THE WICON ROLLING LIBRARY FOR BILLET, BAR AND ROD MILLS[1]
A LIVE DEMONSTRATION OF A REVAMPING PROJECT

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Abstract

Rolling mills require continuously analysis of existing process and equipment in order to improve working conditions, add new products and manage new investment. This paper will show, utilising a demonstration for a revamping project, how the Wicon Rolling Library would greatly simplify the above analysis, reducing relating risks, costs and time.

Key words: Rolling Mill; Process analysis; Equipment; New product; Demonstration

A BIBLIOTECA DE LAMINAÇÃO "WICON" PARA LAMINADORES DE TARUGOS, BARRAS E VERGALHÕES: UMA DEMONSTRAÇÃO AO VIVO DE UM PROJETO DE MODERNIZAÇÃO

Resumo

Laminadores requerem análises continuas de processos e equipamentos, de modo a melhorar as condições de trabalho, adicionar novos produtos e gerenciar novos investimentos. Este trabalho irá mostrar através de uma demonstração para um projeto de reforma, como "Wicon Rolling Library" simplificaria drasticamente as análises acima, reduzindo riscos relacionados, custos e tempo.

Palavras-chave: Laminadores; Análise de Processo; Equipamento; Novos produtos; Demonstração.
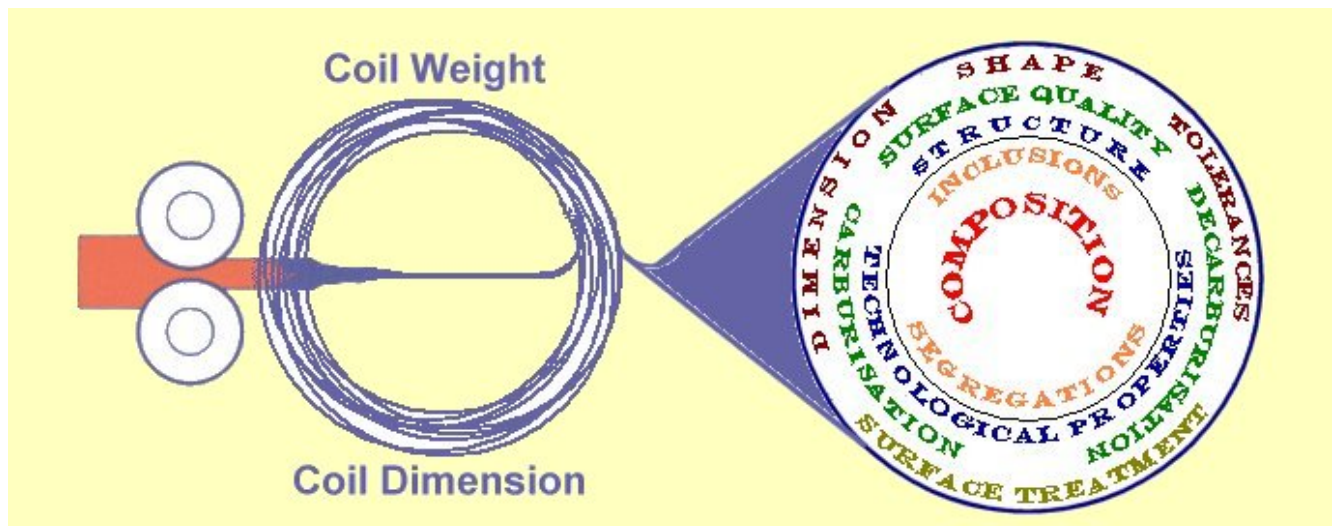
Figure 1: Property parameters for rod and wire rod

The products rod and wire rod (generally semi products) have got more property demands (combinations of properties) than most other rolled steel products. Figure 1 shows the property parameters for rod and wire rod.

The properties

The total property is settled by the COMBINATION of the property parameters.
Changing one parameter, changes the total property of the rod.

The quality

The quality is depending on how well the property parameters are kept.
The difference in quality between two rods is depending on the level of one property parameter only.
To work with the property parameters in order to improve the quality of the product is continuously going on. One of the most common tasks is to improve the surface quality and the tolerances by means of improving the mill setup and/or changing the pass design.
Other common improvements are to increase the billet size and finishing speeds in order to improve the production yield.
The improvements above might include exchange and extension of the equipment e.g. additional stands.
Only by having good knowledge of the process parameters it is possible to make the right decisions and take the right measures for improving the product quality and the yield in the mill. Mill managers require professional tool for making the necessary calculations and simulations of the process parameters in a rolling mill. Customers require to easily test and check their own ideas as well as the technical quotations of the mill suppliers when upgrading existing mills or building quite new mills. This will avoid to make costly investments in unnecessary or wrong equipment having paid off the program investment in a very short period of time by saving just a few hours of standstill or avoiding unsuccessful test of rolling in new passes.
It is of course also of great importance that the mill is designed for the kind of materials to be rolled, see Figure 2.

