Recycling Cigarettes in Concrete

Jonathan Rosete
California Polytechnic State University
San Luis Obispo, California

The objective of my senior project is to find a solution for the growing amount of improperly disposed cigarette butts on our planet. To accomplish this, I created and tested concrete cylinders mixed with different amounts of used cigarettes. It is my goal that we will be able to recycle cigarette butts and incorporate them into our everyday concrete use. By adding cigarettes to our mixes, I also understand their will be concerns with its potential strength. However with this in mind, it is my intention that these current mixes will only be used for non-structural concrete. In the following, I hope to show you how I conducted this experiment and as to why I believe it can be a prime solution to this problem.

Keywords: Cigarettes, Recycle, Concrete, Cylinders, Strength

Introduction

One of the biggest problems in the world today is littering. You may not see it in your everyday life, but collectively around the world it does add up. Of all this waste, the top littered item is cigarettes. Cigarettes make up for a leading 38% of the litter at a shocking 1.2 trillion tons each year. Its also worth noting that this number is rising as the world population continues to grow. On average, cities spend between $3M - $16M each year on cigarette cleanup alone. They do not do this to only clean up the streets, but also because cigarettes are extremely toxic to the environment. Cigarettes are composed of plastic non-biodegradable fibers alongside various dangerous chemicals. This combination results in cigarettes taking 3-5 years to decompose alongside giving off toxic effects to its natural surroundings. With a rise in cigarette waste into the ground each year, the risk of soil contamination and environmental toxicity will rise with it.

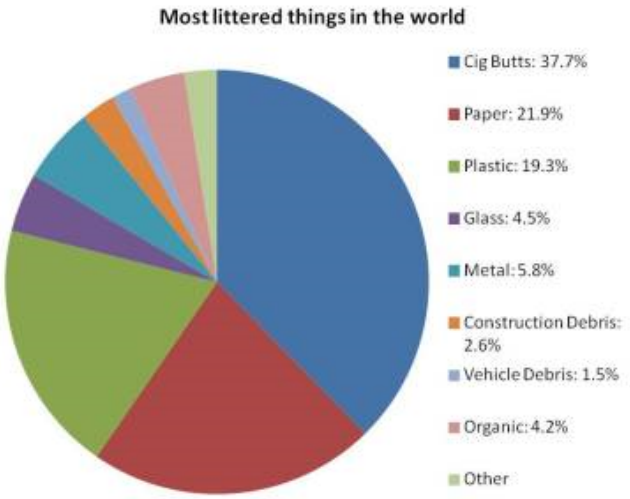

Figure 1: Chart Depicting Most Littered Items in World

I believe the solution to this problem is recycling the littered cigarettes into concrete. There has been no indication that this trend is slowing down and there will always be people who smoke cigarettes. With 1.2 Trillion tons plus of cigarette waste adding up per year, this means by 2025 there will be an additional 6 Trillion tons plus of new added waste on our earth. This is an absurd amount, and some action needs to be taken. This action I believe, is recycling cigarettes into concrete.

Methodology

To find out whether my solution is feasible, I decided to test it. I went out and collected around 250-300 cigarettes and split them into two bags. One a low volume bag containing roughly 70 cigarettes, and the other a high-volume bag containing roughly 210 cigarettes. I then continued with the experiment. The experiment included 3 sets of cylinders for a total of 16. 8 of a standard mix, 4 of low volume mix, and 4 of high-volume mix. By creating multiple cylinders for each mix, I will be able to get a better understand for how strong each set really is.

My plan to break these are on their 7- and 28-day intervals. I chose these days because I wanted data on a partial one-week cure alongside its full cure time. I would break 4 standards, 2 lows, and 2 highs on each day. By doing this, I will have the ability to average their strengths rather than using one specific data point.

