

Installation of castables in the Foundry

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Introduction

In this paper I will talk about the correct way to install a castable in the foundry by following a few simple steps. How to select the right type of castable for the job and what type of equipment will be required to ensure the best possible result from the product used.

Type of castables

For the Foundry applications there are three main types of castables.

Conventional castable

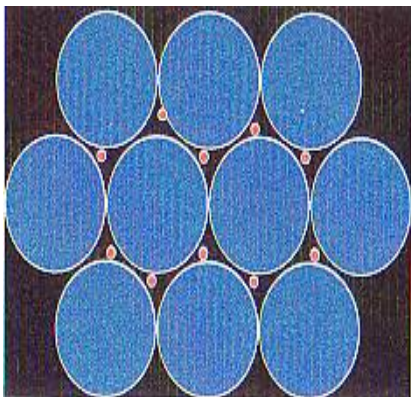
A typical conventional castable would have a high alumina cement binder 25% and 75% aggregate. Water required for mixing would be 6% to 17%

Advantages:

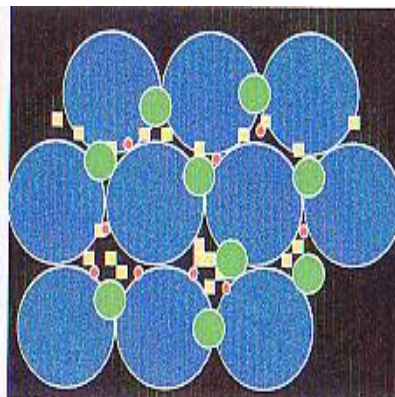
- 1) Quick and easy to install, no real need for a good mixer, could be mixed by hand on the floor or with a concrete mixer.
- 2) There are far fewer cracks in a monolithic structure than there are joints between bricks.

Disadvantages:

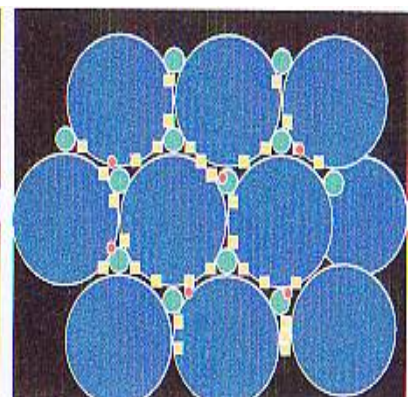
- 1) High porosity (about 20%) due to the high amounts of water required to wet the alumina cement. Once this water is driven off (dried) the hole left is open porosity.
- 2) At temperatures above 800°C, the strength of the product diminishes. At high temperatures, the refractoriness decreases due to the liquid formation in the matrix.
- 3) Needs vibration to de-air the castable and to maximize its density.



