
CERAMIC POT REFRACTORY LINING

GALVANIZING

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YASHASWI FURNACE

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A
PROJECT REPORT
ON
REFRACTORY LINING

OF
CERAMIC POT
BY



M/s YASHASWI FURNACE

YASHASWI FURNACE
AT

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JSW, BELLARY

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EXECUTIVE SUMMARY

Galvanizing is a process of coating metals such as Steel and Iron with Molten Zinc or Combination of Molten Zinc and Aluminium so as to avoid rusting and increasing the durability, life span and formability of these Metals. When the Galvanizing is done on a large scale in Industries Worldwide, the process becomes continuous as the Metal Strips are continuously passed through the Furnace hence called as **CONTINUOUS GALVANIZING LINE**.

The main element that is associated with the entire process is the Zinc Bath. This Zinc bath is the molten Zinc which is coated or bonded with the metal strip surface called as Bonding Zone and this Bonding zone should be as thin as possible. The most important process in this entire Galvanizing line is the Ceramic Pot which consists of the Molten Zinc which is used for the Zinc Bath. This Ceramic Pot is the heart of the entire Galvanizing Process.

The project report is based on the Galvanizing Ceramic Pot furnace Refractory Lining (Lining of Bricks and Castables which can tolerate high temperature) Project which was undertaken at Jindal Steel Works at Bellary by M/s Yashaswi Furnace. The report gives the detailed study about the entire Refractory Lining work that was done for the Ceramic Pot along with the Casting of the Castables (Cement like material with high alumina content) and also the Dry Casting of the High Voltage Inductors with the Dry Castables and there fixing onto each pot facing each other.

These Inductors are used to produce heat electrically which is then used to convert Blocks of Zinc into Molten Zinc.

The report gives us the step by step procedure that was carried out by M/s Yashaswi Furnace under the Visiting Foreign Supervisor. This report not only helps to know the entire procedure to carry out the work of Refractory Lining of the Ceramic Pot Furnace but also gives the idea of the obstructions that was faced and overcome by M/s Yashaswi Furnace so that in the near future the work of the Galvanizing Ceramic Pot Refractory can be carried out smoothly without facing those obstructions and thus by reducing the time period required for this project.

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INTRODUCTION

Galvanizing is the process of coating Iron and Steel with a protective coating of Zinc in order to prevent rusting and increasing the durability of these metals. Initially this process was not known and not used by the masses as extensively as it has been used and known today. In the early 60's, Galvanizing was used at a very small level but now it has become a major contributor in the steel and iron industries.

Continuous Galvanizing Line first came to India in the early 90's. Since then it has been a revelation in the Steel Industries as it has been used extensively to coat the sheet rolls of Steel/Iron so as to not only increase the strength but also increase the durability as well as increase the Quality of the finish of the steel sheets which will further be used for different purposes. Earlier before the coating sheets came into existence, there was hardly any type of high quality finished products of Iron and Steel seen but today, from roof tops to automobile body panels we see coated steel everywhere and with the Automotive industry booming all over the world, sophistication eventually became the need of the hour and providing high quality finished products is not being compromised today anywhere by the manufacturers worldwide.

These Steel products should also have good formability so that they can be modified according to the need of the end user. This process has not only attracted the automotive products manufacturers but investors too started Investing in this industry eyeing the revolutionary potential of this Industry.

THE BASIC PROCESS:

Continuous Galvanizing is the process in which the Zinc is melted with the help of Inductors which are electrically charged and provides a strong heat to melt the Zinc Blocks. Then the Continuous Galvanizing applies a coating of the Zinc to the Steel Sheets which are continuously passing through the Pots in which the melted Zinc is placed. This Process is also referred to as the Zinc Bath.

The thickness of the steel sheets may vary from as thin as 0.25 mm to as thick as 6.5 mm and the width may be as wide as 1000 mm.

In this process, the steel rolls or sheets are passed through the molten Zinc at a speed of about 200 mpm (meters per minute). As the Sheets come out of the Zinc bath, they drag the Zinc with them. The desired Coating Thickness is achieved by special air throwing device called as Gas Knives which throws air to achieve the desired Thickness. These Gas Knives are placed on either side of the Continuous Moving Steel Sheets.

The entire facility is divided into 3 categories all over the world:

- **Light Gauge:** The product from this Gauge is used in applications like Roofing Sheets, Side wall Panels in the Building etc.
- **Intermediate Gauge:** The product from this Gauge is used in application like Automotive Body Panels.
- **Heavy Gauge:** The product from this Gauge is used in application like Automotive Structural Parts.

One of the most important features of this process is the formation of a very strong bond between the steel or iron sheets and the Zinc. The Sheets that are passed through the Zinc Bath (Pot Containing Molten Zinc) are inside the Pot for a very short period of around 2-4 seconds. During this period, the Iron or Steel Sheet should be able to form a strong bond with the Molten Zinc. In this brief period, the Steel or Iron sheets reacts with the Hot Molten Zinc to bond or to stick on the strip surface. The Bonding of the Zinc and Steel Strip is called as Bonding Zone. This Bonding Zone is very critical as the thickness of this Layer is only about 1 to 2

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micrometers. After the coating is applied, the sheet is recoiled and supplied to many customers for forming into different shapes where it might be used on the Rooftops, Automotive body panels etc. If the Bonding Zone is not formed correctly then the Zinc would not stick to the surface of the Strip and the coating would wear off easily. On the other hand if the Bonding Zone becomes too thick then during the process of using it in different applications, cracks may develop and the Layer may disband from the strip surface. Thus it is very important for the Zinc and Strip bond to form properly and it should not be too thick or too thin.

