10th International Research/Expert Conference
„Trends in the Development of Machinery and Associated Technology“
TMT 2006, Barcelona-Lloret de Mar, Spain, 11-15 September, 2006

SLEEVED ROLLS IN ROLLING MILLS

Irena Slavíková, Radka Lipková, Zdeněk Jonšta and Miroslav Tvrdý
VŠB - Technical University of Ostrava,
17.listopadu 15, 708 33 Ostrava
Czech Republic

Bronislav Molinek
Devimex, s.r.o.,
17. listopadu 5, 708 33 Ostrava
Czech Republic

ABSTRACT
Sleeving, which provide the rolls by versatile surface layer of usually different steel, is very usefull variant of solution in rolling mill industry. The steel is hardenable, it could be several times changed and it increases the rolling life. Up to now we have used the steels which have had only modest alloy content and high carbon level. E. g. one of steel 9Cr2MoV covered the needs of rolling industry in Central Europe. The logical step in the development of better steel was the application of higher chromium content in the steel.
The use of 3% and 5% Cr, such as in the advanced world, may increase the usefull life of steel rolls provided by the sleeving variant. The higher chromium steels are usefull with lower carbon content and give the usefull properties mainly by increasing the hardenability and increasing the retained austenite content in the steel. In such a case we may innovate the steels and innovate the properties of such sleeves to much higher level, which resulted in the increased life expectancy.
Keywords: roll sleeves, mechanical properties, retained austenite

1. EXPERIMENTAL MATERIAL
We have used two industrial melts of following chemical composition:

Table 1. Chemical composition of two industrial melts (% by mass)

Melt	C	Mn	Si	P	S	Ni	Cr	Mo
U	0,450	0,580	0,440	0,008	0,015	0,200	3,350	0,600
V	0,390	0,560	0,290	0,017	0,010	0,260	3,120	0,620

2. HEAT TREATMENT
The following heat treatment we used for the segments of sleeves and designed for the industrial practice:
860°C/oil/ + 510°C/furnace + 480°C/furnace
Piece of material has been tempered also at the temperature 680°C to check the properties after such treatment.

3. METALLOGRAPHY

The metallography state of heat treated rolls has been investigated on segments taken from the rolls. All the microstructures of the rolls were hardend or partially hardend, especially in case of the melt U. It means that in that melt the microstructure was fully bainitic with only sporadic localities of pearlite microstructure. On the contrary, in melt V the microstructure was partially pearlitic, where the pearlite formed the colonies on the grain boundaries.

With the increasing depth into core, the presence of pearlite was more definite.

The microstructure of the roll U is shown in the Figure 1.a,b.

4. HARDNESS AND THE BASIC MECHANICAL PROPERTIES

Hardness (in HRc) has been measured in longitudinal direction at the surface and 100 mm below surface, then in the core direction at the surface and in the 150 mm distance from the surface. The results have minimum dispersion and are cited first for U and then for V melt.

Longitudinal direction – surface: 47 - 47, 45 - 43
Longitudinal direction - 100 mm below surface: 45 – 43, 45 - 45
Core direction - surface: 47 - 45, 46 - 44
Core direction - 150 mm from the surface: 47 - 45, 45 - 44

The mechanical properties are summarized in Table 2.

Table 2. Mechanical properties of roll of the melt U

Position	Proof stress	Ultimate tensile strength	Ductility	Reduction per area
	(MPa)	(MPa)	%	%
1441C	1124	1380	3,6	3
1441S	1099	1386	4	4
1442C	1127	1406	9,5	22
1442S	1125	1399	9,4	19
1451C	1187	1390	5,2	5
1421S	1212	1325	2,4	4
1452C	1193	1393	6,6	10
1452S	1187	1391	6,6	7

Legend to the Table 2.

1441, 1442 is the material which is quenched in oil and tempered only at 510°C
1451, 1452 is the material which is quenched in oil and tempered at 510°C and subsequently at 480°C. C means the face of roll, S means the material in the core.

