UDC 624.012.36

VERTICAL PRESSURE OF PLATFORM JOINT OF PRECAST PRESTRESSED HOLLOW CORE SLABS

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The analysis of calculation methods of tangent bond stresses of concrete with high-strength wire taking into account stresses from vertical pressure, comparison of theoretical calculation results and experimental data is provided.

Research of anchoring of high-strength wire is an urgent task. Unlike reinforcement bar with high relief reeves the S1400 high-strength wire has only flat "dents".

Recently the precast prestressed reinforced concrete constructions with their application have become widely implemented. Such reinforcementis are more convenient in use in cross-sections of bending elements with limited concrete area, such as edges of hollow core slabs, webs of T and 2Tslabs etc. since because of higher strength characteristics wires of smaller diameter in comparison with S500 and S800 reinforcement are used that allows to provide sufficient cover and intervals between reinforcement according to the design codes. Cross pressing of the high-strength wire located at upper faces of slabs by transfer of stresses from the upper structures through the cross-section on the support of the bendingreinforced concrete elements in platform joints allows to improve its anchoring and by that to increase efficiency of its usage at absorbtion of negative bending moment. This effect has been researched in work [1], the results obtained showed increase in negative bending moment on support when increasing the pressing of joint. The scheme of experimental installation is showed in fig. 1.

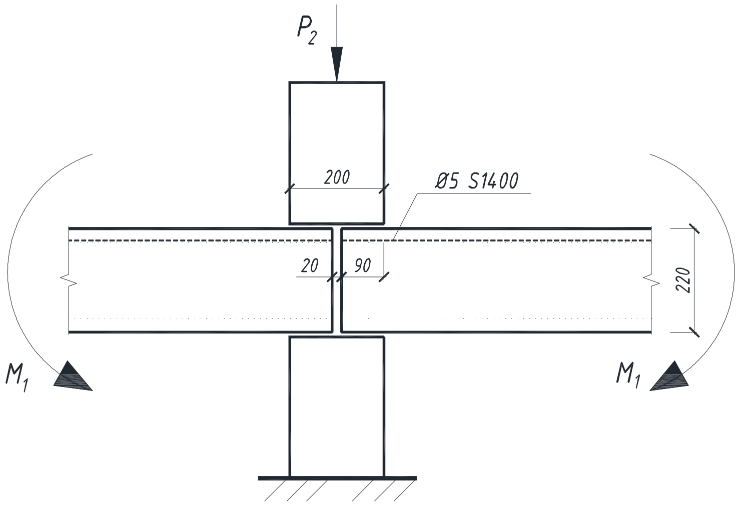

Fig. 1. Experimental installation of platform joints

Anchoring of reinforcement in concrete body was researched by many scientists, such as M.M. Holmyansky [2], L.L. Chou, H. Okamura [3], A.V. Benin [4]. Holmyansky gives parameters α and B for high-strength wire for the law of normal distribution of tangent stresses. As far as the influence of cross-section pressing is concerned only experiments with the flat steel elements clamped between concrete samples are considered in the monograph.

$$\tau = B\frac{\ln(1+\alpha s)}{1+\alpha s}, \quad (1)$$

where α, B represents the characteristic parameters of reinforcement which are determined by the table, or by practical consideration;

s - shift of reinforcing rod in concrete body, mm.

The European CEB-FIP Model code 2010 [5] provides the distribution law of tangent stresses. Two cases of reinforcement bond in concrete are given: good bonding conditions and all others. These conditions differ in different values of the maximum tangent stress and their arrangement on curve τ-s.

$$\tau_b = \tau_{b\max}(\frac{s}{s_1})^{\alpha} \quad \text{for} \quad 0 \le s \le s_1 \quad (2)$$

$$\tau_b = \tau_{b\max} \quad \text{for} \quad s_1 \le s \le s_2 \quad (3)$$

$$\tau_b = \tau_{b\max} + (\tau_f - \tau_{b\max}) \cdot (\frac{s - s_2}{s_3 - s_2}) \quad \text{for} \quad s_2 \le s \le s_3 \quad (4)$$

$$\tau_b = \tau_{bf} \quad \text{for} \quad s > s_3 \quad (5)$$

where α is the characteristic parameter of bond;

s – shift of reinforcing rod in concrete body, mm;

τ_{bmax}, τ_f, τ_{bf} – the tangent stress corresponding to characteristic points of the chart.

For taking note of cross-section pressing on bonding of reinforcement in [5] it is offered to use coefficient $\Omega_{p,tr}$.

$$\Omega_{p,tr} = 1 - \tanh[0.2 \cdot \frac{p_{tr}}{0.1 f_{cm}}], \quad (5)$$

where p_{tr} – the medium stress in concrete (perpendicular rod axes) average in volume of around rod with diameter 3mm.

