INITIAL PLANNING PHASE - MIXING PLAN FOR AIRCRETE, STABILIZED EARTH, AND STUCCO

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Aircrete Plans: new outline Trial and error runs of aircrete.

Video

Success (3x)

From scratch - start with dry cement

4th person the video

1 person per batch

1. Concrete (Control)

Mixing Plan & Materials

a. Materials

i. Using Quikrete ready mix 4000 psi concrete

ii. For every 13.33 lb of mix add 1 pints/.5 liters of water. Adjust water to reach 2-3inchs of recommended slump.

TABLE 2 MIXING WATER FOR QUIKRETE® CONCRETE MIX

Package Size lb (kg)	Starting Water Content pt (L)	Maximum Expected Water Content pt (L)
40 (18.1)	3 (1.4)	4-1/2 (2.1)
50 (22.6)	3-1/2 (1.7)	5-1/2 (2.6)
60 (27.2)	4 (1.9)	7 (3.3)
80 (36.2)	6 (2.8)	9 (4.3)
90 (40.8)	7 (3.3)	10 (4.7)

iii.

iv. A 90 lb bag yields .67ft^3 of concrete. Each cylinder is .196ft^3 which gives a conversion factor of 3.418.

v. For 1 cylinder we need approximately 26.33lbs of ready mix and 2-3.1 lbs of water. If performing a slump test add 2.6lbs more concrete mix and .2 lbs of water. This is proportional to the above specs.

vi. The choice to use 4000 psi strength concrete is because of its strength and wide variety of use. This type of concrete can be used for many applications such as walls, columns, pavement, etc. Considering aircrete users will be using aircrete for many different applications, the use of 4000 psi concrete seems appropriate. Previously the group wanted to use

3000 psi, but that strength is mostly used for general use but with some advice from Dr. Bai 4000 concrete is more widely available and used more often. Seeing that our aircrete mixture will be used for sustainable dome homes I thought it necessary to use 4000 concrete.

vii. The choice to use 4000 psi concrete for our test was also based upon the following references: https://www.portaggregates.com/concrete-used-in-residential-projects/ 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. We feel the backyard shed and workshop closely resembles the strength needed for a dome structure. Thus, the use of 4000 psi is slightly more durable and stronger than 3000 psi and a great choice for these structures.

viii. https://cor-tuf.com/everything-you-need-to-know-about-concrete-strength/#:~:text=Concrete%20footings%20and%20slabs%20on,psi%20is%20needed%20for%20pavement 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, we have chosen to produce concrete in the middle of that range at 4000 psi and to stay consistent with existing widely available ready mixes.

ix. Also we took some advice from our professor, Dr. Bai. He stated that previously the industry standard was 3000 psi concrete, but now the normal concrete strength is 4000 for structural members. This statement is relative to the information stated in the previous paragraph thus we felt it best to use 4000 psi as it is the typical strength of structural members. In many cases 3000 psi concrete is the bare minimum strength used, it is good for climates where freezing points are often reached, because they are less prone to cracking due to having less portland cement in them. Although 3000 psi is not a bad choice to use, in industry and practice 4000 psi concrete is more commonly used and a safer choice for many different applications.

x. Besides its strength and durability, this thinking came from the reasons why we are testing aircrete (cement, 7th gen soap, water) in the first place. This was because it is cost efficient and these products are more widely available to people around the world. So this was one of the ideas behind why we chose a concrete mix which is readily available and cost efficient. The quikrete bag of concrete is very popular and has a rating of 4000psi.

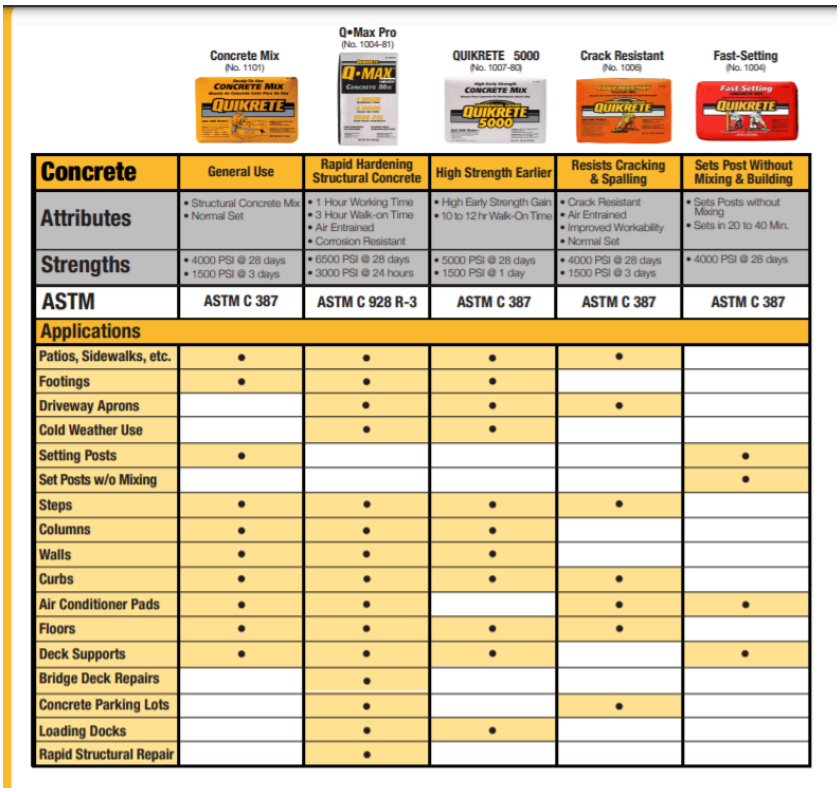
xi. The difference between 3000 and 4000 psi is the contents of the concrete mix. In order to build strength of concrete the addition of more coarse aggregates and portland cement is important. The coarse aggregate and

cement binds and interlocks everything together in the mix and thus provides a higher psi concrete less resistant to breaking apart.

xii. Buy Link: https://www.homedepot.com/p/Quikrete-90-lb-Concrete-Mix-110190/100318523

xiii. - reference:
https://www.gizmoplans.com/is-quikrete-as-strong-as-concrete/
https://www.quikrete.com/pdfs/concreteselectorguide.pdf

xiv.



Concrete	General Use	Rapid Hardening Structural Concrete	High Strength Earlier	Resists Cracking & Spalling	Sets Post Without Mixing & Building
	Concrete Mix (No. 1101)	Q•Max Pro (No. 1004-81)	QUIKRETE 5000 (No. 1007-80)	Crack Resistant (No. 1008)	Fast-Setting (No. 1004)
Attributes	• Structural Concrete Mix • Normal Set	• 1 Hour Working Time • 3 Hour Walk-on Time • Air Entrained • Corrosion Resistant	• High Early Strength Gain • 10 to 12 hr Walk-On Time	• Crack Resistant • Air Entrained • Improved Workability • Normal Set	• Sets Posts without Mixing • Sets in 20 to 40 Min.
Strengths	• 4000 PSI @ 28 days • 1500 PSI @ 3 days	• 6500 PSI @ 28 days • 3000 PSI @ 24 hours	• 5000 PSI @ 28 days • 1500 PSI @ 1 day	• 4000 PSI @ 28 days • 1500 PSI @ 3 days	• 4000 PSI @ 28 days
ASTM	ASTM C 387	ASTM C 928 R-3	ASTM C 387	ASTM C 387	ASTM C 387
Applications					
Patios, Sidewalks, etc.	•	•	•	•	
Footings	•	•	•		
Driveway Aprons		•	•	•	
Cold Weather Use		•	•		
Setting Posts	•				•
Set Posts w/o Mixing					•
Steps	•	•	•	•	
Columns	•	•	•		
Walls	•	•	•		
Curbs	•	•	•	•	
Air Conditioner Pads	•	•		•	•
Floors	•	•	•	•	
Deck Supports	•	•	•		•
Bridge Deck Repairs		•			
Concrete Parking Lots		•		•	
Loading Docks		•	•		
Rapid Structural Repair		•			

xv. The chart shown above shows the many different options provided by Quikrete. On the left portion of the chart is the type of concrete mix that will be used in the experiment, which is the 4000 psi rated concrete mix. The chart shows the many different purposes that this mix can be applied to and further proves the reason why this mix is a great choice for our standard concrete control, because we are assuming aircrete will be used in the same type of applications. When the compression testing is done we can relate the characteristics (such as cracking, deformation, strength, durability etc) of the aircrete back to the control to see how well or worse it performs.

b. Concrete Mix Plan

i. Materials: The concrete chosen for the standard concrete/control consists of a Quikrete High Strength Ready Mix which after 28 days of curing produces a concrete slab with a strength of 4000 psi.

ii. According to the company's instructions and standards a 90lb bag of concrete will need to be mixed with 7-10 pints of water. https://www.quikrete.com/pdfs/data_sheet-concrete%20mix%201101.pdf

iii. For a yield volume of .196ft^3 the amount of concrete mixed used will be 26.33 lbs along with 2-4lbs of water.

iv. The group will mix the dry material (26.33 lbs) of quikrete in the mixing tub before any water is added. This will ensure the contents inside of the bag are thoroughly mixed.

v. Inside of a separate mixing tub the group will pour their desired amount of water then incorporate their dry mix into the water in thirds. Pouring in the dry mix at a slow rate will help minimize clumping of materials.

vi. Once the dry and wet materials are combined the group will utilize their hands as well as mixing tools to mix the combination until a uniform consistency is achieved.

vii. Once the mix is thoroughly mixed the group will perform a slump test. This will determine if the water content in the mixture needs adjusting. This will be done by scooping the concrete into a cone shaped apparatus specifically used for a slump test. The slump cone is to be filled in ⅓ portions. Every ⅓ of the way up a member of the group will take a rod and tamp the mix 25 times. It is important to make sure the rod is angled slightly to evenly distribute the mix in the corners of the slump cone and to tamp in a cross pattern to ensure every part of the surface is leveled. While tamping, the rod should not penetrate until it hits the bottom surface or penetrate the previously tamped portion of the mix.

