Shear strength of RC beams strengthened by FRCM system

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Abstract – In this article shear strength of strengthened and non-strengthened reinforced concrete (RC) beams are described. Beam was reinforced by FRCM system Ruredil XMesh Gold. There was using strengthening type called jacked – textile coated beam from all beam's surfaces. Effect of strengthening inclined cross section is 24.1%.

Keywords – shear strength, FRCM system, RC beam.

I. Introduction

With the development of science and technology, new materials were began to be used in construction. One of them are PBO materials which are used in FRCM (Fiber Reinforced Cement Matrix) and CFRP (Composit Fiber Reinforced Polymer) system. FRCM system – Ruredil XMesh Gold is one of the newest strengthening system. It characterized hightest parameters of fire, water resistance and resistance to environmental influence.

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 A400C Ø22 mm rebar was chosen (according to DSTU 3760:2006). A400C Ø12 mm rebar (according to DSTU 3760:2006) was chosen as compressed reinforcement. Transverse reinforcement - A240C Ø 8 mm rebar (DSTU 3760:2006) located in the supporting area with step 100 mm. (Fig. 1). Claas of the concrete was C32/40.

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

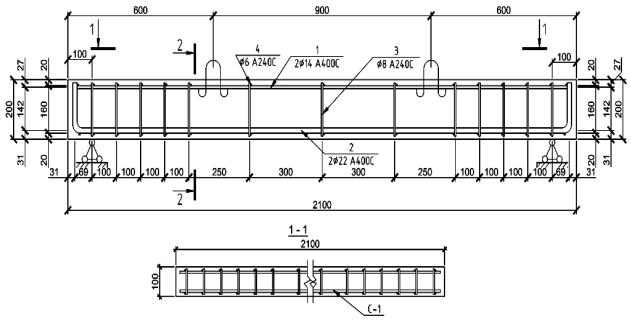


Fig. 1. Reinforcement and dimensions of the designed beam

Beams were tested on the static load. Force was applied at shear span to effective depth ratio which equaled 2 Feature of the researching was testing every beam twice. For the economy material one cross section reinforced by metal jacket (Fig. 2,3). For prevent deformation in the concrete and reinforcement metal jacket was mechanically prestresed.

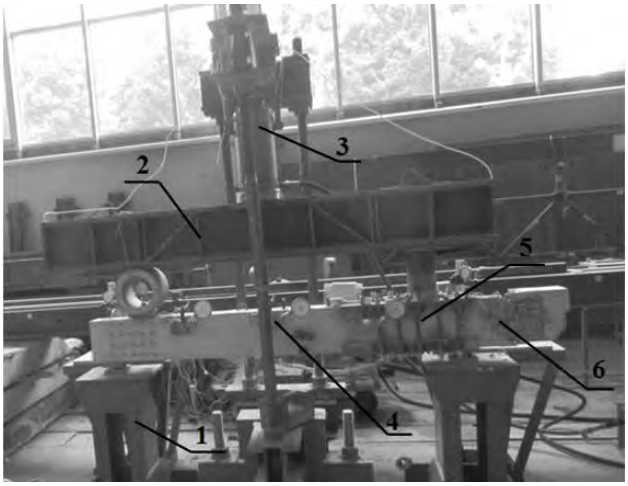


Fig. 2. Testig beam inclined cross section:
1 - Support. 2 - Distributive metal beam. 3 - Hydraulic crank.
4 - Testing beam. 5 - Metal jacket. 6 - Crashed cross section

Beams are reinforced three stripes in support area (Fig. 3). Each strips are 70 mm witdh and coated all beam's surface. For better reinforcing chamfers were removed and all reinforcing area was cleaned. Reinforcing was made according to the technical rules of producent

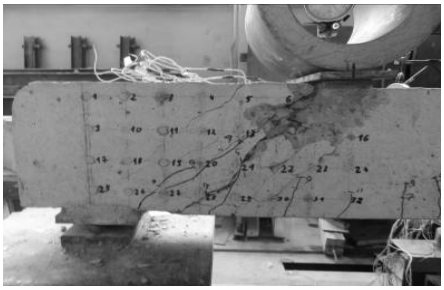
Fig. 3. Causing FRCM system on the beam

A strips of reinforcement were used because it allows to measure deformation in inclined section whithout changing our measuring system.

Beams were marking in this manner: BO - beam ordinary, BR – beam reinforced, the first one - serial number, the second one - prototypes number, and the third one – number of section. For example BO 2.1-2 means that tested the second section of the first beam of second series of beams.

III. Results of experimental researching

There were testing two beams (four tests): one – without reinforcement (for determining shear strength and deformation of inclined cross section) and with transversal reinforcement by FRCM (Fig 4,5).

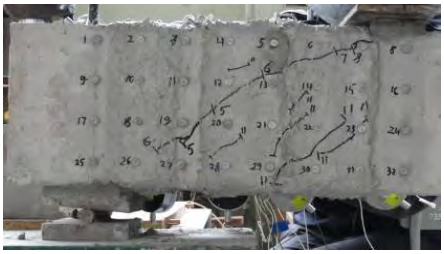


a) BO 2.1.1

b) BO 2.1.2

Fig. 4. Experimental samples destroyed whithout strengthening.

This beams collapsed suddenly with crushing of concrete. Destruction occurred when concrete of compressed area reached maximum values of compressive deformations. Maximum fixed width of inclined crack was 0,7 mm. Acceptable width of inclined crack (0.4 mm) was fixed at 120kN.



a) BR 2.1.1

b) BR 2.1.2

Fig. 5. Experimental samples destroyed with Ruredil XMesh Gold

After testing of reinforced samples we noticed that it failure was not suddenly. Also fracture toughness was better then in non-strengnhening beams. Width of crack - 0,4 mm was fixed before crushing of concrete. So fracture toughness is higher up 40%.

Shear strength of RC beams are presented in Table 1.

TABLE 1

CHARACTERISTICS OF TESTED RC BEAMS

Type of cross section	Cross section axb, mm	Beam span, mm.	Shear strength, kN
BO 2.1.1	204x102	1900	152
BO 2.1.2		1550	147
BR 2.1.1	201x95	1900	187
BR 2.1.2		1550	184

Using ours testing methodology we take a satisfactory convergency between tested twins – up 1.7% (Table 2).

TABLE 2

SHEAR STRENGTH OF TESTED RC BEAMS

Type of cross section	Shear strength, MPa	Averedge values, MPA	Discrepancy,%	Efect of strengthening, %
BO 2.1.1	152	149,5	1.7	-
BO 2.1.2	147			
BR 2.1.1	187	185,5	0.9	24.1
BR 2.1.2	184			

As a result of using FRCM system we have received the strengthening effect by 24.1%. The strip near support was deformated only around 25% of it's limit value, another two ones were reached limit value. Also this composite FRCM reinforcement significantly increases the fracture toughness (up 40%).

Conclusion

Based on the obtained results we can make next conclusions:

- testing separately every inclined cross section of the beams allows to to save speciments witout loss of accuracy (discrepancy was less then 1.7%);
- the reinforced beams by FRCM failure not suddenly;
- the shear strengthening effect of RC beams with FRCM system was up 24.1%;
- the FRCM system significantly improved fracture toughness (up to 40%).

References

[1] DBN B.2.6-98:2009 Betonni ta zalizobetonni kosntruktsii. Minrehionbud Ukrainy, Kyiv, 2011. [SBN B2.6-98:2009 Concrete and reinforced concrete construction. Ministry of Regional Development and Construction of Ukraine, Kyiv, 2011].