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## **FIBRE-REINFORCED POLYMER BARS IN PRECAST SLABS FOR ROADS TO OIL AND GAS EXTRACTION COMPLEXES**

*Considered an example of the application of fibre-reinforced polymer bars in precast slabs for temporary roads to oil and gas extraction complexes. Found that samples of products by geometric requirements similar Ferro-concrete products, but reinforced fibre-reinforced polymer bars accessories instead of metal. The results of replacing metal fittings on the fibre-reinforced polymer bars in the experimental samples. Given the comparative assessment of the conformity of prototypes of requirements on indicates the ability and crack resistance from. Found that fibre-reinforced polymer bars valves may be used in the construction of a prefab temporary roads without reducing their carrying capacity. It is proven that the use of this rebar for reinforcement of structures that work on resilient basis, both at the stage of manufacture and operation. It is shown that the resulting experience can be used in the planning and in the design, manufacture and test prototypes, and the analysis of the obtained results allow you to identify opportunities for the implementation of this direction in Ukraine.*

**Keywords:** *fibre-reinforced polymer bars, road slab, modulus of elasticity, crack resistance.*

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## **ПОЛІМЕР-КОМПОЗИТНА АРМАТУРА В ЗБІРНИХ ПЛИТАХ ДЛЯ ДОРІГ ДО НАФТОГАЗОВИДОБУВНИХ КОМПЛЕКСІВ**

*Розглянуто приклад застосування полімер-композитної арматури в збірних плитах для тимчасових доріг до нафтогазовидобувних комплексів. З'ясовано, що дослідні зразки виробів по геометричним параметрам аналогічні залізобетонним виробам, але армовані полімер-композитною арматурою замість металевої. Наведено результати заміни металевої арматури на полімер-композитну арматуру в дослідних зразках. Надано порівняльну оцінку відповідності дослідних зразків вимогам по несучій здатності та тріщиностійкості. Встановлено, що полімер-композитну арматуру можливо застосувати в збірних плитах для тимчасових доріг без зниження їх несучої спроможності. Доведено, що застосування цієї арматури для армування конструкцій, які працюють на пружній основі, доцільно як на стадії виготовлення так і при експлуатації. З'ясовано, що отриманий досвід можна використовувати при плануванні досліджень та проектуванні, виготовленні і випробуванні дослідних зразків, а одержані результати проведеного аналізу дають змогу визначити можливості для впровадження такого напрямку в Україні.*

**Ключові слова:** *полімер-композитна арматура, плита для доріг, модуль пружності, тріщиностійкість.*

**Introduction.** On the present development of oil and gas extraction requires the reduction of cycle construction drilling, speeding up putting them into operation and reducing the cost of the construction of the wells. One of the components, which significantly affects the data indicators – reduction of time for installation of temporary access roads and roads and reducing their cost, through the use of modern materials.

Commissioning of new wells objectively due execution of drilling in new areas, necessitating the rebasing of drilling companies with drilling one district to another. Among new areas, yak rule, anew create a number of production objects to which it is necessary to lay new driveways and roads.

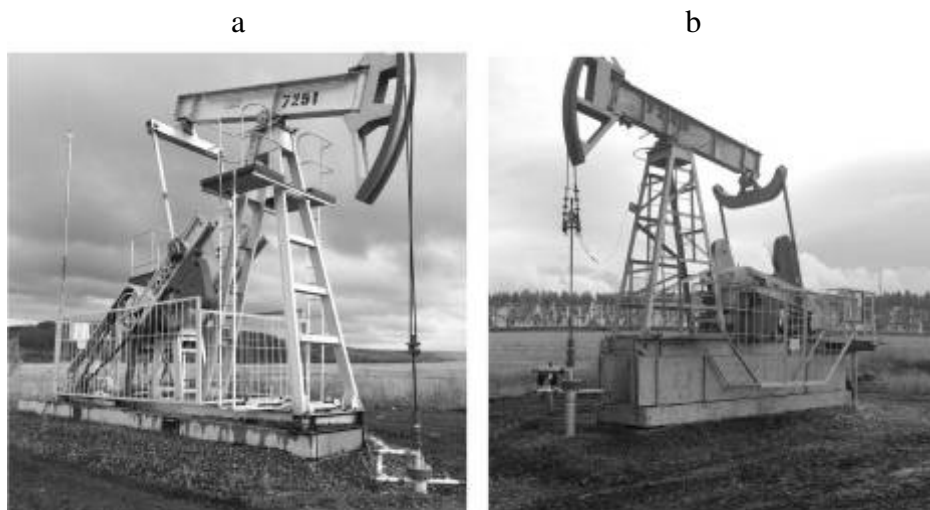
To speed up the commissioning of drilling rigs importance is performing a compulsory minimum training of construction works on the new platforms [1]. The issue of the rapid installation of temporary access roads and highways might solve thanks to the use of precast slabs using non-metal composite rebar, which is significantly cheaper for the metal. In addition, the replacement of the metal fittings on the nemetalevu removes the possibility of damage to the structures as a result of corrosion of the steel and the destruction of the protective layer that allows you to reduce operating costs. These boards have successfully can be reused when the development of new areas for drilling.

