SHRINKAGE

Open or closed cavities, generally with rough, often dendritic walls (but smooth for certain eutectic alloys); isolated or more or less dispersed, localized in areas which are the last to solidify or in contact with reentrant angles of the casting, cores, or gates.

Causes

The principal cause is the volume contraction of the metal:
- in the liquid state, as it cools in the mold to its solidification temperature.
- as it changes from the liquid to the solid state.

Other auxiliary factors can also affect the size, appearance and location of the defect. These are:
- gases evolved by the mold: atmospheric pressure (draw).
- the effect of contraction of solidified portions of the casting upon those still undergoing solidification (shrinkage cracks).
- mold wall deformation caused by expansion due to elevated mold temperature or metal pressure (static pressure or solidification expansion).

Special Case for Gray and Ductile Iron

Solidification contraction is exhibited by all foundry alloys. However, in the case of gray and ductile cast irons, the expansion due to the formation of eutectic graphite tends to offset the effect of such contraction. Therefore, depending upon the amount of eutectic graphite formed, the iron will show:
- a reduction in contraction.
- absence of contraction, or
- a net expansion.

In the latter case, which is the most frequent, the expansion which takes place within the solidified surface layers of the casting causes displacement of the liquid from the central region, creating a void. This void is not filled when the residual liquid solidifies because feeding is impaired by a dense network of dendritic crystals.

The result of these phenomena is the formation of cavities having the appearance of shrinkage, but whose cause is different and which require somewhat different corrective measures.

Diagnosis

A good indication of this behavior is the presence of swells on the casting. Dimensions are significantly increased and the weight of defective castings is usually higher than that of sound castings, in spite of the presence of such cavities.

Terminology

The word "shrinkage", although very commonly used here, is improper in this case and should only be applied to true shrinkage cavities as appear in white, mottled or low carbon cast irons.

The preferred term is “false shrinkage”.

Cast Steel: Dendrites inside a shrinkage cavity.  

Figure 67  
(x 10)