بسم الله الرحمن الرحیم

Defects in Castings

Defects in castings

The general origins of defects lie in three sectors:

- 1. the casting design
- 2. the technique of manufacture–the method
- 3. the application of the technique–‘workmanship’.

Categories of Defect

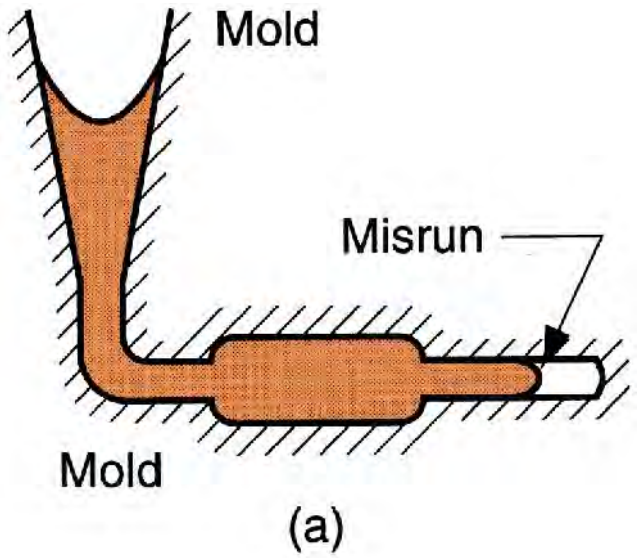
- 1. Shaping faults arising in pouring.
- 2. Inclusions and sand defects.
- 3. Gas defects.
- 4. Shrinkage defects due to volume contraction in the liquid state and during solidification.
- 5. Contraction defects occurring mainly or wholly after solidification.
- 6. Dimensional errors.
- 7. Compositional errors and segregation.

Casting Quality

- There are numerous opportunities for things to go wrong in a casting operation, resulting in quality defects in the product
- The defects can be classified as follows:
  - Defects common to all casting processes
  - Defects related to sand casting process

Misrun

A casting that has solidified before completely filling mold cavity



Some common defects in castings: (a) misrun

Cold Shut

Two portions of metal flow together but there is a lack of fusion due to premature freezing

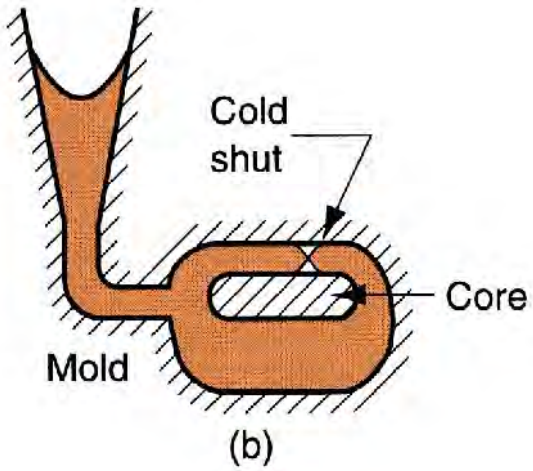
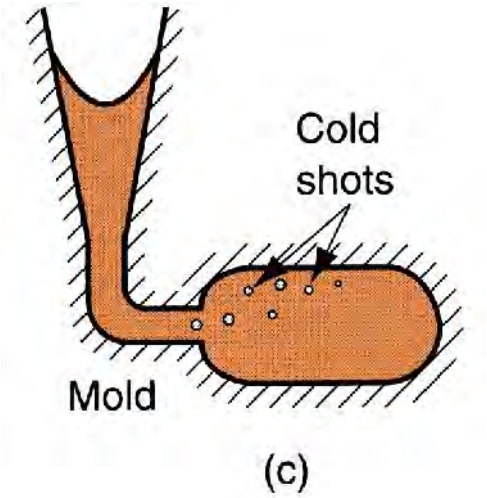


Figure 5.1 Cold laps and shut in a steel casting (courtesy of Institute of British Foundrymen)