Figure 2: Concrete Mix Materials

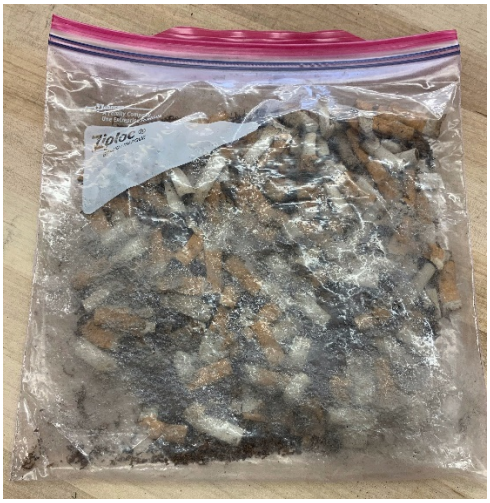

Figure 3: High Volume Bag of Cigarettes

To make these cylinders, I used a standard 3000-4000 psi mix. It included 15 pounds of water, 35 pounds of sand, 45 pounds of coarse aggregate, and 20 pounds of Portland cement. This mix supplied me with four 4” x 8” concrete cylinders per batch. I made 4 batches resulting in 16 concrete cylinders. The first two batches were the standard mix. These batches had no additives and resulted in a 1.5” slump. The next batch was the low volume mix. This batch was made exactly like standard batch, but after pouring it out the mixer and into the wheelbarrow, I hand mixed my low volume bag of cigarettes into the batch. This batch resulted in a 1” slump. Then lastly the high-volume batch. This batch had an identical process as the low volume batch, but instead of adding the low volume bag to the mix, I added my high-volume bag. This batch like

the low volume batch, also resulted in a 1” slump. With my cylinders now complete, I could now move forward to my 7- and 28-day breaks.

It is also worth noting that all this work was done in Cal Poly’s Concrete Lab. They provided me with all the necessary materials and let me use all the necessary equipment. These materials included the water, cement, coarse aggregate, sand, and the cylinders. The equipment included their mixer, rod, tape measure, slump shell, slump tray, and most importantly the concrete compression machine. None of this would be possible without Cal Poly and my SME Paul Redden. Thank you for the assistance as I am pleased to share my following results.

Results

7 Day Break

My day 7 break was an encouraging scene. While unraveling the cylinders from their plastic containers, the first thing I noticed was their fullness in size. All my cylinders were tightly packed, therefore creating a strong and solid shape. With my cylinders portraying this attribute, I can now assume that they will give me accurate and credible information. The next thing I noticed was their color. The standard batch (7A/7B) was the normal concrete color, but the cylinders containing cigarettes were darker. The low volume batch (A7) was a dark grey and the high-volume batch (B7) was more of a charcoal. It almost seemed that with more cigarettes in the mix, the darker the concrete becomes. The last thing I noticed was the smell of cigarettes. Like the color, the smell got heightened with the number of cigarettes. The standard (7A/7B) had no smell, the low volume (A7) had a light smell, and the high-volume (B7) had a high smell. Nothing you could not stand, but if close enough you can tell.

Figure 4: Cylinders on Day 7

Figure 5: Low Volume PSI Data Set #1

Now let us talk about the cylinder’s strengths. After averaging out their data, I found the strongest batch to be the low volume mix (4158.35 psi). This then followed with the high-volume mix (3680.5 psi), and then with the standard mix (3369.53) coming in last. Surprising enough, both cigarette batches were stronger than the standard mix. Even more surprising, the low volume mix hit over 4000 psi and the high-volume mix hit over 3000 psi, all within a 7-day period. This is exactly what I was hoping for, thus giving me positive energy moving into my 28-day break.

