siderably less than that of the deposits described in the subject paper, preconsolidation by surcharge loads still accomplishes a great deal of good. A surcharge load left on for several months can and generally does cause several inches of settlement. Most of this settlement occurs in the uppermost portions of the consolidating deposit; thus producing a thicker mat of stiffer soil materials which tends to spread or "bridge" areas of variable compressibility in the deeper deposits.

Preconsolidation by surcharge, when applicable, has been well worth the effort expended.

Effect of Stress History and Frequency of Stress Application on Deformation of Clay Subgrades Under Repeated Loading

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• ASSESSING the destructive effects of the varying sequence of wheel loads to which the pavement will be subjected is one of the most difficult problems involved in the development of a method of pavement design. A highway pavement must support wheel loads of widely different magnitudes, moving with different speeds and with different intervals between their applications at any given point on the pavement surface. It is of interest to determine, therefore, the relative effects of different magnitudes of load, whether these effects will vary with the age of the pavement, and the influence of the frequency and duration of the load applications.

Complicating features in any attempt to determine the influence of these various factors on an actual pavement are the progressive changes in water content of the subgrade soil throughout the life of the pavement and, often, the lack of control of the wheel load applications. These influences may make interpretation of field data extremely difficult, if not impossible. However, with the development of suitable equipment for testing soils under repeated loading and under controlled conditions in the laboratory, the effects can be individually assessed. Although the maintenance of constant composition for the soil on which the tests are performed may seem unrealistic from the standpoint of field conditions, the results obtained can provide valuable information concerning the significance of the various factors involved and materially assist in the interpretation of field data.

SOIL DEFORMATIONS UNDER REPEATED LOADING

During the past few years apparatus and techniques have been developed at the University of California for testing specimens of soil, representing elements of a highway subgrade, under triaxial stress conditions with repeated axial stress applications (*1, 2*). Specimens are placed in triaxial compression cells and subjected to a confining pressure of the desired magnitude, as for a normal type of unconsolidated-undrained test; but instead of slowly increasing the axial stress until the specimen fails, a constant axial stress is repeatedly applied and removed, and the progressive increase in deformation of the specimens with increase in number of stress applications is recorded. Tests are usually conducted on compacted soils with a degree of compaction between 90 and 95 percent of the maximum density obtained in the modified AASHO compaction test.

Typical results obtained in a test of this type are shown in Figure 1. The specimen of silty clay (water content 19.4 percent, dry density 108.8 pcf) was placed in a triaxial compression cell and subjected to a confining pressure of 14.2 psi. An additional axial stress of 9.9 psi was then applied to the specimen for a period of 0.33 seconds. After a 2.7-sec interval, the same stress was again applied for the same period of time; this procedure was repeated about 100,000 times. The progressive increase in deformation of the specimen is shown in Figure 1. During the first application of

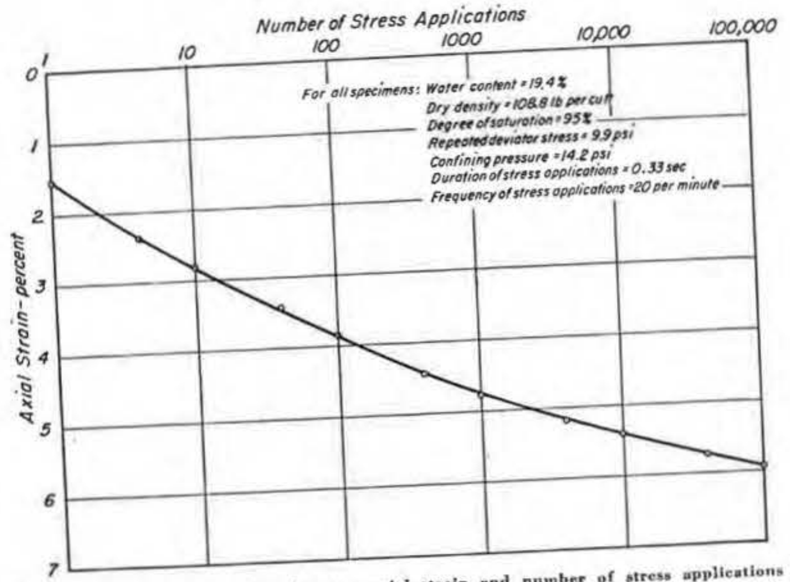


Figure 1. Typical relationship between axial strain and number of stress applications in repeated load test.

stress the specimen deformed 1.57 percent and when the stress was removed the residual deformation was 0.99 percent. During the 1000th stress application the cumulative total deformation was 4.80 percent and the residual deformation on removal of the stress was 4.24 percent while during the 100,000th application the deformation had still further increased to 5.96 percent.

Using this type of procedure the influence of the magnitude of the repeated axial stress on the deformation of a soil can readily be determined. Figure 2 shows the results of tests on identical specimens using axial deviator stresses of 12.8, 14.9, and 17.0 psi. The relative effects of the different stresses can readily be determined from data of this type. Thus, for example, the same deformation of the soil specimens (4 percent) is caused by 25 repetitions of a 17.0-psi stress, by 350 repetitions of a 14.9-psi stress or by 20,000 repetitions of a 12.8-psi stress.

EFFECT OF CHANGE IN STRESS DURING REPEATED LOADING

Having thus determined the deforming effects of individual stresses, it becomes pertinent to evaluate the effects of composite series of applications with different stress magnitudes, since this corresponds more closely to the actual conditions encountered in practice. For example, Figure 2 shows that 10,000 applications of a 12.8-psi stress cause 3.9 percent strain of the specimen, while 100 applications of a 17.0-psi stress cause 4.4 percent strain. What then would be the deformation produced by 10,000 applications of the 12.8-psi stress followed by 100 applications with the stress increased to 17.0 psi? It might be expected that the resulting deformation would exceed that produced either by a series of 100,000 applications of the 12.8-psi stress alone or a series of 100 applications of the 17.0-psi stress alone, but it will be shown that this is not necessarily the case. In fact, the resulting deformation may be appreciably less than would result simply from 100 applications of the 17.0-psi stress.

Comprehensive investigations on a silty clay soil (liquid limit, 37; plastic limit, 23) have shown that the deformations produced by a given series of stress applications depend to a large extent on the previous stress history of the soil (*3*). An example of this influence is provided by the test data in Figure 3. In this series of tests two identical specimens of silty clay with a degree of saturation of 91 percent were subjected to a confining pressure of 14.2 psi and to repeated applications of an axial deviator stress of 5.6 psi. After 100 stress applications both specimens had deformed about 1.0 percent. At this stage the deviator stress on one of the specimens was increased to 7.1 psi. However, for the other specimen, 10,000 applications of the 5.6-psi stress were applied before the repeated stress was increased to 7.1 psi. The resulting deformations of the specimens are shown in Figure 3a. The specimen subjected initially to 10,000 applications of the lower stress deformed considerably less under the increased load than did the specimen previously subjected to only 100 applications of the lower stress.

A comparison of the progress of deformation under the 7.1-psi stress for the two specimens is shown in Figure 3b. The specimen with only 100 previous stress applications deformed continuously under the increased stress and after 100,000 applications had reached an axial strain of 2.8 percent. However, the specimen with 10,000 previous stress applications deformed hardly at all during the first 1,000 applications of the increased stress and, although the deformation increased markedly thereafter, it was only 2.15 percent after 100,000 applications. Furthermore, a combination of 10,000 applications of 5.6 psi and 1,000 applications of 12.1 psi produced only about two-thirds of the deformation (1.55 percent) resulting from the combination of only 100 applications of 5.6 psi and 1,000 applications of 7.1 psi.

The data indicate that a series of stress applications to a compacted clay may produce a considerable stiffening effect in the clay and a consequent increase in resistance to deformation under further stress applications. The cause of this stiffening is not immediately apparent. Previous investigations (*3*) have shown that it cannot be attributed simply to densification of a compacted clay under repeated loading, although this would produce some stiffening in specimens with low degrees of saturation. However, an increase in density of specimens having an initially high degree of saturation will result in a reduced rather than an increased resistance to deformation (*4, 5*). The increased resistance to

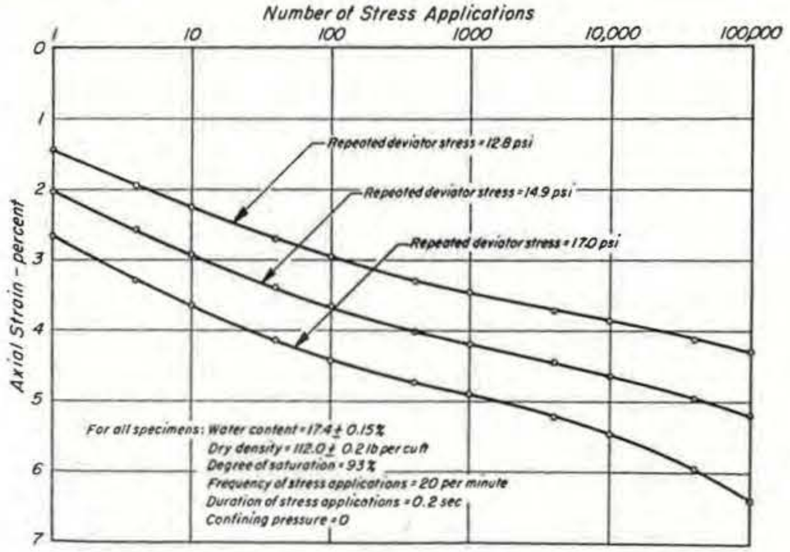


Figure 2. Effect of magnitude of axial stress on deformation of silty clay under repeated loading.

