Department of Materials Engineering
General Materials Branch

Fourth Class

Casting Technology

Lecture Eleven : Design of Casting

Class Code :ofp4npn

The Objective in casting design

1. To Achieve Sound Casting
2. To Reduce Less Cost in Molding ,Cleaning and Machining

Foundry Engineer Role in Mold Design

Foundry Engineer Must Provide The following

1. Parting line
2. Gate & riser location
3. Draft
4. Mechanical Allowance
5. Casting tolerance
6. Cores And locating points to be used in machining

General Design Considerations for Castings

- There are two types of design issues in casting:

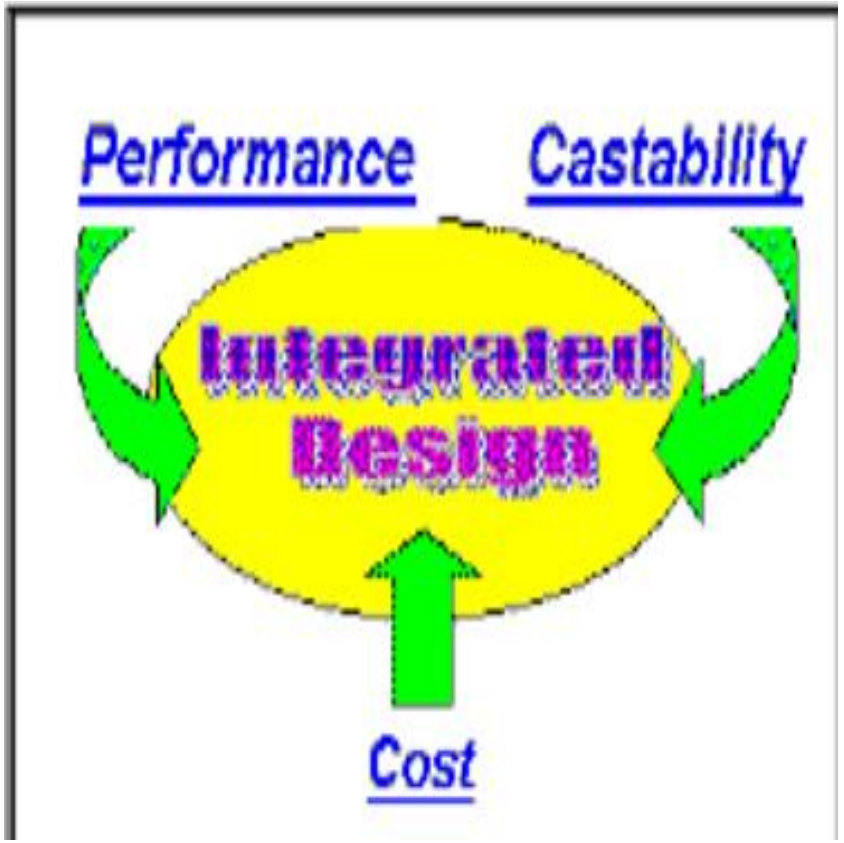
A. Geometric features, tolerances, etc., that should be incorporated into the part .

B. Mold features that are needed to produce the desired casting.

Design For Castability

- The term *castability* refers to the ease with which a cast part can be produced. It depends on the

1. part design
2. metal used for the casting,
3. proper selection of casting process to economically satisfy production requirements.



Considerations For Robust Design of Castings

. Robust design of castings usually involves the following steps:

1. Design the part so that the shape is cast easily. A number of important design considerations are given in this chapter to assist in such efforts.
2. Select a casting process and a material suitable for the part, size, required production volume, mechanical properties, and so on.

Often, steps 1 and 2 in this list have to be specified simultaneously and can be a demanding design challenge.

Considerations For Robust Design of Castings

3. Locate the parting line of the mold in the part.
4. Locate and design the gates to allow uniform feeding of the mold cavity with molten metal.
5. Select an appropriate runner geometry for the system.
6. Locate mold features, such as sprue, screens, and risers, as appropriate.
7. Make sure proper controls and good practices are in place.