STEEL & ALLOY grades depending on COMPOSITION
Approximate resistance to hot deformation, type of mills
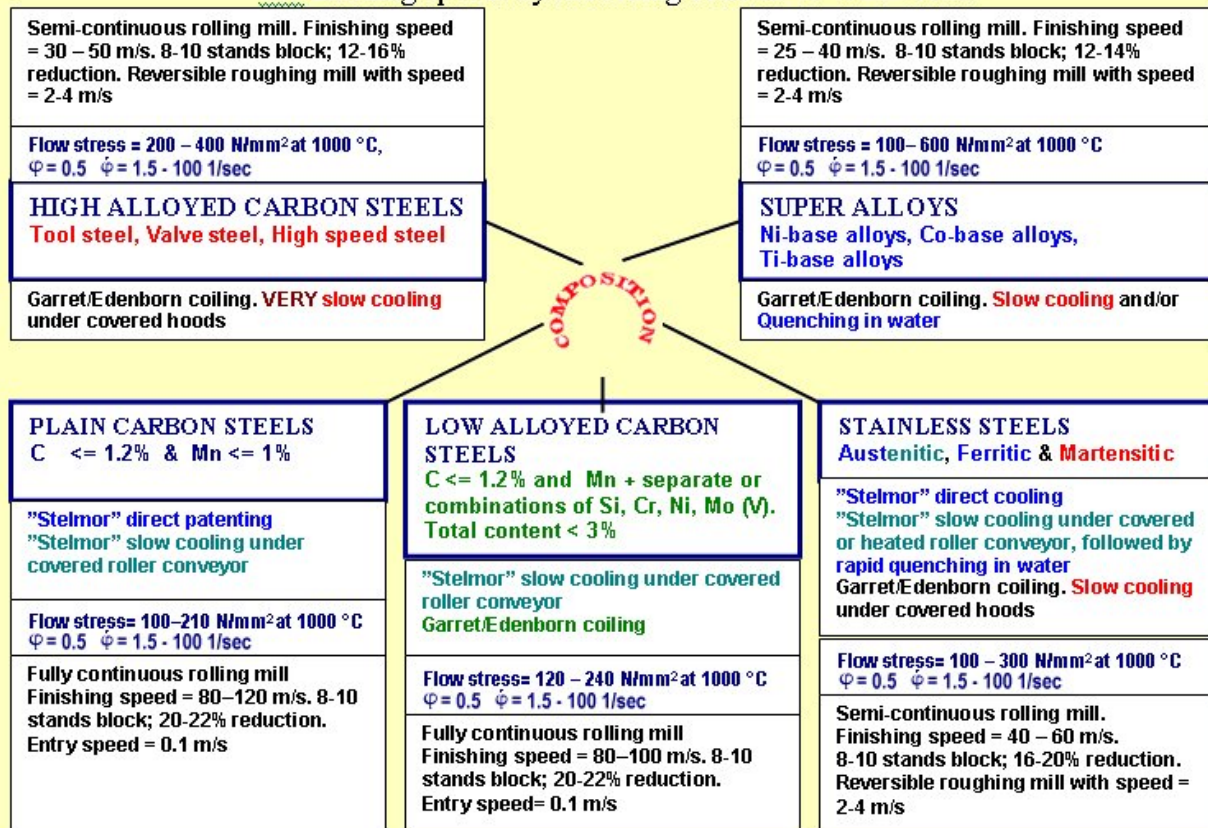and finishing speeds by hot rolling of ROD & WIRE ROD

Semi-continuous rolling mill. Finishing speed = 30 – 50 m/s. 8-10 stands block; 12-16% reduction. Reversible roughing mill with speed = 2-4 m/s

Flow stress = 200 – 400 N/mm^2 at 1000 °C, $\varphi = 0.5$ $\dot{\varphi} = 1.5 - 100$ 1/sec

