

Constructibility n Production n Strength n Buildability



Several differing variables were used in our experimentation to provide results subsequent in choosing the “best” block form and type for wall assemblies.

The first experimental block work dealt with the mixture of the blocks and the strength and weight each produced. The dirt block served as our “control” block. We measured its weight and noted its strength through its stability, which was used to compare and contrast the other blocks. The blocks consisted of a ratio of eighty percent dirt to twenty percent additive, aside from the pure dirt block. The amount of water added varies from block to block due to the absorbency rate of the additive and the amount of water present in the dirt on the various days it was used. Our additives and reasons for usage of each were as follows:

1. Haydite: it is a lightweight substance and has an increased bonding ability
2. Cement: it is known for its strength and durability; unfortunately it is a heavier material
3. Fly Ash: similar to cement; it is a lighter weight Material
4. Linseed Oil: it has a strong bonding ability, requires less water in the mixture, and produces a smoother finish



After testing the stability of the dirt mixtures, we began experimenting with block forms. This was in response to finding a form that would be self-aligning and not require mortar. By doing so, the ease of production, cost efficiency, and amount of labor skill needed could be optimized. Using wood blocks and plains, we created two forms that could be easily inserted into the brick machine, and upon block completion, removed from the brick. Creating tabs in the blocks creates weak spots, which may cause problems in construction. They do, however, yield handgrips which ease lifting and increase grip-ability. The other form causes locking to occur between levels due to its shape.

All of the data collected through our experimentation has been recorded in the following chart:

Materials:

- α Dirt
- α Water
- α Haydite
- α Fly Ash
- α Cement
- α Linseed Oil
- α Wood Forms
- α Brick Machine
- α Shovel
- α Mixing Buckets
- α Measuring Tools



** In each block there is a consistent measurement of eight quarts of dirt to one quart of additive.

** A = Acceptable use for building

F = Failed Block

** Some blocks were not created in Forms 1 or 2 because of their lack of stability in solid state.

| | Dirt |
|-------------|--|
| Solid Block | <ul style="list-style-type: none"> α Sandy / Crumbles at touch α Few cracks α White mold α Only stable in solid form <p>Rating = A</p> |
| Weight | 12 lbs. |
| Form 1 | N/A |
| Weight | |
| Form 2 | N/A |
| Weight | |



| | Linseed Oil |
|-------------|--|
| Solid Block | <ul style="list-style-type: none"> α Deep cracking α Appears Sturdy α Spotted because soil and oil do not mix <p>Rating = F</p> |
| Weight | 12 lbs. |
| Form 1 | N/A |
| Weight | |
| Form 2 | N/A |
| Weight | |



| H2O Amt | Cement |
|---------|--------|
|---------|--------|



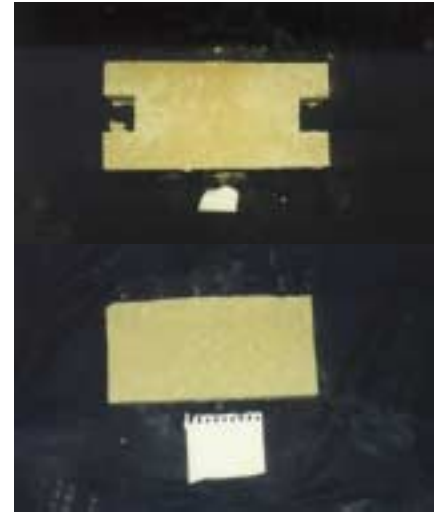
| | |
|-------------|---|
| Solid Block | <ul style="list-style-type: none"> α Solid α Grey tint α Few surface cracks – do not effect strength α 0 oz. H2O added Rating = A |
| Weight | 11.5 lbs. |
| Form 1 | <ul style="list-style-type: none"> α Solid α Grey tint α A lot of cracks, but holds together – no crumbling α 12 oz H2O Rating = A |
| Weight | 11 lbs. |
| Form 2 | <ul style="list-style-type: none"> α Sides and bottom smooth α Top not completely solid – lacking pieces, but structurally sound α 12 oz. H2O Rating = A |
| Weight | 9.5 lbs. |



| | Fly Ash |
|------------------------|--|
| Solid Block | <ul style="list-style-type: none"> α Deep cracking α Appears solid α Flecks of color α Edges crumble α 0 oz. H2O added Rating = F |
| Weight | 12 lbs. |
| Form 1 – Without Water | <ul style="list-style-type: none"> α Falls Apart – no strength α Crumbles at touch α 0 oz. H2O added Rating = F |
| Weight | N/A |



| | |
|------------------------|--|
| Form 1 – With Water | <ul style="list-style-type: none"> α Difficulty forming α Medium-depth crack α Few cracks overall α Speckled α 8 oz. H2O Rating = A |
| Weight | 11.5 lbs. |
| Form 2 | <ul style="list-style-type: none"> α Not completely solid – lacking pieces α Sides not smooth α Grey tint α 6 oz. H2O Rating = A |
| Weight | 9.0 LBS. |



| | |
|-------------|--|
| | Haydite |
| Solid Block | <ul style="list-style-type: none"> α Large Haydite α No bonding strength α Crack/Crumbled during drying α 6 oz. H2O Rating = F |
| Weight | N/A |
| Form 1 | <ul style="list-style-type: none"> α Small Haydite α Corner Broken – probably due to lack of water α Minimal cracking α Color does not change α 12 oz. H2O Rating = F |
| Weight | N/A |
| Form 2 | <ul style="list-style-type: none"> α Large Haydite α No bonding strength α Cracked during drying – cannot be handled α 6 oz. H2O |



| | |
|--------|------------|
| | Rating = F |
| Weight | N/A |

The Two Forms used to create the blocks shapes:



