



FEATURES OF THE DESIGN OF MODERN MODULAR URBAN STRUCTURES

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ABSTRACT

The article examines modular urban structures as a phenomenon in the architecture of the early 20th century, in particular, the design features of modern modular urban structures.

The relevance of this topic is linked to the growing global population, which now exceeds 8 billion, and its growth in poor regions of the world. This increases the need for affordable and quickly constructed housing.

In this paper, we analyze modular urban structures, specifically the design features of modern modular urban structures. The primary goal of this study is to analyze the design specifics of modern modular urban structures. To achieve this, we examined the historical development of modular urban structures and identified the design features of modular urban structures.

Many scholars and practitioners in the field are studying modular urban structures. Among them are:

- Kengo Kuma Kuma is a Japanese architect working in the field of ecological urban planning and the creation of modular urban spaces;
- Christopher Alexander (Christopher Alexander) is an American architect and urban planning theorist who developed a system for creating modular urban spaces;
- Andrey Kulbakin is a Russian architect who developed the concept of small architectural forms for modular urban spaces;
- John Walter (John Walter is a British artist and architect who created portable modular cities;
- Richard Sennett is an American sociologist and urban planner who studies the interaction of people with the environment.

These are just a few of the scholars and practitioners studying modular urban structures. Architects, designers, engineers, ecologists, and other specialists also work in this field.

It's important to note that the prerequisites for the use of temporary structures in human life emerged long before the Industrial Revolution. The first temporary structures were built

during the nomadic era. They can be described as simple structures that were moved to different locations as needed. Among the first temporary structures were windbreaks and huts, which were used as sanctuaries or shelters in warmer climates. They became the prototypes for later tent structures—Roman legionary tents, Bedouin pavilions, and Mongolian yurts—which in turn inspired the structures of modern mobile architecture. For example, tents utilized the structural principle of compression of poles and tension of membranes, while the Asian yurt utilized modular organizational principles, which formed the basis of twentieth-century architecture.

From the history of ancient Rome, we know the story of a giant awning stretched over the Colosseum, which was more astonishing than the gladiatorial combats. "...Architects devised the velarium . It consisted of a system of adjustable building awnings, designed in analogy with the mast and sails of a ship. Near Rome, a ship's crew was stationed, tasked with managing the Colosseum's velarium . Using ropes and pulleys, the crew could stretch the fabric over the upper structures, thereby blocking the sun..."

In the Middle Ages, temporary structures were more closely associated with military affairs. Military fortifications of the Middle Ages typically consisted primarily of stone wall enclosures. Only occasionally were a few earthen ramparts, with palisades on the crest, allowed among the projecting fortifications, serving as temporary fortifications. Large military fortifications, created under political pressure, were erected with extreme speed, as evidenced by the uniformity of style. The construction of such structures utilized extremely simple techniques; for example, walls were constructed from large stone blocks, often with unfinished faces.

Temporary structures only took on a completely new life in the mid-nineteenth century. They then became the basis for international exhibitions, each of which attracted a large number of architects and actively influenced changing ideas about architecture, beginning with Paxton's Crystal Palace for the first exhibition in 1851. The Crystal Palace was constructed of iron and glass (see Fig. 4). The palace was enormous in size: 564 meters long and 39 meters high. The main feature of the structure was its extraordinary lightness and transparency. The roof and walls of the building were made of large glass panels mounted on an iron frame. This allowed for maximum use of natural light and created an airy, open space.

Paxton also created a special ventilation system that allowed air to circulate freely within the building and maintain optimal temperatures. This was particularly important for ensuring comfortable conditions for exhibition visitors and preserving the exhibits. The Crystal Palace's design was a marvel of its time and became a benchmark for unique technology that inspired other architectural projects.

In addition to international exhibitions abroad, the first agricultural exhibition in Russia, held in Moscow in 1923, is also important in the history of temporary structures. Many of the exhibits and kiosks proposed for the exhibition became urban features, such as the flower kiosk designed by F. O. Shekhtel for the Turkestan exhibition. It was built in 1910 as part of a project to construct a complex of buildings for the Turkestan Exhibition in Tashkent. The kiosk was designed in the style of traditional Uzbek architecture, utilizing distinctive architectural elements such as domes and colored ceramic tiles.

The kiosk was designed to sell flowers and plants, and its façade was specifically designed to attract visitors to the exhibition. It featured stucco, wood carvings, and mosaic tile patterns.

Inside, the kiosk featured shelves for displaying flowers and pots, and a rooftop garden terrace offered a relaxing setting for enjoying the scent of flowers.

Shekhtel used local materials and technologies in his design, and the kiosk became a shining example of how traditional architectural elements can be combined with modern construction methods. Today, the flower kiosk is one of Tashkent's landmarks, attracting tourists interested in the architecture and cultural history of Central Asia.

