# ALTERNATIVE LOW COST CONSTRUCTION MATERIALS & TECHNIQUES

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**ABSTRACT**

Affordability is measured in terms of disposable income, In the context of housing, affordability means the financial capacity of an individual to buy or rent a house. In 2008, the High Level Task Force on Affordable Housing for All, setup by the Government of India, defined affordability as a measure of household gross annual income and the size of a housing unit. **In this project we work on Rat Trap Bond and Filler Slab Concept for alternative low cost construction material**. The need of alternative building technologies and materials has arisen in the past few years. Fortunately, there are many such options available at our disposal which when used in suitable combinations can save huge amounts of money and hence can result in affordable construction costs. Filler slab technology is a simple and a very innovative technology for a slab construction. The reason why, concrete and steel are used together to construct RCC slab, is in their individual properties as separate building materials and their individual limitation. Concrete is good in taking compression and steel is good in tension. Thus RCC slab is a product which resists both compressions as well as tensile. One such building technique is the use of 'RAT TRAP BOND' masonry. Contrary to other technologies, this amazing building technology is not new to us. RTB was first introduced in India in 1970, by renowned Architect Sir Laurie Baker. Since then, it has been used in many Government buildings and small village panchayats. In this modern age, we have overlooked this extremely useful technology which, while providing the same strength to the walls also saves us time and labor and also material cost to the extent of about 23% when compared with a standard 230mm brick masonry wall. In this project we have outlined the importance of RTB technology along with the construction details and also provided some comparative calculations to highlight the savings that can be achieved against the conventional solid brickwork

**Keywords:**Building Material; Low-Cost Housing;Sustainability, Rat Trap Bond, Filler Slab.

## 1. INTRODUCTION

### 1.1. Introduction of the project work

Over the last five, or so decades, developing countries in particular have experienced phenomenal growth of urban areas partly due to policies that have tended to favor urbanization as an engine of rapid development. However, this trend has had worsening urban housing conditions and in particular, the sprawl of informal settlements and slums is the single-most manifestation of the urbanization phenomenon that has brought about human misery, poverty, insecurity and failures of

National policies, administration and economies (UN Habitat: 2008).Green building has taken off in recent year with many builders and new home owners looking for new and different methods of construction that can potentially offset energy cost. Construction of low cost housing by using the low cost building materials increases the access to buildings by low income group peoples. Low cost housing can be achieved by use of efficient planning and project management, low cost materials, economical construction technologies and use of alternate construction methods available. The profit gained from use of such methods can decrease the cost of construction and make the low cost housing accessible to all. The use of low cost alternate building materials also prevents the rise of construction cost due to use of scarce building materials which eventually increase the cost of the project. Some alternative building material can be made out of natural materials, while others can help to lower energy costs of the occupant once built. Regardless of what the goal of the builder is, alternative building material and their use is on the rise.

### 1.2 Objective

1. To study different types of construction materials and techniques to reduce cost of constructions mostly Rat Trap Bond and Filler Slab.
2. Alternative & low cost construction material & techniques used for sustainableDevelopment using Rat Trap Bond and Filler Slab.
3. To identify total cost required to completing a project using conventional andCost effective Technology.
4. To compare cost & Time reduction by adopting different material & techniquesfor projects.

### 1.3 Scope of the Project

The scope of the project is low cost house designed and constructed as any other house with regard of foundation, structure and strength using Rat Trap Bond and Filler Slab. The reduction in cost is achieved through effective utilization of locally available building materials and techniques that are durable, economical, accepted by users and not requiring costly maintenance.

## 2. LITERATURE REVIEW

**Anwar Khitab et al.**

The aim of this research paper is to address the futuristic construction materials. Relevant data of the developments made during the recent past are also presented. It is believed that nanotechnology is going to play an important role in the development of futuristic building materials. The innovations could be two-fold; one is the modification of classical materials and the other should cover the invention of novel materials. The primary goal of all such materials should be environment friendliness. Secondarily, they should be durable and cost effective. Thirdly, they should address the space shortage. Innovations are needed as man is also planning to colonize moon and other planets. Fourthly, they should have adequate strength to cater the natural and manmade calamities. In short, they should serve the coming generations in the best possible way, which is the sole purpose of an engineering discipline.

