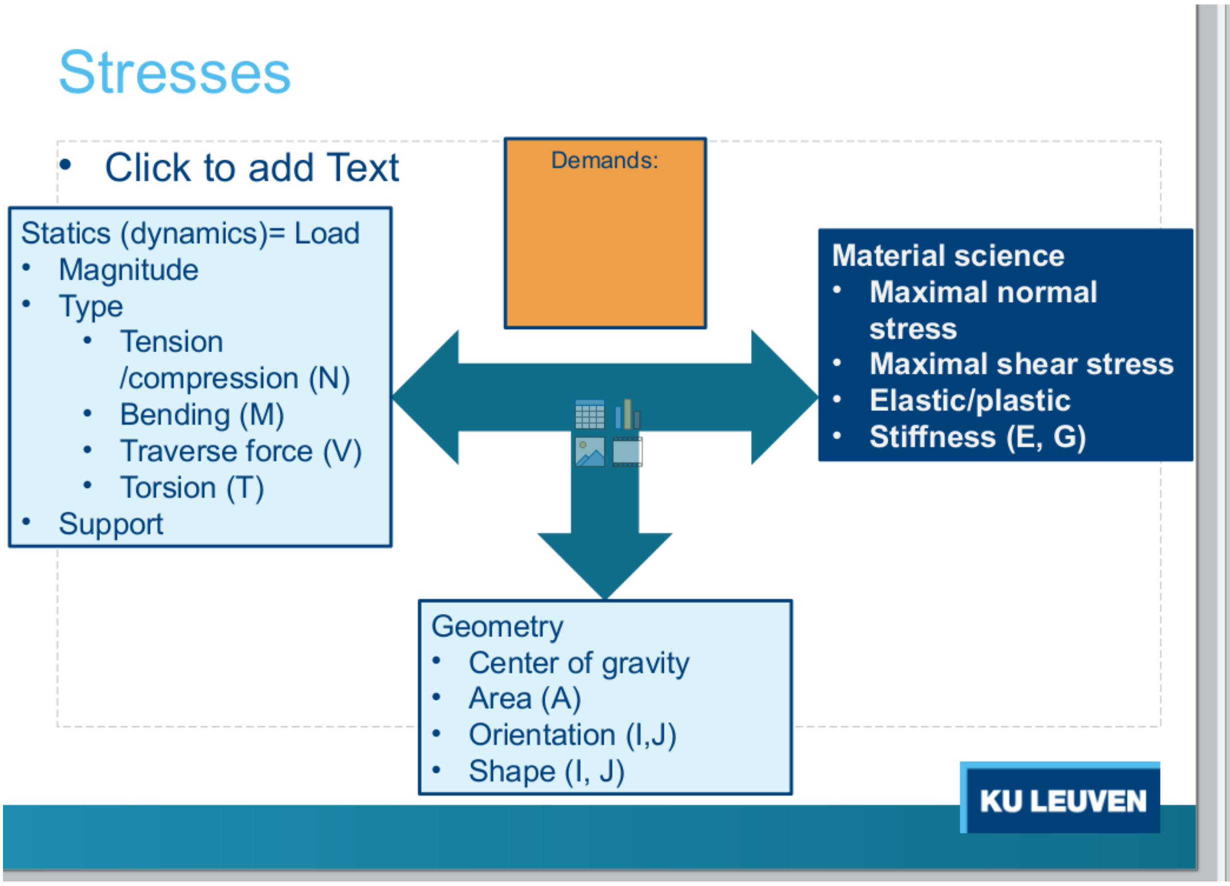
`Statics, T0803`

Block 8a, 8b is covered.

To know how much load a structure will carry, one needs to know:

- Internal load of a structure:
    - Normal forces N
    - Torsion force T_x
    - Bending moments M_x, M_z
    - V_z, V_y
- Material properties
- Geometry



Deformation needs to be also taken into account when considering material properties

Load	Stress	Deformation

Load	Stress	Deformation
N_x	$\sigma_x = \frac{N_x}{A}$ valid for uniform distribution stress	
T_x		
M_y, M_z		
V_y, V_z	$\tau_{xz} = \frac{V_z}{A}$ $\tau_{xy} = \frac{V_y}{A}$ assume uniform distribution this is not theoretically correct, never uniform distrib we are however allowed to use this on the exam	

Internal loading of a potato: we know all external and reaction forces, we cut the potato into half, and replace the load applied by one half with a normal force, torsion moment, shear force, bending moment.
As many cuts as needed can be made until we get a finite element structure.

