SHEAR STRENGTH OF COMPACTED SOILS

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By

ABBAS ELMUBARAK ABUSHAMA

WATER RESOURCES DEVELOPMENT TRAINING CENTRE
UNIVERSITY OF ROORKEE
ROORKEE U.P. (INDIA)
April, 1975

Dr. K.B. Agarwal
Professor and D.T.P.

University of Roorkee
Roorkee, U.P., India.

CERTIFICATE

Certified that the dissertation titled 'Shear Strength of Compacted Soils' which is being submitted by Shri ABBAS ELMUBARAK ABUSHAMA in partial fulfilment of the requirements for award of the Degree of Master of Engineering in Water Resources Development of the University of Roorkee, is a record of Candidate's own work carried out by him under my supervision and guidance. The matter embodied in this dissertation has not been submitted for the award of any other Degree or Diploma.

This is further to certify that Shri Abushama has worked whole time at Roorkee for a period of six months in the preparation of this dissertation.

KB Agarwal

Dr. K. B. Agarwal
Professor and D.T.P.

Roorkee:
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ABBAS ELMUBARAK ABUSHAMA

CONTENTS

ABSTRACT

Whenever we excavate soil and use soil for construction as construction material it will be loose and has to be compacted. The compaction to increase strength and reduce compressibility. When soil is compacted in earth dams or embankments it becomes pertinient to study the short term stability i.e. immediately after construction. Generally we will have to analyse these problems by taking undrained strength into consideration as there will be hardly any time for drainage e.g. 'end of construction.'

Skempton and Sowa (1963) have done experiments on saturated soils concluded that for identical specimens of saturated clay if are subjected to different changes in total stress, the undrained strength will be practically the same and closely equal to the strength in the ground.

The present study deals with the determination of undrained strength in a triaxial machine. In the field where there is failure of slope the rupture surface is taken as part of a circle for finding the factor of safety. The slope of the rupture surface changes from point to point. Generally we take vertical samples to find the undrained strength for analysis. The failure plane for vertical sample will make an angle of $45^{\circ} + \varphi/2$ with the horizontal forming the part of the rupture surface. If this strength is taken the slope of the rupture surface should be $45 + \varphi/2$ with the horizontal at every point which is contrary to the fact. In this study the undrained strengths have been found for different orientations of samples.

Four soils were studied, Kaolin, Bentonite, Black-Cotton Soil and Dhanauri Clay. These are chosen on the basis of clay minerals viz., Kaolinite, illite, .. llonite. The equations for variations of undrained strength with respect to orientation have been derived and the polar

diagrams are shown. The study has also been made for orientation effect on percentage strain at failure energy used by the sample, E_{50} etc.

A simple problem of stability taking only one rupture surface has been studied. The rupture surface has been considered circular and the values of factor of safety have been found out by taking only vertical strength i.e. no orientation effect by taking oriented strengths. The orientation is found to cause reduction in the factor of safety and if not considered it will lead to failure.

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NOMENCLATURE

P	=	Load
A	=	area
LL	=	Liquid Limit
PL	=	Plastic Limit
PI	=	Plasticity index
C_u	=	Undrained strength
ε_f	=	Strain at failure
γ_d	=	dry density
E_{so}	=	elastic modulus at 50 percent strength
t_f	=	time taken to failure
α	=	inclination of the failure plane with the horizontal
w	=	water content
$(\sigma_1-\sigma_3)_f$	=	deviator stress at failure
θ	=	angle of orientation with the vertical axis
O.M.C	=	Optimum moisture content.

Chapter 1

INTRODUCTION

1.1 General Aspect

The shear strength of compacted soils have become of increasing importance in recent years as the number and size of embankments, earth dams, and other such structures being designed and constructed have increased. For satisfactory and economical design, a knowledge of the behaviour of compacted clay is essential. More recent studies by different investigators have lead to a better understanding about the influence of the structure fig 1.1, method of compaction and other factors on the shearing strength of compacted clays.

In most cases, loose dumped soils are too weak and compressible to give satisfactory performance, so the soils are compacted at O.M.C to increase their shearing strength, decrease their compressibility and in some cases to decrease their permeability.

Experience shows that the $\varphi = 0$ analysis usually leads to satisfactory results in calculations of bearing capacity, earth pressure and slope stability in saturated clays based on undrained strength analysis as determined from tests of undisturbed samples. Skempton (1948), confirms this, and it follows that in saturated clays, tested under conditions of no water content change, the failure may be expressed in the form

$$\sigma_1 - \sigma_3 = 2C$$

where,

σ_1 and σ_3 are the major and minor principal stresses at failure and C is the cohesion.

Skempton (1948) concluded that the $\varphi = 0$ analysis cannot be applied to partially saturated clay, nor to those silts which show an angle of shearing resistance greater than zero in the immediate triaxial test.

In the recent years, Skempton and Sowa (1963) have done experiments on saturated clays concluded concluded that if two identical specimens of saturated clay are subjected to different changes in total stress without alteration in water content, and if the strains consequent upon these stress changes cause little alteration in microstructure, then the undrained strength of the two specimens will be practically identical.

Therefore, since there is no water content change during sampling, the undrained strength of a sample of saturated clay will be closely equal to the strength in the ground, provided the strains are not sufficiently large to cause significant microstructural changes. This result helps to explain the success of the $\varphi = 0$ analysis in " end of construction" problems.

1.2 Structure of Compacted Clay

Convincing evidence of the type of structure developed in compacted clays and the influence of structure on soil properties has been presented in recent years by Lambe (1958). As a consequence of this development,many previous observations relating to the strength characteristics of compacted clays, may now be fitted into consistent pattern and used to predict the probable behaviour of the various types of compacted clays under different loading conditions.

Fig.1.1 illustrates the effects of compaction on clay structure as originally conceived by Lambe (1958). The effects of compaction conditions on soil structure,and thus on the engineering behaviour of the soil, vary considerably with soil type and the actual conditions under which the behaviour is determined as discussed by Seed and Chan(1959).

The changes in arrangement at different stages of the density-water content relationship are explained as follows: At point A the amount of water present results in a high concentration of electrolyte which prevents the diffuse double layer of ions surrounding each clay particle from developing fully. The double layer depression leads to low interparticle repulsion, resulting in a tendency towards flocculation of the colloids and consequently a low degree of clay particle orientation in the compacted soil.

This type of structure has been termed a 'flocculated' arrangement of soil particles. If the water content is increased to point 'B', the electrolyte concentration is reduced resulting in an expansion of the double layer, increased repulsion between particles and a low degree of flocculation, that is, an increase degree of particle orientation. Further increase of water content at point 'C' increases this effect and results in still greater increase in particle orientation.

A system of particles which is approached at point 'C', has been termed as a 'dispersed' system.

It is helpful in the study of compacted clay to note that there are similarities between dry side and wet side compacted clays and between undisturbed and remoulded clay. The dry side compacted clay and undisturbed clay both tend to have a flocculated-type structure, while a wet-side compacted clay and a remoulded clay both tend to have oriented 'dispersed' types of structures.

In summary, increasing the molding water content increases the orientation of clay particles and decreases the pore-water tensions. Increasing the compactive effort also increases the particle orientation.

In the extensive literature on the shear behaviour of soils much work was done on consolidated, overconsolidated and saturated compacted cohesive soils. Now further research will be required to understand the shear behaviour

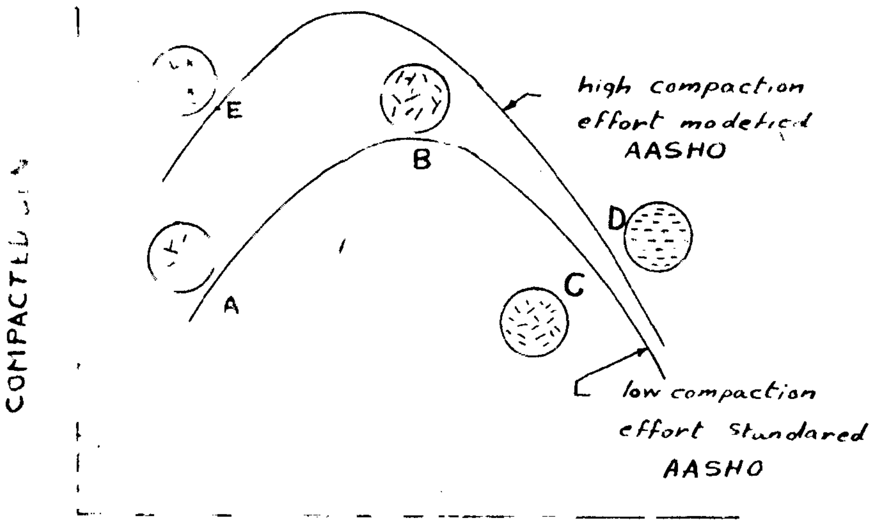

FIG. 1.1 MOLDING WATER CONTENT

(After Lambe, 1958)

EFFECT OF COMPACTION ON STRUCTURE

of unsaturated compacted cohesive soils and the effect of rotation of principal stresses on the undrained shear strength.

1.3 The Orientation of The Failure Surface

The orientation effects on shear strength of London clay in stability of slope problem was first studied by Agarwal (1965,1967). To perform a proper analysis of the stability of such slope, he found that the relationship between undrained strength, and the orientation of the failure surface is of great significance.

The work was carried out by Agarwal(1967) to investigate the failure in the foundation of Wraysbury Dam near London while excavations for construction were in progress - Undrained tests were performed on large sized soil samples (1 ft dia x 2 ft length) taken from the core foundation of the dam. He found that inclined samples experienced lesser strength than vertical and horizontal sample, while diagonal samples (45^{o}) varies about 28 percent than vertical. The failure with foundation of the dam was attributed due to the fact that shear strength values taken for design were from tests on vertical samples only, neglecting the effect of the orientation of the failure surface.

To illustrate the orientation of the failure surface. Fig.1.2 is considered which represent a clay deposit after construction of a cut. Suppose that, because of the changes in shear stresses caused by construction, the cut slope is in a state of incipient failure; that is any increase of load at the top or removal of material from bottom will cause a rotational slide along the failure arc ABCD.

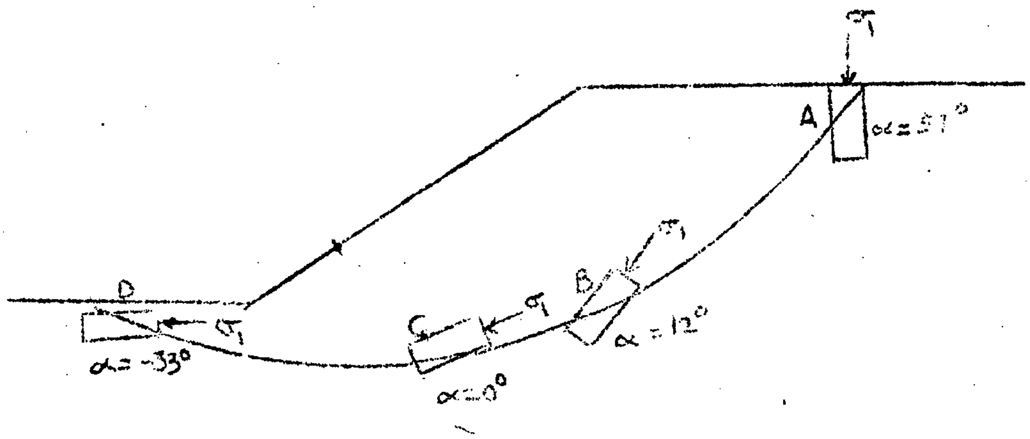

Fig. (1.2)

If the angle between the failure plane and the horizontal plane is called α, then it can be seen that if α is 57° at point A it will be 12° at point B, zero at point C and -33° at point D.

Although the principal stress σ_1 is essentially vertical at point A - the top of the sliding surface, but because the failure plane has a different orientation at every point along the sliding surface, it can be seen that the major principal stress has rotated through some angle. If the angle by which the principal stresses are oriented is termed δ, then it can be seen that δ is approximately equal to $57^\circ - \alpha$. Thus the amount of reorientation of the principal stresses is about zero at A, 45° at B, 57° at C and 90° at D.

Therefore, for better understanding of the shear behaviour of compacted clays and to perform a proper analysis of the stability of such slope, it would be necessary to know the relationship between the undrained strength and the orientation of the major principal stresses.

1.4 Present Study

The study was taken to investigate the undrained shear strength and strengthcharacteristics of compacted soils in a triaxial loading test under different confining pressures. Samples were extracted at different angles of inclination, The soils for study were chosen in such a way as to get a diversified in the clay content and also the composition of the cl· · minerals. Soils were compacted at optimum moisture content in a design mould. Undrained tests were performed on $1^1/2$ inch dia samples trimmed at 0°, $22^1/2^\circ$, 45°, $67^1/2^\circ$ and 90° with no measurements of pore water pressure.

Chapter 2

REVIEW OF LITERATURE

2.1 Shear Strength of Compacted Cohesive Soils

Seed, Mitchel and Chan(1960), conducted undrained tests on compacted soil specimen. The soil was silty clay with optimum moisture content of 19.5 percent and maximum dry density of 107 pcf. Two types of samples were tested. In one case the sample was prepared by kneeding compaction dry of O.M.C (flocculated structure) with an initial water content of 17.4 percent. The other sample was prepared by kneading compaction wet of O.M.C. with an initial water content of 23.5 percent (dispersed structure) values of effective principal stress ratio at failure were plotted with respect to water content. Then effective shear strength parameters were evaluated from two Mohr's envelopes representing samples of the same water content but different structures. It was seen that when strength characteristics are evaluated in this way, the shear strength parameter φ' is independent of water content and initial structure.

They summarized it as 'it would appear from the test data that difference in structure and method of compaction may cause large difference in stress-strain characteristics, pore water pressures and effective stresses in the compacted clays but cause only small changes in the maximum effective principal stress ratio and little, if any, changes in the values of strength parameters expressed in terms of effective stresses.'

2.2 Factors Affecting Strength of Compacted Cohesive Soils

2.2.1 Composition and Structure of Compacted Clays:

A cohesive soil consists of an accumulation of particles ranging from larger granular constituents to the much smaller clay size particles. The behaviour of granular components is well understood, much remains to be learnt about the behaviour of the clay fraction. High surface to-mass ratio and presence of electrical fields at surface of the clay particles give rise to many unusual properties. When clay particles are placed in an aqueous environment, the cations absorbed on the surface of clay particles to balance negative surface charge, tend to spread out into so called 'diffused double layer' surrounding the former. During consolidation or compaction, clay particles come closer resulting in contact of their diffused double layers. Consequently the electrostatic repulsion at contact is balanced by normal effective stress and proportional to d^{-2} (d = distance between adjacent clay particles in contact). In addition, there are forces of attraction due to Vander Waal's forces, edge to face contact, various types of bonds

Lambe (1958), and are proportional to d^{-7}. If clay particles are very close, attractive forces may predominate over repulsive forces. On the other hand repulsive forces may overcome attractive forces when clay particles are not very close to each other. The repulsion, if large enough with respect to attraction, can lead to the development of dispersed structure during soil compaction. The relative magnitude of attractions and repulsions in conjunction with the amount and nature of externally applied compaction energy, will determine the structure. The structure may be of any type between two limiting conditions:

i) A completely flocculated structure

ii) A completely dispersed structure depending on whether attractive forces are predominent or not?

2.2.2 Effect of Moisture Content on Strength and Effective Stresses of Saturated Samples:

In saturated soils the water content, void ratio and dry density are uniquely related. The knowledge of one determines the other. So the study of effect of water content on effective stresses and strength of saturated samples will serve to illustrate the effects of void ratio and dry density on these properties. Seed Michel and Chan (1960) have studied these effects and have summarized as below.

'With the variation of water content there is a variation in compressive strength considerably. Tests were conducted on wet of optimum and it was found that lower the water content higher will be the strength. It will be interesting to know that such samples showed some decrease in pore water pressure, as the axial strain increased. Such decreases are due to the dilation of specimens. The specimens will lower water content (correspondingly higher density) showed greatest dilation and thus developed the lowest pore water pressures. It has also been noted that decrease in water content or void ratio at failure caused either an increase in the effective angle of friction or the effective cohesion.'

The following test results substantiate this fact:

Table 1

Water content at failure	(C_c) kg/cm^2	φ_c degrees
19	0.20	31.6
20	0.13	31.4
21	0.11	31.0
22	.09	31.0

It can be seen that the value of φ_c remains essentially constant for above range of water content and density.

2.2.3 Influence of Void Ratio at Failure on Strength:

It has already been pointed out that void ratio effects the strength of compacted cohesive soils. The void ratio at failure in a strength test will depend on many factors e.g. drainage conditions, stress conditions within the sample, initial void ratio, the water content, soil compressibility and soil structure.

Leonards (1955) in his paper concluded that the relationship between compressive strength and void ratio at failure is unique, regardless of the confining pressures,the quantity of drainage permitted, the water content, or the degree of saturation.

It has long been known, Rendulic (1936), that loose clays undergo reduction in void ratio and dense clays an increase in void ratio during the application of shear stresses provided that the pore water pressure is at all times maintained equal to atmospheric pressure. When saturated clays are subjected to quick tests or consolidated-quick tests; the change in void ratio during the application of the deviator stress is negligible. Any tendency towards a decrease in void ratio is counteracted by an increase in pore-water pressure and, conversely any tendency towards an increase in void ratio is coanteracted by a reduction in pore water pressure.

Rutlege (1947) pointed out that the pattern of strength variation for partly saturated clays is a function of the confining pressure.

2.2.4 Influence of Moulding Water Content and Method of Compaction On Structure:

If there is sufficient water present in the soil, the full double layer around clay particles will develop. This will increase interparticle spacing and hence will decrease attractive forces. On the other hand if the soil is deficit of water, the full double layer will not develop and so attractive forces will predominate. Due to the above reasons, the clay particles exhibit dispersed structure on wet of optimum and flocculant structure on dry of optimum.

The method of compaction including shear strains in a soil will result in more dispersed arrangements than methods of compaction inducing little or no shear strains. A comprehensive study of the effect of the method of compaction and water content on soil structure and strength has recently been completed by Seed and Chan(1959). For samples of same soil having the same density and water content, it has been found that the greater the degree of dispersion of the clay particles, the lower is the strength of the soil at low strains.

Seed and Chan (1959) showed that dry of optimum water content, the method of compaction has no effect on the soil strength, indicating that the various methods of compaction produce similar structures.

During compaction wet of optimum, however, the different methods of compaction induce increasing shear strains and thus greater dispersion in the order: static (least), vibratory, kneeding. It will be seen that the strengths of the resulting samples decrease in the same order.

2.2.5 Change in Structure with Time:

It has been known for some time that many natural clays exhibit change of property with time after remoulding. Notable among these changes is thixotropic hardening but other properties may also be affected. Mitchel (1960), concluded from his extensive tests with petrological study of clay structure that the thixotropy is manifested owing to rearrangement of clay particles after the removal of compaction effort. The soil becomes relatively flocculant and hence gains strength.

Holtz and Ellis (1963) performed some tests and suggested that the effective stress parameters do not change significantly with age and type of compaction. Alan (1965) conducted unconfined compression tests on compacted soil samples and found a marked variation in days and 1 hour strength. He concludes that the effect of aging on the compacted specimens has an important effect on the measured shear strength.

2.2.6 Thixotropic Effects in Compacted Clays:

Thixotropic effects have been found to be of quite general occurrence in fine grained materials. Seed and Chan (1957) has shown that the shearing resistance of compacted clays, particularly at low strains, can be significally increased by aging at constant water content. Further it has been noticed that aging has the effect of reducing the pore water pressure developed during shear of compacted clay.

Discussing the cause of thixotropic behaviour of soil Mitchel (1960) pointed out that a clay will exhibit thixotropic behaviour if two conditions are fulfilled:

1. The net interparticle force balance is such that the clay particles will flocculate if these are given the chance.
2. The flocculation is not sufficiently strong, however, the particles cannot be dispersed by applied shearing strains.

It is known that flocculated structure is developed at water content less than optimum regardless of the method of compaction. In compacted soils having flocculated structures, the thixotropic effects are negligible. With increase in water content, thixotropic effect increases but it decreases at higher moisture contents.

2.2.7 Duration and Rate of Loading:

Previous investigations have shown that the duration and rate of loading can significantly effect the strength of compacted clays. Cassagrande and Shannon(1948) Witman (1947) and Hampton (1958) have shown that the strength is considerably increased under very rapid rates of loading. On other hand data reported by Casagnande and Wilson (1951) for two compacted clays showed that the strength may also be increased by very slow rates of loading.

Seed, Mitchel and Chan (1960) have concluded that the strength of compacted clays depends perhaps, among other things, on the following factors:

a) A tendency for strength to decrease with the increased time available for creep deformation.

b) A tendency for the strength to increase because of increased time available for regain of thixotropic strength lost during initial deformations under load increments.

c) A tendency for strength to decrease due to manifestation of the creep phenomenon after long time when thixotropic effect is over.

2.3 Review of Experimental Work and Case Records

Hoorslev (1960), conducted many series of unconfined compression tests on remoulded vienna and Little Belt clays. Both the soils were preconsolidated are dimensionally to a pressure of 5.0 kg/cm^2. Samples of 2 cm^2 cross section and 4 cm height were trimmed with their axis at different inclination (0°, 45°, 90°) with the plane of orientation of clay particles. Due to slight variation of water content and the strength of individual samples the compressive strength could not be compared directly. However, a comparision of the ratio of compressive strength to equivalent consolidation pressure 'P_e' gives a fairly good idea of strength variation in different directions. In Table 2 relative strengths for different samples have been compared assuming strength of vertical sample as unity.

Table 2

Type of soil	Vertical	Inclined 45°	Horizontal
Vienna clay	1.00	0.92	0.86
Little Belt clay.	1.00	1.08	1.20

It is evident that in Vienna clay the vertical samples had strength about 14% greater than the horizontal samples, whereas in the other case the horizontal sample showed a maximum strength 20 percent greater than that of the vertical samples. The inclined samples had intermediate strength in both cases. However, the opposite nature of the variation in the two cases remains unexplained.

Ward, Samuel and Butler (1960) carried out several unconsolidated undrained tests on horizontal and vertical samples taken from a London clay deposit which is marked for its horizontal Limitations. More than 130 samples were cut from blocks trimmed out of the walls of tunnels at several locations. With the exception of one group of samples described as exceptionally fissured, the horizontal samples were 15 percent to 39 percent stronger than the vertical samples. The only inclined samples (45°) tested were 1 percent weaker than the vertical samples. However, no definite correlation between the strength of samples from different locations and the relative strength of horizontal to vertical samples could be established.

Lo (1960), reported results of soil investigation for the construction of a tunnel in Well and clay,Ontario. Block samples were obtained at 4' interval from a shaft 5' in diameter and excavated 77' deep into the ground. To investigate the strength variation with direction unconfined compre-

-ssive tests were carried out with major principal stresses acting on samples inclined at angles of $0^\circ, 15^\circ, 30^\circ$, $45^\circ, 60^\circ$, 75° and 90° respectively. A horizontal to vertical strength ratio of 0.8 to 0.94 was obtained for the different sites.

Fig.2.1 gives relative picture of the results mentioned so far of unconfined compression tests.

Ward, Samuel and Marsland (1965) conducted quick undrained shear tests on samples taken in horizontal, vertical and inclined directions from a plastic clay deposit at depths 0' to 150' and reported that: 'At all levels the horizontal specimen had strength either greater or equl to the strength of vertical samples, mean value of strength ratio being 1.46 $\pm$ 0.16. At all levels the strength of diagonal samples (at 45°) was less than that for vertical samples.

Aas (1965), did comprehensive studies of the in-situ shear strength of clays, using the vane test and vanes of various shapes. The primary purpose of the tests was to investigate the possibility of measuring the anisotropy of the undrained shear strengths of normally consolidated clays.

The vane test series were performed at four different test sites using vanes having H/D ratios ranging between 0.5 and 4. In addition, two vanes having a greater

H/D ratio were used. Each test series consisted of from 16 to 31 vane borings with the tests performed at 0.5 m intervals of depth through the selected stratum of the clay deposit. The borings were 1.5 to 2 m apart.

The interpretation is based on the usual assumption that the clay fails along the surface of a cylinder, the diameter and height of which are equal to those of the vane. Furthermore, the shear stresses are assumed to be fully mobilized and uniformly distributed across the entire failure surface, although not necessarily equal in magnitude for horizontal and vertical surfaces.

Denoting the undrained shear strength acting along horizontal and vertical planes, respectively, by S_H and S_V, the following expression for the failure torque measured in a vane test is derived

$$M = \pi DH(D/2)\ S_V + 2\ (\pi D^2/4)\ (D/3)\ S_H$$

Hence

$$[2/(\pi D^2 H)]M = S_V + S_H\ (1/3\ D/H) \qquad ..(1)$$

Equation (1) describes a straight line intersecting the vertical axis at a value equal to S_V and having an inclination equal to S_H. Hence, the intersection of this line with the negative (1/3 D/H) axis directly gives the value of S_V/S_H.

On the basis of the above interpretation Aas concluded that the undrained vane tests, involving the use of vanes with different shapes, have enabled an approximate determination to be made of the ratio between the undrained shear strengths acting along horizontal and vertical failure surfaces. This ratio, S_H/S_V, was found to be 1.1 at one test site where the clay is slightly overconsolidated, and varied between 1.5 and 2.0 at three other test sites where the soil consists of normally consolidated clay.

Duncan and Seed (1966) reported recently some tests on Kaolinite clay. They consolidated the soil (water content 66.2 percent) under K_o conditions upto a pressure of 1.5 kg/cm^2 in three moulds of 6" diameter and 8" height. Vertical, horizontal and diagonal (45^o) triaxial samples of 1.4" diameter and 3.5" height were extracted from 6" diameter soil samples. Unconsolidated undrained test were carried out.

Compressive strengths of inclined and horizontal samples as determined by unconsolidated undrained tests are reported as 25 percent and 13 percent respectively, less than that of vertical samples. Consolidated undrained tests yielded strength for horizontal samples about 10 percent less than that of vertical samples. It is shown that there was hardly any directional variation in the effective stress parameter c' and φ', but there was a significant change in the pore pressure A_f at failure with orientation of failure plane. It was always higher for horizontal than for vertical samples, which accounts for loss of strength.

Sharma (1966) conducted consolidated undrained triaxial and unconfined compression tests on compacted soil samples with different particle orientation and showed that compacted clays behave like overconsolidated clays. He reported the strength for horizontal and inclined samples less than vertical samples.

Bishop (1966) studied the variation of lightly and heavily over-consolidated clay with the direction of the applied major principal stress Fig.5.5. The samples were all cut from blocks taken from vertical shafts and average values are given based on a large number of tests. In the lightly overconsolidated well and clay the compression strength in horizontal direction was found to be about 0.75 of the vertical strength. In heavily overconsolidated London clay the ratio of horizontal the vertical strength was 1.46 (range 1.23 to 1.63). However, inclined samples (45^o) of London clay show a great reduction in strength being 0.77 of the vertical value.

Agarwal (1967) was the first to investigate orientation effect on full scale basis. He did both field and laboratory tests. In the field he did 2' x 2' shear base tests and in the laboratory triaxial tests on 1 ft dia x 2 ft high undisturbed samples. He found that there was significant effect of orientation on undrained strength of London clay. He also studied the failure on the Wraysbury Dam and proved that the failure was due to orientations which were not being considered in the design.

2.4 Reorientation of Principal Stresses

During the consolidation process the clay particles acquire a definite structure under the system of principal consolidation pressures. During subsequent shearing any change in the orientation of the principal stresses with reference to the already acquired orientation of particles, is liable to cause a directional variation of strength. This may be even if the soil is essentially isotropic with respect to the shear strength parameter and pore pressure parameter.

Bromes and Casbarian (1965) conducted a series of undrained triaxial compression tests to show the effects of rotation of principal stresses and the intermediate principal stress. Tests were conducted on hollow cylinderical samples of a remoulded Kaolinite clay. Lateral pressure was applied by filling the inside and outside of the sample with water Axial load was applied by air pressure and a torque to the sample by rotating the cell base rigidly attached to a turn table. Load cells were employed to measure the axial load and the torque up to an accuracy of 1 percent. Tests were planned to study the individual and the combined effect of intermediate principal stress and the rotation of principal stresses.

Hansen and Gibson (1949) derived an expression for the undrained strength which could be mobilized on a failure plane, with any orientation, in terms of initial stress and the Hvorslev shear strength parameters. This work was done before Skempton had suggested the pore pressure parameters A and B, and the earlier " λ-theory" proposed by Skempton (1948), was used to relate changes in pore pressure to changes in total stress. The expression derived by Hansen, in terms of the symbols used herein, is

$$\frac{C_u}{p} = \frac{C_e}{p} \cos \varphi_e + 1/2\,(1 + K_o) \sin \varphi_e - \sin \varphi_e \left(\frac{1-\lambda}{1+\lambda}\right) \left[\left(\frac{C_u}{p}\right)^2 - \frac{C_u}{p}(1 + K_o) \cos 2\left(45 + \frac{\varphi_e}{2} - \alpha\right) + \left(\frac{1-K_o}{2}\right)^2 \right]^{1/2} \quad \ldots\ldots (2)$$

in which λ = the ratio of the slope of a swelling curve to the slope of the origin consolidation curve. It was assumed in the derivation that the values of λ, C_e, and φ_e were the same for all values of α, i.e., for any orientation of the failure plane when the initial stress conditions are anisotropic and the soil is isotropic with respect to C_e, φ_e, and λ.

In the λ-theory proposed by Skempton, the change in pore pressure in saturated clay due to the change in total stresses under plane strain conditions is expressed by

$$\Delta u = \Delta\sigma_3 + \frac{1}{1+\lambda}(\Delta\sigma_1 - \Delta\sigma_3) \qquad .. (3)$$

By comparison with the equation

$$\Delta u = B\,\Delta\sigma_3 + \bar{A}\,(\Delta\sigma_1 - \Delta\sigma_3) \qquad .. (4)$$

it can be seen that

$$\bar{A} = \frac{1}{1+\lambda} \qquad .. (5)$$

And B is equal to unity because the clay is saturated. Solving for λ in terms of $\bar{A}$, it is found that

$$\lambda = \frac{1-\bar{A}}{A} \qquad .. (6)$$

$$\frac{1-\lambda}{1+\lambda} = (2\bar{A} - 1) \qquad .. (7)$$

$\lambda = C_s/C_c$; where, C_s = Expansibility, i.e. volume increase per unit volume per unit decrease in effective stress

C_c = Compressibility, volume decrease per unit volume per unit increase in effective stress.

P = vertical effective consolitation pressure

K_o = coefficient of earth pressure at rest.

and $\varphi_\alpha = \varphi_2 + (\varphi_1 - \varphi_2) \sin^2 \alpha$ .. (10)

where

C_1 and φ_1 = the strength parameters along the major principal strength axis.

C_2 and φ_2 = The strength parameters along minor principal strength axis.

C_α and φ_α = The strength parameters along any plane inclined at an angle α to the major principal strength axis.

Furthermore, the strength line must be tangient to the stress circle. The critical value of α is the root of the equation

$$f'(\alpha) = \frac{2f(\alpha)}{\tan 2\alpha} \quad .. \quad (11)$$

The preceding assumption leads to a very simple expression for the critical value of the angle α which will be designated by the letter α_o

$$\tan \alpha_o = \sqrt{\frac{C_2}{C_1}} \quad .. \quad (12)$$

Thus the shear strength of the material in the failure plane is

$$C = \frac{2C_1 C_2}{C_1 + C_2} \quad .. \quad (13)$$

Using this relation between λ and $\bar{A}$, Equation (2) may be written in terms of the more familiar $\bar{A}$ as

$$\frac{C_u}{p} = \frac{C_e}{p} \cos \varphi_e + 1/2 \, (1 + K_o) \sin \varphi_e$$

$$- \sin \varphi_e \, (2\bar{A} - 1) \left[\left(\frac{C_u}{p}\right)^2 - \frac{C_u}{p} (1 + K_o) \cos 2 \left(45 + \frac{\varphi_e}{2} - \alpha\right) + \left(\frac{1 - K_o}{2}\right)^2 \right]^{1/2} \quad \ldots \ldots (8)$$

2.5 Strength Theories and Failure Criteria

Cassagrande and Carrillo (1953) extended the Mohr Coulomb theory for anisotropic materials. They considered two identical cases of

i) Purely cohesive soil ($\varphi = 0$ case)

ii) Purely cohesionless soil ($C = 0$ case)

in which the direction of principal stresses coincided with that of principal strengths. Graphical and analytical solutions are given for determination of shear strength and location of failure in terms of principal strength although the procedure is valid for a general directional variation in strength, in their analysis they have adopted a distribution

$$C_\alpha = C_2 + (C_1 - C_2) \sin^2 \alpha \quad \ldots \ldots (9)$$

and $\varphi_\alpha = \varphi_2 + (\varphi_1 - \varphi_2) \sin^2 \alpha$ .. (10)

where

C_1 and φ_1 = the strength parameters along the major principal strength axis.

C_2 and φ_2 = The strength parameters along minor principal strength axis.

C_α and φ_α = The strength parameters along any plane inclined at an angle α to the major principal strength axis.

Furthermore, the strength line must be tangient to the stress circle. The critical value of α is the root of the equation

$$f'(\alpha) = \frac{2f(\alpha)}{\tan 2\alpha} \quad .. \quad (11)$$

The preceding assumption leads to a very simple expression for the critical value of the angle α which will be designated by the letter α_o

$$\tan \alpha_o = \sqrt{\frac{C_2}{C_1}} \quad .. \quad (12)$$

Thus the shear strength of the material in the failure plane is

$$C = \frac{2C_1 C_2}{C_1 + C_2} \quad .. \quad (13)$$

and the radius of the critical stress circle is

$$r = \sqrt{C_1 \ C_2} \quad .. \quad (14)$$

In general case where the shear strength directions donot coincide with the principal stress directions, the shear strength in any direction is given as,

$$C_\alpha = C_2 + (C_1 - C_2) . \text{Sin}^2 (\alpha - \beta) \quad .. \quad (15)$$

where

β = the angle between principal stress and principal strength axis.

Lo (1960) plotted the results of a large number of unconfined compression and direct shear tests conducted on samples taken from ground in different directions and observed that

$$C_1 = C_2 + (C_1 - C_2) \text{ Cos}^2 \text{ i} \quad .. \quad (16)$$

where,

i = inclination of sample with vertical. This is of the form of expression as given by Cassagrande and Carrillo.

Bishop (1966), on studying variation in the undrained strength of lightly overconsolidated Welland Clay and heavily over-consolidated Lond clay expressed the results by

$$C_u = C_{u_{vert}} \times (1 - a \sin^2 \theta)\ (1 - b \sin^2 2\theta) \quad .. \quad ..(17)$$

where,

a and b are constants . The expression $(1 - a \sin^2\theta)$ reflects the influence of pore pressure and $(1 - b \sin^2 2\theta)$ the direction character of C' and φ' as well as that of pore pressure. This equation was fitted to 0°, 45° and 90°. The values of a and b for London clay were found to be equal to -0.46 and + 0.375 respectively and for Welland clay a = +0.25 and b = +.04.

Agarwal (1967) studied Blue London clay which is a heavily over-consolidated marine clay deposited 4000 years ago. He found that the inclined 45° samples gave 72 percent of undrained strength of vertical samples, and horizontal samples, 107 percent. He found the orientation effect for 1 ft dia. x 2 ft high undisturbed samples also of the same order. He fitted the equation for orientation on polar diagram. The equation given by him is

$$C_u = C_{u_{vert}} (1 + 0.07 \sin^2 \theta)\ (1 - 0.3 \sin^2 2\theta) \quad .. (18)$$

He also studied the orientation effects on small samples of London clay of 1/2 inch dia. x 1 inch high, called lumps.

The inclined 45^{o} lumps gave 82 percent strength and horizontal, 121 percent strength of vertical samples.

Singh and Sharma (1967) studied the directional strength variation of compacted clays for samples at inclination of 90^{o}, 0^{o}, 60^{o} and 30^{o}. They reported maxima and minima of shear strength and its parameters for $\alpha = 90^{o}$ and 30^{o} respectively and fitted the equation

$$C_{\alpha} = C_{3} + (C_{1} - C_{3}) \sin (\alpha - \beta_{f}) \sec \beta_{f} \quad .. \quad (19)$$

where

β_{f} is the angle of the failure plane with the vertical and

α is inclination of the sample with the horizontal.

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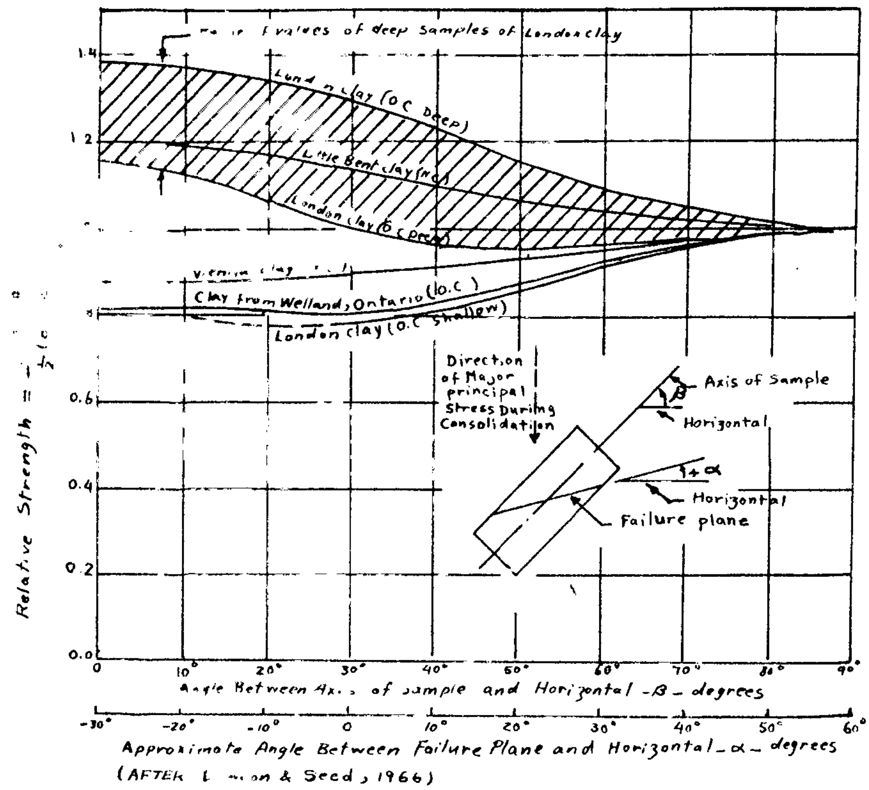

FIG. 2.1 THE VARIATION OF COMPRESSIVE STRENGTH WITH ORIENTATION OF FAILURE PLANE

Chapter 3

TESTING TECHNIQUES AND SOILS STUDIED

3.1 Soils Studied

In selecting suitable soils for this study, guidance was obtained from previous investigations carried out by Agarwal (1967), Lambe 1948 , Seed,Mitchel and Chan (1960), Bishop (1966), Seed and Dincan (1966). Bishop has studied the variation of undrained strength of lightly and heavily over-consolidated clay with the direction of applied principal stress. The influence of compaction on shear strength was studied by Lambe, Seed and others. Hence soils having wide range of clay fraction and different O.M.C. values were selected for study. With these in view and also the availability conditions, four cohesive soils, viz. Kaolin, Dhanauri clay, Bentonite and black cotton soil were chosen.

Commercially available Kaolin and Bentonite were used in the study. Dhanauri clay was obtained locally and black cotton soil was obtained from Kota in Rajasthan(India). Index tests were performed to determine the physical properties of the soils, such as specific gravity, liquid limit, plastic limit, maximum dry density, O.M.C., clay fraction etc. All the above tests were carried out according to Indian Standard Specifications.

3.2 Testing Technique

3.2.1 Apparatus Used:

The Universal Triaxial Cell incorporates the general features suggested by Bishop and Henkel (1962) to carry out shear strength tests on cohesive and cohesionless soils by subjecting the specimen to three compressive stresses at right angles to one-another. Immediate, undrained or quick, consolidated quick or consolidated undrained tests can be carried out with this equipment on $1^{1}/2$ inch dia., 2 inch dia., 3 inch dia., 3 inch dia., and 4 inch dia., soil specimens with a diameter to light ratio of 1:2. Sketch of this is shown on fig. 3.1

In this machine the cell assembly consists of a cell base fitted with three valves. One valve connects to a peripheral hole on the base and serves as water inlet for lateral pressure assembly. The other two valves are tapped to receive the nuts on the plastic tubes. A perspex cylinder with reinforcing bands is fixed in between the cylinder base and the top. The interfaces are sealed with " O" rings. A loading plunger ground bush in the top is provided to reduce friction to the minimum. The top has an air air vent for allowing the air to pass out as the water enters the cell and it is closed by the air-vent screw. The pedestals and loading pads for $1^{1}/2$ inch, 2 inch, 3 inch and

4 inch dia., specimen have shallow radial grooves. They are provided with tapped holes for fixing the drainage connections.

3.2.2 Triaxial Versus Direct Shear Test

The advantages and disadvantages of both triaxial test and the direct shear test have been discussed in textbooks of soil Mechanics(Bharat Singh and Shamsher Prakash, 1963) from the point of view of the accuracy with which they disclose the strength of the soil. In general, the triaxial machine has received great favour because of its adaptability to control and measurements of major and minor principal stresses, pore water pressure, volume changes etc. The triaxial machine is not a perfect instrument for determining the shearing strength of undisturbed soil samples, but it has advantages over the direct shear machine in that the operator can make conditions in the laboratory agree closely with assumed conditions in the field than is possible with the direct shear machine. These advantages make the triaxial machine unquestionably very valuable in research and for many practical problems in foundation engineering.

3.2.3 Test Procedure:

3.2.3.1 Compaction of Soils

The soils were compacted in a bearing capacity box , shown in plate 1, of internal dimensions of 11 cm x 49 cm x 41 cm (B x L x H). The soil is compacted in seven layers for the same energy required for standard proctor method of compaction i.e. 60.6 x 10^3 M-Kg/m^3. Each layer was given 200 blows using 2.5 kg rammer dropped from a height of 30.5 cm.

3.2.3.2 Preparation of Triaxial Samples

The directions in which the samples are required are marked on both side of the box by using set-squares and special protractor for precise angle measurements. These directions are at 0^o, $22^1/2^o$, 45^o, $67^1/2^o$ and 90^o. Using a metallic wire, blocks of approximately 5 inch height were cut and removed from the box. Triaxial samples were obtained by gently trimming a 4 inch diameter sample plate 2 and pushing it gently into a standard proctor Mould by trimming the superfluous material by a thin bladed sharp edged knife. From each mould three samples ($1^1/2$ inch dia.) were obtained by pushing in three sample tubes guided by a three holed metallic guide plate to ensure their verticality, Plate 3. The samples were then labelled with respect to their direction, wrapped in a thin polythene bags and sealed with adhesive tape so that the moisture content was maintained constant.

3.2.3.3 Rate of Testing

It was thought to conduct these tests under a constant rate of loading at 1 percent strain i.e. 0.03 inch/minute. Since this could not be achieved in this machine a rate of 0.025 in/min. was used throughout the test.

3.2.3.4 Mounting Triaxial Machine

Samples of 3.81 cm diameter ($1^1/2$ inch dia.) were extracted from the sample tubes and the desired length of 7.62 cm (3 inch) was obtained by using split mould of 3.8 in. dia. x 7.62 cm ($1^1/2$ in. dia. x 3 in.). The sample was weighed to 0.1 gm accuracy before testing.

A rubber membrane was slipped into the rubber stretcher and then the ends were turned out round its circumfrence. The air was sucked out of the nipple of stretcher and the sample was slipped into it. Plain discs both at the top and the bottom of specimen were used so that no pore water could escape. The loading pad was placed on top and then the membrane was carefully bound to the pad with rubber '0' rings after placing the sample on the base.

The tests were conducted for confining pressures of 0.5, 1, and 2 kg/cm^2 for a number of identical specimens. The axial load readings for a set of deformations were taken.

3.3 Precision of Measurements

Every attempt was made to eliminate the personal and procedural errors. All the gauges and proving rings were calibrated and checked at frequent intervals. The rate of testing, set by the gear system of the machine, was checked by stop watch, However, in the following are discussed some of the sources of errors affecting the precision of measurements.

3.3.1 Probable Variation of The Soil Moisture:

While preparing sample in the bearing capacity box, it was observed that bottom layer gets compacted more than middle and top layers. Reason is that total energy supplied by the rammer is utilized in compacting bottom layer, but in case of middle layer, part of energy supplied by rammer is utilized in compacting the bottom layer, the remaining is utilized in compacting middle layer. Similar phenomena happened in case of top layer. Therefore bottom layer gets compacted more.

Samples were weighed carefully before and after testing. In addition to this, specimens were taken in crucibles from the trimmed soil. Since no difference was noticed, it was assumed that the sample had not dried.

3.3.2 Lack of Control of Chamber Pressure

There was no automatic control arrangement for chamber pressure in triaxial cell. The change in chamber pressure during the test is due to

(a) Change in temperature (b) Immersion of plunger in the cell (c) The probable leakage of cell fluid, (d) Expansion of cell.

During all the tests conducted accuracy depend on the precision of pressure connected to the cell and here all pressure was kept constant by manipulating the valve manually.

3.3.3 Fraction on the Loading Ram

In most of the triaxial test equipment in common use the axial load applied to the specimen is measured outside the cell and the load is transmitted to the specimen by a ram passing through a bush in the top of the cell. If there is any friction in this bush, errors will rise when the axial stress in the specimen is calculated.

Provided the ram and bushing are smooth and have adequate clearance between them, friction can arise only as a result of lateral forces which push the ram against the bushing. Theoretical and experimental studies, Bishop (1962), indicate that the errors normally be between about 1 per cent to 3 per cent of the axial load. Since this is small and oily lubricants were used, no correction was applied for this.

3.3.4 Rubber membrane correction

A method of calculating the correction from the properties of rubber membrane as stated by Bishop(1962) was based on the following assumptions.

1.) That the membrane, when held against the sample by the cell pressure, was capable of taking compression .

2.) That the sample deforms as a right cylinder. The correction, σ_r , to the measured compression strength, due to effect of the rubber membrane is given by

$$\sigma_r = \frac{\pi DM\varepsilon}{A} = \frac{\pi DM\varepsilon\,(1 - \varepsilon)}{A_o}$$

where,

D = is the initial diameter of the sample

M = is the compression modulus of the rubber membrane, per unit width

A_o = the X-sectional area of the specimen

A = the corrected area of the sample at axial strain ε,

The results of the experiment conducted is shown in fig.(4.46). This correction was applied to all tests.

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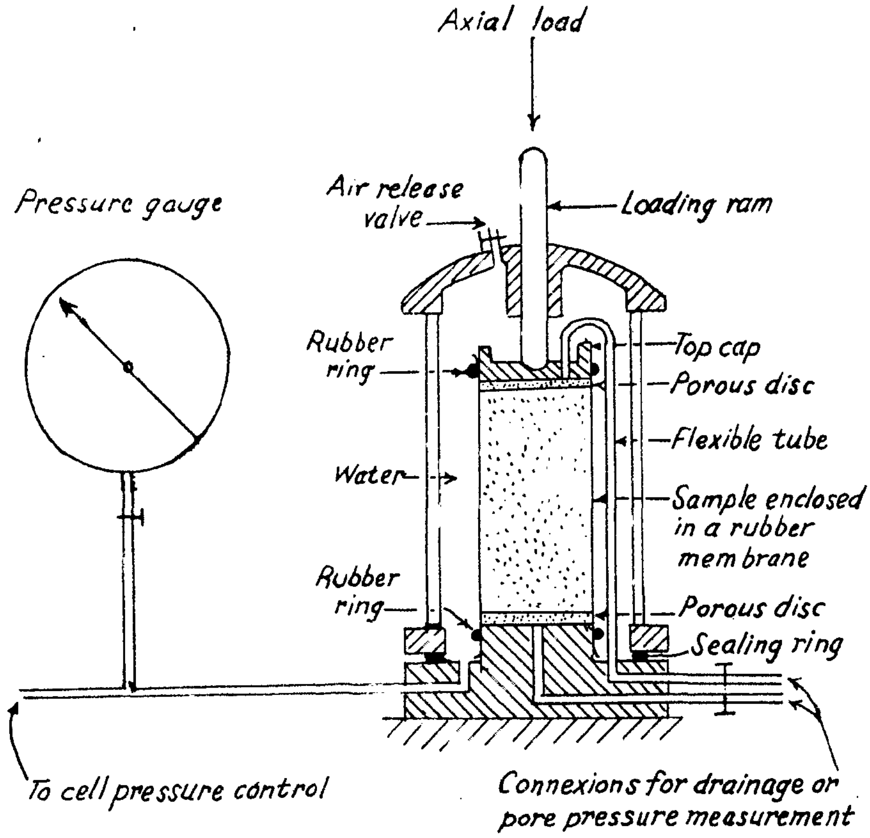

FIG. 3.1 DIAGRAMATIC LAYOUT OF THE TRIAXIAL TEST

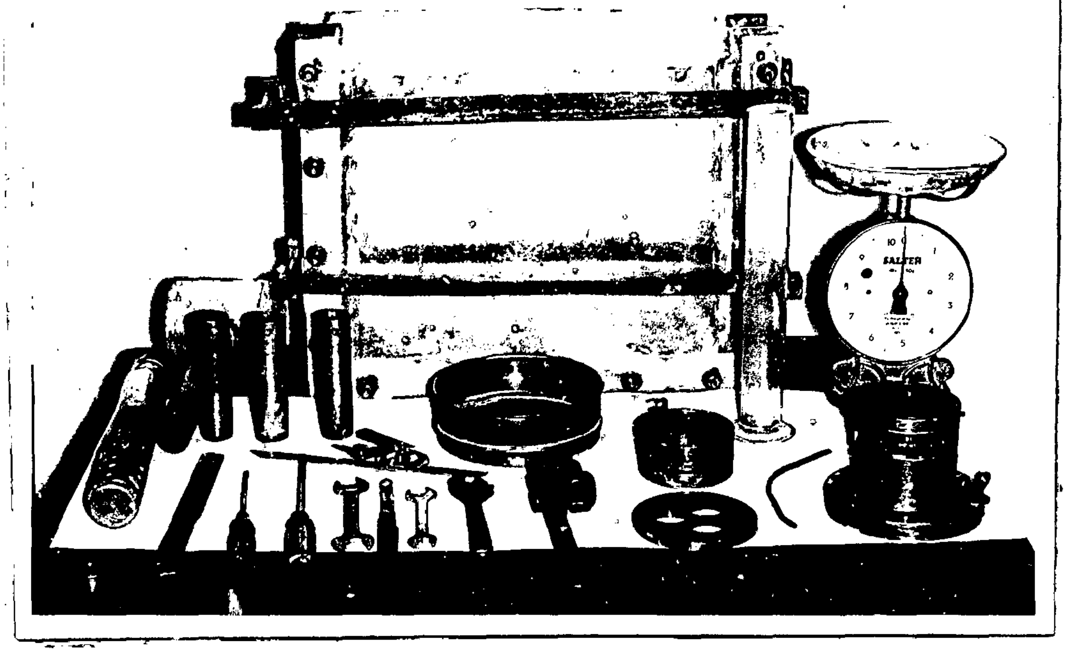

Plate 1 - Various Tools used during Compaction Including the Bearing Capacity Box.

Plate 2 - Trimming 4 inch dia. Sample.

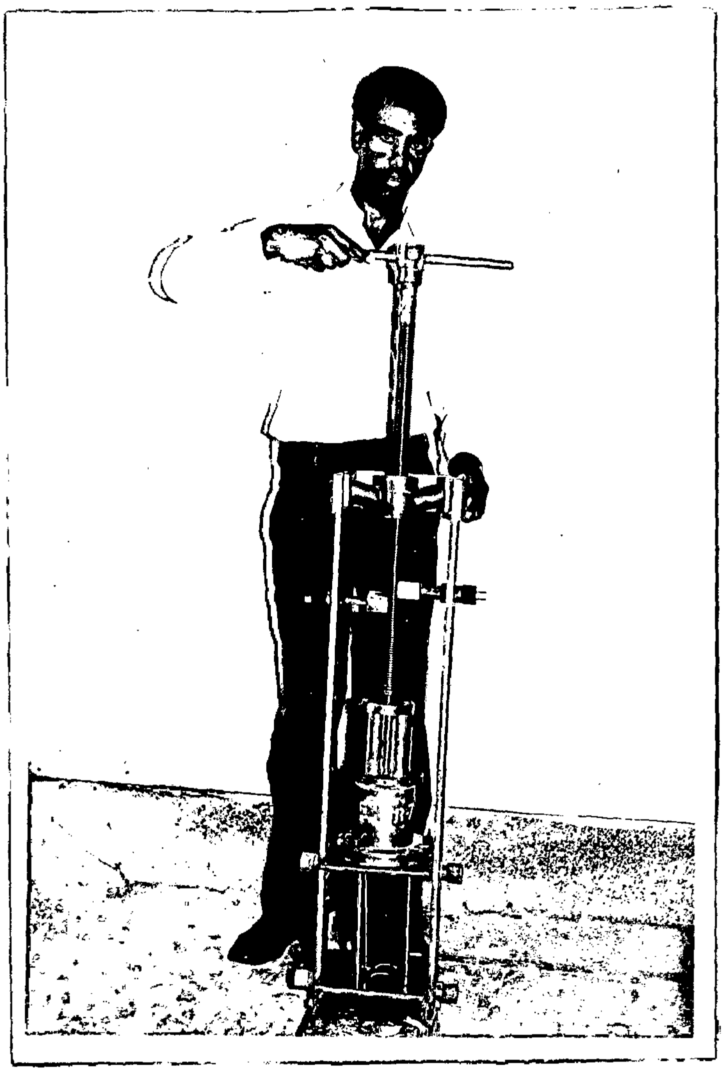

Plate 3 - Extraction of three $1^1/2$ inch dia., Samples from 4 inch dia. Sample.

