Factors Controlling Behavior of Materials

The mechanical behavior of rocks is controlled not only by their inherent properties -mineralogy , grain size , porosity , fractures, etc – but also by factors that are of little Or no concern in planning man-made structures at the surface of the earth.

These factors are

1- Confining pressure

2-Temperature

3-Time

4-Solution.

5- Pore pressure

6-Anisotropy and Inhomogeneity

1-lithostatic or confining pressure

the pressure derived from the weight of entire column of overlying rock.

We concluded from the diagram.

1- the strength increases with increase confining pressure.

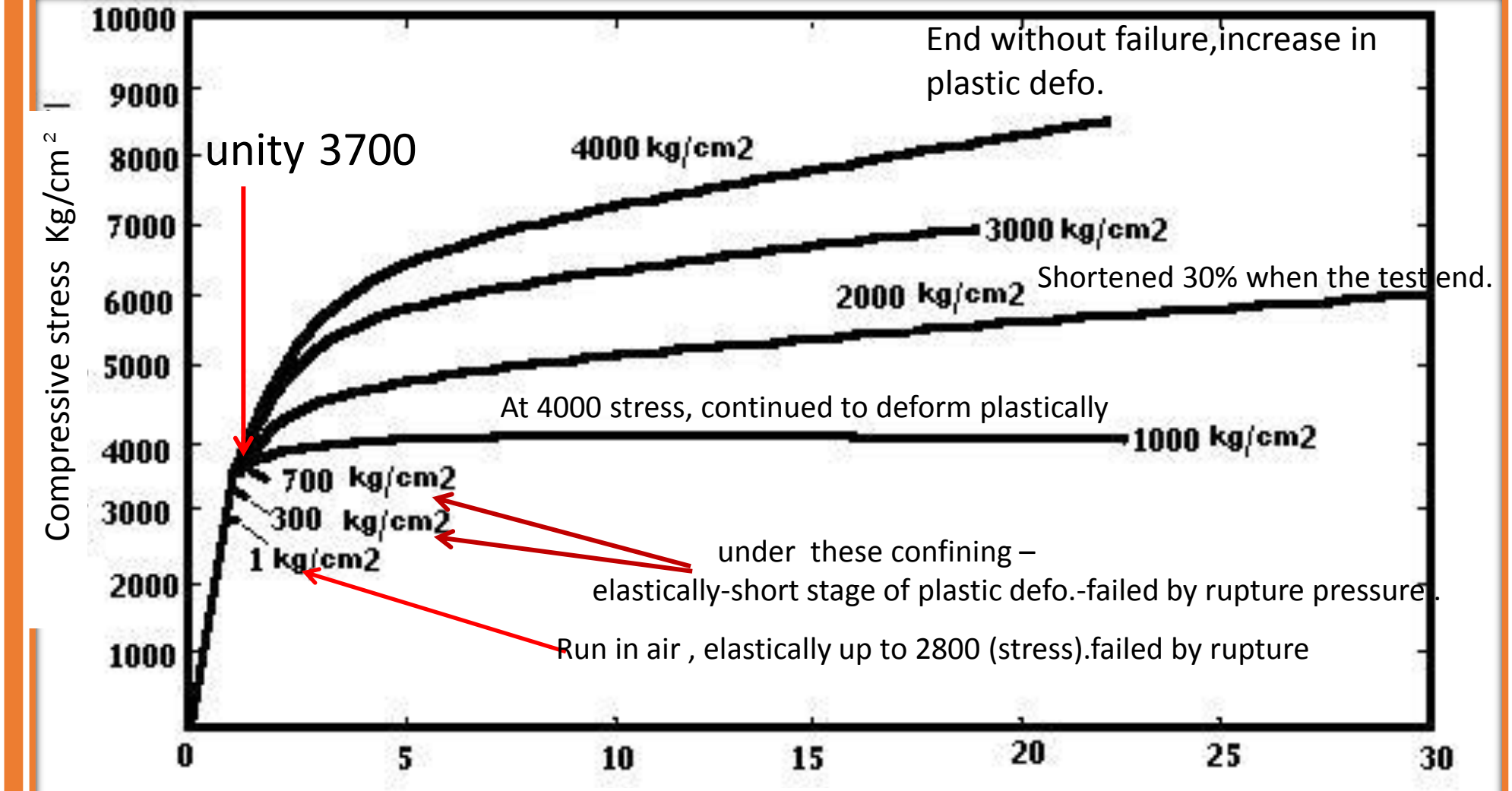
2- the experiment indicate that rocks exhibiting very little plastic deformation near the surface of the earth.