Since the sheets have to go continuously through the line, the process becomes more cumbersome and the special mechanical devices needs to be placed to control the speed of the sheets, steer the sheets in various directions without affecting the finishing of the coating or defecting or wearing off the sheets. The entire line not only needs the mechanical devices to control the speed or control the direction but it also needs various drying sections as the Zinc coating needs to dry off quickly and various cleaning as well as various finishing sections are used for this process.

BASIC CERAMIC POT CONTAINING THE MOLTEN ZINC:

Apart from these mechanical and drying devices, the foremost important process is obviously Galvanizing. If the Zinc bath is not properly achieved, there is no use of all these mechanical devices as the quality is already hampered at the basic level of Coating the Steel/Iron sheets.

So the most important part becomes the CERAMIC POT in which the Zinc is melted. These Pots are of square shape made from SS (Strong Steel).

The Zinc blocks which are placed inside these Ceramic Pots are not melted directly because if it is melted directly then the Molten Zinc will react with the Ceramic Pot and eventually wastage of the Zinc will take place and finally even the Ceramic Pot will get damage from inside.

To avoid all these things, Refractory Lining is done inside the Ceramic Pot.

Refractory Lining is a process of application of different layers of the Bricks and Castables which can tolerate such high temperatures.

After a qualitative Brick Lining is done, the strong Bonding of the Sheets and the Zinc will take place.

The Refractory Lining thus becomes a critical Job and if not done correctly, the Quality gets affected which would eventually affect the end user.

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SEQUENTIAL OPERATIONS OF A CONTINUOUS GALVANIZING LINE

The Iron/Steel sheets that are subjected to Galvanizing have to go through a series of Steps:

- Uncoiler - The coiled Steel Rolls are uncoiled into straight sheets so that they can pass through the Line.
- Welder - The entire operation needs to be continuous so the coils which are uncoiled require to be welded.
- Entry Vertical/Horizontal Accumulators - This section is used to store the Strips.
- Degreasing - The sheets which are passed through the line should not contain any type of oil agents present on the sheets, so degreasing is done to remove the oil. Then the strips are brushed before being heated.
- Pre heat - The strip is passed through a series of heating sections to heat the strip at a high temperature to remove all the dust particles. The sections are Direct Fired Heating, Radiant Tube Heating and Electrical Heating.
- Cooling Section - This section is used to cool down the Strip to a particular temperature that is needed for the coating of the Zinc.
- Briddle Sections - This section is used to tighten the strips and also further heat them.
- Zinc Bath - This is a Pot like structure in which the molten zinc is placed. This is the actual section where the Zinc coating or the process of galvanizing takes place.
- Air/Gas Knives -When the Strips come out of the Zinc Pot, they drag excess of the Zinc with them. The air is passed through the strips from both the sides to remove the excess of the Zinc and achieve a thin coating of Zinc or the Bonding Layer.
- Quenching Tank -As soon as the strip comes out of the pot, the process of the cooling of the strip needs to be fast and quick so that the coating is formed correctly. This section is used to cool down the Strip.
- Cooling Tower - This section is also used to further cool down the strip so as the Zinc layer is allowed to dry.
- Hot Air Dryer - This section is used to further bond the Zinc layer with the Strip so as the Bond Layer is formed correctly and this Zinc coating does not drag out from the strip.
- Temper Mill - This is used to impart the desired surface finish to the coated steel.
- Tension Leveler - Since the strip has to go through a long process of coating, there may be slight wear and tear in the Sheets. This section is used to flatten the strip which maybe unflattened during the entire process.
- Briddle Roll - These are a series of Rolls to let the coil move continuously through the entire Line.
- Deflector Roll - These are used to deflect the Strip in a particular direction
- Logo Marking - In this section the desired logo is marked on the entire strip.
- Steering System - This is a mechanical system which is used to direct the strips.
- Exit Vertical/Horizontal Accumulators - This section is used to store the Strips.
- Recoiler - This is used to coil the strips in the desired length.

PROJECT DETAILS

- PROJECT: **POT REFRACTORY**
- SERVICE PROVIDOR: **M/s YASHASWI FURNACE**
- CLIENT: **JINDAL STEEL WORKS**
- Reference No.: **YF/108/2012-13**
- PURCHASE ORDER No.: **VJNR/P00001/C/4700012139**
- PROJECT SITE: **BELLARY, KARNATAKA**
- DEPARTMENT: **COLD ROLLING MILL #2**
- PROJECT DURATION: **30 Days**
- MANPOWER: **40 (Engineers, Supervisors, Technicians, Masons, Unskilled Labourers).**



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ABOUT M/s YASHASWI FURNACE

Furnace is the heart of any Steel or Iron Industry. Furnaces are seen everywhere from baking a bread to Manufacturing Coated Steel.

M/s Yashaswi Furnace is very well aware of every kind of Furnaces.

M/s Yashaswi Furnace was established way back in 1999 and it has its roots within Vulcan Engineering which was a Prolific Engineering Company during the mid 90's for its Quality of the Furnaces.

