Hello students. This is Bachelor of Science

third year subject geology semester 5

paper code GEC 106 structural geology.

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The outline of the lecture is

concept of stress, compressive,

shearing and tensile, strain,

three stages of deformation,

stress and strain diagram.

Learning outcomes.

Understand the concept of stress and strain.

Understand stages of deformation.

Understand how stress is related to strain.

Now the concept of stress.

So here we will have to imagine a

vertical column of material. Now along any

imaginary horizontal plane within

this column, may it be here,

maybe here, maybe here,

or let us consider here.

The material about the plane,

because of its weight,

pushes downward

the material below the plane.

So basically,

if we consider any particular

line in any imaginary line,

the weight that part of the

column that is above exerts a

force which is going downwards.

Similarly,

the part of the column that is below

the line exerts a force that is upwards,

so pushes the material about the plane.

Hence the mutual action and reaction

along the surface constitutes stress.

Hence we have stress at this imaginary plane.

So the normal component of stress

is compressive stress and the

other one is tensile stress,

third one is the shearing stress.

The normal component is a compressive stress if it tends to push the material from

both the sides towards each other,

and the material gets compressed

or gets pushed.

The normal component is a tensile stress

if it tends to pull apart the

object or the material on the

opposite sides of a plane.

The tangential component is

generally called is shearing stress.

When the force acting acts on different

lines and it acts in two different

directions as shown in this figure.

The stress difference at any point

in the body is the algebraic

difference between the greatest stress

and the least stress at that point.

Now how to calculate stress. Stress is

exhibited in the form of a formula called

as stress is equal to force upon area.

Now if the external forces are known,

the stresses can be calculated. If we

consider if we try to understand the

calculation of force in this diagram is

if there is a vertical column of material,

so this vertical column has an area of five

inch Square is acted upon by a force of 50 pounds,

then every horizontal plane below the

column is subjected to a compressive force

of 10 pounds per square inch,

which is denoted here 10PSI,

so this is the stress that is exerted

at the bottom of this column.

We understand the concept of pressure here.

The concept of stress is related

to pressure only by height.

So if you consider a column of water in

this beaker and then in the second beaker

which is slightly wider width and in

the third funnel which is inverted and

in the fourth funnel which is normal,

the height is very important.

So the pressure exerted at the bottom

of all these two beakers and two

funnels is the same because the height

of the water column is the same and

hence height of the water column is very

important for calculation of pressure.

Let us look at strain.

Strain is the deformation caused by stress.

So strain, maybe dilation or it may be a

change in volume or distortion,

or it may be a change in form or both.

So when there is a change in confining

pressure under confining pressure

conditions an isotropic body will only

change in volume but not in shape

that is, it will become smaller than

what it was before under confining pressure.

So this force is acting vertically downwards,

which results into compression. Under

directed forces,

forces acting in a horizontal direction, which results into a shear stress

resulting into a shear strain distortion happens.

There are three stages of deformation.

If a body is subjected to directed forces

lasting over a short period of time,

that is minutes or hours,

it usually passes through three

stages of deformation.

Although brittle substances,

the intermediate stage may be omitted.

So at first the deformation

is slightly plastic i.e. the object can absorb the stress.

And then if the stress is withdrawn, the body

returns to its original shape and size.

There is always a limiting stress

called as the elastic limit i.e.

if if this elastic limit is exceeded

then the body does not return

to its original shape.

So if the stress exceeds its elastic

limit then the deformation is plastic.

I.e. the specimen only partially

returns to its original shape,

even if the stress is removed.

Now when there is continued

increase in stress,

one or more fractures will

develop into specimen,

eventually fails by rupture. Now brittle

substances are those that rupture

before undergoing any type of

significant plastic deformation,

whereas ductile substances are

those that undergo

plastic deformation before rupture.

Hence there is a concept of

elastic and plastic deformation.

So at room temperature and

pressure and under stress applied

for a short duration of time,

most of the rocks are brittle.

But when they are heated

at higher temperature and when

they're under high pressure,

they can behave in a plastic

way so they behave elastically

until they fail by rupture.

Ideally an elastic substance will return to

its original shape after the deformation or

deforming stress are removed,

although there may be a slight delay,

as unloading occurs that is

coming back to the original shape.

But at higher temperatures

and confining pressures,

the rocks deform plastically.

So this type of deformation is either not

recoverable or only partly recoverable

I.e. if the stress is removed,

the material does not return

to its original shape.

Let us look at stress strain diagrams.

So there is a relationship existing

between stress and strain is commonly

expressed in terms of this diagram,

so the material is under compression,

I.e. stress is applied parallel to the axis of the

cylinder and is in pounds per square inch.

So with increasing stress there is

shortening that is observed of the

specimen that is shown in percent.

Not the part of A is of

a brittle substance.

So until 20,000 pounds per square inch it can

bear load and then it fails by rupture.

Now the curve B is an ideal plastic

substance wherein it behaves

elastically at first where in it

as a slide there is slight strain

shortening is noted slightly less

than 1% and then it reaches to

its proportional elastic limit

that is represented at this point,

which is the point at which the

curve departs from the straight line

and thereafter the specimen deforms

continuously without any added stress.

That is, it starts changing in shape without any

more additional stress. Now the curve

C represents more normal kind

of plastic behavior,

but for every increment of strain,

because if we see curves C

then it is the strain

shortening in percent is slightly

higher than Curve B and Curve A,

but here every increment of strain

and increasing stress is necessary.

So more and more strain shortening

as it takes place more and more

stress is required to be applied

in incremental fashion.

This is a result of work hardening

i.e. specimen becomes progressively

more difficult to deform as more

and more stress is applied.

Curve D represents a very common

type of plastic deformation.

The high point of the curve is

called his ultimate strength.

Now this curve D has strain

shortening much more than curve A B & C.

It also requires a strain to

be continuously applied until

thirty 35,000 pounds per square inch

after that it keeps on deforming

without any added stress.

The ultimate strength of any material

is dependent on many variables.

Example, confining pressure and temperature,

etc.

So curve D represents the

ultimate strength of the

material at this point, and then it

fails by rupture after stress is removed.

So strength of any rock varies according to the conditions assumed, shape of the

test sample may control the test results

I.e. if the test sample is

slightly wider or slightly smaller,

then it may take more strain and

deform plastically.

Finally, such data is for intact rocks,

while rocks in regional geology are marred

by fracturing joints, that is join

It is the rocks in the field

or in the actual geology

In the field are usually

have internal weak planes.

For example bedding planes or maybe

induced planes like that of joints

or fractures that may reduce its

strain shortening or variability.

So it all depends on what type of variables

that are taken into consideration.

I have referred to structural

geology MP Billings, 3rd edition,

Prentice Hall, India.

Thank you.