RESULTS IN USING SEMI-HSS ROLLS SPUN CASTING IN A TEMPER MILL[1]

Alberto Tremea[2]
Angelo Biggi[3]
Massimo Grespi[3]
Victor Avetta[4]

Abstract

In recent years several tests were performed with centrifugally cast bimetallic rolls as work rolls in cold rolling. This paper outlines the exciting results from cast rolls made in a special type of alloyed steel called Semi-HSS used in a temper mill at Siderar. In this specific application of cold rolling is very important imprinting to the sheet not only the desired mechanical properties but also a defined surface aspect. The work roll surface and especially its deterioration during the campaign become of primary importance to establish the real behaviour of a roll grade material. In this temper mill, the use of cast Semi-HSS has permitted to perform longer campaigns in comparison with the usually employed forged rolls: these new rolls are showing an optimal behaviour and are particularly effective in retaining the roughness induced by shot blast texturing. This gives certainly a big positive contribution to the performances of this type of rolls in terms of consumption and allows a reduction of the costs related to grinding and texturing procedures in turning shop. This new application for a non forged roll, with this very positive response from the mill, gives a new chance to reach a continuous decrease in total roll operation cost.

Key words: Cold temper mill; Centrifugal casting rolls; Semi-HSS; Wear; Roughness

RESULTADOS DE CILINDROS CENTRIFUGADOS DE SEMI - AÇO RÁPIDO EM UM LAMINADOR DE ENCRUAMENTO

Resumo

Nos últimos anos, vários testes foram realizados com cilindros de trabalho centrifugados, bi-metálicos, para laminação a frio. Esse artigo ressalta os resultados de cilindros fundidos em aço ligado chamado Semi-HSS, empregados em um dos laminadores de encruamento da Siderar. Nesse tipo de laminação, busca-se não somente a forma e propriedades da tira, como também seu acabamento superficial. A superfície dos cilindros de trabalho e sua deterioração ao longo da campanha são essenciais na avaliação do comportamento de cada material de cilindro. Nesse Temper Mill, o uso de Semi-HSS fundido permitiu campanhas mais longas 'as dos cilindros forjados. Esses novos cilindros estão mantendo a rugosidade do jateamento por granalha, contribuindo para redução do consumo de cilindros e demais custos envolvidos na oficina de cilindros. Essa nova aplicação de semi-HSS acena com uma redução continuada nos custos de laminação.

Palavras-chave: Laminador a frio de encruamento; Cilindros centrifugados; Semi aço rápido; Desgaste; Rugosidade.

1 *Technical contribution to 44th Rolling Seminar – Processes, Rolled and Coated Products, October 16 to 19, 2007, Campos do Jordão – SP, Brazil.*

2 *R&D Dept. – Innse Cilindri Srl - Via A. Franchi 20, 25127 Brescia, Italy*

3 *Sales Dept. – Innse Cilindri Srl - Via A. Franchi 20, 25127 Brescia, Italy*

4 *Cold Mill Roll Shop Coordinator – Centro Siderurgico General Savio – Ternium Siderar – S.Nicolas, Argentina*

INTRODUCTION

In a temper mill the work rolls have an important role in assuring the desired metallurgical properties and surface characteristics in the rolled product. The wear resistance and the roughness retention of the roll are the key factors for roll good results and the final quality of the strip production. In this paper the results of some trials with Semi High Speed Steel centrifugally cast rolls are analyzed and compared with classical forged steel normally used. The tests are conducted in a single 4-high stand at Siderar (Temper 1): some data relating to this mill are summarized in Table 1.

Table 1 Data pertaining to Temper Rolling Mill in Siderar

4 Hi Stand	
Work Rolls	Max. dia. 549mm; Scrap dia. 443mm Body face 1626mm Weight 4.5ton Material Forged Steel (3% Cr)
Backup Rolls	Max. dia. 1356mm; Scrap dia. 1034mm Body face 1626mm Weight 25ton Material Cast Steel
Motor Power	1000HP
Strip Speed	763m/min (max)
Separating Force	800ton (1200ton max)
Coil Sizes	Max. dia. 1829mm Max. width 1500mm Min. width 530mm Max. weight 23ton

This mill is working with a monthly output of 30.000 ton; the 80% of this production is cold rolled and annealed steel Table 2 collects the main operating data concerning the mix of the mill. Figure 1 shows the temper mill arrangement.

