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Determination of an Effective Method as a Result of Calculation Methods of Reinforcement of Reinforced Concrete Plate

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Abstract: This article shows the most effective way to reinforce a reinforced concrete slab. The methodology for applying this method is presented in detail.

Key words: Reinforced concrete slab, basalt packing material, physical decay, polymer solution.

Introduction:

All constructions of buildings and structures are subjected to physical wear and tear over time and lose their previous properties. It depends on the working environment of the building structures. If the physical decay of building structures over time leads to additional financial costs, then the decrease in strength characteristics can lead to global problems and accidents. This is often the case with horizontal load-bearing slabs and surrounding load-bearing walls. Therefore, it is necessary to periodically check the main load-bearing structures of the building and, if necessary, strengthen them.

Recently, prefabricated reinforced concrete slabs have been widely used in the construction of our country. The reason for this is the development of the construction industry and the introduction of new construction technologies into our country. Today's prefabricated reinforced concrete slabs differ from reinforced concrete slabs produced 30 years ago in terms of production technology. Currently produced reinforced concrete slabs can be cut to any size from 1 m to 12 m. Therefore, the connection node of these reinforced concrete slabs with the seismic belt is very different from the nodes of the previous slabs. In addition to the dimensions of the produced reinforced concrete slabs, its strength and number of load-bearing wires may vary. If, as a result of the re-equipment or modernization of the buildings where these reinforced concrete slabs are used, as a result of the increase in the loads acting on the intermediate slabs, it is appropriate to carry out strengthening and strengthening works. When changing the function of the room, it may be necessary to take measures to increase the load-bearing capacity of the floors. For example, when some rooms of an administrative building (temporary load 200 kg/m2) are later re-planned as an archive or warehouse (temporary load 500 kg/m2), it is necessary to strengthen the reinforced concrete slab for an additional load of 300 kg/m2. Or, if heavy equipment needs to be installed on the floor of the platform, a reinforced concrete slab reinforcement project will be developed.

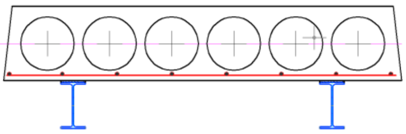
Strengthening of reinforced concrete slabs is carried out in order to restore their integrity, performance characteristics and, in particular, load-bearing capacity. This is done during reconstruction of buildings, re-planning, construction of additional floors or when obvious defects are detected by visual inspection.

There are several methods of reinforcing reinforced concrete slabs, and which method is convenient and cost-effective has not yet been determined. Methods of strengthening building structures and its calculations are presented in [2]. Examples of calculation methods for reinforcement of reinforced concrete column and beam are detailed in this literature. However, the method of calculating the reinforcement of reinforced concrete slab is not given. The elements used in strengthening of reinforced concrete slab, which are used in practice, are selected constructively. Therefore, it is important to develop a calculation method for reinforcing a reinforced concrete slab.

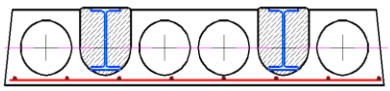
The main part.

In some cases, as a result of changing the functional function of the rooms in the buildings to be reconstructed, the impact of the loads on the reinforced concrete slabs will change. As a result, the loads acting on reinforced concrete slabs may increase or decrease. Reinforcement of reinforced concrete slabs is required due to the increase of the impact loads. Currently, 6 methods of strengthening reinforced concrete slabs are widely used in practice [2]. (Figure 1). These methods are related to inter-floor reinforced concrete slabs of multi-gap slabs, and if the slabs are in the cross section of the last floor, then other effective methods of reinforcing reinforced concrete slabs can be used. Since our scientific research work is the development of reinforcement calculation of reinforced concrete inter-floor slab, we will consider only strengthening methods related to the inter-floor slab.

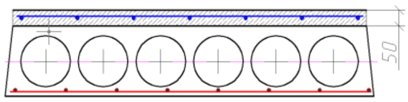
In order to find the most cost-effective reinforcement methods shown in Figure 1, it is necessary to carry out calculations regarding the loads acting on the slab. Table 1 presents a detailed study of the implementation technologies currently used methods and their costs.



