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* Manufacturing :-

Manufacturing is the process of producing goods or product on a large scale by transforming materials into finished items through machinery, tools, human labour and often automated systems. It involves a series of steps to design, create, assemble and test products, often with the goal of making high-quality items that meet specific standards or requirements.

Introduction to foundary :

- A foundary is a factory that produce metal objects by melting down metal and pouring it into molds to solidify.

Foundaries are responsible for transforming raw material like aluminium, steel and iron into finished products.

- Foundary engineering is the process of making casting in molds with the help of patterns.
- The foundary process is suitable for both small and large components, it offers high productivity, small tolerance and a good surface finish.
- The process can be divided into five stages including pattern making, molding and core making, melting and casting, fetting, testing and inspection.

* Steps involved in the Metal casting Process.

1) Pattern - Making :- A wood or metal piece replica of the part is used to create the mold.

2) Melting : The metal is melted in a furnance at high temperature unit its pourable.

3) Pouring : The molten metal is poured into the mold.

4) Removing : The casted part is removed from the mold after its solidifies.

5) Finishing : The part is ground, machined & sanded to achieve the desired shape and surface finish.

→ Foundaries produce a wide variety of metal parts including :-

- Engine components
- Railroad components
- Pipe components
- Machine components
- Boat exhaust manifolds
- Dental brace components
- cookware

Classification and types of foundaries :-

- Based on materials used

(i) Ferrous foundaries :- → A ferrous foundary manufacturing casting with materials such as malleable iron, grey iron, nadular iron, steel or any combination of these metals, the materials, are melted down and poured into molds at the ferrous foundary.

(ii) Non-ferrous foundaries :- → A non ferrous metal foundary is a factory that works with non-ferrous metals, in the factory molten metals are melted down and poured into molds in order to generate a specific desired geometry.

* Explain the safety precaution to be taken in foundaries :-

Safety in foundary is critical due to the hazardous nature of its processes, including handling molten metal, heavy machinery and chemicals. These inaludes -

1) Personal protection equipment (PPE) :-

- Heat - resistant gear :- use flame - resistant clothing, gloves and aprons to protect against ~~mettal~~ molten metal splashes.

- Face and eye protection :-
  Wear face shields, safety goggles or welding masks to prevent eye injuries from sparks and radiant heat.

- Foot protection :
  Use steel-toed, heat-resistant boots to protect feet from falling objects and molten metals.

- Respiratory protection :
  employ mask or respirators to protect against dust, fumes and harmful gases.

- Hearing protection :
  Use earplugs or earmuffs in area with high noise levels.

2). Handling Molten Metals

- controlled pouring
  Use tools designed to control the flow of molten metal to minimize spills.

- Proper ventilation.
  Ensure adequate ventilation to remove fumes generated during metal melting and casting.

- Avoid Moisture contact.
  Never allow water or moisture near molten metal, as it can cause violent explosive due to rapid vaporization

3) Machine and Equipment safety :-

- Regular maintenance

Inspects and maintains all machinary, cranes and tools regularly.

- Safe handling of molds :

use appropriate techiques to lift and position molds, avoiding sudden movements.

4) Foundary environment

- Adequate ventilation

Remove dust, fumes and harmful gases through exhaust system.

- Temperature control.

Manage extreme temperature to avoid that heat stress or burns.

- Spill control

keep the work area free from oil, grease and metals spills to prevent slips and fires.

5) Fire safety

Install fire extinguishers and trained workers on their use and emergency procedures.

6) Chemical safety

- Store chemical like fluxes and binders safely and away from heat sources.

7) Fire and explosion prevention.

- Spark and flame control :
  - Eliminate open flames or sparks near combustible materials

- Check for gas leaks, electrical faults and faulty equipments.

8). Worker Health Monitoring

- Conduct periodic health check-ups to monitor exposure to heat, fumes and noise.

9). Keep workspace clean:

- Keep the workspace clean and free from clutter to reduce tripping hazards.
- Properly dispose of waste materials, including slag and scrap.

* Explain the need of a Pattern:

A pattern is an essential tool in foundary process. It serves as a model or replica of the desired object to be cast and is used to create the mold cavity into which molten metal is poured.

Or

Pattern: A patter may be defined as a model or a form around which sand is packed to give rise to a cavity known as mold cavity in which when molten metal is poured, the result is the cast object.

