SEMI-HSS and HSS SPUN CASTING ROLLS for COLD MILL APPLICATIONS

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ABSTRACT

In recent years several tests have been 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 (Argentina). In this specific application of cold rolling it is very important imprinting to the sheet not only the desired mechanical properties but also a particular surface aspect. The work roll surface and especially its deterioration during the campaign become of primary importance to establish the real behaviour of roll grade material. In this temper mill, the use of cast Semi-HSS has permitted us to perform longer campaigns in comparison with normal forged rolls: these new rolls show an optimal behavior and they are particularly effective in retaining the roughness induced by shot blast texturing. This gives certainly a big positive contribution to the performance of this type of roll in terms of consumption and it leads to reduction of the costs related to grinding and texturing procedures in the turning shop. This new application for a non forged roll, with this very positive response from the mill, gives further opportunities to achieve a continuous decrease in total roll operation costs. Recently the use of Semi-HSS centrifuged rolls has been extended to Tandem Mills for tin plate production. The results were very positive, especially due to high resistance to accidents. Now are in progress also new trials with HSS rolls. These rolls due to their hardness and specific microstructure characteristics should offer better results in terms of consumption and demonstrate an important resistance against the marks in respect to Semi-HSS rolls. In addition these new rolls can permit to avoid the chromium plating for their excellent ability to maintain the initial surface roughness.

1 - INTRODUCTION

With a view to a continuous improvement of a cold mill productivity the behavior of work rolls plays a strategic role. The need to roll hard steel grades and to respect the very tight tolerances regarding sizes and quality of tin plates require the use of very wear-resistant rolls. At the present time forged work rolls are still largely used in cold rolling but a lot of trials are in progress with high alloyed rolls centrifugal casting. We are testing our rolls in different cold mills around the world but there are 2 sites where our presence is important:

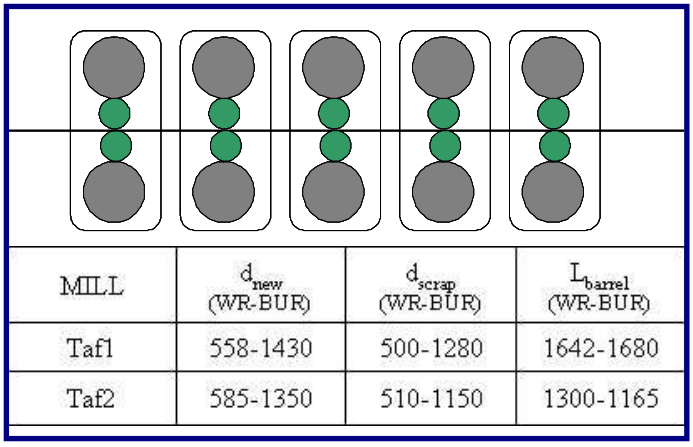
- Ilva Genova Works (2 tandem mills)
- Ternium Siderar San Nicolas Works (Temper and tandem mills)

Ilva Genova Works

In this plant there are 2 tandem mills; both mills have 5 stands. One mill (Taf1) produces mainly sheet for galvanizing lines while the second one (Taf2) makes tin plate. Table 1 and Figure 1 summarize some technical aspects of these cold mills.

Tab.1 Tandem Mills at Ilva Genova

MILL	ANNUAL CAPACITY [ton]	MAX SPEED [m/min]	THICKNESS (mean/min) [mm]	Tmax [°C]
TAF1	1250000	700	0.7/0.35	70
TAF2	400000	2000	0.2/0.17	150



MILL	d_{new} (WR-BUR)	d_{scrap} (WR-BUR)	L_{barrel} (WR-BUR)
Taf1	558-1430	500-1280	1642-1680
Taf2	585-1350	510-1150	1300-1165

Fig.1 Sketch of Tandem Mills at Ilva Genova

Ternium Siderar San Nicolas Works

Trials are running in a temper mill (n°1) and in the tandem mill that in this case has 4 stands. The main product of tandem mill is tin plate while in the temper mill the output is divided by 80% in cold rolled annealed steel and 20% hot rolled steel (Tab.2). In Fig.2 it's shown the temper mill arrangement.

