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SOLVING ANCHORAGE AREA PRESTRESSED AND NONPRESTRESSED COMPOSITES

L. Podolka*

Abstract: *Paper present carry out experimental test for assessment behaviour composites in anchorage area because of element bond in cutting in beam or by rote anchorage. Will be make mathematical models in programm ATENA. Results experimental test and mathematical models will be comparing. Results are design method for determination anchorage length practice.*

Keywords: Composites, Anchorage, Strengthening.

1. Introduction

Of mid-1990s use nonprestressed composites (FRP strips) for strengthening structures throughout world as well as Czech Republic. Experiences obtain on strengthening structures and practise experimental test make for result, that for utilize material property composites and for increasing effectiveness strengthening structures have to need use FRP strips, as that of prestressed reinforcement in the form of reinforcement noncohesion (loose cable). By reason of safety so that do need mechanical failure FRP strips, there are bond in the entire area.

2. Desctipton Experimental Test Make to in Laboratory KÚ ČVUT

For verification new prestressed system firm STADO CZ, Ltd. will be make experimental test in laboratory KU ČVUT in Prague. System is construct of tensive apparatus made in firm “Chartered metrological centre K 103”, Čechova 20, Prague 7 (Mr. Josef Hajek), mechanical anchorage elements, two steel plates thickness 15 mm size 150*168 mm, six chemical anchorage M12 (inactive anchorage), so-called “tray” to which put upon active anchorage with drawing gun. Drawing gun it can be append to mechanical “hand” piston or press. The experimental element consisted of the reinforced concrete beam (250*350*1800mm) made of concrete B 30 according to the Czech Standard CSN 73 1201. Beam has to cutting size 170 x 350 mm depths 15 mm for inactive anchorage and cutting size 900*350 mm depths 20 mm for active anchorage with drawing gun. Tension strip have to take around step by step 7 kN so far maximum force 70 kN, that will be voted by standard strip from offer firm STADO CZ, Ltd. type S, size 50*1,4 mm with Young’s modulus E = 150 GPa and tensile strength σ_t = 2000 MPa. At tension strip will be monitoring strain strip, compression concrete and pressure into exit from mechanical press. Along expiry tension and anchorage FRP strip in active anchorage will be for eight week measuring slip strip in anchorage, change strain concrete (compression) and strain strip.

In laboratories KU ČVUT in Prague experimental tests were conducted with FRP reinforcement glued into the grooves. Experiments have shown that the fins affixed to the groove occurs approximately twofold increase in the anchoring force to anchor the same length compared to the slat affixed only on the lower face of the beam. Experimental tests were conducted on samples of three different classes of concrete (C 20/25, C 30/37 C 40/50) and three different anchor lengths (100 mm, 150 mm and 200 mm), a total of 27 samples were tested. The results were compared with similar results from 2001, when the samples were tested with slats glued to the surface.

The beam size 120*180 mm length 2000 mm of concrete C 20/25 XC1 reinforced bending 2*2 ∅ R14, stirrups ∅ R6/150 mm of length 2 m beam was amplified in the groove located FRP profile

* Assoc. Prof. Dr. Ing. Luboš Podolka: Institute Department of Civil Engineering, University of Technology and Economics in Czech Budejovice, Street Circular No. 517/30; 370 01, Czech Budejovice; CZ, podolka@mail.vstecb.cz

∅ 8 mm length 1700 mm. The beam before amplification was loaded at the moment of crack width of 0.2 mm and under this load then amplified beam and subsequently for about 24 hours, the load held on the same strength in the adhesive to harden. The beam was loaded until further violations.

