ITU A|Z • Vol 23 No 2 • 2026 • 271-286

Cost-effective construction strategies for affordable housing in India: A comparative analysis

Madhumathi PRABHUKUMAR[1]*, Bhoomika UMASHANKAR[2], Suman BILIGEREPALYA LOKESH[3]
[1] madhumathi@sit.ac.in • School of Architecture, Siddaganga Institute of Technology, Tumakuru, Karnataka, India
ORCID: 0000-0003-0766-3213
[2] bhoomikau@sit.ac.in • School of Architecture, Siddaganga Institute of Technology, Tumakuru, Karnataka, India
ORCID: 0000-0002-8631-2827
[3] 1si18at041@sit.ac.in• School of Architecture, Siddaganga Institute of Technology, Tumakuru, Karnataka, India
ORCID: 0009-0006-5349-8967

**Corresponding author*
Received: March 2024 • Final Acceptance: September 2025

Abstract
This research paper undertakes a comparative analysis of low-cost construction techniques with the aim of facilitating affordable housing solutions in India, where a significant portion of the population faces income constraints. With only 20% of the population earning higher incomes, ensuring housing costs remain within 30% of household income is imperative. The study focuses on evaluating the effectiveness of various construction methodologies, particularly emphasizing masonry wall and slab construction, in achieving cost efficiency, structural sustainability, and longevity. Emphasizing the importance of innovative construction approaches, such as the “rat trap bond, filler slab” methodology and the utilization of locally available materials like laterite stone, the paper aims to reduce construction costs while maintaining structural integrity. Through a comprehensive comparative analysis considering factors such as initial construction expenses, long-term maintenance costs, structural strength, and durability, the research provides valuable insights for policymakers, construction professionals, and stakeholders. The findings aim to address the urgent need for affordable housing solutions, contributing to sustainable and cost-effective practices in residential construction and promoting inclusive urban development to enhance living standards for marginalized communities in India and other developing countries.

Keywords
Filler roof slab, Laterite stone masonry, Low-cost housing, Rat trap bond, Sustainable materials.

doi: 10.58278/0.2026.130

1. Introduction

In the realm of housing, particularly in developing countries like India, the use of low-cost construction technologies has gained considerable momentum due to their potential to offer affordable and sustainable shelter solutions to economically vulnerable populations (Arun, 2021). This concern extends across developing Asia, where persistent income disparities and rapid urban growth have intensified housing affordability challenges (Helble, 2021). These technologies challenge conventional construction practices by prioritizing cost-effectiveness, material efficiency, and resource-conscious methods, without compromising structural integrity or long-term performance. National technical agencies such as the Building Materials and Technology Promotion Council have actively promoted innovative, resource-efficient, and cost-effective construction technologies to enhance affordability, sustainability, and large-scale adoption in housing projects (BMTPC Building Materials and Technology Promotion Council, 2020). The essence of low-cost housing lies not only in reducing construction expenditure but also in embracing environmentally responsible practices. Techniques such as rat trap bond masonry and filler slabs—designed to reduce material usage and structural load—exemplify this shift. These innovations are especially well-suited for regions with weak soil conditions and limited infrastructure. Additionally, the use of indigenous materials like terracotta pots, laterite blocks, and country tiles enhances both thermal performance and visual character while supporting local economies and craftsmanship (Marinelli, 2022). However, the deployment of such technologies must be understood within the broader regulatory and institutional framework of India's construction sector. Residential real estate development in India is governed by a complex array of laws, codes, and standards. Key regulatory frameworks include the National Building Code of India (Bureau of Indian Standards [BIS], 2016), The Real Estate Act (Regulation and Development) (RERA, 2016) and various state-level bye-laws and zoning regulations. These establish minimum requirements for structural safety, fire protection, sanitation, building design, and environmental compliance as stated in Central Public Works Department (CPWD, 2021) & Real Estate (Regulation and Development) Act (RERA, 2016). In the context of low-cost housing, these norms play a dual role—ensuring safety and quality, while sometimes inadvertently increasing the cost and complexity of compliance, especially for smaller-scale or community-driven projects (Moghayedi, 2021). Further, the sector faces several institutional and administrative barriers that hinder the widespread implementation of affordable housing. These include lengthy approval processes, inadequate access to subsidized land, rigid building codes, limited availability of low-interest housing finance, and lack of awareness or acceptance of alternative technologies among both policymakers and end-users. While national schemes like Pradhan Mantri Awas Yojana (PMAY), Ministry of Housing and Urban Affairs (Ministry of Housing and Urban Affairs (MoHUA), 2022) aim to accelerate housing supply for the urban poor, ground-level implementation is often challenged by bureaucratic delays and misalignment between policy objectives and local needs (Marinelli, 2022). As a result, even well-intentioned low-cost housing initiatives can become entangled in a web of regulatory constraints, technical conservatism, and socio-economic exclusion. Addressing these challenges requires not only technological innovation but also institutional reforms that recognize and support context-specific, community-friendly construction approaches.Against this backdrop, the present study aims to examine the effectiveness of various low-cost housing construction technologies in delivering affordable, durable, and environmentally responsive housing. Through comparative cost analysis and field-based observations, the paper explores the real-world application of these techniques and their potential to address India's persistent housing shortfall. By situating technical performance within broader socio-economic and regulatory frameworks, this study contributes to the discourse on inclusive and sustainable urban development. Globally, sustainable urbanization has been identified as a critical pathway for addressing housing shortages, environmental degradation, and socio-economic inequality in rapidly expanding cities (UN-Habitat, 2020).

2. Literature review

Affordable housing remains a pressing issue in India, where a significant portion of the population struggles to access adequate housing due to economic constraints. This challenge is not unique to India but reflects a broader trend across developing Asian economies, where rapid urbanization, income inequality, and rising land prices have significantly widened the housing affordability gap (Helble, 2021).

Technical evaluations and demonstration projects compiled by the Building Materials and Technology Promotion Council highlight the performance, feasibility, and scalability of alternative low-cost construction technologies, including filler slabs, rat trap bond masonry, and locally sourced materials (Building Materials and Technology Promotion Council [BMTPC], 2020). One such technique gaining traction is the use of filler slabs in roof construction. Filler slabs involve replacing a portion of the concrete in the slab with filler material, such as terracotta pots or country tiles, to reduce the overall concrete requirement and construction costs (Pattanashetti, 2017). Studies have shown that filler slabs can offer significant cost savings compared to conventional reinforced concrete slabs while maintaining structural stability and thermal comfort (Natarajan, 2019). This approach aligns with broader sustainable construction principles, as discussed by Arun (2021), who emphasize the importance of cost-effective and thermally efficient roofing options for the economically weaker sections (EWS). Their study supports the use of filler slabs and locally available materials to meet both cost and energy-efficiency goals.