- A pattern is a mold forming tool. A pattern is required even if one object has to be cast.

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* Need of a Pattern

(1) Formation of Mould cavity:

- A pattern is used to create an accurate negative impression of the disered part in the molding material (like sand or pattern).
- It determines the shape and size of the final cast product.

(2) Ensures Dimensional Accuracy:

- Pattern account for shrinkage of the metal as it cools and solidifies. pattern are slightly larger than the final product to compansate for this.
- They also include machine allowance to ensure the cast part can be processed further without dimensional issues.

(3) Improve Efficiency:

- Using pattern speeds up the mold-making process by providing a ready template for shaping molds.
- Pattern can be reused multiple times, making the process cost effective for larger-scale production.

(4) Faciliates complex Design

Pattern can include features like cores which create holloco space in the casting.

(5) Support quality control :

- Patterns are designed and tested to ensure consistency and accuracy in - casting.
- Their use minimizes defects like misalignment, improper dimensions or surface imperfections.

(6) Reduces material wastages :

By ensuring precise molding and accounting for allowance, patterns reduce materials wastage, saving costs and improving sustainability.

(7) versatility in materials :

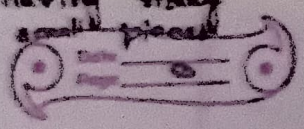
Pattern can be made from material like wood metal or plastic depending on :-

- Durability : for high - volume production, durable materials like metals are preferred.
- Ease of use : for loco - volume or prototype casting, wood or plastic pattern are cost - effective and easy to modify.

Types of Pattern

(i) solid or single piece PH.
(ii) split PH.
(iii) Loose piece PH
(iv) Match plate PH
(v) Gated PH
(vi) Sweep PH.
(vii) Skeleton PH
(viii) cope and Drag PH

Intricate - having many small pieces



(1) Solid or Single piece pattern :

- These are inexpensive and the simplest type of pattern.
- They are made up of a single piece. This type of pattern is used only in cases where the job is very simple & does not create any withdrawals problems.
- It is used for very simple casting and very small scale production.
- It has no joints, partitions or loose pieces.
- This type of pattern is cheap, easy to construct and limited in use.

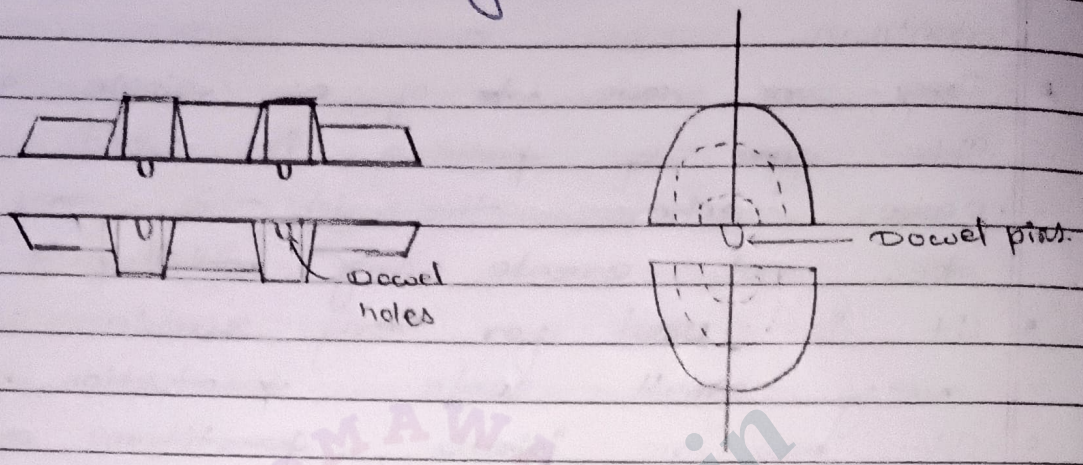
Single piece pattern

(2) Two piece or split pattern

- A pattern consist of two or more pieces is known as split pattern.
- The pieces are joined by dowel pins at the parting surface.
- This is the most widely used type of the pattern for intricate castings.
- It is used when complexity of part is more and the withdrawal of pattern is difficult.

