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STEEL CHEMICAL MEMBERS ANCHORED IN CONCRETE

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Summary

Nowadays the most common steel structural anchorage systems used embed anchoring elements. In recent years however, bonded steel anchors, i.e. elements that are post-installed, have been increasingly used. This system of anchoring is used both in the redevelopment design of existing structures and in the design of new building structures. The problem of real anchorage behaviour in the context of integrated building structure design is an integral part of the design of structures in a real system. Current knowledge in the field of real behaviour of building structures does not provide a global picture of the problem of anchorage – neither the anchorage systems using expanding mechanical steel anchors nor anchorage systems using bonded anchors.

1 INTRODUCTION

Steel chemical anchors are nowadays exploited in far more scale for anchoring steel structures. This system of anchorage takes part (i) in reconstruction of existing objects and (ii) in design of new building works. Problems of real behaviour of this anchorage type are integral part of proposal building works applied in real environment. The up-to-date knowledge in field of real behaviour anchorage of construction doesn't give the general view on problems of anchoring. Available and practically used design procedures are limited by non - uniform regulations issued released by chemical steel anchors manufacturers.

Additionally mounted chemical anchor are, following procedure, installed as a steel threaded rod inserted in pre-drilled slot with diameter 10-20% larger than anchor. Contact material between steel anchor and concrete material usually forms polymethacrylate glue based on epoxide, polyester, polyurethan, vinyl-ester or vinyl-urethan. Anchor design philosophy based on safety conception considering partial coefficients of confidence are likewise impressed with real location and shouldering accuracy of anchor elements in node. Safety of anchorage is not determined only by properties of steel anchor but also by basic material properties. Properties of basic material (commonly concrete or masonry) have usually considerable scatter, as well as properties of contact material which ensure interaction between the anchor bolt and the basic material. Characteristics of contact material aren't as a rule uniquely determined.

2 BEARING CAPACITY OF CHEMICAL ANCHORS

Ultimate bearing capacity of chemical anchor which is loaded by axial tension force, at failure by extraction of anchor bolt, can be calculated according to [2], [4] like

$$N_{m,d} = \tau_d \cdot \pi \cdot d \cdot h_{ef}, \tag{1}$$

whereas to the failure can take place on the interface between steel and glue (contact material), or between glue and concrete.

Since the ratio of steel anchor bolt d and slot diameter d_0 is, while using glue like contact material, little different, can be suppose, that

$$d/d_0 \rightarrow 1. \tag{2}$$

There isn't therefore a need to separately designate the bearing capacity of anchor to interface „ steel – glue" and „ glue – concrete" [3].

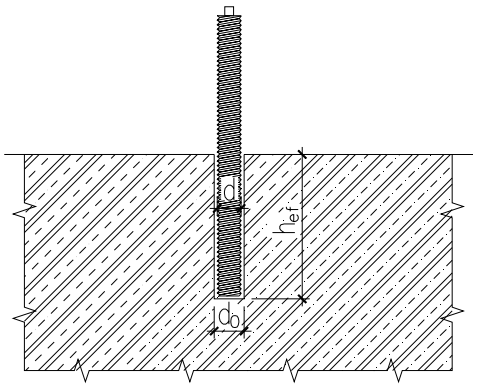

Fig.1 Bonded anchor

Fig.2 Failure of concrete and rupture of anchor after tension test with couple of anchors

One of basic part analysis of real behaviour of steel bonded anchors is assessment of real glue properties. These are usually outspread to characteristics of basic material – concrete. Likewise is that with bonded anchors HILTI, type HVA+HAS, where contact material is double-barrelled vinyl-urethan resin.

3 LABORATORY TESTS OF SHEAR AND TENSION BEARING CAPACITY OF CONTACT MATERIAL, DOUBLE-BARRELLED VINYL-URETHAN RESIN

In order to check physical mechanical parameters of contact material, which is based on vinyl-urethan resin, there were realized static loading shear and tension tests. These tests were performed in laboratories appurtenant to Faculty of Civil Engineering, Brno University of Technology.

