



THE TREND OF MODULAR BUILDING CONSTRUCTION IN THE WORLD

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<https://doi.org/10.5281/zenodo.19418774>

ARTICLE INFO

Qabul qilindi: 22-mart 2026 yil

Ma'qullandi: 26-mart 2026 yil

Nashr qilindi: 31- mart 2026 yil

KEY WORDS

modular, construction,
prefabricated, fashionable,
volumetric.

ABSTRACT

Modular construction is generally considered an ideal alternative for reducing construction time and costs. It has evolved and is also used in high-rise buildings. Modular construction can be categorized as volumetric modules, prefabricated modules, panel modules, and modules with integrated technology. These structures are fully equipped and assembled units in a factory setting. They feature load-bearing and protective structures that ensure thermal parameters, physical and mechanical properties, stability, and rigidity. This method is believed to define the future of the construction industry in countries from Eastern Europe to China, including North America. Modular construction will enable project development in timeframes that would have been impossible 20 years ago. Therefore, this article provides an overview of trends in the use of modular construction in buildings.

Construction can be an expensive and labor-intensive undertaking. Delays are common and can be caused by a variety of factors, including extensive bureaucratic requirements, weather conditions, inadequate planning, staffing shortages, and so on. In this regard, modular construction is often an ideal alternative for reducing construction time and costs. Modular technologies are widely used in low-rise buildings for various functional purposes: office, residential, warehouse, sanitary and special-purpose spaces, etc. However, the rapid expansion of large metropolitan areas is favoring modular construction, which combines several technologies based on the principles of rapid construction [1]. Today, modular construction has been further developed and is also used in high-rise buildings, that is, buildings over 10 stories. [2]

Modular construction can be differentiated by volumetric modules (block boxes, block container) in 3D, which are fully equipped units, that is, they are a spatial structure assembled in a factory, having load-bearing and protective structures that provide thermal parameters, physical and mechanical properties of structures, stability and rigidity. Buildings from volumetric blocks are made of reinforced concrete. Steel is the preferred material for modular

buildings, since it has a higher load-bearing capacity [3]; the use of individual elements of the framing system (beams, columns, floors, wall panels, etc.), which are manufactured off-site and assembled on site [1], they are also known as modular constructions, including 2D panel system. It has a flat assembly approach used in housing, these panels can be equipped with ducts necessary for services such as heating, ventilation and air conditioning. This on-site assembly system is much simpler than traditional construction, but it is more complex than 3D module assembly and requires additional interior finishing [4], [5].

The main structural materials of modular buildings are steel and wood [3], modular buildings can be designed with interior and exterior finishes, and the built-in equipment, being high-quality products, can be assembled and disassembled, and also adapted for transportation [6]. This method is believed to determine the future of the construction industry, this technology is also known as integrated modular construction (MiC) in Hong Kong and permanent modular construction (PMC) in the United States [4].

By 2022, the share of permanent modular construction in North America (Canada, the United States, and Mexico) in the production of temporary and permanent modules will be 6.03% [7]. Industrial modular construction is well accepted in countries such as Brazil, Argentina, and Chile for accommodating the workforce (related to mining and energy); they have a small industry that is growing due to the high demand for office and administrative buildings, retail, and medical centers that are easy and quick to build. In Brazil, until 2019, modular construction was used more in the education sector and in markets [8]. Table 1 shows successful examples of buildings that were assembled in a factory and delivered to the assembly site.

Permanent modular construction is stronger in countries such as the UK, Germany, Belgium, the Netherlands and Luxembourg, in countries such as Italy, France, Poland, Turkey, modular construction is used on a smaller scale, by 2020, modular buildings will account for up to 2.5% of the total construction volume; as in North America, the industry is divided into permanent modular construction and relocatable modular buildings, where various hospitals, schools, apartment buildings, student apartments and hotels are made of prefabricated volumetric modules, transported to the site and assembled [6].

Thus, Russia is also at the forefront of developing residential projects using three-dimensional volumetric modules. Modular construction has enabled the construction of projects such as the Polyclinic in the village of Pervomayskoye in the Troitsky and Novomoskovsky administrative districts, standard modular hospitals in the Sakha Republic and Yakutia, and Holiday. Inn for 140 beds in Voronezh. [16] The growth trend in European countries is very noticeable due to the high demand for low-cost housing, in countries like China and Russia, technological development has allowed them to carry out building construction in a very short time, however, the construction trend is not developing so quickly in North and South America, as there is still some bias towards prefabricated production in the local market due to the lack of understanding and shortage of quality modular construction companies, it is expected that within the next 10 years, the prefabricated module industry will develop and mass production will be streamlined and standardized.

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