In addition to filler slabs, alternative masonry techniques have also been explored to reduce construction costs in wall construction. According to Subha Sinha (2020), rat trap bond masonry involves arranging bricks to create a cavity within the wall, reducing the number of bricks and mortar required while maintaining structural strength. Similarly, Maklur and Narkhede (2018) found that the use of locally available materials such as laterite stone in masonry construction offers cost-effective solutions for affordable housing. According to Raj (2021), laterite and other earthen blocks offer considerable material and thermal advantages when used in wall systems. Their work also highlights the compatibility of rat trap bond masonry with labor-intensive, low-cost housing projects—demonstrating reduced material use, enhanced thermal performance, and ease of implementation with local skills.

Tam (2011) noted that although low-cost construction techniques can reduce construction costs, their effectiveness varies depending on factors such as local material availability, labor costs, and construction practices. Therefore, a comprehensive comparative analysis is essential to determine the most suitable construction techniques for affordable housing projects in India. This is further reinforced by Moghayedi (2021), who provide a critical success framework indicating that material efficiency, stakeholder awareness, and local adaptability are key to the scalability of affordable housing solutions. Their systematic review also calls for integrating sustainability metrics into cost analysis, an aspect considered in the present study.

This paper aims to contribute to the existing body of knowledge by conducting a comparative analysis of various low-cost construction techniques, including filler slabs and alternative masonry methods, to identify the most cost-effective solutions for affordable housing in India. By synthesizing findings from existing literature and conducting empirical analysis, this study seeks to provide valuable insights for policymakers, practitioners, and researchers involved in addressing the housing needs of marginalized communities in India. At the urban scale, sustainable housing delivery plays a vital role in achieving broader goals of inclusive growth, environmental resilience, and social equity, particularly in rapidly urbanizing regions (UN-Habitat, 2020).

2.1. Masonry

2.1.1. Laterite stone masonry

Laterite stone in Figure 1 is a sedimentary rock characterized by its red or brown coloration, initially discovered in the Malabar region of coastal Kerala and other parts of Karnataka, including Dakshin Kannada. Compared to bricks, laterite stone is known for its cost-effectiveness in construction. Its distinct properties include the ability to retain coolness within walls, offering more comfortable interiors during hot summers. Furthermore, due to its larger size, laterite stone contributes to savings on labor and other construction materials, making it an attractive option for building projects aiming for both efficiency and affordability. Raj (2021) and Arun (2021) emphasize that laterite, when sourced locally, not only reduces transportation costs but also supports sustainable construction. These studies suggest that laterite-based masonry, while traditionally limited to single or double-storey structures due to load-bearing constraints, is ideal for rural and peri-urban low-rise housing.

The use of laterite is cost effective as compared to concrete blocks. It reduces cost of plastering and painting. It reduces heat within the house. The porosity of laterite stones is more than bricks. Thus, load bearing structure of laterite masonry cannot be more than double storey. The darker the laterite, the harder, heavier and more resistant to its moisture.

Laterite stone presents a sustainable solution for building materials, capable of meeting the demands of construction while promoting environmental and economic benefits. By encouraging research on local materials and implementing efficient training programs on earth-based construction techniques, laterite can significantly contribute to solving the problem of affordable housing. Utilizing local materials like laterite reduces construction costs, making housing more accessible to a wider population. Moreover, laterite stone is ecological, as it reduces nuisances and pollution associated with cement and steel production, thus mitigating environmental impact. Additionally, its inherent thermal insulation properties contribute to lower energetic costs, further enhancing its sustainability credentials. Maklur and Narkhede (2018) states that the utilization of laterite stone offers a holistic approach to sustainable construction, addressing both economic and environmental concerns in the housing sector.

2.1.2. Rat trap bond

Rat trap bond masonry is suitable for areas with poor soil bearing capacity, making it a viable construction technique for regions, where soil conditions may pose challenges for traditional construction methods. Unlike traditional bonds like English or Flemish, where bricks lay flat, the rat trap bond positions bricks on edge, creating inner and outer faces of the wall with cross bricks connecting them. The key advantage of this technique lies in its ability to reduce the requirement of bricks and mortar compared to English or Flemish bonds, thanks to the cavity formed

Figure 1. *Sample of Laterite stone (Left), Construction of Laterite stone masonry (right).*

within the wall. This optimization of material usage maintains structural integrity, rendering the rat trap bond a cost-effective and efficient method for masonry construction. The study by Raj (2021) highlights the thermal and acoustic benefits of rat trap bond masonry in hot climates, noting its potential to reduce indoor temperatures and improve living comfort. Its lower material usage and skilled-labor adaptability make it particularly suitable for large-scale EWS housing.

In rat trap bond masonry, bricks are arranged vertically so that the 110 mm face is visible from the front elevation, unlike the traditional orientation where the 75 mm face is visible as shown in Figure 2. This arrangement maintains the standard wall width of 230 mm while creating a cavity inside the wall. To reinforce the brickwork, both vertical and horizontal reinforcing bars are installed within the cavities as shown in Figure 2. This configuration enhances structural strength and durability while enabling the placement of electrical conduits and plumbing lines within the cavity, thereby improving the overall aesthetics of the finished wall. Muhammad Haris (2021) identifies rat trap bond masonry as an efficient construction technique that optimizes material usage while maintaining structural integrity and providing flexibility for the integration of utility services.

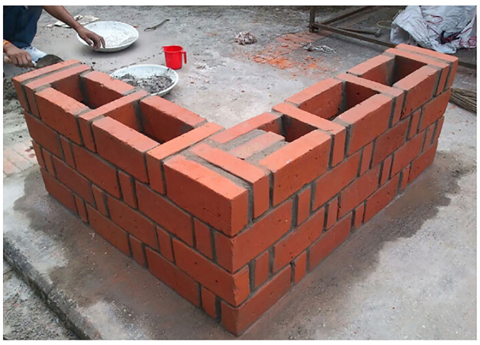
The construction of a rat trap bond involves arranging bricks in a manner that creates a cavity within the wall while maintaining structural integrity. In the T junction configuration, vertical bricks are placed on edge to form the inner and outer faces of the wall, with cross bricks bridging the two faces at the junction. This configuration allows for the formation of a cavity within the wall, reducing the number of bricks and mortar required while maintaining strength.

