

Welcome to the Supercharged Science

# Civil Engineering Teleclass Webinar!

You can fill out this worksheet as we go along to get the most out of time together, or you can use it as a review exercise at the end of the class to see where your strengths are.

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**What we're going to cover today:**

- Bridges
- Buildings
- Skyscrapers
- Dams
- Roads
- Water Supply
- Civil Engineering Challenges
- Ancient and Modern Structures
- Tension & Compression
- Building Materials
- Real Engineering Projects
- Different Types of Engineers

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Do this NOW: Write down two things you want to learn about bridges, dams, or buildings:

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Do this NOW: Write down WHY you want to learn about the things you mentioned above. What will it give you, or provide you with, or make possible for you if you now understand these things that you wanted to learn?

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**IMPORTANT:** During class, you can either fill out the worksheet, OR if that's too stressful or a hassle, just set it aside and fill it out after class is over so you can enjoy watching the class.

**Answer key** is on the last page, so put it in a place where you won't be tempted to peek at the answers until after you've given it your best shot.

## **Material List:**

- Activated carbon (check an aquarium store)
- Alum (check the spice section of the grocery store)
- Barrel Roof template (go to last page of this workbook)
- Bucket (5 gallon size)
- Cheese cloth
- Clay
- Cotton balls (2-3)
- Disposable cups, clear
- Disposable pie tin
- Distilled water
- Distilled white vinegar
- Extra paper to load the roof
- Flat book or light clipboard
- Funnel or empty water bottle with top third cut off (this is your funnel)
- Hammer
- Hot glue gun with glue sticks
- Index cards
- Magnet
- Magnifying lens (handheld works great)
- Measuring cup (mL graduation marks)
- Measuring spoon (1/4 tsp and 1/2 tsp)
- Medicine dropper or syringe (no needle)
- Paper towels
- Pencils (2)
- Penny
- Play sand (clean)
- Popsicle Sticks
- Porcelain tile, unglazed (or the bottom of a coffee mug)
- Scale that measures in grams
- Scissors
- Small plate of glass that is okay to scratch (a microscope slide works great)
- Steel nail
- Straws
- Thread
- Water bottle
- Water sample (a cup of coffee with the ground put back in works great)
- Wood pencil (one that okay to break)  
OR a popsicle stick
- Wooden blocks

If you'd like to do the geology experiments, you'll also need rock samples.

- Here are the ones I used in the videos for the rock and mineral tests:
  - <http://www.hometrainingtools.com/know-your-rocks-study-kit>
  - <http://www.hometrainingtools.com/know-your-minerals>
- Geology Field Trip rock sample pack
  - <http://www.hometrainingtools.com/geology-field-trip-in-a-bag>

### **During the Lesson:**

You can look over the worksheet so you know what to listen for as you go through the class with me, or you can go through it along with me during class. OR... flip it over and forget about it and just enjoy the class. When class is over, flip it back over and fill it out and be amazed at how much you've picked up and learned!

1. A civil engineer \_\_\_\_\_ and \_\_\_\_\_  
public works: bridges, dams, roads, tunnels, airports, buildings, and water supply.
2. An architect focuses on the \_\_\_\_\_ and design and appearance  
of structures.
3. Civil engineers focus on the \_\_\_\_\_ and engineering of the  
structures.
4. Ancient civil engineering projects include Roman \_\_\_\_\_, the  
Great \_\_\_\_\_ of China, and the Cliff Palace in Mesa Verde.
5. How would you move blocks of stone 30 feet long weighing 25 tons each a distance of  
20 miles?  
\_\_\_\_\_  
\_\_\_\_\_
6. Civil engineers test different \_\_\_\_\_ and designs to see how they  
will work.
7. Civil engineers study \_\_\_\_\_, physics, geology, hydrology, and  
materials.

8. They need to know \_\_\_\_\_ to build and  
\_\_\_\_\_ to build it.

9. Tension is when things get \_\_\_\_\_ apart.

10. Compression is when things get \_\_\_\_\_ together.

11. Civil engineers help during \_\_\_\_\_, make sure their project is  
being built correctly.

12. They also help \_\_\_\_\_ problems that arise unexpectedly.

13. What are eight different types of building materials?

|       |       |
|-------|-------|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

14. Name four types of bridges:

|       |
|-------|
| _____ |
| _____ |
| _____ |
| _____ |

15. Dams protect people, store \_\_\_\_\_ for drinking and growing plants, and make hydro-electric \_\_\_\_\_.

16. Name four different types of dams:

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17. Tunnels are underground \_\_\_\_\_.

18. Name three types of tunnels:

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19. Domes are curved \_\_\_\_\_ that enclose a large space \_\_\_\_\_  
\_\_\_\_\_ column support.

20. A skyscraper is a tall building over \_\_\_\_\_ floors, higher than \_\_\_\_\_  
\_\_\_\_\_ meters (492 feet).

21. Planning, \_\_\_\_\_, drainage, and paving are all part of  
building a \_\_\_\_\_.

22. Used water ( \_\_\_\_\_ ) travels through sewage pipes to treatment plants where it is treated and either returned to streams, rivers, and oceans, or used for \_\_\_\_\_.