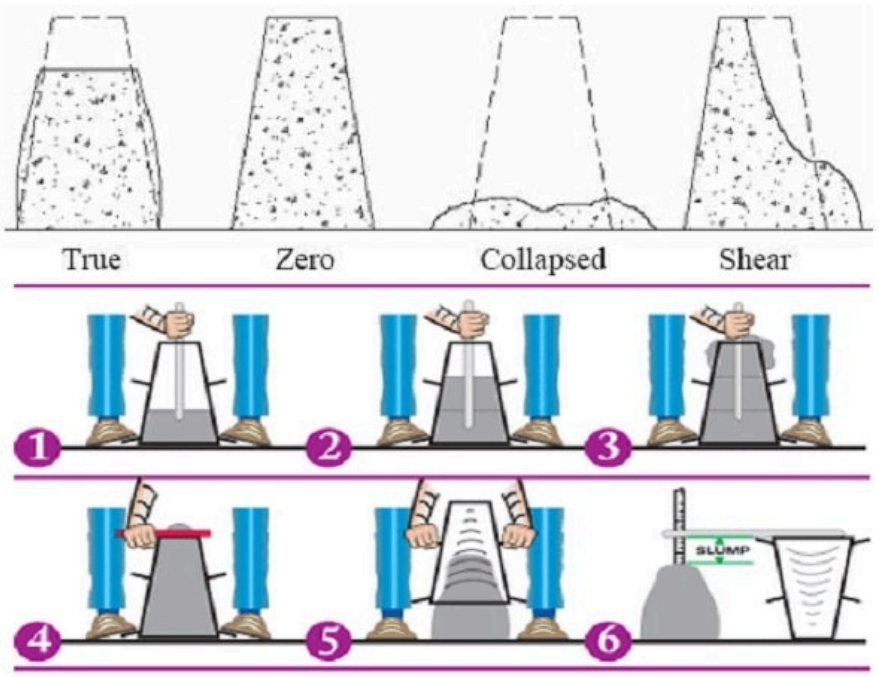
viii. Once the slump cone is filled a member of the group will take the rod and roll it over the top of the slump cone to scrape off any of the excess mix protruding from the top of the apparatus. The excess concrete around the cone will need to be removed from the area before the next step.

ix. The slump cone will now need to be removed from its base. To do so someone will lift the slump cone vertically until it is completely out of the way of the mixture. Left behind will be vertically standing concrete.

x. Picture for reference can be seen below.

xi. Reference: https://theconstructor.org/concrete/concrete-slump-test/1558/

xii.



xiii. According to the manufacturer's specifications, the concrete stack will have drooped down or "slumped" between 2-3 inches. If the concrete slumped greater than the manufacturer's specs then too much water was added, and if it slumped less than not enough water was added.

xiv. After the correct slump is obtained the concrete mixture can be used. According to the manufacturer's instructions the initial curing time is about 24-48 hours until it is able to be handled. Maximum strength and curing will take a minimum of 28 days.

c. Testing the Plan

i. Using the above mixing the plan the concrete mix turned out very well. The group tested the slump before placing the mix into a mold and received a reading of 3 inches of slump. This is within the manufacturers requirements of 2-3 inches of slump. The pile of concrete also did not fall or break apart but slumped down nicely.

ii. 

d. Results of the Plan

i. After 48 hours of curing the cylinder was mostly dry and hardened well. This is well within the manufacturers specifications where it states that the concrete is usable between 24-48 hours of curing. Below is a photo of the concrete mix after 48 hours.

ii.

iii. 

e. Actual Testing

2. Standard Aircrete

a. Mix Materials

1. Foam to water ratio : 2 cups of 7th generation Natural Dish Liquid to 5 gallons of water

2. 7th generation dish soap was used because it is more widely found and easier to obtain. This is important because we want this process to be easily replicable and accessible to the public. From a building standpoint the 7th gen soap contains glycerin, which is a foam stabilizer. The glycerin helps maintain the longevity of the structure of the foam. In other words, it helps the bubbles remain as bubbles. According to https://www.domegaia.com/foaming-agents.html, a company which has utilized aircrete for many years states that 7th generation soap outperformed other brands such as dawn and safeway. It provided the best quality foam for their aircrete structures.

3. Domegaia also has tested Axion if the 7th generation soap is not available. If neither are available, Domegaia suggests going to a local restaurant and asking what soap they use for cleaning. He also suggested finding the soap with the highest sodium lauryl sulfate content and going to the pharmacy and adding glycerin if the soap does not contain glycerin.

4. Aircrete Harry tested soaps out which includes 7th generation, dove, suave, drexel, etc
    a. His choice of soap is the drexel for its more stable results as seen in these links
    b. https://www.youtube.com/watch?v=uDPbJUEthEo
    c. https://www.youtube.com/watch?v=S1ydXgWDU00
    d. https://www.youtube.com/watch?v=rY-oHAYjQ1E

5. Not many other soaps contain glycerin beside drexel. We chose not to use drexel, because it is more of a novelty item, not widely accessible and toxic. Density: 90 - 100 grams / liter (3oz / quart)

6. For our case we use a quart sized measuring cup and have it weigh 100 grams.
    a. The foam density will be the same across all tests.. The only difference between the standard, lighter and heavier is

the amount of foam incorporated into the cement & water mixture.

b. Cement & Water Mixture Materials

1. Cement ratio : 94 lb bag of cement to 6 gallons of water
2. Add water first before putting cement to reduce cement clumps
3. Therefore reduced ratios will be 3.13lbs of cement to 1.67 lbs of water

Mixing Plan

1. The following instructions will create a total volume of 1.5 gallons/.196ft^3 of aircrete. In order to use these directions for any desired amount of aircrete, multiply the total volume until the desired amount is achieved. Similarly multiply the listed cement and water mixture listed below by the same number. For example if a 5 gallon bucket of aircrete is desired, 1.5 gallons x 3.33 = 5 gallons. Therefore multiply the cement and water mixture by 3.33.

   NOTE: Step 2 is not to be multiplied. The soap and water mixture stays the same but if more foam is needed one can simply double or triple the amount of soapy water mixture.

2. First step is to create a soapy water mixture for the foam.
   a. Start by adding 16 ounces 7th Generation Soap into a 5 gallons bucket filled with water.
   b. Stir the soap and water until it is fully mixed. (Always stir the liquid before using)
   c. Placed the Little Dragon on top of the 5 gallon bucket with the poly tubing in the bucket of soapy water.
   d. Connect the foam wand to the Little Dragon by firmly pushing the poly tubing into the fitting under the switch and in the end of the wand.
   e. Adjust the quick connect fitting and ball valve by screwing them into the pressure regulator.
   f. Connect an air-compressor and set the pressure regulator to around 40-60 psi.
   g. Once the Little Dragon is all set up, turn the ball valve off so the pump can prime itself.

h. Turn on the switch and open the ball valve slowly when liquid runs out.

i. After three seconds of the foam wand running, catch the foam in a container and check the foam weight with an accurate scale. (The foam should weigh 90-100 grams per quart. Using a quart size measuring cup, which is widely available from most home improvement stores, fill the cup and weigh the contents inside. Increase the air pressure to produce lighter foam and decrease the air pressure produce heavier foam. Adjust accordingly until it reaches 90-100 grams.)

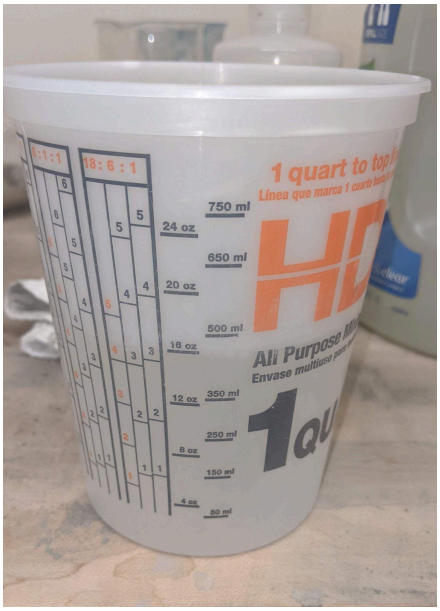
3. Next step will be to create the Portland cement and water mixture.
    a. To obtain standard aircrete, weigh out the standard amount of cement for the mix which is 3.13 lbs of cement and 1.67 lbs of water.

    b. In a clean bucket pour in the water, doing so will prevent the cement from sticking to the bottom of the bucket. Utilize a powerful drill with an auger type of attachment and start stirring the water while slowly pouring the cement into the bucket. The cement and water must be mixed together thoroughly until a uniform consistency is achieved. The mixture should resemble a smooth texture with no large bubbles and no clumps of cement.

    c. Once the cement and water are combined, add in _____ quarts of foam into the cement and water slurry. Another method to incorporate foam into the aircrete mixture has reached 1.5 gallons. Make sure to operate the drill simultaneously ensuring the foam mixes well into the cement mixture. You will know this is achieved correctly when the aircrete has no visible bubbles (but should contain very small micro bubbles) and takes on a smooth toothpaste-like consistency.