HIGH ALLOYED CARBON STEELS
Tool steel, Valve steel, High speed steel

Garret/Edenborn coiling. VERY slow cooling under covered hoods

Semi-continuous rolling mill. Finishing speed = 25 – 40 m/s. 8-10 stands block; 12-14% reduction. Reversible roughing mill with speed = 2-4 m/s

Flow stress = 100– 600 N/mm^2 at 1000 °C $\varphi = 0.5$ $\dot{\varphi} = 1.5 - 100$ 1/sec

SUPER ALLOYS
Ni-base alloys, Co-base alloys, Ti-base alloys

Garret/Edenborn coiling. Slow cooling and/or Quenching in water

COMPOSITION

PLAIN CARBON STEELS
C   <= 1.2% & Mn <= 1%

"Stelmor" direct patenting
"Stelmor" slow cooling under covered roller conveyor

Flow stress = 100–210 N/mm^2 at 1000 °C $\varphi = 0.5$ $\dot{\varphi} = 1.5 - 100$ 1/sec

Fully continuous rolling mill Finishing speed = 80–120 m/s. 8-10 stands block; 20-22% reduction. Entry speed = 0.1 m/s

LOW ALLOYED CARBON STEELS
C <= 1.2% and Mn + separate or combinations of Si, Cr, Ni, Mo (V). Total content < 3%

"Stelmor" slow cooling under covered roller conveyor
Garret/Edenborn coiling

Flow stress= 120 – 240 N/mm^2 at 1000 °C $\varphi = 0.5$ $\dot{\varphi} = 1.5 - 100$ 1/sec

Fully continuous rolling mill Finishing speed = 80–100 m/s. 8-10 stands block; 20-22% reduction. Entry speed= 0.1 m/s

STAINLESS STEELS
Austenitic, Ferritic & Martensitic

"Stelmor" direct cooling
"Stelmor" slow cooling under covered or heated roller conveyor, followed by rapid quenching in water
Garret/Edenborn coiling. Slow cooling under covered hoods

Flow stress= 100 – 300 N/mm^2 at 1000 °C $\varphi = 0.5$ $\dot{\varphi} = 1.5 - 100$ 1/sec

Semi-continuous rolling mill. Finishing speed = 40 – 60 m/s. 8-10 stands block; 16-20% reduction. Reversible roughing mill with speed = 2-4 m/s

Figure 2: Mill configuration as a function of the composition of the rolled material

The WICON Rolling Library contains program modules for making all relevant and necessary calculations for setting up the mill on daily basis as well as for making new pass designs and designing new mills, covering all different mill layouts from single stand blooming mills over old looping trains to modern continuous mills, 3-roll blocks and 2-High finishing blocks.

The library cover also all the conceivable symmetrical groove shapes and rolling sequences which can occur when rolling finishing Rounds, Squares, Hexagons and Flats in Wire Rod, Bar or Blooming Mills. By combining the basic groove types it is possible to form hundreds of different sequences to be used in the rolling process. It is also possible to make simulation and calculations of the slit rolling process.

