Three Stage of Deformation

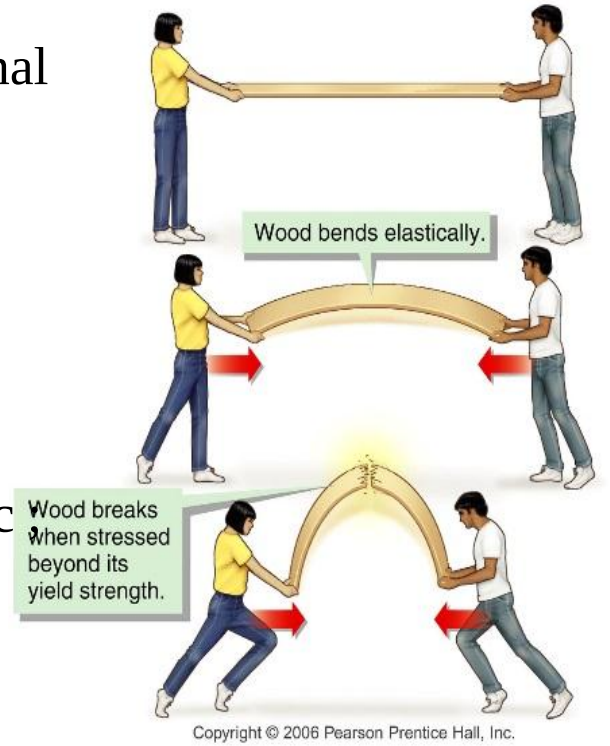
If a body is subjected to direct forces lasting over a short period of time-minute or hours- it usually passes through three stages of deformation.

Elastic deformation- that is if the stress is withdrawn, the body returns to its original shape and size.

Elastic limit- it is the greatest stress that can be applied to an elastic body without permanent deformation.

If this exceeded , the body does not return to its original shape.

Plastic deformation- if the stress exceeds the elastic limit , the deformation is plastic that is the specimen only partially return to its original shape even if the stress is removed.

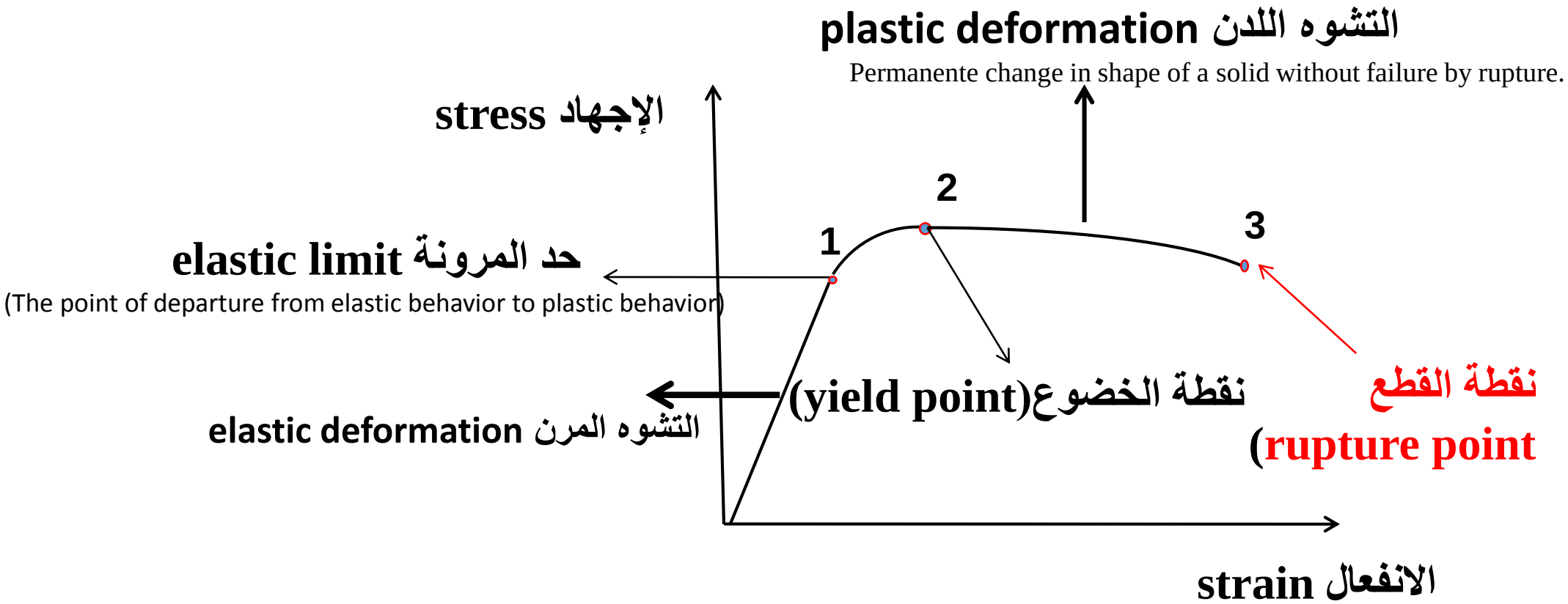


When there is a continued increase in the stress , one or more fractures developed and the specimen eventually fails by rupture. The arrangement and form of the fractures depend upon several factors,..(will be discussed later)

elastic deformation
التشويه المرن

elastic Limit
حد المرونة

plastic deformation
التشويه اللدن



Yield point: the first singe of irreversible deformation even the stress is removed.