Similarly, in the L junction configuration, bricks are arranged in a manner that creates a right angle, with vertical bricks forming the inner and outer faces of the wall and cross bricks bridging the two faces at the corner junction. This configuration also creates a cavity within the wall, optimizing material usage and structural stability.

2.2. Filler roof slab

Filler slab roof construction is a technique employed in building projects, particularly in endeavors focused on low-cost housing solutions, aiming to create lightweight and economical roofing structures. This method entails substituting a portion of the concrete in the roof slab with filler materials, including locally available resources like clay pots, coconut shells, or other suitable materials as in Figure 3. According to Arun (2021), filler slabs are particularly effective in reducing the dead load of roofing systems, which not only brings down construction costs but also lessens foundation loads in weak soil zones. Their study shows strong energy and cost benefits in tropical and subtropical climates, supporting the thermal comfort claims often attributed to filler slab construction.

The fundamental principle of filler slab construction is based on the understanding that, in an RCC (reinforced cement concrete) slab of a given thickness (see Figure 3), the concrete in the lower portion primarily functions as dead weight and does not significantly contribute to compressive



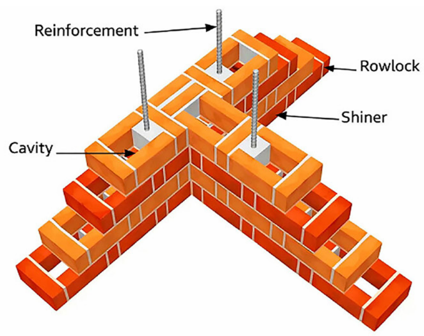


Figure 2. *(Left) Arrangement of bricks in Rat trap masonry courses; & (Right) Construction detail.*

load resistance (Chougule et al., 2015). In an RCC structure, the upper portion of the slab primarily bears compressive loads. Therefore, replacing the concrete in the lower half with suitable filler materials enhances cost-effectiveness and reduces structural weight while preserving overall structural integrity and functionality (Subha Sinha, 2020). This approach contributes to more efficient material utilization in low-cost construction. This technique underscores the importance of optimizing construction materials and methods to achieve sustainable and affordable housing solutions. This aligns with observations by Raj (2021), who emphasize that filler slabs reduce embodied energy and improve the indoor thermal environment, especially in hot-humid climates.

The filler slab roof construction technique is a method used to create lightweight and cost-effective roofing structures, particularly in low-cost housing projects. Here is an outline of the filler slab roof construction technique:

Preparation: The construction process begins with the preparation of the site and the assembly of the necessary materials and tools. This includes arranging the filler materials, such as clay pots, coconut shells, or other locally available materials, and setting up the shuttering framework.

Shuttering: Shuttering, also known as formwork, is installed to create the framework for the roof slab. The shuttering is typically made of wood, metal, or other suitable materials and is assembled to the desired dimensions and shape of the roof.

Reinforcement Placement: After the shuttering is in place, reinforcement bars (rebars) are installed within the shuttering framework. The reinforcement bars are arranged in a grid pattern and are positioned according to structural design requirements to provide strength and support to the roof slab.

Preparation of Filler Materials: Before casting the concrete, the filler materials are prepared. For example, if clay pots are used as filler material, they may be soaked in water to prevent them from absorbing moisture from the concrete mix during casting.

Figure 3. *RCC Filler Slab construction (above – the process of laying & below - site construction).*

Concrete Casting: Once the filler materials are prepared, the concrete mix is poured into the shuttering framework. The concrete covers the reinforcement bars and filler materials evenly, ensuring that they are fully encased within the slab. Care is taken to ensure that the concrete mix is properly compacted and leveled to achieve a smooth and uniform surface.

For instance, for Mangalore tiles, a grid size of 35cm x 50cm is typically utilized, whereas for clay pots with a 40cm diameter, a grid size of 45cm x 45cm is more suitable. It's essential to soak the filler material in water before casting to prevent it from absorbing water from the concrete. Subsequently, the slab is cast using cement concrete, following the same procedures employed for ordinary concrete slabs.

2.2.1. Considerations for filler material

When considering filler material for construction projects, several key factors must be taken into account to ensure optimal performance and cost-effectiveness. Firstly, the filler material should possess inert qualities, safeguarding against adverse reactions with steel or concrete components to maintain structural integrity over time. Additionally, prioritizing lightweight options enhances construction efficiency while minimizing material costs, aligning with the goal of affordability. Local availability further streamlines procurement processes and reduces environmental impact associated with transportation. Size compatibility is paramount, ensuring the filler material fits within the designated structural grid and bottom half of the slab, facilitating seamless integration into the construction process. Emphasizing thermal insulation properties contributes to enhanced indoor comfort, particularly in regions with extreme climates, promoting sustainable living environments. Lastly, aesthetics play a crucial role, with considerations for the shape and finish of the filler material enhancing the overall visual appeal of the constructed space. These design and performance considerations are also highlighted by Moghayedi (2021) who argue for an integrated approach combining functionality, cost-efficiency, and environmental responsibility in sustainable affordable housing solutions. By addressing these considerations, the selection of filler material not only meets structural requirements but also reflects a holistic approach to sustainable and aesthetically pleasing construction practices.

2.2.1.1. Terracotta pots filler slab

The terracotta pots filler slab is a variation of filler slab construction technology, wherein a portion of the concrete in the slab's bottom is substituted with terracotta pots as shown in Figure 4. This innovative approach aims to optimize material usage and reduce construction costs while maintaining structural integrity. Terracotta pots, known for their lightweight and insulating properties, serve as an ideal filler material in this context. Arun (2021), affirm the utility of terracotta pots in filler slabs, citing significant cost savings and a reduction in the building's cooling load, especially in tropical and semi-arid regions. Their analysis supports the practical and environmental advantages of this technique for low-income housing.

By incorporating terracotta pots into the slab, the overall weight of the structure is minimized, resulting in cost savings and improved thermal insulation. This sustainable construction method not only enhances affordability but also contributes to creating comfortable and energy-efficient living spaces. The terracotta pots filler slab exemplifies the ingenuity and practicality of leveraging locally available materials to address housing challenges and promote sustainable building practices (Janmesh Bhoir, 2023).

2.2.1.2. Country tile slab

The country tile slab represents a variant of filler slab construction technology, where a segment of the concrete in the bottom of the slab is substituted with country tiles as shown in Figure 5. This innovative approach aims to optimize material usage and reduce construction costs while upholding structural integrity. Country tiles, renowned for their lightweight and insulating characteristics, are well-suited as filler material in this context. By integrating country tiles into the slab, the overall weight of the structure is diminished, leading to cost-efficiency and enhanced thermal insulation. The Raj (2021) and Moghayedi (2021) advocate for the reuse of vernacular materials like country tiles, citing their compatibility with sustainable design principles and local construction cultures. Their inclusion also supports employment generation in small-scale tile industries. This method illustrates how context-sensitive material choices can align affordability, comfort, and sustainability. The country tile slab model underscores the value of drawing from indigenous knowledge systems to create resource-efficient housing in the Indian context.