Figure 3 shows the different program modules and how they are connected with one another.
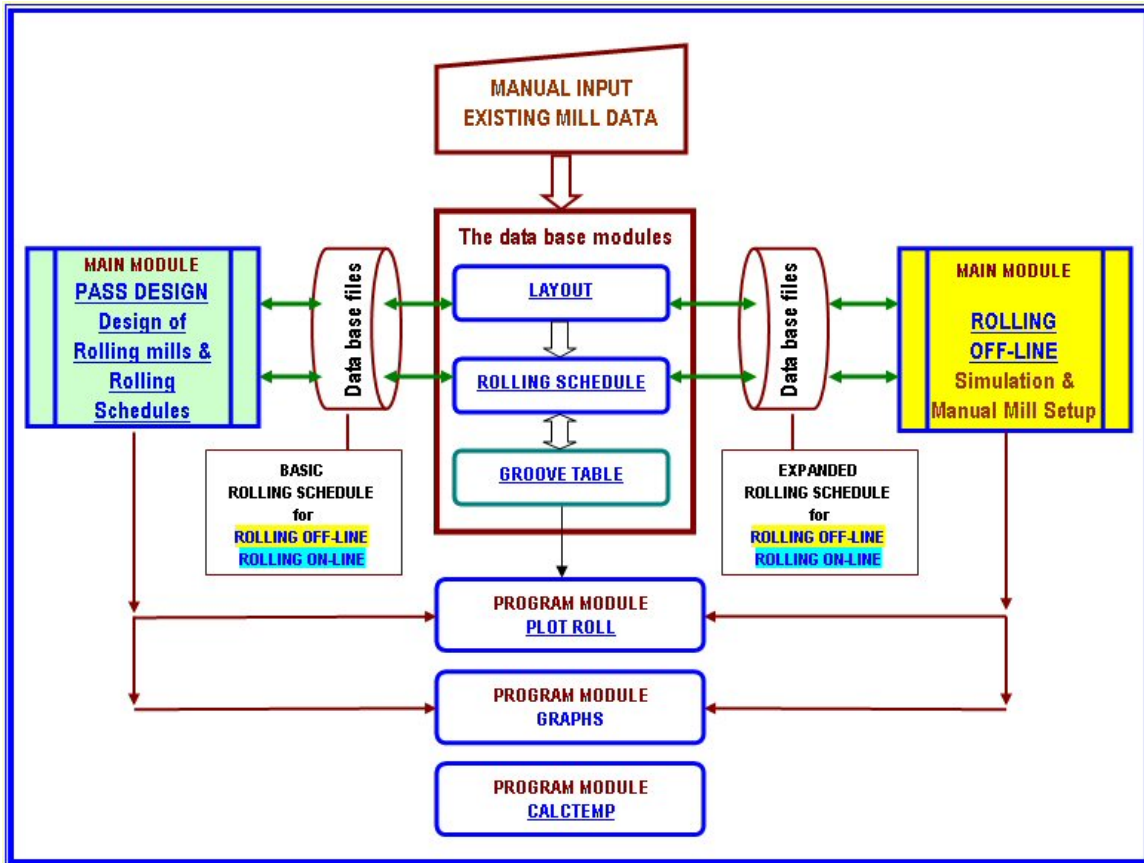
Figure 3: Program modules included in the WICON Rolling Library

The main module ROLLING OFF-LINE is a *dynamic* simulation program which instantaneously recalculates the conditions for the mill setup after any change of the rolling parameters e.g. the gap changing for rolled material with different spread properties.

Making a simulation of an existing mill requires that the database is built in order to load the Layout and the Rolling Schedule data files into the ROLLING simulation module (see the flow chart in Figure 3).
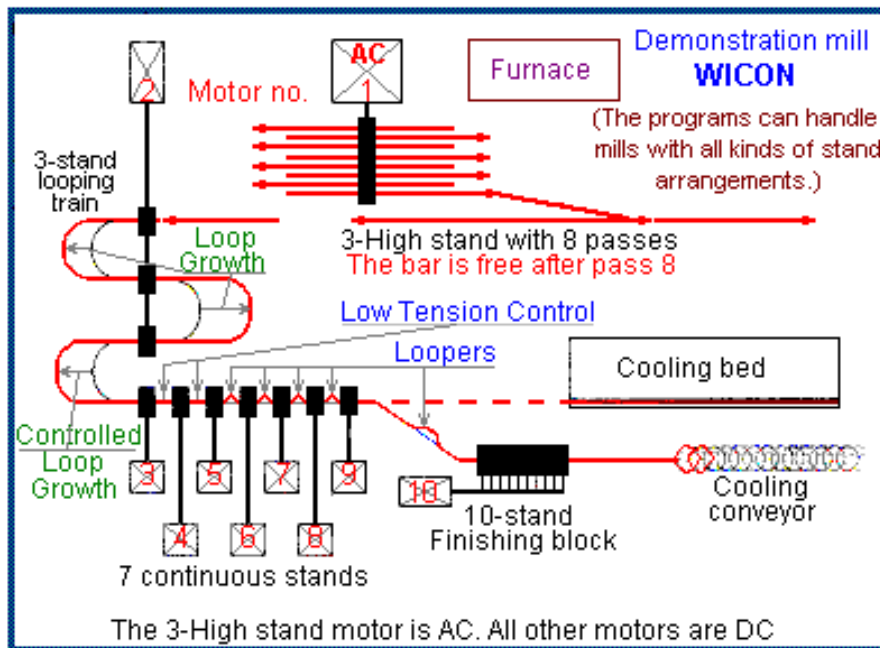

Figure 4: The layout of the existing mill WICON

Figure 4 shows a schematic layout of the existing mill WICON consisting of an older stand configuration in the beginning and a more modern part at the end with continuous stands and a finishing block.