Plate 4 - Accessories of Triaxial Machine for Undrained Test

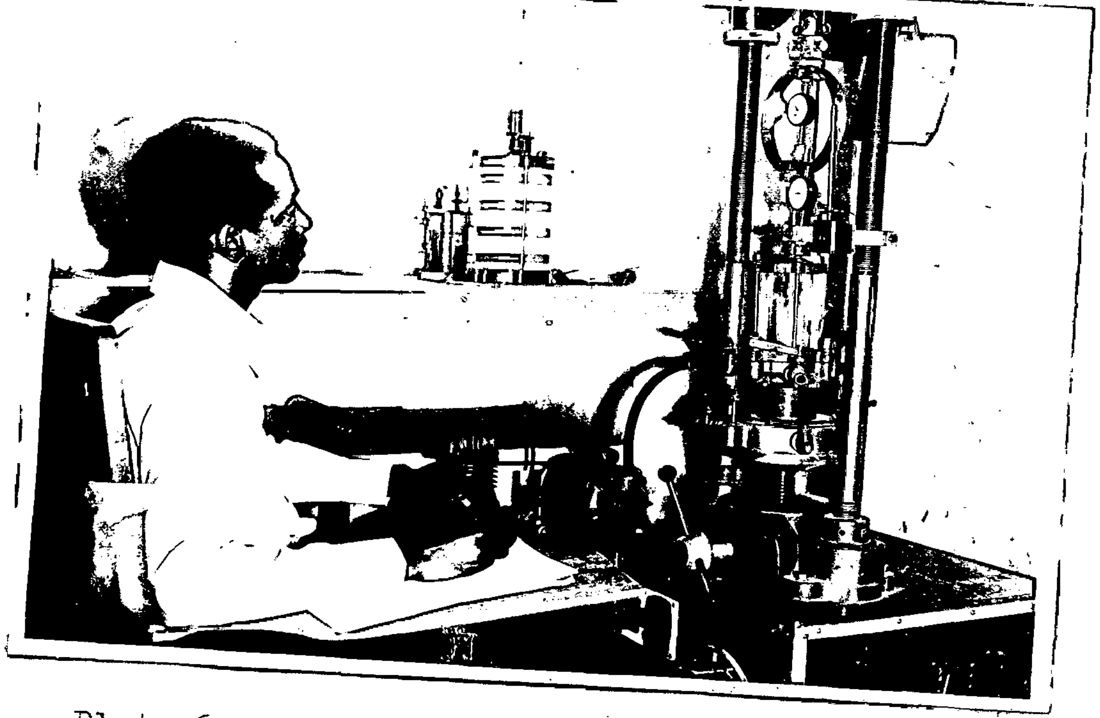

Plate 6 - Undrained Test in Progress

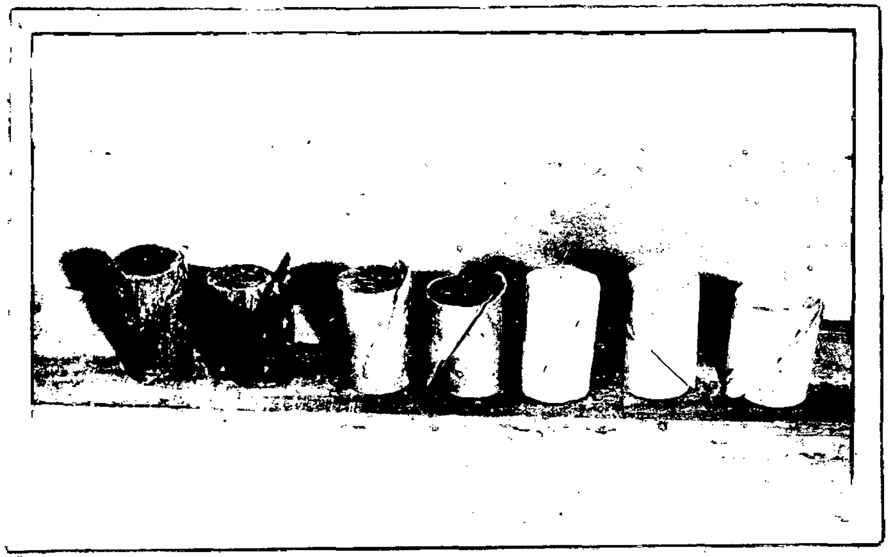

Plate 7 - Sheared Specimens from Undrained Test.

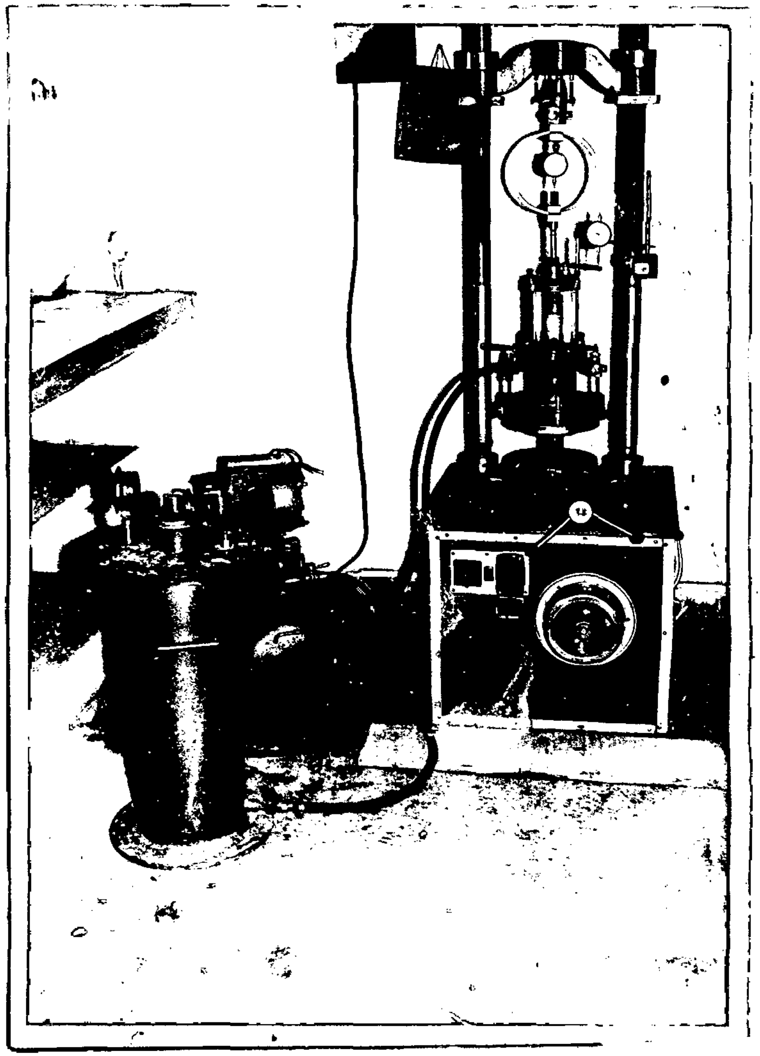

Plate 5 - Mounted Specimen in the Triaxial Machine.

Chapter 4

TEST RESULTS

4.1 General

Undrained tests were performed in a triaxial machine to determine the undrained shear strength of compacted soils. The soils used were Kaolin, Dhanauri clay, Bentonite and Black cotton.

Identical samples, 3.8 cm in dia. x 7.62 cm height compacted at O.M.C. were obtained for each soil and tested with low confining pressures of 1/2 kg/cm^2 1 kg/cm^2 and 2 kg/cm^2 under undrained conditions. The undrained strength was obtained for samples inclined at $\theta = 0$, $22^1/2^\circ$, 45°, $67^1/2^\circ$ and 90° for each soil. Minimum of three samples in each direction of orientation were tested.

Based on observations of these tests, tables 3 to 115, the stress vs strain curves were plotted and these based on average strengths. The polar diagram was obtained for each soil. The index properties for each soil were obtained as for Indian Standard tests.

The corrections for Area and rubber membrane were applied to all undrained test results. The corrections were obtained in the laboratory by extension tests on a piece of rubber membrane as per Bishop and Henkel (1962) and are given in Fig.4.46 with respect to percentage strain.

4.2 Test Results

4.2.1 Results of Tests on Kaolin

The index properties of Kaolin are as follows:

Specific gravity	(Gs)	=	2.57
Liquid limit	(LL)	=	63 percent
Plastic limit	(PL)	=	45.0 percent
Plasticity Index	(PI)	=	18.0 percent
Clay Fraction	(CF)	=	53.0 percent
Optimum moisture content		=	26.0 percent
Natural moisture content		=	2.1 percent
Dry density at O.M.C.		=	1.36 gm/cc

Observations for Kaolin are given in Table 3 to tables 30 and the graphs of deviator stress versus percentage strain in Figs. 4.1 to 4.10. The polar diagram for undrained strength is shown in Fig.5.1.

4.2.2 Results of Tests On Bentonite

In case of Bentonite the index properties are as follows:

Specific gravity	(Gs)	=	2.74

Liquid limit	(LL)	=	400.3	percent
Plastic limit	(PL)	=	65.2	percent
Plasticity Index	(PI)	=	335.1	percent
Clay fraction	(CF)	=	97.0	percent
O.M.C.		=	39.5	percent
Natural moisture content		=	11.56	percent
Dry density at O.M.C.		=	1.224	gm/cc

Observations are given in Tables 31 to 63. The stress strain curves in Figs. 4.11 to 4.23 and the polar diagram in Fig.5.2.

4.2.3 Results of Tests on Dhanauri Clay

The index properties of Dhanauri clay are as follows:

Specific gravity	(Gs)	=	2.75	
Liquid limit	(LL)	=	62.9	percent
Plastic limit	(PL)	=	32.5	percent
Plasticity Index	(PI)	=	30.4	percent
Clay fraction	(CF)	=	51.0	percent
O.M.C.		=	23.5	percent
Natural moisture content		=	2.45	percent
Dry density at O.M.C		=	1.58	gm/cc

Observed data of tests for Dhanauri clay are given in Tables 64 to 91. The deviator stress versus percentage strain curves are given in Figs. 4.24 to 4.35 and the polar diagram in Fig.5.3.

4.2.4 Results of Tests on Black Cotton Soil

In case of Black Cotton Soil the index properties are as follows:

Specific gravity	(Gs)	=	2.818	
Liquid limit	(LL)	=	51.0	percent
Plastic limit	(PL)	=	20.40	percent
Plasticity Index	(PI)	=	30.60	percent
Clay fraction	(CF)	=	44.0	percent
O.M.C.		=	19.5	percent
Natural moisture content		=	7.35	percent
Dry density		=	1.614	gm/cc

The observations are given in Tables 92 to 115, the stress strain curves in Figs 4.36 to 4.45 and the polar diagram in Fig 5.4.

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TABLE NO.(3)

KAOLIN

Vertical Sample

Chamber Pressure 2kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	25	0.33	11.44	1.5	0.13	0.12
20	37	0.67	11.49	2.0	0.17	0.16
30	52	1.00	11.53	2.5	0.21	0.19
40	144	1.33	11.55	8.0	0.69	0.66
50	229	1.67	11.59	12.5	1.07	1.04
60	301	2.00	11.63	16.5	1.41	1.37
70	370	2.33	11.67	20.75	1.77	1.72
80	429	2.67	11.71	23.50	2.00	1.95
90	482	3.00	11.75	26.20	2.22	2.16
100	541	3.33	11.79	28.50	2.41	2.35
120	644	4.00	11.88	35.0	2.94	2.86
150	779	5.00	12.00	41.75	3.47	3.38
180	896	6.00	12.13	48.5	3.99	3.88
240	1067	8.00	12.39	58.0	4.68	4.54
300	1193	10.0	12.67	64.5	5.09	4.91
360	1302	12.00	12.95	70.2	5.42	5.21
420	1559	14.00	13.26	84.0	6.33	5.09
430	1559	14.33	13.30	84.00	6.31	5.17
440	1539	14.67	13.37	82.6	6.19	4.94

TABLE NO.(4)

KAOLIN

Vertical Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	32	0.33	1.44	20	0.17	0.16
20	46	0.67	11.49	2.5	0.21	0.20
30	53	1.00	11.53	3.0	0.26	0.24
40	65	1.33	11.55	3.5	0.30	0.27
50	118	1.67	11.59	6.5	0.56	0.53
60	217	2.00	11.63	12.0	1.03	0.99
70	293	2.33	11.67	16.0	1.37	1.32
80	3.58	2.67	11.71	19.5	1.66	1.61
90	419	3.00	11.75	23.0	1.95	1.89
100	477	3.33	11.79	26.0	2.20	2.14
120	578	4.00	11.88	31.5	2.65	2.57
130	628	4.33	11.92	34.25	2.87	2.79
150	721	5.00	12.00	39.2	3.26	3.17
180	848	6.00	12.13	46.0	3.79	3.68
240	1048	8.00	12.39	57.0	4.60	4.46
300	1196	10.0	12.67	64.75	5.11	4.93
360	1275	12.00	12.95	69.0	5.33	5.12
380	1277	12.67	13.05	69.0	5.28	5.06
420	1138	14.00	13.26	61.65	4.66	4.42

TABLE NO.(5)

KAOLIN

The Vertical Sample

Chamber Pressure 0.5 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Proov-ing Ring Correc-tion	Load P	Stress P/A	Corrected P/A
0	85	0	11.40	0	0	0	0
10	98	0.33	11.45	13	0.75	0.07	0.06
20	108	0.67	11.49	23	1.5	0.13	0.12
30	115	1.00	11.51	30	1.90	0.17	0.15
40	120	1.33	11.53	35	2.20	0.19	0.16
50	125	1.67	11.60	40	2.5	0.22	0.19
60	128	2.00	11.65	43	2.55	0.23	0.19
70	140	2.33	11.71	55	3.2	0.30	0.25
80	143	2.67	11.75	58	3.5	0.33	0.28
90	155	3.00	11.79	70	4.0	0.37	0.31
100	190	3.33	11.83	105	6.0	0.51	0.45
110	272	3.67	11.89	187	10.5	0.88	0.81
120	345	4.00	11.92	260	14.4	1.21	1.13
150	480	5.00	12.05	395	21.6	1.79	1.70
180	585	6.00	12.15	500	27.25	2.24	2.13
240	768	8.00	12.50	683	37.2	2.98	2.84
300	915	10.0	12.77	830	45.0	3.52	3.34
360	1045	12.00	13.05	960	52.2	4.00	3.79
380	1079	12.67	13.15	994	54.0	4.11	3.89
420	1080	14.00	13.37	995	54.0	4.04	3.79

TABLE NO.(6)

KAOLIN

Vertical Sample

Chamber Pressure 2kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	5.0	0.33	11.44	1.0	.08	.07
20	8.0	0.67	11.49	1.5	.13	.12
30	28.0	1.00	11.53	5.5	.47	.45
40	49.0	1.33	11.55	9.0	.77	.74
50	62.0	1.67	11.59	11.5	.99	.96
60	77.0	2.00	11.63	14.5	1.24	1.20
70	88.0	2.33	11.67	16.2	1.38	1.33
80	100.0	2.67	11.71	18.5	1.57	1.52
90	110.0	3.00	11.75	20.1	1.71	1.65
100	120.0	3.33	11.79	22.0	1.86	1.80
120	140.0	4.00	11.88	25.5	2.14	2.06
150	166.0	5.00	12.00	30.0	2.50	2.41
160	192.5	6.00	12.13	35.0	2.88	2.77
240	242.5	8.00	12.39	44.0	3.55	3.41
300	286.0	10.0	12.67	51.8	4.08	3.90
360	324.0	12.0	12.95	58.5	4.52	4.31
420	359.0	14.0	13.26	65.0	4.90	4.66
440	367.0	14.67	13.37	66.5	4.98	4.73
480	374.0	16.00	13.57	67.5	4.98	4.72

TABLE NO.(7)

KAOLIN

Vertical Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	6.0	.33	11.44	1.2	0.10	.09
20	9.5	.67	11.49	2.0	.17	.16
30	31.0	1.0	11.53	6.0	.52	.52
40	48.0	1.33	11.55	9.0	.77	.74
50	62.0	1.67	11.59	11.5	.99	.96
60	74.0	2.00	11.63	14.0	1.20	1.16
70	86.0	2.33	11.67	16.0	1.37	1.32
80	97.5	2.67	11.71	18.0	1.53	1.48
90	108.0	3.00	11.75	20.0	1.70	1.64
100	118.5	3.33	11.79	21.5	1.82	1.76
110	128.5	3.67	11.83	23.5	1.98	1.91
120	139.0	4.00	11.88	25.5	2.14	2.06
130	147.0	4.33	11.92	26.8	2.24	2.16
150	164.0	5.00	12.09	30.0	2.50	2.41
180	190.0	6.00	12.13	34.5	2.84	2.73
240	237.0	8.00	12.39	43.0	3.47	3.33
300	274.0	10.0	12.67	49.5	3.90	3.72
360	292	12.0	12.95	53.0	4.10	3.89
380	285	12.67	13.05	51.5	3.94	3.72

TABLE NO.(8)

KAOLIN

Vertical Sample

Chamber Pressure 0.5 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	6.5	0.33	11.44	1.2	0.10	0.09
20	22.0	0.67	11.49	4.0	0.34	0.33
30	38.0	1.00	11.53	7.1	0.61	0.59
40	52.0	1.33	11.55	9.5	0.82	0.79
50	65.0	1.67	11.59	12.0	1.03	1.00
60	76.5	2.00	11.63	14.0	1.20	1.16
70	87.0	2.33	11.67	16.0	1.37	1.32
80	98.0	2.67	11.71	18.0	1.53	1.49
90	108.0	3.00	11.75	20.0	1.70	1.64
100	118.0	3.33	11.79	21.5	1.82	1.76
110	129.0	3.67	11.83	23.5	1.98	1.91
120	138.0	4.00	11.88	25.0	2.10	2.02
130	148.0	4.33	11.92	27.0	2.26	2.16
150	163.0	5.00	12.00	30.0	2.50	2.41
160	173.0	5.33	12.04	31.5	2.61	2.51
240	236.0	8.00	12.39	42.8	3.45	3.31
300	270.0	10.0	12.67	49.0	3.86	3.68
360	292.0	12.0	12.95	53.0	4.10	3.89
420	286.0	14.0	13.26	52.0	3.92	3.68

TABLE NO.(9)

KAOLIN

$22^{1}/2^{o}$ Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	14	0.33	11.44	2.80	0.24	0.23
20	17	0.67	11.49	3.5	0.30	0.29
30	37	1.00	11.53	7.0	0.60	0.58
40	56	1.33	11.55	10.5	0.90	0.87
50	74	1.67	11.59	14.0	1.20	1.17
60	88	2.00	11.63	16.5	1.41	1.37
70	105	2.33	11.67	19.5	1.67	1.62
80	118	2.67	11.71	21.5	1.83	1.78
90	132	3.00	11.75	24.0	2.04	1.98
100	143	3.33	11.79	26.0	2.20	2.14
110	155	3.67	11.83	28.0	2.36	2.29
120	167	4.00	11.88	30.5	2.56	2.48
130	177	4.33	11.92	32.0	2.68	2.60
150	200	5.00	12.00	36.0	3.00	2.91
180	241	6.00	12.13	43.5	3.58	3.47
240	278	8.00	12.39	50.0	4.03	3.89
300	319	10.0	12.67	58.0	4.57	4.39
340	334	11.33	12.86	60.5	4.70	4.50
360	310	12.00	12.95	56.0	4.32	4.11

TABLE NO.(10)

KAOLIN

$22^{1/2^{o}}$ Sample

Chamber Pressuree 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	38	0.33	11.44	7.5	0.65	0.64
20	55	0.67	11.49	10.3	0.89	0.88
30	73	1.00	11.53	14.0	1.21	1.19
40	87	1.33	11.55	16.0	1.38	1.35
50	99	1.67	11.59	18.5	1.59	1.56
60	111.0	2.00	11.63	20.5	1.76	1.72
70	122.5	2.33	11.67	22.5	1.92	1.87
80	134.0	2.67	11.71	24.5	2.09	2.04
90	144.0	3.00	11.75	26.2	2.22	2.16
100	154.0	3.33	11.79	28.0	2.37	2.31
110	166.0	3.67	11.83	30.0	2.53	2.46
120	176.0	4.00	11.88	32.0	2.73	2.65
150	206.0	5.00	12.00	37.5	3.12	3.03
160	217.0	5.33	12.04	39.5	3.28	3.18
180	236.5	6.00	12.13	43.0	3.54	3.43
240	295.0	8.00	12.39	53.5	4.31	4.17
300	340	10.0	12.67	61.5	4.85	4.67
360	373.0	12.0	12.95	67.5	5.21	5.0
380	379.0	12.67	13.05	68.5	5.25	5.03
420	366.0	14.00	13.26	66.0	4.98	4.74

TABLE NO.(11)

KAOLIN

$22^{1/2°}$ Sample

Chamber Pressure 0.5 kg/cm

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Strain P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	10	0.33	11.44	2.0	0.17	0.16
20	22	0.67	11.49	4.0	0.34	0.33
30	44	1.00	11.53	8.0	0.68	0.66
40	62	1.33	11.55	11.5	0.99	0.96
50	80	1.67	11.54	15.0	1.29	1.26
60	93	2.00	11.63	17.2	1.47	1.43
70	107	2.33	11.67	20.0	1.71	1.66
80	118	2.67	11.71	21.8	1.86	1.81
90	129	3.00	11.75	23.5	2.00	1.94
100	141.0	3.33	11.79	26.0	2.20	1.94
110	152.0	3.67	11.83	27.5	2.32	2.25
120	165.0	4.00	11.88	30.0	2.52	2.44
130	176.0	4.33	11.92	32.0	2.68	2.60
140	186.0	4.67	11.95	34.0	2.84	2.75
150	198.0	5.00	12.00	36.0	3.00	2.91
180	227.0	6.00	12.13	41.0	3.39	3.28
240	276.0	8.00	12.39	50.2	4.05	3.91
260	283.0	8.67	12.48	51.2	4.10	3.94
300	260.0	10.0	12.67	47.0	3.70	3.52

TABLE NO.(12)

KAOLIN

$22^{1}/2^{o}$ Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.4	0	0	0
10	26	0.33	11.45	1.5	0.131	0.121
20	36	0.67	11.49	2.2	0.192	0.182
30	54	1.00	11.51	3.5	0.304	0.284
40	129	1.33	11.53	7.2	0.625	0.595
50	199	1.67	11.60	11.0	0.95	0.92
60	260	2.00	11.62	14.4	1.24	1.20
70	321	2.33	11.65	17.5	1.50	1.45
80	369	2.67	11.71	20.1	1.711	1.66
90	416	3.00	11.75	23.0	1.96	1.90
100	459	3.33	11.75	25.0	2.12	2.06
110	498	3.67	11.83	27.2	2.30	2.23
120	540	4.00	11.89	29.5	2.48	2.40
150	642	5.00	12.00	35.0	2.92	2.83
180	729	6.00	12.12	39.5	3.26	3.15
240	859	8.00	12.39	46.5	3.76	3.62
300	921	10.00	12.68	50.0	3.95	3.77
320	927	10.67	12.77	50.5	3.96	3.77
360	927	12.00	12.95	50.5	3.91	3.70
420	876	14.00	13.25	47.2	3.56	3.32

TABLE NO.(13)

KAOLIN

$22^1/2^o$ Sample

Chamber Pressure 1 Kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.4	0	0	0
10	33	0.33	11.45	2.0	0.175	0.17
20	53	0.67	11.49	3.0	0.261	0.25
30	138	1.00	11.51	8.0	0.695	0.68
40	215	1.33	11.53	12.0	1.04	1.01
50	290	1.67	11.60	16.0	1.39	1.36
60	355	2.00	11.62	19.5	1.68	1.64
70	408	2.33	11.65	22.35	1.92	1.87
80	461	2.67	11.71	25.0	2.14	2.09
90	508	3.00	11.75	28.0	2.38	2.32
100	551	3.33	11.79	30.0	2.55	2.49
110	593	3.67	11.83	32.2	2.72	2.65
120	625	4.00	11.89	34.0	2.87	2.80
150	688	5.00	12.00	38.7	3.23	3.14
180	795	6.00	12.12	43.0	3.55	3.44
240	917	8.00	12.39	49.75	4.02	3.88
280	965	9.33	12.55	32.5	4.18	4.01
300	940	10.0	12.68	51.0	4.025	3.85
320	943	10.67	12.77	51.0	4.00	3.81
340	950	11.33	12.85	51.5	4.01	3.81

TABLE NO.(14)

KAOLIN

$22^1/2^o$ Sample

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.4	0	0	0
10	135	0.33	11.45	7.0	0.611	0.60
20	235	0.67	11.49	13.0	1.13	1.12
30	330	1.00	11.51	18.0	1.56	1.54
40	402	1.33	11.53	22.0	1.91	1.88
50	454	1.67	11.60	25.0	2.16	2.13
60	500	2.00	11.62	27.5	2.37	2.33
70	544	2.33	11.65	29.8	2.564	2.51
80	582	2.67	11.71	31.5	2.69	2.64
90	615	3.00	11.75	33.5	2.85	2.80
100	641	3.33	11.79	35.0	2.97	2.91
110	672	3.67	11.83	36.5	3.09	3.02
120	700	4.00	11.89	38.0	3.20	3.12
130	725	4.33	11.92	39.5	3.31	3.23
140	755	4.67	11.95	41.0	3.43	3.34
150	782	5.00	12.00	42.5	3.54	3.45
180	841	6.00	12.13	45.1	3.72	3.61
210	897	7.00	12.25	48.7	3.97	3.84
240	922	8.00	12.39	50.0	4.04	3.90
270	820	9.00	12.52	44.5	3.86	3.70

TABLE NO.(15)

KAOLIN

45^o Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	121	0.33	11.45	6.75	0.59	0.58
20	203	0.67	11.49	11.2	0.98	0.97
30	271	1.00	11.51	14.9	1.29	1.27
40	326	1.33	11.53	18.0	1.18	1.15
50	376	1.67	11.60	20.5	1.77	1.74
60	416	2.00	11.65	23.0	1.98	1.94
70	459	2.33	11.71	25.0	2.13	2.08
80	491	2.67	11.75	26.75	2.28	2.23
90	524	3.00	11.79	28.50	2.42	2.36
100	563	3.33	11.83	30.60	2.56	2.50
110	591	3.67	11.89	32.00	2.69	2.62
120	622	4.00	11.92	33.70	2.82	2.74
130	651	4.33	11.95	35.50	2.97	2.89
140	679	4.67	12.00	37.0	3.08	2.99
150	706	5.00	12.05	38.5	3.19	3.10
180	791	6.00	12.15	43.0	3.54	3.43
220	855	7.33	12.39	46.5	3.75	3.62
240	843	8.00	12.50	45.5	3.64	3.50
260	821	8.67	12.55	44.6	3.56	3.40

TABLE NO.(16)

KAOLIN

45° Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	14	0.33	11.45	1.00	0.09	0.08
20	19	0.67	11.49	1.3	0.11	0.10
30	27	1.00	11.51	1.70	0.15	0.13
40	52	1.33	11.53	3.0	0.20	0.17
50	102	1.67	11.60	5.6	0.48	0.45
60	142	2.00	11.65	8.0	0.69	0.65
70	180	2.33	11.71	10.0	0.85	0.80
80	209	2.67	11.75	11.5	0.98	0.93
90	240	3.00	11.79	13.25	1.13	1.07
100	270	3.33	11.83	15.0	1.27	1.21
110	294	3.67	11.89	16.2	1.36	1.29
120	319	4.00	11.92	17.5	1.47	1.39
150	389	5.00	12.05	21.2	1.76	1.67
180	449	6.00	12.15	24.0	1.98	1.87
240	537	8.00	12.50	29.40	2.35	2.21
300	609	10.0	12.77	33.1	2.60	2.42
340	618	11.33	12.95	33.6	2.59	2.39
360	625	12.00	13.05	34.0	2.61	2.40
400	617	13.33	13.25	33.6	2.53	2.31

TABLE NO.(17)

KAOLIN

45° Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	10	0.33	11.44	2.0	0.17	0.16
20	16	0.67	11.49	3.0	0.26	0.25
30	20	1.00	11.53	4.0	0.34	0.32
40	40	1.33	11.55	7.5	0.64	0.61
50	60	1.67	11.59	9.5	0.81	0.78
60	78	2.00	11.63	11.5	0.98	0.94
70	93	2.33	11.67	17.2	1.47	1.42
80	106	2.67	11.71	19.5	1.66	1.61
90	118	3.00	11.75	21.5	1.82	1.76
100	130	3.33	11.79	24.0	2.03	1.97
110	140	3.67	11.83	25.5	2.15	2.08
120	151	4.00	11.88	27.5	2.31	2.23
130	162	4.33	11.92	29.5	2.47	2.39
140	174	4.67	11.95	31.5	2.63	2.54
150	186.5	5.00	12.00	34.0	2.83	2.74
160	197.0	5.33	12.04	36.0	2.99	2.89
180	218.0	6.00	12.13	39.5	3.25	3.14
260	283.5	8.67	12.48	51.0	4.04	3.88
320	300.0	10.67	12.76	36.2	2.83	2.62

TABLE NO.(18)

KAOLIN

45^o Sample

Cell Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	10.0	0.33	11.44	2.0	0.17	0.16
20	13.0	0.67	11.49	2.5	0.21	0.20
30	19.0	1.00	11.53	4.0	0.34	0.32
40	39.0	1.33	11.55	7.5	0.64	0.61
50	55.0	1.67	11.59	10.2	0.90	0.87
60	68.0	2.00	11.63	13.0	1.11	1.07
70	79.0	2.33	11.67	15.0	1.28	1.23
80	90.0	2.67	11.71	17.0	1.45	1.40
90	99.0	3.00	11.75	18.0	1.53	1.47
100	108.0	3.33	11.79	20.0	1.69	1.63
110	117.0	3.67	11.83	21.5	1.81	1.74
120	125.0	4.00	11.88	23.0	1.93	1.85
130	133.0	4.33	11.92	24.2	2.03	1.95
140	141.0	4.67	11.95	25.7	2.15	2.06
150	149.0	5.00	12.00	27.0	2.25	2.16
180	175.0	6.00	12.13	32.0	2.63	2.52
240	225.0	8.00	12.39	41.0	3.30	3.17
280	255.0	9.33	12.57	46.0	3.65	3.48
320	109	10.67	12.76	20.0	1.56	1.37

TABLE NO.(19)

KAOLIN

45° Sample

Chamber Pressure 0.5 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	30	0.33	11.44	9.5	0.82	0.81
20	49.0	0.67	11.44	9.5	0.82	0.81
30	65.0	1.00	11.53	12.2	1.05	1.03
40	78.0	1.33	11.55	14.5	1.25	1.22
50	91.5	1.67	11.59	17.0	1.46	1.43
60	104.0	2.00	11.63	19.0	1.63	1.59
70	115.0	2.33	11.67	21.0	1.79	1.74
80	125.0	2.67	11.71	23.0	1.96	1.91
90	135.5	3.00	11.75	24.5	2.08	2.02
100	147.0	3.33	11.79	27.0	2.29	2.23
110	158.0	3.67	11.83	29.0	2.45	2.38
120	168.5	4.00	11.88	30.5	2.56	2.48
130	180.0	4.33	11.92	33.0	2.76	2.68
140	190.5	4.67	11.95	34.5	2.88	2.79
150	201.0	5.00	12.00	36.5	3.04	2.95
160	211.0	5.33	12.04	38.0	3.15	3.05
180	230	6.00	12.13	42.0	3.46	3.35
200	246.0	6.67	12.22	45.0	3.68	3.56
240	101	8.00	12.39	19.0	1.53	1.39

TABLE NO.(20)

KAOLIN

$67^1/2^o$ Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	11.0	0.33	11.44	2.0	0.17	0.16
20	19.0	0.67	11.49	3.5	0.30	0.29
30	50.0	1.00	11.53	9.5	0.82	0.80
40	70.0	1.33	11.55	13.0	1.12	1.09
50	88.0	1.67	11.59	16.5	1.42	1.39
60	98.0	2.00	11.63	18.0	1.54	1.50
70	118.0	2.33	11.67	21.5	1.84	1.79
80	130.0	2.67	11.71	24.0	2.04	1.99
90	143.0	3.00	11.75	26.0	2.21	2.15
100	155.0	3.33	11.79	27.0	2.29	2.23
110	168.0	3.67	11.83	30.5	2.57	2.50
120	178.0	4.00	11.88	32.5	2.73	2.65
150	213.0	5.00	12.00	38.5	3.20	3.11
180	242.0	6.00	12.13	44.0	3.62	3.51
240	299.0	8.00	12.39	54.0	4.35	4.21
300	351.0	10.0	12.67	63.5	5.01	4.83
360	391.0	12.00	12.95	70.5	5.44	5.23
400	408.0	13.33	13.15	73.5	5.58	5.36
420	407.0	14.00	13.26	73.5	5.55	5.31
480	380.0	16.00	13.57	68.5	5.05	4.79

TABLE NO.(21)

KAOLIN

$67^1/2^o$ Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	10	0.33	11.44	2.0	0.17	0.16
20	37	0.67	11.49	7.0	0.60	0.59
30	55	1.00	11.53	10.2	0.91	0.89
40	69	1.33	11.55	13.0	1.12	1.09
50	84	1.67	11.59	15.5	1.33	1.30
60	101	2.00	11.63	18.5	1.59	1.55
70	116	2.33	11.67	21.2	1.81	1.76
80	128	2.67	11.71	23.5	2.00	1.95
90	140	3.00	11.75	25.5	2.17	2.11
100	152	3.33	11.79	27.5	2.33	2.27
110	165	3.67	11.83	30.0	2.53	2.46
120	175	4.00	11.88	32.0	2.73	2.65
130	185	4.33	11.92	33.5	2.81	2.73
140	195.0	4.67	11.95	35.5	2.97	2.88
150	203.0	5.00	12.00	37.0	3.08	2.99
180	227.0	6.00	12.13	41.0	3.38	3.27
240	267.0	8.00	12.39	48.2	3.89	3.75
300	292.0	10.00	12.67	53.0	4.18	4.00
340	284.0	11.33	12.86	51.5	4.00	3.80

TABLE NO.(22)

KAOLIN

$67^{1}/2^{o}$ Sample

Chamber Pressure 0.5 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Strain P/A	Corrected P/A
0	0.0	0	11.40	6	0	0
10	22.0	0.33	11.44	40	0.34	0.33
20	42.0	0.67	11.49	8.0	0.69	0.68
30	59.0	1.00	11.53	11.0	0.95	0.93
40	75.0	1.33	11.55	14.0	1.21	1.18
50	89.0	1.67	11.59	16.5	1.42	1.39
60	102.0	2.00	11.63	19.0	1.63	1.59
70	117.0	2.33	11.67	21.5	1.84	1.79
80	128.0	2.67	11.71	23.5	2.00	1.95
90	141.0	3.00	11.75	26.0	2.21	2.15
100	152.0	3.33	11.79	27.5	2.33	2.27
110	165.0	3.67	11.83	30.0	2.53	2.46
120	175.0	4.00	11.88	32.0	2.69	2.61
130	186.0	4.33	11.92	34.0	2.85	2.77
140	195.0	4.67	11.95	35.5	2.97	2.88
150	204.0	5.00	12.00	37.0	3.08	2.99
180	230.0	6.00	12.13	41.5	3.42	3.31
240	270.0	8.00	12.39	49.0	3.95	3.79
300	283.0	10.0	12.67	41.0	3.23	3.04
340	277.0	11.33	12.86	40.0	3.11	2.90

TABLE NO.(23)

KAOLIN

$6^1/2^o$ Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Strain P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	18	0.33	11.45	1.2	0.11	0.10
20	28	0.67	11.49	1.7	0.16	0.15
30	58	1.00	11.51	3.5	0.32	0.30
40	121	1.33	11.53	6.7	0.58	0.55
50	176	1.67	11.60	10.0	0.86	0.83
60	213	2.00	11.65	11.8	1.01	0.97
70	260	2.33	11.71	14.25	1.22	1.17
80	298	2.67	11.75	16.4	1.40	1.35
90	336	3.00	11.79	18.5	1.57	1.51
100	371	3.33	11.83	20.2	1.69	1.63
110	403	3.67	11.89	22.0	1.85	1.78
120	438	4.00	11.92	24.0	2.21	2.13
150	548	5.00	12.05	30.0	2.49	2.40
180	650	6.00	12.15	35.30	2.90	2.79
240	800	8.00	12.50	43.40	3.47	3.33
300	915	10.0	12.77	49.7	3.89	3.71
360	988	12.0	13.05	53.7	4.12	3.91
400	1021	13.37	13.25	55.25	4.17	3.95
420	998	14.00	13.37	54.3	4.06	3.82

TABLE NO.(24)

KAOLIN

$67^{1}/2^{o}$ Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0.0	11.40	0	0	0
10	20	0.32	11.44	1.25	0.11	0.10
20	26	0.67	11.49	1.65	1.4	0.13
30	34	1.00	11.53	2.0	0.17	0.15
40	40	1.33	11.55	2.5	0.22	0.19
50	50	1.67	11.59	3.0	0.26	0.23
70	77	2.33	11.67	4.0	0.33	0.29
80	173	2.67	11.71	9.5	0.81	0.76
90	243	3.00	11.75	13.5	1.15	1.10
100	306	3.33	11.79	17.0	1.44	1.38
110	365	3.67	11.83	20.0	1.68	1.61
120	420	4.00	11.88	23.0	1.93	1.85
130	465	4.33	11.92	25.5	2.14	2.06
140	515	4.67	11.95	28.2	2.35	2.26
150	555	5.00	12.00	30.2	2.51	2.42
180	680	6.00	12.13	37.0	3.04	2.93
240	877	8.00	12.39	47.5	3.80	3.66
300	1015	10.00	12.67	55.0	4.31	4.13
340	1060	11.33	12.86	57.5	4.44	4.24
380	1032	12.67	13.05	56.0	4.26	4.04

TABLE NO.(25)

KAOLIN

Hôrizontal

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	17	0.33	11.45	1.0	0.874	0.08
20	27	0.67	11.49	1.75	0.1525	0.14
30	84	1.00	11.51	5.0	0.331	0.32
40	180	1.33	11.53	10.0	0.874	0.84
50	248	1.67	11.60	13.5	1.162	1.13
60	308	2.00	11.62	17.0	1.46	1.42
70	364	2.33	11.65	20.0	1.718	1.67
80	417	2.67	11.71	23.0	1.965	1.96
90	466	3.00	11.75	25.5	2.17	2.11
100	511	3.33	11.79	27.8	2.36	2.30
110	549	3.67	11.83	30.0	2.535	2.44
120	588	4.00	11.89	32.0	2.69	2.61
150	688	5.00	12.00	37.50	3.13	3.04
180	759	6.00	12.12	41.25	3.40	3.29
240	884	8.00	12.39	48.0	3.89	3.75
300	979	10.0	12.68	53.0	4.18	4.00
360	1055	12.0	12.95	57.5	4.44	4.23
380	1078	12.67	13.05	58.5	4.49	4.27
420	870	14.00	13.25	47.2	3.56	3.32

TABLE NO.(26)

KAOLIN

Horizontal

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.4	0	0	0
10	14	0.33	11.45	1.00	0.09	0.08
20	22	0.67	11.45	1.50	0.13	0.12
30	33	1.00	11.51	2.00	0.17	0.15
40	99	1.33	11.53	5.00	0.33	0.30
50	178	1.67	11.60	10.00	0.86	0.83
60	258	2.00	11.62	14.3	1.23	1.19
70	322	2.33	11.65	17.6	1.51	1.48
80	378	2.67	11.71	20.7	1.77	1.72
90	425	3.00	11.75	23.2	1.97	1.92
100	473	3.33	11.79	26.0	2.21	2.15
110	520	3.67	11.83	28.4	2.40	2.33
120	558	4.00	11.89	30.5	2.57	2.49
130	600	4.33	11.92	32.7	2.74	2.66
150	676	5.00	12.00	37.0	3.08	2.99
180	773	6.00	12.12	42.0	3.46	3.35
240	918	8.00	12.39	50.0	4.03	3.89
300	1026	10.00	12.68	55.75	4.40	4.22
340	1071	11.33	12.85	58.1	4.52	4.32
350	1071	11.67	12.90	58.1	4.51	4.31

TABLE NO.(27)

KAOLIN

Horizontal Sample

Chamber Pressure 0.5 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	23	0.33	11.45	1.5	0.10	0.09
20	47	0.67	11.49	2.8	0.24	0.23
30	132	1.00	11.51	7.3	0.63	0.61
40	207	1.33	11.53	11.5	1.00	0.97
50	264	1.67	11.60	14.0	1.21	1.18
60	332	2.00	11.62	18.0	1.55	1.51
70	374	2.33	11.65	20.5	1.76	1.72
80	425	2.67	11.71	23.3	1.99	1.94
90	475	3.00	11.75	26.0	2.21	2.15
100	530	3.33	11.79	29.0	2.46	2.40
110	579	3.67	11.83	31.5	2.66	2.59
120	622	4.00	11.89	33.75	2.84	2.76
130	660	4.33	11.92	36.00	3.02	2.94
150	731	5.00	12.00	40.00	3.34	3.25
180	822	6.00	12.12	44.5	3.67	3.56
240	962	8.00	12.39	52.1	4.22	4.08
300	1052	10.0	12.68	57.0	4.50	4.32
360	1120	12.00	12.95	60.75	4.68	4.47
380	1065	12.67	13.05	58.0	4.44	4.22

TABLE NO.(28)

KAOLIN

Horizontal Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	08	0.33	11.44	1.5	0.13	-
20	08	0.67	11.49	1.5	0.13	-
30	08	1.00	11.53	1.5	0.13	0.11
40	13.0	1.33	11.55	2.5	0.21	0.18
50	30.0	1.67	11.59	5.5	0.47	0.44
60	52.0	2.00	11.63	10.0	0.85	0.81
70	70.0	2.33	11.67	13.0	1.11	1.06
80	84.0	2.67	11.71	15.5	1.32	1.27
90	98.0	3.00	11.75	18.0	1.53	1.47
100	109.0	3.33	11.79	20.0	1.69	1.63
110	120.0	3.67	11.83	22.0	1.85	1.78
120	130.5	4.00	11.88	24.0	2.02	1.94
150	160.0	5.00	12.00	29.0	2.41	2.32
180	186.0	6.00	12.13	34.0	2.80	2.69
240	231.5	8.00	12.39	42.0	3.38	3.24
300	282.0	10.00	12.67	51.0	4.02	3.84
360	312.5	12.00	12.95	56.5	4.37	4.16
420	330.0	14.00	13.26	60.0	4.52	4.28
480	325.5	16.00	13.57	59.0	4.35	4.19

TABLE NO.(29)

KAOLIN

Horizontal Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	10.0	0.33	11.44	2.0	0.17	0.16
20	45.0	0.67	11.49	8.5	0.73	0.72
30	62.2	1.00	11.53	11.5	0.99	0.97
40	80.0	1.33	11.55	15.0	1.29	1.26
50	94.0	1.67	11.59	17.5	1.50	1.47
60	109.0	2.00	11.62	20.0	1.71	1.68
70	122.0	2.33	11.67	22.5	1.92	1.87
80	134.0	2.67	11.71	24.5	2.09	2.04
90	147.0	3.00	11.75	27.0	2.29	2.23
100	158.0	3.33	11.79	28.5	2.41	2.35
110	170.0	3.67	11.83	31.0	2.62	2.55
120	181.0	4.00	11.88	33.0	2.77	2.69
130	193.0	4.33	11.92	35.0	2.93	2.85
140	202.0	4.67	11.95	36.5	3.05	2.96
150	212.0	5.00	12.00	38.5	3.20	3.11
180	240.0	6.00	12.13	43.5	3.58	3.47
240	290.0	8.00	12.34	52.5	4.23	4.09
280	312.0	9.33	12.57	56.5	4.49	4.32
320	308.0	10.67	12.76	55.5	4.34	4.15

TABLE NO.30

KAOLIN

Horizontal Sample

Chamber Pressure 0.5 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0.0	11.40	0	0	0
10	06	0.33	11.44	1.5	0.13	0.12
20	20	0.67	11.49	4.0	0.34	0.33
30	36.5	1.00	11.53	7.0	0.60	0.58
40	51.0	1.33	11.55	9.5	0.82	0.79
50	67.0	1.67	11.59	12.5	1.07	1.04
60	79.0	2.00	11.63	15.0	1.28	1.24
70	92.0	2.33	11.67	17.0	1.45	1.40
80	103.0	2.67	11.71	19.0	1.62	1.57
90	115.0	3.00	11.75	21.0	1.78	1.72
100	126.0	3.33	11.79	23.0	1.95	1.89
110	136.5	3.67	11.83	25.0	2.11	2.04
120	146.0	4.00	11.88	26.5	2.23	2.15
130	155.0	4.33	11.92	28.0	2.34	2.26
140	164.0	4.67	11.95	30.0	2.51	2.42
150	172.0	5.00	12.00	32.0	2.66	2.57
160	181.0	5.33	12.04	33.0	2.74	2.64
180	197.0	6.00	12.13	35.8	2.95	2.84
240	235.5	8.00	12.39	42.5	3.43	3.29
300	244.0	10.00	12.67	44.0	3.47	3.39

TABLE NO.(31)

BENTONITE

Vertical Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	7	0.33	11.44	1.5	0.13	0.12
20	10	0.67	11.49	2.0	0.17	0.16
30	15	1.00	11.53	3.0	0.26	0.24
40	27	1.33	11.55	5.0	0.43	0.40
50	57	1.67	11.59	10.5	0.90	0.87
60	83	2.00	11.63	15.5	1.33	1.29
70	101	2.33	11.67	18.5	1.58	1.53
80	119	2.67	11.71	22.0	1.87	1.82
90	133	3.00	11.75	24.3	2.06	2.00
100	146	3.33	11.79	26.5	2.24	2.18
120	167	4.00	11.88	30.2	2.54	2.46
150	192.5	5.00	12.00	35.0	2.91	2.82
180	214.0	6.00	12.13	39.0	3.21	3.10
240	246.0	8.00	12.39	44.5	3.59	3.45
300	274.0	10.0	12.67	50.0	3.94	3.76
360	294.0	12.0	12.95	53.0	4.09	3.88
420	303.0	14.0	13.26	55.0	4.14	3.90
480	309	16.00	13.57	56.0	4.14	3.88
560	305.0	18.67	14.02	55.2	3.93	3.63

TABLE NO.(32)

BENTONITE

Vertical Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	12	0.33	11.44	2.5	0.21	0.20
20	32	0.67	11.49	6.0	0.52	0.51
30	93	1.00	11.53	17.2	1.49	1.47
40	104	1.33	11.55	19.0	1.64	1.61
50	116	1.67	11.59	21.5	1.85	1.82
60	134	2.00	11.63	25.0	2.10	2.06
70	150	2.33	11.67	27.2	2.33	2.28
80	164	2.67	11.71	30.0	2.56	2.51
90	177	3.00	11.75	32.0	2.72	2.66
100	189	3.33	11.79	34.2	2.90	2.84
110	198	3.07	11.83	36.0	3.04	2.97
120	208	4.00	11.88	37.8	3.18	3.10
130	215	4.33	11.92	39.0	3.27	3.19
150	228	5.00	12.00	41.5	3.45	3.36
180	245	6.00	12.13	44.5	3.66	3.55
240	272.0	8.00	12.39	49.0	3.95	3.81
300	292.0	10.0	12.67	53.0	4.18	4.00
320	296.5	10.67	12.76	53.6	4.21	4.02
360	243.0	12.00	12.95	44.0	3.40	3.19

TABLE NO.(33)

BENTONITE

Vertical Sample

Chamber Pressure 0.5 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	10	0.33	11.44	2.0	0.17	0.16
20	30	0.67	11.49	5.5	0.47	0.46
30	58	1.00	11.53	11.0	0.95	0.93
40	86	1.33	11.55	16.0	1.38	1.35
50	107	1.67	11.59	20.0	1.72	1.69
60	126	2.00	11.63	23.0	1.97	1.93
70	141.5	2.33	11.67	25.5	2.18	2.13
80	155.0	2.67	11.71	28.0	2.39	2.34
90	168.5	3.00	11.75	30.5	2.59	2.53
100	181.5	3.33	11.79	33.0	2.79	2.73
110	190.0	3.07	11.83	34.5	2.91	2.84
120	199.0	4.00	11.88	36.0	3.03	2.95
130	209.0	4.33	11.92	38.0	3.18	3.10
150	217.0	5.00	12.00	39.2	3.26	3.17
180	231.0	6.00	12.13	42.0	3.46	3.35
240	250.5	8.00	12.39	45.0	3.63	3.49
300	266.0	10.00	12.67	48.0	3.78	3.60
340	270.0	11.33	12.81	49.0	3.81	3.61
380	260.0	12.67	13.05	47.0	3.60	3.38

TABLE NO.(34)

BENTONITE

Vertical Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area	Load	Stress	Corrected
0	0	0	11.40	0	0	0
10	7.0	0.33	11.44	1.5	0.13	0.12
20	11.0	0.67	11.49	2.2	0.19	0.18
50	23.0	1.67	11.59	4.5	0.38	0.35
60	40.0	2.00	11.63	7.5	0.64	0.60
70	74.0	2.33	11.67	14.0	1.19	1.14
80	103.0	2.67	11.71	19.0	1.62	1.57
90	125.0	3.00	11.75	23.0	1.95	1.89
100	147.0	3.33	11.79	27.0	2.29	2.23
110	163.5	3.67	11.83	29.5	2.49	2.42
120	178.0	4.40	11.88	32.5	2.73	2.65
130	192.0	4.33	11.92	35.0	2.93	2.83
150	216.0	5.00	12.00	39.0	3.25	3.16
180	246.0	6.00	12.13	45.5	3.75	3.64
240	291.5	8.00	12.39	52.5	4.23	4.09
300	320.0	10.0	12.67	58.0	4.57	4.39
360	337.0	12.00	12.95	61.0	4.71	4.50
400	347.0	13.33	13.15	62.8	4.77	4.54
420	348.0	14.00	13.26	63.0	4.75	4.51
460	300.0	15.33	13.46	54.0	4.01	3.75

TABLE NO.(35)

BENTONITE

Vertical Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area	Load	Stress	Corrected
0	0	0	11.40	0	0	0
10	10	0.33	11.44	2	0.17	0.16
20	16.5	0.67	11.49	3.0	0.26	0.25
30	25.0	1.00	11.53	5.5	0.47	0.45
40	58.0	1.33	11.55	11.0	0.95	0.92
50	90.0	1.67	11.59	16.5	1.42	1.39
60	113.0	2.00	11.63	21.0	1.80	1.76
70	136.0	2.33	11.67	25.0	2.14	2.09
80	165.0	2.67	11.71	28.2	2.40	2.35
90	173.0	3.00	11.75	31.5	2.68	2.62
100	187.0	3.33	11.79	34.0	2.88	2.82
110	199.0	3.67	11.83	36.0	3.04	2.97
120	211.0	4.00	11.88	38.2	3.21	3.13
130	220.5	4.33	11.92	40.0	3.35	3.27
140	231.0	4.67	11.95	42.0	3.51	3.42
150	240.0	5.00	12.00	43.50	3.62	3.51
180	266.5	6.00	12.13	48.5	3.99	3.88
240	302.0	8.00	12.39	54.5	4.39	4.25
300	320.0	10.00	12.67	58.0	4.57	4.39
320	324.0	10.67	12.76	58.5	4.58	4.39
360	329.0	12.00	12.95	59.5	4.59	4.38
420	247.0	14.00	13.26	45.0	3.39	3.15

TABLE NO.(36)

BENTONITE

Vertical Sample

Cell Pressure 0.5 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	7.5	0.33	11.44	1.5	0.13	0.12
20	34	0.67	11.49	6.5	0.56	0.55
30	69	1.00	11.53	13.0	1.12	1.10
40	97	1.33	11.55	18.0	1.55	1.52
50	121	1.67	11.59	22.1	1.90	1.87
60	142.0	2.00	11.63	26.0	2.23	2.19
70	160.0	2.33	11.67	29.0	2.48	2.43
80	176.0	2.67	11.71	32.0	2.73	2.68
90	188.0	3.00	11.75	34.0	2.89	2.83
100	200.0	3.33	11.79	36.5	3.09	3.03
110	210.0	3.67	11.83	38.0	3.21	3.14
120	220.0	4.00	11.88	40.0	3.36	3.28
130	229.0	4.33	11.92	41.5	3.48	3.40
140	236.5	4.67	11.95	43.0	3.59	3.50
150	243.5	5.00	12.00	44.0	3.66	3.58
180	262.0	6.00	12.13	47.5	3.91	3.80
240	289.0	8.00	12.39	52.5	4.23	4.09
300	303.0	10.0	12.67	55.0	4.34	4.16
360	285.0	12.0	12.95	51.5	3.94	3.73

TABLE NO.(37)

BENTONITE

$22^1/2^o$ Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	8	0.33	11.44	1.8	0.15	0.14
20	12	0.67	11.49	2.5	0.21	0.20
30	25	1.00	11.53	4.8	0.41	0.39
40	57	1.33	11.55	10.5	0.90	0.87
50	81	1.67	11.59	15.0	1.29	1.26
60	100	2.00	11.63	18.5	1.59	1.55
70	116	2.33	11.67	21.3	1.83	1.78
80	130	2.67	11.71	23.8	2.03	1.98
90	143	3.00	11.75	26.0	2.21	2.15
100	157	3.33	11.79	28.5	2.41	2.35
110	166	3.67	11.83	30.0	2.53	2.46
120	175	4.00	11.88	31.8	2.67	2.59
150	197	5.00	12.00	35.5	2.95	2.86
180	213	6.00	12.13	38.5	3.17	3.06
240	233	8.00	12.39	42.3	3.41	3.27
300	246	10.0	12.67	44.5	3.51	3.33
320	248	10.67	12.76	45.0	3.52	3.33
360	247.0	12.00	12.95	44.80	3.45	3.24
400	238.0	13.33	13.15	43.0	3.26	3.03