It s noticeable :-

1- Strain is directly proportional to stress , and strain completely recovered when the stress is removed (unless elastic limit has been exceeded).

2- Elastic limit:- maximum stress or force per unit area within a solid material that can stand before the onset of permanent deformation. it is also the maximum stress that can withstand rocks before they break .

هو الحد الذي إذا تجاوزه الجسم تحت الاجهاد لا يعود إلى شكله الأصلي وهو أيضا اقصى جهد يمكن ان تتحمله الصخور قبل ان تنكسر

When stresses up to the elastic limit are removed, the material resumes its original size and shape.
below the elastic limit,the deformation obeys ***Hookes law***. which states that strain is proportional to stress.

Stresses beyond the elastic limit cause a material to yield or flow.

For such materials the elastic limit marks the end of elastic behavior and the beginning of plastic behavior.
For most brittle materials, stresses beyond the elastic limit result in fracture with almost no plastic deformation.

3- If the stress exceeds the yield point, the body distorts without any increase in stress and continues until the cutting occurs at point 3 the cutting point.

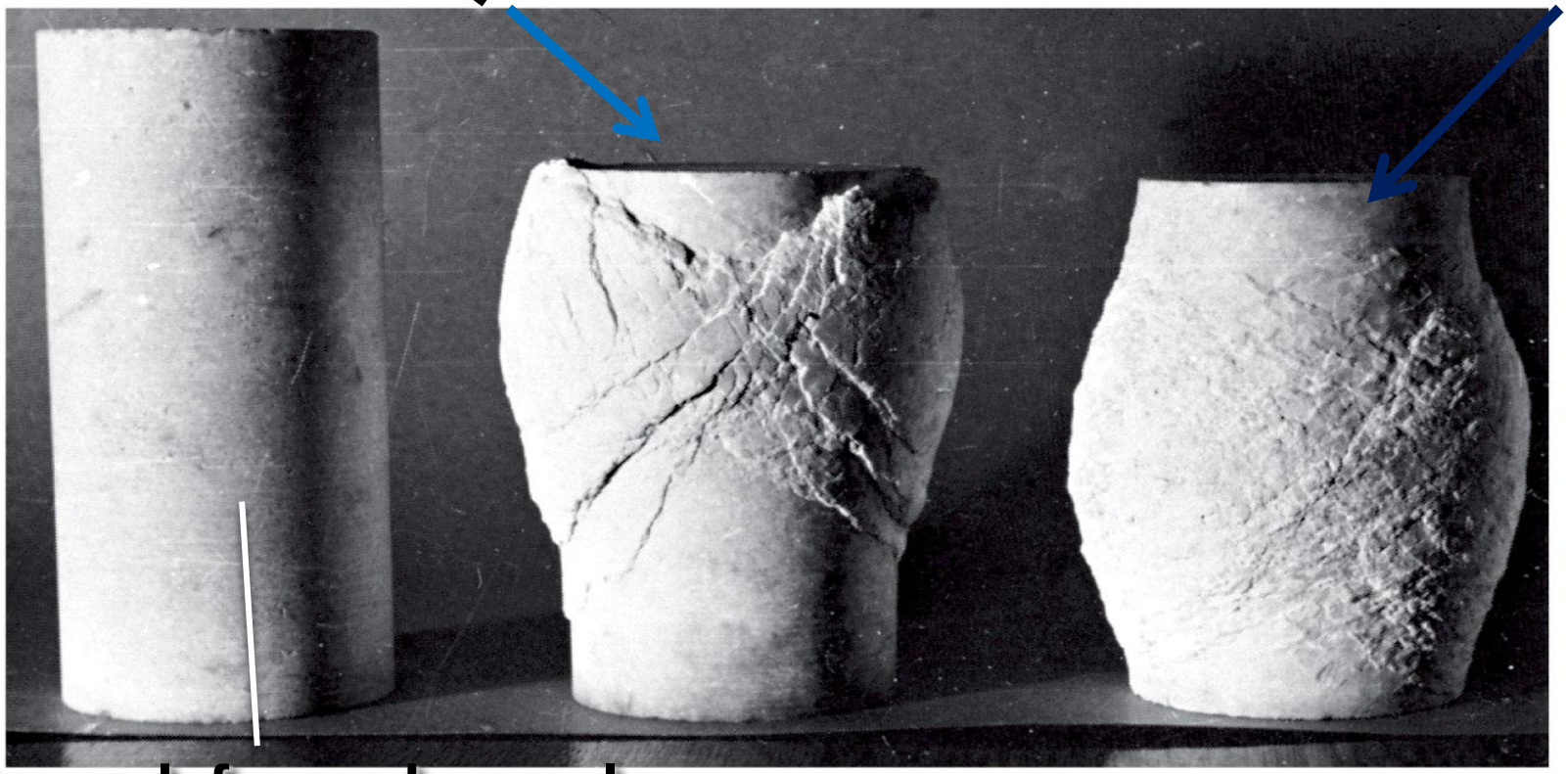
The yield point is the point on a stress–strain curve that indicates the limit of elastic behavior and the beginning of plastic behavior. Yielding means the start of breaking of fibers.