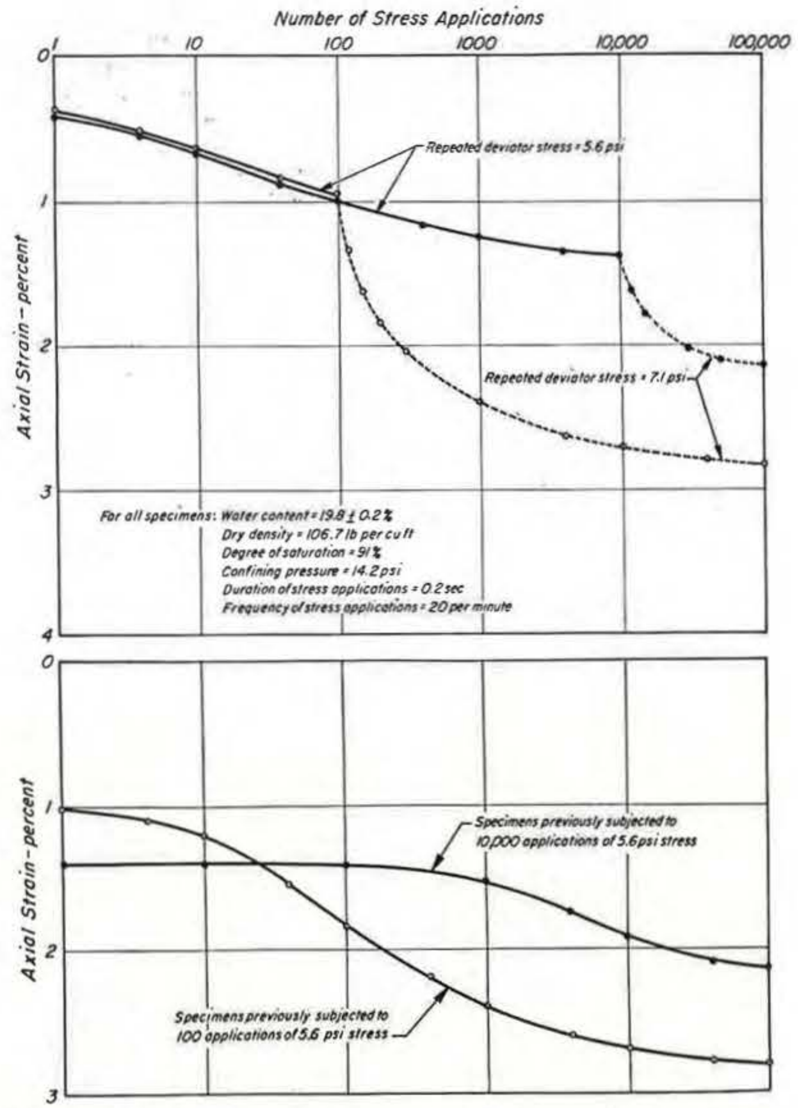


Figure 3. Effect of increase in stress on silty clay during repeated loading (upper), and comparison of deformations of silty clay specimens under increased repeated deviatior stress of 7.1 psi (lower).

deformation resulting from repeated stress applications is probably due to some change in the structural arrangement of the particles. Repeated stress applications may, for example, cause adsorbed water to be extruded from between particles of clay, bringing the particles slightly closer together at points of contact and thereby causing a strength increase. Even a slight decrease in spacing of the clay particles would tend to cause an appreciable increase in stiffness of the clay.

Some support for this concept is provided by the fact that no similar stiffening effects are observed in tests on sands. Figure 4 gives the results of tests on specimens of fine sand; as before, the

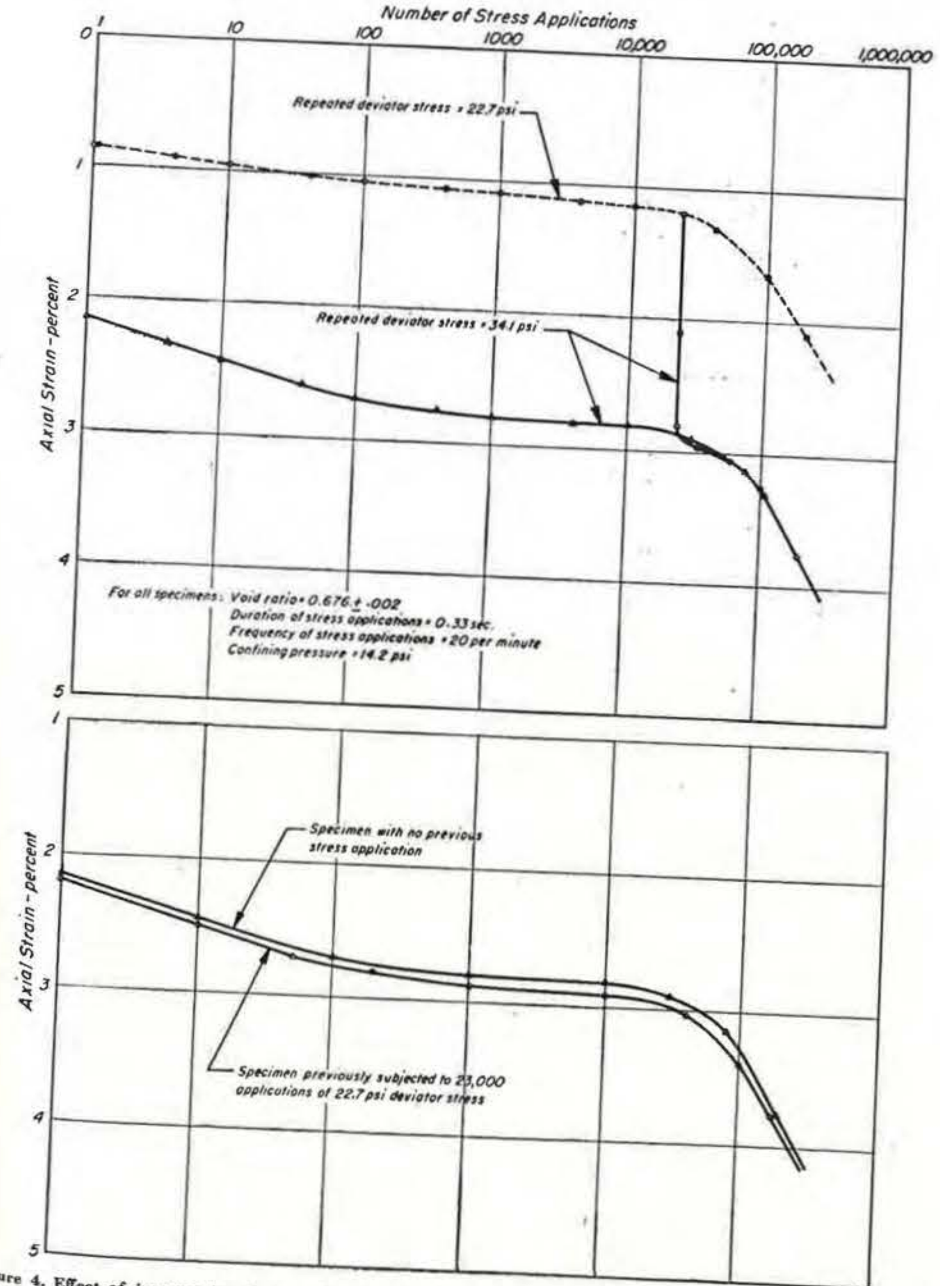


Figure 4. Effect of increase in stress on fine sand during repeated loading (upper), and comparison of deformations of fine sand specimens under repeated deviator stress of 34.1 psi (lower).

stress on one of the specimens was increased after 23,000 applications of a light load but in this case the deformation increased immediately and the magnitude of the deformation appeared to be unaffected by the original series of stress applications. Further evidence is provided by the fact that increased numbers of load applications may cause increased stiffness of clay specimens even though they cause no appreciable deformation of the soil during their application.