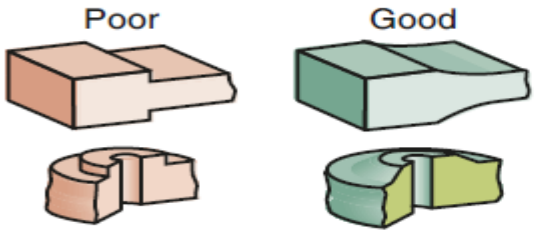
Design of Cast Parts

1. Corners, angles, and section thickness
2. Flat areas.
3. Shrinkage.
4. Draft.
5. Dimensional tolerances.
6. Lettering and markings.
7. Finishing operations.

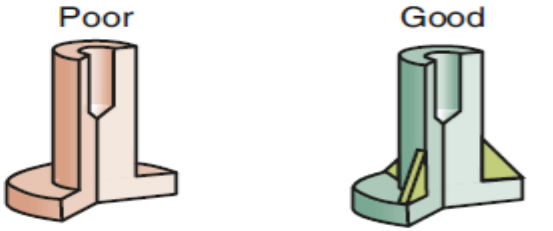
Corners, Angles, and Section Thickness

- Sharp corners, angles, and fillets should be avoided as much as possible, because they act as stress raisers and may cause cracking and tearing of the metal (as well as of the dies) during solidification. Fillet radii should be selected to reduce stress concentrations and to ensure proper liquid-metal flow during pouring.
- Fillet radii usually range from 3 to 25 mm, although smaller radii may be permissible in small castings and in specific applications.

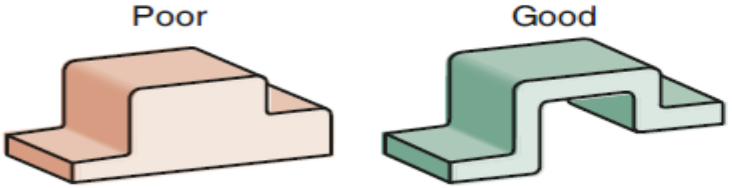
Corners, Angles, and Section Thickness



Use radii or fillets to avoid corners and provide uniform cross-section.

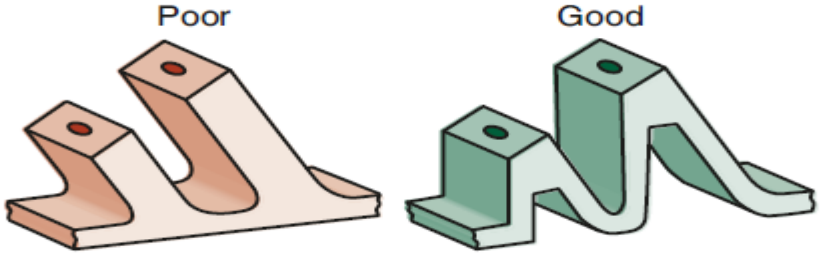


Ribs and/or fillets improve bosses.



