"Concrete on the Farm, 1900 - 1940"

Presented by: Luke M. Snell, P.E., HACI

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This session will show how the farmer learned how to produce quality concrete on the farm. They did not have YouTube, so they had to use self-help publications by cement companies/associations to learn the process. These farmers knew how to work hard and had a "can do" attitude. Thus, they created structures that are still in use today.

Who should attend: Anyone that has a background in farming, been a sidewalk superintendent or just fascinated by construction.

Where: Glen Carbon Library, 198 S. Main St. Glen Carbon. IL

When: 6:30 PM, April 7, 2022

Concrete on the Farm, 1900-1940: Part 1 - Sand

05/12/2020

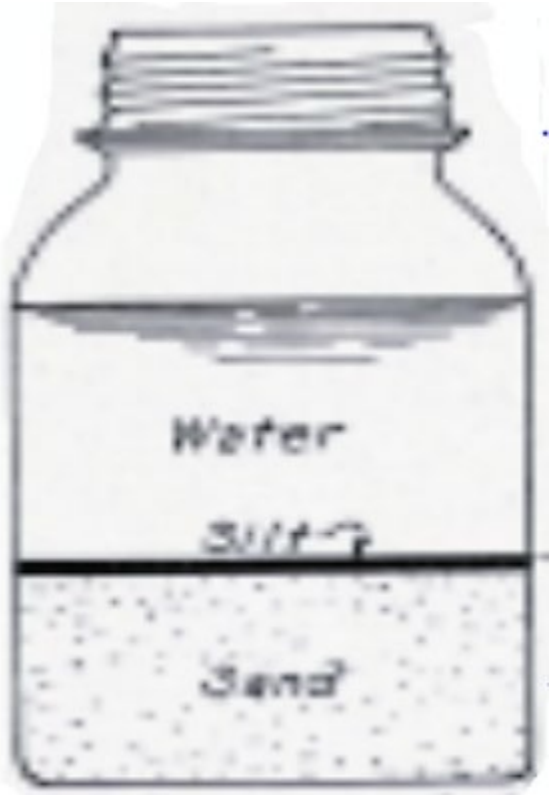
A series by Luke M. Snell

In the early 1900s, the farmer that wanted to improve their farm by putting in a concrete floor in their barns, build a root cellar , or have a dry spot in front of a hog lot had to do it themselves. There were no concrete batch plants and few rural concrete contractors, so the farmer had to learn how to make and place concrete. Many cement companies and farm organizations developed publications that took the farmer through the process. We have more sophisticated equipment and improved materials today but the process remains much the same. I have worked in many third world countries and found that some of the techniques that the early farmers used are as useful today and can keep the contractor out of trouble. Part one of this series of discusses how to get clean concrete sand.

How to get clean sand

In most cases, the farmer was on his own to find a suitable sand to use in concrete. They knew that dirty sand (sand with clay and silt) would result in weaker concrete. Thus most publications presented a simple test to determine if the sand was usable in concrete. To do this test, you need a see-through container. The self-help books of the time recommended a quart canning jar with a top - probably because they were available on most farms. I have used soda and juice bottles when doing this test. The bottle or jar should be about 8 inches high with straight sides. To do the test:

1. Get a representative sample of the sand. You should get samples from several locations in the sand pile or in the sand pit.
2. Mix the sand samples together and put the sand into the bottle to a depth of 2 inches.
3. Add water until the container is about 3/4 full.
4. Put a cap or thumb on top of the bottle and shake vigorously for one minute.
5. Place bottle on a flat surface and let it set for one hour.
6. After the one hour, measure the fine particles that have settled on top of the sand. If it is less than 1/8 inch , the sand is considered clean; If it is greater than 1/8 inch, the sand would be considered dirty.



Silt test, from Permanent Farm Construction, Portland Cement Association, 1916.

If the test has over the 1/8 inch of silt and clay, the farmer has to make a decision. They can look for a different source of sand, wash the sand, or use this sand and add extra cement to maintain the required strength of the concrete.

I have used this method in Mexico and Mongolia when examining sands. I used a soft-drink bottle and followed the steps outlined above. It was a quick way to determine if the sand was acceptable or needed more detailed laboratory testing.

Two other steps are required to make sure the sand is acceptable for use. The farmer should examine the sand to see if it has organic content. The farmer should do a visual inspection looking for tree roots, leaves, animal waste, and construction waste in the sand. In most cases, this will be adequate. If there is doubt, a laboratory test that requires the use caustic chemicals can be performed. This is best done in the laboratory by experienced technicians. The sand piles or where the sand is stored should also be inspected.

