Casting Design Considerations

Every design engineer should follow the following primary casting design considerations.

1. Select a **metal casting process**/method appropriate for the part's mechanical characteristics depending on the casting design considerations. For example, Dawang Casting has three casting processes: investment casting, sand casting, and shell casting. Each of the casting processes comes with its advantage and disadvantage.
2. Designers should consider the **location of the mold and gates**. The design must include uniform feeding with molten metal.
3. The overall casting process must ensure the ideal **controls** and practices.

Casting Design Considerations

Some factors affect the alloy's pouring and solidification during the metal casting. Specifically, these factors affect the type of casting process, the shape of casting sections and junctions, the surface appearance, cast alloy internal integrity, and dimensional accuracy. These casting design considerations factors are highly recommended in designing metal casting.

Professional casting design creates high-quality metal castings. Understanding the casting geometry, the type of alloy, and the preferred casting process is essential to avoid high price and time-wasting problems.

Shape and Size

Shape and size are the first casting design consideration determining the casting method type. Usually, if the target metal cast is round in shape, the investment casting method is the most appropriate. On the other hand, engineers can choose between sand casting and centrifugal casting depending on the design's complexity.

In addition, the type of metal casting method also depends on the casting sizes. Dawang Steel casting factories are capable of making heavy metal castings. In this case, the sand casting method can make heavier metal castings than the investment casting method. Therefore, shape and size are the primary casting design considerations for professional designs.

Fluid Life

Fluid life refers to how freely the molten metal alloy flows inside the mold. The fluid lifespan is the period from the melting to the cooling state that flows via small tubes to the mold chamber with the perfect design surface. Fluid life determines the mold wall thickness and the length of the thin section. On the other hand, fluid life also depends on the temperature given to the mold cavity.

The alloy's unique metallurgical properties and chemical state also determine the fluid life. Therefore, an alloy's Fluid Life changes the casting's structural and esthetic elements.

Solidification Shrinkage

Metal Shrinkage refers to the internal and external change from molten metal alloy to the solid state at a designed surface. Shrinkage is crucial in casting design considerations as it unexpectedly changes the casting dimension. Casting design engineers must consider the shrinkage property of a metal to create accurate casting shape and integrity.

During the cooling of molten metal, Solidification shrinkage creates three different shrinkage stages: Liquid shrinkage stage, Liquid to the solid stage, and solid stage. In casting design considerations, the liquid shrinkage stage doesn't affect significantly, while the other solidification stages are significant for the overall design.

Tooling is the custom mold-making process that calculates the shrinkage dimension to achieve the required tolerances. Investment casting or sand casting further performs the solidification shrinkage by gating process. Gating refers to the molten metal delivery system.

Dross Formation

Some metal alloys are susceptible to oxidation which forms slag or dross. These slags later turn into round or non-metallic parts on the casting. However, the foundry can solve this issue by improving the quality and casting methods.

In contrast, Design engineers can also solve this issue by putting the essential surfaces in the lower part of the mold, which is more likely to oxidation.

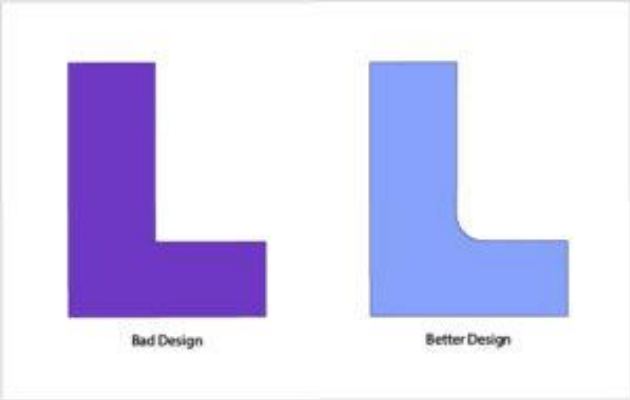
Pouring Temperature

"Pouring temperature" refers to the critical temperature point at which the molten metal is ready to be put into the mold cavity. Sometimes, due to excess temperature, the casting might come with sticky sand or a rough surface.

In that case, the heat concentration might cause problems with lower-temperature alloys. A casting designer can consider a better geometry to eliminate the heat in the mold cavity.

Flow of Fluids

Molten metal flow is one of the designers' most crucial casting design considerations. A laminar flow of molten metals should be considered to avoid unusual dross formation, turbulence, core displacement, and wall erosion.