3- may be very plastic deformation under high confining pressure.

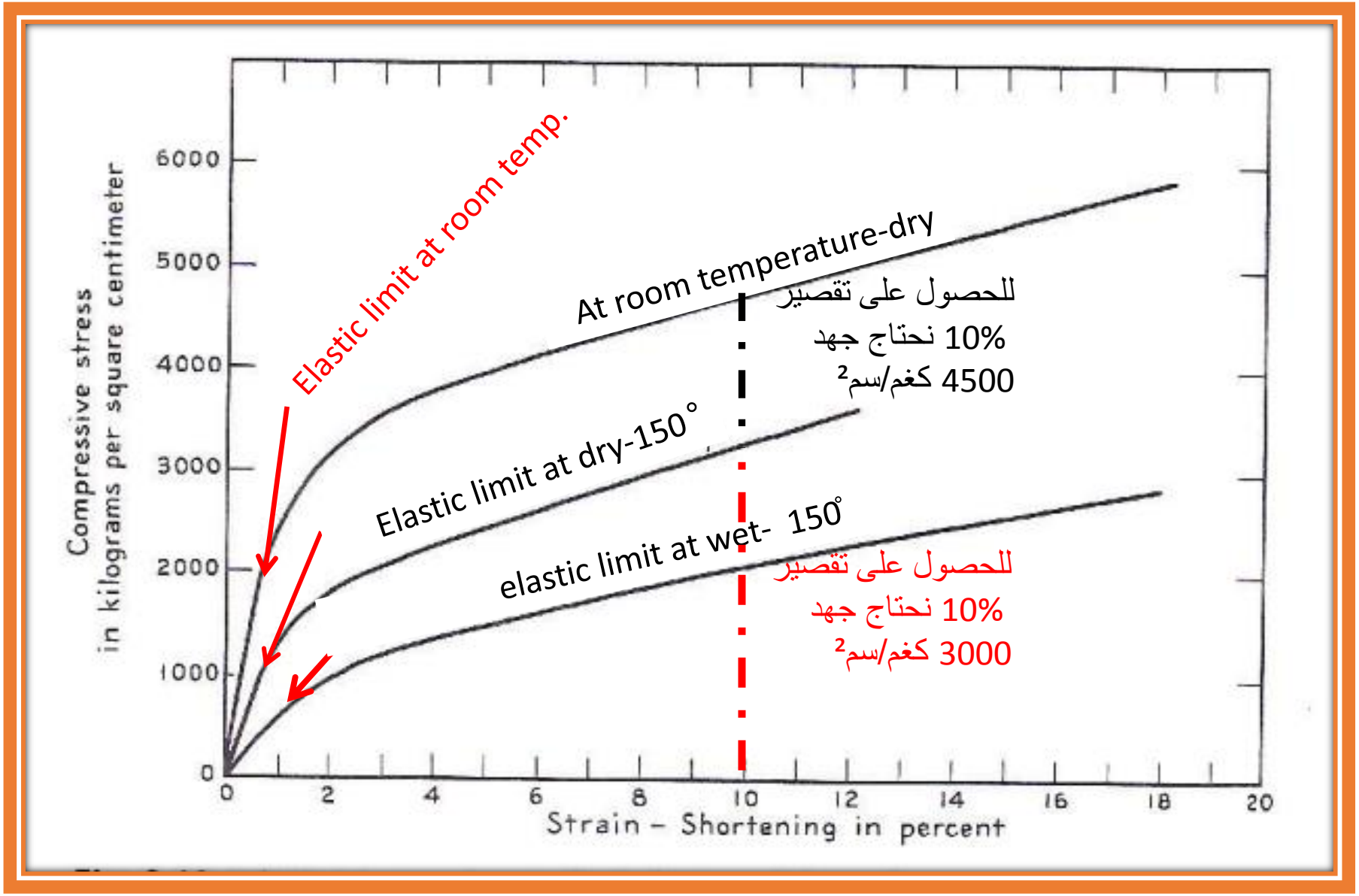
4- rock samples change from brittle to ductile behavior.

