Industeel

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ArcelorMittal

Big sized applications

Why should you choose and use an homogeneous steel?

Necessity of using homogeneous steels for frames, tool holders... especially in big sized applications:

For this first newsletter we will not go too far from the mold industry, but we will investigate in detail the **practical mechanical problems** occurring in the side parts of the molds as typically frames and tool holders. These problems are increasing with the size and complexity of the part to be molded or casted (in the case of die casting).

Usually such "side parts" are considered as "easy parts" without any technical complexity and **the most important criteria for choosing the material are:**

- **The price, to be as low as possible**
- **The machinability, to allow as low machining costs as possible**
- **The availability of the steel in the required dimensions, that could be really big**
- **Not that much technical requirements, only a surface hardness in most of the cases...**

Such parts are also really interesting for steel makers and retailers since usually they are representing 70% and often more of the weight of a complete mold.

← Example of a tool holder

So why there are needs for using steels with high homogeneity instead of the usual commodities like C45, 1.2311, 1.2312, 1.2738, 1.2714 ?

In a molding or casting tool not only the active part but also the tool holders and the frames are loaded and unloaded at each molding cycle. Hence **fatigue phenomena** could occur and especially if there are area **with stress concentrators** as holes, grooves, edges.... And it could lead to cracks if the endurance limit of the steel is exceeded at some location.

This phenomenon is particularly important and the **risk of crack is very high** on tool holders and frames with a big thickness made with steels as C45, 1.2311, 1.2312, 1.2738 and also 1.2714 with lower mechanical properties in the inner part of big blocks than in the outer area. Moreover the drop of mechanical properties on the common grades mentioned here over is not predictable since it highly depends on the chemical composition, heat treatment parameters... and it is different from one producer and lot of production from the other here also, the **stable quality** all over each lot **is very important.**

Advantages of using Industeel's Superplast® steels:

The SP steels are designed for having a very **high homogeneity** of structure and **mechanical properties.**
As an immediate consequence they are the most suitable and secure steels to be used for manufacturing frames and tool holders especially in big dimensions.
Moreover since the SP have been deeply characterized by measurements and since they are produced in highly repeatable characteristics all the data required for calculations are available and reliable even long time before the beginning of the machining.

The main advantages of using the SP are:

- **High homogeneity** of **mechanical properties** in the full section of the part avoiding any doubtful estimation of the loss of hardness at core at the time of calculating the tool holder.
- **Reliable** data on **fatigue endurance** limit allowing an estimation of the life of the part.
- Possibility to reduce the radius of the grooves and also to optimize the design of the areas were geometrical stress concentrating shapes need to be set.
- High level of **cleanliness** avoiding to take an extra safety coefficient for estimating the fatigue endurance.

And of course all the "usual" advantages of the SP steels:

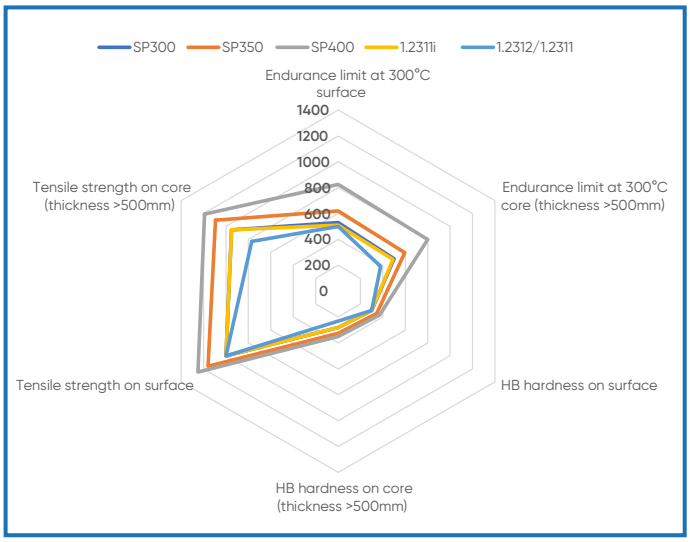
- Delivered in **prehardened** conditions.
- **High machinability** due to the high homogeneity of the steel even for the biggest parts.
- Possibility to be welded for the SP grades.
- In the case of tools under development the possibility of **welding the Superplast®** steels with the same properties in the welded area and in the bulk part of the steel is really helpful in case of some evolution of the design at the last moment.

Technical tip 1

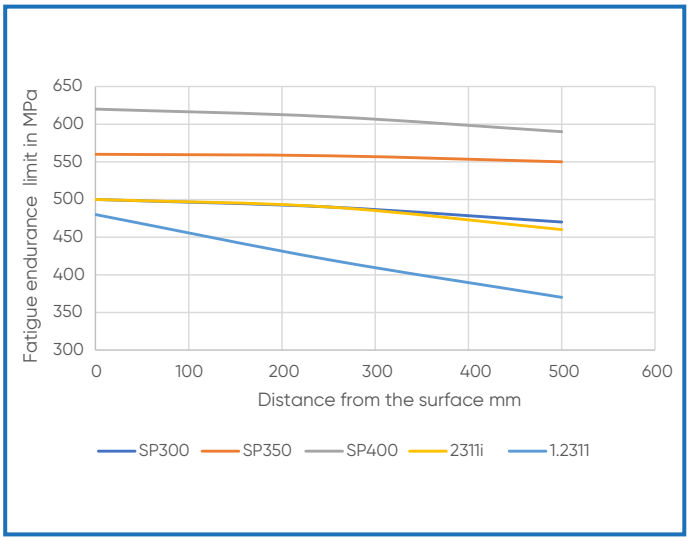
What is fatigue?

