



AN INTERNSHIP REPORT

Submitted by

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In

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Gujarat Technological University, Ahmedabad

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CERTIFICATE

This is to certify that the project report submitted along with the project entitled **“DEFECT REDUCTION IN CASTING PRODUCT THROUGH QUALITY CONTROL TOOLS”** has been carried out by **Raliya Oves Husenbhai** under my guidance in partial fulfillment for the degree of Bachelor of Engineering in Mechanical, 8th Semester of Gujarat Technological University, Ahmadabad during the academic year 2022-23

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DECLARATION

We hereby declare that the internship report submitted along with the internship entitled “**DEFECT REDUCTION IN CASTING PRODUCT THROUGH QUALITY CONTROL TOOLS**” submitted in partial fulfilment for the degree of **Bachelor of Engineering in Mechanical Engineering** to Gujarat technological university, Ahmedabad, is a bonafide record of original internship carried out by me at (**SAINT GOBAIN LTD – GRINDWELL NORTON LTD**) under the supervision of **Mr. Aditya Jha/PROF. Akram Hathida** and that no part of this report has been directly copied from any students’ report or taken from any other source, without providing due reference

.

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Thank You

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ABSTRACT

A Strong international group Saint-Gobain Performance Ceramics & Refractories (PCR) leads the industry in the design, development and manufacturing of the highest performing solutions for extreme operating condition. Performance Ceramic (advanced/fine ceramic) solutions cover every industrial kiln & furnaces, Specialty ceramics, burner solution for industrial heating, wear resistance application and many more demanding applications which rely on high performance ceramic material characteristics. performance refractory solutions are designed and manufactured to overcome operational challenges in metallurgical applications.

In this 12 weeks of internship, I got basic knowledge about slip casting, I got to know in brief that how the company works, how it gets manufactured and how to Inspection and packaging is done and how to use a QC tools.

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1 COMPANY PROFILE

1.1 ABOUT COMPANY



Figure 1 Saint gobain halol plant

Grind well Norton (GNO), a company listed on the Bombay and National Stock Exchanges, pioneered the manufacture of grinding wheels in India in 1941. In 1990, Saint-Gobain acquired Norton Company, USA, worldwide and thereby became a shareholder in GNO. In 1996, Saint-Gobain increased its equity stake, making GNO its first majority-owned subsidiary in India. Today, GNO's businesses include: Abrasives, Ceramic Materials Businesses (Silicon Carbide and Performance Ceramics & Refractories), Performance Plastics and ADFORS. The Saint-Gobain Country Head office, INDEC (the captive India IT Development Centre for the Saint-Gobain Group globally) and CertainTeed are also part of GNO. GNO's subsidiary, Saint-Gobain Ceramic Materials Bhutan Pvt. Ltd., manufactures Silicon Carbide. The Group currently holds 51.66% of the equity capital of GNO.

Grind well Norton is a part of the Saint-Gobain Group in India. Saint-Gobain entered India in 1996, and has achieved strong and profitable growth since then. Today, it is a leader in all its major businesses, has 26 manufacturing sites and has more than 15,788 permanent and temporary employees in India.

In 2021, Saint-Gobain registered sales of about INR 87.384 billion. For Saint-Gobain, India presents a huge opportunity for growth. Two large entities, Grind well Norton Limited (GNO), a publicly traded company, and Saint-Gobain India Pvt. Ltd. (SGI) house Saint-Gobain's businesses in India. The following businesses are present in India - Regional businesses: Glass and Glass Solutions, Gyproc Plasterboard and Plasters, and Weber (Industrial mortars) and Global businesses (which are now part of the High Performance Solutions Division): Abrasives, Sekurit (automotive glazing), Ceramic Materials (Silicon Carbide, Performance Ceramics and Refractories, SEFPRO, Crystals) and Performance Plastics.

The **Performance Ceramics & Refractories (PCR)** business offers complete solutions with expertise in design, engineering and manufacturing refractory systems for high temperature, ballistic and wear applications. The HPR plants are located in Bangalore and Halol (Gujarat). The **Silicon Carbide** business manufactures Silicon Carbide crude and grains at Tirupati (Andhra Pradesh) and near Phuentsholing (Bhutan) and is a major supplier to all leading Refractory, Metallurgy and Abrasives manufacturers in India.

1.2 Quality, Environment, Health and Safety Policy

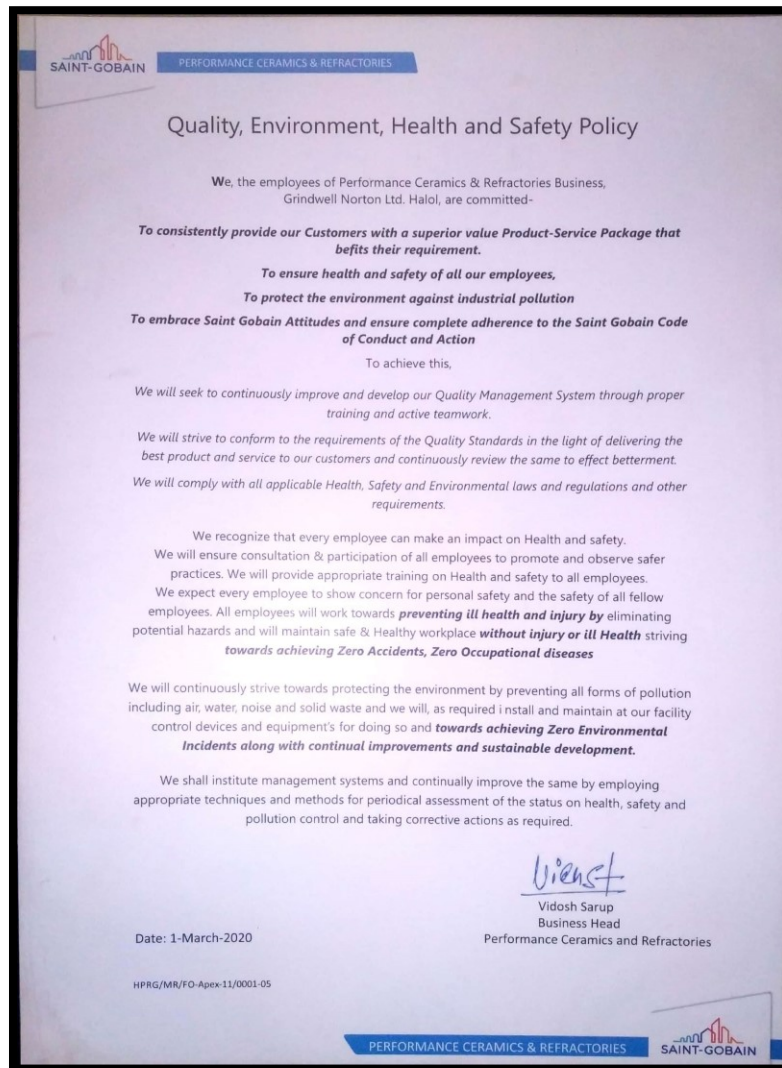


Figure 2 EHS policy

1.3 VISION AND MISSION

The source of a happy life for everyone, the foundation of a better future for mankind. Saint-Gobain designs, manufactures and distributes high-performance materials to provide innovative solutions to consumers. These materials and solutions can be found in every aspect of architecture, transportation, infrastructure and industrial applications and are relevant to our daily lives.

1.4 SWOT Analysis of Saint-Gobain

For Saint-Gobain, SWOT analysis can help the brand focus on building upon its strengths and opportunities while addressing its weaknesses as well as threats to improve its market position. Let us start the Saint-Gobain SWOT Analysis:

Saint-Gobain Strengths

The strengths of Saint-Gobain looks at the key aspects of its business which gives it competitive advantage in the market. Some important factors in a brand's strengths include its financial position, experienced workforce, product uniqueness & intangible assets like brand value. Below are the Strengths in the SWOT Analysis of Saint-Gobain :

1. Operations in Construction materials production and retail, glass, ceramics, plastics, abrasives, packaging, gypsum plasterboards
2. The company has over 180,000+ employees worldwide
3. High Brand Equity and strong presence across the world
4. It is a pioneer worldwide for Glass fabrics
5. Strong branding and marketing exercises make it a high brand recall product
6. High number of research centers, 3500+ researchers and annually more than 400 patents
7. The CSR activities are also spread across the world, as it takes major steps for the environment

Direct access to and timely delivery of parts materials and equipment.

Superior product quality adhering to various standers.

Flexibility on planning and development of sample for approval.

Continuous training of our engineers, technicians and skill worker for bestefficiency and quality workmanship.

Location of business.

Quality processes and procedures.

Diverse profitable products and services.

Solid leadership.

Investment in human capital and technical skills.

Saint-Gobain Weaknesses

The weaknesses of a brand are certain aspects of its business which are it can improve to increase its position further. Certain weaknesses can be defined as attributes which the company is lacking or in which the competitors are better. Here are the weaknesses in the Saint-Gobain SWOT Analysis:

1. The brand is still establishing in the emerging economies
2. Being a market leader, its every operation in under public eye and scrutiny

Saint-Gobain Opportunities

The opportunities for any brand can include areas of improvement to increase its business. A brand's opportunities can lie in geographic expansion, product improvements, better communication etc. Following are the opportunities in Saint-Gobain SWOT Analysis:

1. High growth rate of Real estate sector
2. Company can leverage operations across sectors for higher growth
3. Continuous Innovation and more research
4. Sponsorship, marketing, advertising can boost operations

Saint-Gobain Threats

The threats for any business can be factors which can negatively impact its business. Some factors like increased competitor activity, changing government policies, alternate products or services etc. can be threats. The threats in the SWOT Analysis of Saint-Gobain are as mentioned:

1. Strong Competition in all operating Sectors
2. Pricing wars might impact Saint Gobain's Business
3. Fluctuating global economies can affect international business

1.5 Priorities of Company

1. Safety
2. Quality
3. Production

2 Personal Protective Equipment (PPEs)

Personal Protective Equipment (PPE) is specialized clothing or equipment worn by an employee for protection against infectious materials.

Head

Eyes

Hands

Feet

Hearing



Figure 3 PPE's

First wear defined PPE's before starting Plant visit.

3 MANUFACTURING PRODUCTS

SHAPES

Beams
Custom Shapes
Linings
Plates
Refractory Bricks
Rollers
Saggers
Setters
Support For Kilns And Furnaces
Tubes



MONOLITHICS




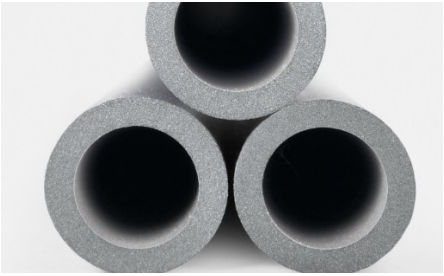
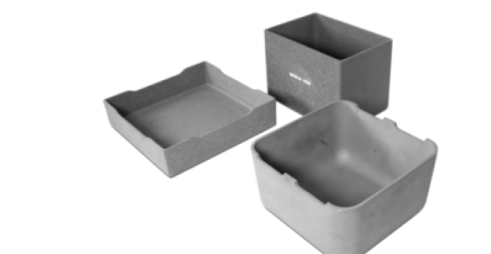
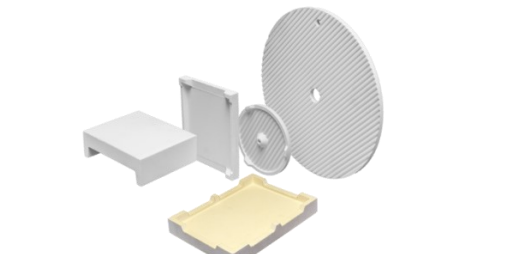
Castables
Mortar
Ramming
Gunning
Shotcrete



PRODUCTS BY APPLICATION

Filters
Blast Furnace Area
Ceramic Protection
Heating Systems
Trough And Runners Products
Steel-Enhanced Ladle Flow
Waste Conversion





3.1 As Per Shapes

Beam	Custom Shapes
	

Linings	Plates
	
Refractory Bricks	Rollers
	
Saggers	Setters
	

Support	Tube
	

3.2 As Per Monolithic

Castable	Mortar
	
Ramming	Shotcrete
	

3.3 As Per Products by Application

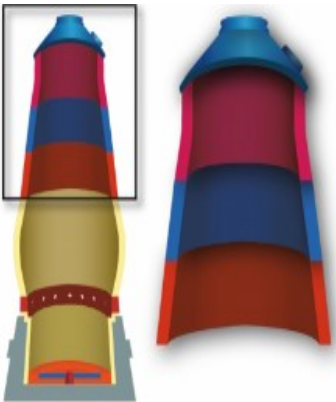

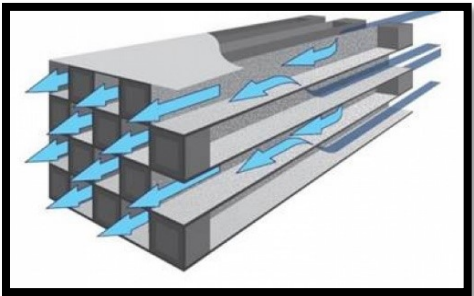

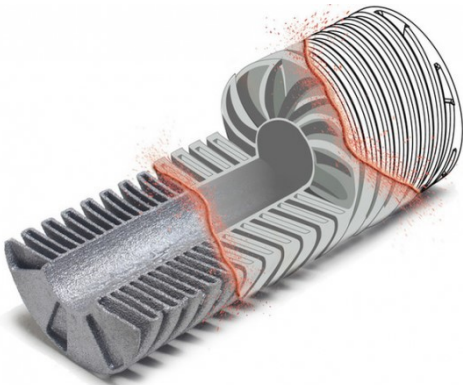
Blast Furnace Area	Ceramic Protection
	
Filters	Heating system (Burner Nozzle)
 	

Figure 4 Products

4 POP (Plaster Of Paris)

Plaster of Paris, quick-setting gypsum plaster consisting of a fine white powder (calcium sulfate hemihydrate), which hardens when moistened and allowed to dry. Known since ancient times, Plaster of Paris is so called because of its preparation from the abundant gypsum found near Paris.



