Thapar Institute of Engineering & Technology – Patiala

Manufacturing Processes
UTA026

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PATTERN

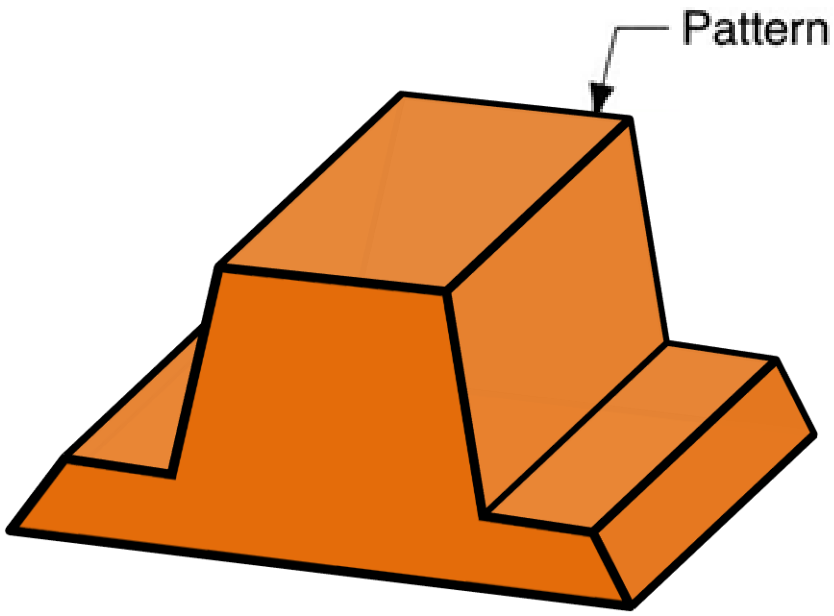
The Pattern

- A ***pattern*** is a full-sized ***model*** of the part which is made ***slightly large*** to account for shrinkage and machining ***allowances*** in the casting.
- Pattern materials:
  - ***Wood*** - common material because it is easy to work, but it warps
  - ***Metal*** - more expensive to make, but lasts much longer
  - ***Plastic*** - compromise between wood and metal

1. Solid (one-piece) pattern

- The simplest is made of one piece, called a ***solid pattern*** —same geometry as the casting, adjusted in size for shrinkage and machining.
- ***One-piece patterns*** are relatively cheap to construct, but the subsequent molding process is usually slow.
- As a result, they are generally used when the shape is relatively simple and the number of duplicate castings is rather small.

1. Solid (one-piece) pattern



Pattern Allowances

- The patterns are not made the exact size as the desired casting because such a pattern would produce undersize casting.
- When a pattern is prepared, certain allowances are given on the sizes specified in the drawing so that the finished and machined casting produced from the pattern will conform to the specified sizes.
- Pattern allowance is a vital feature as it affects the dimensional characteristics of the casting.

Pattern Allowances

- The selection of correct allowances greatly helps to reduce machining costs and avoid rejections. The allowances usually considered on patterns are as follows:

1. Shrinkage or contraction allowance
2. Machining or finish allowance
3. Draft or taper allowance
4. Distortion or camber allowance
5. Rapping allowance

1. Shrinkage or Contraction Allowance

- In practice it is found that all common cast metals shrink a significant amount when they are cooled from the molten state.
- The total contraction in volume is divided into the following parts:

a) Liquid contraction, i.e. the contraction during the period in which the temperature of the liquid metal or alloy falls from the pouring temperature to the liquidus temperature.

1. Shrinkage or Contraction Allowance

b) Contraction on cooling from the liquidus to the solidus temperature, i.e. solidifying contraction.