The team of M/s Yashaswi Furnace previously worked along with the Vulcan Engineers which provided various Furnaces all over India.

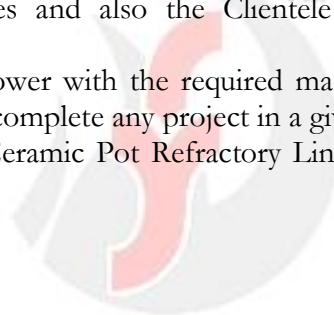
When Continuous Galvanizing Line first came to India it was totally a new concept for the Indian Industries. During the Mid 90's the team of M/s Yashaswi Furnace along with the Vulcan Engineers started providing Refractory Lining for the Ceramic Pot Furnaces which are used for Melting the Zinc blocks for the purpose of Zinc coating.

Since then M/s Yashaswi Furnace has been doing Ceramic Pot Furnace Refractory Lining all over India. Gradually they started doing Pot Furnaces everywhere and eventually they achieved the tag of specialists of CERAMIC POT FURNACES.

Today the team of M/s Yashaswi Furnace boasts a team of having experience for more than 30 years in the Furnace Industries and also the Clientele list is a big achievement for this organization.

They have the required man power with the required machinery for a particular job and they have the skills and capability to complete any project in a given time schedule.

They have not only provided Ceramic Pot Refractory Lining only in India but also across the Continents of Asia, Africa etc.



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1. THE VISIT

M/s YASHASWI FURNACE acquired the job of Refractory Lining of the Ceramic Pot at JSW.

Looking at the Clientele List and the Profile of M/s Yashaswi Furnace, the Ceramic Pot Refractory was never an Alien project for them. They had already done major Ceramic Pot Refractory Projects across India and especially across Maharashtra. Not only they have the experience of doing this project but they also have the capability to provide the Quality required for the Refractory Lining.

JSW, Bellary is a Steel plant which manufactures the Steel Coated products all over the world. The Cold Rolling Mill-2 Department required a new Galvanizing Line so they allotted this project to M/s Yashaswi Furnace.

Since this was a Crucial Project, M/s Yashaswi Furnace decided to start the entire project with a visit to the site and scheduling a meeting with the Officials at the Site.

This visit was important as it would not only help to device a Blue Print for the Project but it would also help them to specify various points and clear out various doubts regarding the project.

Since this was a new territory that was being explored by M/s Yashaswi Furnace, the planned visit would ease out the nerves regarding this project initially.

1.1 DATE OF VISITING THE SITE: 6/9/2013

A visit was planned to check the working conditions of the site by M/s Yashaswi Furnace and a meeting was conducted with Officials of JSW and J.P. STEEL PLANTECH.

1.2 POINTS DISCUSSED:

- Duration of the Project.
- Day of Starting the Project.
- Day of Mobilizing the Man Power and No. of Men required for completing the entire project.
- Day of arrival of the Refractory Materials and Equipments.
- Special Tools and Tackles required for the project.

1.3 POINTS SPECIFIED BY JSW:

- No accommodation will be provided even on rental basis.
- No transportation will be provided.
- All the requirements related to Safety Equipments and all the Machines will be provided by Yashaswi Furnace.
- The rules and regulations have to be followed and all the Men will have to go through Safety Drills for the gate passes.
- The shifting of the materials will have to be done by Yashaswi Furnace and only overhead crane will be provided by JSW.

1.4 WORKING CONDITIONS:

- According to the visit at the Job Site it was observed that the Job Site was still under construction and it would require more one week for the Job site to be ready.
- Accordingly M/s Yashaswi Furnace planned the Mobilization of the Man Power.

2. THE PLANNING

After the meeting was completed with the Site Incharge and along with the site visit at JSW, Bellary; the plans were chalked out by M/s Yashaswi Furnace to start and complete the entire job.

Since it was a critical job and the responsibility of completing this job was enormous, stage wise planning was done so as to complete the job without any hurdles.

2.1 PLAN OF ACTION:

- The equipment list that was provided by J.P. STEEL PLANTECH was gone through and the availability of all the equipments was checked.
- Dry Ramming Mass Machine which is used to Dry cast the High Voltage Electrically Charged Inductors was not present and so it was purchased after a lot of trouble as it was not available at any place and it had to be specially imported.
- Mobilization of the Manpower was done.
- Extra Electric Vibrators and Mechanical Vibrators were purchased in case of the emergency along with the Leads of 60 mm and 40 mm.
- All the machinery required for the Job like Mixture Machines, Vibrators, and Grinders etc. were dispatched from the Workshop in the third week of October as they were not needed initially.
- Accommodations for the Manpower near the Project Site were arranged.
- Workmen Compensation Policy and Group Insurance was arranged.

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3. THE BEGINNING

3.1 STARTING THE PROJECT:

- On 29th November all the Manpower reached Bellary and they went through the safety drills required for the gate passes as directed by the Site Incharge at OPJC.
- On 30th November all the Men reached the Job Site but the work was delayed as the Foreign Visiting Supervisor had not arrived.
- For the next two weeks only shifting of the materials took place from the storage to Job Site according to the requirement.
- Only the shifting of the materials and the unloading of the machines took place till the third week of October.
- The Supervisor arrived on 17th October.