NUMBER OF APPLICATIONS REQUIRED TO PRODUCE STIFFENING EFFECT

Since the previous data show that a large number of stress applications may produce an increase in resistance to deformation of a compacted clay, it becomes of interest to determine how many applications are required to produce any substantial effect. Some information concerning this aspect of the problem is provided by the data in Figure 5.

Five specimens of silty clay having a 91 percent initial degree of saturation were subjected to repeated applications of a 5.6-psi deviator stress. After different numbers of applications of this stress (3; 100; 1,000; 10,000; and 85,000) the magnitude of the deviator stress was increased to 7.1 psi. The resulting deformations are shown in Figures 5a and 5b. Although 100 and 1,000 stress applications produce a slight initial stiffening of the specimens, the effect is not permanent and the final deformations of these specimens are about the same as that of the specimen with only 3 previous applications of the lighter stress. Each of these specimens deformed about 3 percent after 100,000 applications of the 7.1-psi stress.

However, 10,000 applications of the light stress produced a marked stiffening effect and, after a further 100,000 applications of the 7.1-psi stress the deformation was only 2.15 percent; the effect of 85,000 applications of the light stress was even more pronounced.

It would appear from this data that the number of stress applications required to produce any appreciable stiffening is greater than 1,000 and that marked changes in deformation characteristics can be produced by numbers of applications in the range 10,000 to 100,000.

TESTS WITH CONSTANT PRINCIPAL STRESS RATIO AND REPEATED CONFINING PRESSURES

A surprising feature of the test data presented in Figure 3 is the marked increase in deformation of the specimens resulting from a small increase in repeated deviator stress. However, the stress conditions in these tests differ in two respects from those to which a soil element under a pavement would be subjected. In the preceding tests the lateral pressure on the specimen remained constant when the axial stress was increased. In actual practice, any increase in axial stress on a soil element will be accompanied by a simultaneous increase in lateral pressure, and thus a somewhat more realistic test condition is obtained by keeping the ratio of major to minor principal stresses constant throughout the test. This means that an increase in axial stress will be accompanied by an increase in lateral pressure and consequently for the compacted silty clay the increase in axial stress required to cause appreciable increases in deformation will be somewhat greater than would be indicated by the data in Figure 3.

Typical data obtained in a repeated load test using a constant ratio of major to minor principal stress are shown in Figure 6. An increase in axial stress of 9.5 psi was used in this case, whereas an increase of only 1.5 psi was required to produce similar deformations for the test described in Figure 3. However, the cumulative nature of the results is the same. Repeated applications of a light stress still produced an increase in resistance to deformation of the soil.

The second major difference between the preceding test procedure and actual test conditions lies in the fact that a constant confining pressure was used in the laboratory tests with only the deviator stresses being repeatedly applied,

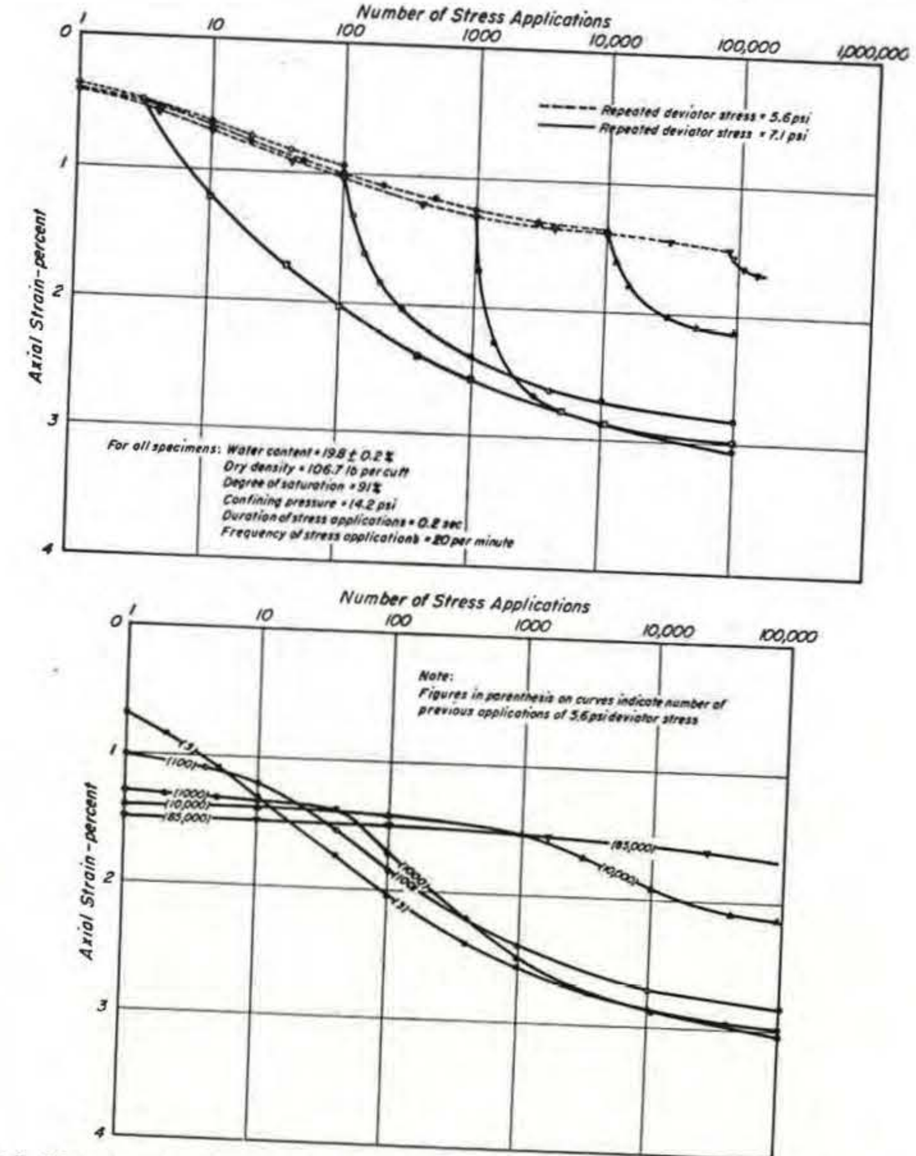


Figure 5. Effect of number of previous stress applications on subsequent deformation of silty clay under increased repeated stress (upper), and deformations of specimens of silty clay under increased repeated deviator stress (lower).

whereas both lateral and axial stresses are repeated under field conditions. Repeated loading tests using repeated vertical and axial stresses have been conducted in the laboratory (2) but the equipment and techniques are somewhat more elaborate than those required using constant confining pressures. The results show that slightly more deformation of the specimens occurs under repeated confining pressure conditions than is obtained with sustained confining pressures, but apart from this quantitative aspect of the resulting deformations,