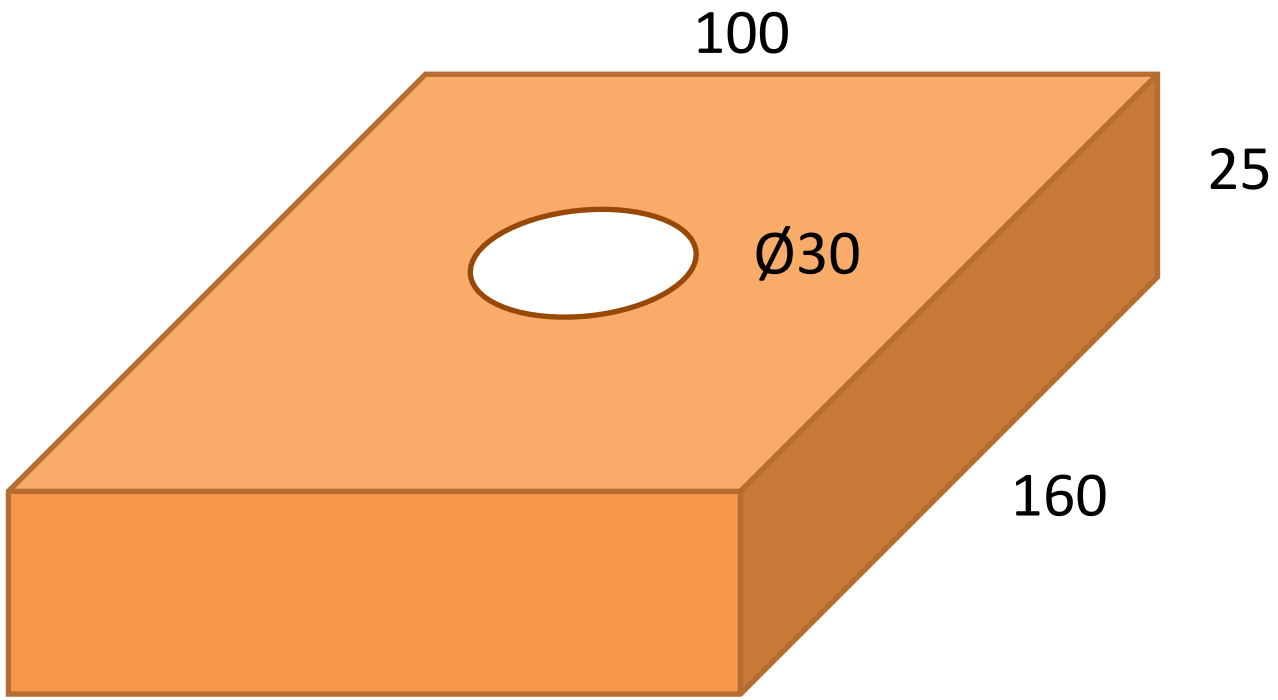
c) Contraction that results there after until the temperature reaches the room temperature. This is known as solid contraction.

- The first two of the above are taken care of by proper gating and riser design. Only the last one, i.e. the solid contraction is taken care by the pattern makers by giving a positive shrinkage allowance.

1. Shrinkage or Contraction Allowance

- This contraction allowance is different for different metals.
- The contraction allowances for different metals and alloys such as
  - Cast Iron : 10 mm/mt.
  - Brass : 16 mm/mt.
  - Aluminium Alloys : 15 mm/mt.
  - Steel : 21 mm/mt.
  - Lead : 24 mm/mt

