

Engineering Design *An Introduction*

Developing Appropriate Tests

- Define exactly what you want to test
- Investigate testing possibilities
- Devise tests
- Implement tests
- Types of tests
 - Product testing
 - Market testing (market analysis)

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Testing a Toy

- Example objectives of toy design
 - Educational
 - Hold the interest of preschoolers
 - Durable
- All three aspects can be measured
 - Use of experts
 - Measuring time of play
 - Tests must be “fair”

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Testing a Toy (cont'd.)

- Testing durability of a toy
 - Study typical events that happen to toys
 - Find ways to simulate these events
 - Research how companies test toys
 - Expectations and requirements
 - Investigate whether there are regulations or guidelines for toy safety

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Testing an Engineering Solution

- Engineering testing
 - Component level
 - Product as a whole
- Example: competition robot
 - Test motors to determine if they can withstand expected loads
 - Test structural integrity of components
 - Test if chassis can support the components

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Materials Testing

- Reasons for materials testing
 - Determine properties of materials
 - Find their suitability for applications
- Data exists on a wide range of materials
- Stress
 - Force applied per unit area to a material

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Materials Testing (cont'd.)

- Strain
 - Actual change in length of the material that results from a stress
- Tensile testing
 - Material is pulled apart until failure
- Elastic limit or yield strength
 - Point at which permanent deformation occurs

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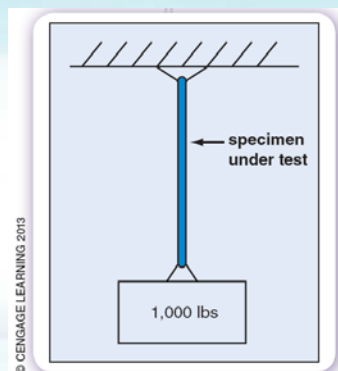


Figure 9-4: This diagram shows a material under tension. One end is fixed and the other has a load attached.

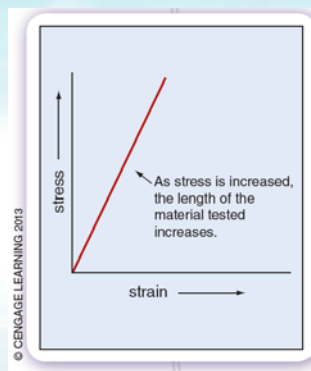


Figure 9-5: Materials under tension will elongate. The more force that is applied (stress), the more the material stretches (strain).

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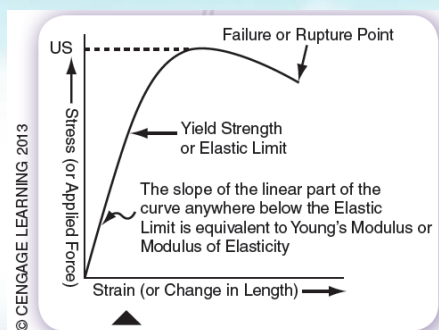


Figure 9-6: Typical graph of stress versus strain on a material loaded to its rupture point.

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Materials Testing (cont'd.)

- Failure point
 - Point at which the material fails
- Ultimate strength
 - Maximum force a material can withstand
- Hooke's law
 - Stress applied to a material is proportional to the resulting strain
 - True within the elastic limit of the material

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- Hooke's law (cont'd.)
$$\frac{\sigma}{\epsilon} = E$$
- E is a constant known as Young's modulus
 - Also called modulus of elasticity
- Some materials do not obey Hooke's law
 - Example: rubber

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Materials Testing (cont'd.)

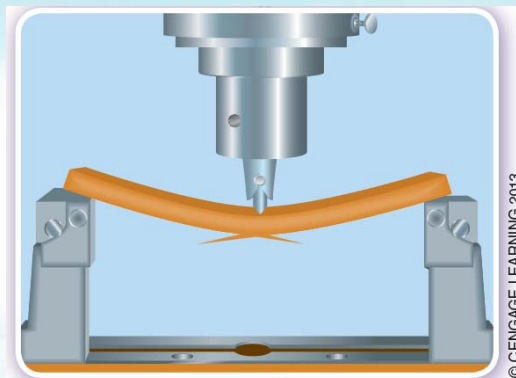
- Fatigue
 - Fracture that occurs when a material is subjected to a repeating stress
 - Stress value is less than the tensile strength of the material
 - Example: bending a paper clip back and forth until it breaks

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Figure 9-10: Fatigue testing by repeatedly deforming a material until failure.

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Materials Testing (cont'd.)

- Hardness testing
 - Applying force to a material in a very small area
- Rockwell hardness test
 - Standard test
 - Diamond or hardened steel point pushed into a material

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Testing and Evaluating Your Own Design Work

- Important attributes of design work
 - Aesthetics
 - Ergonomics
 - Performance/functionality
 - Durability
 - Cost
 - Impact to the environment or society

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Aesthetics

- Appearance influences human response to an object or experience
 - Form/shape
 - Color
 - Scale
- Surveys can be used to determine how well consumers like the appearance of a design

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Ergonomics

- Ease of use or comfort while using a product
- Questions to ask
 - Is product appropriately sized or weighted?
 - Are controls in an appropriate place?

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Performance/Functionality

- Refers to whether the product does what it is supposed to do
- Simulations or controlled trials
 - Necessary if there is potential for accident or injury

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Durability/Reliability

- Durability
 - Product's ability to remain functional over its expected lifetime
- Reliability
 - How long a population of a product remains functional:
 - Under accelerated or nonaccelerated conditions

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Cost

- Important considerations
 - Cost of manufacturing a product
 - How much a customer is willing to pay
 - Cost of maintenance and disposal
- Life-cycle cost
 - Total cost of the product
 - Includes energy to run it
 - Cost of recycling or environmental impact cost

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Impacts

- Describe the positive and negative qualities of an object
 - Purpose, function, materials, and processes
- Types of impacts
 - Environmental
 - Personal
 - Social
 - Legal

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Presenting Test Results

- Descriptions
 - Written description with graphics
- Numbers
 - Graphic presentations may be effective
 - Figures must be well labeled and clear
- Checklists
 - Visual summary of the extent the solution meets the requirements

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Presenting Test Results (cont'd.)

- Testimonials
 - Opinions of those who have tried the product
 - Individuals give permission to have their names associated with product comments

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Evaluating Your Design Skills

- Assessment of a project
 - Look at your role
 - Team's role
- Example assessment questions
 - Did design brief provide solid direction?
 - Did you collect appropriate information about the problem?

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Evaluating Your Design Skills (cont'd.)

- Example assessment questions (cont'd.)
 - Can you defend the chosen solution?
 - Did you work out problems before developing working drawings?
 - Was the model or prototype well crafted?
 - Were the tests appropriate?
 - Did you use the time allowed appropriately?

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