Strength of the Reinforced Concrete Beams, Strengthened by the Prestressed Reinforcing Bars

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Abstract – this article describes strengthening normal cross-section of reinforced concrete beams with prestressed reinforcement under load. The effect of strengthening at the level 0,5Mcr was 65%.

Key words – concrete beams, strengthening, normal cross section, reinforcement.

I. Introduction

At present more attention in many countries is paid to the reconstruction of existing buildings and structures, rather than to new constructions.

Building-up the section with additional prestressed reinforcing bars is one of effective ways to strengthen structure in terms of not only strength of normal sections of the structure, but also its stiffness (limitation of deflections and width of cracks) [2,3].

II. Experimental data

The samples of RC beam with 2100 mm. length, 100 mm width, and 200 mm height was tested. As beam's tension reinforcement A500C Ø12 mm rebar was chosen. B500 Ø5 mm rebar was chosen as compressed reinforcement. Transverse reinforcement – B500 Ø 5 mm rebar located in the supporting area with step 75 mm. (Fig. 1). Class of the concrete was C20/25.

RC beam was designed to provide flexural bearing capacity according to recommendations [1].

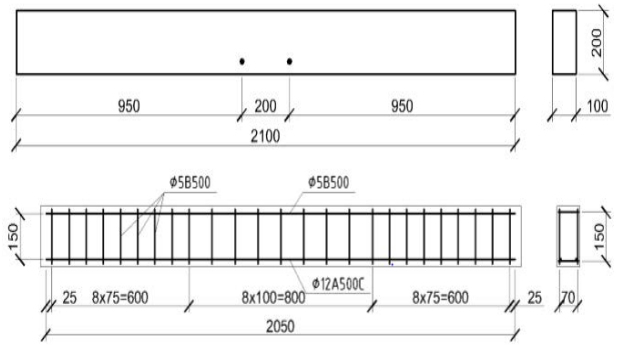


Fig. 1. Reinforcement and dimensions of the designed beam

The beams were tested for a pure flexure. The load was added using the hydraulic cell in the thirds of the span (Fig. 2). Along with the strengthening of normal section with metal clips the inclined sections were strengthened as well.

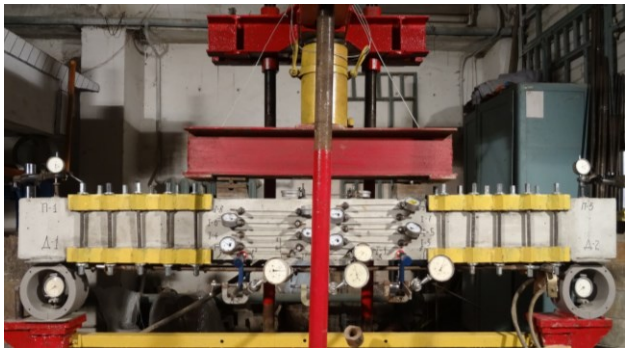


Fig. 2. Sample beam with strengthened normal cross section

The beams were strengthened using two prestressed reinforcing bars A500C Ø12 mm (Fig. 3). Reinforcing bars were connected with the main beam reinforcement by means of welding using reinforcing bars Ø28 mm.

Fig. 3. The beam strengthened with prestressed reinforcing bars

During the experiments, the beams were marked as follows: BO – a normal beam, BR – a beam strengthened with prestressed reinforcing bars. The first numbering digit means a series number, the second one - the prestressed level at which strengthening was carried out, the third one – the number of the the series sample. Thus, identification mark BR -2-0.5-1 means that corresponding beam belongs to the second series strengthened with $0,5M_{cr}$ and it is the first sample of these series.

III. Results of experimental research

The beams of two series were tested: two beams of the BO series and two beams strengthened with the prestressed reinforcing bars at $0,5M_{cr}$ (Fig 4,5).

All tested beams were destroyed in the central zone. The beams of BO series were destroyed after to the onset of the flow of the beam's longitudinal reinforcement and with further chipping of the compressive zone of the concrete. The beams of BR series were destroyed after the flow of the additional prestressed reinforcing bars, further flow of the main reinforcing bars and the destruction of the compressive zone of the concrete.