Table 2 Characteristics of the rolled material

Mix Production (referring to month)	
Cold Rolled Annealed Steel	Quantity 23000ton Min. thickness 0.3mm Max. thickness 2mm Roughness 2.8-3.3μm
Hot Rolled Steel	Quantity 5000ton Min. thickness 1.6mm Max. thickness 2mm Roughness 4.3-4.6μm
Pickled Steel	Quantity 2000ton Min. thickness 0.2mm Max. thickness 0.6mm Roughness 4.3-4.6μm

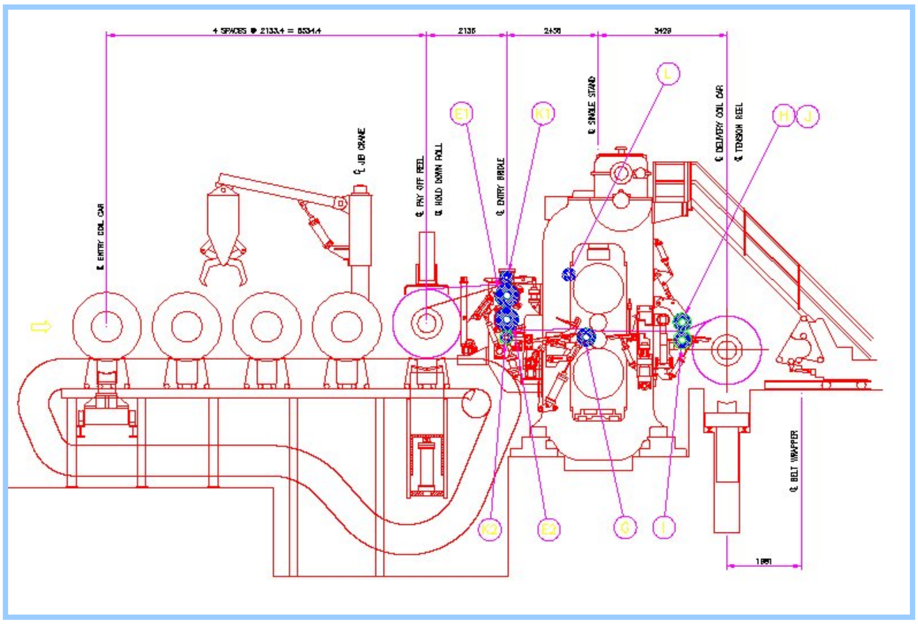

Figure 1. The Temper Mill 1 at Siderar

WORK ROLL MATERIALS

This mill is using standard forged roll grades (3.5% Cr). These steels are subjected to a strong hardening to reach the high level of hardness required to guarantee wear and mark resistance.[(1)] The tempering process, that represents the last step of forged steel roll manufacturing, allows reducing the level of residual stress coming from hardening operations: this stage of the roll heat treatment is important to meet the requested hardness and useful to prevent disastrous failures.[2] Table 3 shows typical range about the chemical analysis of these forged steels for rolls while Figure 2 illustrates the hardness profile below the roll surface.

Table 3 Chemical composition of forged rolls (wt%)

C	Si	Mn	Cr	Mo	V
0.7-1.0	0.2-0.5	0.2-0.5	2.8-3.5	<0.2	<0.1

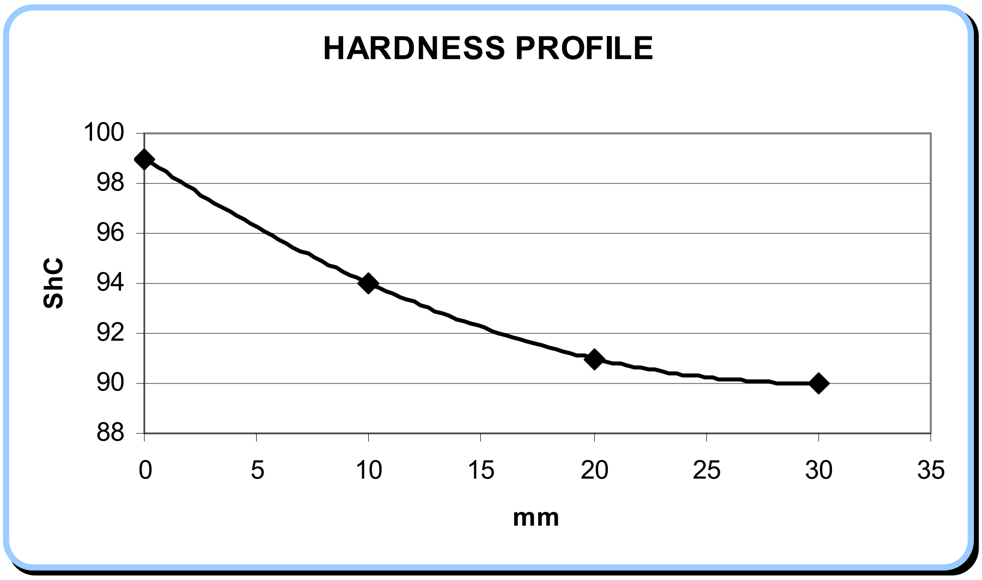

Figure 2. Hardness profile for forged steel rolls

In these forged steel rolls, the specific chemical analysis and the heat treatment operations have a very important role to establish the microstructure of the working layer. In general these materials show a rich presence of small and spherical carbides well dispersed into a martensitic matrix (Figure 3). The relative balancing between carbon and chromium allows obtaining different situations in terms of type and quantity of carbides with strong consequences on hardenability of the material. The optimization of heat treatment becomes a strategic point to ensure a good result in terms of safety and performance of the roll[3].