__Figure 4.__ Terracotta Pots Filler Slab (left: construction of the slab, right: finished view of the slab).

3. Methodology

This research adopts a quantitative, analytical, and comparative approach to evaluate the cost-effectiveness, efficiency, and sustainability of select low-cost construction methods commonly employed in affordable housing schemes across India. The methodology integrates a systematic literature review, field-based visual observations, and a standardized hypothetical modeling framework to derive objective, data-driven insights into material usage, labor productivity, and construction feasibility as shown in the flow chart in Figure 6.

Primary data were collected through structured field visits to three ongoing low-cost housing construction projects located in Pavagada, Mangalore, and Bangalore, Karnataka, conducted between January and April 2024. The selected case study sites employed alternative construction techniques, including rat trap bond masonry, laterite stone block masonry, and filler slab roofing systems incorporating terracotta pots, country tiles, and Mangalore tiles. These techniques were chosen based on their documented effectiveness in enhancing cost efficiency and sustainability in affordable housing delivery (BMTPC Building Materials and Technology Promotion Council, 2020). Each site was observed over a period of 2–3 days, during which comprehensive documentation was undertaken through direct visual observation, systematic photographic recording, and semi-structured interviews with site engineers and skilled masons. The collected observational data encompassed material specifications, labor deployment and productivity, construction sequencing and duration, and the adaptability of these techniques to varying site and environmental conditions, thereby enabling a robust comparative evaluation of their practical feasibility and performance.

Secondary data for this study was obtained through a structured systematic literature review. Searches were conducted across electronic academic databases, including ScienceDirect, SpringerLink, ResearchGate, and Google Scholar, using predefined keywords such as "low-cost construction India," "rat trap bond masonry," "filler slab," "laterite masonry," and "affordable housing technologies." The initial search yielded approximately 85 publications. After screening titles and abstracts for relevance to the study's objectives and removing duplicates, 32 articles were shortlisted. Of these, 15 articles were included in the final review based on their specific focus on cost-benefit analysis, material efficiency, sustainability, and applicability within the Indian affordable housing context.

In addition to peer-reviewed literature, supplementary technical references—including State PWD manuals, the CPWD Schedule of Rates, vendor quotations, and previously published case studies—were consulted to establish realistic unit rates for materials and labor. This mixed-source data foundation enabled a robust comparative assessment of low-cost construction techniques grounded in both academic research and practical field conditions. To enable accurate and consistent comparison, a normalized hypothetical case model was developed. This model comprised a 10-meter-long, 3-meter-high masonry wall and a 10-meter by 10-meter slab, reflecting common unit dimensions found in Economically Weaker Section (EWS) housing layouts in India. The use of a hypothetical yet representative module allowed for

Figure 5. *Country Tile Filler Slab (left: construction of the slab, right: finished view of the slab)*

methodical comparison across techniques while ensuring relevance to practical building configurations.

The study focuses on a comparative evaluation of three wall systems—conventional brick masonry, rat trap bond masonry, and laterite stone masonry—and four slab systems—conventional RCC slab, filler slab with terracotta pots, country tile filler slab, and Mangalore tile roofing with concrete base. For each construction type, cost analysis was carried out under three primary parameters: Material costs, labor costs, estimated construction duration.

Additionally, a 5% allowance for miscellaneous costs (e.g., site overheads, temporary supports, scaffolding, tools) was included to approximate real-world construction variables.

All cost estimations were calculated in Indian Rupees (INR). To improve comprehension for an international audience, total costs—including subtotals and overheads—were also converted into US Dollars (USD) and Euros (EUR).

By integrating rigorous field data collection, structured literature review, and comparative cost modeling, this methodology provides a robust framework for assessing low-cost construction techniques. The findings are expected to support policy makers, architects, and developers in identifying viable, scalable, and locally suitable approaches to addressing India's ongoing affordable housing needs, particularly in regions with constrained resources and rising urban demand.

4. Analysis

In the analysis, the focus revolves around estimating material requirements for various types of masonry walls, including brick masonry, laterite stone masonry, and rat trap bond masonry, all with a thickness of 9 inches. This comprehensive analysis aims to provide insights into the intricate process of estimating materials for different construction methodologies, shedding light on the practical considerations and challenges involved in each scenario.

4.1. Masonry wall

Masonry walls are a fundamental component of building construction and are known for their durability, strength, and versatility. These walls can serve various purposes, including providing structural support, partitioning spaces, or acting as protective barriers. Masonry walls come in different types, each with its characteristics and applications. The construction process involves laying individual masonry units in a pattern and bonding them together with mortar, a mixture of cement, sand, and water.

The estimation for masonry entails calculating the number of bricks and volume of mortar required for constructing a wall with specified dimensions. For the estimation, a wall with dimensions of 10 meters in length, 3 meters in height, and a thickness of 9 inches, and a cement mortar mix ratio of 1:6 is considered.

4.1.1. Estimation for brick masonry (9" thick)

Estimating materials for brick masonry with a thickness of 9 inches, using bricks measuring 9 inches in length, 10 inches in width, and 13 inches in height, involves a systematic process. Initially, the total area of the wall to be constructed is calculated based on its dimensions. Then, the number of bricks required is determined by dividing the wall area by the surface area of one

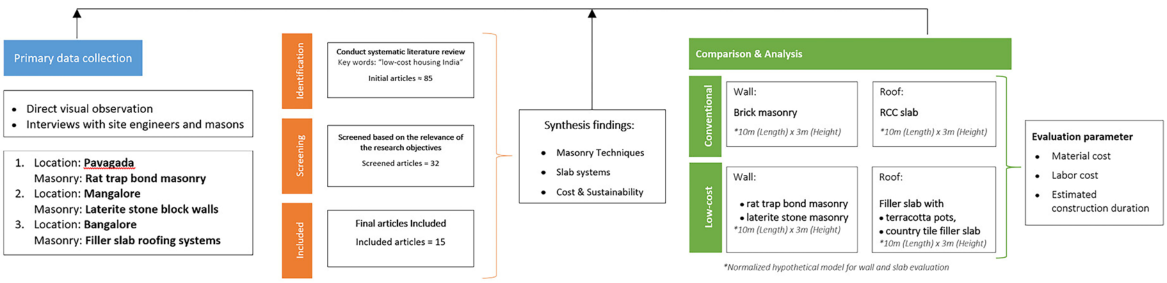


Figure 6. *Methodology Flowchart.*

brick, accounting for mortar joints. Additionally, the volume of mortar needed is calculated based on the mortar mix ratio, considering factors like cement and sand proportions.