Figure 11.22 - Some common defects in castings: (b) cold shut

Cold Shot

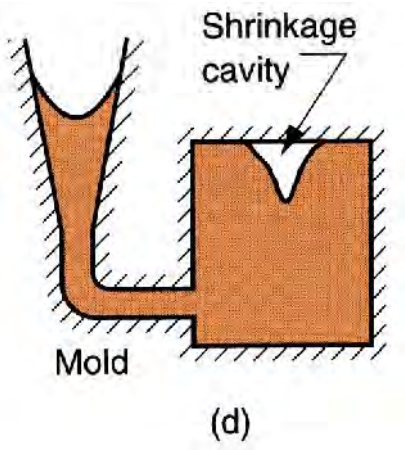
Metal splatters during pouring and solid globules form and become entrapped in casting



Some common defects in castings: (c) cold shot

Shrinkage Cavity

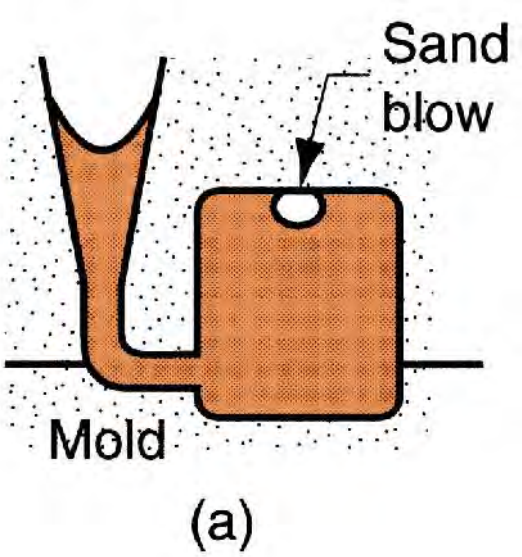
Depression in surface or internal void caused by solidification shrinkage that restricts amount of molten metal available in last region to freeze



Some common defects in castings: (d) shrinkage cavity

Sand Blow

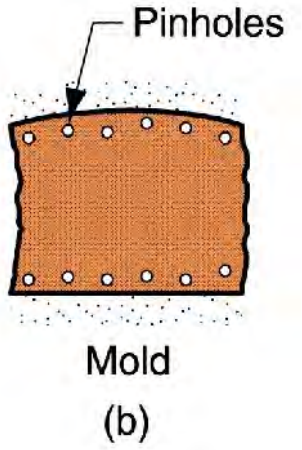
Balloon-shaped gas cavity caused by release of mold gases during pouring



Common defects in sand castings: (a) sand blow

Pin Holes

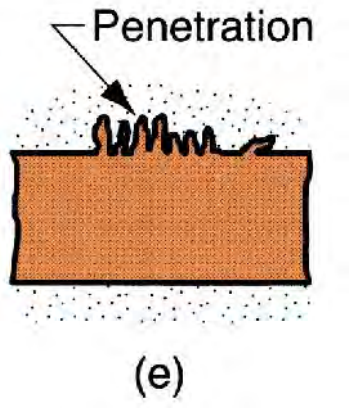
Formation of many small gas cavities at or slightly below surface of casting



Common defects in sand castings: (b) pin holes

Penetration

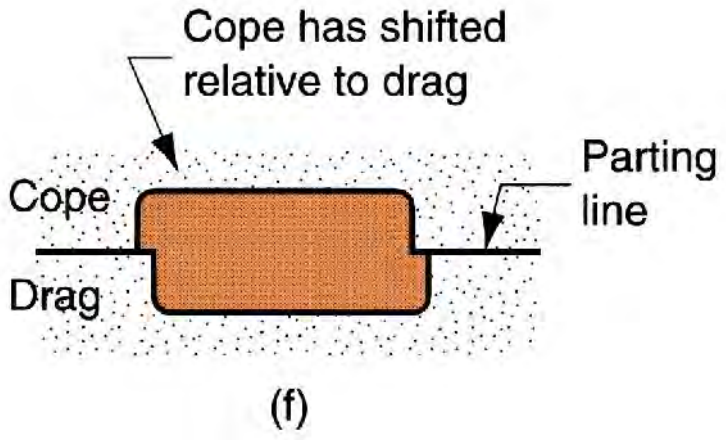
When fluidity of liquid metal is high, it may penetrate into sand mold or sand core, causing casting surface to consist of a mixture of sand grains and metal



