Engineering Principles Name_____
Material Science and Engineering 7.3.1
Plaster Mix Ratio Design of Experiments Date_____ Team _____

Plaster Design-of-Experiments Worksheet

A civil engineer has called upon you and your team of materials science engineers to develop a composite bridge that is both strong and lightweight. You know that plaster performs differently based on the plaster-to-water mix ratio. Determine an optimal plaster water-to-mix ratio by doing a **design of experiments** to test several mix ratios. We are interested in weight, strength and workability of the plaster.

Plaster to Water Mix Ratio Experiment

The plaster packaging calls for a mix ratio of 2 parts plaster to 1 part water for normal applications. You want to see how small variations in this range will affect the cured plaster. For this experiment you will produce 3 test pucks with different mix ratios including the recommended 2:1 as well as three others either slightly dryer or slightly wetter to see how these variations affect weight, strength and workability. You must choose 3 different plaster-to-water mix ratios to test. Do NOT select ratios wetter than 1.5:1 or drier than 2.5:1.

You will start with 1 cup of water. You will measure your plaster using measuring cups and/or a tablespoon. There are 16 tablespoons in 1 cup. Calculate the volume of plaster in cups you will use and the plaster to water ratio. Record both in the table below.

Puck Number	Water volume (cups)	Plaster volume (cups)	Mix Ratio	Cured Weight (grams)	Drop test observations including max height of weight dropped before puck failure
1	1				
2	1				
3	1				

Before mixing your plaster, prepare three 4-1/2" diameter paper bowls as follows:

1. Measure **¾ inch** from the bottom along the slope of the inside edge of the bowl and make a mark.
2. Using a small **sponge** apply a **thin** coating of **petroleum jelly** to the bottom and sides of your bowl to improve release of your puck from its mold.
3. Label your bowls with your **mix ratios**

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Mixing Instructions

Important safety precautions: When mixing, **wear safety glasses and gloves**. Do not allow bare skin to have prolonged exposure to plaster.

Never pour any plaster down the drain. Construct a washbasin by lining a 5-gallon bucket with a plastic bag and filling the bag with water. To clean plaster from any parts, first wipe plaster away with newspaper, then rinse with water in a washbasin. Allow the plaster to settle in the washbasin until it has cured. Pour off the water and discard the plaster in the bag.

1. Measure your volume of water and pour it into your mixing container.
2. Measure your volume of plaster into separate cups. Before adding it to the water break up any lumps using a mixing spoon.
3. Gently sprinkle the plaster, slowly and evenly, onto the surface of the water until the entire volume of plaster has been added to the water.
4. Tap the side of your mixing container to release any air bubbles. Let your plaster soak for 2 – 4 minutes, without further agitation.
5. Gently mix the slurry, using a side-to-side motion, until you have a smooth, even consistency. Do not stir vigorously to avoid introducing any air bubbles.
6. Pour plaster into your labeled bowl up to the mark you made.
7. Tap bowl on the table to release any air bubbles.

Allow the plaster to set for 20 – 30 minutes. Remove the plaster from its mold. Allow plaster to cure for 24 – 48 hours.

Drop Test

Your sample will be subject to a drop impact test. A weight attached to a hinged wooden structure will be dropped from progressively higher elevations onto your samples until they fail. Failure is defined as 1/4 of the material separating from the rest of the material.

1. Weigh each puck and record its weight.
2. Place puck in the impact tester.
3. Lift the weight 2”
4. Release the weight.
5. Inspect the puck for damage.
6. Increase the weight by an additional two inches (measure vertical height) and repeat from step 4 until the puck is damaged: 1/4 of the material has separated from the bulk.
7. Record the height at which failure occurred.