Some examples of what can go wrong

Here are three examples of how inspection of the sand and sand piles easily identified a problem and one example where an inspection could not catch the problem.

1. I visited a batch plant that was having strength issues with their concrete. It was located in a wooded area and the sand piles had leaves and twigs falling on it. The organics in the sand was one of the problems that was causing low strength.
2. One of my previous students e-mailed me from a project he was working on outside the US. They were getting inconsistent concrete strength and he asked what he needed to do. I recommended he visit the batch plant and inspect the aggregates piles and the batching procedures. He observed broken pieces

of masonry blocks and concrete waste scattered throughout the sand piles. The simple solution was to remove these from the sand pile.

3. During concrete placement, a contractor noticed balls in the concrete that he at first thought were cement balls (resulting from inadequate mixing of the concrete). But when one of the balls broken open, it was mud. Inspection of the sand pile at the batch plant showed that it was on the ground (instead of on a concrete base) and the operator had run the front end loader onto the sand pile. The mud balls in the concrete were caused by getting base material (mud) in the front end loader's bucket plus the mud that was tracked onto the pile. The solution was to retrain the front end loader operator on correct procedures and put the sand onto a concrete pad.
4. While placing a concrete floor, the contractor noticed plants starting to grow in the concrete. I was asked to inspect the batch plant to determine what happened. Inspection of the materials and procedures did not indicate a problem. I later learned that the batch plant was having labor issues. I surmised that a disgruntled worker put a pick up truck load of soybeans onto the sand pile and mixed it in. Since the soybeans were basically the same size and color as the sand , a visual inspection of the sand pile did not catch the problem.

The farmer is now ready to move to the next step of gathering the other materials needed to make concrete.

Note: this was published on the World of Concrete website:

https://www.worldofconcrete.com/en/articles/concrete_on_the_farm_part1.html

Concrete on the Farm, 1900 - 1940: Part 2--Materials

06/09/2020

To make concrete you need only water, cement, and aggregates. On the farm, cement was the only manufactured material; water and aggregates could be found locally, and thus the cost could be low if the farmer selected good local materials. The many self-help books provided detailed instructions so the farmer could select the best materials to produce good quality concrete. Part 1 of this series discussed how to get quality sand. In part 2, we look at the other materials needed for good concrete.

Water

Water used to mix concrete must be clean—free from oils, alkali, and acids. This may sound complicated and that the farmer must test the water to insure it is suitable for making concrete. But most farms had a well or spring that was used for drinking water for their livestock and home and this water would be considered acceptable to make concrete.

When I attended a conference in Mongolia about how to make quality concrete, the engineers discussed how to ensure the quality of the water was acceptable for use in concrete. They presented several laboratory tests they thought were needed and asked what tests we require in the U.S. for making concrete. I told them our approach was simple: If you can drink it, you can use it to make concrete (the technical term is potable water). They laughed at the simplicity of this approach. But note that in cases where there is not a good source of potable water, there are laboratory tests that can determine if the available water can be used to make concrete.

Cement

Cement had to be purchased and was available to the farmer in paper or cloth bags or in barrels. One cement company recommended that the farmer buy cement in cloth bags since they could return the bags and get a rebate if they kept the bags dry and untorn. A bag would weigh 94 pounds and contain one cubic foot of cement. The size of the bag will prove to be significant when we look at how to make concrete in the next article. Most

farmers would buy the cement in bags since this was easier to handle. A barrel of cement would contain 4 bags of cement and would be used on larger projects.

Today most cement is sold in bulk to batch plant and precast companies. It is blown into the cement silos by air thus it requires little manual labor to handle. For those of us that are doing small projects, cement is still available in paper bags at our local stores. This is a tiny piece of the market for the cement companies.

Once the cement was purchased, the farmer had to protect the cement bags from moisture. They were encouraged to store the cement in a watertight barns or sheds and on pallets that were at least 6 inches above the ground. They were warned that if the cement bags were stored in a damp place, the cement would become lumpy or a solid mass.

To make sure the cement was usable, the farmer was told to use the cement only if the lumps could crumble when hit with a shovel. If the lumps in the cement would not break up, the cement would be considered unusable and thrown out.

