Investigation of anchorages in concrete using nonlinear FE analyses

Student

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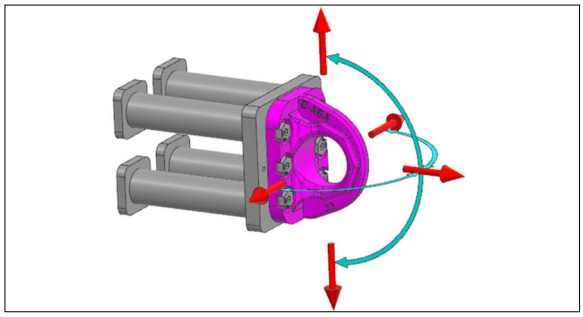
Initial Situation: In cable car construction, mounting forces must be temporarily introduced into the concrete during maintenance and installation. For this purpose, anchorages are placed in the concrete at various points during the construction of the installations. The calculation was previously carried out using punching shear verification in accordance with SIA 262. EN 1992-4 standard was published in 2018 and is used to calculate such anchorages in a similar way to headed studs. However, the calculation method with EN 1992-4 leads to significantly greater anchoring depths and edge distances for similar loads compared to calculatio according to SIA 262
The aim of this work is to determine whether the calculation according to EN 1992-4 is justified or whether it leads to excessive dimensioning.

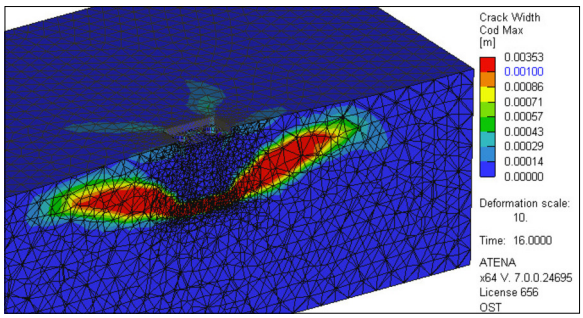
Approach: The behaviour of the anchorages in concrete and reinforced concrete was investigated in more detail using non-linear FE calculations with the for concrete specialised ATENA-software. Two main loading conditions were investigated: loading perpendicular to the concrete surface and loading paralell to the concrete surface. First, simple models were created in order to compare the plausibility with values from the literature and to carry out sensitivity analyses of the various concrete parameters. Subsequently, the models were adapted to the realistic anchorage geometry in more detail and further FE-analyses were carried out with ATENA-software.

Result: Simple FE-models gave good accordance with the experiments. In the case of realistic anchorage geometry, although many calculations were carried out with different concrete parameters, no fully satisfactory agreement with the test results could be achieved. The FE calculations of simple load situations with standard parameters showed a load-bearing capacity that was 2 times higher than the mean value of numerous anchor pull-out tests. A significantly flatter spread angle of the concrete cone in the simulations of about 22° compared to the 35° measured in tests was discovered.
In order to identify optimization potential, an explanation must be found for the deviation between the FE calculation and the tests. Until that, it is recommended to design such anchorages in accordance with the standard EN 1992-4.

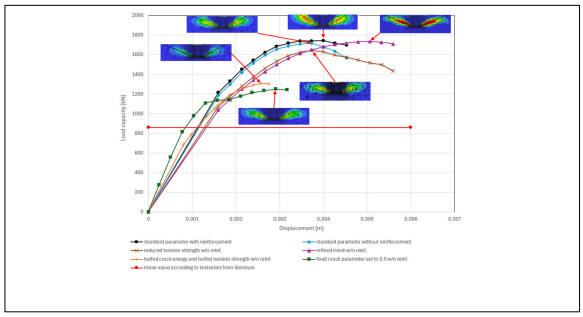
Anchorage with mounted anchor point and possible load directions
Quelle: Garaventa AG



Concrete cone failure at 1735 kN tension force calculated with ATENA
Own presentment



Displacement load curves from different calculations with ATENA compared to the mean value of test results in literature
Own presentment



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Subject Area
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