The question of influence of cross-section pressing on bonding strength of reinforcement bar periodic 12mm has also been considered by diameter in work [6] which offers to use the coefficient $\gamma_{p,ad}$:

$$\gamma_{p,ad} = 1 + 0.271 \cdot e^{-13.8 \cdot (\frac{\sigma_m}{R} - 0.46)^2}. \quad (6)$$

Comparison of influence of coefficients $\Omega_{p,tr}$ and $\gamma_{p,ad}$on the bonding conditions between concrete and reinforcement is presented with concrete in fig. 2.

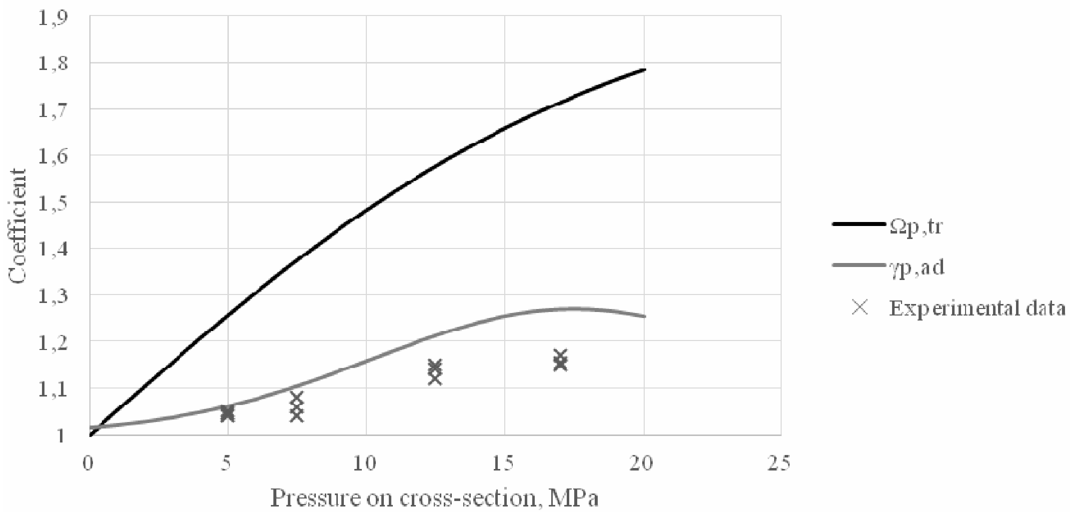

Fig. 2. Dependence of coefficients of increasing bonding of reinforcements and concrete on pressure

In order to research the influence of pressing force on bonding of upper longitudinal reinforcement of hollow core slabs in platform joint zone and establish the valid bonding law (charts τ-s for high-strength wire, the authors have made experimental samples sized 150x150x600mm with five reinforcement rods of high-strength wire S1400 located perpendicular to the axis of the element (fig. 3). In the course of production of samples rods were prestressed to the level of 480 MPas according to series for production of such slabs. Prestressing of rods was completed with the help of hydraulic jack having hollow rod and the manual pumping station with the model manometer. The prestress was carried out on metal frame and fixed - by means of collet clips.

The production of the samples was manufactured in the laboratory of Polotsk State University. Filling of the samples was accomplished together with the cubs production for further control of concrete strength. In order to research into bonding of upper longitudinal reinforcement in precast prestressed hollow core slabs with support length 90mm there was formed a segment 60mm long with zero bpnding of concrete and reingorcements with the help of plasticine.

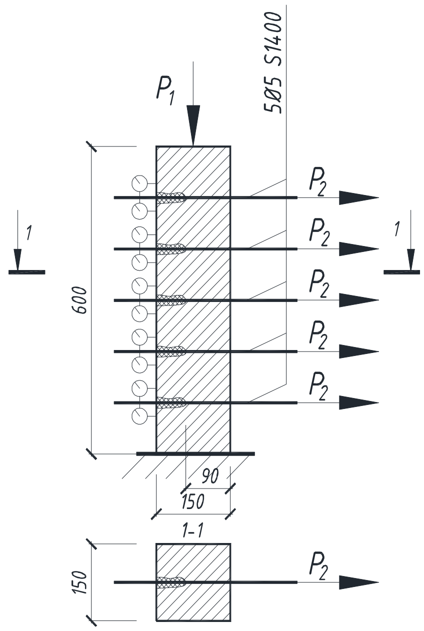

Fig. 3. The scheme of samples for carrying out research

The purpose of the experimental research was to work out dependence of bonding (force P_2) of reinforcing rods on the size of cross pressing (force of pressing P_1), obtaining graphic dependence of tangent stress on movements of rod (τ-s). The scheme of carrying out expreimental research is given in fig. 3.

During the experimental research loading from pressing (forceP_1) was effected with the help of hydraulic press. The valueP_2 was put by means of hydraulic jack with hollow rod

and the manual pumping station with the model manometer.