**Analysis of recent studies and publications sources.** Application of non-metal composite rebar construction designs is a progressive direction in the construction [2 – 8]. However, the application of polymer-composite cable and significantly limits the number of flaws and features composite fittings that do not allow direct replacement of reinforcement in composite:

- low modulus of elasticity;
- lower fire products, reinforced composite reinforcement;
- low strength at transverse loads;
- the difficulty in making bent rebar products;
- the complexity in the manufacture of prestressed structures.

One of the perspective directions of use of non-metal composite rebar is the reinforcement of structures that work on resilient basis.

In 2014-2015 by specialists of the Kazan State Architectural Construction University together with JSC «Tatneft» was working on the introduction of fibre-reinforced polymer bars for reinforcement of prefabricated elements, which are used for the extraction of petroleum-slabs, the slabs and walls under machines-rocking, plate under drives cepni (fig. 1, a, b) [9 – 11].



**Figure 1 – Beam and slab under machines-rocking**  
*a – Beam under machines-rocking; b – Plate under machines-rocking*

The nature of such products is virtually the same, they will be subject to a uniformly distributed load and work on resilient basis. With the possibility of applying developments in Ukraine, the most important is to work on the introduction of polymer-composite rebar for reinforcement of precast slabs for temporary roads to oil extraction.

**Parts of general problem unsolved before.** At present in Ukraine not manufactured at industrial level and does not apply to prefabricated slabs using non-metal composite fittings. This occurs as a result of insufficient awareness about innovative projects that exist in the world and the lack of development in this direction.

**Problem formulation.** The main purpose of this work is the analysis of the results of research on the application of polymer-composite rebar at armuvannì prefabricated panels for temporary roads and estimation of prospects of development of this direction in Ukraine.

**The basic material and results.** Oпитnij sample team plates for temporary roads 2P 30.18-30 using polymer-composite fittings have been, manufactured and tested [9 – 11]. This plate is similar to reinforced concrete plates, given the fact that its geometric parameters are accepted according to [12]. In this case the metal fittings used in reinforced concrete slabs according to [13], was replaced by a polymer-composite on the criterion – of the strength longitudinal.

It was also complied with the preservation of the total number of cores and save the locations of them in opalubcì. The process of reinforcement plate shown in figure 2.

Given the great corrosion resistance of composite reinforcement, protective layer top and bottom plate was taken 20 mm instead of 30 mm. The class is concrete and technology of concreting was performed by [13] without changes. On the basis of measurements at the load plate was built the schedule according to the «load-your backbends». Fixing strain was used to load 11 t., thus destroying the plates with a load of 14 t took place [10].



**Figure 2 – Reinforcing plate**

With a load of 11 t the magnitude of deflection equal to 50 mm, indicating significant your backbends plate. Raised deformativnìst' plates under load and the occurrence of cracks in concrete structure due to the zone stretched polymer composite, namely low elasticity module. This fact is compensated for by corrosion resistant polymer-composite reinforcement and the occurrence of cracks in concrete will not cause corrosion destruction of structures, as in the case with metal reinforcement.

As a result of the tests established that the plate 2P 30.18-30 (fig. 3, b) meets the criteria of strength – by controlling stress fracture plates. Plate 2P 30.18-30 also meets the criteria of crack resistance from (fig. 3, a) when controlling the load plate width of the disclosure of the cracks smaller than 0.2 mm.



