ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 7 , July 2019

Creation of Conditions for Industrial Use in the Construction of Non-Metallic Composite Rebar Produced in the Republic of Uzbekistan

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ABSTRACT:The prospects of application in the construction of basalt, plastic and glass-reinforced plastic fittings, produced in the Republic of Uzbekistan, as well as the field of their rational use in concrete structures are considered. It is noted that for the industrial application of composite polymer reinforcement in construction it is necessary to create a regulatory framework, including departmental building codes that take into account the specifics of the branches of the country's economic complex, and setting requirements for the design of relevant structures and construction in seismic areas, as well as the production of concrete structures reinforced with composite polymer reinforcement. There is a basis for this - a national regulatory document has been developed for the design of structures with composite polymer reinforcement. For effective introduction (in industrial volume) of composite polymer reinforcement in the construction of the country and for close cooperation of manufacturers, designers and builders, it is planned to create a research and development center for nonmetallic composite fittings at the Tashkent Architectural and Construction Institute.

I.INTRODUCTION

The durability of reinforced concrete structures is largely due to the corrosion resistance of steel reinforcement, the damage to which leads to a decrease in the strength resistance and rigidity of the structure and the development of large deformations and cracks. It is known that 75% of reinforced concrete structures are exposed to aggressive media.
In the design and construction of buildings and structures of any functional purpose, the issues of increasing the efficiency of structural and technological solutions by reducing energy-consumption and the cost of building products are considered. Composite polymer reinforcement is an innovative building material that allows to achieve positive results that are impossible when using traditional steel reinforcement, being an economically viable alternative to steel reinforcement.

The positive difference of composite polymer reinforcement is the following:
• composite reinforcement has a tensile strength indicator 2.5 times higher than that of steel reinforcement of class A500 with an equal diameter (steel reinforcement of class A500 is the most common in the construction of the CIS countries);
• composite reinforcement has a high corrosion resistance to aggressive media (acids, alkalis, salts, sulfur dioxide, ammonia water, etc.), which solves the problem of reinforcement corrosion in structures;
• specific weight is 4.5 times less, even for steel reinforcement, which allows to reduce the weight of the structure and reduces transport costs;
• composite polymer reinforcement refers to “self-tapping materials; The maximum working temperature of composite reinforcement in the thickness of concrete is 200 ° C;
• coefficients of linear temperature deformation of composite reinforcement and concrete almost coincide, which reduces the cracking in the structures);

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 7 , July 2019

• is a dielectric and magneto-inert (the possibility of use in structures for the energy industry and in medicine), radio-transparent (the armature does not create a shielding effect);
• thermal conductivity is almost 100 times less than that of steel - the absence of “cold bridges” in structures;
• does not lose physical and mechanical properties when exposed to low temperatures;
• the length of the reinforcing bar is not limited - the technological equipment for the production of composite reinforcement allows to provide any dimensional length to the requirements of the project;
• valves with a diameter of 4 to 10 mm can be transported in coils of 300 ... 500 m. M.;

II. SIGNIFICANCE OF THE SYSTEM

Due to the fact that the modulus of elasticity of composite reinforcement is 3.5 ... 4.0 times less than that of steel reinforcement, but the tensile strength of such reinforcement is many times greater than the strength of steel reinforcement, it is more efficient to use composite reinforcement in constructions with preliminary reinforcement. voltage. Since the values of modulus of elasticity of composite reinforcement and concrete are relatively close, and such reinforcement is deformed from stress during shrinkage of concrete, which provides a higher adhesion strength of reinforcement and concrete structures.

In studies [1, 2], it is stated that with an increase in the specific surface area of the tensioned reinforcement (a decrease in the diameter of the rods while maintaining their total area), the rigidity of bent structures significantly increases. The same experiments showed that, due to the elastic characteristics of basalt-plastic reinforcement, it is compatible with shrinkage deformations of concrete, which ensures a high value of adhesion of this reinforcement to concrete, while possessing high tensile strength, i.e., basalt-plastic reinforcement having a low modulus of elasticity (close to the modulus of elasticity of concrete) than steel reinforcement is more “sensitive” and responds easily to shrinkage of concrete.