Figure 5 POP

4.1 Types of POP (Plaster Of Paris)

There are two types of pop

- 1.Alpha
- 2.Beta

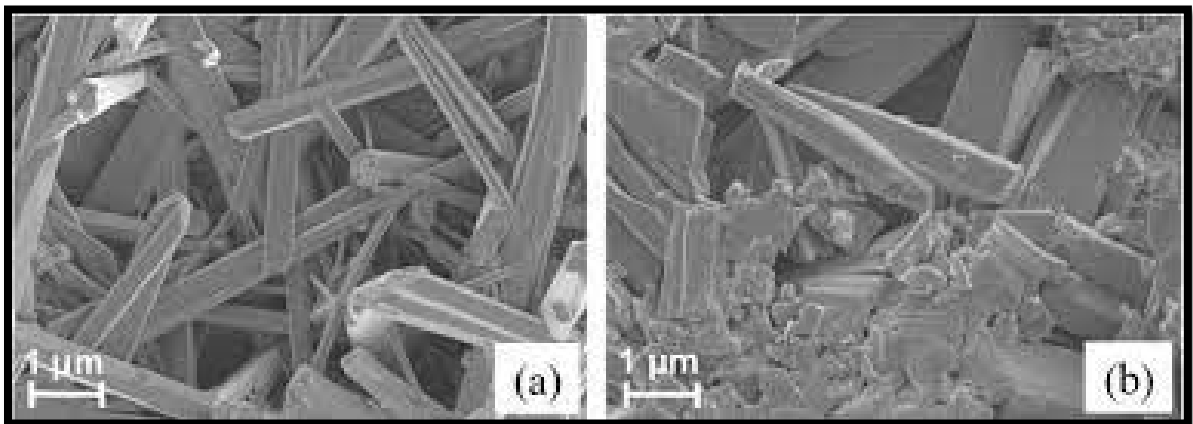


Figure 6 Alpha & Beta POP

4.2 Manufacturing Flow diagram of POP

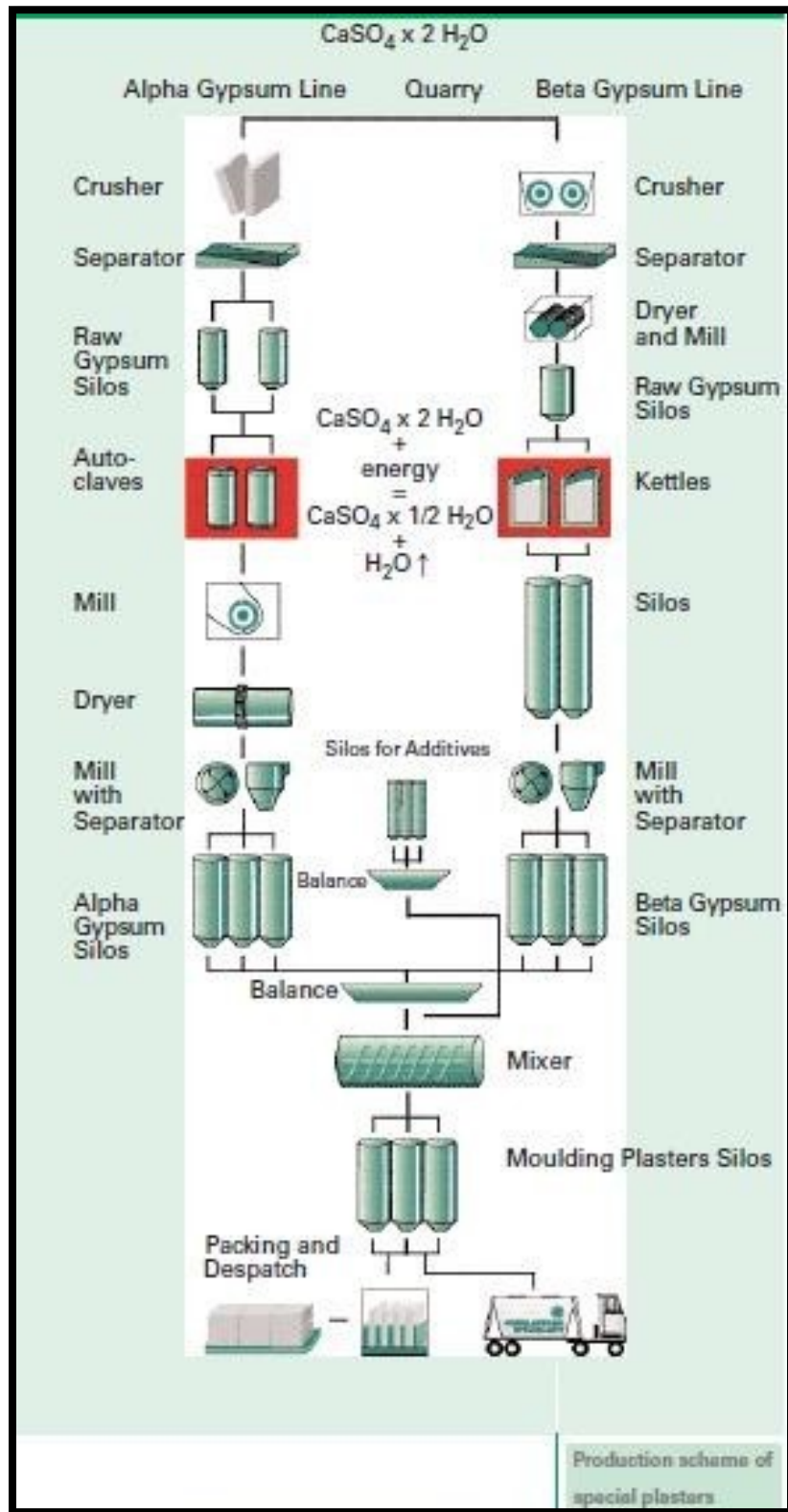


Figure 7 Manufacturing process of Alpha & Beta POP

5 Forming

The fine, platy morphology of clay particles is used to advantage in the forming of clay-based ceramic products. Depending upon the amount of water added, clay-water bodies can be stiff or plastic. Plasticity arises by virtue of the plate-shaped clay particles slipping over one another during flow. (Nonclay ceramics can be similarly formed if plasticizers—usually polymers—are added to their mixes. In many cases organic binders are used to help hold the body together until it is fired.) With even higher water content and the addition of dispersing agents to keep the clay particles in suspension, readily flowable suspensions can be produced. These suspensions are called **slips** or slurries and are employed in the slip casting of clay bodies. The mechanisms of plastic forming and slip casting are described below.



Figure 8 Forming

6 Plastic forming

Plastic forming is the primary means of shaping clay-based ceramics. After the raw materials are mixed and blended into a stiff mud or plastic mix, a variety of forming techniques are employed to produce useful shapes, depending upon the ceramic involved and the type of product desired. Foremost among these techniques are pressing and extrusion.

Pressing involves the application of pressure to eliminate porosity and achieve a specific shape, depending upon the die employed. Refractory bricks, for example, are often made by die presses that are either single-action (pressing from the top only) or dual-action (simultaneously pressing from top and bottom). Structural clay products such as brick and tile can be made in the same fashion. In pressing operations the feed material tends to have a lower water content and is referred to as a stiff mud.

The problem with die casting is that it is a piecemeal rather than a continuous process, thereby limiting throughput. Many silicate ceramics are therefore manufactured by extrusion, a process that allows a more efficient continuous production. In a commercial screw-type extruder, a

screw auger continuously forces the plastic feed material through an orifice or die, resulting in simple shapes such as cylindrical rods and pipes, rectangular solid and hollow bars, and long plates. These shapes can be cut upon extrusion into shorter pieces for bricks and tiles.

7 Slip Casting

In slip casting, a slurry of clay and water is poured into a porous mold, usually made of plaster. As the mold is rotated, the slurry coats the mold wall, and water is absorbed into the plaster, thereby drying the slurry closest to the wall. After some time, the mold is emptied of the excess slurry.

A different approach to the forming of clay-based ceramics is taken in slip casting of whiteware, as shown in Figure 1. As mentioned above, with sufficient water content and the addition of suitable dispersing agents, clay-water mixtures can be made into suspensions called slurries or slips. These highly stable suspensions of clay particles in water arise from the careful manipulation of surface charges on the platelike clay particles. Without a dispersing agent, oppositely charged edges and surfaces of the particles would attract, leading to flocculation, a process in which groups of particles coagulate into flocs with a characteristic house-of-cards structure. Dispersing agents neutralize some of the surface charges, so that the particles can be made to repel one another and remain in suspension indefinitely. When the suspension is poured into a porous plaster mold, capillary forces suck the water into the mold from the slip and cause a steady deposition of clay particles, in dense face-to-face packing, on the inside surface of the mold. After a sufficient thickness of deposit has been obtained, the remaining slip can be poured off or drained and the mold opened to reveal a freestanding clay piece that can be dried and fired. Surprisingly complex shapes can be achieved through slip casting.

7.1 Types of casting

1 Drain Casting

The slip is poured into a permeable mold at a controlled casting rate such that liquid is extruded from the mold walls as quickly as it arrives at the mold walls. Once the desired thickness has been attained the remaining slip is poured out (drain casting)

2 Solid Casting

Solid casting is used for thick pieces such as sanitary ware, chemical stoneware and refractory blocks. The slip is again poured into a mold which is surrounded by plaster on all sides with a reservoir for slip, and is removed when the solid piece is held within.

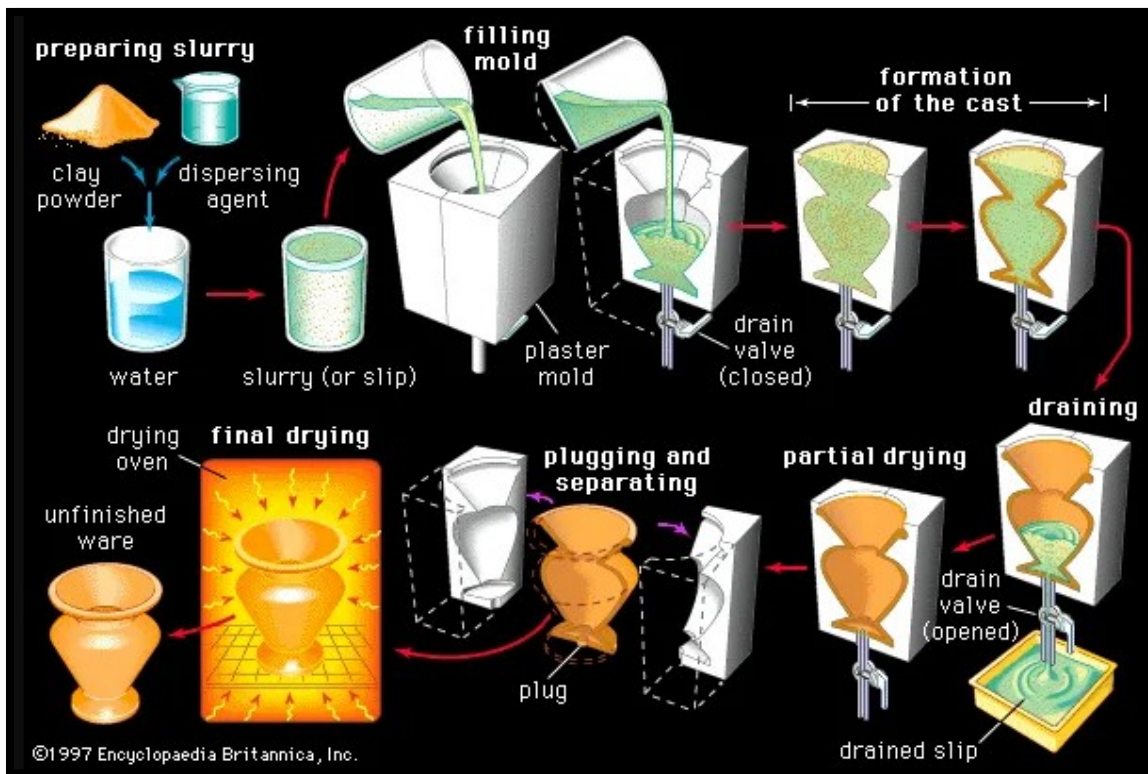
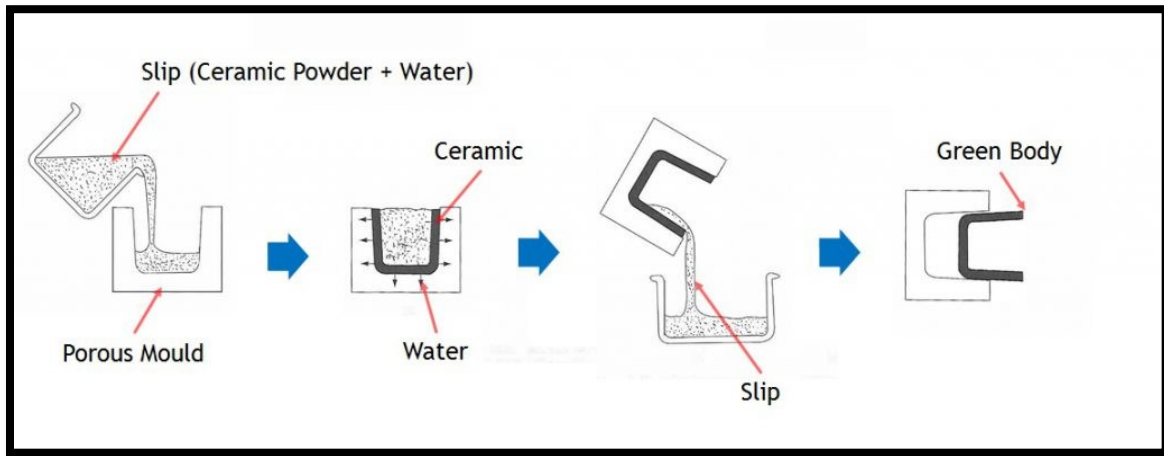


Figure 9 Slip Casting

8 Finishing

If fired ceramic ware is porous and fluid impermeability is desired, or if a purely decorative finish is desired, the product can be glazed. In glazing, a glass-forming formulation is pulverized and suspended in an appropriate solvent. The fired ceramic body is dipped in or painted with the glazing slurry, and it is refired at a temperature that is lower than its initial firing temperature but high enough to vitrify the glaze formulation. Glazes can be colored by the addition of specific transition-metal or rare-earth elements to the glaze glass or by the suspension of finely divided ceramic particles in the glazes

9 Oven Drying and Air Drying



Figure 10 Dryer

A Drying oven is designed to remove moisture from the oven chamber so to dry the samples as quickly as possible. The drying oven process introduces fresh dry air to the chamber and expels the warm moist air simultaneously allowing to rapidly dry the samples. A drying oven provides high performance drying and heating.

The process of removing moisture from surfaces and coatings by using air (forced, dry or hot). Air drying prevents rusting and corrosion, which may be caused by redundant moisture. It is a principle used in the making of air-drying paints and coatings.