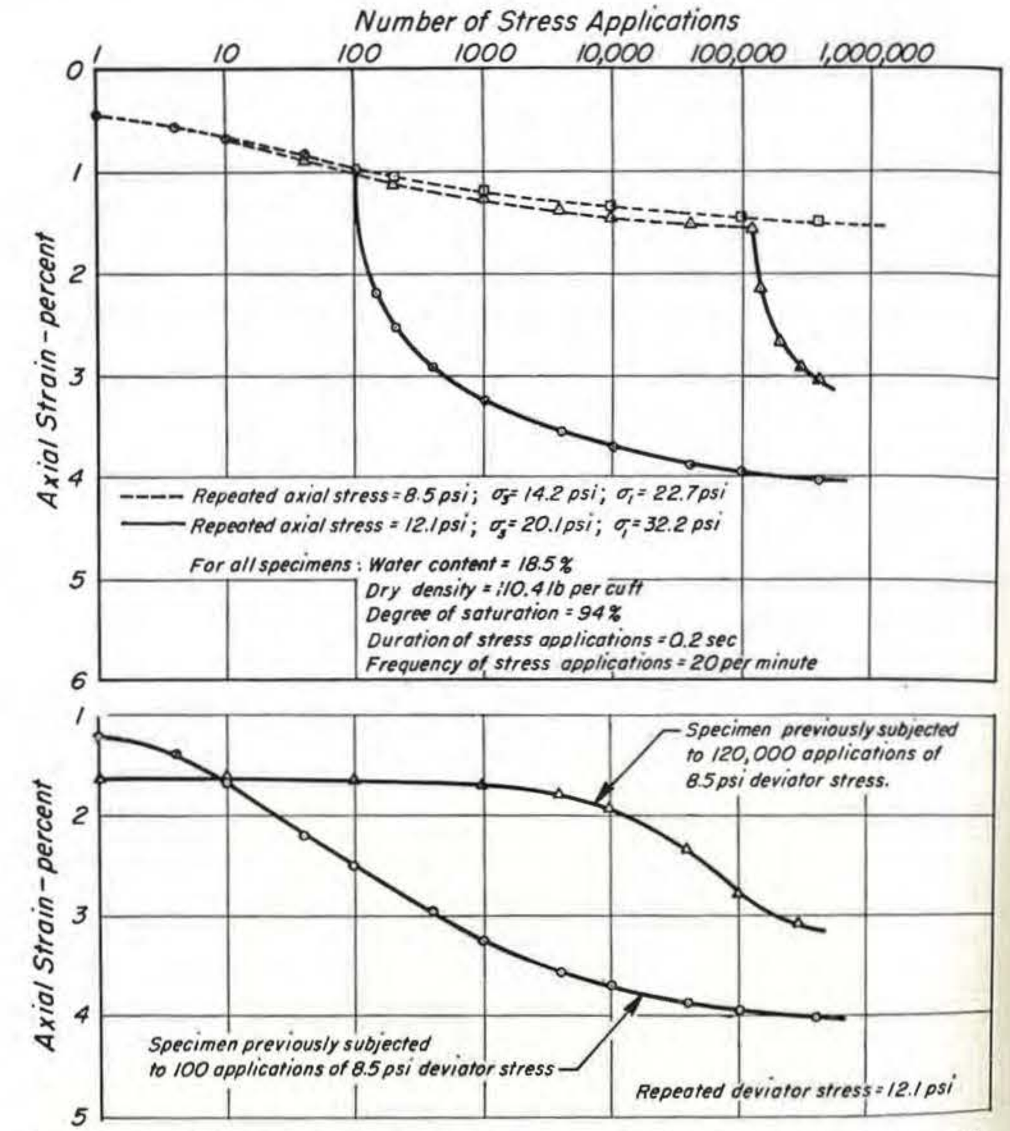


Figure 6. Effect of change in stress on silty clay during repeated loading with constant principal stress ratio (upper), and deformation of specimens of silty clay under increased repeated deviator stress with constant principal stress ratio (lower).

the stiffening effect produced by repeated stress applications is still apparent (Fig. 7).

EFFECT OF MAGNITUDE OF STRESS CHANGE ON SOIL DEFORMATION

In conducting investigations to determine the possible causes of the increased resistance to deformation of the silty clay as a result of repeated loading, it was observed that the increased resistance disappears if the specimens are subsequently deformed appreciably by increased stress application. This is illustrated by the test data in Figures 8 and 9. In these tests specimens were first subjected to 30,000 applications of an axial

stress of 5.7 psi. On some specimens the axial stress was then increased to 7.1 psi; on others, to 9.9 psi; and on still others, to 14.2 psi.

The deformations of these specimens under further repeated stress applications were then compared with those of specimens subjected to the higher stresses without previous load application. That the 30,000 applications of the 5.7-psi axial stress caused some stiffening of the soil is apparent from a comparison of the deformations occurring under repeated applications of the 7.1-psi axial stress. Even after 300,000 applications of this stress the previously loaded specimens had deformed considerably less than previously unloaded specimens.

However, for those specimens on which the repeated axial stress was changed to 9.9 psi the effect of the previous stiffening is less apparent and when the repeated stress was increased to 14.2 psi the stiffening effects of the previous stress applications disappeared completely (Figs. 8 and 9).

Presumably the change in soil structure resulting from repeated stress applications is destroyed by large deformations. Such an effect would not be likely if the increased resistance were due merely to an increase in density of the specimens.

In addition to indicating the nature of the effect, the above data also illustrate the necessity of avoiding large stress changes if the increased resistance resulting from repeated loading is to be used to practical advantage.

DEMONSTRATION OF EFFECTS OF STRESS HISTORY ON SOIL DEFORMATION

To illustrate the important effects that a previous stress history in the form of a series of repeated stress applications may have on the subsequent deformation of a soil, a series of tests were conducted in which specimens were subjected to a progressive increase in repeated axial stress over a period of about 8 days. Three identical specimens were subjected progressively to 30,000 stress applications at each of the following repeated deviator

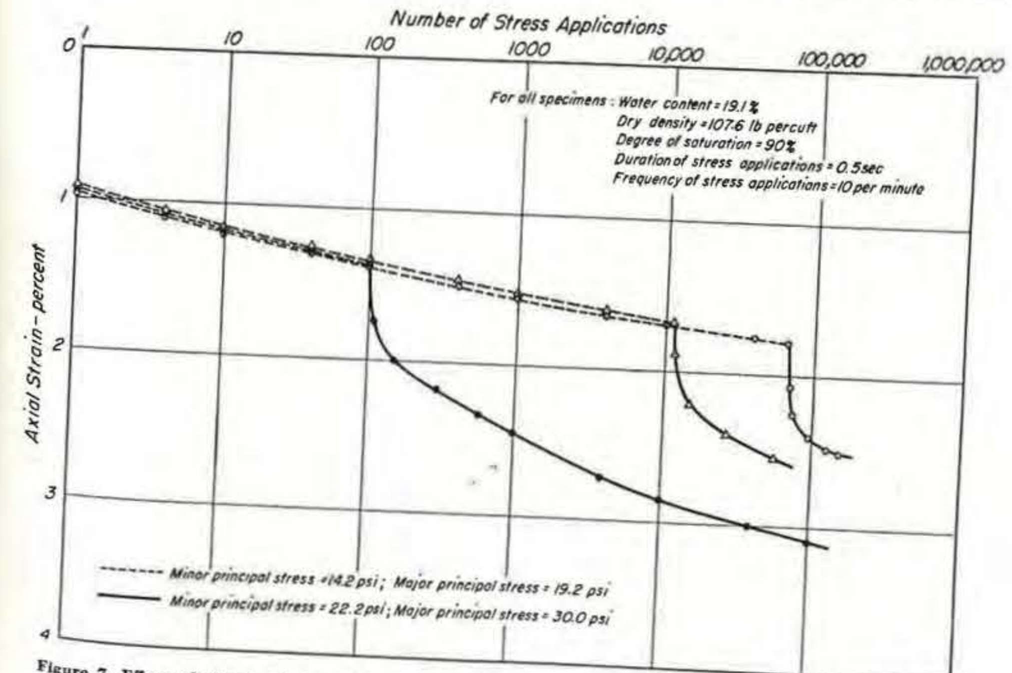


Figure 7. Effect of change of stress on silty clay during repeated loading with repeated lateral pressure.

