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**Stress Strain Fundamentals**

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**Acknowledgement**

Mr John Gibson is a highly regarded educator and engineer. John taught Industrial Arts at a number of high schools before taking a position at Sydney Teachers’ College, then University of Sydney. He had an engineering education consultancy and has extensive experiencing working with NESA on Engineering Studies syllabus development and the HSC examination committee. The STEM Industry School Partnerships (SISP) Program asked John for his responses to the iTeachSTEM topic discussion questions. SISP is grateful to John for submitting these example discussion responses.

# Define stress and list the common types of stress.

When an external load is applied to a physical body (a beam or a strut) an internal reaction is set up according to Newton’s third law of motion. The internal reaction is divided by the area over which it acts. The reaction, divided by the area is termed stress.

Stress (Pa) = Load (N)/Area (A)

Types of stress included:

* tensile
* compressive
* shear
* torsion
1. **Explain the units used in stress values.**

Stress is an internal reaction and not a force. The unit for stress is the Pascal (Pa).

1. **Explain the difference between a Load/Extension graph and a Stress/Strain graph.**

A Load/Extension graph is produced when a specimen is placed in a testing machine and loaded to cause it to distort. The raw data from this test, prepared as a graph, will provide information specific to the behaviour of the test specimen, and no others!

A Stress/Strain graph is produced where the load and extension data is converted to stress/strain data. In this form, the data is comparable with any other specimen data produced on any other machine.

1. **Describe the activity being performed to create a Load/Extension diagram.**
* prepare test machine ~ correct load and extension settings
* prepare specimen ~ measure and record gauge length and diameter (if round)
* insert specimen into machine, load specimen ~ start graph recorder, continue to failure, stop recorder
* record maximum load, remove specimen
* record the extension (new length – original length/100)
* record the change in area (original area – new area/100)
* assess information from graph

1. **Outline how material properties can be identified by the curve produced by a tensometer, eg: strength, elasticity, ductility, toughness and stiffness.**

Various engineering materials have characteristic behaviour which can be identified on test graphs. Some properties include:

* strength: maximum vertical height of graph
* stiffness: slope of straight line portion
* elasticity: overall length of graph
* proportional limit: top of straight line portion
* toughness: area under the curve
1. **Outline how a Stress/Strain graph varies for a range of engineering materials, eg: ceramics, metals and polymers.**

The Stress/Strain graph presents a range of material properties as defined shapes on the graph. Once tested, some properties of a material will be visible on the graph, and these can be recorded.

* ceramics: tend to show high strength and low ductility
* metals: have a wide range of properties, with moderate strength, and good ductility
* polymers: have a wide range of properties, but generally show low strength and high ductility
1. **Define strain.**

Where a specimen is under stress it will tend to elongate. The elongation relative to the original length is termed strain.

1. **Explain the units used in strain values.**

The units of strain are a percentage. A 100mm specimen having elongated 32mm will have a strain of:

New length – original length/original length/100

(132 – 100)/100 = 32%