**Jerry Magutu et al .**

This paper is based on a literature review and an evaluation of practices that have been I place with respect to low cost building materials and technologies so as to lower costs and hence make the buildings, especially housing for the majority urban poor who have meager resources and hence cannot afford conventionally built houses. The paper utilized both secondary data from the literature, and an empirical study of pilot projects that have been constructed in different regions of Kenya by utilizing traditional architectural research techniques akin to observational techniques in the social sciences, augmented by open-ended interviews and discussions with the different actors in the advocacy and use of low cost materials and technologies in building. This study found out that topmost of the constraints that hinder wider application and universalism for the alternative materials and technologies is largely due to both lack of standards and specifications, and also information by the general populace about them. Otherwise I general, the alternative materials and their technologies are quite economical, durable, sanitary and safe in construction as attested to my findings from the case studies for this paper
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**Ar.Vidya et al.**

Since economical factors have influenced the construction industry dramatically in recent years and in many parts of the world steel is scarce and expensive, many researchers are searching for low-cost materials as a substitute or alternative for the present situation. Recently, various materials have shown promise for future use as a major construction material. The purpose of this paper is to highlight alternative low-cost building materials for possible use in low-cost housing having advantages on areas such as India where concrete or steel housing is expensive.

**Shruti Mutkekaretal.**

Housing is major problem faced by developing countries like India. The most basic building material for construction of permanent houses is the burnt clay brick, Cement and steel. A significant quantity of raw material and fuel is utilized in making these conventional building materials and even the manufacturing processes of these materials create environmental problems. This paper presents study on sustainable and low-cost alternative building material – Flyash, having advantages on areas where conventional building material for housing is expensive and hazardous to environment.

**S M SITUMBEKO et al.**

The provision of housing that is fully serviced and affordable remains a major challenge for most developing countries. A lot of settlements still comprise of poor housing structures that are prone to damage during inclement weather, with poor or no utilities, few community facilities and poor roads. Several third world governments have attempted to address the issue through housing policies or programmes such as provision of serviced sites and extendible units. Other measures include housing schemes such as subsidized home loans, distribution of (free-) house plans, and through promoting private sector involvement.

These attempts have not addressed the issue in full; indications are that the main problem is that all systems that have been tried are aimed at providing conventional housing units using inadequate resources – skills, equipment, materials and finance. The reality though is that most developing countries do not have adequate capital resources to construct conventional dwellings.

Clearly there is need to look for alternatives; this paper examines and suggests alternatives building techniques and designs that while still providing acceptable housing, do so at reduced costs.

**Mohammad Sharif Zami et al.**

Earth has been used as a construction material in every continent and in every age, largely due to its versatility and widespread availability. It is one of the oldest building materials. The use of earth on site as a building material saves manufacturing cost, time, energy, environmental pollution and transportation cost. As a result of Operation Murambatsvina (Cleanup campaign carried out in 2005) in Zimbabwe, the percentage of squatters has increased. A solution has to be found out to provide sustainable low cost housing for these squatter's that is 'eco'-friendly and will preserve the environment for future generations whilst catering for the needs of the present inhabitants. This paper discusses an alternative building material; earth can also be used in the construction of low cost sustainable houses in Zimbabwe which is significantly cheaper than using conventional bricks.

## 3. METHODOLOGY

### Methodology 1 – Rat trap bond

**Rat trap bond**- Rat trap bond is a brick masonry method of wall construction, in which bricks are placed in vertical position instead of conventional horizontal position and thus creating a cavity (hollow space) within the wall. Architect Laurie Baker introduced it in Kerala in the 1970s and used it extensively for its lower construction cost, reduced material requirement and better thermal efficiency than conventional masonry wall, without compromising strength of the wall.

