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APPLICATION AND CLASSIFICATION OF COMPOSITE REINFORCEMENT IN CONSTRUCTION

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Abstract:
The article provides information about the properties of composite reinforcement, its main advantages and disadvantages compared to traditional steel reinforcement. The areas of application of composite reinforcement are considered, examples are given in which it is advisable to use this type of reinforcement.

Keywords: reinforcement, fiberglass, fiberglass, composite reinforcement, steel reinforcement, concrete, reinforcement properties, corrosion.

Introduction

Polymer composite rebar (PCR) is an innovative development in the field of advanced materials for the construction industry. Such fittings are superior to steel counterparts in terms of strength, resistance to external factors and price characteristics. It is actively used in reinforcing concrete structures, strengthening the roadway, building foundations and other construction processes. As a result of the production of PCD, a material is obtained that fully meets all modern requirements for quality, safety and reliability.[14][15] In addition, composite reinforcement is distinguished by its unpretentiousness in operation. It can be used in a wide temperature range from -70°C to +100°C. At the same time, PCD has a long service life and is characterized by a high degree of corrosion resistance [1–3]. However, the use of polymer composite reinforcement is possible only with some caution. This is due to the fact that the regulatory framework is not sufficiently developed, and for the widespread use of PCA in design, it must be developed on the basis of comprehensive studies. [16]

Reinforced concrete was created unintentionally in the middle of the 19th century and fundamentally changed the development of building science and technology. By the first third of the 20th century, reinforced concrete had already won a leading position in construction and still remains the main modern structural material. As construction practice has shown, despite numerous advantages, reinforced concrete has a number of disadvantages, as a result of which research is currently underway to develop a new material that will eliminate the disadvantages of reinforcing steel and will have all its advantages. An alternative to steel reinforcement, according to the inventors, is composite (polymer composite) reinforcement [4]. Over the past 15 years, composite materials have become the most advantageous when applied in flexible concrete structures. Currently, more than 10 million running meters of such reinforcement are used every year in the world [5].

The first mention of polymer-composite reinforcement dates back to the second half of the 20th century, and research on the creation of high-strength non-metallic reinforcement, the study of its properties and rational area of use was started in the United States as early as 1960. [19][20]

As is known, composites reinforced with fibers or whiskers are called fibrous, examples of which are bricks with straw and papier-mache. However, the use of even a small content of fillers in such composites contributes to the emergence of new and qualitatively improved physical and mechanical properties and characteristics. [13] [14]

It should be noted that a change in the dimensional configuration and concentration of fibers contributes to a wide variation in the properties of the material. In addition, “reinforcement with fibers gives the material anisotropy of properties (the difference in properties in different directions), and by adding conductor fibers, it is possible to impart electrical conductivity to the material along a given axis.” The matrices and fillers of this material structure are arranged in layers (layers of extra strong glasses reinforced with polymer films).[6]

Data analysis allows us to note the main divisions in this classification: by the type of composite materials (Fig. 1), by the geometry of the filler (Fig. 2).

Also, after analyzing, composite materials can be divided into two main groups according to the nature of the components (usually the matrix material):

- with a metal matrix;
- with non-metallic matrix.

However, due to the fact that this classification covers a rather large scope in the construction industry, it is necessary to clarify this classification, the result of which is shown in Fig.1.

It should be noted that metal composite materials include materials based on a metal or alloy component (most often such components are Al, Mg, Ni and their alloys). [12][17][18]

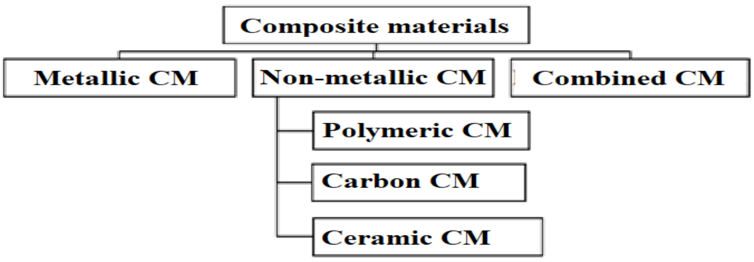

Figure 1. - Refined classification of composite materials by the nature of the components.

Non-metallic composite materials are divided into:
- polymeric (epoxy, polyester, thermosetting resins and polymeric thermoplastics);
- carbon;
- ceramic.