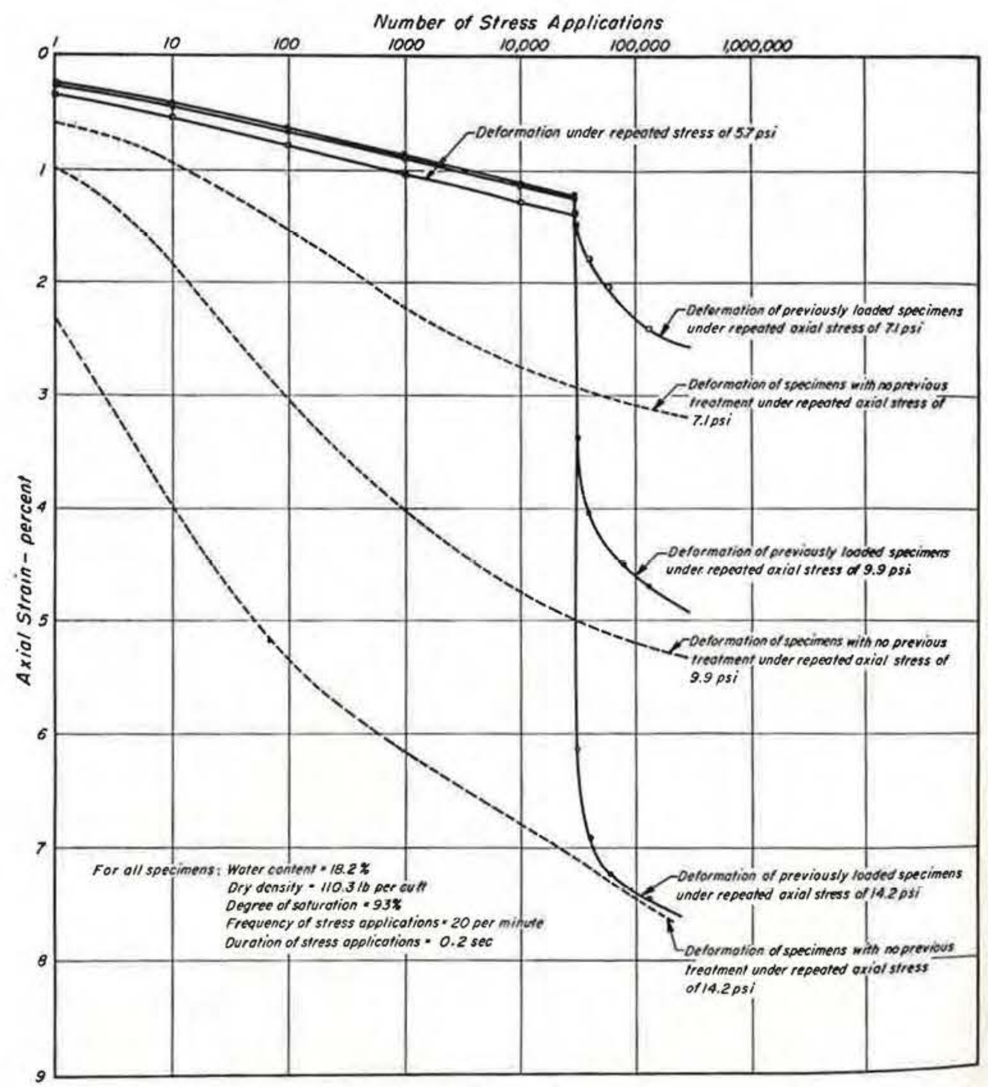


Figure 8. Effect of magnitude of stress change on deformation of silty clay under repeated loading; unconfined compression tests.

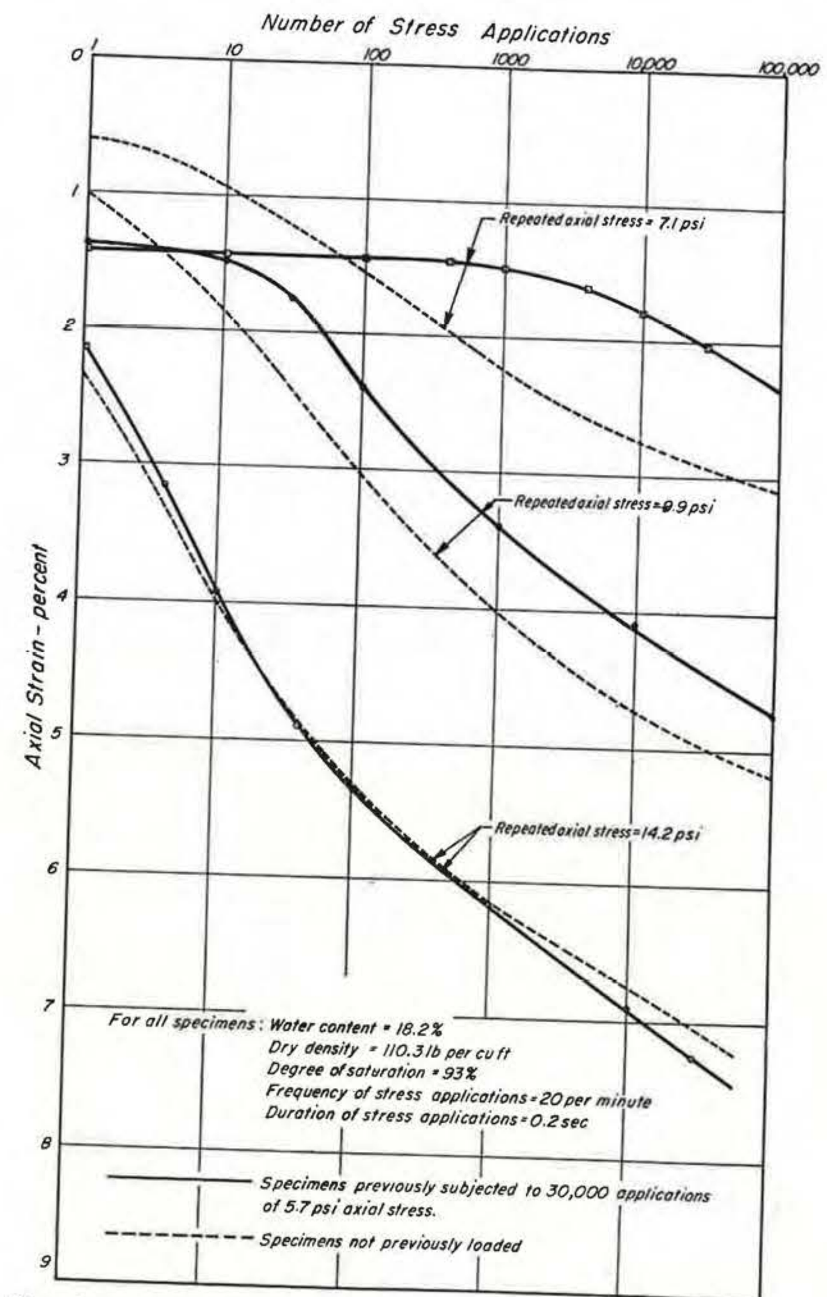


Figure 9. Effect of magnitude of stress change on deformation of silty clay under repeated loading; unconfined compression tests.

stresses: 7.1, 8.5, 10.0, 11.4, 12.8, 14.2, 15.6, and 17.0 psi. The average deformations of these specimens are shown by the solid lines in Figure 10.

Identical specimens of the soil with no previous stress history were subjected to repeated applications of the same stresses. The average deformations of these specimens are shown by the dashed lines in Figure 10.

Comparisons of the deformations produced in soil specimens with and without a preceding stress history can readily be made from these data. For example, Figure 10 shows that different magnitudes of stress cause the following deformations:

No. of Applications	Deviator Stress (psi)	Resulting Deformation (%)
30,000	7.1	1.77
30,000	8.5	2.22
30,000	10.0	2.94
30,000	11.4	3.52
30,000	12.8	4.08
30,000	14.2	4.60
30,000	15.6	5.23
30,000	17.0	5.84
240,000 [1]	—— [2]	5.00 [3]

[1] Total.
[2] 30,000 at each magnitude.
[3] Average.

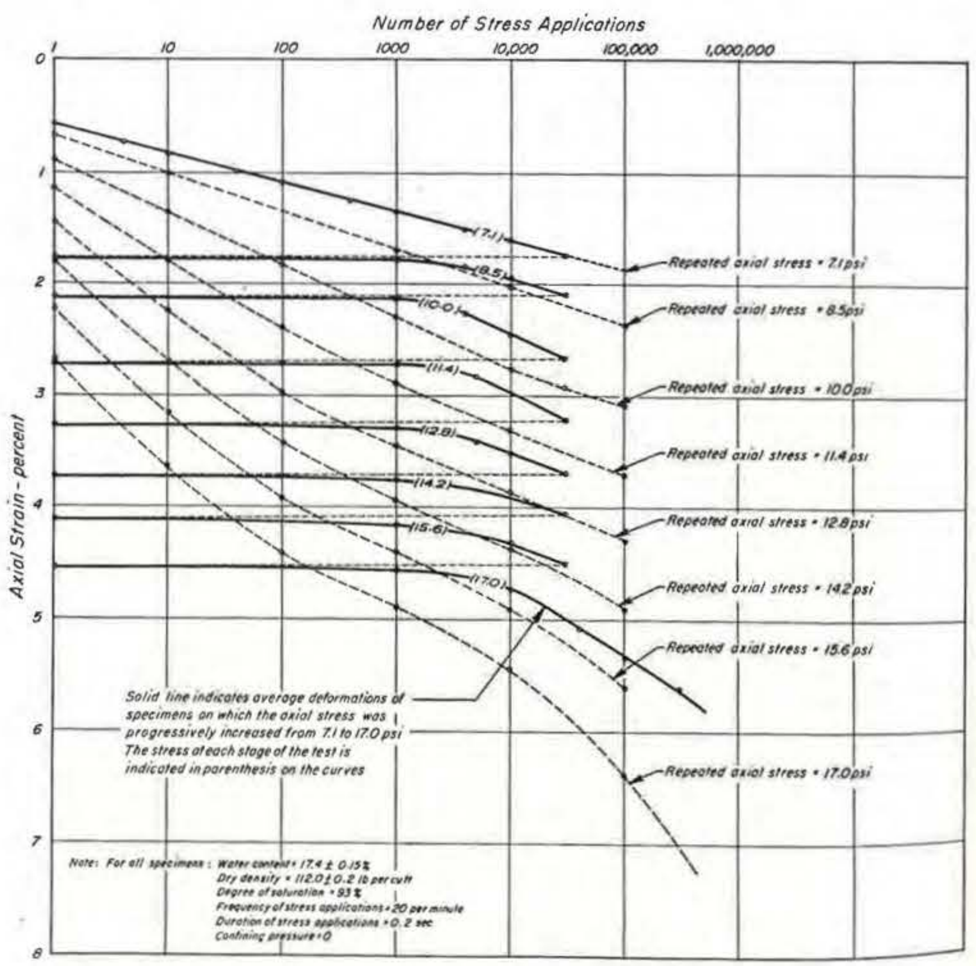


Figure 10. Deformation of specimens of silty clay under progressively increased repeated stress.