TABLE NO.(38)

BENTONITE

$22^1/2^o$ Sample

Cell Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	11	0.33	11.44	2.2	0.19	0.18
20	37	0.67	11.49	7.0	0.60	0.59
30	61	1.00	11.53	11.5	0.99	0.97
40	80	1.33	11.55	15.0	1.29	1.26
50	100	1.67	11.59	18.5	1.59	1.56
60	113	2.00	11.63	21.9	1.88	1.84
70	126	2.33	11.67	23.0	1.97	1.92
80	138	2.67	11.71	25.0	2.13	2.08
90	147	3.00	11.75	26.8	2.28	2.22
100	157	3.33	11.79	28.8	2.41	2.35
110	164	3.67	11.83	29.9	2.52	2.45
120	172	4.00	11.88	31.2	2.62	2.54
130	179	4.33	11.92	32.5	2.72	2.64
140	184.5	4.67	11.95	33.4	2.79	2.70
150	191.0	5.00	12.00	34.5	2.87	2.78
180	205.0	6.00	12.13	36.5	3.0	2.89
240	228.0	8.00	12.39	41.2	3.32	3.18
340	249	11.33	12.86	45.5	3.53	3.33
400	334.0	13.33	13.15	42.5	3.23	3.00

TABLE NO.(39)

BENTONITE

$22^{1}/2^{o}$ Sample

Chamber Pressure 0.5 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	21	0.33	11.44	4.0	0.34	0.33
20	48	0.67	11.49	9.0	0.78	0.77
30	71	1.00	11.53	13.0	1.12	1.09
40	94	1.33	11.55	17.5	1.51	1.48
50	112	1.67	11.59	20.5	1.76	1.73
60	128	2.00	11.63	23.5	2.02	1.98
70	140	2.33	11.67	25.5	2.19	2.14
80	153	2.67	11.71	27.8	2.37	2.32
90	163	3.00	11.75	29.8	2.53	2.47
100	173	3.33	11.79	31.5	2.67	2.61
110	181	3.67	11.83	32.5	2.74	2.67
120	187	4.00	11.88	34.0	2.86	2.78
130	192	4.33	11.92	35.0	2.93	2.85
150	203.5	5.00	12.00	37.0	3.08	2.99
180	217.0	6.00	12.13	39.5	3.25	3.14
20	223.0	6.67	12.22	40.5	3.31	3.19
240	234.0	8.00	12.39	42.5	3.43	3.29
300	246.0	10.00	12.67	44.5	3.51	3.33
360	235.0	12.00	12.95	42.5	3.28	3.07

TABLE NO.(40)

BENTONITE

$22^1/2^o$ Sample

Chamber Pressure 2.0 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	13.5	0.33	11.44	2.5	0.21	0.20
20	19.0	0.67	11.43	4.0	0.34	0.33
30	52	1.00	11.53	10.0	0.86	0.84
40	85	1.33	11.55	16.0	1.38	1.35
50	110	1.67	11.59	20.1	1.73	1.70
60	130.5	2.00	11.63	24.0	2.06	2.02
70	150.0	2.33	11.67	27.2	2.33	2.28
80	165.0	2.67	11.71	30.0	2.56	2.51
90	179.0	3.00	11.75	32.5	2.76	2.70
100	190.0	3.33	11.79	34.5	2.92	2.86
110	201.0	3.67	11.83	36.5	3.08	3.01
120	209.0	4.00	11.88	38.0	3.19	3.11
130	219.0	4.33	11.92	39.5	3.31	3.23
140	225.0	4.67	11.95	40.8	3.41	3.32
150	233.0	5.00	12.00	42.0	3.50	3.41
180	247.0	6.00	12.13	45.0	3.70	3.59
240	263.0	8.00	12.39	47.5	3.83	3.69
300	263.0	10.0	12.67	47.5	3.74	3.52
340	238.0	11.33	12.86	43.0	3.34	3.14

TABLE NO.(41)

BENTONITE

$22^{1}/2^{o}$ Sample

Chamber Pressure 2 kg/cm^2

Strain dial gauge	Proving Ring dial	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	17	0.33	11.44	3.5	0.30	0.29
20	20	0.67	11.43	4.0	0.34	0.33
30	45	1.00	11.53	8.5	0.73	0.71
40	66.0	1.33	11.55	12.2	1.05	1.02
50	84.0	1.67	11.60	15.5	1.33	1.30
60	100	2.00	11.63	18.5	1.52	1.55
70	113	2.33	11.67	21.0	1.79	1.74
80	126	2.67	11.71	23.0	1.96	1.91
90	136	3.00	11.75	25.0	2.12	2.06
100	147	3.33	11.79	27.0	2.29	2.23
110	157	3.67	11.83	28.5	2.40	2.33
120	166	4.00	11.88	30.0	2.52	2.44
130	175	4.33	11.92	32.0	2.68	2.60
150	188	5.00	12.00	34.0	2.83	2.72
180	205	6.00	12.13	37.0	3.05	2.94
240	228.5	8.00	12.34	41.5	3.43	3.29
300	242.5	10.0	12.67	44.0	3.48	3.30
320	245	10.67	12.76	44.5	3.50	3.30
360	240.5	12.00	12.95	43.5	3.35	3.14

TABLE NO.(42)

BENTONITE

$22^1/2^o$ Sample

Chamber Pressure 1 kg/cm^2

Strain dial gauge	Proving Ring dial	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	12	0.33	11.44	2.5	0.21	0.21
20	19	0.67	11.48	3.5	0.30	0.29
30	56	1.00	11.53	10.5	0.91	0.89
40	90	1.33	11.55	17.0	1.47	1.44
50	112	1.67	11.59	20.5	1.76	1.73
60	132	2.00	11.63	24.0	2.06	2.02
70	149	2.33	11.67	27.0	2.31	2.26
80	162	2.67	11.71	29.5	2.51	2.46
90	174.5	3.00	11.75	31.5	2.68	2.62
100	182	3.33	11.79	33.0	2.79	2.73
110	190	3.67	11.83	34.5	2.91	2.84
120	195.5	4.00	11.88	35.5	2.98	2.90
130	202.0	4.33	11.92	36.5	3.06	2.98
140	206.0	4.67	11.95	37.2	3.11	3.02
150	209.5	5.00	12.00	38.0	3.16	3.07
180	218.0	6.00	12.13	39.5	3.25	3.14
220	224.5	7.33	12.31	40.7	3.30	3.17
240	226.0	8.00	12.39	41.0	3.30	3.16
300	199.0	10.00	12.67	36.0	2.84	2.68

TABLE NO.(43)

BENTONITE

$22^1/2^o$ Sample

Chamber Pressure 0.5 kg/cm^2

Strain dial gauge	Proving Ring dial	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	14	0.33	11.44	2.5	0.21	0.21
20	50	0.67	11.43	9.5	0.82	0.81
30	85	1.00	11.53	16.0	1.38	1.36
40	114	1.33	11.55	21.0	1.81	1.78
50	137	1.67	11.59	25.0	2.15	2.12
60	155	2.00	11.63	28.0	2.40	2.36
70	171	2.33	11.67	31.0	2.65	2.60
80	183	2.67	11.71	33.0	2.81	2.76
90	193	3.00	11.75	35.0	2.97	2.92
100	202	3.33	11.79	35.5	3.09	3.03
110	209	3.67	11.83	38.0	3.21	3.14
120	216	4.00	11.88	39.0	3.28	3.20
130	221.5	4.33	11.92	40.0	3.35	3.27
140	227.5	4.67	11.95	41.0	3.43	3.34
150	232.0	5.00	12.00	42.0	3.50	3.41
180	243.0	6.00	12.13	44.0	2.26	3.15
220	251.5	7.33	12.31	45.5	3.69	3.56
240	252.0	8.00	12.39	45.5	3.67	3.53
260	249.0	8.67	12.48	45.0	3.60	3.44
300	237.5	10.00	12.67	43.0	3.39	3.21

TABLE NO.(44)

BENTONITE

45° Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	14.0	0.33	11.44	2.5	0.21	0.20
20	24.0	0.67	11.49	4.5	0.39	0.38
30	60.0	1.00	11.53	10.2	0.88	0.82
40	91.0	1.33	11.55	17.0	1.47	1.44
50	118	1.67	11.59	21.5	1.85	1.82
60	139	2.00	11.63	25.5	2.19	2.15
70	158	2.33	11.67	28.8	2.41	2.36
80	172	2.67	11.71	31.2	2.66	2.61
90	185	3.00	11.75	33.5	2.85	2.79
100	195	3.33	11.79	35.5	3.01	2.95
110	203	3.67	11.83	37.0	3.12	3.05
120	212	4.00	11.88	38.3	3.22	3.14
130	218	4.33	11.92	39.5	3.31	3.23
150	231.5	5.00	12.00	42.0	3.50	3.41
180	247.0	6.00	12.13	45.0	3.70	3.59
240	272.0	8.00	12.39	49.0	3.95	3.81
300	287.0	10.0	12.67	52.0	4.10	3.92
320	290.0	10.67	12.86	52.5	4.11	3.92
360	272.0	16.00	12.95	49.0	3.78	3.57

TABLE NO.(45)

BENTONITE

45^o Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	8.5	0.33	11.44	1.8	0.15	0.14
20	15.0	0.67	11.49	3.0	0.26	0.25
30	30.0	1.00	11.53	5.5	0.47	0.45
40	60.0	1.33	11.55	11.5	0.99	0.96
50	87.0	1.67	11.59	16.0	1.38	1.35
60	109.0	2.00	11.63	20.0	1.71	1.69
70	127.0	2.33	11.67	23.2	1.98	1.93
80	145.0	2.67	11.71	26.5	2.26	2.21
90	158.5	3.00	11.75	28.8	2.40	2.34
100	172.0	3.33	11.79	31.2	2.64	2.58
110	188.0	3.67	11.83	33.0	2.78	2.71
120	191.0	4.00	11.88	34.8	2.92	2.84
130	200.0	4.33	11.92	36.5	3.06	2.98
140	208.0	4.67	11.95	37.8	3.16	3.07
150	215.0	5.00	12.00	39.0	3.25	3.16
180	233.0	6.00	12.13	42.0	3.46	3.35
240	261.0	8.00	12.39	47.5	3.83	3.69
300	273.0	10.0	17.67	50.0	3.94	3.76
360	267.0	12.00	12.95	48.5	3.74	3.53

TABLE NO.(46)

BENTONITE

45^o Sample

Cell Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	50	0.33	11.44	9.5	0.63	0.62
20	80	0.67	11.49	15.0	1.30	1.29
30	103	1.00	11.53	19.0	1.64	1.62
40	119	1.33	11.55	22.0	1.90	1.87
50	133	1.67	11.59	24.5	2.11	2.08
60	145	2.00	11.63	26.5	2.27	2.23
70	157	2.33	11.67	28.5	2.44	2.39
80	167	2.67	11.71	30.5	2.60	2.55
90	176	3.00	11.75	32.0	2.72	2.66
100	186	3.33	11.79	34.0	2.88	2.82
110	194.5	3.67	11.83	35.0	2.95	2.88
120	204.0	4.00	11.88	37.0	3.11	3.03
130	210	4.33	11.92	38.0	3.18	3.10
140	216	4.67	11.95	39.0	3.26	3.17
150	221	5.00	12.00	40.0	3.33	3.24
180	237.0	6.00	17.13	43.0	3.54	3.43
240	263.0	8.00	12.39	47.5	3.83	3.69
300	282.0	10.0	12.67	52.0	4.10	3.92
360	281	12.00	12.95	51.0	3.93	3.72

TABLE NO.(47)

BENTONITE

45^o Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	31	0.33	11.44	6.0	0.52	0.41
20	61	0.67	11.49	11.5	1.00	0.99
30	85	1.00	11.53	16.0	1.38	1.36
40	107	1.33	11.55	20.0	1.73	1.70
50	124	1.67	11.59	23.0	1.98	1.95
60	139	2.00	11.63	25.5	2.19	2.14
70	152	2.39	11.67	27.5	2.35	2.30
80	164	2.67	11.71	30.0	2.56	2.51
90	173	3.00	11.75	31.5	2.68	2.62
100	182	3.33	11.79	33.0	2.79	2.73
110	189	3.67	11.83	34.5	2.51	2.44
120	196	4.00	11.88	35.5	2.98	2.90
150	212	5.00	12.00	38.5	3.20	3.11
180	226	6.00	12.13	41.0	3.38	3.27
240	248	8.00	12.39	45.0	3.63	3.49
300	265	10.0	12.67	48.0	3.78	3.60
340	273	11.33	12.86	50.0	3.88	3.68
360	271	12.00	12.95	49.0	3.78	3.57
380	252	12.67	13.05	45.5	3.48	3.26

TABLE NO.(48)

BENDONITE

45^{o} Sample

Cell Pressure 0.5 Kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	24	0.33	11.44	4.5	0.39	0.38
20	46	0.67	11.49	8.5	0.73	0.72
30	64	1.00	11.53	10.2	0.88	0.86
40	82	1.33	11.55	15.5	1.34	1.31
50	95	1.67	11.59	17.5	1.50	1.47
60	108	2.00	11.63	20.0	1.71	1.67
70	118	2.39	11.67	21.5	1.84	1.79
80	127	2.67	11.71	23.5	2.00	1.95
90	137	3.00	11.75	25.0	2.12	2.06
100	145	3.33	11.79	26.5	2.24	2.18
110	152	3.67	11.83	27.8	2.34	2.27
120	158	4.00	11.88	28.8	2.42	2.34
150	174	5.00	12.00	31.8	2.65	2.56
180	188.0	6.00	12.13	34.0	2.80	2.69
240	207.5	8.00	12.39	37.5	3.02	2.88
300	221.0	10.0	12.67	40.0	3.15	2.97
320	224.0	10.67	12.76	41.5	3.25	3.06
360	223.0	12.00	12.95	40.4	3.11	2.90
400	210.0	13.33	13.15	38.0	2.88	2.65

TABLE NO.(49)

BENTONITE

45° Sample

Chamber Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	28	0.33	11.44	5.5	0.48	0.47
20	66	0.67	11.49	12.2	1.06	1.05
30	96	1.00	11.53	18.0	1.56	1.54
40	121	1.33	11.55	22.2	1.92	1.89
50	142.5	1.67	11.59	26.0	2.24	2.21
60	161.0	2.00	11.63	29.5	2.53	2.49
70	176.0	2.33	11.67	32.0	2.74	2.69
80	190.0	2.67	11.71	34.5	2.94	2.89
90	199.0	3.00	11.75	36.0	3.06	3.00
100	209.0	3.33	11.79	38.0	3.22	3.16
110	216.5	3.67	11.83	39.5	3.33	3.26
120	225.0	4.00	11.88	40.5	3.40	3.32
130	231.0	4.33	11.92	42.0	3.52	3.44
140	237.0	4.67	11.95	43.0	3.59	3.50
150	242.5	5.00	12.00	44.0	3.66	3.57
180	258.0	6.00	12.13	46.5	3.83	3.72
220	270.5	7.33	12.31	49.0	3.97	3.84
240	271.0	8.00	12.39	49.0	3.95	3.81
280	258.0	9.33	12.57	46.5	3.69	3.52

TABLE NO.(50)

BENTONITE

45^0 Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	42	0.33	11.44	8.0	0.69	0.68
20	75	0.67	11.49	14.0	1.21	1.20
30	103	1.00	11.53	19.0	1.64	1.62
40	123	1.33	11.55	22.5	1.94	1.91
50	141	1.67	11.59	29.5	2.54	2.51
60	154	2.00	11.63	28.0	2.40	2.36
70	166.5	2.33	11.67	30.0	2.57	2.52
80	176.0	2.67	11.71	31.0	2.64	2.59
90	185.0	3.00	11.75	33.5	2.85	2.79
100	192.5	3.33	11.79	35.0	2.96	2.90
110	198.0	3.67	11.83	36.0	3.04	2.97
120	205.0	4.00	11.88	37.0	3.11	3.03
130	209.0	4.33	11.92	38.0	3.18	3.10
140	214.0	4.67	11.95	39.0	3.26	3.17
150	217.0	5.00	12.00	39.5	3.29	3.20
160	221.5	5.33	12.04	40.0	3.32	3.22
170	223.5	5.67	12.09	40.2	3.32	3.21
180	225.5	6.00	12.13	40.7	3.35	3.24
220	214.5	7.33	12.31	38.8	3.15	3.03

TABLE No.(51)

BENTONITE

45° Sample

Chamber Pressure 0.5 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0.0	11.40	0.	0	0
10	34	0.33	11.44	6.5	0.56	0.55
20	74	0.67	11.49	14.0	1.21	1.20
30	109	1.00	11.53	20.0	1.73	1.71
40	137.5	1.33	11.55	25.0	2.16	2.13
50	159.0	1.67	11.59	29.0	2.50	2.47
60	176.5	2.00	11.63	32.0	2.75	2.71
70	192.0	2.33	11.67	35.0	2.99	2.94
80	204.0	2.67	11.71	37.0	3.15	3.10
90	216.0	3.00	11.75	39.0	3.31	3.25
100	224.5	3.33	11.79	40.5	3.43	3.37
110	233.5	3.67	11.83	42.0	3.55	3.48
120	240.0	4.00	11.88	43.5	3.66	3.58
130	247.0	4.33	11.92	45.0	3.77	3.69
140	252.0	4.67	11.95	45.5	3.80	3.71
150	257.0	5.00	12.00	46.5	3.87	3.78
160	263.0	5.33	12.04	47.5	3.94	3.84
170	265.5	5.67	12.09	48.0	3.97	3.86
180	269.0	6.00	12.13	49.0	4.03	3.92
220	247.0	7.33	12.31	45.0	3.65	3.52

TABLE NO (52)

BENTONITE

Sample at $67^1/2^o$

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	15.5	0.33	11.44	3.0	0.26	0.25
20	24.0	0.67	11.49	4.5	0.39	0.38
30	55.0	1.00	11.53	10.5	0.91	0.89
40	80.0	1.33	11.55	15.0	1.29	1.26
50	101.0	1.67	11.59	18.5	1.59	1.56
60	119.0	2.00	11.63	22.0	1.89	1.85
70	133.0	2.33	11.67	24.5	2.10	2.05
80	147.0	2.67	11.71	27.0	2.30	2.25
90	160.0	3.00	11.75	29.0	2.46	2.40
120	186.0	4.00	11.88	34.0	2.86	2.78
150	208.0	5.00	12.00	38.0	3.16	3.07
180	226.0	6.00	12.13	41.0	3.38	3.27
240	255.0	8.00	12.39	46.5	3.73	3.59
300	283.0	10.0	12.67	51.5	4.06	3.88
360	295.5	12.00	12.95	53.5	4.13	3.92
420	304.5	14.0	13.26	55.0	4.14	3.90
460	310.0	15.33	13.46	56.0	4.30	4.04
480	310.0	16.00	13.57	56.0	4.12	3.86
520	278.0	17.33	13.80	50.5	3.65	3.37

TABLE NO.(53)

BENTONITE

$67^{1}/2$ Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0.0	11.40	0	0	0
10	11	0.33	11.44	2.5	0.21	0.20
20	24	0.67	11.49	4.5	0.39	0.38
30	56	1.00	11.53	10.5	0.91	0.89
40	83	1.33	11.55	16.0	1.38	1.35
50	110	1.67	11.59	18.5	1.59	1.56
60	125	2.00	11.63	23.0	1.97	1.93
70	140.5	2.33	11.67	25.5	2.19	2.14
80	156.0	2.67	11.71	28.5	2.43	2.38
90	170.0	3.00	11.75	31.0	2.63	2.57
100	182.0	3.33	11.79	33.00	2.79	2.73
110	192.0	3.67	11.83	35.0	2.95	2.88
120	200.0	4.00	11.88	36.6	3.03	2.95
130	209.0	4.33	11.92	38.0	3.18	3.10
140	216.0	4.67	11.95	39.0	3.26	3.17
150	223.5	5.00	12.00	40.5	3.37	3.28
180	240.5	6.00	12.13	43.5	3.58	3.48
240	267.0	8.00	12.39	48.5	3.91	3.77
300	273.0	10.0	12.67	50.0	3.94	3.76
320	2.67.0	10.67	12.76	48.5	3.80	3.61

TABLE NO.(54)

BENTONITE

$67^{1}/2^{o}$ Sample

Chamber Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	15	0.33	11.44	3.0	0.26	0.25
20	49	0.67	11.49	9.2	0.80	0.79
30	62	1.00	11.53	11.8	1.02	1.00
40	84	1.33	11.55	16.5	1.42	1.39
50	103	1.67	11.59	19.0	1.63	1.60
60	121	2.00	11.63	22.5	1.93	1.89
70	136	2.33	11.67	25.0	2.14	2.09
80	150	2.67	11.71	27.5	2.34	2.29
90	162.5	3.00	11.75	29.5	2.51	2.45
100	174.0	3.33	11.79	31.5	2.67	2.61
110	184.0	3.67	11.83	33.5	2.83	2.76
120	193.0	4.00	11.88	35.0	2.94	2.86
130	200.0	4.33	11.92	36.5	3.06	2.98
140	208.0	4.67	11.95	37.5	3.13	3.04
150	214.0	5.00	12.00	39.0	3.25	3.16
180	231.5	6.00	12.13	42.0	3.46	3.35
240	256.0	8.00	12.39	46.5	3.75	3.61
300	273.0	10.0	12.67	50.0	3.94	3.76
340	212.0	11.33	12.86	38.5	2.99	2.79

TABLE NO.(55)

BENTONITE

$67^1/2^o$ Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	10	0.33	11.44	2.0	0.17	0.16
20	15	0.67	11.49	3.0	0.26	0.25
30	35	1.00	11.53	6.5	0.56	0.54
40	65	1.33	11.55	12.0	1.03	1.00
50	94	1.67	11.59	17.1	1.47	1.43
60	115	2.00	11.63	21.0	1.80	1.76
70	136	2.33	11.67	25.0	2.14	2.09
80	152.5	2.67	11.71	28.0	2.39	2.34
90	168.0	3.00	11.75	30.5	2.59	2.53
100	182.0	3.33	11.79	33.0	2.79	2.73
110	193.0	3.67	11.83	35.0	2.95	2.88
120	206.0	4.00	11.88	37.5	3.15	3.08
130	216.0	4.33	11.92	39.0	3.27	3.19
150	234.5	5.00	12.00	42.5	3.54	3.45
180	255	6.00	12.13	46.0	3.79	3.68
240	285.0	8.00	12.39	51.5	4.15	4.01
280	292.0	9.33	12.57	53.0	4.21	4.04
300	292.0	10.0	12.67	53.0	4.18	4.00
340	265.0	11.33	12.86	48.0	3.73	3.53

TABLE NO.(56)

BENTONITE

$67^1/2^o$ Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	8.5	0.33	11.44	1.5	0.13	0.12
20	13.0	0.67	11.49	2.5	0.21	0.20
30	28.0	1.00	11.53	5.5	0.47	0.45
40	58.0	1.33	11.55	11.0	0.95	0.92
50	82.0	1.67	11.59	15.1	1.30	1.27
60	103.0	2.00	11.63	19.0	1.63	1.59
70	124.0	2.33	11.67	22.5	1.92	1.87
80	140.0	2.67	11.71	25.5	2.17	2.12
90	156.0	3.00	11.75	28.5	2.42	2.36
100	170.0	3.33	11.79	31.0	2.62	2.56
120	193.0	4.00	11.88	35.0	2.94	2.86
150	224.0	5.00	12.00	40.5	3.37	3.28
180	252.5	6.00	12.13	45.5	3.75	3.64
240	297.0	8.00	12.39	54.0	4.35	4.21
300	325.0	10.0	12.67	59.0	4.65	4.47
360	338.5	12.0	12.95	61.0	4.71	4.50
400	348.0	13.33	13.15	63.0	4.79	4.56
420	350.0	14.00	13.26	63.2	4.76	4.52
480	340.0	16.00	13.57	61.5	4.53	4.27

TABLE NO.(57)

BENTONITE

Horizontal Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	13	0.33	11.44	2.5	0.21	0.20
20	18	0.67	11.49	3.5	0.30	0.29
30	28	1.00	11.53	5.30	0.45	0.43
40	65	1.33	11.55	12.2	1.05	1.02
50	91	1.67	11.59	17.0	1.46	1.43
60	112.5	2.00	11.63	20.5	1.67	1.63
70	135	2.33	11.67	24.5	2.09	2.04
80	153	2.67	11.71	28.0	2.39	2.34
90	171	3.00	11.75	31.0	2.63	2.77
100	186.5	3.33	11.79	34.0	2.88	2.82
110	199.0	3.67	11.83	36.0	3.04	2.97
120	213.0	4.00	11.88	38.5	3.24	3.16
130	224	4.33	11.92	40.5	3.39	3.31
150	246.5	5.00	12.00	45.0	3.75	3.66
180	275.0	6.00	12.13	50.0	4.12	4.01
240	317.0	8.00	12.39	57.5	4.64	4.50
300	343.0	10.0	12.67	62.0	4.89	4.71
360	347.0	12.0	12.95	63.0	4.86	4.65
420	338.0	14.0	13.26	61.0	4.60	4.36

TABLE NO.(58)

BENTONITE

Horizontal Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	8	0.33	11.44	1.5	0.13	0.12
20	22	0.67	11.49	4.5	0.39	0.38
30	58	1.00	11.53	11.0	0.95	0.93
40	78	1.33	11.55	16.0	1.38	1.35
50	110	1.67	11.59	20.0	1.72	1.69
60	133	2.00	11.64	24.5	2.10	2.06
70	153	2.33	11.67	28.0	2.39	2.34
80	170	2.67	11.71	31.0	2.64	2.59
90	187	3.00	11.75	34.0	2.89	2.83
100	200	3.33	11.79	36.2	3.07	3.01
110	210	3.67	11.83	38.0	3.21	3.14
120	223	4.00	11.88	40.5	3.40	3.32
130	234	4.33	11.92	42.5	3.56	3.48
140	243	4.67	11.95	44.0	3.68	3.59
150	254	5.00	12.00	46.0	3.83	3.74
180	279	6.00	12.13	50.5	4.16	4.05
240	313	8.00	12.39	56.0	4.56	4.42
300	330	10.0	12.67	59.5	4.71	4.53
360	314.0	12.0	12.95	57.0	4.40	4.19

TABLE NO.(59)

BENTONITE

Horizontal Sample

Chamber Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	16.5	0.33	11.44	3.0	0.26	0.26
20	48.0	0.67	11.49	9.0	0.78	0.77
30	80.0	1.00	11.53	15.0	1.30	1.28
40	103.0	1.33	11.55	19.0	1.64	1.61
50	125.0	1.67	11.59	23.0	1.98	1.95
60	145	2.00	11.63	26.5	2.27	2.23
70	160	2.33	11.67	29.0	2.48	2.43
80	175	2.67	11.71	32.0	2.73	2.68
90	188	3.00	11.75	34.00	2.89	2.83
100	198	3.33	11.79	36.0	3.05	2.99
110	209	3.67	11.83	38.0	3.21	3.14
120	217	4.00	11.88	39.5	3.32	3.24
130	227	4.33	11.92	41.0	3.43	3.35
140	236	4.67	11.95	43.0	3.59	3.50
150	245	5.00	12.00	44.5	3.70	3.61
180	270	6.00	12.13	49.0	4.03	3.92
240	304	8.00	12.34	55.0	4.43	4.29
300	320	10.0	12.67	58.0	4.57	4.39
320	323	10.67	17.76	58.5	4.58	4.39
360	310	12.0	12.99	56.0	4.32	4.11

TABLE NO. (60)

BENTONITE

Horizontal Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	12	0.33	11.44	2.5	0.21	0.20
20	16	0.67	11.49	3.0	0.26	0.25
30	37	1.00	11.53	7.0	0.60	0.58
40	65	1.33	11.55	12.2	1.05	1.02
50	87	1.67	11.59	16.0	1.38	1.35
60	98	2.00	11.63	18.0	1.54	1.50
70	126	2.33	11.67	23.0	1.97	1.92
80	141	267	11.71	25.5	2.17	1.12
90	156.5	3.00	11.75	28.2	2.40	2.34
100	170.0	3.33	11.79	31.0	2.62	2.56
120	190.0	4.00	11.88	34.5	2.90	2.82
150	218	5.00	12.00	39.5	3.29	3.20
180	241	6.00	12.13	44.0	3.62	3.51
240	277	8.00	12.39	50.0	4.03	3.89
300	308	10.0	12.67	55.5	4.38	4.20
360	324	12.0	12.95	58.5	4.51	4.30
400	332.0	13.33	13.15	60.0	4.56	4.33
480	336.5	16.0	13.57	61.0	4.49	4.23

TABLE NO.(61)

BENTONITE

Horizontal Sample

Cell Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	14	0.33	11.44	2.8	0.24	0.23
20	47	0.67	11.49	9.0	0.78	0.77
30	73	1.00	11.53	13.5	1.17	1.15
40	95	1.33	11.55	17.5	1.51	1.48
50	114	1.67	11.59	21.0	1.81	1.78
60	130	2.00	11.63	24.0	2.06	2.04
70	144	2.33	11.67	26.0	2.22	2.17
80	158	2.67	11.71	28.5	2.43	2.38
90	168	3.00	11.75	30.5	2.59	2.53
100	180	3.33	11.79	32.5	2.75	2.69
110	189	3.67	11.83	34.5	2.91	2.84
120	198.5	4.00	11.88	36.0	3.03	2.95
150	218.5	5.00	12.00	39.5	3.29	3.20
180	237.0	6.00	12.13	43.0	3.54	3.43
240	262	8.00	12.39	47.5	3.83	3.69
300	280	10.0	12.67	50.7	4.00	3.82
320	283.5	10.67	12.76	51.5	4.03	3.84
360	285.0	12.00	12.95	51.5	3.97	3.76
400	275.0	13.33	13.15	50.0	3.80	3.57

TABLE NO.(62)

BENTONITE

Horizontal Sample

Cell Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	21	0.33	11.44	4.0	0.34	0.33
20	48	0.67	11.49	9.0	0.78	0.77
30	70	1.00	11.53	13.0	1.12	1.10
40	88	1.33	11.55	16.5	1.42	1.39
50	105	1.67	11.59	18.5	1.59	1.56
60	121	2.00	11.63	22.0	1.89	1.85
70	132.5	2.33	11.67	24.0	2.06	2.01
80	144.5	2.67	11.71	26.0	2.22	2.17
90	154.0	3.00	11.75	28.0	2.38	2.32
100	163.5	3.33	11.79	29.5	2.50	2.44
110	173.0	3.67	11.83	31.0	2.62	2.55
120	180.0	4.00	11.88	32.5	2.73	2.65
130	187.0	4.33	11.92	34.0	2.85	2.77
140	192.0	4.67	11.95	34.9	2.92	2.83
150	197.0	5.00	12.00	35.8	2.98	2.89
160	202.5	5.33	12.04	36.5	3.03	3.93
180	211.0	6.00	12.13	32.0	3.13	3.02
200	217.0	6.67	12.22	39.5	3.23	3.11
240	205	8.00	12.39	37.0	2.98	2.84

TABLE NO.(63)

BENTONITE

Horizontal Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	06	0.33	11.44	1.2	0.1	0.09
20	10	0.67	11.49	2.0	0.17	0.16
30	31	1.00	11.53	6.0	0.52	0.50
70	132	2.33	11.67	24.0	2.05	2.00
80	150	2.67	11.71	27.5	2.34	2.29
90	163	3.00	11.75	30.0	2.55	2.49
100	174	3.33	11.79	31.5	2.67	2.61
110	183	3.67	11.83	33.1	2.79	2.72
120	192	4.00	11.88	35.0	2.94	2.86
130	200	4.33	11.92	36.0	3.02	2.94
140	206	4.67	11.95	37.5	3.13	3.04
150	214	5.00	12.00	39.0	3.25	3.16
160	219	5.33	12.04	40.0	3.32	3.22
180	230	6.00	12.13	42.0	3.46	3.35
240	256	8.00	12.39	46.5	3.75	3.61
300	270	10.0	12.67	49.0	3.86	3.68
320	273	10.67	12.76	50.0	3.91	3.72
360	375.0	12.00	12.95	50.0	3.86	3.65
420	262.0	14.00	13.26	47.5	3.58	3.34

TABLE NO.(64)

DHANAURI CLAY

Vertical Sample

Cell Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Axial Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	6.5	0.33	11.44	3.0	0.263	0.25
20	9.0	0.67	11.48	5.00	0.436	0.43
30	23.0	1.00	11.52	9.5	0.825	0.81
40	30.5	1.33	11.55	12.5	1.08	1.05
190	70.5	6.33	12.17	29.0	2.38	2.26
200	73.0	6.67	12.22	30.0	2.46	2.34
210	76.5	7.00	12.26	32.0	2.61	2.48
240	90.5	8.00	12.39	37.7	3.04	2.90
270	10.10	9.00	12.53	42.0	3.35	3.19
300	110.5	10.0	12.67	47.0	3.71	3.33
330	119.5	11.0	12.81	50.0	3.90	3.71
360	126.5	12.0	12.95	53.0	4.09	3.88
390	132.0	13.0	13.10	55.0	4.20	3.98
420	135.5	14.02	13.26	56.6	4.27	4.03
450	138.0	15.00	13.41	58.0	4.33	4.08
460	141.0	16.00	13.57	59.0	4.35	4.09
510	143.0	17.0	13.74	60.0	4.37	4.09
540	142.0	18.0	13.90	59.5	4.28	4.00
570	138.0	19.0	14.07	58.0	4.12	3.82

TABLE NO.(65)

DHANAURI CLAY

Verticle Sample

Chamber Pressure 1 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	21.5	0.33	11.44	9.0	0.80	.79
20	29.5	0.67	11.48	12.5	1.09	1.08
30	36.0	1.00	11.52	15.0	1.30	1.28
40	40.0	1.33	11.55	18.0	1.56	1.53
50	48.5	1.67	11.59	20.0	1.73	1.70
60	55.0	2.00	11.63	23.0	1.98	1.96
70	61.0	2.33	11.67	25.5	2.19	2.14
80	68.0	2.67	11.71	28.0	2.39	2.34
90	74.5	3.00	11.75	31.5	2.68	2.62
100	79.0	3.33	11.79	33.5	2.84	2.78
120	90.0	4.00	11.88	37.5	3.16	3.08
150	104.0	5.00	12.00	43.0	3.58	3.49
180	118.5	6.00	12.13	49.0	4.09	3.93
240	142.0	8.00	12.39	59.2	4.78	4.64
280	156.5	9.33	12.57	65.0	5.17	5.00
300	162.0	10.0	12.67	67.5	5.33	5.15
360	179.5	12.00	12.95	75.0	5.79	5.58
420	191.0	14.00	13.26	79.5	6.02	5.78
440	193.5	14.67	13.37	81.0	6.06	5.81
480	195.5	16.00	13.57	81.1	5.98	5.72

TABLE NO.(66)

DHANAURI CLAY

Vertical Sample

Chamber Pressure 1/2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	18.5	0.33	11.44	7.5	0.656	0.65
20	26.5	0.67	11.48	11.0	0.958	0.95
30	32.5	1.00	11.52	13.70	1.20	1.18
40	38.5	1.33	11.55	16.0	1.39	1.36
50	43.0	1.67	11.59	18.0	1.55	1.52
60	47.5	2.60	11.63	20.0	1.72	1.68
70	52.5	2.33	11.67	22.5	1.93	1.88
80	57.0	2.67	11.71	24.0	2.06	2.01
90	61.5	3.00	11.75	26.0	2.21	2.15
100	66.5	3.33	11.79	28.0	2.38	2.32
120	75.0	4.00	11.88	31.5	2.65	2.57
150	88.5	5.00	12.00	37.0	3.08	2.99
180	100.0	6.00	12.13	42.0	3.46	3.35
240	122.5	8.00	12.39	51.0	4.12	3.98
300	139.5	10.00	12.67	58.5	4.62	4.44
360	157.0	12.00	12.95	65.5	5.06	4.85
420	170.0	14.00	13.26	71.0	5.35	5.11
460	175.0	15.33	13.46	73.5	5.46	5.20
480	174.5	16.00	13.57	73.0	5.38	5.12

TABLE NO.(67)

DHANAURI CLAY

Vertical Sample

Cell Pressure 2 kg/cm^2

Strain dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	17	0.33	11.44	3.2	0.28	0.27
20	25	0.67	11.48	5.0	0.44	0.43
30	40	1.00	11.52	7.5	0.65	0.63
60	121	2.00	11.63	22.0	1.88	1.84
90	184	3.0	11.75	33.5	2.85	2.79
120	237	4.00	11.88	43.0	3.62	3.54
150	283.0	5.00	12.00	51.0	4.25	4.16
180	313.0	6.00	12.13	56.5	4.67	4.56
210	338.0	7.00	12.26	61.00	5.00	4.87
240	361.0	8.00	12.39	65.0	5.25	5.11
270	381.5	9.00	12.53	69.0	5.50	5.34
300	396.0	10.0	12.67	71.5	5.65	5.47
330	410.0	11.0	12.81	74.0	5.80	5.61
360	422.5	12.0	12.95	76.0	5.88	5.67
390	439.5	13.00	13.10	79.0	6.05	5.83
420	449.5	14.00	13.26	81.0	6.10	5.86
430	452.0	14.32	13.31	81.5	6.13	5.89
450	455.5	15.00	13.41	82.0	6.12	5.87
480	430.0	16.00	13.57	77.5	5.75	5.49

TABLE NO.(68)

DHANAURI CLAY

Vertical Sample

Cell Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	15.0	0.33	11.44	3.0	0.26	0.25
20	41.0	0.67	11.49	8.0	0.70	0.69
30	63.0	1.00	11.52	12.0	1.04	1.02
40	84.0	1.33	11.55	15.5	1.14	1.11
50	102.0	1.67	11.59	19.0	1.20	1.17
60	119.0	2.00	11.63	22.0	1.89	1.85
90	169.0	3.00	11.75	30.5	2.60	2.54
120	212.0	4.00	11.88	38.5	3.24	3.16
150	250.0	5.00	12.00	45.00	3.75	3.66
180	274.0	6.00	12.13	49.5	4.07	3.96
210	294.0	7.00	12.26	53.0	4.33	4.20
240	314.0	8.00	12.39	56.5	4.57	4.43
300	340.0	10.0	12.67	61.5	4.84	4.64
360	363.5	12.0	12.95	65.5	5.07	4.86
400	378.0	13.33	13.15	68.1	5.20	4.97
420	379.0	14.00	13.26	68.5	5.17	4.93
480	376.0	16.00	13.57	68.0	5.03	4.77
520	374.5	17.33	13.80	67.5	4.90	4.62
540	371.0	18.0	13.90	67.0	4.80	4.58

TABLE NO.(69)

DHANAURI CLAY

$22^1/2^o$ Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	5.0	0.33	11.44	2.0	0.175	0.165
20	22.5	0.67	11.48	9.5	0.828	0.818
30	27.0	1.00	11.52	11.0	0.955	0.935
40	42.5	1.33	11.55	17.5	1.52	1.49
50	50.0	1.67	11.59	21.0	1.81	1.78
60	56.5	2.00	11.63	23.5	1.98	1.58
70	63.0	2.33	11.67	26.0	2.23	2.18
80	68.0	2.67	11.71	28.0	2.39	2.34
90	74.0	3.00	11.75	31.0	2.64	2.58
100	79.0	3.33	11.79	33.0	2.80	2.74
120	88.5	4.00	11.88	37.5	3.16	3.08
150	100.0	5.00	12.00	42.0	3.51	3.46
180	110.5	6.00	12.13	46.0	3.79	3.68
240	130.0	8.00	12.39	54.0	4.36	4.22
300	145.5	10.0	12.67	60.5	4.78	4.60
360	161.0	12.0	12.95	67.0	5.17	4.96
420	172.5	14.0	13.26	72.0	5.44	5.20
460	178.0	15.33	13.46	74.0	5.50	5.24
480	179.0	16.00	13.57	74.8	5.51	5.25
540	182.0	18.00	13.90	75.5	5.43	5.13

TABLE NO.(70)

DHANAURI CLAY

$22^1/2^o$ Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	15.5	0.33	11.44	6.5	0.568	0.56
20	28.0	0.67	11.48	11.5	1.002	0.99
30	36.0	1.00	11.52	14.5	1.26	1.24
40	43.0	1.33	11.55	18.0	1.56	1.53
50	49.0	1.67	11.59	20.2	1.74	1.71
60	54.5	2.00	11.63	23.0	1.98	1.94
70	59.5	2.33	11.67	25.0	2.14	2.09
80	65.0	2.67	11.71	27.0	2.31	2.26
90	69.0	3.00	11.75	29.0	2.47	2.41
100	74.5	3.33	11.79	31.0	2.63	2.57
110	80.0	3.67	11.83	33.5	2.83	2.76
120	83.0	4.00	11.88	34.5	2.90	2.82
150	96.0	5.00	12.00	40.0	3.33	3.24
180	105.0	6.00	12.13	44.0	3.63	3.52
240	123.0	8.00	12.39	51.0	4.12	3.98
300	136.0	10.0	12.67	57.0	4.50	4.32
360	148.5	12.0	12.95	62.0	4.79	4.58
420	147.0	14.0	13.26	61.5	4.64	4.40
440	144.5	14.67	13.37	60.0	4.49	4.24

TABLE NO.(71)

DHANAURI CLAY

$22^1/2$ Sample

Chamber Pressure 0.5 kg/cm^2

Strain Drain Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	4.5	0.33	11.44	2.0	0.18	0.17
20	13.5	0.67	11.48	6.0	0.52	0.51
30	25	1.00	11.52	10.5	0.911	0.89
40	32	1.33	11.55	13.5	1.17	1.14
50	37	1.67	11.59	15.5	1.34	1.31
60	41	2.00	11.65	17.0	1.46	1.42
70	46	2.33	11.67	19.0	1.63	1.58
80	50	2.67	11.71	21.0	1.79	1.74
90	54	3.00	11.75	22.5	1.92	1.86
100	57.5	3.33	11.79	24.0	2.04	1.98
120	66.0	4.00	11.88	27.5	2.32	2.24
150	77.0	5.00	12.0	32.5	2.71	2.62
180	83.0	6.00	12.13	35.0	2.89	2.78
240	100.5	8.00	12.39	42.0	3.40	3.26
300	108.0	10.0	12.67	45.1	3.57	3.39
360	111.0	12.0	12.95	46.3	3.58	3.37
380	113.0	12.67	13.05	47.0	3.60	3.38
420	113.5	14.00	13.26	47.5	3.58	3.34
450	112.5	15.00	13.41	46.8	3.50	3.25

TABLE NO.(72)

DHANAURI CLAY

$22^{1}/2^{o}$ Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	20	0.33	11.44	4.0	0.351	0.34
60	28	2.00	11.63	5.5	0.473	0.43
70	48	2.33	11.67	9.0	0.771	0.72
80	64	2.67	11.71	12.0	1.03	0.98
90	80	3.00	11.75	15.0	1.28	1.22
100	92	3.33	11.79	17.0	1.44	1.38
110	105	3.67	11.83	19.5	1.65	1.58
120	127.5	4.00	11.88	23.5	1.98	1.90
130	131.0	4.33	11.92	24.0	2.01	1.93
140	140.0	4.67	11.95	25.5	2.13	2.04
150	149.5	5.00	12.00	27.3	2.28	2.19
160	155.0	5.33	12.04	28.2	2.34	2.24
180	169.0	6.00	12.13	31.0	2.56	2.45
240	205.5	8.00	12.39	37.0	2.99	2.85
300	227.5	10.00	12.67	41.2	3.25	3.07
360	254.5	12.00	12.95	46.0	3.55	3.34
380	262.0	12.67	13.05	47.5	3.65	3.43
420	267.0	14.00	13.26	48.5	3.66	3.42
480	268.0	16.00	13.57	48.6	3.58	3.32

TABLE NO.(73)

DHANAURI CLAY

$22^{1}/2^{o}$ Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	15.0	0.33	11.44	3.0	0.262	0.26
20	29.0	0.67	11.48	5.5	0.479	0.47
30	55.0	1.00	11.52	10.5	0.911	0.89
40	78.0	1.33	11.35	14.5	1.26	1.23
50	98.0	1.67	11.59	18.0	1.55	1.52
60	117.0	2.00	11.63	21.5	1.85	1.81
70	135.0	2.33	11.67	24.5	2.11	2.06
80	152.5	2.67	11.71	27.8	2.37	2.32
90	169.0	3.00	11.75	31.0	2.64	2.58
100	183.0	3.33	11.79	33.2	2.82	2.76
120	206.0	4.00	11.88	37.5	3.16	3.08
150	236.0	5.00	12.00	43.0	3.58	3.53
180	258.0	6.00	12.13	46.8	3.86	3.75
240	294.0	8.00	12.39	53.0	4.28	4.14
300	320.0	10.0	12.67	58.0	4.57	4.39
360	346.5	12.0	12.95	62.5	4.83	4.62
420	366.5	14.0	13.26	66.0	4.98	4.74
500	387.0	16.67	13.68	70.0	5.12	4.85
540	391.5	18.00	13.90	70.5	5.07	4.78

TABLE NO.(74)

DHANAURI CLAY

$22^1/2^o$ Sample

Chamber Pressure 1 kg/cm^2

0	0	0.0	11.40	0	0	0
10	7	0.33	11.44	3.0	0.26	0.25
20	18.5	0.67	11.49	7.5	0.65	0.64
30	34.0	1.00	11.53	14.5	1.25	1.23
40	45.0	1.33	11.55	19.0	1.64	1.61
50	54.0	1.67	11.59	23.0	1.98	1.95
60	62.5	2.00	11.63	26.0	2.23	2.19
70	71.0	2.33	11.67	30.0	2.57	2.52
80	77.0	2.67	11.71	32.5	2.77	2.72
90	83.5	3.00	11.75	35.0	2.97	2.91
120	99.0	4.00	11.88	41.5	3.49	3.41
150	117.5	5.00	12.00	49.0	4.08	3.99
180	130.0	6.00	12.13	54.0	4.45	4.34
240	148.5	8.00	12.39	62.0	5.00	4.86
300	168.5	10.00	12.67	70.5	5.56	5.38
360	185.5	12.00	12.95	77.0	5.94	5.73
420	197.5	14.00	13.26	82.5	6.22	5.98
440	200.0	14.67	13.37	83.5	6.24	5.99
480	200.0	16.00	13.57	83.5	6.15	5.88
500	189	16.67	13.68	79.0	5.77	5.49

TABLE NO.(75)

DHANAURI CLAY

45° Sample

Cell Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	7.5	0.33	11.44	3.0	0.26	0.25
20	10	0.67	11.49	4.5	0.39	0.38
30	11	1.00	11.53	4.7	0.40	0.38
40	12.0	1.33	11.55	5.0	0.43	0.40
50	16.0	1.67	11.59	6.5	0.56	0.53
60	36.0	2.00	11.63	15.0	1.28	1.24
70	47.5	2.33	11.67	20.0	1.71	1.66
80	54.0	2.67	11.71	23.0	1.96	1.91
90	62.5	3.00	11.75	26.0	2.21	2.15
120	82.5	4.00	11.88	34.5	2.90	2.82
150	97.0	5.00	12.00	40.5	3.37	3.28
180	109.0	6.00	12.13	45.5	3.75	3.64
240	130.5	8.00	12.39	54.0	4.35	4.21
300	148.5	10.0	12.67	62.0	4.85	4.67
360	163.0	12.0	12.95	67.9	5.25	5.04
420	170.0	14.0	13.26	71.0	5.35	5.11
460	176.0	15.33	13.46	73.5	5.46	5.20
480	177.5	16.00	13.57	74.0	5.45	5.19
540	175.0	18.00	13.90	73.0	5.25	4.96

TABLE NO.(76)

DHANAURI CLAY

45^{o} Sample

Cell Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain - in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	5	0.33	11.44	2.0	0.17	0.16
20	21	0.67	11.49	9.6	0.83	0.82
30	29	1.00	11.53	12.5	1.08	1.06
40	35	1.33	11.55	15.0	1.29	1.26
50	40	1.67	11.59	16.5	1.42	1.39
60	45	2.00	11.63	18.5	1.59	1.54
70	49.5	2.33	11.69	20.5	1.75	1.70
80	54.5	2.67	11.71	23.0	1.96	1.91
90	59.0	3.00	11.75	25.0	2.12	2.06
100	63.5	3.33	11.79	26.0	2.20	2.14
120	71.5	4.00	11.88	29.5	2.48	2.40
150	83.5	5.00	12.00	35.5	2.95	2.86
180	95.0	6.00	12.13	40.0	3.29	3.18
240	118.0	8.00	12.39	49.0	3.95	3.81
300	136.5	10.0	12.67	57.0	4.49	4.31
360	150.5	12.00	12.95	62.5	4.82	4.61
420	163.0	14.00	13.26	68.0	5.12	4.88
480	173.5	16.00	13.57	72.5	5.34	5.08
540	172.0	18.00	13.90	71.5	5.14	4.85

TABLE NO.(77)

DHANAURI CLAY

45^o Sample

Cell Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	21.0	0.33	11.44	9.0	0.78	0.77
20	31.5	0.67	11.49	13.0	1.13	1.12
30	39.5	1.00	11.53	16.5	1.43	1.41
40	45.5	1.33	11.55	19.0	1.64	1.61
50	51.0	1.67	11.59	21.5	1.85	1.82
60	56.0	2.00	11.63	23.5	2.02	1.98
70	61.5	2.33	11.67	25.5	2.18	2.13
80	65.0	2.67	11.71	27.0	2.30	2.25
90	70.5	3.00	11.75	29.0	2.46	2.40
120	85.5	4.00	11.88	36.0	3.03	2.95
150	97.0	5.00	12.00	40.5	3.37	3.28
180	107.5	6.00	12.13	45.0	3.70	3.59
240	128.5	8.00	12.39	53.5	4.32	4.18
300	146.0	10.0	12.67	60.5	4.77	4.59
360	160.0	12.0	12.95	66.8	5.16	4.95
420	170.0	14.0	13.26	71.0	5.35	5.11
480	170.0	16.0	13.57	71.0	5.24	4.98
500	164.0	16.67	13.68	69.0	5.05	4.78

TABLE NO.(78)

DHANAURI CLAY

45^o Sample

Cell Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	10	0.33	11.44	2.0	0.18	0.170
20	18	0.67	11.48	3.5	0.31	0.30
30	53	1.00	11.53	10.0	0.87	0.85
40	79	1.33	11.55	15.0	1.30	1.27
50	102	1.67	11.59	19.0	1.64	1.61
60	123	2.00	11.63	22.5	1.93	1.89
70	143.5	2.33	11.67	26.0	2.23	2.18
80	164.5	2.67	11.71	30.0	2.56	2.51
90	182.0	3.00	11.75	33.0	2.81	2.75
100	200	3.33	11.79	36.0	3.05	2.99
110	218	3.67	11.83	39.5	3.34	3.27
120	235	4.00	11.88	42.5	3.58	3.50
150	278.0	5.00	12.00	50.0	4.17	4.08
180	308.0	6.00	12.13	55.5	4.58	4.47
240	340.0	8.00	12.39	61.5	4.96	4.82
260	348.5	8.67	12.48	63.0	5.05	4.89
300	355.5	10.0	12.67	64.0	5.05	4.87
340	356.0	11.33	12.86	64.5	5.01	4.81
360	350.0	12.00	12.95	63.0	4.86	4.65

TABLE NO.(79)

DHANAURI CLAY

45^{o} Sample

Cell Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	9.	0.33	11.44	2.0	0.17	0.16
20	13	0.67	11.48	2.5	0.22	0.21
30	14	1.00	11.52	3.0	0.26	0.24
40	40	1.33	11.55	8.5	0.74	0.71
50	59	1.67	11.59	12.2	1.05	1.02
60	72	2.00	11.63	15.0	1.30	1.26
70	83	2.33	11.67	17.0	1.46	1.41
90	101	3.00	11.75	21.0	1.79	1.73
120	125	4.00	11.88	26.0	2.19	2.11
150	142	5.00	12.00	29.0	2.42	2.33
180	164	6.00	12.13	34.0	2.80	2.69
240	202	8.00	12.39	42.0	3.40	3.26
300	240	10.0	12.67	50.0	3.95	3.77
360	274	12.0	12.95	57.0	4.40	4.19
420	294	14.0	13.26	61.2	4.62	4.38
450	299	15.0	13.41	62.2	4.64	4.39
460	299	15.33	13.46	62.2	9.62	4.36
480	301	16.00	13.57	62.5	4.61	4.35
500	303	16.67	13.68	63.0	4.61	4.34

TABLE NO.(80)

DHANAURI CLAY

45° Sample

Cell Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	52	0.33	11.45	11.0	0.961	0095
20	68	0.67	11.49	14.0	1.22	1.21
30	79	1.00	11.52	16.2	1.41	1.39
40	88	1.33	11.55	18.5	1.61	1.58
50	98	1.67	11.59	20.5	1.77	1.74
60	107	2.00	11.63	22.5	1.93	1.89
70	114	2.33	11.67	24.0	2.06	2.01
80	123	2.67	11.71	25.2	2.15	2.10
90	131	3.00	11.75	27.0	2.29	2.23
100	141	3.33	11.79	29.0	2.45	2.39
120	158	4.00	11.88	33.1	2.78	2.70
150	182	5.00	12.00	38.0	3.17	3.08
180	205	6.00	12.13	43.0	3.55	3.44
240	244	8.00	12.39	51.0	4.12	3.98
300	276	10.0	12.67	57.5	4.54	4.36
360	313	12.0	12.95	65.0	5.03	4.82
420	341	14.0	13.26	71.0	5.35	5.11
480	365	16.0	13.57	76.0	5.60	5.34
520	368.5	17.33	13.80	77.0	5.58	5.30

TABLE NO.(81)