10 Firing

10.1 Kiln operation

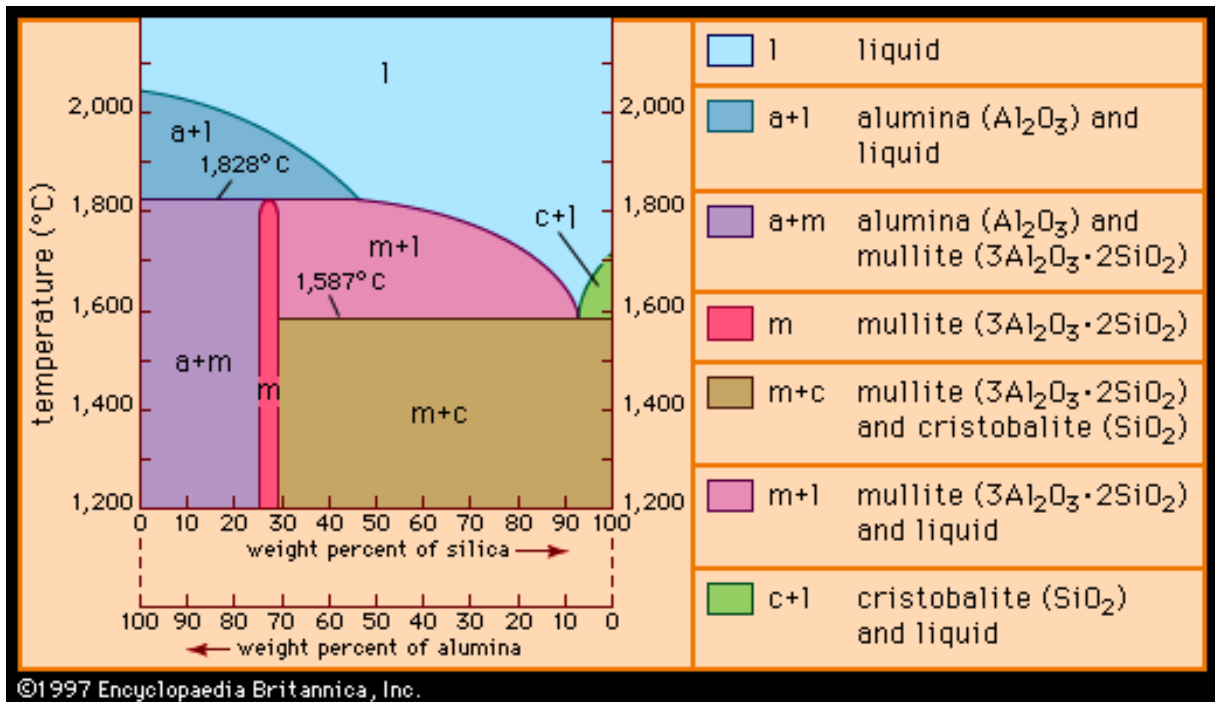
After careful drying to remove evaporable water, clay-based ceramics undergo gradual heating to remove structural water, to decompose and burn off any organic binders used in forming, and to achieve consolidation of the ware. Batches of specialty products, produced in smaller volumes, are cycled up and down in so-called batch furnaces. Most mass-produced traditional ceramics, on the other hand, are fired in tunnel kilns. These consist of continuous conveyor belt or railcar operations, with the ware traversing the kiln and gradually being heated from room temperature, through a hot zone, and back down to room temperature. Pyrometric cones, which deform and sag at specific temperatures, often ride with the ware to monitor the highest temperature seen in the traverse through the kiln



Figure 11 Kiln

10.2 Vitrification

The ultimate purpose of firing is to achieve some measure of bonding of the particles (for strength) and consolidation or reduction in porosity (*e.g.*, for impermeability to fluids). In silicate-based ceramics, bonding and consolidation are accomplished by partial vitrification. Vitrification is the formation of glass, accomplished in this case through the melting of crystalline silicate compounds into the amorphous, non crystalline atomic structure associated with glass. As the formed ware is heated in the kiln, the clay component turns into progressively larger amounts of glass. The partial vitrification process can be analyzed through a phase diagram such as that shown in Figure 2. In this diagram three crystalline phases are shown: the end members cristobalite (one crystallographic form of silica [SiO_2]) and alumina (Al_2O_3) and an intermediate compound, mullite ($3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$). The melting points of alumina and cristobalite, as shown on the left and right edges of the diagram, are quite high. However, intermediate compositions begin to melt at lower temperatures. As shown by the two horizontal lines on the diagram, melting begins to occur at $1,828^\circ\text{C}$ ($3,322^\circ\text{F}$) for high alumina compositions and as low as $1,587^\circ\text{C}$ ($2,889^\circ\text{F}$) for high silica compositions. (These temperatures can be lowered still further by the addition of fluxing agents, such as alkali or alkaline-earth oxide feldspars.) Between the two horizontal lines and the region of the diagram marked liquid, all compositions are only partly liquid (*e.g.*, mullite and liquid, alumina and liquid). This partial vitrification allows for the retention of solid particles, which helps to maintain the rigidity of the ceramic piece during firing in order to minimize sagging or warpage.



The role of the glassy liquid phase in the consolidation of fired clay objects is to facilitate liquid-phase or reactive-liquid sintering. In these processes the liquid first brings about a denser rearrangement of particles by viscous flow. Second, through solution-precipitation of the solid phases, small particles and surfaces of larger particles dissolve and reprecipitate at the growing “necks” that connect large particles. Rearrangement and solution-precipitation lead to bond formation and to progressive densification with reduction of porosity. A range of glass contents and residual porosities can be obtained, depending on the ingredients and the time the object is held at maximum temperature.

11 Inspection

A quality inspection involves measuring, examining, testing, or gauging various characteristics of a product and comparing those results with specified requirements to determine whether there is a conformity.

Quality Control (QC) is critical to build and deliver products that meet or exceed customers' expectations.

Quality assurance (QA) is any systematic process of determining whether a product or service meets specified requirements. QA establishes and maintains set requirements for developing or manufacturing reliable products.



11.1 Types of quality inspection

- 1.Pre-Production Inspection
- 2.In line Inspection
- 3.Final Inspection

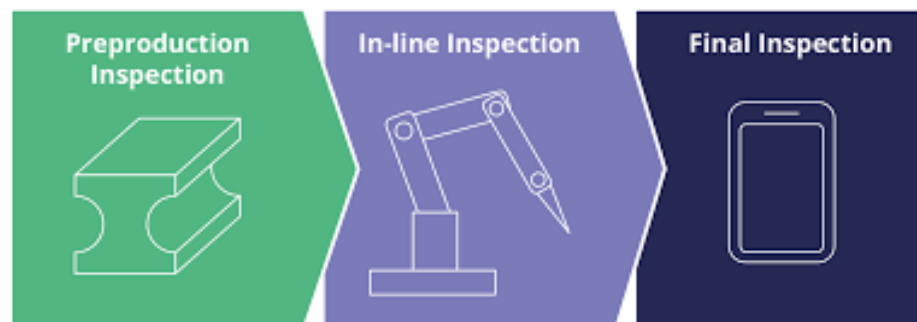


Figure 12 Types of Inspection

12 Packing

Packaging is a subset of marketing where a brand designs and develops the wrapper or container to aid its transport, handling, delivery, and communicate the brand and product information by making it look attractive.

12.1 Types of Packing

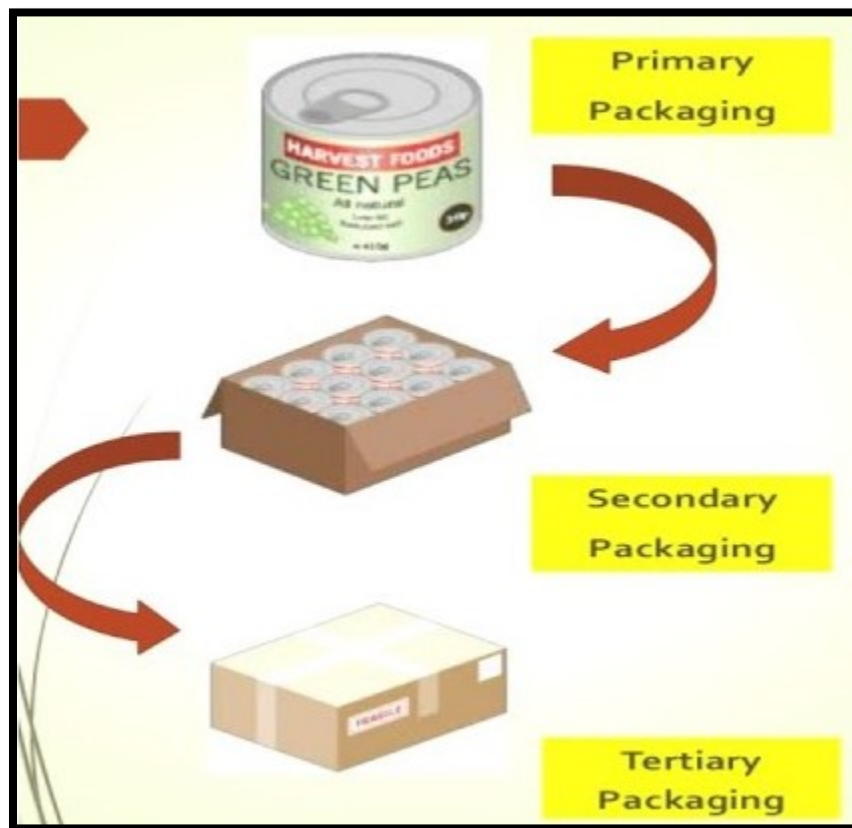


Figure 13 Types of Packing

1.Primary Packaging

Primary packaging is the packaging in direct contact with the product itself and is sometimes referred to as a consumer unit. The main purpose of primary packaging is to contain, protect and/or preserve the finished product, particularly against contamination. This is the first layer containing the finished product, such as a plastic pouch holding whole-grain cereal or the cardboard box containing the pouch of cereal. This type of packaging is often intended for the end user or consumer. In addition to making it easier for consumers to handle products, it makes the products look more appealing and can be used for communication purposes to convey printed information about the products to consumers.

2.Secondary Packaging

This type of packaging is used outside of primary packaging to group a certain number of products to create a stock-keeping unit, commonly referred to as a SKU. It facilitates the handling of smaller products by collating them into a single pack. This type of packaging also provides supplementary protection to help maintain the integrity of the primary packaging. In addition, it can serve as a shipping container for small shipments, making it highly useful in e-commerce. Secondary packaging is frequently made up of multiple components (box, padding, separators, reinforcements, bags, paper, etc.). It may also be customized to make a product easily identifiable in the warehouse setting. In the case of cereal, for example, the secondary packaging would be the corrugated cardboard box containing multiple individual boxes of cereal.

3.Tertiary Packaging

Often also referred to as bulk or transit packaging, this type of packaging is used to group larger quantities of SKUs to transport them from point A to point B (e.g. from production facility to point of sale). During this stage, products are handled as distribution units. This type of packaging makes it easier to transport large and/or heavy loads safely and securely. In addition to helping prevent damage, it consequently facilitates the handling, storage and transport of goods. An example of tertiary packaging is a stretch-wrapped pallet containing a quantity of cardboard boxes (secondary packaging) to enable efficient product shipping.

12.2 Packing Materials

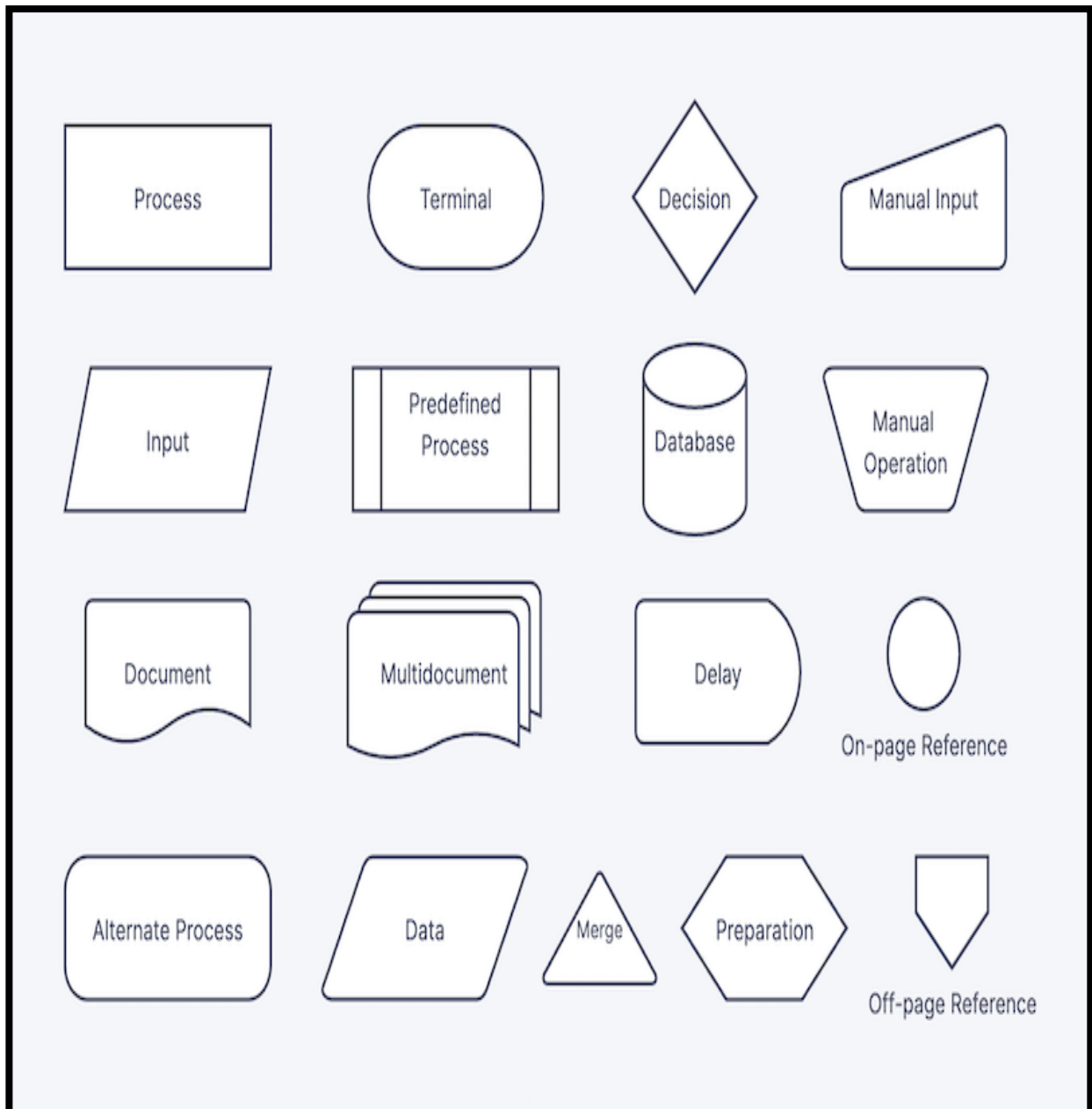


Figure 14 Packing material

13 Flow Chart

A flowchart is a picture of the separate steps of a process in sequential order. It is a generic tool that can be adapted for a wide variety of purposes, and can be used to describe various processes, such as a manufacturing process, an administrative or service process, or a project plan.