Making the Blocks

Through trial and error we found that the best way to create the mixture for the blocks was in a wheelbarrow. The dirt was not sifted because that would counteract our hope for ease of production and efficiency; the unsifted dirt allowed for several more cracks and bumps in the block. The dirt was placed in the wheelbarrow first, and then the additive was mixed into the dirt with a hoe. After thoroughly mixing the dirt and additive, cups of water were slowly sprinkled over the entire surface of the mixture. (The mixture being combined continuously.) The best way to determine when enough water had been added was to pick the dirt up and squeeze it in the palm of your hand. If it had the consistency of "Taco Bell Meat" and clumped together, it was usually about right. We found that by adding a small amount of water beyond that point produced the best blocks. The brick machine was sprayed with WD-40 on all four sides, the bottom, top, and any molds placed in the machine. We placed the dirt in the machine and prepared to compress it into a block. When compressing, it is necessary to make sure there is an adequate amount of dirt in the machine. If there is some resistance when compressing the brick, the proper amount of dirt is probably in the machine. Upon removal, if you find there are holes in the top and sides of the brick, you may need to repress it using a little more dirt or possibly add water to your

mixture. After pressing a firm, smooth brick, we used the wooden block on the bottom of the machine to aid in setting the block aside. For any form that is stable enough, it is best to set the brick on its side so, that it will dry quicker and more evenly. It is also best for the brick if it is placed in an environment where the temperature does not fluctuate. This will allow the brick to dry evenly and reduce the risk of cracking.

1. Solid Blocks:

The production of the solid blocks was by far the most time and material efficient. To increase the production rate, we did not sift the soil, but shoveled through it, chopping up the larger pieces to create a somewhat even mixture. The shoveling took place as we dumped dirt into the machine. This ensured an even consistency in the mixture. By spraying the sides, bottom, and top plate of the brick machine with WD-40 before inserting the dirt, the bricks could be removed from the machine quickly and easily. A wooden plank was placed in the bottom of the machine, which allowed easy removal of the brick and guaranteed that it would not break due to early handling. To find the right amount of dirt needed for each block, it was necessary to test the force needed to compress the bar on the machine. This could only be done through trial and error. Once the correct amount of soil is discovered, the block will appear smooth on all sides and fairly smooth on the top and bottom plains as well. The amount of water added to the mixture effects the bricks greatly because of the cement additive. Without the water the bricks will not stick together well and you will be unable to produce a smooth faced brick. Too much water, however, will result in the inability to lift the block and the drying time increases greatly.

2. Form 1 Blocks:

Again, shoveled dirt instead of sifted dirt was involved in the testing of production. Water also determined the binding strength and the wooden plank provided support to remove the bricks once compressed. The efficiency of production, however, greatly decreased. This occurred because of the formwork that destabilized the sides of the brick. Due to the break in the shorter side of the brick, a large "control joint" was created, which of course led to cracking. This cracking resulted in the tabs of the bricks breaking off easily. Many bricks had to be produced before finding ones that were adequate and useable. This form also increased the drying time because in order to dry them without having them fall apart, it is necessary to lay them flat instead of on their sides. This also increases the need of space for drying.

3. Form 2 Blocks:

The last form was by far the easiest to produce and also required the least amount of time. In the same fashion, the dirt was shoveled into the machine. The form sat in the bottom of the press making removal simple. This form also allowed for the most grip ability and weighed the least of the three shapes tested. The downside to this bricks lies in that it is not as tall as the other forms, meaning that the production of more bricks is needed in order to reach the same height as one of the thicker forms.

**A mixture of approximately 75% Flyash, 25% Cement, plus the dirt and water will produce a much stronger block than one of Cement or Flyash alone.

Wall Assembly

Each brick form was given 3 days to dry. We were then able to use the bricks to construct walls with the different forms. The solid bricks and form 2 bricks served as the easiest to manipulate and lock together. It is suggested that when creating a mortar-less wall one should wet the bricks and then stack them. The wet dirt forms a bond between the bricks that replaces the mortar. We found that it may be better to use mortar because if many imperfect bricks are manufactured and placed together, the wall will eventually become uneven and unstable. The mortar forms a cushion between the bricks and allows for imperfections. We also discovered that form 1 did not interlock well, resulting in the end tabs breaking from the main block. When altering a brick form, it is best to not destroy the sides, but change the face. This will allow the brick to retain its strength. By cutting out pieces from the opposite sides of the brick, we decreased its strength and created a place where cracking was highly likely. Of the three, the most efficient to produce, self-aligning, interlocking brick was form 2. The only way this block could be bettered is if it took on a diamond shaped form. This would cause each level to interlock, instead of every other level.



Solid Block Wall Assembly



Form 1 Wall Assembly



Form 2 Wall Assembly

Jennifer Morris n

Ashley Whitham n

Enjoli Dixon

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