2-Temperature

Change in temperature modify the strength of rocks , the diagram below shows the effect of temperature on deformation of marble rocks under axial compressive stress,and confining pressure was 1000 atmospheres.



Effect of confining pressure on behavior of limestone



Effect of temperature and solution on deformation of marble

What we deduced from increased temperature

1- Modify the strength of rocks.

2- Change behavior from brittle to ductile.

3- When the specimen is hot ,less stress is necessary to produce a given strain than when the specimen is cold.

It is apparent that plastic deformation is far less common near the surface of the earth, Where the confining pressure and temperature are low .

With greater depth where higher temp. and greater confining pressure, the possibility of plastic deformation increase.

3-Time Factor

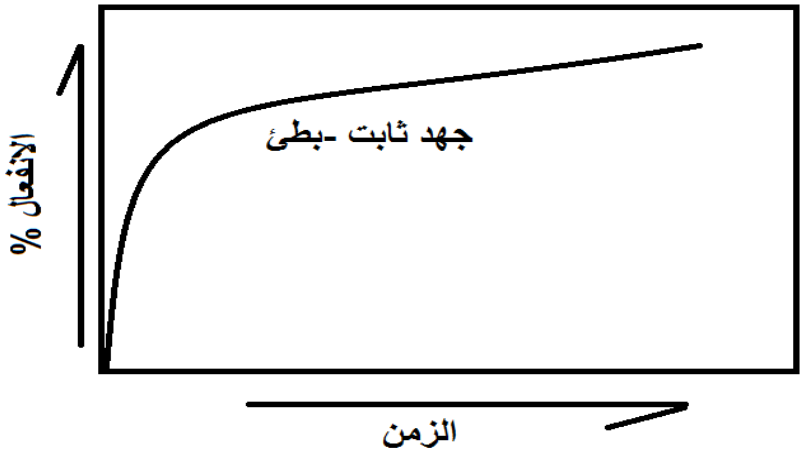
Geological process have great of time in which to operate. Although geological time is impossible to duplicate experimentally, It is possible to make some deductions concerning the influence of time.

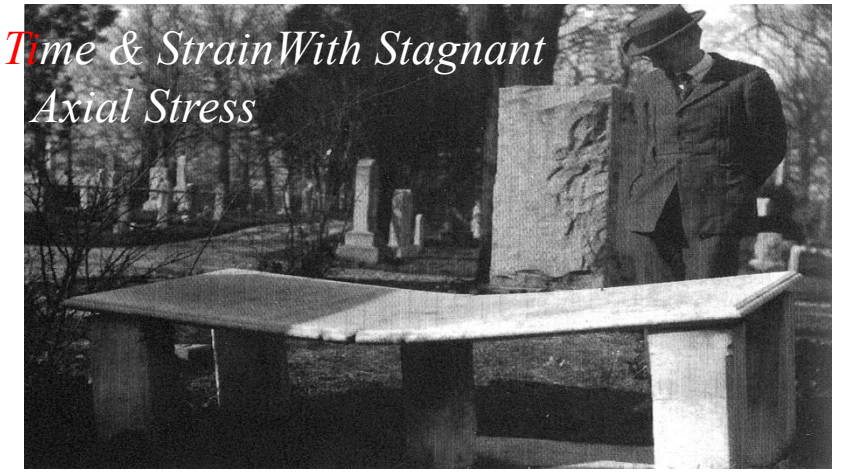
An analysis of the effect of time is concerned with such subjects as Creep, Strain Rate, and Viscosity.