Common defects in sand castings: (e) penetration

Mold Shift

A step in cast product at parting line caused by sidewise relative displacement of cope and drag



Common defects in sand castings: (f) mold shift

Gas cavities

Description and reasons:

- **Cavities in castings, especially in the upper parts of the castings**
- **Formation during solidification because of decrease of gas solubility**
- **often in combination with oxide and slag inclusions**
- **formation of gas cavities depends on the concentration of oxygen, nitrogen and hydrogen**
- **the inner surface of the cavities is smooth**

Gas cavities

Gas cavities

Prevention:

- **use of dry materials and ladles**
- **use of clean charge**
- **degasification of the melt**
- **look at the mould sands (permeability of gas, vent…)**

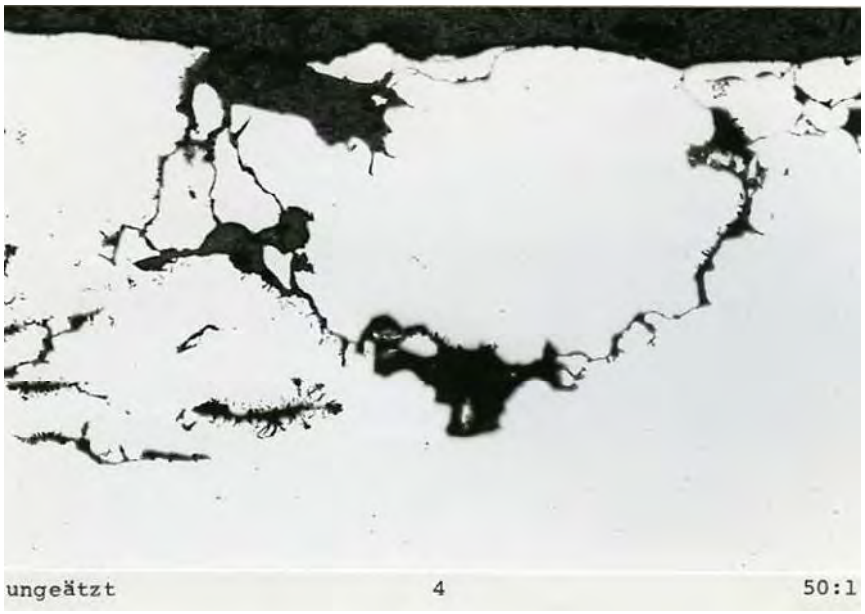
Oxide and slag inclusions, nonmetallic inclusions

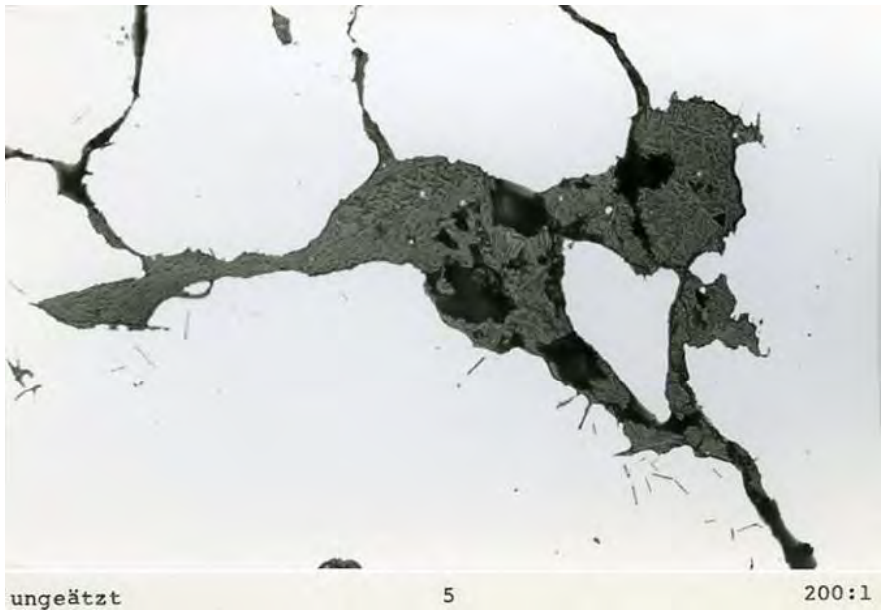
Description and reasons:

- **Classification: endogenous and exogenous inclusions**
- **endogenous inclusions are caused by the reaction products during the melting process (especially during deoxidation)**
- **exogenous inclusion are caused by other materials in the melt (e.g. refractory lining)**
- **thin fluid slag can precipitate at the grain boundaries ➔danger of formation of hot tears is higher**
- **Classification of size:**

Macro inclusions	**> 20 µm**
Micro inclusions	**< 20 µm**

Oxide and slag inclusions, nonmetallic inclusions





Slag inclusions

GX3CrNiMoN17-13-5

GX2CrNiMo18-14-3

Oxide and slag inclusions, nonmetallic inclusions

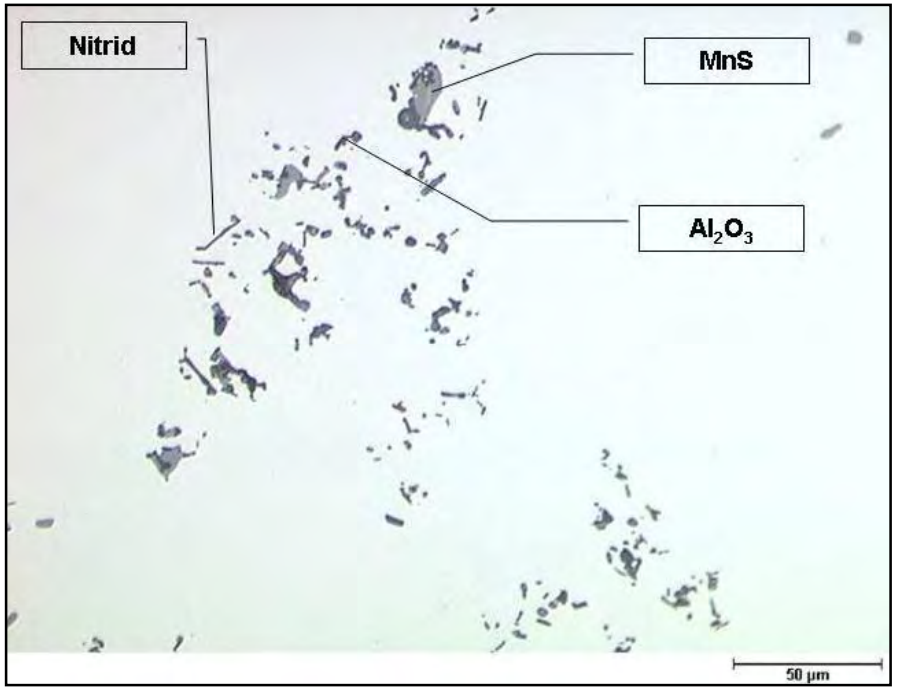
Prevention:

- **use of clean charge**
- **optimization of gating and feeding system (lamellar flow)**
- **decrease of the dissolved oxygen**
- **decrease of the overheating temperature**