**Figure1. Rat trap bond mechanism**

**Advantages of using rat trap bond**

1. Requires approximately 25% less bricks and 40% less mortar than traditional masonry
2. Reduced material requirement results in considerable cost saving
3. Strength of wall is not compromised, it remains same as traditional masonry wall.
4. Cavity induced in wall provides better thermal insulation, resulting in cooler interiors during summer and warmer interiors during winter.
5. All vertical and horizontal reinforced bands, lintels (for standard size openings), electrical conduits are hidden inside wall, resulting in better aesthetic appearance without plastering (exposed brickwork).

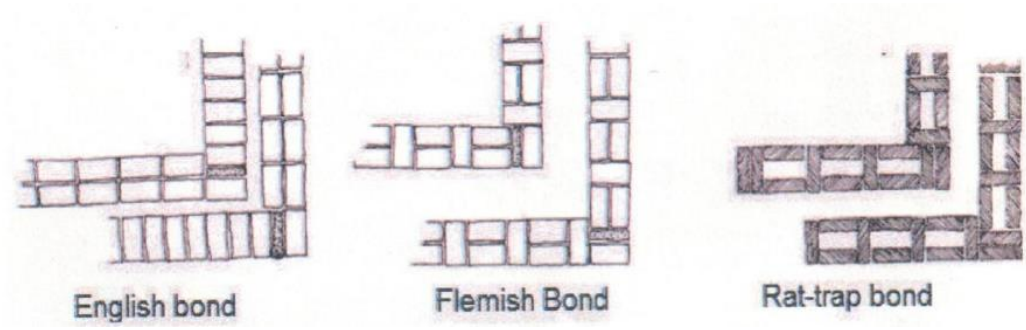



**Figure2.Various Bonds in Brick Masonry**

**3.1 Construction Details** The following Flowchart explains the general schematic of the wall construction process using Rat Trap Bond Masonry:

**Figure3. How chart fin- Rat Trap Bond Masonary Construction Process**

**Methodology- 2: Filler slab**

**Filler slab-** Filler slab technology is a simple and a very innovative technology for a slab construction. The reason why, concrete and steel are used together to construct RCC slab, is in their individual properties as separate building materials and their individual limitation. Concrete is good in taking compression and steel is good in tension. Thus RCC slab is a product which resists both compressions as well as tensile. Which indicates the neutral axis and also tension concrete in the bottom fibers of the slab which is in tension but the top fibers will be in compression. Knowing this much is the key to understand the filler slab technology. Tension in a slab is on the bottom fiber and compression on the top fiber. That means if we want to optimize the structure we can remove concrete from the tension zone where it is not much needed. That's the key behind filler slab construction.Filler slab technology is a simple and a very innovative technology for a slab construction.The reason why, concrete and steel are used together to construct RCC slab, is in their individual properties as separate building materials and their individual limitation. Concrete is good in taking compression and steel is good in tension. Thus RCC slab is a product which resists both compressions as well as tensile.

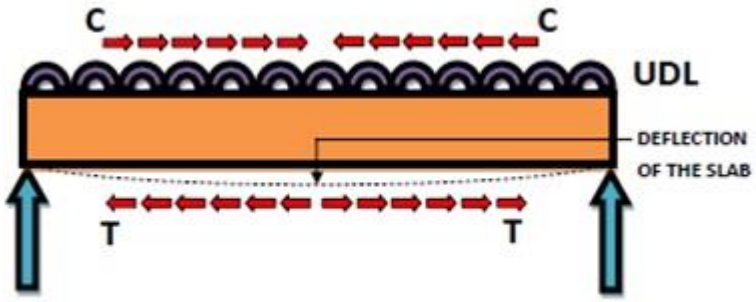



**Figure4. Simply supported slab cross section**

## 4. EXPERIMENTAL ANALYSIS / CASE STUDY

### 1. RAT-TRAP BOND

**Design and Construction**

Rat-trap bond masonry can be used to construct a small double storeyed residential building in load bearing construction, using the specific construction details which are followed in this technique. The principal requirement for rat-trap brickwork is the availability of good quality bricks.