The proposed classification of composite materials was based on the following features: the geometric component of the component composition of the material, the location and nature of the composites.[7]

Composite materials can be divided "according to the arrangement of fillers, three groups of composite materials are distinguished:
- with a uniaxial (linear) arrangement of the filler in the form of fibers, threads, whiskers in the matrix parallel to each other;
- with a biaxial (planar) arrangement of the reinforcing filler, whisker mats, foil in the matrix in parallel planes;
- with a triaxial (volumetric) arrangement of the reinforcing filler and the absence of a preferred direction in its location.

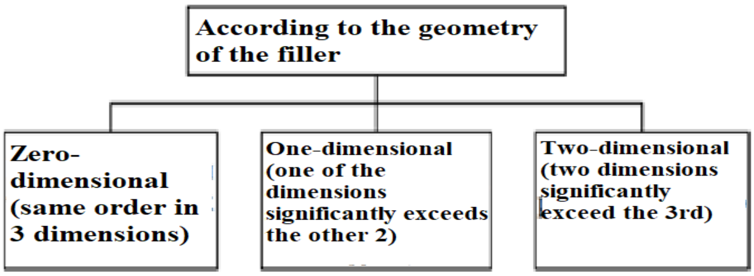

Figure 2. - Classification of composite materials according to the geometry of the filler

After analyzing the scientific works of Kuzevanov D.V., Umansky A.M., as well as materials, the main advantages that can be provided by the use of composite materials:[8]
- comparatively low density;
- high specific strength and rigidity, the average values of which, in comparison with traditional materials, are given in table. one;
- high chemical and corrosion resistance;
- manufacturability of processing into products;
- high fatigue characteristics of fibrous CM;
- the ability to control power flows due to the rational arrangement of fittings;
- the presence of special properties (radio transparency, heat resistance, etc.).

However, it should be noted that composite materials also have a number of disadvantages: [11].
- anisotropy - the same properties can differ tenfold depending on the direction of the external action (along the fibers or across);
- high specific volume;
- hygroscopicity - a property of the material, which is characterized by the absorption of water vapor from the air;
- toxicity.

Having analyzed the basic information about composite and metal reinforcement, the main areas of its application, as well as its characteristics and main properties, a comparative analysis of metal and composite reinforcement was carried out, the results of which are summarized in Table 1. As part of the analysis, the types of reinforcement were compared in terms of parameters, the main of which are: modulus of elasticity, coefficient of linear expansion, and tensile strength [9] [10].

Comparative Analysis of Metal and Composite Rebar

Table 1

Specifications	Metal reinforcement of class A-III (A400)	Non-metallic composite reinforcement (RFG - fiberglass, RBP - basalt-plastic)
Specific gravity	According to the norms	Lighter than metal reinforcement
Modulus of elasticity, MPa	200 000	45 000- RFG 60 000- RBP
Relative extension, %	0,195	2,2- RFG and RBP
Linear expansion coefficient αx×10-6°C-1	13-15	9-12
Density, t/m³	7,85	1,9- RFG и RBP
Electrical conductivity	Electrically conductive	Not electrically conductive - dielectric
Produced profiles	6-80	Russia: 4-20. Foreign suppliers 6-40
Environmental friendliness	Eco-friendly	Eco-friendly - does not emit harmful and toxic substances
Durability	According to building codes	Projected durability of at least 80 years
Replacement of reinforcement according to physical and mechanical properties (except for the value of elongation under load)	-5Bp-1 wire -6A-III -8A-III -10A-III -12A-III -14A-III - 16A-III	- RFG -4, RBP -4 - RFG -6, RBP -6 - RFG -8, RBP -8 - RFG -8, RBP -8 - RFG -10, RBP -10 - RFG -12, RBP -12
Replacement of reinforcement by elongation under load (same elongation under the same load, within the limits of elastic deformation of steel reinforcement)	-6A-III -8A-III -10A-III -12A-III -14A-III - 16A-III	- RFG -12 - RFG -16 - RFG -20 - - -
Temporary tensile resistance, MPa	390	600-1200 - RFG (with increasing diameter, the temporary tensile strength decreases, for example RFG 8-1200, RFG 16-900, RFG 20-700) 700—1300 — RFG

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