# Department of Materials Engineering
# General Materials Branch

Fourth Class

Casting Technology I

Lecture Nine :Casting Design

# The Objective in casting design

1. To achieve sound casting
2. To reduce less cost in molding ,cleaning and machining

# Design Stages

1. Make sketches on casting
2. Determine forces on casting
3. Calculate the metal sections will operate under these forces
4. Make model(wood or clay)
5. Make a pattern layout
6. Make the Pattern Equipment
7. Make a Trial Casting
8. Machine the casting & then make a brittle coating test

# Design Stages

9. Locate areas of higher stress
10. Use wire strain gauge to calculate stresses
11. Remove metal to reduce high stress
12. Redistribute metal to reduce high stresses
13. Make trial casting
14. Make test and additional changes
15. Release for production
16. Make production type-Pattern

# 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

# Guidelines for economical production

1. Avoid irregular parting line
2. Keep section thickness as uniform as possible
3. Reduce number of cores
4. Avoid undercut in casting design
5. Avoid external losses

# Guidelines for economical production

6. Consider core holes vs. drill holes
7. Consider ribbed and/or Hollow casting
8. Consult a welding engineer if it is a cast weld construction .
9. Reduce Area of Machining
10. Choose an alloy with a great machinability

# 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.

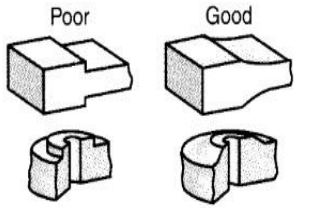
# General Design Considerations for Castings

. Robust design of castings usually involves the following steps:

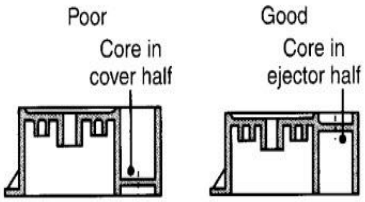
1. Design the part so that the shape is cast easily. A number of important design considerations are given in this chapter to assist in such efforts.
2. Select a casting process and a material suitable for the part, size, required production volume, mechanical properties, and so on. Often, steps 1 and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

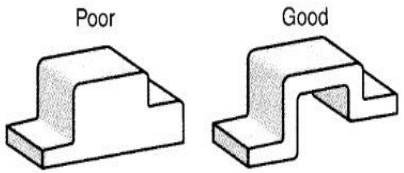
1. Corners, angles, and section thickness
2. Flat areas.
3. Shrinkage.
4. Draft.
5. Dimensional tolerances.
6. Lettering and markings.
7. Finishing operations.



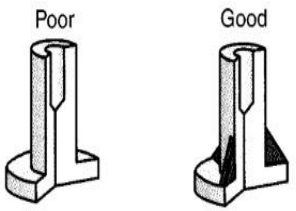
Use radii or fillets to avoid corners and provide uniform cross-section.



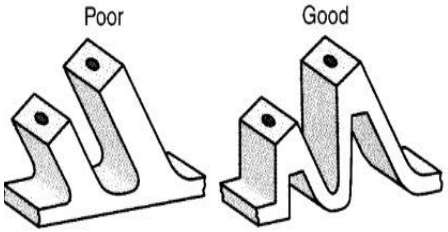
Deep cavities should be on one side of the casting where possible.



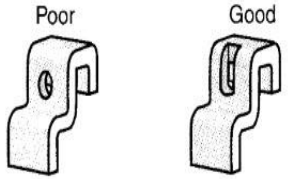
Wall sections should be uniform.



Ribs and/or fillets improve bosses.



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



Side cores can be eliminated with this hole design.