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4. THE INITIAL PROCESS

Finally when the Foreign Supervisor Arrived under whom all the work was to be done, he had conducted a meeting with the JSW Site Incharge and the Supervisors of M/s Yashaswi Furnace. The Supervisor planned out the entire day to day schedule so that the entire work would not get delayed.

M/s Yashaswi Furnace decided that the Initial Supervision will be carried out by their Supervisors and if satisfied then only the Visiting Supervisor will be called upon for the Final Inspection.

4.1 CLEANING OF THE CERAMIC POTS:

- The entire Procedure for the Ceramic Pot Refractory Lining starts with a simple procedure of cleaning the Ceramic Pot with Cloth, Broom and wire Brushes.
- The cleaning is done so as to remove rusts, dust particles, water, oil etc. from the Pot as any of these agents may cause improper working of the entire Line and the Quality of the coating of the Zinc on the Sheet surface may be affected.
- Since it was raining, Ceramic Pot was left to dry so that the moisture evaporates completely and the Lining can be started.



Image 1: CERAMIC POT Cleaning

5. BRICK LINING

The Earth Level of the CERAMIC POT has to be at a perfect level before the Brick Lining can be started as then only the Brick Lining Levels can be checked so that they are proper.

Since the high Voltage Electrical Inductors will generate heat to melt the Zinc Blocks, the Heat should keep on circulating Inside the Ceramic Pot and it should not radiate outside the Pot, so the Brick Lining is done from all the sides as well as it is done on the Bottom of the Pot.

There are several layers of the Brick Lining which is done inside the CERAMIC POT.

The first and the foremost layer is that of the Light Weight Insulation Bricks.

5.1 BRICK LINING OF THE BOTTOM LEVEL:

- The bottom level of the Ceramic Pot is always started first so that it could be taken as the reference to measure the level of the Brick Lining for the side walls.
- The cleaned dry pot is then begun with the first layer of the Light weight Insulation Bricks.
- Only one layer of the Brick Lining is done at the bottom.
- Special Mortar (Cement like material) is used to stick the Bricks to each other.
- The Brick Lining is done by the Masons.
- When the entire Brick Lining is done, the levels of the Lining is checked and if the levels are not proper then the level of the Pot is checked and if the Level of the Pot is improper then changes are done accordingly so as the Brick Lining is proper.



Image 2: Brick Lining of the Bottom of the POT

5.2 BRICK LINING OF THE SIDE WALLS:

- As soon as the Brick Lining of the Bottom Level is completed, the Brick Lining of the Side walls is started.
- The side walls have different layers of Brick Lining.
- The first and the second layers are of Light Weight Insulation Bricks.
- After the first layer is completely finished, it is checked for the levels. For this Pot the up and down nature of the Brick Lining was accepted as the Pot itself was not leveled.
- Special Mortar (Cement like material) is used to stick the Bricks to each other.
- Then the second layer of the Light Weight Brick Lining is done.
- Here Special Mortar (Cement like material) is used to stick the Bricks to each other as well as to the Brick Lining of the first layer.
- After erecting the first two layers of the side walls along the height of the Pot, the third layer is started.
- The Third layer is Heavy Weight High Alumina Fire Bricks and here too Special Mortar (Cement like material) is used to stick the Bricks to each other.



Image 3: Brick Lining of the Side Walls of the POT

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- The Top of the Third layer is not completely done as the top is completed with the Tile Lining which is bigger version of the Fire Bricks.



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6. SHUTTERING

After all the layers of the side walls are completely finished, the next stage in this process is Castable Casting of the Bottom layer of the Pot as there is only one layer of the Bricks and they won't be able to tolerate the high temperature of the molten zinc and the bricks would eventually be damaged.

So a layer of Castable (Cement Like material capable of tolerating very high to extreme temperature of the Molten Zinc) of around 305 mm is done.

Before the actual casting is done, the entire Bottom of the Pot is divided in different layers because the casting of the entire bottom cannot be done.

So the entire Bottom is divided into three layers:

1. Outer Layer: The outer layer consisted of 16 small parts.
2. Middle Layer: It consisted of 10 large parts.
3. Inner Layer: It consisted of only 2 large parts.

6.1 SHUTTERING:

Shuttering is a procedure of providing the support for the Wet Castables to be moulded in a Particular Shape and left to dry out or also called as the curing period.

This type of casting is also called as Monolithic Lining as the Lining is given a particular shape with the help of some materials.

The shuttering materials may be made of Iron, Steel or Ply wood depending on the requirement of the application.

Here High Quality Water Proof Ply Woods were used for the shuttering.



Image 4: Shuttering for the Outer Layer

7. CASTING OF THE BOTTOM LEVEL OF THE CERAMIC POT

Initially the Casting of the Outer Layer i.e. the layer consisting of 16 small parts was to be casted. Out of 16 only 8 alternate parts can be casted as two consecutive layers cannot be casted.

So a Plastic coating was applied to the entire outer layer.

After the Plastic Coating was applied, the Shuttering materials made of the Ply woods were prepared by the carpenter.

Eight C shaped woods were made and fixed.

All the C shaped woods were provided support with the help of Woods and Nails so that the C shaped woods would not move when it will be filled with the Wet Castable and it should hold on.