**Figure 3 – Test plates 2P30.18-30**

- a – Test the load on crack resistance from 3,8 t, the width of the disclosure of the cracks smaller than 0.2 mm;*  
*b – Test the load on strength of 7,0 t, the destruction of the plates do not happen*

The results confirmed the possibility of polymer-composite rebar in the construction of temporary roads without reducing their carrying capacity. As a result of technical-economic evaluation of applying polymer-composite reinforcement in the slabs found that the cost of manufacturing reinforcing mesh is reduced by 12%, thus decreasing labor costs on the reinforcement plates as a result of significantly lower weight of reinforcing products from polymer-composite cable compared with metal. In addition, concrete slabs, reinforced polymer-composite accessories have increased corrosion resistance and consequently increased the term of operation. Thus the application of polymer-composite rebar in the construction of temporary roads economically feasible as at the stage of manufacture and operation.

To implement this direction in Ukraine need to perform research, similar to the above, with the use of regulations, the existing in Ukraine. In Ukraine at the present time operates a normative document regarding the design and manufacture of concrete structures with composite with accessories [14], which contains information about the scope of application, General provisions of design elements with composite reinforcement, structural requirements for these elements. In this document these characteristic parameters for composite reinforcement with links to [15, 16] for the reinforcement of concrete structures with basalt fixtures and accessories based on glass rovìngu respectively. But there is no documentation (DSTU) on requirements to composite cable, there are no common technical terms. No standardized methods of calculation of concrete of composite reinforcement, methods for determining the minimum percent reinforcement. Not enough studied experience of operation of composite products. Given the above indicated, a very important and urgent task is to develop recommendations regarding the practical application of polymer-composite reinforcement in precast slabs for temporary roads. It is advisable in this case to use the world experience [8, 11, 17 – 19].

Work in this direction was launched in Poltava National Technical University named after Yuri Kondratyuk – were conducted experimental research of mechanical characteristics of skloplastikovoï fittings. The characteristic of the composite samples of the fittings listed in table 1. Skloplastikova fittings in accordance with the provisions of [14] is a nemetaleva composite fittings, produced on the basis of continuous glass rovìngu. According to tests, the characteristic values of resistance stretching skloplastikovoï rebar is 500 MPa, and the modulus of elasticity is 33 000 MPa (average value of the three samples). According to table 6.2 [14] the characteristic value of the resistance to stretching for composite reinforcement based on glass rovìngu should be equal to 600 (800) MPa, and the modulus of elasticity is 50 000 Psi

while steel must meet the requirements [16]. For comparison, table 2 shows the mechanical characteristics of skloplastikovoї fittings, which were obtained in an experimental trial and what the steps in the how to document [14]. Relationship between straight deformation of composite reinforcement and tensions are in figure 4.

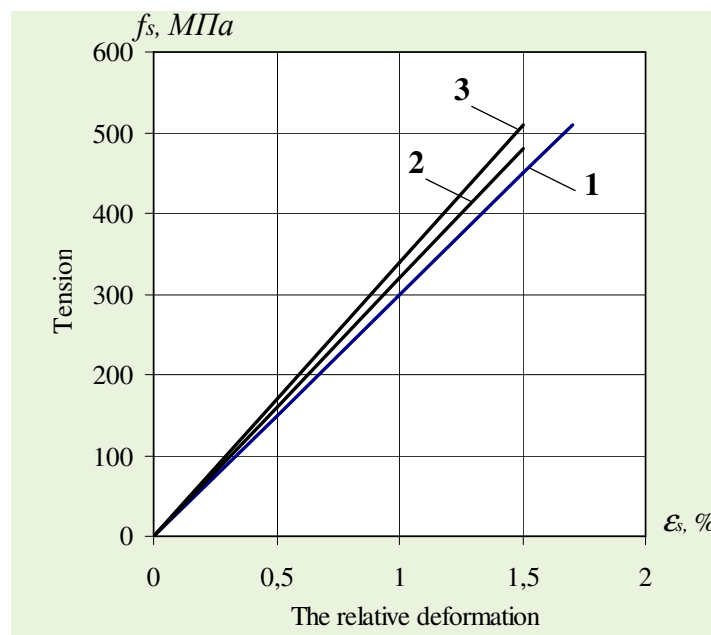
**Table 1 – Characteristics of composite rebar**

| The name | Geometric parameters              | The mass of the 1 p. m., g | The density of the g/cm <sup>3</sup> | The amount of binder, % | The degree of polymerization, % |
|----------|-----------------------------------|----------------------------|--------------------------------------|-------------------------|---------------------------------|
| FCS      | Ø 5,0mm<br>A=7,065mm <sup>2</sup> | 16,27                      | 1,75                                 | 26                      | 93                              |

