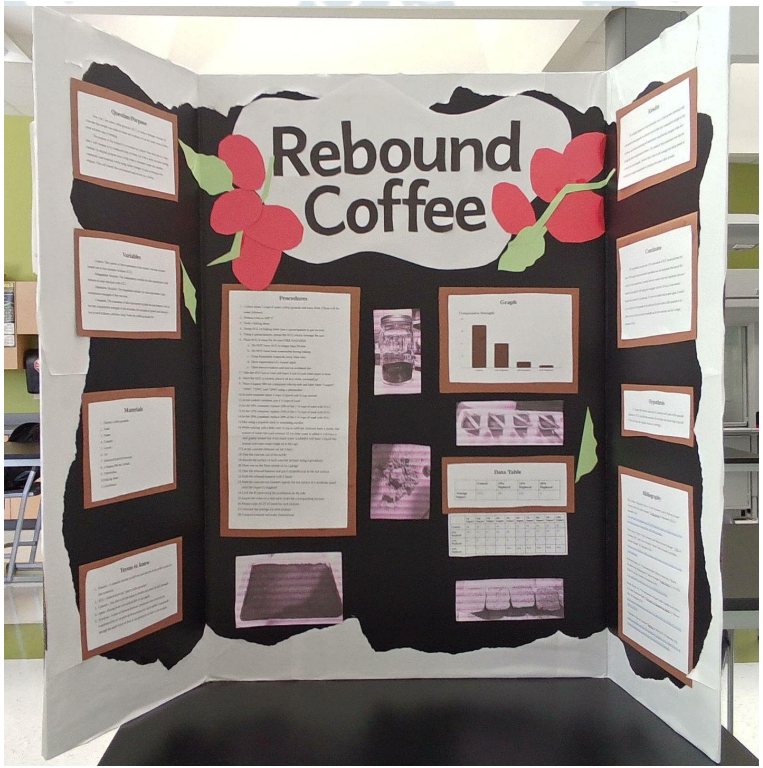
Rebound Coffee



Grade Level: 8th

Category: Plants and the Environment

Constants and Variables

Variables

Control: The control of this experiment is the normal concrete mixture people use at this moment (without SCG)

Independent Variable: The independent variable for this experiment is the amount of sand replaced with SCG.

Dependent Variable: The dependent variable for this experiment is the compressive strength of the concrete.

Cured concrete mixtures
Control - 10% - 15% - 20%

Constants

The constants of this experiment include the procedures I use to test the compressive strength of the mixtures, the amount of gravel and cement I use in each mixture, and how long I bake the coffee grounds for.

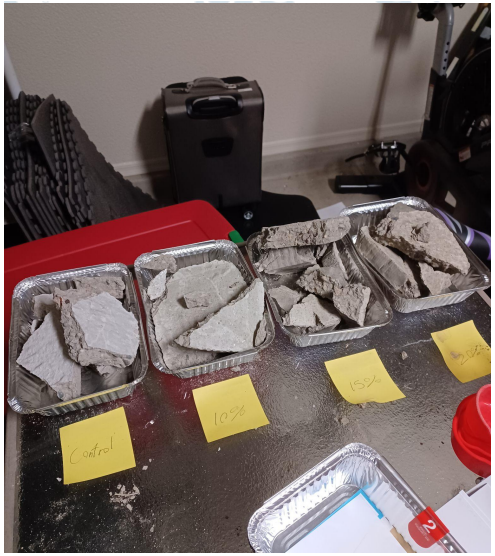
Question and Purpose

Question

How can I use spent coffee grounds (SCG) to make a stronger mixture of concrete that people can make at home and continue to use for many years (with a more reliable way of testing)?

Purpose

The purpose of this project is to recreate my project from last year in a way that it still remains to be conducted only at home, but with a more accurate testing method. Its original purpose was to help reuse a common waste into another commonly used material; while being either stronger or just as strong as the original. This will benefit the environment and society as a whole.



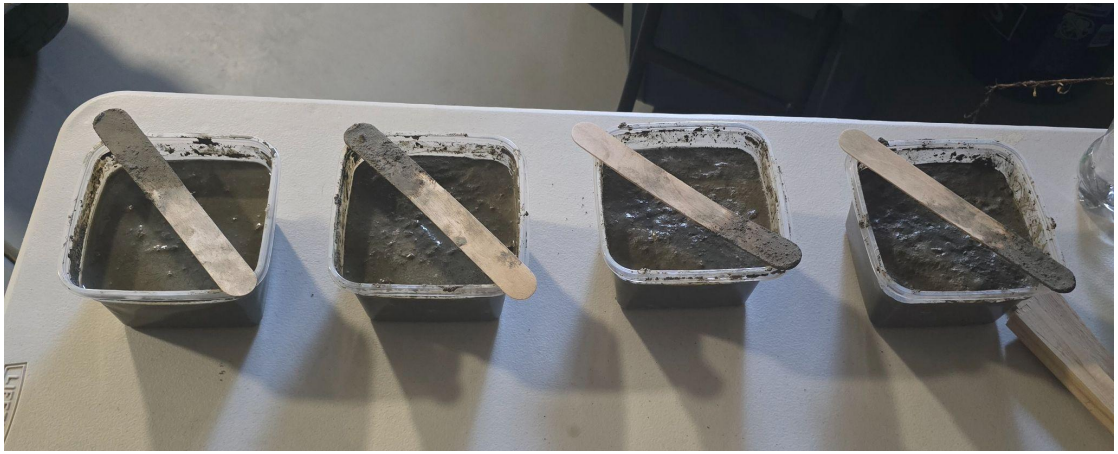
Results from previous experiment last year