Considering the wall measuring 10m x 3m for estimation, Table 1 (i) shows the calculation for the brick masonry.

4.1.2. Estimation for laterite stone masonry (9" thick)

Estimating materials for laterite stone masonry with a thickness of 9 inches is essential for effective construction planning, especially in regions rich in laterite deposits. Laterite stone, known for its unique red or brown coloration, holds significant value in building construction due to its durability and aesthetic charm. When estimating materials for laterite stone masonry, several factors come into play. The dimensions of the wall, including its length, height, and thickness, must be carefully measured to determine the required quantity of laterite stones. Additionally, the irregular shape and size of laterite stones present a challenge in estimation, requiring meticulous consideration to ensure accurate calculations. Moreover, the mortar mix ratio, specifying the

Table 1. *Estimation for (i) Brick Masonry, (ii) Laterite Masonry & (iii) Rat Trap Bond Masonry.*

i)	**ESTIMATION OF BRICK MASONRY**								
Sl. No	**Description of work**	**Unit**	**Nos.**	**Length**	**Breadth**	**Depth**	**Quantity**	**Rate**	**Amount**
1	**Brick for masonry** including transportation loading and unloading **(9"x10"x13"); B.R – Rs.18)**	Nos	2458				2458	₹ 25.00	₹ 61,450.00
2	Cement mortar (1:6)	Cft	1	56			56	₹ 250.00	₹ 14,000.00
3	Labor charges	Sft	1	32.8	9.85		323.08	₹ 120.00	₹ 38,769.60
Sub total									**₹ 1,14,219.60 ($ 1,309.14)**
Miscellaneous (10%)									**₹ 11,421.96 ($ 130.91)**
Grand total									**₹ 1,25,641.56 ($1440.05)**
ii)	**ESTIMATION OF LATERITE MASONRY**								
Sl. No	**Description of work**	**Unit**	**Nos.**	**Length**	**Breadth**	**Depth**	**Quantity**	**Rate**	**Amount**
1	**Laterite for masonry** including transportation loading and unloading **(9"x10"x13"); B.R – Rs.28)**	Nos	274				274.00	₹ 43.00	₹ 11,782.00
2	Cement mortar (1:6)	Cft	1	20			20.00	₹ 250.00	₹ 5,000.00
3	Labor charges	Sft	1	32.8	9.85		323.08	₹ 160.00	₹ 51,692.80
Sub total									**₹ 68,474.80 ($ 784.83)**
Miscellaneous (10%)									**₹ 6,847.48 ($ 78.48)**
Grand total									**₹ 75,322.28 ($ 863.31)**
iii)	**ESTIMATION OF RAT-TRAP BOND BRICK MASONRY**								
Sl. No	**Description of work**	**Unit**	**Nos.**	**Length**	**Breadth**	**Depth**	**Quantity**	**Rate**	**Amount**
1	**Brick for masonry** including transportation loading and unloading **(9"x10"x13"); B.R – Rs.18)**	Nos	2458				1844	₹ 25.00	₹ 46,100.00
2	Cement mortar (1:6)	Cft	1	42			42	₹ 250.00	₹ 10,500.00
3	Labor charges	Sft	1	32.8	9.85		323.08	₹ 120.00	₹ 38,769.60
Sub total									**₹ 95,369.60 ($ 1093.60)**
Miscellaneous (10%)									**₹ 9,536.96 ($ 109.31)**
Grand total									**₹ 1,04,906.56 ($ 1202.40)**

proportion of cement to sand, is crucial for determining the amount of mortar needed to bond the laterite stones together securely. By carefully considering these factors, the accurate estimation can be achieved, facilitating successful and durable laterite stone masonry construction projects.

Considering the wall measuring 10m x 3m for estimation, Table 1 (ii) shows the calculation for the laterite stone masonry.

4.1.3. Estimation for rat trap bond (9" thick)

The estimation process for rat trap bond masonry involves several key considerations. First, the dimensions of the wall, including its length, height, and thickness, are carefully measured to determine the total surface area to be covered. Next, the size and quantity of bricks needed for the project are calculated, taking into account the specific layout of the rat trap bond pattern and the spacing between bricks. Additionally, the volume of mortar required to bond the bricks together and fill the cavities is determined based on the mortar mix ratio. Furthermore, factors such as labor costs, availability of materials, and any additional construction requirements must be considered during the estimation process.

Considering the wall measuring 10m x 3m for estimation, Table 1 (iii) *shows* the calculation for the rat trap bond masonry.

4.1.4. Inference

When comparing brick, laterite, and rat trap bond masonry, the analysis shown in Figure 7 reveals that laterite stone masonry emerges as the most cost-effective option. Despite the popularity of brick masonry and the efficiency of rat trap bond masonry in reducing material usage, laterite stone masonry offers distinct advantages in terms of cost-effectiveness. This finding may be attributed to several factors unique to laterite stone, including its availability, affordability, and natural insulating properties, which contribute to reduced construction costs. Additionally, the larger size of laterite stones compared to bricks allows for savings on labor and other construction materials. Furthermore, the porous nature of laterite stone enhances its thermal insulation capabilities, reducing the need for additional insulation materials and resulting in long-term cost savings. Overall, the findings suggest that laterite stone masonry represents a cost-effective and sustainable choice for construction projects compared to traditional brick and rat trap bond masonry methods.

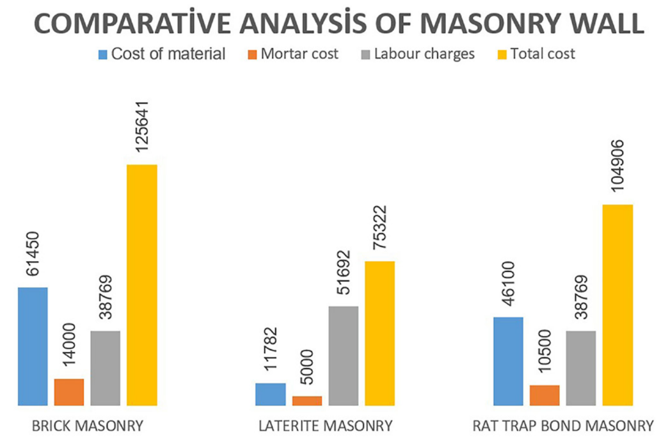


Figure 7. *Comparative analysis of masonry walls.*

4.2. Roof slab

When comparing the cost of roof slabs for a span of 10m x 10m, three options are considered: regular slab, terracotta pots filler slab, and country tile filler slab. The regular slab is the conventional method of constructing a concrete roof slab, while the terracotta pots filler slab and country tile filler slab involve incorporating filler materials to reduce the amount of concrete required.