DHANAURI CLAY

45° Sample

Cell Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg..	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	65	0.33	11.44	14.0	1.23	1.22
20	82	0.67	11.48	17.5	1.52	1.51
30	90	1.00	11.52	19.0	1.65	1.63
40	98	1.33	11.55	20.5	1.77	1.74
50	107	1.67	11.59	22.5	1.94	1.91
60	114	2.00	11.63	23.8	2.05	2.01
70	122	2.33	11.67	25.0	2.14	2.09
80	129	2.67	11.71	27.0	2.31	2.26
90	136	3.00	11.75	28.0	2.38	2.32
100	142	3.33	11.79	29.0	2.47	2.41
120	157	4.00	11.88	32.8	2.76	2.68
150	180	5.00	12.00	37.5	3.13	3.04
180	204	6.00	12.13	42.3	3.49	3.38
240	250	8.00	12.39	52.2	4.21	4.07
300	285	10.0	12.67	59.0	4.66	4.48
360	310	12.0	12.95	64.5	4.98	4.77
420	325	14.00	13.26	67.5	5.09	4.85
460	326	15.33	13.46	68.0	5.05	4.79
480	321	16.00	13.57	66.5	4.90	4.64
500	312	16.67	13.68	65.0	4.75	4.48

TABLE NO.(82)

DHANAURI CLAY

$67^{1}/2^{o}$ Sample

Cell Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0.087	0.08
10	12.5	0.33	11.44	2.50	0.087	0.08
20	18.5	0.67	11.49	3.50	0.305	0.30
30	43.0	1.00	11.53	8.0	0.69	0.67
40	57.0	1.33	11.55	11.0	0.95	0.92
50	95.0	1.67	11.59	17.5	1.51	1.48
60	114.5	2.00	11.63	21.0	1.81	1.77
70	135.5	2.33	11.67	24.5	2.10	2.06
80	154.5	2.67	11.71	28.0	2.39	2.34
90	172.0	3.00	11.75	31.2	2.66	2.60
120	220.0	4.00	11.88	40.0	3.37	3.29
180	293.5	6.00	12.13	53.0	4.37	4.26
290	342	8.00	12.39	62.00	5.00	4.86
300	385.5	10.0	12.67	69.5	5.49	5.31
360	426.5	12.00	12.95	77.0	5.96	5.76
420	457.5	14.00	13.26	82.5	6.22	5.98
480	483.5	16.00	13.57	87.0	6.43	6.17
540	503.0	16.00	13.90	90.0	6.51	6.22
580	520.0	19.33	14.13	93.5	6.62	6.31
600	525.5	20.00	14.25	94.0	6.596	6.28

TABLE NO.(83)

DHANAURI CLAY

$67^{1}/2^{o}$ Sample

Cell Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	20	0.33	11.44	4.0	0.35	0.34
20	52.5	0.67	11.48	10.0	0.871	0.36
30	76.5	1.00	11.53	14.0	1.21	1.19
40	99.0	1.33	11.55	18.5	1.60	1.57
50	118.0	1.67	11.59	21.5	1.86	1.83
60	137.5	2.00	11.63	25.0	2.15	2.11
70	158.0	2.33	11.67	28.8	2.47	2.42
80	175.5	2.67	11.71	32.0	2.73	2.68
90	194.0	3.00	11.75	35.0	2.98	2.92
100	209.0	3.33	11.79	38.0	3.22	3.16
110	226.0	3.67	11.83	41.0	3.47	3.40
120	241.5	4.00	11.88	43.5	3.66	3.58
150	283.0	5.00	12.00	51.2	4.27	4.18
180	315.0	6.00	12.13	57.0	4.70	4.59
240	369.0	8.00	12.39	67.0	5.41	5.27
300	408.5	10.0	12.67	74.0	5.84	5.66
360	440.0	12.0	12.95	79.5	6.14	5.93
420	447.0	14.0	13.26	80.5	6.07	5.83
460	438.0	15.33	13.46	79.0	5.87	5.61

TABLE NO.(84)

DHANAURI CLAY

$67^1/2^o$ Sample

Cell Pressure = 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	14	0.33	11.64	2.5	0.219	0.21
20	36	0.67	11.48	7.0	0.653	0.64
30	54	1.00	11.52	10.0	0.868	0.85
40	66	1.33	11.55	12.2	1.06	1.03
50	77.5	1.67	11.59	14.5	1.251	1.22
60	88	2.00	11.63	16.5	1.42	1.38
70	98	2.33	11.67	18.0	1.54	1.49
80	107	2.67	11.71	20.0	1.71	1.66
90	116	3.00	11.75	21.2	1.80	1.74
100	125	3.33	11.79	23.0	1.95	1.89
120	142.5	4.00	11.88	26.0	2.19	2.11
150	168.5	5.00	12.00	30.5	2.54	2.45
180	192.0	6.00	12.13	35.0	2.89	2.78
240	234.5	8.00	12.39	42.5	3.43	3.29
300	270.0	10.0	12.67	49.0	3.87	3.69
360	301.0	12.00	12.95	54.0	4.17	3.96
420	327.0	14.00	13.26	59.0	4.46	4.22
460	337.5	15.33	13.46	61.0	4.53	4.27
480	324.0	16.00	13.57	58.5	4.31	4.05

TABLE NO.(85)

DHANAURI CLAY

$67^1/2^o$ Sample

Cell Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	16.5	0.33	11.44	3.0	0.262	0.252
20	20.0	0.67	11.48	4.0	0.3.48	0.338
30	23.5	1.00	11.52	4.5	0.391	0.371
40	25.5	1.33	11.55	5.0	0.433	0.403
50	29.0	1.67	11.59	5.8	0.500	0.470
60	45.0	2.00	11.63	8.5	0.731	0.691
70	65.5	2.33	11.67	12.2	1.05	1.00
80	82.0	2.67	11.71	15.25	1.30	1.25
90	98.0	3.00	11.75	18.0	1.53	1.47
120	135.5	4.00	11.88	24.8	2.09	2.01
150	171.5	5.00	12.00	31.0	2.58	2.49
180	198.5	6.00	12.13	36.0	2.97	2.86
240	249.0	8.00	12.39	45.0	3.63	3.49
300	287.5	10.0	12.67	52.0	4.10	3.92
360	326.5	12.0	12.95	59.0	4.56	4.35
390	347.5	13.0	13.10	63.0	4.81	4.59
420	364.0	14.0	13.26	66.0	4.98	4.74
490	588.0	16.33	13.63	70.0	5.14	4.87
540	387.0	18.00	13.90	70.0	5.04	4.75

TABLE NO. (86)

DHANAURI CLAY

$67^{1}/2^{o}$ Sample

Cell Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	12	0.33	11.44	2.3	0.202	0.192
20	34	0.67	11.48	6.5	0.566	0.556
30	52	1.00	11.52	9.8	0.825	0.805
40	65	1.33	11.55	13.0	1.13	1.10
50	77.5	1.67	11.59	14.2	1.23	1.20
60	87.5	2.00	11.63	16.2	1.39	1.35
70	98.0	2.33	11.67	18.0	1.54	1.49
80	107.0	2.67	11.71	20.0	1.71	1.66
90	115.0	3.00	11.75	21.0	1.79	1.73
100	125.0	3.33	11.79	23.0	1.95	1.89
120	143.0	4.00	11.88	26.0	2.19	2.11
150	174.0	5.00	12.00	31.5	2.63	2.54
180	199.0	6.00	12.13	36.0	2.97	2.86
240	246.0	8.00	12.39	44.5	3.59	3.45
300	284.0	10.0	12.67	51.5	4.06	3.86
360	323.5	12.00	12.95	58.5	4.52	4.31
420	357.0	14.00	13.26	64.5	4.86	4.62
460	369.5	15.33	13.46	67.00	4.98	4.72
480	365.5	16.00	13.57	64.4	4.89	4.63

TABLE NO.(87)

DHANAURI CLAY

$67^{1}/2^{o}$ Sample

Cell Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	32.0	0.33	11.44	6.0	0.525	0.515
20	57.0	0.67	11.48	10.5	0.914	0.904
30	71.5	1.00	11.52	13.2	1.15	1.130
40	84.0	1.33	11.55	15.5	1.34	1.31
50	93.0	1.67	11.59	17.1	1.48	1.45
60	102.0	2.00	11.63	19.0	1.63	1.59
70	110.5	2.33	11.67	20.1	1.72	1.67
80	119.0	2.67	11.71	22.0	1.88	1.83
90	127.5	3.00	11.75	23.5	2.00	1.94
100	137.0	3.33	11.79	25.0	2.12	2.06
110	145.0	3.67	11.83	26.5	2.24	2.17
120	155.0	4.00	11.88	28.1	2.37	2.29
150	181.0	5.00	12.00	33.0	2.75	2.66
180	206.5	6.00	12.13	37.5	3.09	2.98
240	253.0	8.00	12.39	46.0	3.71	3.57
300	290.0	10.0	12.67	52.5	4.14	3.96
360	320.0	12.0	12.95	58.0	4.48	4.27
400	335.0	13.33	13.15	60.5	4.60	4.37
420	332.0	14.00	13.26	60.0	4.53	4.29

TABLE NO.(88)

DHANAURI CLAY

Horizontal Sample

Cell Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0.0	11.40	0.0	0	0
10	4.5	0.33	11.44	2.5	0.21	0.20
20	8.5	0.67	11.49	4.0	0.34	0.33
30	27.5	1.00	11.53	11.5	0.99	0.97
40	37.5	1.33	11.55	15.5	1.34	1.31
50	46	1.67	11.59	19.5	1.68	1.65
60	54	2.00	11.63	22.5	1.93	1.89
70	59.5	2.33	11.67	25.0	2.14	2.09
80	66.0	2.67	11.71	27.5	2.34	2.29
90	71.5	3.00	11.75	30.0	2.55	2.49
100	76.5	3.33	11.79	32.0	2.71	2.65
120	86.0	4.00	11.88	36.0	3.03	2.95
150	99.0	5.00	12.00	41.5	3.45	3.36
180	109.0	6.00	12.13	46.0	3.79	3.68
240	128.5	8.00	12.39	54.0	4.35	4.21
300	141.0	10.0	12.67	59.0	4.65	4.47
360	154.0	12.00	12.95	64.0	4.94	4.73
400	159.0	13.33	13.15	66.5	5.05	4.82
420	160.5	14.00	13.26	67.0	5.05	4.81
480	161.5	16.00	13.57	67.0	4.93	4.67

TABLE NO.(89)

DHANAURI CLAY

Horizontal Sample

Cell Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in ~~Reading~~ Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	6.0	0.33	11.44	2.5	0.219	0.209
20	25.0	0.67	11.48	10.5	0.915	0.905
30	35.0	1.00	11.52	14.5	1.26	1.240
40	94.0	1.33	11.55	18.5	1.60	1.570
50	51.5	1.67	11.59	21.5	1.86	1.830
60	58.5	2.00	11.63	24.5	2.11	2.070
70	64.0	2.33	11.67	26.5	2.27	2.220
90	75.5	3.00	11.75	31.5	2.68	2.620
120	90.0	4.00	11.88	37.5	3.16	3.080
150	101.5	5.00	12.00	42.5	3.54	3.450
180	112.0	6.00	12.13	47.0	3.88	3.770
240	129.0	8.00	12.39	54.0	4.36	4.22
300	144.5	10.0	12.67	60.0	4.74	4.56
360	157.5	12.0	12.95	65.5	5.06	4.85
420	169.0	14.0	13.26	70.6	5.32	5.08
480	178.5	16.0	13.57	74.5	5.49	5.23
520	182.5	17.33	13.80	76.0	5.51	5.25
540	183.0	18.00	13.90	76.1	5.48	5.19
600	182.5	20.00	14.25	76.0	5.15	4.84

TABLE NO.(90)

DHANAURI CLAY

Horizontal

Cell Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	12	0.33	11.44	2.0	0.175	0.17
20	47	0.67	11.48	9.5	0.828	0.82
30	60	1.00	11.52	12.5	1.09	1.07
40	75	1.33	11.55	14.5	1.26	1.23
50	89	1.67	11.59	18.5	1.60	1.57
60	99	2.00	11.63	20.5	1.76	1.72
70	107	2.33	11.67	22.5	1.93	1.88
80	120	2.67	11.71	25.0	2.14	2.09
90	132	3.00	11.75	27.1	2.31	2.25
100	144	3.33	11.79	29.0	2.46	2.40
120	161	4.00	11.88	33.5	2.82	2.74
150	183	5.00	12.00	38.0	3.17	3.08
180	204	6.00	12.13	42.5	3.50	3.39
240	237	8.00	12.39	49.5	4.00	3.86
300	263	10.0	12.67	54.5	4.30	4.12
360	283	12.0	12.95	59.0	4.56	4.35
390	290	13.0	13.10	60.5	4.62	4.40
420	290	14.0	13.26	60.5	4.56	4.32
440	278	14.67	13.37	58.0	4.34	4.09

TABLE NO.(91)

DHANAURI CLAY

Horizontal Sample

Cell Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	21	0.33	11.44	9.0	0.786	0.776
20	30.5	0.67	11.48	12.5	1.091	1.081
30	37.0	1.00	11.52	15.2	1.317	1.297
40	42.5	1.33	11.55	18.0	1.557	1.527
50	49.5	1.67	11.59	20.2	1.742	1.712
60	54.5	2.00	11.63	23.0	1.975	1.945
70	59.5	2.33	11.67	25.0	2.150	2.110
80	64.5	2.67	11.71	27.0	2.310	2.260
90	72.0	3.00	11.75	30.0	2.550	2.500
100	75.5	3.33	11.79	31.5	2.670	2.610
120	84.5	4.00	11.88	35.5	2.990	2.910
150	99.5	5.00	12.00	41.5	3.460	3.370
240	127.0	8.00	12.39	53.0	4.275	4.130
300	142.5	10.0	12.67	59.5	4.700	4.520
360	157.0	12.0	12.95	65.2	5.03	4.820
420	167.5	14.00	13.26	70.0	5.28	5.040
440	169.5	14.67	13.37	71.0	5.31	5.060
480	169.5	16.00	13.57	71.0	5.225	4.965
500	167.0	16.67	13.68	70.0	5.120	4.850

TABLE NO.(92)

BLACK COTTON

Vertical Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Strain P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	33	10.33	11.44	6.5	0.56	0.55
20	92	0.67	11.49	15.0	1.30	1.29
30	148	1.00	11.53	27.0	2.34	2.32
40	212	1.33	11.55	38.5	3.33	3.30
50	275	1.67	11.59	50.0	4.31	4.28
60	337	2.00	11.63	61.0	5.24	5.20
70	397	2.33	11.67	71.5	6.12	6.07
80	455	267	11.71	82.0	7.00	6.95
90	510	3.00	11.75	92.0	7.82	7.76
100	562	3.33	11.79	100.0	8.48	8.42
110	613	3.67	11.83	110.0	9.29	9.22
120	661	4.00	11.88	119.0	10.01	10.93
130	709	4.33	11.92	127.5	10.69	10.61
150	785	5.00	12.00	141.0	11.75	11.66
180	881	6.00	12.13	158.0	13.02	12.91
240	1015	8.00	12.39	182.0	14.68	14.54
280	1070	933	12.57	191.5	15.23	15.06
300	1077.5	10.00	12.67	193.0	15.23	15.05
360	1050.0	12.00	12.95	188.0	14.50	14.29

TABLE NO.(93)

BLACK COTTON

Vertical Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	32	10.33	11.44	6.0	0.52	0.51
20	58	0.67	11.49	11.0	0.95	0.94
30	112	1.00	11.53	20.5	1.77	1.75
40	175	1.33	11.55	32.0	2.77	2.74
50	237	1.67	11.59	43.0	3.71	3.68
60	293	2.00	11.63	53.0	4.55	4.51
70	346	2.33	11.67	62.5	5.35	5.30
80	400	2.67	11.71	72.1	6.15	6.10
90	452	3.00	11.75	81.5	6.93	6.87
100	498	3.33	11.79	89.8	7.61	7.55
110	544	3.67	11.83	97.00	8.19	8.12
120	584	4.00	11.88	105.0	8.83	8.75
130	623	4.32	11.92	112.0	9.39	9.31
140	656	4.67	11.95	118.0	9.87	9.78
150	688	5.00	12.00	123.5	10.29	10.20
180	748	6.00	17.13	134.0	11.04	10.93
220	784	7.33	12.31	141.0	11.45	11.32
240	768	8.00	12.39	138.0	11.13	10.99
260	718	8.67	12.48	129.0	10.33	10.17

TABLE NO.(94)

BALCK COTTON

Vertical Sample

Chamber Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	57.0	10.33	11.44	11.0	0.96	0.95
20	123.0	0.67	11.49	22.5	1.95	1.94
30	188.0	1.00	11.53	34.0	2.94	2.92
40	255.0	1.33	11.55	46.0	3.98	3.95
50	320.0	1.67	11.59	58.0	5.00	4.97
60	385.0	2.00	11.63	70.0	6.01	5.97
70	450.0	2.33	11.67	81.0	6.94	6.89
80	505.0	2.67	11.71	91.0	7.77	7.72
90	560.0	3.00	11.75	101.0	8.59	8.53
100	612.0	3.33	11.79	110.0	9.32	9.26
110	662.0	3.67	11.83	119.0	10.05	9.98
120	712.0	4.00	11.88	128.0	10.72	10.69
130	760.0	4.32	11.92	136.5	11.45	11.37
140	802.0	4.67	11.95	144.0	12.05	11.96
150	842.0	5.00	12.00	151.0	12.58	12.49
160	880.0	5.33	12.04	158.0	13.12	13.02
180	947.0	6.00	12.13	170.0	14.01	13.90
240	1063.0	8.00	12.39	190.0	15.33	15.19
300	1020.0	10.00	12.67	182.5	14.40	14.22

TABLE NO.(95)

BLACK COTTON

Vertical Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	87	0.33	11.44	16.0	1.39	1.38
20	172	0.67	11.49	31.2	2.71	2.70
30	250	1.00	11.53	45.0	3.90	3.88
40	324	1.33	11.55	58.5	5.06	5.03
50	392	1.67	11.59	71.0	6.12	6.09
60	461	2.00	11.63	83.0	7.13	7.09
70	525	2.33	11.67	94.5	8.09	8.04
80	585	2.67	11.71	105.2	8.98	8.93
90	646	3.00	11.75	116.0	9.87	9.81
100	705	3.33	11.79	126.5	10.72	10.66
110	760	3.67	11.83	136.2	11.51	11.44
120	812	4.00	11.88	145.5	12.24	12.16
130	861	4.33	11.92	154.5	12.96	12.88
140	910	4.67	11.95	163.0	13.64	13.55
150	960	5.00	12.00	172.0	14.33	14.24
180	1092	6.00	12.13	195.5	16.11	16.00
240	1290	8.00	12.39	230.5	18.60	18.46
300	1372	10.00	12.67	245.5	19.37	19.19
360	1326	12.00	12.95	237.0	18.30	18.09

TABLE NO. (96)

BLACK COTTON

Vertical Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	70	0.33	11.44	13.0	1.13	1.12
20	157	0.67	11.49	28.5	2.48	2.47
30	238	1.00	11.53	43.0	3.72	3.70
40	332	1.33	11.55	60.0	5.19	5.16
50	393	1.67	11.59	71.0	6.12	6.09
60	450	2.00	11.63	81.0	6.96	6.92
70	500	2.33	11.67	90.0	7.71	7.66
80	550	2.67	11.71	99.0	8.45	8.40
90	592	3.00	11.75	106.5	9.06	9.00
100	635	3.33	11.79	114.0	9.66	9.60
110	678	3.67	11.83	122.0	10.31	10.24
120	715	4.00	11.88	128.5	10.81	10.73
130	749	4.33	11.92	134.5	11.28	11.20
140	778	4.67	11.95	139.5	11.67	11.58
150	805	5.00	12.00	144.5	12.04	11.95
180	857	6.00	12.13	154.0	12.69	12.58
220	888	7.33	12.31	159.0	12.91	12.78
240	890	8.00	12.39	160.0	12.91	12.77
280	883.0	9.33	12.57	156.5	12.45	12.28

TABLE NO.(97)

BLACK COTTON

$22^1/2^o$ Sample

Cell Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	20.0	10.33	11.44	4.0	0.34	0.33
20	50.0	0.67	11.49	9.5	0.82	0.81
30	107.0	1.00	11.53	20.0	1.73	1.71
40	168.0	1.33	11.55	30.5	2.64	2.61
50	200.0	1.67	11.59	36.2	3.12	3.09
60	270.0	2.00	11.63	49.0	4.21	4.17
70	330.0	2.33	11.67	60.0	5.14	5.09
80	382.0	2.67	11.71	69.0	5.89	5.84
90	428.0	3.00	11.75	76.5	6.51	6.45
100	470.0	3.33	11.79	84.5	7.16	7.10
110	510.0	3.67	11.83	92.0	7.77	7.70
120	545.0	4.00	11.88	98.0	8.24	8.16
150	639.0	5.00	12.00	115.0	9.58	9.49
180	706.0	6.00	12.13	127.0	10.46	10.35
240	796.0	8.00	12.29	143.0	11.54	11.40
280	830.0	9.33	12.57	149.0	11.85	11.68
300	834.0	10.0	12.67	149.5	11.79	11.61
360	824.0	12.0	12.95	148.0	11.45	11.24
380	815.0	12.67	13.05	146.0	11.20	10.98

TABLE NO.(98)

BLACK COTTON

$22^{1}/2$ Sample

Cell Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	20.0	0.33	11.44	9.0	0.34	0.33
20	50.0	0.67	11.49	9.5	0.82	0.81
30	98.0	1.00	11.53	18.0	1.56	1.54
40	153.0	1.33	11.55	28.0	2.42	2.39
50	210.0	1.67	11.59	38.0	3.27	3.24
60	263.0	2.00	11.63	47.7	4.10	4.06
70	305.0	2.33	11.67	55.0	4.71	4.66
80	345.0	2.67	11.71	62.5	5.33	5.28
90	382.0	3.00	11.75	69.0	5.87	5.81
100	420.0	3.33	11.79	76.0	6.44	6.38
110	452.0	3.67	11.83	81.5	6.88	6.81
120	482.0	4.00	11.88	87.0	7.32	7.24
130	510.0	4.33	11.92	92.0	7.71	7.63
140	528.0	4.67	11.95	95.0	7.94	7.85
150	547.0	5.00	12.00	98.5	8.20	8.11
180	585.0	6.00	12.13	105.5	8.69	8.58
240	615.0	8.00	12.39	110.5	8.91	8.77
300	570.0	10.0	12.67	102.5	8.08	7.90
320	525.0	10.67	12.76	94.5	7.40	7.21

TABLE NO.(99)

BLACK COTTON

$22^1/2^o$ Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	10	0.33	11.44	2.0	0.17	0.16
20	38	0.67	11.49	7.0	0.60	0.59
30	92	1.00	11.53	17.0	1.47	1.45
40	153	1.33	11.55	28.0	2.42	2.39
50	215	1.67	11.59	39.0	3.36	3.33
60	280	2.00	11.63	50.5	4.34	4.30
70	347	2.33	11.67	62.5	5.35	5.30
80	390	2.67	11.71	70.5	6.02	5.97
90	432	3.00	11.75	78.0	6.63	6.57
100	485	3.33	11.79	87.5	7.42	7.36
110	540	3.67	11.83	97.5	8.24	8.17
120	585	4.00	11.88	105.0	8.83	8.75
130	635	4.33	11.92	114.0	9.56	9.48
150	715	5.00	12.00	128.5	10.70	10.61
180	856	6.00	12.13	153.5	12.65	12.54
240	1130	8.00	12.39	202.0	16.30	16.16
300	1268	10.0	12.67	226.5	17.87	17.69
320	1285.5	10.67	12.76	230.0	18.02	17.83
360	1225.0	12.00	12.95	218.5	16.90	16.69

TABLE NO.(100)

BLACK COTTON

$22^1/2^o$ Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	30	0.33	11.44	5.5	0.48	0.47
20	84	0.67	11.49	15.5	1.34	1.33
30	145	1.00	11.53	26.5	2.24	2.27
40	215	1.33	11.55	39.0	3.37	3.34
50	285	1.67	11.59	51.5	4.44	4.41
60	345	2.00	11.63	62.5	5.37	5.33
70	400	2.33	11.67	72.5	6.21	6.16
80	460	2.67	11.71	83.0	7.08	7.03
90	518	3.00	11.75	93.0	7.91	7.85
100	573	3.33	11.79	103.0	8.73	8.67
110	630	3.67	11.83	113.0	9.55	9.48
120	685	4.00	11.88	123.0	10.35	10.27
130	740	4.33	11.92	133.0	11.15	11.07
140	793	4.67	11.95	142.5	11.92	11.83
150	847	5.00	12.00	152.0	12.66	12.57
180	983	6.00	12.13	176.0	14.50	14.39
240	1217	8.00	12.39	217.0	17.51	17.37
280	1301	9.33	12.57	232.5	18.45	18.32
300	1270	10.0	12.67	227.0	17.91	17.73

TABLE NO.(101)

BLACK COTTON

$22^1/2^o$ Sample

Chamber Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	30	0.33	11.44	5.5	0.48	0.47
20	85	0.67	11.49	16.0	1.39	1.38
30	167	1.00	11.53	30.2	2.61	2.59
40	230	1.33	11.55	41.5	3.59	3.56
50	285	1.67	11.59	51.5	4.44	4.41
60	350	2.00	11.63	63.0	5.41	5.37
70	408	2.33	11.67	74.0	6.34	6.29
80	463	2.67	11.71	83.5	7.13	7.08
90	515	3.00	11.75	93.0	7.91	7.85
100	568	3.33	11.79	102.0	8.65	8.59
110	613	3.67	11.83	110.0	9.29	9.22
120	658	4.00	11.88	118.0	9.93	9.85
130	700	4.33	11.92	126.0	10.57	10.49
140	737	4.67	11.95	132.2	11.05	10.97
150	770	5.00	12.00	138.0	11.50	11.41
160	798	5.33	12.04	143.0	11.87	11.77
170	816	5.67	12.09	146.5	12.11	12.00

TABLE NO.(102)

BLACK COTTON

Chamber Pressure 2 kg/cm^2 45° Sample

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	15	0.33	11.44	3.0	0.26	0.25
20	30	0.67	11.49	5.5	0.47	0.46
30	60	1.00	11.53	11.5	0.99	0.97
40	118	1.33	11.55	21.5	1.86	1.83
50	175	1.67	11.59	32.0	2.76	2.73
60	233	2.00	11.63	42.0	3.61	3.57
70	290	2.33	11.67	52.5	4.49	4.44
80	344	2.67	11.71	63.00	5.38	5.33
90	400	3.00	11.75	22.5	6.17	6.11
100	450	3.33	11.79	81.0	6.87	6.81
110	498	3.67	11.83	89.5	7.56	7.49
120	547	4.00	11.88	98.5	8.29	8.21
130	592	4.33	11.92	106.5	8.93	8.85
150	672	5.00	12.00	121.0	10.08	9.99
180	773	6.00	12.13	138.5	11.41	11.30
240	900	8.00	12.39	161.5	13.03	12.89
280	929	9.33	12.57	166.5	13.24	13.07
300	924	10.0	12.67	165.5	13.02	12.84
340	898	11.33	12.86	161.0	12.51	12.31

TABLE NO.(103)

BLACK COTTON

45° Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	23	0.33	11.44	4.5	0.39	0.38
20	78	0.67	11.49	14.5	1.26	1.25
30	142	1.00	11.53	26.0	2.25	2.23
40	203	1.33	11.55	37.0	3.20	3.17
50	265	1.67	11.59	48.0	4.14	4.11
60	320	2.00	11.63	58.0	4.98	4.94
70	376	2.33	11.67	68.0	5.82	5.77
80	429	2.67	11.71	77.5	6.61	6.56
90	482	3.00	11.75	87.0	7.40	7.34
100	530	3.33	11.79	95.5	8.10	8.04
110	577	3.67	11.83	104.0	8.79	8.72
120	617	4.00	11.88	111.0	9.34	9.26
130	652	4.33	11.92	117.0	9.81	9.73
140	688	4.67	11.95	123.5	10.33	10.24
150	715	5.00	12.00	128.5	10.70	10.61
180	774	6.00	12.13	139.0	11.45	11.34
200	785	6.67	12.22	141.0	11.53	11.41
240	746	8.00	12.39	134.0	10.81	10.67
260	724	8.67	12.48	130.0	10.26	10.10

TABLE NO.(104)

BLACK COTTON

45° Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	49	0.33	11.44	9.0	0.78	0.77
20	112	0.67	11.49	20.5	1.78	1.77
30	180	1.00	11.53	32.5	2.81	2.79
40	257	1.33	11.55	46.5	4.02	3.99
50	315	1.67	11.59	57.0	4.91	4.88
60	375	2.00	11.63	68.0	5.84	5.80
70	438	2.33	11.67	79.0	6.76	6.71
80	495	2.67	11.71	89.0	7.60	7.55
90	550	3.00	11.75	99.0	8.42	8.36
100	602	3.33	11.79	108.5	9.20	9.14
110	652	3.67	11.83	117.0	9.89	9.82
120	700	4.00	11.88	125.510.56		10.48
130	742	4.33	11.92	133.0	11.15	11.07
150	816	5.00	12.00	146.5	12.20	12.11
180	915	6.00	12.13	164.0	13.52	13.41
240	1043	8.00	12.39	186.5	15.05	14.91
280	1098	9.33	12.57	196.5	15.63	15.46
300	1107.5	10.0	12.67	198.0	15.62	15.44
360	1067.0	12.0	12.95	191.0	14.75	14.54

TABLE NO.(105)

BLACK COTTON

45° Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	32	0.33	11.44	6.0	0.52	0.51
20	100	0.67	11.49	18.5	1.61	1.60
30	165	1.00	11.53	30.0	2.60	2.58
40	227	1.33	11.55	41.0	3.54	3.51
50	287	1.67	11.59	52.0	4.48	4.45
60	343	2.00	11.63	62.5	5.37	5.33
70	395	2.33	11.67	71.5	6.12	6.07
80	446	2.67	11.71	80.0	6.83	6.78
90	490	3.00	11.75	88.2	7.50	7.44
100	535	3.33	11.79	96.2	8.15	8.09
110	572	3.67	11.83	103.0	8.70	8.63
120	608	4.00	11.88	109.5	9.21	9.13
130	637	4.33	11.92	114.5	9.60	9.52
140	660	4.67	11.95	118.5	9.91	9.82
150	680	5.00	12.00	122.0	10.16	10.07
160	693	5.33	12.04	125.0	10.38	10.28
180	714	6.00	12.13	128.0	10.55	10.44
240	751.0	8.00	12.39	135.0	10.89	10.75
300	730	10.0	12.67	131.0	10.33	10.15

TABLE NO.(106)

BLACK COTTON

45^{o} Sample

Chamber Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	40	0.33	11.44	7.5	0.65	0.64
20	85	0.67	11.49	16.0	1.39	1.38
30	140	1.00	11.53	25.5	2.21	2.19
40	195	1.33	11.55	35.5	3.07	3.04
50	260	1.67	11.59	47.0	4.05	4.02
60	307	2.00	11.63	55.5	4.77	4.73
70	355	2.33	11.67	64.0	5.48	5.43
80	400	2.67	11.71	72.0	6.14	6.09
90	442	3.00	11.75	80.0	6.80	6.74
100	480	3.33	11.79	86.5	7.33	7.27
110	510	3.67	11.83	92.0	7.77	7.70
120	535	4.00	11.88	96.0	8.08	8.00
130	551	4.33	11.92	100.0	8.38	8.30
140	568	4.67	11.95	102.0	8.53	8.44
150	577	5.00	12.00	104.0	8.66	8.57
160	584	5.33	12.04	105.0	8.72	8.62
180	591.0	6.00	12.13	106.5	8.77	8.66
240	590.0	8.00	12.39	106.0	8.55	8.41
300	580.0	10.0	12.67	104.5	8.25	8.07

TABLE NO.(107)

BLACK COTTON

$67^1/2^o$ Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	18.0	0.33	11.44	3.5	0.30	0.29
20	81.0	0.67	11.49	15.0	1.30	1.29
30	142.0	1.00	11.53	26.0	2.25	2.23
40	202.0	1.33	11.55	36.5	3.16	3.13
50	262.0	1.67	11.59	48.0	4.14	4.11
60	320.0	2.00	11.63	58.0	4.98	4.94
70	375.0	2.33	11.67	68.0	5.82	5.77
80	428.0	2.67	11.71	77.0	6.57	6.52
90	483.0	3.00	11.75	87.0	7.40	7.34
100	534.0	3.33	11.79	96.0	8.14	8.08
110	584.0	3.67	11.83	105.0	8.87	8.80
120	627.0	4.00	11.88	112.5	9.46	9.38
150	752.0	5.00	12.00	135.0	11.25	11.16
180	857.0	6.00	12.13	153.5	12.65	12.54
240	974.0	8.00	12.39	174.5	14.08	13.94
280	998.0	9.33	12.57	178.8	14.30	14.13
360	992	12.00	12.95	178.0	13.75	13.54
380	983	12.67	13.05	176.0	13.50	13.28

TABLE NO.(108)

BLACK COTTON

$67^1/2^o$ Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	40	0.33	11.44	7.5	0.65	0.64
20	98	0.67	11.48	18.0	1.56	1.55
30	155	1.00	11.53	27.0	2.34	2.32
40	213	1.33	11.55	38.5	3.33	3.30
50	271	1.67	11.59	49.0	4.22	4.19
60	325	2.00	1.63	59.0	5.07	5.03
70	378	2.33	11.67	68.0	5.82	5.77
80	428	2.67	11.71	77.0	6.57	6.52
90	478	3.00	11.75	86.0	7.31	7.25
100	525	3.33	11.79	94.5	8.01	7.95
110	570	3.67	11.83	102.5	8.66	8.59
120	610	4.00	11.88	110.0	9.25	9.17
130	648	4.33	11.92	116.5	9.77	9.69
140	684	4.67	11.95	123.0	10.29	10.20
150	707	5.00	12.00	127.0	10.58	10.49
180	797	6.00	12.13	143.0	11.78	11.67
220	840	7.33	12.31	151.0	12.26	12.13
240	848	8.00	12.39	152.0	12.26	12.12
300	818.0	10.0	12.67	146.5	11.56	11.38

TABLE NO.(109)

BLACK COTTON

$67^1/2^o$ Sample

Cell Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	25	0.33	11.44	5.0	0.43	0.42
20	78	0.67	11.49	14.5	1.26	1.25
30	145	1.00	11.53	26.5	2.29	2.27
40	210	1.33	11.55	38.0	3.29	3.26
50	275	1.67	11.59	50.0	4.31	4.28
60	340	2.00	11.63	61.5	5.28	5.24
70	398	2.33	11.67	72.0	6.16	6.11
80	460	2.67	11.71	83.0	7.08	7.03
90	520	3.00	11.75	93.5	7.95	7.89
100	578	3.33	11.79	104.0	8.82	8.76
110	634	3.67	11.83	114.0	9.63	9.56
120	688	4.00	11.88	123.5	10.39	10.31
130	742	4.33	11.92	133.0	11.15	11.07
140	790	4.67	11.95	142.0	11.88	11.79
150	835	5.00	12.00	150.0	12.50	12.41
180	956	6.00	12.13	171.0	14.09	13.98
240	1141	8.00	12.39	204.0	16.46	16.32
300	1227	10.0	12.67	218.5	17.24	17.06
380	1215	12.67	13.05	217	16.65	16.43

TABLE NO.(110)

BLACK COTTON

$67^1/2^o$ Sample

Cell Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	17	0.33	11.44	3.5	0.30	0.29
20	89	0.67	11.49	16.5	1.43	1.42
30	160	1.00	11.53	29.0	2.51	2.49
40	225	1.33	11.55	41.0	3.54	3.51
50	293	1.67	11.59	53.0	4.57	4.54
60	358	2.00	11.63	65.0	5.58	5.54
70	423	2.33	11.67	76.1	6.52	6.47
80	485	2.67	11.71	87.5	7.47	7.42
90	544	3.00	11.75	98.0	8.34	8.28
100	605	3.33	11.79	109.0	9.24	9.18
110	665	3.67	11.83	119.5	10.10	10.03
120	724	4.00	11.88	130.0	10.94	10.86
130	775	4.33	11.92	139.0	11.66	11.58
150	875	5.00	12.00	157.0	13.08	12.99
180	1017	6.00	12.13	182.2	15.02	14.91
240	1255	8.00	12.39	223	17.99	17.85
300	1370	10.0	12.67	245	19.33	19.15
320	1350	10.67	12.76	241.5	18.92	18.73

TABLE NO.(112)

BLACK COTTON

Horizontal Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	35	0.33	11.44	7.0	0.61	0.60
20	65	0.67	11.49	12.0	1.04	1.03
30	128	1.00	11.53	23.5	2.03	2.01
40	202	1.33	11.55	36.5	3.16	3.13
50	265	1.67	11.59	48.0	4.14	4.11
60	340	2.00	11.63	61.5	5.82	5.78
70	400	2.33	11.63	72.0	6.16	6.11
80	465	2.67	11.71	84.0	7.17	7.12
90	524	3.00	11.75	94.5	8.04	7.98
100	584	3.33	11.99	105.0	8.90	8.84
110	640	3.67	11.83	115.0	9.72	9.65
120	693	4.00	11.88	125.0	10.52	10.44
130	739	4.33	11.92	132.5	11.11	11.03
150	822	5.00	12.00	147.5	12.29	12.20
180	927	6.00	12.13	166.0	13.68	13.57
240	1063	8.00	12.39	190.0	15.33	15.19
300	1126	10.0	12.67	201.5	15.90	15.72
360	1131.0	12.0	12.95	202.5	15.63	15.42
400	1112.0	13.33	13.15	198.5	15.10	14.87

TABLE NO.(111)

BLACK COTTON

$67^{1}/2^{o}$ Sample

Cell Pressure 0.5 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	30	0.33	11.44	5.5	0.48	0.47
20	93	0.67	11.49	17.2	1.49	1.48
30	155	1.00	11.53	28.1	2.43	2.41
40	220	1.33	11.55	40.0	3.46	3.43
50	282	1.67	11.59	51.0	4.40	4.37
60	345	2.00	11.63	62.5	5.37	5.33
70	405	2.33	11.67	73.0	6.25	6.20
80	465	2.67	11.71	84.0	7.17	7.12
90	520	3.00	11.75	93.5	7.95	7.90
100	573	3.33	11.79	103.0	8.73	8.67
110	618	3.67	11.83	111.0	9.38	9.31
120	662	4.00	11.88	119.0	10.01	9.93
130	700	4.33	11.92	126.0	10.57	10.49
140	734	4.67	11.95	132.0	11.04	10.95
150	770	5.00	12.00	138.0	11.50	11.41
180	853	6.00	12.13	153.0	12.61	12.50
220	908	7.33	12.31	163.0	13.24	13.11
240	918	8.00	12.39	164.5	13.27	13.13
300	853	10.00	12.67	153.0	12.07	11.89

TABLE NO.(112)

BLACK COTTON

Horizontal Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	35	0.33	11.44	7.0	0.61	0.60
20	65	0.67	11.49	12.0	1.04	1.03
30	128	1.00	11.53	23.5	2.03	2.01
40	202	1.33	11.55	36.5	3.16	3.13
50	265	1.67	11.59	48.0	4.14	4.11
60	340	2.00	11.63	61.5	5.82	5.78
70	400	2.33	11.63	72.0	6.16	6.11
80	465	2.67	11.71	84.0	7.17	7.12
90	524	3.00	11.75	94.5	8.04	7.98
100	584	3.33	11.99	105.0	8.90	8.84
110	640	3.67	11.83	115.0	9.72	9.65
120	693	4.00	11.88	125.0	10.52	10.44
130	739	4.33	11.92	132.5	11.11	11.03
150	822	5.00	12.00	147.5	12.29	12.20
180	927	6.00	12.13	166.0	13.68	13.57
240	1063	8.00	12.39	190.0	15.33	15.19
300	1126	10.0	12.67	201.5	15.90	15.72
360	1131.0	12.0	12.95	202.5	15.63	15.42
400	1112.0	13.33	13.15	198.5	15.10	14.87

TABLE NO.(113)

BLACK COTTON

Horizontal Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	39.0	0.33	11.44	7.5	0.65	0.64
20	100.0	0.67	11.49	18.5	1.61	1.60
30	170.0	1.00	11.53	31.0	2.68	2.66
40	240.0	1.33	11.55	43.5	3.76	3.73
50	310.0	1.67	11.59	56.0	4.83	4.80
60	376.0	2.00	11.63	68.0	5.84	5.80
70	440.0	2.33	11.67	79.5	6.81	6.76
80	505.0	2.67	11.71	91.0	7.77	7.72
90	565.0	3.00	11.75	102.0	8.68	8.62
100	620.0	3.33	11.79	111.5	9.45	9.39
110	675.0	3.67	11.83	121.2	10.24	10.17
120	725.0	4.00	11.88	130.0	10.94	10.86
130	772.0	4.33	11.92	138.5	11.61	11.53
150	852.0	5.00	12.00	153.0	12.75	12.66
180	958.0	6.00	12.13	171.5	14.13	14.03
240	1100.0	8.00	12.39	197.0	15.89	15.75
280	1141.0	933	12.59	204.0	16.22	16.05
300	1134.0	10.0	12.67	203.0	16.02	15.84
320	1092.0	10.67	12.76	195.0	15.28	15.09

TABLE NO.(114)

BLACK COTTON

Horizontal Sample

Chamber Pressure 2 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	57	0.33	11.44	11.0	0.96	0.95
20	118	0.67	11.49	21.5	1.87	1.86
30	176	1.00	11.53	32.00	2.77	2.75
40	231	1.33	11.55	42.0	3.63	2.60
50	285	1.67	11.59	51.5	4.44	4.41
60	334	2.00	11.63	60.0	5.15	5.11
70	385	2.33	11.67	70.0	5.99	5.94
80	433	2.67	11.71	78.0	6.66	6.61
90	482	3.00	11.75	87.0	7.40	7.34
100	520	3.33	11.79	93.5	7.93	7.87
110	558	3.67	11.83	100.0	8.45	8.38
120	594	4.00	11.88	107.0	9.00	8.92
130	630	4.33	11.92	113.0	9.47	9.39
150	696	5.00	12.00	125.0	10.41	10.32
180	775	6.00	12.13	139.0	11.45	11.34
240	859	8.00	12.39	154.0	12.42	12.28
280	881	9.33	12.57	158.0	12.56	12.39
300	877	10.0	12.67	157.0	12.39	12.21
320	854	10.67	12.76	153.0	11.99	11.80

TABLE NO.(115)

BLACK COTTON

Horizontal Sample

Chamber Pressure 1 kg/cm^2

Strain Dial Reading	Proving Ring Reading	Strain in Pctg.	Area A	Load P	Stress P/A	Corrected P/A
0	0	0	11.40	0	0	0
10	72	0.33	11.44	13.5	1.18	1.17
20	172	0.67	11.49	31.2	2.71	2.70
30	243	1.00	11.53	44.0	3.81	3.79
40	332	1.33	11.55	60.0	5.19	5.16
50	397	1.67	11.59	72.0	6.21	6.18
60	440	2.00	11.63	79.5	6.83	6.79
70	500	2.33	11.67	90.0	7.71	7.66
80	556	2.67	11.71	100.0	8.53	8.48
90	604	3.00	11.75	108.5	9.23	9.17
100	640	3.33	11.79	115.0	9.75	9.69
110	680	3.67	11.83	122.0	10.31	10.24
120	740	4.00	11.88	133.0	11.19	11.11
150	895	5.00	12.00	160.5	13.37	13.28
180	1025	6.00	12.13	183.5	15.12	15.01
240	1127	8.00	12.39	201.5	16.26	16.12
300	1208	10.00	12.67	216.0	17.04	16.86
340	1236	11.33	12.86	221.0	17.18	16.98
360	1240	12.00	12.95	221.5	17.10	16.89
420	1140	14.00	13.26	204.0	15.35	15.11

Table - 118 SUMMARY OF RESULTS KAOLIN

No.	Orientation	C_u Kg/cm^2	ε_f (percent)	m.c. (percent)	γ_d gm/cc	E_{50} Kg/cm^2	t_f minutes	α degrees	Energy Kg/cm^2	$\frac{\text{Energy}}{(\sigma_1-\sigma_3)_f}$
1	Vertical	1.95	12.00	25.5	1.36	0.524	13.4	66	30.2	7.75
		1.95	12.00	26.5	1.36	0.524	13.4	65	30.6	7.85
		2.37	14.67	26.0	1.36	0.484	17.6	64	44.0	9.30
		2.70	13.33	26.0	1.36	0.710	16.0	65	43.5	8.05
		2.56	12.00	26.5	1.36	0.640	14.4	63	38.6	7.54
		2.05	12.67	26.0	1.36	0.370	15.2	64	27.1	6.61
	Average	2.26	12.78	26.25	1.36	0.542	15.0	64.5	35.67	7.90
2	22½°	1.97	8.67	26.5	1.36	0.660	10.4	60	25.6	6.50
		2.52	12.67	26.5	1.36	.645	15.2	58	35.0	6.95
		2.25	11.33	26.5	1.36	.703	13.6	65	33.8	7.51
		1.95	8.00	27.0	1.34	1.390	9.6	60	23.6	6.05
		2.01	9.33	25.5	1.36	.805	11.2	62	23.5	5.85
		1.89	9.67	26.0	1.36	0.630	11.5	62	25.3	6.70
	Average	2.10	9.945	26.33	1.36	0.605	10.26	61.1	27.8	6.62
3	45°	1.78	6.67	25.7	1.36	0.742	8.0	59	14.40	4.04
		1.74	9.33	25.5	1.36	0.458	11.2	55	17.25	4.96
		2.04	10.0	25.5	1.36	0.567	12.0	53	26.55	6.51
		1.31	7.33	25.5	1.36	1.000	8.0	56	17.40	4.81
		1.30	11.33	25.5	1.36	0.352	13.6	59	17.50	6.74
	Average	1.73	8.93	25.54	1.36	0.624	10.72	56.4	18.62	5.38

[table contd..]

[Table 118 contd..]

No.	Orientation	C_u Kg/cm^2	ε_f (percent)	m.c. (percent)	γ_d gm/cc	E_{50} Kg/cm^2	t_f minutes	α degrees	Energy Kg/cm^2	$\frac{\text{Energy}}{(\sigma_1-\sigma_3)_f}$
4	$67\frac{1}{2}^\circ$	1.93	9.33	26.5	1.36	0.742	11.2	60	25.5	6.61
		2.00	10.00	26.5	1.36	0.715	12.0	61	28.3	7.08
		2.68	13.33	26.5	1.36	0.654	16.0	59	46.7	8.71
		2.12	11.33	26.0	1.36	0.473	13.6	63	28.8	6.80
		1.97	13.33	26.0	1.36	0.520	16.0	64	32.6	8.28
	Average	2.14	11.46	26.3	1.36	0.621	13.76	61.4	32.4	7.57
5	Horizontal	2.24	11.67	26.5	1.36	0.723	14.0	63	35.8	8.00
		2.16	11.00	26.5	1.36	0.655	13.2	60	31.0	7.18
		2.16	14.00	26.0	1.36	0.702	16.6	62	44.0	10.19
		1.70	10.00	26.5	1.36	0.708	12.0	65	23.0	5.77
		2.16	9.33	26.5	1.36	0.744	11.2	61	26.6	6.16
		2.14	14.00	26.5	1.36	0.465	16.6	64	28.5	6.66
	Average	2.09	11.57	26.41	1.36	0.666	13.93	62.5	31.5	7.55

Average α = 61.0°

Table - 119 SUMMARY OF RESULTS Bentonite

No.	Orientation	C_u Kg/cm^2	ε_f (percent)	m.c. (percent)	γ_d gm/cm^3	E_{50} kg/cm^2	t_f minutes	α degrees	Energy kg/cm^2	$\frac{\text{Energy}}{(\sigma_1-\sigma_3)_f}$
1	Vertical	2.08	10.00	40.0	1.224	1.100	12.0	57	32.2	7.75
		2.19	10.67	40.0	1.224	0.910	12.8	55	34.3	7.85
		2.26	13.33	39.0	1.223	0.670	16.0	53	42.4	9.38
		1.95	14.33	40.0	1.224	0.673	17.5	52	37.0	9.50
		2.10	10.67	40.0	1.224	1.050	12.8	51	31.8	7.58
		1.80	11.33	40.0	1.224	0.947	10.6	52	30.6	8.50
	Average	2.05	11.69	39.63	1.224	0.891	13.63	53.3	34.70	8.42
2.	$22^1/2^0$	1.66	10.00	40.0	1.224	0.760	12.0	51	26.9	8.10
		1.55	10.67	40.0	1.224	1.040	13.5	52	26.7	8.05
		1.66	10.67	40.0	1.224	1.040	12.8	52	27.9	8.40
		1.78	7.33	40.0	1.224	1.365	8.8	53	19.4	5.45
		1.59	7.00	40.0	1.224	1.370	8.4	54	16.7	5.25
		1.55	10.0	40.0	1.224	0.750	12.0	51	23.0	6.97
		1.85	8.00	40.0	1.224	1.060	9.5	52	20.5	5.54
	Average	1.69	9.07	40.0	1.224	1.056	11.03	52.3	23.01	6.80
3	45^0	1.53	10.67	40	1.224	1.03	12.8	52	25.60	8.37
		1.84	11.33	40	1.224	1.22	13.6	55	35.00	9.51
		1.96	10.67	39	1.223	1.40	12.8	58	33.80	8.62
		1.88	10.00	40	1.224	0.81	12.0	57	26.0	6.92
		1.96	10.67	40	1.224	1.03	12.8	53	31.30	8.00
		1.92	7.33	40	1.224	2.14	8.8	54	20.20	5.26
		1.62	6.00	40	1.224	1.62	7.2	55	14.55	4.50
		1.96	6.00	39	1.223	1.63	7.2	56	16.65	4.25
	Average	1.83	9.07	40	1.224	1.36	10.65	54.6	25.40	6.94

[table contd..]

[Table 11 contd..]

No.	Orientation	σ_u kg/cm^2	ε_f (percent)	m.c. (percent)	γ_d gm/cm^3	E_{50} kg/cm^2	t_f minutes	α degree	Energy kg/cm^2	Energy / $(\sigma_1-\sigma_3)_f$
4	$67\frac{1}{2}$	1.88	10.00	40.5	1.224	0.90	12.0	55	28.6	7.60
		1.92	8.67	40.5	1.224	0.92	10.4	53	24.6	6.41
		2.02	15.33	40.5	1.224	0.96	18.4	55	50.5	12.50
		2.23	13.33	40.0	1.224	0.79	16.0	54	43.0	9.44
		2.02	9.33	40.0	1.224	0.84	11.2	53	25.9	6.42
	Average	2.02	11.27	40.3	1.224	0.882	13.60	54.4	34.52	8.55
5	Horizontal	1.55	6.67	40.0	1.224	1.03	8.0	51	15.4	4.98
		1.92	11.33	40.0	1.224	1.01	13.6	50	34.6	9.01
		2.16	13.33	40.0	1.224	0.80	16.0	54	43.0	9.96
		2.19	10.00	40.0	1.224	1.10	12.0	54	34.5	7.90
		2.26	10.00	41.0	1.224	0.87	12.0	54	33.8	7.48
		2.35	10.00	39.5	1.224	1.02	12.0	56	33.4	7.10
		1.86	10.67	40.0	1.224	0.85	12.8	59	27.8	7.49
	Average	2.04	10.29	40.0	1.224	.954	12.34	54.0	31.80	7.80

Average $\alpha = 54^\circ$

Table - 120 SUMMARY OF RESULTS Dhanauri Clay

No	Orientation	C_u kg/cm^2	ϵ_f (percent)	m.c. (percent)	γ_d gm/cm^3	E_{50} kg/cm^2	t_f minutes	α degrees	Energy kg/cm^2	Energy / $(\sigma_1-\sigma_3)_f$
1	Vertical	2.59	15.00	23.3	1.58	0.62	18.00	63	54.7	10.55
		2.90	14.67	23.3	1.58	0.81	16.00	63	61.0	10.50
		2.04	16.00	23.6	1.58	0.37	19.20	64	51.6	12.65
		2.49	13.00	23.0	1.58	0.83	15.60	63	52.5	10.55
		2.94	14.33	23.5	1.58	1.10	17.20	63	61.5	10.45
	Average	2.59	14.6	23.3	1.58	0.746	17.2	63.2	56.26	10.85
2	$22^1/2^{\circ}$	1.70	13.00	23.2	1.58	0.65	15.60	65	35.2	10.35
		2.29	12.00	23.3	1.58	0.85	12.00	60	38.6	8.44
		2.62	16.00	23.5	1.58	0.87	19.20	63	62.0	11.82
		.11	17.00	23.6	1.58	0.86	20.40	53	66.0	13.70
		1.72	13.00	23.2	1.58	0.47	15.60	62	30.6	8.90
		3.00	14.67	23.2	1.58	1.15	17.60	63	58.5	9.75
	Average	2.15	14.2	23.36	1.58	0.740	16.36	62.5	46.5	10.80
3	45°	2.43	13.00	23.0	1.58	0.79	15.60	61	49.0	10.05
		2.07	16.00	23.3	1.58	0.70	19.20	63	61.0	14.72
		2.19	15.00	23.3	1.58	0.51	18.00	64	44.0	10.05
		2.15	14.00	23.2	1.58	0.91	16.80	63	47.3	11.05
		2.33	16.00	23.2	1.58	0.60	19.20	62	51.0	10.95
		2.20	15.33	23.2	1.58	0.70	18.40	64	53.3	12.10
		2.45	3.67	23.2	1.58	0.94	10.40	63	26.5	5.41
	Average	2.26	14.00	23.2	1.58	0.735	16.8	62.86	47.0	10.40

[table contd..]

[table 120 contd..]