**The Guiding Principle** The following can be taken as guiding principle for strength of bricks for Rat-trap brickwork: The data presented here is for Short Span not exceeding 4.2 meters, and Roof/ Floor Loads as per IS 875.

**Table 1: The Strength Requirement Guide**

| Sr. No. | Type of Building Construction | Recommended Compressive Strength of Bricks | |
|---|---|---|---|
| Best Practice | | Minimum Allowable | |
| 1 | 1 Load bearing, double storied | More than 50 kg/cm2 | 40 kg/ cm2 |
| 2 | Load bearing, single storied | More than 40 kg/ cm2 | 35 kg/ cm2 |
| 3 | Infill masonry in frame structure, no restriction on number of storey | Minimum 35 kg/ crn2 | -- |

**Modular Design**

To ensure maximum advantage of the technique, it is preferable that the masonry is designed in a modular pattern at the design stage itself, after the prevailing brick size available for use has been ascertained. For best rat-trap brickwork, there should be no half bricks/ quarter bricks used in brickwork, unlike their common use in conventional brickwork. This will disturb the staggering of joints in rat-trap brickwork and affect the integrity of brickwork.

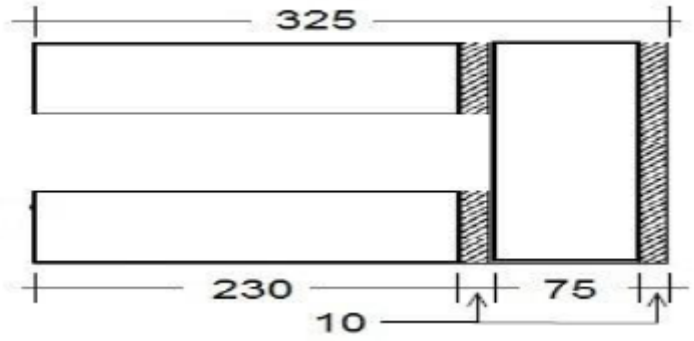



**Figure7. Module of Rat trap Bond Masonry**

## 2. FILLER SLAB

Size of the filler material will be very crucial. It is must to decide the filler material before the slab is designed. The dimension of filler material will help decide the spacing of reinforcement and accordingly the depth of the slab and other structural details will be worked out.Also, filler material should be properly soaked in water so that it does not absorb any water from the concrete. While installing the filler material, one will have to decide the concreting sequence of the slab i.e. from where the concrete will be started and how will it progress to cover the whole slab.Filler materials like Manglore tiles/Clay tiles can be installed in two layers (2 nos. one over the other) entrapping an air cavity between the two tiles. A sketch showing cross section of a filler slab with manglore tile is shown below. This will improve the thermal properties of the slab.

