



Material properties

We'll focus on:

- Elasticity and plasticity
- Stages in elastic and plastic deformation(tensile testing)
- Hardness
- Fatigue , fracture toughness and creep(materials problems in aircraft construction)
- Basic thermal properties(ex)

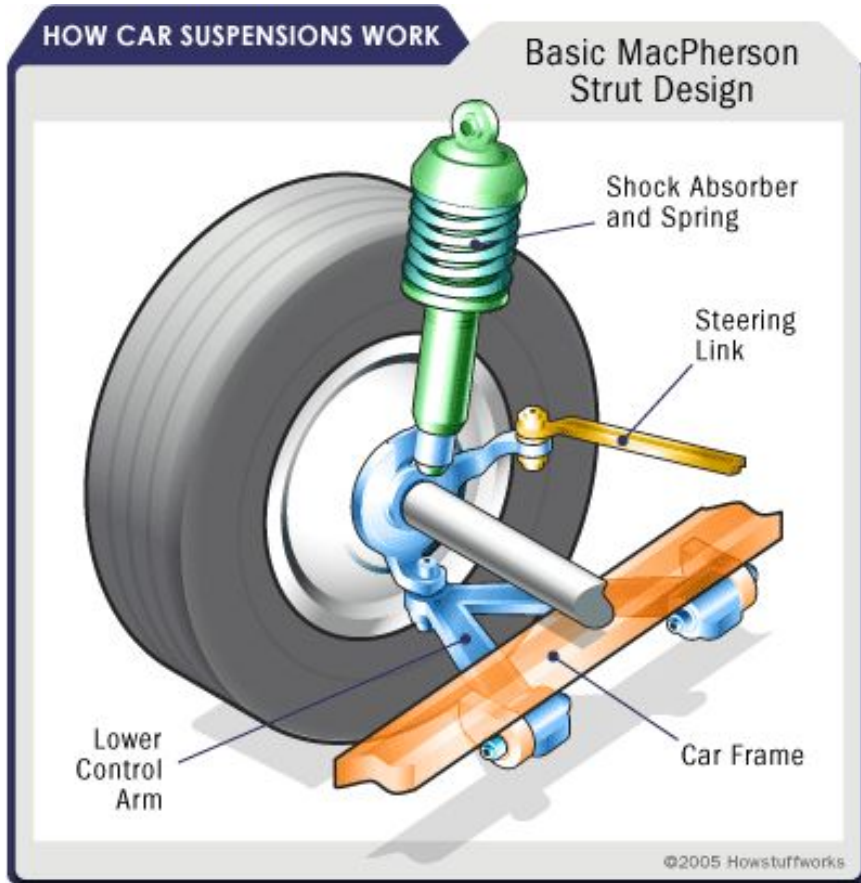
# *Types of force and deformation*

<u><b>TENSION</b></u>	<u><b>COMPRESSION</b></u>	<u><b>BENDING</b></u>	<u><b>SHEAR</b></u>	<u><b>TORSION</b></u>
TENSILE STRENGTH *It will <b>extend</b> (lengthen) * <b>Tension fracture</b>	COMPRESSIVE STRESS *It will <b>compress</b> (shorten) * <b>Compression fracture</b> (crush,buckle)	BENDING STRESS *It will <b>bend</b> ( <b>deflect</b> , <b>flex</b> ) *Beams usually <b>sag</b> or <b>hog</b> .	SHEAR STRESS It will deform very little , failing suddenly.	TORSIONAL STRESS *It will <b>twist</b> * <b>Torsional rigidity</b> * <b>Shear ,torsion rupture</b>



When vertical members can no longer resist a load they either **crush** or **buckle** (bending out of shape)

# *How are the springs(in car suspension)made springy?*



Spring act like a cushion , providing comfort and performance, allowing the wheel to maintain contact with road surface when travel over a bump. Spring must be *elastic*.

# ***Elasticity and plasticity***

***Elasticity***-ability to extend significantly, but still return to their original shape(rubber)

Low elasticity , strong => **stiff**

Low elasticity , weak => **brittle** (glass)

***Plasticity***-ability to change shape significantly, but DO NOT return to their original shape

Can be plastically deformed by hammering or rolling=> malleable(lead , Pb)

Can be stretched into a long length=> ductile(Cu)

