ON THE DETERMINATION OF IN SITU K_o IN SAND

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Laboratory methods

In his State-of-the-Art Paper to the Raleigh Conference Wroth (1975) pointed out, based on well supported arguments, the unreliability of present laboratory methods for estimating in situ K_o of natural deposits.

Wroth concerned himself primarily with cohesive soils, but his conclusions appear even more valid for sandy soils, much more vulnerable to disturbance during sampling and handling.

In situ methods

a) Direct methods

The only presently existing instrument which in principle can measure in situ K_o is the self boring pressuremeter. The words "in principle" need to be emphasized, since many problems involved in the measurement still need to be solved. For instance : "In sands the measured K_o is sensitive to any slight disturbance caused during insertion of the instrument" (Wroth, 1977) and "The self boring pressuremeter with total load cells may suffer from problems of compliance in that the stiffness of the sand may not be insignificant compared with the load cell itself" (Wroth, 1975).

Experience of the writer with the flat dilatometer indicates that, in a sand of medium stiffness, a pressure of about 100 KPa is needed to expand a 6 cm diameter membrane into the soil of only 0.1 mm. This suggests that any slight misalignement or bending of the pressuremeter or perhaps even soil bedding obliquities can be suspected to be responsible of considerable errors.

In any case,if meaningful K_o measurements are to be obtained,the level of qualification of the personnel running the test must be very high,which makes at present the self boring pressuremeter test still a very special one.

In spite of these difficulties,we must pursue our efforts with this instrument,as the self boring pressuremeter provides the only direct method presently available of in situ K_o determination.

b) Indirect methods

It is opinion of the writer that indirect methods based on the use of specialized penetrometers will be developed in the near future.This opinion is based on the well recognized fact that K_o has a dominating influence on many soil responses (incidentally,such dominating influence is the reason why we are so interested in determining in situ K_o). Therefore there seems to be a basis for expecting that we should become able to infer K_o from several observed responses offered by the soil to our specialised probes.

The chances to trace back K_o are the higher :

- The least we modify the soil during penetration
- The more "fundamental" are the soil responses we determine (0)
- The more we improve our soil modelling capability

For instance,by determining the soil pressure against several flat penetrometers of decreasing thickness (Fig. 1 a) we would obtain responses corresponding to a state of stress increasingly closer to the in situ state of

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(0) For instance the writer considers much more fundamental the point resistance q_c than the sleeve friction determined by CPT.

stress (Fig.2). Obviously we cannot hope to perform determinations in correspondence of the initial state of stress,but we can reasonably expect to improve the accuracy of our extrapolations towards the vertical axis.

Figs. 1b and 1c show sketches of probes in principle able to recover,by only one sounding,information similar to that recovered by different soundings performed using the probes in Fig.1a.

It must be emphasized that indirect methods,such as those based on the use of special penetrómeters,need a thorough calibration (at least until we become able to develop a theoretical interpretation). Large triaxial chambers and the self boring pressuremeter appear as the more suitable tools available at present for performing such calibrations.

In conclusion it is opinion of the writer that the development of our ability to evaluate in situ K_o requires simultaneous efforts in 3 directions : calibration chambers,self boring pressuremeter,special penetrometers.

