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استخدام قضبان الالياف المركبة في المنشات الخرسانة

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الخلاصة

يستخدم حديد التسليح في المنشات الكونكريتية كمادة اساسية في تعزيز الخرسانة.

نظرا لارتفاع تكلفة حديد التسليح تحول العديد من الباحثين والمصنعين لاستبدال حديد التسليح لمواد اخرى ذات خصائص هندسية افضل وتكاليف منخفضة. في بعض البلدان المتقدمة مثل روسيا بدأوا باستخدام قضبان من البلاستك المقوى بالألياف ومع ذلك فان فعالية هذا التحليل المقارن البديل بين حديد التسليح والالياف البلاستيكية المقواة بالالياف تم انجاز المقارنة من خلال قائمة من الانشاءات التي تشير الى استخدام هذه القضبان هو اكثر فعالية من حديد التسليح.

الكلمات المفتاحية: مركب التسليح المقوى بالألياف التعزيز، بناء الخرسانة المسلحة الكفاءة الاقتصادية، تكنولوجيا البناء.

ABSTRACT

In concrete construction, steel has been used as a fundamental component of concrete reinforcement

Due to the high cost of steel, many researchers and manufacturers have turned to replace steel with other material better engineering properties and low costs. The study discusses metal reinforcement with fiber-reinforced plastic bar (FRP). In some developed countries began using fiber-reinforced plastic bar. However the effectiveness of such replacement comparative analysis between steel reinforcement and fiber-reinforced plastic bar (FRP). The comparison is accomplished by a list of constructions in which indicate the using of FRP is more effective than steel reinforcement

Keywords: composite reinforced rebar, reinforced construction, Optimization, engineering

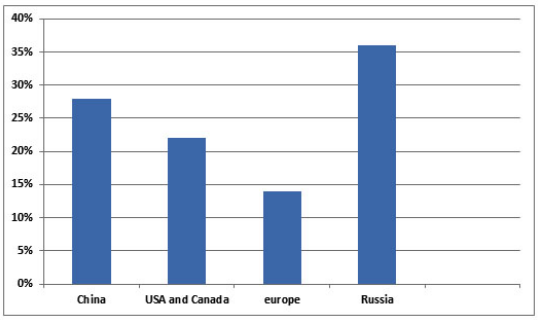
Introduction

The rise of mankind's requirements led to the construction of not only buildings, but also various facility structures. Buildings have become more complicated, higher, and wider than ever before, requiring an increase in structural stiffness. Even in the beginning of A.D. On Cecilia Island were attempts to make building walls stiffer by placing metal bars into brickwork. However, this technology became wide spread only from the middle of the XIX century, when a great number of concrete constructions began. The combination of stiffness and compression of concrete with tension of reinforcement opened the new age of construction. In modern time reinforced concrete is most popular construction material. The reinforcement is made of separate bars, wire meshes, cages and embedded parts. The reinforcement bars may have different shape to improve contact with concrete. In the middle of XX century the science of polymers appeared which is bound with physics and chemistry. Research of polymer properties has a great influence to construction. It allowed not only to improve properties of existing materials but also to create a new ones such as fiber-reinforced plastic rebar. Replacement of old building materials by modern with same characteristics is important, because it leads to significant cost savings. In particular modern materials allow not only reducing the consumption of expensive raw materials, such as steel, but also to facilitate the production process and significantly reduce the transportation and installation costs due to its light weight. The study of the construction market in Russia revealed that fiber-reinforced plastic (FRP) production is well established, while its use is not so extensive [1-3

FRP) bars are a new structural material in the field of civil engineering. The basic constituent materials for reinforced concrete design have changed very little in the past 100 years. A structural reinforcing bar made from filaments or fibers held in a polymeric resin matrix binder. The FRP Bar can be made from various types of fibers such as Glass (GFRP) or Carbon (CFRP). FRP bars have a surface treatment that facilitates a bond between the finished bar and the structural element into which they are placed. FRP Bars are intended for use as concrete reinforcing in areas where steel reinforcing has a limited life span due to the effects of corrosion. They are also used in situations where electrical or magnetic transparency is needed. In addition to reinforcing for new concrete

construction, FRP bars are used to structurally strengthen existing masonry, concrete or wood members

Since 2008, China has been the leading producer of composite reinforcement, accounting for around 28% of the global total. Composite reinforcement is commonly used in the United States and Canada, and according to various estimates, it accounts for around 22% of the entire volume of the reinforcement market. The EU countries collectively account for around 14% of the global composite reinforcing market. The Russian market absorbs only about 0.4%. These data demonstrate the potential opportunities of the Russian market for composite materials



1-Objectives of study

The purpose of this research is to give suggestions about FRP and its applications. These issues possess been resolved to realize this objective

1-Make an evaluation of metal reinforcement and FRP properties .

