Understanding the Concept of Temporary Structures Through Prefabricated Construction System

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Abstract— This research examines the changing significance of temporary structures by focusing on prefabricated construction systems, which are essential in creating responsive, efficient, and sustainable built environments. The study delves into modular, panelized, and volumetric prefabrication techniques, emphasizing their ability to fulfill immediate functional needs while maintaining architectural quality and environmental stewardship. Through a comprehensive literature review and analysis of practical case studies, this research demonstrates how prefabrication alters the understanding of temporality in architecture, shifting it from a limitation to a driving force for innovation, adaptability, and contextually aware design.

Index Terms—**Temporary structures, Prefabricated materials, Construction efficiency.**

1. INTRODUCTION

Prefabricated construction, referred to as modular construction or off-site construction, represents an approach to building that entails the production of components or modules within a factory setting, followed by their subsequent transportation to the construction site for assembly. These modules are designed and engineered in advance, ensuring accuracy and consistency in every facet. Prefabrication provides a more efficient alternative to conventional on-site construction practices. By fabricating modules in controlled environments utilizing high-quality materials, labor-intensive steps are eliminated, and waste is reduced. This optimized process enhances efficiency and guarantees a superior standard of construction (Pressmach, 2023).

1.1. Applications for Prefabrication in Temporary Architecture.

Prefabricated buildings are becoming more and more common in the building sector because of their many benefits, especially for short-term settings like offices or classrooms. One major benefit is that prefabricated buildings can be constructed 20% to 50% faster than conventional concrete constructions, which reduces operating disturbances. Additionally, they provide a substantial degree of customization, enabling users to choose sizes and layouts that are tailored to specific requirements, whether open-plan areas or individual rooms. Cost-effectiveness constitutes another pivotal benefit. With diminished labor costs and streamlined manufacturing processes, prefabricated buildings are generally 15% less expensive than conventional construction, rendering them suitable for budget-sensitive clients or projects that necessitate economic efficiency.

Moreover, their modular design facilitates easy disassembly and relocation, providing long-term flexibility as spatial needs change. Durability represents another strength; high-quality materials guarantee that these structures endure wear and tear, delivering sustained performance. With the rise of environmental concerns, prefabrication additionally supports sustainability objectives. Controlled production environments decrease material waste and enhance resource efficiency in comparison to traditional methodologies. In summary, prefabricated structures amalgamate speed, adaptability, affordability, mobility, resilience, and eco-consciousness. These attributes render them a highly practical solution for temporary uses without sacrificing functionality or quality (Pressmach, 2023).

2. LITERATURE REVIEW

2.1. Temporary Architecture

Temporary structures are designed to function as short-term small mobile theatre and a floating cinema to a community swimming area on a repurposed railway track or an improvised theatre made entirely from reclaimed materials. Many of these projects feature grassroots initiatives that promote collaborative, participatory design and self-directed construction. They often challenge the aesthetics of existing permanent structures and embody creativity and boldness. Always intended for public engagement, these initiatives involve the community in both their development and execution. Urban public spaces have increasingly witnessed the rise and fall of such temporary constructions, often referred to as "pop-ups," which serve as whimsical attractions designed for photography. However, a rich history of holistic temporary architecture suggests more harmonious approaches to work, recreation, and living (DesignCurial, 2015).

2.2. Types and Applications

The design process encompasses various aspects such as intentional temporality and unexpected temporality. It is influenced by functional and programmatic elements, including practical objectives, the desire to modify the environment, and marketing intentions. Additionally, structures may be linked to celebrations and are shaped by their urban context, which includes cultural landscapes, proximity to significant natural features, public spaces, and important institutions. Temporary building structures can be broadly categorized into the following categories:

2.2.1. Traditional Marquees

Traditional marquees are built in sections, which makes them easier to transport and simpler to assemble. The wall panels permit adaptable positioning of the entrance. While the primary function of a marquee is to provide overhead protection, the walls are separate and can be attached or removed as required. While setting up a marquee is generally uncomplicated if the guidelines are adhered to, some expertise is essential because of the canvas' weight. These marquees typically extend to 120 feet in width and are commonly utilized in classic environments and private events (DesignCurial, 2015).

