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Mechanical Testing

Compression Test

Because of the presence of submicroscopic cracks, brittle materials are often weak in tension, as tensile stress tends to propagate those cracks which are oriented perpendicular to the axis of tension. The tensile strengths they exhibit are low and usually vary from sample to sample. These same materials can nevertheless be quite strong in compression. Brittle materials are chiefly used in compression, where their strengths are much higher. A schematic diagram of a typical compression test is shown in figure 2.

Figure 1 shows a comparison of the compressive and tensile strengths of gray cast iron and concrete, both of which are brittle materials.

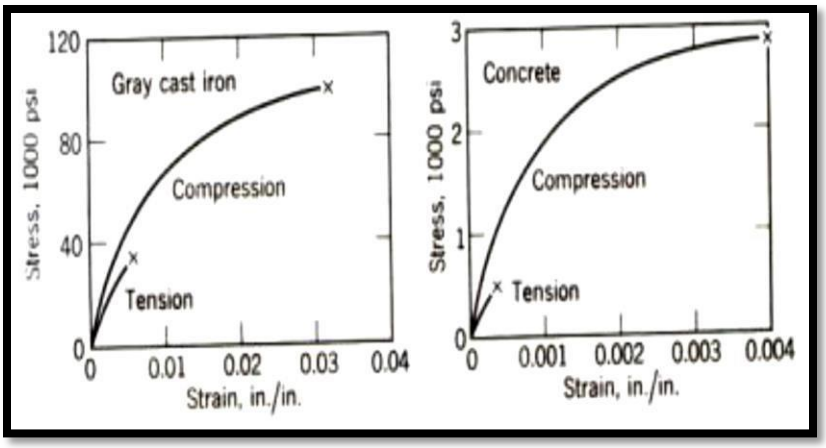

Figure 1. Tensile and compressive engineering stress-strain curves for gray cast iron and concrete.

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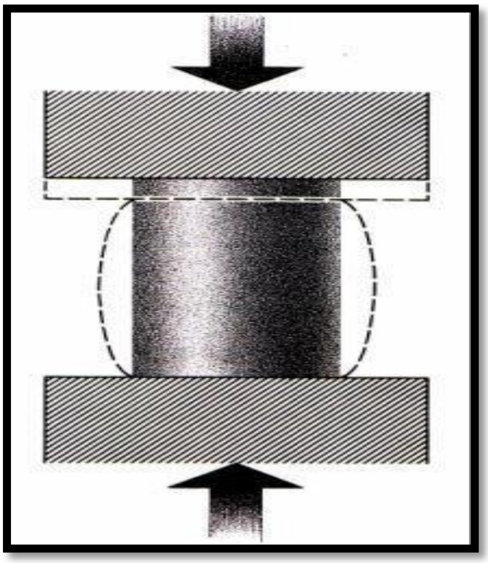

Figure 2. Compression test of ductile material.

Because the compression test increase the cross-sectional area of the sample, necking never occurs. Extremely (majorly), ductile materials are seldom tested in compression because the sample is constrained by friction at the points of contact with the plants of the apparatus. This constraint gives rise to a complicated stress distribution which can only be analyzed in an approximate fashion.

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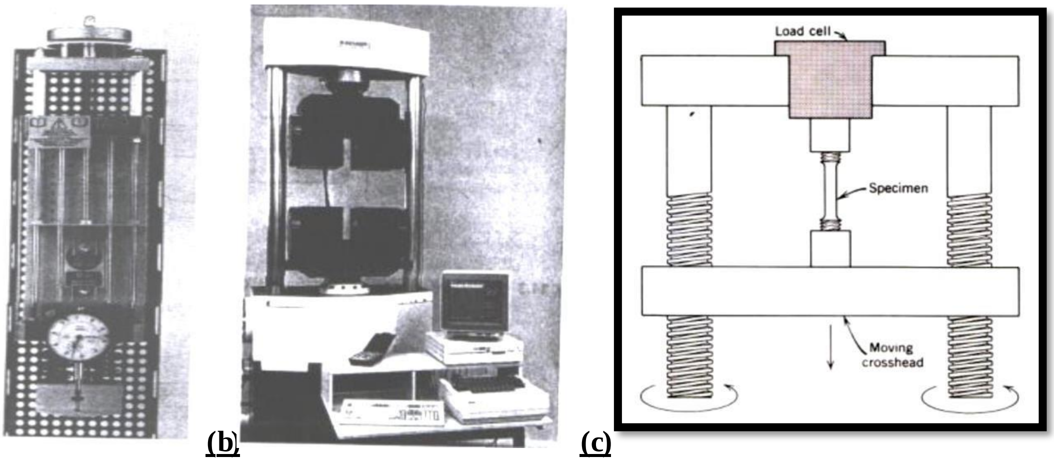
Tensile Test

The main principle of the tensile test is representing the resistance of a material to a tensile load applied axially to a specimen. There are a several tensile testing machine, as in figure 3 (a) shows a popular bench-mounted tensile testing machine, whilst figure 1(b) shows a more developed machine suitable for industrial and research laboratories, while in figure 1(c) shows the schematic drawing of a tensile testing apparatus. These machines are capable of performing compression, shear and bending tests as well as tensile tests.

It is very important to the tensile test to be considered is the **standard dimensions** and **profiles (shapes)** are adhered to.



(a) (b) (c)

Figure 3. Tensile testing machines.

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The Tensile Test Experimental Results on Some Materials

The explanation of tensile test data requires skill accepted from experience, since many factors can affect the test results, for instance, the **temperature** at which the test is carried out, since the tensile modulus and tensile strength decrease as the temperature rises for most metals and plastics, while the ductility increases as the temperature rises. The test results are also influenced by the **rate at which the specimen is strained**.

Figure **4** shows a typical stress-strain curve for a **grey cast iron**. From such a curve we can deduce (conclude) the following information.

1. The material is **brittle** since there is little plastic deformation before it fractures.
2. A gain the material is fairly (completely) rigid since the slope of the initial elastic range is steep (sharp).
3. It is difficult to determine the point at which the limit of proportionality occurs, but it is approximately 200 MPa.
4. The ultimate tensile stress (**UTS**) is the same as the **breaking stress** for this sample. This indicates (shows) negligible reduction (necking) in cross-section and minimal ductility and malleability. It occurs at approximately 250 MPa.

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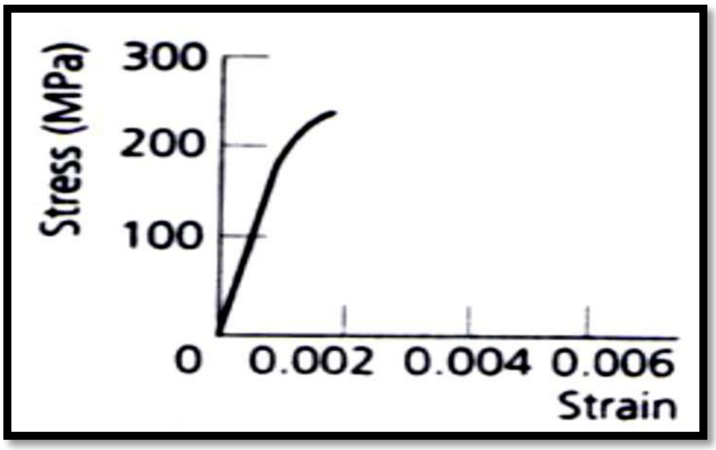

Figure 4. Typical stress-strain curve of grey cast iron (Brittle Material).