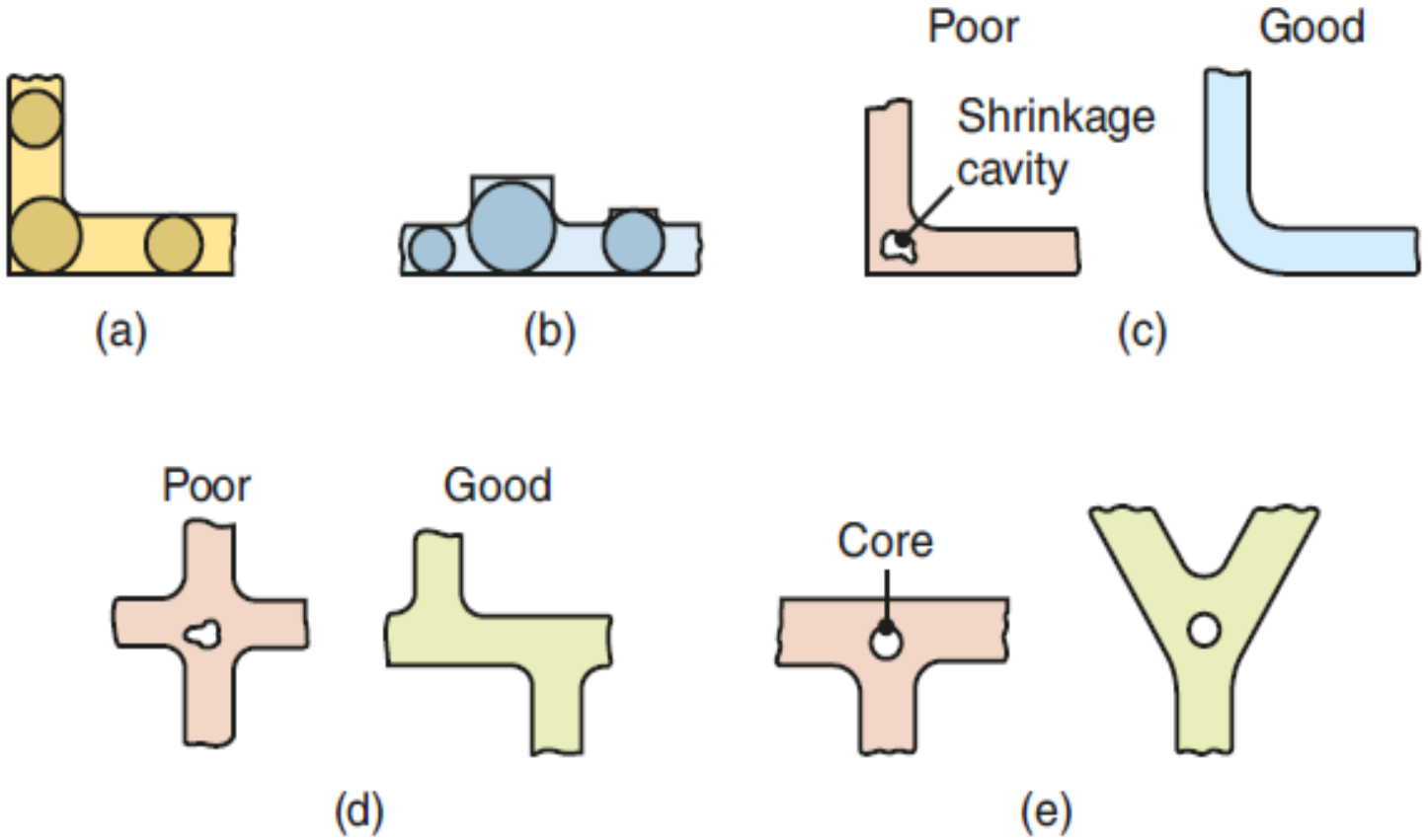
Wall sections should be uniform.

Side cores can be eliminated with this hole design.



Sloping bosses can be designed for straight die parting to simplify die design.

