Unit 3 Structures:
Testing Constructions and Techniques

Concept
The way that we join parts of structures depends upon the materials we are joining and upon the loads the joints and the members will experience.

Content objective
Explore ways to make and join structural members; then create an information piece on construction techniques to present at a class symposium.

Language objectives
Orally describe various materials using target vocabulary.
Orally describe design characteristics *in detail* and group investigations using sequential language (*first, second, then, ultimately)*.

Standards

- **NGSS**:
  - **3-5 ETS 1.** Define a simple design problem, including criteria for success and constraints on materials, time, or cost.
  - **3-5-ETS1-2.** Generate and compare multiple solutions based on criteria and constraints of the problem.
  - **3-5-ETS1-3.** Plan and carry out fair tests that control for variables and identify failure points to improve a model.
- **TEKS**:
  - **3A** Students will analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing.
  - **3D** Students will connect grade-level appropriate science concepts with the history of science, science careers, and contributions of scientists.
  - **4A** Students will collect, record, and analyze information using tools.
  - **6D** Students will test the effect of force on an object such as a push or a pull, gravity, friction, or magnetism.

- **ELPS**:
    - **1A** Students will use prior knowledge and experiences to understand meanings in English. [Prior Knowledge]]
    - **1C** Students will use strategic learning techniques, such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary. [Metacognitive Strategies]
    - **2F** Students will listen to and derive meaning from a variety of media, such as audio tape, video, DVD, and CD ROM to build and reinforce concept and language attainment [Listening Across Contexts]
    - **3H** Students will narrate, describe, and explain with increasing specificity and detail as more English is acquired.

Materials

Set up activity areas as follows:

- Use white paper, woodcraft sticks, drinking straws, string, pencils, or thin dowels (for rolling paper).
- Use low-temperature glue guns and sticks, white glue, staplers, transparent tape, and paper clips.
- Use weights, such as dictionaries, encyclopedias, bricks, or cinder blocks.
- Lesson handouts **4.3.1- 4.3.2**

Literature Connections

Twenty-One Elephants & Still Standing by April Jonew Prince

Day 1: Review[1] Engage/Explore

Teacher Says/Does	Student Says/Does	Language Requirements
1. Have students watch part of the National Geographic Megastructures documentary on the Golden Gate Bridge: https://www.youtube.com/watch?v=LmqWAz3OYlA 2. Ask students their opinion on what makes the bridge so strong, where compression and tension are present, and other aspects of the bridge and the design. Allow students to freely share their reactions. 3. Suggest to the children that they form construction company teams. Each company of four or fewer students will eventually build a bridge, but for now students will explore some construction techniques that will improve their bridge-building skills. 4. Write “Properties of Materials” on a chart and have students give you some examples of properties that they know (bendability, durability, and strength). Add "compression" and "tension" to the list. Have students volunteer the meanings they think apply to these property words. 5. Have students form teams to analyze whether or not a soft ball, clay, crackers, marbles, the floor of a house, and a plastic jug can be compressed or tensed (see handout **4.3.1**)	Students watch and analyze a documentary and share ideas Students share what they know about the properties of common materials	Compression Tension Bridge design Bendability Durability Strength

[1] The contents of this review are from lesson 1, Level C.

Day 2: Explore/Explain

Teacher Says/Does	Student Says/Does	Language Requirements
1. Introduce the concepts of columns and beams as part of buildings. Discuss the following questions: • Can you make a paper column that will hold a book? • Is a column that is made of straws strong under compression? • How can we build columns that are strong? • Can you make a paper beam that will hold a book? • Is a beam that is made of straws strong under bending forces? 2. Point out the stations and materials. 3. Form teams and have student teams look at *Activity A-Making Strong Columns and Beams* and *Activity B-Finding Best Ways to Connect* (in handout **4.3.2**) for directions. 4. Students are to find the best way to make columns and beams and join them. Then, they will test their connections with loads. 5. Let students begin work. 6. When the teams have finished exploring and have helped clean up, gather all students for a symposium; a sharing of research.	Students discuss columns and beams as part of buildings Students investigate how to make columns and beams and join them. Students write the results of their investigations (see handouts for Activities A and B) Students share the results of their investigations	Columns Beams