1. Shrinkage or Contraction Allowance

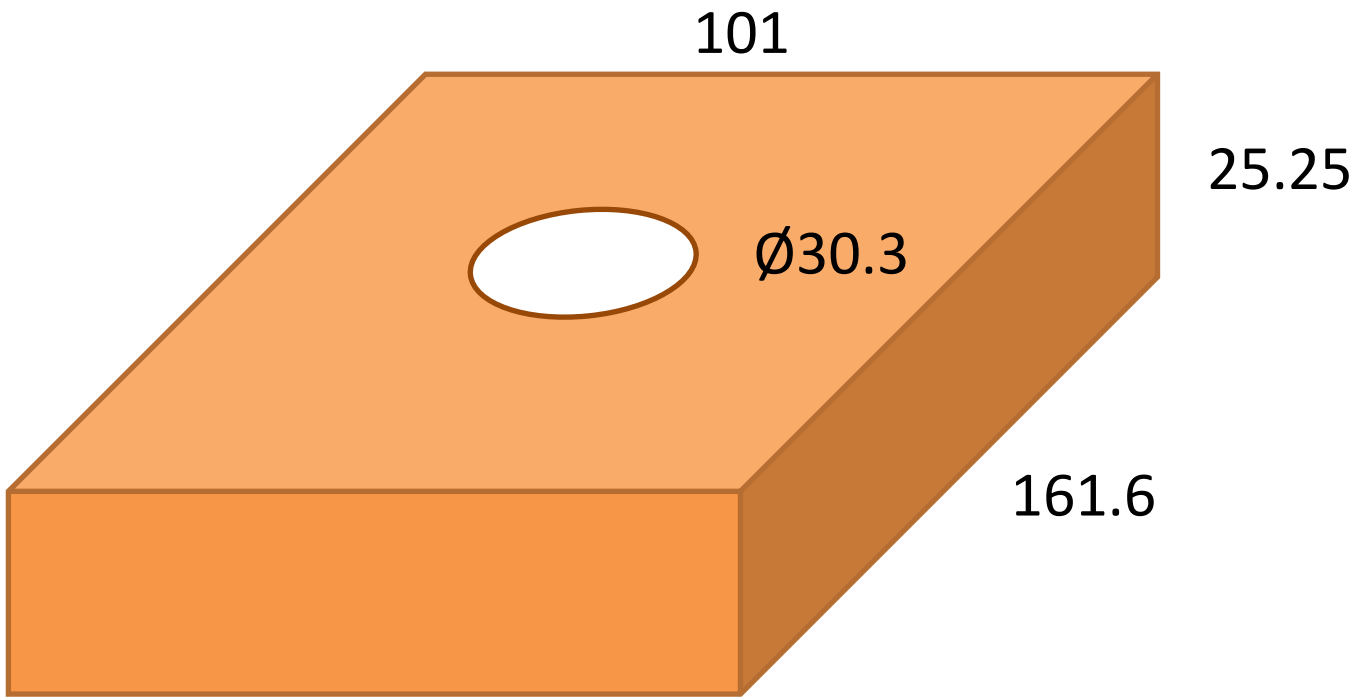


The casting shown is to be made in ***cast iron*** using a wooden pattern. Assuming only shrinkage allowance, calculate the dimension of the pattern

1. Shrinkage or Contraction Allowance

- For dimension **100mm**,
  - allowance = 100 *X* 10 /1000 = **1mm**
- For dimension **160mm**,
  - allowance = 160 *X* 10 /1000 = **1.6mm**
- For dimension **25mm**,
  - allowance = 25 *X* 10 /1000 = **0.25mm**
- For dimension **30mm**,
  - allowance = 30 *X* 10 /1000 = **0.3mm**