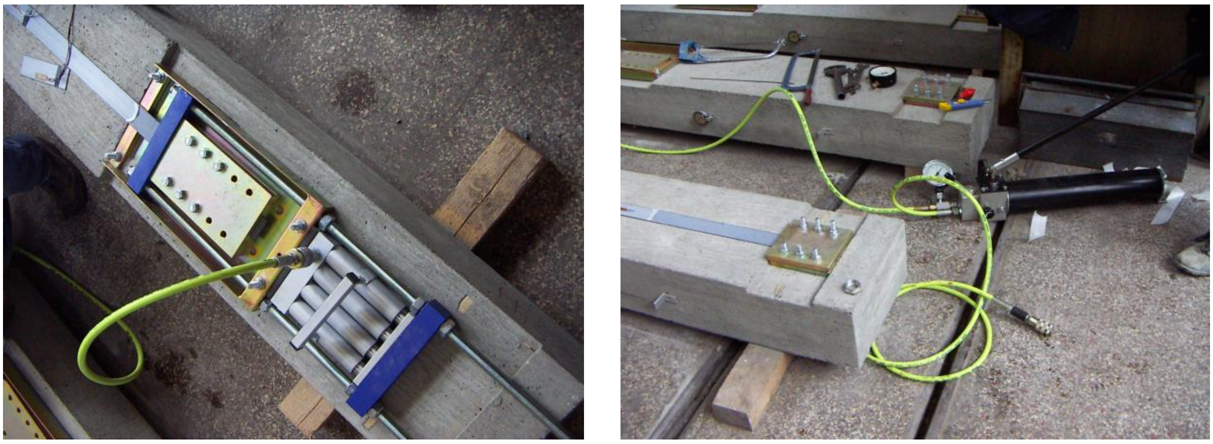

Fig. 1: Detail drawing gun, (four coupled piston all of piece) and mechanical piston.

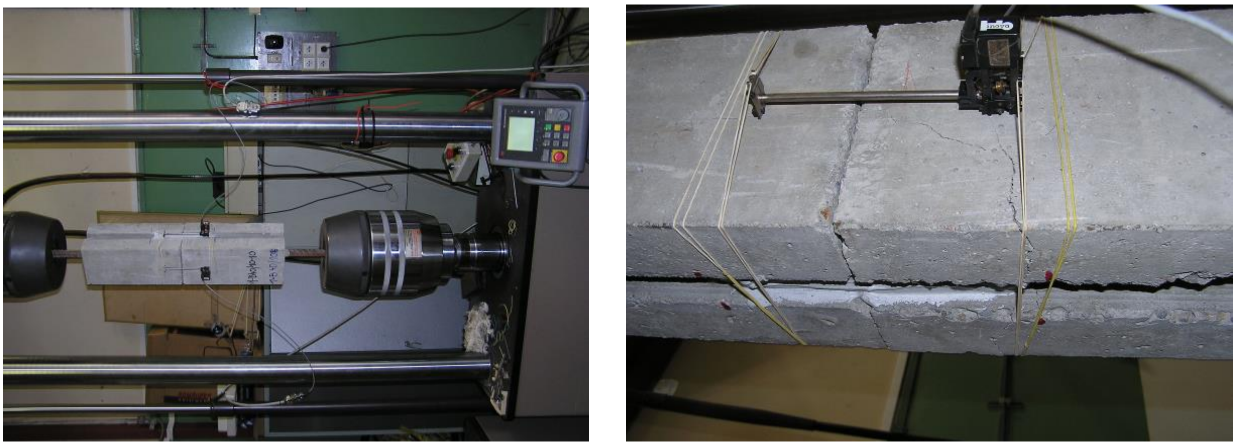

Fig. 2: Sight to experimental test, detail failure element.

