Georgiannou, V. N. (2010). *Géotechnique* **60**, No. 4, 307–308 [**doi:** 10.1680/geot.8.D.022]

DISCUSSION

Unstable behaviour of model Jamuna micaceous sand

V. N. GEORGIANNOU (2008). *Géotechnique* **58**, No. 10, 825–829

D. Wanatowski, *University of Nottingham and*
J. Chu, *Nanyang Technological University*

The discussers would like to point out that the statement 'The instability observed under fully drained conditions does not involve collapse or loss of strength' made by the author in the conclusion (*c*) may not be generally true for two reasons.

(*a*) A specimen can collapse under a drained condition if the test is conducted under a load-controlled loading mode as shown and discussed in detail by Chu & Leong (2003a, 2003b) and Chu & Wanatowski (2009).

(*b*) By confining the conclusion to 'fully drained conditions', the discussers would assume that the author considers that instability under 'fully undrained conditions' involves collapse or loss of strength. This is also an observation made by a number of researchers (e.g. Lade & Pradel, 1990; Lade, 1992, 1993; Sasitharan *et al.*, 1993; Leong *et al.*, 2000; Chu & Leong, 2003a, 2003b; Chu *et al.*, 1993, 2003; Chu & Wanatowski, 2009). As the author did not specify otherwise, the discussers assume that the term 'drained' is used to refer to a condition where water is allowed to flow in or out of the specimen under a constant back pressure condition. Under such drained condition, the effective confining stress or the effective stress path can be controlled by varying the cell pressure. With today's laboratory testing techniques, it is possible to carry out a special 'drained' triaxial test to trace the curved effective stress path followed in an undrained test in which the specimen has collapsed. Assume this special test is conducted under a load-controlled loading mode, would the specimen in this test collapse or not? If it would, then this collapse is under a drained condition. If it would not, then what are the other factors that control the collapse in addition to the effective stresses?

In the discussed technical note, the author states correctly that 'unstable behaviour is associated with the sudden increase in the accumulation of plastic strains at an accelerating strain rate'. However, no graph indicating the acceleration in strain rate has been shown in the discussed note. The figures shown in the discussed note indicate yielding behaviour only. It should be pointed out that although yielding is a necessary condition for the instability to occur, it is not sufficient, as shown by Chu *et al.* (2003). This is because yielding means the development of a large strain for a small change in stress, which does not imply that the specimen will become unstable. For example, the same yielding points can be obtained for two 'identical' specimens tested under strain-controlled and stress-controlled modes. However, only the latter may become unstable, as studied in detail by Chu & Leong (2001) and Chu & Wanatowski (2009). For the same reason, a comparison of a deformation-controlled undrained compression test (WT1) with a load-controlled drained probing test (WT5–WT7) in Fig. 4(b) of the discussed note is not meaningful.

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Author's reply

The statement 'the instability observed under fully drained conditions does not involve collapse or loss of strength' refers clearly to the 'observed' instability in this work. What may happen during a 'special' drained test, which is not presented in the discussion, is a matter of speculation and is irrelevant to this work. I have simply referred to the drained path crossing the undrained stress path, which has been shown to act as a bounding surface in some of the references quoted by the discussers, and the crossing corresponding to a major change of behaviour but not collapse or loss of strength (see Fig. 3). Obviously, one cannot exclude that, under drained conditions, collapse may occur for some loose states of density, effective confining pressure range, loading conditions including stress path and possibly other factors.

On p. 828, the work by Sasitharan *et al.* (1993), which is also referred to by the discussers, is compared with the results of this note and it is stressed that the post-peak portion of a constant void ratio stress path (undrained stress path) does not form a state-boundary surface and the fully drained stress paths cross it. It should be noted that in the referred work, although collapse was induced on the bounding surface under fully drained conditions in the drained tests, catastrophic failure took place under undrained condi-

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tions, leading to a complete loss of the specimen's strength. Were the discussers' tests fully drained under load control?

Although a graph of strain rate is not presented in the paper to indicate unstable response, the sudden onset of volumetric reduction is clearly indicated by the steep portion of the curves in Fig. 4(a). Regarding the acceleration in strain rate, it is clearly stated in the note that the solid arrows shown in Figs 3 and 4 indicated the sudden increase in the volumetric strain and that each point marked by the dashed arrows 'corresponds to the maximum rate of volumetric strain measured during the test'. The latter, as stated at the top of the right column of p. 827, is of the order of 3%/h. The accelerating strain from minor volumetric change in the plateau to about 3%/h at the points marked by the dashed arrows (see Fig. 4(a)) is self evident.

Leong *et al.* (2000) considered the instability behaviour of a granular fill material. They stated that 'the occurrence of instability was indicated by a sudden increase in axial strain'. Lade (1993) stated that instability is not synonymous with failure, although both may lead to catastrophic events. The stress-controlled drained tests presented in this note have shown instability in the vicinity of the post-peak portion of the undrained effective stress path and did not show collapse.

Finally, a number of researchers concur (references given on p. 828) that the deformation-controlled undrained compression test forms a bounding envelope for undrained cyclic stress-controlled tests and/or drained stress-controlled tests, such as constant deviator stress. These comparisons justify the comparison of the undrained deformation-controlled stress path (WT1), which shows loss of strength after peak, with the drained stress-controlled tests (WT5–WT7). The main point of this work is that the undrained stress path does not form a bounding envelope for the drained paths.

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