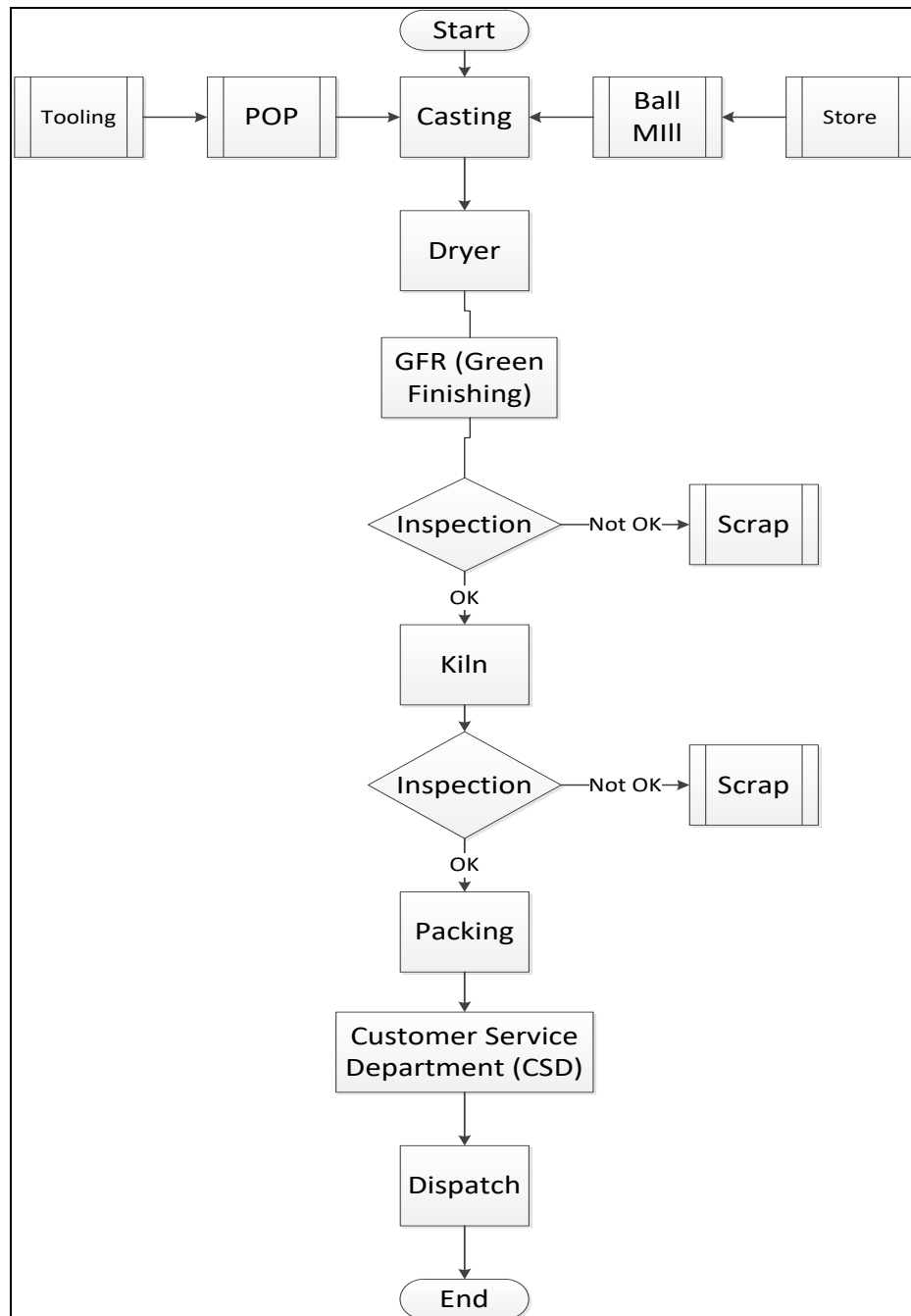
Symbols for draw flow chart



14 SLIP CASTING PROCESS

Now, we are learn how to actually slip casting work in plant.

14.1 Flow Chart for Slip Casting Process



14.2 Mold Preparation of POP (Plaster of Paris)



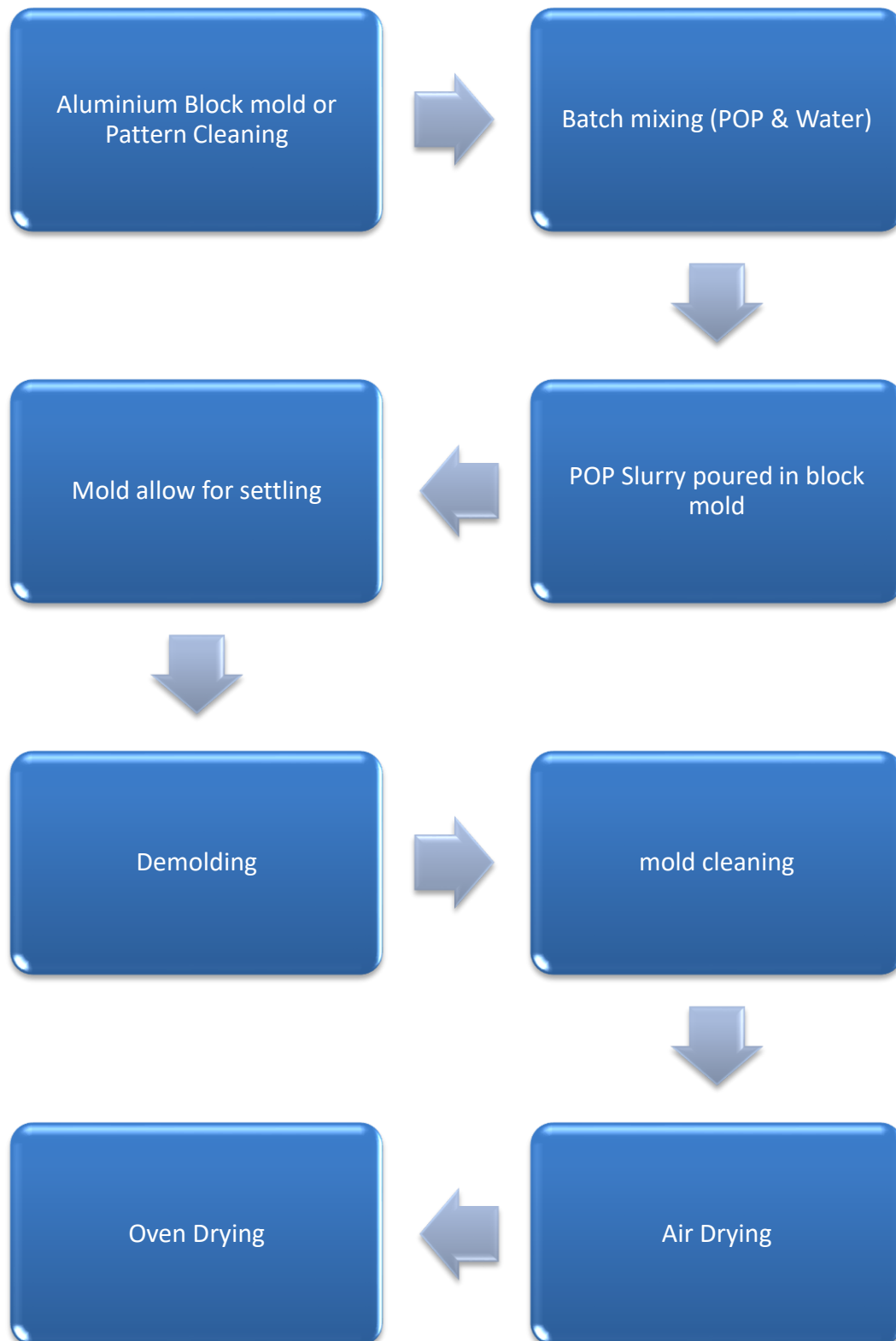
Figure 15 Plaster mold

POP : An ideal plaster mix is one in which the plaster particles are completely dispersed in the water to produce a uniform, homogenous slurry. In order to accomplish this goal, batch size, mixer design, mixing time, water purity and temperature must be controlled.

Water : When water for industrial use is taken from contaminated sources and is high in organic impurities, it will lengthen the setting time of the plaster. Large amounts of soluble salts such as sodium chloride, sodium sulfate, and magnesium sulfate, which may be in the water, can migrate to the surface of the mold during drying. The resulting efflorescence forms hard spots on mold surfaces that can result in problems with the mold or cast. Other chemicals in the water may react with the gypsum to produce these soluble salts. In general, any compound that has a greater solubility than gypsum can produce efflorescence.

Water: POP ratio: Variations in water-to-plaster ratio will affect cast absorption, strength, and performances

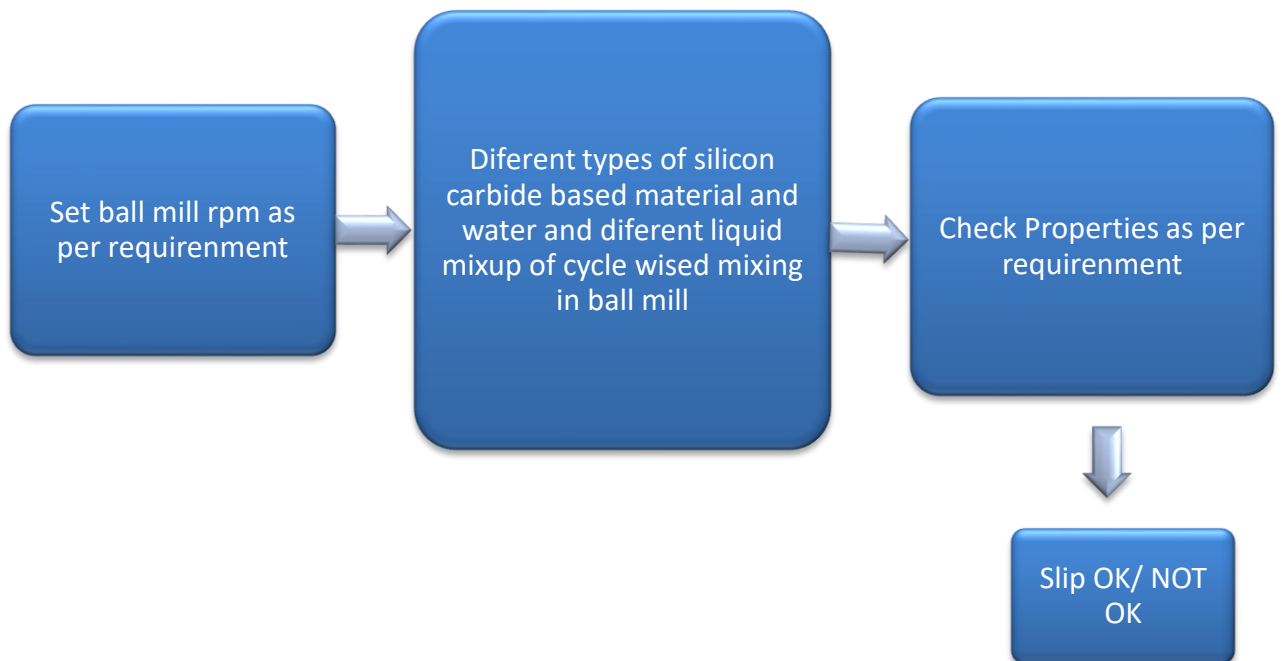
14.2.1 POP Mold Preparation Flow diagram