Creep refer to the low continuous deformation with passage of time

Strain rate is the amount of strain divided by the time.

Viscosity is a measurement of the ratio of applied stress to strain rate.





4- Solution:

Much rock deformation take place while the solutions that present in the pore spaces are capable of reacting chemically with the rocks the solution dissolve old minerals and precipitate new ones.
Under such condition the mechanical properties of rock are greatly modified
The elastic limit and strength of the wet specimen is much less than strength of dry specimen at the same temperature.

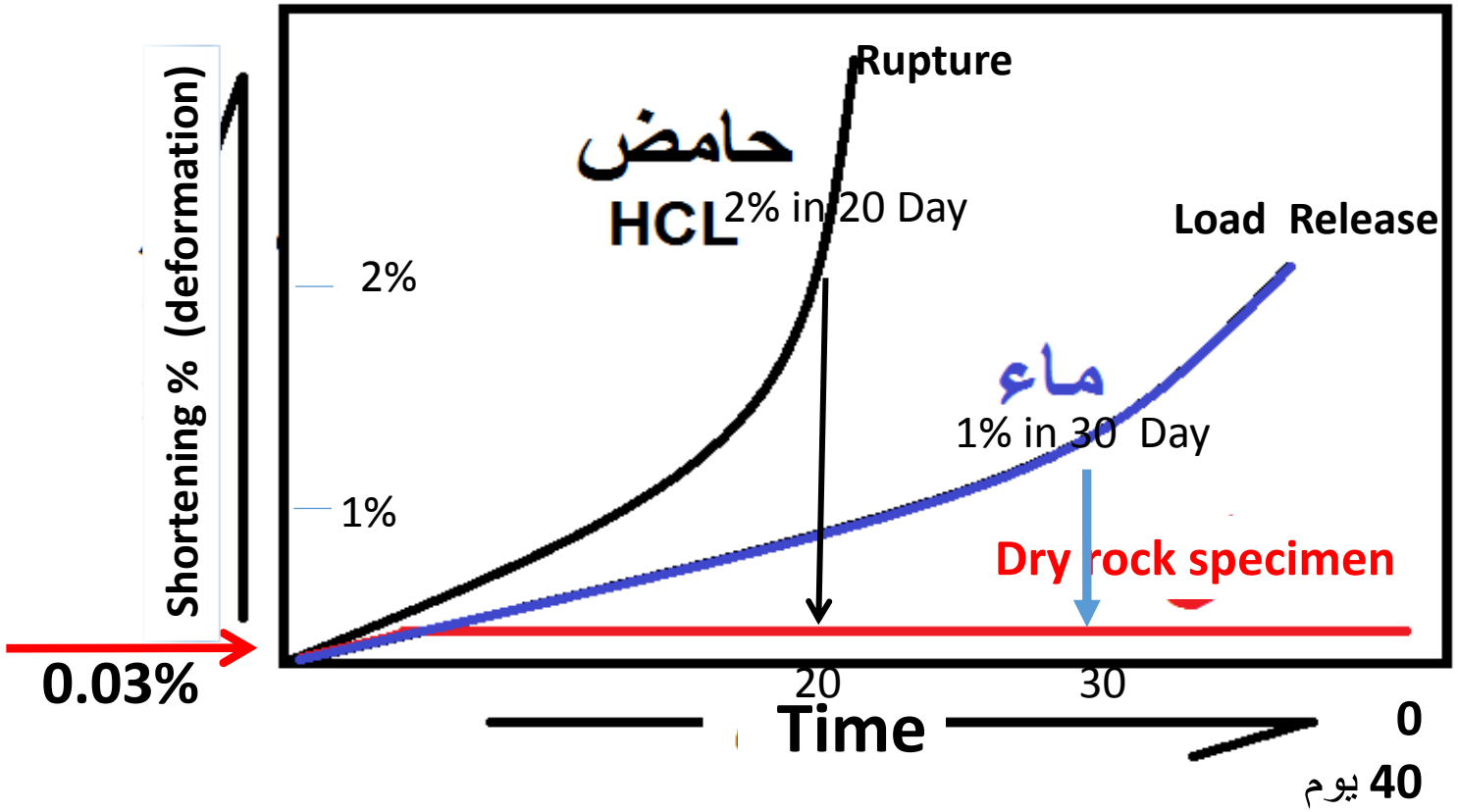
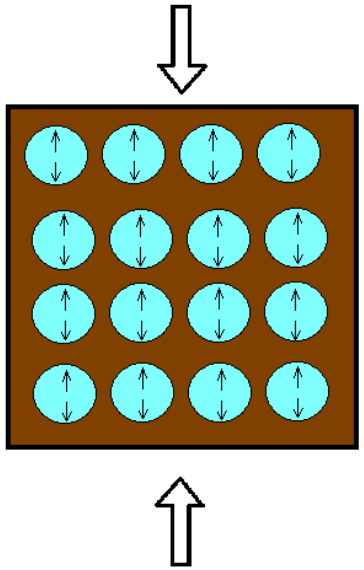