No.	Orientation	σ_u kg/cm^2	ϵ_f (percent)	c.m. (percent)	γ_d gm/cm^3	E_{50} kg/cm^2	t_f minutes	α degrees	Energy kg/cm^2	Energy $(\sigma_1-\sigma_3)_f$
		2.19	12.33	24.0	1.575	0.59	14.80	62	42.4	9.70
		2.35	15.33	24.0	1.575	0.51	18.40	60	50.0	10.62
4	$67\frac{1}{2}^{\circ}$	2.43	16.33	23.9	1.578	0.50	19.60	65	71.5	14.70
		2.15	15.00	23.2	1.580	0.53	18.00	54	43.0	10.00
		2.96	12.00	23.2	1.580	0.96	14.40	63	48.6	8.21
		3.15	19.33	23.2	1.580	0.85	23.20	62	87.0	13.80
	Average	2.54	15.05	23.60	1.578	0.657	18.07	62.7	57.08	11.21
		2.53	14.33	23.6	1.58	0.79	17.20	61	54.8	10.81
5	horizontal	2.20	13.00	23.0	1.58	0.76	15.60	60	43.0	9.77
		2.61	18.33	23.2	1.58	0.67	21.60	62	66.8	12.80
		2.41	13.33	23.2	1.58	0.86	16.00	63	43.2	8.96
	Average	2.44	14.75	23.2	1.58	0.770	17.60	61.5	51.56	10.60

Average value of α = 62.56°

Table - 121 SUMMARY OF RESULTS Black Cotton Soil

No.	Orientation	C_u kg/cm^2	ε_f (percent)	m.c. (percent)	γ_d gm/cm^3	E_{50} kg/cm^2	t_f minutes	α degrees	Energy gm/cm^2	Energy / $(\sigma_1-\sigma_3)_f$
1	Vertical	9.60	10.00	20	1.612	3.20	12.0	55	135.0	7.04
		6.39	7.33	20	1.612	3.36	8.8	55	66.5	5.20
		7.53	9.33	20	1.612	2.51	11.2	51	92.2	6.12
		5.67	7.33	20.0	1.612	2.27	8.8	59	53.8	4.75
		7.60	8.00	19.5	1.612	2.86	9.6	59	76.7	5.05
	Average	7.36	8.40	20.0	1.612	2.84	10.08	55.8	84.84	5.83
2	$22^1/2^\circ$	5.84	9.33	20.0	1.612	2.16	11.2	58	71.0	6.10
		4.39	8.00	20.0	1.612	1.91	9.6	57	49.8	5.68
		6.00	5.67	20.0	1.612	2.14	6.8	57	40.3	3.36
		9.16	9.33	20.0	1.612	2.54	11.2	57	103.0	5.62
		8.92	10.67	19.0	1.614	2.12	12.8	56	116.0	6.50
	Average	6.86	8.60	19.5	1.612	2.17	10.32	57	76.0	5.45
3	45°	5.70	6.67	20.0	1.612	2.54	8.0	57	46.5	4.08
		6.55	8.67	20.0	1.612	2.08	10.4	56	67.5	5.15
		4.33	6.00	19.0	1.614	2.28	7.2	60	33.8	3.90
		5.37	8.00	20.0	1.612	2.68	9.6	53	61.5	5.73
		7.73	9.33	20.0	1.612	2.67	11.2	55	94.7	6.12
	Average	5.94	7.73	19.8	1.612	2.45	7.28	56.6	60.8	5.00

[table contd..]

[table 121 contd..]

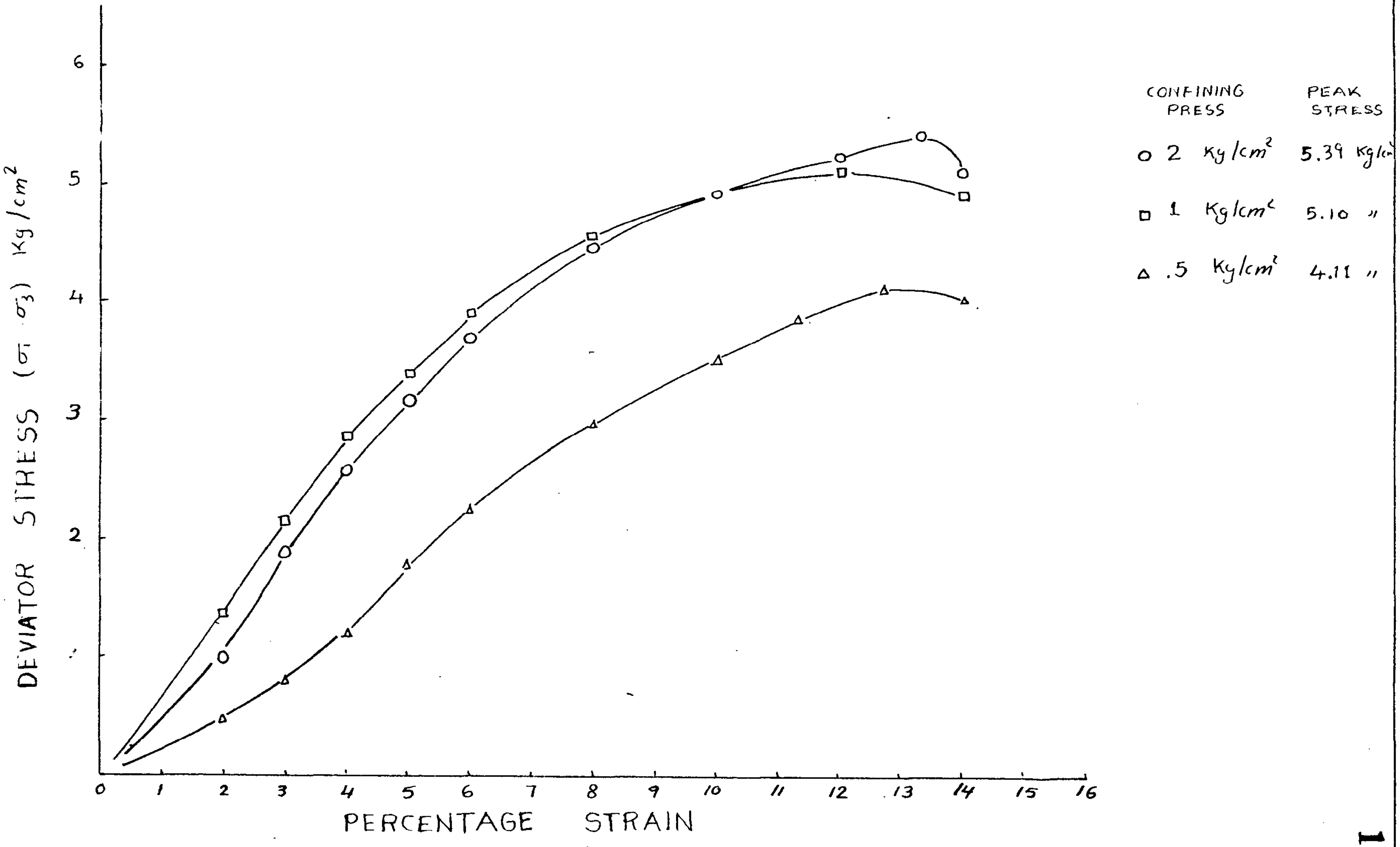
No.	Orientation	C_u kg/cm^2	ε_f (percent)	m.c. (percent)	γ_d gm/cm^3	E_{50} kg/cm^2	t_f minutes	α degrees	Energy gm/cm^2	Energy $(\sigma_1-\sigma_3)_f$
		6.06	7.33	19.0	1.614	2.62	8.8	50	54.9	4.52
		7.06	9.33	20.0	1.612	2.35	11.2	59	85.3	6.03
4	$67^1/2^o$	6.56	8.00	20.0	1.612	2.67	9.6	57	69.0	5.25
		9.57	10.00	19.5	1.614	2.64	12.0	55	120.0	6.26
		8.53	10.0	20.0	1.612	2.67	12.0	55	112.0	6.56
	Average	7.56	8.93	19.7	1.613	2.59	10.72	55.2	88.24	5.72
		8.02	9.33	20.0	1.612	2.87	11.2	55	100.0	6.23
		7.86	10.0	20.0	1.612	2.72	12.0	53	107.0	7.38
5	Horizontal	8.49	11.33	19.0	1.614	3.03	13.6	61	142.0	8.38
		6.19	9.33	19.0	1.614	2.38	11.2	57	82.6	6.68
	Average	7.64	10.0	19.6	1.613	2.75	12.0	56.5	107.9	7.27

Average $\alpha=56^o$

KAOLIN

FIG 4.1

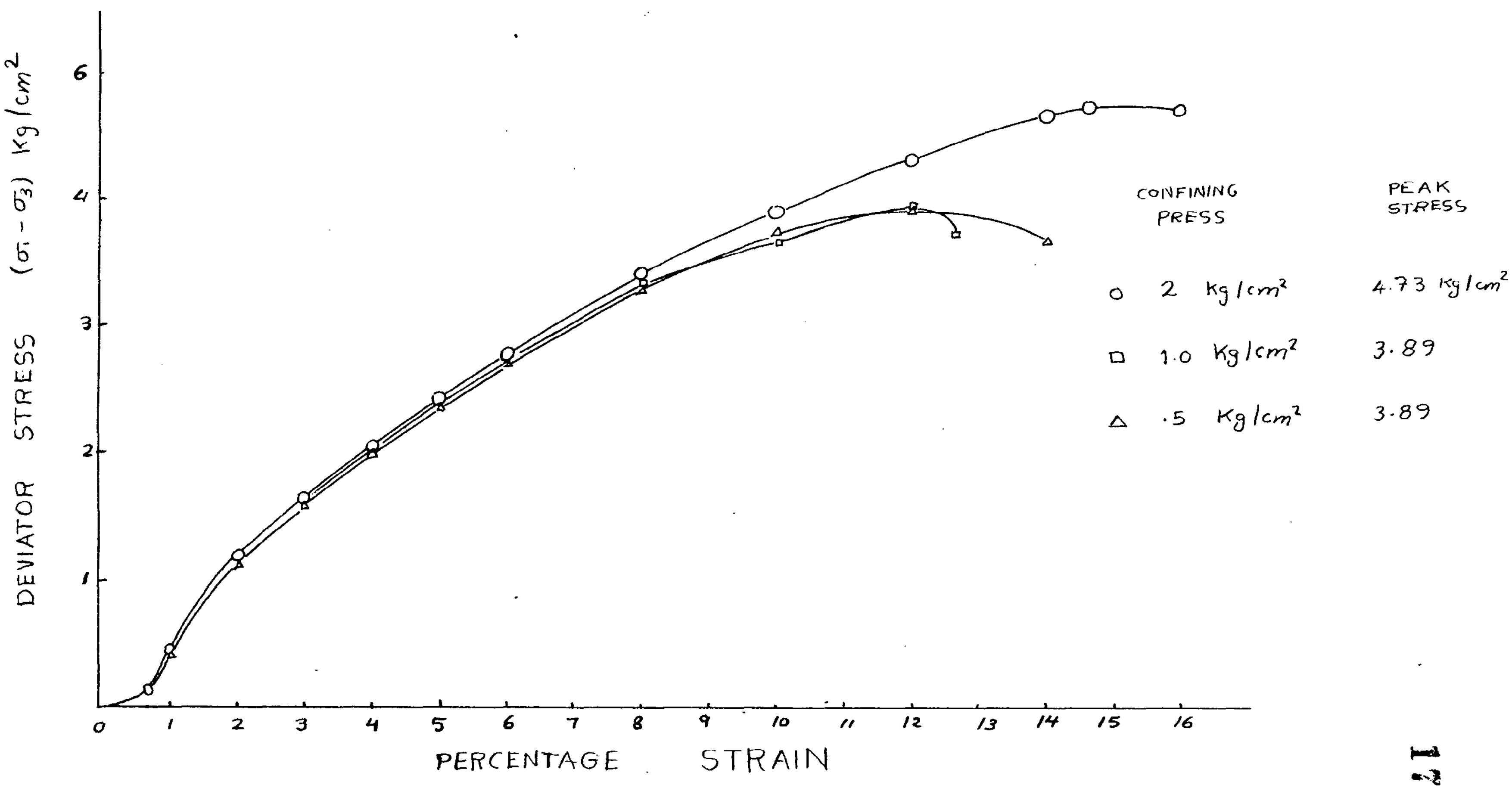
VERTICAL SAMPLE



KAOLIN

FIG 4.2

VERTICAL SAMPLE



KAOLIN

FIG 4.3

22.5° SAMPLE

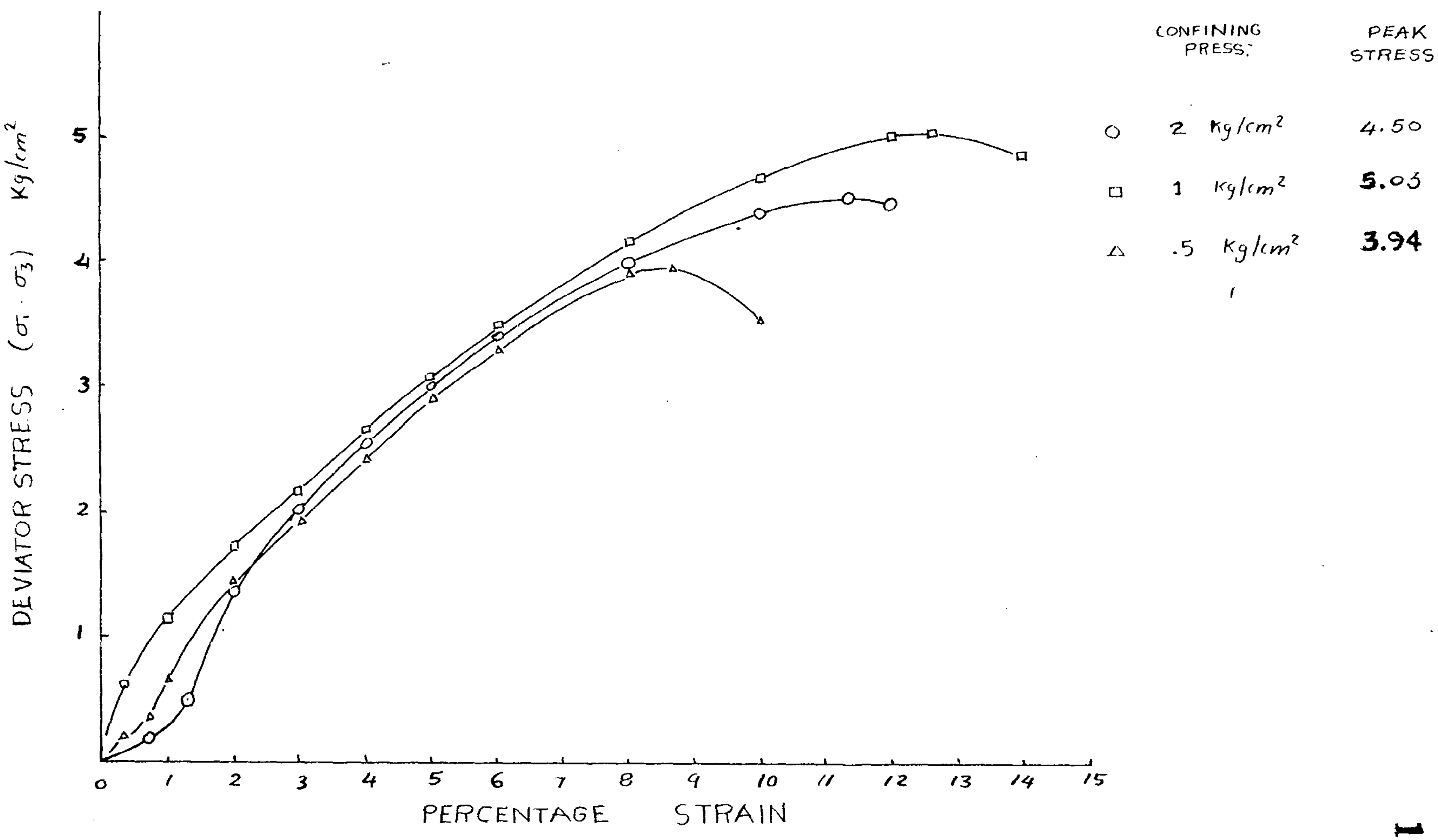
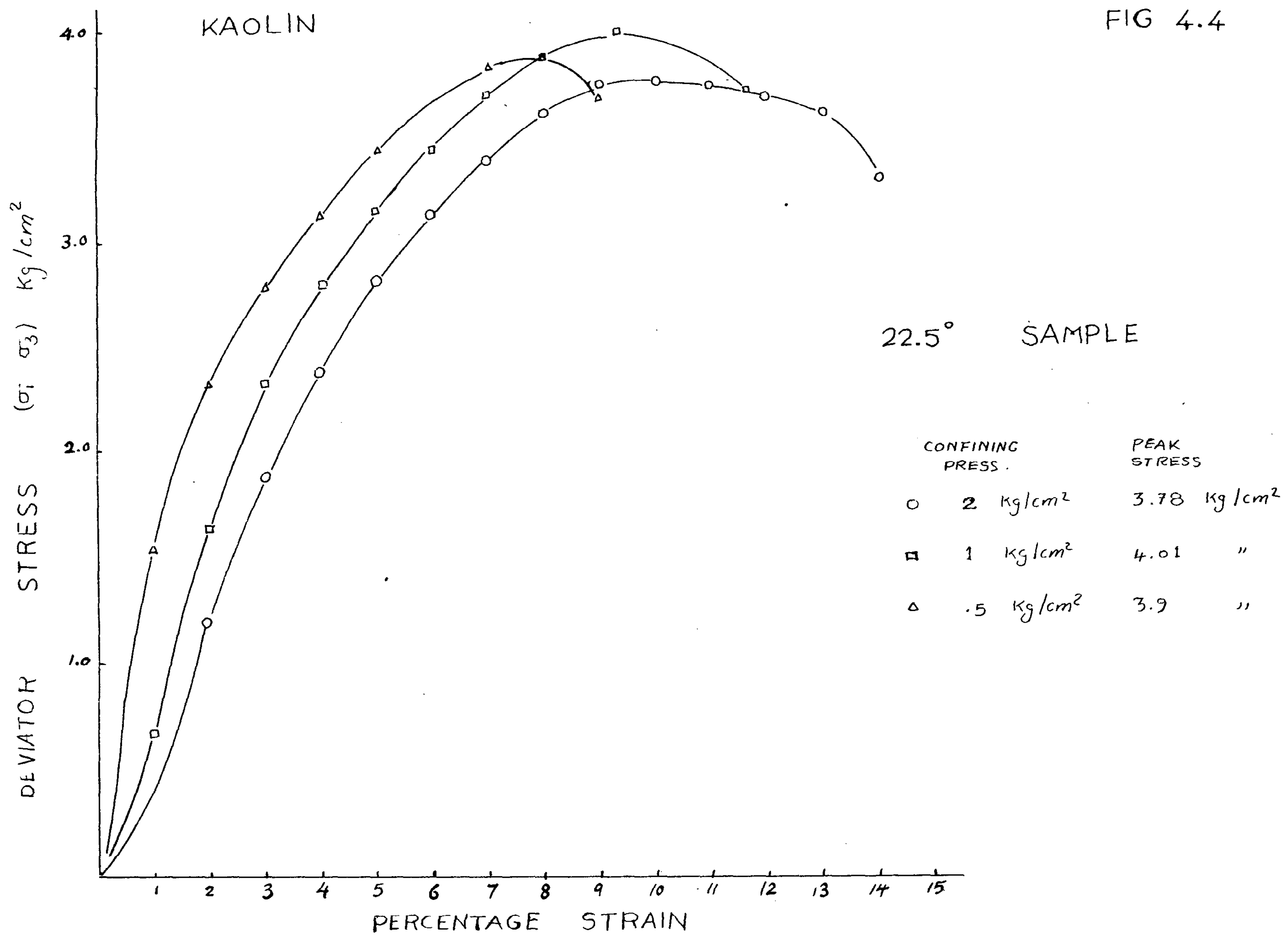


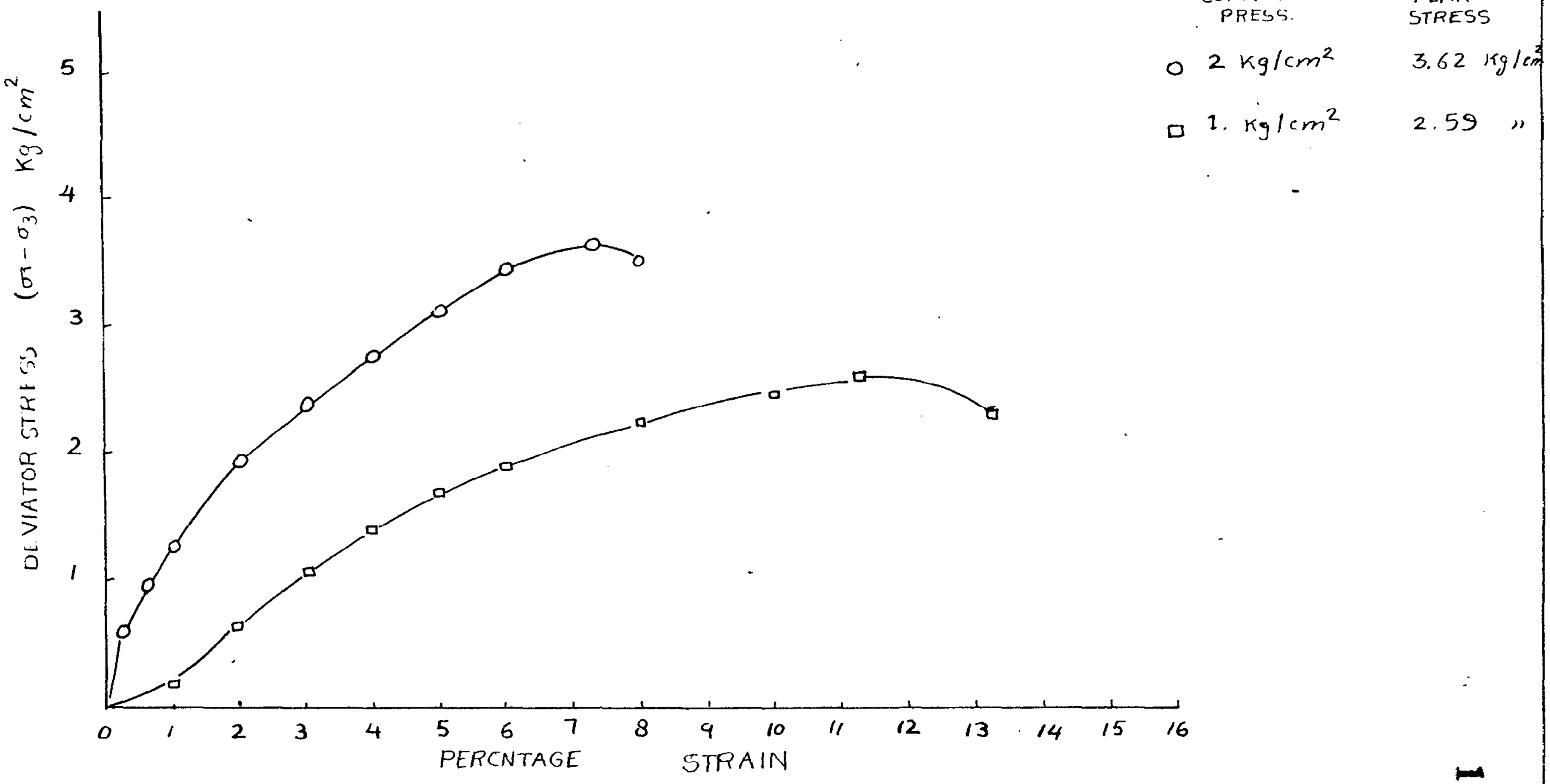
FIG 4.4


KAOLIN
22.5° SAMPLE
CONFINING PRESS.
PEAK STRESS
○ 2 kg/cm² 3.78 kg/cm²
□ 1 kg/cm² 4.01 "
△ .5 kg/cm² 3.9 "
DEVIATOR STRESS (σ1 σ3) kg/cm²
4.0
3.0
2.0
1.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
PERCENTAGE STRAIN

KAOLIN

FIG. 4.5

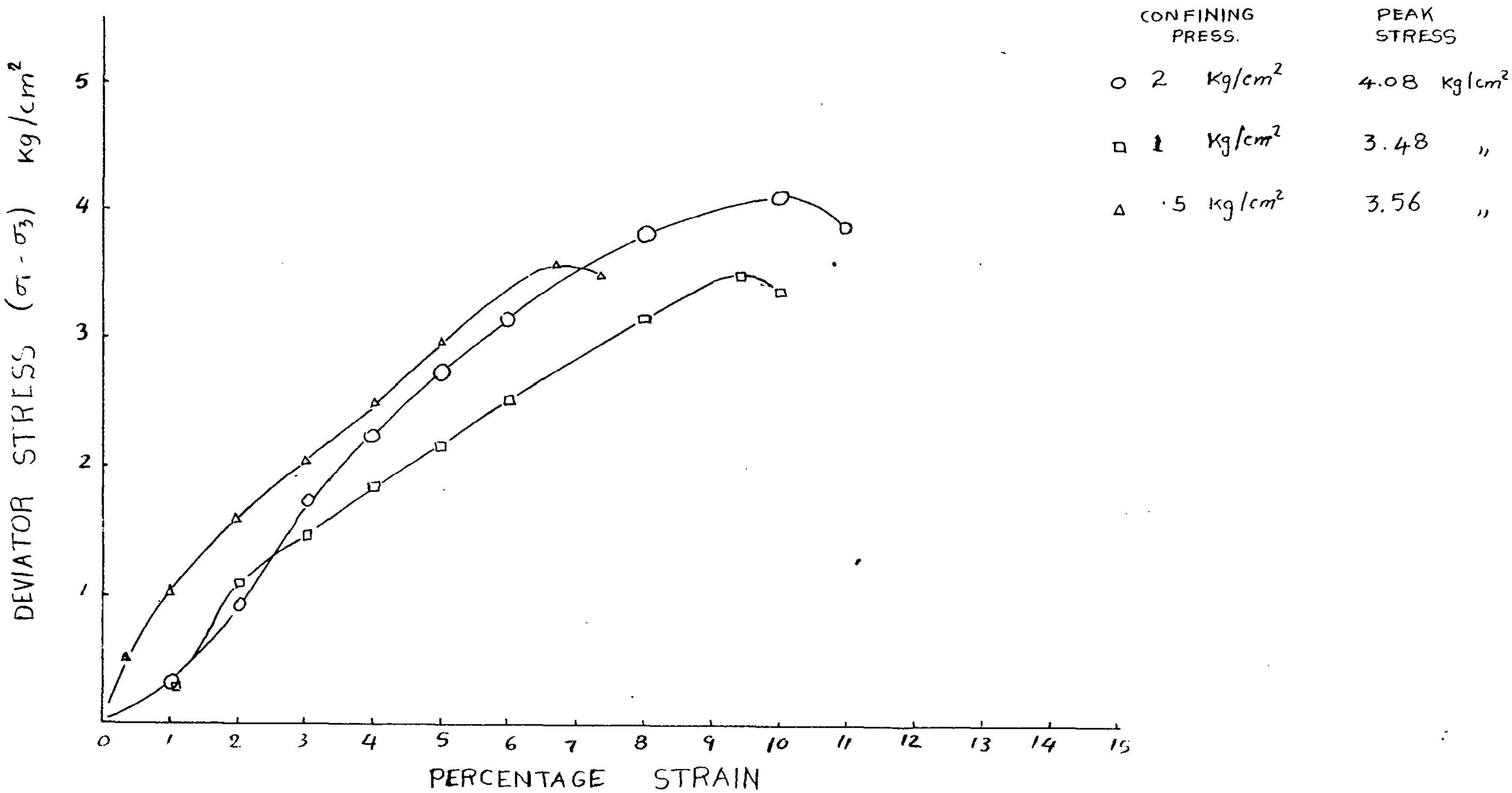
45° SAMPLE



KAOLIN

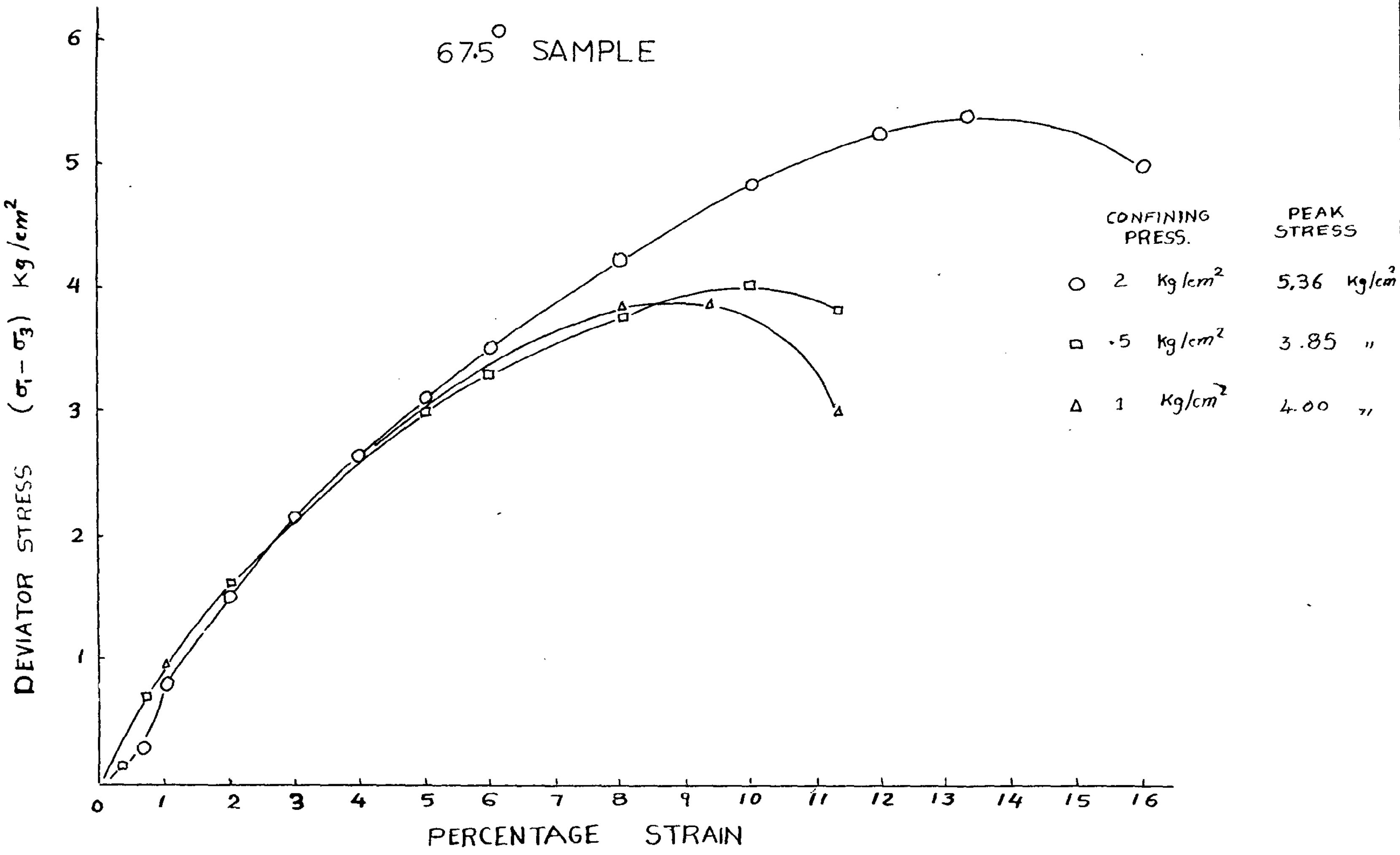
FIG 4.6

45° SAMPLE



KAOLIN

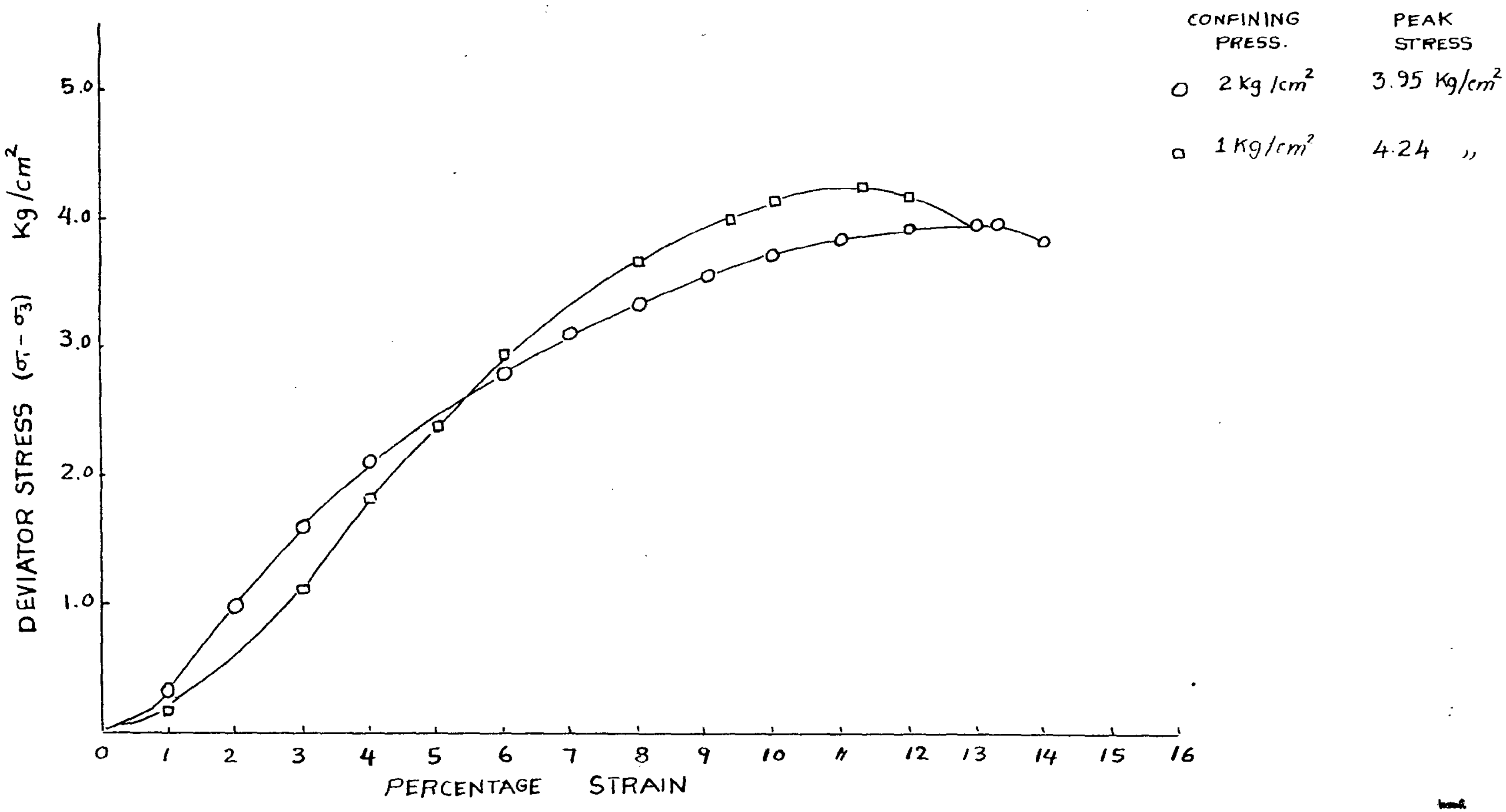
FIG. 4.7



KAOLIN

FIG. 4.8

67.5° SAMPLE



KAOLIN

FIG. 4.9 179

HORIZONTAL SAMPLE

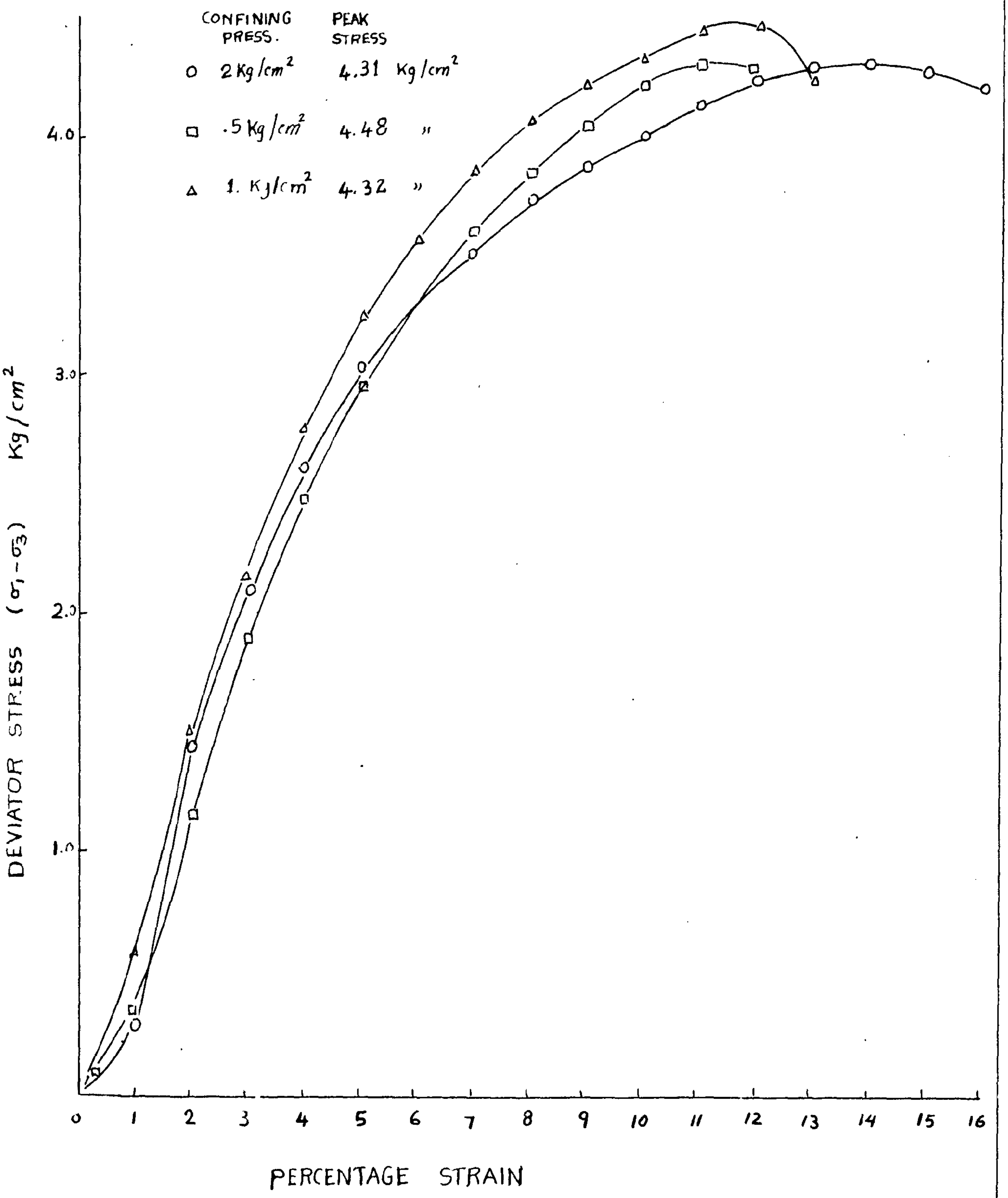
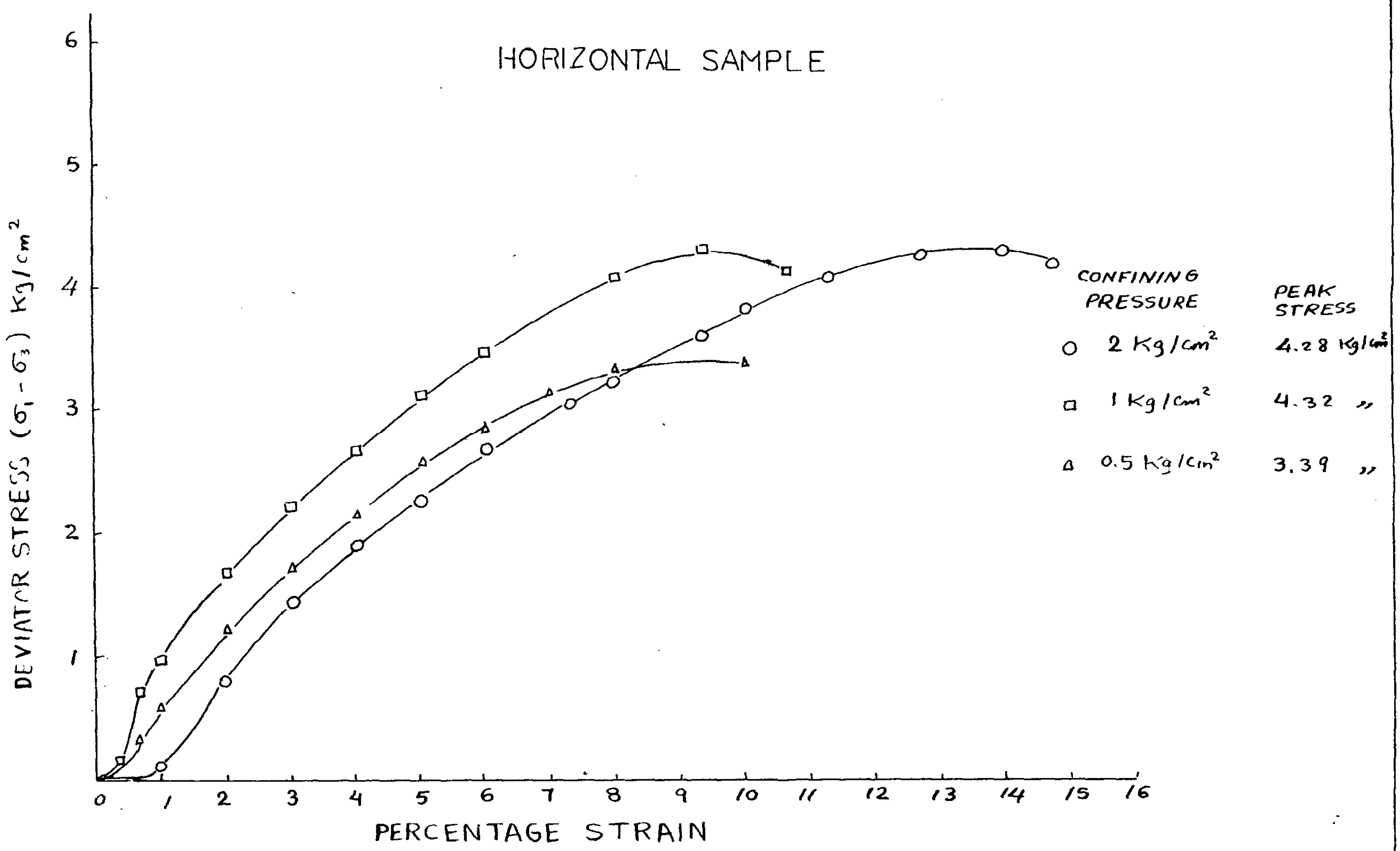


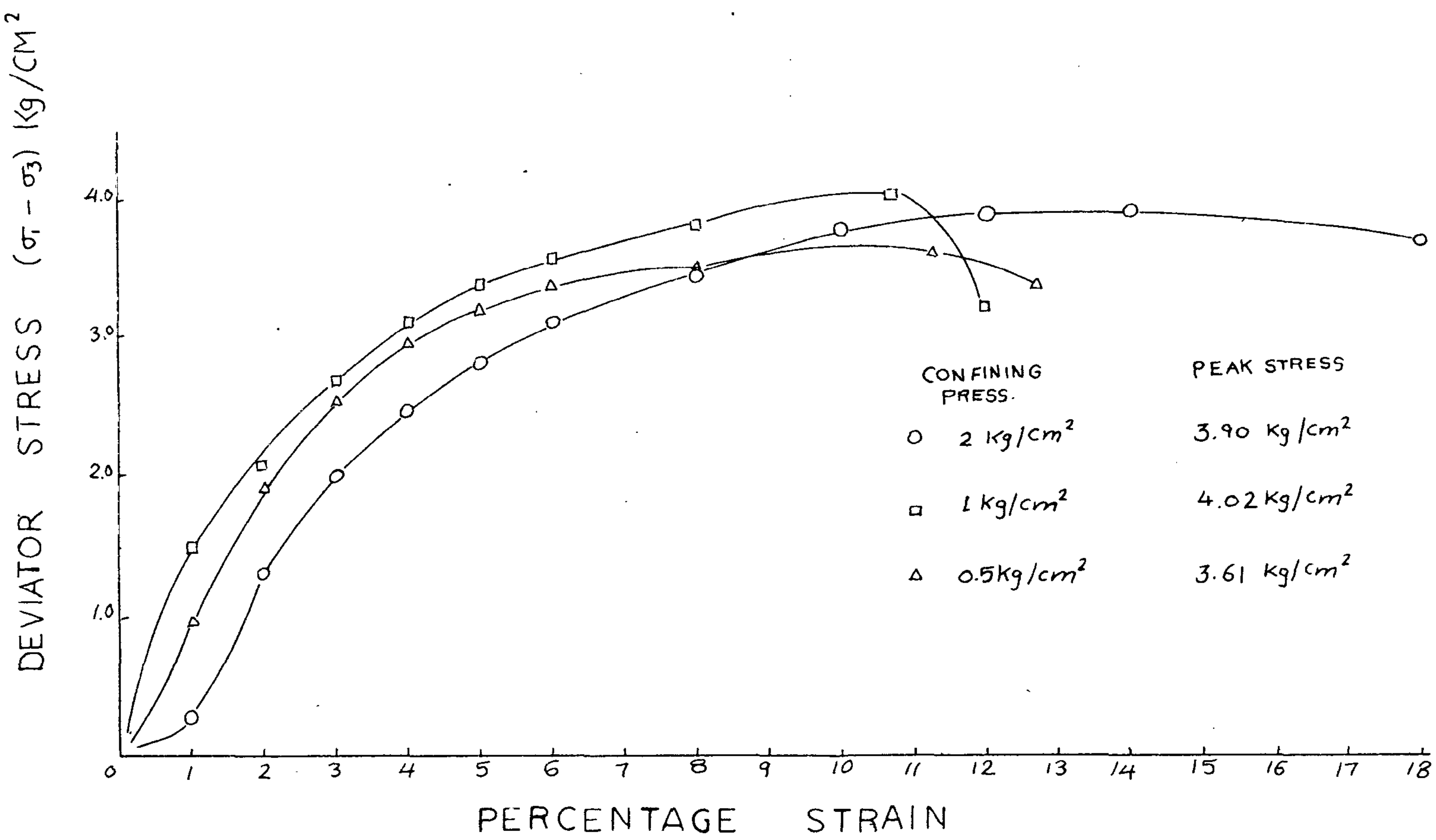
FIG. 4.10


KAOLIN
HORIZONTAL SAMPLE
DEVIATOR STRESS ($\sigma_1 - \sigma_3$) Kg/cm²
PERCENTAGE STRAIN
CONFINING PRESSURE
PEAK STRESS
2 Kg/cm²
4.28 Kg/cm²
1 Kg/cm²
4.32 ,,
0.5 Kg/cm²
3.39 ,,

