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ScienceDirect

Procedia Engineering 153 (2016) 361 – 365

Procedia Engineering

www.elsevier.com/locate/procedia

XXV Polish – Russian – Slovak Seminar “Theoretical Foundation of Civil Engineering”

Application FRP-rebar in the manufacture of reinforced concrete structures

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Abstract

Reinforced concrete is one of the first places in terms of use in various areas of construction. This is primarily determined by its relative cheapness and durability. Concrete Durability significantly associated with metal reinforcement durability. Durability depends upon the metal reinforcement corrosion that occurs under the influence of an aggressive environment. As a result, corrosion of the metallic reinforcement and, to some extent, of the concrete, there is a loss of bearing capacity of concrete structures in general and buildings. To ensure the durability of concrete structures is necessary to take measures against the development of concrete and reinforcement corrosion. The object of the study are reinforced concrete constructions basalt reinforcement. Restore the bearing capacity of reinforced concrete structures with corroded reinforcement is possible using known design techniques.

However, essentially no use of technology in the construction field and specific data on the bearing capacity of concrete structures with basalt reinforcement. No complete information on the value of its adhesion to concrete and its dependence: the composition of concrete and its method of compression; treatment of the outer surface of basalt reinforcement in various ways to increase its adhesion to concrete; destruction of the nature of such structures from the effects of external loads.

The search for alternative ways of replacement of the metal reinforcement in concrete structures bearing on the composite, not subject to corrosion and, at the same time having a high load-bearing capacity, is the actual research task. It is known that composite materials to minimize corrosion and other security and environmental impact. At the same time, they must be extremely reliable to manufacture environmentally friendly and does not emit harmful substances polluting the environment.

Currently, intensive research to find ways to replace metal in structures of the other valves. An example of such research is to create different types of plastics, which are gradually replacing it. Work is underway in the field of replacement of the metal reinforcement in the non-metallic fittings on the basis of modern composite materials.

A major breakthrough in this direction in recent years was the opening of "basaltic technology" that allowed the "update" the base of building materials for new building designs types of valves.

Peer-review under responsibility of the organizing committee of the XXV Polish – Russian – Slovak Seminar “Theoretical Foundation of Civil Engineering”.

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Peer-review under responsibility of the organizing committee of the XXV Polish – Russian – Slovak Seminar “Theoretical Foundation of Civil Engineering”.
doi:10.1016/j.proeng.2016.08.128

Keywords: information modeling; organizational and technological documentation; formal language; CAD systems

Introduction

It should be noted the fundamental results in the direction of improving physical models of the power of resistance of concrete structures exposed to power and environmental impacts, resulting in works N.H. Harutyunyan, V.M. Bondarenko, V.N. Baikov, A.A. Gvozdev, V.I. Rimshin, and others [3].

The concept of structural safety and designation of the main factors determining its formulated Y.N. Robotnov and V.M. Bondarenko, who originated the idea of taking into account history of work structures, allowing a realistic assessment in the aftermath of constructive security.

Subsequently, scientists V.V. Bolotin, O.D. Astafev, E.A. Korol, A.G. Tamrazyan, developed and supplemented by questions of project impacts caused by emergency situations, taking into account the evolution of accumulation of power and environmental damage [2].

Protective layer of concrete reinforcement provides protection from external influences in reinforced concrete structures. The protective layer provides reinforcement joint work with concrete, protection from exposure to high temperatures and other effects as well. Take into account the type and size of structures, operating conditions, the valve diameter and the appointment in the appointment of the thickness of the protective layer. High-strength non-metallic fittings on the basis of basalt fibers and synthetic resins are of particular interest. Searches research and test results on the strength, alkali resistance, adhesion to concrete (instead of metal) have shown high efficiency of rebar based on basalt fiber in their operation in aggressive environments. These data allow us to judge the performance of this valve.

On the basis of a complex of experimental and theoretical studies to identify the clutch mechanism basalt rebar to concrete - the purpose of research.

Method

As is well known metal fittings does not have full adhesion to concrete over the entire contacted surface due to the formation of water lenses and voids around the shaft during concreting, which adversely affects the fracture toughness designs [1]. Furthermore, due to the action of alkaline medium of the concrete mix and water, after contact of the concrete with a metal rod corrosion processes begin polling. This is one of the main factors affecting the strength of reinforced concrete structures.