Oxide and slag inclusions, nonmetallic inclusions

Example: G42CrMo4

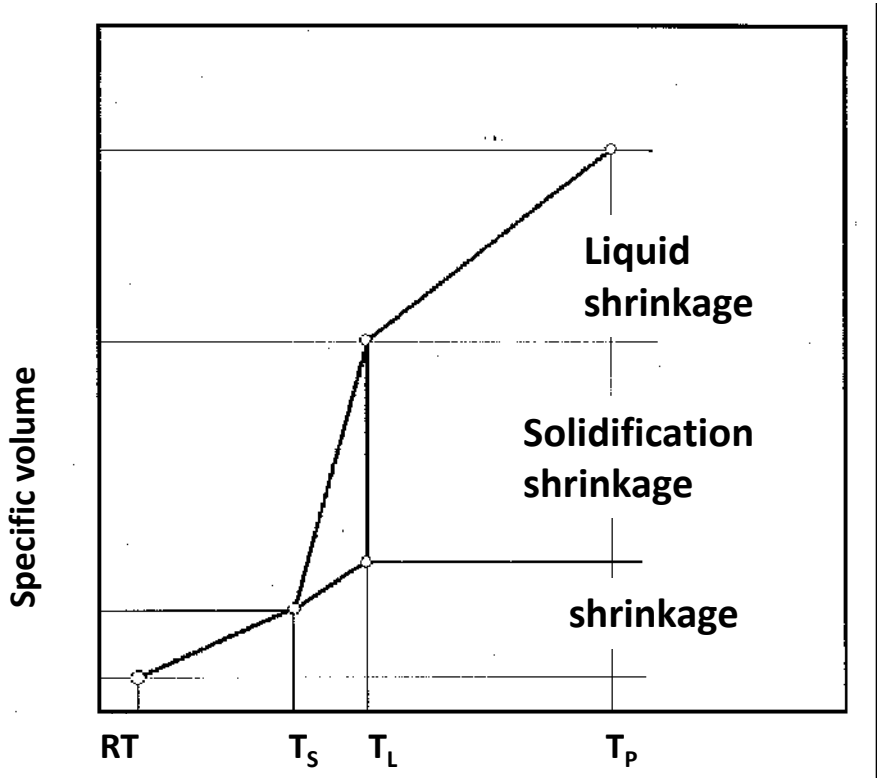
- **nonmetallic inclusions arise by reason of the reactions during the melting process**



