EXPERIMENT 6

A) EXPERIMENT NAME: Compression test

B) THE AIM OF THE EXPERIMENT:

The goal of a compression test is to determine the behavior or response of a material while it experiences a compressive load by measuring fundamental variables such as, strain, stress, and deformation.

The compressive strength, yield strength, ultimate strength, elastic limit, and the elastic modulus can be determined in compression test.

The materials used in places where compression forces are effective are generally brittle materials and their properties are determined by compression tests. The ductility of those material cannot be measured with the tensile test since percentage elongation and reduction in area are so small and nearly zero.

Metallic materials such as gray cast iron, bearing alloys and nonmetallic materials such as brick and concrete have much higher compression strength than tensile strength so such materials are used in the applications where compression forces are effective and their mechanical properties are determined by compression test.

C) EXPERIMENTAL SETUP AND APPARATUS

The testing equipment is Shimadzu Autograph AG-IS 100 computerized servo hydraulic universal testing machine (UTM). The compression tests are performed according to DIN EN 826:2103 "Thermal insulating products for building applications - Determination of compression behaviour". This standard specifies the method for determining the ability of foam materials to undergo plastic deformation in compression. The specimen is placed between the pressure pads and simply compressed (Figure 1)

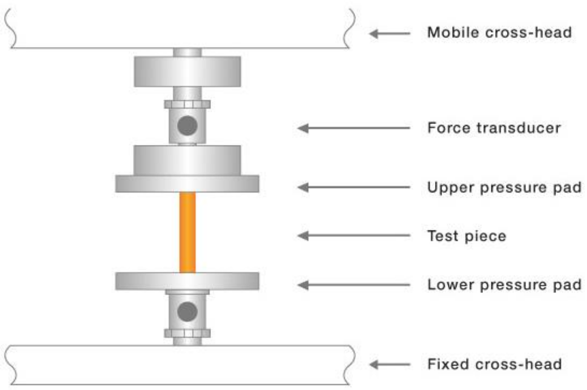

Figure 1: Components of compression test machine.

D) THEORY

Generally, compression test is carried out to know either simple compression characteristics of material or column action of structural members. In principle compressive strenght is the opposite of the tensile strength. Figure 2 shows that the compression diagram is similar to the tensile diagram of a material. After the flow limit in the compression diagram, plastic deformation occurs immediately. While there is a decrease in the tensile strength after the maximum point in the tensile diagram, an increase in the compresion strength may be observed after the maximum point in the compression diagram because of the continuous increase of the cross-sectional area of the specimen (Figure 3).

