Thermo-Mechanical Controlled Processing of Steels and the Essential Role of Niobium

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Summary

Thermo-Mechanical Controlled Processing (TMCP) is a technology for simultaneously improving the strength and toughness in any hot rolled steel. Intelligent metallurgical design and precise control of thermal and physical characteristics of the metal in rolling can optimize both strength and ductility in any given steel. In using this technique, the steel produced will be higher in strength and ductility than current standard steels, and so can be substituted into building structures with reduced dimensions and masses but will still meet all construction requirements. This can allow up to a 20% reduction in the mass of steel used in significant projects,, as demonstrated in the given case studies.

Keywords: Fine Grained, TMCP, Niobium, Long Products, Process Control, Metallurgy

1. Introduction

I attended the IABSE Conference in Nara, Japan in 2015 and noted with interest that several of the papers referenced “TMCP Steels” or “Thermo-Mechanical Controlled Processing of Steels”, [1], [2], [3]. In discussion with other delegates I realized that there was not a good understanding of the concept and yet this type of steel processing is becoming more common in the Structural Steel world. Given that I have knowledge on this subject, I believed it would be advantageous to give a simplified overview of how TMCP of steels has evolved and its benefits.

2. What is steel

“Steel” is a generic term for a hard, strong metal alloy which is used as a structural and fabricating material. Steel is an alloy of iron, with additions of carbon, manganese, chromium, silicon, aluminum, nickel, molybdenum, vanadium, titanium and niobium amongst other elements. There are several steel types but here I will deal with “carbon steels”. They can be broken down into 3 groups by the level of carbon they contain. Carbon strengthens the iron atomic lattice of iron, with more carbon giving more strength but reducing ductility.

Type	Carbon (%)	UTS (MPa)	Description	Typical Uses
Mild Steel	**0.05- 0.27**	**300 - 500**	**Low strength, high ductility**	**Pipe, rivets, structural steel**
Medium Carbon	**0.28 – 0.54**	**500 - 700**	**Balances strength & ductility**	**Gears, shafts, crane hooks**
High Carbon	**0.55 – 0.95**	**700 - 900**	**High strength low ductility**	**Tool steels, rail wheels**

Table 1: Typical Steels and their Uses

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