1. Shrinkage or Contraction Allowance



The pattern drawing with required dimension

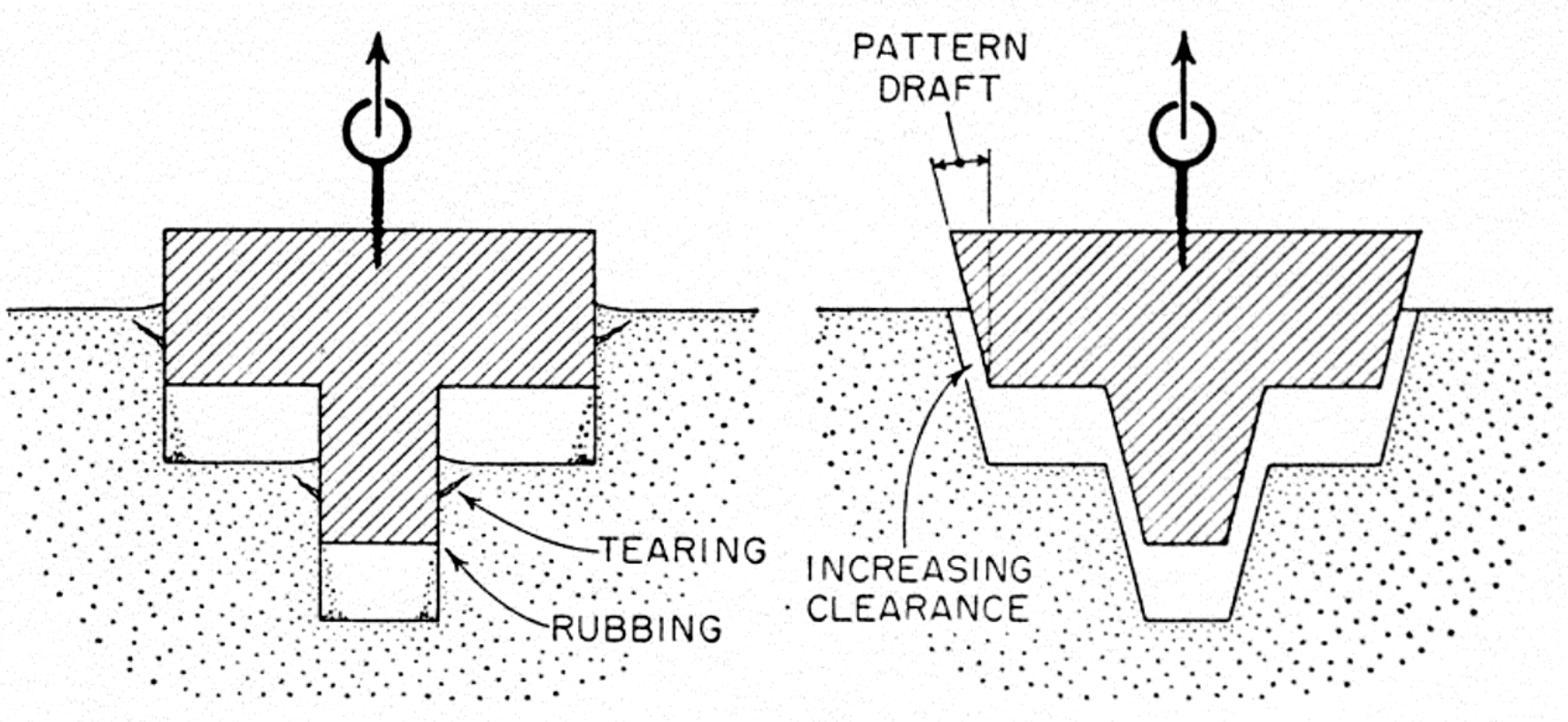
2. Machining or Finish Allowance

- The finish and accuracy achieved in sand casting are generally poor and therefore when the casting is functionally required to be of good surface finish or dimensionally accurate, it is generally achieved by subsequent machining.
- Machining allowance is a positive allowance given to compensate for the amount of material that is lost in machining or finishing the casting.
- If this allowance is not given, the casting will become undersize after machining.

2. Machining or Finish Allowance

- The amount of this allowance depends on the size of casting, methods of machining and the degree of finish. In general, however, the value varies from 3 mm. to 18 mm.

