

## GLOSSARY

### BEARINGS

A support, guide, or locating piece for a rotating or reciprocating mechanical part.

### BOX GIRDER

A large beam, as of steel, reinforced concrete, or timber, for supporting masonry or joists, that is hollow and square, or rectangular in shape.

### CABLE STAYED

A bridge consisting of one or more columns, towers, or pylons with cables supporting the bridge deck.

### CAISSON

A watertight chamber open at the bottom and containing air under pressure, used to carry out construction work underwater.

### CANTILEVER

Any rigid construction extending horizontally well beyond its vertical support, used as a structural element of a bridge or building foundation.

### COFFERDAM

A watertight structure, usually of sheet piling, that encloses an area under water, pumped dry to enable construction work to be carried out. Below a certain depth a caisson is required.

### DAMPENING

Shock absorption system that dissipates energy.

### DREDGE

To remove material from a riverbed or channel by means of a dredge.

### GPS

(Global Positioning System) – A system of satellites combined with receivers on the Earth that determine the latitude and longitude of any particular receiver through triangulation.

### HYDRAULIC

Operated by the pressure of water or other liquids. Hydraulic systems, such as hydraulic brakes, allow mechanical force to be transferred along curved paths (through pipes or tubes) that would be difficult for solid mechanisms, such as levers or cables, to negotiate efficiently.

### PARABOLIC

Having the form of a parabola. Parabola: a plane curve formed by the intersection of a right circular cone with a plane parallel to a generator of the cone; the set of points in a plane that are equidistant from a fixed line and a fixed point in the same plane or in a parallel plane.

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# Show Me Science

## ENGINEERING Bridges by Design

*Exploring the World Of Science  
for High School and Beyond*

**Advanced Teachers Guide**

## SYNOPSIS:

Engineers and architects are creating bridges that combine the best of both art and design. Bridges are no longer just a tool to get from one side of the river to the other. Some bridges have the goal of being aesthetically pleasing and efficient for pedestrians. Others rely on the cantilever design to span a distance equivalent to three and a half jumbo jets. Bridges are often classified by their structure and how the forces of tension, compression, bending, torsion and shear are distributed. In this program, students will learn how designs vary depending on the function of the bridge, the environmental factors, the materials and technology used to construct them.

## CURRICULUM UNITS:

- Architecture
- Engineering
- Environmental Science
- Physical Science
- Physics

## CAREER OPPORTUNITIES:

- Architect
- Building Construction
- Engineer

## PROGRAM OVERVIEW:

There are six main types of bridges: beam, cantilever, arch, suspension, cable-stayed and truss. Bridges are used for several different purposes; some are only for pedestrians while others are used exclusively by automobiles. Bridges are built to cross rivers and lakes or to make deep ravines easier to cross.

The Gateshead Millennium Bridge in England is the first tilting bridge in the world. It is strictly for pedestrians and cyclists, and was built to span the river Tyne connecting Newcastle to Gateshead. Its unique tilting feature was included to allow boat traffic to pass underneath. Six 45 cm (18 in) diameter Hydraulic rams, three on each side, each powered by a 55 kW electric motor rotate the bridge on large bearings to allow watercraft to pass underneath. It takes as little as 4 minutes to rotate through the full 40° from closed to open, depending on wind speed. As it tilts open, the center of mass moves across the pivot point, requiring very little power from the rams as they simply hold the bridge open.

London's Millennium Bridge is a steel suspension bridge that crosses the river Thames, built specifically for pedestrians. Eight suspension cables pull with a force of 2,000 tons against the piers on the banks, which can support a working load of 5,000 people at one time. However, the bridge was shut down after its opening day because of an unexpected wobble caused by synchronous lateral excitation. The problem was fixed by engineers and the bridge was later reopened after it was retrofitted with 37 fluid viscous dampers to dissipate energy and 52 tuned mass dampers to control vertical movement.

## ISSUES & CRITICAL THINKING:

- 1) How do scientists and engineers decide which type of bridge is the right one to build in a specific place? List the variables that scientists might consider when choosing the design for a bridge.
- 2) Why is it important that the science of bridge engineering be exact? How do scientists cope with unexpected problems, as was the case in the Millennium Bridge project?
- 3) Create a model for a bridge to be designed in your location. What purpose will the bridge serve? Describe environmental concerns that may hinder your project.