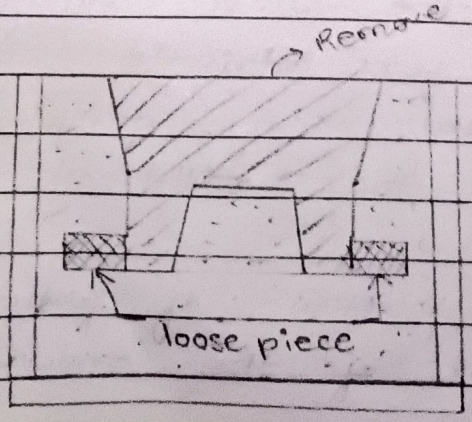
One - half portion of pattern is placed into upper part of the moulding box (known as cope)

other in
and the lower part of the moulding box (known as drag).



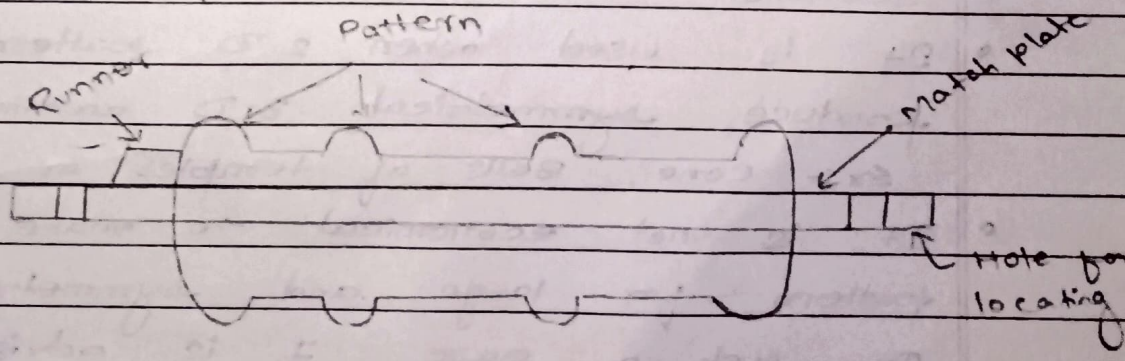
(3) Loose - piece pattern

- These type of pattern cannot be withdrawn once they are embedded in the molding sand.
- Patterns are usually made with one or more loose ~~pattern~~ pieces.
- Loose pieces are joined by dowel ~~pins~~ ~~parts~~. The main body of the pattern drawn first and then loose parts are removed from molding sand.
- Moulding with loose pieces is a highly skilled job and is generally expensive and therefore, should be avoided where possible.



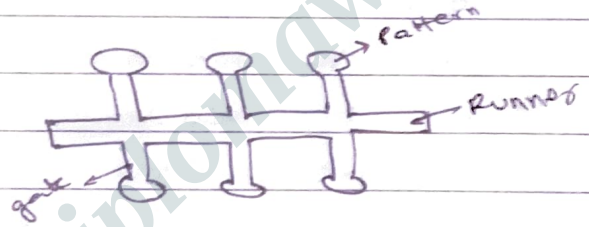
(4) Match plate pattern :

- A number of different sized and shaped pattern may be mounted on one match plate.
- Preferred for producing small casting on large scale.
- One side of the match plate, the cope flask is prepared and on the other, the drag flask.
- After moulding when the match plate is removed, a complete mould with gatting is obtained by joining the cope and the drag together.
- The complete pattern with match plate is entirely made of metal, usually aluminium, for its light weight and machinability.
- The casting of the match-plate pattern is done usually in plaster moulds but sometimes moulds are also used.
- These are generally used for small casting with higher dimensional accuracy and large production.
- They are expensive, but since they increase productivity, the additional cost is justified.



(5) Gated Pattern

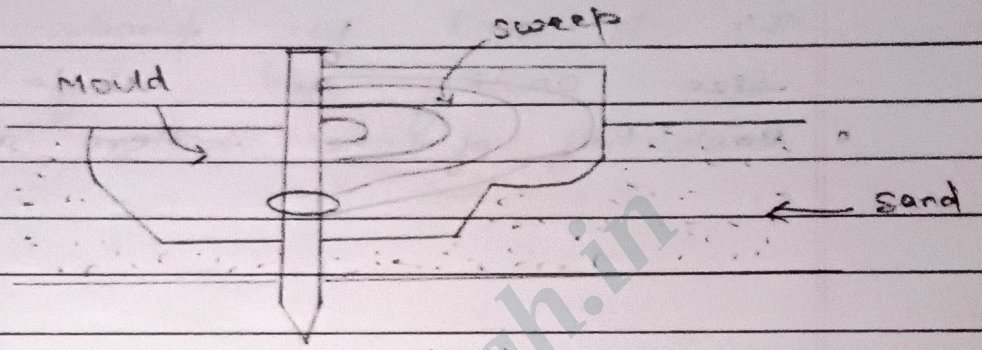
- These are the patterns with gates in a runner system.
- They are used in mass-production of small-size castings to eliminate the hand-cutting of gates and saves enormous time.
- It consists of metal or wooden pieces fixed to the patterns to form the gates, runner and rising channels in the mould.
- When the molten metal is poured in a place, it distributes in all the cavities formed into the mould.



