Engineering Structures

Name _____

Do eight of the following requirements from any topic (1-20)

Structures

_____1. Study regional differences in design and construction of facilities. Describe how an engineer might design a house differently for desert, tropical, and arctic climates.

_____2. With your parent's permission, look up LEED certification on the Internet. Describe to your Leader the criteria (sustainable sites, water efficiency, energy and atmosphere, etc.) that are used to assign points to achieve LEED certification. Suggest three ways a facility can be designed to minimize energy usage. Describe why it is important that a project have a LEED goal from the outset.

_____3. Sometimes when a building is being constructed, parts of the building that were drawn by designers of different disciplines are designed to be in the same place. For example, the ductwork to carry heating air may be shown on the drawings in the same place as the pipes for a fire protection system, creating a conflict on the construction site between installers of the two different systems.

_____a. Explain how do you think this sort of problem can be avoided.

_____b. With your parents' permission, go the Internet and look up Building Information Management (BIM). Write a 100-word paper describing how this computer design tool can help engineers reduce or eliminate conflicts, and obtain feedback from a Licensed Professional Engineer.

_____4. Participate in a Bridge or Tower design, build and test competition in your area.

_____5. Participate in a Troop, Unit or local Paper Bridge contest.

_____a. Construct a Paper Bridge between two blocks 6" apart, using only an 8.5 X 11 sheet of paper or card stock, and two paper clips.

_____b. Load your bridge with pennies, washers, or small toy cars to determine how many your bridge can support.

_____c. Compare your design with others in terms of load capacity and construction.

_____6. Lead a younger unit or patrol in assembling a gumdrop dome and a simple gumdrop cube using gumdrops and toothpicks. Discuss which type of structure will hold the most weight. After allowing the assemblies to dry, test your theory using books as your weight.

_____7. Lead a younger unit or patrol in Making Tunnels Meet. Place a large sheet of cardboard or poster board (at least two feet by two feet) vertically between two heavy books. Have two Trailmen, one on each side of the board, each draw three 3/8" circles on their side of the board, without their partner seeing them. Then, the Trailmen describe to each other the exact location of their circles; their partner then marks where they think the circles on the other side of the board are located. When both are finished, with adult supervision, each Trailman punches or drills through the board. See how close you came!

Historical Structures

_____8. Create and present a video or presentation including images to your troop, unit, or other group about the designer and the purpose of one of the following engineering accomplishments, which supported a great work of art or architecture.

- Hagia Sophia (in Turkey)
- The Sistene Chapel (In Italy)
- Saint Peters Cathedral (Vatican)
- Santa Maria Del Fiore cathedral (Florence)
- The Taj Mahal
- The theater at Epidaurus and its acoustic engineering

_____9. Create and present a video or presentation about one of the following historic engineering accomplishments, and describe a technological barrier that was overcome in its construction (see DVD series "Engineering an Empire", published by the History Channel). Include pictures and/or diagrams as appropriate:

- Pyramids of Egypt

- Colosseum at Rome
- The Tunnel at Samos (Ancient Greece)
- The Parthenon (Ancient Greece)
- The Great Wall of China
- The Road system of the Incas (America)
- The Aquaducts (Ancient Rome)
- The Pantheon (Ancient Rome)
- Tomb of Agamemnon (Corbel Arch - Mycenae, Greece)

_____10. Not everything that is designed and built is a success. Research the Tacoma Narrows Bridge and what the caused its collapse. Find and show a video to your patrol. Tell them about the bridge, when it was built and what caused it to collapse.

_____11. Understanding Nehemiah

_____a. Read Nehemiah, Chapters 1 and 2. Describe the condition of the city of Jerusalem, and the condition of the Israelites who lived there.

_____b. Read Nehemiah 8. Explain how the building of the wall and the construction of a platform facilitate the spiritual growth of the Jewish people, and the renewal of their culture.

_____c. Read Nehemiah 12: 27-40. Tell your Leader or parent about the joy of the worship experience the Hebrews felt as the celebrated the completion and dedication of the city wall of Jerusalem.

_____d. Read Nehemiah 12:44. Explain how the rebuilt facility supported storage of food supplies.

Strength of Materials

_____12. Explain the meaning of tensile, compressive (or compression), and shear as these terms relate to forces and do the following:

_____a. Identify some materials that are used that are to resist tensile, compressive, and shear forces. Explain why some materials do not work well under certain loads.

