Formula sheet for testing materials

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1 Material properties

1.1 Strength

Strength is actually a stress value. Strength is the stress at which a material "fails".

- The "yield strength" of a material is when it starts to plastically deform.

- The "breaking strength" of a material is when it actually breaks.

1.2 Young's Modulus

Young's modulus is an indication of the stiffness of a material (how much strain is produced by a stress while deforming elastically). It is given by stress over strain, and denoted as E:

$$E = \frac{\sigma}{\epsilon} \tag{1}$$

As the units of σ are Pa and ϵ is dimensionless, we can conclude that E has units Pa.

Also, as we know formulas for both σ and ϵ, we can substitute in:

$$E = \frac{\sigma}{\epsilon}$$
$$= \frac{\frac{F}{A}}{\frac{x}{l}}$$
$$= \frac{Fl}{Ax}$$

2 Formulas

2.1 Stress

The stress is defined as force applied divided by cross-sectional area and denoted as σ:

$$\sigma = \frac{F}{A} \tag{2}$$

Hence, stress is measured in Nm^{-2}, which is called Pa (scals).

2.2 Strain

Strain is a measure of the deformation of a material. It denoted as ϵ and given by extension over original length:

$$\epsilon = \frac{x}{l_0} \tag{3}$$

As the units of both x and l_0 are m,

$$\text{units} = \frac{m}{m}$$
$$= \text{dimensionless}$$

2.3 Area of a circle

This is given by

$$A_{circle} = \pi r^2 \tag{4}$$

We can also make some substitutions, as we know

$$r = \frac{d}{2}$$
$$\Rightarrow A_{circle} = \frac{\pi d^2}{4}$$