Conventional Castable
75% aggregates
25% cement



L.C. Castable
75% aggregates
10% cement



Self Flowing Castable
75% aggregates
<3% cement
20% fines
2% additives

Low cement castable

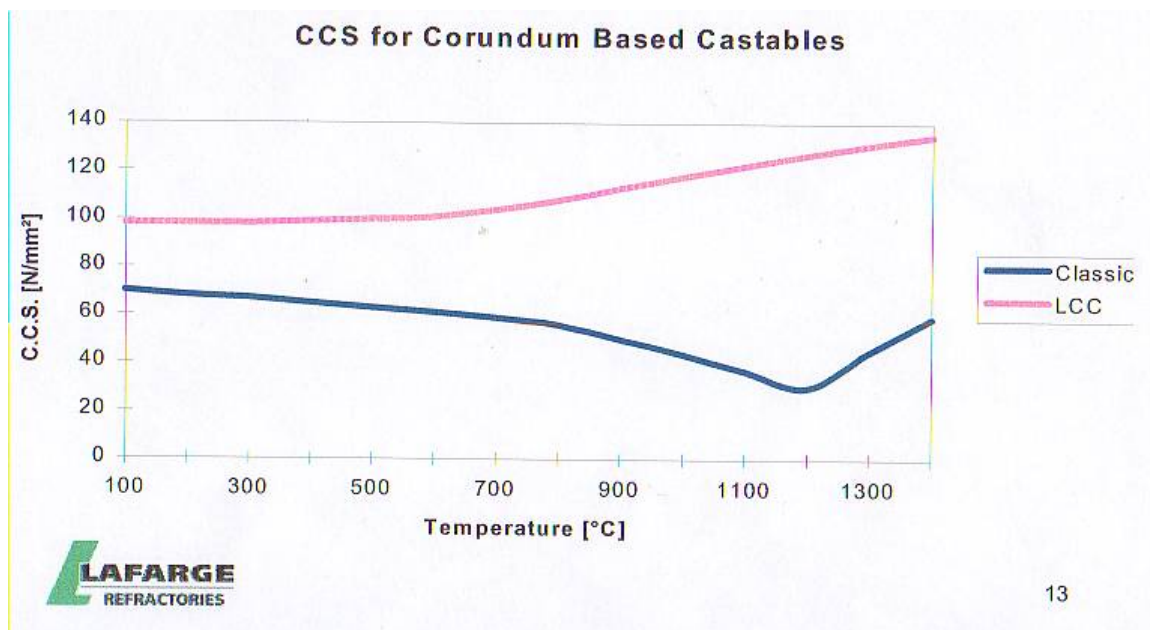
A typical low cement castable would contain 75% aggregate 10% refractory cement and 15% refractory fines. Water required for mixing would be for some products as low as 4.5% to 5.5%

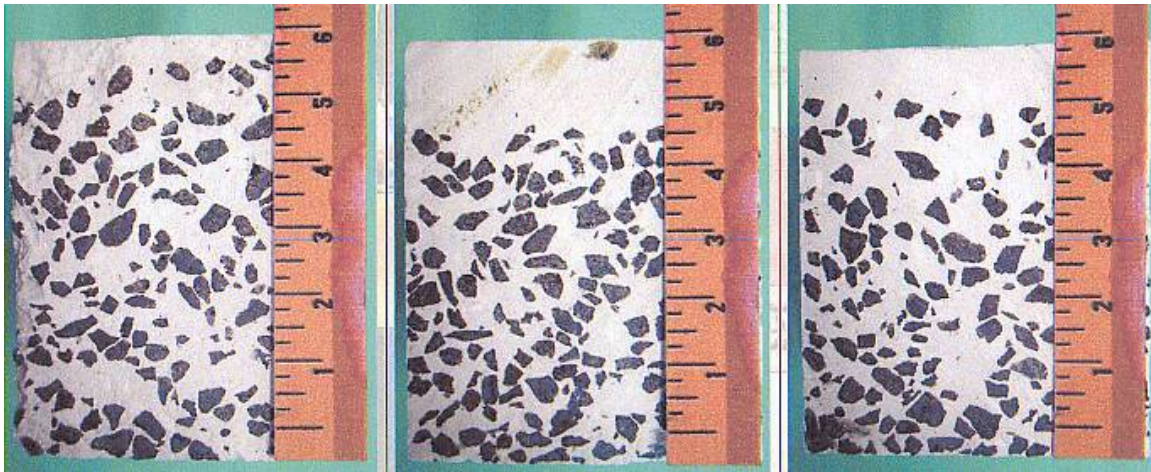
Advantages:

- 1) Lower porosity about 10% High compact structure.
- 2) No loss in mechanical strength at intermediate temperatures 800°C
- 3) Less liquid formation at high temperatures 1400°C

Disadvantages:

- 1) Needs a good mixer not an Armstrong type mixer, must have high shear mixing action. (not a cement mixer)
- 2) Installation quality must be very high, stick to the data sheet for the correct % of water, and the quality of the water must be potable and use the correct vibration. Check ambient temperature is not too high or too low, this could effect the setting times of the product.





Product installed in normal conditions, i.e. recommended amount of water and normal vibration time

Product installed with 1.5% extra water

Product installed with correct amount of water and vibrated for 3 times the standard vibration time

Self-flowing Castable

A self-flowing castable is a low cement or an ultra-low cement castable characterised by a consistency after mixing which allows it to flow and to de-air without any external vibration or energy. Anyone can make a castable flow without vibration. Just add extra water, however in doing so, they will lose all the advantages of a high compact castable.