23. Civil engineers plan and design the systems that not only bring you \_\_\_\_\_ drinking water, they also design and maintain the systems that \_\_\_\_\_ to clean it.

24. A \_\_\_\_\_ engineer evaluates and stabilizes foundations for buildings, roads, and other structures.

25. An \_\_\_\_\_ engineer designs systems to provide safe drinking water and controls pollution in water, air, and land.

26. An \_\_\_\_\_ engineer designs and builds electrical devices and systems that use electrical energy.

27. A \_\_\_\_\_ engineer investigates structures to make sure they are safe for people.

28. A \_\_\_\_\_ engineer designs and builds anything that moves.

29. What I didn't know about civil engineering until class today was:

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## **Vocabulary Words**

Aluminum - a lightweight chemical element (Al); the most abundant metallic element in the Earth's crust

Anchorage - a secure fixing, usually made of reinforced concrete to which the cables are fastened

Aqueduct - a bridge or channel for conveying water, usually over long distances

Arch Bridge - a curved structure that converts the downward force of its own weight, and of any weight pressing down on top of it, into an outward force along its sides and base

Arch Dam - a dam with an arched shape that resists the force of water pressure; requires less material than a gravity dam for the same distance

Architect - a person who designs all kinds of structures; must also have the ability to conceptualize and communicate ideas effectively -- both in words and on paper -- to clients, engineers, government officials, and construction crews

Beam - a rigid, usually horizontal, structural element

Beam Bridge - a simple type of bridge, composed of horizontal beams supported by vertical posts

Bedrock - the solid rock layer beneath sand or silt

Bend - (v.) to curve; bending occurs when a straight material becomes curved; one side squeezes together in compression, and the other side stretches apart in tension

Brace - (n.) a structural support; (v.) to strengthen and stiffen a structure to resist loads

Brittle - characteristic of a material that fails without warning; brittle materials do not stretch or shorten before failing

Buckle - to bend under compression

Buttress - a support that transmits a force from a roof or wall to another supporting structure

Buttress Dam - a gravity dam reinforced by structural supports

Cable - a structural element formed from steel wire bound in strands; the suspending element in a bridge; the supporting element in some dome roofs

Cable-Stayed Bridge - a bridge in which the roadway deck is suspended from cables anchored to one or more towers

Caisson - a watertight, dry chamber in which people can work underwater

Cantilever - a projecting structure supported only at one end, like a shelf bracket or a diving board

Cast Iron - a brittle alloy with high carbon content; iron that has been melted, then poured into a form and cooled; can be made into any shape desired

Civil Engineer -an engineer who plans, designs, and supervises the construction of facilities essential to modern life

Cement -a binding material, or glue, that helps concrete harden

Coffer -a sunken panel in a ceiling

Cofferdam -a temporary dam built to divert a river around a construction site so the dam can be built on dry ground

Column - a vertical, structural element, strong in compression

Compressed-Air Chamber -the space at the bottom of a caisson into which air is introduced under pressure to exclude water so that excavation can take place

Compression - a pressing force that squeezes a material together

Concrete -a mixture of water, sand, small stones, and a gray powder called cement

Construction Manager -a person who coordinates the entire construction process -- from initial planning and foundation work through the structure's completion

Continuous Span Beam Bridge -simple bridge made by linking one beam bridge to another; some of the longest bridges in the world are continuous span beam bridges

Core -central region of a skyscraper; usually houses elevator and stairwell

Cut and Cover -a method of tunnel construction that involves digging a trench, building a tunnel, and then covering it with fill

Deck -supported roadway on a bridge

Deform -to change shape

Dome -a curved roof enclosing a circular space; a three-dimensional arch

Downstream Face -the side of the dam that is not against the water

Dynamite -a blasting explosive, based on nitroglycerin, but much safer to handle than nitroglycerin alone

Embankment Dam -a dam composed of a mound of earth and rock; the simplest type of gravity dam

Engineering -a profession in which a knowledge of math and natural science is applied to develop ways to utilize the materials and forces of nature for the benefit of all human beings



Fire-Setting -an ancient tunneling technique in which rock is heated with fire and then doused with cold water, causing the rock to fracture

Force - any action that tends to maintain or alter the position of a structure

Geodesic Dome -a dome composed of short, straight pieces joined to form triangles; invented by Buckminster Fuller

Gravity Dam -a dam constructed so that its great weight resists the force of water pressure

Iron -a chemical element (Fe); one of the cheapest and most used metals

Joint - a device connecting two or more adjacent parts of a structure; a roller joint allows adjacent parts to move controllably past one another; a rigid joint prevents adjacent parts from moving or rotating past one another

Load - weight distribution throughout a structure; loads caused by wind, earthquakes, and gravity, for example, affect how weight is distributed throughout a structure

Masonry - a building material such as stone, clay, brick, or concrete

Pier -a vertical supporting structure, such as a pillar

Pile - a long, round pole of wood, concrete, or steel driven into the soil by pile drivers

