STP361-EB/Dec. 1964

DISCUSSION

B. Ladanyi[1]—In the very carefully conducted study the authors have shown, among other things, that the distribution of deformation within triaxial specimens during drained compression tests is quite different from that occurring during drained extension tests, so that any conclusion based on the comparison between the two types of triaxial tests may be misleading. There is, however, one more source of error that may influence the results of such a comparison.

If a conventional triaxial shear test is preceeded by an isotropic consolidation, it is assumed regularly that, at the very beginning of the shear test, no shear stresses are mobilized in the specimen. This is, however, only true if the applied isotropic stress produces only volume changes in the specimen with no change in shape. Actually, it is known that owing to the rigidity of end platens this condition is rarely fulfilled during a triaxial consolidation. Most often it is observed that during the consolidation the specimen has undergone a slight axial extension. As a result, the apparent origin of stress-strain coordinates will not coincide with the actual one, corresponding to the condition that both the shear strain and the stress difference q are equal to zero, but will be shifted to a point located on the stress-strain curve for axial extension. If now a conventional compression test is performed on such a specimen, the shear strains will first return to zero, and then increase in the opposite direction. The stress difference q measured from the apparent origin will, therefore, be greater than the actual one.

If, however, such a specimen is subjected to an axial extension test, the measured stress difference q will be smaller than the actual one mobilized in the specimen. The two tests will, therefore, differ from each other for the double value of the stress difference mobilized during isotropic consolidation. This phenomenon may be clearly identified in the results of some triaxial compression and extension tests published by Parry.[2]

W. B. Truesdale[3] and R. W. Rusin[3]—In the triaxial testing of soils, one of the main problems facing the investigator is the nonuniform distribution of stress and strain in the soil specimen undergoing deformation. Professors Roscoe, Schofield, and Thurairajah have brought this point out in their paper discussing the yield criterion of soils. Utilizing surface measuring techniques they have shown that the distribution of deformation within triaxial specimens during drained compression tests is different from that during drained extension tests. It is the purpose of this discussion to present additional data on the nonuniformity of internal specimen deformations in drained triaxial compression tests.

In an effort to study the problem of strain distribution, a gage has been

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[2] R. H. G. Parry, "Strength and Deformation of Clay," Ph.D. Thesis, University of London, 1956.

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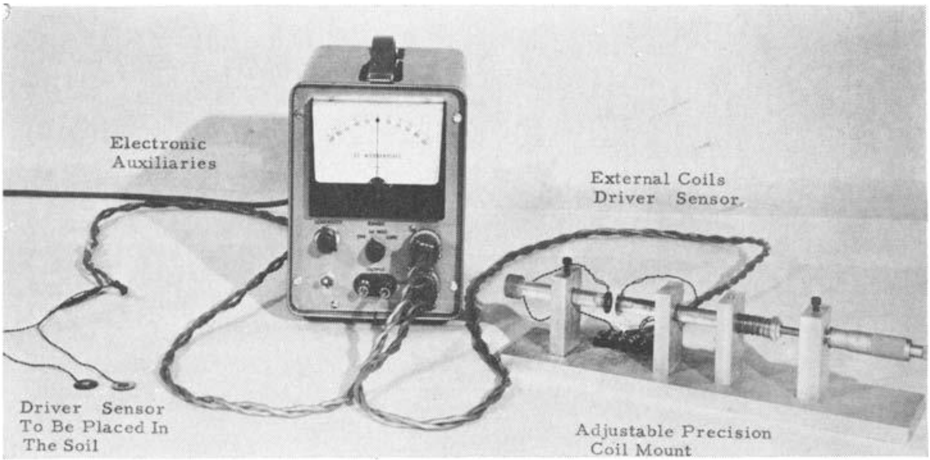

FIG. 23—Soil Strain Gage.

