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Comparing tests with a conventional and an improved box-shear apparatus with vertical parallel guides as a basis for DIN 18137-3

Abstract

In the conventional box-shear apparatus after CASAGRANDE, the upper frame rests movably upon the lower one which is guided horizontally, and the loading plate can rotate around its central point and leans in the horizontal direction on the upper frame because of the shear force. In the past twenty years, the assumption that the rotation of the loading plate could influence the shear resistance of the specimen gave rise to different constructions with frictionless parallel guides of the upper frame and the loading plate. The first one, even described in a draft of the code DIN 18137-3 proved to produce errors itself: self- equilibrated constrains could arise between the guides and the soil specimen. As a consequence of this experience, in the final version of the code a construction with vertical independent and frictionless guides of the upper frame and the piston was described as alternative to the conventional apparatus. But only a few experiences with this improved apparatus are available.

In this research project, comparing shear tests on different soils – sand, silt, clay – were performed to investigate whether serious differences exist between the test results from the conventional and the improved apparatus or both apparatuses can be seen as appropriate, and what kind of construction has to be preferred in practice, respectively. The following results were obtained:

With the apparatus with independent and frictionless vertical guides no indications for systematical falsifications of the test results were observed.

The rotation of the loading plate of the conventional apparatus during shearing does not influence evidently the resulting shear resistance but reduces only the shear stiffness and increases the amount of the deformations. On the other hand, the results concerning the shear strength obtained with the conventional apparatus can be falsified seriously by the vertical friction force between the loading plate and the upper frame. This friction force acts and can influence the shear resistance if the height of the specimen decreases by contractancy during shearing up to the limit state. But no error comes if the height increases by dilatancy or keeps constant. Therefore, the conventional apparatus is suitable and sufficiently accurate for sand and silt dilating mostly. However, concerning the tested clay, the friction angle was obtained 4 to 5 degrees too high because of the described effect. The errors cannot be detected on the basis of contradictions within a series of tests with the same apparatus.