14.3 Slip Preparation



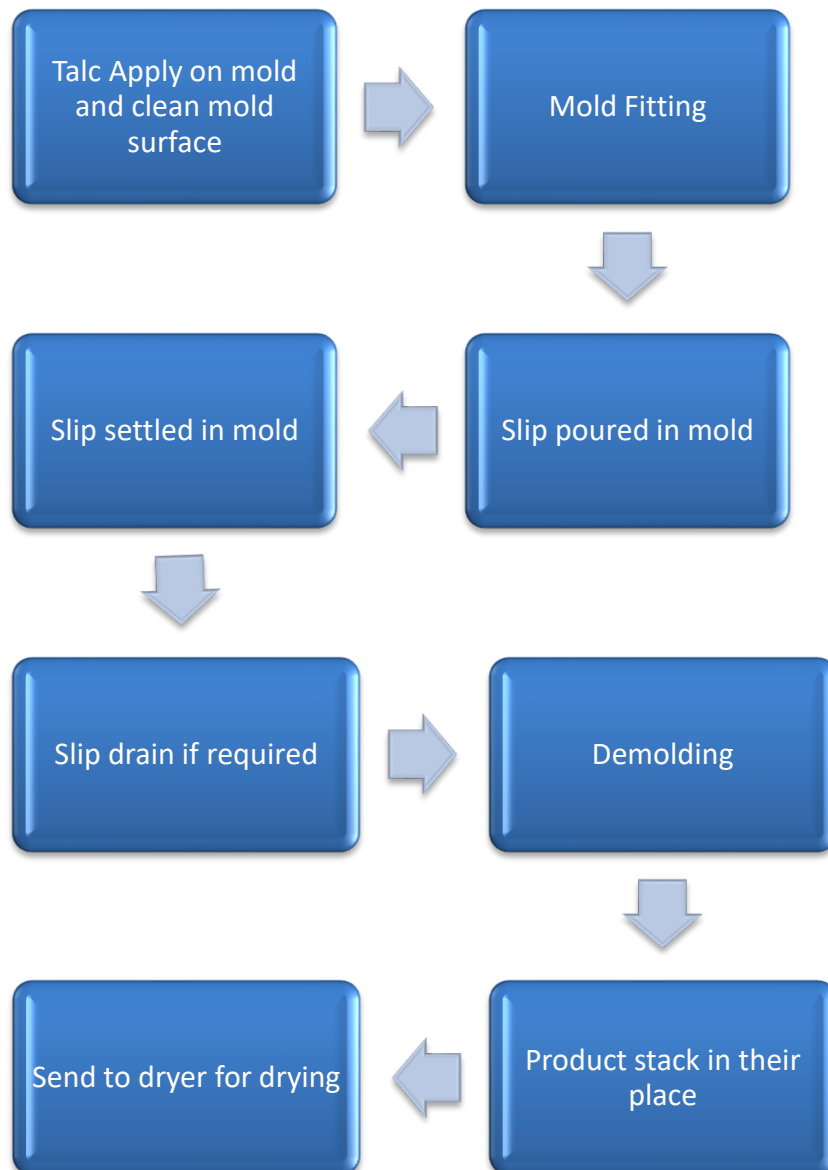
Figure 16 Slip



14.4 Casting Process



Figure 17 Slip pouring



14.5 Green Finishing Process



Figure 18 Finishing

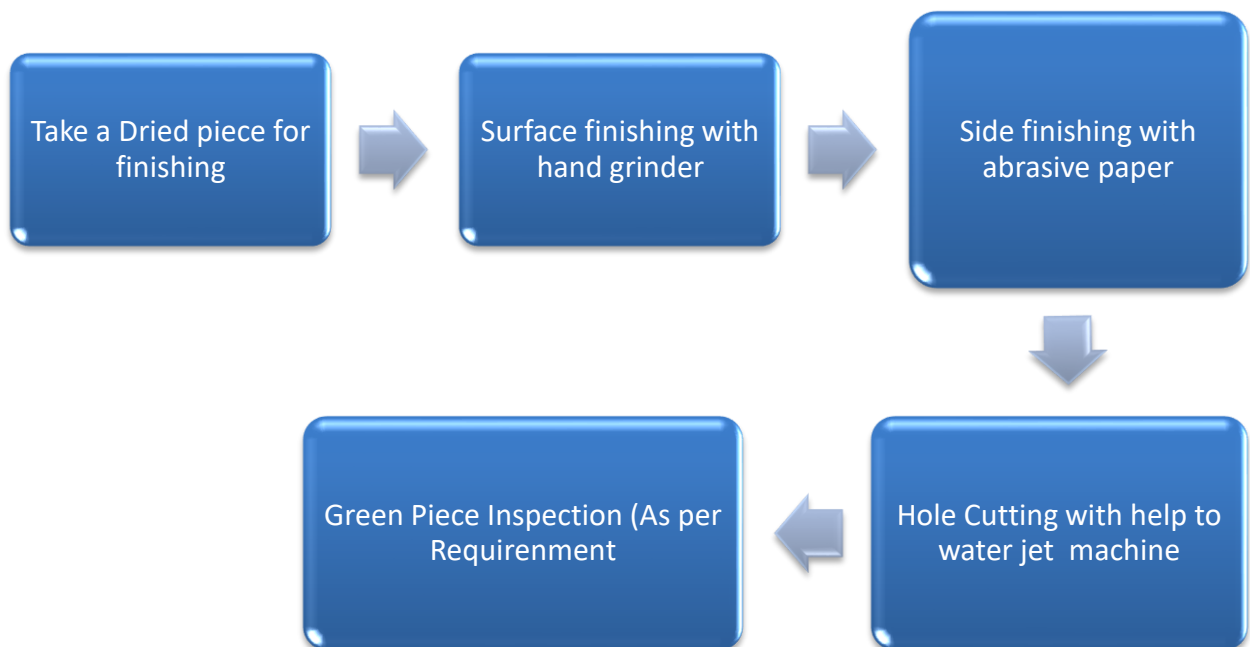


Figure 19 Water jet cutting

14.6 Firing Process

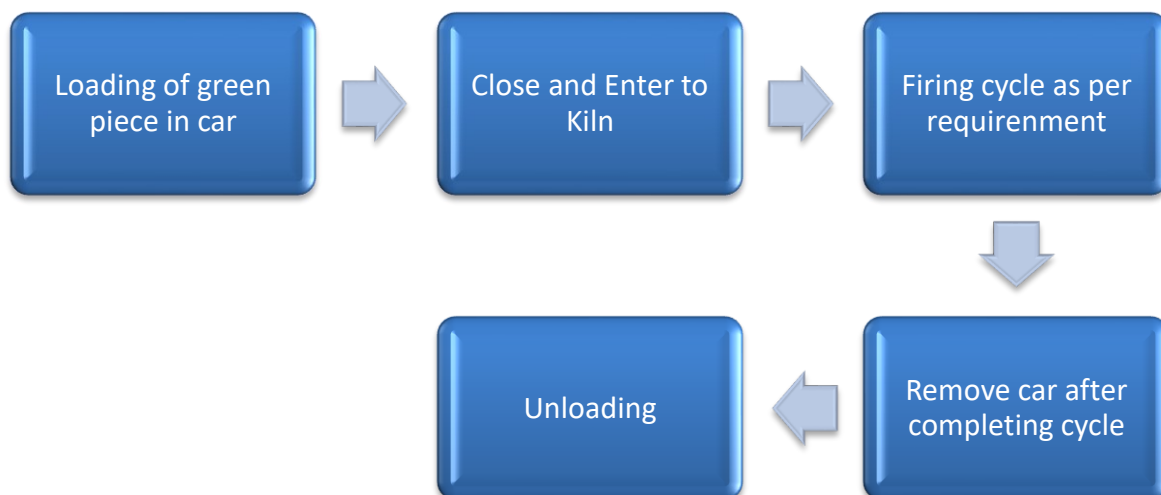


Figure 20 Kiln firing area

The firing process turns raw clay into ceramic through high-temperature heating. This usually happens in a kiln. Clay often goes through two types of firing - bisque firing and glaze firing. There are two types of firing used in plant

1 OB (Oxygen bonding)
(Use oxygen for bonding)

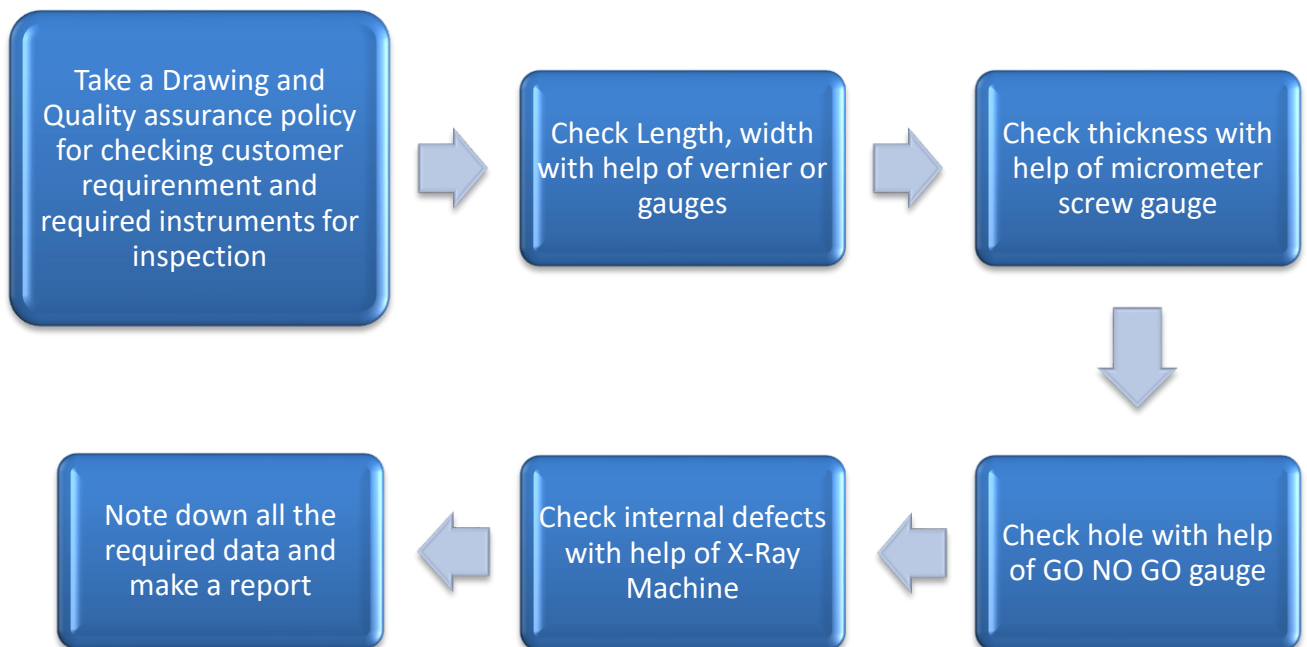
2 NB (Nitrogen bonding)
(Use Nitrogen for bonding)



14.7 Inspection



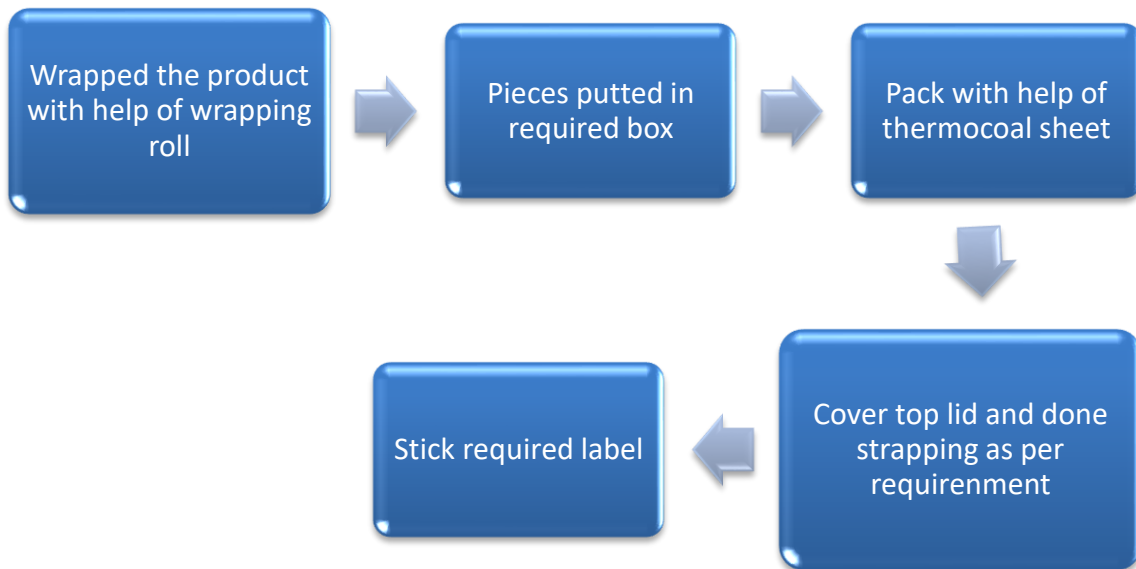
Figure 21 Inspection



14.8 Packing



Figure 22 Packing



14.9 Assembly of Kiln Furniture Products

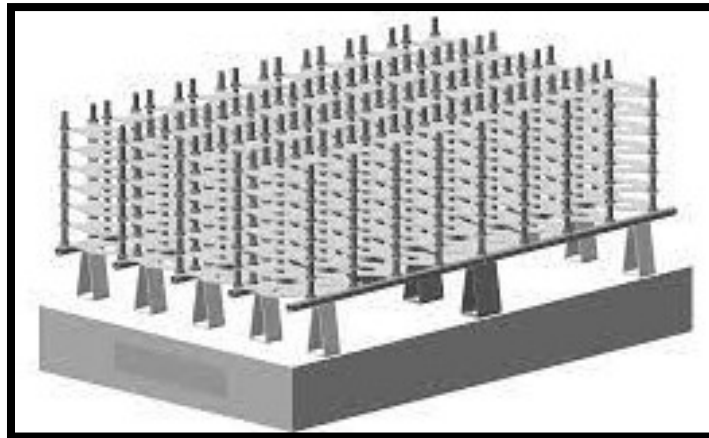
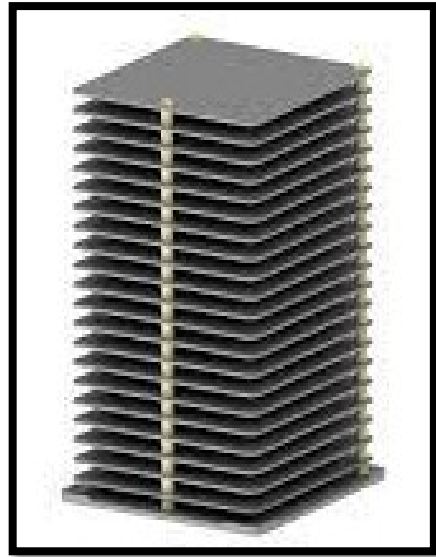


Figure 23 Assembly

15. PROJECT SELECTION - DEFECT REDUCTION THROUGH QUALITY CONTROL TOOLS

15.1 PLANT OVERVIEW

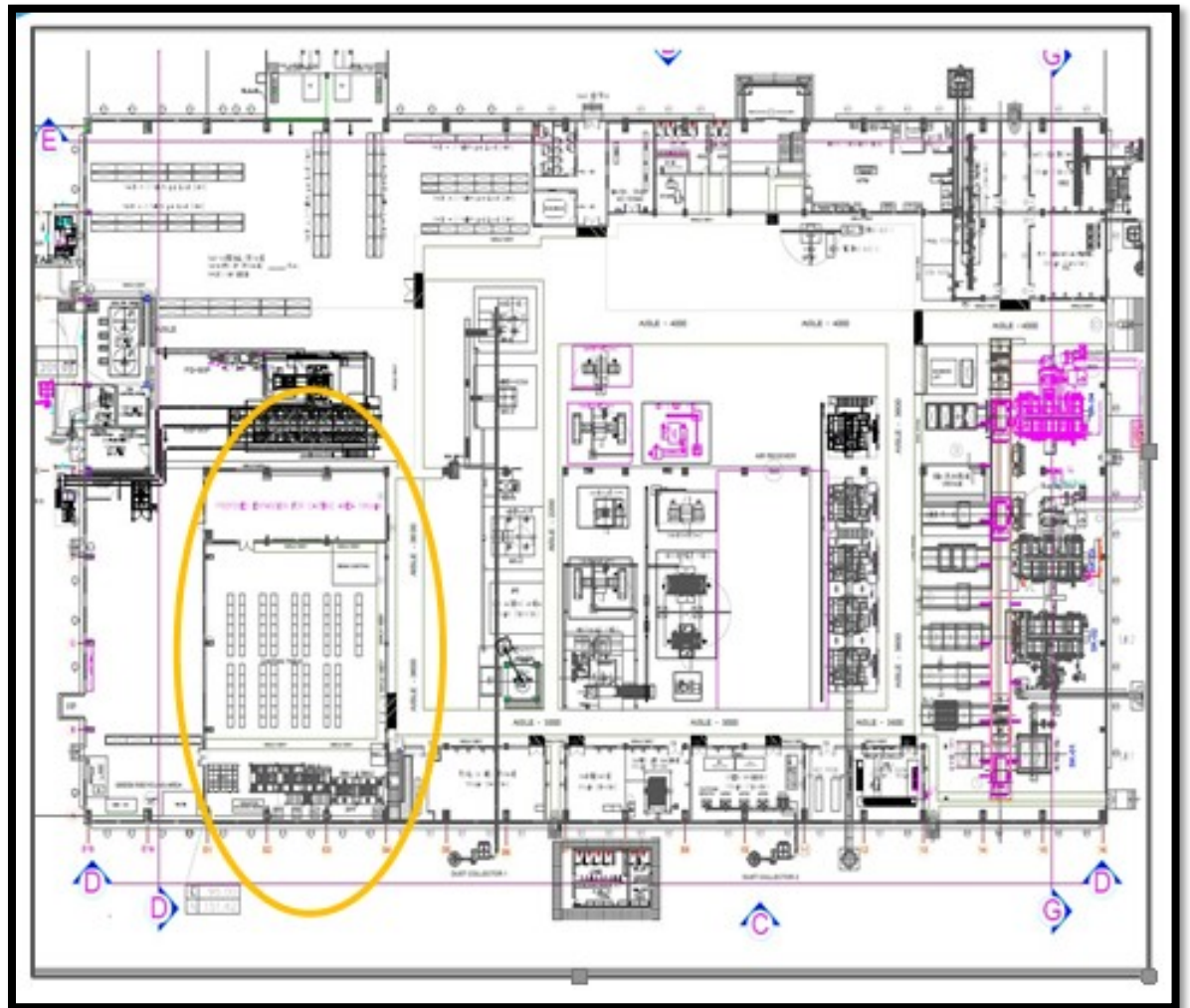


Figure 24 Plan layout

15.2 DEPLOYMENT

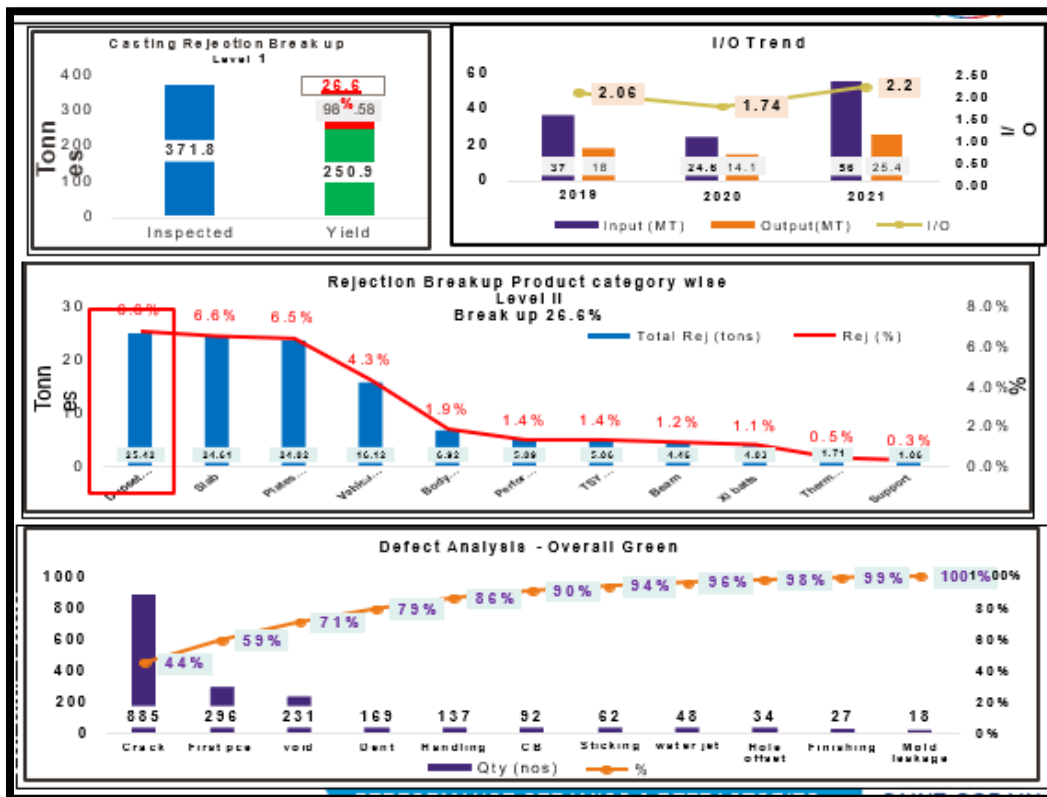
Site Objectives : To reduce the Input of Duo setter

Area Objectives : Casting Dinnerware Line – Target to reduce casting green rejection

casting overall rejection 26.6% to 23.4%

Department Objectives : Duo setter green rejection reduction from 6.8% to 3.5%

Team Objectives : To reduce the cracks in duo setter through quality control tools



15.3 DEPARTMENT AND MACHINE INVOLVED

Casting section - Dinnerware product line

Problem description (What problem / Why is it a problem)

What is the Problem ? :

Casting Green Rejection is 26.6%

Why it is a problem ?: Higher rejection will lead to capacity loss & incurs cost for reprocessing, Value loss & increases lead time

Internal Customer (sponsor of the project)

Jignesh Patel - Production Manager

Expected Output of the Project (in 1.5 months)

Duo setter green rejection will be reduced from 38.5% to 29%

Quantitative (long term - 4 months) Objectives of the Project (to be achieved with the full implementation of all countermeasures)

Duo setter green rejection will be reduced.