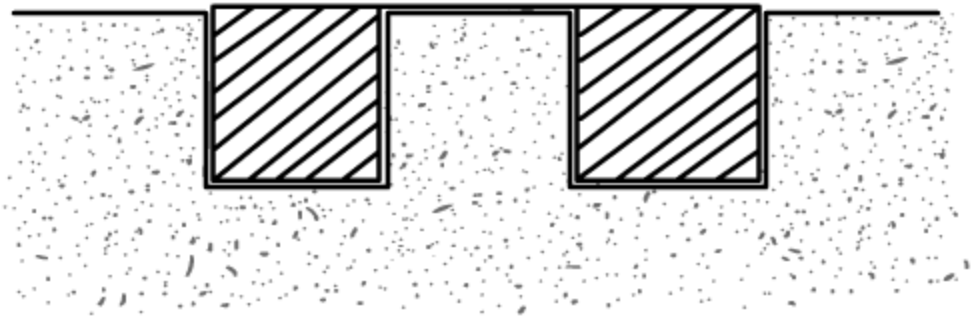
3. Draft or taper allowance



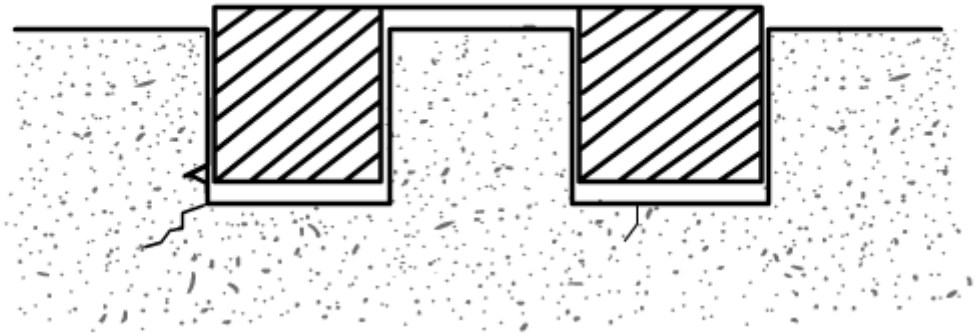
3. Draft or taper allowance

- Draft is the taper provided by the pattern maker on all vertical surfaces of the pattern so that it can be removed from the sand without tearing away the sides of the sand mold and without excessive rapping by the molder.
- Figure shows a pattern having no draft allowance being removed from the pattern.
- Till the pattern is completely lifted out, its sides will remain in contact with the walls of the mold, thus tending to break it.

