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Concrete & Aircrete Compression Testing

One Community Global - Highest Good Housing

(Date)

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COMPRESSIVE STRENGTH OF AIRCRETE AND

CURRENT STATE OF KNOWLEDGE

One Community is committed to creating open source and freely available blueprints for The Highest Good of All™. This is our highest value and foundation of our operations and decision making process. We aim to provide ecologically-sustainable and holistic developments in all areas of sustainability. To do so, One Community aims to provide directly applicable information about the most sustainable options for everyday resources like building materials. This page shares our most current research on aircrete with the following sections:

We were not paid or incentivized in any way during this research.

RELATED PAGES (mouse-over for descriptions and click for complete pages)

WHAT IS AIRCRETE

~~Aircrete is a type of building material that closely resembles concrete, but the filler is foam (small air bubbles) instead of sand and gravel. This relatively new material consists of three key components: cement, water, and detergent foam. Similar to concrete, Aircrete is often poured into molds, then cured over a period of time to allow the product to harden and strengthen. The result is a cementitious block with a uniform composition.~~

~~Unlike concrete, Aircrete does not utilize a mixture of aggregates. Instead it relies on the foam component of the mix. The foam component is incorporated into the cement slurry, and the nearly microscopic bubbles (from the foam) fill the cement slurry with air cells. The large number of air cells distributed throughout the Aircrete allows it to be far lighter and have greater insulation properties when compared to traditional concrete.~~

~~Aircrete is intended to be utilized like concrete, but the compressive strength of Aircrete is not well documented. This content was generated to document a scientific approach to defining the compressive strength of Aircrete. This effort was pursued because of the many benefits associated with Aircrete - Only consisting of three relatively affordable ingredients which are widely available all around the world (detergent, water, and cement). The most important benefit of Aircrete is the ability to produce this material without heavy machinery or intensive labor - it can be made using a few everyday items. Aircrete has the potential to provide an economical, lightweight, and easily accessible option as a suitable building material.~~

~~WHY RESEARCH AIRCRETE AND ITS PRODUCTION~~

~~Sustainable building materials is a foundation of One Community's open source strategy for building a global collaboration of self-sufficient and self-sustainable teacher/demonstration communities, villages, and cities for The Highest Good of All. One of the biggest ways to build sustainably is to add well-designed research to answer questions of structural strength to further the use of non-mainstream building options. With this in mind, we have researched compressive strength of Aircrete as part of our open source contribution to comprehensive sustainable living. This page is a collection of our initial research and will evolve with our experience.~~

~~Ways to Contribute and Consultants~~

~~PROJECT PURPOSE~~

~~The purpose of testing aircrete is to obtain data and knowledge of Aircrete's compression strength and compare the results to that of concrete. The One Community organization has plans to utilize the material in a community of sustainable dome housing arrangements. These dome structures will utilize Aircrete and other materials to support the sustainable and low cost housing option. As a potential building material, this research was of key importance in order to have a greater understanding of the new material for future building plans as well as providing the public with that same knowledge.~~

~~RESEARCH AND EXPERIMENTATION JOURNEY~~

~~The research and hands-on experimentation journey to date ended up falling under these following distinct phases:~~

1. ~~Initial Planning Phase~~
2. ~~Initial Trial Phase~~
3. ~~Planning Phase Re-Visited~~

4. ~~Trial Phase Re-Visited~~
5. ~~**Experiment 1 Phase**~~
    a. ~~**Test Parameters**~~
    b. ~~**Materials and Procedures**~~
    c. ~~**Results**~~
    d. ~~**Discussion**~~

~~**Initial Planning Phase**~~

~~The overall research and experimentation process began with the assumption that the methodology available to make aircrete was robust and reproducible. As such, at the start of the project, the goal was to make traditional concrete, various compositions of Aircrete (including the standard used by Domegaia and Aircrete Harry), various compositions of stabilized earth cylinders, and stuccoed cylinders to determine their compressive strengths. During this Phase, information was gathered about the production and properties of Aircrete and stabilized earth. By researching these building materials, a greater understanding was gained to understand how to make the different mixes. The initial planning documents included a Mixing plan, a Cleaning plan, and a Video/documentation plan.~~

~~The top resources for Aircrete that were used were from Domegaia and Aircrete Harry. Both of these resources were used to understand how Aircrete is made and how it works.~~

~~**Initial Trial Phase**~~

~~Calculations were done during this time to figure out how much material was needed for each mix. Equipment was tested to get familiar with the overall process of making the Aircrete and stabilized earth. The Little Dragon foam generator was being utilized - The setup of that machine needed an air compressor set to 90 psi.~~

~~Although the production process is presented through some instructions by these resources (namely Domegaia and Aircrete Harry), it was discovered that making Aircrete is not that simple, as described in the next section. After the initial attempt at making the Aircrete, it was noticed that the Aircrete would lose volume over time. So, the major issue experienced was~~

~~aircete not maintaining the target volume. Even with access to recipes used by these resources, it was quickly discovered that Aircrete is difficult to execute using online instructions. Countless hours were spent attempting what appeared to be a simple recipe to make Aircrete and add to the knowledge base its compressive strength. Online resources were secured to figure out a way to make Aircrete that did not collapse/shrink (e.g., lose its target volume). Given Hajjar's (Founder of Domegaia) successes with Seventh Generation Dish Soap, and with Seventh Generation Dish Soap being an affordable, easily accessible, and environmentally conscious foam option, the suitability of the foaming agent was tested to make Aircrete. After thorough research and much experimentation, Seventh Generation Dish Soap proved to be prone to shrinkage thus unable to maintain its target volume. This project quickly shifted from simply making Aircrete and doing compression testing to add compressive strength to the bank of knowledge already online, to a full research project exploring different variables to reliably make Aircrete that maintained its volume.~~

~~Trial runs were done to determine how to fix the Aircrete which would be used for compression testing. These trials consisted of testing different mixing methods that included the amount of Aircrete that was mixed, mixer type, mixer speed, mixing time, testing different mix proportion by determining foam structure strength, foam solution type, foam solution amount, and lastly testing the different minor adjustment for the mix through water temperature, water amount, water type, plastic wrap, and foam amount. Throughout this process, there were many trial cylinders being made to see how each adjustment would impact the cylinder. The main problem encountered was the shrinkage or loss in volume for the cylinder.~~

~~Several variables were adjusted to mitigate Aircrete cylinders from collapsing. The trials were all performed by making key changes to the various components of the mixing method, components and curing process in an effort to successfully make Aircrete cylinders. The trials are explained below, but to view a set of slides covering the original Aircrete Testing trials follow this link. A table which showcases the trial runs can found here: Trial Run Data Sheet.~~

~~Trials 1 - 3~~

~~The first three trials showcased the inconsistency of working with Aircrete. These trials were all created in the same manner, utilizing the same amount of cement, water, foam and soap solution, as well as same method and timing. The result was that Trial 1 failed, since the Aircrete collapsed by about half its volume early in the curing process. Trial 2, which was an exact replication of Trial 1, was successful and experienced collapse in the curing process. Trial 3, which was an exact replication of Trials 1 and 2, was a failure since it collapsed early in the curing process. The conclusion of these first three trials proved that Aircrete was not easily replicable and there was an issue with either the materials, mixing method, conditions or mixing tools.~~

~~Trial 4: Egg beater mixing attachment~~

~~In the fourth trial, different types of mixing attachments to the drill were utilized. Previously trials were performed using an auger drill bit. Trial 4 utilized an egg beater style mixing bit. The idea behind this decision was to mix the Aircrete quicker. This trial also collapsed which led to searching elsewhere to fix the collapsing issue.~~

~~Trial 5: Foam first then cement slurry~~

~~In the fifth trial, the cement slurry was added to a bucket that already contained the foam. The idea behind this decision was that having the foam on top of the slurry (as was done in all previous trials) was not allowing the cement slurry to combine with the foam well. The reason for trying this was that the foam was of a lighter weight and thus it was difficult to pull the foam down into the cement slurry. The result of this trial still showed that the egg beater style mixer was a good mixing tool but there was still collapse in the Aircrete during its curing. The search for a solution continued.~~

~~Trial 6: Injecting foam directly into cement slurry~~

~~Trial 6 was similar to Trial 5, in that the introduction of foam into the mix was changed in order to achieve a non collapsing cylinder of Aircrete. This time the foam was injected directly from the foam wand into the cement slurry. This meant that the foam was not measured into a separate bucket, then added to the slurry, like previous trials. The idea was that the foam would be directly injected into the cement slurry allowing it to mix faster and more thoroughly. It also meant that the foam did not spend time in a~~