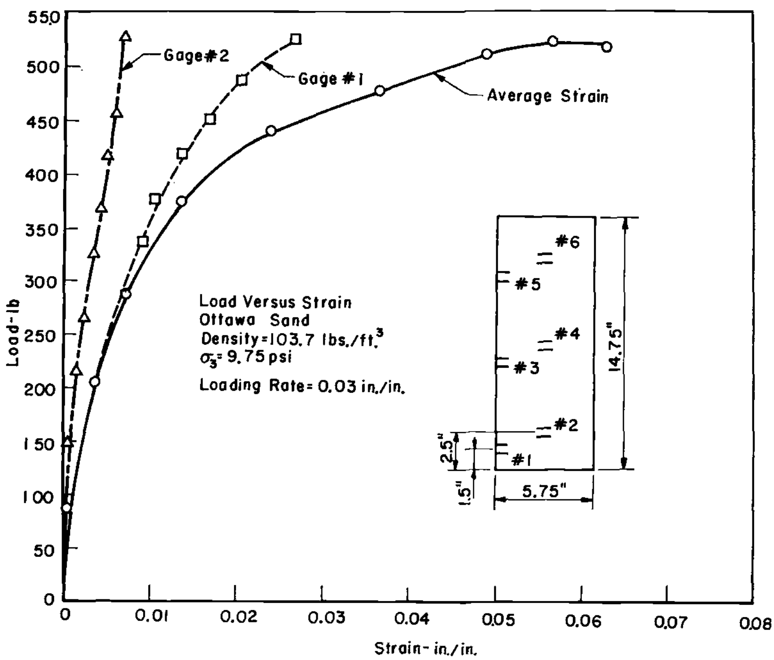

FIG. 24—Comparison of Local Strain Near Specimen End and Average Strain.

developed at IIT Research Institute under a contract for the Air Force Weapons Laboratory. This gage, shown in Fig. 23, is used to measure small increments of displacement over a short gage length in a triaxial soil specimen undergoing deformation at a uniform rate. This gage consists of two sets of two uncoupled $\frac{1}{16}$ in. thick coil disks and associated electronic driving, amplifying,

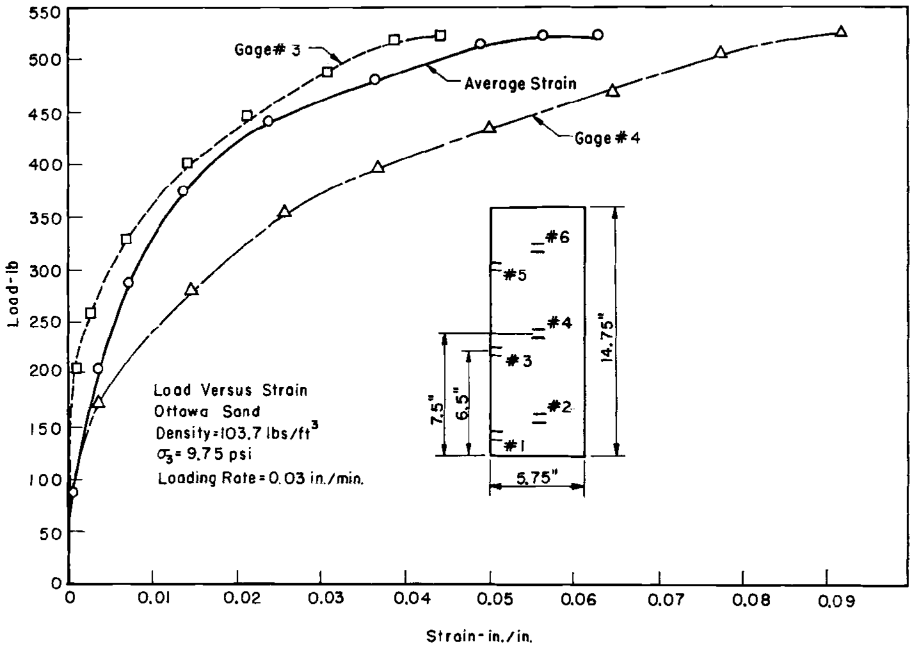

FIG. 25—Comparison of Local Strain Near Specimen Mid-height and Average Strain.