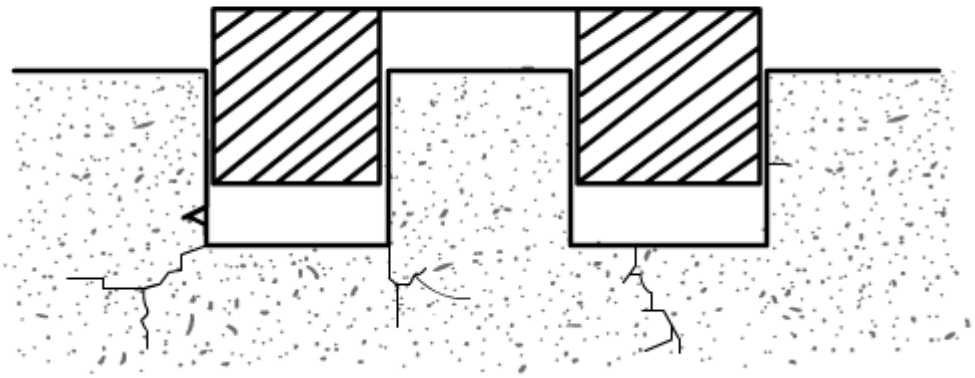
Removal of Pattern without Draft



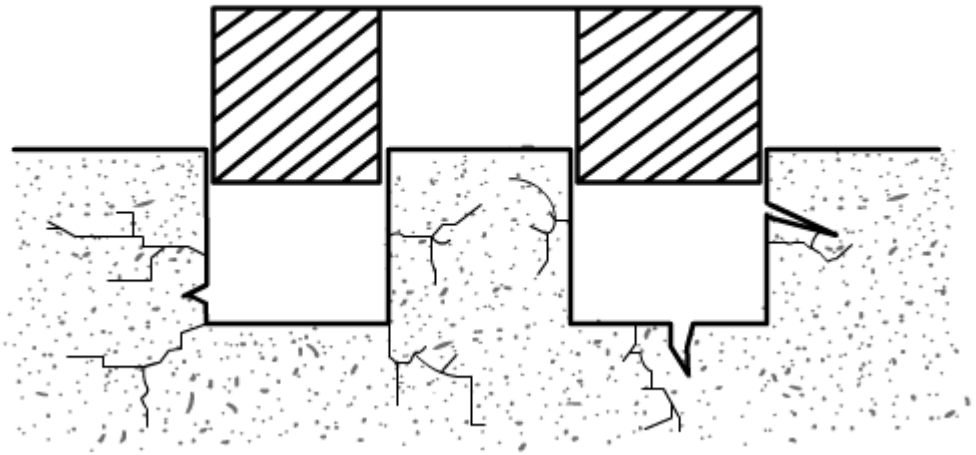
Removal of Pattern without Draft



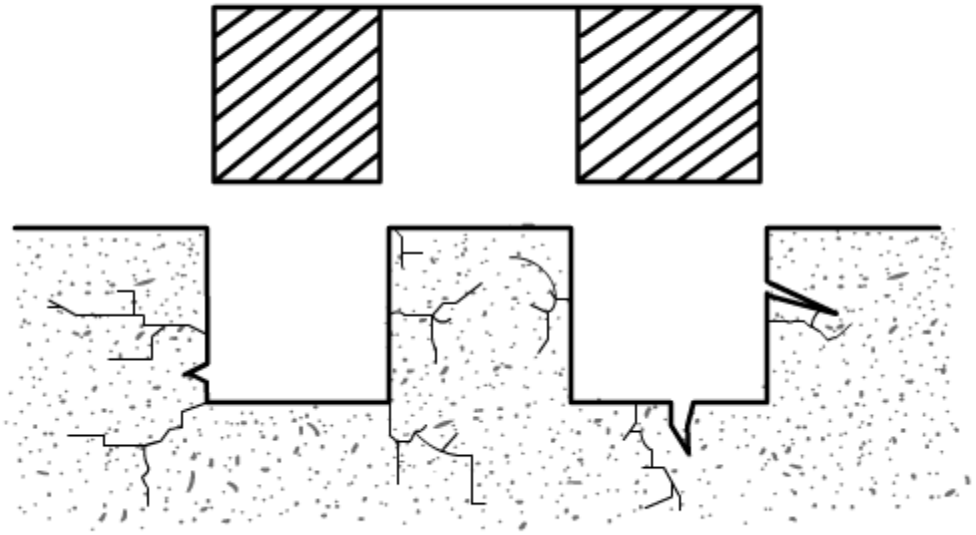
Removal of Pattern without Draft



Removal of Pattern without Draft



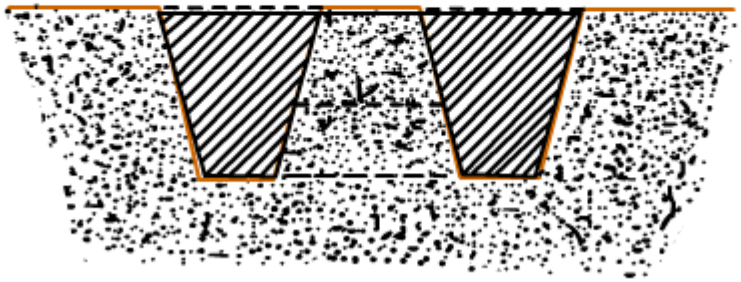
Removal of Pattern without Draft



3. Draft or taper allowance

- Next figure shows an illustration of a pattern having proper draft allowance.
- Here, the moment the pattern lifting commences, all of its surfaces are well away from the sand surface.
- Thus the pattern can be removed without damaging the mold cavity