7 Day Break 10/9/2020					
Data Set	Cylinder Type	Weight (lbs)	PSI Strength	Slump (in)	Notes
1	Standard	8.215	2302.2	1.5"	Standard Concrete Look/Full Shape
1	Standard	8.76	3416.3	1.5"	Standard Concrete Look/Full Shape
1	Low Volume	8.63	4019.5	1"	Darker than Standard/Light Smell of Cigarette/Full Shape
1	High Volume	8.49	3266.7	1"	Darker than Standard & Low Volume/High Smell of Cigarette/Full Shape

7 Day Break 10/9/2020					
Data Set	Cylinder Type	Weight (lbs)	PSI Strength	Slump (in)	Notes
2	Standard	8.66	4173	1.5"	Standard Concrete Look/Full Shape
2	Standard	8.68	3586.6	1.5"	Standard Concrete Look/Full Shape
2	Low Volume	8.57	4297.2	1"	Darker than Standard/Light Smell of Cigarette/Full Shape
2	High Volume	8.56	4094.3	1"	Darker than Standard & Low Volume/High Smell of Cigarette/Full Shape

Figure 6: Day 7 Break Results

28 Day Break

Day 28 was not as encouraging as Day 7. Unlike the first set of cylinders, most of these were rocky formed and not filled to capacity. Without a strong and solid shape, it is safe to assume that these cylinders could potentially be weaker than the ones on day 7. Another problem with this is that our data may not be fully credible. While the cylinders could potentially be weaker, it also means that it may give us less accurate data. Another trait unlike the cylinders on day 7 was the smell. Although still there, it was much fainter. The standard batch (28A/28B) kept no smell, the low volume (A28) now had no smell, and the high volume (B28) had a light smell. These however were a more positive note on our Day 28 Break. The color however was consistent with our cylinders on Day 7. The more cigarettes in the mix, the darker the concrete becomes.

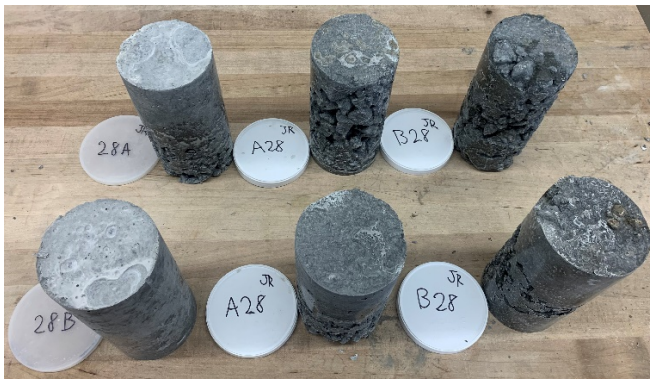

Figure 7: Cylinder on Day 28

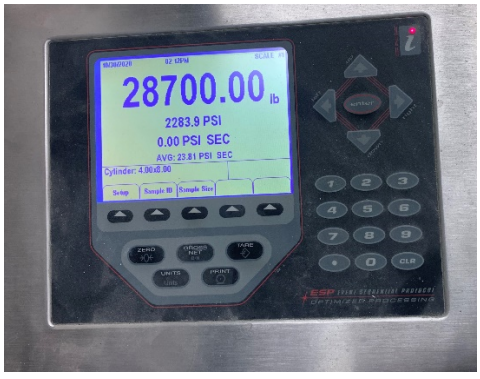

Figure 8: Low Volume PSI Data Set #2

Now its time to investigate their strengths. After averaging out their data, the standard batch (4391.3 psi) seemed to be the strongest. This then followed with the high-volume batch (2698.1 psi), and last with the low volume (2497.15 psi). This data was the absolute opposite of the results on Day 7, and neither the low nor high-volume batches reached 3000 psi. Although disappointing, it was somewhat foreseen as the cigarette batched cylinders were more deformed than the standard. Perhaps if the cigarette batched cylinders were better formed, they would have produced better results.

