HOT TEARING

More or less deep intercrystalline fissures of irregular outline. The cracks often show a fine dendritic structure with an oxidized surface.

The defect most often appears in the last sections of the casting to solidify in which constraints are present (section changes and reentrant angles, for example).

Possible Causes

- Basic mechanism:
  A solidifying alloy, upon reaching a temperature close to the solidus, is subjected to constraint or deformation.

- In general:
  Hindered contraction due to faulty design:
  • Large differences in section thickness.
  • Abrupt transition from one thickness to another.
  • Too many branching, connected sections.
  Hindered contraction arising from the mold:
  • Excessively rigid mold and cores.
  • Rough mold surfaces (metal molds).
  • Vitrification of the sand.
  • Elongation or deformation of the mold:
  • Heated sand or metal mold components.

- For permanent molding or die casting:
  • Excessive cooling time prior to knockout.
  • Hindered contraction due to insufficient taper.
  • Mold opened too soon, casting damaged by extraction.
  • Tears due to extraction of cores which are improperly aligned or guided.
  • Poor ejector locations, causing bending stresses.
  • Creation of hot spots due to excessive pouring temperature or thin corners of sand (cores).
  • Insufficient flow of liquid metal.
— Metallurgical causes:

Certain alloys can be sensitive to hot tearing because of incorrect composition.

- Cast Steel:
  Sulfur or aluminum content too high.

- Malleable:
  Excessively high contraction due to insufficient silicon and carbon, combined with too high a pouring temperature.

- Cast Iron (especially permanent molded): rolling mill cylinders: insufficient phosphorus content.

- Tin Bronze:
  Lead segregation.

Remedies

— Correct the general causes listed above.

— Place cooling fins or external chills at locations subject to tensile stresses and where delayed freezing can be expected to occur.

— Metallurgy:
  - For cast steel: desulfurization (less than 0.02% S) and deoxidation must be adequate. Reduce pouring time.
  - For light alloys: refine grain size.

— Schematic representation of the formation of hot tears and of various corrective measures possible in the case of a flanged, cast steel tube.

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C 221 - Steel

Hot tears in a steel casting.

Fracture shows dendritic structure.

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C 221 - Steel

Hot tears in the wall of a Cr-Mo steel casting.
C 221 - Steel

**Figure 101**
Hot tear in a steel casting.

C 221 - Steel

**Figure 102**
Hot tears formed in a steel casting at the end of a chill, due to restraint of contraction.
Use a chill which is less thick.

C 221 - Malleable Iron

**Figure 103**
Hot tear in an as-cast malleable iron part.

C 221 - Malleable Iron

**Figure 104**

<table>
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<tr>
<th>%</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
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Pouring temperature: 1450°C (2642°F)
Hot tear has been largely refilled by molten metal.
Tear due to tensile stresses.
C 221 - Maileable Iron

Maileable iron sprocket gear. Hot tear caused by improper design of part.

C 221 - Cast Iron, Green Sand

Gas engine piston weighing about 400 kg (880 lb). Shows dendritic interior wall of a hot tear.

C 221 - Copper Alloy, Dry Sand

Casting of 85-5-5-5 bronze.

The 50 mm (2 in.) diameter boss results in serious internal shrinkage which extends to the surface as a hot tear.

The part was cast in dry sand in the reverse position from that shown in the photo.

Remedies: Increase riser size (above the boss) from 55 mm dia x 55 mm high to 65 mm dia x 75 mm high (from 2.2 in. dia x 2.2 in. high to 2.6 in. dia x 3 in. high).

Use exothermic riser sleeves and external chills in the corners subject to hot tearing.

The foregoing eliminated both shrinkage and hot tearing.
C 221 - Copper Alloy, Green Sand

Oil reservoir casting of 10% Sn, 1% Zn bronze with 10 to 25 mm (0.4 to 1 in.) wall thickness; hot tear caused by restrained contraction.

C 221 - Copper Alloy, Green Sand

Brass valve body. Hot tear due to restrained contraction and excessive pouring temperature.

C 221 - Aluminum Alloy, Green Sand

Light metal casting with hot tear at intersecting walls; caused by restrained contraction and the effect of a reentrant angle.

Remedy: Use a chill.

C 221 - Aluminum Alloy, Permanent Mold

Permanent molded aluminum alloy casting. Poor part design: the boss creates a large difference in thickness and prohibits contraction.
C 221 - Magnesium Alloy, Green Sand

Magnesium alloy crank case casting, 400 mm diameter x 700 mm high (16 in. diameter x 28 in. high), cast in sand. The part was gated with a vertical, continuous web gate. The hot tear occurs at a hot spot opposite the gate.

*Cause:* Insufficient collapsibility of the core.

C 221 - Aluminum Alloy, Diecasting

Light alloy die casting. The U-shaped projection is restrained by the mold cavity during contraction, causing a hot tear at the edge of the projection; transition in section thicknesses should be more progressive.

C 221 - Zinc Alloy, Diecasting

Zamak alloy die casting.

Hot tearing occurred due to lateral force on the boss when the core pull was retracted.