# 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.

TABLE 12.1

| Metal | Percent |
|---|---|
| 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 |
| Yellow brass | 1.3–1.6 |
| Phosphor bronze | 1.0–1.6 |
| Aluminum bronze | 2.1 |
| High-manganese steel | 2.6 |

# Design of Cast Parts.

1. Corners, angles, and section thickness
2. Flat areas.
3. Shrinkage.
4. Draft.
5. Dimensional tolerances.
6. Lettering and markings.
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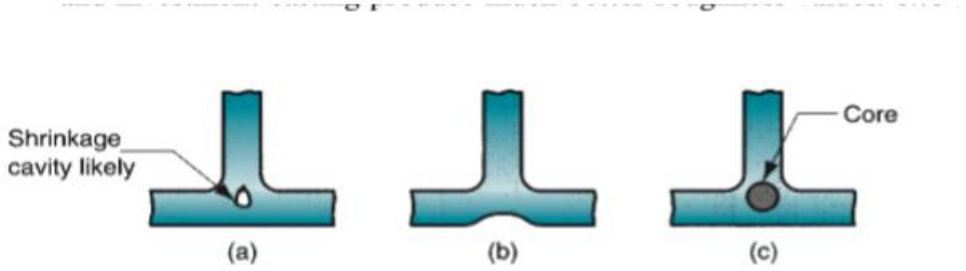
# Type of Casting Sections

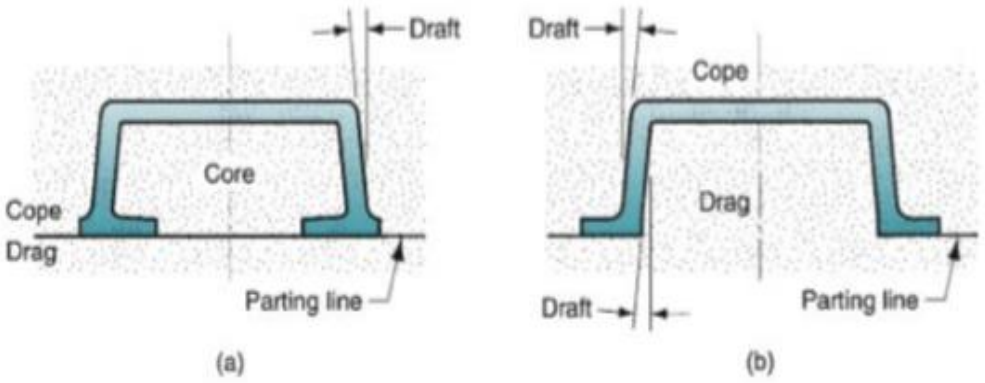
castings can usually be resolved into a series of rather simple shapes that make up the complex shape. These simple shapes are:

1. · T-sections (plate intersections forming a T)
2. · X-sections (plate intersections forming an X)
3. · L-sections (plate intersections forming an L)
4. · Plates
5. · Cylinders
6. · Cylinder/plate intersections

# Casting Design

1. Geometric simplicity..
2. Corners.
3. Section thicknesses.
4. Draft
5. Use of Cores
6. Dimensional tolerances
7. Surface finish
8. Machining allowance