Turbulence is one of the common casting defects in metal casting methods. It happens due to the speed and direction of the liquid molten metal. Designers can reduce turbulence by improving the gating system to achieve more smooth flow of molten metal.

Especially, sharp corners in the design section are the primary cause of turbulence. Therefore, corner casting has to be round corners to avoid defects like turbulence, wall erosion, or core displacement.

The Heat Transformation System

A proper heating system is essential to get perfect metal casting. Therefore, an ideal heat management system is necessary for casting design geometry. Directional solidification is a critical factor for defining a perfect heat management system.

Directional solidification refers to the solidification process from the cavity walls inwards. A suitable geometry design can ensure a continuous thermal gradient to avoid unexpected shrinkage. Sometimes, a regular flow of fluids may not be enough. In that case, external chills can accelerate the solidification.

There are two types of chills: internal chills and external chills. Internal chills are usually found inside the mold cavity, and external ones are outside the mold. External chills are made of iron, copper, and graphite, which can decrease the heat from casting faster than the surrounding mold. The primary purpose of these chills is to ensure the proper solidification process of the metal.

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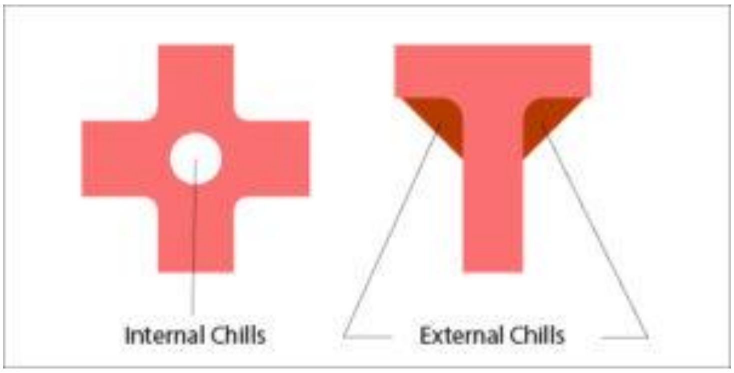

Why Should You Avoid Metal Concentration at the Joints?

As mentioned earlier, the solidification process might not be similar at all places in a mold. In that case, chills help eliminate heat and provide a perfect solidification process. Usually, the solidification process at the joints is y slower than in other places. Therefore, internal chills help here a lot.

In that case, you should avoid the metal concentration at the joints. Otherwise, some casting defects might appear due to an abnormal solidification process.

Junction Design Considerations

Joints such as L, T, V, Y, and + are the most common examples of joints in metal casting. The place of joints contains a higher volume than the other places of the part. This higher volume represents the extreme hot spots zone. This type of place can cause abnormal solidification.

Design engineers can solve this issue by redesigning the junction from sharp edges to rounded corners. Using internal chills for T and + type joints can solve the problem.

Dimensional Tolerance

Tolerance is an integral part of casting design. Dimensional tolerance refers to the nearest deviation from the required measurement of the metal casting. According to casting standard tolerance, investment casting can limit a linear tolerance of ±0.13 mm up to 25 mm, and sand casting can define a tolerance of ±0.53mm up to 175 mm. Usually, investment casting has fewer tolerances than other metal casting methods.

Surface Finishing

All casting parts require surface finishing. It refers to the external texture of the metal casting. Usually, Investment casting has a better surface finish than the sand casting method. It means that investment casting requires less machining than the sand casting process. On the other hand, if the buyer requires sand casting with a more refined surface finish, design engineers would go for a more complex design. A more elaborate plan will cost additional capital and time.

Surface Finish, thus, is an integral part of casting design considerations factors. Different casting methods require different surface finish rates.

Final Requirements for Machining

After the molten metal gets shaped, it still doesn’t achieve the required shape. Later, It will go through the final machining stage and remove some portions of the metal casting. That means the design engineers must consider the specific amount of materials removed from the last metal casting part. Thus, it is also an integral part of casting design considerations.

In carbon steel casting, the decarburization layer appears during the casting process. Therefore, the machining allowance should be equal to the decarburization layer thickness. The machining allowance is for 2 ~ 4 mm, and other surface processing is for 0.5 ~1.5mm.

Machining is a time-consuming and costly process. For that reason, Dawang Casting finds other ways to find a better solution. In this case, in place of fabrications, forged parts, and conventional casting, the near-net shape manufacturing process combines sand casting or investment casting with centrifugal casting. The near-net shaping method is close to the required dimension. Thus, this method decreases the need for final machining.