The fact that the material is brittle or ductile is a relative issue that depends on factors such as:

pressure, temperature and time factor.

Under conditions representative of the shallow crust, the marble is brittle.

Under conditions representative of the deeper crust, marble is ductile



An undeformed sample

Ductile deformation

FOLD

In the case of a fault or a fold, the elastic limit is exceeded and the deformation becomes a permanent structure of the rock.

Brittle deformation

FAULT

Elastic deformation:

At room temperature and pressure , and under stresses applied for a short period of time,most rocks are brittle. They behave elastically until they fail by rupture. For such rocks the elastic limit or yield point is the stress at rupture.

Ideally an elastic substance will return to the original shape after the deforming stress has been removed, although there may be a slight delay as unloading occurs.

There are three deformational types

1- longitudinal

If a solid cylinder of rock is subjected to stress parallel to its long axis it will lengthen under tension and shorten under compression.it is defined as the ratio of change in length to it is original length ($\Delta L/L0$). It is dimensionless quantity.

The ratio of stress to the deformation(below elastic limit) is a measure of the property of the rock to resist deformation . which called **young's modulaus y**

$$Y = \frac{stress}{longitudinal\langle \text{strain} \rangle}$$

$$Y = \frac{F_n / A}{\Delta L / L_0}$$

Under tension the diameter of cylinder subject to tension parallel to the axis become smaller ; under compression parallel to the axis the diameter become greater.

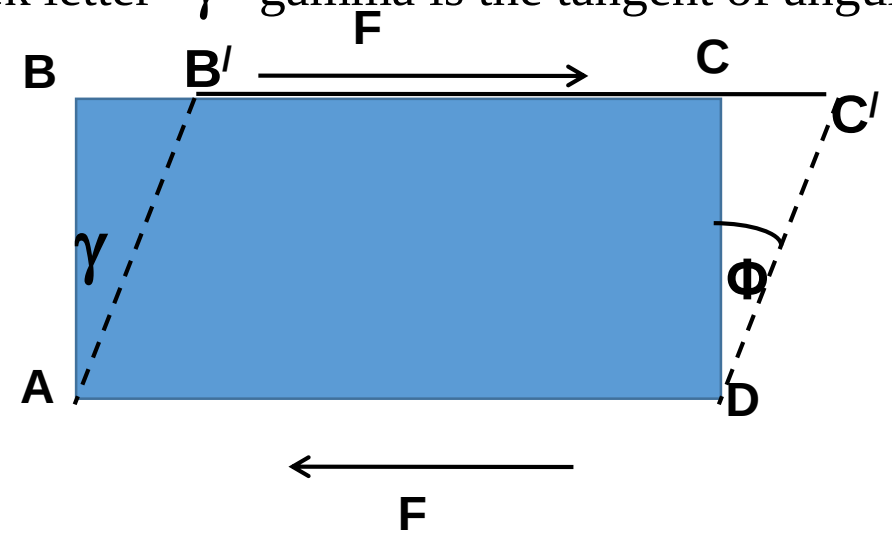
Poisson ratio is the ratio of transverse strain to axial strain.

$$\upsilon = \frac{\Delta d/d_o}{\Delta l/l_o}$$

2-Shear Strain:

If the original shape of a deformed object is known , then changes in angular relationship Can be measured. Angular shear, symbolized by creek letter ψ is (psi),is the angular change after deformation of two line that were originally perpendicular.

Shear strain: symbolized by the creek letter γ gamma is the tangent of angular shear.



3- Volumetric strain:

For *volumetric strain* ,, the relationship is

$\delta = (V - Vo)/Vo$ or $\delta = \Delta V/Vo$ where V is the final volume, Vo is the original volume,. Like longitudinal strain , volumetric strain is a ratio of values with the same units, so it also is a dimensionless quantity. Positive values represent volume gain, whereas negative values represent volume loss.

Plastic deformation:

Although most rocks at room temperatures and pressures fail by rupture before attaining a stage of plastic deformation, Most rocks ,at sufficiently high temperatures and pressures deform plastically even in experiment lasting for a short time.

This plastic deformation is not recoverable or is only partially recoverable

That is ,if stress removed, the material does not return to its original shape.

Plastic strain(deformation) is the permanent change in shape or size of a body without fracture, strain is accumulated over time by a sustained stress beyond the elastic limit (yield point) of the material.

Plastic deformation is the permanent distortion (change in shape or size of a body without fracture, that occurs when a material is subjected to tensile, compressive, bending, or torsion stresses that exceed its yield point and cause it to elongate, compress, buckle, bend, or twist.

The yield point is the point on a stress–strain curve that indicates the limit of elastic behavior and the beginning of plastic behavior. Yielding means the start of breaking of fibers.