Research

Through research, I discovered many important facts that helped me to learn more about my project, as well as helping me to create my hypothesis. Through research I learned that there was only a small portion of spent coffee grounds that were reused in things like soil or fertilizer, and the rest of it ends up in landfills where it releases methane. This strong greenhouse gas would cause harm to the environment, so researchers thought of a way to reuse SCG. They roasted SCG in the absence of oxygen, and obtained something called “biochar”. They added it into concrete as a replacement for sand then proceeded to run it through test trials. Through their own experiment, they discovered a 30% increase in strength when replacing 15% of the sand with SCG. These discoveries could also help with how much natural resources we are using that when used, are gone.

Hypothesis

If I replace the normal sand used in concrete with spent coffee grounds (biochar or SCG) as different amounts, the mixture with about eight replaced (15%) will have the highest increase in strength.



After mixing all of the concrete (not cured)
Control - 10% 15% - 20%

Materials (Add measurements)

1. (Spent) Coffee grounds
2. Sand
3. Water
4. Cement
5. Gravel
6. Jar
7. Rebound/Schmidt hammer
8. 4 Square 900 mL molds
9. Pen/marker
10. Baking sheet
11. Grindstone

Concrete slabs after using the grindstone
Control - 10% - 15% - 20%

Procedures

1. Collect about 3 cups of spent coffee grounds and store them (There will be some leftover)
2. Preheat oven to 500° F
3. Grab a baking sheet
4. Dump SCG on baking sheet (use a spoon/spatula to get excess)
5. Using a spoon/spatula, spread the SCG evenly amongst the pan
6. Place SCG in oven for 30 min (FIRE HAZARD)
    a. Do NOT leave SCG in longer than 30 min
    b. Do NOT leave oven unattended during baking
    c. Keep flammable materials away from area
    d. Have supervision of a trusted adult
    e. Open doors/windows and turn on overhead fan
7. Take the SCG out of oven and leave it out to cool when timer is done
8. Once the SCG is cooled, place it all in a clean, enclosed jar

Spent Coffee grounds inside jar after baking

Procedures

9. Place 4 square 900 mL containers side-by-side and label them “control”, “10%”, “15%”, and “20%” using a pen/marker
10. In each container place 2 cups of gravel and ⅔ cup cement
11. In the control container, put 1 ⅓ cups of sand
12. In the 10% container, replace 10% of the 1 ⅓ cups of sand with SCG.
13. In the 15% container, replace 15% of the 1 ⅓ cups of sand with SCG.
14. In the 20% container, replace 20% of the 1 ⅓ cups of sand with SCG.
15. Mix using a popsicle stick or something sturdier
16. While mixing, add a little over ⅓ cup or until the mixtures have a slushy like texture of water into each mixture (If too little water is added it will have a wet, grainy texture but if too much water is added it will have a liquid like texture and some water might sit at the top)
17. Let the concrete mixtures set for 3 days
18. Take the concrete out of the molds
19. Smooth the surface of each concrete mixture using a grindstone

Procedures

20. Place one on the floor outside or in a garage
21. Take the rebound hammer and put it perpendicular to the test surface
22. Hold the rebound hammer with 2 hands
23. Push the concrete test hammer against the test surface at a moderate speed until the impact is triggered
24. Lock the R value using the pushbutton on the side
25. Import the value on a data table under the corresponding mixture
26. Repeat steps 20-25 10 times for each mixture
27. Calculate the average for each mixture
28. Compare/contrast and make observations

