

Cast Steel and Hollow Sections – New Applications and Technologies

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ABSTRACT

In this paper, new delivery conditions for cast steel are described. The special properties of the various grades are given and problems relating to cast steel and the differences between carbon steel and cast steel are pointed out. Furthermore, first results of fatigue investigations dealing with end-to-end CHS connections are presented. Experiences with cast steel in these connections are summarized.

KEY WORDS: fatigue, cast steel, CHS, end-to-end

INTRODUCTION

With the implementation of carbon steel as a result of modern manufacturing advances, cast iron has been replaced by steel due to its unfavourable characteristics. The situation has changed further; improvements in the material properties have been made and cast steel with properties comparable to modern carbon steel are now available to engineers and architects.

New ways of using cast steel, especially in major projects, are being considered and many advantages are seen in the use of cast steel. Complicated joint types are easily manufactured and the shape can be optimized for the distribution of stresses. The stress concentration is reduced, which is very important for fatigue behaviour. However, due to the limited use hitherto of cast steel, the special properties of the various grades of cast steel are not widely known. The advantages are unknown to a majority of engineers and the existing rules and design guides are seldom sufficient. More experience in this field is required.

Therefore, new delivery conditions, especially dealing with cast steel, have been developed in Europe. Special problems relating to casting failures and differences with respect to carbon steel are dealt with. The progress in standardization will be presented.

Furthermore, the first results of fatigue investigations on end-to-end CHS connections will be presented.

STANDARDIZATION AND CAST STEEL USAGE

Nowadays, cast steel for application in steel structures in civil engineering is considered as a steel with a carbon percentage less than 2.1 %. Cast steel has properties comparable to rolled steel products. The yield stress, tensile stress, hardness or notch bar impact value are available in similar properties. The weldability is especially comparable. Cast steel is particularly suitable for structures with complicated geometry (e.g. three dimensional structures) and/or high stresses under fatigue loading. It is possible to omit a weld prone to fatigue cracking in highly stressed areas, and design a cast node better suited to such areas.

In Eurocode 3-1-1, no particular regulations are specified, but it rather refers to other European regulations. However, with the current progress in using cast steel in different applications, the normative regulations have been revised. The European standard EN 10293 was established in June 2005 to replace the older guidelines. A short overview of the replaced standards, especially German Standards, is given here.

In general, cast steel is graded according to its alloying additions. Unalloyed cast steel contains only a small amount of silicon and manganese with a carbon percentage of 0.1 up to 0.7 %. These cast steel types were described in the German normative regulation DIN 1681. There, they are graded according to their minimum tensile strength. GS-38 for example has a minimum tensile strength of 380 N/mm². In the new standard this has changed. The notation now refers to the yield stress. The cast steel GS-38 is now GE 200. However, the unalloyed cast steel grades are not suitable for welding. Steel castings with improved weldability were given in the German Standard DIN 17182. This improvement in weldability and toughness is achieved with a higher carbon content. Furthermore quenched and tempered steel castings are listed in DIN 17205.

With a higher percentage of carbon, the yield and tensile strength are improved and the elongation after fracture and the notch bar impact value are reduced. Low alloy cast steel has up to 10 % of alloying additions (chrome, nickel, molybdenum and tungsten). Cast steels with a percentage higher than 10 % of alloying additions are called high alloy cast steel.