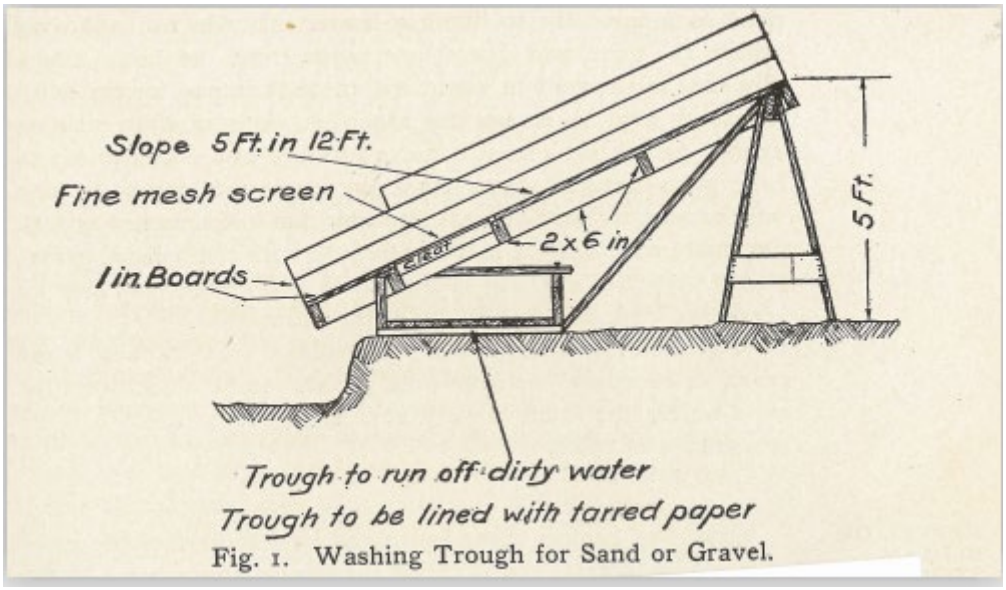


Fig. 1. Washing Trough for Sand or Gravel.

How to wash sand—from *Concrete Construction about the Home and on the Farm*, Atlas Portland Cement Co, 1909

Aggregates

Aggregate (gravel and sand) makes up about 70% of concrete and is the cheapest material (other than water) in the mix. The farmer had to consider that:

- Aggregate must be clean (without silt and clay). The test to determine if the sand was clean enough to use was presented in part 1. If the aggregate needed to be cleaned, the farmer would build a washing trough.

- Coarse aggregate must be small enough to fit into the slabs or walls. Normally aggregate used in the concrete would be no larger than 2 inches. Large pieces of aggregate could be thrown out when mixing the concrete. If there were several pieces of large aggregate, the farmer could screen it with a homemade sieve.

- The farmer must be able to finish the concrete. Too much rock (coarse aggregates) will make the concrete difficult to finish and place.

- The aggregates should not be soft or easily broken. The farmer was warned not to use soft sandstone, soft limestone, slate, or shale.

- If the sand is very fine, the farmer was encouraged to double the amount of cement. A good sand would have particles from about 1/4 inch down to 1/100 of an inch. A fine sand would have few particles bigger than 1/8 inch.

Since cement was the most expensive material in concrete, many farmers looked for ways to reduce the amount of cement. One method used when placing a foundation was to look for large rocks. When placing the concrete, they would throw these rocks into the fresh concrete. These rocks were called plum or pudding stones and could weight up to 100 pounds. This would reduce the amount of concrete and thus the amount of cement needed. This concrete was called cyclopean concrete (See wall in photo above) named for the race of Cyclopes from Greek mythology that had a huge single eye in the center of their head.

Now that the farmer has determined the materials needed to make good concrete, he must put it all together and make the concrete. This will be presented in Part 3.

Note: This was published on the World of Concrete website:

https://www.worldofconcrete.com/en/articles/Concrete_on_the_Farm,_Part_2.html

Concrete on the Farm, 1900 to 1940: Part 3—Getting the Right Mixture

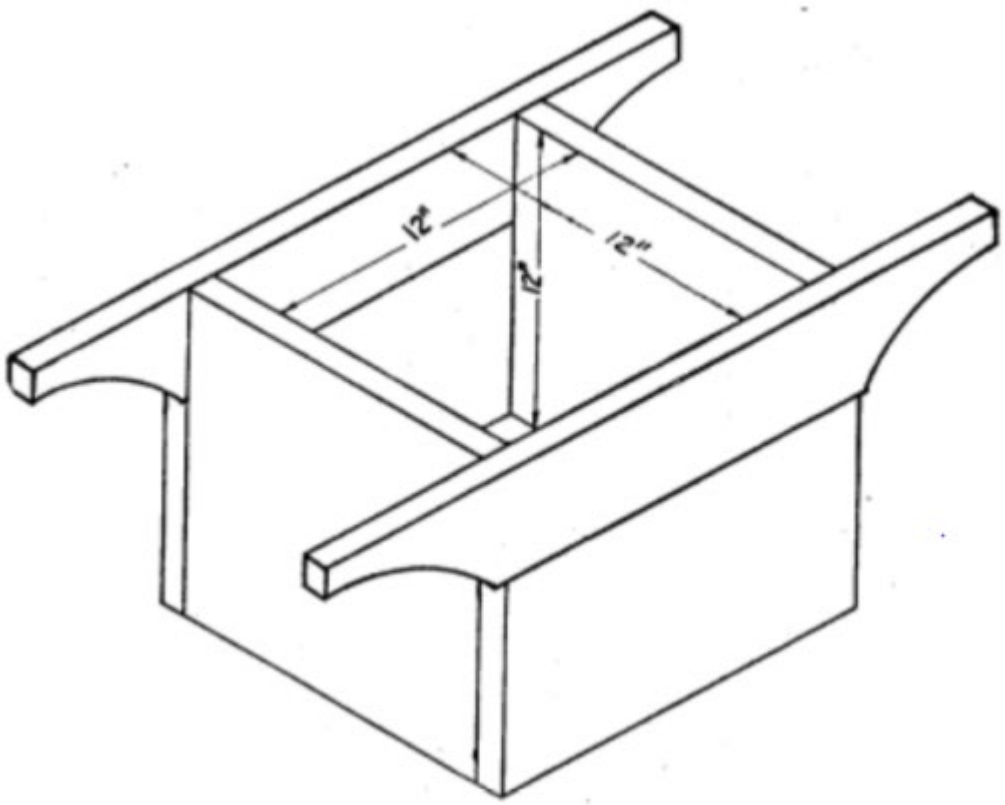
06/23/2020

One of the good things about concrete is that you can custom make it for the project needs. If you need strong concrete, use more cement to achieve your goal. If strength is not critical, reduce the amount of cement which lowers the cost. Today when you order concrete from a batch plant, they weight all of the individual ingredients and deliver concrete to an exact mixture design. On the farm, weighting the materials needed to make concrete would be difficult, so the farmer used a simpler method: measuring the volume of the materials needed to make concrete.

This is still a time-proven method. A common concrete mixture is 1:2:3, that is 1 part cement, 2 parts sand, and 3 parts rock or gravel. In many parts of the world this method is still common. They load the mixer with shovels full of each material (1 shovel of cement, 2 shovels of sand, 3 shovels of rock) and add water until the concrete looks “right.” I have seen this method used in Algeria and Mongolia when they were site batching concrete. Although widely used, this method does not provide consistent concrete. Each person’s shovel amount may be different and when adding water, what looks right to each person can vary.

