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UDC 69:504.03

CONVERSION OF DESIGN PRINCIPLES TO «GREEN» STANDARDS IN REPUBLIC OF BELARUS. SOLAR BATTERIES

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The term «green building» is examined in the article. The definitions of solar batteries and solar panels are given. Advantages and restrictions on the use of solar energy are specified. Some examples of solar panels usage in constructions on the territory of Belarus are presented. The analysis of potential efficiency of solar batteries usage on the territory of the Republic of Belarus at the expense of favorable conditions of insolation is carried out.

In the recent years the relation to housing construction in the highly developed countries has been changing under the influence of such global factors as exhaustion of natural resources, climate changes, overexploitation of lands and growth of population.

It is known that buildings around the world use 40 % of all consumed primary energy, 67 % of electricity, 40 % of raw materials and 14 % of reserves of drinking water, and also make about 35 % of emissions of carbon dioxide and nearly a half of all solid city waste [1]. In this regard, it is necessary to consider the main characteristics of housing in complex: environmental friendliness, profitability, energy efficiency, providing healthy lifestyle and comfort. These principles are fundamental in «green construction».

«Green construction» («Sustainable building») is a practice of construction and exploitation of buildings at simultaneous preservation or improvement of buildings quality, the purpose of which is to decrease the level of energy consumption and material resources throughout all life cycle of the building: beginning with a site choice for design, construction, operation, and finishing with repair and demolition.

The energy which is spent on production of materials is one of the main indicators: the energy consumption is lower, the used material is better. In this regard, steel, plastic, cement belong to the most energy-intensive construction materials, wood – to the least. That is why the statement that wood is the basis of the «green» house and is an environmentally friendly material is right.

The construction of buildings from wood on «green» technologies at this stage of development is actively conducted in the USA, Canada, Europe (Germany, Austria, France, Sweden, Norway, Finland), Japan, South Korea and some other countries. Belarus and Russia are lagging behind the developed countries and for the present use «green» technologies and materials only a little [2].

Most of people don't think over what amount of energy they consume and how these indicators can be lowered due to energy saving. Energy certification gives stimulus to people and to the organizations to invest in energy saving actions in their own buildings. In the Republic of Belarus within the pilot project energy certification of five buildings is carried already out and the results are very impressive [3]. The Renewable Power association has been created, the law «About Renewables» is adopted. Belarus entered the International agency on renewables.

The potential of solar energy in Belarus is rather big. Already now on roofs of private houses a large number of solar batteries appear [4].

«*Solar panels*» (solar batteries) are sets of the «solar cells» connected with each other and enclosed in a frame. «*The solar cell*» (a solar element) represents the small semiconductor device transforming light energy to electric energy.

This phenomenon was opened in 1839 by the French physicist Edmond Bekkerel and called in a consequence «photoeffect». The use of solar energy for receiving electricity has a number of advantages: it doesn't demand fuel, works constantly, silently. It has a long term of accident-free service, reliability, general availability, possibility of any change of power of operating system. Solar panels are an optimum choice for autonomous systems of power supply, but also they

have restrictions: in winter time the productivity of solar batteries decreases by one and a half or two times, they have low efficiency for use in heating systems, the need of high energy efficiency and sufficient intensity of light [5].

In general, in Minsk it is possible to use the same amount of energy, as in Warsaw, Berlin, Amsterdam, London. And in Riga, Tallinn and Scandinavian cities of solar energy it is much less, than in Minsk. Thus Germany provides 20 % of all the needs for energy at the expense of alternative sources, and by the amount of the sun energy it is on the first place in the world. By quantity of the solar energy arriving on a surface, Belarus is at the same level as Germany, Japan, Canada, where the solar power engineering develops very actively. Potential efficiency of solar batteries usage on the territory of the Republic of Belarus only at the expense of favorable conditions of insolation is more than 10 % higher, than in Poland, the Netherlands; it is more than 17 % higher, than in Germany.

In our country there are conditions for the development of the science intensive photo-power. There are large research centers in the field of micro and optoelectronics, the corresponding analytical and production equipment, a number of essential scientific results in the areas of materials science, chemistry, technology of silicon, connections of A3B5, A2B6, formation clarifying luminescent, sheetings, etc. which can be used when developing solar elements. Rather big material base isn't loaded and it is suitable for providing a large-lot production of solar elements and heliostations. In areas there are highly qualified personnel and there is experience of the international scientific cooperation in definite areas. Industrial production of solar batteries in the republic hasn't been developed yet, and there are no consumers as well. But there is a possibility of joint (complementary) use of photo-power with other types of renewables (solar collectors, bio-energetics, etc.). Some niches in Belarus where the photo-power with success can be used can be also found. The special system of preparation and retraining of personnel capable to make solar batteries hasn't been organized so far, but it can be created easily.