7.1 CASTING OF THE 1st ALTERNATE 8 PARTS OF THE OUTER LAYER:

- Iced water of temperature between 18 to 25 degree Celsius is used else if normal or hot water is used the Dry Castable would heat up early and it won't be set perfectly and eventually it will crack down.
- So a drum was filled up with normal water and Ice was dropped inside the drum.
- As soon as the Shuttering was done, it was time for the Casting.
- 2 Castable Pan Mixers (machine used for mixing the Dry Castable and water) were deployed for the Casting, with every men stationed at suitable places.
- In both the Castable Mixtures, 10 bags of Castable were put in every batch with around 5-6 litres of Cold water (from 18-25 Degree Celsius) which was according to the Visiting Supervisor.
- Electric Vibrators were used regularly to level the Wet Castables so that they could mould in the shape of the shutters and there would be no air bubbles formed at the bottom and the casting would be proper.
- It took around one and a half hour to complete the casting of those 8 parts.
- After around 2-3 hours of setting of the Castable wet Gunny bags were put on top of every part to avoid overheating and ultimately to avoid cracking of the Set Castables.



Image 5: Casting of the Outer Layer of the POT

After the casting of the 1st 8 parts were finished, it was left to dry out in the shape of the shuttering materials for around 24 hours.

This process is called **Curing**.

During the process of curing, the gunny bags kept on top of the castable needs to be replaced frequently so that the Casting won't crack.

7.2 SHUTTERING FOR THE REMAINING 8 PARTS OF THE OUTER LAYER:

- After the Curing of the Castables, it was time to remove the shuttering materials and fix the shuttering materials for the remaining 8 parts.
- The Ply woods were removed in a specific way so that they won't break and can be reused for other shuttering process.
- After removing the shuttering for the 1st 8 parts, shuttering for the remaining 8 parts were done.

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- Plastic coating was applied to the remaining 8 parts of the outer layer.
- After applying the plastic coating, 4 L shaped Ply woods were made for the 4 corners of the Pot and 4 straight Ply Woods were made and fixed.
- All the shutters were provided proper support with the help of Woods and Nails so that the L shaped Woods and the straight wood would not move when it will be filled with the Wet Castable and it should hold on.

7.3 CASTING OF THE REMAINING 8 PARTS OF THE OUTER LAYER:

- 2 Castable Pan Mixers (machine used for mixing the Dry Castable and water) were deployed for the Casting, with every men stationed at suitable places.
- In both the Castable Mixtures, 10 bags of Castable were put in every batch with around 5-6 litres of Cold water (from 18-25 Degree Celsius) which was according to the Visiting Supervisor.
- Electric Vibrators were used regularly to level the Wet Castables so that they could mould in the shape of the shutters and there would be no air bubbles formed at the bottom and the casting would be proper.
- It took around one and a half hour to complete the casting of the remaining 8 parts.
- After around 2-3 hours of setting of the Castable wet Gunny bags were put on top of every part to avoid overheating and ultimately to avoid cracking of the Set Castables.



Image 6: Casting of the remaining 8 parts

After the casting of the remaining 8 parts were finished, it was left to dry out in the shape of the shuttering materials for around 24 hours.

During the process of curing, the gunny bags kept on top of the castable needs to be replaced frequently so that the Casting won't crack.

After 24 hours of the curing time, the Middle layer was to be casted.

Only 4 large parts of the middle layer were to be casted.

7.4 SHUTTERING FOR THE 1st 4 BIG PARTS OF THE MIDDLE LAYER:

- After the Curing of the Castables, it was time to remove the shuttering materials and fix the shuttering materials for the 1st 4 big parts of the middle layer.
- After removing the shuttering for the remaining 8 parts of the outer layer, shuttering for the remaining 8 parts were done.
- Plastic coating was applied to the 4 big parts of the outer layer.
- After applying the plastic coating, 2 L shaped Ply woods were made for the 2 corners and 2 C shaped Ply woods were made for the other 2 parts and fixed.
- All the shutters were provided proper support with the help of Woods and Nails so that the L shaped Woods and the straight wood would not move when it will be filled with the Wet Castable and it should hold on.

7.5 CASTING OF THE 1st 4 BIG PARTS OF THE MIDDLE LAYER:

- After fixing the shutters, the Casting was to be done of the middle layer.

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- 2 Castable Pan Mixers (machine used for mixing the Dry Castable and water) were deployed for the Casting, with every men stationed at suitable places.
- In both the Castable Mixtures, 10 bags of Castable were put in every batch with around 5-6 litres of Cold water (from 18-25 Degree Celsius) which was according to the Visiting Supervisor.
- Electric Vibrators were used regularly to level the Wet Castables so that they could mould in the shape of the shutters and there would be no air bubbles formed at the bottom and the casting would be proper.
- It took around one and a half hour to complete the casting.
- After around 2-3 hours of setting of the Castable wet Gunny bags were put on top of every part to avoid overheating and ultimately to avoid cracking of the Set Castables.

After the casting of the 4 big parts were finished, it was left to dry out in the shape of the shuttering materials for around 24 hours.

During the process of curing, the gunny bags kept on top of the castable needs to be replaced frequently so that the Casting won't crack.

After curing, the casting of the remaining 4 parts of the middle layer was to be done.