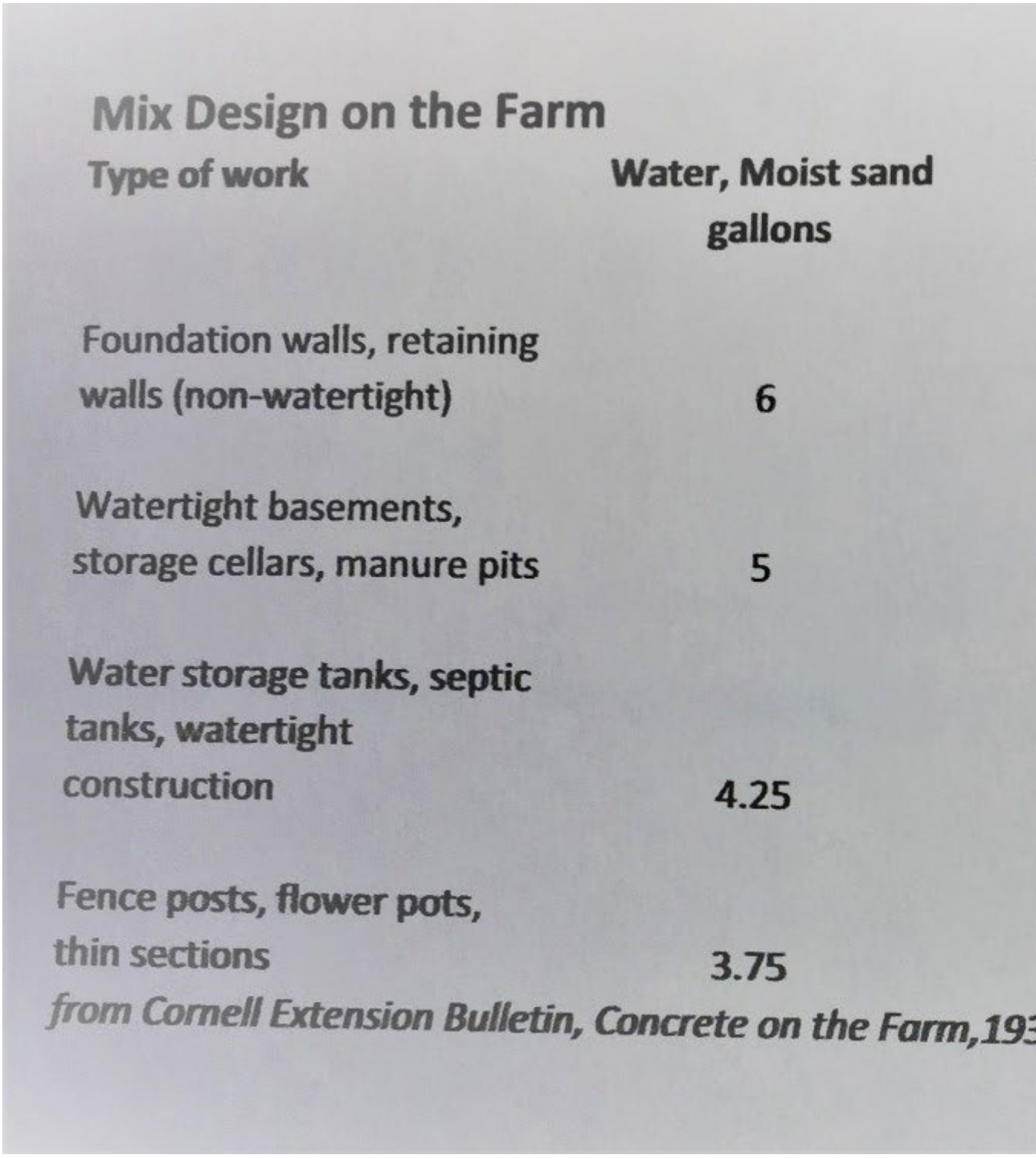
Although the 1:2:3 mixture is widely used, it may not be the best or cheapest concrete mixture for a project. Typically, the concrete used in a building foundation does not need to be as strong as the concrete for barn floors or roadways. To make more consistent concrete, farmers were encouraged to use a concrete mixture that had exact amounts of materials that met the needs of what they were building.

To ensure the quantities of materials were exact, the farmer would make a bottomless box of exactly 1, 2, or 3 cubic feet. Shown here is a one cubic foot bottomless box.



If the farmer was using a 1:2:3 mixture, he would fill the box 2 times with sand and 3 times with rock. After filling the box, the farmer would lift the box giving him an exact amount of sand and rock. The farmer would not need to measure the cement because it came in a 1 cubic foot bag that weighed 94 pounds. Many people wonder why modern cement bags have the odd weight of 94 pounds—now you know.

To make sure the farmer tailored the concrete to what was needed, he was encouraged to batch the concrete with the proportions shown in the table below.



Mix Design on the Farm

Type of work	Water, Moist sand gallons
Foundation walls, retaining walls (non-watertight)	6
Watertight basements, storage cellars, manure pits	5
Water storage tanks, septic tanks, watertight construction	4.25
Fence posts, flower pots, thin sections	3.75

from Cornell Extension Bulletin, Concrete on the Farm,19

The control of the water was the difficult part. If the concrete was too dry, it was difficult to place, if too wet the strength would be low. Since most sands have some moisture, the farmer had to determine how much water was in the sand. If sand was considered too wet, he would be instructed to reduce the amount of water. This was good advice however the final amount of water added to the concrete mixture was based on judgment and hopefully experience.

Some books gave the “water-cement ratio law” that had only been recently discovered. “For a given material and condition of handling, the strength of concrete is determined solely by the ratio of the volume of mixing water to the volume of cement so long as the mixture is plastic and workable.”