28 Day Break 10/30/2020					
Data Set	Cylinder Type	Weight (lbs)	PSI Strength	Slump (in)	Notes
1	Standard	8.58	4602.8	1.5"	Standard Concrete Look/Full Shape
1	Standard	8.265	3023.9	1.5"	Standard Concrete Look/Rocky Formed
1	Low Volume	8.17	2710.4	1"	Darker than Standard/ Rocky Formed
1	High Volume	7.98	3059	1"	Darker than Standard & Low Volume/Light Smell of Cigs/Rocky Formed

28 Day Break 10/30/2020					
Data Set	Cylinder Type	Weight (lbs)	PSI Strength	Slump (in)	Notes
2	Standard	8.625	4454.8	1.5"	Standard Concrete Look/Full Shape
2	Standard	8.685	5483.7	1.5"	Standard Concrete Look/Rocky Formed
2	Low Volume	7.895	2283.9	1"	Darker than Standard/ Rocky Formed
2	High Volume	7.86	2337.2	1"	Darker than Standard & Low Volume/Light Smell of Cigs/Rocky Formed

Figure 9: Day 28 Break Results

New Information

Although the experiment did not go as fortunate as hoped, I was still able to learn a lot. The main idea I learned was that even with a cigarette additive, concrete can still be just as strong. My Day 7 results were amazing. Not only did the cigarette batches prove better than the standard, but they also hit over 3000 psi. This was both a promising and successful stat. Day 28 however, was not as great. Both cigarette batches were outperformed by the standard, but the cigarette batches did break at, at least 2500 psi. That is rather good for deformed cylinders if you ask me. With better form and a full shape, I have no doubt that these cylinders would have reached 3000 psi.

I also learned other important information. The first of which was the difference in slump. The cigarette batches had a 1" slump, where the standard batch had a 1.5" slump. Although successful in the 1" – 2" range, it does tell me that the cigarette batches are less workable than the standard. The next important piece of information was the smell. At first on Day 7, the smell of cigarettes was too much. It was something I would not be able to deal with over an extended period of time. On day 28 however, the smell was faint. As the concrete cured, the smell left as well. This is a good sign as if it were to become a solution, we would not have to worry about the smell. The last important part of information is the color. The more cigarettes in the batch, the darker the concrete became. This might be a concern for those seeking a set look, but for those using this for more of a general use, there is no concern. Overall there was a lot of great information found, and enough so to at least consider this a feasible solution.

Conclusion

In conclusion, recycling cigarettes in concrete can prove to be remarkably successful. When compared to a standard batch, not only were they proven strong, but workable as well. This leads me back to my original solution. I believe if we can recycle cigarettes in concrete, we can reduce the worlds littered cigarette problem. At a shocking 1.2 trillion tons littered each year, if we could even dissipate that amount by 10%, we would be making a difference. 10% may not sound like much, but 10% of 1.2 trillion is 120 billion. That is 120 billion tons of used cigarette butts taken off our planet each year. Companies could start off by using this mix for a variable of things. Pours such as cinderblocks, driveways, sidewalks, and patios to name a few. Also being

that this is a green initiative, I too believe that many companies would entertain this practice. More companies would then adopt this type of work, hence our percentage cleaned would go up.

Figure 10: Littered Cigarettes

In closing, I believe this is an amazing solution. It may not be perfect right now, but with more experiments, time, and effort anything is possible. Bottom line, we are citizens of earth. Not only are we responsible to take care of the planet for us, but for the following generations to come. As a person moving into construction, I believe we should do our part. A way to do our part, is by recycling cigarettes into concrete.

Jonathan Rosete **Recyling Cigarettes In Concrete Data** **Senior Project**

7 Day Break 10/9/2020					
Data Set	**Cylinder Type**	**Weight (lbs)**	**PSI Strength**	**Slump (in)**	**Notes**
1	Standard	8.215	2302.2	1.5"	Standard Concrete Look/Full Shape
1	Standard	8.76	3416.3	1.5"	Standard Concrete Look/Full Shape
1	Low Volume	8.63	4019.5	1"	Darker than Standard/Light Smell of Cigarette/Full Shape
1	High Volume	8.49	3266.7	1"	Darker than Standard & Low Volume/High Smell of Cigarette/Full Shape