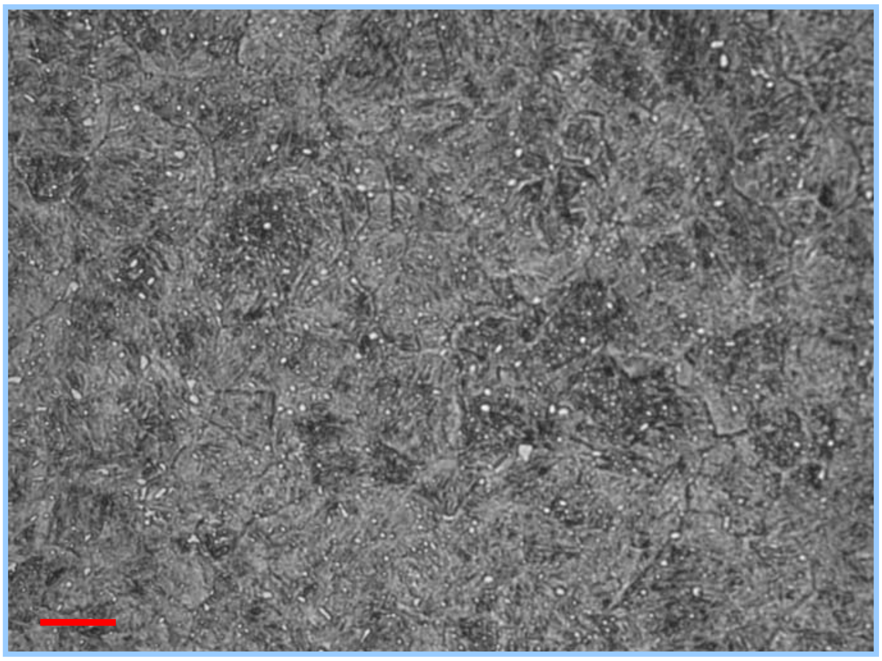

Figure 3. Microstructure of forged steel roll (1000x)

The new rolls, involved in the tests in this application of cold rolling, are manufactured in special high-alloyed steel centrifugally casting. These compound rolls (the core is made in nodular cast iron) have a working layer with optimal mechanical and technological properties: excellent hot hardness and thermal fatigue resistance enable this material to withstand rolling stresses successfully(4). The typical range of chemical analysis of this material, called currently semi-HSS, is showed in Table 4.

Table 4 Chemical composition range of cast Semi-HSS rolls (wt%)

C	**Cr**	**W_{eq}**	**V**
0.5-0.8	3.0-6.0	4.0-8.0	0.5-1.0

W_{eq}= W+2Mo

The microstructure of this steel is characterized by a low presence of eutectic chromium carbides (M_7C_3 type) plus a high-alloyed ferrous matrix made of tempered martensite (Fig.4). The level of carbon is optimized to avoid the precipitation of a continuous pattern of primary chromium carbides and to guarantee a sufficient hardenability of ferrous matrix. This grade shows, after a quenching treatment and a double tempering above 500°C, a constant hardness through the entire working layer (~ 80ShC).

