

Flour Concrete Activity

Age level: K – 3rd grade

Time required: 1 hour, may require 2 sessions

Adult supervision required: Yes, general skills

Introduction

This activity is designed to introduce children to some fundamental processes involved in placing concrete for basements and floor slabs. To avoid safety issues with using Portland cement, a mixture of flour and sand will be used. The 3" x 15" x 3/4" specimens will have to be baked to fully harden. Children can reinforce some specimens with a wire mesh and compare the flexural behavior and strengths of unreinforced and reinforced samples. If it is not feasible to bake specimens during the scheduled activity, premade beams can be tested after fabrication. The new specimens can be baked and retained for the next activity day. The required materials are shown in Figure 1.



Figure 1. Materials for Flour Concrete Activity

Material List (quantities given for one pair of specimens)

Baking sheet, 11" x 17"	1 ea.
Parchment paper 10"x17"	1 ea.
1x2 x 16" PVC trim	3 ea.
Kitchen scale	1 ea.
Fine sand	3 lb.
Flour	1 1/2 lb.
Water	1 lb.+
Hardware cloth 2-1/2" x 15"	1 ea.
Landscape blocks	10 ea.
Wall paper roller	1 ea.
Small drywall knife	1 ea.
Oil w/ brush	1 ea.
Tooth picks	
Mixing bowl and spoon	1 ea.

Preassembly Instructions

Before meeting with the children, cut three 1x2 PVC trim pieces ($\frac{3}{4}$ " x $1\frac{1}{2}$ " actual) to fit on the baking sheet. Cut two additional $10\frac{1}{2}$ " long pieces of 1x2 to form the ends of the beams if using a flat baking sheet.

Specimen Fabrication

Formwork

An old 11" x 17" baking sheet is used to make 2 beams roughly 3" x 15" x $\frac{3}{4}$ " thick. Specimens don't have to be exactly this size.

Cover the baking sheet with parchment paper. Place the three pieces on the baking sheet, approximately 3" apart, as shown in Figure 2. The PVC trim pieces will be adjusted after placing the concrete to make two equal-sized beams. Oil the PVC that will be in contact with the concrete using vegetable oil (Figure 3).



Figure 2. Formwork

Figure 3. Oil formwork

Concrete Batching

Weigh out 3 lbs. of fine sand and $1\frac{1}{2}$ lbs. of all-purpose flour (Figure 4) and thoroughly mix the dry ingredients in a large bowl using a spoon (Figure 5). Add one pound of water (Fig. 6). Mix thoroughly (Figure 7). It will probably be necessary to knead the ingredients by hand to finish mixing. Add small amounts of additional water, as required (Figure 8), until the ingredients form a cohesive ball (Figure 9). The mix will be very stiff, but workable.

Pro Tip: Provide 5-gallon buckets of water for rinsing hands and dispose of rinse water outdoors, not down the drains.



