05. June 2018

Test report No. 11.02.26 U

Bearing behaviour of headed studs in light-weight concrete

– Abstract –

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Light-weight concrete was already used in the ancient world. For constructing the Pantheon light-weight concrete was used in three section with different aggregates and decreasing density.

Today light-weight concrete is also used in building construction, i. e. at the airport Berlin-Brandenburg and for the cran houses in Cologne. Every year approximately 1.5 million m^3 of light-weight aggregates are used mostly in constuction works (www.leichtzuschlag.de).

Fasteners for use in normal-weight concrete were investigated systematically based on the introduction of ETAG 001. However for anchorages in light-weight concrete neither design code nor approvals exist. Evaluation of these fastenings is only possible by agreement for every single case.

Furthermore, an adoption of the knowledge from normal-weight concrete to anchorages in light-weight concrete is unfeasible, since the force-displacement behaviour and the composition is different. Therefore, the basic bearing mechanism in light-weight concrete with a dense micro-structure were investigated on headed studs.

The bearing behaviour of normal-weight concrete under tensile load is specified mainly by the cementious matrix, which ist the weakest part in the concrete. For light-weight concrete industrial fabricated bloated or naturally porous aggregates are used. These aggregates are less strong than the ambient cementous matrix and therefore limit the bearing capacity of light-weight concrete due to tension.

The fundamental bearing behaviour was investigated on headed studs because these studs transfer the loads via pure interlocking. However, the relatively small area of load transfer at the head leads to high stress, which may damage the light-weight concrete and lead to increased deformations.

At the maximum load the cone break-out occurs at an angle of 20 ° and not at 35 °, which is valid for normal-weight concrete. Thus, the edge distance and spacing might have to be increased due to overlapping concrete cones. The maximum bearing capacity in uncraked light-weight concrete depends on the embedment depth as well as on the area of the head of the stud. Therefore, the design method known from normal-weight concrete cannot be transferred to light-weight concrete.

The tests conducted in cracked concrete do not confirm the empirical equation for the bearing capacity in uncracked concrete because no dependency of the diameter of the head could be found. Therefore, more tests are necessary in cracked concrete.

Pull-out failure was also investigated during the research project. Conical break-out was neglected by using a confined test setup. The failure was characterized first by compression of the load introduction zone and then shear failure of the concrete. The design method well known from normal-weight concrete could be transferred neither for these test results.

To sum up, fastenings in light-weight concrete are able to transfer loads reliably. A design concept based on that fpr normal-weight concrete could not be found yet. Therefore, additional tests are necessary for evaluation of all boundary conditions.

Dortmund, 6. June 2018

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