BENTONITE

FIG. 4.11

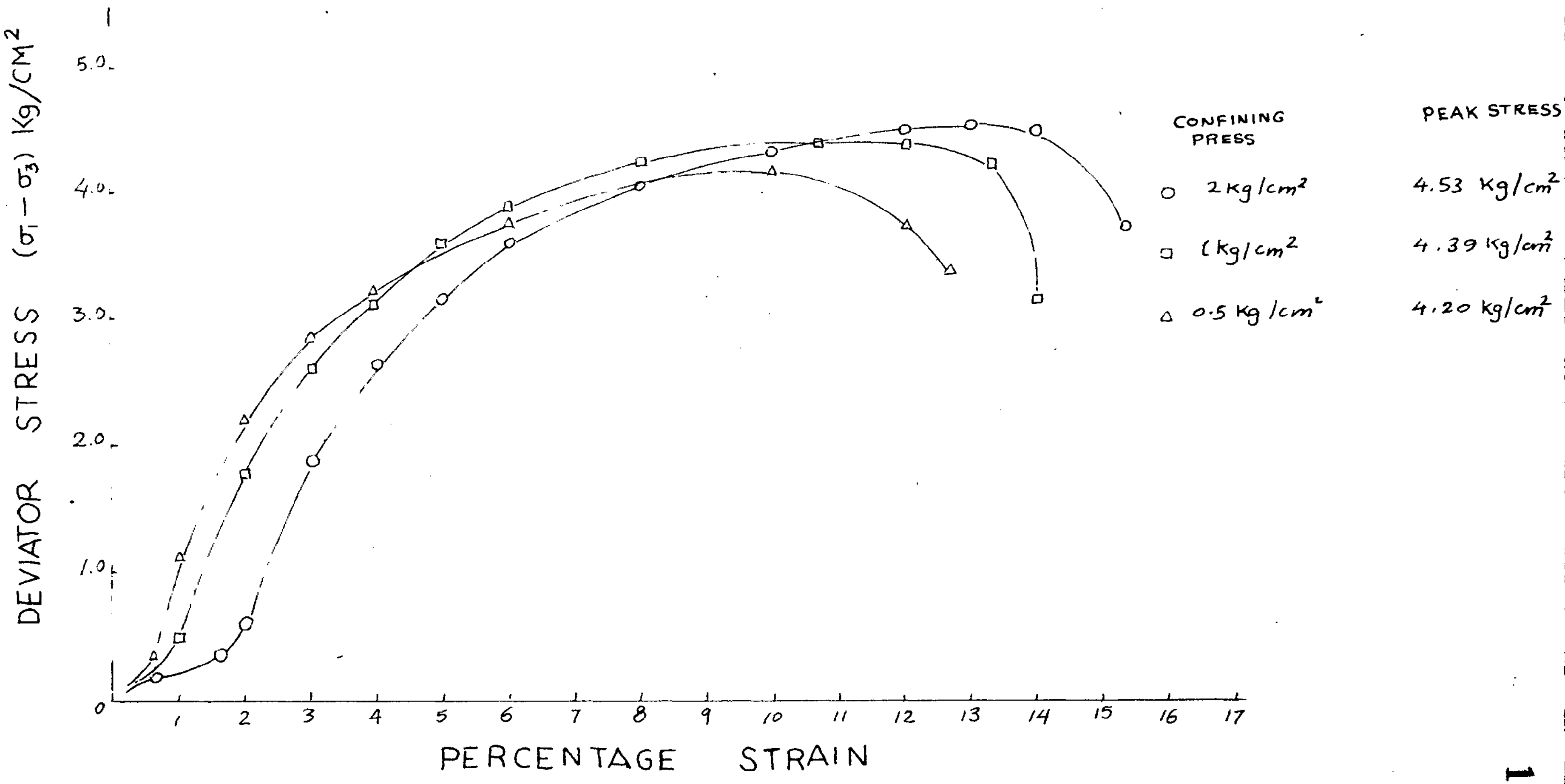
VERTICAL SAMPLE



BENTONITE

FIG. 4.12

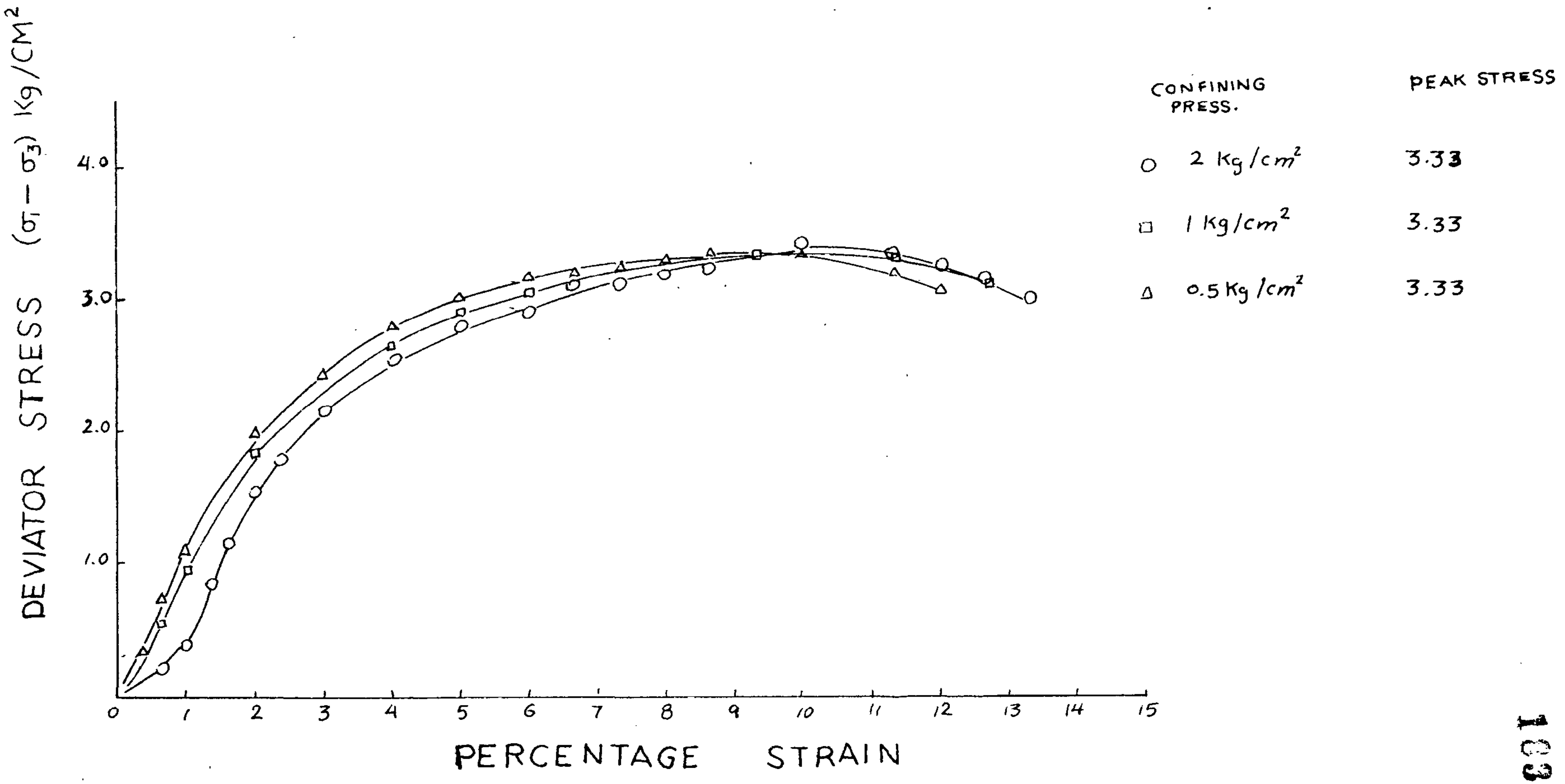
VERTICAL SAMPLE



BENTONITE

FIG 4.13

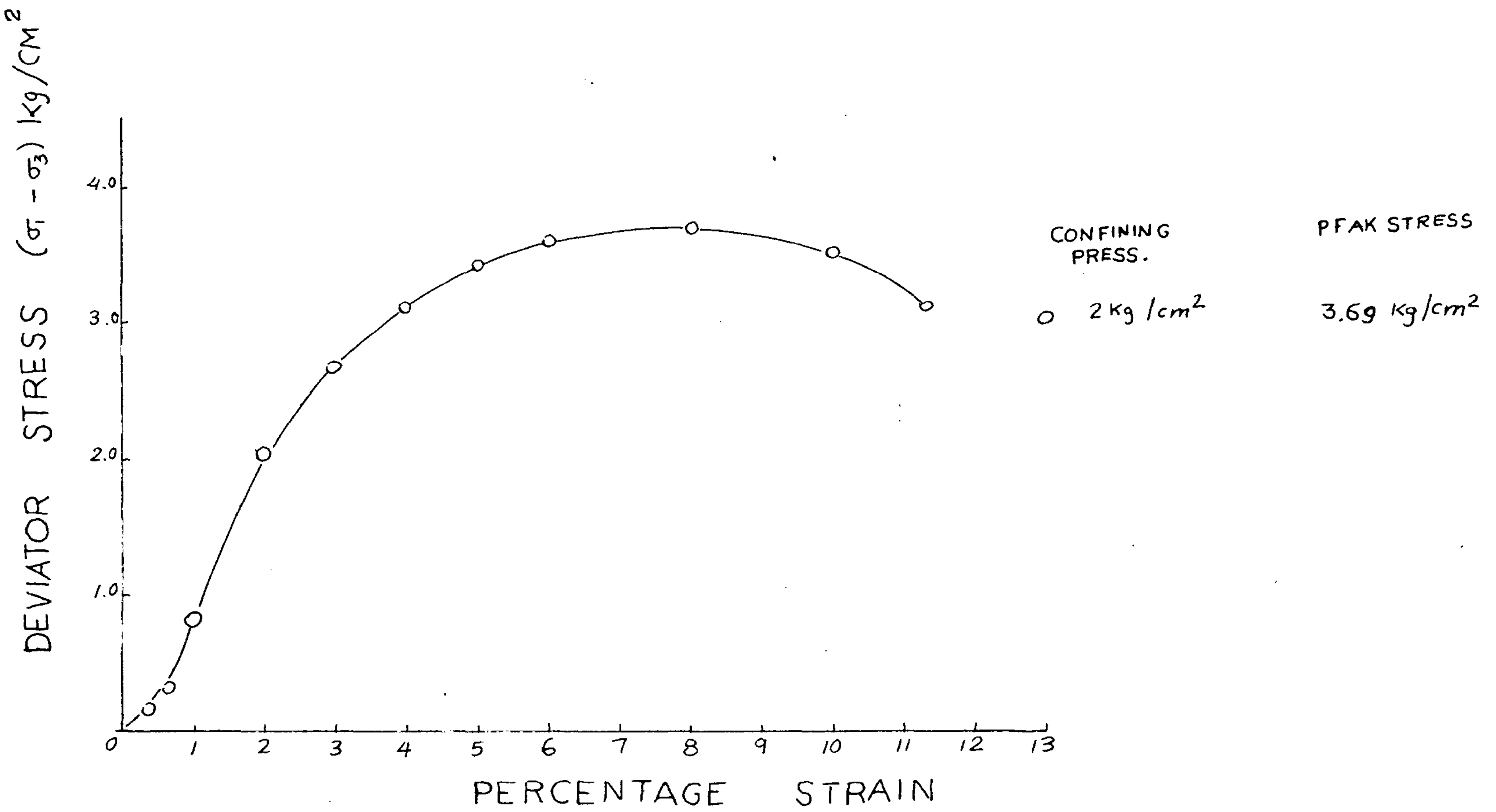
22.5° SAMPLE



BENTONITE

FIG. 4.14

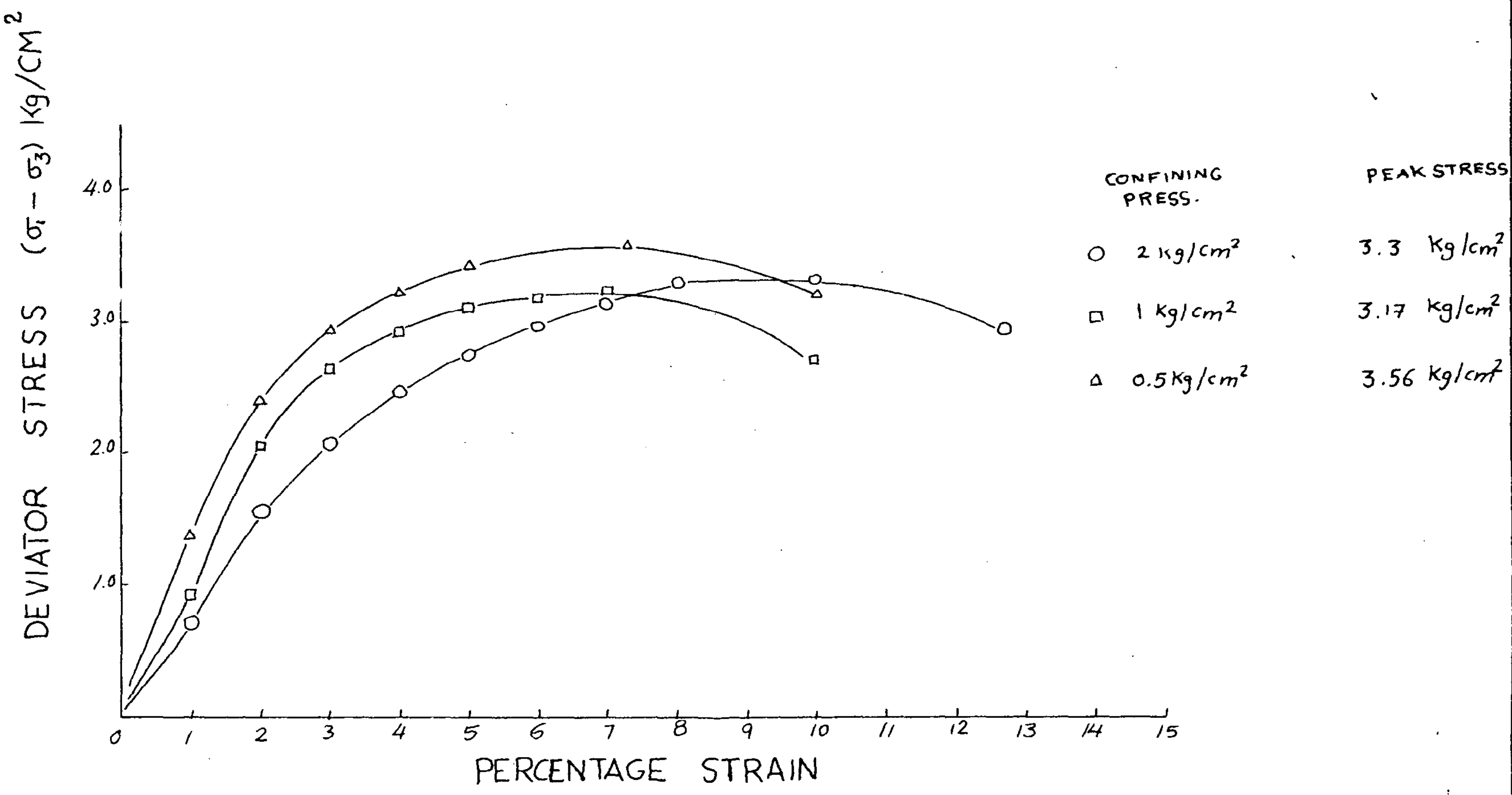
22.5° SAMPLE



BENTONITE

FIG. 4.15

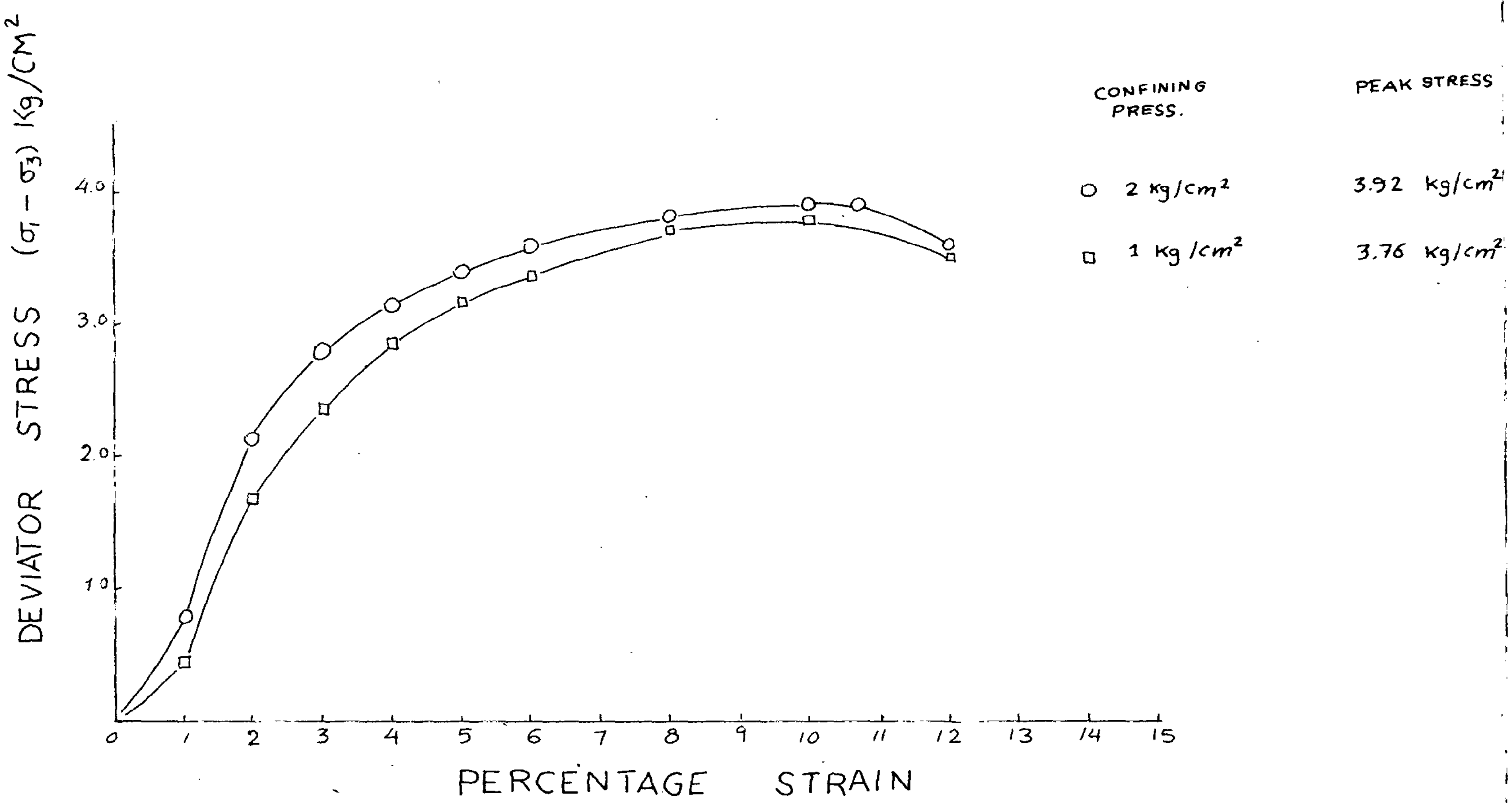
22.5° SAMPLE



BENTONITE

FIG. 4.16

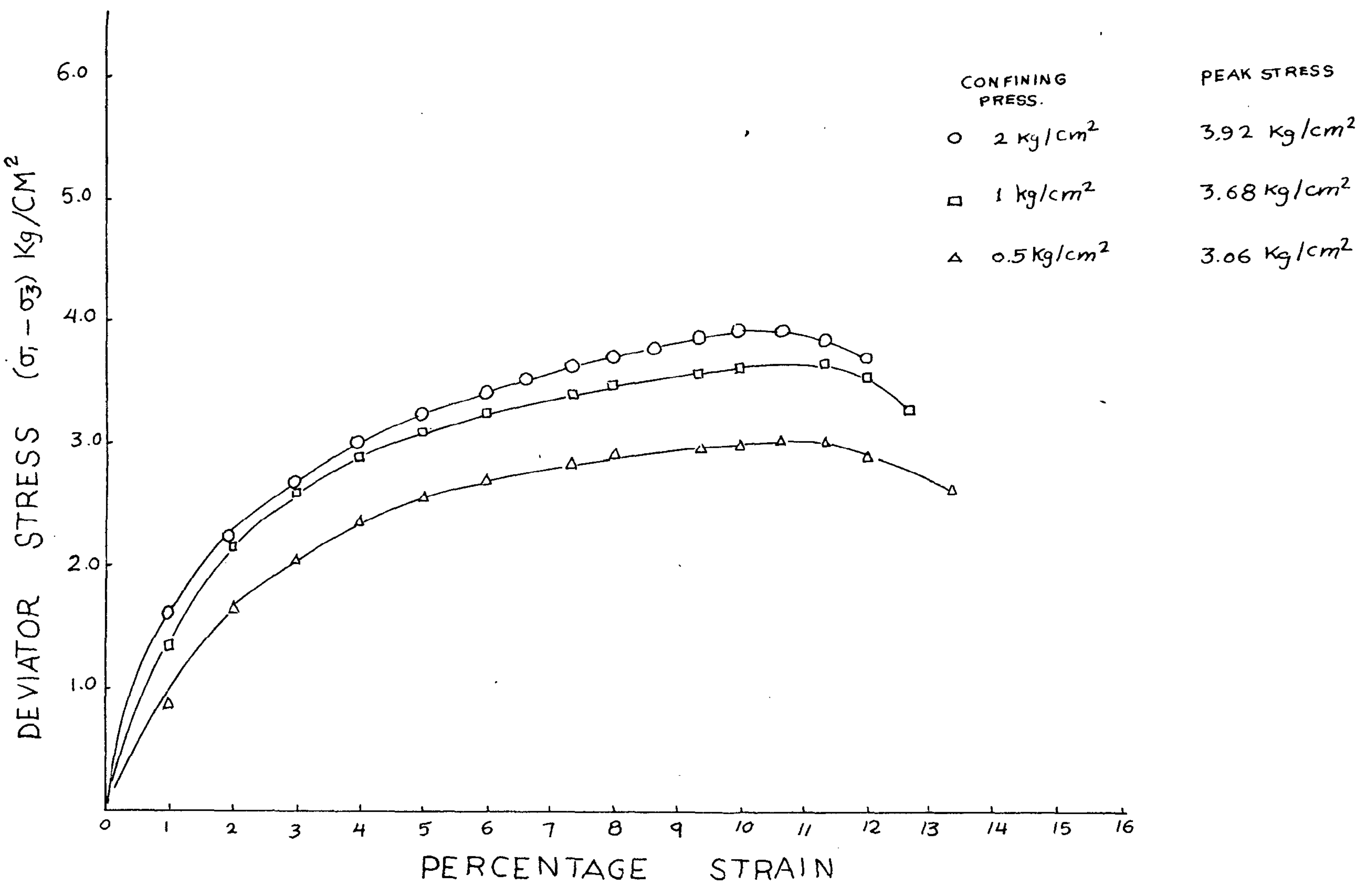
45° SAMPLE



BENTONITE

FIG. 4.17

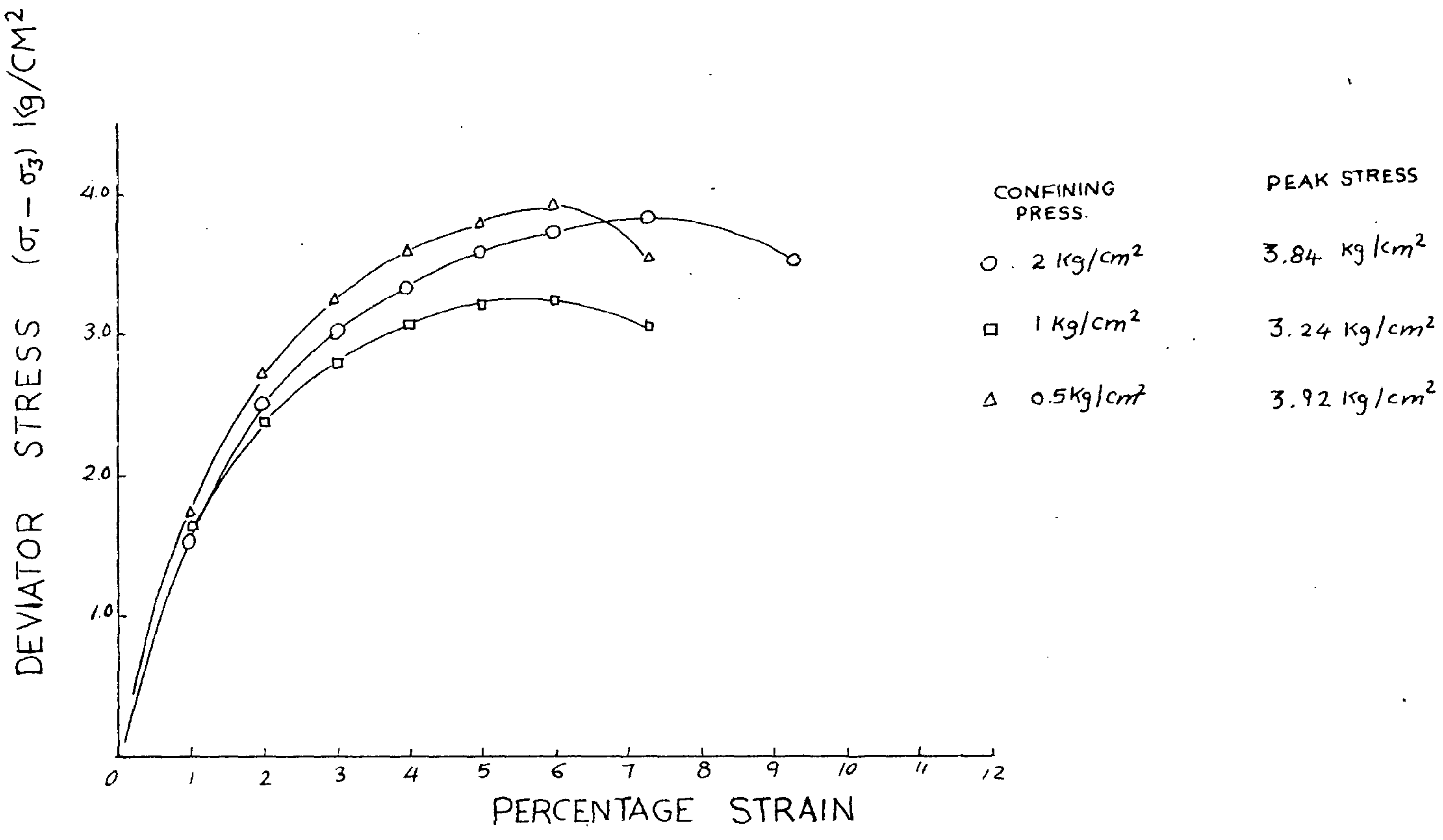
45° SAMPLE



BENTONITE

FIG. 4.18

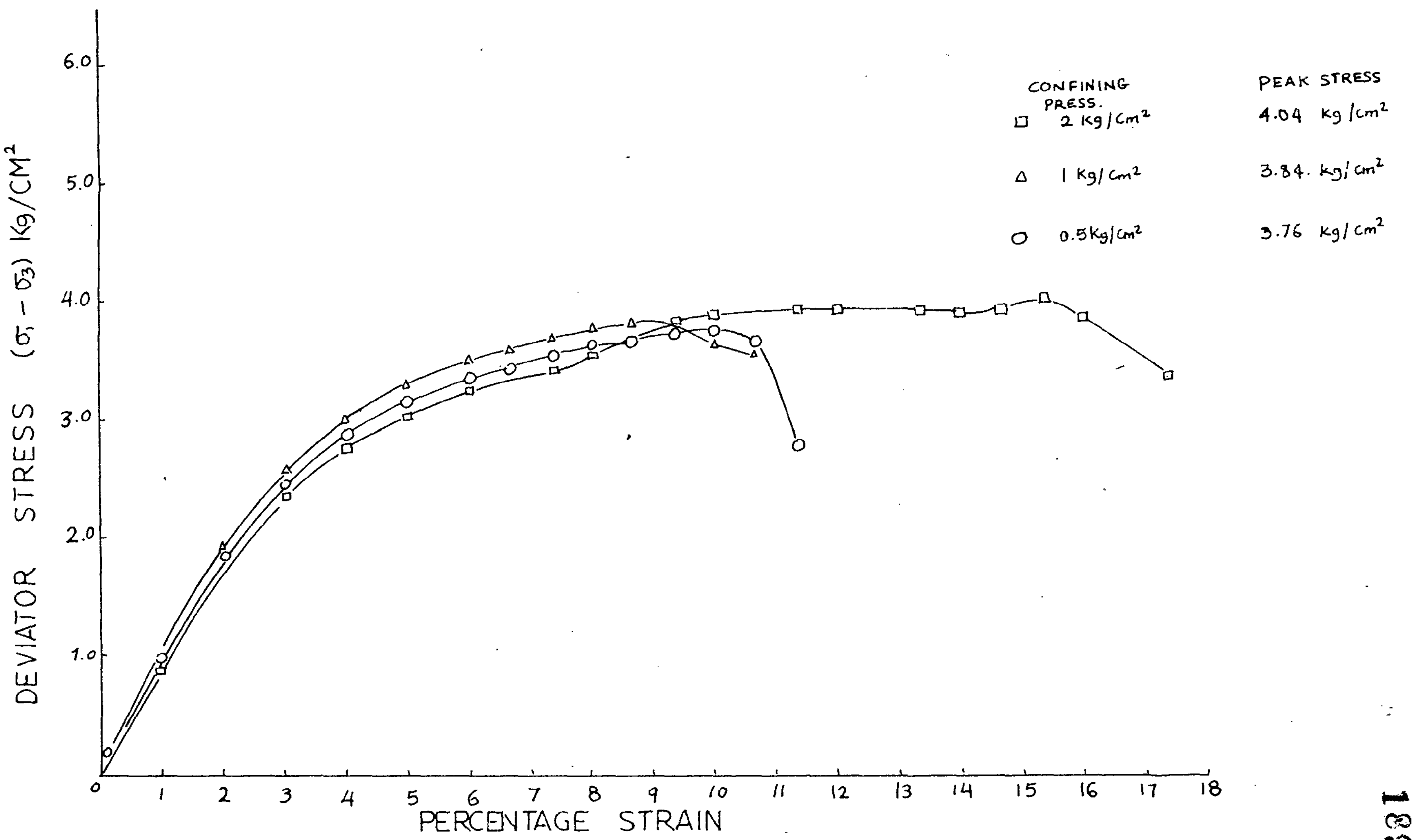
45° SAMPLE



BENTONITE

FIG. 4.19

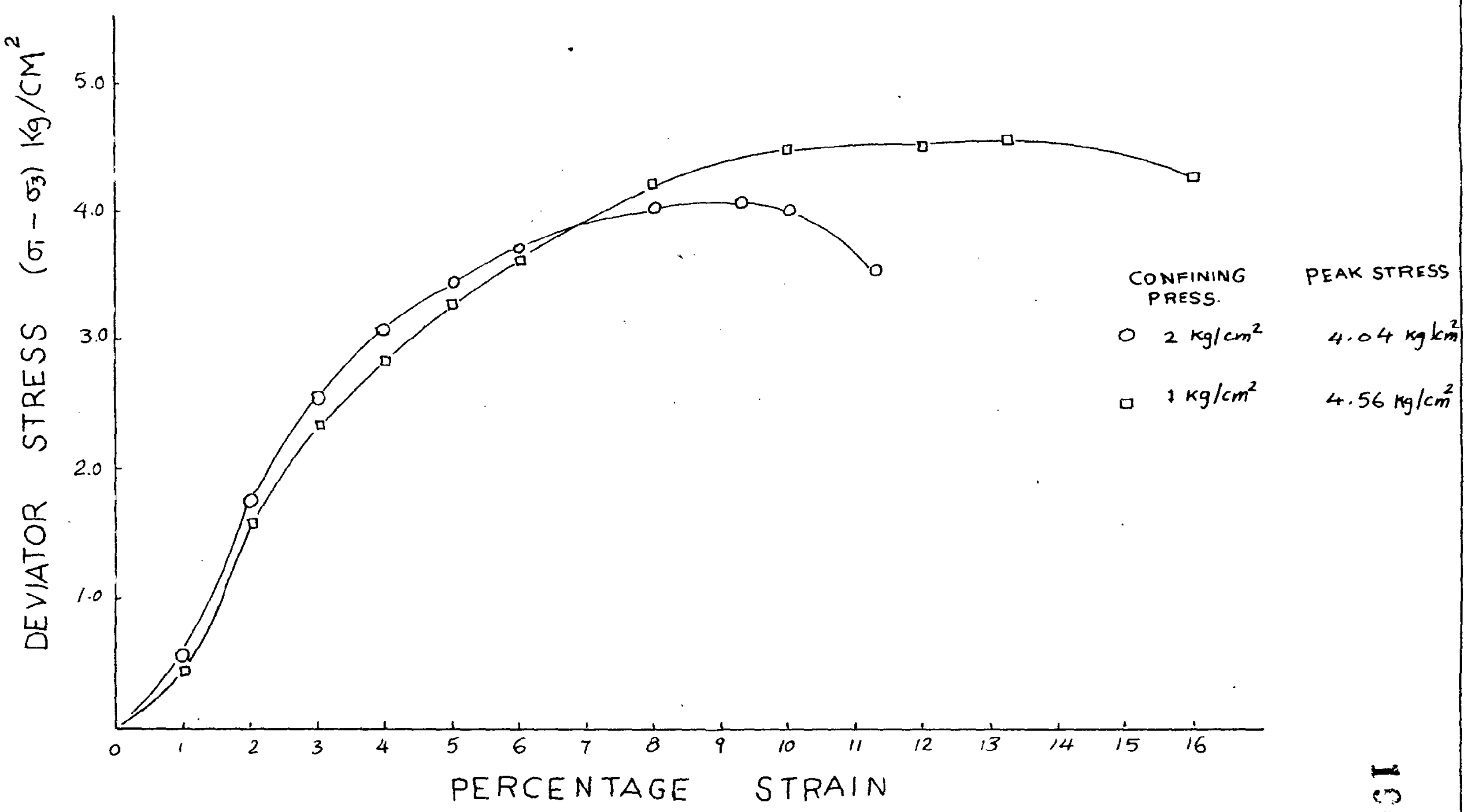
67.5° SAMPLE



BENTONITE

FIG. 4.20

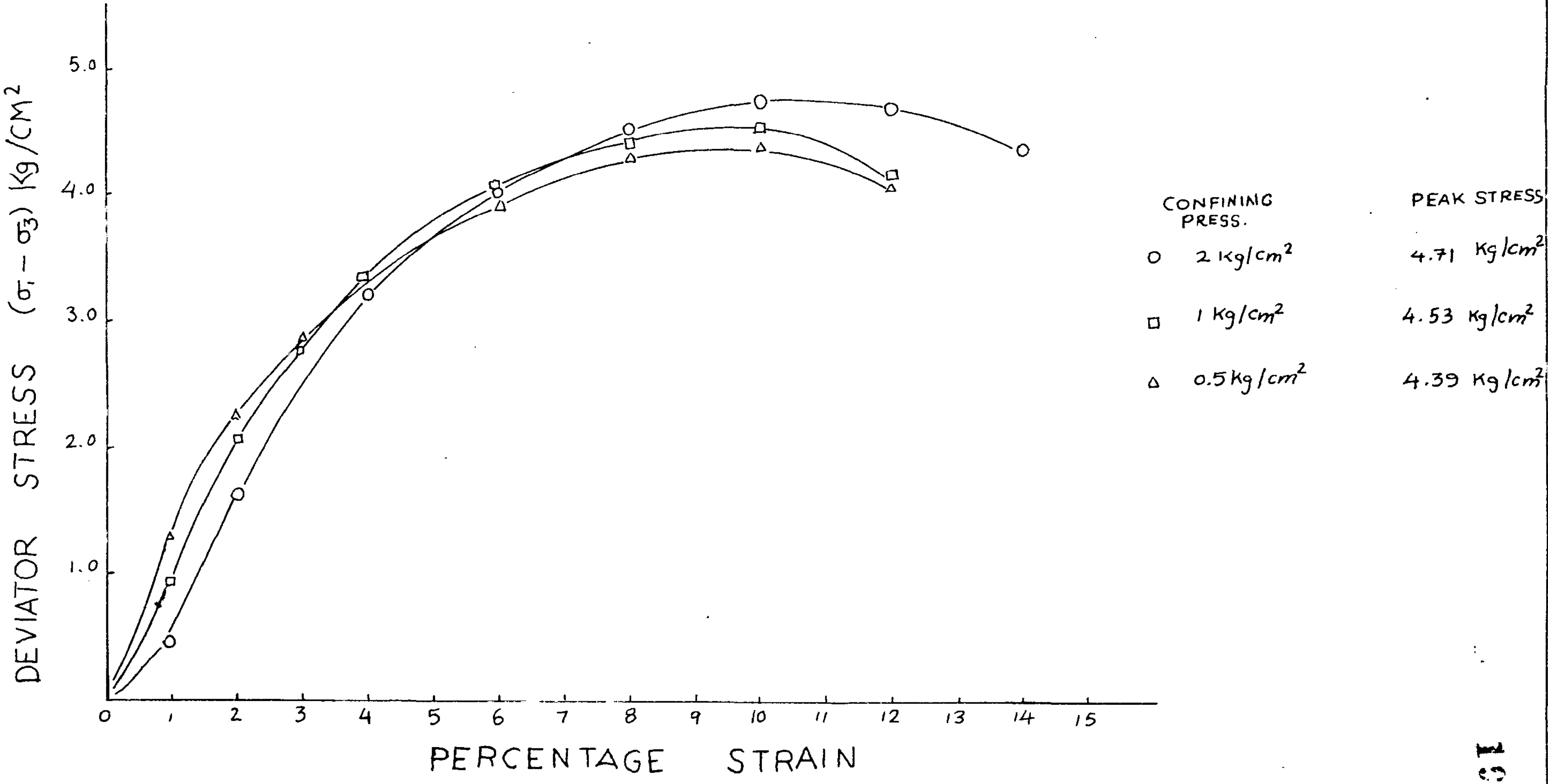
67.5° SAMPLE



BENTONITE

FIG. 4.21

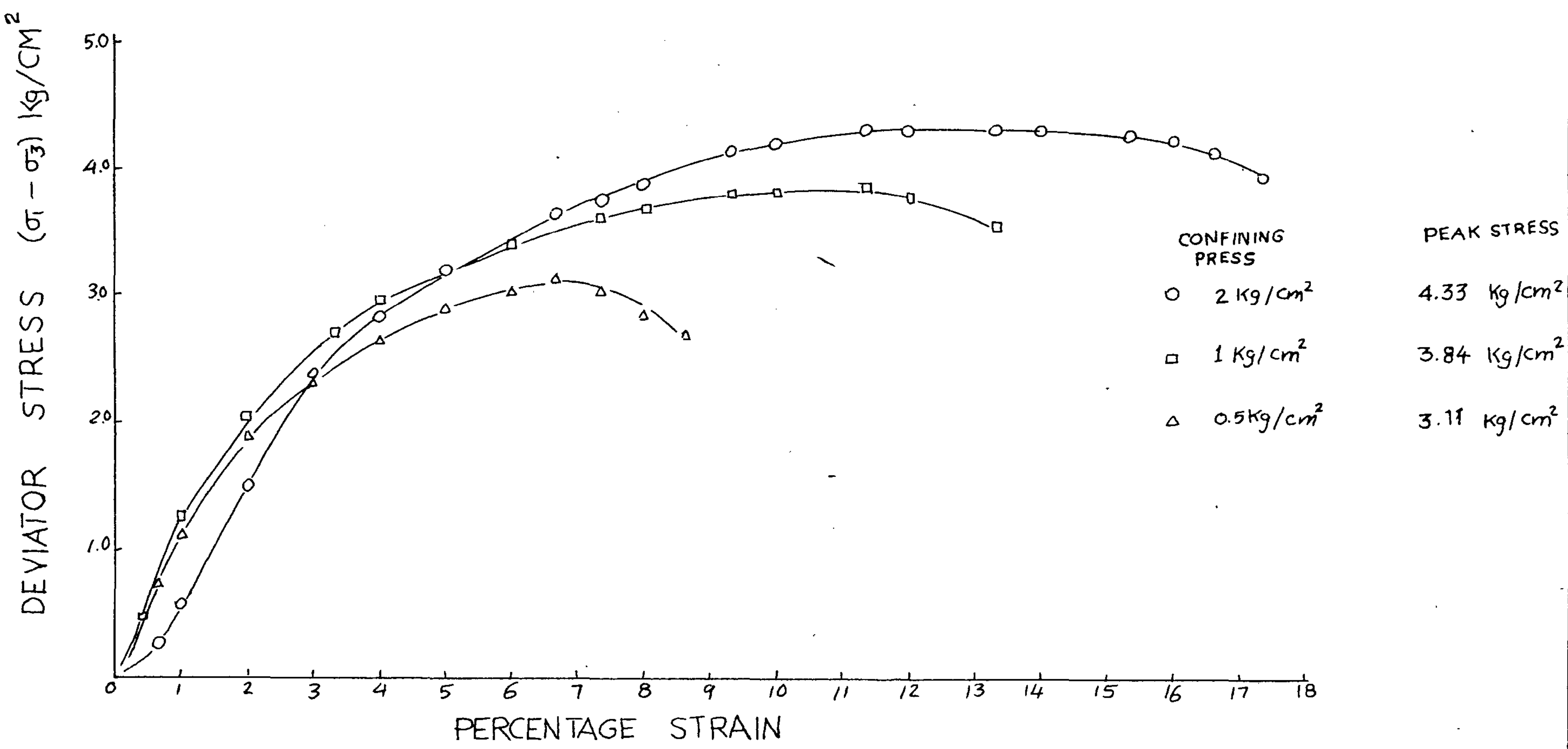
HORIZONTAL SAMPLE



BENTONITE

FIG 4.22

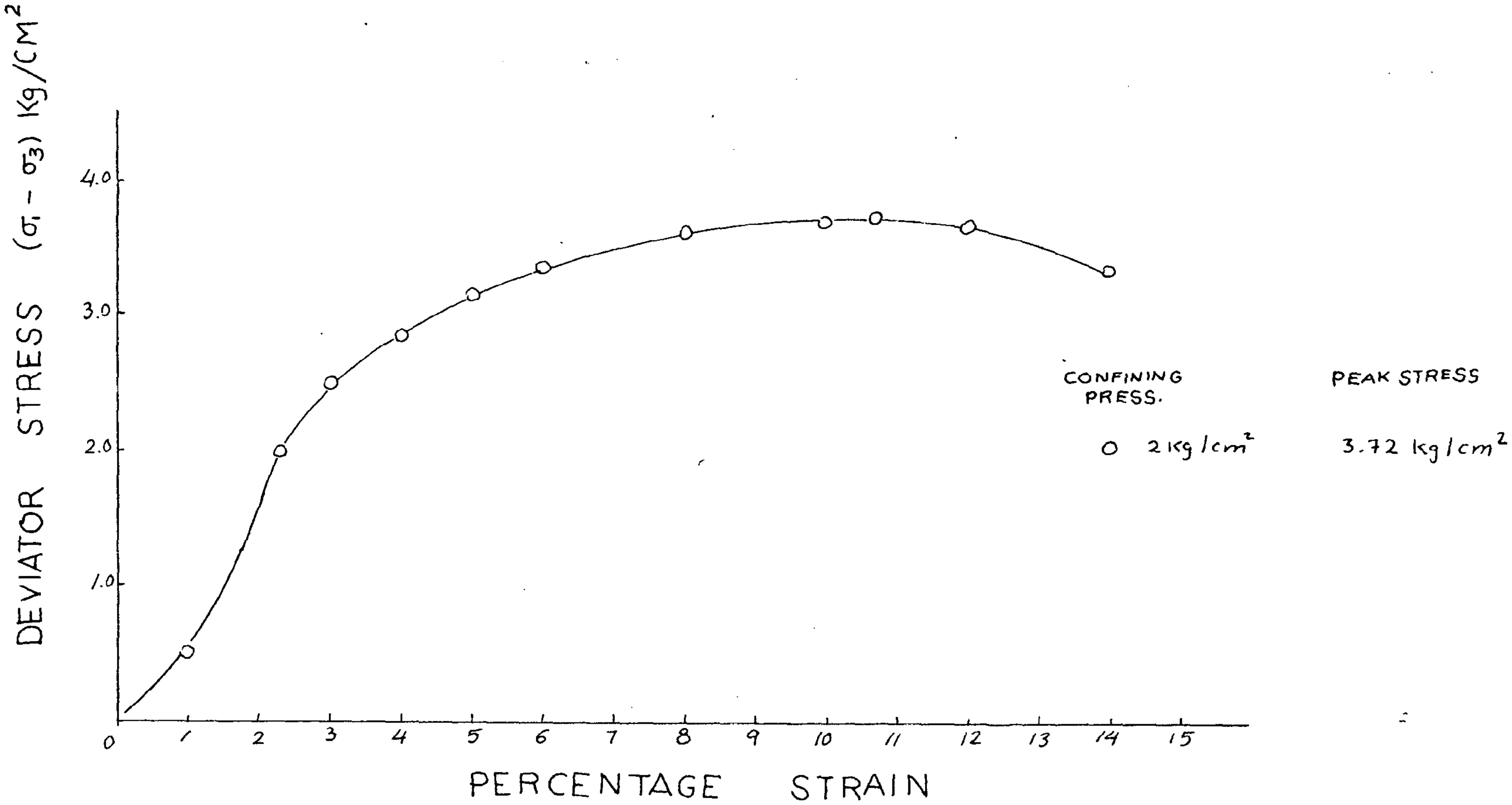
HORIZONTAL SAMPLE



BENTONITE

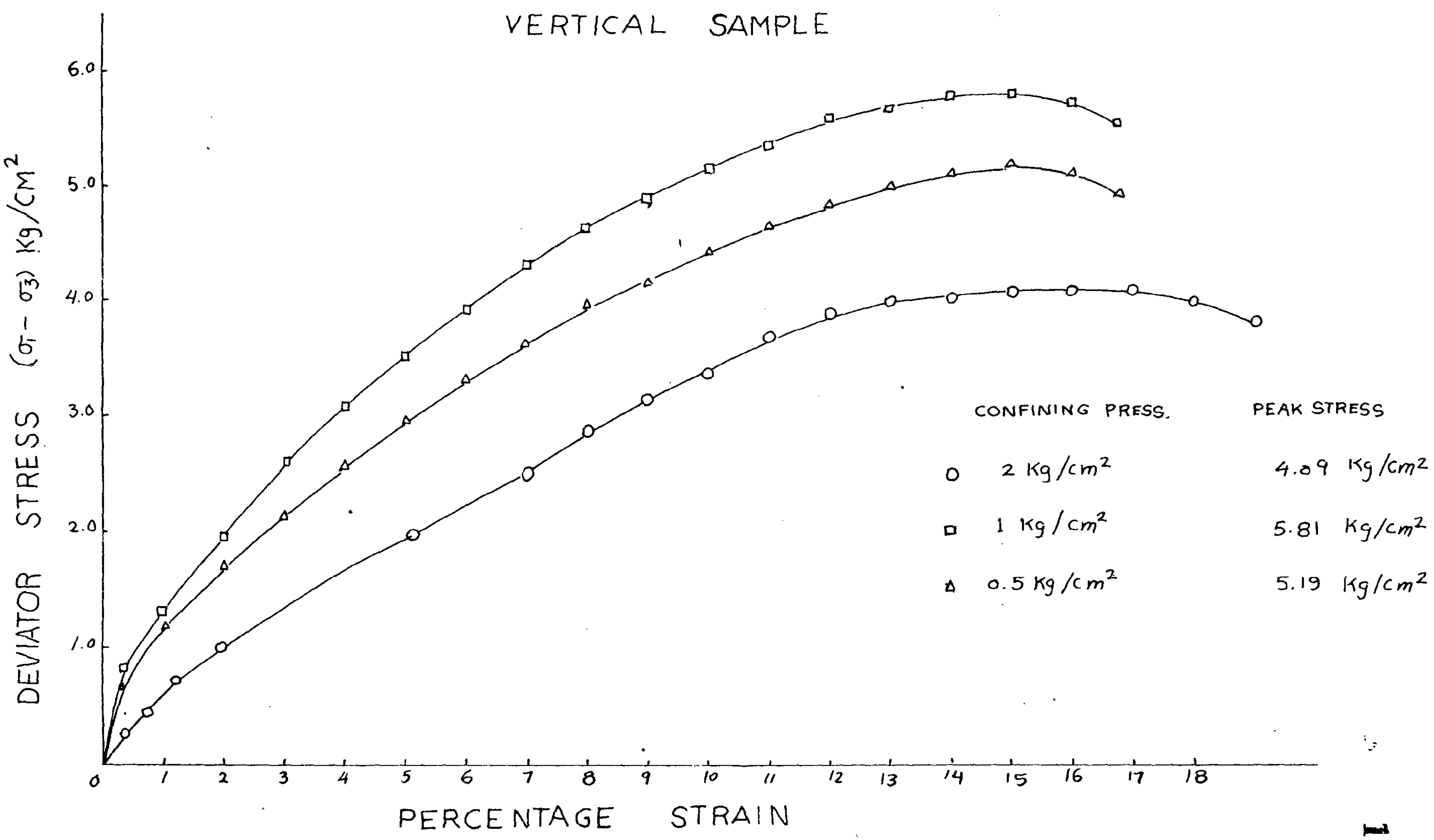
FIG. 4.23

HORIZONTAL SAMPLE



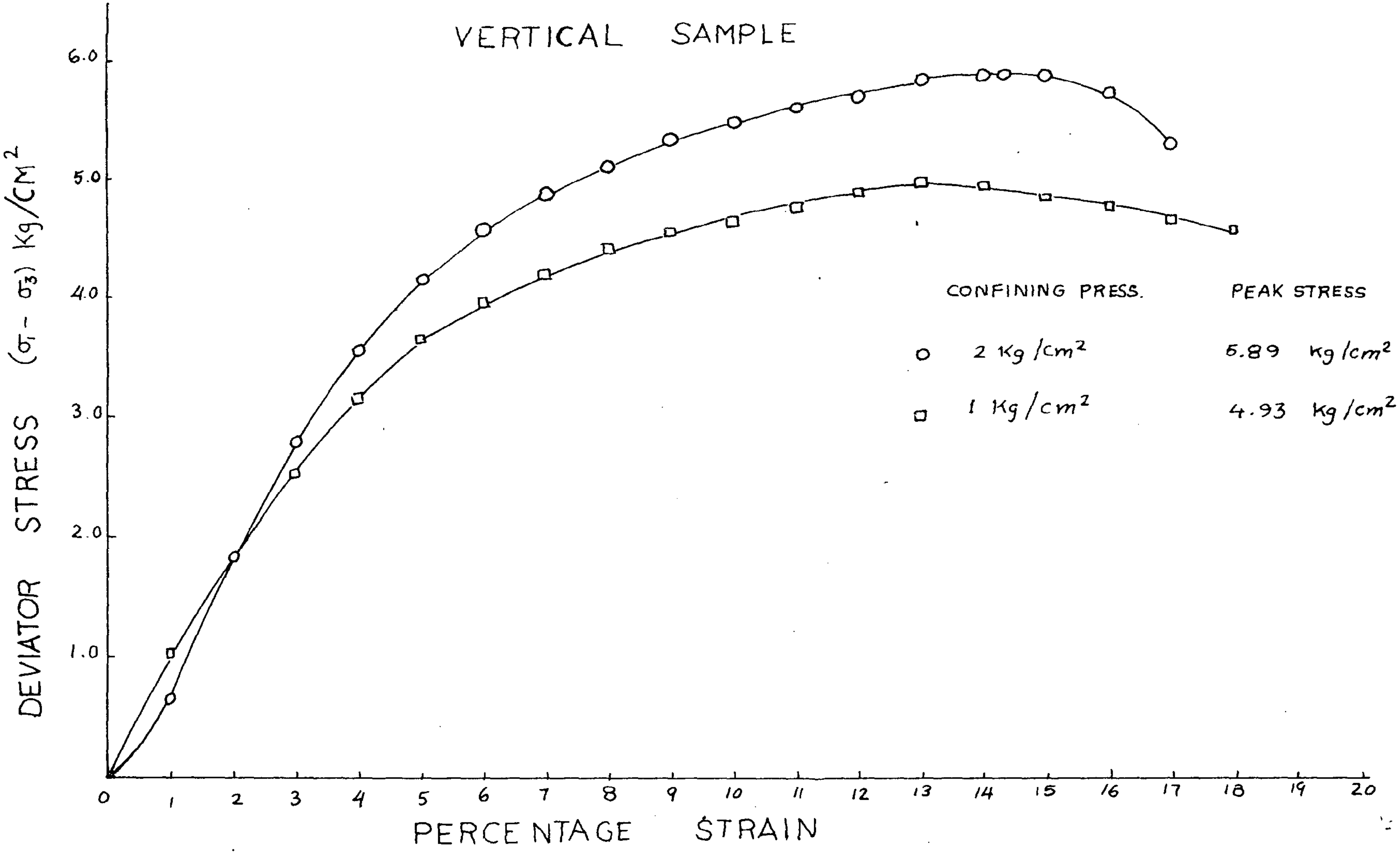
DHANAURI CLAY

FIG. 4.24



DHANAURI CLAY

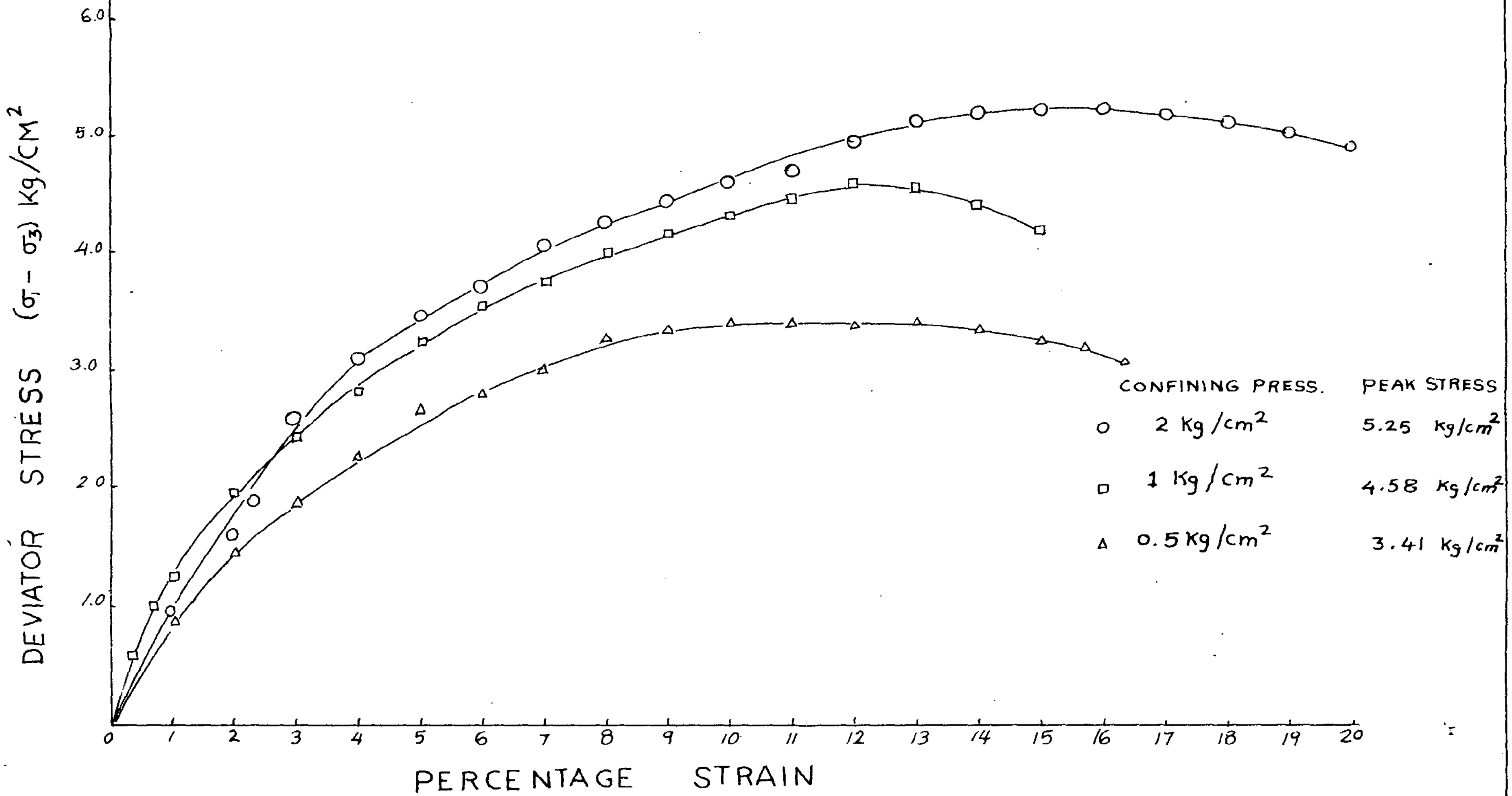
FIG. 4.25



DHANAURI CLAY

FIG. 4.26

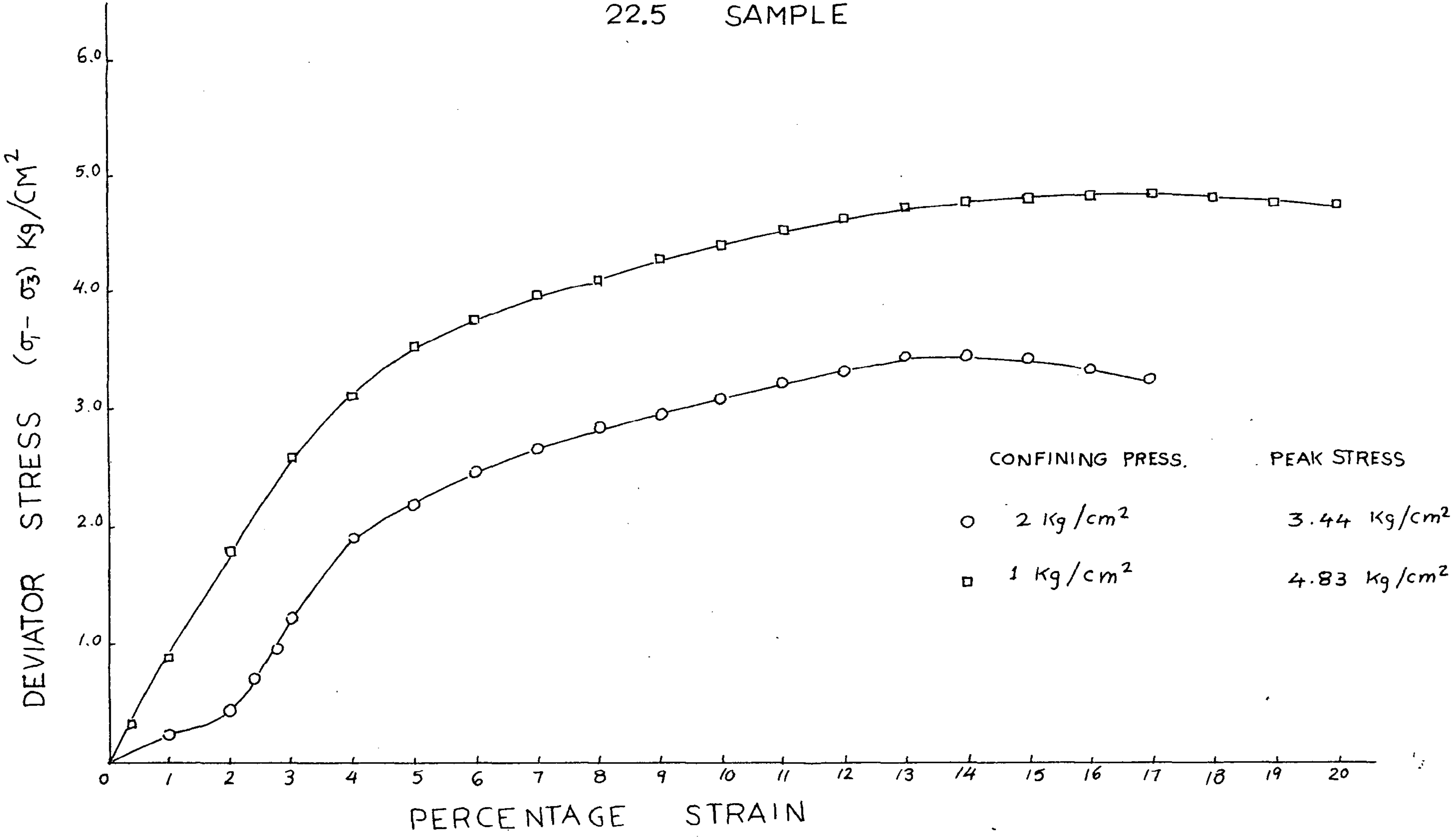
22.5° SAMPLE



DHANAURI CLAY

FIG. 4.27

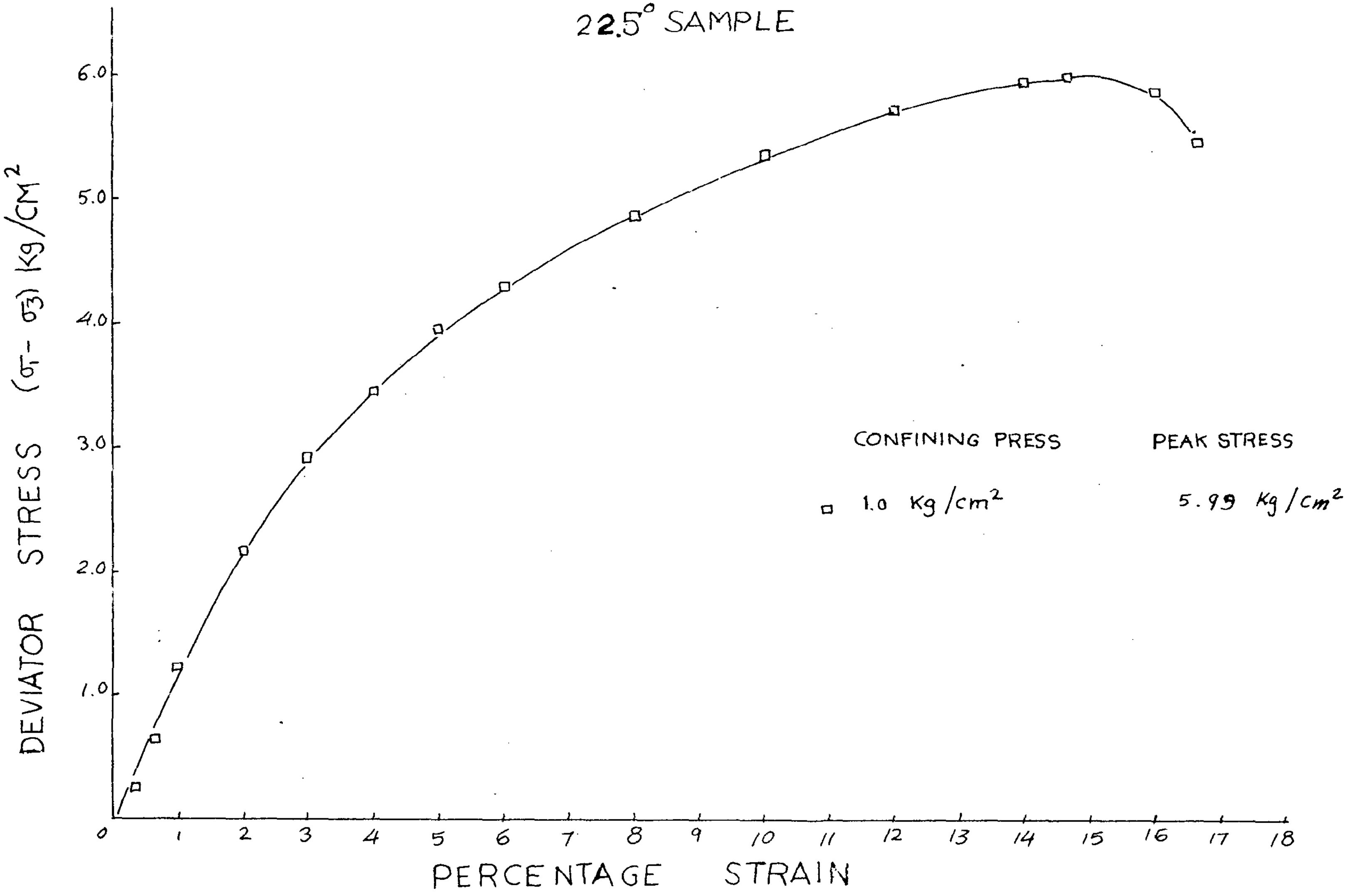
22.5° SAMPLE



DHANAURI CLAY

FIG. 4.28

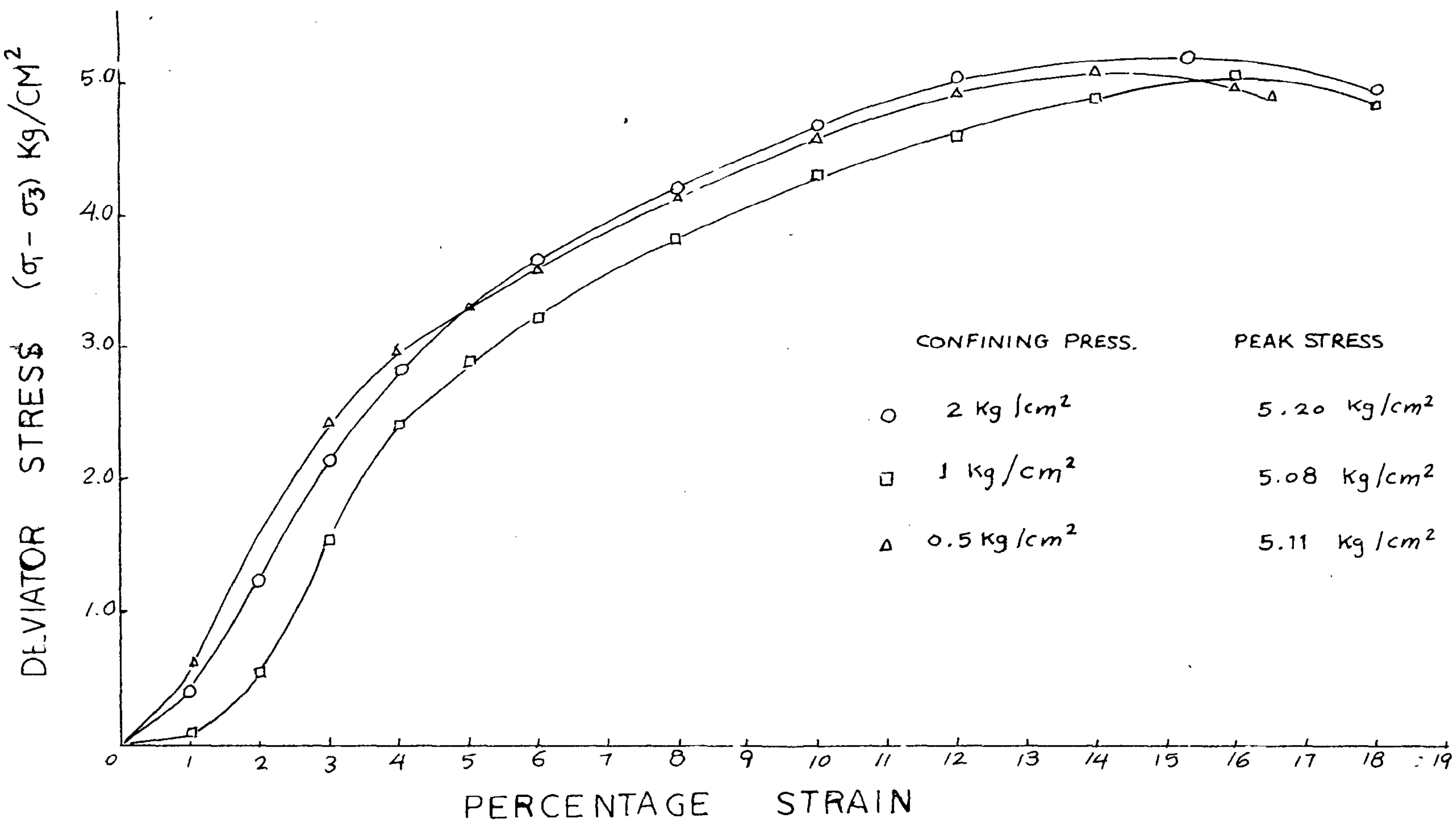
22.5° SAMPLE



DHANAURI CLAY

FIG. 4.29

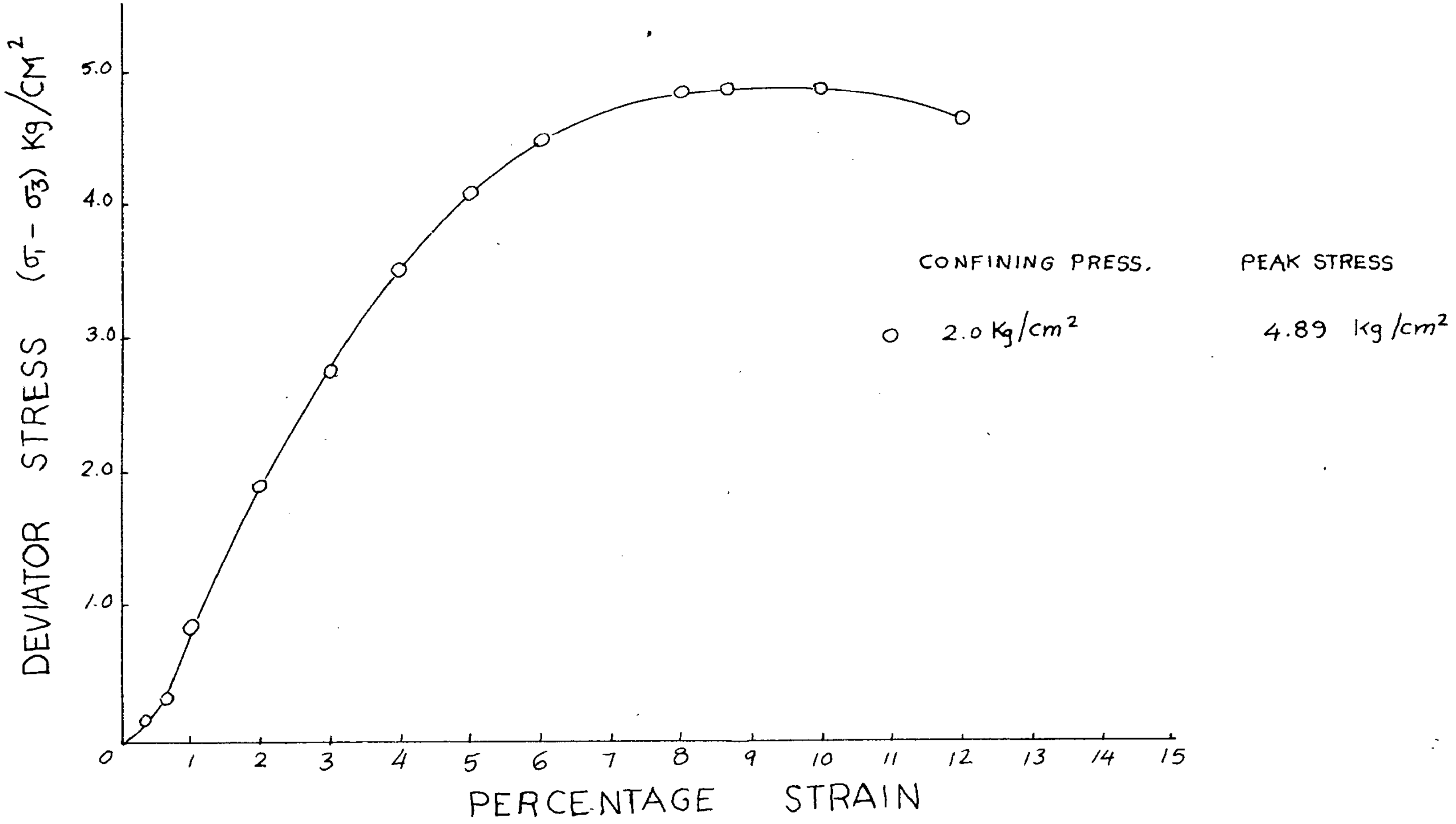
45° SAMPLE



DHANAURI CLAY

FIG. 4.30

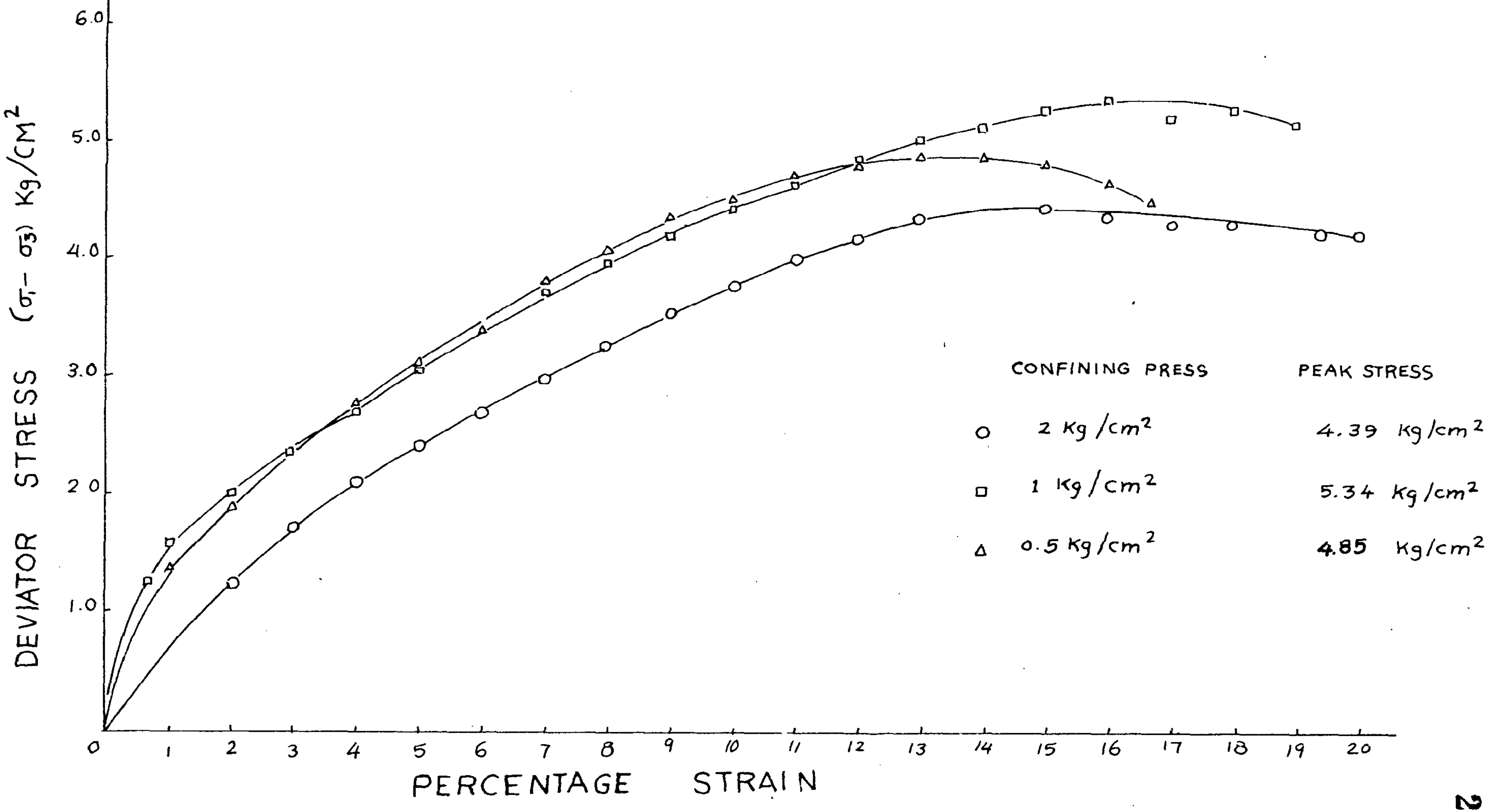
45° SAMPLE



DHANAURI CLAY

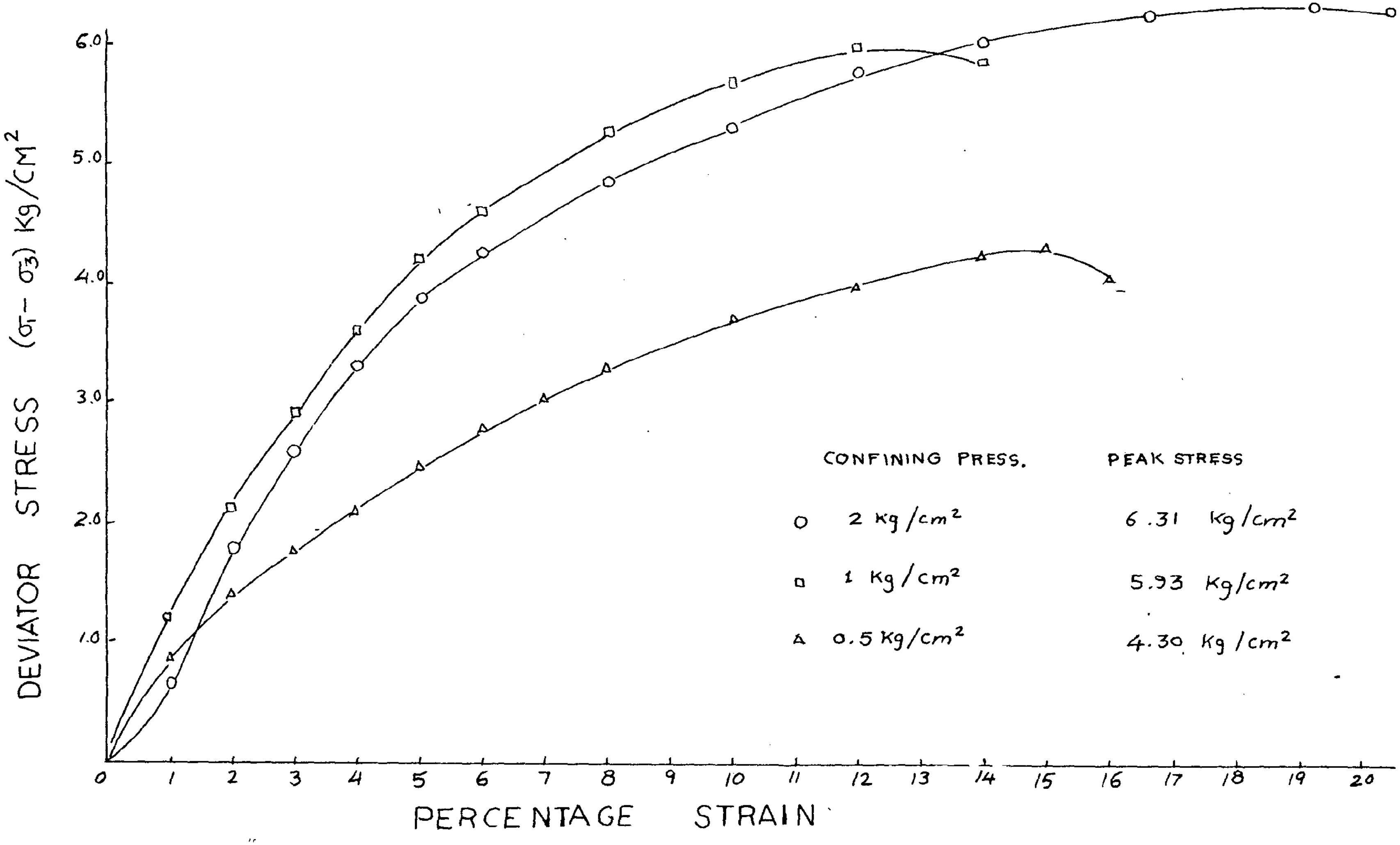
FIG. 4.31

45° SAMPLE



DHANAURI CLAY

FIG. 4.32

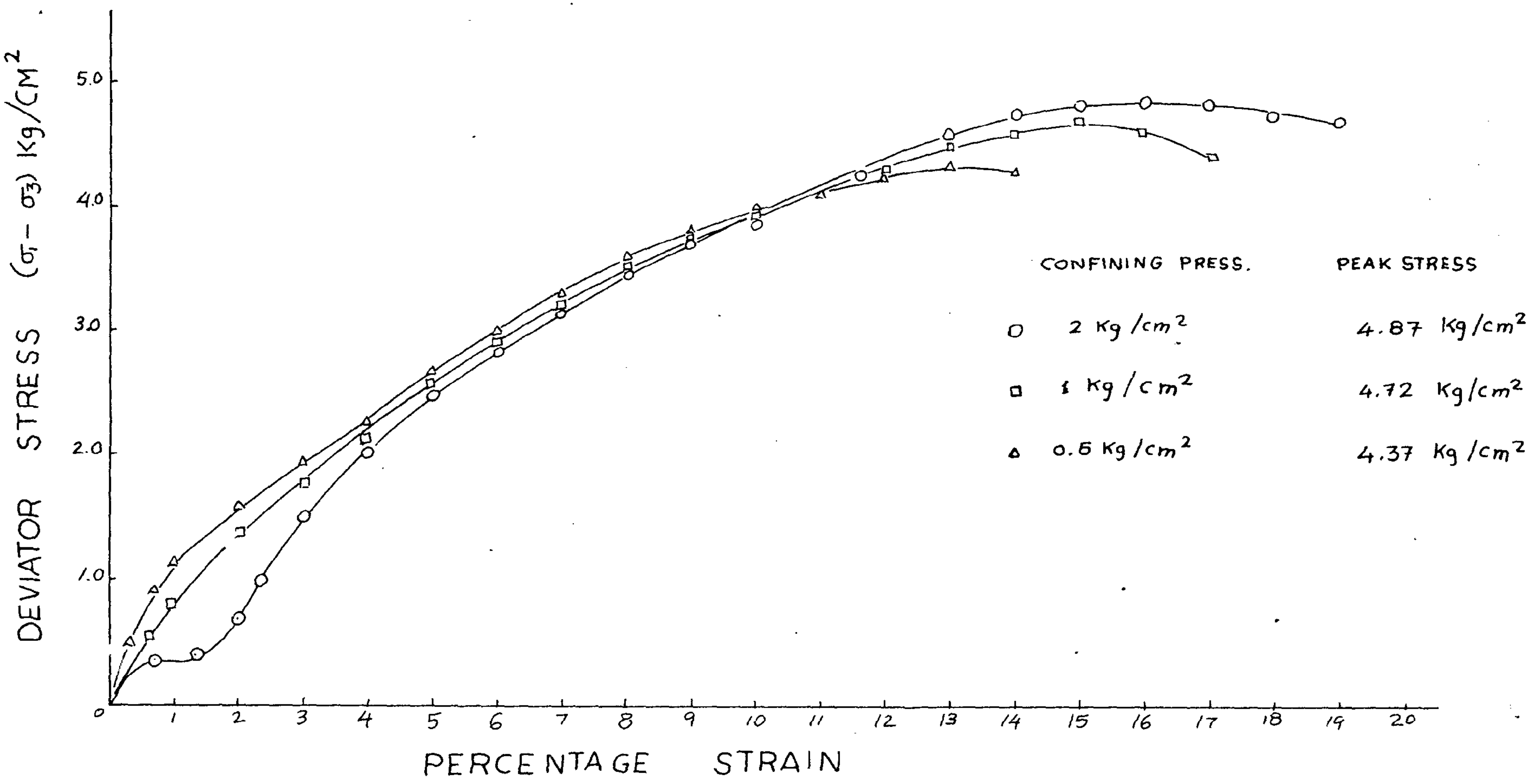


67.5° SAMPLE

DHANAURI CLAY

FIG. 4.33

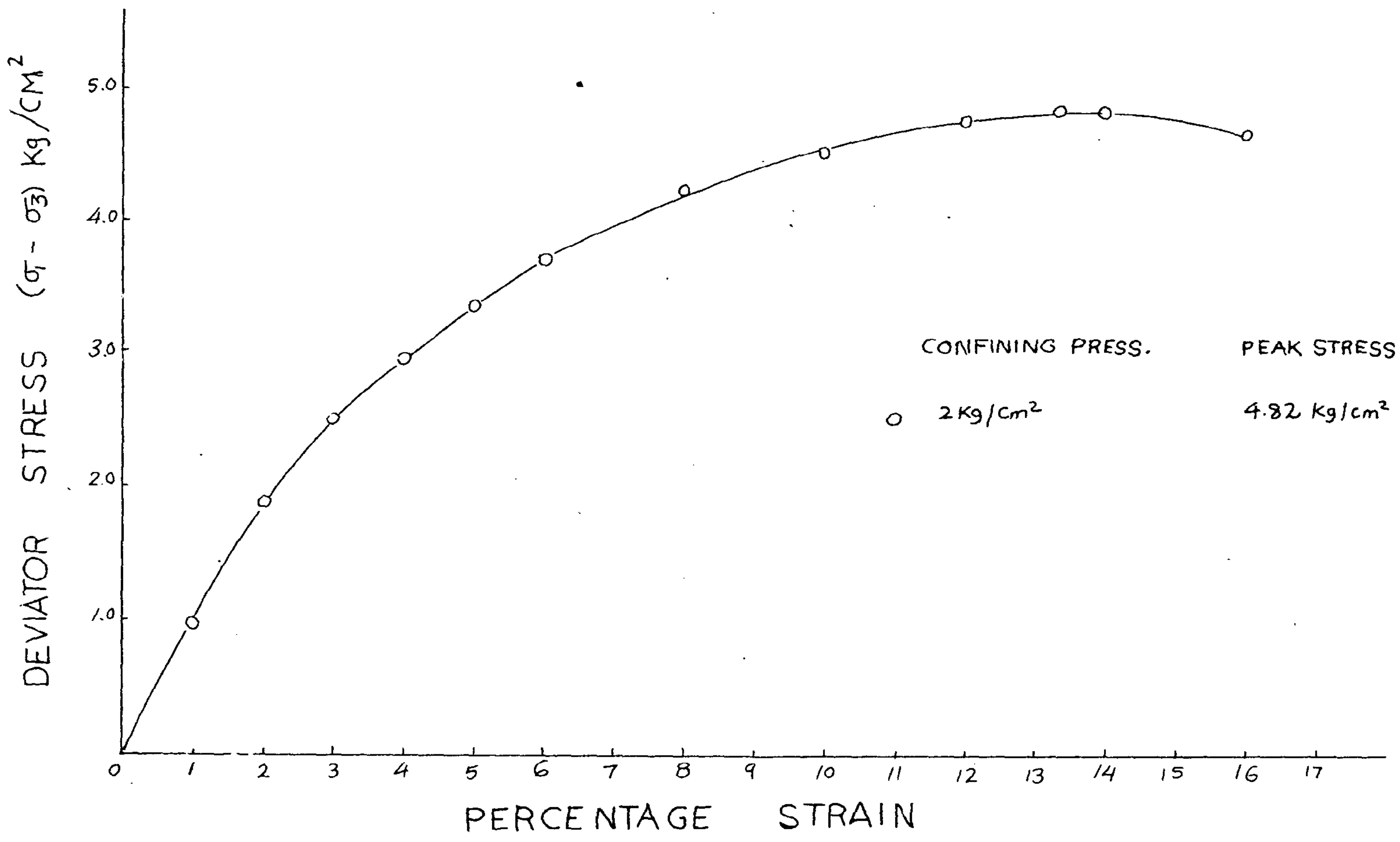
67.5° SAMPLE



DHANAURI CLAY

FIG. 4.34

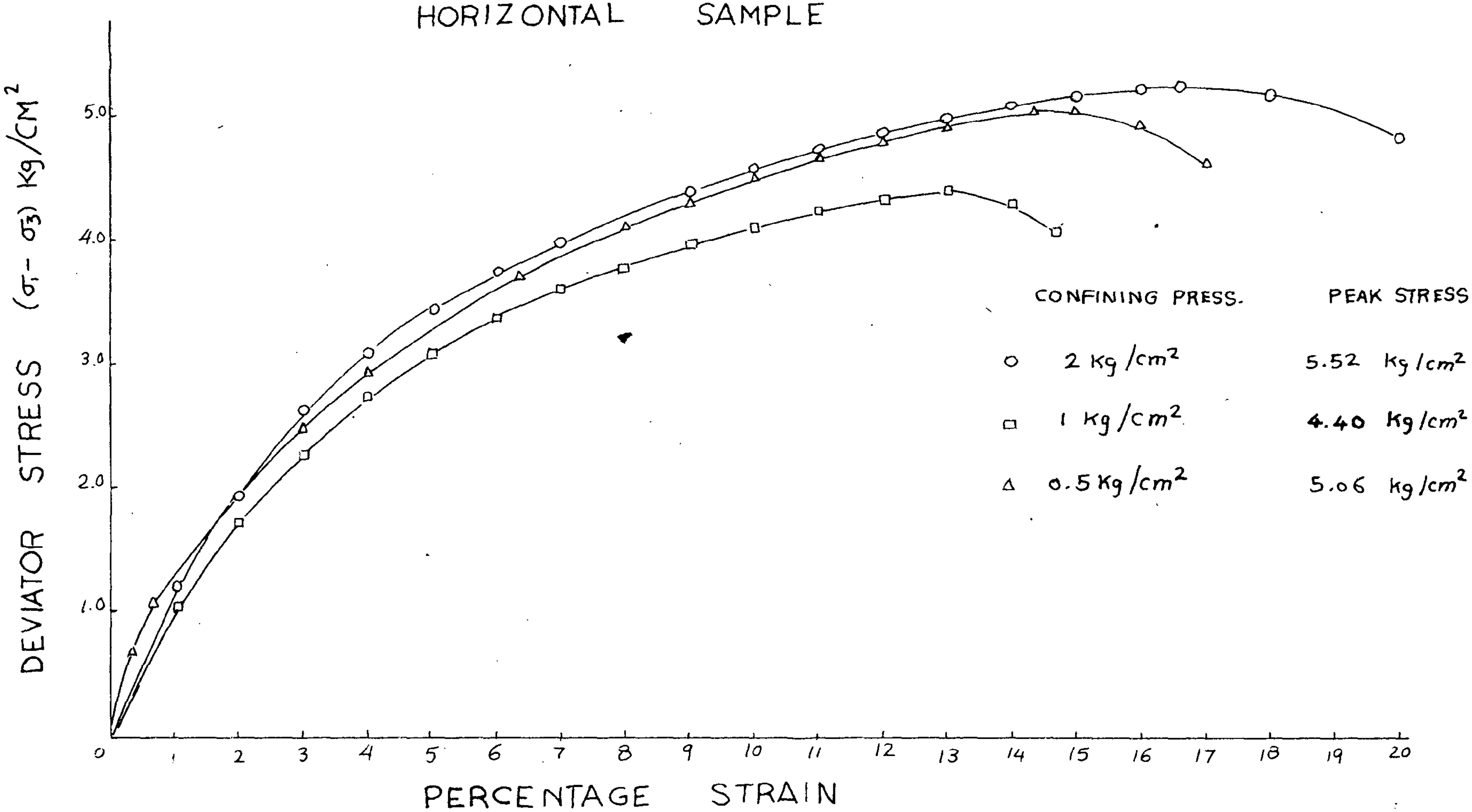
HORIZONTAL SAMPLE



DHANAURI CLAY

FIG. 4.35

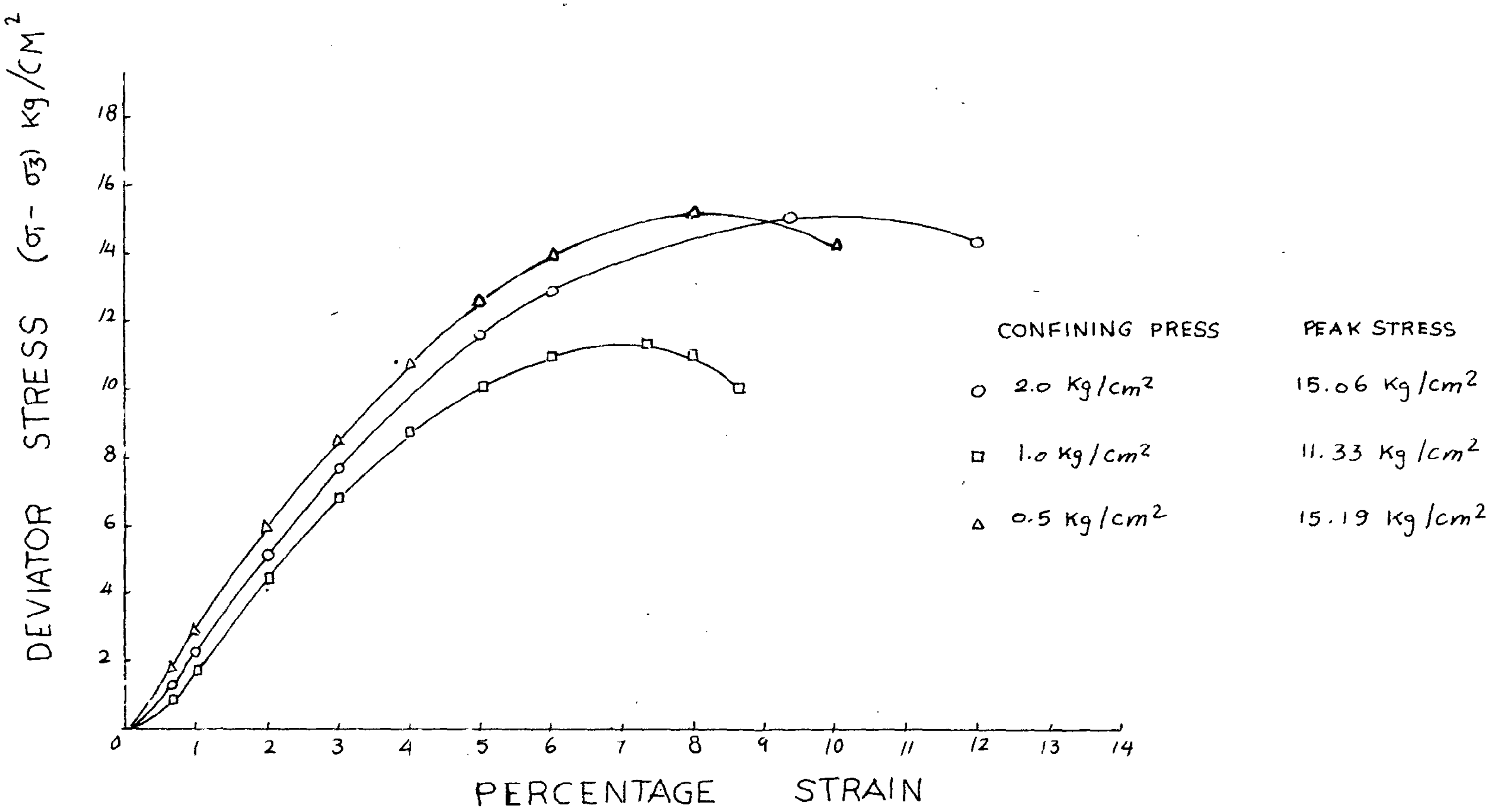
HORIZONTAL SAMPLE



BLACK COTTON

FIG. 4.36

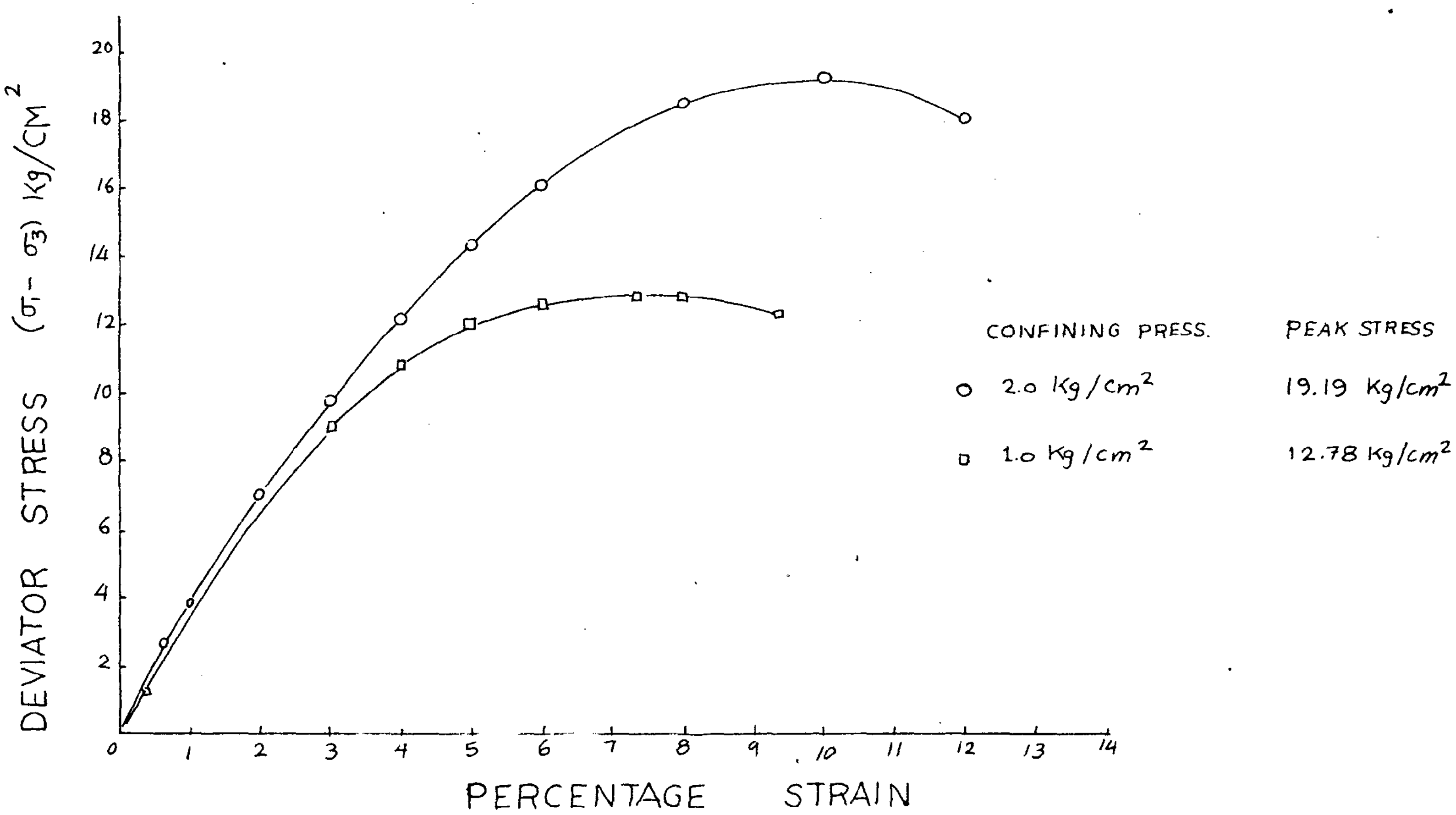
VERTICAL SAMPLE



BLACK COTTON

FIG 4.37

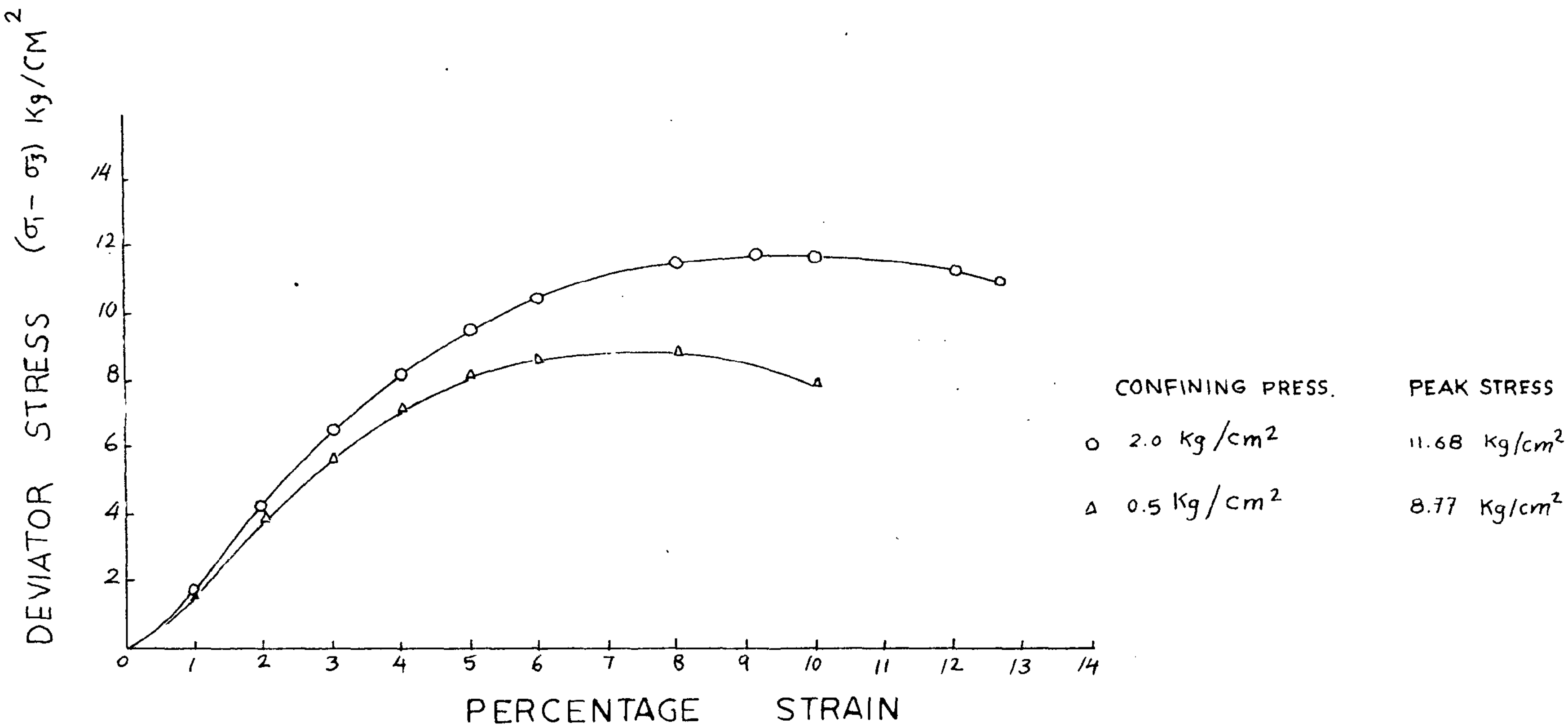
VERTICAL SAMPLE



BLACK COTTON

FIG. 4.38

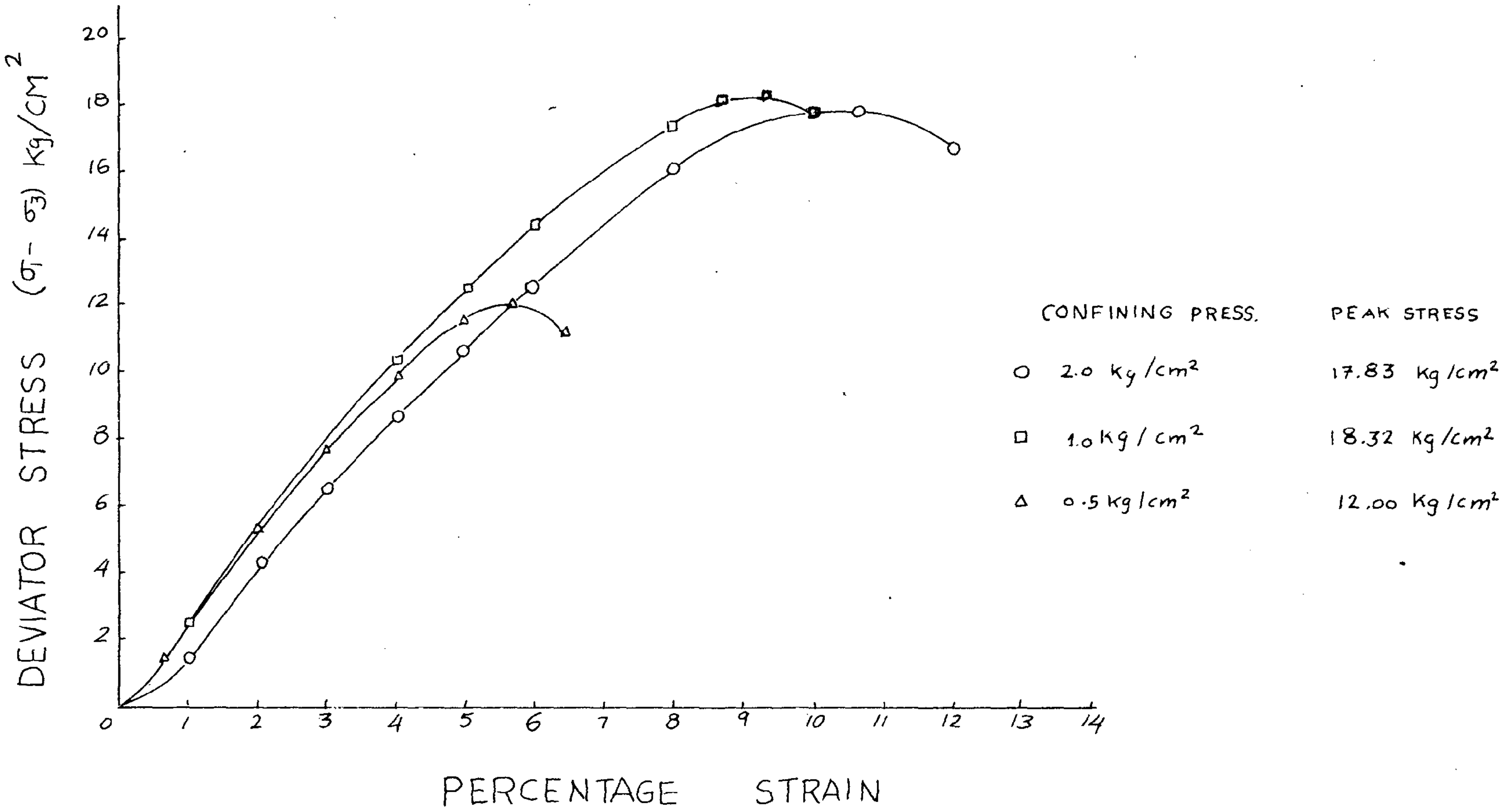
22.5° SAMPLE



BLACK COTTON

FIG. 4.39

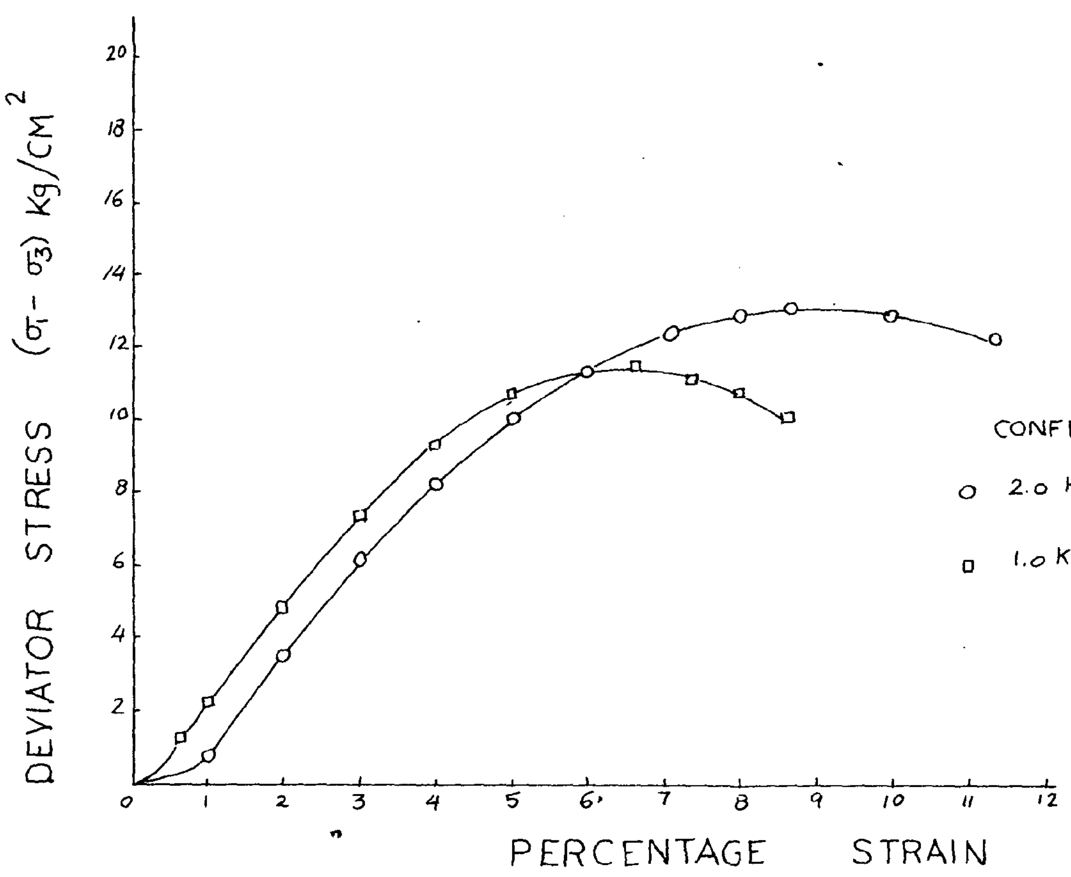
225° SAMPLE



BLACK COTTON

FIG. 4.40

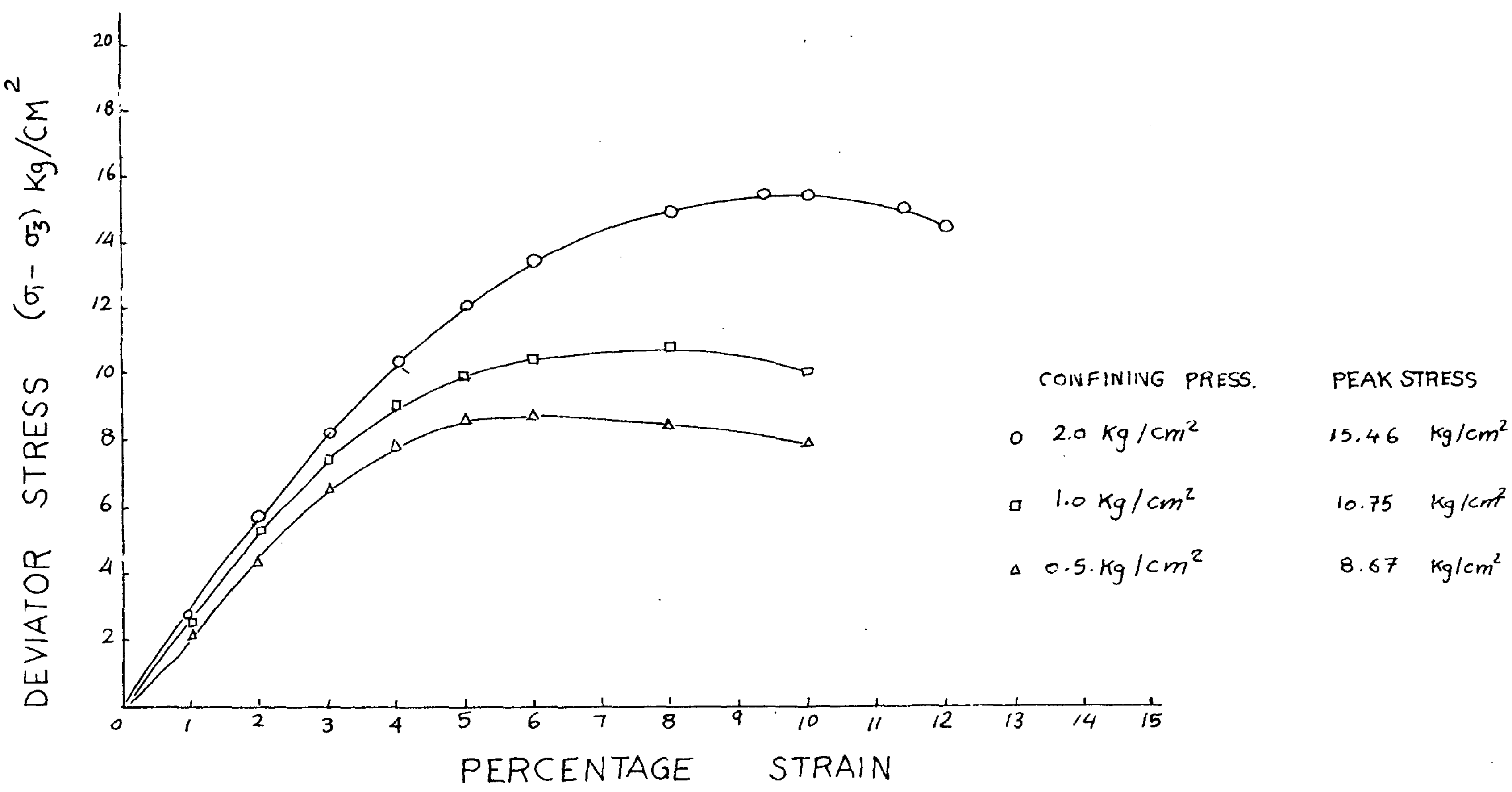
45° SAMPLE



BLACK COTTON

FIG. 4.41

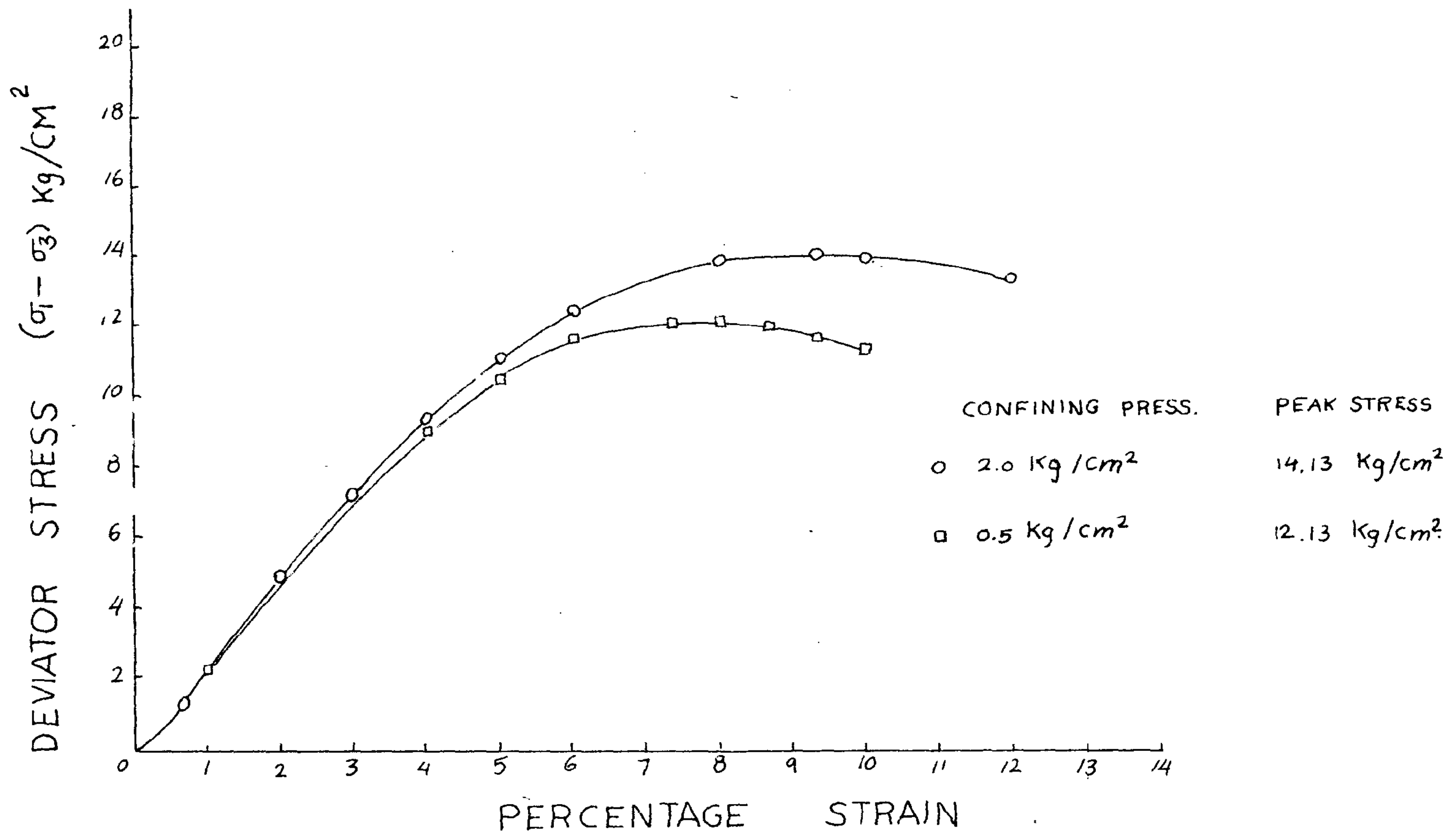
45° SAMPLE



BLACK COTTON

FIG. 4.42

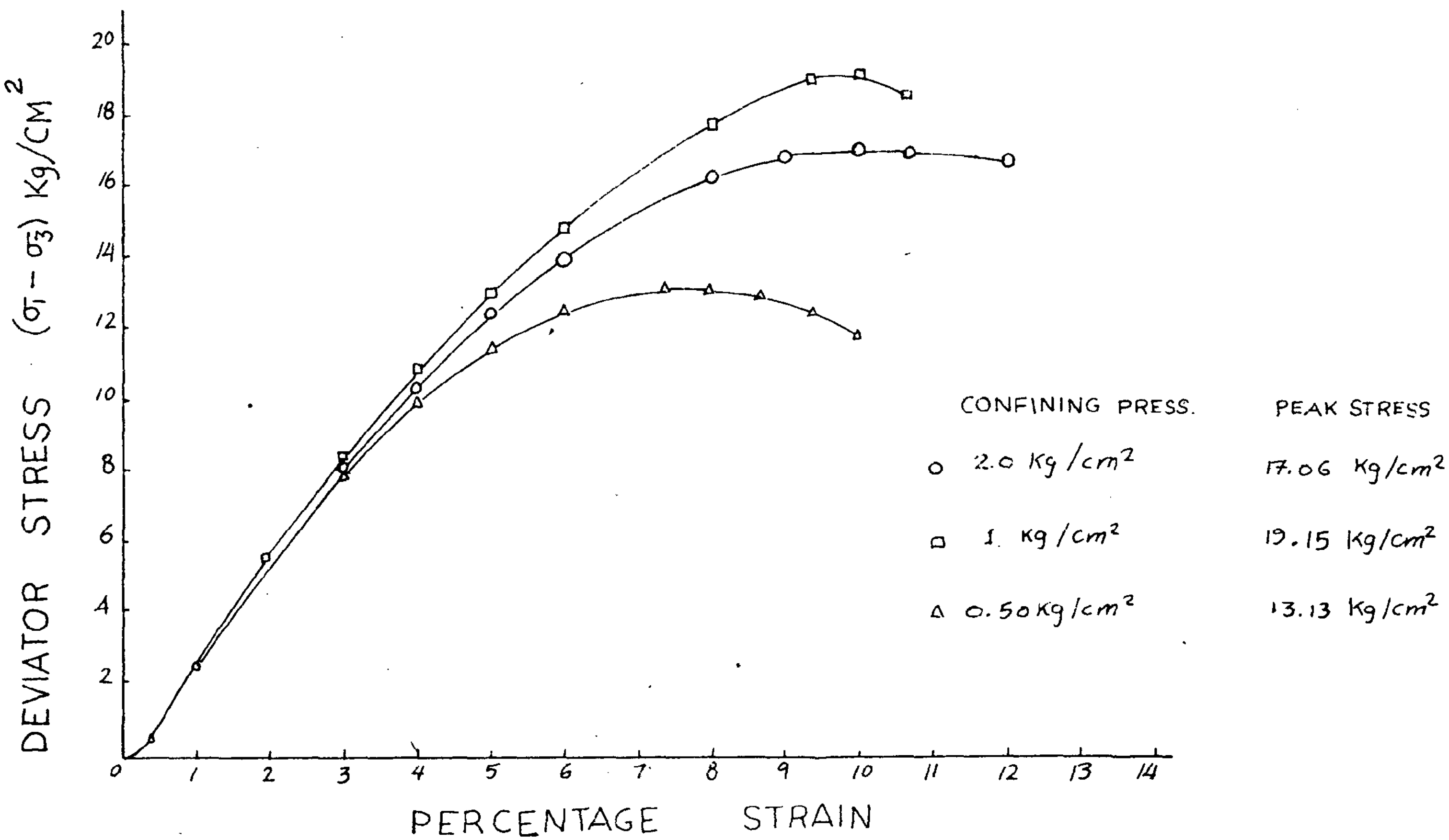
67.5° SAMPLE



BLACK COTTON

FIG 4.43

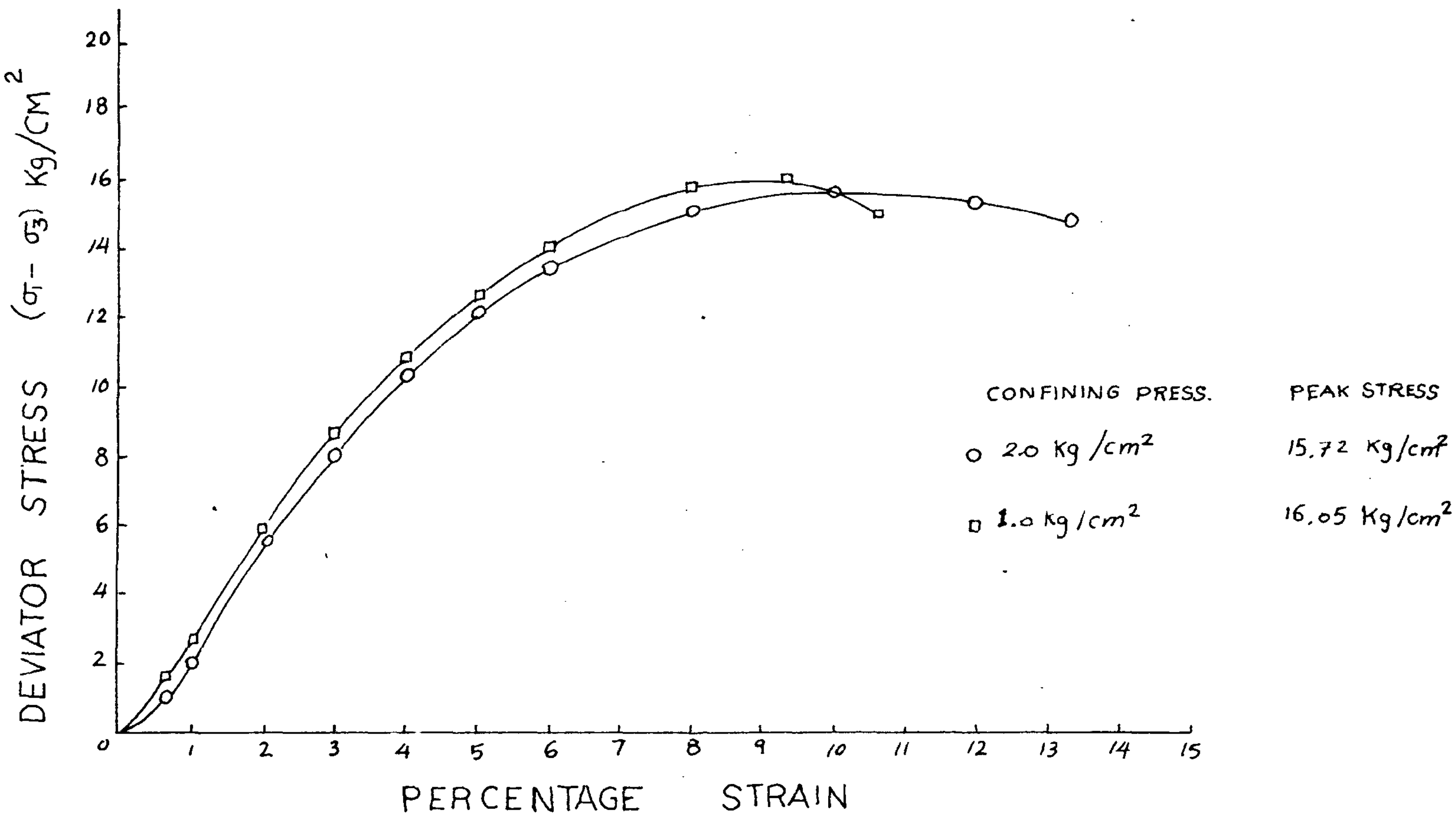
67.5° SAMPLE



BLACK COTTON

FIG 4.44

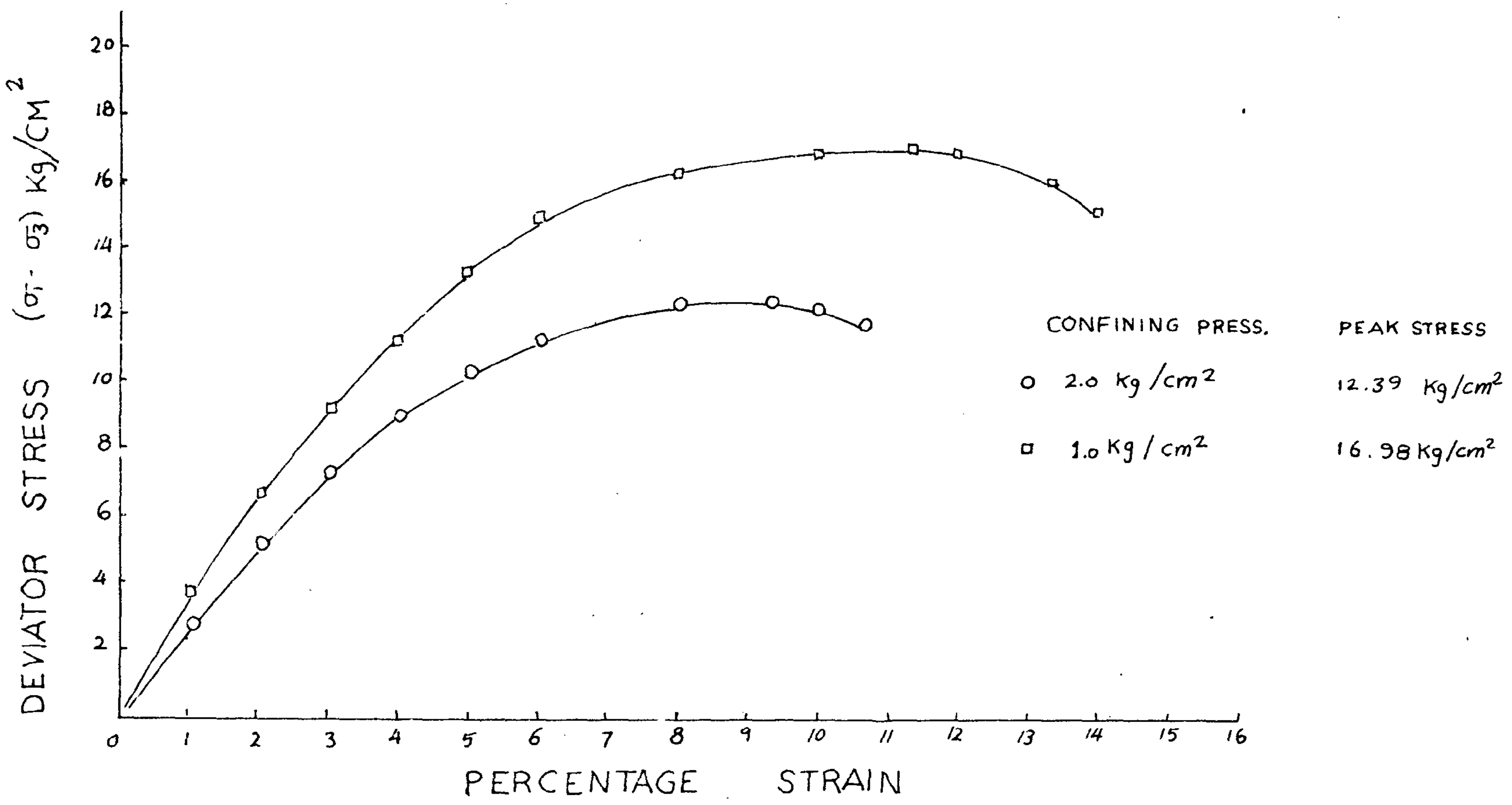
HORIZONTAL SAMPLE



BLACK COTTON

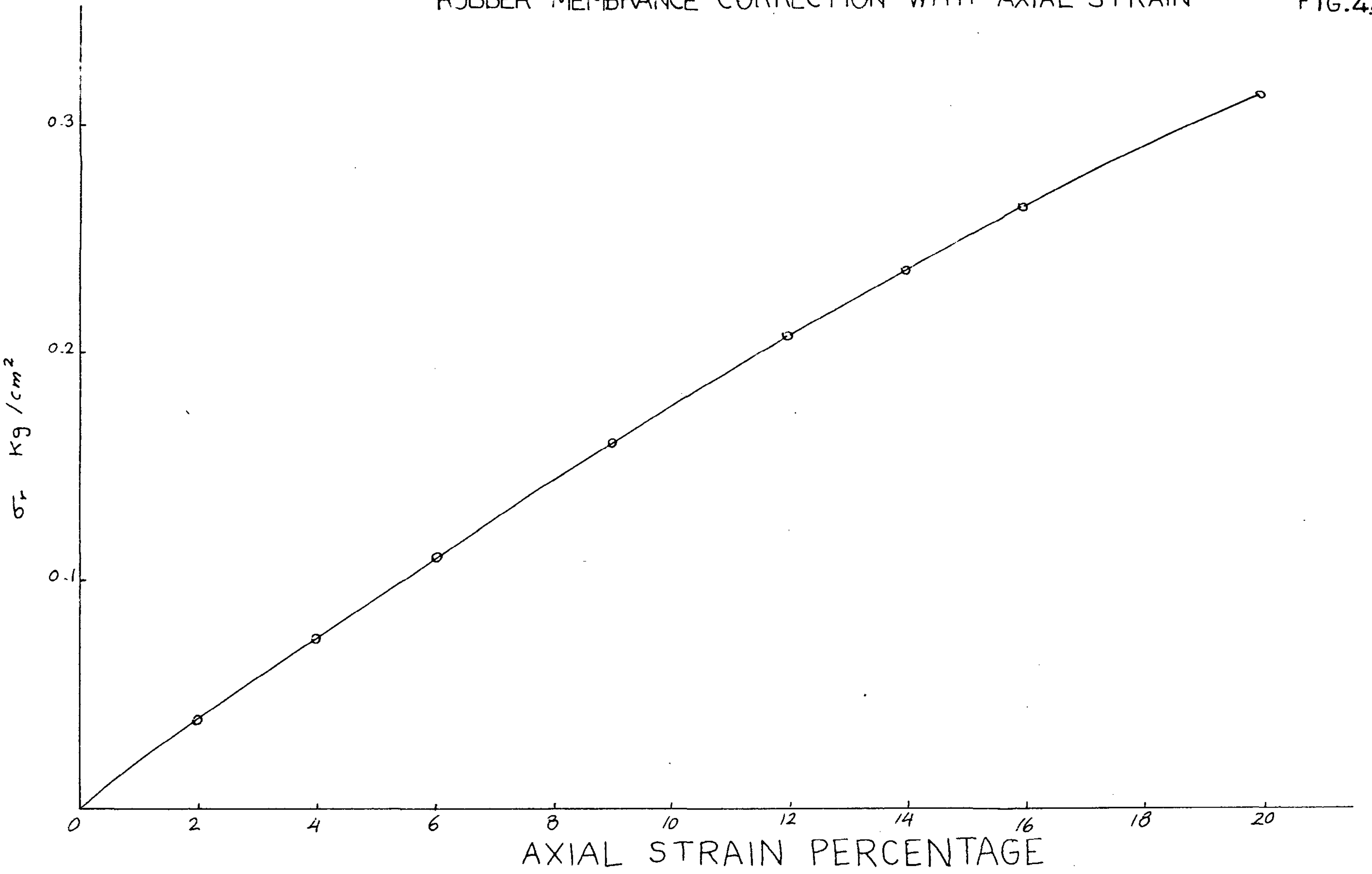
FIG. 4.45

HORIZONTAL SAMPLE



RUBBER MEMBRANCE CORRECTION WITH AXIAL STRAIN

FIG.446



Chapter 5

DISCUSSION OF THE RESULTS

5.1 Summary of Results

Summary of results at a glance for Kaolin, Bentonite, Dhanauri clay and Black Cotton soil are given in Tables 118 to 121 respectively. Comparison of test results of this study with those of Bishop (1966) and Agarwal (1967) are shown in Fig.5.5. The strength with respect to vertical strength and percentage strain at failure for each type of soil are given in the form of polar diagram in Figs.5.1 to 5.4.

Table 116 - Directional Variation of Strength in percentage with Vertical Strength as 100 percent.

Type of soil	0° (Vertical)	22½°	45°	67½°	90° (Horizontal)
Kaolin	100	93	76.5	94.8	92.7
Bentonite	100	83	88.5	98.0	99.0
Dhanauri clay	100	83	87.5	98	94.3
Black Cotton Soil	100	93.1	80.6	102.8	103.8

Table 1117 - Directional Variation of Strain at Failure in Percentage with Strain at Failure of Vertical Samples.

Type of Soil	0^o (Vertical)	$22^1/2^o$	45^o	$67^1/2^o$	90^o (Horizontal)
Kaolin	100	78	70	89.8	91.4
Bentonite	100	77.8	77.8	96.5	88.0
Dhanauri Clay	100	97.2	96.0	103	101
Black Cotton	100	102	92	106	119

5.2 Discussion of Results

5.2.1 Kaolin

It can be seen from Tables 116 and 118, as well as figure 5.1 that there is a remarkable variation in the undrained strength of compacted Kaolin at O.M.C. with respect to orientation. The maximum strength is shown by the vertical sample where as, the minimum by 45^o inclined samples. From Table 118 it can be observed that the energy utilized by the sample up to failure is also maximum for the vertical sample and minimum for the 45^o sample. Similar is the variation observed in case of ratio of Energy divided by $(\sigma_1 - \sigma_3)_f$.

The angle of the failure plane with respect to base of the sample was measured in all the cases. As shown in table 118 the angle α of the failure plane varies from about 64^{o} to 56^{o}. The average value of the angle of failure plane is 61^{o} for Kaolin. This angle of the failure plane indicates to certain extent the orientation of particles i.e. the structure of the compacted Kaolin at O.M.C. If this is taken too, the sample with orientation of 61^{o} with the vertical should have shown the minimum strength, but the minimum strength had been shown by the 45^{o} inclined sample whereas for the $67^{1}/2^{o}$ sample the strength is more as compared to other orientation, but less than that for vertical sample.

As can be seen from the polar diagram the strength vary in the descending order for $\theta = 0^{o}$, $67^{1}/2^{o}$, $22^{1}/2^{o}$, 90^{o}, 45^{o}. The equation for the polar variation of strength has been obtained and is given by

$$C_u = C_{vert} \times (1 - 0.0752 \sin^2\theta)(1 - 0.205 \sin^2 2\theta)$$