Studies [3,4] showed that the structure of reinforcing bars has a significant impact on the strength and modulus of tensile strength of composite reinforcement. First, the polymer sheath of the reinforcing bar is subjected to stretching to a certain extent, and then internal longitudinally arranged threads enter the work. It has been established that with an increase in the diameter of reinforcing bars from 5 to 10 mm, the tensile strength of reinforcement decreases in some cases by 35%.

In work [5] it is stated that to substantiate the use of composite polymeric reinforcement in compressed elements and introduce them into national standards for designing methods for calculating such elements, it is necessary to conduct studies to study the effect of the following parameters on the strength and deformability of compressed sample elements : specimen cross-sectional shape, pitch and diameter of transverse reinforcement (clamps), percentage of longitudinal reinforcement, non-centre load application.

At the Centre for Studies of Seismic Resistance of Structures [6], they were tested by dynamic load, corresponding to the intensity of seismic effects of 7–9 points, concrete panels reinforced with fiberglass reinforcement. The authors found no mechanical damage in the tested structures. The solution to the problem of using composite polymer reinforcement as a working reinforcement in the construction of buildings and structures in seismic areas requires detailed study.

Due to the low modulus of elasticity of composite polymer reinforcement and, naturally, less rigidity compared to steel reinforcement, the calculated cross-sectional area of composite reinforcement of bending elements must exceed the cross-sectional area of steel reinforcement (to ensure regulatory requirements for Group II of limit states - for deformability). Therefore, composite reinforcement can be used for those conventional structures for which the requirements for Group II of limit states are not determinative. In this case, you can get more economic benefits.

In Uzbekistan, there is no ferrous metallurgy yet, so the use of composite polymer reinforcement in industrial volume allows us to reduce our country's dependence on imports of steel reinforcement.

Today, in Sioux economic features, the composite construction of glass and basalt fiber, which is produced by seven enterprises, is becoming widespread in the construction of the country, and basalt fiber is produced from local raw materials, the reserves of which are in the hundreds of years.

In our opinion, the introduction of composite polymer reinforcement (and other composite polymer materials) construction in industrial volume is achievable with:

• attraction of technologies for the production of composite building materials;
• successful commercialization of composite materials and products in our country;

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 7 , July 2019

• developing the potential of our own solutions in the field of “composite building materials and their application”.

In this regard, in the system "customer - designer manufacturer" should be established indivisible communication, which consists in the following:

• for the customer, the project should be economically profitable given the long-term operation of the facility;

• for designers, the physic mechanical characteristics of composite polymeric reinforcement and the regulatory framework for the design of structures reinforced with these reinforcements should be clear;

• the manufacturer must have an interest in producing high-quality building material in accordance with state standards and must be sure that the materials produced by them will be in demand.

In our opinion, this requires the creation of a regulatory framework, as well as the development of design and technological documentation for the production of individual structures reinforced with composite polymeric reinforcement (with the definition of the product range) and conducting test tests of experimental structures.

An interstate standard has been developed (GOST (STATE STANDARDS)(STATE STANDARDS)31938-2012 “Composite polymer reinforcement for reinforcement of concrete structures”), which classifies composite reinforcement according to the required characteristics and regulates requirements for its quality, mechanical properties, control method, general designation and acceptance rules, which allows to design structures with reference to the features of a particular manufacturer of composite fittings. This standard was adopted in 2012 by the Interstate Scientific and Technical Commission on Standardization, Technical Regulation and Compliance Assessment in construction, which includes representatives from the Republic of Uzbekistan.

III. LITERATURE SURVEY

Specialists of the Tashkent Institute of Architecture and Construction (TASI) developed the town planning norms and rules of Codes of the urban-planning 2.03.14-18 “Concrete structures with composite polymer reinforcement”, approved by the Minister of Construction of the Republic of Uzbekistan and put into operation on November 1, 2018. This project was carried out taking into account the results of the analysis of the basic standards and recommendations adopted in the existing technical documents on the design of concrete structures reinforced with composite polymer reinforcement in countries such as Russia , USA, Belarus, Ukraine, Japan, as well as the results of the analysis of the studies performed in this field over the past 10 years.

In the “Scope” section of the aforementioned town-planning norms and rules, composite polymer reinforcement has been recommended for use in the construction of facilities for the following branches of the country's economic complex: road and transport infrastructure, hydraulic engineering and water management, chemical and oil and gas production, urban engineering infrastructure, agricultural government destination, mines and tunnels of metro, energy, housing and communal services. Here, where necessary, the corresponding structures and specific structures are indicated. It is indicated that these standards do not apply to elements of buildings and structures that perceive vertical and horizontal seismic loads (columns and crossbars of the framework, floors, vertical supporting elements of large-panel and monolithic buildings, diaphragms and hardness cores).