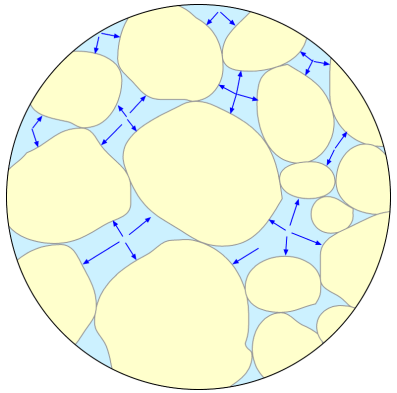
Figure shows that the dry rock suffers from a slight deformation compared to rock immersed in Water and Acid, since in the last two cases the deformation is high in a short time .

5- Pore Pressure

Many rocks contain a significant amount of pore filled with fluids.

Fluid pressure is hydrostatic (equal in all direction),so the fluid supports part of the applied load.





1- occurrence pore pressure weaken the rock.

2- With increase pore pressure the rocks tend to behave as a brittle on the expense of ductile behavior.

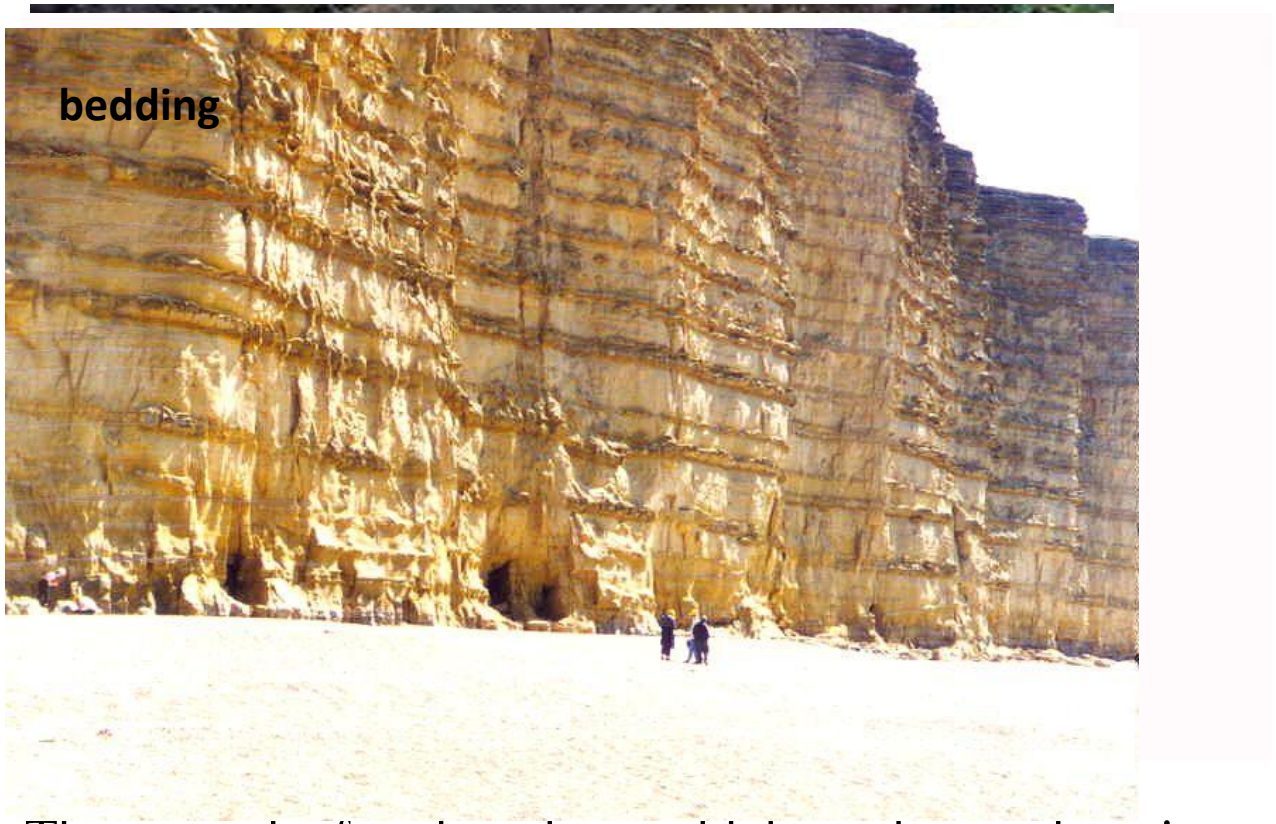
3-Normally the strength of a rock increase at depth because of the increase in confining pressure P*c* , but with increasing pore pressure P*f* the effective pressure decreases. P_e

$$P_e = Pc - Pf$$

4-with increasing pore pressure the rocks are less coherent.

