Dear, PECG

Recently we entered the LA County Science and Engineering Fair and were excited to hear that we had received the James E. Roberts Award from the Professional Engineers in California Government, for our research. We are both thankful to Crescenta Valley High for giving us the opportunity to compete in the fair and are grateful that the PECG allowed us to share our findings with the LA community.

Our projects title was **Eco**ncrete: an alternative approach to creating environmentally favorable concrete, using the saltwater carbonate buffer system, and carbon sequestration. We decided on the research topic of an alternative approach to concrete, because we understood that cement production leads to over 5% of the carbon dioxide emissions, due to the burning of limestone. Furthermore, we quickly realized, that with concrete demand on the rise; a solution to this environmental crisis was desperately needed.

With a goal in mind, we decided that in order to minimize the Carbon dioxide emission from the concrete production Industry, our zero-emission concrete would have to eliminate the burning of limestone. Therefore, the main target was to achieve a form of synthetic Calcium carbonate crystallization around a series of aggregates, that was not dependent on the burning of limestone for ingredients. We predicted that the calcium carbonate would act as a cement to “glue” the aggregate together.

To achieve the Calcium Carbonate crystallization we needed, numerous combinations of CaCl2, Ca(OH)2, and Mg(OH)2 was dissolved in solutions and placed in a modified vacuum chamber. The ingredients then disolved to yield the a source of calcium. After all air was pumped out of the vacuum chamber, the chamber was then saturated with CO2 to promote the formation of carbonate. After multiple trials, we experimentally determined the correct ratio of calcium chloride, magnesium hydroxide, water, carbon dioxide to maximize the amount of calcium carbonate created. Aggregate was then added to the ratio we had determined. Within an hour the calcium carbonate had formed around the agragate, which resulted in a durable concrete like structure.

The experimentally determined ratio for the ingredients CaCl2, Mg(OH)2, Ca(OH)2,CO2 and water in moles is, 6.25 / .6 / 2.5 / 192.5 / 1. With this ratio, we gained the ability to synthesize a calcium carbonate-based concrete that could withstand a substantial amount of pressure. When testing the "hardness" of the newly synthesized concrete according to the Moh's test of hardness, our concrete received an average of 7-8. This means that the concrete we had created was as strong as topaz, which is an aluminum-based gemstone. Furthermore, after experimentation with the element magnesium, we discovered that our concrete had the capability to trap toxic materials within itself, to clean up lead or arsenic rich areas.

After lots of experimentation, we decided that at this stage our concrete would be suitable replacement for cinder blocks, or decorative concrete. However, with additional research we found biological additives that could be added to our concrete to increase the strength or alter the concretes qualities.

We predict that the addition of carbonic anhydrase and cocolithophore will catalyze the saltwater carbonate buffer system and the formation of calcium carbonate, to create a more durable concrete structure. The first additive is an algae called the cocolithophore, which we believe will increase the concrete strength and more importantly the algae will allow the concrete to heal tiny fractures in the concrete by reacting with carbon dioxide in the atmosphere. The Second additive is called carbonic anhydrase; an enzyme that should shorten the curing time of our concrete due to its ability to catalyze the reaction between carbon dioxide and water.

Conclusively we believe our concrete offers an alternative approach to traditional concrete, while removing carbon dioxide from the atmosphere, and cleaning up the environment. Additionally, the concrete we have created should be around 10% cheaper then traditional concrete due to the elimination of burning limestone which is and energy and cost intensive process.

Once again, we would like to thank the PECG for supporting us in our goal to create environmentally sustainable concrete, and are excited to continue working on sustainable solutions for the future of LA.

-Sincerely, Jad Soucar & Andrew Hong