He abbreviates a moment as two opposite forces given enough cuts, bending and shear forces will arise as a result of reaction forces between elements, which means the moment information is encoded within the forces.

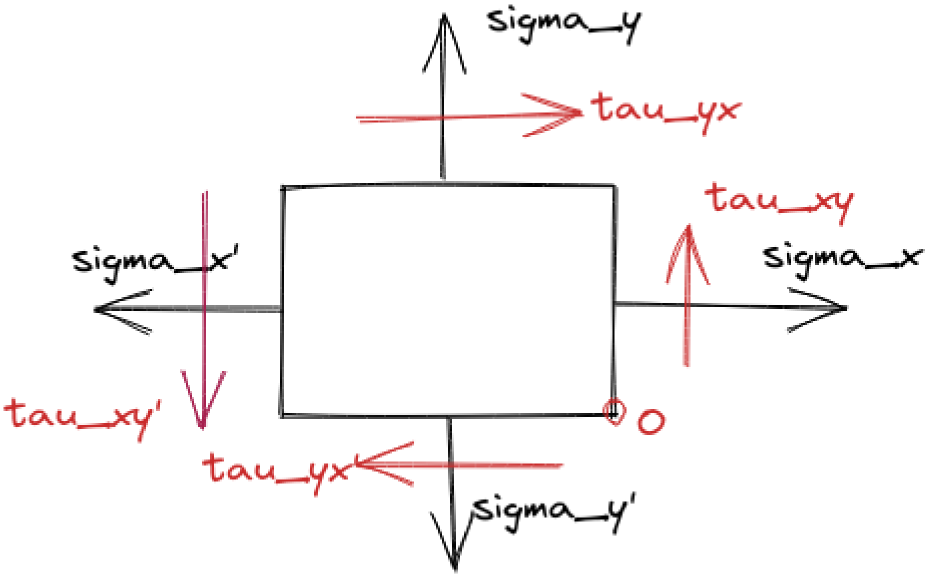
σ are normal forces.

$$\sigma_i = \lim_{A \to 0} \left(\frac{N_i}{A} \right) \mid i \in \{x, y, z\}$$

τ are shear froces.

$$\tau_{zx} = \lim_{A \to 0} \frac{V_{x,z}}{A}$$
$$\tau_{zy} = \lim_{A \to 0} \frac{V_{y,z}}{A}$$

There are 18 different forces to cause stress, as this is too much we relate some of the forces to each other.



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$$\Sigma F_x = 0 \Rightarrow \sigma_x * A - \sigma_x' * A = 0$$
$$\Sigma F_y = 0 \Rightarrow \sigma_y = \sigma_y'$$
$$\tau_{yx} = \tau_{yx}'$$
$$\tau_{xy} = \tau_{xy}'$$

$$\Sigma M_{z,o} = 0$$
$$+\tau_{xy} * A * d - \tau_{yx} * A * d \Rightarrow \tau_{xy} = \tau yx$$

Thus, we have reduced all variables to 6: $\sigma_{x,y,z}, \tau_{xy}, \tau_{xz}, \tau_{yz}$

When there are uncertainties in material properties and dimensions and shapes used, we introduce safety factors to make sure the structure will hold.

$$\frac{\sigma_{\text{max}}}{\gamma_{\text{material}}} \geq \gamma_{\text{load}} * \frac{N}{A}$$

γ_{material} is a standard value given to you.
γ_{load} depends on application, designer will decide.

Differnet types of analysies:

1. max load σ_{max}, force N, area A are known.
   here, we just check if it is strong enough.
2. max load σ_{max}, area A are known; force N is unknowm.
   calculate the max load the structure can bear.

3. max load $\sigma_{\max}$, force N are known; area A is unknown.
   dimensioning problem, most commonly faced problem.
4. force N, area A are known; max load $\sigma_{\max}$ is unknown
   material selection

`Dynamics`

Impulse $J = \int F\,dt = F * t$