SFC's flow because the grains are floated apart, not on water, but with a slurry of refractory fines. So on drying, there is almost no increase in the porosity and no lose of strength.

Advantages:

- 1) No vibration required.
- 2) Often less water is required.
- 3) Very strong bond to old layers of refractory.

Disadvantages:

- 1) Installation temperature (may require to retard or accelerate the mix)
- 2) Not cheap
- 3) Need a good mixer.

A Good Casting Operation

Make or use a good check list, minimise or eliminate any reason for stopping the casting process or causing a poor installation of the castable.



“A Checklist” For Casting Operations

A GOOD CASTING OPERATION SHOULD NOT LAST MORE THAN 8 HOURS
(except very large volumes) and SHOULD BE UNINTERRUPTED
(less than 30 minutes between mixing operation)

BEFORE STARTING WORK

CHECK THAT

SUFFICIENT PRODUCTS ARE AVAILABLE ON THE SITE

THE WORKING AREAS ARE CLEAN

FORMWORK HAS BEEN **GREASED OR WAXED**

DRINKING -QUALITY WATER IS AVAILABLE WITH MEANS OF MEASURING
VOLUME (graduated bucket, water meter) - (ideal water: 15 to 25°C)

CHECK THAT

THE MIXER IS CLEAN

And CORRECTLY ADJUSTED (VANES AND BLADES) THE VOLTAGE SETTING IS
CORRECT, CHECK ITS DIRECTION OF ROTATION AND RELIABILITY
(avoid electrical trip-outs)

ALSO CHECK

THAT THE VIBRATION EQUIPMENT IS AVAILABLE

READY FOR USE and

SUITABLE FOR THE VOLUMES TO BE CAST

(thickness to be cast = rod diameter x 2.5)

PREPARE

EQUIPMENT TO TRANSPORT THE PRODUCT

(buckets, wheelbarrows, etc.)

FINISHING TOOLS (shovels, trowels, straightedges, etc.)

YOU CAN NOW START CASTING

(minimum ambient temperature: 5°C)



MIXING

(Mix the sack(s) dry before use)

To obtain maximum efficiency, only fill mixers to: 50-60% of their capacity

WET THE FIRST BATCH (within the recommended range, choose the maximum average for the product quality)

PROGRESSIVELY ADJUST THE QUANTITY OF WATER OVER THE FIRST 2 OR 3 BATCHES UNTILL REQUIRED CONSISTENCY IS OBTAINED

THE TOTAL MIXING TIME VARIES FROM 3 TO 6 MINUTES, DEPENDING ON THE SIZE OF THE MIXER USED

IF THE PRODUCT IS TO BE CAST AND RODDED: USE THE “BALL TEST”

(throw handful of product a dozen times from one hand to the other to form a ball)

This casting method aims at eliminating air bubbles and filling voids left when the product is poured. The product must be “energetically worked with a metal rod or trowel”: the same result can be obtained by slightly vibrating the product

IF THE PRODUCT IS TO BE CAST AND VIBRATED: FIRST VIBRATE A BUCKETFULL

(the concrete must compact and spread, forming a flat surface in less than 10 seconds – otherwise adjust the quantity of water)

A flat surface indicates compactness. Continuing could lead to segregation, causing a slurry on the surface

CASTING MUST BE COMPLETED WITHIN 30 MINUTES OF COMPLETION OF MIXING (at an ambient temperature between 15 and 25°C)

IF THE STRUCTURE REQUIRES CASTING IN SEVERAL LAYERS, SEPRATE THE ZONES SO THAT NEW MATERIAL IS ALWAYS POURED LESSTHAN 30 MINUTES AFTER THE PREVIOUS LAYER

FINISHING

DO NOT SMOOTH THE SURFACE

DO NOT LEAVE SURFACES TO THE OPEN AIR, COVER THEM WITH WET PAPER OR JUTE BAGS

IN GENERAL TERMS, THE PRODUCTS MUST BE KEPT IN A DAMP ATMOSPHERE FOR 24 HOURS AT LEAST, AND 48 HOURS IF POSSIBLE, AFTER SETTING.

UPON COMPELETION OF WORK, CLEAN THE MIXER, TOOLS, etc.



