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FOAM CONCRETE AND LIGHT STEEL THIN-WALL CONSTRUCTIONS IN BUILDINGS AND STRUCTURES

ROMAN RADKEVICH, ELENA KREMNEVA, ALEXANDER KREMNEV
Polotsk State University, Belarus

Prefabricated frame and frameless technologies for the construction of buildings and structures are considered. The structures of roof and floor slabs made of foam concrete and light steel thin-walled structures are shown. The issue of the possibility of taking into account the joint work of light steel structures and foam concrete is considered.

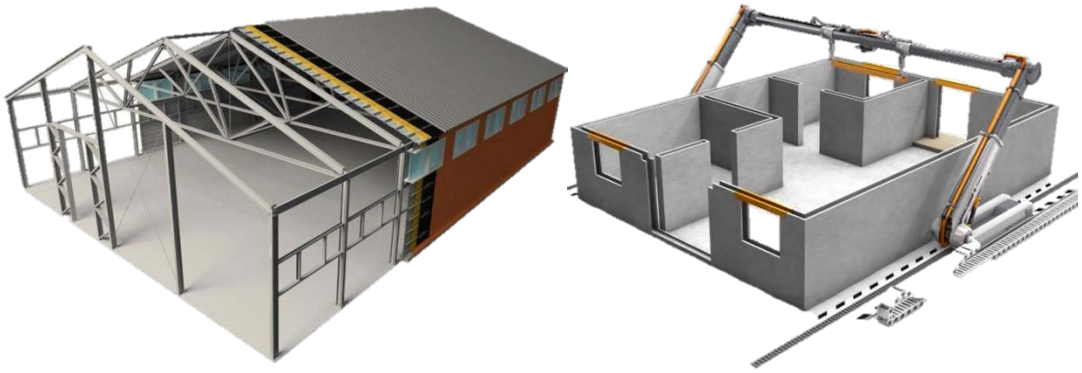
Innovative technologies can significantly simplify any processes. The construction industry is no exception. Today it is possible to build constructions and houses much faster, easier and cheaper due to quickly erectable structures. Such structures are built within a short period of time with minimal labor costs [1,2]. At the same time, technological progress in various types of structures leads to a decrease in their weight and cost of manufacturing or installation, while maintaining the same load-bearing capacity and performance. [3]

Among the construction technologies used for the construction of prefabricated houses, it is possible to distinguish frame and frameless ones (Fig.1). Further, to frame technologies we can refer:

– construction of light steel thin-walled structures (LSTWS). With the use of lightweight galvanized profile sheet [4];
– construction of light metal structures (LMS);
– technologies with the use of SIN beams, bisteel beams, post tensioned beams, beams with an orthotropic deck;
– tent constructions, etc.

The frameless technologies are:

– Arch technology;
– Construction of 3D printed houses [5], etc.



a) b)

Fig. 1 Technologies of prefabricated buildings and structures: a) frame [4]; b) frameless [5]

Table 1 provides a comparison of selected technologies in the construction of buildings of metal structures, bricks, monolithic concrete and panels [2].

It can be seen from the table that the best result for the ratio of indicators is typical for metal frame buildings and structures. One of the types of metal frames is LSTWS, which are becoming increasingly popular [2, 6–8]. The main advantage of LSTWS framing is its industriality. Building frames are delivered to the construction site in the form of ready-to-mount sets of marked parts, equipped with erection drawings and instructions. Structures of thin-walled frames are light-weight, which allows using shallow foundations. It should also be noted that the house, built of LSTWS, has virtually no construction waste. The construction uses hypoallergic materials that are safe for human health and the environment [2, 7, 8].