# *Stages in elastic and plastic deformation*

## *Point 0-1:*

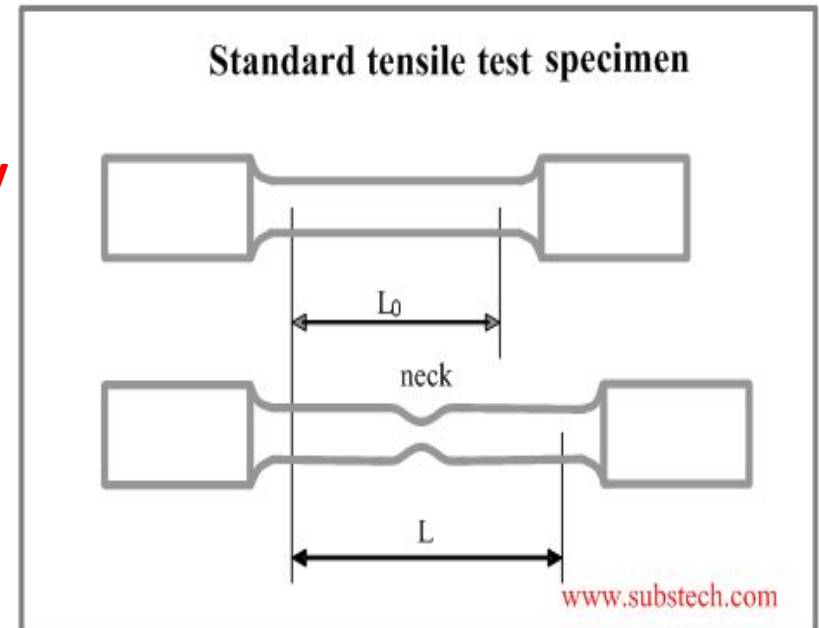
The extension of the bar is proportional to the increase in tension.

## *Point1:*

The limit of proportionality

## *Point2:*

The elastic limit



# *Stages in elastic and plastic deformation*

Point 3:

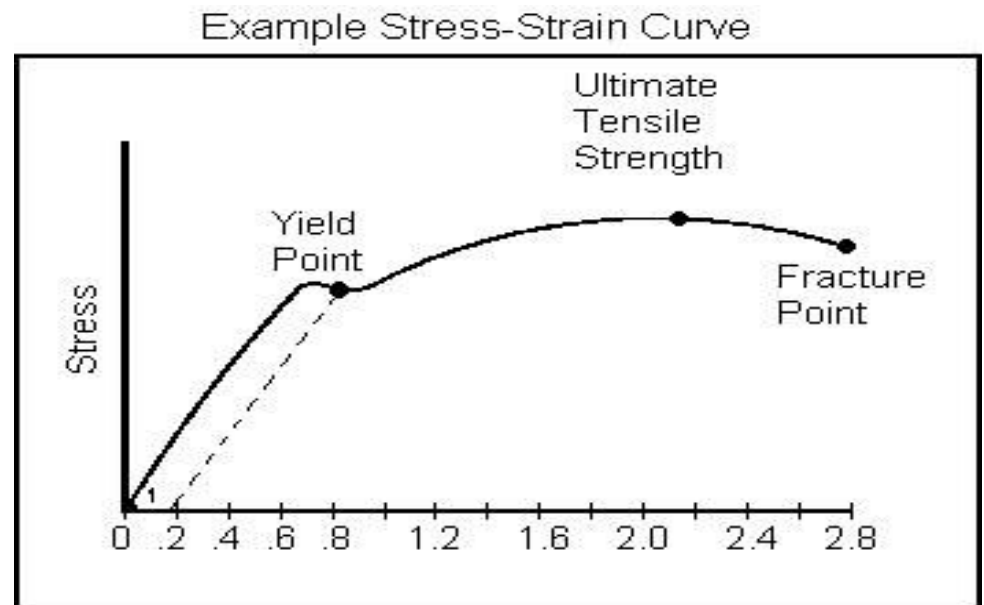
The Yield point

Point 4:

UTS-the Ultimate Tensile Strength

Point 5:

The fracture point



# **Heat treating metal**

- The properties of a metal can be changed by heat treating it – that is , heating and cooling the metal.





# **The main types of heat treatment**

- Quenching(quenched metal is harder , but tends to be more brittle)
- Annealing(annealed metal is generally softer and more elastic)
- Tempering(tempered metal possesses a balance between hardness and elasticity)
- Age hardening,surface hardening

# *Hardness*

- Affects a material's **durability**
- Can be defined in two ways:
  - Scratch hardness
  - Indentation hardness



# *Fatigue / creep*

There are two important problems:

- **Fatigue** (caused by cyclic loads)
- **Creep** (components  
Become permanently  
damaged)





- Springs are made from wire(wire made from **ductile** metal)
- When the wire manufactured , it is stretched beyond its **elastic limit and even yield point**
- To put back the springiness to a spring , it is **tempered**

# *Comparing copper or aluminium as materials for electrical wires*



- *The thermal conductivity* of copper is 40% greater than that of aluminium. Copper is a much more effective thermal conductor.
- Copper has *a coefficient of thermal expansion* apprx. 40% lower than that of aluminium.

TO BE CONTINUED