Advantages of basalt reinforcement:

• is not subject to corrosion, very little changes its mechanical properties under the influence of acids, salts and alkalis;

• is an insulator, radio waves, magnitoinertna (possible change in strength properties under the influence of electromagnetic fields);

• has a high modulus of elasticity with a small coefficient of elongation, high resistance to stress conditions;

• has excellent rheological properties;

• does not lose its strength properties under the influence of ultra-low temperatures;

• a coefficient of thermal expansion (CTE) CTE corresponds basalt concrete reinforcement, which prevents cracking and gusts reinforcement in the protective layer of concrete under the influence of temperature cycles;

• has high levels of tensile strength.

The main objective of the research on the bend of concrete beams, bridges, reinforced basalt rods were: the definition of the bearing capacity of the beams with basalt reinforcement to control; the value of the clutch basalt rods with concrete; determination of total and surface strength of concrete cubes made with these valve types.

Results

Experimental study on bending concrete beams-lintels-reinforced basalt-plastic rods. As main structures, the first stage of research, were made of small beams with dimensions of 0,06x0,12x0,4m (to test them for bending) and cubes 10x10x10см (to determine the cube strength and the cubes 10x10x10см, with embedded in them, to a depth of 6cm metal rods ∅6, ∅8 A-II and with basalt rebar.

Length of tested basalt cores was adopted in 45 cm with a diameter of 6.5 mm (the cross sectional area of the rod is approximately equal to 0.33 cm^2). Deformation of the basalt rods in time recorded recording device press and its average value amounted to 14mm.

The main factor determining the carrying capacity and durability of concrete structures with basalt reinforcement is its grip with concrete. More than 90% of concrete and reinforced concrete structures, operated in real conditions, subjected to bending, eccentric compression or tension. Thus there stretched zone, where the value of the valve coupling with concrete plays a crucial role. One of the major types of stress-strain state of concrete structures is a bend and there is the task of studying the VAT when bending.

To determine the strength of concrete cubes were prepared following standard composition: cement, sand and gravel in proportions of 1: 2: 3 / C = 0.5; rubble was sifted through a standard sieve fractions 5-10. Cement (M500) Novorossiysk plant.

The same composition were filled at the same time all forms, thereby eliminating the possibility of divergence concrete properties of the samples. Total was made 10 small beams 0,06h0,12h0,4m and 3 dice 10h10h10sm.

At the same time of the same composition were made concrete and standard cubes (10/10/10sm) with embedded in them to a depth of 6 cm from the basalt and metal rods for research quantities of coupling them with concrete (Figure 1). All samples were made after a two-hour pre-soaking, steamed in a cycle 2 + 4 + 6 + 3, that is 15 hours. Then, the samples form raspalublivalis.

In general, the analysis of the small beams of the test results leads to the following conclusions:

• all dependencies in general are linear;

• The nature of the destruction of the beams with metal fittings ∅6 A-I, ∅8 A-II occurs in about a classic case;

• The nature of the destruction of the beams with basalt reinforcement is not typical and is more like a cross-section;

• bearing capacity of the beams with basalt reinforcement ∅6,5mm 50-70% higher load-bearing capacity of beams with reinforcement ∅6 A-I.

During the analysis, data obtained previously, it was found that a significant impact on have: how evenly press the gripper pulls the valve cover; how deep you can pinch the rod in the gripper; Does rod seal depth in the concrete; affect whether brand of cement, concrete grade, slump and the degree of compaction. Testing by definition, is hampered by the fact that the majority of the testing machine, used in construction and industrial laboratories, there is no node allows to pull out of the concrete cores.

To determine the effect of planting depth of basalt rods grip of concrete were made and tested 10x10x10 cm cubes with embedded rods to a depth of 4, 6 and 8 cm. Parallel investigated and the questions above (the effect of cement composition of concrete and its compaction, etc..).

A total of 27 pieces of cubes using stamps made of cement: 300 and 400; Concrete class: B12 and B15; with a draft of 2 cm cone. With the slump in 2cm cubes produced a batch of cement brand M300 and M400 with concrete B12 class with deep embedment basalt rods 4, 6 and 8 cm (18 pieces).