To drive home this fact, instructional books of the time further explained that if we use 7.5 gallons of water per sack of cement, the compressive strength of the concrete would be 1500 psi, 6 gallons per sack would be 2500 psi and 4.5 gallons of water per sack would give 3600 psi.(these strengths were measured at 28 days). This is excellent advice, however, the less water you put into the concrete, the more difficult it is to place and consolidate. Many times, the farmer would add more water than stated above just to make the job of placing the concrete just a little easier.

Today we have moisture meters that determine how much water is in the sand and computers that automatically adjusts the concrete mixture so there is a consistent amount of water in each batch. The farmer had to use a simple test to determine if the sand was dry, moist, or wet. He would take a handful of sand, squeeze it, then let it fall through their fingers. If it freely fell with no residue on the palm and fingers, the sand was dry. If it fell through the fingers but lefts a residue on the palm and fingers, it was moist. If after squeezing the sand, water ran out, the sand was wet.

The advice given in these self-help books for the farmer is still valid today.

We now produce a higher strength concrete; our durable concrete now exceeds 4000 psi and we add chemicals (admixtures) to keep the amount of water much lower that stated above.

If the farmer followed the advice provided in these self-help books, he had clean sand, good rock and a mixture design tailored to where he planned to place the concrete. Now comes the hard part. He had to mix the concrete, and that’s the subject of our next article

Note: this was published on the World of Concrete website:

https://www.worldofconcrete.com/en/articles/Concrete_on_the_Farm_Mixtures.html

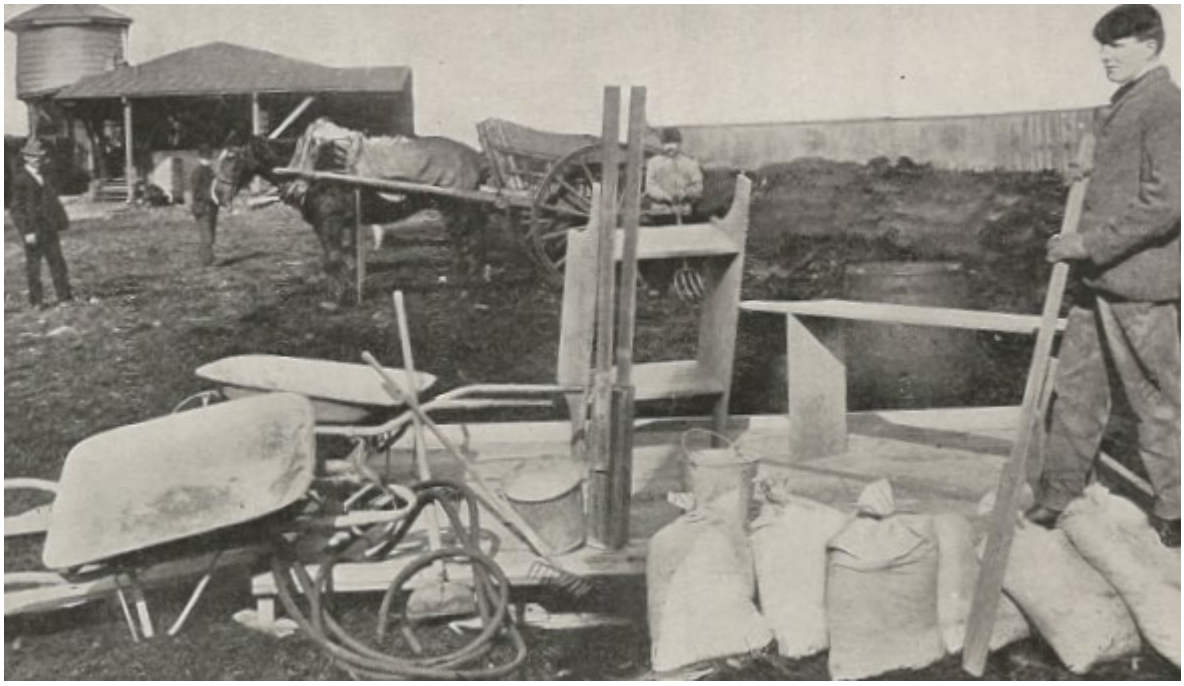
Concrete on the Farm, 1900-1940: Part 4--Making Concrete

