

FORGED HSS WORK ROLL FOR STEEL COLD ROLLING MILLS: SURVEY OF APPLICATIONS & PERFORMANCES¹

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Abstract

Use of forged HSS work roll is more and more widespread in cold rolling mills for various configurations as reversing or tandem mill with 4Hi or 6Hi stands and various rolled steel products as tin plate, silicon sheet or automotive sheet. The trend to roll high strength steels as AHSS grades or GO silicon steels requires higher rolling load and leads to replace standard forged (3% to 5%Cr) work rolls by forged HSS rolls: the forged HSS rolls present enhanced roughness retention, strengthened resistance to thermal and mechanical stresses, enable extended rolling runs while decreasing stock removal. Moreover the chrome plating practice can be suppressed when used in cold rolling process. The present paper aims to sum up the different applications and associated performances achieved with the forged HSS rolls.

Keywords: Cold mill rolls; Forged rolls; HSS

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1 INTRODUCTION

The general trend for development in cold rolling both for the ferrous and the non ferrous metal industries is to roll faster, thinner and wider while achieving perfect control of flatness, thickness and surface aspects compatible with a high productivity. This trend calls for the use of advanced rolling technologies that control key rolling parameters. The key objectives that are directly linked with work roll technology can be identified as listed here below:

- To roll harder grades (AHSS) while keeping the mill incident rate low. Indeed these incidents may create safety problems (roll spalling) and poor mill availability due to frequent stops for the roll changes.
- To roll consistently in tighter tolerances with respect to flatness, thickness, roughness and surface quality.
- To guarantee very long runs while keeping the roughness transfer constant.
- To widen out without leaving a track line on the strip from roll wear or dirt build-up; this is one of the most aims in cold rolling mills (schedule-free rolling).
- To optimize the overall costs of rolling; this remains a permanent and essential objective.

Some key parameters as roughness retention and surface aspects can be guaranteed through chrome plating of work rolls. This practice is effective and efficient, but is becoming more and more questionable and in a near future unacceptable due to environmental restrictions. Consequently investments for new chrome plating pits are nowadays rather questionable even if chrome plated rolls are still commonly used in temper mills and early stands of tandem mills.

Trials have been carried out in 20 rolling mills worldwide including 4Hi and 6Hi configurations for sheet and tin plate applications in continuous and discontinuous tandem mills. Previous papers⁽¹⁻⁹⁾ have shown the improvement of performance in terms of tons/mm and tons/run using HSS rolls. Table 1 hereunder summarizes the performance improvement achieved in the mills when using HSS rolls.

Table 1: Achieved performances

Grade	% run length (tons / campaign)	% roll consumption (mm / 1000tons)
Standard 5% Cr forged	100	100
Standard 5% Cr forged + Chrome plated	~200	100
HSS forged	300 - 500	< 30

2 SURVEY OF APPLICATIONS AND PERFORMANCES

Owing to the promising results obtained in various mills, official event has been launched in September 2011 aiming to the extension in the market of this new grade.⁽¹⁰⁾

Since this event, updated performances have been carried out in 24 additional cold rolling mills of whom twelve tandems for automotive (including AHSS rolled grades), four tandems for tin plate, one 6HI tandem mill for silicon electric steel, and two reversing mills for silicon electric steel and five skin-pass mills. For the time been, the HSS work rolls have been installed in more than 40 cold rolling mills worldwide.

The table 2 indicates the recent status collected during the last 2 years in the frame of the extension and implementation of the HSS grades to total 170 work rolls. The size of the rolls ranges from 400 to 600mm on diameter and 1200 to 2000mm on barrel length apart from for the plant "O" which is smaller.

It has to be noted that in all cases the performance of HSS grade work rolls are in line with the previous one as reported in Table 1 and achieved without chrome plating confirming its avoidance as established fact when such practice is applicable.

Table 2: Status of the HSS performances collected in the additional mills

Plant	Mill (Application)	Status
A	TDM 5Sts (Automotive)	Stand#0: roll consumption is 3.6 times less than standard WR. Stand#1 roll consumption is 2.2 times less than standard WR Avoidance of Cr Plating
A	SKIN PASS (Automotive)	Skin Pass mill (EDT): Avoidance of Cr Plating
B	Reversing (Silicon electric steel)	Double campaign length, 3 times less removal, high resistance against mill incident
C	TDM 5Sts (Automotive)	Double campaign length. Low roll consumption (0.13mm / 1000t). Avoidance of Cr Plating
D	TDM 4Sts (Automotive)	Implementation in progress
E	TDM 5 Sts (Tin Plate)	Implementation in progress
E	SKIN PASS (Tin Plate)	Implementation in progress
F	TDM 5 Sts (Automotive)	Implementation in progress
G	TDM 5 Sts (Automotive)	Implementation in progress
H	TDM 5 Sts (Tin Plate)	New trials in stand#1 in progress after revamping (Previously 1.67 times longer campaign)
I	TDM 4 Sts (Automotive)	EDT textured HSS rolls in Stand#4 performs 2.6 times better than standard grades (less roll consumption). Avoidance of Cr Plating
J	TDM 4 Sts (Automotive)	Implementation in progress
K	TDM 5 Sts (Tin Plate)	Additional trials in progress (previously 2.4 times better yield)
K	SKIN PASS (Tin Plate)	Implementation in progress
L	6Hi TDM 5 Sts (Automotive)	Implementation in progress
M	TDM 5 Sts (Automotive + AHSS)	Campaign length 4 times better than standard Cr Plated rolls. Rolled tons/mm 3 times better than standard grades. Widen out in stand 1.
N	TDM 5 Sts (Automotive + AHSS)	Stock loss factor 3.2 times better than standard grades in stands 1 to 4.
O	Reversing (Silicon electric steel)	Campaign length 2.75 times better while stock removal is 3 times less + improved resistance against mill incidents
P	TDM 5 Sts (Automotive)	2.5 times longer campaign and 2 times less stock removal
P	SKIN PASS (Automotive)	
Q	6Hi TDM 5 Sts (Silicon electric steel)	Campaign length 3.52 times better than standard rolls. Stock removal 2 times less
R	TDM 5 Sts (Tin Plate)	Double campaign length. Stock removal 2 times less.
S	6Hi SKIN PASS 2Sts (Tin Plate)	Trial on progress
T	TDM 5 Sts (Automotive)	Target: Avoidance of Cr plating in stand# 2, 3, 4 and 4000 T/campaign in all stands (improvement of mill availability)

3 CONCLUSIONS

- Recent results have confirmed avoidance of Cr-Plating as definitively established.
- For cold steel rolling applications, longer rolling campaigns in combination with lesser stock removal lead to significant impact on the total cost of ownership generating substantial savings.
- Such outcomes require adjustments of grinding and rolling practices.

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