7.6 SHUTTERING FOR THE REMAINING 6 PARTS OF THE MIDDLE LAYER:

- The plastic coating was applied to the 6 parts of the middle layer that was to be casted.
- 7 Straight ply woods were used for the shuttering.
- All the shutters were provided proper support with the help of Woods and Nails so that the L shaped Woods and the straight wood would not move when it will be filled with the Wet Castable and it should hold on.

7.7 CASTING OF THE REMAINING 6 PARTS OF THE MIDDLE LAYER:

- After fixing the shutters, the Casting was to be done of the middle layer.
- The time that would be required to complete the casting of the 6 parts would be more as these parts were bigger.
- 2 Castable Pan Mixers (machine used for mixing the Dry Castable and water) were deployed for the Casting, with every men stationed at suitable places.
- In both the Castable Mixtures, 10 bags of Castable were put in every batch with around 5-6 litres of Cold water (from 18-25 Degree Celsius) which was according to the Visiting Supervisor.

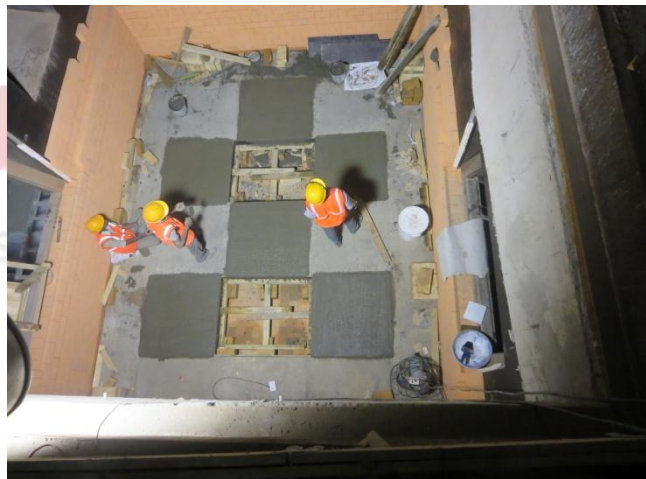


Image 7: Complete Casting of the Middle Layer

- Electric Vibrators were used regularly to level the Wet Castables so that they could mould in the shape of the shutters and there would be no air bubbles formed at the bottom and the casting would be proper.
- It took around two and a half hours to complete the casting.
- After around 2-3 hours of setting of the Castable wet Gunny bags were put on top of every part to avoid overheating and ultimately to avoid cracking of the Set Castables.

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After the casting of the 6 remaining big parts were finished, it was left to dry out in the shape of the shuttering materials for around 24 hours.

During the process of curing, the gunny bags kept on top of the castable needs to be replaced frequently so that the Casting won't crack.

After curing, the last two parts of the bottom of the Pot was remaining.

Since it was last two parts of the casting, there was no need for the Shuttering.

7.8 CASTING OF THE 2 PARTS OF THE INNER LAYER:

- 2 Castable Pan Mixers (machine used for mixing the Dry Castable and water) were deployed for the Casting, with every men stationed at suitable places.
- In both the Castable Mixtures, 10 bags of Castable were put in every batch with around 5-6 litres of Cold water (from 18-25 Degree Celsius) which was according to the Visiting Supervisor.
- Electric Vibrators were used regularly to level the Wet Castables so that they could mould in the shape of the shutters and there would be no air bubbles formed at the bottom and the casting would be proper.
- It took around 45 minutes to complete the casting.
- After around 2-3 hours of setting of the Castable wet Gunny bags were put on top of every part to avoid overheating and ultimately to avoid cracking of the Set Castables.

After the casting of the last 2 big parts of the middle were finished, it was left to dry out in the shape of the shuttering materials for around 24 hours.

During the process of curing, the gunny bags kept on top of the castable needs to be replaced frequently so that the Casting won't crack.