2-to specify the kinds of buildings where using FRP is recommended .

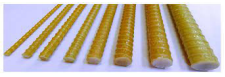
3-investigate the application requirements for metal reinforcement and FRP

4-to investigate a cost-benefit analysis of FRP and metal reinforcing applications

2-Description of the research

The research was based on the available source data. Due to the received information, FRP could be classified into the following types based on the type of continuous reinforcing filling [5] (see Table .(1

Table1. Species of Fiber-reinforced plastic

.No	Name	Abbreviation	The type of reinforcing fiber
1	Glass-reinforced plastic 	GRP	Fibers formed from a melt of Inorganic glass
2	Basalt- reinforced plastic 	BRP	Fibers formed by melt basalt And gabbro diabase
3	carbon-reinforced plastic 	CRP	Fibers is formed be organic Fibers by pyrolysis of Precursor and containing at Least 90% by weight carbon
4	Aramid-reinforced plastic 	ARP	A fiber formed from the Linear fiber-forming polymers In which at least 85% of the amide groups directly linked to two benzene rings
5	-Combined-fiber reinforced plastic-	CFRP	GRP, BRP, CRP or ARP additionally Filled with continuous reinforcing Filler of another type or types of fiber

According to the research, the most commonly used forms of composite reinforcement are glass-reinforced plastic (GRP) and basalt-reinforced plastic (BRP). [6;7]. Table 2 represents a compared ..study of the two types of composite reinforcement characteristics and metal reinforcement

Table 2. analysis of two types of composite reinforcement characteristics and steel reinforcement

Characteristic	SR	GRP	BRP
Material	Steel	Glass fiber of 13-16 microns diameter bond with polymer.	Basalt fiber of 10-16 microns diameter bond with polymer
Tensile strength, σb, MPa	360	600-1200	700-1300
Modulus of elasticity, E, MPa	200,000	45,000	60,000
Elongation, δ, %	25	2.2	2.5
Density, t/m³	7.85	1.9	2.0
Operating Temperature Range	from -60 °C to + 650 °C	from -60 °C to + 650 °C	from -260 °C to + 982 °C
Corrosion resistance to aggressive environments	Corrodes with rust release products.	Stainless material. Resistance to alkaline medium of concrete.	Stainless material. Resistance to alkaline medium of concrete.
Thermal conductivity, Vt/(m*K)	56 for reinforcement of ordinary carbon steel; 17 for stainless steel reinforcement	<1.0	< 0.46
Electro conductivity	Electro conductive	Dielectric (if necessary, may imparting electrical properties)	Dielectric (if necessary, may imparting electrical properties).
Magnetic behavior	Magnetic	Non magnetic	Non magnetic
Produced sections, mm	6-80	4-20 (in Russia); 4-40 (foreign suppliers)	4-20 (in Russia); 4-40 (foreign suppliers)
Length, m	6-12	Any length on request	Any length on request 100 years
Lifetime	~40 years	~80 years	~100 years
Usage in prestressed concrete	Does not involve additional difficulties	Requires special anchor.	Requires special anchor.

Table 2 shows that with increase of reinforcement bar diameter temporary tensile strength decreases. So for example GRP of 8mm diameter possess temporary tensile strength of 1200 MPa, .[while the GRP of 16mm diameter - is 900 MPa, and for diameter 20mm - 700 MPa. [4

Also it should be remarked; that the steel reinforcement have significantly higher modulus and elongation than composite rebar [8]. Graphs of load elongation behavior shows that FRP has no plot point. Thus, in the case of tensile strength approaching the distraction of reinforcement happens instantly. However, this disadvantage is compensated by considerably bigger GRP and BRP tensile strength compared with metal rebar. Small density and significantly lower thermal conductivity, compared with steel reinforcement may be defined as advantages of FRP [9]. Also GRP and BRP .[resistance an alkaline environment of concrete doubles their life compared to steel [10