Table 1. – Comparison of certain types of erection technologies

Characteristics	Metal frame construction	Brick construction	Cast-in-situ concrete	Panel construction
Average construction period of a 6-storey building	4–6 months	10–12 months	8–10 months	6–8 months
Average ratio of construction cost	1	2	1,5	1,2
Average ratio of the cost of finishing works	1	1,5	1,5	1,5
Average ratio of reduced labor costs	1	2	1,5	1,2
Average ratio of energy consumption for heating	1	1,5	1,5	1,3
Possibility of light foundation	there is	no	no	no

As insulation for LSTWS systems, basalt mineral wool mats and plates, fiberglass wool, green fiber or other fibrous insulating materials are used. [8] Erecting LSTWS, foam concrete which is a light porous faux stone material on a cement binder, has become widespread too.

Cast-in-situ foam concrete is absolutely noninflammable and is applied in fireproof designs, creates monolithic layer of thermal insulation and can be filled practically into any mould. It is also extremely durable and cost-effective [9]. The possibility of obtaining foam concrete under any weather conditions is important too.

With the joint use of LSTWS and foam concrete the best types of corrosion protection of steel is galvanizing as it provides mechanical protection against oxidants, high adhesion to foam concrete, cathodic protection of iron due to excessive zinc electrons [2].

The combination of light steel thin-walled structures and cast-in-situ foam concrete allows such quality of construction that rare domestic or foreign technology can offer. Durable and reliable structures are ideal for both private residence and commercial use [10].

The most common structures in buildings and structures are flexible members such as beams, roof and floor slabs. Designs of roof and floor slabs of lightweight foam concrete are very diverse. They are a combination of foam concrete with a corrugated sheet used as a leave-in-place form; with a corrugated sheet throughout concrete with flexible C section interior supports; and as floor slabs of C sections or C section trusses filled with foam concrete (Fig.2).

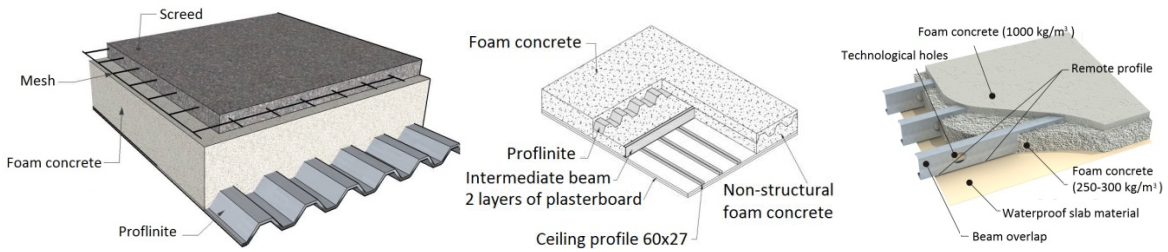


Fig. 2. Options for slab designs with joint use of LSTWS and foam concrete [3, 4]

Despite the widespread nature of such structures currently there are certain ambiguities in standard technical documents for the calculation of the design of roof and floor slabs of foam concrete and light sections, it is not clear how to account for joint work of LSTWS and foam concrete. This aspect needs further study [11]. It can be assumed that accounting for joint work of LSTWS and foam concrete in calculations will cut corners on materials of steel structures choosing light sections [10].

This kind of research is conducted in Russia, Belarus, Ukraine, Poland etc. [2,7,8]. Polotsk State University conducts research on the joint work of foam concrete and light steel thin-walled structures using flexible members as an example, namely, roof slabs.

The analysis of the studied material allows us to draw the following conclusions:

1) Buildings made of metal frame are very popular and profitable compared to brick, panel and monolithic ones.

2) Buildings and structures of LSTWS have little construction waste, safe for human health and the environment.

3) Heat-storing properties of the walls of LSTWS and foam concrete buildings are higher in comparison with wood and brick ones.

3) The combination of LSTWS and lightweight concrete allows us to increase the speed of construction, as well as significantly reduce the load on the foundation.

4) The standard technical basis for the calculation of structures of foam concrete and LSTWS needs to be supplemented in terms of accounting for the joint work of foam concrete and LSTWS.

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