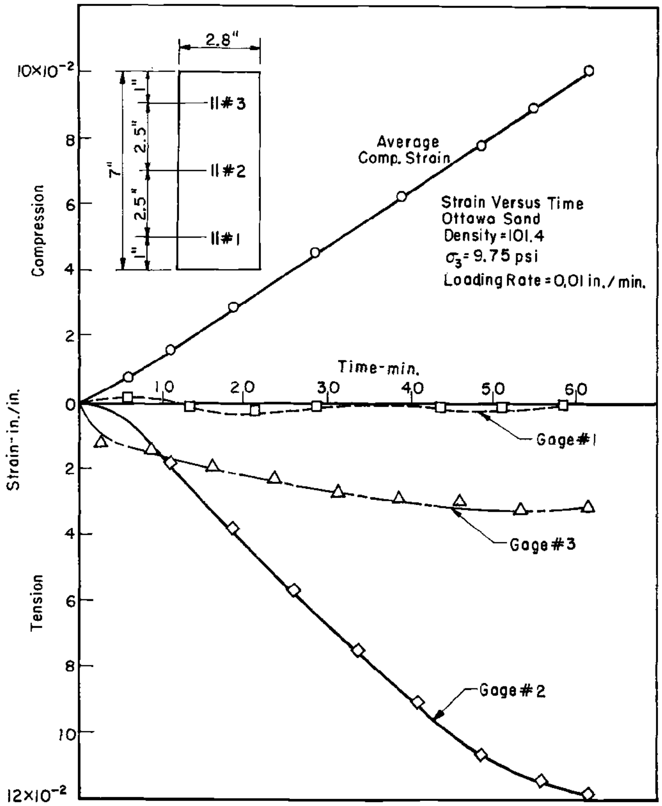

FIG. 26—Comparison of Local Lateral Strains and Average Strain.

and recording circuitry. The principle of operation is that of a null balance differential transformer, that is, each set of coils represents transformer primary and secondary windings and are so arranged in the circuitry that the resulting signal is the difference of the individual coil outputs. Hence, when the coils in each set are equally spaced, the resulting differential output is zero or nulled.

In the ensuing program to study the variation of strain in a triaxial specimen, gages were placed at the axial center and along a vertical axis on the periphery of the specimen. The specimen was loaded axially at a constant rate. Load was measured through a force washer and deflection for average strain calculations with a dial gage.

Figures 24 and 25 show the results of experiments performed on a 5.75 in. diameter specimen of Ottawa sand at a confining pressure of 9.75 psi. The height-to-diameter ratio of all tests is approximately 2.5 in. Figure 24 shows the load-strain relationships of the gages placed 2.50 in. from the bottom of the specimen in relation to the average load-strain-curve. Figure 25 shows the same relationships with respect to gages placed at the center. Gages placed 2.50 in. from the top of the specimen show relationships similar to the bottom gages. The