IV. ANALITICS AND RESULTS

Also, at the suggestion of the leading design and research organizations of the country, the following recommendations are included in the “Scope” section of these standards: “When using composite polymeric reinforcement in structures, as well as when using combined reinforcement with steel and composite polymer rods, stipulated by the recommendations of these rules and regulations, it is necessary in the project to provide a calculation and experimental assessment of the strength, crack resistance and deformability of these structures, taking into account m requirements of the norms “Construction in seismic regions”.

The above limitations on the use of composite polymer reinforcement in the construction of seismic areas included in the Codes of the urban-planning standards 2.03.14-18 are associated with a lower modulus of elasticity and relative deformations of this reinforcement compared with the corresponding indicators of steel reinforcement. To expand the scope of composite polymer reinforcement in construction requires appropriate experimental research.

Prospects and problems of using composite reinforcement have an interdisciplinary character (in all fields of the economic complex of any country there is a sphere of construction).

ISSN: 2350-0328
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Vol. 6, Issue 7 , July 2019

The main areas of introduction of composite polymer materials should be the objects of the following branches of the country's economic complex (the leadership of the relevant ministries and departments are ready for “this” and are waiting for “this”):
• road construction;
• hydraulic engineering;
• land reclamation and water management;
• energy;
• chemical and gas-petrochemical industry;
• rural construction;
• housing and communal services.

To introduce composite polymeric materials into the construction industry of the above-mentioned branches of the country's economic complex, it is necessary to develop departmental building codes that take into account the specifics of these industries, and establish requirements for the design and construction in seismic areas, the production of building structures and products related to the use of composite in polymeric materials.

For close cooperation of manufacturers of composite polymer reinforcement, designers, builders, it is proposed to create a research and development centre for composite non-metallic reinforcement, using the appropriate human resources of the Tashkent Architectural and Construction Institute. The same opinion is shared by the leadership and members of the Technical Council of the Ministry of Construction of the Republic of Uzbekistan.

The main goal of the creation of the Republican Scientific and Innovative Centre for Composite Building Materials is to support and practical development of the “composite industry” in construction with close interaction of manufacturers, designers, builders.

The tasks of the Centre should be:
• establishment of mutually beneficial relations between producers and consumers of composite materials and products;
• creation of a laboratory base (certified and licensed) for testing and research of composite materials and products;
• organization of effective services to interested organizations in testing composite materials and products, the selection of technologies, the search for solutions in the application and development of technical regulations, standards, and the use of other regulatory documentation;
• organization of a group of consultant experts in the "composite industry";
• combining the efforts of ministries, departments, enterprises in the "composite industry";
• formation of the “ideology” of experimental design (due to the lack of a regulatory framework”).

There are 12 modern technological lines for the production of iron-concrete constructions at the concrete goods factories in Uzbekistan - bench-shaped moulding lines from Spain, Germany, Russia and the Republic of Belarus. The advantage of this technology is that despite the fact that projects are being developed “individually”, but production can be reoriented in a very short time in accordance with emerging needs. Different designs can be made on the same production line. Therefore, we can expect a significant increase in the share of use of composite reinforcement in construction in the production of structures without formwork moulding, and this will happen in a very short time.

In connection with the aforementioned argument, bar bridges with prestressed composite polymer reinforcement have been developed, designed to block openings in the brick walls of buildings for various purposes.

There are bar lintels manufactured according to the interstate standard GOST (STATE STANDARDS) 948 - 84 “Reinforced concrete lintels for buildings with brick walls. Technical conditions, reinforced with non-wound longitudinal reinforcement A400. In addition, such bridges contain cross-sectional armature of a bark-like curved mesh, which increases its intensity, and also makes it impossible to apply modern manufacturing techniques for reinforced concrete structures - the bench moulding method.

For the proposed bar lintels, ordinary heavy concrete of class B30 and longitudinal pre-stressed composite polymer reinforcement with a diameter of 5 mm are used, the lintel has a height of 140 mm, and a width of 120 mm. The prestressing of composite polymer reinforcement makes it possible to increase the rigidity and crack resistance of the lintel, which leads to an increase in the operational load on it, and makes it possible to do without steel reinforcement and such products from it: grids, frameworks, sling loops (Fig. 1).