The characters in the notation of composite fittings have the following explanation:  
*F – fittings; C – composite; S – skloplastikova fittings on the basis of a glass rovìngu.*

**Table 2 – Mechanical characteristics of composite rebar**

| The name   | FCS, DSTU [14] | FCS, sample № 1 | FCS, sample № 2 | FCS, sample № 3 |
|--|----------------|-----------------|-----------------|-----------------|
| Characteristic value of resistance strength, MPa | 600<br>800     | 510             | 480             | 510             |
| Modulus of elasticity has been worked out, MPa   | 50 000         | 30 000          | 35 000          | 34 000          |



**Figure 4 – Graph of dependencies between straight deformation of composite fittings and tensions**

1 – sample № 1; 2 – sample № 2; 3 – sample № 3

Based on the results of the tests, was given the variability of the characteristic values of skloplastikovoї reinforcement – characteristic value of resistance strength and modulus of elasticity is significantly lower than stated in the rules [14]. The reason is that the skloplastikova steel is a rod and profile are made with continuous reinforcing glass fiber (glass rovìngu) and the termoaktivnogo binding. Physical and mechanical characteristics of such fittings depends on the fibers, percentage «fiber – binder» and production technology.

Today in the market of building materials appeared in many large and small producers who work for their own technical, mechanical characteristics of skloplastikovoï fittings vary widely.

Feature of the application of this reinforcement is the fact that it is very important to have technical specifications on each batch of composite reinforcement used in the designs. At performance of works using a composite cable, you need to determine its micnostnì and deformation value, and validate these values [14]. When the disparity of these values need to calculate the design for the real values of the characteristics of strength and deformability, engaging for this specialized laboratories that have the corresponding certificate. Special attention should be paid to the quality of the fittings. Not allowed: chipped, bundles, conch, gusts of winding, dents from mechanical impact damage fibers.

For the reliability of the results that will be obtained when conducting research on the use of polymer-composite rebar in the construction of temporary roads will be required to produce and test a minimum of 3 samples. Put into operation in Ukraine DSTU [20] (with the abolition of [12]) and the entry into force of DSTU [21] (with the abolition of [13]). Imposed national standards [20, 21], [12] and [13] in addition to the normative references cited in appendix A. So when planning your experiment, you can use the technique listed above in the example.

Geometric parameters, class of concrete and technology of concreting of prototypes of plates for temporary roads P-1, P-2, P-3 be taken like slabs of reinforced concrete 2P 30.18-30 [20]. In this case the metal rebar used in concrete slabs replaced by polymer-composite on the criterion of equal strength longitudinal.

By calculations using these tests (table 2), is an example of replacing the metal fittings on the polymer-composite (table 3).

**Table 3 – Replacement of reinforcement for polymer-composite rebar**

| № | The diameter of the metal rod, mm | Diameter polymer-composite of rod, mm |
|---|-----------------------------------|---------------------------------------|
| 1 | Ø8F400                            | Ø6FCS                                 |
| 2 | Ø10F400                           | Ø8FCS                                 |
| 3 | Ø12F400                           | Ø10FCS                                |
| 4 | Ø14F400                           | Ø12FCS                                |
| 5 | Ø16F400                           | Ø14FCS                                |

Determined that the longitudinal steel Ø10F400 in research samples P-1, P-2, P-3 can be replaced by a composite Ø8FCS, of the metal rods, that located along the short side plates Ø8F400 – on the composite Ø6 FCS. Diagram of the reinforcement of research designs P-1, P-2, P-3 take in accordance with [21, 22], while maintaining the total number of rods and their locations in the opalubcì.

Opitnih test samples necessary to carry out the static load by a technique for evaluation of their strength and compliance with regulatory requirements. In this case, the main goal of the tests is to research the destruction and deformation of plates reinforced fibre-reinforced polymer bars.

The final stage of data research is the development of technical specifications for the manufacture of prefabricated plates with the use of a composite cable.

**Conclusions.** The use of plates with fibre-reinforced polymer bars leads to a reduction of the cycle of building wells, their accelerated commissioning, that gives the effect in increasing production and reducing the cost of the construction of the wells.

You can use the experience gained in the planning and the design, manufacture and test prototypes, and the analysis of the obtained results allow you to identify opportunities for the implementation of this direction in Ukraine.

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