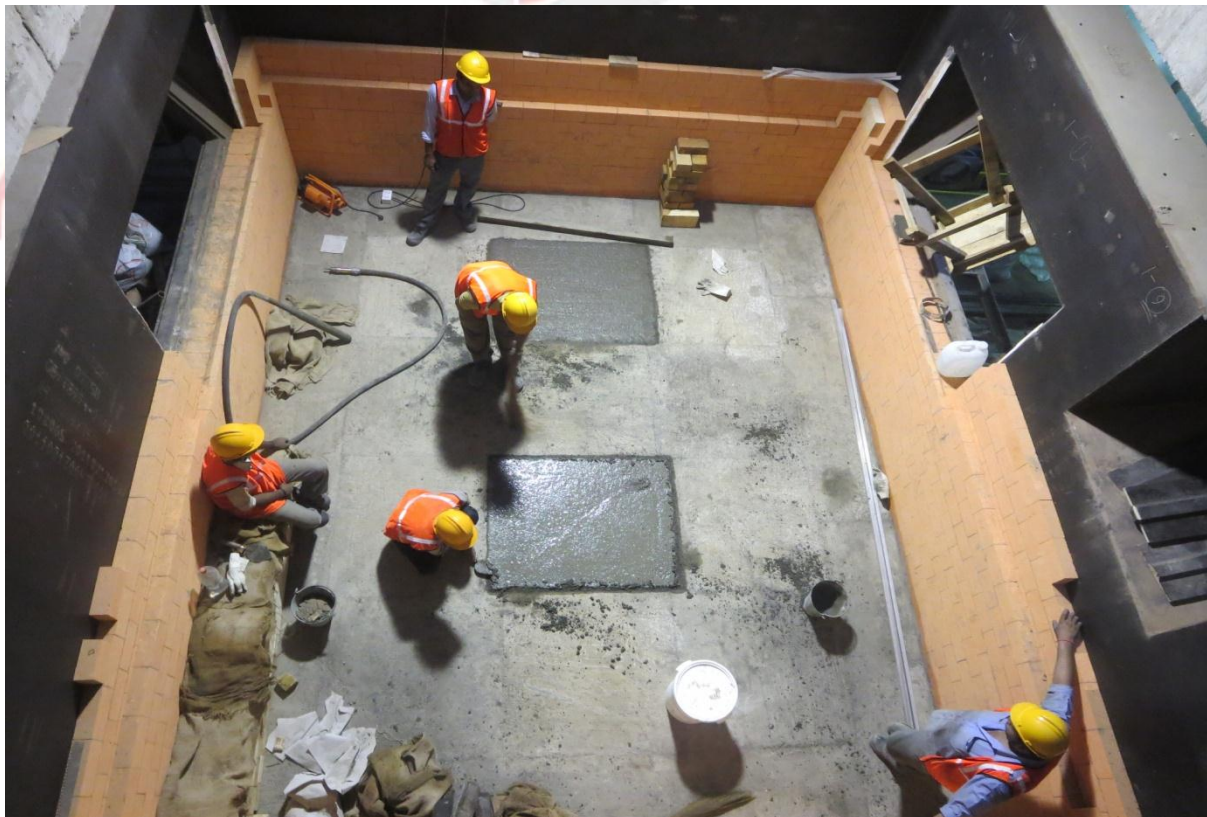


Image 8: Completed with the Casting of the entire Bottom of the POT

8. THROAT CASTING FOR THE INDUCTORS

After the entire casting of the bottom part of the Pot was completed, it was time for the casting of the throat of the 2 Inductors.

The throat is the space in the side walls where the Inductors would be fixed.

These Inductors are placed in such a way that they are always facing each other.

Only 2 Inductors are used for heating and melting the Zinc in the Pot.

The Inductors which were to be used in this Pot was of very high Voltage so the size of these Inductors was very large hence the throat portion was also very big.

Since these Inductors were of special shape, a special shuttering material made of Iron also called as Farma was used along with a plate which would cover the front portion of the Throat with a gap of about 305 mm from the walls.

8.1 SHUTTERING FOR THE THROAT:

- The Shuttering that was to be done for the throat casting was a very tedious and cumbersome process due to the Large Size and Shape of the Inductors.
- The Shuttering was to be done by a special farma which was provided by the suppliers and the front portion was to be covered with a plate that was also provided with the farma.
- The Farma fixing for the throat was done from the front inside the Pot with the help of a chain block.
- After fixing the farma, the front part was covered with ceramic paper and then it was covered with a plate.
- After Farma was fixed proper support with the help of Woods and Nails so that the farma and the plate would not move when it will be filled with the Wet Castable and it should hold on.



Image 9: Farma Fixing for the Throat Casting

8.2 CASTING OF THE 1st THROAT:

- After the entire farma fixing and plate fixing was completed, the casting was to be done.
- 2 Castable Pan Mixers (machine used for mixing the Dry Castable and water) were deployed for the Casting, with every men stationed at suitable places.
- In both the Castable Mixtures, 10 bags of Castable were put in every batch with around 5-6 litres of Cold water (from 18-25 Degree Celsius) which was according to the Visiting Supervisor.
- 2 Electric Vibrators were used regularly to level the Wet Castables from the either side so that they could mould in the shape of the shutters and there would be no air bubbles formed at the bottom and the casting would be proper.
- It took around 1 and a half hour to complete the casting.
- After around 2-3 hours of setting of the Castable wet Gunny bags were put on top of every part to avoid overheating and ultimately to avoid cracking of the Set Castables.

After 24 hours of curing time, the farma was to be removed along with the plate.

Since fixing of the farma and the plate took a lot of time, even removing of the farma was not an easy job.

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Hammers were used and somehow the Farma was removed by hammering the farma from the back.

The same farma was used to shutter the second throat for the casting.

8.3 CASTING OF THE 2nd THROAT:

- After the entire farma fixing and plate fixing was completed, the casting was to be done.
- 2 Castable Pan Mixers (machine used for mixing the Dry Castable and water) were deployed for the Casting, with every men stationed at suitable places.
- In both the Castable Mixtures, 10 bags of Castable were put in every batch with around 5-6 litres of Cold water (from 18-25 Degree Celsius) which was according to the Visiting Supervisor.
- 2 Electric Vibrators were used regularly to level the Wet Castables from the either side so that they could mould in the shape of the shutters and there would be no air bubbles formed at the bottom and the casting would be proper.
- It took around 1 and a half hour to complete the casting.
- After around 2-3 hours of setting of the Castable wet Gunny bags were put on top of every part to avoid overheating and ultimately to avoid cracking of the Set Castables.

After 24 hours of curing time, the farma was to be removed along with the plate.

The entire casting of the POT was completed.

There were two pots and a total of two entire Bottom level along with the 4 Inductor Throats were to be casted.

The entire procedure for carrying out the Brick Lining as well as the casting for the 2nd Pot is similar.