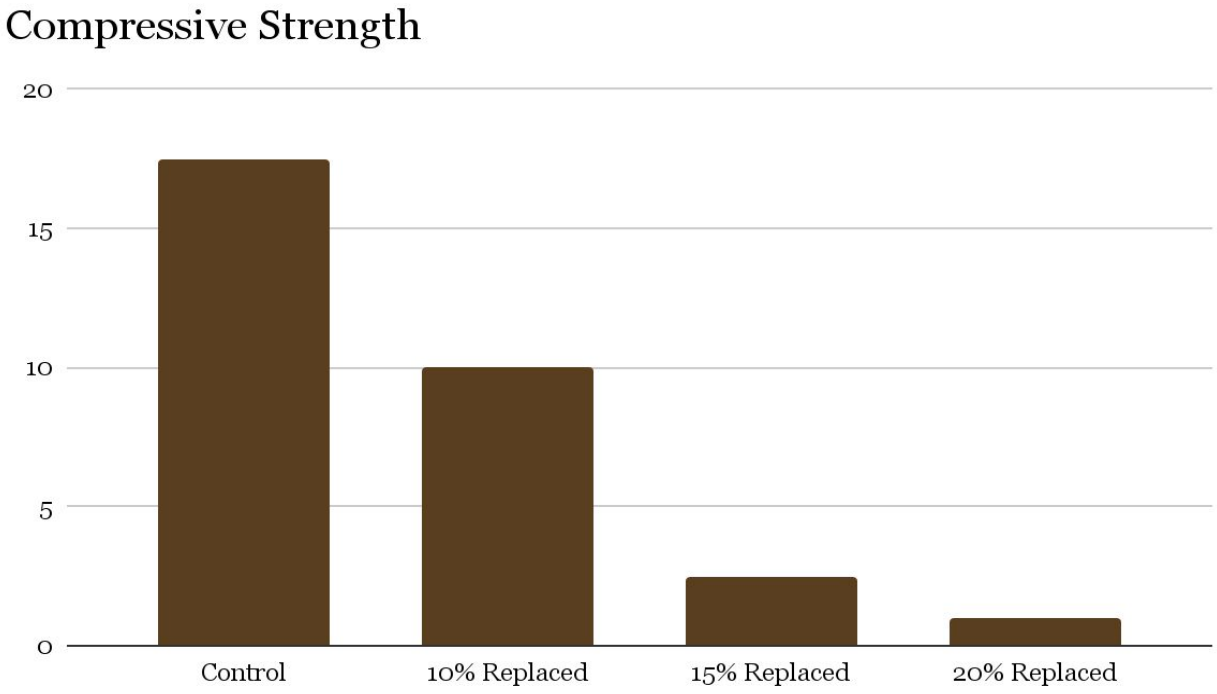
20% replaced after all trials were completed

Data Table

	Control	10% Replaced	15% Replaced	20% Replaced
Average Impact	17.5	10	2.5	1

	1st Impact	2nd Impact	3rd Impact	4th Impact	5th Impact	6th Impact	7th Impact	8th Impact	9th Impact	10th Impact
Control	28	18	12	15	17	18	18	18	15	16
10% Replaced	14	11	6	14	10	13	13	12	14	13
15% Replaced	6	3	2	4	3	2	1	2	1	1
20% Replaced	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A

Graph


Compressive Strength
20
15
10
5
0
Control
10% Replaced
15% Replaced
20% Replaced

Data Analysis and Conclusion

The original purpose of this experiment was to find out how replacing sand with spent coffee grounds in concrete would affect the compressive strength of the mixture, and which percentage of replacement would be the strongest while also doing the entire experiment at home. The results of this experiment were that the control was the strongest. I believe this is due to the average oven being unable to replicate the proper requirement to pyrolyze the spent coffee grounds.

My hypothesis was that the 15% replacement of SCG would perform the best. The results indicate that this hypothesis was not supported. Because of the results of this experiment, I wonder how my results from my experiment last year ended up having the 10% being the strongest with the 15% as a close second despite the absence of pyrolyzing. If I were to conduct this project again, I would try to reach out to companies to try and pyrolyze the spent coffee grounds to be able to see an actual increase in strength and let the concrete cure for a longer amount of time.

Abstract

The purpose of this experiment was to figure out what percentage of sand replaced with spent coffee grounds in concrete would result in a stronger mixture. I was trying to redo my experiment from the previous year to have a more reliable way of testing the concrete strength while keeping it as an at home project. My hypothesis was that if I replace the sand used in concrete with SCG the mixture with 15% replaced will have the highest increase in strength.

My experimental procedure consisted of collecting spent coffee grounds, creating each of the mixtures in separate molds, waiting for them all to cure, and using a rebound hammer to test the strength of the concrete. The sample included 4 different mixtures: the normal concrete mixture consisting of no coffee grounds, and mixtures replacing 10%,15%, and 20% of the sand with SCG. The manipulated variable was the amount of sand replaced with SCG in each mixture. The responding variable was how strong each mixture was. To measure the responding variable, I recorded 10 impacts from the rebound hammer of each mixture and put the results in a table.

The results of the experiment was that the control mixture was the strongest. Some of the errors were how I was unable to properly pyrolyze the spent coffee grounds using my normal oven which would've likely changed the results drastically. My hypothesis was not supported.

My findings could be useful for future constructions and people who want to reuse their spent coffee grounds in projects that involve concrete in a way that better helps the environment. In the future, I would like to reach out to companies to organize a way I could properly pyrolyze the SCG or do a different way of testing that could get slightly more accurate results than from a rebound hammer.

Acknowledgements

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- My parents for providing the necessary materials needed to complete this experiment
- My dogs for making sure the materials were safe

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