4. Once the aircrete mix meets all of the above characteristics and specifications the aircrete can be poured into your desired mold.

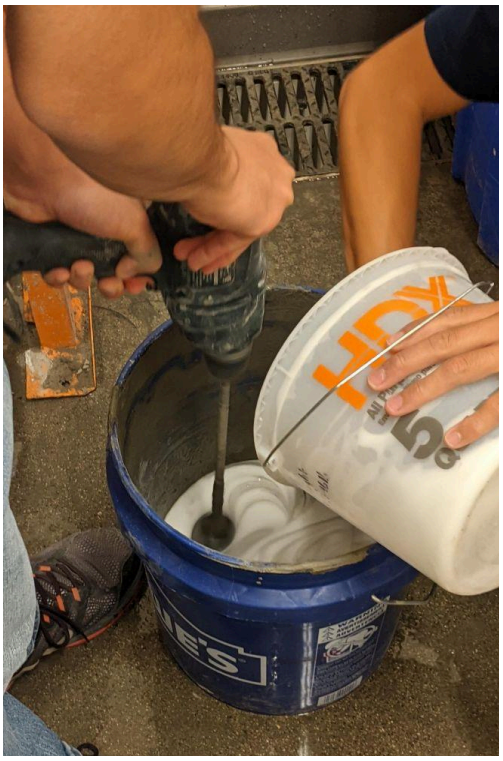
Testing the Plan



This is 16 ounces (2 CUPS) of 7th gen soap

Mixing the 2 cups of soap into 5 gallons of water

Setting our pressure to obtain 90-100g/qt of foam



Measuring out our foam and pouring it in.

Mixed for a short period of time. Only enough time to thoroughly mix our aircrete.

Results of Plan

1. After about 30 minutes the pour had collapsed. Thus deeming it a failure. After this initial mixture the group had pondered about the contributing factors that lead to the collapsing. One idea which was found on https://www.domegaia.com/aircrete-faqs.html was that using 12 inch high cylinders caused the collapse. The reasoning was that the air cell strength was too weak compared to the force of gravity.

Shrunken aircrete mix

New Mixing Plan

1. Since having the cylinders upright was near the max recommended height of 12 inches we decided to cure the cylinders on their sides. Therefore the height of the cylinder is only about 6 inches. We also will pour our mix into a cylinder which we have cut in half at 6 inches tall. Then we observe them for any shrinking.

Testing the New Plan & Results of Plan

1. So we repeated the exact procedures as previously stated above, but after pouring them into the 12 inch tall cylinder we plastic wrapped the top then laid it on its side to cure. We also poured one 6 inch tall cylinder to cure. We let them sit for some time to observe any collapsing. We do not have many photos of these cylinders but this did not fix our collapsing issue. There was still a significant amount of collapsing whether on its side or in a shorter cylinder.

New Mixing Plan

1. So since we were experiencing shrinking/collapse we thought it was the type of mixing drill bit. We felt that the previously used auger type of attachment took far too long to mix, incorporated too much air and was too small. Jarot went to the local home depot to pick up a larger egg beater style attachment and paired that with a more powerful drill to use to mix the aircrete.
2. Below is a picture of the auger drill bit (left) and the egg beater attachment (right).

Results of Plan

1. The group utilized the same previously mentioned measurements except with this style of drill bit making sure not to overmix by only using the drill for a short period of time until a uniform color was achieved. The drill bit did mix the aircrete much quicker but after pouring them into the cylinders the aircrete still collapsed.

New Mixing Plan

1. Before we measured out what we thought was the correct amount of foam prior to incorporating the foam into the mix. For this next trial we decided to add the foam directly to the mixing bucket while at the same time mixing the aircrete instead of weighing it out beforehand. The reasoning behind this was because we felt the foam could potentially lose its integrity while sitting in the measuring bucket.

Results of Plan

1. So after adding foam directly to the mix we found that the aircrete still collapsed after some time had passed. It seemed as if their was still to much air in the mixture

New Mixing Plan

1. The group felt that all of the drill bit types of mixers incorporated too much air into the mix. Therefore, we decided we should try the large rolling cement mixer. We felt that the mixer moved at a slower pace and was less aggressive and that this would ultimately mean less air whisking motion would take place thus meaning less air in the mix. We would leave the slurry to mix in the mixer only until everything was thoroughly mixed. We wanted to avoid overmixing the aircrete.

Results of Plan

1. In the mixer it is typical that some amount of the material will be lost because it clings to the sides of the barrel. To make up for the amount loss we doubled all of our amounts of ingredients (cement, water, foam). Although the mixer seemed like a great idea the poured cylinder still suffered from collapse. Using the cement mixer was a failed attempt.

New Mixing Plan

1. So since all of the above mixers (auger, egg beater, cement mixer) yielded failed results, we decided to look towards how we incorporate foam. Before we measured out the foam in a separate container then added the foam to the mix. We did this because we assumed the volume of foam never changed even when incorporated into the mix. For this plan we decided to shoot the foam directly to the mix (not inside but on top because we did not have a longer attachment) then

mix simultaneously. We did this until the volume of the mix reached 1.5 gallons (size of our cylinder) without going over the 1.5 gallon mark.This idea came from watching Domgaia's videos where they utilize a drill attachment that shoots foam directly to the mix. Although their method doesn't shoot the foam on top of the mix we focused on the fact that they did not let the foam sit around; they injected the foam right away. Later on we came up with an idea on how to shoot foam directly into the mix.

Results of Plan

1. All of the measurements of cement and water remained the same as the previous trials. First we mixed the cement and water then added foam to the top of it while mixing. The foam was mixed in right away and we did not let it sit at all. Still after about 30 minutes to an hour the mix started to rapidly collapse.

New Mixing Plan

1. This time around we decided to make an attachment for the little dragon so that we could inject foam directly to the bottom of the bucket right next to the spinning drill bit. We made this possible by duct taping a piece of pvc pipe to the little dragon wand (picture can be found below on the left). This way we could inject foam directly into the mix. This idea came directly from domegaia's foam injector (shown below on the right). Their apparatus shoots foam directly to the bottom of the mix. Then we would mix the aircrete (not overmix) until a uniform color and consistency was achieved.

Results of Plan

1. The process seemed to work better; it was easier and faster to mix. We did not mix the aircrete too long making sure that the foam was not broken down too much. After 30 minutes to an hour the aircrete still collapsed. We feel that this was not the issue because there are examples of people making successful aircrete by injecting foam and also pouring it on top. As we see from videos from aircrete Harry (https://www.youtube.com/watch?v=3gvQnWMTdIQ) he is able to make successful aircrete by pouring it on top. Domegaia injects their foam but both methods seem to produce good aircrete.

New Mixing Plan

1. So having searched domegaia's forums we thought we had found a good thread dealing with troubleshooting aircrete. https://forum.domegaia.com/topic/41/aircrete-is-collapsing. One of the members on the thread stated that the quality of water was important. They utilized reverse osmosis water and they were able to stop their collapsing mixture. We are dealing

with Riverside tap water so we thought it best to try a different source of water, distilled water.

Results of Plan

1. This mix turned out like all of the others and still collapsed. Now we know that the water quality is not the issue here.

New Mixing Plan

1. Another idea was that the temperature of water was not correct. According to members on the domegaia forum https://forum.domegaia.com/topic/790/collapsing-forms-remedy-warm-water using warm water could help the cement set up. We decided to try using warm water to our plan to see if this would help.

Results of Mixing Plan

1. The use of warm water actually did something interesting. The cylinder still collapsed but it took a bit longer to collapse. When it usually collapsed at about 30 minutes this time around it took about 2 hours. We know that this is still a failure but it was interesting to see the difference in the time it took to fail.

New Mixing Plan

1. So for the new plan we thought about how much we were incorporating to the mix. According this video (https://youtu.be/6OFsm22t9eM) I noticed that he mixed the mixture for a very long time. It seemed as though he added foam until it went past his marking, then he mixed it for a long time until the mixture reduced in volume. It seemed as if he was breaking down the foam in the mix

until the foam was liquified and there was a balance of broken down foam and normal in the mix and reduction did not take place. We thought we would try this method out by adding foam past the 1.5 gallon mark and then mixing for a long time until the entire mixture reduced down until 1.5 gallons.