It is apparent that the entire sequence of 240,000 applications in which the stress is gradually increased causes less deformation than either of the latter two parts of the sequence applied individually; and, in fact, the entire series of 240,000 applications, including 30,000 applications with a 17.0-psi stress, causes only as much deformation as would only 1,500 applications of the 17.0-psi stress alone. It would appear from these data that, for clay soils, there is no simple means of assessing the cumulative effects of a series of stress applications of different magnitudes from data concerning their individual effects and further research will be required before assessments of this type can be made.

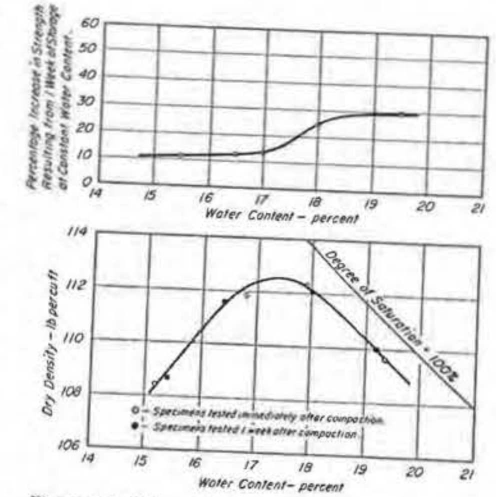


Figure 11. Effect of composition on thixotropic characteristics of compacted silty clay.

EFFECT OF FREQUENCY OF STRESS APPLICATION ON SOIL DEFORMATION UNDER REPEATED LOADING

Previous investigations have shown that compacted clays often show an increase in strength with the passage of time after compaction, even though there may be no discernible change in their composition (6). The phenomenon of strength gain with time in saturated clays has long been recognized in soil mechanics and is often referred to as a thixotropic effect. Available data would seem to indicate that the effect in compacted clays may be quite large for samples with high degrees of saturation —specimens of the silty clay discussed previously compacted to a degree of saturation of 95 percent showed a strength increase of 30 percent over a period of one week— but is quite small for samples compacted to low degrees of saturation. This is illustrated by Figure 11 which shows the percentage increase in strength over a period of one week for samples compacted at various water contents using a constant compactive effort.

For a thixotropic material — or one which shows a strength loss on remolding or deformation followed by a strength regain on standing — it would be expected that a period of rest following a series of repeated stress applications would have a significant effect on the form of the relationship between deformation and number of stress applications. That this is in fact the case is shown by the data in Figure 12a. The specimens used in this study were tested 6 weeks after compaction and thus had acquired considerable thixotropic strength. When first deformed by repeated stress applications a part of this thixotropic strength is lost; if the applications are continuously applied the soil shows large deformations. However, if the specimen is allowed to rest for several days under no load after 10 applications the soil regains a part of the lost thixotropic strength and consequently, when the repeated stress applications are continued, the deformations are markedly reduced (Fig. 12a).

It is important to note, however, that for specimens of the same soil compacted to a low degree of saturation a period of rest has practically no influence on the relationship between deformation and number of stress applications (Fig. 12b). Since specimens of this soil with low degrees of saturation have little thixotropic strength, no effect of a period of rest would be anticipated.

Since the deformation characteristics

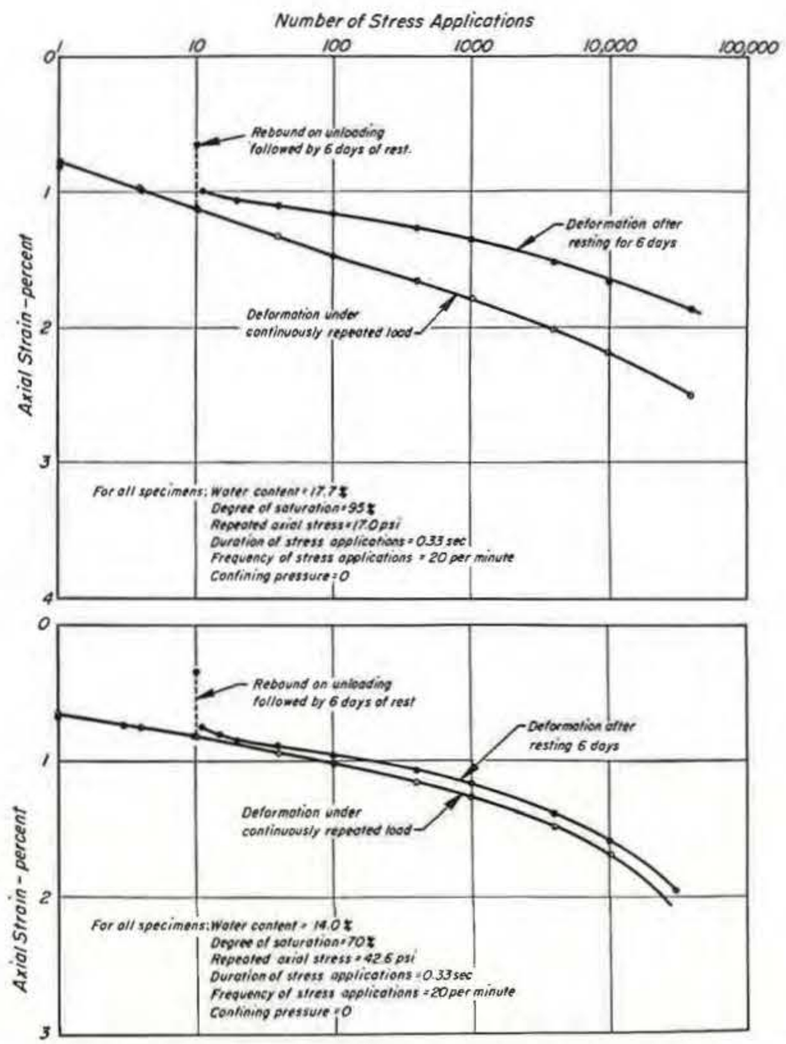


Figure 12. Effect of period of rest on deformation during repeated loading of silty clay with (upper) high degree of saturation, and (lower) low degree of saturation.

of a thixotropic soil are affected by a period of rest in the loading sequence, it would also be expected that the deformation pattern would be influenced by the period of rest between successive load applications, that is by the frequency of load applications. Long intervals between repeated stress applications (low frequencies) would allow thixotropic soils to regain more strength between applications than would short intervals (high frequencies) and consequently cause smaller deformations of the soil. However, no such effects would be anticipated in non-thixotropic soil specimens.

Figure 13 shows a comparison of the deformations caused by repeated stress applications of the same magnitude and duration but with frequencies of 3 and 20 applications per minute on 3 pairs of identical specimens having approximately the same density, but water contents of 14.5, 17.3 and 19.4 percent. For the specimens having a water content of

14.5 percent, and a correspondingly low degree of saturation, a change in frequency from 3 to 20 applications per minute has apparently no effect on the deformation characteristics. However, when the water content is increased to 17.3 percent (which corresponds approximately to the optimum water content for the compactive effort used in preparing the specimens), a slight influence of the frequency of stress application can be observed. This can presumably be attributed to the greater thixotropic effects associated with the high degree of saturation of the specimens (see Fig. 11). Finally, at a water content of 19.4 percent and a degree of saturation of 95 percent the specimens possessed still greater thixotropic characteristics and the influence of the frequency change is still more apparent.

It is interesting to note that the data in Figures 13b and 13c were included in an earlier paper (*1*) and led to the conclusion:

> The results of numerous tests to determine the deformation of partially saturated specimens of silty clay subjected to repeated applications of a constant stress in triaxial compression tests indicate that up to at least 100,000 applications of stress, the specimen deformation depends only on the number of stress applications and is independent of the frequency of stress application within the frequency range of 3 to 20 applications per minute. A limited number of tests indicate that this conclusion is also valid to frequencies as low as 1 application per minute.