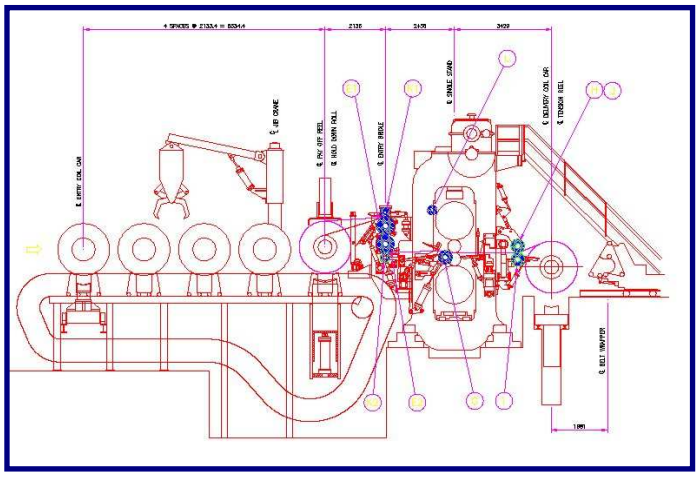


Fig.2 Temper n°1 at Siderar

Tab.2 Monthly Production of Temper 1 at Siderar

COLD ROLLED ANNEALED STEEL	Quantity: 24000 ton Min. Thickness: 0.3mm Roughness (Ra): 3µm
HOT ROLLED STEEL	Quantity: 6000 ton Min. Thickness: 1.6mm Roughness (Ra): 4.5µm

2 – SPUN CASTING WORK ROLLS

The centrifugal casting process allows to produce bimetallic rolls where the external layer is made in a very hard steel with optimal mechanical properties. These steels, called semi-High Speed Steel (SHSS) and High Speed Steel (HSS), have been developed for the hot rolling during the last decade. These materials contain a large amount of alloying elements to guarantee hardenability and high resistance also at high temperature. The microstructure of these materials is characterized by the presence of primary carbides plus a martensitic matrix enriched with many secondary carbides. The main difference between SHSS and HSS is the presence of primary carbides; in the SHSS the network of eutectic carbides is almost absent and slightly interconnected while in the HSS material this constituent characterizes heavily the microstructure. Table 3 reports the indicative chemical analysis of these type of work rolls.

Tab.3 Rolls Chemical Analysis [wt%]

MATERIAL	%C	%Cr	%(Mo, W)	%(V, Nb)
SHSS	0.8	5	3	1
HSS	1.8	5	5	5

Some aspects relating to the microstructure and mechanical properties of these steels are show in Table 4: there is also a comparison with standard forged steels (3.5% Cr).
The microstructure of these steels is shown in Figure 3,4 and 5.

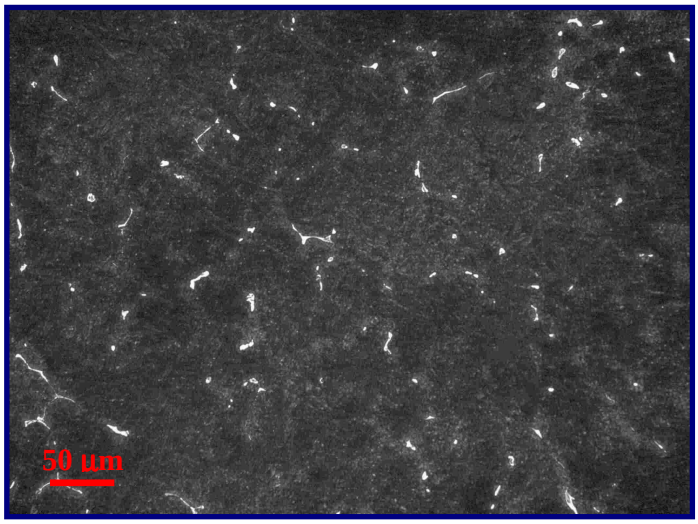


Fig.3 Microstructure of SHSS (M_7C_3 carbides 2-4%)