Anyway the work on installation of solar panels in the republic has begun. They can serve as an example: the building of Kraysk agricultural cooperative (Fig. 1), the house in Voronyansky St. in Minsk (Fig. 2), one of the buildings of Milavitsa factory (Fig. 3), BSUIR university (Fig. 4) and private houses in Minsk and Minsk area (Fig. 5.) and many others.

Fig. 1. Agricultural cooperative

Fig. 2. Minsk, Voronyansky St.

Fig. 3. Milavitsa factory

Fig. 4. BSUIR

Fig. 5. Private house in Minsk

Installed capacity of station in Kraysk agricultural cooperative makes 70 kW. There are 280 solar batteries and 3 inverters which transform the direct current developed by the battery to the variable. The farm is planned approximately on 400 animals. The electric power requirement of one cowshed with a milking office is about 40 kW • h. The installed batteries will allow supplying in the summer the requirement of this cowshed and one more which construction has only begun. «Excess» energy can be provided to a network. The station cost 1 billion rubles, and has to be repaid approximately in 8 years. In spite of the fact that the buildings belongs to the state, energy will go to a network at the usual price without the raising factor. The state is ready to buy such energy from the private companies three times more expensively than a usual tariff in order to stimulate the development of «green power».

On the rooftop of the building in Voronyansky St. as experiment solar batteries are installed from which the illumination of entrances works. The battery will transform solar energy into electric. The electric power is accumulated and

transferred in the special place where LED lamps are installed. For some years of their usage the economic feasibility in installation of similar solar batteries weren't seen therefore in practice they aren't used widely in Minsk.

The solar thermal collector installed on a roof of one of buildings of Milavitsa factory allows to heat up to 500 l of water.

On the roof of the building of BGUIR and ecological university named after A.D. Sakharov solar batteries are installed, but their application is more for demonstration and education, than practical.

Requirements to modern housing are constantly growing: they can't be satisfied without the use of the most perfect technologies and materials. The ecological assessment of construction materials becomes equivalent to indicators of their bearing ability.

It is necessary to consider the main characteristics of housing in complex: environmental friendliness, profitability, energy efficiency, providing healthy lifestyle and comfort.

The energy which is spent for materials production is one of the main indicators: the lower is energy consumption, the better is material for usage.

The advantages of solar energy usage: lack of fuel need, permanent and silent job during the long term of accident-free service, reliability, general availabilвity, possibility of any change of power of system.

The restrictions of solar batteries usage: decline in production in winter time by one and a half or two times, low efficiency for use in heating systems, need of high energy efficiency and sufficient intensity of light.

Potential efficiency of use of solar batteries on the territory of the Republic of Belarus only at the expense of favorable conditions of insolation is more than 10 % higher, than in Poland, the Netherlands; is more than 17 % higher, than in Germany.

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UDC 624.04: 620.17 (043.3)

EXPERIMENTAL STUDY OF WELDED BEAMS, SUPPORTED BY SLOPING REINFORCEMENT RIBON A FLAT BEND

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The article investigates the impact of the geometry and type of sloping reinforcement rib on the bending stiffness of reinforced thin-walled bars. Experimental study is designed to determine the coefficient changesin deformability of beams in the formulation along their length of sloping reinforcement rib. A quantitative assessment of the impact of sloping reinforcement rib on the stiffness of thin rods with bending moment is given.

The theory calculation of thin-walled spatial rods (they include I-composite beams) is continuously improving on the basis of the achievements in the field of theoretical and experimental studies. However, the foresaid does not apply to simple bending of thin-walled open section with sloping reinforcement rib.

In the special literature, predominantly national, only a few papers of theoretical [1, 2, 3, 5] and experimental [4, 6, 7] character are published, in which the authors discuss the issue of the steel continuous beams to flat bend with walls reinforced of sloping rib. The main disadvantage of these experimental studies was that they were conducted on models with small geometric dimensions (L = 1500mm). The lack of complete experimental data on the effect in an arbitrary section of the beam, as well as its bending stiffness required further research implementation, which are described below.

Moving in the middle of the span is found according to the formula Mor-Vereshchagin.

$$\Delta_i = \sum \int_0^l \frac{m_i \cdot M_P}{EI} dx \,. \tag{1}$$

Moments of cargo and unit status:

$$M_P^x = (\frac{ql}{2} \cdot x - \frac{qxl}{2}), \quad m_1^x = \frac{1}{2} x \,. \tag{2}$$