~~separate bucket, where bubbles were likely collapsing even before adding it to the slurry. Trial 6 was also a failure and the Aircrete collapsed soon after starting to cure.~~

~~Trial 7: Mixing using large traditional concrete mixer~~

~~This trial used a different mixing method and vessel by using a cement mixer. Although this provided a quick way to produce Aircrete in large quantities, the Aircrete lost a great amount and volume in the mixer, and thus the mixer was deemed not well suited for mixing such a smooth material like Aircrete.~~

~~Trial 8: Distilled water~~

~~Having many previous trials fail after utilizing many different mixing methods, distilled water was used in Trail 8. The idea came from a forum where a member was experienceing a collapsing Aircrete, but later determined it was due to his faucet water being "hard". This usually indicates the water has minerals and additives. Another member suggested that the hard water caused the bubbles in the foam to collapse.~~

~~This trial was performed using the egg beater style mixer but this time distilled water was used instead of the water provided in the laboratory to make cement slurry. Unfortunately, distilled water was not used to make the foam solution. This trial was a failure and showed similar results to others and the Aircrete collapsed during the curing process.~~

~~Since this trial was done, a hardness test was performed on the tap water. It was found that the water is very hard, measuring at 13 grains of $CaCO_3$ per gallon or 223 mg of $CaCO_3$ per liter.~~

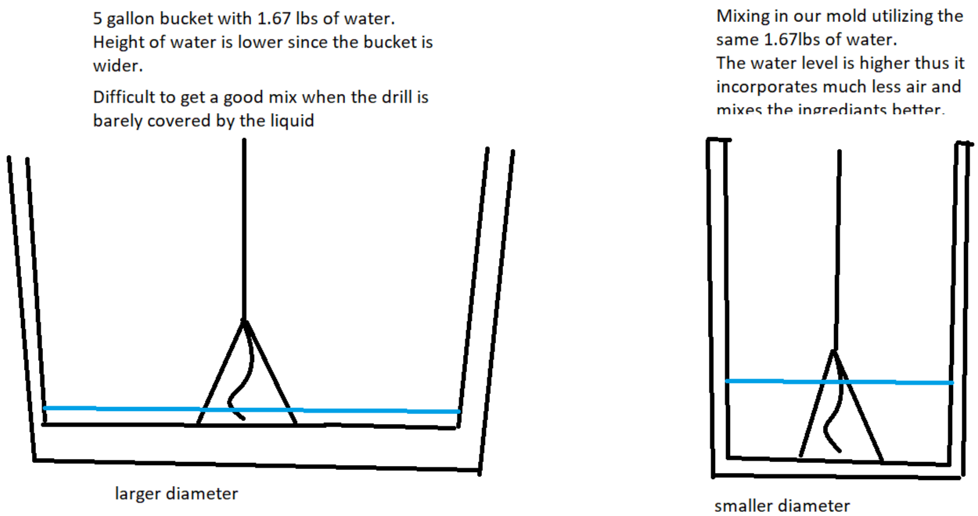
Water Hardness Scale

Grains/Gal	mg/L & ppm	Classification
Less than 1	Less than 17.1	Soft
1 - 3.5	17.1 - 60	Slightly Hard
3.5 - 7	60 - 120	Moderately Hard
7 - 10	120 - 180	Hard
over 10	over 180	Very Hard

~~(source: https://libertylake.org/water-hardness/)~~

~~Trial 9: Mixing Aircrete in the Cylinder Mold~~

~~For this trial, a single batch of Aircrete was mixed in the compression testing cylinder itself. Previously the mixes were done in 5 gallon buckets and the compression cylinder is significantly smaller: 6 inch diameter and 12 inch tall (about 1.5 gallons). The idea to try this experiment was that the mixer bit was not fully submerged in the cement slurry. This meant that the mix was not getting properly mixed. The figure below demonstrates this reasoning.~~



~~**Figure 1 : Smaller Diameter Advantage**~~

~~Trial 9 proved to be successful - the Airerete cylinder did not collapse.~~

~~Trials 10,11 & 12: Replication of Trial 9~~

~~Trial 10,11,12 was performed solely to determine replicability of the success of Trial 9. After performing the exact same procedures, all trials were a failure and had a collapse in the Airerete.~~

~~This result relates back to trial 1, where Airerete shows its inconsistency. All procedures and methods were the same, yet the Airerete continued to collapse.~~

~~Trial 13 & 14: Try Producing 3 cylinders simultaneously~~

~~For trials 13 & 14 the idea from trial 9 was implemented using a 5 gallon bucket. The idea was that the more material that was in the mix would allow the mixer to fully submerge and mix 3 cylinders thoroughly. In addition, having the mixer fully submerged would again, allow less air to be introduced into the mix.~~

~~These trials were also performed using a lighter mix (more foam in the Airerete) and a heavier mix (less foam in the Airerete). Both Trial 13 & 14 were failures, the Airerete in both runs collapsed.~~

~~Trial 15: Heaviest Mix~~

~~Trial 15 utilized the methods stated in Trials 13 & 14 but the trial was done with the "heaviest" Aircrete mixing quantities. This meant that this mix had the greatest amount of cement and least amount of foam when compared to all of the previous trials.~~

~~Trial 15 was successful and the Aircrete did not suffer any collapse. This was likely due to the small amount of foam in this mix of Aircrete. Since the air cells of the foam are the components of the Aircrete which has the ability to reduce the initial/target volume, it would make sense that the foam is the cause of collapse.~~

~~Planning Phase Re-Visited~~

~~With these failed attempts, more research was conducted to find out how to make an Aircrete mix that did not collapse in the curing process. There were many factors in the Aircrete making process which could affect the final product. Additional online research was completed to help resolve the shrinkage issues encountered. The finding of a second round of online research is summarized~~ here. ~~The overarching finding was that other foaming agents work better than Seventh Generation Dish Soap and mixing is an important aspect of making Aircrete that doesn't collapse.~~

~~Trial Phase Re-Visited~~

~~This second round of research led to further exploration into the foaming agents, which led to additional trials: Trials 16 through 21.~~

~~Trial 16: Drexel Foam~~

~~Trial 16 explored the choice detergent used in the Aircrete. For Trial 16 the foaming agent called Drexel was used. First, foaming agent testing was completed (click link to view detailed results), which deemed that Drexel was a far superior foaming agent~~

~~when compared with 7th generation dish detergent. Drexel was used to created 3 cylinders of standard Aircrete using a 5 gallon bucket. The trial was successful, the Aircrete in all samples did not collapse. Moving forward, Drexel was used as the foaming agent.~~

~~Trial 17,18,19 and 20:~~

~~Each of the trials 17-20 were performed using the same foaming agent as Trial 16. The purpose of these trials was to replicate the findings in Trial 16. Although unlike Trial 16, some trials experienced collapse and failed. Different types of mixes were explored that were different from the "standard" mix. Again the inconsistency as seen in Trial 1 was experienced again.~~

~~Trial 21: More Concentrated Drexel Foam Solution~~

~~This trial tested the effects of increasing the amount of detergent added to the foaming solution, since foam is thought to be a major factor in these Aircrete failures. Several foam tests were run (which can be found here: Foam Test) to see if a greater amount of drexel in the foam solution would provide a longer lasting and better quality foam. 6 oz of drexel was used in the solution rather than the previously (and expert recommended) 4 oz. The result was a better foam and the Aircrete did not collapse.~~

~~In addition, 3 test batches were made, with each batch providing 4.5 gallons of Aircrete. Where this test differed from others was the variation in the Aircrete mix. One test was a standard mix using 9.4 lbs cement, .6 gallons of water, and 5.6 gallons of foam. The second test consisted of 20% more cement with 11.28 lbs of cement, .7 gallons of foam, and 4.5 gallon of foam. The third test consisted of less water in the cement slurry with 9.4 lbs of cement, .5 gallons of water, and 6.8 gallons of foam.~~

~~The results were that the standard mix and 20% more cement mix was successful and did not experience any collapse. The mix which consists of the decreased water + increased foam collapsed. The standard mix was used moving forward with the experiment.~~

~~Experiment 1 Phase~~

~~The original task, which included testing stabilized earth and stucco, was narrowed to only experimenting with Aircrete and future teams of students would pursue other questions worth answering in the quest for a more sustainable building material.~~

~~With the demonstration of consistently making successful Aircrete cylinders (e.g. Aircrete that did not collapse during the mixing, pouring, and curing process), the first experimentation phase was initiated.~~