Results of Plan

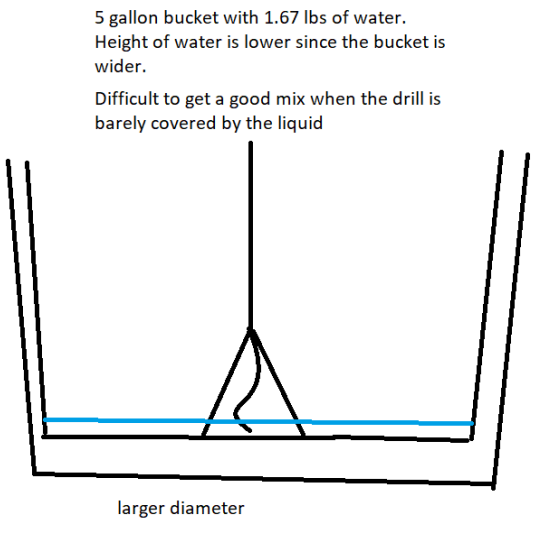
1. For this mix we closed the lid to prevent any air from escaping. So far it has been over 2 hours there is not shrinking, but this mix is still curing and we will check on this tomorrow (8/3/21).

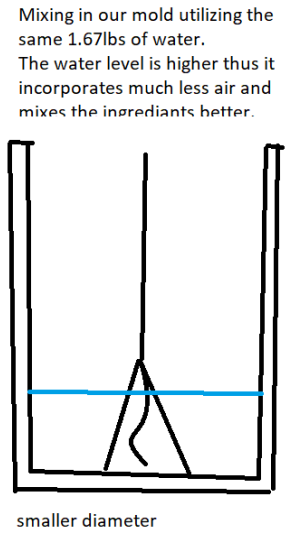
2. Update: (8/4/21) The cylinder did not experience any collapsing or shrinking. Here are photos of it after 48 hours of curing.

New Mixing Plan

1. So for this plan we decided to do our mix inside of a cylinder. Before we were making our mix in a 5 gallon bucket but this time we decided to use a smaller container. Using the 5 gallon bucket we were putting in there 1.67 lbs of water and 3.13 lbs of cement mix. This portion of the materials in a relatively large 5 gallon bucket only covered the bottom of the auger tool. In our minds it seemed like since only the bottom of the auger tool was in the liquid the rest of the tool

was not covered by liquid. This meant that it was incorporating air to the mix. Doing the mixing in the smaller cylinder meant the height of the cement and water mixture was higher than in the 5 gallon bucket. This meant that the tool was more submerged meaning theoretically very minimal air will be introduced to the mix. SO we are going to add our mix into the mold, mix it in there and add foam while mixing until it fills the cylinder. This method is very similar to domegaia's but on a smaller scale. Domegaia uses a 55 gallon barrel and fills it with 6 gallons of water. That 6 gallons of water is enough to cover their mixing attachment fully (picture shown on right). This helps to improve the mixing and also doesnt let the mix get too frothy or filled with air. Utilizing a smaller mixing container raises our water level in the same fashion and helps us get a better less frothy aircrete.





Results of Plan

1. So far this mix looks very good. The texture is velvety, smooth and not too frothy like our other mixes. This seems to be the most consistent with what we have seen online. We copied exactly as domegaia has done but we have plastic wrapped this

cylinder to trap any air from escaping. So far there is not shrinking, but this mix is still curing and we will check on this tomorrow (7/3/21)

2. Update: (7/4/21) This cylinder turned out very well. It was more dry and harder than the previously made test. Below is a photo of the cylinder

New Mixing Plan

1. We tried to recreate the same mixture as the above cylinder. We followed our procedure exactly as we did previously.

Results of Plan

1. The outcome was not very good. For whatever reason we had a collapsing aircrete cylinder. We are not sure what happened since we recreated the exact procedure. The feel of the aircrete was hard and dry to the touch after 24 hours but the volume of the aircrete has collapsed. We are going to try to make adjustments to our previous process.

New Mixing Plan

1. So our issue with the above cylinder was that we didn't spend enough time running the drill and mixing the aircrete. Our new plan is to mix the aircrete much longer to make sure we get a thorough mix.

Results of Plan

1. Our aircrete cylinder was stable and did not collapse. For all of our runs now we extended our mixing time to about 5-10 minutes. Before we only mixed until a uniform color was achieved, but now we have decided to mix longer and more thoroughly. We are making sure to bring the drill up to the surface and down to the bottom of the container repeatedly to get every part of the mix. After the extended mixing time (5-10 minutes) we noticed the mix was a smoother and creamier texture much like the reference shown on the right (https://www.youtube.com/watch?v=nDk4_G1WNHU) .

The picture below is of the cylinder after 24 hours of curing. Yes the top layer is a bit jagged looking but this is due to some aircrete attaching onto the plastic wrap.

3. **Light Aircrete**
    a. Mix Materials
        i. Foam to water ratio : 2 cups of 7th generation Natural Dish Liquid to 5 gallons of water
        ii. 7th generation dish soap was used because it is more widely found and easier to obtain. It also contains glycerin which is a foam stabilizer which other soap does not contain beside drexel, however; drexel is more of a novelty item and harder to obtain. It is important to use a foaming agent which provides long lasting and firm foam. According to https://www.domegaia.com/foaming-agents.html, a company which has utilized aircrete for many years states that 7th generation soap outperformed other brands such as dawn and safeway. It provided the best quality foam for their aircrete structures.
        iii. Density: 90 - 100 grams / liter (3oz / quart)
        iv. For our case we use a quart sized measuring cup and have it weigh 100 grams.
            1. The foam density will be the same across all tests.. The only difference between the standard, lighter and heavier is the amount of foam incorporated into the cement & water mixture.
4. Cement & Water Mixture Materials
        i. The mix utilized 30% less cement and water in this mixture. This means more foam will be used.
        ii. Cement: lb
        iii. Water: lb
        iv. Foam: quarts

    b. Mix Plan
        i. For this set the group decided to use 30% less cement and water for a single cylinder. Utilizing less cement and water would mean that the rest of the cylinder would need more foam than the standard mix. This would

ultimately mean a much lighter weight aircrete over the standard mix. After the cement and water mixture is mixed thoroughly the group will add the remaining volume of the cylinder with foam which is approximately 4.7 quarts of foam.

c. Testing the Plan
d. Results of Plan
e. New and Improved Plan
f. Actual Testing

5. Lighter Aircrete (30% more foam compared to standard)

a. Mix Materials
    i. Foam to water ratio : 2 cups of 7th generation Natural Dish Liquid to 5 gallons of water
    ii. 7th generation dish soap was used because it is more widely found and easier to obtain. This is important because we want this process to be easily replicable and accessible to the public. From a building stand point the 7th gen soap contains glycerin, which is a foam stabilizer. The glycerin helps maintain the longevity of the structure of the foam. In other words it helps the bubbles remain as bubbles. According to https://www.domegaia.com/foaming-agents.html, a company which has utilized aircrete for many years states that 7th generation soap outperformed other brands such as dawn and safeway. It provided the best quality foam for their aircrete structures. Not many other soaps contain glycerin beside drexel. We chose not to use drexel, because it is more of a novelty item, not widely accessible and toxic. Density: 90 - 100 grams / liter (3oz / quart)
        1. Density: 90 - 100 grams / liter (3oz / quart)
        2. For our case we use a quart sized measuring cup and have it weigh 100 grams.
            a. The foam density will be the same across all tests.. The only difference between the standard, lighter and heavier is

the amount of foam incorporated into the cement & water mixture.

iii. Cement & Water Mixture Materials

1. The mix utilized 30% less cement and water in this mixture. This means more foam will be used.
2. Cement: 2.19lb
3. Water: 1.17lb
4. Foam: 5.214 quarts

b. Mixing Plan

i. For this set the group decided to use 30% less cement and water for a single cylinder. Utilizing less cement and water would mean that the rest of the cylinder would need more foam than the standard mix. This would ultimately mean a much lighter weight aircrete over the standard mix. After the cement and water mixture is mixed thoroughly the group will add the remaining volume of the cylinder with foam which is approximately 4.7 quarts of foam.

c. Testing the Plan

i. The process started out with mixing the cement and water in the mold. This allowed the auger drill bit to be more submerged than using a 5 gallon bucket. Once the cement and water were fully mixed together the group measured out 4.7 quarts of foam at 100g/qt and incorporated it into the mix. They made sure not to overmix and did not want the overall mix to reduce at all.

d. Results of Plan

i. The cylinder collapsed more than any previous tests that we have performed. We believe that perhaps this was caused by improper mixing or taking out 30% of cement and water was far too much of a reduction which meant the foam did not have enough liquid to hold the air cells in place. Below is the photo of the collapsed cylinder

e. New and Improved Plan
    i. For our new plan we are going to try and mix the aircrete more thoroughly. Before we may have not run the drill in reverse and forward so for this test we will try both. Running the drill in the forward direction only brings the denser material downward leaving the majority of the air at the top. Running it backwards brings the denser material upward leaving the majority of the aircells at the bottom. So we may need to balance these actions in order to get a good mixture.
f. Results of Plan
    i. We tested this procedure out twice making our mix 30% lighter/less cement but both times our cylinders failed by collapse. We believe that this is because utilizing a mix with 30% less cement is far too little an amount of cementitious mixture. We believe this is true because we tested another mixture with 20% lighter than standard and that did not collapse.
    ii. On the left is after 24 hours of curing and on the right is after 3 hours of curing.

iii. 

g. Actual Testing

6. Heavy Aircrete
    a. Mix Materials
        a. Foam to water ratio: 2 cups of 7th generation Natural Dish Liquid to 5 gallons of water
        b. Density: 90 -100 grams / liter (3oz / quart)
            i. For our case we use a quart sized measuring cup and have it weigh 100 grams.
                1. The foam density will be the same across all tests.. The only difference between the standard, lighter and heavier is the amount of foam incorporated into the cement & water mixture.
        c. Cement & Water Mixture Materials
            i. The mix utilized 30% more cement and water in this mixture.
            ii. Cement: 4.07 lb
            iii. Water: 2.17 lb
            iv. Foam: 4.54 qt
    b. Mixing Plan
        i. For the heavy aircrete we copied our exact same procedure as our successful standard aircrete.
        ii. The first step is to mix the cement and water very thoroughly making sure to add the cement slowly to avoid clumping.
        iii. Once the cement and water is combined thoroughly we will measure out 4.54 qt of foam at 90-100 gram/quart.
        iv. We will incorporate the foam into the cementitious mix utilizing the auger mixer on the end of a drill bit. We will continue mixing until the consistency and color is even and uniform.
        v. We will need to make sure to move the mixer vertical and around the container to make sure that the entire mix has been gone through.
    c. Testing the Plan

i. When doing the above procedure we found that mixing the heavy aircrete and combining it with foam happened more efficiently and faster. We believe that this was due to having more liquid/cementitious mix compared to standard.

ii. After a couple of hours of waiting we did not notice and collapsing or shrinking of the cylinder.