In the cost comparison, factors such as material costs, labor costs, and structural requirements are taken into account. The regular slab typically requires a significant amount of concrete, resulting in higher material and labor costs. On the other hand, the terracotta pots filler slab and country tile filler slab utilize filler materials such as terracotta pots or country tiles to reduce the amount of concrete needed, leading to cost savings.

Additionally, the structural performance of each option is considered to ensure that the roof slab meets safety standards and can withstand the intended loads. While the regular slab may offer the highest structural strength, the terracotta pot filler slab and country tile filler slab can still provide adequate support for typical residential or low-rise commercial buildings.

Overall, the cost comparison between the regular slab, terracotta pots filler slab, and country tile filler slab for a span of 10m x 10m will depend on factors such as material availability, labor costs, and specific project requirements. However, incorporating filler materials in the slab construction process can offer cost-effective alternatives to traditional concrete slabs while maintaining structural integrity.

4.2.1. Estimation for conventional RCC roof slab

Estimating the materials required for a conventional RCC roof slab involves several components, including formwork, M20 grade concrete, and steel reinforcement, plastering, and painting. Here's a breakdown of each component:

Formwork: Formwork is the temporary structure used to support the concrete until it sets and gains sufficient strength. The quantity of formwork needed depends on the dimensions and shape of the roof slab.

M20 Concrete: M20 grade concrete refers to a mix of concrete with a characteristic compressive strength of 20 mega pascals (MPa) after 28 days of curing. The quantity of concrete required is calculated based on the dimensions (length, width, and thickness) of the roof slab.

Steel Reinforcement: Steel reinforcement, typically in the form of steel bars or mesh, is used to reinforce the concrete and enhance its tensile strength. The quantity of steel reinforcement required is determined based on the design specifications, including the spacing and diameter of the reinforcement bars.

Plastering: Plastering involves applying a coat of mortar to the surface of the roof slab to create a smooth and even finish. The quantity of plastering material required depends on the surface area of the roof slab and the desired thickness of the plaster.

Painting: Painting the roof slab is optional but can provide additional protection against weathering and enhance its aesthetic appearance. The quantity of paint needed depends on the surface area to be painted and the number of coats desired.

By accurately estimating the quantity of each component required for the conventional RCC roof slab, construction planners can ensure efficient resource allocation, cost-effectiveness, and timely completion of the project.

Considering the roof measuring 10m x 10m for estimation, Table 2 (i) shows the calculation for the conventional RCC Roof Slab.

4.2.2. Estimation for filler slab roof (country tile filler)

Estimating the materials required for a filler slab roof with country tile filler involves several components, including formwork, plastered surface, M20 grade concrete, country tile filler, steel reinforcement, and weatherproof coating. Here's a breakdown of each component:

Formwork: Formwork is the temporary structure used to support the concrete until it sets and gains sufficient strength. The quantity of formwork needed depends on the dimensions and shape of the roof slab.

Plastered Surface: Before installing the country tile filler, the surface of the slab may need to be plastered to create a smooth and even base. The quantity of plastering material required depends on the surface area of the roof slab and the desired thickness of the plaster.

M20 Concrete: M20 grade concrete refers to a mix of concrete with a characteristic compressive strength of 20 mega pascals (MPa) after 28 days of curing. The quantity of concrete required is calculated based on the dimensions (length, width, and thickness) of the roof slab.

Country Tile Filler: The country tile filler is the primary material used to fill the voids in the slab, reducing the amount of concrete required. The quantity of country tile filler needed depends on the dimensions of the voids and the spacing between them.

Steel Reinforcement: Steel reinforcement, typically in the form of steel bars or mesh, is used to reinforce the concrete and enhance its tensile strength. The quantity of steel reinforcement required is determined based on the design specifications, including the spacing and diameter of the reinforcement bars.

Weatherproof Coating: Weatherproof coating is applied to the surface of the roof slab to protect it from moisture, UV radiation, and other environmental factors. The quantity of weatherproof coating needed depends on the surface area of the roof slab and the recommended application rate.

By accurately estimating the quantity of each component required for the filler slab roof with country tile filler, construction planners can ensure efficient resource allocation, cost-effectiveness, and the successful completion of the project.

Considering the roof measuring 10m x 10m for estimation, Table 2 (ii) shows the calculation for Country Tile filler slab.

4.2.3. Estimation for filler slab roof (terracotta pot filler)

Estimating the materials required for a filler slab roof with terracotta pot filler involves several components, including formwork, plastered surface, M20 grade concrete, terracotta pot filler, steel reinforcement, and weatherproof coating. Here's a breakdown of each components:

Formwork: Formwork is the temporary structure used to support the concrete until it sets and gains sufficient strength. The quantity of formwork needed depends on the dimensions and shape of the roof slab.

Plastered Surface: Before installing the terracotta pot filler, the surface of the slab may need to be plastered to create a smooth and even base. The quantity of plastering material required depends on the surface area of the roof slab and the desired thickness of the plaster.

M20 Concrete: M20 grade concrete refers to a mix of concrete with a characteristic compressive strength of 20 mega pascals (MPa) after 28 days of curing. The quantity of concrete required is calculated based on the dimensions (length, width, and thickness) of the roof slab.

Terracotta Pot Filler: The terracotta pot filler is the primary material used to fill the voids in the slab, reducing the amount of concrete required. The quantity of terracotta pot filler needed depends on the dimensions of the voids and the spacing between them.

Steel Reinforcement: Steel reinforcement, typically in the form of steel bars or mesh, is used to reinforce the concrete and enhance its tensile strength. The quantity of steel reinforcement required is determined based on the design specifications, including the spacing and diameter of the reinforcement bars.

Weatherproof Coating: Weatherproof coating is applied to the surface of the roof slab to protect it from moisture, UV radiation, and other environmental factors. The quantity of weatherproof coating needed depends on the surface area of the roof slab and the recommended application rate.

By accurately estimating the quantity of each component required for the filler slab roof with terracotta pot filler, construction planners can ensure efficient resource allocation, cost-effectiveness, and the successful completion of the project.