It can be further seen from table 117 and Fig.6.1 that the percentage strain at failure vary with the orientation in the similar way as the strength does. The maximum value of percentage strain at failure is 12.8 percent for the vertical sample, where as 8.9 percent for the 45^{o} inclined samples.

From table 118 it can be found out that the moisture content vary within a narrow limit from 26.4 percent to 25.6 percent. The dry density for all the samples was about the same i.e. 1.36 gm/cc. Therefore, it is clear that the variation in undrained strength with the orientation cannot be due to change in moisture content or density. But, it must be due to orientation of principal stresses, pore pressure variation anisotropy due to structure and stress history.

The modulus of Elasticity at 50 percent called E_{50} is minimum for the vertical samples whereas for $22^1/2^o$, 45^o and $67^1/2^o$ inclined samples it is about the same with intermediate values and for the horizontal samples, the maximum value. The time to failure (t_f) is maximum to vertical samples and minimum for $22^1/2^o$ sample. The time to failure for 45^o sample is nearly the same as that for $22^1/2$ sample. The E_{50} as well as t_f indicate that the vertical sample showed plastic behaviour as compared to inclined, 45^o and horizontal samples.

5.2.2 Bentonite

It can be observed from Tables 116 and 119, as well as Fig. 5.2 that the maximum undrained strength was shown by vertical samples whereas, the minimum by $22^1/2^o$ samples. From Table 119 it can be seen that the energy utilized by the sample up to failure also maximum for vertical sample and minimum for the $22^1/2^o$ sample. The variation in case of ratio of energy divided by $(\sigma_1 - \sigma_3)_f$ is also minimum at $22^1/2^o$, but maximum at $67^1/2^o$.

The average angle of the failure plane measured with respect to base in this case was found to be 54°. It can be observed that the horizontal samples yield more strength compared to other orientation, but less than that for vertical sample.

As can be seen from the polar diagram in Fig.5.2 the strength vary in the order of $\theta = 0^{\circ}, 90^{\circ}, 67^{1}/2^{\circ}$, 45° and $22^{1}/2^{\circ}$. The equation for the polar variation of strength has been obtained and is given by

$$C_u = C_{u_{vert}} (1\text{-}0.01 \sin^2 \theta) (1 - 0.11 \sin^2 2\theta)$$

Furthermore as shown in Tables 117 and 5.2 that the percentage strain at failure vary with orientation and gave higher value at $67^{1}/2^{\circ}$ compared with other orientation, but maximum value for vertical sample. The moisture content is almost constant for all samples as shown on Table 119. The dry density corresponding to these was also constant. Hence, it is clear that the variation in undrained strength with the orientation cannot be due to change in moisture content but for the same reasons stated above for Kaolin.

The modulus of elasticity at 50 percent (E_{50}) is minimum and about the same for vertical and $67^{1}/2^{\circ}$ sample, whereas for $22^{1}/2^{\circ}$, and horizontal samples it is about the same, and for 45° the maximum value. The time to failure for vertical and $67^{1}/2^{\circ}$ is nearly the same; and minimum for

45° sample. The E_{50} as well as t_f indicate that the vertical sample and $67^1/2^{\circ}$ sample showed plastic behaviour as compared to inclined 45° and $22^1/2^{\circ}$ samples.

5.2.3 Dhanauri Clay

From the summary of results on Table 116 and 120, Dhanauri clay showed similar behaviour as that of Bentonite in the order of variation of undrained strength with respect to orientation as well as the energy produced upto failure. The ratio of Energy divided by $(\sigma_1 - \sigma_3)_f$ is maximum for vertical samples and minimum for 45° sample.

The angle of the failure plane with respect to base of the sample was measured in all cases resulting in an average value of 62.56°. It is observed that one distinction in case of Dhanauri clay it showed more strength as compared to other orientation, but less than that for vertical sample.

From Fig. 5.3 it can be observed that the strength variation is in the order of $\theta = 0^{\circ}$, $67^1/2^{\circ}$, 90°, 45° and $22^1/2^{\circ}$. The equation obtained fitted for $\theta = 0^{\circ}$, 45°, 90° is expressed as

$$C_u = C_{u_{vert}} (1 - 0.057 \sin^2\theta)(1-0.1 \sin^2 2\theta)$$

Further observations can be seen from Table 117 and Fig.5.3, that the percentage at failure vary with the orientation yielding in maximum values at $67^1/2^{\circ}$, 90° and 0° respectively and minimum values at 45° samples.

From Table 120 it can be found that no change in moisture content and dry density observed and hence strength vibration only due to orientation effect.

The modulus of Elasticity at 50 percent (E_{50}) is minimum for $67^1/2^o$ samples and maximum for horizontal samples. The time to failure is maximum for $67^1/2^o$ samples and minimum for $22^1/2^o$ sample. The E_{50} as well as t_f indicate that the $67^1/2^o$ samples showed plastic behaviour than $22^1/2^o$ samples.

5.2.4 Black Cotton Soil

In Tables 116 and 121, as well as Fig.5.4 it can be seen that Black Cotton also showed a considerable variation in the undrained strength for compacted samples at O.M.C. with respect to orientation. The maximum strength showed by horizontal sample where the minimum by 45^o inclined samples. In Table 121 it can be observed that the energy utilized by the sample up to failure is also maximum for horizontal samples and minimum for diagonal (45^o) samples as well as energy to $(\sigma_1 - \sigma_3)_f$ ratio.