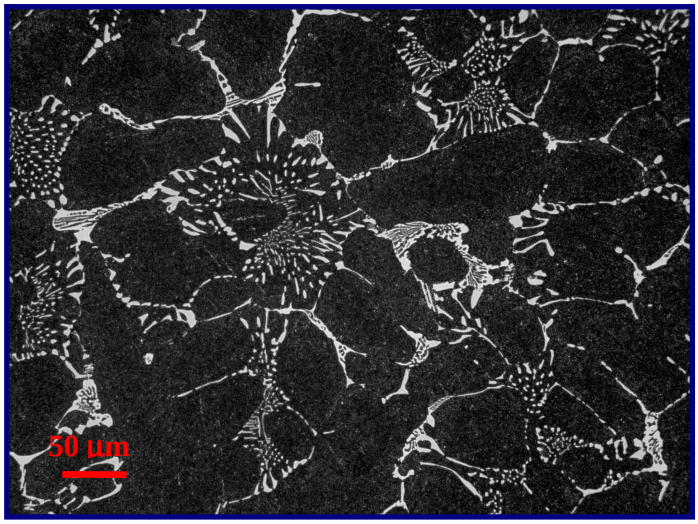


Fig.4 Microstructure of HSS (M_7C_3 + MC carbides 8%)

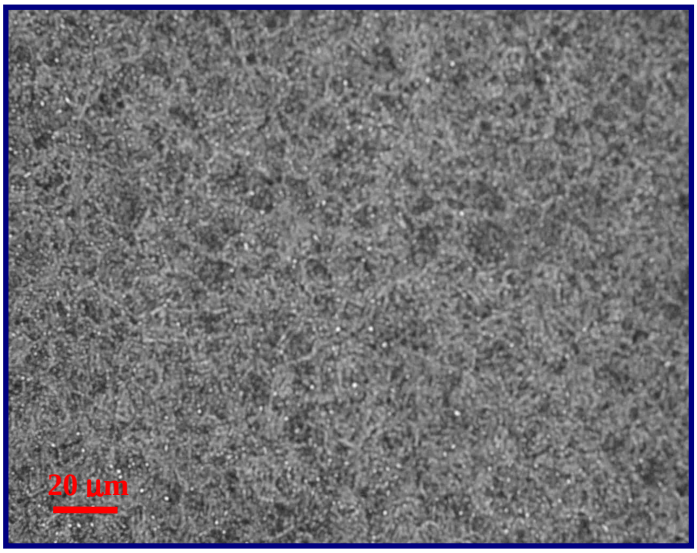


Fig.5 Microstructure of standard forged steel

Tab.4 Rolls Properties

MATERIAL	SHSS*	HSS*	FORGED
Tensile Strength [MPa]	900	900	1800
Hardness [ShC]	80	80	95
Thermal Conductivity [W/mK]	25	18	35
Tempering Temperature [°C]	500-550	500-550	100-250

* these rolls are bimetallic with a core in nodular cast iron (see below some properties)

Tensile Strength [MPa]	Thermal Conductivity [W/mK]
400	35

3 – OUTCOME FROM ONGOING ROLL TESTS

The tests are followed keeping in mind the priorities of the roll user to compare the behavior of the standard forged rolls with the new cast rolls. The main topics analyzed, in order of importance, are:

1. Safety and accident resistance.
2. Grindability.
3. Roughness retention (texturing & wear resistance).
4. Strip cleanliness.

SHSS ROLLS

1. To date, no heavy spalls have occurred. Furthermore the mechanical cracks are shallower on average respect to that shown from standard forged rolls. The graph in Figure 6 points out the better behavior, for this topic, of SHSS rolls: the result, expressed as a percentage, shows how much the grindings exceed the campaigns.

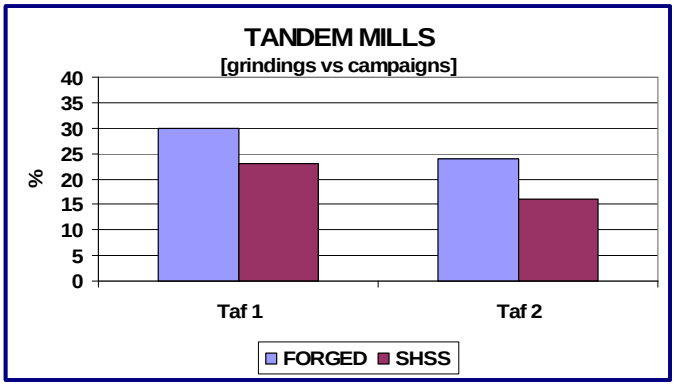


Fig.6 Grindings vs Campaigns at Tandem Mills

2. The standard grinding procedures are also suitable for this type of rolls.
3. This material shows an optimal attitude to retain roughness also in the case of shot blasting texturing. For example, at Temper 1 in Siderar, the introduction of SHSS enables the elimination of roll redressing during the normal eight-hour shift; with SHSS the campaign are longer and roll wear isn't a problem (Tab.5 – Fig.7).