~~First, the highest foam content was identified while maintaining the target volume during curing. A 95% of foam to 5% of cement slurry was tested. This resulted in shrinkage. The foam percentage by volume was decreased and the cement slurry was increased incrementally by 5% until the successful foam limit was reached. The upper limit amount of foam that worked the best was 85% foam to 15% cement slurry by volume. The successful foam limit was 7% more foam than the standard mix. The following links share part of the process for getting these results: Aircrete and Stabilized Earth Data Collection Sheet and Week Testing Summary .~~

~~Test Parameters~~

~~The impact of 6 cementitious recipes, as well as 5 curing times, on compressive strength was explored. The 6 cementitious recipes included control mix (standard concrete mix) and 5 Aircrete mixes. The 5 curing stages included 48 hours, 1 week, 2 weeks, 3 weeks, and 4 weeks from when the cylinders were made. Each mix type and curing time were done in replicas of 5. After the cylinder had time to cure for that corresponding time, the molds were removed from the cylinder and its compressive strength (pounds per square inch) was tested using a compression testing machine. The test parameters are summarized in the table below:~~

~~Mixes Tested~~	~~48 Hours Curing~~	~~1 Week Curing~~	~~2 Weeks Curing~~	~~3 Weeks Curing~~	~~4 Weeks Curing~~
~~Concrete~~ ~~(quikrete: cement and aggregate - traditional concrete)~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~
~~Standard Aircrete~~ ~~(22% cement slurry + 78% foam)~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~
~~Light Aircrete~~ ~~(15% cement slurry + 85% foam)~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~
~~Heavy Aircrete~~ ~~(40% cement slurry + 60% foam)~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~
~~Heavier Aircrete~~ ~~(50% cement slurry + 50% foam)~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~
~~Heaviest Aircrete~~ ~~(60% cement slurry + 40% foam)~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~	~~5 cylinders~~
~~Testing Parameters~~	~~Compression testing~~				

~~Materials and Procedures~~

~~The Experiment 1 Phase (Aircrete Data Collection Sheet) involved a cylinder building day to make 125 cylinders of Aircrete and 25 cylinders of concrete that were used for compression testing. A practice day was held to get familiar with the cylinder making process (Pre-Run Work Plan), prior to constructing the 125 cylinders of Aircrete and 25 cylinders of concrete. On the day of making all the cylinders, volunteers were divided into three teams. The following link shares the instructions used on the day of making all the cylinders: Cylinder Making Day Procedures. The Compression Testing Phase was completed at 48 hours, 1 week, 2 weeks, 3 weeks, and 4 weeks after the day of making of the cylinders (e.g., Curing times of 48 hours, 1 week, 2 weeks, 3 weeks, and 4 weeks). The data was recorded for each of the cylinders with the weight, compressive strength, and pictures. Once all those data were completed in the data collection sheet.~~

~~Materials~~

~~The items listed below were utilized to produce the Aircrete and concrete materials. Links to each of the materials are provided for ease of access and replication of the project's processes.~~

~~In addition the following link has a materials list utilized during the project: Materials request list. The following materials requested were items that were still needed to conduct testing on this project. The items below are all the necessary materials for this project.~~

~~Concrete Materials:~~

- ~~Concrete Mixer - This popular item is used to mix and combine concrete, usually in large quantities. (When purchasing this item, make certain that the capacity of the mixer is large enough for the desired amount of concrete)~~
- ~~Mixing Tray - This item has multiple uses, but its main purpose is for mixing concrete materials. (Multiple mixing trays provide easier containment of the concrete for easier cleanup and control)~~
- ~~Slump Test Cone - The slump cone is a vital component of the slump test procedure. Follow the link for the slump test explanation: Slump Test Instructions (In short slump test is useful for gauging the quality of mixed concrete)~~
- ~~Quikrete Concrete - The concrete mix used for the experiment is a popular readily available store bought item from the company Quickrete ™. (Quikrete 4000 psi concrete was utilized in this experiment).~~
- ~~Tamping Rod - The tamping rod is used to scrape off concrete and used in slump tests which is explained here. In addition it is also used to tamp the concrete material.~~
- ~~Water~~

~~Aircrete Materials:~~

- ~~Aircrete Harry Foam Generator - The AH Foam generator in conjunction with the air compressor and detergent produces the foam for the Aircrete.~~
- ~~Air Compressor (capable of producing 90 PSI) - The air compressor is needed to provide air for the AH Foam generator.~~

- ~~Corded Power Drill - It is important that the Aircrete is mixed thoroughly and the drill is the driving force of the mixing process for the Aircrete. (A corded drill was used in this experiment, battery operated drills can also be used if backup batteries are provided)~~
- ~~Mixing Auger: Steel Spiral Mixer for 5 Gallon Bucket - The auger will be connected to the drill and will be utilized to properly mix the Aircrete material.~~
- ~~Striking Tool / Tamping Rod (See the above explanation here)~~
- ~~Measuring Stick - This item was used in the experiment to measure the amount of Aircrete in the 5 gallon bucket. (Metric or standard unit measuring sticks can be utilized here)~~
- ~~Mixing Tray (See above explanation here)~~
- ~~Cylinder Molds with Lids - Cylinder molds are used for compression testing. Concrete or Aircrete was poured into and cured within these cylinder molds.~~
- ~~55 Gallons Trash Can - This trash was used for the containment of foam, or for large batches of Aircrete mixing. (If replicating this experiment any large container will suffice)~~
- ~~Multiple 5 Gallons Bucket - The buckets were utilized for multiple purposes such as holding and mixing small batches of Aircrete, foam containment, Aircrete disposal, cleaning, etc.~~
- ~~5 Quarts Bucket - This bucket was utilized mainly to measure and hold items such as dry cement mix, water, foam, etc. (5 quart container should contain markings for measuring quarts/liters/gallons etc)~~
- ~~1 Quart Bucket This bucket was utilized mainly to measure the density of the foam. (1 quart container should contain markings for measuring quarts/liters etc)~~
- ~~Scale capable of measuring ounces - The small scale is useful for measuring small weights such as the detergent required for the soap solution.~~
- ~~Scale capable of measuring pounds - This large scale is useful for measuring larger weights such as water, cement, Aircrete, etc.~~
- ~~Portland Cement - The cement is a vital component in the Aircrete making process.~~
- ~~Water - Tap water available in the labroom was used..~~

~~Safety Materials:~~

- ~~[Shop Towels] - These shop towels are useful and durable enough for cleaning of the tools, containers, and labroom.~~
- ~~[Gloves] - The gloves are useful for keeping the work environment and self clean, and also protects hands from cement, water and detergent.~~
- ~~[Safety Goggles] - Protect your eyes from Aircrete splatter, detergents and dust. (Aircrete production can be very messy).~~

~~Procedures~~

~~CONCRETE MIX AND MIXING PROCESS~~

~~This section has details on how concrete was produced. Step-by-step instructions are provided below for replication and production of ready mix concrete. Concrete rated at 4000-PSI was used because it is a more commonly used strength of concrete for applications regarding similar structures such as smaller dome structures like One Community intends to utilize Aircrete for.~~

~~The choice to use 4000 psi concrete for the compression test was also based upon the following reference: https://www.portaggregates.com/concrete-used-in-residential-projects/ . Portaggregates.com states that this strength of concrete is usually used for foundations and footings but is a great option for backyard sheds and workshops due to its strength and surface durability.~~

~~Cor-Tuf.com states that traditional concrete walls and columns tend to have a range of 3000-5000 psi. Although it is sufficient to use 3000 psi strength concrete, the 4000 psi option was chosen to produce concrete and to stay consistent with existing widely available ready mixes.~~
~~(https://cor-tuf.com/everything-you-need-to-know-about-concrete-strength/#:~:text=Concrete%20footings%20and%20slabs%20on,psi%20is%20needed%20for%20pavement)~~

~~Besides its concrete's strength and durability, the reasoning stemmed from the reasons behind why Aircrete (cement, 7th gen soap, water) was being tested in the first place. This was because it is cost efficient and these products are more widely available to people around the~~

~~world. Therefore, this was one of the ideas behind why this particular concrete mix was utilized which is readily available and cost efficient. The quikrete bag of concrete is very popular and can be easily obtained at local hardware stores and it also is rated for a compression strength of 4000 PSI.~~

~~Quikrete® Concrete Mix (No. 1011) 4000 PSI rated concrete was utilized in the experiment and therefore the instructions are intended to use the same Quikrete concrete material.~~