(6) Sweep pattern

- The sweep patterns are used for moulding of large size and symmetrical circular sections.
- It is used when 2-D pattern used to produce symmetrical 3-D casting.
  Ex:- Cone, Bells of temples or cylindrical.
- It is not economical to make a full pattern for large and symmetrical casting. In such a case it is advisable to use sweep pattern.

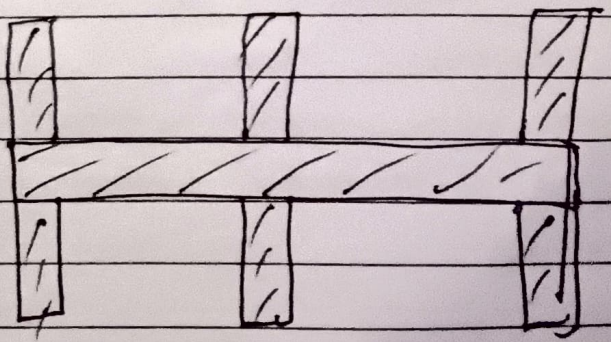
- A sweep is a template of a half part of the shape corresponding to the shape and size of casting required.
- This template is rotated about a spindle attached vertically to the base in the moulding sand.



Sweep pattern

(7) Skeleton Pattern :

- A skeleton Pattern made of strips of wood is used for building the final pattern by packing sand around the skeleton.
- After packing the sand, the desired form is obtained with the help of a strickle.
- This type of pattern is useful generally for very large casting.
- It is used to prepare shells and drums.



Strickle → an instrument for removing surplus sand.

(8) Cope and drag pattern :

- Cope and drag pattern is a type of split pattern which split on a convenient joint line.
- One part of the patter is rests in cope and another part is rests in drag box. This is used for produce very large size casting and single piece pattern.
- Each half of the pattern are finally assembled

Pattern Allowance

- The excess materials provide in the dimension on the time of pattern making, is known as pattern allowance.

A pattern is a replica of casting but it has slightly large dimensions. This change in pattern in casting due to various reasons is known as pattern allowance in casting.
For example:

When the cast solidify, it shrink at some extent due to metal shrinkage property at the time of cooling. So a pattern is made slightly larger to compensate it.

- Types of Pattern Allowance.
  1) Shrinkage / contraction allowance
  2) Draft / Taper allowance
  3) Machining or finish allowance
  4) Distortion / camber allowance
  5) Rapping / Shake allowance.

i) Shrinkage Allocoance :

- Shrinkage is defined as reduction is the dimension of the cast during the cooling or solidification process. This is the general property of all materials
- The magnitude of shrinkage varies from materials to materials but every materials shrinks.
- The metals ~~exist~~ contrast in size when it cools and solidifies. To ~~complete~~ compensate this shrinkage the pattern must be made larger than the finished casting.

It is of two types : (a) solid shrinkage
(b) Liquid shrinkage

(a) Solid shrinkage : Solid shrinkage is the reduction in volume when the metal loose in temperature in solid state. Shrinkage allocoance is always added to the linear dimension, it shrinks during the phase transformation.

(b) Liquid shrinkage : When the metal changes from liquid state (pouring temp) to solid state (freezing temp). There is a volume reduction. The riser is provided to compensate for liquid-shrinkage.

Note : (i) liquid shrinkag is maxm for Aluminium it requires a large volume of raiser.

(ii) Solid shrinkage is maxm for Brass, it requires large volume of pattern.