Potential gains: 532k INR

15.4 IDENTIFY THE ORIGIN OF DEFECTS- ANALYSE THE HISTORICAL DATA

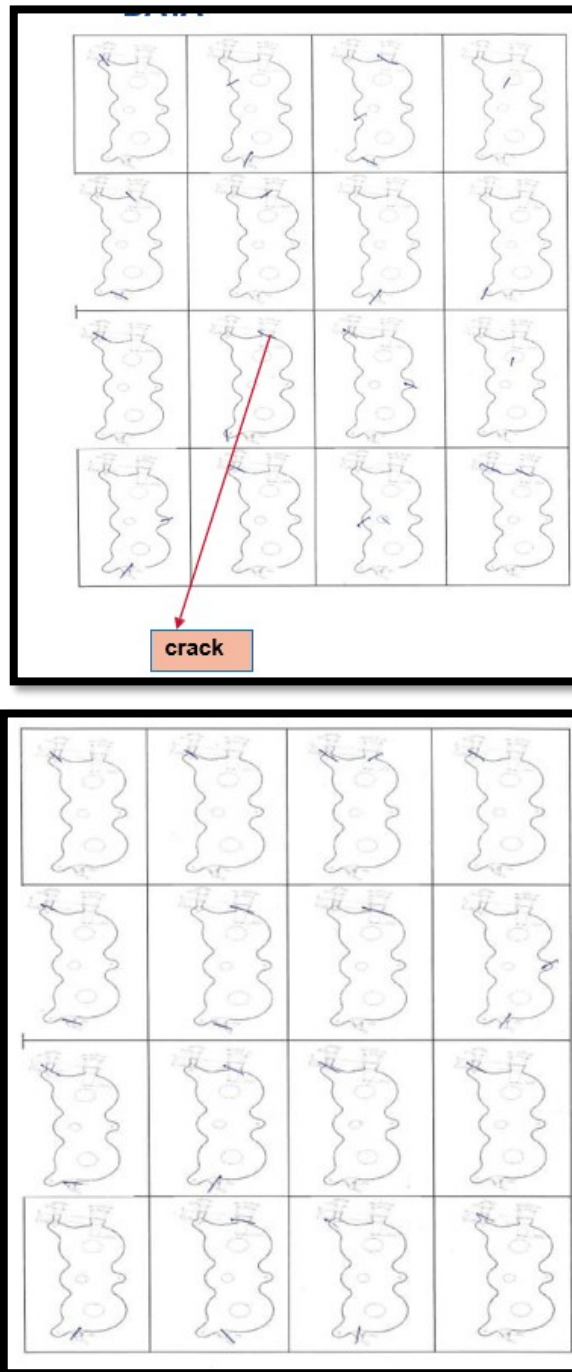
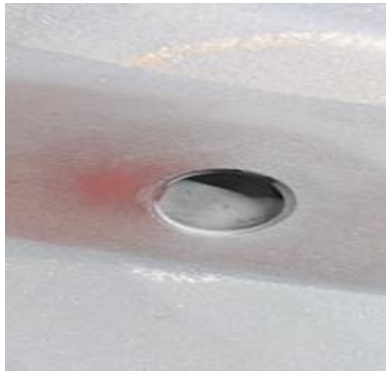


Figure 25 Defect Data

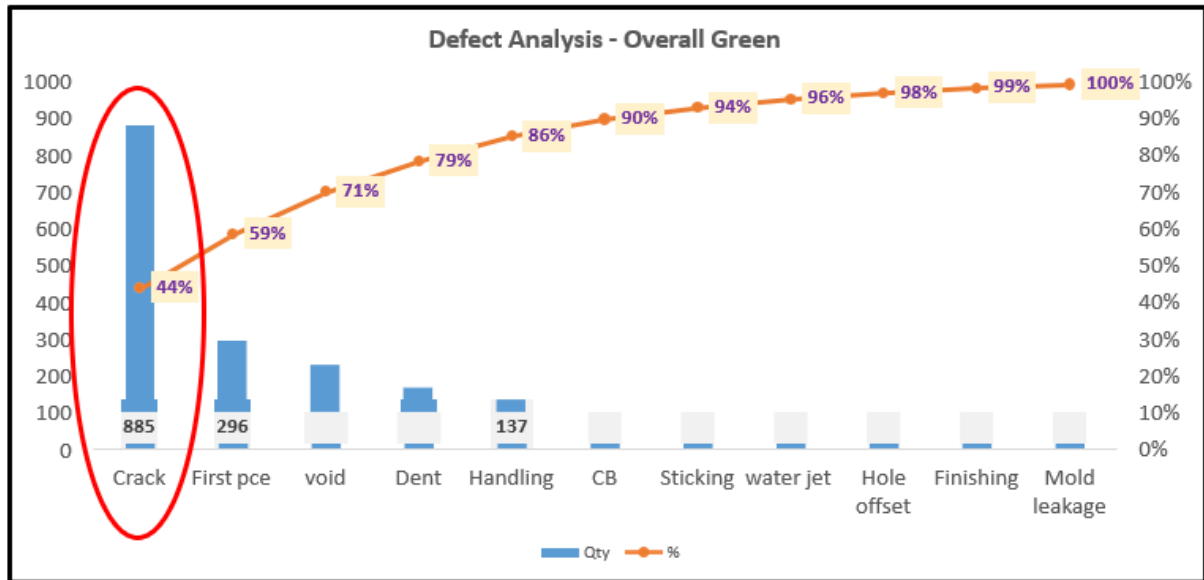
Quantity in Nos								
	Inspected	Ok	RW	crack	Dent	sticking	void	Handling
FEB'23	514	198	68	94	25		7	31
MAR'23	3641	2390	945	595	99	50	179	54
APR'23	2359	1928	635	196	45	12	45	52
Total	6514	4516	1648	885	169	62	231	137
in %		69%	25%	14%	3%	1%	4%	2%





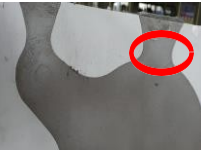
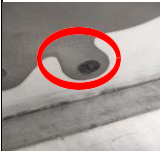
Dye penetration test for crack checking

Figure 26 Dye penetration test

15.5 IDENTIFY THE ORIGIN OF DEFECTS- RANK DEFECT DATA & PRODUCE PARETO GRAPH



15.6 IDENTIFY ORIGIN OF DEFECTS – LIST & DESCRIBE DEFECT MODES

Visual Display	Crack	Description	Visual Display	Crack	Description
	A1	Crack along top sprue leg portion		A5	Crack along body above 200 mm from bottom sprue
	A2	crack along top sprue		A6	Crack along bottom sprue






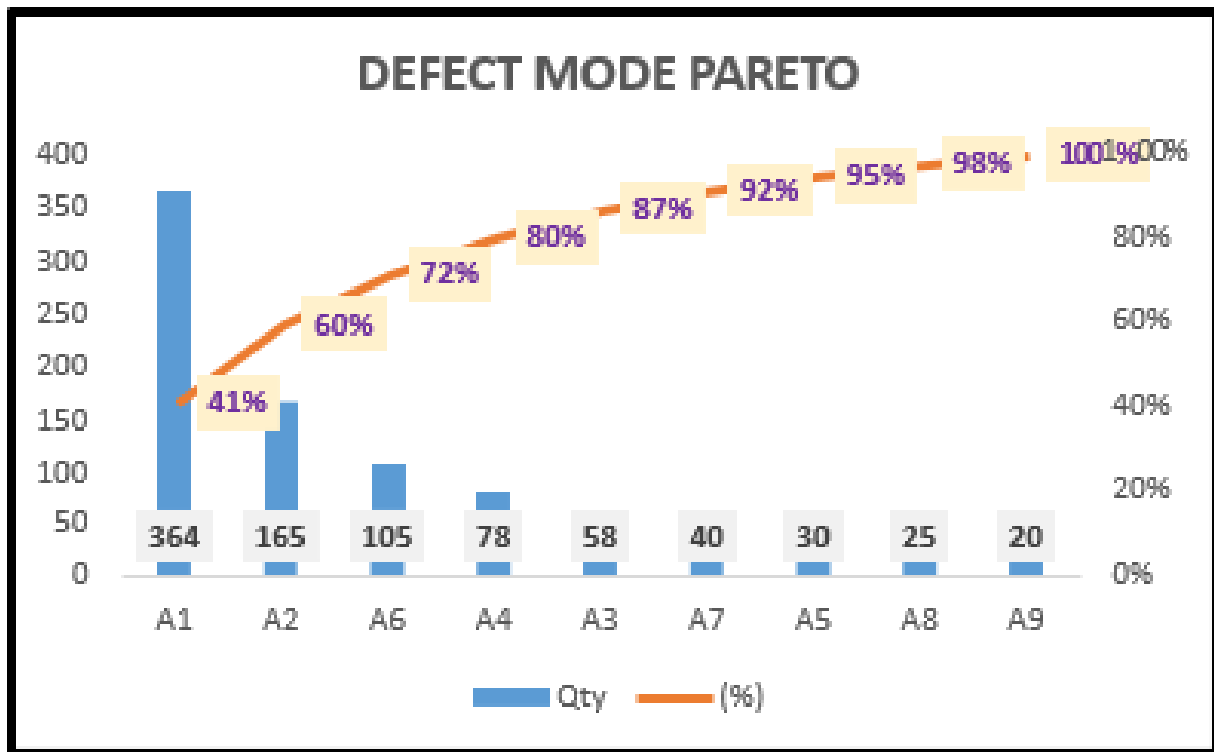
	A3	Crack along body below 200 mm from top sprue		A7	crack along side holes
	A4	crack along center of the pce		A 8	crack along center hole below the top sprue
				A9	crack along center hole above the top sprue

Figure 27 Defect Identification



15.7 IDENTIFY THE ORIGIN OF DEFECTS- SETUP DATA COLLECTION SYSTEM

The image shows two identical hand-drawn process data collection sheets. Each sheet is divided into several sections for recording process parameters and defects. The top section includes fields for 'size', 'defects', 'cavity/non-cavity', 'void No.', 'ife', 'temp', 'alc (wet/dry)', 'alc application time', 'casting: Demolding time', 'demolding operator', and 'moisture'. Below this is a section for 'defects' with sub-fields for 'cavity/non-cavity', 'void No.', 'ife', 'temp', 'alc (wet/dry)', 'alc application time', 'casting: Demolding time', 'demolding operator', and 'moisture'. The sheets are dated '7-03-2022' and contain various handwritten entries, including numbers, names, and signatures. A red arrow points from the word 'CRACKS' in a blue box to the 'defects' section of the left sheet.

CRACKS

15.8 FOR DEFECT REDUCTION SUMMARY : RESTORE BASIC CONDITIONS ON CRITICAL AREAS AND SET STANDARDS-IDENTIFY CRITICAL AREAS

Process	Man	Method	Material	Machine	environment
POP	sprue portions not finished	Overdried molds used for production	POP is settling fast	RPM of the blade is not proper	
		Molds made not used in production within 7 days	Shelf life of POP got expired	Blade worn out	
		Mixing time of POP is not proper		Preventive maintenance	
		POP bag kept open			
Molds inspection	Operator not competence enough	molds without inspection taken into production			
Raw materials	sample collection not done properly	Sample collection process in warehouse	ph,EC,LPD & PSD of SiC grains is not within the specification	Equipment not calibrated	
	Testing not done properly		Shelf life of RM got expired		
Sprue design	Not done as per SOP	SOP			

Ball Mill	RPM not fixed properly	fixing of rpm in potentiometer	Rubber balls are not added properly	Alignment issue	Temperature of casting shop
			Size of the rubber balls	Preventive maintenance	AC not working
Deairing	Slip kept as idle not consuming more than 2 hrs	Agitator not running while pouring of slip		Vacuum not achieved due to water pot not maintained	
Talc Preparation	Ratio not maintained	Insufficient mixing time		RPM is not proper	
Talc Application	talc not applied	0.2 bar pressure not maintained	talc settled in the bottom of container while spraying	nozzle size	
		250 mm distance not maintained between nozzle & mould			
Demolding	Top sprue not hold	Dust in tiles/demolding setters		tools used for cutting	
	Both operators not lift the mold in the same time	keeping sprue hanging 10 mm outside the tiles			
	Demolding not done timely				
Drying	Drying of pcs at 110 degree	transfer of pcs to drier	Pcs are drying fast	Drier running in manual mode	
Finishing	Handling	Grinding	Finishing template		
Stacking	without finishing keeping in C- Frames	stacking more pcs than specified			
Mold Drying	Mold not send as per SOP	Drying schedule		Drier running in manual mode	
	Molds drying at 65 degree	Spacer between the molds			
Water jet drilling	Pcs not kept matching the profile	Drawing not matching	Speed of nozzle		
			Diameter of nozzle		
Green inspection	Handling				
	Operator not competent enough				

15.9 RESTORE BASIC CONDITIONS ON CRITICAL AREAS & SET STANDARDS PERFORM INITIAL CLEANING & TAGGING



Figure 28 Restore basic condition

15.10 RESTORE BASIC CONDITIONS ON CRITICAL AREAS AND SET STANDARDS-DEFINE & IMPLEMENT CLEANING, INSPECTION & LUBRICANT STANDARDS