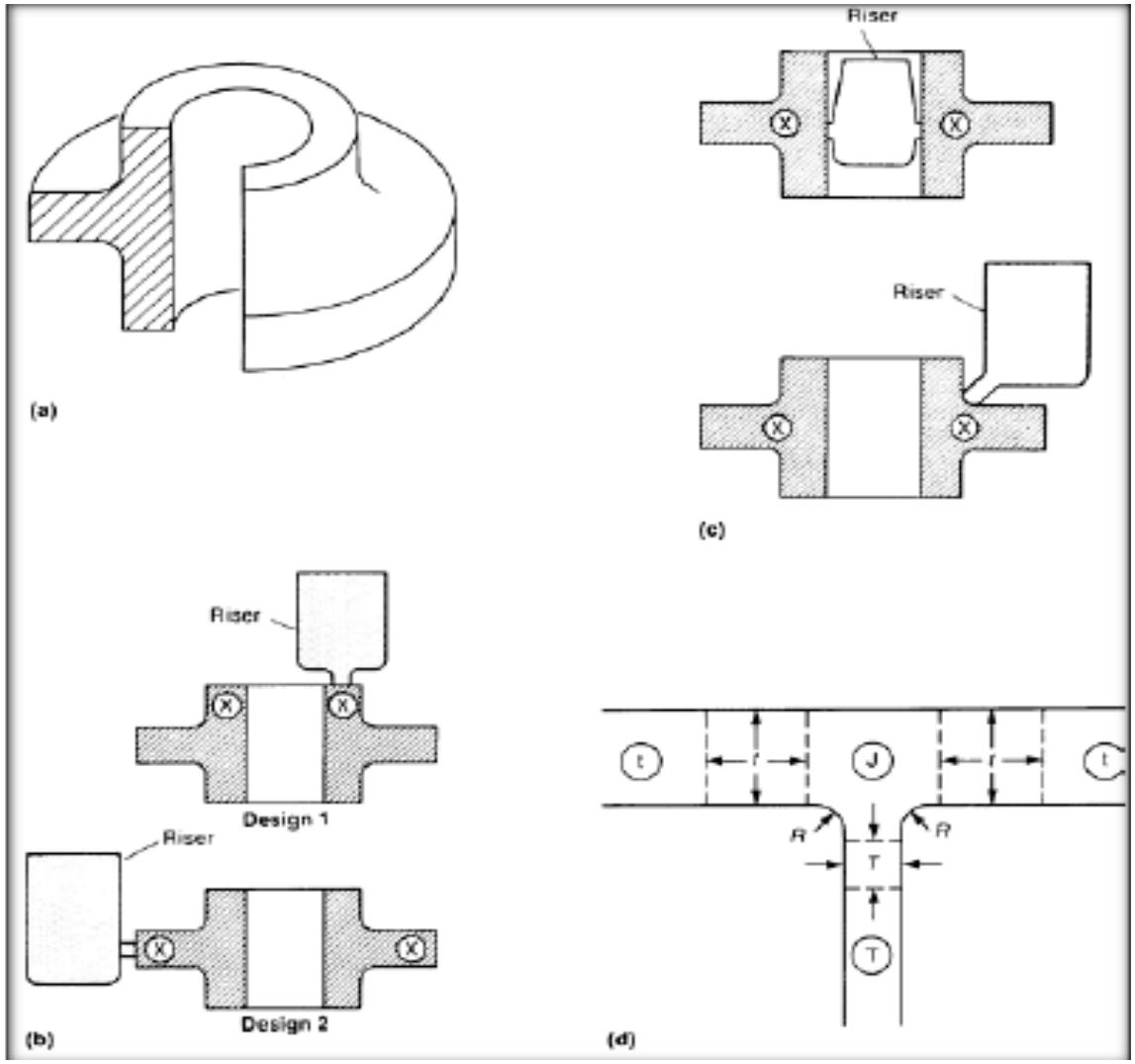



# Casting Design

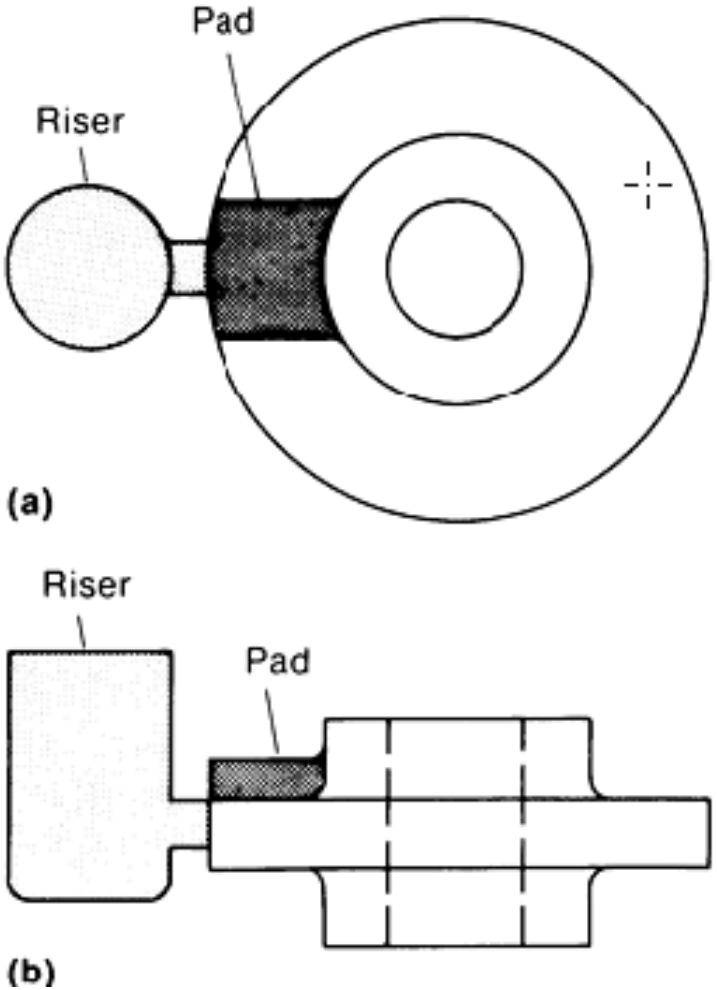
**TABLE 11.2 Typical dimensional tolerances for various casting processes and metals.**

| 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 |