REFERENCES

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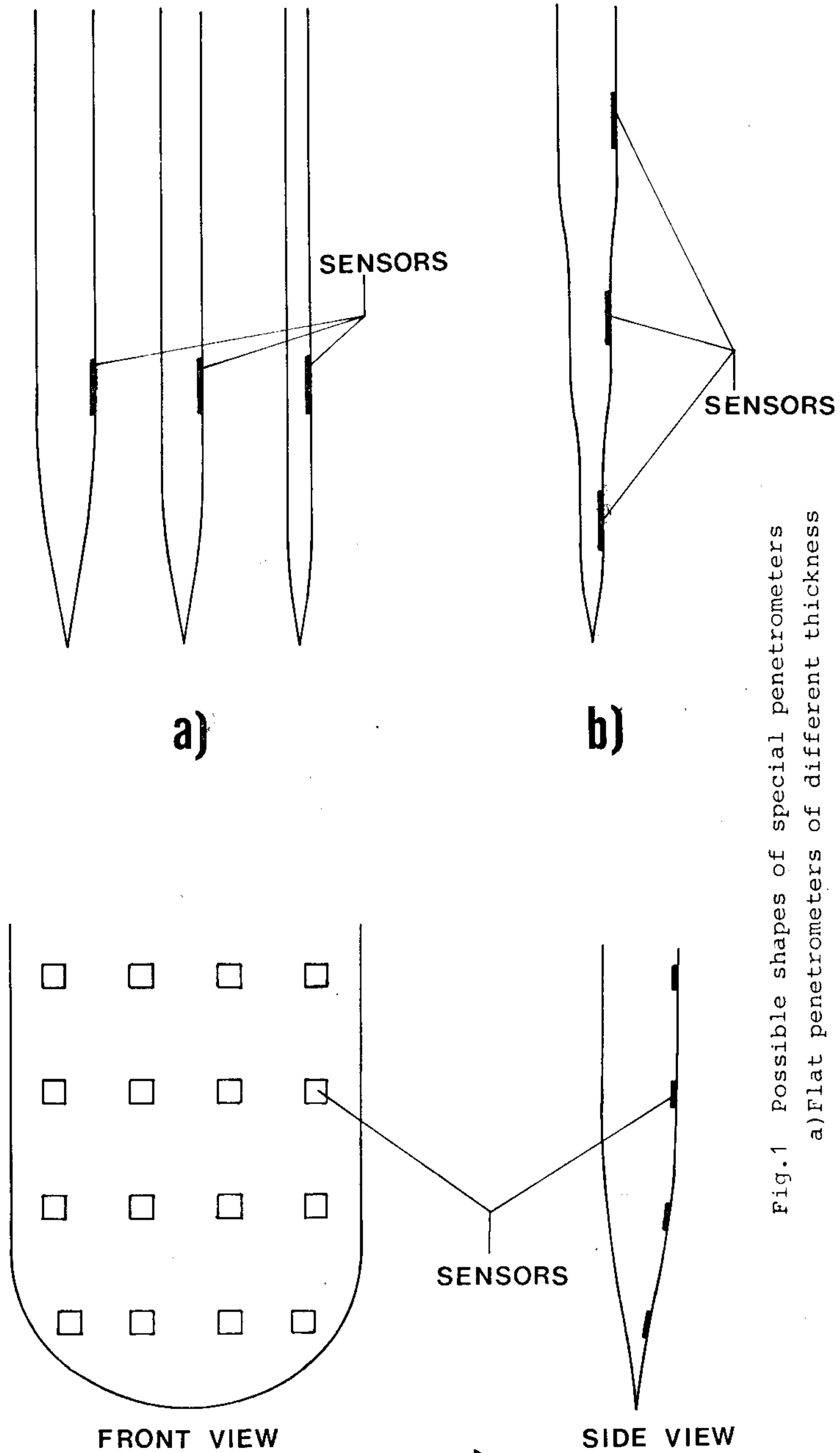

Fig.1 Possible shapes of special penetrometers
a) Flat penetrometers of different thickness
b) Flat penetrometer of variable thickness
c) Flat penetrometer instrumented with an array of sensors.

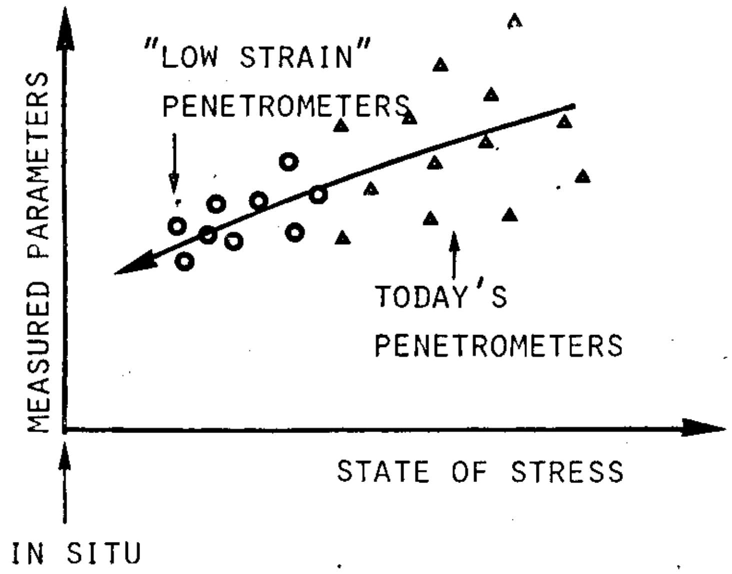

Fig.2 Parameters determined by today's penetrometers and by "low strain" penetrometers.