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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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 the theoretical breaking load, calculated by formula (1) was close to experimental values, straying outside them in average by 2% [1].

$$N_p = R_c \cdot (A_c - A_s) + R_y \cdot A_s \quad (1)$$

where R_c - design compressive resistance of concrete;
R_y - design compressive resistance of steel;
A_c - cross-section area of a column;
A_y - cross-section area of a metal rolled stock.

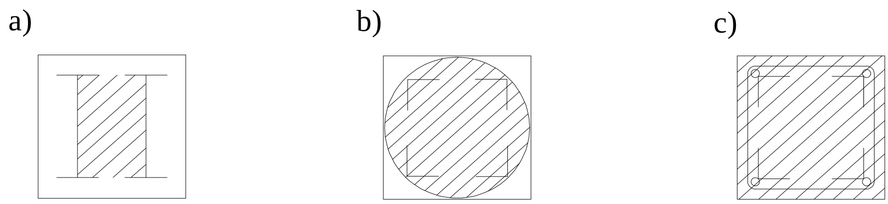

Fig. 1. Cross-section of columns tested by Professor Emperger

Rigid reinforcement is also used in columns with eccentric compression. The studies of such columns have also been carried out in the post-Soviet area. Based on the results obtained by the Central Research Institute of Building Materials Industry, eccentrically compressed columns with rigid reinforcement tend to show similar results as axially loaded columns. In the group of columns without ties the destruction was a sudden peeling of an unreinforced layer of concrete in the compressed zone along the plane of the flanges and webs leading to loss of stability and suitability for further use of the structure. At the same time in the columns with tie reinforcement there was a more peaceful and gradual destruction of the compressed zone under higher loads. In this case concrete didn't peel off from the rigid reinforcement, and being tied was gradually crumbling, allowing the full use of the strength characteristics of metal and concrete.

Let's consider the behavior of rigid reinforcement in bending using the findings of the tests of Central Scientific Research Institute of Construction. All the tested beams were single span, had a T-section and the same shuttering sizes (Fig. 2) [1].

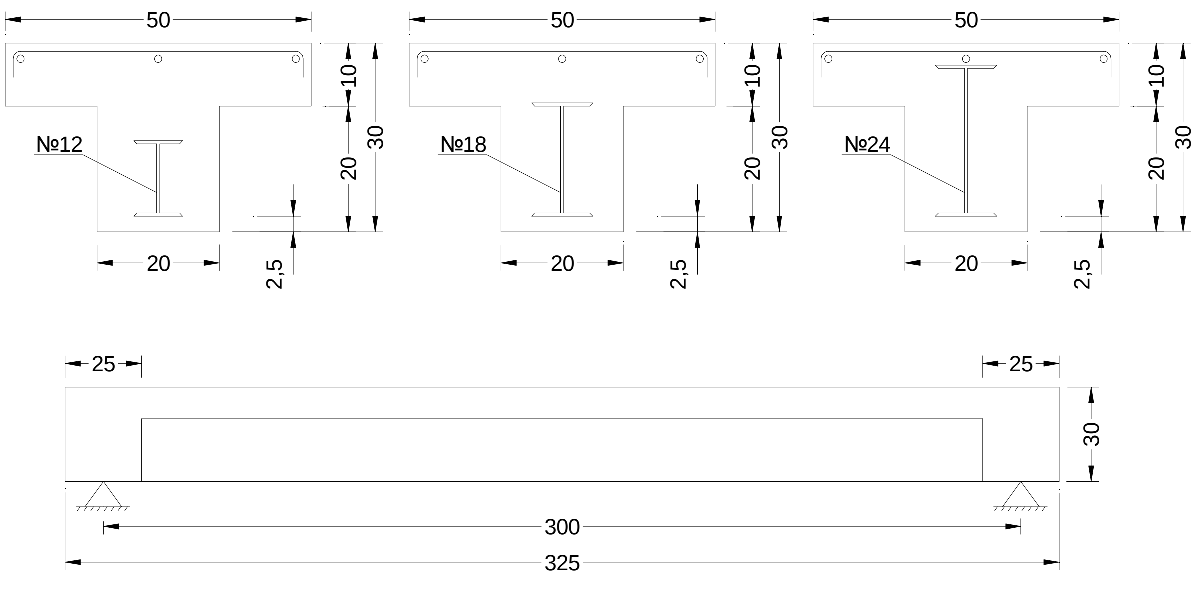

Fig. 2. Beams with rigid reinforcement tested by Central Scientific Research Institute of Construction

In I-shaped reinforced beams No.12 and No.14 in the absence of ties and anchoring ends of the rigid profiles the destruction was characterized by the shear fracture of concrete. At loads close to the destruction, there were diagonal cracks in supporting parts. These cracks were quickly spreading and developing into a longitudinal crack separating the web from the slab. The development of these cracks was accompanied with debonding of I-beams with concrete and pulling them out of the separated support sections. It should be noted that by the time of shear failures there had already been well developed vertical cracks (Fig. 3).