Monitored characteristics were shearing strength σ_s, secant static strain modulus in shear E_s, tensile strength σ_t and secant static strain modulus in traction E_t

Shear and tension resistance σ_s or σ_t were interpreted by quotient of loading force in anchorage failure state F and sectional surface of tested specimen A.. Static secant strain modulus E_s was intended by equation:

$$E_s = \sigma_S / \varepsilon_S \,, \tag{3}$$

where σ_S is value of the shear tension on specimen at failure state

ε_s is value of vertical relative deformation of specimen in assessed step

Tests were realized at specimen 24 hours old.

Tab. 1 Evaluation of shear tests

Evaluation of shear tests - vinyl-urethan resin						
specimen	Surface proportions		Load on ultimate state	Relative deformation on ultimate state	Shear resistance	strain modulus in shear
	thickness	width				
	a [mm]	*b [mm]*	*F [kN]*	*ε [mm/m]*	*σ [Mpa]*	*E_s [Mpa]*
V1	16	51,9	8,3	458	10	21900
V2	16	50,9	7,8	422	9,6	22600
V3	16,1	51,3	7,1	417	8,6	20600

Tab. 2 Evaluation of tension tests

Evaluation of tension tests - vinyl-urethan resin						
specimen	Surface proportions		Load on ultimate state	Realtive deformation on ultimate state	Tension resistance	strain modulus in tension
	thickness	width				
	a [mm]	*b [mm]*	*F [kN]*	*ε [mm/m]*	*σ [Mpa]*	*Et [Mpa]*
V1	16	51,9	8,3	458	10	21900
V2	16	50,9	7,8	422	9,6	22600
V3	16,1	51,3	7,1	417	8,6	20600

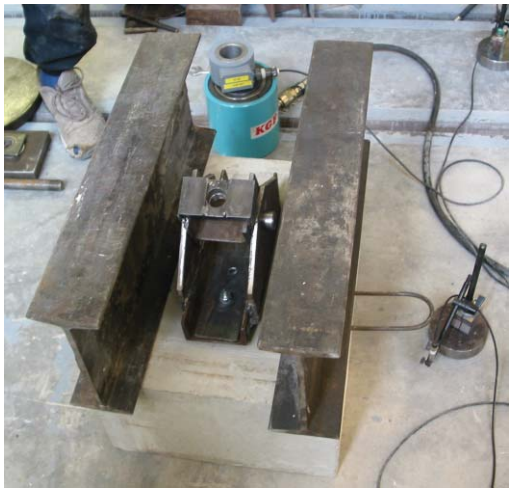

Fig. 3 Couple of anchors before tension test

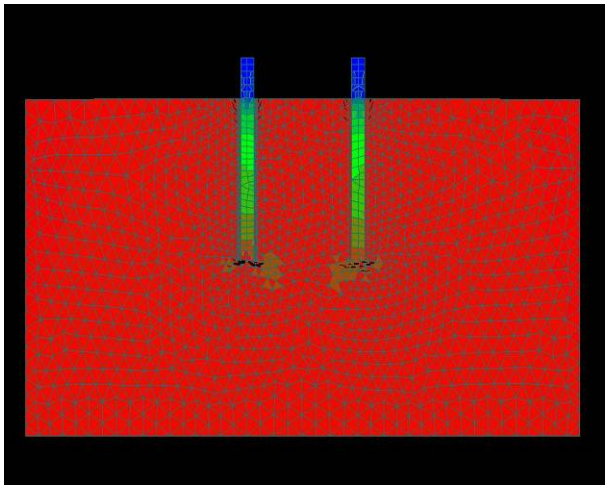

Fig. 4 Demonstration of numerical simulation with ATENA software

4 CONCLUSION

Results of these experiments will be used in verification and refinement of mathematical computational models (in this case ATENA software). Numerical modelling is in this case used for checking safety and durability of anchorage with additionally shouldered bonded anchors exposed to static loading effects.
Real input value of factors influencing bearing capacity of anchorage system as a whole, in this case the properties of contact material are the base of improvement mathematical methods used to assessment bearing capacity of anchorage with additionally steel bonded anchors.

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