~~Concrete Tutorial~~

~~Video Description: Step-by-step instructions showcasing for replication and production of Quikrete® Concrete Mix (No. 1011) 4000 PSI rated concrete.~~

~~Steps for making Quikrete 4000 PSI concrete:~~

1. **Weigh the materials prior to mixing.** ~~First determine the desired amount of concrete the project requires. This will require one to take measurements of the volume needed to obtain the correct quantity of concrete desired. The following link is useful for determining the amount of concrete mix and water to use for the desired amount of concrete needed: Concrete Mix Calculations. The user can type in the desired amount, then follow the specifications given in the spreadsheet.~~

   ~~The numbers mentioned provide the user with some background on the findings. According to the manufacturer, every 90 pound bag of Quikrete Mix requires approximately 7 to 10 pints (7.3-10.43 pounds) of water. This combination produces approximately 0.675 cubic feet of concrete. Each project will require a different amount of concrete and 0.675 cubic feet of concrete is not always desired.~~

   ~~*Instructions for a single compression testing cylinder (if needed):* The goal in this paragraph is to produce enough concrete to fill a standard compression cylinder mold (approximately 1.5 gallons or 0.196 ft^3). To produce 1.5 gallons of concrete to fill a single cylinder, use 10 lbs of mix and aim to use between 0.8-1.1 lbs of water.~~

2. ~~**Set aside the materials.** After having the desired amount of dry concrete and water set aside, prepare the rotating concrete mixer by assuring the interior of the barrel is clean and to a certain extent free from debris.~~

   ~~*These steps can also apply to the use of a large mixing tray if a concrete mixer is not readily available. Typically the utilization of a mixing tray is needed when the desired amount of concrete is of a smaller amount.*~~

3. ~~**Setting up the mixing materials.** To start properly mixing your concrete, pour about half the portion of the required water into the concrete mixer. Adding the water first will help prevent the dry concrete from sticking to the mixer and allow the contents to mix more thoroughly. Modulate the concrete mixer by tilting it to different angles to ensure the water has coated the majority of the interior of the mixer.~~

   ~~*When performing this procedure in a plastic mixing tub the same steps will apply. Add water to the mixing tub first. Adding water first will prevent the mix from sticking to the bottom of the tub and better prevent clumping in corners of the tub.*~~

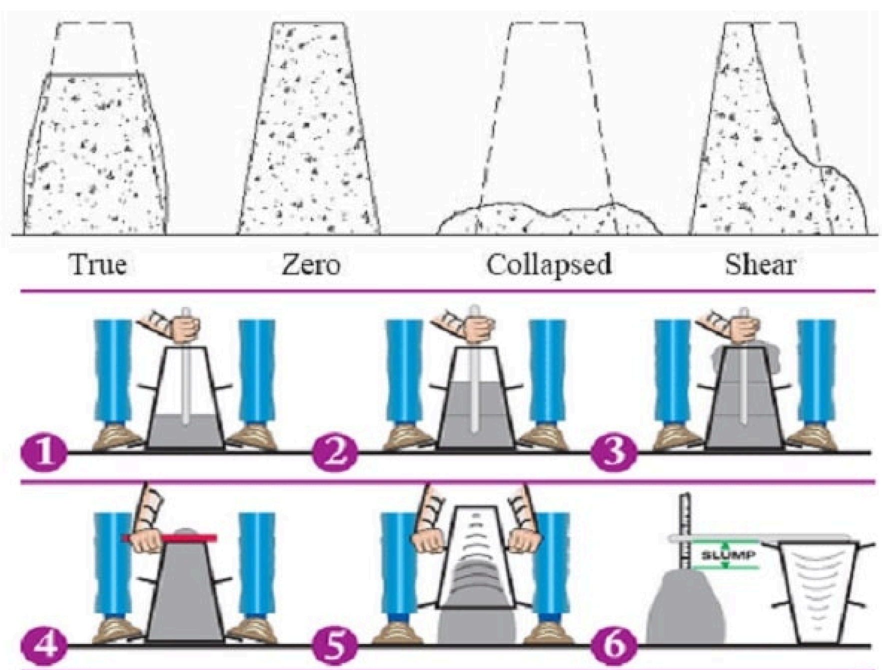
4. ~~**Begin Mixing.** Next it is important to add the concrete dry mix in increments and not in one attempt. Pour about half of the required concrete mix into the mixer and start mixing the contents together making sure the contents mix thoroughly. After a few rounds of mixing, add the rest of the water into the mixer and allow the mixer to combine those materials together. After it is thoroughly mixed, add the rest of the concrete dry mix into the slurry and allow the mixer to rotate until all contents are thoroughly combined. The concrete is thoroughly mixed when there are no areas of the slurry that consists of dry material. The slurry should have a uniform consistency.~~

   ~~*If utilizing a mixing tub, use one's hands to thoroughly push together, spread, and thoroughly mix the concrete slurry. The concrete will be fully mixed when there are no areas in the slurry which still contain dry mix.*~~

   ~~Concrete dries quickly thus it is important to keep the mixer rotating if the concrete will not be used immediately. This will prevent the slurry from hardening when not in use.~~

~~5. **Slump Test: Checking the Concrete Mix.** It is industry standard and important to check one's concrete mixture to ensure that it is up to the manufacturer's specifications and that it is not overly wet or dry. A wet mix typically means that an excess of water was added to the mix and thus it will have a higher chance of shrinking/cracking during the curing process. A dry mix will yield a concrete mix that is difficult to shape and work with.~~

~~To check for proper concrete content and mixing, one must utilize a slump cone to check for the slump of one's concrete. In a slump test you place a slump cone securely to its base, fill the cone with concrete in 3 parts. Every ⅓ of its way up you must take a rod and tamp mixture 25 times. This ensures that pockets of air are penetrated and removed from the mix. The image below shows the types of slump and most importantly the slump procedure.~~



~~**Figure 2 : Slump Test Figures and How to**~~

~~Once the cone is filled to the top, scrape off the excess concrete protruding the cone. The cone is now completely filled with all of the air pockets removed. Next (if needed, not all~~

~~slump test bases have hinges/hold downs) unhinge the cone from the base, lift the cone in an upward motion leaving the concrete contents on the base. Measure the amount of droop or slump that occurs after the cone is removed. Ideally the goal is to aim for 2-3 inches of slump - Quikrete manufacturer recommends 2-3 inches of slump for their product. The manufacturer's recommended slump can be found at the following link: Slump Requirement. A collapsed slump is one which contains too much water, while a zero slump has too little water. Refer to the image below and see the following link to learn more about the slump test. Slump Test information~~

6. ~~**Adjusting Concrete Mixture (if applicable).** If the concrete's slump was within range, then the concrete is ready for use. If the slump exceeded the allowable range of slump you can still adjust the mix to achieve the allowable range of slump. To fix a concrete mix which has zero slump, place the concrete back in the mixer and add small amounts of water to hydrate the mix and then repeat Step 4 to check its slump range. To fix a concrete mix which has collapsed or sheared slump, place the mix back in the mixer and add in small portions of dry concrete mix to thicken the contents more. In any case adjust the mix accordingly and repeat the slump test until desired slump is achieved. A concrete mix with a proper amount of slump guarantees a workable, strong and long lasting concrete product. The image below is a slump test done utilizing the above mixing process. The slump shown is within the manufacturer's specifications of 2-3 inches.~~

~~**Figure 3 : Slump Test results**~~

7. ~~**Using concrete.** At this point the concrete mix has been mixed thoroughly, is hydrated properly and is ready for use. It is important to keep the mix moving if concrete is not used right away.~~
8. ~~**Applying to concrete cylinders.** When adding the concrete to the cylinder, fill the cylinder ⅓ full. After filling ⅓ of the cylinder, take a rod and tamp the length of the concrete added 25 times. After tamping (aka rodding) 25 times, use your hand or tool to mallet the cylinder 10 to 15 times to consolidate. Add another ⅓ and repeat rodding and malleting. Once the cylinder reaches the top, use the rod to strike the excess concrete from the top.~~

~~Aircrete Mix and Mixing Process:~~

~~Aircrete Tutorial~~

~~Video Description: Step-by-step instruction showcasing for replication and production of the standard Aircrete mix.~~

~~The Aircrete mixing process used for the Compression Testing Phase of the project, was curated through a series of trial attempts to create Aircrete, more specifically the 21 trials previously noted above. The Aircrete making process used here differs from that of popular Aircrete pioneers such as Domegaia and Aircrete Harry. The Aircrete production process was recorded and documented and can be viewed in the following link:~~

~~Foam Tutorial~~

~~Video Description: Step-by-step instruction showing how to replicate and produce foam using Drexel by finding the density.~~