Figure 1. Traditional Marquees
(Dezeen, 2012)

2.2.2. Giant Structure

Typically characterized as large-span aluminum frame or tensioned pole tents exceeding 25 meters in width, these are classified as specialized structures. They can have spans of 30, 40, or even 50 meters, often necessitating the use of telescopic equipment or cranes for their assembly and disassembly. In contrast, giant pole tents can generally be set up manually, distinguishing them from big tops that require machinery for installation (Massie, 2014).

Figure 2. Giant Structure
https://inhabitat.com/stunning-moroccan-tent-installation-contrasts-with-nouvels-famous-institute-du-monde-arabe-in-paris/

2.2.3. Inflatable Tents

Lightweight fabric skins that encase a volume of pressurized air make up air-inflated fabric structures. The fabric is usually constructed in a range of textile architectures, such as those depicted in figure (3). Every architecture has unique implications for design, production, tooling, and expense. These architectures will respond differently to loads due to their structure (Paul Cavallaro, 2006).

Figure. 3 Inflatable Tents
https://www.archdaily.com/111922/jnby-hhd_fun-architects/50076ca928ba0d41480022cf-jnby-hhd_fun-architects-image

2.2.4. Saddles pan

They are constructed from tensioned PVC and are supported by architectural aluminum trusses. These are frequently utilized for substantial marquees, exhibition spaces, audience enclosures, and stage canopies due to their capability to be affixed to sizable structures and their availability in a diverse range of colors (DesignCurial, 2015).

Figure 4. Saddles pan (Architizer, 2014)

2.2.5. Multi-deck

Multi-deck configurations may comprise double, triple, or quadruple tiers. The lower floors are built with an integrated steel upright and horizontal beam system, while the top floor has a typical clear span aluminum frame layout.

Figure 5. Multi-deck
https://www.dezeen.com/2019/11/06/biobasecamp-studio-marco-vermeulen-timber-pavilion/

2.3. Prefabricated Construction

As we are all aware, constructing conventional and traditional buildings requires significantly more time, and the associated costs are considerably high. Furthermore, this approach results in greater waste and contributes to environmental pollution; additionally, labourers face safety risks during the construction of traditional buildings. Given the multitude of challenges associated with adhering to conventional practices, why should we not seek a more efficient and optimal method for construction work? Indeed, we must adopt modern techniques, specifically Prefabricated Modular and steel structures. This approach to building structures will reduce construction costs, time, and waste. Conversely, it enhances the quality of the building, work efficiency, and the aesthetic appeal of the structures. Both Modular and Panel Built systems fall within the broader category of prefab. A modular house signifies the pinnacle of a particular category of construction system. The construction process commences with the application of efficient modern factory assembly line techniques (Prajjwal Paudel, 2016).

2.3.1. Materials and Methodology

- Structural Insulated Panels (SIPs)

SIPs, often known as sandwich panels, are composed of two layers of oriented strand board or plywood that are adhered to a rigid foam core, typically made of expanded polystyrene. This structure offers superior thermal insulation and robust structural strength. The panels are produced with a high degree of accuracy, facilitating rapid assembly on-site and minimizing thermal bridging. Nevertheless, it is essential to handle SIPs with care to prevent problems like insect tunneling or delamination. These possible concerns can be mitigated by utilizing borate-treated foam and appropriate surface treatments.

Figure 6. Structural Insulated Panels
(Prajjwal Paudel, 2016)

- Insulating Concrete Forms (ICFs)

ICFs consist of modular, hollow blocks made from EPS that are arranged similarly to bricks and subsequently filled with concrete. After the concrete sets, the forms stay intact, offering insulation and structural integrity. ICF systems diminish construction waste and accelerate the building process. Additionally, they are known for their high energy efficiency, soundproofing capabilities, and resistance to fire and pests, particularly when the EPS is treated with borate-based substances.