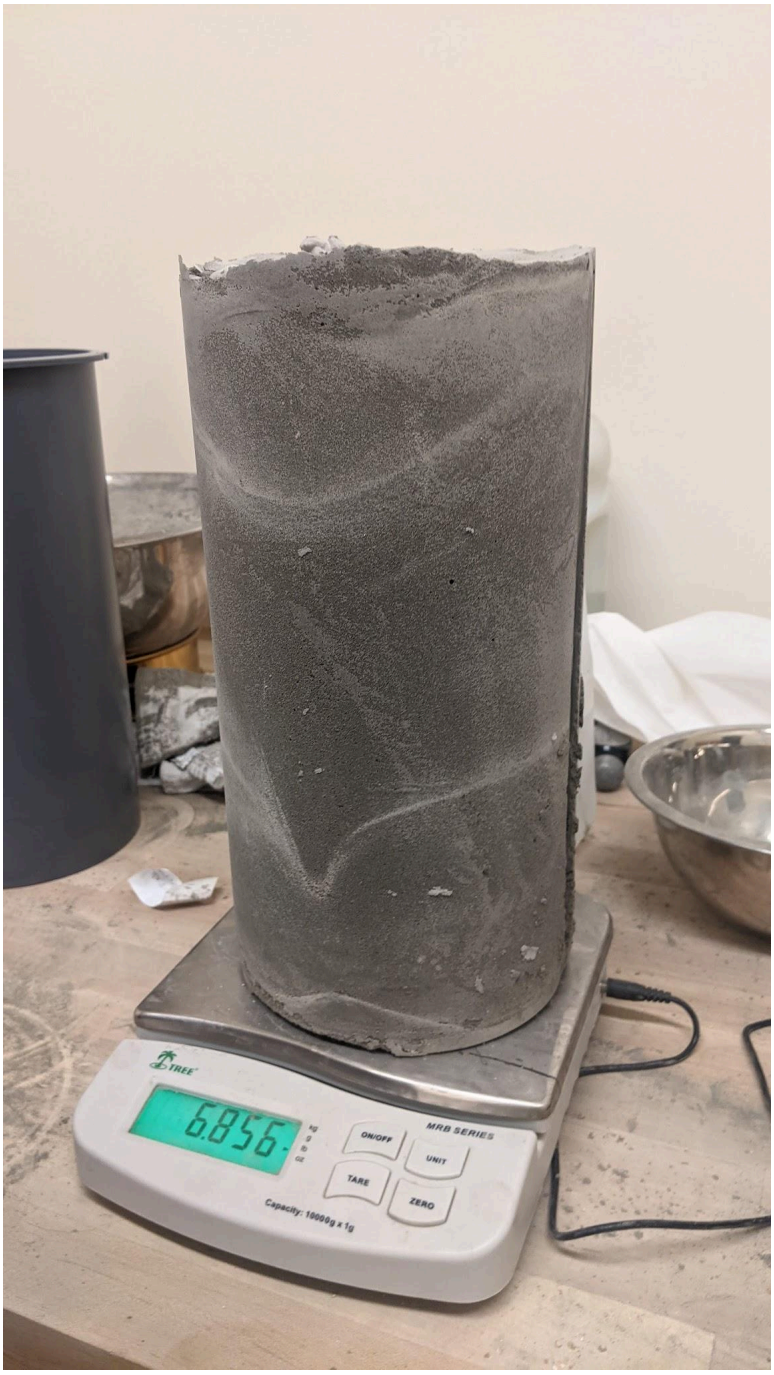
d. Results of Plan

i. When we tested the plan we used the above procedure. After mixing thoroughly and letting it cure for a few days the aircrete cylinder became hard and solid.

ii. Comparing it to standard aircrete the cylinder was heavier and had a smoother exterior.

iii. The successful aircrete cylinder is shown below

1. Cement: 4.07 lb
2. Water: 2.17 lb
3. Foam: 4.54 qt

iv. 

e. New and Improved Plan

   i. The plan proved to be successful and resulted in a sturdy solid cylinder of aircrete. We do not believe we need to restructure the process in any other way.

f. Actual Testing

7. **Heavier Aircrete**
    a. Mix Materials
        a. Foam to water ratio: 2 cups of 7th generation Natural Dish Liquid to 5 gallons of water
        b. Density: 90 -100 grams / liter (3oz / quart)
            i. For our case we use a quart sized measuring cup and have it weigh 100 grams.
                1. The foam density will be the same across all tests.. The only difference between the standard, lighter and heavier is the amount of foam incorporated into the cement & water mixture.
        c. Cement & Water Mixture Materials
            i. The mix utilized 60% more cement and water in this mixture.
            ii. Cement: 5.01lb
            iii. Water: 2.67 lb
            iv. Foam: 4.21 qt
    b. Mixing Plan
        i. For this mixture the group decided on using 60% more cement and water in the cylinder which means there is less foam needed to be incorporated for the heavier aircrete mix. Since there is way more cement being added, it is going to be a heavier aircrete mix. Once the cement and water have been thoroughly mixed together, the group will add in the foam which is about 4.21 quarts.
    c. Testing the Plan
        i. In order to do the process, the cement and water are mixed together in the cylinder until it is mixed properly. The auger drill bit is allowed to be more submerged than using the 5 gallon bucket. Once the cement and water are fully mixed together, the group measured 1.88 quarts of foam at 100g/qt and incorporated it into the mix.

d. Results of Plan

    i. After the 48 hours that the cylinder sat for and dried, it was a success. The mix stayed in the same spot at the top and did not shrink. One reason for the success was that it was mixed thoroughly so that the cement and foam are fully incorporated together. If it is not mixed properly, the unmixed foam causes the shrinking. Not only that but this was expected with this mix because it did have less foam and more cement in it which caused it to not produce as much air.

ii. 

8. Stabilized Earth Mix A (standard)
    a. Mix Materials
        i. Stabilized Earth Proportions (1 cylinder = 1.5 gallon)
            1. 85% soil mixture (30% clay, 70% Sand), 15% cement mixture
                a. 56% sand of soil mixture

b. 25.5%% clay of soil mixture
c. 15% cement mixture
    i. 17 lbs soil : 1.7 lbs water (soil mixture)
    ii. 2.57 lbs cement : 1.28 lbs water (cement mix)

2. Water ratio:
    a. 10% of the total amount of clay and sand for soil mixture
    b. 94 lbs cement to 6 gallons (49.97 lbs) of water
    c.

b. Mixing Plan
    i. Dirt needs to be sifted before being mixed with cement
    ii. Measure out all needed components (shown above)
    iii. In the tray, combined the soil and water and in a bucket mix the cement and water
    iv. Pour the cement slurry into the soil/water mixture and mix thoroughly
    v. Put into the cylinder while tamping every ⅓ or ¼ (Tamping means we are packing the cylinder as tight as possible with the dirt to make sure there are no holes inside or gaps for air. We use a metal rod to do this. We only tamp it after filling the cylinder 1/3 of the way and then again 1/4 of the way.)
    vi. Tamp again when it's full with a pipe
c. Testing the Plan
    i. Video: https://drive.google.com/file/d/10xASEb0ELKWpU_0VEzGC-4NzvPOvu6IO/view?usp=sharing
    ii. Pictures:

d. Results of Plan

e. New and Improved Plan

f. Actual Testing

g. Resource:

i. http://www.earthbagbuilding.com/index.htm

9. Stabilized Earth Mix B

a. Mix Materials

i. 85% soil mixture (10% clay, 90% Sand), 15% cement mixture

a. 80.75% sand of soil mixture

b. 8.5% clay of soil mixture

c. 15% cement mixture

i. 17 lbs of soil: 1.7 lbs water

1. 2.57 lbs cement : 1.28 lbs water (cement mix)

ii. Water ratio:

1. 10% of the total amount of clay and sand for soil mixture

2. 2:1 parts for cement and water

b. Mixing Plan
c. Testing the Plan
d. Results of Plan
e. New and Improved Plan
f. Actual Testing