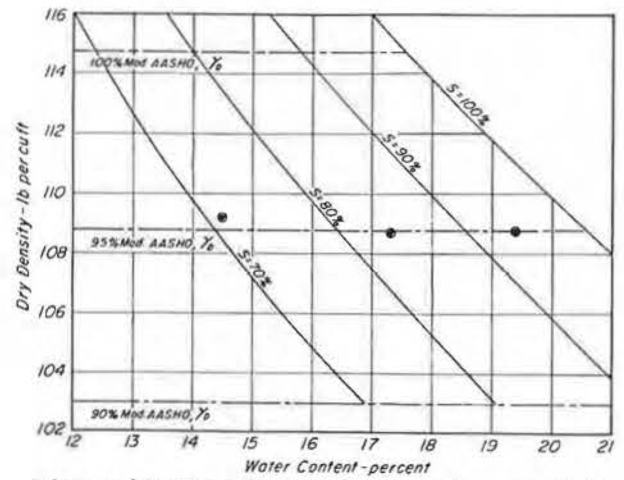
By chance all of the tests on which this conclusion was based were performed on specimens having low degrees of saturation and little thixotropic strength gain. Although the conclusion was valid for the conditions and data discussed at that time, it cannot be applied to specimens of the same soil with high degrees of saturation or, in fact, to any material possessing appreciable thixotropic characteristics.

The large influence that changes in frequency of stress application may have on the magnitude of soil deformations during repeated loading is shown in Figure 14. In this series of tests identical specimens compacted to an initial degree of saturation of 95 percent were subjected to repeated stress applications of the same magnitude and duration but with frequencies of 20 applications per minute, 2 applications per minute, 1 application every 2 minutes, and 1 application every 20 minutes. The large difference in number of applications required to cause a given amount of strain in the specimens is readily apparent. With a frequency of 20 applications per minute a specimen reaches a strain of 5 percent after about 2,700 applications. However, if the frequency is reduced to 2 applications per minute the same deformation is only reached after 15,000 applications, whereas if the frequency is less than 1 application every 2 minutes it appears likely that the specimen could withstand an unlimited number of applications without reaching 5 percent strain.

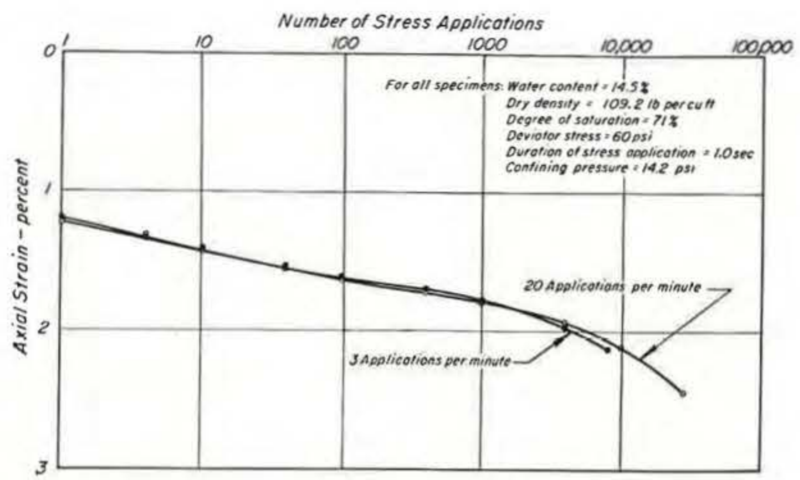
However, Figure 15 shows that even for this wide variation in frequencies there is little change in deformation produced in the less thixotropic specimens of the same soil compacted to low degrees of saturation.

Apart from the influence of thixotropy on the deformation resulting from different frequencies of repeated stress application, the normal thixotropic strength increase with time of some compacted soils may have large effects on the deformations resulting from repeated stress applications of the same magnitude, duration and frequency. Identical specimens of silty clay compacted to a high degree of saturation were tested under repeated stress applications of constant magnitude and duration but with different frequencies (Fig. 16). Some of the specimens were tested immediately after compaction, whereas others were tested 2 weeks later after being stored at constant water content for this period of time.

It is apparent that the changes in deformation resulting from the strength gain in the 2-week period far exceed the changes in deformation characteristics resulting from the use of different fre-

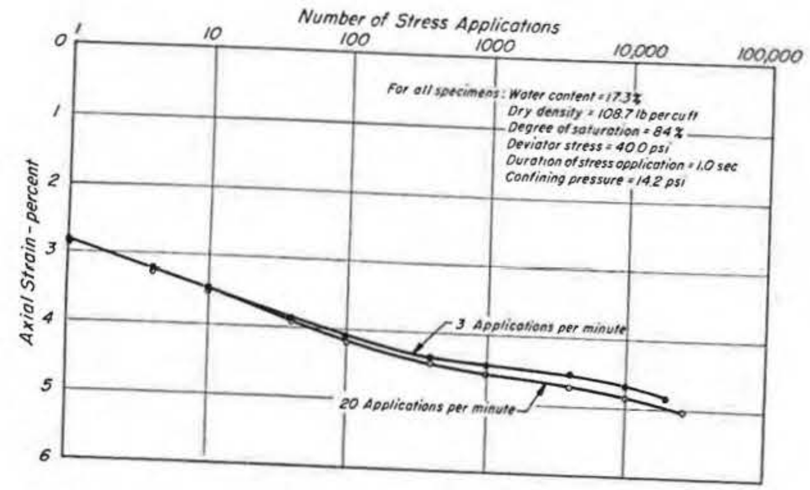


(a) Compositions of specimens used to compare frequency effects.

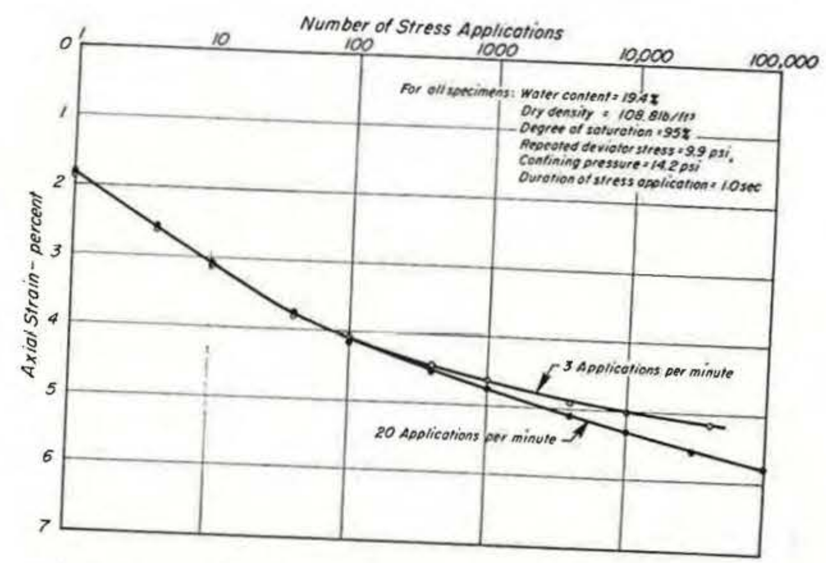


(b) Comparison of deformations for specimens with degree of saturation = 71%

Figure 13. Effect of frequency of stress applications on deformations of silty clay at different degrees of saturation.



(c) Comparison of deformations for specimens with degree of saturation = 84%



(d) Comparison of deformations for specimens with degree of saturation = 95%

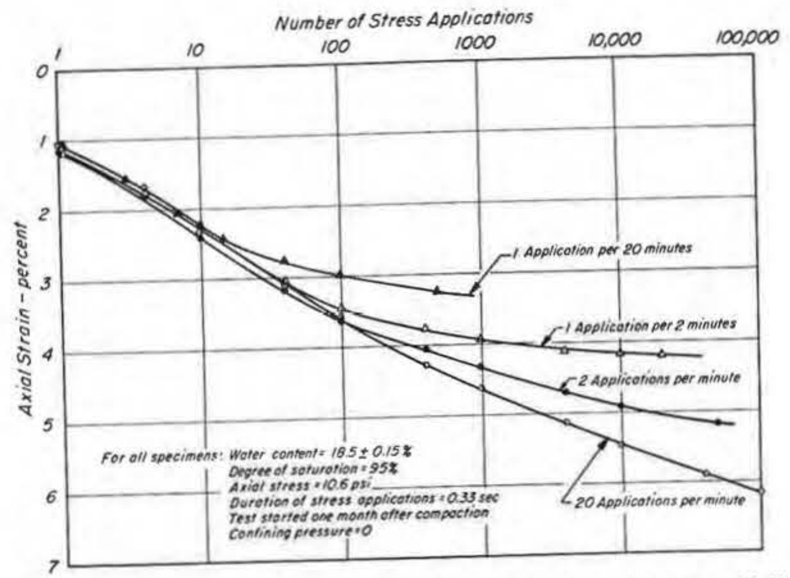


Figure 14. Effect of frequency of stress applications on deformations of silty clay with high degree of saturation.

