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USING 3D PANELS IN SHORT-TERM BUILDINGS AS EXTERNAL CONSTRUCTIONS

S.E. Petrosyan, S.K. Petrosyan
National University of Architecture and Construction of Armenia, Yerevan, RA

3D panels are considered to be up-to-date external structures with certain important features.

The article first presents what 3D panels are, why they should be used and then methods of panel erection. We refer to their thermal resistance and present the advantages and disadvantages of using 3D panels.

Key words: 3D panels, structure, construction, construction construction technologies, foamed concrete, short creating.

Introduction

Under present-day conditions of technological development new demands are required from science. Particularly it concerns the introduction of technological achievements in the construction sector. Before launching them into the construction process, they go through many stages: processing, testing and commissioning. The main challenge of construction sector of the 20th century was to reduce construction period and costs.

There is currently a crisis of fundamental innovation around the world and in many areas. For example, not more than 7% of the natural raw material extracted in technologies for converting materials and energy is consumed in the finished product and the rest is wasted or used in vain. The current situation has led to new trends in the development of construction:

- Transition from discrete (cycle) technologies to continuous (intranet) production processes as the most efficient and rational.
- Introduction of non-waste technology cycles into production as it is more environmentally friendly [1].

3D panels used in short-term buildings is one such environmentally friendly and affordable technology.

Conflict setting

The technology of 3D panels is based on polystyrene foam and the use of shotcreting method. This advanced technology is unique in its simplicity and profitability; it reduces energy consumption and allows reducing both construction costs and time spent on the construction.

3D panel is a versatile element used to create almost all basic building elements and infrastructures (foundation, floors, walls, partitions, roof, stairs).

3D panel is a spatial structure consisting of a expanded polystyrene plate both sides of which are fixed wire fabrics made of high strength wire. The mesh fabrics are connected by penetrating metal rods [2]. Mesh fabrics are welded at an angle; it gives a spatial rigidity to the structure and simultaneously prevents expanded polystyrene core shifting.

Main advantages and disadvantages of 3D panels compared to traditional building structures:

3D panel consists of three-dimensional metal frame and expanded polystyrene foam light core.

The strength of this structure is additionally provided by diagonal cross rods attached to the mesh on all sides.

Standard panel with dimensions of 3x1.2 m weighs about 20 kg.

The advantages of 3D panels are:

1. strength;
2. simplicity of structure;
3. the possibility to quickly and easily install with hands;
4. energy and heat savings;
5. absence of strict foundation requirements.

As it has been already mentioned, the second component of 3D panels is expanded polystyrene which means that 3D panels have an organic structure. Expanded polystyrene has the following major disadvantages:

1. susceptible to UV degradation (corrosion);
2. low resistance to mechanical shock.

These two disadvantages of expanded polystyrene indicate that 3D panels with expanded polystyrene are not suitable for long-term buildings.

Given the fact that the 3D panel is considered an organic material, its core deteriorates over the years (25-30 years) and becomes a sandlike mass. It follows that after deterioration of the core two layers of foam concrete remain and the air between the layers, resulting in a complete change of thermal resistance and an adverse effect, as the thermal resistance of the air layer is quite low. Therefore, when calculating the durability of 3D panels, it is also necessary to calculate the thermal resistance.

The thermal resistance is calculated by the following formula:

$$K = \frac{1}{\sum R} = \frac{1}{\frac{1}{\alpha_i} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \cdots + \frac{\delta_n}{\lambda_n} + \frac{1}{\alpha_o}} \quad (1)$$

where:

λ – coefficient of thermal conductivity
δ – layer thickness
K – heat transfer coefficient
R – heat transfer resistance

Using formula 1, we will have in our example:

$$K = \frac{1}{\sum R} = \frac{1}{\frac{1}{\alpha_i} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \frac{\delta_3}{\lambda_1} + \frac{1}{\alpha_o}} = \frac{1}{\frac{1}{8.7} + \frac{0.035}{1.5} + \frac{0.07}{0.05} + \frac{0.04}{1.5} + \frac{1}{23}} = 0.61 \text{W/m}^2\text{°}C$$

where:

δ_1 = 35mm thickness of the first layer
δ_2 = 70mm thickness of the second layer
δ_3 = 40mm thickness of the third layer
λ_1 = 1.5 W/m°C the first and the third layers coefficient of thermal conductivity
λ_2 = 0.05W/m°C the second layer coefficient of thermal conductivity