Figure 5: The Layout database table of the **WICON** rod mill

PS no	MOTOR no	STAND Number or Design.	ROLLDIA-METER Outer mm	DIST. m TIME -s	LOOP PULL max m,-%	LOOP PULL min m,-%	MOTOR revol. Max rpm	MOTOR F.W.Ratio Max rpm/ Base rpm	GEAR RATIO motor rpm/ roll rpm	MOTOR Power max kW	Heat Trans. water W/m²°C	Heat Trans. air W/m²°C	Roll Defl. mm/kN*10^4 (- Influence of oil film layer =f(Roll RPM)
1	1	1.1	600.0	-4.00			1050	1.0	7.896	1500	3000	30	3.0
2	1	1.2	600.0	-4.00			1050	1.0	7.896	1500	3000	30	3.0
3	1	1.1	600.0	-4.00			1050	1.0	7.896	1500	3000	30	3.0
4	1	1.2	600.0	-4.00			1050	1.0	7.896	1500	3000	30	3.0
5	1	1.1	600.0	-4.00			1050	1.0	7.896	1500	3000	30	3.0
6	1	1.2	600.0	-4.00			1050	1.0	7.896	1500	3000	30	3.0
7	1	1.1	600.0	-4.00			1050	1.0	7.896	1500	3000	30	3.0
8	1	1.2	600.0	-4.00			1050	1.0	7.896	1500	3000	30	3.0
9	2	1	450.0	10.00	8.0	1.0	900	3.0	14.35	800	3000	30	4.0
10	2	2	450.0	10.00	8.0	1.0	900	3.0	11.285	800	3000	30	4.0
11	2	3	450.0	10.00	8.0	1.0	900	3.0	9.25	800	3000	30	4.0
12	3	1	350.0	4.00		-1.0	800	3.721	2.00	600	3000	30	4.0
13	4	1	350.0	4.00		-1.0	800	3.721	1.4258	600	3000	30	4.0
14	5	1	350.0	4.00			800	3.721	1.00	600	3000	30	4.0
15	6	1	325.0	3.00			1200	1.5	2.935	600	3000	30	5.0
16	7	1	325.0	3.00			1200	1.5	2.3865	600	3000	30	5.0
17	8	1	325.0	3.00			1200	1.5	2.036	600	3000	30	5.0
18	9	1	325.0	20.00			1200	1.5	1.6345	600	3000	30	5.0
19	15	1	216.0	-0.90	-2.0	-0.2	1200	2.0	1.09526	4000	3000	30	60-1.4
20	15	2	216.0	-0.90	-2.0	-0.2	1200	2.0	0.87976	4000	3000	30	60-1.4
21	15	3	216.0	-0.90	-2.0	-0.2	1200	2.0	0.71724	4000	3000	30	60-1.4
22	15	4	216.0	-0.90	-2.0	-0.2	1200	2.0	0.5762	4000	3000	30	60-1.4
23	15	5	216.0	-0.90	-2.0	-0.2	1200	2.0	0.4694	4000	3000	30	60-1.4
24	15	6	216.0	-0.90	-2.0	-0.2	1200	2.0	0.37709	4000	3000	30	60-1.4
25	15	7	216.0	-0.90	-2.0	-0.2	1200	2.0	0.30612	4000	3000	30	60-1.4
26	15	8	216.0	-0.90	-2.0	-0.2	1200	2.0	0.24593	4000	3000	30	60-1.4
27	15	9	216.0	-0.90	-2.0	-0.2	1200	2.0	0.19949	4000	3000	30	60-1.4
28	15	10	216.0				1200	2.0	0.16027	4000	3000	30	60-1.4