Fatigue is a physical phenomenon leading to the crack of a part submitted to repeated stresses or loading even when the stress or the load is much weaker than the tensile strength of the material.

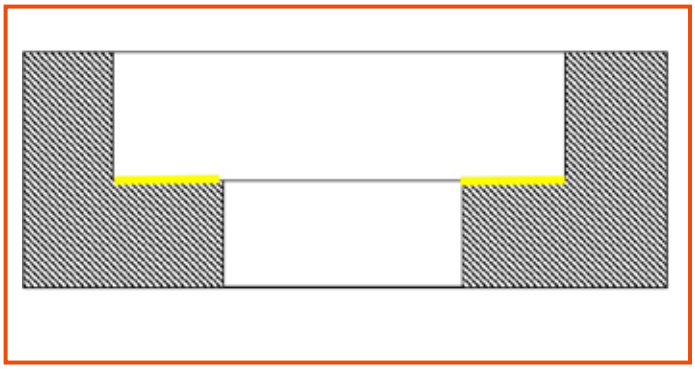
Global overview of the properties of the Superplast ® grades in comparison with 1.2311/1.2312
1.2311i is not suitable for welding and needs to be used only in applications were there is no need for welding.
If there is an eventuality of welding then the SP300 must be choosen.



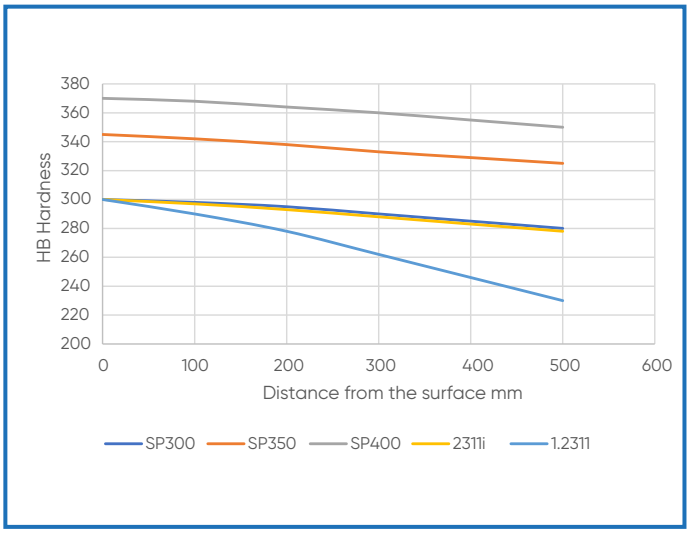
Comparative evolution of the fatigue endurance limit from surface to core on blocks with a thickness of 500 mm at 300°C.



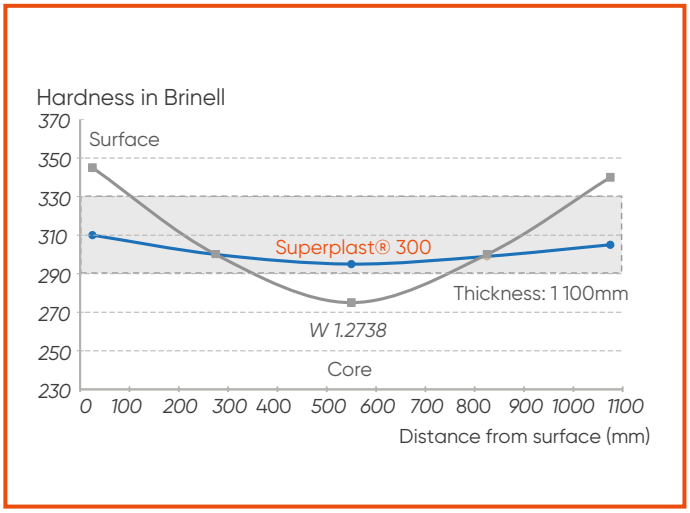
Typical cut of a tool holder with deep machining.
The stressed surface in use is underlined in yellow and is far below the surface of the block



Comparative evolution of the hardness from surface to core on blocks with a thickness of 500 mm.



Comparison of the evolution of hardness between surface and core in SP300 and in 1.2738.



Technical tip 2

What is stress concentration?

Stress concentration occurs when there are geometrical irregularities leading to a local higher stress level than in if there was no irregularity.
It happens on edges, holes, notches, grooves and fillets

Conclusions:

Most of the time the "side parts" of molding equipment are considered as not critical and only the price and the machinability are taken in account in the choice of the material.

But even if the surroundings of a molding cavity are neither polished nor textured they play an important part in the mechanical behavior of the molding device and any problem on such parts will lead to the immediate stop of the molding or casting machine.

In the most up to date molding machines (and this is also available for the die casting machines) and in the first place for the giga molding and die casting machines the "side parts" and the tool holders are deeply machined and are heavy loaded.

So, for all these reasons the use of very homogeneous steels as the SP is really the best solution for securing the life of the molding/casting machine.

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