10. Stabilized Earth Mix C
    a. Mix Materials
    b. Mixing Plan
        i. 85% soil mixture (35% clay, 65% Sand), 15% cement mixture
            a. 55.25% % sand
            b. 29.75%% clay
            c. 15% cement mixture
                i. 17 lbs of soil: 1.7 lbs water
                    1. 11.05 lb sand
                    2. 5.95 lb clay
                    3. By taking out .85 lbs of clay content and adding in .85 lbs of Sand
                ii. 2.57 lbs cement : 1.28 lbs water (cement mix)
        ii. Water ratio:
            1. 10% of the total amount of clay and sand for soil mixture
            2. 2:1 parts for cement and water
    c. Testing the Plan
    d. Results of Plan
    e. New and Improved Plan
    f. Actual Testing
11. Stabilized Earth Mix D
    a. Mix Materials
        i. 92.5% soil mixture (30% clay, 70% Sand), 7.5% cement mixture
            1. 64.75 % sand
            2. 27.75% clay

3. 7.5% cement mixture\
    a. 18.27 lb soil : 1.83 lb water (soil mixture)
    b. 1.285 lb cement : .6425 lb cement (cement mix)

ii. Water ratio:

1. 10% of the total amount of clay and sand for soil mixture
2. 2:1 parts for cement and water

b. Mixing Plan
c. Testing the Plan
d. Results of Plan
e. New and Improved Plan
f. Actual Testing
g. One community link for 1000 psi after 28 days curing cement percentage: https://docs.google.com/spreadsheets/d/1gN0SLeNlmnyJhKxSffWnLw58Bwa8Amat2SDDYMHtb0U/edit#gid=629749971

12. Stucco with fiberglass reinforcement
    a. Mix Materials
        i. We are utilizing Quikrete Stucco with fiberglass reinforcement: https://www.lowes.com/pd/QUIKRETE-One-Coat-80-lb-Premixed-Finish-Coat-Stucco-Mix/3034358
        ii. According to the manufacturer's specifications https://www.quikrete.com/pdfs/data_sheet-one%20coat%20fiberglass%20reinforced%20stucco%201200%201216.pdf
        iii. An entire 80 lb bag of stucco mix needs to be mixed with 5.5 quarts of water.
        iv. An entire 80 lb can cover this much square feet at the given thickness which it is applied. At ⅜ inches thick and 80 lb bag makes a volume .75 cubic feet. The recommended thickness is shown below:

COVERAGE

QUIKRETE® One Coat One Coat Fiberglass Reinforced Stucco, per 80 lb (36.2 kg) bag:

3/8" (9.5 mm)	20-24 ft² (1.9-2.2 m²)
1/2" (13 mm)	15-18 ft² (1.4-1.7 m²)
3/4" (19 mm)	10-12 ft² (0.9-1.1 m²)

QUIKRETE® One Coat Fiberglass Reinforced Stucco Concentrated, per 80 lb (36.2 kg) bag, blended with 210 pounds (95.3 Kg) of plaster sand:

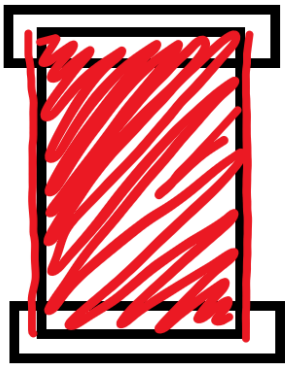
3/8" (9.5 mm)	73-87 ft² (6.8-8.1 m²)
1/2" (13 mm)	54-65 ft² (5.0-6.0 m²)
3/4" (19 mm)	36-44 ft² (3.3-4.1 m²)

All coverages are approximate and vary with thickness, waste, etc.

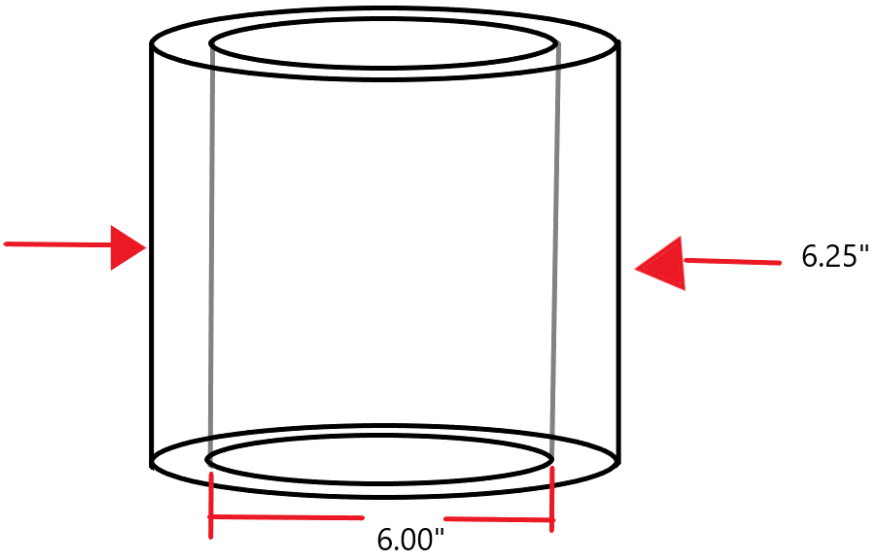
1.

v. The figure below shows the amount of space available to apply stucco to our cylinders. The cylinder must fit between the two metal plates and only leaves a very small amount of room for the application of stucco.

    1. The image below shows the two cups that we are working in between.



2. The image below is the area that we are left with for stucco. 29.9 cubic inches = .0167 cubic feet



3. So if a 80lb bag and 5.5 qts of water makes .75 ft^3 of stucco. Dividing by .75 by 45 = .0167 ft^3 which is what we need.
4. So dividing the rest of the components by 45 we get:

   1.78lbs stucco + .122qt water = .0167 ft^3 stucco mixed

b. Mixing Plan
   i. According to the manufacturer's instructions we will first add water into the mixing bucket. With the mixer on we will then follow up by slowly pouring in the dry stucco mix. We will mix the ingredients for 3-5 minutes or until a firm workable consistency is achieved. We will avoid over mixing because doing so can lead to damaged fibers in the stucco. If more water is needed one can add water in small increments while mixing.
   ii. Once the stucco is workable it can be applied to the cylinder walls.
   iii. According to the manufacturer, curing time is about 48 hours before the stucco can be handled.
c. Testing the Plan
d. Results of Plan

-

Mixing Instructions

6" by 12" cylinder			Notes	To get 1.5 gallons of aircrete, 45 gallons of aircrete needs to be divided by 30.
339.292	in^3	<-	N/A	
0.19635	ft^3	<-	convert from in^3 to ft^3	
1.468797	gal	<-	convert from ft^3 to gal	

	45 Gallons of Aircrete	
	Foam Volume for 45 gal Aircrete	
Standard	8450.418	in^3
	4.890	ft^3
	146.328	quart
	36.582	gal

1.5 Gallons of Aircrete	
Foam Volume for 1.5 gal Aircrete	
281.681	in^3
0.163	ft^3
4.878	quart
1.219	gal

Foam Volume Percentage to Height

	Height		% in Height of Cylinder	
Water	1.633991	in	18.67418	%
Water + Cement	2.240902	in	Height of 55 Gallon Drum	
Volume Change %	0.729167	%	24.4	in

Cement Proportion Values

Standard	One Cylinder (1.5 Gallons)					
Cement Mix	water	0.2	gal	1.666	lb	1.5 Gallons of Aircrete
		46.2	in^3			
	cement	3.133	lb			

Standard Aircrete Mix Steps: This is the Mixing Plan

1. The following instructions will create a total volume of 1.5 gallons/.196ft^3 of aircrete. In order to use these directions for any desired amount of aircrete, multiply the total volume until the desired amount is achieved. Similarly multiply the listed cement and water mixture listed below by the same number. For example if a 5 gallon bucket of aircrete is desired, 1.5 gallons x 3.33 = 5 gallons. Therefore multiply the cement and water mixture by 3.33.

NOTE: Step 2 is not to be multiplied. The soap and water mixture stays the same but if more foam is needed one can simply double or triple the amount of soapy water mixture.