Considering the roof measuring 10m x 10m for estimation, the Table 2 (iii) shows the calculation for Terracotta Pot filler slab.

4.2.4. Inference

Based on the cost comparison between conventional RCC slab, terracotta pots filler slab, and country tile filler slab (Figure 8) for a span of 10m x 10m, it can be inferred that the filler slab options offer significant cost advantages over the conventional RCC slab.

The conventional RCC slab typically requires a substantial amount of concrete, resulting in higher material and labor costs. In contrast, both the terracotta pots filler slab and country tile filler slab utilize filler materials to reduce the amount of concrete needed, leading to cost savings.

Furthermore, the use of filler materials such as terracotta pots or country tiles can contribute to additional cost savings by reducing the need for formwork and steel reinforcement. These

Table 2. Estimation for (i) RCC slab, Filler Slab Roof - (ii) County Tile & (iii) Terracotta Pot filler.

i)	ESTIMATION OF CONVENTIONAL RCC ROOF SLAB								
SL No	**Description of work**	**Unit**	**Nos.**	**Length**	**Breadth**	**Depth**	**Quantity**	**Rate**	**Amount**
1	Centring and shuttering for roof slab	SFt	1	32.80	32.80		1075.84	₹ 35.00	₹ 37,654.40
2	M20 Concrete for 6" thick roof slab	CFt	1	32.80	32.80	0.50	537.92	₹ 330.00	₹ 1,77,513.60
3	Steel reinforcement for roof beam, slab and concealed beams (Base rate-Rs. 70000 + Rs. 20000 Labor)	MT	1	1075.84		0.0018	1.94	₹ 90,000.00	₹ 1,74,286.08
4	Plastering work for RCC roof ceiling	SFt	1	32.80	32.80		1075.84	₹ 75.00	₹ 80,688.00
5	Painting for plastered ceiling	SFt	1	32.80	32.80		1075.84	₹ 35.00	₹ 37,654.40
Sub total									**₹ 5,07,796.48 ($ 5820.16)**
Miscellaneous (5%)									**₹ 25,389.82 ($ 291.01)**
Grand total									**₹ 5,33,186.30 ($ 6111.61)**
ii)	ESTIMATION OF COUNTY TILE FILLER SLAB								
SL No	**Description of work**	**Unit**	**Nos.**	**Length**	**Breadth**	**Depth**	**Quantity**	**Rate**	**Amount**
1	Centring and shuttering for roof slab	SFt	1	32.80	32.80		1075.84	₹ 35.00	₹ 37,654.40
2	2" thick profile making using soil and cement of ratio 1:10 with smooth plastered surface	CFt	1	32.80	32.80	0.17	182.89	₹ 180.00	₹ 32,920.70
3	Transportation and placing of filler material in place to design detail using cement mortar (Country tile - 1'0"x4"x3"; BR - Rs. 55/-)	Nos	72				72.00	₹ 165.00	₹ 11,880.00
4	M20 Concrete for 7" thick Filler slab (3"Filler + 4" concrete								
a	volume of M20 concrete required for 7" thick concrete slab	CFt	1	32.80	32.80	0.583	627.21		
b	Volume of country tile fillers (DEDUCTION)		72	0.111			7.99		
(a-b)	Total quantity of M20 concrete required for pot filler slab after deduction of pot filler volume	CFt	1				619.22	₹ 330.00	₹ 2,04,343.50
	SLAB AREA (MT/SFt)								
5	Steel reinforcement for roof beams, slab and concealed beams (BR- Rs.70,000 + Labour - Rs.20,000)	MT	1	1075.840		0.0015	1.61	₹ 90,000.00	₹ 1,45,238.40
6	Weatherproof coating	SFt	1	32.80	32.80		1075.84	₹ 35.00	₹ 37,654.40
Sub total									**₹ 4,69,691.40 ($ 5383.41)**
Miscellaneous (5%)									**₹ 23,484.57 ($ 269.17)**
Grand total									**₹ 4,93,175.97 ($ 5652.58)**
iii)	ESTIMATION OF TERRACOTA POT FILLER SLAB								
SL No	**Description of work**	**Unit**	**Nos.**	**Length**	**Breadth**	**Depth**	**Quantity**	**Rate**	**Amount**
1	Centring and shuttering for roof slab	SFt	1	32.80	32.80		1075.84	₹ 35.00	₹ 37,654.40
2	2" thick profile making using soil and cement of ratio 1:10 with smooth plastered surface	CFt	1	32.80	32.80	0.17	182.89	₹ 180.00	₹ 32,920.70
3	Transportation and placing of filler material in place to design detail using cement mortar (Terracotta pot- 9"dia x3"; BR - Rs. 140/-)	Nos	100				100.00	₹ 140.00	₹ 14,000.00
4	M20 Concrete for 7" thick Filler slab (3"Filler + 4" concrete								
a	volume of M20 concrete required for 7" thick concrete slab	CFt	1	32.80	32.80	0.583	627.21		
b	Volume of country tile fillers (DEDUCTION)		100	0.033			3.27		
(a-b)	Total quantity of M20 concrete required for pot filler slab after deduction of pot filler volume	CFt	1				623.94	₹ 330.00	₹ 2,05,901.76
	SLAB AREA (MT/SFt)								
5	Steel reinforcement for roof beams, slab and concealed beams (BR- Rs.70,000 + Labour - Rs.20,000)	MT	1	1075.840		0.0015	1.61	₹ 90,000.00	₹ 1,45,238.40
6	Weatherproof coating	SFt	1	32.80	32.80		1075.84	₹ 25.00	₹ 26,896.00
Sub total									**₹ 4,62,611.26 ($ 5302.26)**
Miscellaneous (5%)									**₹ 23,130.56 ($ 265.11)**
Grand total									**₹ 4,85,741.82 ($ 5567.37)**

filler materials are often more affordable than concrete and can be sourced locally, further lowering construction costs.

Overall, the inference drawn from the cost comparison is that filler slab options, such as terracotta pots filler slab and country tile filler slab, offer a cost-effective alternative to conventional RCC slabs for roof construction projects. By opting for filler slab solutions, construction projects can achieve significant cost savings while maintaining structural integrity and durability.

5. Conclusion

The comparative study of low-cost construction methods for affordable housing in India sheds light on the need to choose proper construction methods and materials that are cost-effective, perform well, and are sustainable. The analysis of filler slab systems, especially terracotta pot and country tile types, proves that the selection of the filler material greatly affects cost-effectiveness, structural weight, and thermal comfort. In parallel, the contrast between laterite stone masonry and rat trap bond masonry illustrates how construction efficiency, material properties, and regional availability influence the practicality and cost of alternative wall systems.