Corners, Angles, and Section Thickness



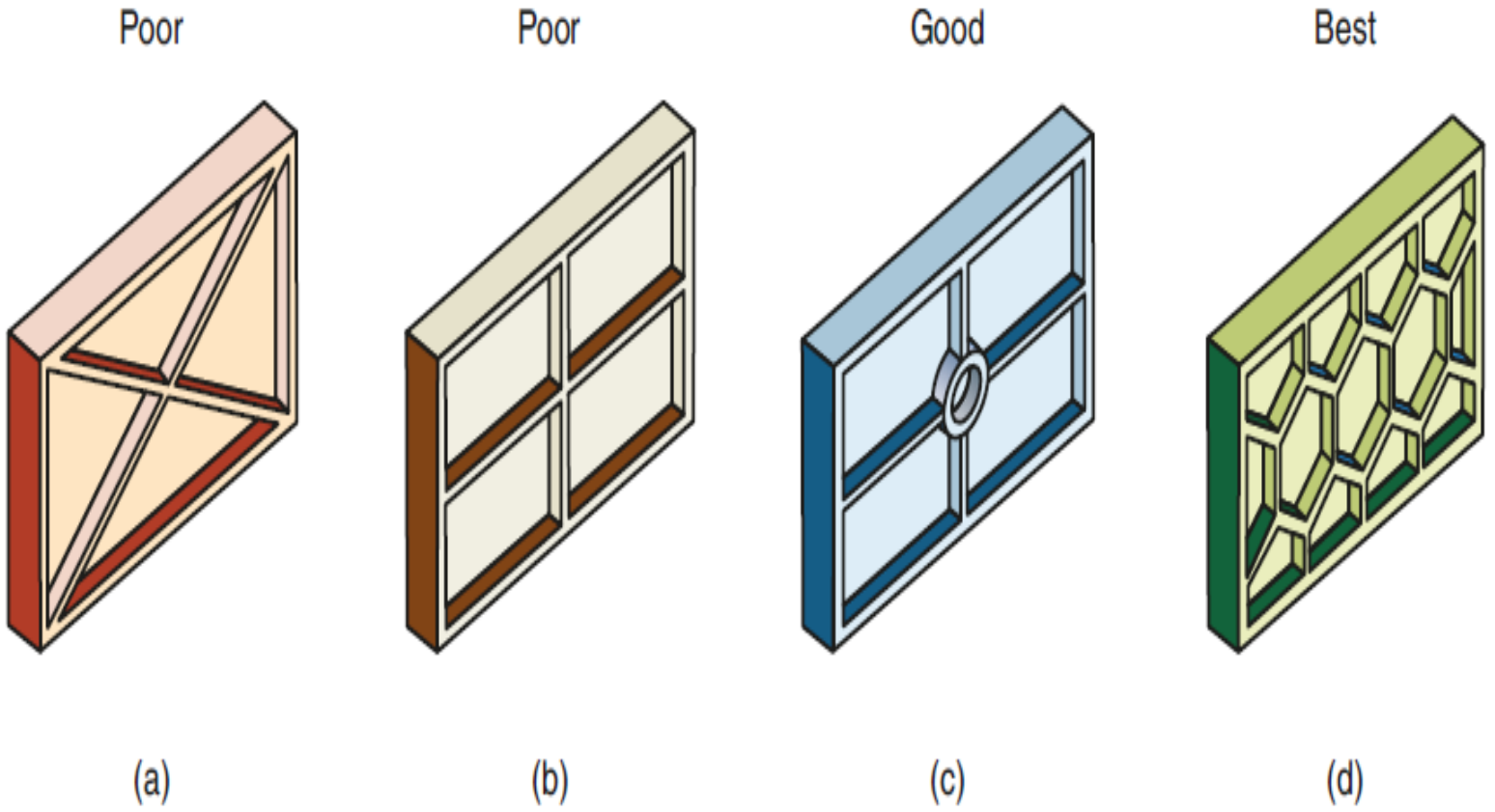
Flat Areas.

- Large flat areas (plane surfaces) should be avoided, since they may Warp during cooling because of temperature gradients, or they develop poor surface finish because of an uneven flow of metal during pouring.
- One of the common techniques for avoiding either of these problems is to break up flat surfaces with staggered ribs and serrations

Shrinkage.

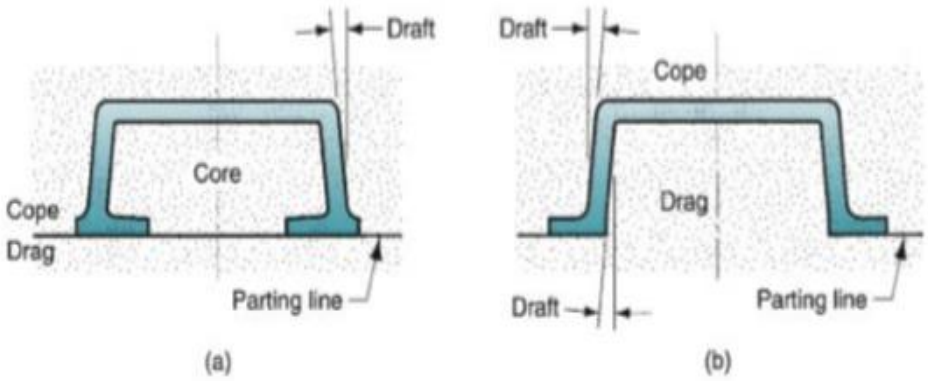
Metal	Shrinkage allowance (%)
Cast Irons	
Gray cast iron	0.83–1.3
White cast iron	2.1
Malleable cast iron	0.78–1.0
Aluminum alloys	1.3
Magnesium alloys	1.3
Copper alloys	
Yellow brass	1.3–1.6
Phosphor bronze	1.0–1.6
Aluminum bronze	2.1
High-manganese steel	2.6

Ribs.