2. First step is to create a soapy water mixture for the foam.
    a. Start by adding 16 ounces 7th Generation Soap into a 5 gallons bucket filled with water.
    b. Stir the soap and water until it is fully mixed. (Always stir the liquid before using)
    c. Placed the Little Dragon on top of the 5 gallon bucket with the poly tubing in the bucket of soapy water.
    d. Connect the foam wand to the Little Dragon by firmly pushing the poly tubing into the fitting under the switch and in the end of the wand.
    e. Adjust the quick connect fitting and ball valve by screwing them into the pressure regulator.
    f. Connect an air-compressor and set the pressure regulator to around 40-60 psi.
    g. Once the Little Dragon is all set up, turn the ball valve off so the pump can prime itself.
    h. Turn on the switch and open the ball valve slowly when liquid runs out.
    i. After three seconds of the foam wand running, catch the foam in a container and check the foam weight with an accurate scale. (The foam should weigh 90-100 grams per quart. Using a quart size measuring cup, which is widely available from most home improvement stores, fill the cup and weigh the contents inside. Increase the air pressure to produce lighter foam and decrease the air pressure produce heavier foam. Adjust accordingly until it reaches 90-100 grams.)
3. Next step will be to create the Portland cement and water mixture.
    a. To obtain standard aircrete, weigh out the standard amount of cement for the mix which is 3.13 lbs of cement and 1.67 lbs of water.
    b. In a clean bucket pour in the water, doing so will prevent the cement from sticking to the bottom of the bucket. Utilize a powerful drill with an auger type of attachment and start stirring the water while slowly pouring the cement into the bucket. The idea to use the auger drill bit came from the domegaia website

(https://www.domegaia.com/how-to-make-aircrete.html). The idea is that the auger attachment's spiral construction draws the the mixture downward. In our case it would draw the the foam downward and thrououghyl mix the foam in the cement. The cement and water must be mixed together thoroughly until a uniform consistency is achieved. The mixture should resemble a smooth texture with no large bubbles and no clumps of cement.

c. Once the cement and water are combined, add in _____ quarts of foam into the cement and water slurry. Another method to incorporate foam into the aircrete mixture has reached 1.5 gallons. Make sure to operate the drill simultaneously ensuring the foam mixes well into the cement mixture. You will know this is achieved correctly when the aircrete has no visible bubbles (but should contain very small micro bubbles) and takes on a smooth toothpaste-like consistency.

4. Once the aircrete mix meets all of the above characteristics and specifications the aircrete can be poured into your desired mold.

TRIAL FOR AIRCRETE, MIXER (THIS METHOD WAS NOT CONSISTENT

After a few weeks of experimenting with aircrete using the exact scaled down measurements and methods our aircrete cylinders have just not turned out well. Time and time again they have shrunken whether we cure them on their side or standing upright, sometimes even with differing proportions. We believe we have found the issue and it is because of using the drill for mixing. We know that these tools are widely used across our resources, but we believe the auger mixing bit or egg beater style attachment is incorporating too much air into the mix. Think of when people are whisking cream into whip cream. We do believe we have an alternate solution to our problem and this is to use a concrete mixer (shown in photos below). We got this idea from some individuals on youtube creating aircrete (https://youtu.be/q5xqT2sFGdI). This method combines the foam and cement thoroughly but without the addition of excessive air into the mix. We performed a test run shown below and this mix showed very minimal shrinking. Going forward we wanted to use the mixer for our aircrete mixes.

For accuracy of our mixes. Here is the density of our foam that we used in all our mixes. Domegaia states that it should be between 90-100g/qt here it is measuring at 98g/qt. I will need to take another picture of the texture of our foam, but it is very similar to domegaia's. Below it is

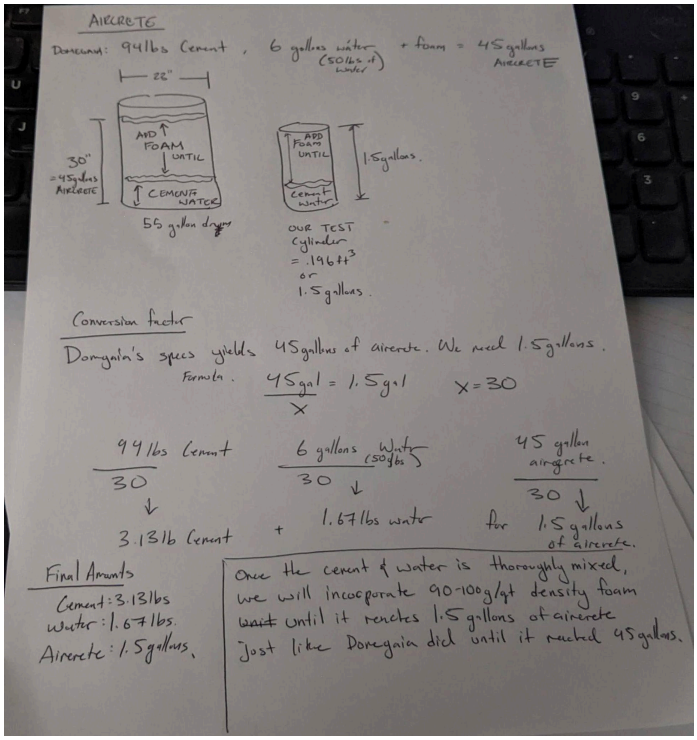
a screenshot taken from domegaia's youtube video and a screenshot of their measurement of density of the foam.


SKU 402 240
Recycle
Reciclo
MADE IN USA
HECHO EN E.E.U.U.
98
ON/OFF
TARE
UNIT
ZERO
MRB SERIES
Capacity:10000g x 1g

postal or kitchen scale to check the weight of your foam. It should be between 90 - 100 grams/liter (about 3 ounces/quart).

Below left to right (Aircrete created in mixer, 2 collapsed aircrete using auger)

Also here are our calculations for our standard aircrete mix



TRIAL USING DOMEGAIA CALCULATIONS AND AUGER

For these trials we are using the same calculations shown below. For these cylinders we decided to do as instructed by domegaia and utilize the auger type of drill attachment also to better replicate their process. We started by mixing our cement and water mixture making sure to add in the cement slowly. Then we setup our foaming tool to give us a foam density of 90-100g/quart as instructed by domegaia. Once properly set up we incorporated our foam to reach our desired volume of 1.5 gallons of aircrete. This time we made sure not to overmix and only mix until a uniform color is achieved (white foam is no longer visible). For some reason this mixture still collapsed after some time. We are sure our measurements for cement, water, foam are sound with domegaia's instructions. 94lbs of cement and 6 gallons of water create 45 gallons of aircrete when the foam is added. (https://www.domegaia.com/how-to-make-aircrete.html). Scaled down that is 3.13lbs cement, 1.67 lbs water and then incorporate foam until our desired volume is

reached.

> Mix one 94lb bag of **cement** with 6 gallons (US) **water**. Put all the water in your container first and add the cement while you are mixing to avoid clumping. When the cement and water are well mixed, turn on the **Little Dragon** and add foam to the mixture. Add enough **foam** to make a total of 45 gallons of AirCrete. That's about 30" high in a standard 55 gallon drum. The foam is very light weight and so it wants to float on top of the cement mixture. Our **foam injection mixer** works great because it injects the foam directly into the mixing paddles at the bottom of the barrel where it is mixed into the cement before it can float to the top.

Although I did find this thread when searching collapsed aircrete. https://forum.domegaia.com/topic/41/aircrete-is-collapsing. And this thread https://forum.domegaia.com/topic/638/troubleshooting-aircrete Some state that the collapsing can be caused the tap water quality of which we are using. Not saying this is our problem as we have had some success not using domegaia's specs. Other claim 7th gen soap foam does not last very long, but I understand we using it because of the natural ingredients and domegaia's success. We are not really sure why our failures are occurring. My ideas that come to mind are maybe its because making them in small batches, domegaia's measurements arent precise, maybe we need to mix it longer and let some foam break down, more cement is actually needed than the standard says, or we need to attach a pipe to inject foam at the bottom of the mix.

TRIAL NOT USING DOMEGAIA'S MIX BUT OUR OWN CUSTOM MIX

We made these cylinders early on to test out our own mixes to see if it was possible to obtain a solid cylinder without collapse. This was before the decision to use domegaias exact specs as our standard. Our methods were exactly the same as the domegaia's the only difference is that we increased our cement and water proportions.

The cylinder on the left was when we were playing with the overall density of aircrete. We used triple the amount of cement and water as our standard mix, then added foam until an overall density of 55 lb/ft^3 was reached. (measurements: 9.39lbs cement, 5lbs water add foam until 55 lb/ft^3density of aircrete reached.)

The cylinder on the right is double the amount of cement and water but using the about the same amount of foam as our current standard. (measurements 6.26lb cement, 3.34lbs water, 4.75 quarts foam)

We did not go into much detail on these because it strayed away from domegaia's standard mix, but these cylinders are very solid and smooth. We feel it was important to include these as part of our experimenting.

Standard Stabilized Earth Mix Steps

1. The jar test was done first to find out the content of the soil which we got 30% clay 70% sand
2. We then did a squeeze test, ball test, and drop test to find out the optimal moisture content for the soil to be firm which was between 9-10% and many sites recommend 10% moisture content for the soil.
    i. Can I build with my soil.docx (earthbagbuilding.com)

ii. testing soil (earthbagstructures.com)
iii. The Dirt - Earthbag Building - Northern Architecture
iv. How to Build for Earthquake Resistance: Earthbag Construction Manual (engineeringforchange.org)

3. Testing the soil:
    a. Squeeze test
        i. The test shows in which 3 categories the soil being tested.
            1. First we get soil and add a few drops of water to it
            2. It is then squeezed in the hand (almost football like)
            3. The 3 categories it can fall into are :
                a. Soft lump - has enough clay for use
                b. Crumble lump - needs more clay or reinforcement to hold build together
                c. Firm lump - has high content of clay (may need other test to see precise content)
    b. Ball drop test
        i. Shows if soil has enough clay content
        ii. Get 40 grams of soil and add between 9-15% of water or until just enough for clay to hold together
        iii. Mold into a ball and drop at a height of 1.5 meters
        iv. The 3 categories the soil will fall upon are:
            1. Weak soil : not enough soil
                a. When dropped the result is that it will crumble completely
            2. Soil with some clay: has enough clay for earthbag use
                a. When dropped the result is that it will crack and have some crumbling
            3. Rich clay soil : clay content above 15%

