# Unit 5: Structures and Forces

Content Area: **Technology**
Course(s): **Engineering Design 1**
Time Period: **December**
Length: **8 blocks**
Status: **Published**

## Enduring Understandings

1. Structures are always under stress from forces whether it is from gravity, the environment, or people.

2. Dead loads are easy to plan for because they do not change while live loads are difficult to plan for because they are variable.

3. A material's properties will determine how it reacts to particular forces.

4. A certain material may perform well under one type of force and/or stress but poor under another type.

5. Cost and efficiency of structures are interrelated.

6. Materials science is an important factor to consider when deciding which products to use in a structure.

7. Quality of construction is an essential part of the efficient design of structures.

## Essential Questions

1. How do different forces affect the design of a structure?

2. How can materials be combined together to create stronger structures?

3. How are forces distributed around a structure?

4. How does materials science influence the design of a structure?

5. What is the difference between designing structures effectively vs efficiently?

6. Why does cost of materials and labor affect the design of a structure?

7. How does a combination of forces affect a structure?

8. How does the phrase, "A chain is only as strong as its weakest link." apply to the field of structural engineering?

9. How is the design process used when solving a structural engineering problem?

10. What information can we gain from destructive testing of a structure?

## Content

Vocabulary:

Structural integrity, Point of failure, Stress point, Fracture, Destructive testing, Non-destructive testing, Strength-to-weight ratio, Dead load, Live load, Compression, Tension, Bending, Torsion, Shear, Stress, Strain, Elastic deformation, Modulus of elasticity, Plastic deformation, Cantilever, Force, Static load, Dynamic load, Beam, Arch, Girder, Truss, Gusset, Bending moment, Newton, Tensile strength, Hooke's law, Structure, Load factor, Materials science, Natural structure, Man-made structure, Deflection, Material failure, Composite material

## Skills

1. Evaluate a scenario to determine which forces are affecting a structure.

2. Calculate the amount of stress on a structure caused by a force.

3. Calculate the amount of strain on a structure caused by a force.

4. Calculate forces acting on a simply supported beam.

5. Calculate forces acting on a moment arm.

6. Manipulate a structural engineering computer program to design a bridge as efficient as possible.

7. Apply the design process to design and build a structure that meets instructor created specifications.

8. Document work completed on a structural engineering project using an engineering portfolio.

9. Identify where different forces are affecting a structure.

10. Calculate a structure's efficiency.

11. Conduct an analysis of structural engineering data and present the findings.

## Resources

Engineering drawing tools (various)

Engineering drawing paper

Calipers

Physical objects to be measured

Teacher presentation device

Document camera

Desktop computers

Research database access

2D & 3D CAD systems

3D printer

Laser cutter

Color laser printers

Large format printer

Prototyping equipment (hand-held and power tools)

Prototyping materials

Prototyping furniture

Presentation device

## Standards

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|---|---|
| TECH.8.2.12.C.5 | Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled. |
| TECH.8.2.12.C.7 | Use a design process to devise a technological product or system that addresses a global problem, provide research, identify trade-offs and constraints, and document the process through drawings that include data and materials. |
| TECH.8.2.12.D.1 | Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review. |
| TECH.8.2.12.D.3 | Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system. |
| TECH.8.2.12.D.4 | Assess the impacts of emerging technologies on developing countries. |
| TECH.8.2.12.D.5 | Explain how material processing impacts the quality of engineered and fabricated products. |
| TECH.8.2.12.D.CS1 | Apply the design process. |
| TECH.8.2.12.E.1 | Demonstrate an understanding of the problem-solving capacity of computers in our world. |