_____b. Be able to explain which of the following materials and forms are used to resist tensile, compressive, or shear loadings:

- Concrete slab
- Steel cable
- Tent guy line
- Tent pole

_____c. Use a sponge with lines drawn across it, and bend the sponge. Explain to your Unit Leader or parent what part of the sponge is in tension, and what part is in compression.

_____13. The engineering term stress is used to describe the distributed internal forces used to react an applied load of a given material or structural member. Some materials have better stress properties than others making them stronger in resisting certain loads. Estimate the compressive stress by performing doing the below activity with a brick and a bathroom scale:

_____a. Weigh yourself. This will be your applied force.

_____b. Measure the length (l) and width (w) of the brick. The cross sectional area is (l * w).

_____c. Carefully balance on one foot on top of the brick.

_____d. Compute the stress in pounds per square inch (psi) = Applied Force (pounds) / Area (square inches)

_____e. Brick compressive strengths can range from 1,000 psi to 15,000 psi. Explain how close to crushing the brick you were.

_____14. Using a raw egg, a hard-boiled egg, and several tablespoons of salt, lead a younger unit or patrol in the following experiments:

_____a. Spin a raw and a hard-boiled egg on a table surface. Explain the different results and the term inertia.

_____b. Squeeze a raw egg by gripping it with one hand making sure your fingers are completely wrapped around, applying even pressure towards the center of the egg. (Don't wear a ring while performing this experiment!)

_____c. Using a thumb and forefinger, squeeze the top and bottom of the egg. Explain why it's difficult to break such a fragile egg and the difference between even and uneven force distribution. Explain if beaks break eggshells with an even force distribution or a concentrated force.

_____d. Put an uncooked egg in a glass of water. Take note if it floats or sinks. Start adding salt. Explain to them why the change in the water density causes the egg to float.

_____15. Lead a younger unit or patrol in demonstrating the following engineering principles using the materials listed:

_____a. Using a marshmallow, demonstrate compression by squeezing the marshmallow between your hands. Explain why an engineer would like to build a house on rock, rather than marshmallow or sand.

_____b. Using a licorice stick, demonstrate torsion by twisting the licorice stick; then demonstrate tension by pulling each end of the licorice sticks. Discuss how an engineer might use a steel cable in tension to hold up a bridge.

_____c. With a friend holding a pencil at each end, use your finger to put some weight in middle of the pencil. Do you think that if you moved your finger closer to the end of the pencil and then pushed down, your friend could tell? Try it! Do you think engineers can use math to determine how much weight each hand would feel?

Professional Activities

_____16. Research two famous engineers in civil or structural engineering and report what engineering degrees these engineers earned, their major accomplishments, and what organizations they led or for which they performed significant engineering.

_____17. With a parent, attend a meeting of a local professional engineering society in your locality related to structures. List any scholarships or special opportunities for youth and young engineers that the Society may sponsor.

_____18. Modern structural engineering specialties include architectural, aerospace, civil, construction, control systems, environmental, geotechnical, mechanical, mining, naval architecture and marine, structural, systems, and transportation engineering. Choose two specialties you have not used for another Science and Technology Trail Badge and do the following:

_____a. Describe what type of work is done in those two engineering specialties and how the work of those two specialties is related.

_____b. Choose one specialty, and explain the education, training, and experience required to serve successfully in that profession.

_____19. Note: This requirement is listed in multiple Trail Badges, but may only be used for one Trail Badge. Explain what it means to be an Engineer Intern and a Licensed Professional Engineer. List the requirements to become a Licensed Professional Engineer in your state.

_____20. Note: This requirement is listed in multiple Trail Badges, but may only be used for one Trail Badge. Read the Code of Ethics or Professional Conduct for Professional Engineers for your state (or NSPE Code of Ethics for Engineers if your state does not have one). One role of the engineer is providing society with accurate facts in order to make the best possible decisions.

_____a. Explain how the code you read relates to the Trailman Oath and good stewardship.

_____b. List possible consequences to the public if an engineer does not follow this Code.

Trail Badge Mentor Signature _____ Date _____