



UNIVERSITY OF  
LINCOLN

## LESSON IDEA ISSUE 6 – SUSTAINABLE CONCRETE

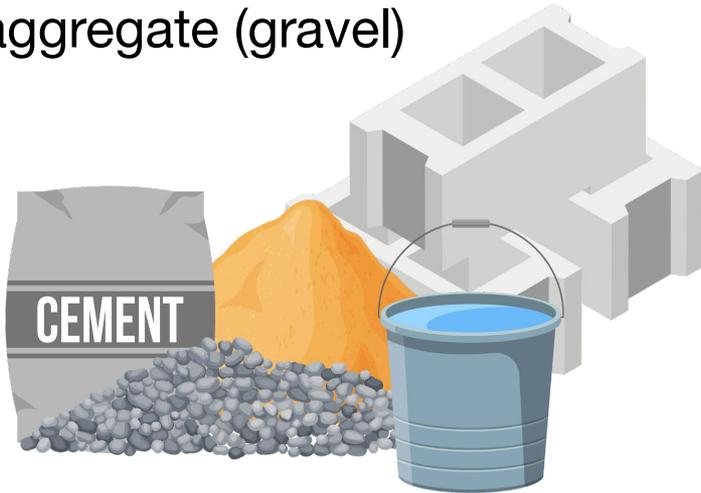
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*Beta testing – Finnian McElroy (age 9)*



# Cake is a bit like concrete!

## Concrete Ingredients:

- Fine aggregate (sand)
- Coarse aggregate (gravel)
- Water
- Cement



## Cake Ingredients:

- Flour
- Sugar
- Oil
- Water
- Egg



# Cake is a bit like concrete!

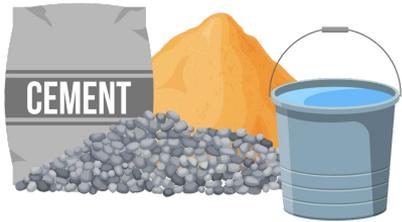
## Concrete Ingredients

Fine aggregate (sand)

Coarse aggregate (gravel)

Water

Cement



The stuff that makes up most of the final material, it needs something to stick it together

## Cake Ingredients

Flour

Sugar

Oil

Water

Egg



# Cake is a bit like concrete!

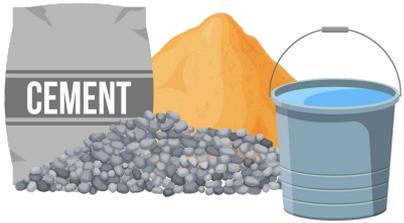
## Concrete Ingredients

Fine aggregate (sand)

Coarse aggregate (gravel)

Water

Cement



## Cake Ingredients

Flour

Sugar

Oil

Water

Egg



The bit (solvent) that helps everything mix together.

# Cake is a bit like concrete!

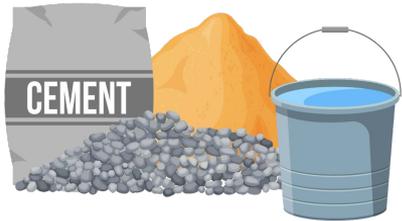
## Concrete Ingredients

Fine aggregate (sand)

Coarse aggregate (gravel)

Water

Cement



The bit (adhesive) that sticks everything together.

## Cake Ingredients

Flour

Sugar

Oil

Water

Egg





# Experiment: Making Cupcakes!



- This experiment requires making 6 cupcakes:
  - 2 cupcakes that represent concrete made with cement
  - 2 cupcakes that represent what happens when concrete is made with no cement
  - 2 cupcakes made with a cement alternative

The question: How does varying the cupcake's ingredients affect its stability?

**Learning outcomes: How to measure, the importance of binders**

# Case 1: Two Concrete Cupcakes (our concrete with cement)

Ingredient	Amount
Self-raising flour	25 g
Sugar	25 g
Oil	25 g (27 ml)
Egg	1/2 (25 g)
Water	5 g (5 ml)

## Method

- Add flour, sugar, oil egg and water to a mixing bowl and mix into a paste
- Split mixture into two cupcake cases

# Case 1: Making Two Concrete Cupcakes (our concrete with cement)



# Case 2: Two Control Cupcakes (no cement)

Ingredient	Amount
Self-raising flour	25 g
Sugar	25 g
Oil	25 g (27 ml)
Water	30 g (30 ml)

## Method

- Add flour, sugar, oil and water to a mixing bowl and mix into a paste
- Split mixture into two cupcake cases



# Case 3: Two Replacement Egg Cupcakes (supplementary cementitious material)

Ingredient	Amount
Self-raising flour	25 g
Sugar	25 g
Oil	25 g (27 ml)
High protein yogurt	30 g

## Method

- Add flour, sugar, oil and yogurt to a mixing bowl and mix into a paste
- Split mixture into two cupcake cases



# Cooking (setting the concrete)

- Preheat an oven to 180 °C fan/190 °C/Gas mark 4
- Bake in the oven for 15 minutes, or until golden-brown on top
- Remove to cool on a rack for 5 minutes



**Case 3:** Replacement Egg Cupcakes (supplementary cementitious material)

**Case 2:** Control Cupcakes (no cement)

**Case 1:** Concrete Cupcakes (concrete with cement)

# *Results*

# How they came out



We left them in the oven a bit too long, the yogurt cake is more than golden-brown!

It was still tasty.



# Why?



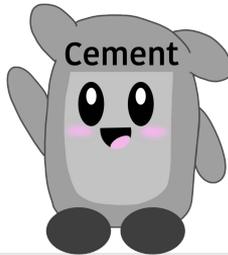
**Case 1:**  
Concrete  
Cupcakes  
(concrete  
with  
cement)

**Case 2:**  
Control  
Cupcakes  
(no  
cement)

**Case 3:**  
Replacement  
Egg Cupcakes  
(supplementary  
cementitious  
material)

- Protein in the egg binds the ingredients together
- No protein and the cake falls apart as nothing is holding the ingredients together (also why it doesn't rise as much)
- Protein in the high protein yogurt acts like the egg protein sticking the ingredients together

# Cement, SCMs



- To make concrete, just like to make cake, you need something to stick it all together
- In standard cakes that's egg, in concrete that's cement
- To reduce the carbon footprint of concrete, cement is partially or wholly replaced by supplementary cementitious material (SCMs)
- In the cake we replaced the egg by the high protein yogurt