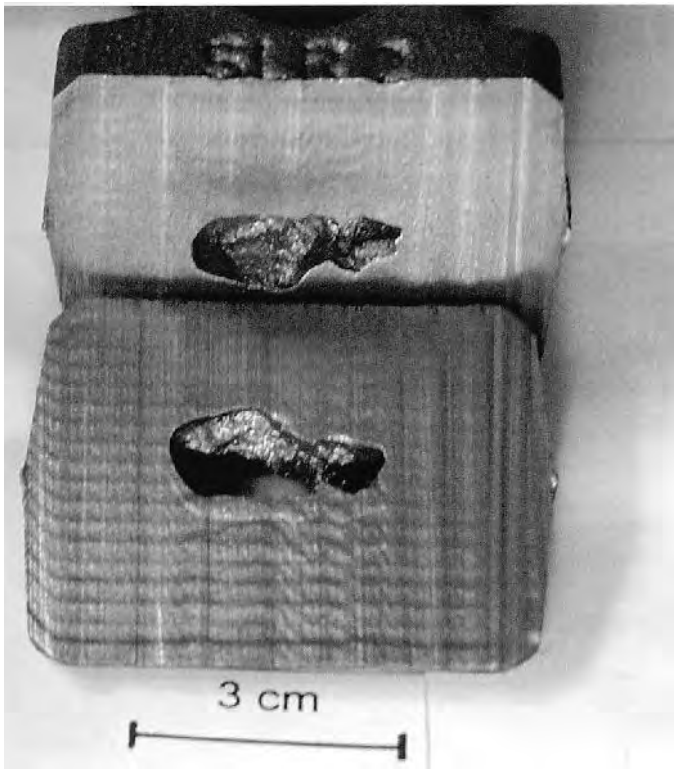
Shrinkage cavities

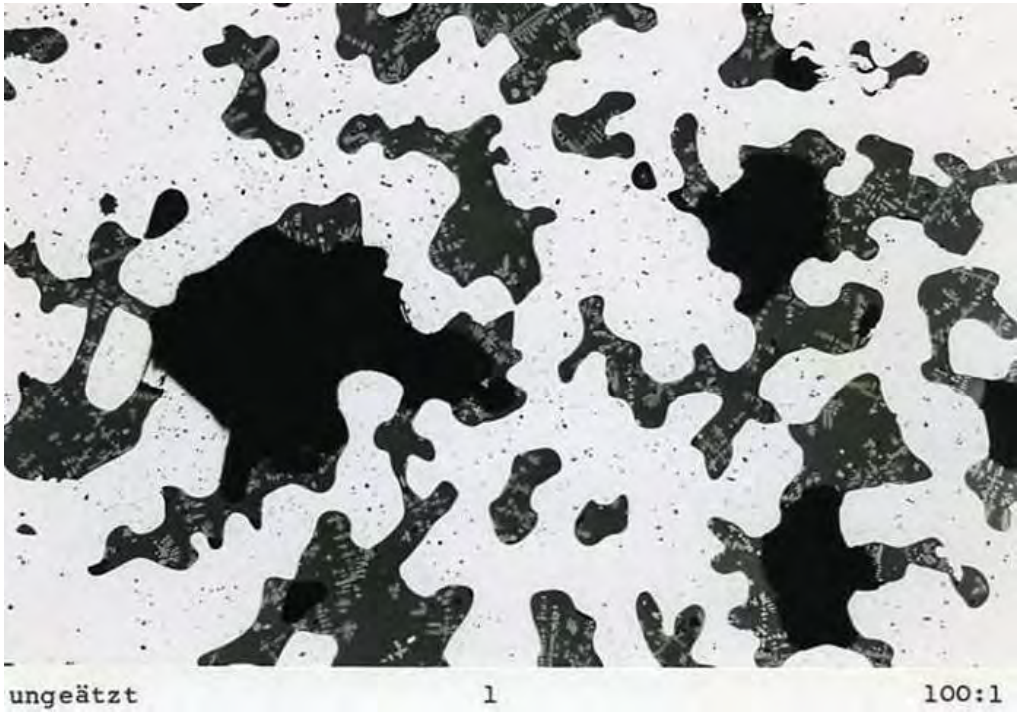
Description and reasons:

- specific volume of melt is higher than the specific volume of solid ⇘
- contraction during solidification and cooling
- feeding is necessary – if the feeding is not optimal ⇘ formation of shrinkage cavities
- the shrinkage volume of cast steel is about 4-7 %
- the inner surface is rough



Shrinkage cavities





GE 300 (GS 60)

Shrinkage cavities

Prevention:

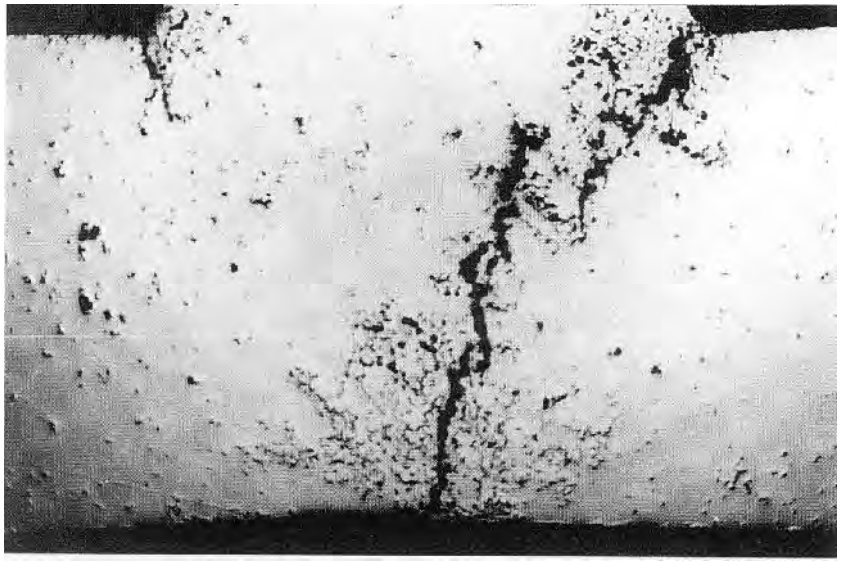
- **use of optimal feeding system (calculation and simulation)**
- **warranty of directional solidification**
- **use of exothermic feeder sleeve**
- **decrease of the pouring temperature**

Hot tear

Description and reasons:

- **hot tears are intercrystalline discontinuity**
- **cracks run along the grain boundaries**
- **the risk of cracks at alloys with a high freezing range is higher than with a small freezing range**
- **the reason are stresses during solidification because of hindered contraction (residual stress)**
- **the main reason for formation of hot tears are the geometry of casting**
- **if melt can flow into the crack - partial or completely annealed hot tears are possible**

Hot tear



Hot tear

Prevention:

- **design appropriate to casting, prevention of residual stresses, wide difference in the wall thickness and hot spots)**
- **prevention of hot sand effects**