When testing, the movements of retraction of reinforcing rods were measured by means of clock type indicators with division of 0,001 mm. The varying factor of experiment was the value of pressing (P_1).

Our experimental research resulted in the data which showed that the law of bonding on source [3] is true for all other bonding conditions. This is due to the fact that pasting of high-strength wire with concrete at the time of issue at prestressing is broken. In further work the greater influence is obtained by friction forces. Comparison of experimental data with the studied theoretical laws of bonding is presented in fig. 4.

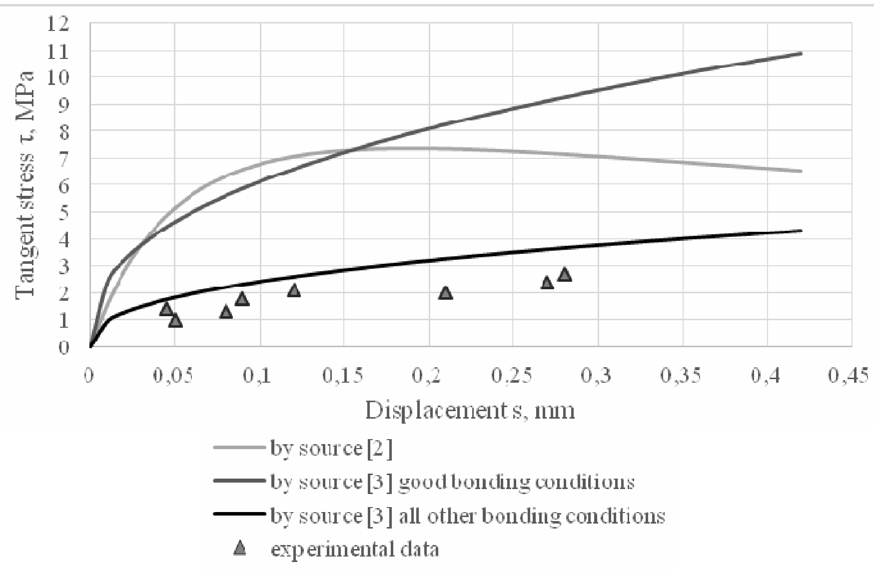

Fig. 4. The dependence graph of tangent tension (τ) on movements (s)

1. The conducted experimental and theoretical studies have shown positive influence of cross-section pressing on bonding strength of prestressed high-strength wire.
2. The studied theoretical bases do not reflect the valid distribution law of tangent stress for high-strength wire.

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UDC 624.016

METHODS OF PROVIDING COMBINED ACTION OF CONCRETE AND METAL ROLLED STOCK IN REINFORCED CONCRETE CONSTRUCTIONS WITH RIGID ARMORING

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The author studies pilot research works into combined action of concrete and metal profiles in reinforced concrete constructions with rigid armoring carried out by scholars from both near and far foreign countries. The main methods of providing co-action of the two materials in the compression elements are outlined through the example of columns and flexural elements through the example of a T-beam. The advantages and disadvantages of the proposed methods are analysed.

We understand reinforced concrete with rigid armoring as structures designed under the assumption of combined action of a metal profile and concrete.

The combined action of a rolled metal profile and concrete must be ensured in all types of structures, regardless of its operating conditions (bending, compression, shear).

The main compression elements are columns. Rigid angle-shaped reinforcement is placed at the corners of normal cross-section, U-sections are arranged in inversed manner in the section of the column with their webs to the face of the column and I-beams are installed in the cross-section of the column so that the flange of the beam is located in the tensile zone of the cross section (eccentric compression) and parallel to the column face. Depending on the operating conditions it's necessary to provide a protective layer of concrete when you place metal profile in the cross-section of a column. When there is no combined work of a metal rolled stock and concrete, the main problem is early peeling of a protective layer observed in columns with longitudinal rigid bars without profile bordering in the column body (Fig.1 a). With that in mind to provide combined action Professor Emperger and Professor Zaliger from Higher Technical College of Vienna advise to use spiral hoopings and ties of metal flexible reinforcement 5-8 mm in diameter. Using spiral hooping increases the ability of the concrete to deform under compression without breaking and, hence, makes it possible to fully use refined steel up to the yield point at its combined action with concrete[1].

The feature of using spiral winding is that in the columns of square section only the concrete within winding is taken into consideration (Fig. 1 b). With that in mind, it is more efficient to use ties with additional longitudinal bars in the corners of the column that will allow considering all the section of the column, providing an additional protective layer of metal rolled profile and thereby increasing the rigidity of the element (Fig.1 c).

By the time of the destruction of column concrete of compression because of its significant plastic deformations, its rigid reinforcement reaches its yield point too. Thus, the basis for the calculation of axially loaded elements can be the sum of metal and concrete forces, which was first proposed by Prof. Emperger. Therefore