The angle of the failure plane measured was found to be equal to 56^o with the horizontal plane. This angle indicates to certain extent the orientation of particles. In addition to this it can be seen from the polar diagram that the strength vary in a descending order for $\theta = 90^o$, $67^1/2^o, 0^o$, $22^1/2$, 45^o. The expression fitted to $\theta = 0^o$, 45^o, 90^o is given by

$$C_u = C_{u_{vert}}(1 + 0.038 \sin^2\theta)(1-0.209 \sin^2 2\theta)$$

Further-more, the percentage strain at failure obtained showed maximum value for horizontal samples and minimum for 45^o and intermediate for other inclinations. The maximum value of percentage strain at failure is 10 per cent for horizontal samples whereas 7.73 percent for 45^o inclined samples.

From table 121 it can be found out that the moisture content vary within a narrow limit from 19.5 percent to 20 percent. The dry density for all the samples was about the same i.e. 1.613 gm/cc. Therefore the variation in strength can be attributed only due to orientation.

The modulus of elasticity at 50 percent (E_{50}) is minimum for the 22^1/2^o samples whereas it is maximum for vertical samples. The time to failure (t_f) is maximum for horizontal samples and minimum for 45^o sample. Thus, the E_{50} as well as t_f indicate that the horizontal samples showed plastic behaviour as compared to inclined, 45^o and vertical samples.

5.3 Comparison With Results of Previous Workers

The results obtained in case of all the four cohesive soils agree closely to the fact that vertical samples gave the maximum strength while inclined samples showed minimum strength.

The test results showed minimum strength occurred at 45° samples in case of Kaolin and black cotton, and at $22^1/2^o$ in case of Bentonite and Dhanauri Clay.

Simple expressions have been obtained by fitting the data obtained for $\theta = 0^o$, 45^o and 90^o. The expressions are:

1 $C_u = C_{u_{cert}} (1 - 0.0752 \sin^2 \theta)(1-0.205 \sin^2 2\theta)$

2 $C_u = C_{u_{vert}} (1 - 0.01 \sin^2 \theta)(1-0.11 \sin^2 2\theta)$

3 $C_u = C_{u_{vert}} (1 - 0.057 \sin^2 \theta)(1-0.1 \sin^2 2\theta)$

4 $C_u = C_{u_{vert}} (1 + 0.038 \sin^2 \theta)(1-0.209 \sin^2 2\theta)$

these for Kaolin, entonite, Dhanauri clay and Black-cotton soil respectively.

These coefficients of $\sin^2\theta$ and $\sin^2 2\theta$ agree closely with the values given in equation 17 Bishop(1966), and equation 18. Agarwal (1967) for orientation effects represented on polar diagram.

In another attempt for fitting an expression for the test results of Kaolin it was found that the expression given by Cassagrande and Carrillo (1953) holds good for samples of inclinations of 0^o, $67^1/2^o$ and 90^o.

5.4 An Analysis of Stability of Slope Problem

For illustrating the orientation effects a simple problem of comp uting the factor of safety for the stability of the slope has been solved Only one rupture surface was considered and the embankment was assumed to be constructed of Kaolin, Bentonite, Dhanauri clay and Black-Cotton soil at O.M.C, respectively. The slope of the embankment for analysis is taken as 3 horizontal to 1 vertical. The problem is shown in Fig.5.6.

The factor of safety for the rupture surface was found first by taking the undrained strength of vertical samples only, as in the conventional method. Later the mass of soil in the rupture surface was divided into slices and for each length of rupture surface included in the slice the oriented strength was considered to find the factor of safety. The values of the factor of safety for both the above cases are given in Table 122.

Table - 122

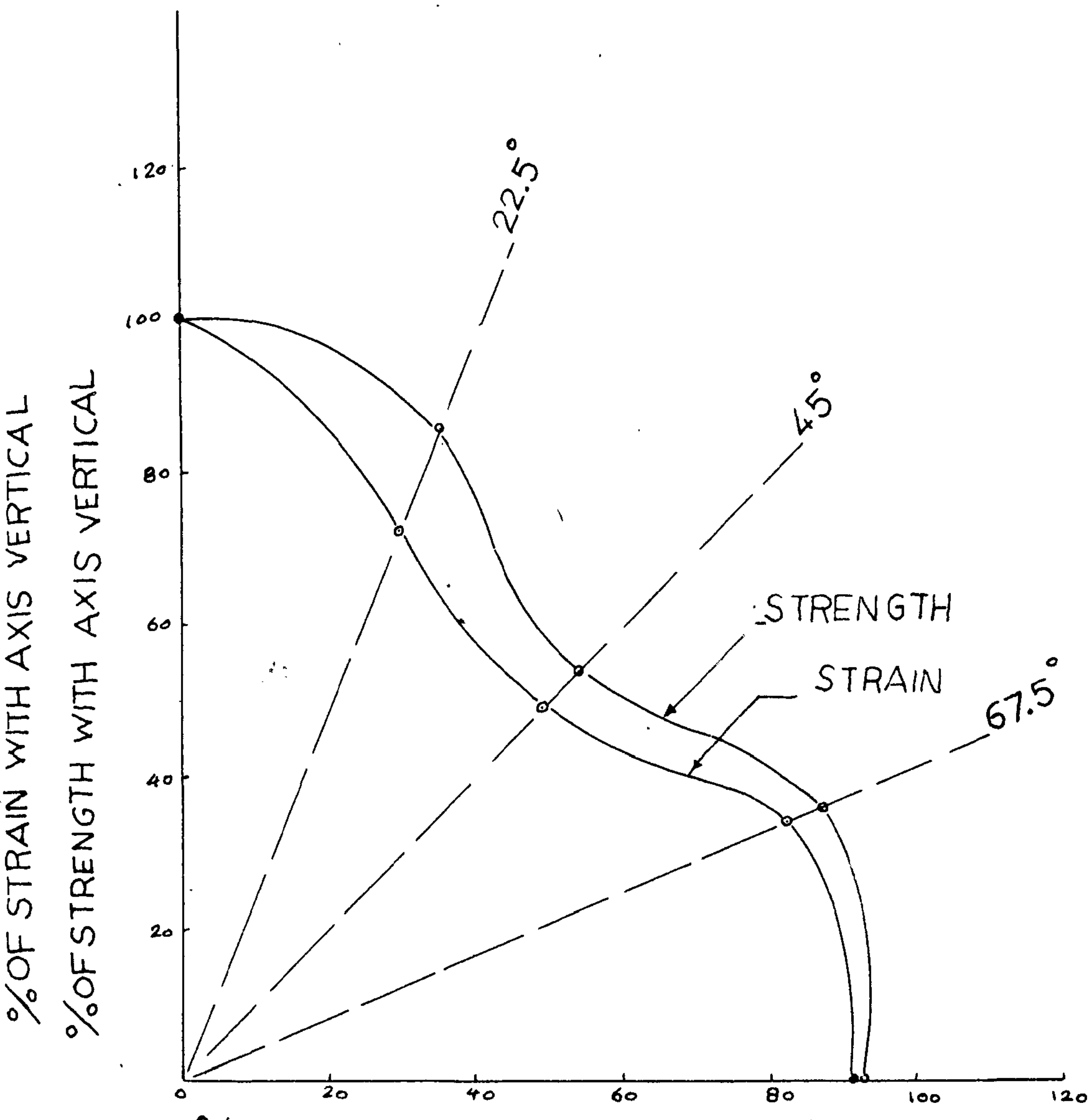
Soil	Bentonite	Dhanauri	Black Cotton	Kaolin
F.S. without orientation	1.08	1.05	2.93	1.06
F.S. with orientation	1.03	0.987	2.85	0.96
Percentage of reduction in F.S	4.6	5.7	2.7	9.5

It can be clearly seen from the table that the factor of safety reduces if the orientation effects are considered. If the slope is designed without considering orientation effects, the factor of safety will be higher but the same slope could fail due to orientation effects i.e. the conventional method leads to unsafe slopes.

-[][]-

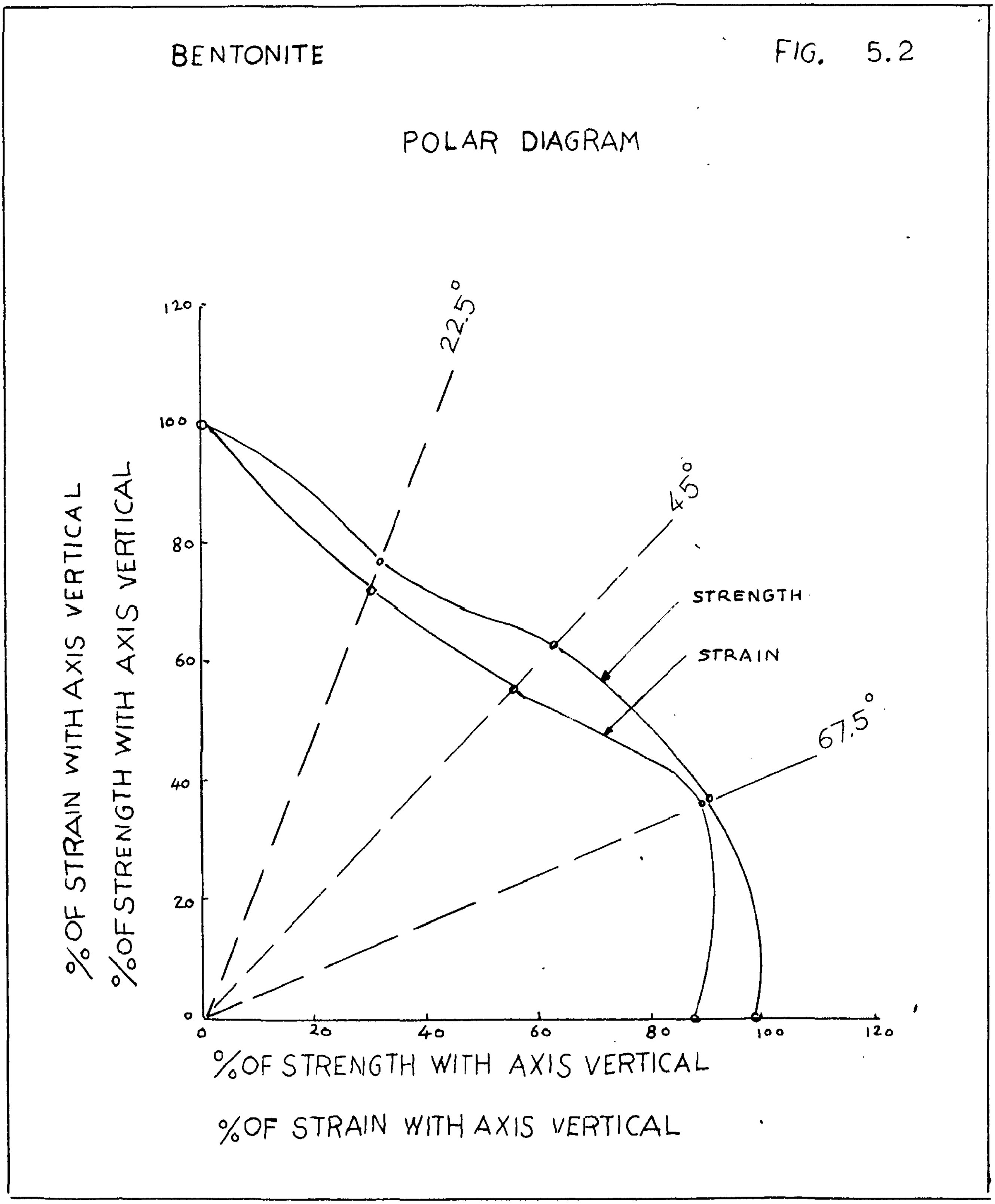
KAOLIN FIG 5.1

POLAR DIAGRAM



%OF STRENGTH WITH AXIS VERTICAL

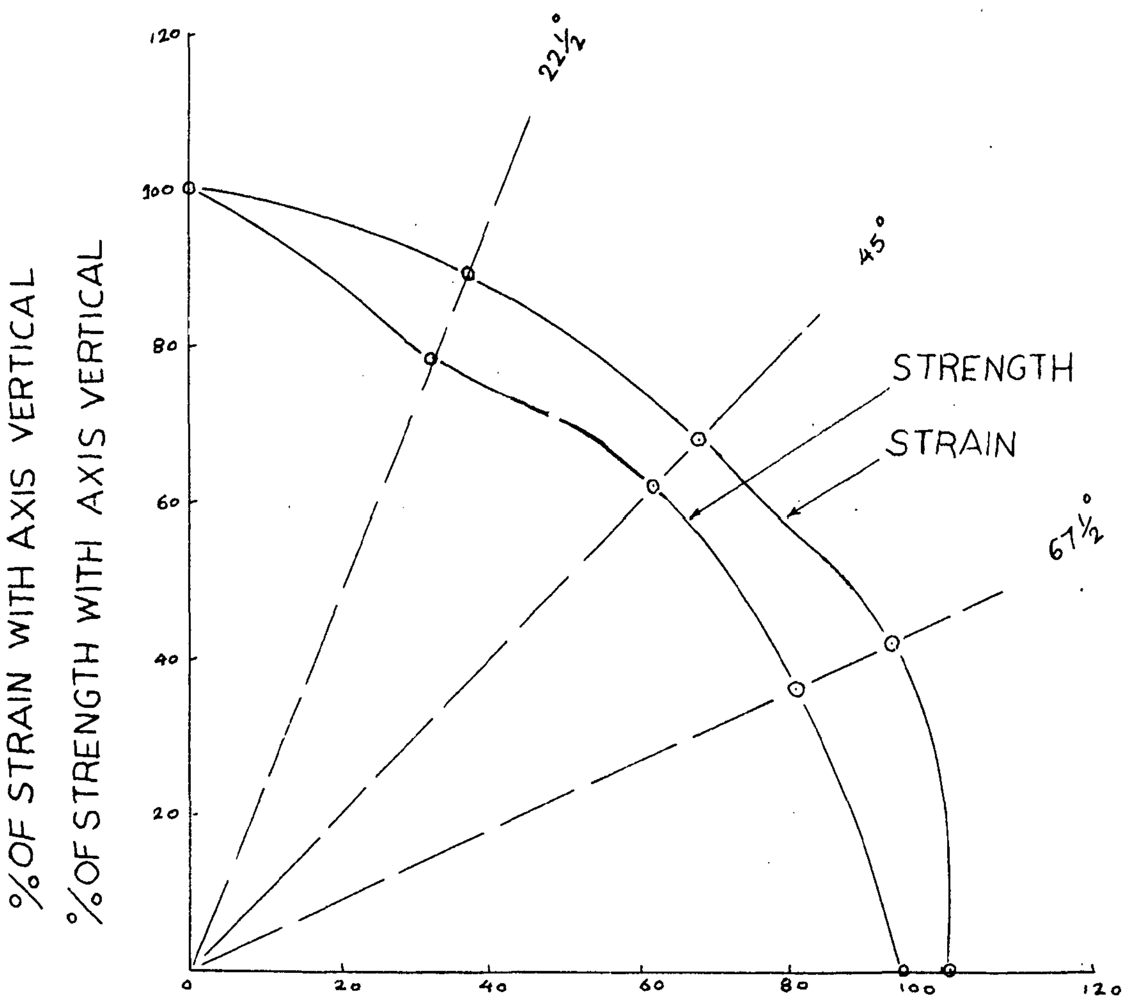
%OF STRAIN WITH AXIS VERTICAL


BENTONITE
FIG. 5.2
POLAR DIAGRAM
22.5°
45°
67.5°
STRENGTH
STRAIN
120
100
80
60
40
20
0
0
20
40
60
80
100
120
% OF STRAIN WITH AXIS VERTICAL
% OF STRENGTH WITH AXIS VERTICAL
% OF STRENGTH WITH AXIS VERTICAL
% OF STRAIN WITH AXIS VERTICAL

DHANAURI CLAY

FIG. 5.3

POLAR DIAGRAM



% OF STRENGTH WITH AXIS VERTICAL

% OF STRAIN WITH AXIS VERTICAL

BLACK COTTON

FIG. 5.4

POLAR DIAGRAM

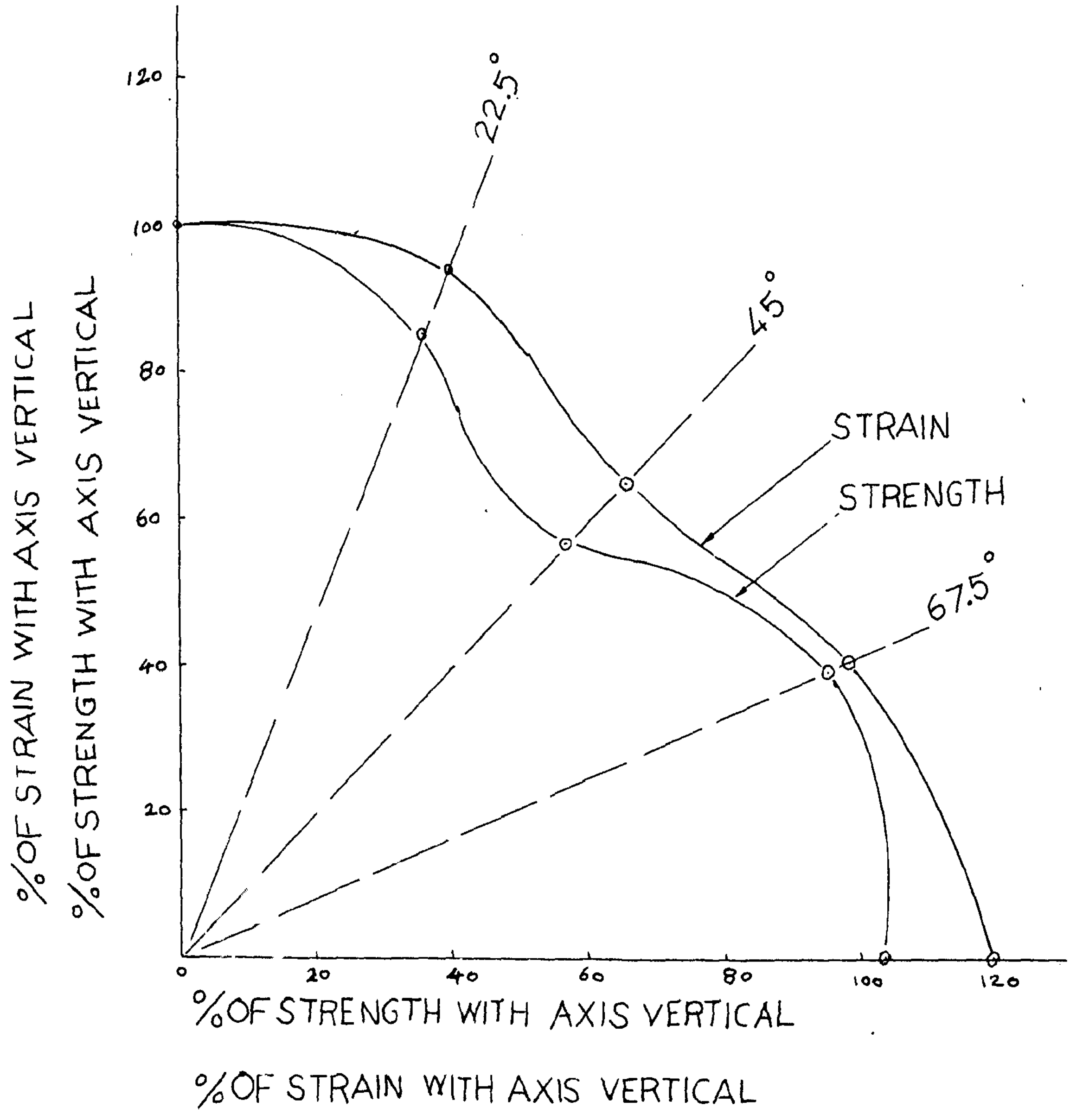
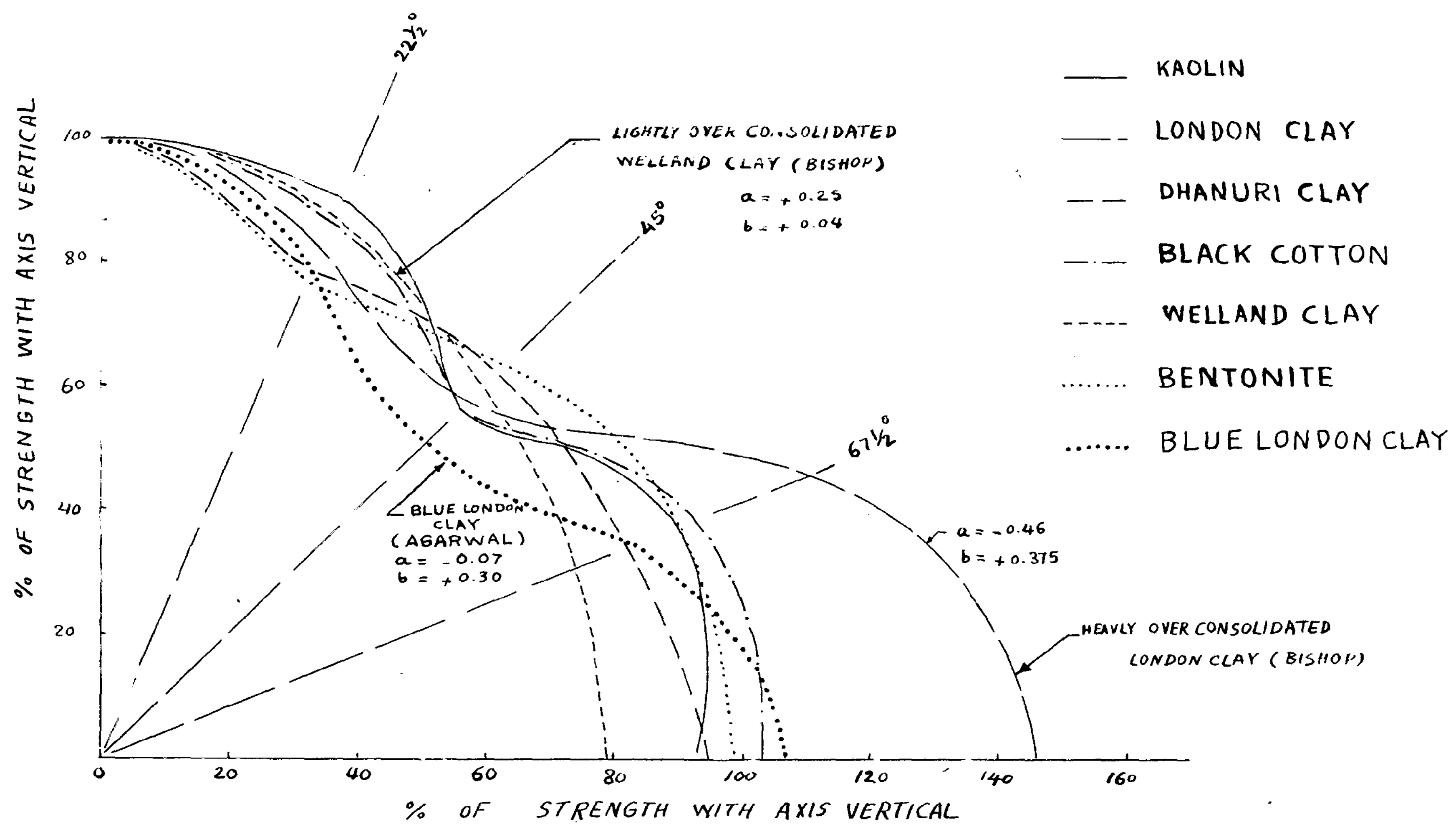
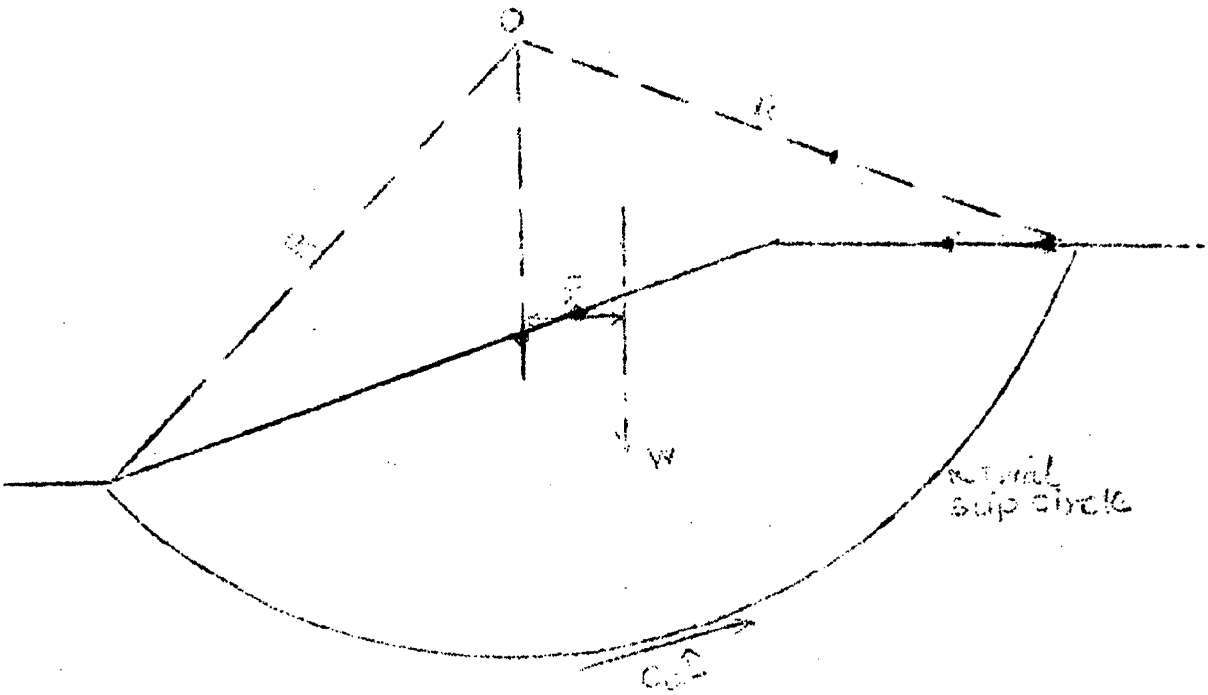


FIG. 5.5

POLAR DIAGRAM





$$F.S = \frac{C_u . L}{W\bar{x}}$$

FIG.5.6

CONCLUSION

From the study of undrained strength of compacted soils, viz, Kaolin, Bentonite, Dhanauri clay and Black cotton soil, the following conclusions can be made:-

1. There is significant orientation effect on the undrained strength behaviour in soils compacted at O.M.C.
2. For all the soils studied the maximum undrained strength was shown by vertical samples except for Black-cotton soil. The minimum strength was shown by 45° inclined samples in case of Kaolin and Black cotton soil and by $22^{1}/2^{o}$ samples in case of Bentonite and Dhanauri clay.
3. The conventional method of designing slope by considering the undrained strength of vertical sample only may lead to unsafe conditions and to failure in exceptional cases.
4. For safe designing of the slope the undrained strength should be considered according to the orientation of the rupture surface.

-00-

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