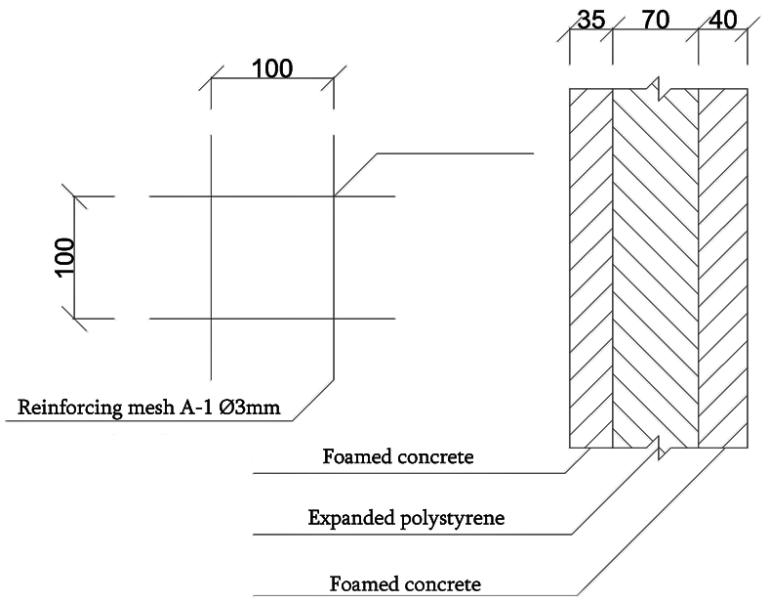

Fig. 1 Schematic structure of 3D panel

Features of erecting 3D panels

Now let us discuss the technology of assembly of elements and general installation more detailed. The 3D panel is a spatial branched structure consisted of high quality wire fastening meshes and rods which are welded at an angle with polystyrene foam and are held by fire rod (Fig.2).

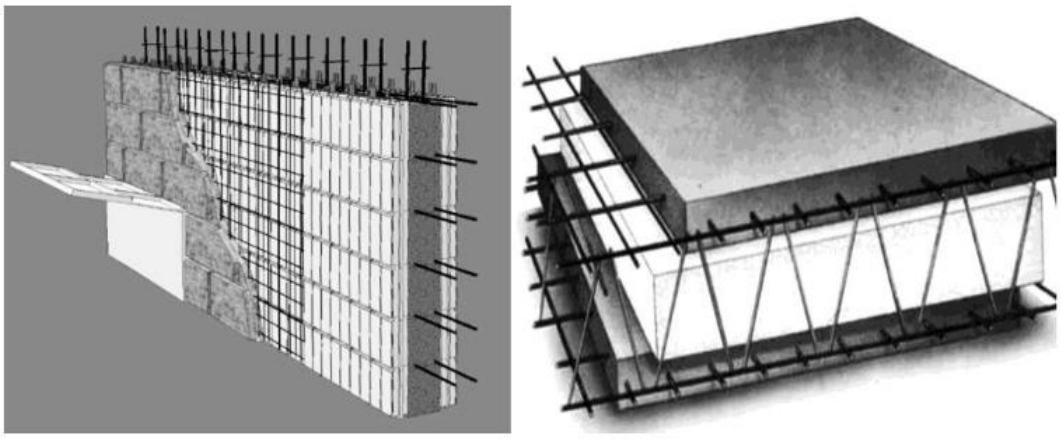

Fig. 2 Structure of 3D panels

Shotcreting is one of the most important stages of erecting 3D. This is a method of applying concrete layer or other mortar (plaster, clay) to the surface of concrete or reinforced concrete structures. This is a coating with foamed concrete. Shotcreting is applied under the compressed air pressure as a result of which the cement particles interact closely with the surface of the structure filling even the cracks and small pores (Fig. 3) [3].