~~An important component of the Aircrete making process is the use of a foam generator. A foam generator created by Aircrete Harry was used. Aircrete Harry's website provides a multitude of information regarding his machine as well as the proper setup. The first step is to properly assemble and set up the Aircrete Harry Foam Generator (information about the AH Foam Generator can be found here). On the website one can obtain the written instructions on the proper assembly and use of Aircrete Harry's Foam Generator. Proper setup of the foam generator requires the inlet and outlet line to be primed. A video is provided on the website that also demonstrates how to correctly prime the line before using the machine. The following link is a video recording which showcases the process utilized in order to create a foam which meets the requirements for use in an Aircrete mix:~~

~~Aircrete Instructions~~

~~Here are the step by step procedures for making Aircrete.~~

1. ~~**Gather the required materials**. The first step to making Aircrete is to set up Aircrete Harry's foam generator. A simple list of materials needed for this procedure is listed below (A more informative list can be found here):~~

- ~~5 gallon bucket~~
- ~~A large container~~
- ~~Drexel foaming agent~~
- ~~An air compressor~~

- ~~Aircrete Harry foam generator~~
- ~~A scale~~
- ~~A mixing paddle~~
- ~~A measuring cup~~

2. ~~**Preparing the Soap Solution.** The ratio used for the foam was 6 ounces of Drexel to 5 gallons of water. To make this, fill a 5 gallon bucket with 5 gallons of water. Use a measuring cup to measure 6 ounces of Drexel, then pour into the 5 gallon bucket with the 5 gallons of water. Mix the Drexel and water solution thoroughly with a mixing paddle. Stir the solution until a small amount of foam begins to form at the top.~~
3. ~~**Preparing the Air Compressor.** The air compressor was set to 90 PSI. Turn on the compressor a few minutes prior to use and keep it running. This allows the compressor to fill its tank and discharge the correct amount of air. Set the compressor 90 PSI throughout the entire process.~~
4. ~~**Preparing the Foam Generator.** To properly set up the Aircrete foam generator it is important that the provided hoses are placed in accordance with labels provided on the generator (picture shown on the right). The 3 hoses are connected to 3 separate ports labeled: foam solution in, air in, and foam wand. Place the hose labeled "foam solution in" into the 5 gallon bucket containing the water and drexel solution. Place the hose labeled "foam wand" into a large container during the priming of the generator. Connect the "air in" hose to the air compressor stated above.~~

~~Power the foot switch by connecting it to an outlet. This foot switch allows ease of use by allowing the user to modulate the machine on and off, thus providing foam at will.~~

~~The Aircrete Harry's Foam generator utilizes an air valve which allows the user to allow or block air coming from the compressor into the foam generator.~~

~~First, prime the generator by first closing the air valve and stopping any air from flowing into the generator - when air is off, the valve will be perpendicular to the direction of the hose. With the valve closed and all the hoses in the respective places, use the footswitch to turn on the generator and let the generator pump the soap solution up through the "foam solution in" hose and out of the "foam wand". After allowing the solution to cycle through for 5 seconds the generator is sufficiently primed. This means that the foam solution has filled the foam generator and the hoses.~~

~~After priming the foam generator, open the air valve (when open the air valve is turned so it is parallel with the air hose). Once the air valve is opened, the air from the compressor will flow through the foam generator and foam will discharge through the foam wand, thus providing the foam needed for the Airerete. Note: The foam will need to be tested before use and this step is stated in *Step 6: Foam Density Measurement* shown below.~~

5. ~~**Weighing Out Materials**. The following tools were used to weigh the water and cement: cement scoop, large scale (ounces and pounds), and various bowls/containers. First, set the scale on a flat surface and power it on. It is important that the scale is free of any debris on or underneath it. Once free of all debris, set the container on the scale and set it to zero. Pour cement into the containers and weigh out in pounds. Then repeat for the water.~~
6. ~~**Foam Density Measurement.** To perform the foam density measurement, use the setup for the foam generator in steps 2, 3 and 4. Use a scale that measures in units of grams and place a 1 quart bucket on the scale and zero the scale. Take the 1 quart bucket to the foam generator.~~

   ~~At the foam generator, step on the foot pedal, prime the machine and open the air valve to discharge the foam. While doing this, look at the pressure on the air compressor and make sure it is first set to 90 psi. Allow the foam to discharge for 3 seconds, then fill the quart cup completely. It is important that there are no gaps in the filled cup. Once it is filled, switch off the generator and close the air valve. Remove the excess foam, by scraping it off and place it on the scale.~~

~~Confirm that the weight of the foam is between 90 and 100 grams but aim for 95 grams. This translates to a density of 90-100 grams per quart which is required for Aircrete.~~

~~If the measured foam is not between 90-100 grams per quart, the air pressure needs to be adjusted and the density needs to be re-checked. Adjust the air pressure until the correct foam density is achieved. The air pressure is in units of pounds per square inch (psi) and can be changed by turning the knob to either increase the air or decrease the air flow. For example, adjusting for a heavier density foam decreases the air pressure, and adjusting for a lighter density foam increases the air pressure. A picture for reference is shown on the right.~~

7. ~~**Cement Slurry Mixture.** Mix the cement slurry by taking the previously measured container of water (the water for the cement slurry) and place water into a 5 gallon bucket. Place the drill and auger into the 5 gallon bucket. Add the cement into the water in small increments - This prevents the cement from clumping and sticking to the bottom of the 5 gallon bucket. As cement is added, mix the slurry throughout the entire process. The drill can be modulated to run slowly or quickly depending on the trigger pressure placed on the drill.~~

   ~~Operate the drill until the cement and water are thoroughly mixed. If the foam is not readily available it is important to mix the cement and water continuously to prevent hardening of the materials.~~

8. ~~**Adding Foam to Cement Slurry.** Before adding the foam to the cement slurry, it is important that the foam is at the correct density which was done during step 6. With the density already measured, discharge the foam into a measuring bucket and obtain the desired amount of foam. Once the correct amount of foam is obtained, take the foam and pour it into the cement slurry mixture. If all the foam does not fit at one time, add it in increments or pour half and then the other half. The total foam content that the cylinders were based upon resulted from the overall volume left in the cylinder mold. From the testing of how much cement slurry filled the cylinder mold, the rest of the mold needed to be filled in with foam to get the total volume of Aircrete being made to be 1.5 gallons of~~

~~Aircrete. The ratio of the different mixes had to change to the amount of foam added to the cement slurry in order to get the maximum amount of foam. Note that about an additional 1 to 2 gallons of foam had to be added to account for the foam breaking down during the mixing process.~~

9. ~~**Cement Foam Mixture.** This visualization of what is happening in the bucket is helpful when mixing cement slurry and foam: At the bottom of the bucket there is a thick cement/water slurry and on top of that is light foam. The goal is to mix the contents thoroughly by bringing the cement up into the foam and drawing the foam down into the cement slurry. Use a drill with an auger attachment to mix the cement slurry into the foam. Spin drill in both directions - one direction pulls the cement up and the other direction pushes the foam down.~~

   ~~Modulate the drill at a medium speed, avoid mixing at full speed. First, have the drill with the settings set to rotate the auger counter clockwise. The counterclockwise direction rotates the auger and draws the material from the bottom to the top (in this case bring the cement into the foam). Then drill in a clockwise rotation to bring the top mixture down to the bottom (in this case bring foam into the cement). Alternate between the counter clockwise and clockwise mixing to ensure that the Aircrete goes through a more thorough mix and the foam and cement slurry are combined into each other well. In addition, raise the drill up and down slowly while mixing to further aid in thorough mixing and therefore achieving a homogeneous distribution throughout the bucket. Also, tilt the drill in different directions to get a proper mix. Tilting the drill adds another mixing characteristic where the material in the bucket does not only spin in one direction but it spins in multiple directions. This again creates a more thorough mix because of the added complexity of the tilted drill.~~

   ~~Mix the Aircrete as quickly as possible, which helps in keeping the foam's (tiny bubbles) integrity and structure. Mixing is complete when the Aircrete mix is uniform in color and consistency.~~

10. ~~**Pouring into Cylinders.** After the Aircrete is completely mixed, pour into the cylinder molds for curing. Scrape any excess Aircrete mix that is protruding on the top by scraping off with a straight edge. Finish by cleaning the surrounding surfaces and place the lid on top of the cylinder mold.~~

~~CYLINDER MOLD REMOVAL PROCESS~~

~~Video Tutorial: Cylinder Mold Removal (follow the link for a video tutorial)~~

~~Video description: Step-by-step instruction on how to utilize the T Handle Mold Stripper.~~