# T-Section



# Factors Influencing the Solidification Sequence.



# Area and Volume

To Calculate Area

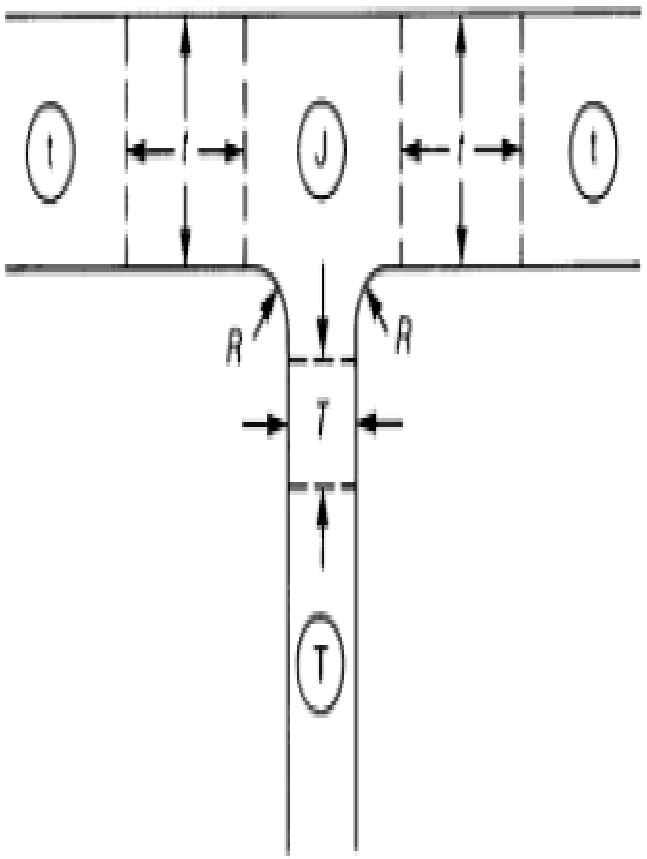
$$\text{Surface area} = 4t + 2R + T + 3.1416\,R + 2T$$