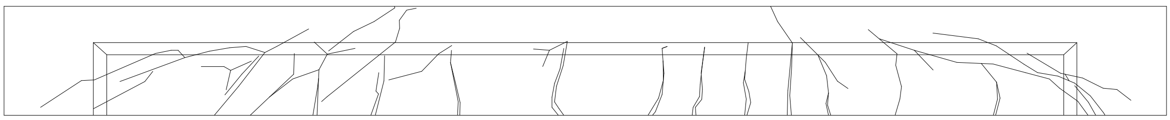

Fig. 3. The nature of the beam destruction with I-shaped reinforcement No. 12 without anchoring

Beams with I-shaped reinforcement and ends anchoring also had shear failure but at higher loads. The failure was characterized by the development of a horizontal crack that separated the bottom part of the web from the beam slab. By the time of the failure the concrete under the anchoring U-profile had crumbled, and the anchor hit into a support beam part. Anchoring of metal rolled profiles (rigid reinforcement) in the body of the sample was carried out by welding U-profiles to the ends, which is represented in Figure 4. At the same time anchoring in the samples without welding at the ends of U-profiles was performed by widening the concrete cross-section of the support parts of the beam - haunches[1].

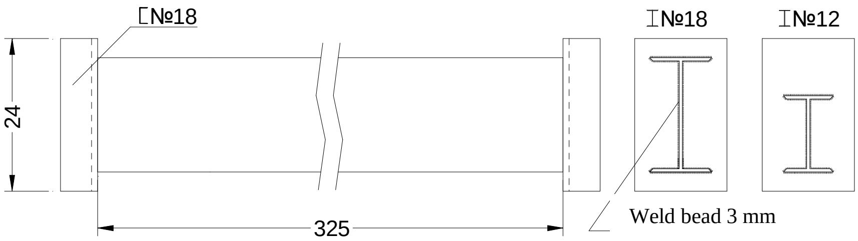

Fig. 4. Anchoring the ends of rigid armoring of test beams

Beams with ties were destroying at higher loads, wherein there were no longitudinal cracks separating the web from the slab, and diagonal cracks in supports weren't developing. The failure was characterized by vertical cracks opening in flight and the destruction of compressed slabs. Pulling the I-beams from the supporting part was not observed, indicating that ends anchoring doesn't affect the reinforcement of test samples with ties around the metal rolled profile, i.e. combined action of reinforcement and concrete was fully ensured that contributed to the full use of the strengths of both materials of the reinforced concrete structure[1].

By the moment of destruction the beams, that had neither anchoring of the ends of I-beams nor the mesh in the slabs, had lost bend stress and the beam had been split along its axis, and the beams with I-beams anchoring and a slab, and fabric-reinforced, the failure was also characterized by web shear on the verge of connecting with a slab, but we didn't observe the segregation of beams along the axis. The value of fracture loads in the presence of anchoring was much higher and by the time of destruction a significant disclosure of vertical cracks in the middle of the span had been present.

Our earlier experimental researches of strength and stiffness of splice connection of reinforced concrete foundation and concrete footing with rigid reinforcement showed the results, which also confirmed the need for ties or spiral winding around the metal profile. Since spirals (ties) in the experiment were not used, and at failure there was the loss of bond stress and a test element was split along the axis of the rigid reinforcement, which is shown in Figure 5 [2].

The destruction of all beams reinforced with I-beams No. 24, was basically the same, characterized by a sharp opening of vertical cracks, their development up to the height of the rib and at the bottom of the slab, and finally the destruction of the compressed zone of concrete in the middle part between the points of application of loads. The nature of beams failure and the results of strain measurements showed that at high profiles of I-beams, setting the top flange in the compressed zone of the concrete, as well as at short profiles connected with the compressed area of concrete by ties, rigid armoring acts with the concrete. [1]

In the experiments carried out by Central Scientific Research Institute of Construction the fracture practically always occurred at sharply defined yielding of the metal not only in the bottom I-beams flanges, but also in the wall of the rolled metal. In the beams reinforced with I-beams №12 and ties it is obvious that the entire profile cross section reached the yield point. Although in the beams with short profiles without ties the failure was characterized by a shear of a concrete web along the upper flanges of I-beams, by that time the reinforcement stress had also been quite high and for the beams with reinforcement anchoring had apparently reached the yield point.

In all of the above samples the height of the compressed area was less than 0.5 and the beginning of the failure in all the cases was really determined by the yielding of the metal (but for the samples with an early failure due to the shear fracture).

Fig. 5. General view of the foundation block experimental sample reinforced
with the help of a rigid rod - I-beam (welded of U-profiles № 6,5)

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THE PRINCIPLES OF BASES AND FOUNDATIONS CALCULATION CONSIDERING DEFORMATIONS ACCORDING TO THE NATIONAL AND EUROPEAN STANDARDS

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The principles of bases and foundations calculation considering deformations in accordance with the national and European standards are provided. The limit state designs USL and SLS are considered according to the European standards. The similarities and differences of bases and shallow foundations calculation considering deformations in accordance with the national and European standards are identified and generalized.

In May 2015 the Republic of Belarus has officially become a participant of the Bologna Process. The participation in the Bologna process allows the higher education in the Republic of Belarus to be reformed according to the global and European tendencies. Thus, nowadays the harmonization of national and European design standards is of current interest. The Eurocodes introduction in the Republic of Belarus may increase the inflow of foreign investment in construction, therefore one of the main issues nowadays is Eurocodes developing and the ability to use them in practice.

Eurocodes are the normative documents in the construction sector, developed by the European Committee for Standardization and recommended for use in accordance with the national characteristics by the European Union member countries. The National Annexes to the Eurocodes provide the additional requirements for the construction individual parameters, which can be higher, but not lower than the common European ones. Each country defines these requirements independently. In Europe a common approach in geotechnical design hasn't been developed yet.

The National normative documents [1, 2] as well as Eurocode 7 [3] decree the design of various objects according to the two groups of limit states (depending on the bearing capacity and deformation) and have uni-