~~Here are step-by-step instructions to utilize a T Mold Stripper for removal of cylinder mold.~~

1. ~~A T Handle Mold Stripper is a tool used to remove the Aircrete cylinder from the cylinder mold.~~
2. ~~Place the bottom of the stripper with the sharp end in the indent portion of the plastic mold. Next, grab the T Handle and place downward pressure on the tool. The sharpened end will slide through the cylinder mold and allow the casing to split open, this will release the concrete or Aircrete cylinder from the mold.~~

~~COMPRESSION TESTING MACHINE PROCESS~~

~~Compression Testing Tutorial~~

~~Video Description: Step-by-step instruction showing how to utilize the compression testing machine.~~

~~Here are step-by-step instructions for compression testing the cylinders:~~

1. ~~**DO NOT unplug or turn off the machine unless authorized to do so.**~~
2. ~~Place the cylinder caps onto the specimen being tested~~
3. ~~Place the specimen with the caps into the middle of the loading base of the machine~~
4. ~~Close the gate once the specimen is inside before compressing the specimen~~
5. ~~Flip on the motor switch, which is in the back~~

6. ~~From the retract lever position, shift the lever to the full advance until it makes contact with the specimen and then shift the lever to metered advance for the compression testing~~
    a. ~~Slowly turn the meter valve position counterclockwise to increase pressure if the specimen needs more pressure to fail. (Once your test is done, remember to turn the metering valve clockwise to decrease and reset the pressure)~~
7. ~~Once the specimen reaches failure point, shift the lever to the retract position to reset the compression machine. The machine will beep when the specimen has failed and will show the readings on the top screen. (Use the hold position on the lever if you need to pause the compression testing)~~
8. ~~Open the gate and carefully remove the specimen from the compression machine.~~
9. ~~Hit ESC on the machine on the top right keypad and repeat from Step 1 before compression testing another specimen.~~

~~Results~~

~~Compression testing was done on a control mix (standard concrete mix) and 5 Aircrete mixes at each curing stage of the cylinder, namely after 48 hours, 1 week, 2 weeks, 3 weeks, and 4 weeks from when the cylinders were made. Each mix type and curing time were done in replicas of 5. After the cylinder had time to cure for that corresponding time, the molds were removed from the cylinder and its compressive strength (pounds per square inch) was tested using a compression testing machine.~~

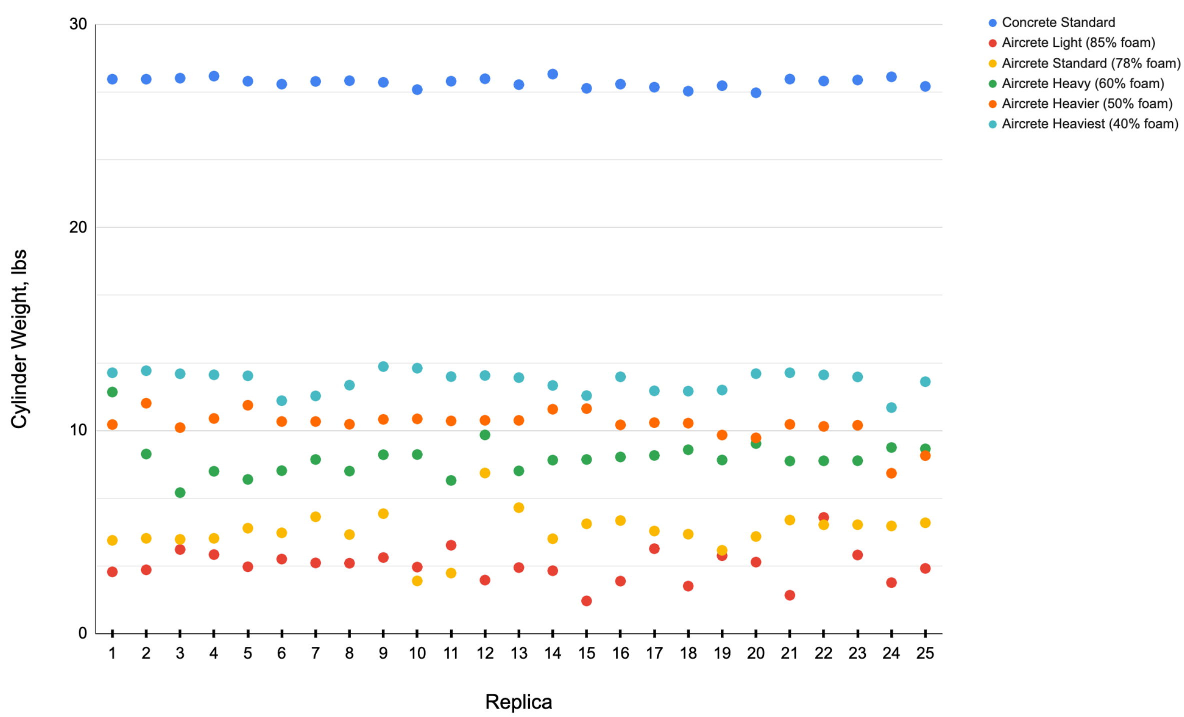
~~Mixes Tested~~	~~48 Hours Curing~~	~~1 Week Curing~~	~~2 Weeks Curing~~	~~3 Weeks Curing~~	~~4 Weeks Curing~~
~~Concrete (quikrete: cement and aggregate - traditional concrete)~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~
~~Standard Aircrete (22% cement slurry + 78% foam)~~	~~- 5 cylinders made - 4 collapsed~~	~~- 5 cylinders made - 2 collapsed~~	~~- 5 cylinders made - 2 collapsed~~	~~- 5 cylinders made - 1 collapsed~~	~~- 5 cylinders made - 3 collapsed~~
~~Light Aircrete (15% cement slurry + 85% foam)~~	~~- 5 cylinders made - 2 collapsed~~	~~- 5 cylinders made - 5 collapsed~~	~~- 5 cylinders made - 3 collapsed~~	~~- 5 cylinders made - 4 collapsed~~	~~- 5 cylinders made - 4 collapsed~~
~~Heavy Aircrete (40% cement slurry + 60% foam)~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~
~~Heavier Aircrete (50% cement slurry + 50% foam)~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~
~~Heaviest Aircrete (60% cement slurry + 40% foam)~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~	~~- 5 cylinders made - 0 collapsed~~
~~Testing Parameters~~	~~Compression testing~~				

~~Figure 4: Collapsion of Cylinder Result~~

~~Raw data is available here for concrete and Aircrete. The quikrete mix (standard concrete) is rated at 4000 psi when it has cured for a period of 28 days. Looking at the results, the average psi strength from all 5 cylinders increased from 1800 psi at 48 hours to 4000 psi at 28 days. The data for this are summarized here. From the current state of knowledge that we have, we know that the cement/concrete strength increases over a period of 28 days. The results from these cylinders show exactly that. As a result, the concrete cylinders were a success as it reached the targeted rating.~~

~~The results for Aircrete are less clear because substantial collapse occurred with the light and standard Aircrete cylinders. Of the 25 light Aircrete cylinders, 18 experienced collapse, which represents 72% of the total cylinder. Fewer standard Aircrete cylinders experienced collapse, but nonetheless, more than expected. Out of 25 standard cylinders, 12 experienced collapse, which represents 48% of the total cylinder. This is not considered acceptable. Since this was an issue, there were Aircrete cylinders that were not usable because they were too small to fit into the compression machine. It needs to be a full cylinder in order to have an accurate data reading.~~

~~Additionally, the Aircrete cylinders had greater variability in their weight than concrete cylinders, as shown in the plot below:~~



