Casting Defect: Cavities – Suck-in Shrinkage

1. Defect code B211-DI-GS (Ductile iron, in green sand)

2. Name: Outer sunk, suck-in, suck down, depression

3. Description:
   A depression on casting surface near risers or hot spots, on top surfaces as well as vertical walls in heavier sections of castings. This is primary liquid shrinkage. The surface of the depression may be similar in appearance to the rest of the casting finish or even smoother.

4. Pictures are at the end of this document.

5. Mechanism of defect formation
   Liquid contraction of cooling liquid is not compensated either from the sprue or riser. The initial skin that formed on the casting surface is thick enough to prevent hole formation due to external pressure and internal vacuum. When the liquid feed metal supply is cut off (due to in-gate freezing or riser top freezing, or dishing), there will be a void developing at the heavier sections of casting, as the liquid metal is still contracting upon cooling. If the casting has developed a thick enough skin in these areas, this prevents puncturing and external gases entering the casting to compensate for the shrinkage. But the pressure of the external gases pushes the skin inwards thus reducing the internal void, which is replaced by external void or depression. This location of the defect being a hot spot acts as a feeder for the some of the casting and sometimes for the riser also.

6. All possible causes
   - **Design**
     - Riser not isolating from sprue quickly- thick in-gates, feeding the casting from the sprue and keeping the riser full too long.
     - Riser below top of casting, riser top is kept full long enough to skin over
     - Riser top too small for the in-gate size
     - Too many risers, not all of them piping well
     - Modulus of riser too small compared to the casting section, riser body freezes even if the riser pipes
     - Spherical shape riser – too much surface area on top freezing quickly
     - Large size riser, dishes rather than pipes
• Riser is located too close to the casting, causing a hot spot near the casting and riser junction. This narrow area also can result in soft mold further reducing the heat extraction.
• Runner or other components of gating system too close to the casting area.
• Not enough fillet radiiuses at casting corners
• Not risering or feeding at heavy sections
• Intermediate sections – too thin - isolating the heavier section too early
• Too much iron entering the cavity at or near this location super heating the area and delays solidification

➤ Incomplete riser
• Short poured, riser not filled completely
• Mold run out after filling, emptying riser
• Plugged filter, resulting in short riser
• Filling rate is too slow, in-gates (thin gates) prematurely freezing

➤ Process
• Carbon Equivalent too low, increasing feed metal requirement.
• Low carbon equivalent also cuts off feed metal supply at thin sections quickly due to increased formation of austenite (C < 3.55%)
• Pouring temperature too low, riser top freezes quickly
• Pouring temperature too high, keeping metal liquid longer in heavier sections
• Pouring rate too slow, the riser top to freezes quickly
• Soft mold, and low density sand, slowing down heat extraction at the hot spot area

7. Most probable causes
• Riser not isolated from the sprue quickly
• Riser top not designed to delay skin formation (too much surface area)
• More than one riser, one riser does not have a deep pipe. One riser feeds the casting and the other riser.
• Not risering or chilling (external or cooling fins) the isolated heavier section
• Sharp corners creating hot spot areas (Not large enough radius)
• Riser neck (feeder gate) too small isolating the casting from the riser too quickly
• Low carbon or carbon equivalent

8. Process variables that should be controlled to avoid the defect
• Final carbon 3.60-3.80 % (3.30-3.45% for Si-Mo irons) (lower carbon for heavier section castings- 3.50-3.60)
• CE (C+1/3Si) =4.40-4.60% (4.60-4.755 for Si-Mo irons)
• Pouring temperature high enough to avoid riser top freezing too soon, but not too high to increase the liquid shrinkage (2500-2600F)
• Maintain a hard mold especially around the riser contact
• Pouring rate- maintain a pouring time near the designed value

Ensure risers are piping, with proper design of in-gates and riser top
Riser dished and did not have secondary pipe. This casting has two risers, one pipes well the other does not pipe well some of the time, resulting in suck-in and some times gate holes.
Top of the riser has too much surface area. The riser is dishing in the early stages but the top skins over due to radiation heat transfer. Intermediate section freezes later isolating the riser and the heavier section, resulting in suck-in defect.