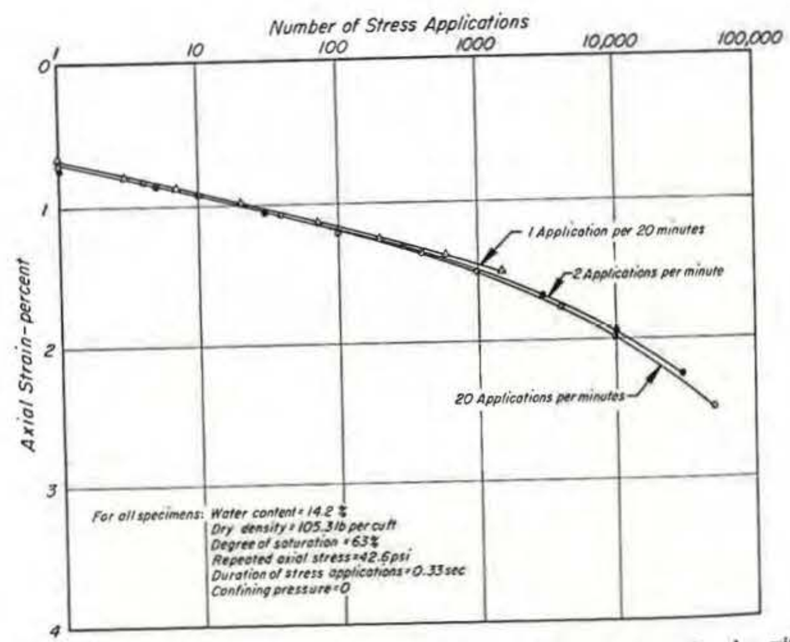


Figure 15. Effect of frequency of stress applications on deformations of silty clay with low degree of saturation.

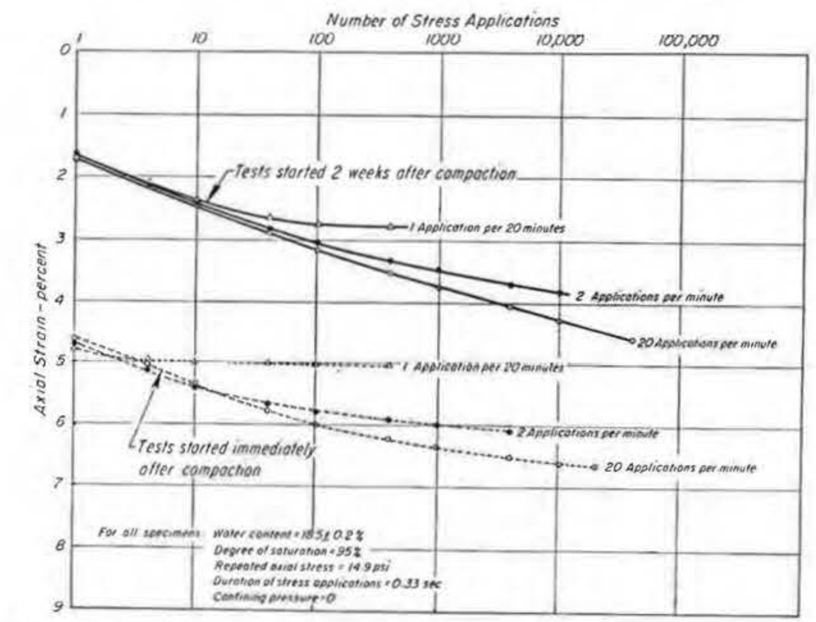


Figure 16. Effect of age of specimens and frequency of stress applications on deformations of silty clay under repeated loading.

quencies of stress application. Furthermore, the influence of the frequency of repeated stress applications depends to some extent on the age of the specimens at the time of testing. For example, the effects of a change in frequency from 20 applications per minute to 1 application every 20 minutes become evident after only 3 stress applications for specimens tested immediately after compaction but are not apparent until about 20 applications for specimens tested two weeks after compaction.

The deformation curves for specimens tested immediately and 2 weeks after conpaction, using a frequency of 1 application every 20 minutes, are reproduced in Figure 17. For this low frequency there is very little increase in deformation observed after the first 2 stress applications if the specimens are tested immediately after compaction. Apparently, the rate of increase in strength of these specimens is sufficient to offset the increase in deformation which would normally result from additional stress applications. However, this is not the case if the specimens are tested 2 weeks after compaction when the rate of strength gain is relatively low; therefore increased numbers of applications cause increased deformations of these specimens over a longer period of time.

CONCLUSION

In recent years there has been a growing realization of the need for studies of soils under repeated loading if improvements in pavement design procedures are to be made, and also of the need for methods of determining the number of wheel load applications that are likely to cause failure of highway pavements. The tremendous difference in estimations of the number of repetitions likely to cause failure of the pavement in the WASHO test road (7) is an outstanding example of the differences in opinions and experience of the different states in this connection.

The purpose of the present paper has been to illustrate some of the factors which should be considered in planning and interpreting studies of soil behavior under repeated loading and also the com-

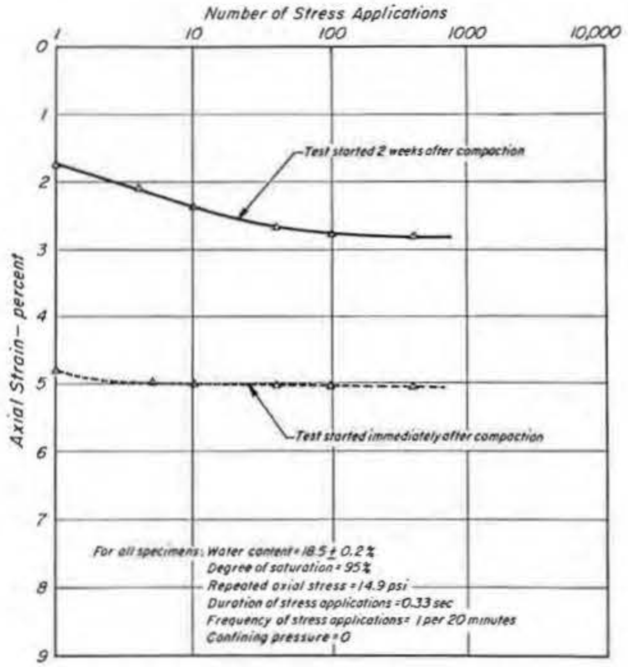


Figure 17. Change in deformation characteristics of silty clay under repeated loading due to aging of specimens.

plexity of assessing the deformations resulting from combinations of wheel loads in design.

The deformation of a compacted clay, even at constant composition, resulting from a given series of stress applications may vary widely depending on its previous stress history, and in general it appears that a gradual increase in the magnitude of the applied stress may often cause less deformation than the direct application of a short sequence of wheel loads. It has been said by older engineers that "a roadway that grows with the traffic" is a better pavement than one constructed with modern techniques. Younger engineers may well be inclined to regard such statements with some degree of skepticism but a pronounced influence of stress history would amply justify such claims. In fact, the previous studies indicate that if traffic could be controlled on a modern highway in such a way that the wheel loads were gradually increased over a period of years, reductions in pavement thickness might well be achieved. The practical difficulties of such a control system seem insurmountable since, if pavements are designed for saturated conditions in the subgrade, there is no need for control until the water content of the soil increases to such an extent that a high degree of saturation is attained and the length of time required for this to occur is likely to vary widely. Nevertheless, the data indicate the need for careful consideration of stress history in the interpretation of past experience of highway performance and the possible danger of extrapolating experience with long service pavements to new construction.

The studies have also shown that in some soils the frequency of stress application may have a marked effect on the resulting deformation, and this factor should not be overlooked in attempts to relate the results of accelerated testing programs to actual field conditions. The effect of thixotropy on the deformation characteristics of compacted clays requires careful consideration if laboratory tests on compacted samples are to be used to maximum advantage for pavement design purposes.

No attempt has been made in this investigation to determine the applicability of the results to a wide range of soils. Certainly the effects are not apparent in sands but several clay soils investigated show some thixotropic characteristics; however, it is not known at the present time whether this is a frequently or infrequently encountered phenomenon. No attempt has been made to determine if thixotropy and stress history effects are exemplified to the same degree in soil specimens compacted to low degrees of saturation and then raised to high degrees of saturation by soaking. However, some justification for testing soil specimens compacted to initially high degrees of saturation may possibly be claimed by the fact that this is the current practice of a number of state highway departments, and it is hoped that the limitation of the test data to one particular soil is justified by the fact that the principles involved are of sufficient importance to warrant an early presentation.

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