Standard impact toughness is presented in Table 3.

Table 3. Impact toughness of the experimental material of roll (melt U) at +20°C

Specimen marking	KV (J)
1441/2	7
1441/2	7
1441/3	5
1442/1	9
1442/2	13
1442/3	8
1451/1	5
1451/2	6
1451/3	9
1452/1	10
1452/2	6
1452/3	4

Higher tempering results are summarized in Table 4.

Table 4. Strength and toughness values after tempering of roll material at 680°C (melt U)

Re (Mpa)	Rm (Mpa)	A5 (%)	Temperature (°C)		KV (J)	
711	855	18,3	20	40	52	60
810	851	19	-20	16	20	22

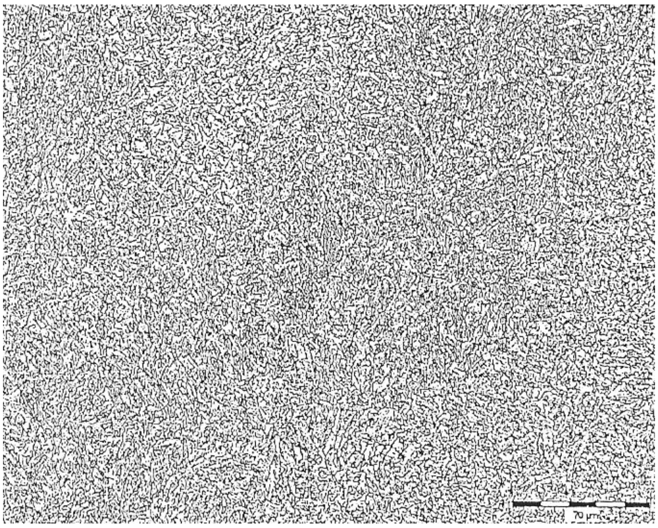
5. MEASUREMENTS OF RETAINED AUSTENITE CONTENT

The X – ray technique has been used for the checking of retained austenite content. In the quenched state only the retained austenite has been determined on the level 22%. The first tempering at 510°C reduced the austenite content to 6%. The last tempering at 480°C produced 0% of retained austenite.

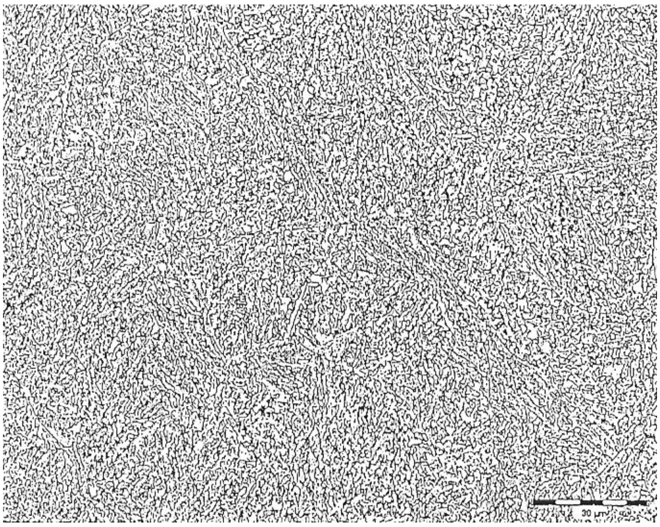
6. CONCLUSIONS

1. It is worthwhile to use the higher chromium grades of steel (3%Cr) in industry for the production of roll sleeves. The reason is visible from the higher hardenability of the steel and from the measured values of mechanical properties.

2. The high tempered 3%Cr steel at 680°C produces still high strength properties but also the satisfactory level of toughness. It may be used for components in the off shore structures and generally in the special steel industry.



a)



b)

Figure 1 . Microstructure of steel roll U after complete heat treatment 1411 – 500x