Plastic -a synthetic material made from long chains of molecules; has the capability of being molded or shaped, usually by the application of heat and pressure

Pressure - a force applied or distributed over an area

Reinforced Concrete - concrete with steel bars or mesh embedded in it for increased strength in tension; in pre-tensioned concrete, the embedded steel bars or cables are stretched into tension before the concrete hardens; in post-tensioned concrete, the embedded steel bars or cables are stretched into tension after the concrete hardens

Richter Scale -used to measure the magnitude of an earthquake; introduced in 1935 by the seismologists Beno Gutenberg and Charles Francis Richter

Rigid - (adj.) ability to resist deformation when subjected to a load; rigidity (n.) the measure of a structure's ability not to change shape when subjected to a load

Rock Tunnel - a passage constructed through solid rock

Shear - a force that causes parts of a material to slide past one another in opposite directions

Shear-Walls - solid concrete walls that resist shear forces; often used in buildings constructed in earthquake zones

Soft-Ground Tunnels -a passage constructed through loose, unstable, or wet ground, requiring supports to keep the walls from collapsing

Span -(n.) the distance a bridge extends between two supports; (v.) to traverse a specific distance

Spillway -an overflow channel that allows dam operators to release lake water when it gets high enough to threaten the safety of a dam

Stable -(adj.) ability to resist collapse and deformation; stability (n.) characteristic of a structure that is able to carry a realistic load without collapsing or deforming significantly

Steel - an alloy of iron and carbon that is hard, strong, and malleable

Stiff - (adj.) ability to resist deformation; stiffness (n.) the measure of a structure's capacity to resist deformation

Story -floor of a skyscraper

Strong - (adj.) ability to carry a realistic load; strength (n.) the measure of a structure's ability to carry a realistic load

Suspension Bridge - a bridge in which the roadway deck is suspended from cables that pass over two towers; the cables are anchored in housings at either end of the bridge

Tailings Dam -a dam, usually made of earth and rock, used to contain mining waste

Tension - a stretching force that pulls on a material

Tension Ring -a support ring that resists the outward force pushing against the lower sides of a dome

Torsion -an action that twists a material

Tower -the vertical structure in a suspension bridge or cable-stayed bridge from which cables are hung; also used loosely as a synonym for the term skyscraper

Truss - a rigid frame composed of short, straight pieces joined to form a series of triangles or other stable shapes

Tunnel Boring Machine (TBM) -a mechanical device that tunnels through the ground

Tunnel Shield -a cylinder pushed ahead of tunneling equipment to provide advance support for the tunnel roof; used when tunneling in soft or unstable ground

Unstable -characteristic of a structure that collapses or deforms under a realistic load

Wood -a common natural material strong in both compression and tension

*Vocabulary words source: PBS Online for Educators*

## **Answer Key**

1. A civil engineer designs and builds public works: bridges, dams, roads, tunnels, airports, buildings, and water supply.
2. An architect focuses on the art and design and appearance of structures.
3. Civil engineers focus on the science and engineering of the structures.
4. Ancient civil engineering projects include Roman Roads, the Great Wall of China, and the Cliff Palace in Mesa Verde.
5. How would you move blocks of stone 30 feet long weighing 25 tons each a distance of 20 miles? (Answers vary)
6. Civil engineers test different materials and designs to see how they will work.
7. Civil engineers study math, physics, geology, hydrology, and materials.
8. They need to know what to build and how to build it.
9. Tension is when things get pulled apart.
10. Compression is when things get squashed together.
11. Civil engineers help during construction, make sure their project is being built correctly.
12. They also help solve problems that arise unexpectedly.
13. What are eight different types of building materials? Wood, plastic, aluminum, brick, concrete, reinforced concrete, cast iron, and steel.
14. Name four types of bridges: beam bridge, truss bridge, arch bridge, and suspension bridge.
15. Dams protect people, store water for drinking and growing plants, and make hydro-electric power.
16. Name four different types of dams: embankment, gravity, arch, and buttress.
17. Tunnels are underground passages.
18. Name three types of tunnels: Soft-ground tunnels, rock tunnels, and underwater tunnels.
19. Domes are curved surfaces that enclose a large space without column support.
20. A skyscraper is a tall building over 40 floors, higher than 150 meters (492 feet).
21. Planning, earthwork, drainage, and paving are all part of building a road.

22. Used water (wastewater) travels through sewage pipes to treatment plants where it is treated and either returned to streams, rivers, and oceans, or used for irrigation.
23. Civil engineers plan and design the systems that not only bring you safe clean drinking water, they also design and maintain the systems that takes dirty water away to clean it.
24. A geotechnical engineer evaluates and stabilizes foundations for buildings, roads, and other structures.
25. An environmental engineer designs systems to provide safe drinking water and controls pollution in water, air, and land.
26. An electrical engineer designs and builds electrical devices and systems that use electrical energy.
27. A structural engineer investigates structures to make sure they are safe for people.
28. A mechanical engineer designs and builds anything that moves.