07/14/2020

By Luke M. Snell

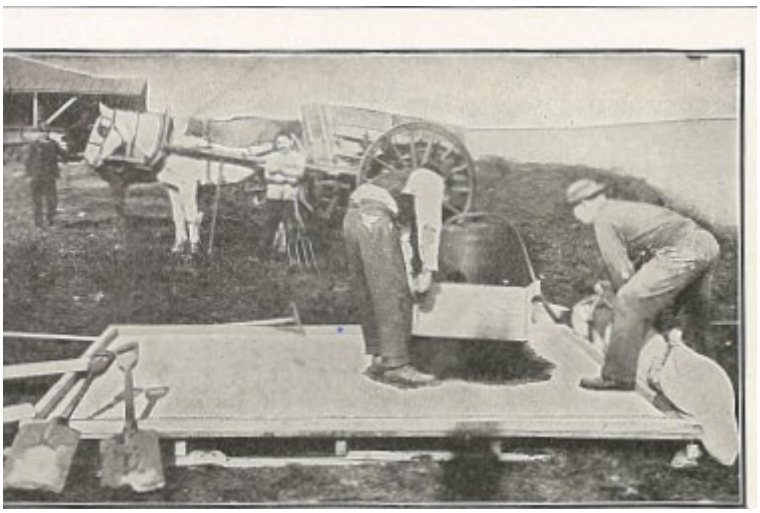
The farmer now has quality materials and a mixture design tailored to what he needs. Now it’s time to make the concrete. The self-help books of the time tried to simplify the process by providing pictures of each step, which may appear simple in a book, but making concrete is hard work.

The first step (Picture 1) is to gather all the necessary materials and to have a work platform to make the concrete. The work platform can be any level spot. In this picture, the farmer built a working platform out of wood.



1. Gathering all the materials onto the work platform.

The next step (Picture 2) is to accurately measure the amount of sand needed for the mixture. The farmer used a bottomless box (see Part 3, Getting the Right Mixture) to get the volume of sand correct according to the mixture design. In this picture the bottomless box looks to be 3 cubic feet.



2.. Making sure the volume of sand is correct.

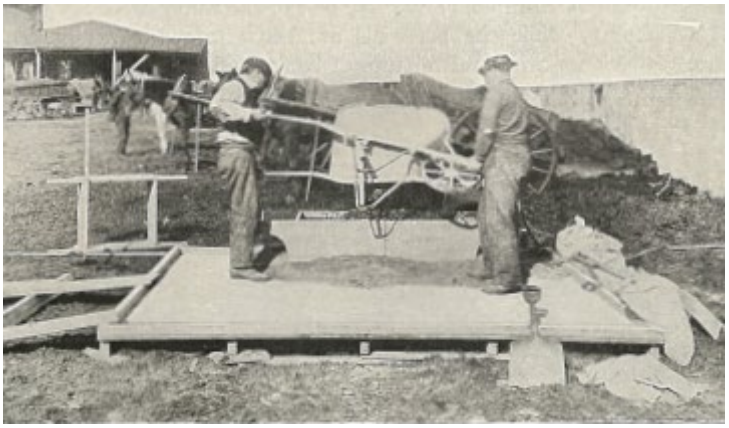
The farmer added the cement directly onto the sand (Picture 3). Note that the farmer did not need to measure the amount of cement in the bottomless box since it came in a 1 cubic foot bag. The cement bags appear to be made of cloth. These bags could be recycled if returned to the cement company undamaged.

3. Adding the cement on top of the sand.

They would then mix the sand and cement together (Picture 4). They know they are done when the sand and cement appear to be uniformly mixed.

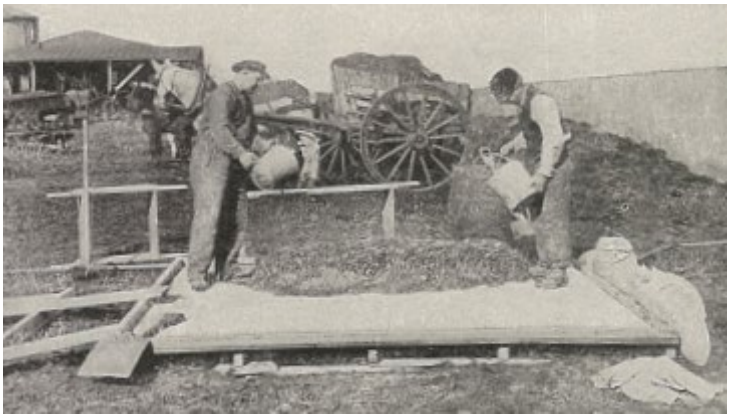
4.. Mixing together the sand and cement.