Machine	Critical parts	What to do	How to do	Frequency	Responsibility
Vacuum pump	Vacuum gauge	check the working condition	Visual	Daily	Ball mill operator
Vacuum pump	water pot	check the working condition	Visual	Monthly	Maintenance
Deairing vessel	Lid	check for air leakage	Visual	Daily	Ball mill operator
Deairing vessel	Vacuum gauge	Physical damages	Visual	Daily	Ball mill operator
Deairing vessel	Rotor	check for oil leakage	Visual	Daily	Ball mill operator
Deairing vessel	Agitator	check for cleaning	Visual	Daily	Ball mill operator
Deairing vessel	Agitator	Check for alignment	Visual	Monthly	Maintenance
Talc Mixer	Stirrer	check for rustiness	Visual	Daily	Casting Team Member
Talc Mixer	Stirrer	Check for alignment	Visual	Monthly	Maintenance
compressed air source	air leakage	check on individual	Visual	Monthly	Maintenance
compressed air source	pressure regulator	check the working condition	Visual	Daily	Casting Team Member
compressed air source	pressure regulator	Physical damages	Visual	Daily	Casting Team Member
compressed air source	pressure regulator	check for water droplets	Visual	Daily	Casting Team Member

Talc container	Nozzle	check for blockages	Visual	Daily	Casting Team Member
Air conditioner	Filter	Daily cleaning	Visual	Daily	Casting Team Member
Casting gun	Nozzle	check for blockages	Visual	Daily	Casting Team Member

15.11 RESTORE BASIC CONDITIONS ON CRITICAL AREAS AND SET STANDARDS- RESTORE ALL THE OPERATING STANDARDS



BEFORE



AFTER



BEFORE



AFTER



BEFORE



AFTER



BEFORE



AFTER

Figure 29 Restore basic condition (Before & After)



Figure 30 Tagging

No of SOP available - 1

No of OPL's available - 3

No of OPL's required - 5

15.12 FOR DEFECT REDUCTION SUMMARY :UNDERSTAND THE ROOT CAUSES FOR RECURRING DEFECT MODES: FISH BONE DIAGRAM

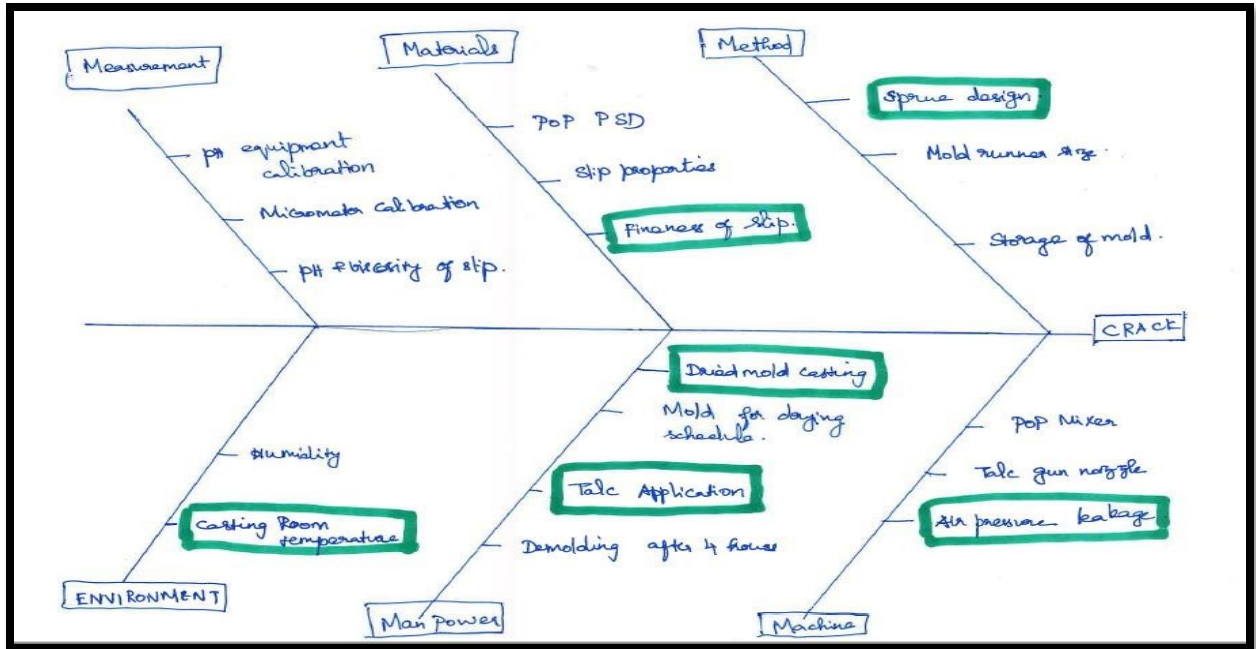
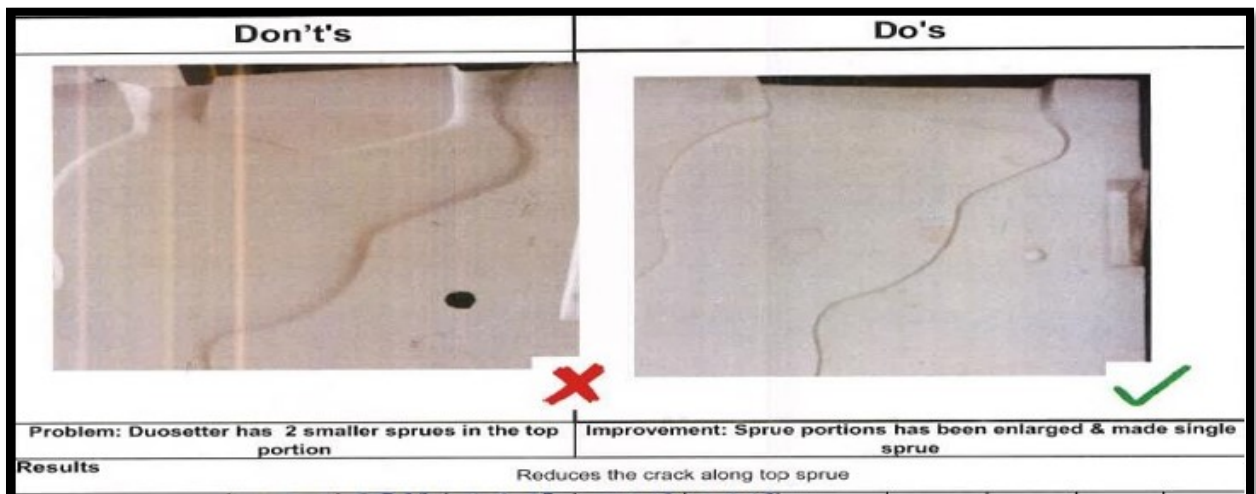
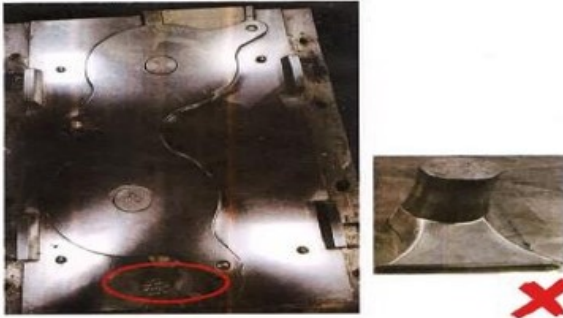





Figure 31 Fishbone Diagram

15.13 STANDARDISE COUNTERMEASURES BY MEAN OF OPLS AND IMPROVED STANDARDS



Don't's	Do's
	
Problem: Duosetter bottom sprue is plain resulting in difficulty in hole cleaning & generates cracks	Improvement: Duosetter bottom sprue has been given taper for ease of mold cleaning
Results	Reduces mold rework & crack along bottom sprue

Don't's	Do's
	
Problem: Duosetter has 2 smaller sprues in the top portion	Improvement: Sprue portions has been enlarged & made single sprue
Results	Reduces the crack along top sprue



Don't's	Do's
	
Problem : Handling of the products along the sprue / side hole portion	Improvement : Handling of the products in the body portions
Results	Handling of the products along the body portions resulted in decrease in crack along A1,A6 & A7

Figure 32 OPL's

15.14 INTRODUCE A TRAINING SYSTEM

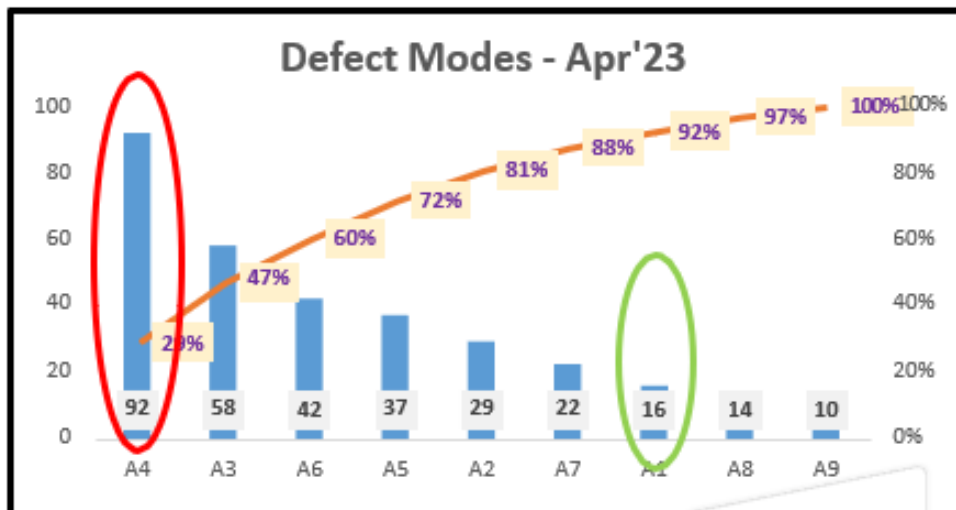
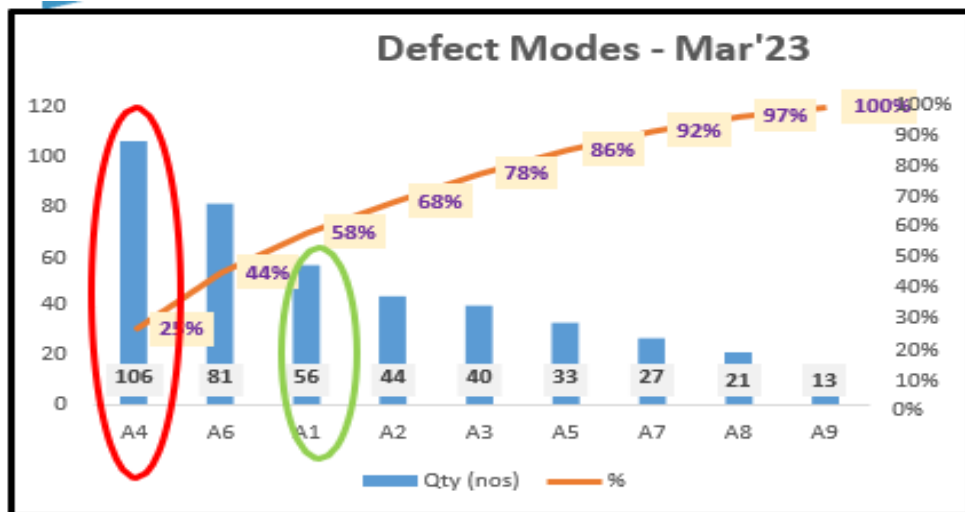
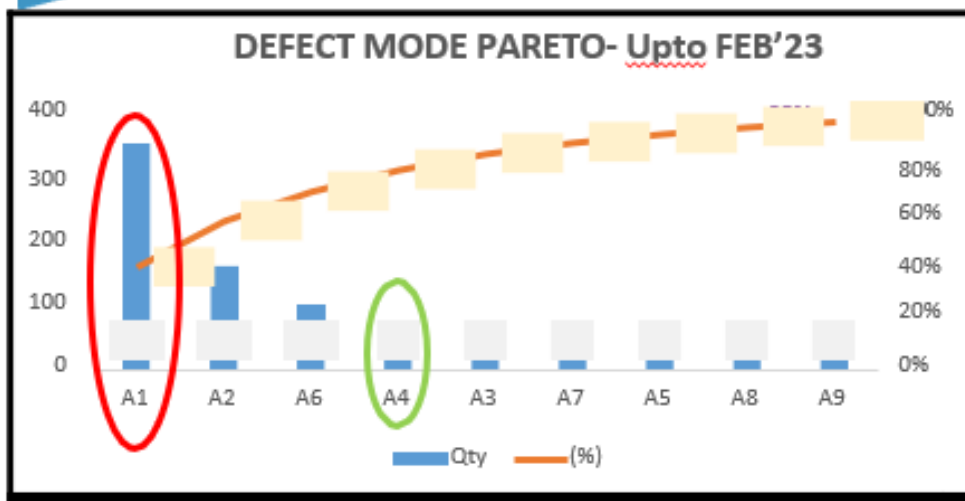
Name of Trainer	Oves Raliya						
Name of Training	OPL 1	OPL 2	OPL 3	OPL 4	OPL 5	Talc Application	Demoulding Training
Date of Training	11-Feb-23	23-Feb-23	06-Mar-23	14-Mar-23	28-Mar-23	04-Apr-23	08-Apr-23
Venue	POP	Casting		GFR		Casting	
Damor	x	x	X			x	x
Hemanth	x	x	X			x	x
Rahul	x	x	X			x	x
Vishal	x	x	X			x	x
Paresh	x	x	X			x	x
Suresh				x	X		
Irappa				x	X		
Kuldeep				x	X		
Amish				x	X		

X Planned

XX Completed

Name of Trainer	Oves Raliya						
Name of Training	OPL 1	OPL 2	OPL 3	OPL 4	OPL 5	Talc Application	Demoulding Training
Date of Training	13-Feb-23	25-Feb-23	07-Mar-23	16-Mar-23	30-Mar-23	07-Apr-23	16-Apr-23
Venue	POP	Casting		GFR		Casting	
Damor	XX	XX	XX			XX	XX
Hemanth	XX	XX	XX			XX	XX
Rahul	XX	XX	XX			XX	XX
Vishal	XX	XX	XX			XX	XX
Paresh	XX	XX	XX			XX	XX
Suresh				XX	XX		
Irappa				XX	XX		
Kuldeep				XX	XX		
Amish				XX	XX		
X Planned							
XX Completed							

15.15 RECORD & PLOT RESULTS



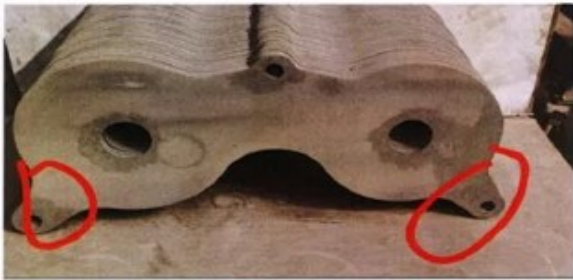
15.16 ORGANISE THE DEFECT ANALYSIS

A document that captures each problem identified, and analyses it in a set structure

Date	12 Mar 23		
Contract			
Type			
Problem description			
Crack in Duosetter			
Immediate Action			
Handling Procedure has been changed			
Cost of the problem	Potential loss if not detected (K€)		
Defect mode			
Crack in A4 along the hole			
<small>Use the back of the sheet for 5 why analysis on the defect mode identified</small>			
Root Causes		Cat (*)	Preventive Actions
After hole drilling wet pcs are stacked in C-Frames		2	OPL has been made & training has been given
Pieces are kept hanging in the tiles after water jet drilling		2	OPL has been made & training has been given
complexity of the shape		4	Brainstorming to be done to arrive at a optimum process loss
<small>Were checks already planned to prevent this defect? If yes, please specify</small>			
Description	By Whom	Process stage	
<small>Are new checks required? If yes, please specify in which phase they should be done</small>			
Description	By Whom	Process stage	



Figure 33 organize defect analysis

SAINT-GOBAIN		ONE POINT LESSON		WCM	
<input type="checkbox"/> Basic Knowledge	<input type="checkbox"/> Problem	<input checked="" type="checkbox"/> Improvement	OPL No. HPRG/QUA/OPL/007		
Title: Handling of green product after water jet process		Filled by: Oves Raliya		Date: 3-Sep-22	
Team Casting Team		Department: Casting			
<div style="text-align: center;"> <div style="border: 1px solid red; border-radius: 10px; padding: 5px; display: inline-block;">Don'ts</div> </div> 		<div style="text-align: center;"> <div style="border: 1px solid green; border-radius: 10px; padding: 5px; display: inline-block;">Do's</div> </div> 			
Problem: After completing water jet machining process product stack in C frame.		Improvement: After completing water jet machining process product stack in rack.			
Results: Reduce green defects. (Crack, BFL etc..)					



