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Experiments on strain localisation in dense sand under isochoric conditions

V. Roger & J. Desrues
Laboratoire Sols Solides Structures, UJF-INPG-CNRS Grenoble, France

G. Viggiani
Università della Basilicata, Potenza, Italy

ABSTRACT: The objective of the experimental investigation summarised herein is to provide further insight into the phenomenon of shear banding in dense sand under (globally) isochoric conditions. This paper briefly describes the experimental apparatus and summarises the experimental program. Results from undrained plane strain compression test on dense Hostun RF sand are presented. Findings concerning the relation between strain localisation and pore fluid cavitation in dense sand are discussed. Moreover, preliminary results are presented from an ongoing experimental program involving newly developed tests, referred to as fluid injection tests. These results confirm the finding that strain localisation is prevented under undrained conditions, and possible as soon as the undrained constraint is released. Evidence is presented of strain localisation occurring in one dimensional unloading conditions.

1 INTRODUCTION

Experimental investigations regarding shear banding in sand have traditionally focused on dry or drained material, with little attention paid to the occurrence of strain localisation in undrained conditions. On the other hand, the behaviour of sand under undrained conditions is often derived simply neglecting the possibility of strain localisation. For example, Ishihara (1993) does not mention strain localisation in any context in his recent Rankine Lecture concerning sand liquefaction. In fact, recent experimental studies have shown that, at least in plane strain conditions, shear bands occur in both loose and dense sand when loaded under undrained conditions (Han & Vardoulakis 1991, Mokni 1992, Finno et al. 1996, 1997).

The evaluation of strain localisation is important in understanding the behaviour of loose sand subject to undrained loading, as loose sand is known to be susceptible to liquefaction. However, undrained shear banding has important practical implications also in the case of dense sand. In fact, while the undrained strength of a dense sand may be several times greater than its drained strength, the possibility always exists for the pore fluid to cavitate (*e.g.* Whitman & Healy 1962, McManus & Davis (1997). In that case, the nature of loading will abruptly change from undrained to drained, which implies a drastic reduction of shear strength. It has been recently shown (Mokni 1992, Mokni & Desrues 1998) that in dense sand sheared undrained, cavitation of the pore fluid goes hand-in-hand with the formation of a shear band. The objective of the experimental investigation summarised herein is, in essence, to investigate and provide further insight into the nature of such a relation between strain localisation and pore fluid cavitation in dense sand. This paper briefly describes the experimental apparatus and summarises the experimental program. Results from undrained plane strain compression test on dense Hostun RF sand are presented, which extend the experimental program by Mokni (1992). Moreover, preliminary results are presented from an ongoing experimental program involving newly developed tests, which will be referred to as *fluid injection tests*.