The stamp cement M400 and B12 class concrete slump to 2 cm and a depth of sealing bars 4, 6 and 8 cm were manufactured further 9 cubes. Steaming cubes produced in a cycle: 2 + 4 + 6 + 3 h. Tests on the pull-out rods cubes made one day after their steaming.

Analysis of the data gives an indication that the first pull rods cubes 8cm deep embedment in any case not possible. In each case, the pull-out rods with a depth of 8cm in termination occurred slippage of the outer shell of the rod from the basalt core from the tip. The same slippage observed in previous studies and trials, which suggests the idea - the depth of seal bars in the tip and gripping device must be equal to or greater than the depth of embedding rods in concrete.

The data in Table 1 indicate that: an increase of cement increases the magnitude; increase in concrete class increases; increase in planting depth of 4 to 6 cm in all cases leads to an increase; slump positively affects the magnitude of the increase in concrete class. In all cases there is an increase with decreasing slump. The test results showed that the methodology used is not possible to determine if termination to 8cm.

The experimental studies have shown that more research is needed to determine with increasing embedment basalt rods in the concrete cubes.

For this purpose were made 10x10x10sm 9 cubes with rods in length of 45 cm and depth of embedment in concrete for 4, 6 and 8 cm. Concrete Structure: cement brand M400; B15 class concrete. Cubes were steamed in a cycle: 2 + 4 + 6 + 3 h. Tests were carried out on the pull-rods through the night after steaming.

The value of sealing the reinforcing bars in the grippers press when pulling rods was more than 20cm. First of all, the tests showed that in any case was not found sliding outer shell cores as in the previous test cases.

Table 1. The test results on the pull-out rods basalt cubes, enshrined in the gripping device to a depth of 20cm

A series of samples	Depth of seal bars into cubes, cm	Pulling force, P, kg	The area of the lateral coupling surface cm^2	The amount of coupling
I(three dice)	4	300	7,52	4,02
II(three dice)	6	900	11,3	8
III(three dice)	8	1900	13,04	14,6

Before pulling the rods in all three dice with 8cm deep embedment in their curling was observed and at the time of pulling the gap observed in a dice cutting height throughout.

Analysis pull-test results show that the depth of embedding reinforcing bars in the gripping device plays an important and perhaps primary, role in determining. How value can really be defined, so as to be characterized by a load-bearing capacity design as a whole. Comparing previous data determined by other methods and new data suggest significant differences values (1.5 or more) in the direction of increasing.

Cterzhni of basalt rebar deformed at a sufficiently low loads, almost as an elastic system. At the same time, a significant shift in the plastic state occurs at loads within 50kN and complete transition rods into a plastic spiral for both surface and a circular surface occurs at the same load 124,9kN. Testing of metal rods ∅6 A-I (A240) with a smooth surface have shown that their deformation properties begin to appear significantly under load> 144kN. These studies showed that the basalt rods exhibit transverse deformability under load is three times lower than metal rods, suggesting that their modulus of elasticity is closer to the module of elasticity of concrete.

Fig. 1. General view of the test rigbeamsbending

Discussion

Basalt reinforcement of adhesion due to uneven deformation of the surface layer (the loss of stability of the shell) on the volume shrinkage of concrete increases significantly. It should be noted that in experiments pulling rod itself detectable effect prestressing reinforcement.

As a result of the concrete rods increases the bearing capacity of concrete structures and their fracture.

Main conclusions:

1. Evaluated properties basalt fittings, the technology of manufacturing of concrete structures with basalt fittings and various methods investigated properties of small beams with basalt reinforcement.
2. The mechanism of adhesion basalt rebar to concrete.
3. Established analytical relationship between t, f, p, when tested with the small beams of basalt rebar and beams with metal fittings.
4. Investigated carrying capacity of structures in the form of real bridges 0,12x0,22x1,2m sizes.
5. Practical recommendations to increase the carrying capacity of basalt rods in concrete structures.
6. Produced technical and economic evaluation of the use of basalt reinforcement in the manufacture of concrete structures.

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