In the mid-1960s, the theory of temporary, mobile architecture began to emerge, when architectural theorist Cedric Price, in opposition to the still-relevant functionalism, first conceptualized the city's mutability, defining architecture as something unnoticeable yet capable of connecting elements—an "anti-architecture." Price believed that architecture is a weak and ineffective performer because, despite its monumentality, it always arrives last. Only by recognizing architecture's insignificance can it function as a system of connections that creates diverse activities.

His project Fun Palace, created in 1964 and designed for 10 years, expressed the idea that architecture should not be enclosed in a permanent building, but rather remain mobile, adaptable, and reusable, a concept later realized in the design of the Pompidou Center, created by Georges Pompidou in Paris. Reflections on temporariness and capital in urban space led Price to the concept of "non-plan." This implied the rejection of planning laws in urban development and the creation of free zones that would always remain empty or be filled with buildings that, when obsolete, would be destroyed, giving way to the architecture of new social demands. In the 1960s, influenced by the beliefs of the hippie subculture, American architect Steve Baer created a settlement of hemispherical tin huts, "Drop City," in Arizona, where he laid down the principles of maximum mobility in architecture, rejecting permanence as the opposite of freedom and promoting a return to nature.

In the 2000s, mass internet access began to influence the consideration of new directions in urban development, displacing residents from city streets and depriving cities of social connections. In this context, American architectural theorist William Mitchell, drawing on sociologist Henri Lefebvre's "Right to the City" concept, proposed a theory of "spatial diversification," which envisions providing a person with all their needs within a single urban fragment through the creation of portable devices, including electronic ones. An architectural example of this theory's implementation is the MVRDV group's project "Container." city." At the same time, temporary architecture as a typological trend became the foundation for the development of festival architecture, a field of architectural creativity. For example, the Serpentine Gallery annually invites a Pritzker Prize-winning architect to bring his concepts to life in a seasonal pavilion. Shigeru Ban deserves special mention. Ban demonstrated the ability of materials that were not originally building to serve as a structural framework. The architect also set a precedent for architecture as a purely short-lived object (a temporary traveling museum on the Hudson River made of cardboard tubes and shipping containers). In recent years, the development of temporary urban architecture, temporary spaces, and temporary urbanism have been explored in the work of the Berlin-based architectural group Urban. Pioneers. Robert Kronenburg has made a significant contribution to the study of contemporary temporary architecture theory, describing individual concepts and examples. Since 1995, he has authored nearly 30 books on temporary, mobile, flexible, and ephemeral architecture. His works have unified temporary and mobile structures into a system.

When discussing temporary structures, it's also important to mention the main types of modular structures, as well as the materials they use. These include:

I. Metal structures are a lightweight and durable material that is easy to assemble and construct on-site. Metal structures are also easy to transport and relocate, making them an ideal option for projects requiring flexibility and speed of construction.

Metal structures play a significant role in modular construction, as they are one of the most popular materials for fast and efficient design. In modular construction, metal is used as the primary building material for structural elements such as frames, columns, beams, trusses, framed walls, and roofs, allowing for significant reductions in weight and dimensions.

Advantages of metal structures in modular buildings:

Ease and compactness of transportation – metal structures are lighter and easier to transport than traditional materials such as brick, concrete, and so on. They also take up less space during transportation.

Strength and durability – metal structures are among the strongest and most durable of all building materials, allowing for the creation of durable and reliable structures.

Quick and easy assembly – metal structures are quickly and easily assembled on-site thanks to prefabricated elements, saving time and reducing construction costs.

Cost-effectiveness and ease of use – metal structures can be more cost-effective to use, both during construction and in the long term. They require no regular maintenance and can be easily dismantled and reinstalled elsewhere.

Aesthetic appeal – thanks to excellent performance features, metal structures can look beautiful and stylish in any architectural project.

Metal structures are an ideal option when designing modular buildings, as they combine numerous advantages—from high strength and durability to quick and cost-effective installation—allowing for high-quality construction projects.

II. Sandwich panels are one of the most popular materials for low-budget construction projects. They consist of two layers of metal or fiberboard with insulating foam between them. Sandwich panels are easily assembled on-site using special fasteners and allow for quick assembly without the need for additional structures. Sandwich panels are one of the most popular materials for the construction of modular urban structures. They are lightweight, easy to install, and have excellent insulating properties.

