Research report
„Bearing behaviour of cement grouted anchors under aggressive carbonic acid attack"

Summary

The sensitivity of cement grouted ground anchors to the solving attack of carbonic acid strongly depends on the bearing behaviour of the interface interaction between anchor surface and soil. Due to the attack of the carbonic acid a corroded layer of cement forms on the surface of the anchor body. The developing amorphous, gel-like layer consisting of hydrous silicon dioxides is mechanically very unstable and shows a lubricious consistence. The corroded layer leads to a reduction of the frictional angle as well as to a loss of restraint. Corrosion simulation tests showed that the thickness of the corroded layer grows mainly due to diffusion processes and therefore the corrosion depth is proportional to the root of the corrosion time. The concentration of carbonic acid in the groundwater and in particular the permeability of the surrounding soil control the thickness of the developing corroded layer. Shear tests were performed in order to examine the corroded contact zone between cement and ground. Special direct shear apparatus were developed to first corrode the cement body over a certain period starting from several months up to one year under different concentrations of aggressive carbonic acid contents and than to shear them directly off to the overlaid soil. The experiments show, that the peak shearing resistance diminishes only to max. 92 % and the residual shearing resistance up to max. 97 % of the uncorroded value. The influence of the corroded layer on the shear parameters is clearly smaller than expected. The reduction of the shearing resistance is independent of the surrounding soil, but it depends only on the thickness of the corroded layer. The reduction runs highly flattening. These factors lead to the assumption, that the inner shear angle, the grain-to-grain-shear strength, is not affected by the corroded material and only the direct contact zone between cement body and grains is weakened. The dilatancy of the interface material does not diminish. This result concludes, that a statement over the loss of restraint cannot be made via the direct shear tests. The shear strain needed to reach the peak and the residual values if the shear strength reduces due to corrosion effects, which means, that corroded anchors behave more brittle than uncorroded ones. The shear tests show, that the substantial loss of bearing capacity due to corrosion processes can only in a very small account be attributed to the reduction of shearing resistance. On the basis of this results the reduction of bearing capacity must be a consequence of loss of radial restraint. Pull out tests after corrosion are to be carried out in order to allow a quantitative statement of the loss of bearing capacity.

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