Also composite rebar is nonmagnetic and dielectric [11], what makes it very useful in the construction of such facilities as rooms for magnetic resonance imaging in hospitals and toll fees, .which uses radio frequency identification of pre-paid customers

Due to the composite reinforcing bars can be manufactured with any length and shape, they

can be effectively used in the construction of complex architectural forms, for which usage of steel reinforcement is often impossible. [12] At the same time, the use of composite reinforcement in prestressed concrete is related with considerable difficulties. To fix the FRP additional anchoring [requires. Without using anchors destruction of fixed parts observed. [13-14

The heterogeneous composite reinforcement structure gives the opportunity to include in it materials with additional properties. Thus, using a steel core one can impart conductive properties to FRP. And integration of optic sensors to the reinforcement fiber allows remote monitoring of structures and pavement state. [15

For comparison of technical and economic characteristics composite reinforcement economic efficiency calculation was conducted. Such characteristics as weight and price per meter of bar were selected as a basis for the calculation

meter composite reinforcement weight is determined according to the manufacturers' data. 1 Cost of 1 meter reinforcement is defined as the average value of the market prices. [16-21]Table 3. Replacement of MR on FRP

SR		GRP		BRP	
Type	Weight of 1 lm (kg)	Type	Weight of 1 lm (kg)	Type	Weight of 1 lm (kg)
6A- III*	0.222	GRP-4**	0.026	BRP-4**	0.026
8A- III*	0.395	GRP-6	0.040	BRP-6	0.040
10A- III*	0.617	GRP-8	0.072	BRP-8	0.072
12A- III*	0.888	GRP-8	0.072	BRP-8	0.072
14A- III*	1.210	GRP-10	0.110	BRP-10	0.110
16A- III*	1.580	GRP-12	0.184	BRP-12	0.184

N A-III: N- rebar diameter, mm; A-III - class of reinforcement according to GOST*

Yield point m 390 N/mm2) ** GRP- N, BRP- N – rebar diameter, mm)*5781-82

3-Conclusions

Advantages and disadvantages

The research showed the following advantages

1-High stiffness .

2-Low specific weight .

3-Low thermal conductivity .

4-High corrosive resistance inside aggressive environment .

5-Wider than steel reinforcement operating temperature range. In case of BRP .

6-The possibility to manufacture bars of any length and shape on request .

7-Durability is 2-3 times higher than for steel reinforcement .

8-Possibility to include optic sensors in the reinforcement fiber that allows remote monitoring .

of structures

Following limitations of FRP was reveal as well

1-Low modulus in comparison with steel reinforcement .

2-No possibility of structural folds during reinforcement works. However, this is offset by ability to make curved fiber reinforcement directly during production process in accordance with the certain project

3-Inconvenient to use in prestressed concrete .

4-Recommendations for application

As the result of conducted research the following use of FRP can be recommended

1-For the reinforcement of concrete structures and mixed concrete reinforcement .

2-In the reinforced structures affected by aggressive environment, corrosive for steel (reinforcement) chloride salts, high concentrations of corrosive gas, etc

3-In the elements of road construction, which are exposed to aggressive anti-icing agents .

4-In the repair of concrete structures damaged by exposure to corrosive environments .

5-In cases with no possibility to provide the regulatory requirements for the thickness of the protective layer (thin-walled structures for various purposes, such as panels of noise protection (structures, fences, architectural design and other purposes

6-For reinforcing masonry, especially in winter time when curing accelerators and antifreeze are (adding to mortar (chloride salts that cause corrosion of steel reinforcement

7-In the design of bridges, as they are the most susceptible to corrosion. (The support because of constant contact with the water, and the upper part of the slab due to the application of anti-icing (agents

8-In areas for magnetic resonance imaging in hospitals .

9-In traffic booth uses radio frequency identification of pre-paid customers. Usage of steel . reinforcement in this case is not possible, because it interacts with the electromagnetic signals generated by the equipment

10-In building structures of complex shape, where difficult to use steel reinforcement

11-In the constructions requiring their internal state monitoring

In the common case for building structures is recommended to use steel reinforcement. Due to the fact that it has the higher modulus and elasticity, what in the emergency case provides a longer collapse period of constructions. And this, in turn, allows people to safely leave the dangerous area

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