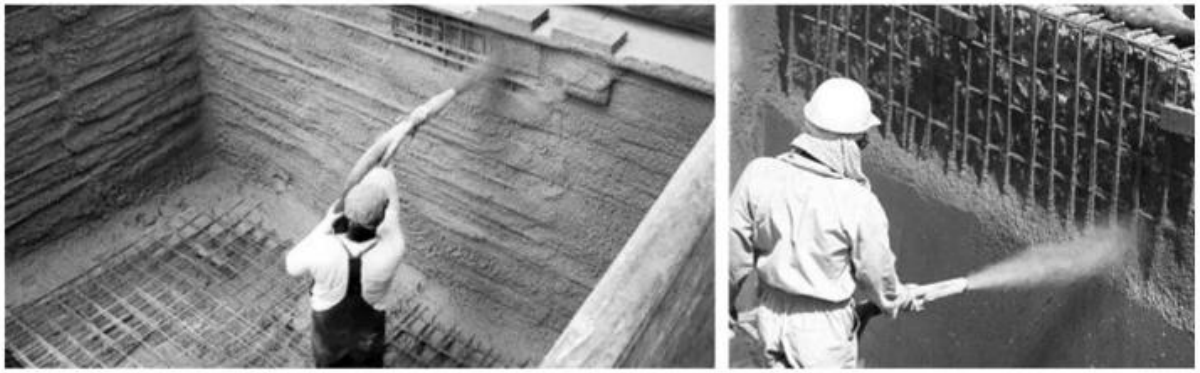

Fig. 3 Shotcreting process

Fast-hardening cement is used when a method of shotcreting with foamed concrete is applied. The panel is coated with 4-5cm thick foamed concrete layer from the outside and with 3-4 cm thick layer – from the inside.

3D panels can be applied to any building if the service life of the building and the heat-resistance calculation match [4].

3D panels are also used for internal walls. To ensure surface roughness the installation of panels starts at the corner of the building and they are successively fixed with reinforcing bars ensuring them with a soft wire. Installation of panels in one of the floors takes an average two-three days.

Fig. 4 Window and door parts installation

Installation of utilities is another important point in the building erection. The advantage of this technology is that it is quite easy to install all communications or initially to identify them considering the correct technological sequence of work. After all the steps are completed, proceed to the next design - the roof. 3D panels allow you to get any angle the most convenient for the roof.

Smooth surface allows to apply absolutely any type of coating [5].

Research results

The use of 3D panels provides the most rationality in economic terms. Compared to other traditional building structures, the cost of 3D panels is reduced by 60-70%. In addition, any method of interior decoration can be used: paints, wallpapers, tiles etc.

Combining correctly all structures we can obtain an appropriate reinforced concrete structure where the 3D panels are completed with reinforced concrete mesh.

The result is a building with fairly simple construction method.

Conclusion

Consequently as a result of our research we realized that 3D panels are one of the contemporary construction innovations and are widely used abroad. They are especially important when used in the short-term buildings.

An important advantage of 3D panels is that they are efficient. Compared to traditional constructions, 3D panels have a low cost threshold. However, in addition to the advantages, 3D panels have disadvantages making them suitable for buildings with short-term maintenance as due to air temperature fluctuations they will be corroded and the building will become unreliable.

Hence, these studies allow to realize that for meeting current construction requirements, the infrastructures or structures with features complying all the proposed construction requirements like 3D panels shall be used.

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3D ՊԱՆԵԼՆԵՐԻ ՕԳՏԱԳՈՐԾՈՒՄԸ ԿԱՐՃԱԺԱՄԿԵՏ ՇԻՆՈՒԹՅՈՒՆՆԵՐՈՒՄ ՈՐՊԵՍ ԱՐՏԱՔԻՆ ԿՈՆՍՏՐՈՒԿՑԻԱ

Ս. Ե. Պետրոսյան, Ս. Կ. Պետրոսյան
Ճարտարապետության և շինարարության Հայաստանի ազգային համալսարան, ՀՀ, ք. Երևան

3D պանելները համարվում են ժամանակակից շինարարական արտաքին կոնստրուկցիա, որոնք ունեն որոշակի կարևոր առանձնահատկություններ:

Հոդվածում նախ ներկայացվում է, թե ինչ են իրենցից ներկայացնում 3D պանելները, ինչի համար է անհրաժեշտ դրանց կիրառությունը, որից հետո ներկայացվում է, թե ինչ մեթոդներով է այն մոնտաժվում: Անդրադառնում ենք նրա ջերմային դիմադրողականությանը: Ներկայացվում են նաև 3D պանելների կիրառման առավելություններն ու թերությունները:

Բանալի բառեր. 3D պանելներ, կոնստրուկցիա, շինարարություն, շինարարական տեխնոլոգիաներ, փրփրաբետոն, տորկրետավորում:

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ИСПОЛЬЗОВАНИЕ 3D-ПАНЕЛЕЙ В НЕДОЛГОВЕЧНЫХ СООРУЖЕНИЙ В КОЧЕСТВЕ НАРУЖНЫХ КОНСТРУКЦИЙ

С.Е. Петросян, С.К. Петросян
Национальный университет архитектуры и строительства Армении, г. Ереван, РА

3D панели считаются современными внешними стороительными конструкциями, которые имеют некоторые важные своиствия.

В статье сперва говориться что из себя представляют 3D панели, для чего важны ихние использывание, а так же говориться как эти конструкции монтажируеться. Мы ссылаемся на его тепловое сопротивление. Также представлены преимущества и недостатки использования 3D панелей.

Ключевые слова: 3D панели, строительство, строительные технологии, пенобетон, кладка, торкретирование.

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