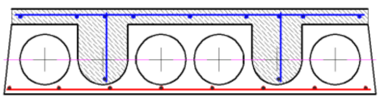
a) The method of strengthening the plate from the bottom with metal profiles



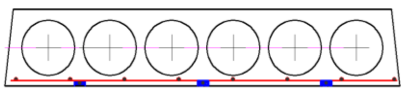
b) Reinforcement with metal profiles



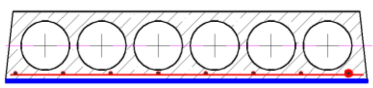
d) Reinforcement of the upper part of the plate with an additional reinforced concrete slab



e) Reinforcement of the upper part of the slab with an additional reinforced concrete base and frame



f) Reinforcement by installing additional reinforcements to the polymer mixture



g) A method of reinforcing a metal sheet in a polymer solution to the lower part of a reinforced concrete slab

Figure 1. Methods of strengthening multi-cavity reinforced concrete slab.

Table 1. Reinforced concrete floors and the cost of reinforcing slabs

t/r	The name of the amplification method	Total expenses (soums)
1	The method of strengthening the plate from the bottom with metal profiles	6683794
2	Reinforcement with metal profiles	8197106

3	Reinforcement of the upper part of the plate with an additional reinforced concrete layer	1147093
4	Reinforcement of the upper part of the slab with an additional reinforced concrete base and frame	4378864
5	Reinforcement by installing additional reinforcements in the polymer mixture	11422930
6	A method of strengthening a metal sheet in a polymer solution to the lower part of a reinforced concrete slab	649328

It can be seen from Table 1 that strengthening method 6. The method of strengthening the metal sheet in a polymer solution on the lower part of the reinforced concrete plate turned out to be economically effective compared to other methods.

Taking into account the effects of permanent and temporary static loads acting on the reinforced concrete slab, the elements used to strengthen the intermediates from the stress and deformation states that is, the cross-sectional surfaces of the steel sheet material, are selected. Based on the fact that the 6th strengthening method is the most economically effective compared to the above methods, its analytical calculations are performed based on the calculation scheme shown in Figure 2. Calculations are performed as follows.

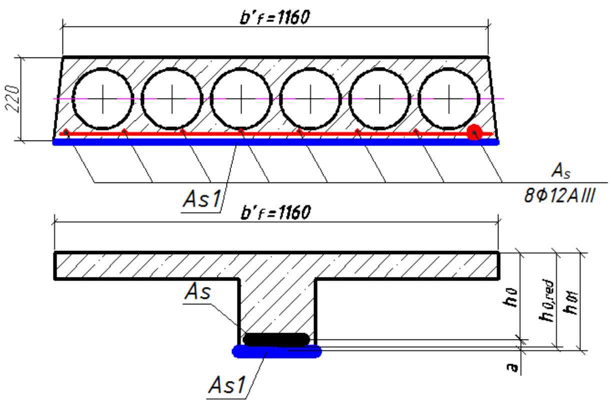


Figure 2. Calculation scheme for strengthening the metal sheet from the lower part of the reinforced concrete plate by gluing it in a polymer solution.

The load acting on a reinforced concrete slab 1 p.m. is determined by the expression (1);

$q = q_1 \cdot B$ (1)

The calculated length of the reinforced concrete slab is determined by the expression (2);

$l_o = l - \frac{b_o}{2} = 6 - \frac{0.25}{2} = l - 0.125$ (2)

The value of the bending moment generated in the reinforced concrete slab is determined by the following expression;

$$M_1 = \frac{q_1 \cdot B \cdot (l - 0.125)^2}{8}, \quad (3)$$

The following condition is checked: if the condition is fulfilled, the neutral axis passes through the shelf part of the plate, otherwise it passes through the rib part;

$$M_1 = \frac{q_1 \cdot B \cdot (l - 0.125)^2}{8} \leq R_b \cdot \gamma_b \cdot b_f' \cdot h_f' \cdot (h_{0,red} - 0.5 \cdot h_f'), \quad (4)$$

By simplifying the expression (4), we get the following expression (5);

$$\frac{q_1 \cdot B \cdot (l - 0.125)^2}{8} \leq R_b \cdot 0.9 \cdot B \cdot 0.031 \cdot (0.207 - 0.5 \cdot 0.031);$$

$$\frac{q_1 \cdot B \cdot (l - 0.125)^2}{8} \leq 0.005 \cdot R_b \cdot B \quad (5)$$

We determine the α_m coefficient using expressions (3) and (4);

$$\alpha_m = \frac{\frac{q_1 \cdot B \cdot (l-0.125)^2}{8} - R_b \cdot 0.9 \cdot (B - n \cdot D) \cdot 0.031 \cdot (0.207 - 0.5 \cdot 0.031)}{R_b \cdot 0.9 \cdot n \cdot D \cdot 0.207^2} =$$

$$= \frac{q_1 \cdot B \cdot (l-0.125)^2 - 0.01 \cdot R_b \cdot (B - n \cdot D)}{0.077 \cdot R_b \cdot n \cdot D} \quad (6)$$

Where q_1 is the load acting on the reinforced concrete slab at 1 m kN/m; B-plate width m; l-plate length m.