Figure 4. Weigh out sand and flour



Figure 5. Thoroughly mix dry ingredients

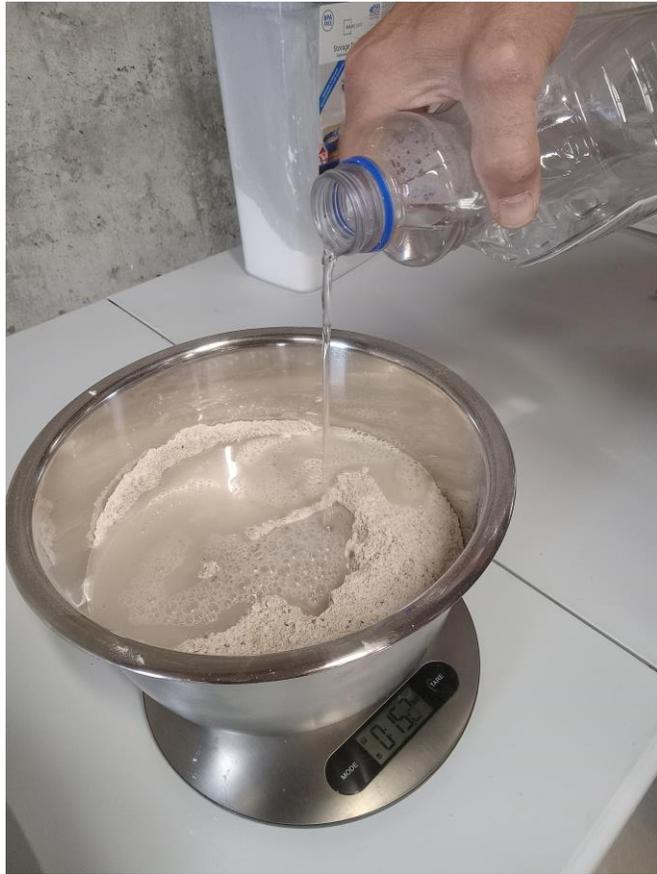


Figure 6. Add one pound of water

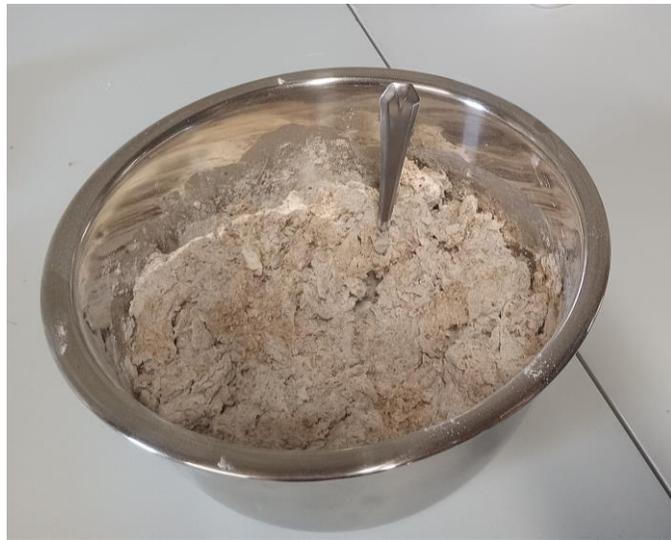


Figure 7. Thoroughly mix water and dry ingredients



Figure 8. Knead mixture and add small amount of water, as needed



Figure 9. Cohesive ball of flour concrete

Concrete Placement

Place the concrete in the mold for the unreinforced beam and press firmly to completely fill the mold. Hold the center piece of PVC in place while placing the concrete. Use the wall paper roller to compact the concrete and ensure a uniform, 3/4" thickness (Figure 10). It may help to moisten the roller or lightly flour the surface of the concrete when finishing.



Figure 10. Place, press and roll concrete for unreinforced specimen

Place a small amount of concrete in the mold for the reinforced beam. Roll it out to a thickness of approximately 1/8", and place a 2-1/2" x 15" piece of hardware cloth on the concrete (Figure 11). Work the hardware cloth to make it as flat as possible before placement. Fill the mold completely with concrete and finish it like the unreinforced specimen. Check that the middle piece of PVC formwork remained centered so the two beams are the same size (Figure 12a). Adjust the middle PVC piece, if required; the specimens should be rectangular and widths within 1/4" of each other. Use a drywall knife to remove excess concrete (Figure 12b). The specimens do not need to be "perfect."



Figure 11. Place reinforcement on thin layer of concrete



Figure 12a. Check beam widths

Figure 12b. Remove excess concrete

Using a toothpick, poke holes spaced 1/2" in both directions through the two beams. This will aid in drying the specimen (Figure 13).



Figure 13. Poke holes in the specimens

Baking the Concrete

Place the baking sheet with the concrete in a warm, dry place for a couple of hours to set the concrete. Run a knife along the edge of the formwork and remove it. Bake the specimens for 30 minutes at 375°F. Turn the beams over and bake another 30 minutes.

Clean Up

Clean up with water, but do not run the sandy waste water through the drains in a building. Rinse outside.

Testing

Place two concrete blocks approximately 13" apart on a sturdy table (or the floor). Rest the ends of the reinforced beam on the two blocks as shown in Figure 14.



Figure 14. Set the unreinforced specimen across a 13" gap

Gently place concrete blocks on the center of the beam one at a time. Be careful that the blocks don't fall off of the beam, and keep the children far enough away so that the falling tower of blocks doesn't hit anyone when the beam breaks. Record the number of blocks required to break the beam and calculate the total weight. The blocks shown in Figure 15 weighed 7.5 pounds. The unreinforced beam broke when placing the fourth block in this test.



Figure 15. Maximum load on unreinforced beam

Repeat the test with the reinforced specimen. Be sure that the reinforcement is nearest the bottom of the beam (i.e. toothpick holes will be on top). Record the number of concrete blocks required to break this specimen. The reinforced beam did not break with 11 blocks as shown in Figure 16.



Figure 16. Reinforced beam loaded with 77 pounds

Discuss the differences between the way the two specimens failed.

Additional Activities

Do a “tour” of the building and identify the places concrete is used. Discuss why concrete is used for various functions in home building.