Simple Ball Test

Types of Mixers

An Arm strong type mixer is when you mix the product by hand on the floor with a shovel. This method should only be used with a conventional castable and as a last resort if you can not find a mixer.

Concrete mixer should also only be used for conventional castables, and care should be taken to insure that the mixer is clean. Any Portland cement will effect the setting time of the castable.

Paddle mixers are the next suitable mixer but still have some poor mixing features. Some areas of the mixing bowl contain unmixed product due to ineffective mixing blade pattern or poorly maintained blades. I find that all paddle mixers need cleaning every few mixes due to the build up of product around the centre shaft, this slows the casting process down on large jobs.



Paddle Mixer

Pan mixers are the most effective mixer used today due to the way the mixing blades or tines make sure all areas of the mixing pan are mixed, at no time should any product be left in the mixer when it is emptied. This type of mixer will allow the minimum water to be used when mixing low cement castables because of the high shear energy put into the product by the mixers action. The pan mixer makes the mixing of self flow castables very easy. The more you mix the better the flow-ability, not like the other types of mixers.



Pan Mixer



Speed Bowl mixer

Vibration

A vibrator must be used on all conventional castables, low cement, and light weight castables to insure maximum product density. Vibration should never be used on a self flow castables because the vibration will only cause total segregation of the aggregate and the binder, leaving a large film of binder on the top and most of the aggregate on the bottom of the job.

There are two main types of vibration used today, internal vibration and external vibration.

Internal vibrators are the old poker vibrators, they come in many sizes from 20mm to 100mm in diameter. They can be powered by air, electricity and petrol motors just like you could find on a building site.

External vibrators are vibrators that are fixed to the outside of the former or the ladle shell. They are powered by air or electricity. I find them the best way to install castables in the Foundry, because of the type of casting required. Most casting in the Foundry are ladles, they must be cast in one piece making the floor area very hard to vibrate with a internal vibrator.



Internal air and petrol powered vibrator



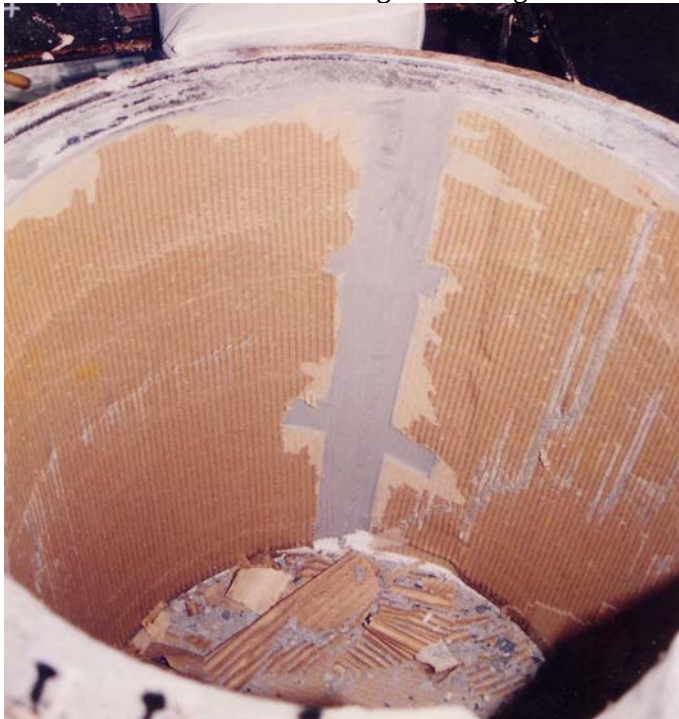
External air vibrator



Former Preparation

Release Agents

I have found the most effective way to ensure the former is removed without damage to the green castable is to use corrugated cardboard as the release agent. Oil and grease do not give any chance of removing a steel former that has been damaged in storage.

