

DISCUSSION

L. BARDEN¹—The use of pressure transducers is a most promising method of measuring pore pressures, whether in short term undrained triaxial tests or in more prolonged tests where automatic recording is obviously a great advantage. I have used transducers similar to the type described in the paper, and also a much smaller and more sensitive type, for measuring pore pressures in the triaxial test.

A stabilized d-c supply is essential and will give a constant gain and an almost negligible zero drift over periods of many days. There is, therefore, no need for the ancillary circuit and the adjustments during test described by the author, which were only necessary because batteries were used as the d-c supply.

The very small sensitive transducer referred to above is based on the piezo-resistance characteristics of quartz crystals. The entire transducer is about the size of a pea and so has a very small volume change under pressure. It has a full scale, 100 psi, output of 500 mv, compared with 40 mv for most transducers, and when used with a small driver unit which supplies constant current as well as constant voltage, it is extremely stable.

The null method of pore pressure measurement requires some flexibility in the system for it to be efficient. A completely rigid system would hunt too much. However the closed transducer

circuit should be as rigid as possible, and the transducer should preferably be connected directly to the cell base. The volume of the connecting water should be a minimum and no air bubbles should be present.

The author's method of connecting his transducer housing to the cell base by a length of flexible copper tube does not seem advisable. Also, from my own experience, the suggested method of deairing is not always reliable and there is no method of checking for air bubbles. To ensure complete deairing it is best to leave the water under a pressure of about 100 psi overnight and then to flush through to prevent the air from coming out of the solution again when the pressure drops. It is highly desirable to incorporate some device for checking the compliance of the deaired system; I use the system illustrated in Fig. 4. One null indicator can be used to check a whole bank of transducers.

The author uses a chart recorder as his output device. This is an excellent device for long term tests when automatic recording is really necessary. However for short-term tests a digital voltmeter is very accurate and easy to use, and for automatic recording it can print out tabulated results on an electric typewriter.

I agree that, provided the system is correctly deaired, the response time is excellent, but it is unlikely to be so quick as to be limited only by that of the recorder for all types of soil. The system always possesses some compliance (often

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of the order of 1×10^{-6} in.³/psi), and with a clay of low compressibility and permeability the response time must be appreciable.

The value of the compliance of the transducer described in the paper is given as 0.2×10^{-6} in.³ for full scale pressure (100 psi). Should this value not be 0.2×10^{-6} in.³/psi?

Barden pointed out, virtually eliminates the need for an ancillary circuit to check amplification. This circuitry is, however, still extremely convenient in selecting the correct amplification for visual recording of pressures on a chart.

The manufacturer's calibration chart, giving the compliance of the transducer, was not interpreted correctly. The

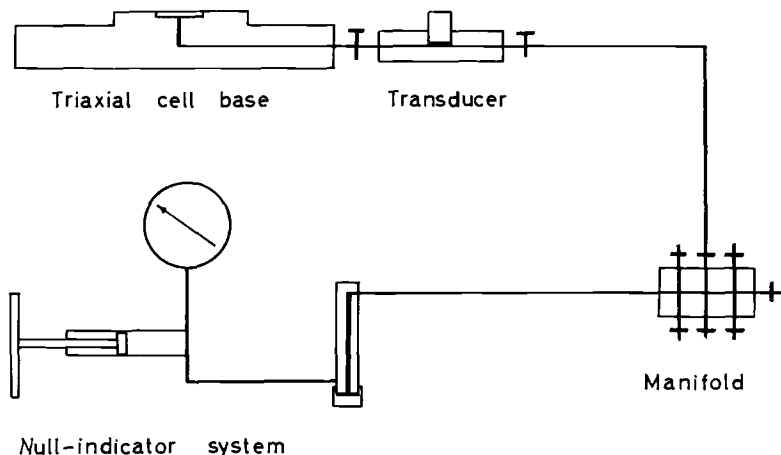


FIG. 4—Device for Checking Compliance of Desired System.

In conclusion, I would like to express my support for the author's advocacy of the use of transducers for pore pressure measurement.

K. N. BURN (*author's closure*)—Mr. Barden's comments on my equipment and the description of the pore pressure measuring apparatus he has developed are very useful and sincerely appreciated.

Shortly after writing this paper and before the conference, I procured a 7-v stabilized d-c supply which, as Mr.

figure given in the paper is not for full-scale load, but for each psi change in pressure. Although this is still a very small volume, it is considerably larger than that required to activate a solid state transducer.

I am also indebted to Mr. Barden for his observations on difficulties of de-airing the pressure system. I thank him for sharing these thoughts and for describing the technique he uses to reduce this problem.