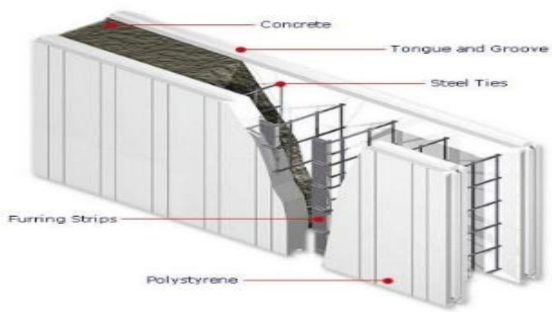

Figure 7. Insulating Concrete Forms (Said, 2013)

- Other Prefabricated Materials

A diverse selection of prefabricated materials is currently accessible in the market. Zincalume and Colorbond steels are favored selections for roofing and wall cladding, attributable to their robustness, resistance to corrosion, and modern aesthetic. Sandwich panels with EPS or Polyurethane Foam (PUF) cores are also widely used, offering lightweight construction, superior thermal performance, and easy installation. Aerocon panels, made from recycled fly ash, are eco-friendly, fire-resistant, and moisture-resistant, making them suitable for both interior and exterior wall uses. Additionally, FRP (Fiber-Reinforced Plastic) corrugated sheets are lightweight, durable, and weather-resistant, frequently employed for roofing and translucent skylight applications.

- Prefabricated Components and Systems

Prefabricated wall and roof systems consist of insulated sandwich panels, drywall, and aerated concrete blocks. EPS and PUF panels provide excellent energy efficiency, while drywall systems, which include metal frames and gypsum or cement boards, are lightweight, thermally insulated, and simple to install. Solid cement wall panels are valued for their durability and eco-friendly properties, often made with fly ash and polymers.

- Roof, Wall, and Flooring Options

Roofing for prefabricated buildings may consist of PUF or EPS corrugated panels, UPVC sheets, asphalt shingles, and CGI (corrugated galvanized iron) sheets, all of which provide protection against the elements and thermal insulation. The wall systems are generally made up of insulated panels, drywall, or composite cladding. Flooring choices vary from cement boards and plywood to ceramic tiles, vinyl planks, and hardwood, tailored to the functional and aesthetic needs of the area.

- Steel as a Primary Structural Material

Steel is extensively utilized in prefabricated construction because of its favorable strength-to-weight ratio, resistance to seismic activity, and straightforward assembly process. This material facilitates the creation of large-span structures, shortens construction timelines, and is recyclable, thereby enhancing sustainability. Additionally, steel components can be manufactured off-site, which reduces the need for on-site labor and accelerates the construction process.

Figure 8. Steel Structure
https://www.indiamart.com/proddetail/pre-engineered-steel-building-2854614090791.html

- Construction Methodology

The construction of prefabricated structures often begins with site clearance and marking. Following excavation and leveling, the foundation—typically a combination of RCC footings and base plates—is laid. Steel structural components are then delivered to the site and bolted or welded together. The wall and roof panels are next erected, followed by the installation of doors, windows, and utility services such as electricity and plumbing. Finally, the building is completed with finishing touches such as painting, flooring, and interior partitions, resulting in an efficient and waste-free prefabricated structure (Prajjwal Paudel, 2016).

3. CASE STUDY (Darwin Bucky, Ahmedabad, India)

The Darwin Bucky is a multi-purpose black box space that can function as an exhibition gallery, town hall, expo center, performance venue, or even a nightclub. Designed A for public gardens, exhibition grounds, or city centers, it was placed in Ahmedabad, a city known for its cultural hubs. A 12-meter prototype was tested through various cultural events, accommodating up to 100 people, to assess its effectiveness as a theatre and exhibition space. The Darwin Bucky draws its inspiration from the geodesic designs of Buckminster Fuller, incorporating triangular patterns to enhance the structural integrity. While it does not qualify as a genuine geodesic dome, it employs a parametric design methodology, utilizing computer algorithms to develop a lightweight and adaptable framework. Situated in Ahmedabad, the Bucky Gallery and Café have emerged as a venue for cultural activities. This design merges contemporary technology with traditional craftsmanship, leveraging digital modeling to effectively modify dimensions and forms. This approach enables customization and optimization of material usage, resulting in a structure that is both practical and resource efficient (Studio, 2023).