Draft.

1. Part sections that project into the mold should have a draft or taper, as defined in The Figure .
2. In expendable-mold casting, the purpose of this draft is to facilitate removal of the pattern from the mold. In permanent-mold casting, its purpose is to aid in removal of the part from the mold.
3. Similar tapers should be allowed if solid cores are used in the casting process. The required draft need only be about 1 for sand casting and 2 to 3 for permanent-mold processes.



Surface Finish.

- Typical surface roughness achieved in sand casting is around 6 mm (250 m-in). Similarly poor finishes are obtained in shell molding, while plaster-mold and investment casting produce much better roughness values: 0.75 mm (30 m-in).
- Among the permanent-mold processes, die casting is noted for good surface finishes at around 1 mm (40 m-in).

Dimensional Tolerances

TABLE 11.2 Typical dimensional tolerances for various casting processes and metals.

Casting Process	Part Size	Tolerance mm	Tolerance in
Sand casting			
Aluminum[a]	Small	±0.5	±0.020
Cast iron	Small	±1.0	±0.040
	Large	±1.5	±0.060
Copper alloys	Small	±0.4	±0.015
Steel	Small	±1.3	±0.050
	Large	±2.0	±0.080
Shell molding			
Aluminum[a]	Small	±0.25	±0.010
Cast iron	Small	±0.5	±0.020
Copper alloys	Small	±0.4	±0.015
Steel	Small	±0.8	±0.030
Plaster mold	Small	±0.12	±0.005
	Large	±0.4	±0.015
Permanent mold			
Aluminum[a]	Small	±0.25	±0.010
Cast iron	Small	±0.8	±0.030
Copper alloys	Small	±0.4	±0.015
Steel	Small	±0.5	±0.020
Die casting			
Aluminum[a]	Small	±0.12	±0.005
Copper alloys	Small	±0.12	±0.005
Investment			
Aluminum[a]	Small	±0.12	± 0.005
Cast iron	Small	±0.25	±0.010
Copper alloys	Small	±0.12	±0.005
Steel	Small	±0.25	±0.010

Lettering and Markings

- It is common practice to include some form of part identification (such as lettering or corporate logos) in castings.
- These features can be sunk into the casting or can protrude from the surface; which one is most desirable depends on the method of producing the molds.
- For example, in sand casting, a pattern plate is produced by machining on a computer numerically controlled mill and it is simpler to machine letters into the pattern plate.

Finishing Operations

- In designing a casting, it is important to consider the subsequent machining and finishing operations that may be required.
- For example, if a hole is to be drilled in a casting, it is better to locate the hole on a flat surface than on a curved surface in order to prevent the drill from wandering.
- An even better design would incorporate a small dimple as a starting point for the drilling operation.
- Castings should include features that allow them to be clamped easily into machine tools if secondary machining operations are necessary.

Machining Allowance

- Because most expendable-mold castings require some additional finishing operations, such as machining and grinding, allowances should be made in casting design for these operations.
- Machining allowances, which are included in pattern dimensions, depend on the type of casting and increase with the size and section thickness of castings.
- Allowances usually range from about 2 to 5 mm for small castings to more than 25 mm for large castings.

Integrated Computational Materials Engineering (ICME).

- The use of modern computational tools allows identification of design and manufacturing issues and allows the prediction of material properties and microstructure that results from a particular mold cavity design.
- The time spent in process simulation actually saves time that normally would be expended in tooling rework and cost associated with defects.

Computer-Aided Casting Design

1. Those based on classical heat transfer equations
2. Those based on finite-element methods or finite-difference methods (FEM or FDM), which are iterative Techniques based on classical heat transfer
3. Those based on ratios of surface area to volume.