Now they are ready to add the rock or coarse aggregate (Picture 5). They placed the bottomless box directly on the cement and sand pile. The wheelbarrow and the ramp made this process a little easier.



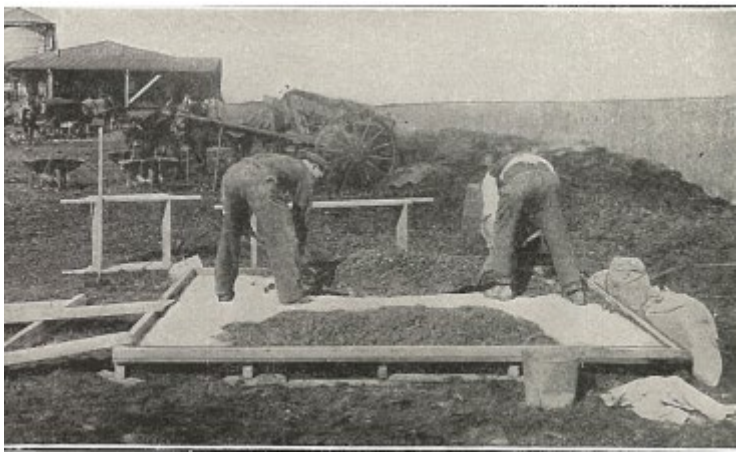
5. Adding the rock to the sand and cement.

After mixing the rock into sand and cement, water would be added. A predetermined amount would be measured and added so that they would not get too much water into the mixture (Picture 6).



6. Adding water to the sand, cement and rock.

The final step is mixing all the ingredient together. They knew they were done when the entire mixture was of uniform appearance (Picture 7). In the picture, they divided the pile into two parts for ease of mixing. They would put the piles back together as a final step.



7. Final mixing of the concrete.

If you have ever mixed concrete by hand, you know how tiring this work can be. Unfortunately for the farmers, their work is not done. They now must place the concrete--without pumps, conveyor belts, power buggies, or vibrators, so they still have a lot of work to do. The next (and last) article in this series will discuss how the farmer placed the concrete.

Luke M. Snell is a concrete historian and Emeritus Professor at Southern Illinois University Edwardsville.

Note: this was published on the World of Concrete website:

https://www.worldofconcrete.com/en/articles/Concrete_on_the_Farm_Part_4.html

Concrete on the Farm, 1900-1940: Part 5--Placing and Finishing the Concrete

07/28/2020

By Luke M. Snell

Now that the concrete is mixed, the farmer has to get it in place and finished. The first task is to move the concrete from where it was mixed it to where it is to be placed. This would normally be done with a wheelbarrow balanced on a plank as shown in Picture 1.

1. Moving the concrete by wheelbarrow.

Once the concrete was in place, the farmer would need to consolidate it. In modern construction this would be done with a vibrator that get the entrapped air out of the concrete and make the concrete into a solid mass. Vibrators were unfortunately not available, so the farmer would use one of two methods (Picture 2). For a flat surface, such as a floor, they would use a tamping rod. This method basically beats the concrete into a

flat surface and provides a very dense and durable concrete. When building a concrete wall, they would use a spade. By today's standards the concrete was quite stiff and took a lot of effort to consolidate.

2.. Consolidating the concrete with a tamping rod (top) and spade (bottom).

Once the concrete was consolidated, the farmer would finish the concrete surface. In Picture 3, the farmer is using a wooden float. This left a slightly rough surface, which was ideal. If the surface was finished smooth, it would be slippery and provide little skid resistances. This slightly roughen surface was desirable especially for barn floors since they did not want a cow to slip and fall.

3. Finishing the concrete.

Below are pictures of projects that the self-help books of the early 20th Century suggested that the farmer was now able to accomplish. These include a building foundation, a clean area in front of a building, a clean area for livestock, a corn crib floor, tree repair, and concrete fence posts. These pictures only touch on some of the projects where the farmer could use concrete.

Hopefully this series of articles, Concrete on the Farm, have helped you realize how important concrete was to farmers in those days. While researching these articles, I developed an appreciation (and hopefully you did too as you read them) of the many skills these farmers had to master while running their farm.

Luke M. Snell is a concrete historian and Emeritus Professor at Southern Illinois University Edwardsville.

This was published on the World of Concrete 360 website:

https://www.worldofconcrete.com/en/articles/Concrete_on_the_Farm_Part_5.html