Removal of Pattern with Draft



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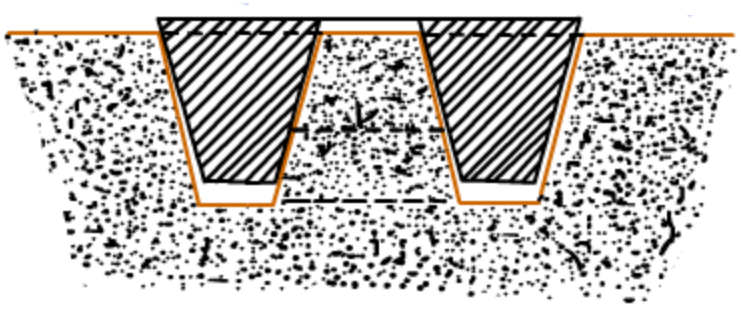

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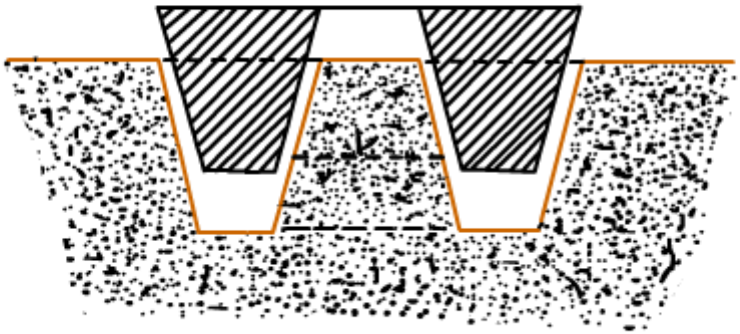

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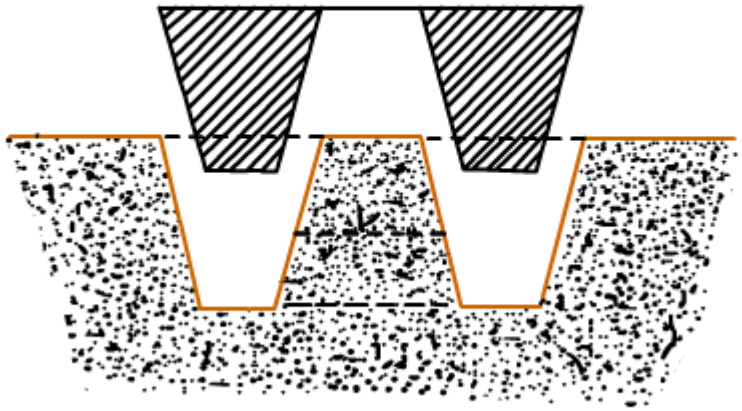

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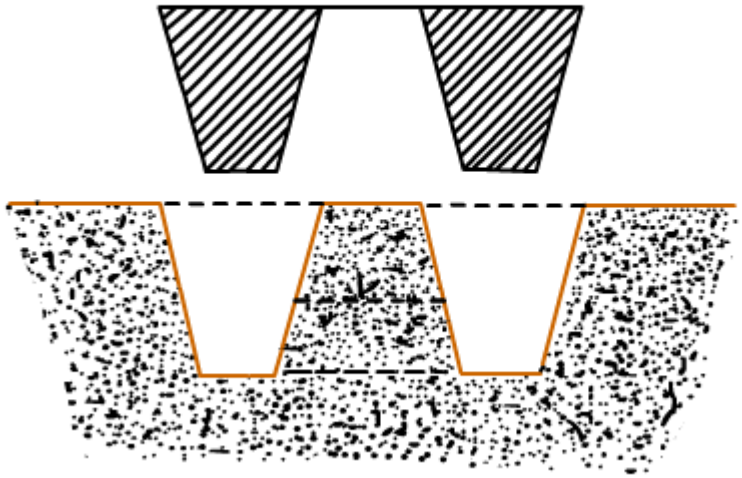


3. Draft or taper allowance

- The normal amount of taper on the external surfaces varies from 10 mm to 20 mm/mt.

