TEACHING REINFORCED CONCRETE WITH SPONGES

LEARNING OBJECTIVES
This is an in-class demonstrate that uses scrubbing sponges and Styrofoam to help students understand how a reinforced concrete beam works, and the role of tension and compression in a reinforced concrete beam.

After this activity, students should be able to:
- Explain why reinforcement strengthens a concrete structure
- Identify the parts of a beam that are under compression and tension
- Decide where to place the steel reinforcement in a reinforced concrete beam under different loading conditions

Materials List
Demo 1: Dried scrubbing sponges (such as Scotch-Brite heavy duty scrub sponge)
Demo 2: Styrofoam (5” x 12” x 1.25” white blocks), duct tape, basket, cans, clip

Procedure
Buy packages of sponges far in advance of the lecture time. Let the sponges dry out in air until they are brittle. If the class size is large, you can save material by cutting the sponges in half length-wise. Students can work in pairs with half a sponge.

Introduce the concept of reinforced concrete to the students, explaining that the concrete is strong in compression but weak in tension, while steel is strong in tension but weak in compression. In reinforced concrete, the two materials are combined such that the resulting beam has strength in both compression and tension.

You can then ask a series of polling questions to further explore this concept.

Next, ask the students to flip the sponge so the green side is now on top. You can then ask the students:

2) When you press down on the flipped sponge, it is now..
   A. stronger than before
   B. weaker than before
   C. the same strength as before

   The students should find that, when inverted, the sponge/beam can support much less load, and can even snap into pieces. This should be followed with an open-ended question about why the sponge is weaker upside-down. Through discussion, the students should arrive at the conclusion that the green face of the sponge is strong in tension (analogous to the steel in a reinforced concrete beam) while the yellow is weak in tension (analogous to the concrete in a reinforced concrete beam). Thus when the sponge is inverted, the bottom part which is under tension is no longer sufficiently reinforced.

To follow up, you can assess students’ understanding of this concept with a think-pair-share polling question about a different beam configuration:

3) In the reinforced concrete cantilever beam shown above, where should you place the steel bars?

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3) In the reinforced concrete cantilever beam shown above, where should you place the steel bars?

Depending on the students’ background and prior knowledge, this question may be conceptually challenging. If there is significant disagreement in the responses, allow the students to discuss their responses with each other, followed by a re-vote.

The solution to these polling questions can be provided with the following demonstrations. To model a beam, you may use a long piece of styrofoam. Parallel lines drawn along the side of the beam can help indicate which face is under compression (lines closer together) or under tension (lines further apart).

One face of the styrofoam is reinforced with duct tape (a layer of duct tape pasted along on one side of the foam). The tape corresponds to the steel in a reinforced concrete beam by providing additional tensile strength.

**Simply Supported Beam**

**Cantilever Beam**

Here the beam cantilevers from a ledge and a load is suspended from the free end, in our case a small basket attached with a clip. First, we attempt to load the beam (with cans in the basket) while the tape below. Second, we load the beam with the tape above.

Students will observe that for the cantilever beam, the basket can hold more cans when the tape is on top, as the stretched tape helps resist the tension. Hence the top face is in tension, in contrast to the simply supported beam where the bottom face is in tension.

By the end of this activity, the students should be able to identify the parts of a beam under tension and compression in different loading configurations, and recognize that the steel in a reinforced concrete beam should be placed wherever the beam in tension.

**References**

The sponge and Styrofoam demonstrations are modified and adapted from the following source: