زبان تخصصی مهندسی مکانیک

قسمت نهم

۳-۳- نمودار تنش و کرنش (Stress- Strain diagram)

We saw previous Section that the diagram representing the relation between stress and strain in a given material is an important characteristic of the material.

To obtain the stress-strain diagram of a material, one usually conducts a tensile test on a specimen of the material. One type of specimen commonly used is shown.

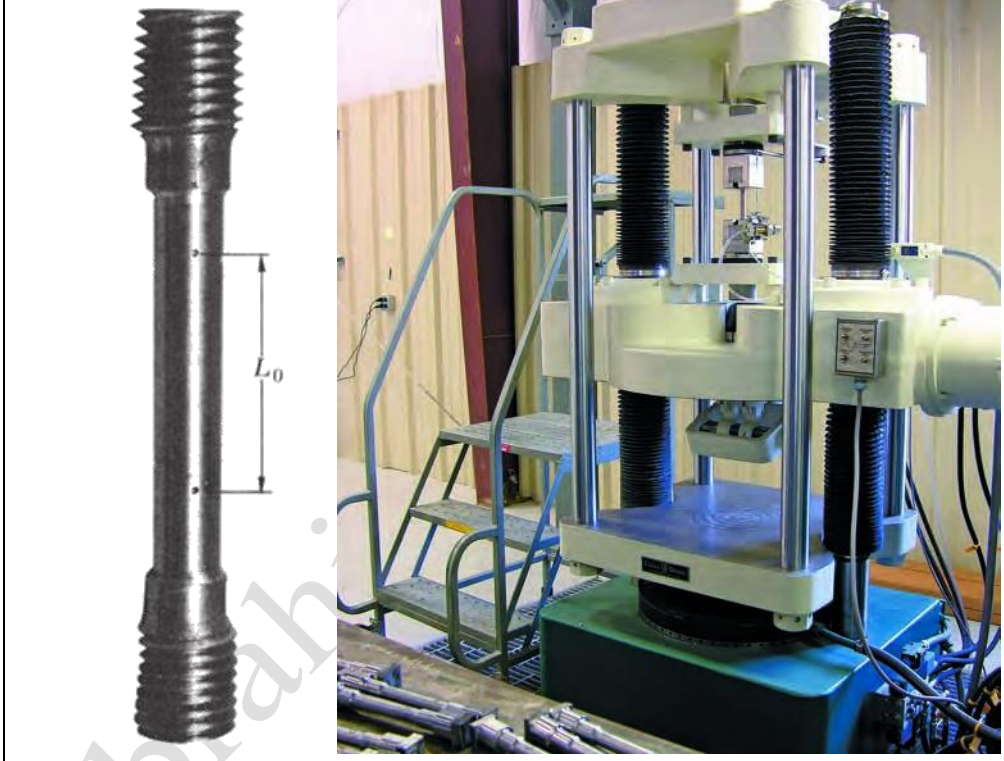

Figure 3 – 6: specimen and

معنی	کلمه	معنی	کلمه
کشش	tensile	استوانه ای	cylindrical
معمولا	commonly	دقیق	accurate
قسمت- بخش	portion	درجه- وسیله اندازه گیری	gage
ثبت کردن- درج کردن	inscribe	اندازه گیری کردن	measure

The cross-sectional area of the cylindrical central portion of the specimen has been accurately determined and two gage marks have been inscribed on that portion at a distance L_0 from each other. The distance L_0 is known as the gage length of the specimen.

The test specimen is then placed in a testing machine shown above, which is used to apply a centric load *P*. As the load *P* increases, the distance *L* between the two gage marks also increases.

Figure 3 – 7 : applying tensile load on the specimen

The distance L is measured with a dial gage, and the elongation $\delta = L - L_0$ is recorded for each value of *P*.

A second dial gage is often used simultaneously (/ˌsɪmlˈteɪnɪəsli/) to measure and record the change in diameter of the specimen. From each pair of readings *P* and δ, the stress σ is computed by dividing P by the original cross-sectional area A_0 of the specimen, and the strain ε by dividing the elongation δ by the original distance L_0 between the two gage marks. The stress-strain diagram may then be obtained by plotting ε as an abscissa and σ as an ordinate.

Stress-strain diagrams of various materials vary widely, and different tensile tests conducted on the same material may yield different results, depending upon the temperature of the specimen and the speed of loading.