7 Day Break 10/9/2020					
Data Set	**Cylinder Type**	**Weight (lbs)**	**PSI Strength**	**Slump (in)**	**Notes**
2	Standard	8.66	4173	1.5"	Standard Concrete Look/Full Shape
2	Standard	8.68	3586.6	1.5"	Standard Concrete Look/Full Shape
2	Low Volume	8.57	4297.2	1"	Darker than Standard/Light Smell of Cigarette/Full Shape
2	High Volume	8.56	4094.3	1"	Darker than Standard & Low Volume/High Smell of Cigarette/Full Shape

28 Day Break 10/30/2020					
Data Set	**Cylinder Type**	**Weight (lbs)**	**PSI Strength**	**Slump (in)**	**Notes**
1	Standard	8.58	4602.8	1.5"	Standard Concrete Look/Full Shape
1	Standard	8.265	3023.9	1.5"	Standard Concrete Look/Rocky Formed
1	Low Volume	8.17	2710.4	1"	Darker than Standard/ Rocky Formed
1	High Volume	7.98	3059	1"	Darker than Standard & Low Volume/Light Smell of Cigs/Rocky Formed

28 Day Break 10/30/2020					
Data Set	**Cylinder Type**	**Weight (lbs)**	**PSI Strength**	**Slump (in)**	**Notes**
2	Standard	8.625	4454.8	1.5"	Standard Concrete Look/Full Shape
2	Standard	8.685	5483.7	1.5"	Standard Concrete Look/Rocky Formed
2	Low Volume	7.895	2283.9	1"	Darker than Standard/ Rocky Formed
2	High Volume	7.86	2337.2	1"	Darker than Standard & Low Volume/Light Smell of Cigs/Rocky Formed

References

"5 Ways Cigarette Litter Impacts the Environment." *Truth Initiative*, truthinitiative.org/research-resources/harmful-effects-tobacco/5-ways-cigarette-litter-impacts-environment.

"Cigarette Butt Bricks - Physical Properties and Advantages." *The Constructor*, 27 Jan. 2019, theconstructor.org/building/cigarette-butt-bricks/29224/.

"Did You Know?" *Did You Know? | University Health Services*, uhs.berkeley.edu/tobaccofacts.

"Double Advantage to Using Cigarette Butts to Make Bricks." *Double Advantage to Using Cigarette Butts to Make Bricks | Engineers Australia*, www.engineersaustralia.org.au/News/double-advantage-using-cigarette-butts-make-bricks.

Hook, Jason. "9 New Construction Materials to Explore in 2019." *Buildsoft*, www.buildsoft.com.au/blog/9-new-construction-materials-to-explore-in-2019.

Luo1, Tao, et al. "IOPscience." *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 1 Feb. 2019, iopscience.iop.org/article/10.1088/1755-1315/233/5/052030.

Treacy, Megan. "Cigarette Butts Make for Better, Cleaner Bricks." *Treehugger*, www.treehugger.com/cigarette-butts-make-better-bricks-4858215.

"We Apologize for the Inconvenience..." *ShieldSquare Captcha*, iopscience.iop.org/article/10.1088/1755-1315/233/5/052030/pdf.

Figure References

Figure 1: "Social Issues." *Smoking On Campus*, 9 May 2014, smokingoncampus.wordpress.com/social-issues/.

Figure 2: Self Took – Jonathan R

Figure 3: Self Took – Jonathan R

Figure 4: Self Took – Jonathan R

Figure 5: Self Took – Jonathan R

Figure 6: Self Made Table – Jonathan R

Figure 7: Self Took – Jonathan R

Figure 8: Self Took – Jonathan R

Figure 9: Self Made Table – Jonathan R

Figure 10: CBS Detroit. "Group Brings Attention To #1 Litter Problem In America: Cigarette Butts." *CBS Detroit*, CBS Detroit, 21 Apr. 2012, detroit.cbslocal.com/2012/04/21/group-brings-attention-to-1-litter-problem-in-america-cigarette-butts/.