10. SHEAR TEST BY TRIAXIAL METHOD.
(IS : 2720 – PART – 12)

INTRODUCTION:

Shear tests are generally carried out on small soil samples in the laboratory to evaluate the strength properties of the element in the soil mass. The strength parameters, namely the cohesion and angle of shearing resistance are usually found from these tests. The two methods of shear tests commonly used are the direct shear test and the triaxial test.

Apparatus:

The triaxial machine consists of a pressure cell assembly and equipment for loading and measuring the load and deformation.

Triaxial pressure cell: Cylindrical soil specimen inserted in a thin rubber membrane and kept sealed to prevent the entry of lateral fluid, can be placed in position in the cell. There is provision to apply radial fluid pressure and vertical stress through a piston. There is also facility to allow or prevent drainage of specimen during the application stresses. A pressure gauge may be used to measure the fluid pressure in the cell.

Loading equipment: Usually strain controlled equipment is used; stress controlled equipment is also used in some tests. A proving ring assembly may measure the vertical load applied on the piston. A dial gauge attached to the piston measures the deformation of specimen.

Procedure:

Preparation of specimen: Either undisturbed or remoulded specimens may be prepared as desired. Larger size of undisturbed soil sample may be taken and trimmed to desired size. But undisturbed soil sample can be prepared only from soils having sufficient cohesion. Remoulded samples of cohesive soils may be prepared either by compacting first in large mould and by pressing hollow cutters or in constant volume moulds. Special care is needed while preparing specimens of cohesion less soil, in special mould after placing the membrane in proper position. The cylindrical specimens usually have height to diameter ratio equal to two; this ratio does not however exceed 2.5.

Test type: Three types of triaxial tests may be performed in partially or fully saturated specimens. These are (i) undrained or quick test, (ii) consolidated – undrained test and (iii) drained or slow test.

In the undrained or quick test the out let valve is closed and no drainage is allowed from the specimen during the test, from the time of application of lateral pressure $\bullet_3$ till the specimen fails under gradually increasing vertical load. In the consolidated undrained test, the drainage valve is kept open and the specimen is allowed to fully consolidate

under the applied lateral pressure • $_3$; but no further drainage is allowed during the application of the vertical load, till failure.

In the drained or slow test the drainage is allowed during all stages of testing. First the specimen is allowed to fully consolidate under the applied lateral pressure • $_3$ and later the vertical load is also applied in such a way that there is enough time for the drainage of pore water pressure developed from time to time.

There are two methods of applying the lateral or confining pressure. Usually the lateral pressure • $_3$ is maintained constant throughout the test. But in some studies the volume of the specimen is maintained constant by adjusting the lateral pressure.

Procedure:
The specimen enveloped properly in the membrane is kept in the triaxial cell and a desired lateral pressure • $_3$ is applied. Then the vertical load is increased till the specimen fails noting the vertical deformation and load readings at desired intervals. The experiment is repeated for various other values of lateral pressure. To find the values of cohesion and angle of internal friction, tests should be carried out with at least two or three different lateral pressure values. Soils may be tested with lateral pressures of 0, 0.75 and 1.5 kg/cm^2.

Calculations:
The triaxial test specimen is subjected to the all round pressure equal to the lateral pressure • $_3$ and the applied vertical stress or deviator stress • $_d$ such that the total vertical stress • $_1$ = • $_d$•• + •• $_3$. Mohr stress circles are plotted at normal stress intercepts • $_3$ and • $_1$ or with diameters equal to deviator stresses. Mohr rupture envelope is then obtained by drawing a tangent to the circles. The intercept of this line with Y-axis represents the cohesion (C) and the inclination with X-axis represents the angle of internal friction (•) of the soil.

Correction for area of cross section: It is necessary to correct the deviator stress values for the increased area of cross section due to loading. Assuming that the volume of specimen remains constant and the area of cross section of the specimen increases uniformly, the corrected value of deviator stress • $_d$ is calculated from the relation:

$$\bullet_d = \frac{P_1}{A_0}\left(1 - \frac{\bullet}{l_0}\right)$$

Where, P_1 = applied load.
A_0 = original area of cross section.
•••••••••••••• •= deformation of specimen.
l_0 = original length of specimen.

The shearing resistance is found the following equation:

$$S = C + \bullet \tan \bullet$$

Mohr's Envelope from Triaxial Test.