کلمه	معنی	کلمه	معنی
record	ثبت کردن	elongation	افزایش طول
pair	جفت	simultaneously	باهم- همزمان
ordinate	عمودی (محور)	abscissa	افقی (محور)
vary	تفاوت داشتن	various	مختلف-گوناگون
temperature	دما	wide	وسیع

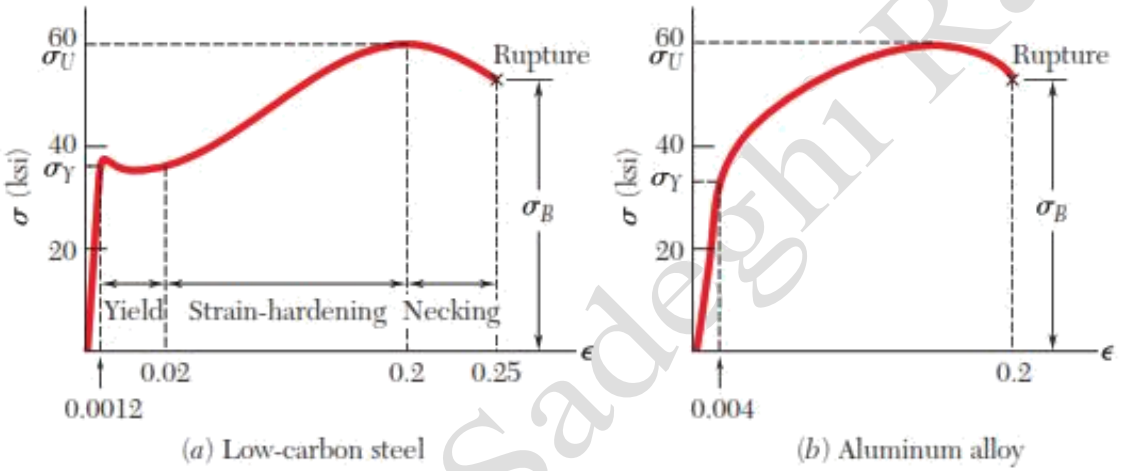

Figure 3–8: Stress-Strain diagram

It is possible, however, to distinguish some common characteristics among the stress-strain diagrams of various groups of materials and to divide materials into two broad categories on the basis of these characteristics, namely, the ductile materials and the brittle materials.

Ductile materials, which comprise structural steel, as well as many alloys of other metals, are characterized by their ability to yield at normal temperatures. As the specimen is subjected to an increasing load, its length first increases linearly with the load and at a very slow rate.

کلمه	معنی	کلمه	معنی
broad	پهناور- وسیع	distinguish	تشخیص دادن
alloy	آلیاژ	comprise	دربرداشتن
linear	خطی	ability	توانایی- قابلیت
initial	اولیه	rate	آهنگ
Steep slope	شیب تند	straight	مستقیم

Thus, the initial portion of the stress-strain diagram is a straight line with a steep slope.

However, after a critical value σ_Y of the stress has been reached, the specimen undergoes a large deformation with a relatively small increase in the applied load.

This deformation is caused by slippage of the material along oblique surfaces and is due, therefore, primarily to shearing stresses.

As we can note from the stress-strain diagrams of two typical ductile materials shown above, the elongation of the specimen after it has started to yield can be 200 times as large as its deformation before yield.

After a certain maximum value of the load has been reached, the diameter of a portion of the specimen begins to decrease, because of local instability.

This phenomenon is known as necking. After necking has begun, somewhat lower loads are sufficient to keep the specimen elongating further, until it finally ruptures.

We note that rupture occurs along a cone-shaped surface that forms an angle of approximately 45° with the original surface of the specimen. This indicates that shear is primarily responsible for the failure of ductile materials, and confirms the fact that, under an axial load, shearing stresses are largest on surfaces forming an angle of 45° with the load.

The stress σ_Y at which yield is initiated is called the yield strength of the material, the stress σ_U corresponding to the maximum load applied to the specimen is known as the ultimate strength, and the stress σ_B corresponding to rupture is called the breaking strength.

معنی	کلمه	معنی	کلمه
تحمل کردن	undergo	لغزش – سر خوردن	slippage
مورب- مایل	oblique	مرسوم- معمول	typical
ناپایداری	instability	گلویی شدن	necking
کافی	sufficient	بیشتر	further
گسیخته شدن- پاره شدن	rupture	رخ دادن	occur
قیف- مخروط	cone	تقریبا	approximately
زاویه	angle	شکست	failure
تاییدکردن	confirm	نهایی	ultimate

Figure 3 – 8 : ductile and brittle specimen

Brittle materials, which comprise cast iron, glass, and stone, are characterized by the fact that rupture occurs without any noticeable prior change in the rate of elongation.

Thus, for brittle materials, there is no difference between the ultimate strength and the breaking strength. Also, the strain at the time of rupture is much smaller for brittle than for ductile materials. Note the absence of any necking of the specimen in the case of a brittle material, and observe that rupture occurs along a surface perpendicular to the load.