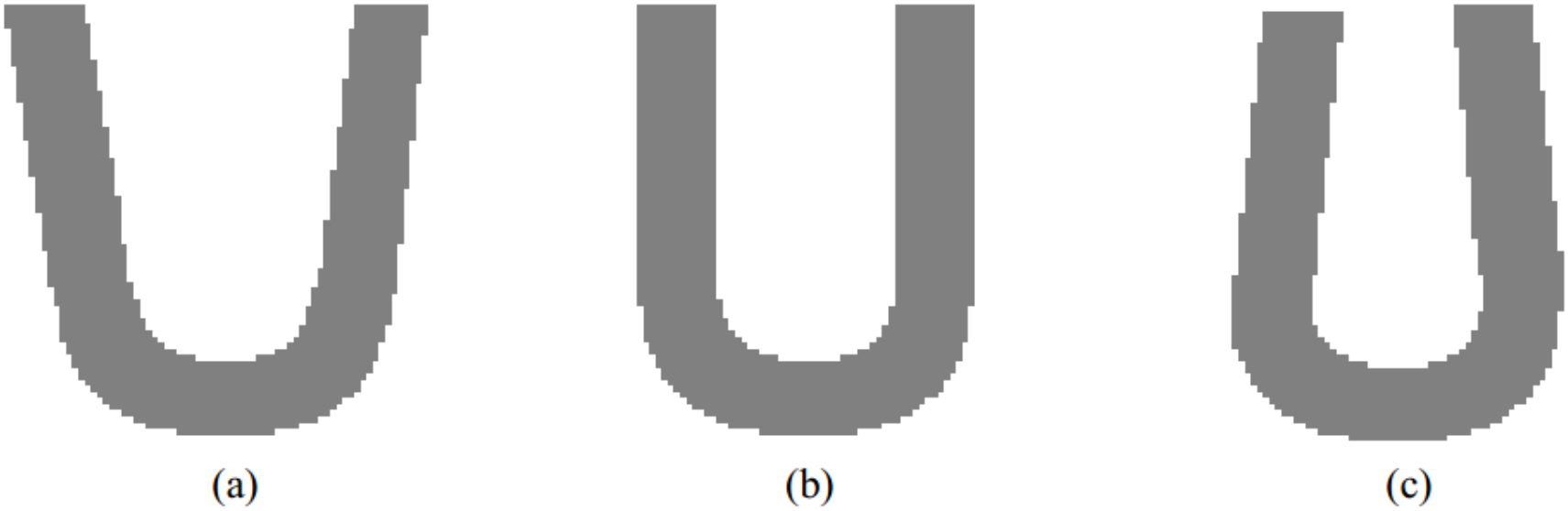
4. Distortion or Camber Allowance

- Sometimes castings, because of their size, shape and type of metal, tend to warp or distort during the cooling period depending on the cooling speed.
- This is due to the uneven shrinkage of different parts of the casting.
- Expecting the amount of warpage, a pattern may be made with allowance of warpage.
- It is called camber.

4. Distortion or Camber Allowance

- For example, a U-shaped casting will be distorted during cooling with the legs diverging, instead of parallel .
- For compensating this warpage, the pattern is made with the legs converged but, as the casting cools, the legs straighten and remain parallel.
- Warpage depends on the thickness and method of casting and it is actually determined by experience. Generally 2 to 3 mm is considered appropriate for 1 metre length.

4. Distortion or Camber Allowance



Example of camber: (a) Casting without camber, (b) Actual casting, (c) Pattern with camber allowance

5. Rapping or Shaking Allowance

- Before withdrawing the pattern it is rapped and thereby the size of the mould cavity increases.
- Actually by rapping, the external sections move outwards increasing the size and internal sections move inwards decreasing the size.
- This movement may be insignificant in the case of small and medium size castings, but it is significant in the case of large castings.

5. Rapping or Shaking Allowance

- This allowance is kept negative and hence the pattern is made slightly smaller in dimensions 0.5-1.0 mm.

6. Mould wall Movement Allowance

- Movement of mould wall in sand moulds takes place because of heat and the static pressure exerted on the walls of the mould which comes in contact with the molten metal.