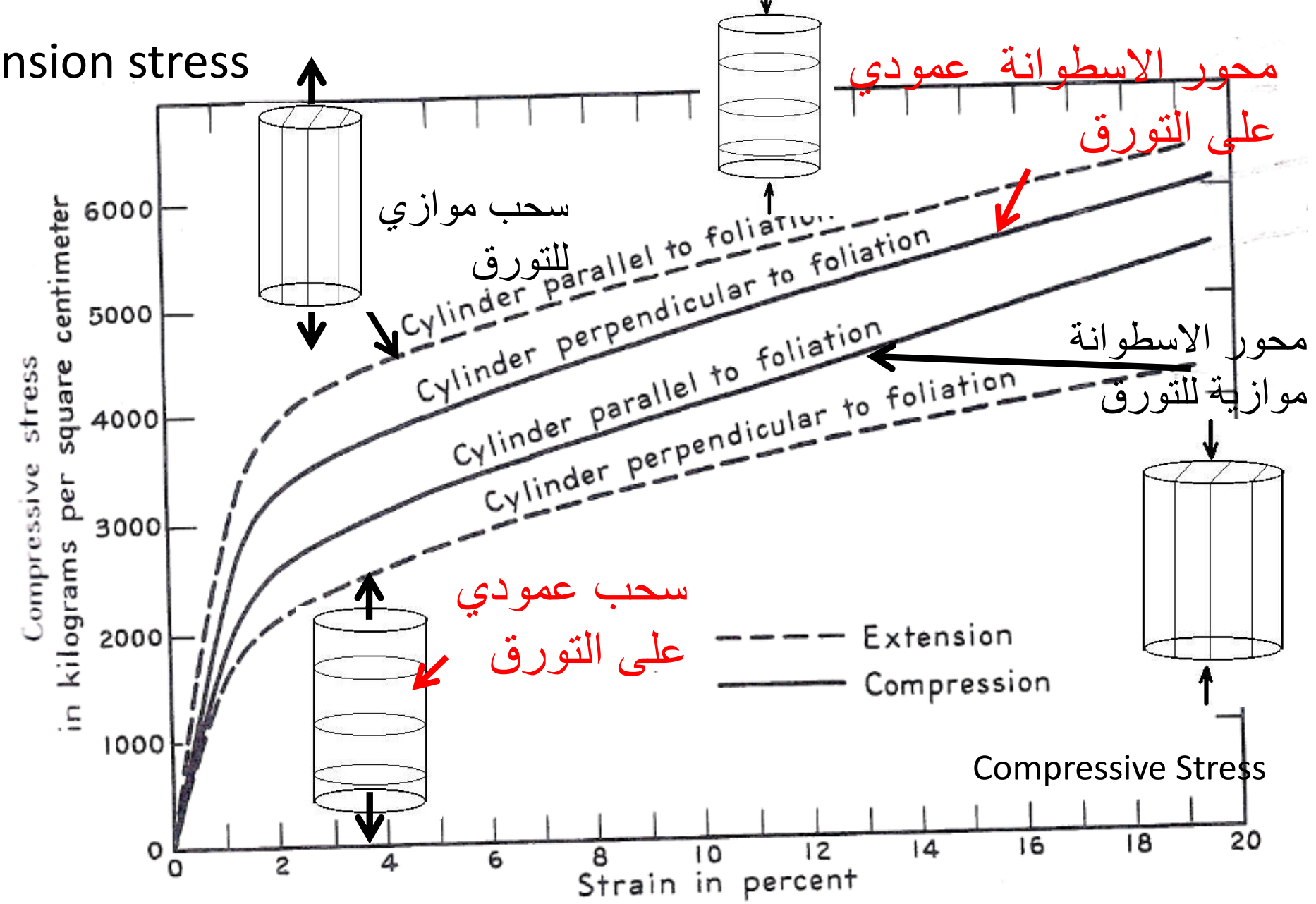
6- Anisotropy and Inhomogeneity

Most of the test described in preceding section were made on ***isotropic*** materials that the rocks whose mechanical properties were uniform on all directions. Rock that show bedding , banding,or floiation are ***not isotropic***



The strength of such rocks would depend upon the orientation of the applied forces
To the planar structures of the rock.
The figure below illustrated this point.

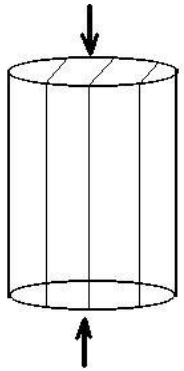
tension stress



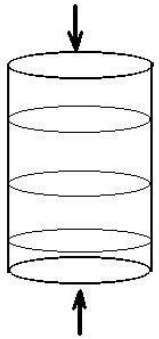
Effect of anisotropy on deformation of marble

What we deduce from the previous chart:

1- under compression ,the cylinder perpendicular to the foliation us stronger than cylinder parallel to the foliation.

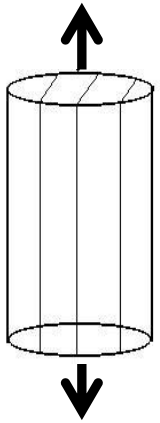


Compression parallel to foliation

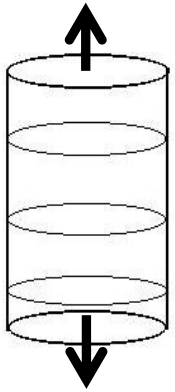


Compression perpendicular to foliation

2- under tension the cylinder parallel to the foliation is much stronger than the cylinder perpendicular to foliation.



tension parallel to foliation



Tension perpendicular to foliation

summery

It is clear that the mechanical properties of rocks are profoundly modified by confining pressure , temperature ,the time factor , and the presence of reacting solution.

The combination effect of these factors is so great that it is impossible in the present state of our knowledge to treat rock deformation in a quantitative way.

Increase in confining pressure increases the elastic limit and the ultimate strength

Increase in the temperature weakens the rocks.

After long continued stress the rocks become much weaker.

Reacting solutions lower the strength of rocks.