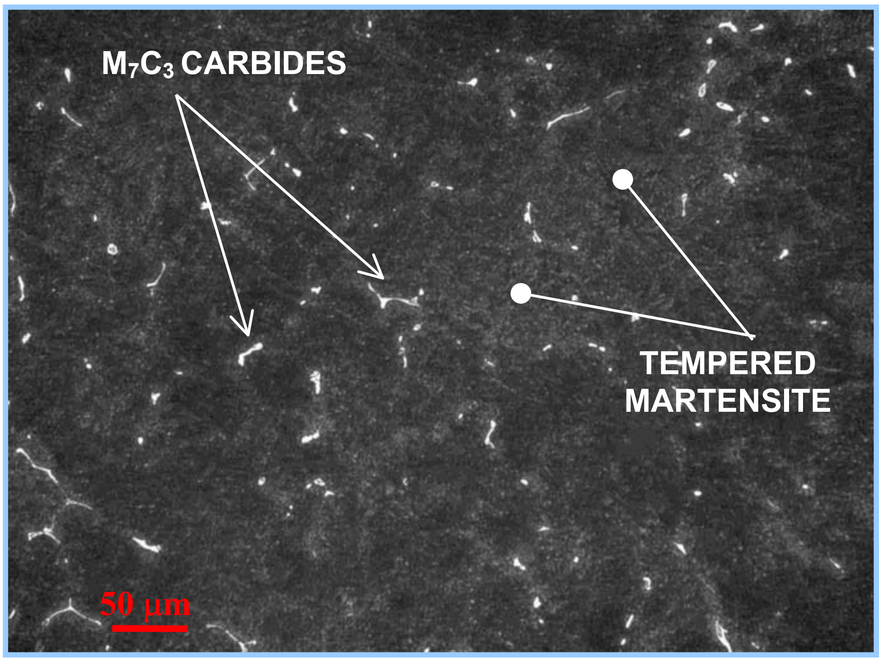

Figure 4. Microstructure of cast Semi-HSS roll (200x)

RESULTS FROM THE MILL

The trials made with bimetallic spin casting SemiHSS appear positive for a variety of reasons. The normal working conditions adopted with forged rolls are still applicable: no adjustments of the crown and shot blasting practices are required. In this period of tests the SemiHSS rolls didn't show particular cases of surface damaging. The optimal thermal fatigue resistance of this cast steel well proven in laboratory tests[5] has been confirmed together a comforting level of safety in rolling. Table 5 summarized the results obtained.

Table 5 Rolls performances

MATERIAL	ton per campaign	mm per grinding
FORGED STEEL	134	0.2
SEMIHSS	280	0.2

The SemiHSS allows to extent the campaign (more than two times longer) because of its superior attitude to retain roughness given by shot blasting on roll surface. This fact acquired more importance in hot steel strip rolling ("BO" production) where the limit admissible for the roughness is quite important (min. R_a= 2.8µm). In this situation, the good ability to limit the smoothing of imprinted texturing of SemiHSS makes possible the elimination of roll redressing during the normal eight-hour shift. The consumption of SemiHSS appears in media at an optimal low level comparable with standard forged rolls.

DISCUSSION

These initial trials with SemiHSS highlighted clearly all the potentiality of this cast steel. The optimal high temperature properties of this high-alloyed material guarantee an excellent surface quality with reference to the main target of this application: to retain initial roughness during the service. When the tests will be terminated it'll be possible to make a comprehensive evaluation of the benefits in using this type of rolls.

CONCLUSIONS

A new application in cold rolling field for a centrifuged bimetallic cast roll in SemiHSS seems to be possible with also improvements for the mill management. The cast SemiHSS has demonstrated several good aspects when compared with standard forged rolls normally used:

- ✓ No particular operating problems
- ✓ Traditional shot blasting process can be carried out
- ✓ Adequate wear resistance
- ✓ Excellent ability in retain roughness during the campaign

Looking on these results, it's clear as the use of this material can give an important contribution to the quality improvement and cost savings in the temper mill application.

REFERENCES

1 G. Odin, J. Terrasse, V. F. Vidalenc "Work Rolls for Cold Rolling of Silicon Electrical Strip and Stainless Steel", *Proc. of Fundamentals and Practice Short Course* , Hamilton – Ontario – Canada, October 22, 1995, Published in "Rolls for the Metalworking Indusries", Iron & Steel Society, Chapter 19, p.325.

2 R. L. Bodnar, S. S. Hansen, "The Physical Metallurgy of Forged Cold-Mill Work-Roll Steels", *Proc. 33rd Mechanical Working and Steel Processing*, St. Louis, MO, October 20-22, 1991, Iron & Steel Society – AIME, Vol XXIX, 171.

3 F. Goyanes, K. Reppert, K. Marsden, "Maximizing Depth of Hardness of Conventionally Hardened 3% Cr Forged Steel Work Rolls Through Optimization of Chemistry, Austenitization, and Quenching", *Presented to ROLLS 2007,* Birmingham, UK, March 14-16, 2007.

4 A. Molinari, M. Pellizzari, A. Biggi, G. Corbo, A. Tremea, "Metallurgical Development of Hot Rolls with improved Rolling Performances", *Proc. of Saruc 2002*, 17-18 October 2002, Gauteng (RSA), p.37.

5 M. Pellizzari, A. Molinari, A. Biggi, G. Corbo, A. Tremea, "Semi High Speed Steels for Roughing Rolls with Improved Thermal Fatigue Resistance", *La Metallurgia Italiana*, Vol.9, 2005, 57-61.