Image 10: Completed Casting of the 2nd Throat

9. THE FINISHING TOUCHES

After completing the entire casting of the bottom as well as the throat of the Inductors, the final finishing touches were done.

- The Brick lining beneath and Top of the Throats was done which needed to be cut in a special shape.
- Grinding (Process of smoothening out the rough surfaces with the help of grinding wheel and machine) was done to the entire bottom casting which was a little rough and a little up down to smoothen the casting surface and also to level the casting.
- The Throat of the Inductors was also grinded to smoothen the casting and level them.
- After the entire brick lining was finished inside the Ceramic Pot, a special coating material was applied all over the side walls.



Image 11: Special Coating being applied to the Side Walls of the Pot

10. THE INDUCTOR CASTING

After finishing all the Castings and Brick Linings of the Pot Furnace, it was time for the casting of the Inductors.

Inductors do play a very important role in the conversion of Zinc Blocks to Molten Zinc.

The Inductors are electrically charged which produces heat to melt the Zinc Blocks.

Even if one out of the 2 Inductors that are used in a Single Pot fails, the entire Galvanizing Process will stop and the failed Inductor will need to be replaced. So the Casting of these Inductors is also very critical.

The Inductors which were to be used in this Pot were special Inductors.

These Inductors had to be Dry Casted with a Dry Ramming Machine which works like a Pneumatic Hammer.



Image 12: High Voltage electrically charged Inductor

10.1 CASTING:

- The Inductor that was to be casted, it had to be cleaned first to remove any dust, moisture, oil etc.
- The Coil of the Inductor was also removed for the Casting.
- The Inductor had a hollow structure made of fibre that had to be removed for the casting.
- After removing the Structure, 16 bags of Dry Castable were put inside the Inductors.
- Since Dry Ramming was to be done, the procedure was a bit complex.
- After dropping 16 bags of the Castable, the Dry Ramming Machine was used.
- Each layer was to be rammed three times.
- For the first time, only soft ramming was to be done just like patting.
- For the second time, a little force was to be applied so the Dry Castable starts to set in the Inductors.
- For the third time, full force was to be applied so the Dry castable is completely set.
- Then again another layer of 16 bags were to be put inside the Inductor and the same procedure was to be followed but this time the hollow structure was to be put again inside the Inductor.
- Then for the third layer, again 16 bags were put and the procedure was repeated.
- After third layer was completely rammed, the Inductor was fixed at one of the throat of the Side wall of the 1st Pot.
- It took exactly 48 bags of 5 kilograms each to complete the Casting of one Inductor.
- Similarly the remaining 3 Inductors were Dry Casted using the same procedure.



Image 13: Dry Ramming of the Castable inside the Inductor

11. OVERCOMING THE HURDLES

The Brick Lining was never a concern as it was similar to the Previous Projects.

The only new thing was the High Voltage Inductors which were of Large Size and different shape.

During the Casting of the first throat, there was no problem whatsoever and the casting was done without any hiccups.

During the Casting of the second Throat of the first Pot, the Electrical Vibrators which were used during the previous castings started to heat up and they were not able to take the load due to extensive use during the first Throat Casting.

The leads (these are like iron rods which rotate when connected to the vibrators) which were used during the entire casting previously stopped working.

We had a stock of around 8 leads so the Casting was completed without any problems.

During the Casting of the 1st Throat of the 2nd Pot, the major issue was the power supply which posed a deeper threat as Materials of more than 40 bags were about to be wasted which were inside the Mixer Machines as well as those inside the Farma.

Due to lot of fluctuations in the power supply the cables of the Vibrators started heating up and they were stopping and starting and one of the vibrators even sparkled and stopped.

We somehow got a vibrator from the company and the casting of the throat of the 2nd Pot was completed.

During the Last throat casting, looking at the Fluctuations of the power supply, new cables were bought, new switches were bought, new electric board was made, new leads were bought, new electric as well as mechanical (working on fuel) were bought.

And thus during the last Casting everything went as smoothly as if there was no problem whatsoever faced previously

The entire project was completed professionally except during the two casting of the throat of the Inductors.

11.1 QUALITY CHECK:

- The entire Pot Refractory Lining was done under the supervision of the Foreign Supervisor so the Quality check was sterner than expected.
- The levels of the Brick Lining were checked by the Supervisor with digital level checker.
- The Bricks that were cut by the Brick cutting machine was inspected closely.
- During the entire process of Shuttering, the Supervisor was himself inside the Pot to make sure that Shuttering was fixed tightly.
- For Casting, it was made sure that the water was kept cool with the help of Ice.
- During Casting, the supervisor was monitoring the entire procedure very closely. He was very tensed during the power fluctuations that was occurring during the second and third Inductor Throat Casting.
- After the casting, it was made sure that the castings are kept cool by replacing the Gunny bags.
- During the Inductor's Dry Casting, there was no problem faced and the Supervisor was very much happy with the speed at which the Casting was completed.

12. THE END RESULT



- Finally the entire CERAMIC POT Refractory Project was completed according to the schedule.
- In fact the Refractory Lining was completed 36 hours before the scheduled Time.
- The above Images are the Final Product that was achieved by the M/s YASHASWI FURNACE.
- Ultimately the Quality that was delivered by the firm shows the capability, skills and the experience of this firm.