                When dropped the result is that it will stay together with minimal cracking
4. 1 cylinder is 1.5 gallons = 0.196 ft^3
5. The ratio for cement is 15%

   a. 15% cement is based on onecommunity result of 15% cement for more than 1000 psi of compressive strength
      i. https://www.onecommunityglobal.org/earthbag-village-engineering/
      ii. https://docs.google.com/spreadsheets/d/1gN0SLeNlmnyJhKxSffWnLw58Bwa8Amat2SDDYMHtb0U/edit#gid=629749971
6. Based on the 15% cement mixture the rest of the cylinder will be soil (85%)
   a. 85% soil of a 1.5 gallon is roughly about 5 quarts of soil. (roughly 17.028 lb)
   b. 15% cement slur was found with a volume test. We added about .225 gallons of cement in a bucket with volume measurement. To find the cement weight, minus the total weight of cement and bucket to the bucket weight which was .346 lb. The bucket and cement weight was 3.724. Cement weight is 3.378, so you need 1.689 lb of water to do a 2 parts cement to 1 part water ratio.
   c. 10% of water was added for the soil (1.7 lb) and mixed with the soil, then the cement and water were mixed separately then added into the soil mixture.
   d. After thoroughly mixing all components together, the mixture was put into a 6”x12” cylinder. Tamped half and when full. Then the sides were tamped to decrease any void in the cylinder.

Reference Links:

Standard Concrete Mix

1. Article: Concrete Footings
2. Article: Concrete Mix
3. Article: Everything about concrete
4. Article: How concrete is made
5. Sheet: Portland Cement
6. Video: Concrete Mix Ratio

Aircrete

1. Article: Cracking Aircrete Blocks
2. Article: How to make Aircrete
3. Video: Aircrete bricks by Off Grid Living for Beginners
4. Video: Aircrete Harry
5. Video: Aircrete Materials by Be Good Fam
6. Video: Aircrete panels by Honey do Carpenter
7. Video: How to make Aircrete by Aircrete Harry
8. Video: How to make aircrete by Prana Tech

Earthbag Mixture :

1. Article: Cement Rammed Earth
2. Article: Earthbag Construction
3. Article: Earthbag Construction
4. Article: Earthbag Filling
5. Article: Earthbag Homes
6. Article: Earthbag Ingredients
7. Article: Earthbag Q&A
8. Article: Jar Test for Soil Testing
9. Video: Earthbag Building by GoPro
10. Video: Jar Test by Green Dream Project
11. Video: Jar Test by Valley Roots

Initial Week Mixing Plan Steps (First week of building and testing)

Purchasing of materials

- Students will be picking up the supplies from the nearest Home Depot (*3323 Madison St, Riverside, CA 92504*) to CBU with the purchases being made be Jae, the group will then buy the soap from walmart (*5200 Van Buren Boulevard, Riverside, CA 9250*) and an item from the nearest Lowes (*9851 Magnolia Ave, Riverside, CA 92503*).
- These items will be purchased by Jae as an online order and will need to be set as a "pickup in person" type of delivery option. The order should state that the items are to be picked up by the students (John, Jarot, Dominick or Marcus). The group will utilize Jarot's truck to transport materials to CBU.
- Students have come up with a list of materials needed for the first **initial week** of building (This will be sent in a separate google sheets file). This will be used as a trial run. After the initial trial runs the students will determine the exact amount of materials needed for the rest of the building phase.

Standard Concrete Mix

- For the initial week (12th-16th) of the build students will use a standard concrete ratio for 3000-4000 psi compressive strength concrete. According to the research done the ratios for this strength concrete is 1:3:3 part cement, aggregate, sand for 3000 psi and 1:3:2 part mix ratio for 4000 psi.
- In the lab students will combine the concrete dry concrete mixture to make sure the contents are thoroughly distributed before the addition of water. After doing the mixture according to ratios, students will perform a slump test. (http://www.concreteexchange.com/how-to-center/concrete-mixes-and-additives/concrete-slump-test/)
- The slump test will determine if the correct amount of water is in the slurry. The drop in the slump shows if the mixture is too wet or not wet enough.
- Students will then make adjustments to the mixture depending on the outcome of the slump test. These parameters will be recorded and used for the following weeks.

Standard Aircrete Mix

A. For the initial week of the aircrete mix, we will start by making the foaming agent to determine the density of the foam. The proportion of the foaming agent will be determined by how many cylinders would be made per day.
B. The next step is to weigh the foam in a 1 quart bucket on a scale to find its weight which should be 90 - 100 grams per liter (3 oz per quart).
C. A 94 lb bag of portland cement will then be mixed with 6 gallons of water.
D. The cement mixture and foaming agent will then be mixed together to create aircrete. (Proportion will need to be adjusted depending on how many cylinders we will make per day/week)
E. The aircrete mixture will then be poured into a cylinder mold to set and cure for a certain amount of time.

2 Lighter Aircrete

A. For the initial week to make the 2 lighter aircrete mixes, we will start by performing a density test with the foam to get the best lighter density for the mix.
B. Using the weighted density, measure the foam into the 1 quart bucket and scrape off the excess foam. Weight the bucket on the scale.
C. When the foam weight is determined, it will be mixed together with the concrete slurry to make the aircrete mixture.
D. Once it is fully mixed, pour the aircrete mix into the cylinder molds.
E. Shake the cylinders to release any air bubbles that may have formed when pouring the aircrete into the cylinders.
F. Shake the cylinders to release any air bubbles that may have formed when pouring the aircrete into the cylinders.

2 Heavier Aircrete

A. For the initial week to make the 2 heavier aircrete mixes, we will start by performing a density test with the foam to get the best heavier density for the mix.
B. Using the weighted density, measure the foam into the 1 quart bucket and scrape off the excess foam. Weight the bucket on the scale.
C. When the foam weight is determined, it will be mixed together with the concrete slurry to make the aircrete mixture.

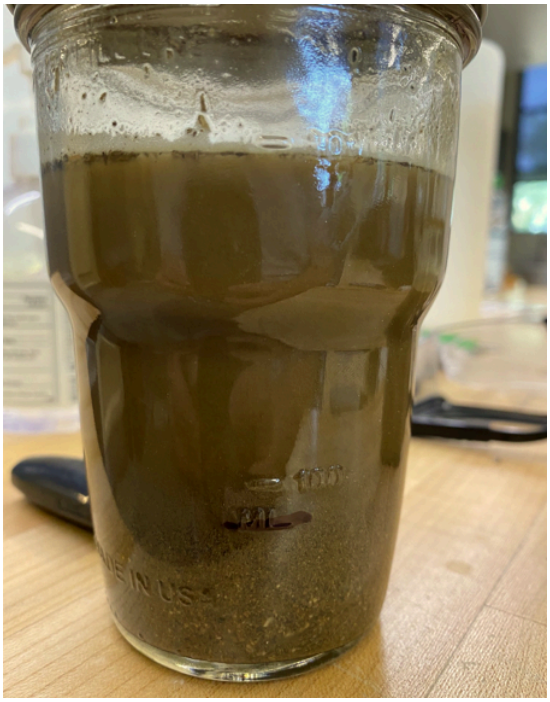
D. Once it is fully mixed, pour the aircrete mix into the cylinder molds.
E. Shake the cylinders to release any air bubbles that may have formed when pouring the aircrete into the cylinders.
F. Shake the cylinders to release any air bubbles that may have formed when pouring the aircrete into the cylinders.

4 Stabilized Earth Mixes

- Jar Test:

1. Sample soil was added till the 100 ml mark and water was then added and jar was shaken

2. After shaking, make a dot or line where the sand starts resting because the clay particles are still floating on the water



3. The jar was then rested for two days
4. The jar test then shows the difference in soil makeup. Layers that are in most soil have clay, silt, sand

5. Calculations: 2 Method
    a. Method 1: using a ruler, measure
        1. Measure total height : 1.81 inches
        2. Measure height of sand : 1.36 inches

3. Minus total - sand for height of clay : .45 inches

ii. Calculate %

1. Sand : 1.36 / 1.81 = 75%
2. Clay : .45 / 1.82 = 25%

b. Method 2: Observation method

i. Assume a estimation of percentage based on the lines drawn

ii. Used a combination of both because of slight slope of jar

6. Picture results: https://www.dropbox.com/home/_Compression%20Testing/John%20Weekly%20Summary%20Pics/Jar%20Test
7. Resource: https://hgic.clemson.edu/factsheet/soil-texture-analysis-the-jar-test/ https://www.youtube.com/watch?v=77kQPIx-sIQ https://preparednessmama.com/jar-soil-test/ https://growitbuildit.com/mason-jar-soil-test-clay-sand-silt/

- Initial week (7/12/2021), find the soil(s), use the jar test for clay content testing, and also do a moisture test to find moisture content.
- Based on these testing, the next steps will be made, to find a way to change the ratio or if impossible find different areas with different mixture contents(ratio).
- Cylinder testing will come after determining the above. This will consist of :
    - Standard soil ratio with cement
    - Standard soil ratio
    - Ratio with more sand percentage(by adding more sand into mix)
    - Ratio with more clay percentage (using jar test, then oven to take out moisture, adding it to a different batch)