معنی	کلمه	معنی	کلمه
چدن	cast iron	بدون	without
قابل توجه	noticeable	قبل	prior
عدم وجود- غیبت	absence	عمود	perpendicular
شروع	onset		

We conclude from this observation that normal stresses are primarily responsible for the failure of brittle materials.

In the case of structural steel, the stress remains constant over a large range of values of the strain after the onset of yield. Later the stress must be increased to keep elongating the specimen, until the

maximum value σ_U has been reached. This is due to a property of the material known as strain-hardening.

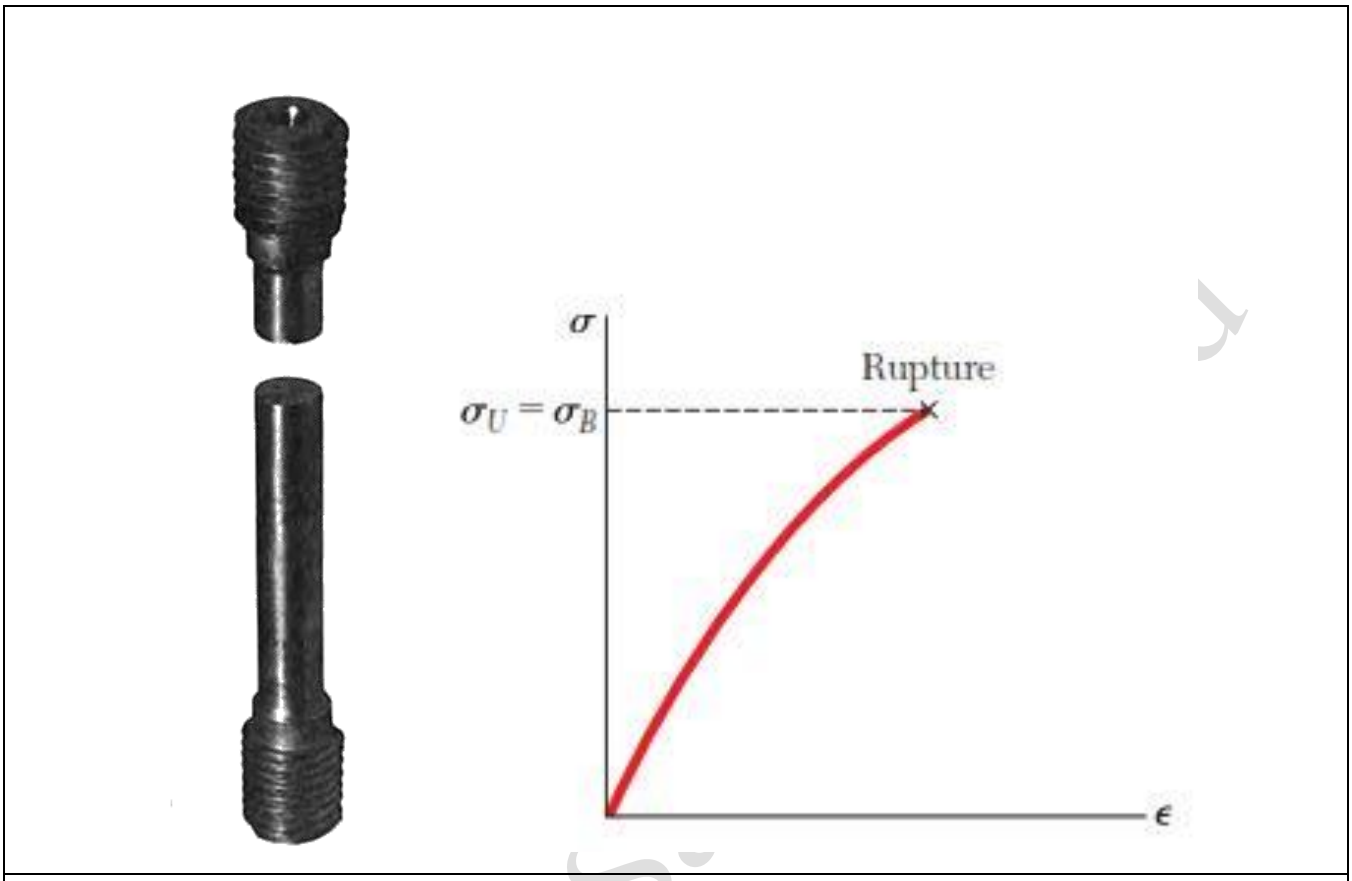

Figure 3 – 9: brittle specimen