After the tests there is an increase in strength of the reinforced of the beams for 65%, and also the increase of crack strength and the reduction of deflections.

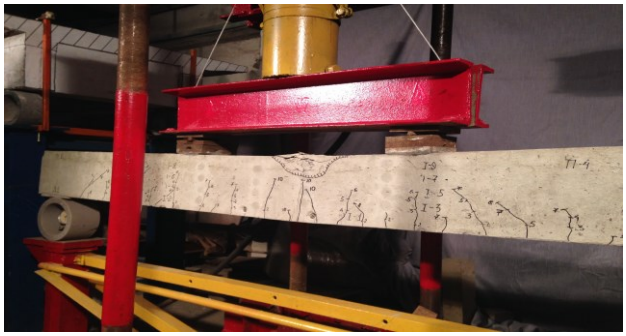
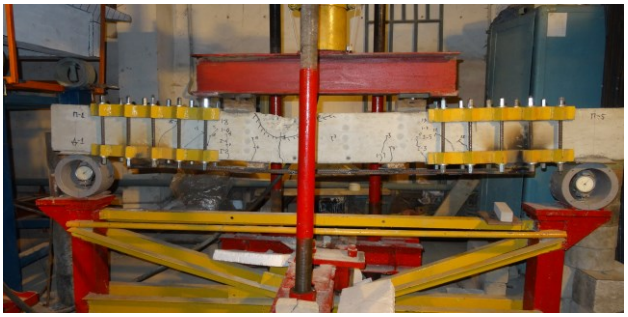


Fig. 4. Destroyed BO series beam



a) Destroyed BR-2-0.5-1

b) Destroyed BR-2-0.5-2

Fig. 5. Destroyed BR series beam

The destructive values of the beams are given in Table 1.

TABLE 1

CHARACTERISTICS OF TESTED RC BEAMS

Type of beams	Cross section axb, mm	M, kNm
BO-1	200x100	19
BO-2		18,8
BR-2-0.5-1	200x100	31,4
BR-2-0.5-2		31,2

In order to study out the effect of strengthening the results are summarized in Table 2.

TABLE 2

THE EFFECT OF STRENGTHENED BEAMS

Type of beams	Strength, kNm	Averedge values, kNm	Efect of strengtheni ng, %
BO-1	19	18,9	–
BO-2	18,8		
BR-2-0.5-1	31,4	31,3	65

The diagram of the deformations of reinforcement and concrete was build up according to the results of tests of strengthened samples (Fig 6).

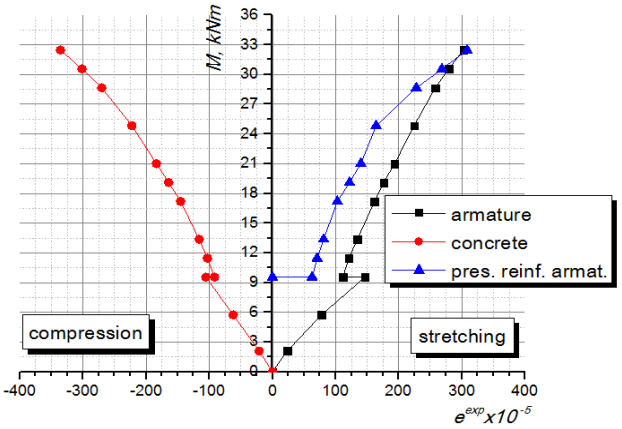


Fig. 6 The deformations of reinforcement and concrete of beams of BR series

The flow of the main and the additional prestressed reinforcement (Fig 6) was achieved almost simultaneously.

Conclusion

As the result of research we could make the following conclusions:

- The strengthening of beams by the flexible elements with prestressed reinforcing bars is simply to use and does not require a lot of costs;
- The strengthening of beams in this way make its strength, crack resistance and reduces deflection;
- The effect of strengthening at the level 0,5Mcr was 65%.

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