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* Shrinkage values of materials

(i) Invar and Bismuth - Negligible
(ii) White metal (Tin) - 5 mm/m
(iii) cast iron - 10 mm/m
(iv) Al (Maxm liq. shrinkage) - 13 mm/m
(v) copper (Cu) - 15 - 16 mm/m
(vi) Steel - 20 mm/m
(vii) Brass (Maxm sol. Shrinkage) - 23 mm/m

(2) Draft / Taper Allocance :

- For easy removal of metal from the mould form the vertical surface of the pattern. to minimize the continuous contact betn pattern and mould surface draft allowance is provided.
- This value depends on vertical height of the pattern.
- Internal surface of pattern required more draft than external surfaces ranges from $\frac{1}{2}^\circ$ to 2°.

(3) Machining / Finish Allowance :

- As we knowm that the product of a casting processes gives very poor surface finish.
- So to obtain good surface finish, the final product of casting is machined with the processes like turning or grinding to improve the surface finish.
- This machining after the casting process causes a significant loss of metal from

the casting. To compensate this loss, machining allowances are given in the pattern of casting.

- it ranges from 2 mm to 15 mm based on the size of material of the part.

- It is required for removal of ~~extra~~ materials and for surface finish. Due to this, size of casting will be reduced to overcome this the size of pattern will be increases.

(4) Distortion / camber Allocoance :

- When the metal is in cooling proeess, stress is developed in the solid-metal due to uneven metal thickness in the casting process. This stress may cause distortion or bending in the casting.
- To avoid this bending or distortion in casting, camber is provided in the opposite direction so that when bending occurs due to uneven thickness of metal, casting becomes straight.

(5) Shake / Rapping Allocoance

- For easy removal of pattern from the mould, some clearance is provided between pattern and the mould surface. This can be achieved by shaking in pattern Due to this the size of casting will be increase. To overcome, the size of pattern will be ~~increased~~ reduced.

by considering the shake allocoance.
It is a negative allocoance provided on the pattern.
This will depend on :- (a) Skilled operator required
(b) Type of ramming
(c) Type of moulding sand.

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OR.

- Before the withdraoal from the sand mold, the pattern is rapped all around the vertical faces to enlarge the mold cavity slightly, which facilitates its removal.

- Since it enlarges the final casting made, it is desirable that the original pattern dimention should be reduced to account for this increase

→ Materials used for pattern :-

(i) wood :- • lightweight, easy to carve & inexpansive.
• suitable for small-scale or prototype production.

(ii) Metal :- • Aluminium, brass, cast iron, steel.
• used to in mass production where high accuracy & longerity.

(iii) Plastic :- common types include polyurethane, epoxy resin. and polystrene.
• suitable for medium scale - production and intricate designs.

(iv) Plaster of Paris (PoP) :- • used for complex and detailed pattern.
• used for decorative and prototype application.

(v) foam
(vi) composite material
(vii) wax.

Ingredients :-

(i) Silica sand (SiO_2) :- provides bulk, heat resistance and strength to the mold.

(ii) clay :- acts as a binder, with bonding agent like bentonite, that holds the sand particles together & control plasticity.

(iii) H_2O - 2-8%, moisture. activates clay, controls
↳ Increased moldability but reduces strength of the mixture.

(iv) Fines :- fine particles that increases cocrkability

(v) Additives :- optional materials like resins or fluxing agents to enhance properties such as sea coal, graphite, cooeel flour..

Foundary tools:

1. Riddle – Cleaning the moulding sand.
2. Shovel – Mixing the moulding sand
3. Hand Rammer – packing & ramming the sand for bench moldld.
4. Pin Rammer – Packing the moulding sand in pockets and corners.

6) Sprue :- helps to make a passage for pouring molten metal in mould through gating system.

7) Strike off bar : Remove the excess sand from the top of the moulding box after completion of ramming thereby making its surface plane & smooth.

8) Mallet :- used for striking molds, patterns and cores without damaging them.

9) Tongs : Pliers like tools used for handling hot metals or moulds during the casting process.

10). Trowels : finishing flat surfaces & joints.

11). Slick : Repair and finish the mold surface after the pattern remove.

12). Scoab : Moistning the sand around the edge before the pattern is removed.

13) Gaggers : To provide strongness to molding sand in cope part of molding sand.

14) vent rod : To escape of steam & gases during pouring mold.

15) standard lifter :- clining repairing & finishing the bottom & sides of deep & narrow opening in mold cavity after withdrawal of