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PS no	Std. no	SEQ no	GR shape	OOVE no	SPREAD COEFF. S.C.	GAP nom. mm	MOTOR revol. nom. rpm	LOOP PULL nom. m,-%	ROLL designation	ENTRY GUIDE designation	EXIT GUIDE designation	OPTIONS: Temperature, Bar.Div.by x/, Mult.Slit by S	Number of Strands IF > 1
1	1-1.1	1	BX	1	1.00	8.00			R1-1.1	ROLLER	EX-1	1100	
2	1-1.2	1	TBX	2	1.00	8.00			R1-1.2	BX-2	EX-2	TURN	
3	1-1.1	1	BX	3	1.00	8.00			R1-1.1	BX-3	EX-3		
4	1-1.2	2	DI	4	1.00	8.00			R1-1.2	DI-4	EX-4		
5	1-1.1	2	SQ	5	1.00	8.00			R1-1.1	SQ-5	EX-5		
6	1-1.2	3	BO	6	1.10	8.00			R1-1.2	BO-6	EX-6		
7	1-1.1	3	OV	70	1.20	8.00			R1-1.1	OV-70	EX-70	GZ-L9	
8	1-1.2	3	RD	8	1.25	8.00			R1-1.2	RD-8	EX-8		
9	2- 1	4	BX	9	1.30	4.00			R2-1	BX-9	EX-9		
10	2- 2	4	SQ	10	1.30	4.00			R2-2	SQ-10	EX-10		
11	2- 3	5	BO	11	1.40	2.60		3.0	R2-3	BO-11	EX-11		
12	3- 1	5	SQ	12	1.30	3.20			R3-1	SQ-12	EX-12		
13	4- 1	6	BO	71	1.35	3.00			R4-1	BO-71	EX-71		
14	5- 1	6	RD	81	1.25	1.40			R5-1	RD-81	EX-81		
15	6- 1	7	FL	1	1.30	13.40			R6-1	FL-6-1	EX-6-1		
16	7- 1	7	RD	101	1.20	1.60			R7-1	RD-101	EX-101	RD-R25	
17	8- 1	8	FL	2	1.30	9.80			R8-1	FL-8-1	EX-8-1		
18	9- 1	8	RD	160	1.20	2.30			R9-1	RD-160	EX-160		
19	15- 1	9	OV	1	1.30	2.20			B-1	OV-1	BEX-1	BLOCK	
20	15- 2	9	RD	125	1.20	2.40			B-2	RD-125	BEX-125	BLOCK	
21	15- 3	10	OV	3	1.30	2.40			B-3	OV-3	BEX-3	BLOCK	
22	15- 4	10	RD	105	1.20	1.60			B-4	RD-105	BEX-105	BLOCK	
23	15- 5	11	OV	5	1.30	1.20			B-5	OV-5	BEX-5	BLOCK	
24	15- 6	11	RD	85	1.20	1.50			B-6	RD-85	BEX-85	BLOCK	
25	15- 7	12	OV	6	1.30	0.80			B-7	OV-6	BEX-6	BLOCK	
26	15- 8	12	RD	70	1.20	1.05			B-8	RD-70	BEX-70	BLOCK	
27	15- 9	13	OV	7	1.30	1.20			B-9	OV-7	BEX-7	BLOCK	
28	15-10	13	FRD	55	1.20	1.30			B-10	RD-55	BEX-55	BLOCK	

Show Groove data on/off

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Figure 6: The Rolling Schedule database table of the finishing dimension Round 5.50 mm for the rolling mill WICON
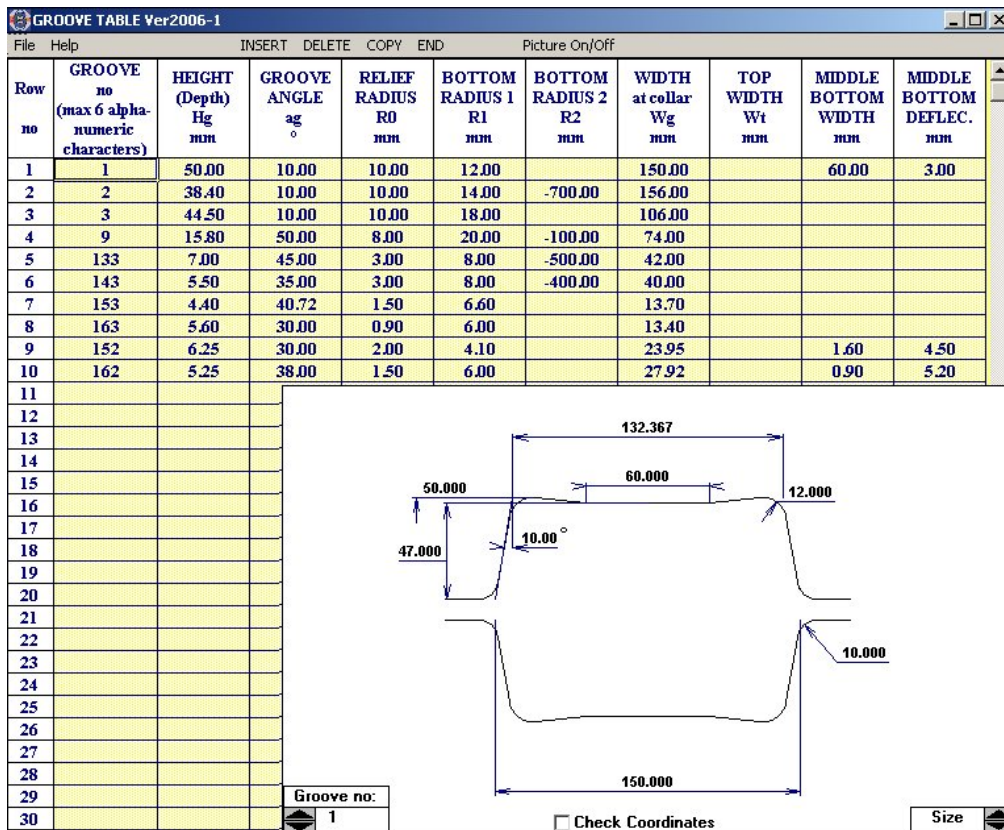
Figure 7: The Groove Table of all the BOX grooves included in the different Rolling Schedules

