclaving.
5. **Fly ash-Lime-Gypsum (Fal-G) Products:** manufactured by blending fly ash, lime and calcined gypsum (from byproduct of phosphogypsum or natural gypsum) for making a useful product, named Fal-G, and can be used as a cementeous material for mortar/plasters and for masonry blocks of any desired strength. It can also be used for road pavements and plain concrete in the form of Fal-G concrete.
6. **Clay Red Mud Burnt Bricks:** produced from alumina red mud or bauxite an industrial waste of aluminum producing plants in combination with clay. Possess all the physical properties of normal clay bricks and solves the problem of disposal of the waste product and environmental pollution. In addition, they have good architectural value as facing bricks due to their pleasing hues of colour. Red mud in addition improves the quality of bricks made from inferior soil deficient in clay content.
7. **Lato Blocks:** are improved bricks made from lateritic soil and cement or lime. Available in South-West India as large soft rock masses. The blocks are moulded under pressure to produce strong and good quality blocks which consume lesser energy than conventional bricks and hence cheaper. They are available in pleasing hues of colours ranging from cream to light crimson.
8. **Precast Stone Blocks:** of larger size than normal bricks are manufactured by using waste stone pieces of various sizes with lean cement concrete and enable a rationalized use of natural locally available materials. Shaping stones in this manner, enables speedy construction saves on cement, reduces thickness of stone walls and effects overall saving by eliminating plasters on internal/external wall surface. Appropriate architectural rendering on exterior surfaces can also be given.
9. **Precast Concrete Blocks:** made to similar dimension of stone blocks without large size stone pieces, but using coarse and fine graded aggregate with cement. They have excellent properties comparable to other masonry block, are cheaper and facilitate speedy construction and especially suitable where good quality clay for brick making is not available.

10. **Hollow Concrete Blocks:** are manufactured using lean cement concrete mixes and extruded through block making machines of egg laying or static type need lesser cement mortar and enable speedy construction as compared to brick masonry. The cavity in the blocks provides better thermal protection and also do not need external or internal plastering. These can be used for walling block or as roofing blocks along with inverted precast tee beams.
11. **Fly ash Based Light Weight Aerated Concrete Walling and Roofing Blocks:** are manufactured by a process involving mixing of fly ash, quick lime or cement and gypsum, foaming agents such as aluminum powder. These are considered excellent products for walling blocks and prefab floor slabs.
12. **Precast Aerated/Cellular Concrete Walling Blocks and Roofing Slabs:** are manufactured through aerated cellular concrete manufacturing process. When used in multistoried structures reduce weight, resulting more in economic design of structure. These components can also be worked and handled easily, have high fire resistance rating and provide better insulation.
13. **Rat-Trap Bond:** is an alternate brick bonding system for English and Flemish bond. This is economical, strong and aesthetic. 25% of the total number of bricks and 40% of motor the cost of the wall can be saved by using RAT -TRAP BOND. It is simple to build and has better insulation properties.
14. **Bamboo/Timber Mat Based Walls (Ekra Walling):** plastered on either side by mud or cement mortar over bamboo mat placed between horizontal and vertical timber/bamboos as a frame. Are easy to construct, cost less and are popular in hilly areas due to self help. However, these are non-load bearing and need supporting structure. This upgraded traditional technology is a relevant for earthquake view point walling option.
15. **Composite Ferro Cement System:** simple to construct and made of ferro cement i.e. rich mortar reinforced with chicken and welded wire mesh. These reduce the wall thickness and allow larger carpet area. Precast ferro cement units in trough shape are integrated with R.C.C. columns. Ferro cement units serve as a permanent skin unit and as a diagonal strut between columns. Inside cladding can be done with mud blocks or any locally available material. Ideally suitable for seismic areas.

4. ROOFS

1. **Life Extended Thatch Roofing:** is self-help, locally available and environmentally sound option. By treating it with copper sulphate solution, its life can be lengthened to reduce biodegradability effect. By using thatch in the form of compact panels instead of bunches,

its combustibility is also reduced. Additional coating of treatment on the roof surface using phosphorilated spray or CNSL oil also achieves water proofing, fire resistance, termite proofing and weathering resistance.