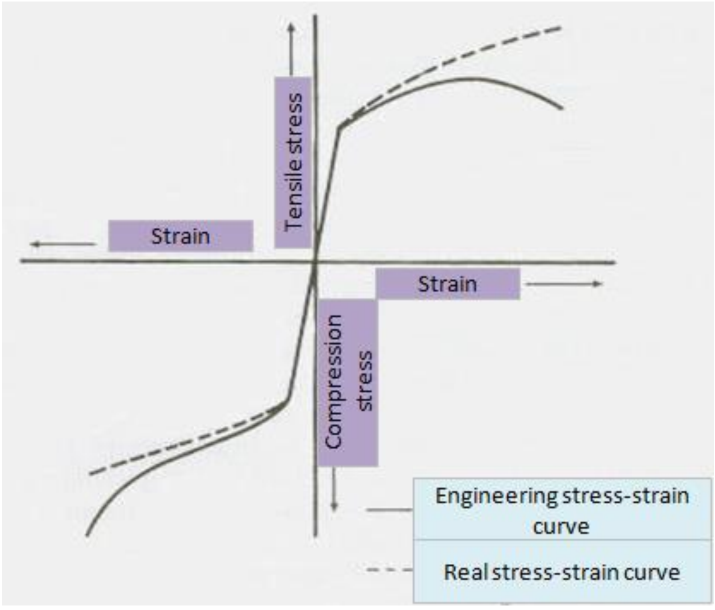

Figure 2: Stress and strain curve in tension and compression

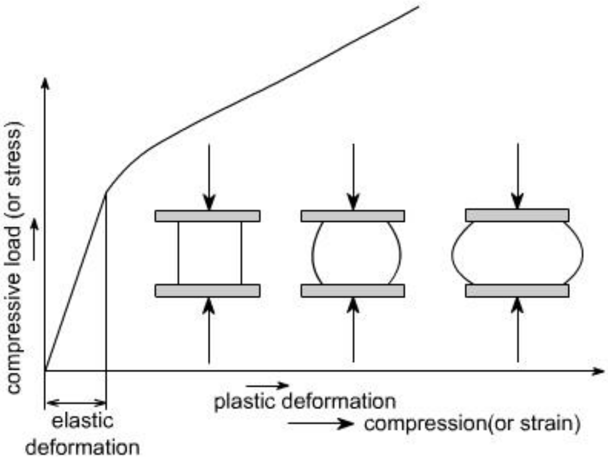

Figure 3: Compressive load-strain diagram.

Modes of deformation in compression testing

It has been observed that for increasing height of member, keeping crosssectional and the load applied constant, there is an increased tendency towards buckling of a member. For compression test specimens, the ratio of $\mathbf{h_o/d_o}$ is significant. $\mathbf{h_o}$ and $\mathbf{d_o}$ are initial height and diameter of the specimen respectively. If the ratio $\mathbf{h_o/d_o}$ of the specimen is too large, **buckling** may occur during the test and cause an inhomogeneous stress distribution. If this ratio is small, the friction between the specimen and the pad will affect the test results greatly. For this reason it is recommended that the ratio $\mathbf{h_o/d_o}$ of the specimen should be kept in the range between 1.5 and 10 to prevent buckling and shearing modes of deformation. For metallic materials, $\mathbf{h_o/d_o}$ ratio is 2 in general.

The compressive stress, in the metric system, is usually measured in N/m^2 or Pa, such that 1 N/m^2 = 1 Pa. From the experiment, the value of stress is calculated by dividing the amount of force (P) applied by the machine in the axial direction by its cross-sectional area (A_o), which is measured prior to running the experiment. Mathematically, it is expressed in Equation 1.

$$\sigma = \frac{P}{A_o} \tag{1}$$

Percentage elongation (shortening) is the highest plastic elongation percentage value. If the sample subjected to the compression test is broken, the final length (L) can be measured after fitting together the broken parts of the sample. Then percentage elongation is calculated by Equation 2

$$\%\ \text{Elongation} = \frac{L - L_o}{L_o} \text{x } 100 \tag{2}$$

Percent increase of area is determined by measuring the minimum diameter of the broken test specimen after the two pieces are fitted together and the difference is expressed as a percentage of the original cross sectional area prior to the test (Equation 3)

$$\%\ \text{Increasing of area} = \frac{A - A_o}{A_o} . 100 \tag{3}$$

A_o and A are initial cross sectional area of the sample and final area of sample respectively. To find final area (A), volume constancy principle (V_o = V) can be used as follows (Equation 4, 5).

A_o L_o = A L
(4)

Then

$$A = \frac{A_o \, L_o}{L} \tag{5}$$

E) EXPERIMENTAL PROCEDURE:

1. The size of the specimen is to be measured accurately
2. Place the specimen carefully on the compression pads of a universal testing machine. The specimen must be kept at the centre of cross-head so that a uniform compressive loading can be assured on the specimen.
3. Switch on the UTM
4. Bring the drag indicator in contact with the main indicator.

5. Select the suitable range of loads and space the corresponding weight in the pendulum and balance it if necessary with the help of small balancing weights

6. Operate (push) the button for driving the motor

7. Carry out the bend test

8. Stop the UTM as soon as the specimen fails.

F) ASSIGNMENTS

1. Calculate the maximum compressive strength of the specimen
2. Plot compressive stress-strain curve and mark the critical points on the curve.
3. Calculate percentage shortening of the specimen length and percentage increase in specimen's crossectional area.