Notably, several of these methods are not only theoretically sound but are being incrementally implemented in different parts of India. Construction techniques like rat trap bond masonry and filler slabs have been favored by both government-majority housing programs as well as NGO-initiated projects because of their material economy and adaptability to local conditions. In regions like Kerala, Karnataka, and parts of Maharashtra, building with laterite stone and terracotta fillers has become popular because of cultural acceptability, local source availability, and adaptability to climate.

End-user and project stakeholders' feedback indicates a positive overall view of these methods, most notably thermal comfort and aesthetics. People living in houses constructed using filler slabs have testified to less indoor heat and improved living comfort, with rat trap bond masonry having been valued for allowing room for inbuilt services such as plumbing and electrical lines. Still, there are challenges, especially concerning the shortage of skilled manpower trained in non-traditional construction and low awareness among housing boards and contractors, which at times slows down common usage.

For future research, it is suggested to conduct more comprehensive comparative analyses including various construction methods, accounting for region-specific factors like labor wages, transport expenses, and fluctuating prices of materials. Further, longitudinal analyses evaluating the long-term durability, maintenance requirements, and client satisfaction with these low-cost housing options would provide in-depth analysis of their sustainability and performance in real settings.

Ultimately, the integration of such construction practices requires not only technical endorsement but also strong policy support, capacity-building initiatives, and active social mobilization. Strengthening these dimensions can significantly enhance the living standards of economically weaker sections and advance India's vision of inclusive and sustainable urban development. These findings align with global policy frameworks that advocate sustainable urbanization as a key strategy for improving housing affordability, environmental performance, and social inclusion in developing cities (UN-Habitat, 2020).

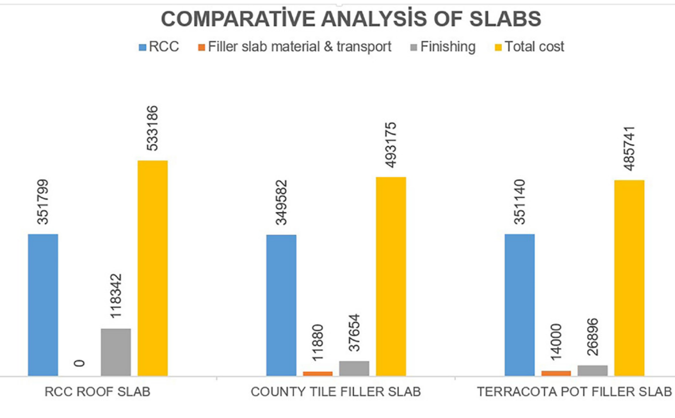


Figure 8. *Comparative analysis of slabs.*

References

Arun, M. B. (2021). Affordable housing: Cost-effective construction materials for economically weaker section. *Materials Today: Proceedings, 46*(20), 7838–7844. https://doi.org/10.1016/j.matpr.2020.12.265

Bhoir, P. J., Ade, P., Gupta, K., Lokare, A., & Rajan, J. (2023). Design and analysis of filler slab using terracotta fillers. *International Journal of Scientific Research in Engineering and Management, 7*(8). https://doi.org/10.55041/IJSREM25359

Bureau of Indian Standards. (2016). *National building code of India*. New Delhi: Bureau of Indian Standards. Retrieved from Bureau of Indian Standards website: https://www.bis.gov.in

Building Materials and Technology Promotion Council. (2020). *Compendium of innovative technologies*. New Delhi: Building Materials and Technology Promotion Council. Retrieved from BMTPC website: https://www.bmtpc.org

Central Public Works Department. (2021). *Delhi schedule of rates 2021*. New Delhi: Central Public Works Department. Retrieved from CPWD website: https://cpwd.gov.in

Chougule, A. D., Mota, M. H., & Patil, D. M. (2015). To study the filler slab as alternative construction technology: A review. *Journal of Information, Knowledge and Research in Civil Engineering, 3*(2), 199–202.

Government of India. (2016). *Real estate (regulation and development) act, 2016*. New Delhi: Ministry of Law and Justice. Retrieved from India Code website: https://www.indiacode.nic.in

Haris, S. M. (2021). Experimental investigation on the behaviour of rat trap bonded masonry. *International Journal of Scientific Research and Engineering Development, 4*(5), 61–65.

Helble, M. O. (2021). How (un) affordable is housing in developing Asia? *International Journal of Urban Sciences, 25*(Suppl. 1), 80–110. https://doi.org/10.1080/12265934.2020.1810104

Maklur, N., & Narkhede, P. (2018). Study of laterite stone as building material. *International Journal of Engineering Research, 7*(Special 3), 223–226. https://doi.org/10.5058/2319-6890.2018.00063.6

Marinelli, M., Konanahalli, A., & Dwarapudi, R. (2022). Assessment of barriers and strategies for the enhancement of off-site construction in India: An ISM approach. *Sustainability, 14*(11), 6595. https://doi.org/10.3390/su14116595

Ministry of Housing and Urban Affairs. (2022). *PMAY progress report*. New Delhi: Government of India. Retrieved from PMAY website: https://pmay-urban.gov.in

Moghayedi, A., Awuzie, B., & Omotayo, T. (2021). A critical success factor framework for implementing sustainable innovative and affordable housing. *Buildings, 11*(8), 317. https://doi.org/10.3390/buildings11080317

Natarajan, S. S. (2019). A study on filler slab technology in building construction. *International Journal of Innovative Technology and Exploring Engineering, 9*(1), 271–275.

Pattanashetti, N. P. (2017). Comparative study of filler slab with conventional slab. *International Journal of Engineering Research & Technology, 6*(7), 157–160.

Raj, P. V. (2021). Housing with low-cost materials and techniques for sustainable construction in India. *Materials Today: Proceedings, 43*(Part 2), 1850–1855. https://doi.org/10.1016/j.matpr.2020.10.816

Sinha, S. M., & Mishra, S. (2020). Sustainable low-cost housing using rat trap bond masonry and filler roof slab in Bihar. *International Journal of Engineering Research & Technology, 9*(11), 1780–1785.

Tam, V. W. Y. (2011). Cost effectiveness of using low-cost housing technologies in construction. *Procedia Engineering, 14*, 156–160. https://doi.org/10.1016/j.proeng.2011.07.018

UN-Habitat. (2020). *World cities report 2020: The value of sustainable urbanization*. Nairobi: United Nations Human Settlements Programme. Retrieved from UN-Habitat website: https://unhabitat.orge.