SAINT-GOBAIN		ONE POINT LESSON		WCM	
<input type="checkbox"/> Basic Knowledge	<input type="checkbox"/> Problem	<input checked="" type="checkbox"/> Improvement	OPL No. HPRG/QUA/OPL/008		
Title: Stacking of green piece after completing water jet machining process		Filled by: Oves Raliya		Date: 3-Sep-22	
Team Casting Team		Department: Casting			
<div style="text-align: center;"> <div style="border: 1px solid red; border-radius: 10px; padding: 5px; display: inline-block;">Don'ts</div> </div> 		<div style="text-align: center;"> <div style="border: 1px solid green; border-radius: 10px; padding: 5px; display: inline-block;">Do's</div> </div> 			
Problem: Stacking of Green piece on out of tiles after completing Water jet machining process.		Improvement: Stacking of Green piece on tiles after completing Water jet machining process.			
Results: Reduce green defects					

Figure 34 OPL's

Problem Description	Potential causes										4M	Actions	
	Why (1)	Check	Why (2)	Check	Why (3)	Check	Why (4)	Check	Why (5)	Check		PREVENTIVE ACTION	CORRECTIVE ACTION
Crack along A4	Design	yes	Complexity of the shape	yes	Tailor made product	yes	special application	yes			Method	Block mold design to be relooked	Mold design has been relooked & corrected in POP
	Handling	yes	After hole drilling wet pcs are stacked in C-Frames	yes	Human error	yes	New operator	yes	Training not provided	yes	Method	On job training provided	Wet pcs stacked in C-Frames
				yes	Shortage of racks	yes					Material	Adequate qty of racks to be procured	Wet pcs stacked in C-Frames
		yes	Pcs are kept hanging after water jet drilling	yes	Human error	yes	No standard proced	yes			Method	On job training provided	Stacked fully inside the tiles in racks

15.17 DEFINE THE DEFECT ANALYSIS PROCEDURE

Defect collection in casting

Size:	208x286x6 mm		Date & Shift:	7-03-2022
Defects	one		one	
Cavity/non-Cavity	non-cavity		non-cavity	
Mold No.	22		14	
Life	242/244		254/256	
Temp.	Wet		Wet	
Calc (wet/dry)	(A) Shift		(A) Shift	
Calc application time	2:41 PM / 6:42 PM		12:41/12:4	
Casting - Demolding time	Somay / Kishan		11:6/11:3	
Demolding operator	12:4/12:4		12:4/12:4	
Moisture	11:6/12:4		one	
Defects	one		one	
Cavity/non-Cavity	non-cavity		non-cavity	
Mold No.	51		36	
Life	221/224		22/25	
Temp.	Wet		Wet	
Calc (wet/dry)	(A) Shift		(A) Shift	
Calc application time	2:41 PM / 6:42 PM		Somay / Kishan	
Casting - Demolding time	11:4/12:4		12:4/12:4	
Demolding operator	11:4/12:4		12:4/12:4	
Moisture	11:4/12:4		one	
Defects	one		one	
Cavity/non-Cavity	non-cavity		non-cavity	
Mold No.	12		20	
Life	226/226		226/224	
Temp.	Wet		Wet	
Calc (wet/dry)	(A) Shift		(A) Shift	
Calc application time	2:41 PM / 6:42 PM		12:4/12:4	
Casting - Demolding time	11:4/12:4		12:4/12:4	
Demolding operator	11:4/12:4		12:4/12:4	
Moisture	11:4/12:4		12:4/12:4	

Process TM sign

Defect collection in GFR

Grindwell Norton Limited - PCR, Halol										WCM																																																																																																
Section: Quality Control - Green Inspection					Customer: Kutahya Porcelen San. A.Ş.					Duo Setter 626x283x6mm_02_02																																																																																																
Document Name: Defect Mode Sheet					Material Description: 3292325					Material Code: 3292325																																																																																																
<p>offset- 02.</p> <table border="1"> <thead> <tr> <th>Date:</th> <th>Shift:</th> <th>A</th> <th>Total Inspected</th> <th>156</th> <th>Total Defects</th> <th>18</th> </tr> </thead> <tbody> <tr> <td>Defect/</td> <td>A1</td> <td>A2</td> <td>A3</td> <td>A4</td> <td>A5</td> <td>A6</td> <td>A7</td> <td>A8</td> <td>A9</td> <td>Total</td> </tr> <tr> <td>Crack</td> <td></td> <td></td> <td></td> <td>6</td> <td>2</td> <td>1</td> <td></td> <td>3</td> <td></td> <td>12</td> </tr> <tr> <td>LT</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>HT</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Dent</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Stretch Mark</td> <td></td> <td></td> <td>1</td> <td>2</td> <td></td> <td></td> <td></td> <td>1</td> <td></td> <td>4</td> </tr> <tr> <td>CB</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Total</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>16</td> </tr> </tbody> </table> <p>Inspected by: Jazdy</p>												Date:	Shift:	A	Total Inspected	156	Total Defects	18	Defect/	A1	A2	A3	A4	A5	A6	A7	A8	A9	Total	Crack				6	2	1		3		12	LT											HT											Dent											Stretch Mark			1	2				1		4	CB											Total										16
Date:	Shift:	A	Total Inspected	156	Total Defects	18																																																																																																				
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Total										16																																																																																																

Figure 34 defect analysis

15.18 CREATE CHECKLISTS & STANDARDS TO MAINTAIN THE CONDITIONS

SAINT-GOBAIN		Q points		WCM	
Mold temperature					
				S.No	Defects
				1	crack
What to check			Specification		
Temperature of the molds to be checked before casting after drying			The mold temperature should be less than 25 degree		
Date	Shift	Date	Shift	Date	Shift
A	B	C	A	B	C
1		9		17	
2		10		18	
3		11		19	
4		12		20	
5		13		21	
6		14		22	
7		15		23	
8		16		24	

SAINT-GOBAIN		Q points		WCM	
Mold temperature					
				S.No	Defects
				1	crack
What to check			Specification		
Sprue design should be flat			The length of the sprue should be 250 mm		
Date	Shift	Date	Shift	Date	Shift
A	B	C	A	B	C
1		9		17	
2		10		18	
3		11		19	
4		12		20	
5		13		21	
6		14		22	
7		15		23	
8		16		24	

Figure 35 Checklist

15.19 IMPROVE THE REACTIVITY TO DEFECTS

Defect Reactivity Table						
Target	< 7%				Date	22-04-2023
Defect	crack					
Process steps						
	POP Molds	Sprue design	Slip	Talc Application	Air pressure	Demolding
Machine	Check the Mixing & POP falling			Check for settling in the talc	Pressure should be less than 2 bar	Dryer cycle
Material	Quality of POP		Higher fines in the slip	Talc having moisture or not		
Man		Sharp edges				Should be done within 30 mins after slip draining
Method		Enlarged top sprue				Stacking of POP Molds
Environment					Water leakage in the airline	Room Temperature

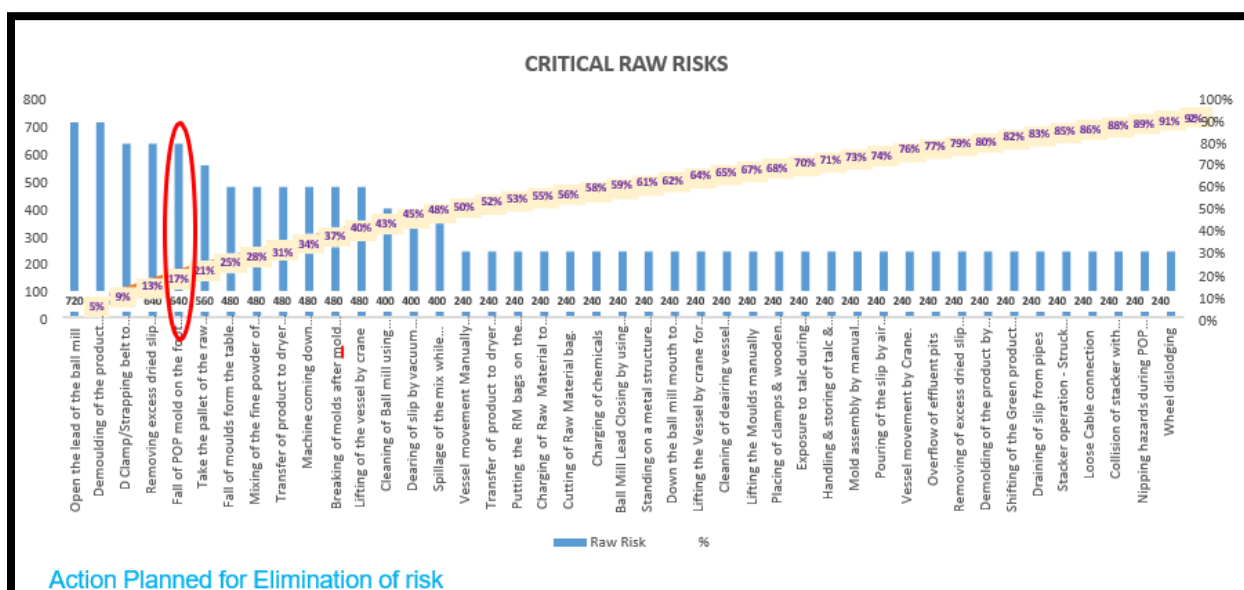
Figure 36 Defect reactivity table

15.20 IMPROVE THE CONTROL SYSTEMS

Sr no.	Checklist For Duosetter
1	Increasing the top sprue size (ટોપ સ્પ્રુ ની સાઈઝ વધારી)
2	Casting and Demolding Should be done in front of process (કાસ્ટીંગ અને ડી મોલ્ડીંગ રોસેસ ની સામે થવાનું જોઈએ)
3	Single Casting / day (વસીંગલ કાસ્ટીંગ / દિવસ)
4	Top up initial 10 min is critical. It should be done from bottom pipe (શરુઆતની 10 લક્ષ્મટ ટોપ-અપ જરૂર છે. તે નીચેની પાઇપમાથી થવું જોઈએ.)
5	Filling time need to be noted (ભરવાનું નો ટાઈમ લખવાની જરૂર છે.)
6	Gap between the molds while drying should be 35-40mm (ડ્રાઈર મા મોલ્ડ સ્કુ વાળી ડ્રિયિંગમાં મોલ્ડ વચ્ચે ગેપ 35-40 mm હોવી જોઈએ)
7	Wet talc to be applied (Slurry preparation solid content to be checked) (વેટ ટાલ્ક વખતે (ટાલ્ક ની સ્પર્શીયક કરવી. તેમાં ટાલ્ક નીચે બેઠેલો અને ઉપર એકલુ પાણી ન હોવું જોઈએ))
8	Sodium silicate solid content to be checked (સોડિયમ વસલ્ફેટ મા ઘન સામગ્રી ચેક કરી)
9	Temperature different between slip and mold need to be monitored (સ્લિપ અને મોલ્ડ વચ્ચે નું અલગ અલગ તાપમાન ચેક કરવું જરૂરી છે)
10	Deairing vessel details (BM no, Deairing no, ph, Density and Viscosity) (ડી એરોંગ વેસેલ લડેટલ્સ બોલ બમ નંબર ડી એરોંગ નંબર પીએચ, ડેન્સિટી અને વીસ્કોસિટી)
11	Size of dent (ડેન્ટ ની સાઈઝ)
	Remarks

Figure 37 Checklist for duo setter

15.21 RESULTS ACHIEVED & FINAL H&S ASSESSMENT



15.22 TRIAL ON RISK ELIMINATION

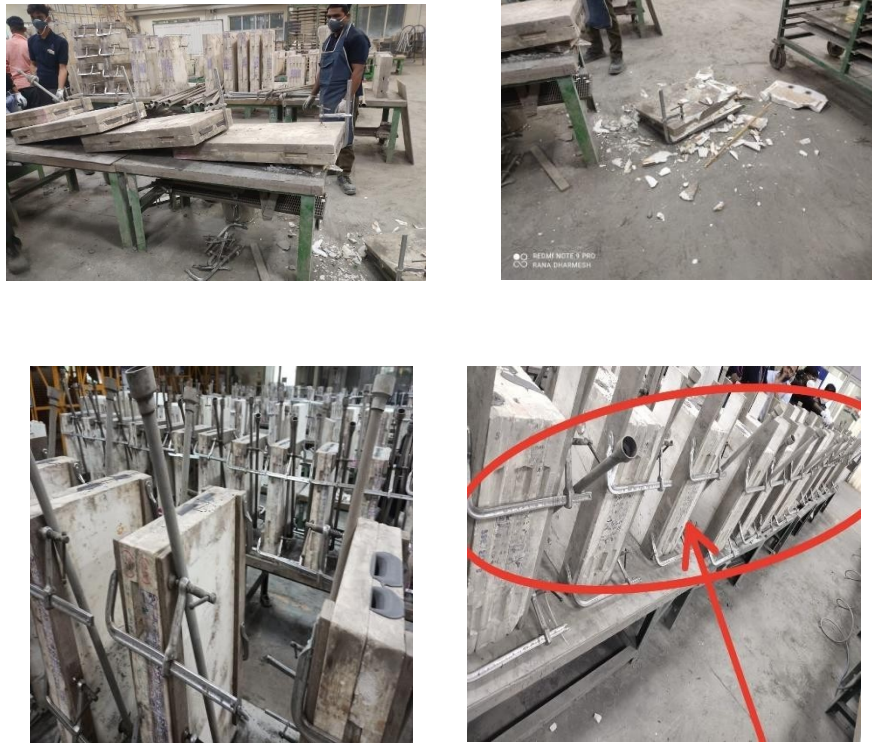


Figure 38 Risk Elimination 1

Current Method:

Pipes in each molds to be drained & removed which leads to ergonomics issue

Molds tend to fell down too often & Broken



Figure 39 Risk Elimination 2

Implemented:

Converted to battery casting with 9 pcs/set. Which reduces bending activity of operators from 40 to 16 & also saves time & also reduces the consumption of water used for pipe washing & increases productivity

15.23 TEAM AUDIT

Project Name		Reduction of IO of duosetter from 2.2 to 1.65				Start Date		29-05-2023															
Project Number		P20211265107																					