Many modular urban structures using sandwich panels are currently being built around the world. These include office buildings, shopping centers, dormitories, hotels, medical facilities, and even schools and kindergartens. Sandwich panels consist of two sheets of metal or fiberboard sandwiched between them by a layer of insulating material, typically mineral wool or foam. This construction creates a strong and durable material that is easily assembled on-site thanks to special fasteners. Advantages of sandwich panels in modular urban structures:

Cost-effectiveness – sandwich panels are one of the most affordable construction materials, which helps reduce the cost of construction and operation of urban structures.

Resistance to external influences – sandwich panels provide excellent protection against atmospheric factors such as rain, wind, solar radiation, and other factors. This makes them ideal for urban structures typically located in urban environments with daily climate fluctuations.

Insulating properties - thanks to the insulating layer, sandwich panels provide excellent thermal insulation and sound protection, making modular urban structures more comfortable for living or working.

Ease of installation – sandwich panels are very easy to assemble on-site thanks to special fasteners. This makes them ideal for speeding up the construction process and reducing finishing time.

Innovation and design – sandwich panels can be used to create modern and innovative designs, while meeting contemporary urban design requirements.

The use of sandwich panels in modular urban structures is an advantage that allows one to create a high-quality structure for various needs and purposes, ensuring a high level of comfort and safety.

III. Wooden structures – wood is one of the most affordable materials for prefabricated architectural structures. Wood combines beautifully with other materials to create a durable and functional structure. Wooden structures are one of the most traditional materials for constructing various types of buildings, including modular ones. They are well known for their environmental friendliness, high aesthetic appeal, quick installation, and durability. In modular buildings, wooden structures are most often used to construct the frames of houses, cottages, cafes, bathhouses, and other small structures. The production of prefabricated wooden modules or panels is facilitated by factory manufacturing using computer programming and robotics. After modular structures are assembled on-site, the wooden panels are often clad with other materials, which increases their weather resistance, improves sound absorption, and provides a more modern look. Advantages of wooden structures in modular buildings:

Eco-friendliness – timber structures are among the most environmentally friendly materials used in construction. Their environmental footprint is significantly smaller than that of most other materials.

Ease and speed of assembly – wooden modules are lightweight and ideal for modular construction. They are easy to assemble and can be transported to the construction site in small vehicles due to their compact size.

Aesthetic appeal – wood is a beautiful and pleasant material, creating a special atmosphere and uplifting mood. It's easy to work with and allows for the creation of unique architectural designs.

Thermal insulation and heat retention – wood is one of the best insulating materials, retaining heat up to 6 times better than brick and concrete. This significantly reduces heating costs and reduces the size of the heating system.

Ease of maintenance – wooden structures are easy to maintain. They require no regular upkeep and can retain their original appearance for a long time.

Wooden structures offer numerous advantages for modular buildings, including environmental friendliness, ease of installation, aesthetic appeal, thermal insulation, ease of maintenance, and much more. They are one of the most popular materials for creating cozy and elegant modular structures.

IV. Aluminum frames are lightweight and durable structures made from cost-effective aluminum. They are easily assembled on-site, allowing for rapid construction. Aluminum frames are widely used in modular construction worldwide. They are structures made of profiled tubes made from lightweight and durable aluminum. Aluminum frames offer many

advantages. Firstly, aluminum is corrosion-resistant, ensuring the durability of the structure. Secondly, it is a very lightweight material, making it easy to transport and install. Thirdly, aluminum frames are durable and resistant to deformation, allowing them to be used in a wide range of conditions and under varying loads. Aluminum frames are used in the construction of modular structures such as office buildings, warehouses, industrial buildings, shopping centers, etc. They allow for quick and easy site preparation, reducing construction time, and producing a high-quality finished product. Overall, aluminum frames are highly efficient and durable. They retain their shape and integrity for a long time, making them an excellent choice for modular construction.

V. Brick and concrete are more traditional construction materials, but they can be used for prefabricated architectural structures through the use of modern technologies, such as the speed of material joining or simplified construction methods using facade panels. Brick structures are often used to construct interior walls in modular buildings. The use of brick allows for high wall strength and improved sound insulation. Brick walls also have good thermal insulation, which helps reduce heating and air conditioning costs. Concrete structures are used for foundations, flooring, roofing, and exterior walls. Concrete provides high rigidity and load-bearing capacity, making it an ideal choice for modular structures. Concrete also provides excellent thermal and acoustic insulation, which is especially important for exterior walls and roofs. Overall, brick and concrete structures are used in modular structures to ensure high strength, durability, and stability. These materials also have excellent thermal and acoustic insulation properties, making them an ideal choice for creating comfortable and functional modular buildings.

Finally, I'd like to point out that modular urban structures offer great flexibility and mobility, making them an ideal solution in emergency situations. Rapid deployment of modular structures can save significant time and money, as well as ensure that those in need receive the necessary assistance during this challenging time.

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