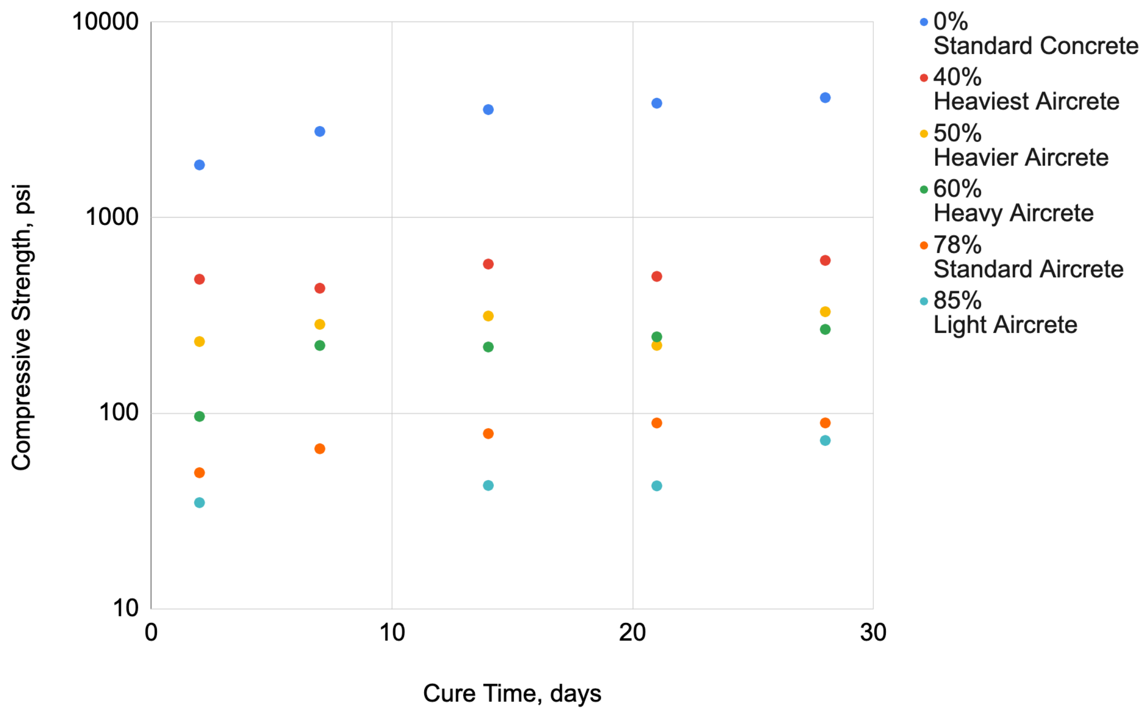
~~**Figure 5: Chart of Weight of all Mixes' Weight Deviation**~~

~~This indicates inadequate mixing. The percent deviation was about 1% for concrete and 25% for the light Aircrete, followed by a gradual decrease with Aircrete containing more cement:~~

	~~Concrete~~	~~85% foam Aircrete~~	~~78% foam Aircrete~~	~~60% foam Aircrete~~	~~50% foam Aircrete~~	~~40% foam Aircrete~~
~~Percent deviation~~	~~1~~	~~25~~	~~20~~	~~11~~	~~7~~	~~4~~

~~To assess the compressive strength, the cylinders that collapsed or shark were taken out of the final assessment. Aircrete was much weaker than concrete, but generally exhibited an increase in compressive strength over longer cure times and with increased amounts of cement:~~

~~Foam Content >>>>~~ **~~Cure Time, days~~**	**~~0% Standard Concrete~~**	**~~40% Heaviest Aircrete~~**	**~~50% Heavier Aircrete~~**	**~~60% Heavy Aircrete~~**	**~~78% Standard Aircrete~~**	**~~85% Light Aircrete~~**
~~2~~	~~1859~~	~~484~~	~~232~~	~~96~~	~~50~~	~~35~~
~~7~~	~~2757~~	~~435~~	~~285~~	~~222~~	~~66~~	~~All cylinders shrank~~
~~14~~	~~3566~~	~~579~~	~~314~~	~~218~~	~~79~~	~~43~~
~~21~~	~~3843~~	~~500~~	~~222~~	~~246~~	~~89~~	~~43~~
~~28~~	~~4104~~	~~604~~	~~330~~	~~268~~	~~89~~	~~73~~



~~**Figure 6: Compressive Strength vs Cure Time Charts**~~

~~The heaviest Aircrete was the strongest, but still much lower than standard concrete (600 psi versus 4100 psi, respectively). Another noteworthy observation was that the light and standard mixes were not fully drying in the cylinders when it was time for the compression test, even after 28 days. When it was time to remove them from the cylinders, water would rush out and because of that, the cylinders were still moist. When it got put into the compression test, the machine continued to apply pressure because it could not read that the cylinder had already reached its peak and because of this, the data was inaccurate. The cylinder just got squashed together and became compacted as it went through the testing.~~

~~Discussion~~

~~At the start of the project, it was thought that the instructions available online for making Aircrete were robust. With this not being the case, a slough of pre-experiments were completed~~

~~and in the end were not able to recreate online successes, because they were not able to make Aircrete that consistently retained its volume. This effort, which lasted just under a year, ended up having a lot of unknowns that were discovered during the journey and the search for Aircrete that maintains its volume continues. The standard and light Aircrete mixes proved to be delicate mixes that were not easily reproducible. The Aircrete mixes with 60% or less foam (i.e., more cement) did not experience collapse, but did experience variable weights indicating the difficulty in achieving adequate mixing. Also the presence of moisture in the Aircrete cylinders indicates that allowing a longer cure time or curing outside of the molds may result in increased compressive strengths specifically for the cylinders with high foam content.~~

~~Future Plans for Aircrete and Other Sustainable Building Materials~~

~~Based on the lessons learned and the sustainability potential of Aircrete, additional experiments are recommended. Continued exploration is warranted and recommended next steps for Aircrete include:~~

1. ~~New mixer and Soft water~~
2. ~~Curing time duration~~
3. ~~Stucco Application~~
4. ~~Perfecting Lightest Mixture~~
5. ~~Stabilized Earth~~
6. ~~New compression with new test parameters~~
7. ~~R value~~
8. ~~Aircrete Harry's hardening agent~~

~~A new mixer and using soft water instead of hard water. The new mixer could consist of a double bit to provide a more thorough mix and would save time. This would have resulted in the cement more evenly distributed thus resulting in a homogenous mixture. Another aspect is using soft water because the water used was hard water. Hard water makes the micro-bubbles collapse, thus quickly causing the Aircrete to collapse and loss of stability.~~

~~Also test-worthy are longer curing time for all the mixes and possibly removing the mold once the cylinders can self-hold itself and finishing the curing of the cylinder out of the mold. A good test with this could include outdoor curing which could cure the cylinder faster.~~

~~For added compressive strength, stucco application is recommended. The two methods for stucco application worth testing are Domegaia and Aircrete Harry's(1,2) method for application.~~

~~Once the fundamental issue with the standard Aircrete shrinkage is resolved, attention is needed to establish the lightest possible Aircrete mix. This is particularly beneficial for using Aircrete as an insulative material.~~

~~Another environmentally friendly building material is Stabilized Earth. Stabilized Earth was dropped from the original project like other components of the test because of time constraints. More detailed research of Stabilized Earth and determination of its compressive strength is needed, as there is a knowledge gap and insufficient data for this building material.~~

~~A repeat of the final testing discussed in this report is warranted once the above mentioned concerns are ironed out. This includes the original Aircrete, Stabilized Earth, stucco, and concrete which would have been close to 300 test cylinders plus trial and error cylinders.~~

~~Given the findings from this 1-year long experimental phase, Aircrete still has potential and some variables should be investigated further, as outlined above, before solidifying the recommendations on how applicable Aircrete structurally or for use as insulation.~~

~~FAQ~~

1. ~~What is Aircrete?~~
    a. ~~Aircrete is a mixture of foam from a foaming agent such as Seventh Generation Dish Liquid or Drexel that is mixed with cement slurry until homogenous.~~
2. ~~How did you know the consistency?~~
    a. ~~The consistency was based on time and color consistency of the mix. This was a limiting point because a test or parameter to accurately test evenly consistency of the mix was not used to tell if one part of the mix is heavier than another. Further~~

~~testing will include a density test and a comparison of the measured density with what was expected.~~

3. ~~How was the ratio of Aircrete determined?~~
    a. ~~Aircrete ratio was determined in a few ways. One was to use the Domegaia ratio and scale it down. The other way was Aircrete Harry's proportion which was already sealed down; however, to convert it to a cylinder amount, the ratio was sealed down more. The last way which was used during the experiment was by volume.~~
4. ~~What problems were recurring throughout the project that needed to be improved or thoroughly checked?~~
    a. ~~Some of the constant difficulties we ran into was one of the little dragon pressures not being constant for a longer period of time. An example is one time the density was 95 gram per liter and 10 minutes later the density fell by 10 and then a minute later it was less. This may have been a machine malfunction that we did not find until the later part of the project.~~
    b. ~~Another difficulty was the shrinkage during mixing and curing phase because of the inaccurate consistency of mixes. These happened only during light and standard because mixes with high foam ratios are more delicate/less stable, thus more susceptible to collapse, resulting in a lower final volume of Aircrete than targeted.~~
5. ~~Why use Aircrete?~~
    a. ~~Aircrete is another building resource that is more affordable, lighter (makes it easy to transport and use), and less toxic than concrete because there is less cement in the mix.~~
6. ~~Why not use other types of building material?~~
    a. ~~There are other options such as stabilized earth, recycled materials, and shipping containers. These are all options that One Community has envisioned in their question for a better world. Beside Stabilized Earth which One Community has~~