Tab.5 Rolls Results at Temper 1 (Siderar)

MATERIAL	ton/camp	mm/grind
FORGED	134	0.2
SHSS	280	0.2

In the tandem mills at Ilva Genova, these rolls are working very well in all stands. The behavior is optimal also in the last stand when the surface are shot blasted to produce steel for the galvanizing lines.
Figure 8 shows a first rough assessment of the specific consumption of SHSS in comparison with standard forged rolls. This situation should be rechecked in the future

when the presence of SHSS rolls in the mills will be more consistent.

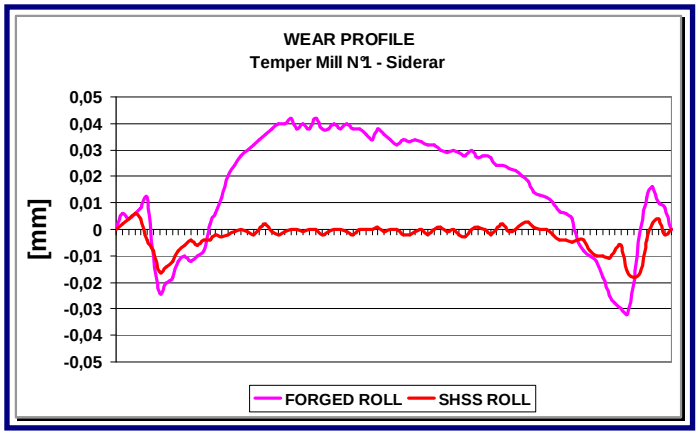


Fig.7 Wear Profile Comparison

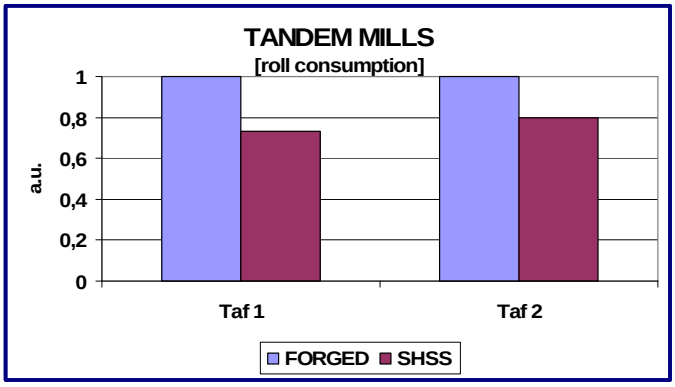


Fig.8 Roll Performance Comparison

4. The use of SHSS rolls doesn't worsen the cleanliness of the strip.

HSS ROLLS

The trials with these rolls are still at the beginning but some remarks can be made.

1. There isn't the evidence of abnormal level of roll accidents.
2. It seems to be necessary a revision of standard grinding practice because can be difficult, in some cases, to reach the desired roughness.
3. This type of roll has proven an excellent roughness retention; its use with textured surface in the last stand at Taf1 in Ilva is aligned with the behavior of standard forged roll.
4. It's too early to draw conclusions about possible interactions between this roll material and the cleanliness of the strip.

4 - CONCLUSIONS

The results of ongoing trials, using centrifuged bimetallic cast rolls made in SHSS and HSS like work rolls in cold rolling, are very positive.

These rolls are showing an adequate wear resistance together an excellent capacity in retain roughness also without the chromium plating.

Another important thing is a remarkable accident resistance of these rolls: a very positive fact to improve the roll performance.

So there is the evidence that the use of these rolls can give an important contribute to cut costs for a cold mill.

5 – REFERENCES

- *Technical documentation of Innse Cilindri.*
- *"Spun Cast Semi-HSS Rolls in a Cold Mill Applications"; paper presented at AISTech 2010 (Proceedings Conference – Vol 2 – pag.359).*