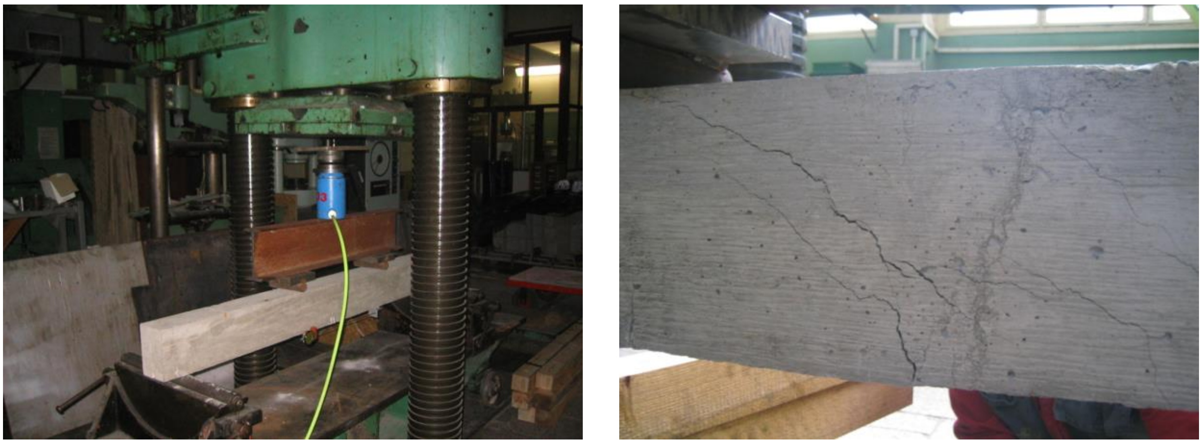

Fig. 3: Pictures experimental element, respectively. Detail the damaged beam.

3. Check on Experimental Data Upon Model Make to Programm Atena

Above describe experimental element will be model in programm ATENA, that will be have to monitoring behaviour element at point active and inactive anchorage, i.e. transmission force from strengthening strip by mechanical anchorage to the concrete and propagation stress in concrete near anchorage. Flexion strain concrete beam gauge on experimental test in axis has been 0.005 - 0.007 mm by up to auxiliary aiming longitude 500 mm, e.i. $\varepsilon = 0.00001$.

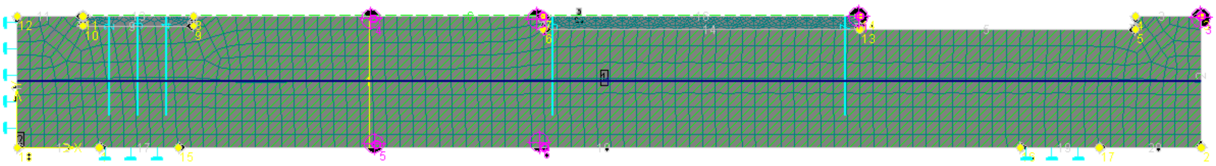

Fig. 4: Sight experimental model in program ATENA.

The above described experimental element was modeled program ATENA, so that it can monitor the behavior of the element in place anchorage reinforcing reinforcement, i.e., the force transmission from the glued reinforcing FRP reinforcing bars and concrete stress propagation in the groove.

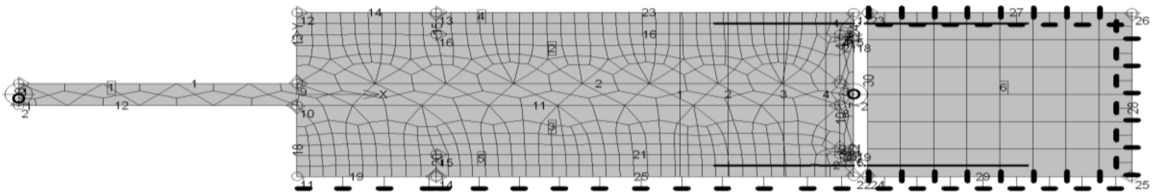

Fig. 5: Sight experimental model in program ATENA.

The above described experimental element was modeled in program ATENA, so that it can monitor the behavior of the element in place both active and passive anchors, i.e. power transfer from reinforcing bars through mechanical anchoring to the concrete and spread stresses in the concrete for anchors. Resp. the beam reinforced reinforcement glued in the groove spreading around enhancing tension reinforcement and transmission over the glued joints to crosslinking element.

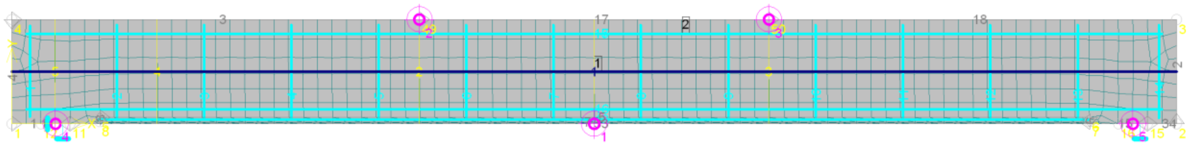

Fig. 6: View of the experimental model of program ATENA.