~~researched, Aircrete was the other concrete-like building resource that needed to be tested.~~

~~RESOURCES~~

~~Aircrete Video Resource~~

~~Aircrete Harry: Aircrete Collapsing Time Lapse~~

~~"Aircrete Collapsing Time Lapse." *YouTube*, Aircrete Harry, 2 Sept. 2018, https://www.youtube.com/watch?v=hPxrsHNGKuo.~~

~~Aircrete Harry: Aircrete Column Foam Agent Test Part 1 of 2~~

~~"AirCrete Column Foam Agent Test Part 1 of 2." *YouTube*, Aircrete Harry, 27 Aug. 2017, https://www.youtube.com/watch?v=y8tfn7RSFx8&t=573s.~~

~~Aircrete Harry: Aircrete Final Test Results AFter 4 weeks of Curing~~

~~"Aircrete Final Test Results After 4 Weeks of Curing." *YouTube*, Aircrete Harry , 4 Sept. 2018, https://www.youtube.com/watch?v=dI8WMa6lzkE&t=1s.~~

~~Aircrete Harry: Aircrete Foam Generator~~

~~"Aircrete Foam Generator." *YouTube*, Aircete Harry, 14 Sept. 2018, https://www.youtube.com/watch?v=biVuBSGiYh0.~~

~~Aircrete Harry: New Dome Building System~~

~~"Aircrete Harry NEW Dome Building System." *YouTube*, Aircrete Harry, 2 Dec. 2020, https://www.youtube.com/watch?v=DVk6xNFduH4.~~

~~Aircrete Harry: Aircrete Tools~~

~~"Aircrete Tools." *YouTube*, Aircrete Harry, 31 Aug. 2018, https://www.youtube.com/watch?v=6p-gWB3PDqM.~~

~~Aircrete Harry: Best Aircrete Foaming Agents for your Money~~

~~"Best Aircrete Foaming Agents for Your Money." *YouTube*, Aircrete Harry, 29 July 2018, https://www.youtube.com/watch?v=rY-oHAYjQ1E&t=581s.~~

~~Domegaia: Domegaia's Little Dragon Foam Generator Kit~~

~~"Domegaia's Little Dragon Foam Generator Kit." *YouTube*, Domegaia, 21 Sept. 2018, https://www.youtube.com/watch?v=u3Cx5YRuUyc&t=622s.~~

~~Domegaia: Domegaia's Low Cost Aircrete Housing~~

~~"Domegaia's Low Cost Aircrete Housing." *YouTube*, La Maison Du 21e Siècle André Fauteux , 4 Jan. 2022, https://www.youtube.com/watch?v=hDdIrpXTgJE.~~

~~Domegaia: Domegaia Aircrete Mixing Part 3: Foam Generation~~

~~F, David, director. *Domegaia Aircrete Mixing Part 3: Foam Generation 4K*. *YouTube*, Domegaia, 12 Sept. 2020, https://www.youtube.com/watch?v=CtzutTv4aLA&t=17s.~~

~~Aircrete Harry: How to Make Aircrete in a Mortar Mixer~~

~~"How To Make Aircrete In a Mortar Mixer." *YouTube*, Aircrete Harry, 23 July 2021, https://www.youtube.com/watch?v=4MdIyIEIjXc.~~

~~Aircrete Harry: How to Make Aircrete Part 1~~

~~"How To Make Aircrete Part 1." *YouTube*, Aircrete Harry, 1 Sept. 2018, https://www.youtube.com/watch?v=m28yNWnisvQ.~~

~~Aircrete Harry: How to Make Aircrete Part 2.0~~

~~"How To Make Aircrete Part 2.0." *YouTube*, Aircrete Harry, 2 Sept. 2018, https://www.youtube.com/watch?v=3gvQnWMTdIQ&t=1s.~~

~~Aircrete Harry: How to Make Aircrete Part 3~~

~~"How To Make Aircrete Part 3." *YouTube*, Aircrete Harry, 2 Sept. 2018, https://www.youtube.com/watch?v=NEX1O9VM_1M.~~

~~Aircrete Harry: How to Make Aircrete Part 4~~

~~"How To Make Aircrete Part 4." *YouTube*, Aircrete Harry, 2 Sept. 2018, https://www.youtube.com/watch?v=RrnxFmk5rMc.~~

~~My Tiny Wagon: How to Make Aircrete Using the Dragon XL~~

~~“How to Make AirCrete Using the Dragon XL.” *YouTube*, My Tiny Wagon, 4 Aug. 2019, https://www.youtube.com/watch?v=fPg23c39LiU.~~

~~Domegaia: How to Make Aircrete with Domegaia's Little Dragon and Foam Injection Mixer~~
~~“How to Make Aircrete with Domegaia's Little Dragon and Foam Injection Mixer.” *YouTube*, Domegaia, 22 Sept. 2018, https://www.youtube.com/watch?v=XVklJJRnaYM&t=18s.~~

~~Aircrete Harry: How to Operate the Aircrete Harry Foam Generator~~
~~“How To Operate The Aircrete Harry Foam Generator.” *YouTube*, Aircrete Harry, 30 Aug. 2019, https://www.youtube.com/watch?v=p8DtiI7VTG8.~~

~~Domegaia: How to Use Domegaia's Aircrete Foam Injector Mixer~~
~~“How to Use Domegaia's Aircrete Foam Injector Mixer.” *YouTube*, Domegaia, 22 Sept. 2018, https://www.youtube.com/watch?v=yICB1yc6cMo.~~

~~Aircrete Article Resource~~

~~Domegaia Home~~

~~"Domegaia Home." *Domegaia*, https://www.domegaia.com/.~~

~~Domegaia~~

~~*Domegaia*, https://forum.domegaia.com/.~~

~~Need Assistance with Air-Crete Making~~

~~HandyDan. "Need Assistance with Air-Crete Making." *Domegaia*, 30 Mar. 2018, https://forum.domegaia.com/topic/216/need-assistance-with-air-crete-making.~~

~~HOW TO MAKE AIRCRETE~~

~~"HOW TO MAKE AIRCRETE." *DIY Aircrete*, https://diyAircrete.com/howtomakeAircrete/.~~

~~Aircrete Is Collapsing~~

~~Leroy. "Aircrete Is Collapsing." Edited by Hajjargibran, *Domegaia*, 24 Aug. 2018, https://forum.domegaia.com/topic/41/Aircrete-is-collapsing.~~

~~Making Foam Concrete~~

~~"Making Foam Concrete." *FoamConcreteWorld.com*, Foamconcreteworld, 5 Feb. 2022, https://foamconcreteworld.com/making-foam-concrete/.~~

~~Aircrete Guide: Everything You Need to Know~~

~~Roberts, Tobias. "Aircrete Guide: Everything You Need to Know." *Rise*, 18 Jan. 2020, https://www.buildwithrise.com/stories/Aircrete-everything-you-need-to-know#:~:text=What%20is%20Aircrete%3F,material%20with%20impressive%20compressive%20strength.~~

~~Aircrete Character Resource~~

~~Aircrete Harry Aircrete Solution~~

~~Aircrete Harry. "Aircrete Problem."~~

~~Dr. Bai Concrete Solution~~

~~Bai, Jong-Wha. "Concrete Expert."~~

~~Hajjar Gibran Aircrete Solution~~

~~Gibran, Hajjar. "Domegaia Aircrete."~~

~~List of DIY videos:~~

~~Concrete Tutorial~~

~~Foam Tutorial~~

~~Aircrete Tutorial~~

~~Cylinder Mold Removal~~

~~Compression Testing Tutorial~~

List of helpful documents:

Concrete Mix Calculations - Make this its own sheet

Initial Planning Documents

Mixing plan

here - materials

a cleaning plan,

video/documentation plan

Aircrete Testing trials follow this link

Trial Run Data Sheet

foaming agent test

here - my summary

Add foam investigation tab from here:

https://docs.google.com/spreadsheets/d/1rAZU4LC4P9mid5Pc9M5hRlcKOgn9jmtoHxq3u2Co_28/edit#gid=1947627194

Actual Test Cylinder Data Charts.pptx Actual Test Cylinder Data Sheet