2. **Coconut Fiber and Wooden Chips Roofing Sheets:** coconut fiber and wooden chips or fiber are soaked in water for two hours and water drained off .Later these are mixed with cement and laid over a corrugated mould and kept under pressure for 8 to 10 hours. After remolding, these are cured and dried before use.
3. **Corrugated Bamboo Roofing Sheet:** an innovative roofing material with an up gradation of traditional material from Bamboo Board. It is eco-friendly, light in weight, strong and durable and minimal fire hazard compared to thatch and other materials. These sheets can be used for roofing, walling, door and window shutters and other components in building construction. Sheets are bonded with phenol formaldehyde resin to which anti-termite chemical is added at the time of mat impregnation. These are termite resistant and fire retardant also.
4. **Country Tile Roofing:** can be less expensive than Mangalore tiles on wood when laid on balli understructure, when moulded tiles are made longer and distance between supporting members is increased.
5. **Guna Tile Roof:** such type of roof is very useful for villages. Its construction is possible only with use of Terra-cotta cones made by village potter and village artisans with nominal cost. Appropriate water resistant treatment can be given on top. It is cheaper by 30 percent than normal roof.
6. **Pyramidal Brick Roof:** in coastal areas where corrosion of reinforcement is possible construction of such roof is useful. There is no reinforcement in such roof. It is cast with ordinary bricks used with cement mortar/concrete in the form of pyramid. A ring beam is used along the periphery over walls. Such roofs are useful in cyclone prone areas.
7. **Cement Bonded Fiber Roofing Sheets:** are made by profitably utilizing coir waste, coconut pith, wood wool or sisal fiber, in combination with cement as binder for production of corrugated or plain roofing sheets. These sheets use lesser cement than AC sheets, are 50% cheaper than AC/CGI sheets, light weight, fire resistant, water proof and can be used for sloping roof option.
8. **Micro Concrete Roofing Tile:** are made of graded cement mortar layer vibrated and formed over sloping mould and cured, used in pitched roofing system and is less expensive

than ACC/CGI sheets and burnt country tile roofing at all spans. It is appropriate where fired clay tiles are not available and timber supporting skeletal system is costlier. The rafter and purlin system cost lesser by using micro concrete roofing tiles. Further reduction can be made by using ferro cement rafters and purlins.

9. **Stone Patti Roofing:** is a flat roofing system with sand stone slab (patties) resting over steel or slender RCC section beams. The slabs are laid over with terracing for insulation. It is appropriate where (sand) stone slabs are available and is more economical than RCC slabs. Where larger granite stone patties are available like in Rajasthan, MP, AP the beams are not needed and can rest on walls.
10. **Extruded Structural Clay Unit Floor/Roof:** is made from extruded structural clay units, placed between tee-sections containing rectangular hollows. These are used along with precast joist and filler between the precast joint. Results in savings in cost and time over conventional RCC cast-in-situ slabs and also provide better thermal insulation.
11. **Precast Brick Panels:** used in combination with partially precast joists (beams) save in economic use of steel and cement and provide an alternative to reinforcement concrete roofing/flooring where good quality bricks are available.
12. **Precast L-Panel Elements:** provide a better alternative to RCC sloping roofs. Water seepage can be eliminated in precast L shaped panels where better quality control is possible. Pre casting also result in saving on expensive shuttering.
13. **Jack Arch Roof/Floor:** are easy to construct, save on cement and steel, are more appropriate in hot climates. These can be constructed using compressed earth blocks also as alternative to bricks for further economy.
14. **Precast Brick Arch Panel System:** in this technique, the precast brick arch 50cm x 50cm in size is cast on a platform. These precast arches are placed side by side over the partially precast joist. The hauches between the arches are filled with cement concrete to have a level surface on top. Such roof/floor is 30 percent economical, when compared with conventional RCC also.
15. **Ferro Cement Units:** provide an economic solution to RCC slab by providing 30 to 40% cost reduction on floor/roof units over RCC slabs without compromising the strength. These being precast, construction is speedy, economical due to avoidance of shuttering and facilitates quality control.

16. **Precast Waffle Units:** provide speedy construction with overall saving up to 10% besides avoiding shuttering work. These consist of precast concrete waffle floors/roofs units with nominal reinforcement. The shape is like an inverted trough with square or rectangular in plan having lateral dimension up to 1.2m. Suitable for large spans beyond 6m in either direction, on laying in grid pattern with reinforcement and cast in situ concrete joints between them.
17. **Precast Channel Units:** easy to construct a roofing/flooring with an effective saving in cost and time. These units are reinforced cement concrete elements channel shaped in section and 2.5 to 4.2m long providing for ceiling that looks like one way rib beams.
18. **Precast Cored Units:** are simple to manufacture and provide a speedy and economical flush ceiling. Consist of extruded concrete sections units with circular hollows and can be used up to 4.2 m span. Used for floors or roof in load bearing walls and framed structures.
19. **Precast in-situ Thin Ribbed Slab:** made from precast/in-situ ribs provided at a spacing of 1.2 m with cast-in-situ RC flange. These can be used for floor/roof slab. As the ribbed slab is thin, roof treatment should be provided over the slab for better thermal insulation. It is cheaper and easy to construct in comparison to conventional cast in-situ RCC slab.
20. **Filler Slabs:** are normal RCC slabs where bottom half (tension) concrete portions are replaced by filler materials such as bricks, tiles, cellular concrete blocks, etc. These filler materials are so placed as not to compromise structural strength result in replacing unwanted and nonfunctional tension concrete, thus resulting in economy. These are safe, sound and provide aesthetically pleasing pattern ceilings and also need no plaster.

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