ISSN: 2350-0328
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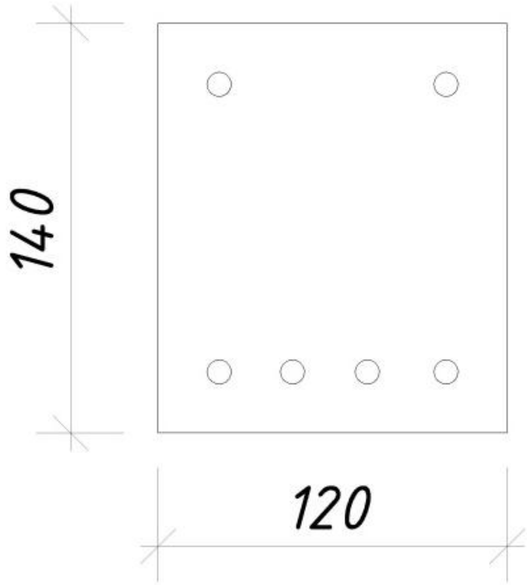
Vol. 6, Issue 7 , July 2019

Fig. 1. Bar lintel with prestressed composite polymer reinforcement Ø5mm.



Thus, a nomenclature of bar-shaped concrete bridges with composite polymer reinforcement having a length of 1.0 to 3.0 m is created for use in wall fences made of brick masonry 120, 250, 380 and 510 mm of reduced metal content (Fig. 2).

The design of the proposed lintel makes it possible to apply a modern method of manufacturing pre-stressed structures and to obtain a product of any length, starting from the greatest and less - the bench-free moulding method.

ISSN: 2350-0328
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Vol. 6, Issue 7 , July 2019

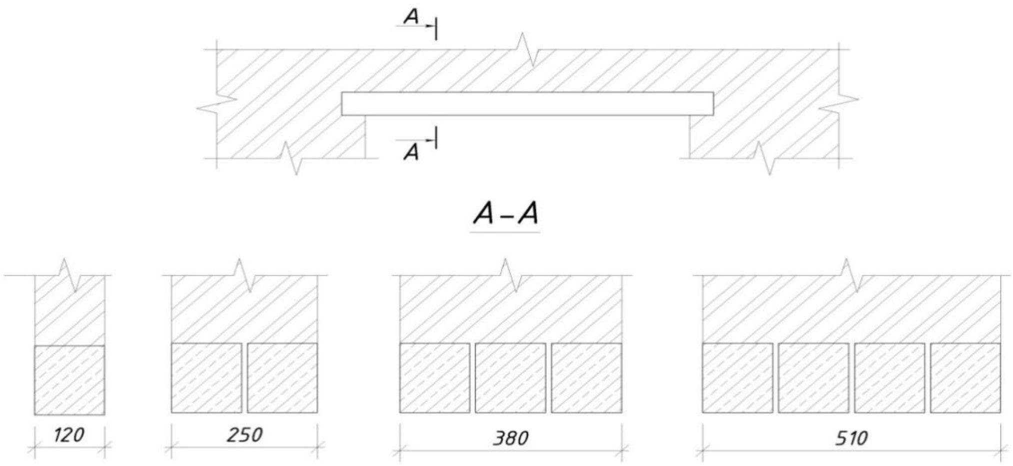

Fig. 2. The possibility of using the proposed lintel bridges in the wall fences of brick masonry.

The peculiarity of the proposed jumpers is that with a brick wall thickness of 120 mm (half-brick) one jumper is installed, with a thickness of 250 mm (one brick) two jumpers, with a thickness of 380 mm (one and a half brick) four jumpers. The device of such a jumper on the wall opening can be performed manually, since the jumper weight from 1.0 to 3.0 m in length is from 41 to 123 kg.

By order of the Uzbek-Russian enterprise BINOKOR TEMIR-BETON SERVICE JV, the specialists of the Tashkent Architectural and Construction Institute developed project documentation and technical conditions for the production of squared concrete lintels, reinforced with pre-stressed composite polymer reinforcement, and produced using the form-free molding technology.

A patent was received for the pre-stressed jumper utility model under number FAP01319, registered in the state register of utility models of the Agency for Intellectual Property of the Republic of Uzbekistan on November 30, 2018.

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