The data of each groove is inserted in the Rolling Schedule from the Groove Table database. Each type of groove has its own specific table and Figure 7 shows the Box grooves used in the WICON mill

The groove dimensions are as X-Y coordinates included in the Rolling Schedule (Figure 6) in order to display a graphic presentation of the result of the simulation in the ROLLING and PASS DESIGN program modules.

The passes 1 – 13, 15 and 17 marked with the red rectangles in the Rolling Schedule in Figure 6 will be exchanged with a new pass design as described later in this paper.

The Layout table (Figure 5) and the Rolling Schedule table (Figure 6) are loaded into the ROLLING simulation module, in which all the relevant calculations instantly are carried out. Figure 8 shows the result of the simulation as seen on the screen.
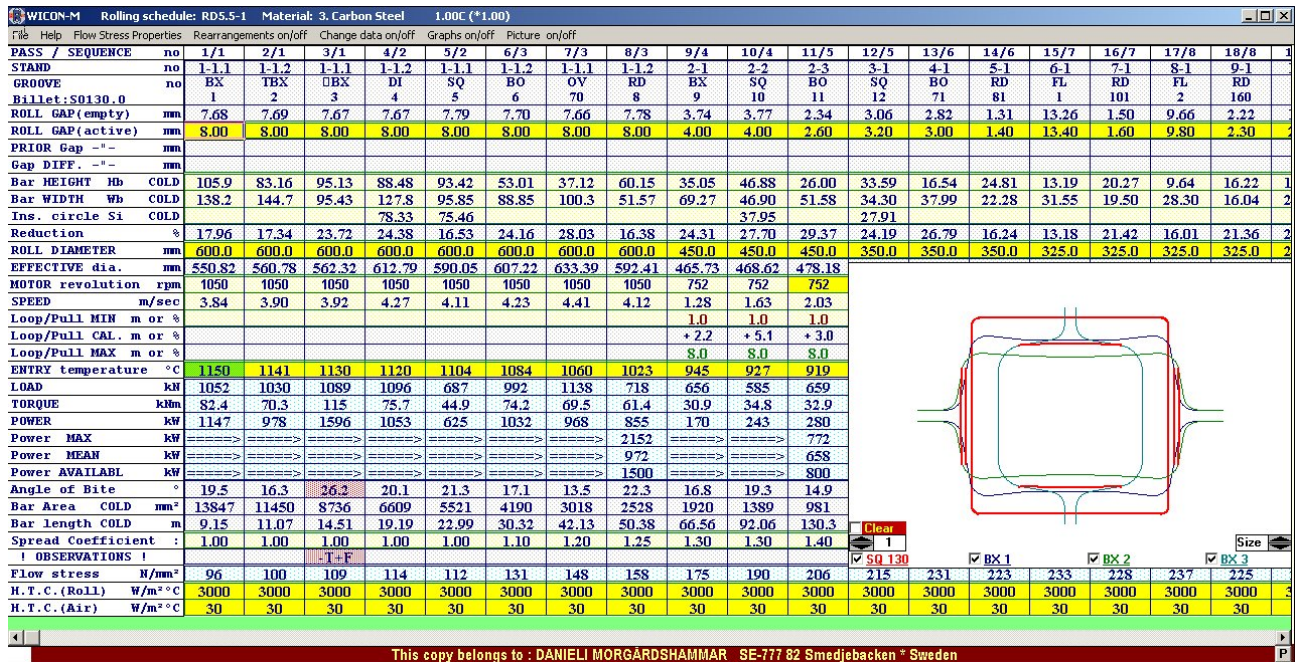
WICON-M   Rolling schedule: RD5.5-1   Material: 3. Carbon Steel   1.00C (*1.00)
File Help Flow Stress Properties   Rearrangements on/off   Change data on/off   Graphs on/off   Picture on/off