To Calculate Volume

$$Volume = 2r^2 + t(2R + T) + RT + T^2 + \frac{4R^2 - 3.1416R^2}{2}$$

So Solidification Time

$$T_c = K\left(\frac{Vc}{Ac}\right)^n$$

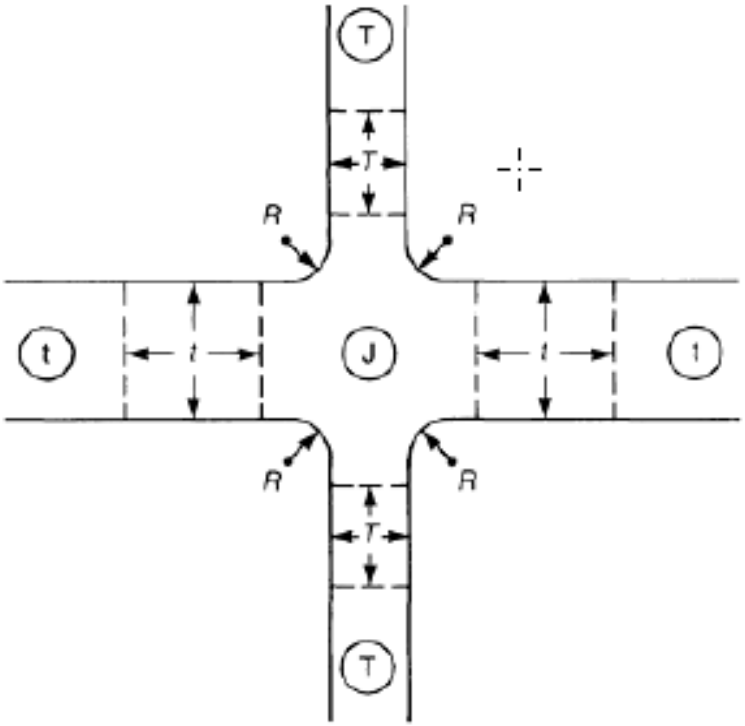


(d)

# *X-Sections*

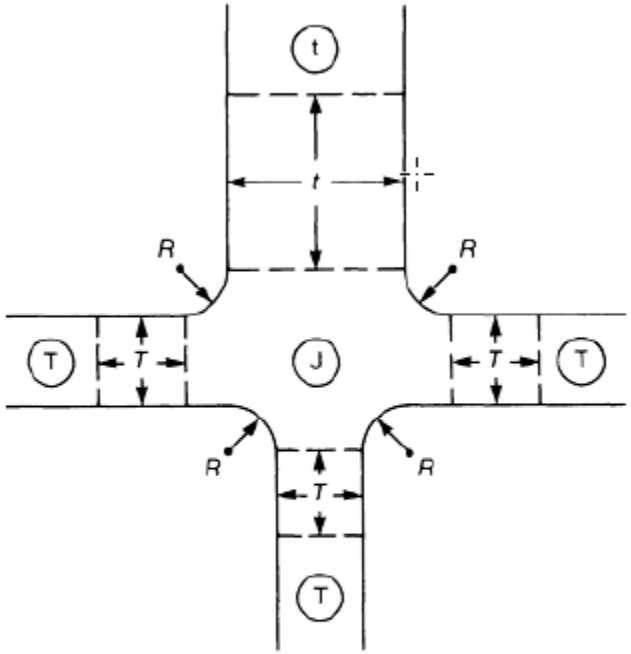
- Equal Opposite Legs. The first type of X-section design is that in which the opposite legs of the X are equal. The model for this case is shown in Fig. 7. The solidification sequence curves of this model, the casting modulus equations for the plates making up the X-section are *T/2 and t/2. For X-sections in which the opposite legs of the section are equal, the casting modulus for the J- or X-junction is as follows:*

# X-Section :Equal Opposite Legs.




$$\frac{Volume}{Surface\ \text{Area}} = \frac{2t^2 + 2T^2 + 2Rt + 0.8584R^2}{4t + 4T + 6.2832R}$$

# Three Legs Equal




$$\frac{Volume}{Surface\ \text{Area}} = \frac{2t^2 + 3T^2 + 3RT + Rt + Tt + 0.8584R^2}{5T + 3t + 6.2832R}$$

# *L-Sections :*External Radius Greater than Internal Radius