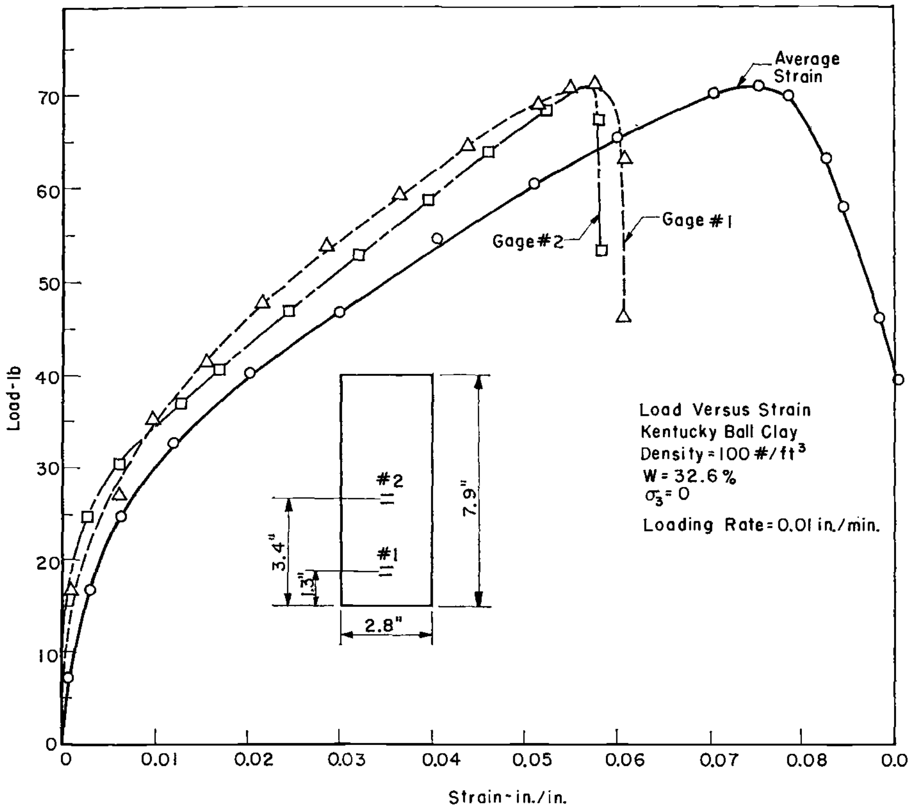

FIG. 27—Comparison of Axial Compressive Strains and Average Strain.

results show a definite variation of strain along the axial center, and a variation of strain radially at a cross-section of the specimen from the center to the periphery.

Other tests have been conducted to measure the lateral strains of a specimen. Figure 26 shows the results of three gages placed in a 2.80 in. diameter Ottawa sand specimen. Here the extreme variation in lateral strain can be seen. The gage approximately 1 in. from the bottom shows no appreciable lateral strain with build-up of load, whereas the lateral strains at the center exceeds, in this instance, the average axial strain. Other tests, at present, are being performed at higher lateral pressures to see what effect it has on the distribution of lateral strains.

The effects of lateral pressure on the axial strain distribution in a triaxial specimen are shown in Figs. 27 and 28. Figure 27 shows the gage response in a compacted ball clay specimen (plasticity index = 31 per cent) at zero confining pressure. The strains as measured by the gages lag the average strain. In Fig. 28 the confining pressure was 60 psi. The strains as registered by the gages show a closer correspondence to the average strain.

On the basis of the tests, the following remarks are made concerning the triaxial compression test:

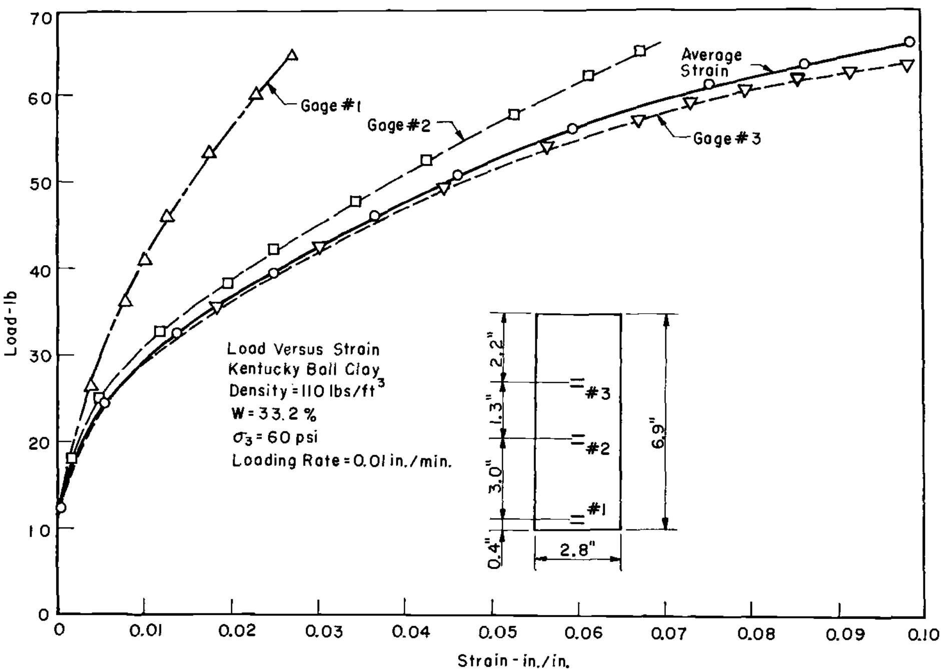

FIG. 28—Comparison of Local Axial Strains and Average Strain.

1. Nonuniform straining is most prominent at low confining pressures.

2. Strain varies both longitudinally and radially throughout the specimen.

3. In the Ottawa sand specimens, greatest straining occurred near the specimen center at mid-height.

4. In the ball clay specimens, greatest straining occurred near the specimen ends.