4. Power Transferred Anchorage:

a) for l_v < 115 mm

$$F_{v,k} = b_f . \tau_{k,k} . \sqrt[4]{a_r} . l_v . (0.4 - 0.0015 l_v) . \frac{E_f}{E_{f,prum}} \quad (1)$$

$$\tau_{k,k} = \sqrt{\left(2.f_{kt,k} - 2\sqrt{\left(f_{kt,k}^2 + f_{kc,k}.f_{kt,k}\right)} + f_{kc,k}\right) f_{kt,k}} \quad (2)$$

$f_{kt,k}$ - characteristic strength of the adhesive strength in N/mm^2,

$f_{kc,k}$ - characteristic strength of the adhesive pressure in N/mm^2,

a_r - spacing from the free edge of the workpiece in mm (max. 150 mm),

l_v - anchor length,

E_f - modulus slats guaranteed,

$E_{f,\,prum}$ - average modulus of elasticity of the slats.

For experimentation can be considered:

$f_{kt,k}$ = 16 N/mm^2, $f_{ct,k}$ = 75 N/mm^2, $\tau_{k,k}$ = 22.16 N/mm^2, a_r = 75 mm, b_f = 6 mm, t_f = 6 mm,

l_v = 100 mm, E_f = 150 GPa, $E_{f,prum}$ = 180 GPa, $\rightarrow F_{v,k}$ = 8143.8 N, for two rods 16287.6 N,

Force measured in the experiment of F_{exp} = 29.7 kN, Force from the calculation F_{vyp} = 16.3 kN

$$s = \frac{F_{exp}}{F_{vyp}} = \frac{29.7}{16.3} = 1.82$$

Security design patterns :

b) for l_v > 115 mm

$$F_{v,k} = b_f . \tau_{k,k} . \sqrt[4]{a_r} . \left(26.2 + 0.065.\tanh\left(\frac{a_r}{70}\right)(l_v - 115)\right) . \frac{E_f}{E_{f,prum}} \quad (3)$$

$$T_k = T_{\max,k} \cdot \frac{l_t}{l_{t,\max}} . \left(2 - \frac{l_t}{l_{t,\max}}\right) \quad (4)$$

$$T_{k,\max} = 0.225.b_f . \sqrt{E_f . t_f . \sqrt{f_{ck} \cdot f_{ctm}}} \quad (5)$$

$$l_{t,\max} = 1.46. \sqrt{\frac{E_f . t_f}{\sqrt{f_{ck} \cdot f_{ctm}}}} \quad (6)$$

$T_{k,max}$ - maximum power transferred in the anchorage,

$l_{t,max}$ - max corresponding bond length for power $T_{k,max}$,

l_t - of the proposed anchorage length,

b_f - slat width or diameter in mm rods,

t_f - segment thickness or diameter in mm rods,

E_f - guaranteed modulus slats or bars,

f_{ctm} - tensile strength of concrete, or strength value measured in the exhaust test of the concrete surfare,

f_{ck} - characteristic value of the cylinder compressive strength of concrete.

5. Conclusions

For experiments with sealed rod showed the possibility of replacing the front discs glued laminated rod into the groove, the effectiveness of the same surface anchoring plates and rods is about 1.5 to 2 times.

Using prestressed FRP rods increases their utilization to 60 up to 70 %, while the rod is glued into the groove used to 35 up to 40 % of its strength when there is a sufficient reserve of pressure in the crosslinked section. While normally glued lamella on the surface of the beam is used to 15 up to 20 % of its strength. Using the prestressing tendon is also eliminate distortion amplified structure , while non-prestressed FRP reinforcement either on the surface or in a groove only contribute to the enhancement in terms I. Limit state (carrying capacity) minimum increase stiffness .

In cooperation with STADO CZ, Ltd. offers dimensioning software for amplification using FRP rods glued in the groove or on the surface of glued lamellas. The other vendor FRP technology for strengthening concrete structures offering similar dimensioning software as a tool for planners.

Acknowledgement

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