Day 3: Elaborate and Evaluate

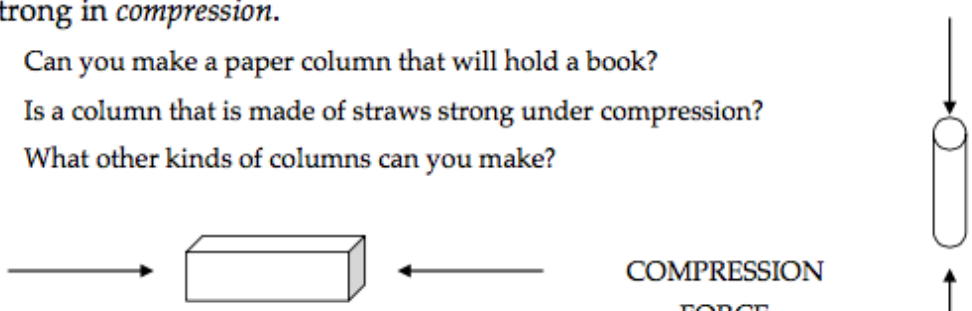
Teacher Says/Does	Student Says/Does	Language Requirements
1. Each team should summarize their results in a booklet or video called "Construction Tips," and present it to the class. 2. After all students have shared in this symposium, ask the following questions: • How many chances do you think a builder gets to make a bridge? Why only one chance? (It is probably too expensive in time and money to do over again!) • What does a bridge builder need to know before construction begins? (All about materials and joints) 3. What was some construction ideas you tried that did NOT work? This will save your classmates some problems and time. Display the booklets, student results, and some samples in a Design Gallery.	Students share their results as part of a symposium, and reflect on their work.	

	What can be compressed (pushed in)?	What can be tensed (pulled apart)?
Soft ball		
Clay		
Crackers		
Marbles		
The floor of a house		
Plastic milk jug		

Activity A Making Strong Columns and Beams

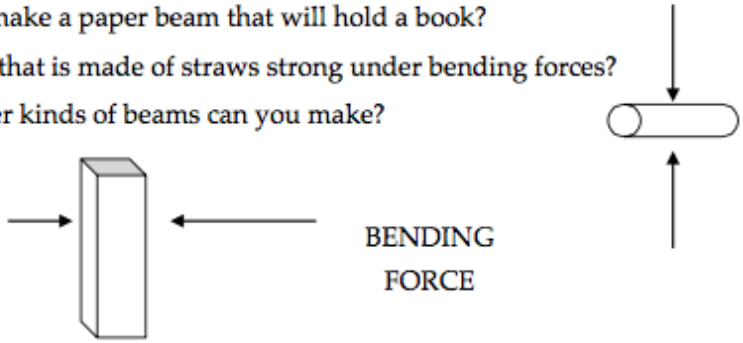
Use the materials you see to make some **columns**. Remember, a column must be strong in *compression*.

- Can you make a paper column that will hold a book?
- Is a column that is made of straws strong under compression?
- What other kinds of columns can you make?



Now use the materials you see to make some beams. Remember, a beam must be strong under *bending* forces.

- Can you make a paper beam that will hold a book?
- Is a beam that is made of straws strong under bending forces?
- What other kinds of beams can you make?



Make some extra samples for Activities B, C, and D.

Activity B Finding Best Ways to Connect

Use the connecting materials to join your columns and beams.

What works best to join materials together?

The Joining Chart

Write in the name of the best joining material or method:

	PAPER	WOOD	STRING	STRAW
PAPER				
WOOD				
STRING				
STRAW				