Figure 9. Darwin Bucky, Ahmedabad
(Source – Author)

3.1. Materials & Assembly

Darwin Bucky is a prefabricated, modular building created for simple dry assembly and disassembly without the requirement for a plinth, foundation, or heavy machinery. Constructed from traditional materials such as steel, wood, aluminum, and glass, its durability and cost are like those of standard buildings. Its shape is based on structural performance, making it suitable for remote areas with limited access to roads, electricity, or where digging is impractical. The structure incorporates lightweight insulated panels that are prefabricated, flat-packed, and are easy to transport. Featuring a conical shape and triangulated facade, Bucky provides both structural integrity and ideal acoustics. It utilizes half the materials needed for typical buildings, improving material efficiency. The complete metal framework is recyclable, minimizing energy consumption and ecological footprint. Damaged materials can be reused, including insulation. Bucky's design allows it to efficiently encapsulate space, and it can be taken apart without leaving any lasting evidence. Its sustainable, mobile, and high-performance design offers a distinctive answer for flexible and environmentally mindful construction (Studio, 2023).

Figure 10. Structural Detail
https://www.archdaily.com/990764/darwin-bucky-gallery-and-theatre-andblack-design-studio

3.2. Structural Details

The Darwin Bucky attains its distinctive look through structural transparency, utilizing a 1 mm-thick folded metal insulated panel system that can be flat-packed for shipping in a container. After being assembled on-site, it creates a shell structure that encases a generous 520 m³ volume with an open floor layout of 116 m². Ridges along the shape secure it to the base pedestal and serve for load distribution, ambient lighting, electrical conduits, and waterproof joinery. The structure's lively silhouette and tessellated geometry enrich the spatial experience and visual appeal. The doorway is thoughtfully located at the highest point on an intermediate ridge, projecting outward to establish a threshold. A brick foundation anchors and enhances the stark metallic shape. Airflow is facilitated through low-placed windows, including a specially crafted pivoting panel that aligns with the overall shape, combining functionality with architectural expression.

Figure 11. Art Gallery, Darwin bucky Ahmedabad (Source – Author)

4. CONCLUSION

This research examines the transforming architectural narrative of temporary structures, highlighting the application of prefabricated materials as a sustainable, efficient, and adaptive solution. Temporary structures, previously regarded merely as provisional interventions, are now being reconceived through prefabrication to address various functional, environmental, and aesthetic requirements. The study investigated how such structures can be swiftly deployed, disassembled, and relocated with minimal ecological impact, particularly in contexts such as expos, cultural pavilions, and remote site installations. Case studies like Darwin Bucky demonstrate how prefabricated systems enhance not only structural performance and material efficiency but also design innovation and environmental awareness.

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REFERENCE

[1] Architizer. (2014). *Suedpack 2014.*
[2] DesignCurial. (2015). *This is Temporary: Transient Architecture.* Progressive Media International.
[3] Dezeen. (2012). *Frieze Art Fair NYC by SO-IL.*
[4] Massie, C. (2014). *Kilo's organic Moroccan tent juxtaposes with Jean Nouvel's contemporary architecture.*
[5] Paul Cavallaro, A. M. (2006). *Air-Inflated Fabric Structure.*
[6] Prajjwal Paudel, S. D. (2016). *Study on Pre-fabricated Modular and Steel* . SSRG International Journal of Civil Engineering (SSRG – IJCE).
[7] Pressmach. (2023). *Advantages of Getting Temporary Room Setup Done Using Prefabricated Structures.* Pressmach.
[8] Said, I. (2013). *Insulated formwork system component and application.*
[9] Studio, A. D. (2023). *Darwin Bucky dome by andblack Design Studio is a mobile event space in India.* Dezeen.
[10] https://inhabitat.com/stunning-moroccan-tent-installation-contrasts-with-nouvels-famous-institute-du-monde-arabe-in-paris/
[11] https://www.archdaily.com/111922/jnby-hhd_fun-architects/50076ca928ba0d41480022cf-jnby-hhd_fun-architects-image
[12] https://www.dezeen.com/2019/11/06/biobasecamp-studio-marco-vermeulen-timber-pavilion/
[13] https://www.indiamart.com/proddetail/pre-engineered-steel-building-2854614090791.html
[14] https://www.archdaily.com/990764/darwin-bucky-gallery-and-theatre-andblack-design-studio