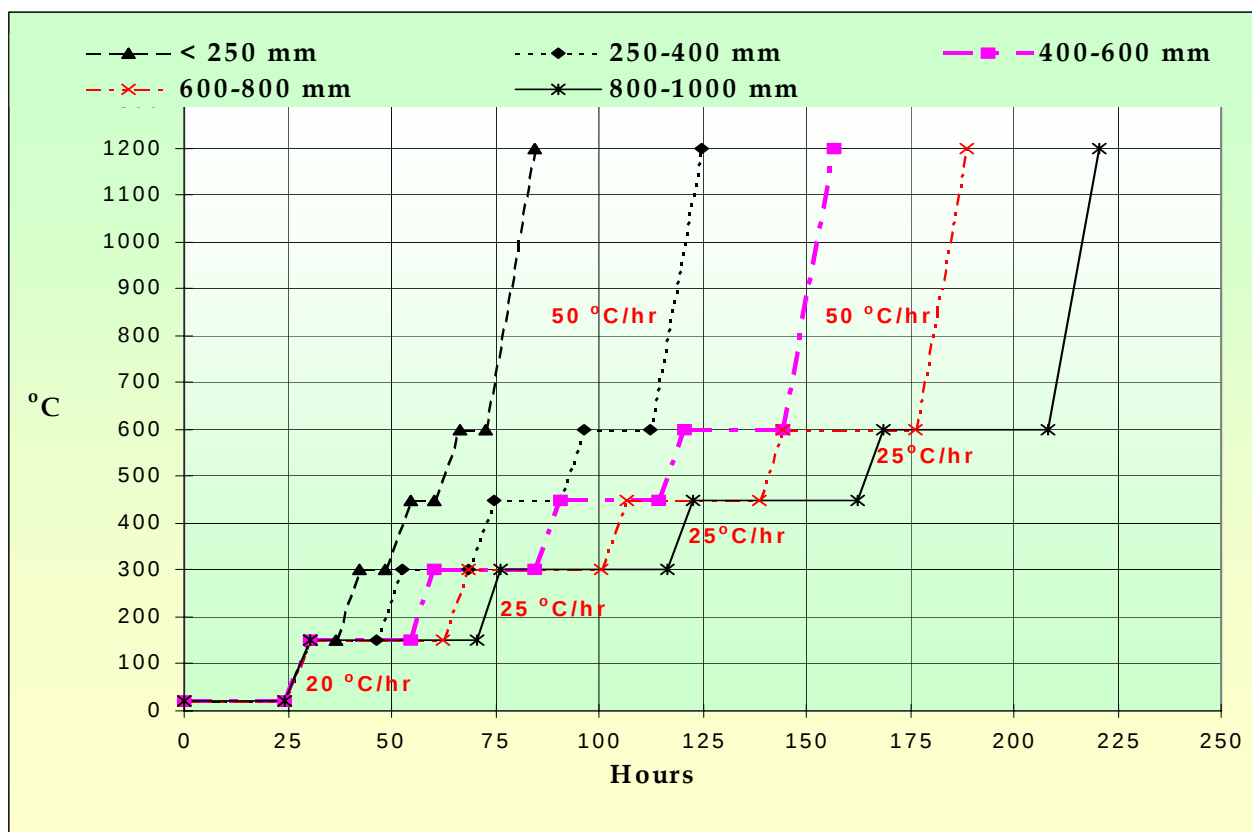


Drying and heating –up of castables

Once the setting time has elapsed, the castable can be dried to remove the free water that is still present in the castable. This will leave the rest of the water as chemically combined water that has reacted with the cement to form hydrates, the remaining water will be removed on the final heat-up.

Both process must be done slowly and gradually to avoid damaging the castable. If the free water and then the combined water are heated rapidly they will form steam, and if the pressure is higher than the outside pressure the steam will escape from the material. The temperature must be increased slowly to ensure that the mechanical strength of the material is always sufficient to easily withstand the steam pressure generated in it. This is the only way to stop a steam explosion from damaging the castable.

Please follow dry out schedule that are supplied by the manufacturer. It is always safer to go slower than faster with the dry out.



Dry out and heat-up schedule

Conclusion

When using a castables in the Foundry time should be taken in selecting the best type of castable, for one the mixing equipment available, and two the job to be cast e.g. self flow for a ladle repair, or Low cement for a new ladle for iron.

The most important thing to remember when trying to get the longest life from a product is. It will only last as long as you use it not miss use it.