If the condition $\alpha_m > \alpha_R = \xi_R \cdot (1 - 0.5\xi_R) = 0.526 \cdot (1 - 0.5 \cdot 0.526) = 0.387$ is fulfilled, then we accept $\alpha_m = \alpha_R = 0.387$and the coefficient ξ=0.524 from the table given in [1] . Otherwise, depending on the value of α_m, we accept the value of ξ from the table given in [1].

We determine the cross-sectional surface of the steel sheet and its reinforcements, which are installed on the lower part of the plate for strengthening:

$$A_{s,tot} = \frac{R_b \cdot \gamma_{bl} \cdot \left[\xi \cdot b \cdot h_{0,red} + \left(b'_f - b\right) \cdot h'_f\right]}{R_s} =$$

$$= \frac{R_b \cdot 0.9 \cdot [\xi \cdot n \cdot D \cdot 0.208 + (B - n \cdot D) \cdot 0.031]}{R_s} \quad (7)$$

To determine the dimensions of the selected element steel or basalt wrapping material to strengthen the plate, we determine from expression (8):

$$A_{sl} = \left[\frac{R_b \cdot 0.9 \cdot [\xi \cdot n \cdot D \cdot 0.208 + (B - n \cdot D) \cdot 0.031]}{R_s} - F_a \cdot A_s\right] \cdot \frac{R_s}{R_{sl} \cdot 0.95}; \quad (8)$$

Where F_a is the rate of strength reduction (%) of reinforcement of reinforced concrete slabs as a result of physical destruction.

The physical decay F_a is defined as follows:

$$F_a = 100 - F_{i.a}; \quad (9)$$

$F_{i.a}$- The level of physical destruction of the reinforced concrete slab (%),

R_b is the concrete grade of the physically aged reinforced concrete slab.

If the concrete class of the slab is determined according to UzDSt, then we use expression (10). Otherwise, the concrete class R_b obtained in the laboratory from the physical wear of the reinforced concrete slab is accepted in the expression (8);

$$R_b = R_b \cdot (100 - F_{i.b}) \text{ (MPa)}; \quad (10)$$

where $F_{i.b}$ is the degree of corrosion of the concrete part of the reinforced concrete slab (%).

B is the width of the reinforced concrete slab (m);

D - the width or diameter of the spaces of the reinforced concrete slab (m);

n - the number of spaces of the reinforced concrete slab;

R_s_s is the tensile strength of the working reinforcement applied to the reinforced concrete slab (MPa);

R_{sl} is the tensile strength (MPa) of the steel or basalt packing material selected for reinforcement of the reinforced concrete slab;

A_s is the sum of the cross-sectional surface of the working fittings of the reinforced concrete slab (mm^2) If the width of the slab is 1.2 m, A_s= 904 mm^2 If the width of the slab is 1.0 m, A_s= 628 mm^2 is accepted.

The method of strengthening a metal sheet in a polymer solution to the lower part of a reinforced concrete plate is calculated using expressions (5), (6), (8) and (9).

Conclusion: The following conclusions can be drawn from the development of the calculation expression for the method of strengthening a reinforced concrete plate by sticking a metal sheet in a polymer solution to the lower part:

1. The 6th method of reinforcing reinforced concrete slabs shown in Figure 1, i.e., the method of strengthening a metal sheet from the lower part of a reinforced concrete slab by gluing a metal sheet in a polymer solution, is economically effective, so it is appropriate to use this method in practice.
2. In the reinforcement method of sticking metal sheet in polymer solution from the lower part of the reinforced concrete plate, not only steel sheets can be used, but also if basalt packing material, which is widespread nowadays and stronger than steel, is used, the strengthening method will have a convenient and compact solution. .
3. Mathematical expression of reinforced concrete plate strengthening method (8) was proposed. This mathematical expression applies only to the 6th method.

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