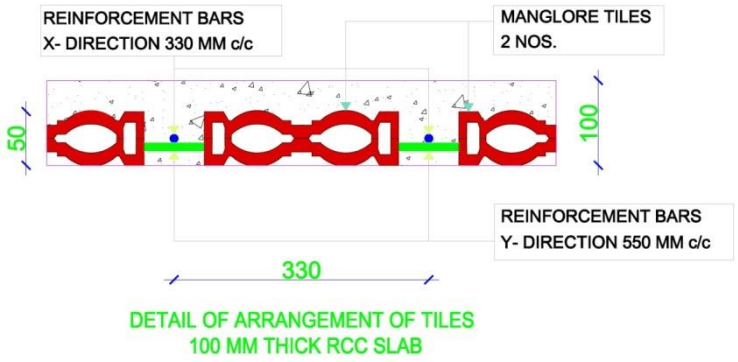


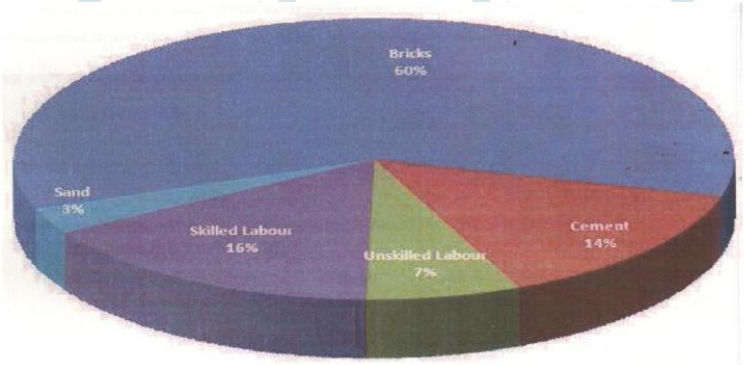

**Figure9.Filler slab section - Manglore tile filler material.**

## 5. RESULT AND DISCUSSION

### 1. Rat Trap Bond

**Cost Analysis, Advantages and Comparison**

Following is a general cost breakup of a brick masonry built in Rat Trap Bond.




**Figur10. Cost Breakup**

As we can see the major component of the cost involved in the construction is the cost of bricks i.e. about 60 %, followed with Skilled Labour (16%) and then Cement (14%). Hence, the saving in the required quantity of bricks attained in this masonry technique goes a long way in achieving cost-effective housing solution to the public.

**Labour, Material & Cost Savings:**

For having a general idea of the savings that can be obtained on a normal basis by switching from conventional brickwork to Rat Trap Bond Masonary technique is given below. Following assumptions are made for the given calculations:

1. Number of Storey: 2
2. Plinth Area: 100 Sq.m
3. Total Brickwork: 70 Cu.m
4. Class of Bricks used: Class I
5. Sand Grading : Moderately Coarse/ Not too fine
6. Mortar Ratio: 1:4
7. Basic Rates of materials: Cement = Rs. 275/ Bag Sand = Rs. 1770/ Cu.m Bricks = Rs. 4000/ 1000 No.

**Table 2: Savings in Materials**

| Sr. No. | Description | Unit | Savings | |
|---|---|---|---|---|
| In units | | In Percentage | | |
| 1 | Cement | Bags | 78 | 57 |
| 2 | Bricks | No | 5599 | 19 |
| 3 | Sand | Cu.m | 13 | 61 |

**Table 3: Savings in Cost**

| Sr. No. | Description | Unit | Savings |
|---|---|---|---|
| In units | | In Rs. | |
| 1 | Cement | Bags | 78 | 21450 |
| 2 | Bricks | No | 5599 | 22396 |
| 3 | Sand | Cu.m | 13 | 23010 |

Embodied Energy is the sum of all the energy required to produce any goods or services, considered as if that energy was incorporated or 'embodied' in the product itself. The concept can be useful in determining the effectiveness of energy-producing or energy-saving devices, or the "real" replacement cost of a building, and, because energy-inputs usually entail greenhouse gas emissions, in deciding whether a product contributes to or mitigates global warming. One fundamental question is: does the device produce more energy or save more energy than it took to make it? Embodied energy is an accounting method which aims to find the sum total of the energy necessary for an entire product life-cycle. Determining what constitutes this life-cycle includes assessing the relevance and extent of energy into raw material extraction, transport, manufacture, assembly, installation, disassembly, deconstruction and/or decomposition as well as human and secondary resources. Different methodologies produce different understandings of the scale and scope of application and the type of energy embodied.

