Sensitivity of CPT and DMT to stress history and aging in sands for liquefaction assessment

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ABSTRACT: Sand liquefaction resistance depends on a large number of factors, some of which are arduous to detect. Without the possibility of retrieving undisturbed samples in sands and reproducing their natural structure in the laboratory, evidence of stress history, aging and similar factors – not easy to capture - must be obtained from in situ tests. This paper deals with the possibilities offered by CPT and DMT to capture stress history and aging. Consideration is also given to the fact that even the state parameter ψ may be an incomplete indicator of the liquefaction resistance CRR, since ψ, according to its definition, does not contain the possible benefits of stress history and aging to liquefaction resistance.

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CONCLUSIONS

Liquefaction resistance depends on a large number of factors including: relative density D_r, in situ K_o, stress and strain history, aging, bonding, structure. Some of these factors, in particular stress history and aging, are very difficult to sense, both for the impossibility of reproducing the characteristic structure of natural sand in laboratory specimens, and for the scarce sensitivity of in situ penetration tests to such factors. The results reported in this paper, along with additional evidence presented, suggest that the parameter K_D is considerably more sensitive than q_t to stress history and aging, two factors strongly influencing the resistance to liquefaction. On the other hand this result was expectable, considering that the less disruptive insertion of the blade, compared with the cone, destroys less the effects of stress history and aging. Since ignoring aging is equivalent to omitting an important parameter in the correlations with CRR, it is not surprising that current correlations with CRR are dispersed or, as hypothesized by Mayne et al. (2000), may be multiple. It seems expectable, on the other hand, that, using as liquefaction index a parameter sensitive to aging and stress history, will results in correlations with CRR less dispersed than previous correlations.

Recent research has identified a link between K_D and state parameter ψ. In this regard it is noted that the state parameter alone is an incomplete indicator of the tendency of a sand to dilate or contract, and in general of the resistance to liquefaction. In fact, equality of ψ does not imply equality of CRR. The structure effect is missing in ψ. To be related to CRR, ψ of a structured element should be increased to match the increased level of CRR due to the structure. It does not appear illogical to expect that K_D, being a parameter related to ψ, but at the same incorporating stress history and aging effects, could be uniquely well correlated with CRR.

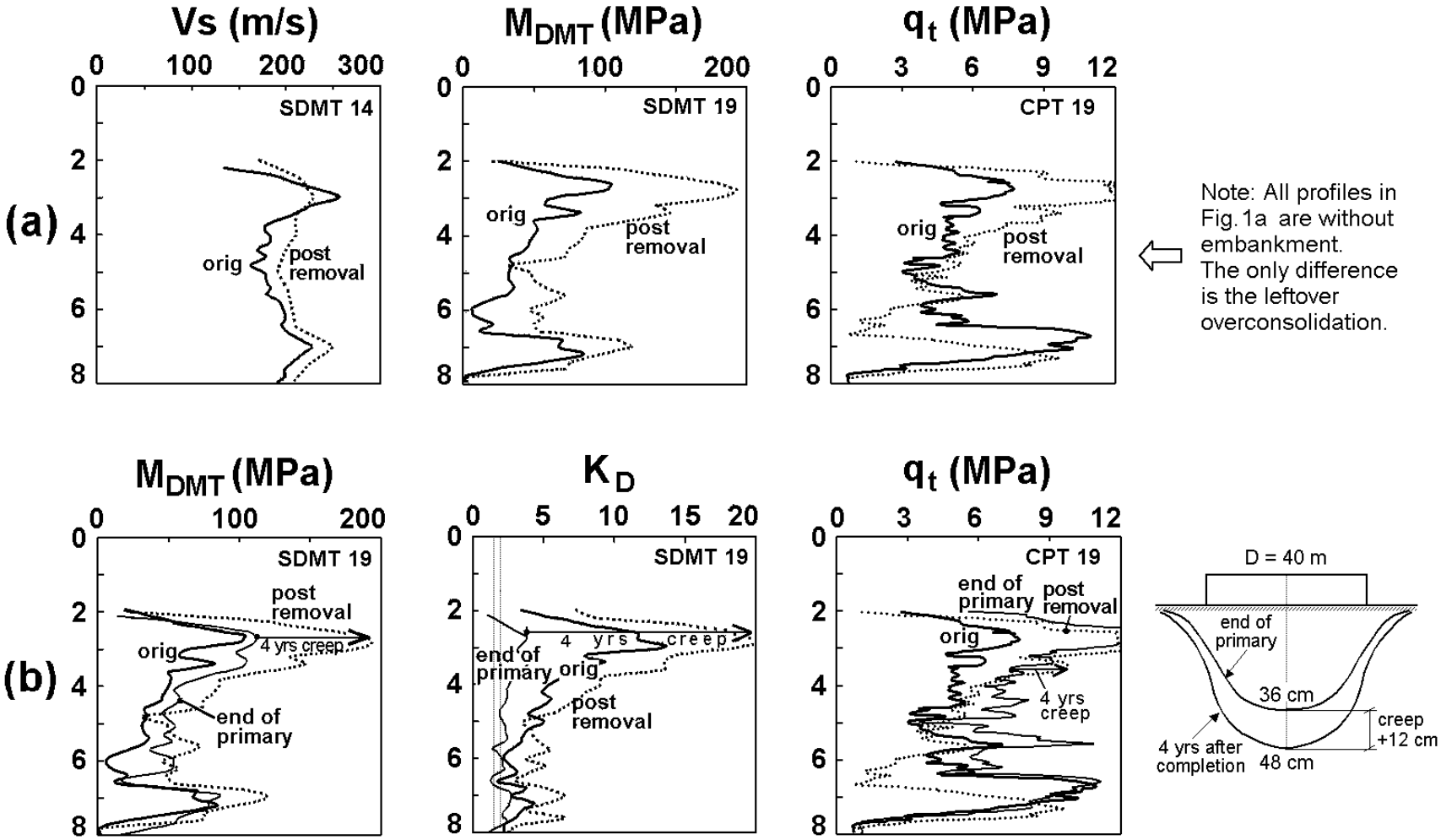

Figure 1. Treporti (Venezia) Test Embankment. All profiles are for the sand layer 2 to 8 m depth. (a) Influence on the various parameters of the overconsolidation caused by the embankment. (b) How the various parameters reacted to stress history and aging.