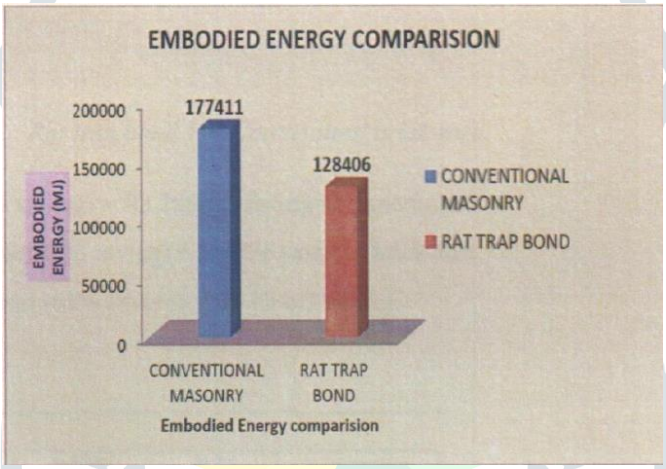



**Figure11.Embodied Energy Sayings**

**Comparison and Advantages of Rat Trap Bond**

**Advantages:-**

1) By adopting this method of masonry, you can save on- approx. 20-35% less bricks and 30-50% less mortar; also this reduces the cost of a 9 inch wall by 20-30% and productivity of work enhances.
2) For 1 m3 of rat trap bond, 470 bricks are required compare to conventional brick wall where a total of 550 bricks are required.
3) Rat trap bond when kept exposed, create aesthetically pleasing wall surface and cost of plastering and painting also may be avoided.
4) Rat trap bond can be used for load bearing as well as thick partition walls. 5) Rat trap bond wall is a cavity wall construction with added advantage of thermal comfort. The interior remain cooler in summer and warmer in winters.

**Cost Saving**

Material saving per m3: Rat trap bond VS. Convention) brickwork • 1.11 bags(57% saving) = Rs 288/m3 saving in cement cost. • 80 nos. of bricks(20% saving) = Rs 576 saving in brick cost. • 40.18 m3 less sand (61% saving) = Rs 13/m3 saving.

2. **COST SAVINGS FILLER SLAB**

Material saving assuming a 100 mm thick slab 2.54×3.86 m, and calculating the material and cost savings as per market material rates of Ahmedabad, Gujarat, August, 2011 and comparing the savings **for 1 $m^3$** : RCC Filler slab vs. Conventional Solid RCC Slab.

- 1.61 bags (19% saving) = Rs 418/ $m^3$ saving in cement cost.
- 0.09 $m^3$ less sand (19% saving) = Rs 21/ $m^3$ saving in sand cost.
- 0.18 $m^3$ less aggregates (19% saving) = Rs 127/ $m^3$ saving in aggregates cost.
- 10 kg less steel/$m^3$ of slab casted = Rs 500/$m^3$ saving in reinforcement cost.

## CONCLUSION

Housing is the basic need and right of all human beings. During our ages, due to tremendous rise in property market rates, the dream of common middle class and lower income group people remains a dream, as the reality of non-affordability is bitterly painful. **In this project we work on Rat Trap Bond and Filler Slab Concept for alternative low cost construction material**. Many efforts at governmental levels have failed to alleviate the problems of the common people's housing shortage which continues to grow at an alarming rate. Filler slab technology is a simple and a very innovative technology for a slab construction. The reason why, concrete and steel are used together to construct RCC slab, is in their individual properties as separate building materials and their individual limitation. Concrete is good in taking compression and steel is good in tension. Thus RCC slab is a product which resists both compression as well as tensile. The shortage we see today is not about housing itself, it's actually about `Affordable Housing' Fortunately enough, the solution to affordable housing shortage (especially urban) is within our reach. We cannot control the hikes in the land rates, but Endeavour to minimize the costs of construction by switching to some simple, cost-effective building materials and technologies. One such solution is the use of Rat-Trap Bond Masonry Technique. It's simple, and easy to construct and effects into an overall savings of about 23 % in the costs in comparison to conventional brick work, while also reducing its impact on the environment by achieving a huge saving in the embodied energy consumption. We think that this is the need of the hour that our governments take up this issue on war-foot level and promote and subsidize as much as possible the use of such green, environment-friendly and cost-effective technologies. This will help today's common man to bring the house of his dreams a reality.

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