	1/1	2/1	3/1	4/2	5/2	6/3	7/3	8/3	9/4	10/4	11/5	12/5	13/6	14/6	15/7	16/7	17/8	18/8
PASS / SEQUENCE no	1/1	2/1	3/1	4/2	5/2	6/3	7/3	8/3	9/4	10/4	11/5	12/5	13/6	14/6	15/7	16/7	17/8	18/8
STAND no	1-1.1	1-1.2	1-1.1	1-1.2	1-1.1	1-1.2	1-1.1	1-1.2	2-1	2-2	2-3	3-1	4-1	5-1	6-1	7-1	8-1	9-1
GROOVE no	BX	TBX	□BX	DI	SQ	BO	OV	RD	BX	SQ	BO	SQ	BO	RD	FL	RD	FL	RD
Billet:S0130.0	1	2	3	4	5	6	70	8	9	10	11	12	71	81	1	101	2	160
ROLL GAP(empty) mm	7.68	7.69	7.67	7.67	7.79	7.70	7.66	7.78	3.74	3.77	2.34	3.06	2.82	1.31	13.26	1.50	9.66	2.22
ROLL GAP(active) mm	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	4.00	4.00	2.60	3.20	3.00	1.40	13.40	1.60	9.80	2.30
PRIOR Gap -"- mm																		
Gap DIFF. -"- mm																		
Bar HEIGHT Hb COLD	105.9	83.16	95.13	88.48	93.42	53.01	37.12	60.15	35.05	46.88	26.00	33.59	16.54	24.81	13.19	20.27	9.64	16.22
Bar WIDTH Wb COLD	138.2	144.7	95.43	127.8	95.85	88.85	100.3	51.57	69.27	46.90	51.58	34.30	37.99	22.28	31.55	19.50	28.30	16.04
Ins. circle Si COLD				78.33	75.46					37.95	27.91							
Reduction %	17.96	17.34	23.72	24.38	16.53	24.16	28.03	16.38	24.31	27.70	29.37	24.19	26.79	16.24	13.18	21.42	16.01	21.36
ROLL DIAMETER mm	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	450.0	450.0	450.0	350.0	350.0	350.0	325.0	325.0	325.0	325.0
EFFECTIVE dia.	550.82	560.78	562.32	612.79	590.05	607.22	633.39	592.41	465.73	468.62	478.18							
MOTOR revolution rpm	1050	1050	1050	1050	1050	1050	1050	1050	752	752	752							
SPEED m/sec	3.84	3.90	3.92	4.27	4.11	4.23	4.41	4.12	1.28	1.63	2.03							
Loop/Pull MIN m or %									1.0	1.0	1.0							
Loop/Pull CAL. m or %									+ 2.2	+ 5.1	+ 3.0							
Loop/Pull MAX m or %									8.0	8.0	8.0							
ENTRY temperature °C	1150	1141	1130	1120	1104	1084	1060	1023	945	927	919							
LOAD kN	1052	1030	1089	1096	687	992	1138	718	656	585	659							
TORQUE kNm	82.4	70.3	115	75.7	44.9	74.2	69.5	61.4	30.9	34.8	32.9							
POWER kW	1147	978	1596	1053	625	1032	968	855	170	243	280							
Power MAX kW	=====>	=====>	=====>	=====>	=====>	=====>	=====>	2152	=====>	=====>	772							
Power MEAN kW	=====>	=====>	=====>	=====>	=====>	=====>	=====>	972	=====>	=====>	658							
Power AVAILABL kW	=====>	=====>	=====>	=====>	=====>	=====>	=====>	1500	=====>	=====>	800							
Angle of Bite °	19.5	16.3	26.2	20.1	21.3	17.1	13.5	22.3	16.8	19.3	14.9							
Bar Area COLD mm²	13847	11450	8736	6609	5521	4190	3018	2528	1920	1389	981							
Bar length COLD m	9.15	11.07	14.51	19.19	22.99	30.32	42.13	50.58	66.56	92.06	130.3							
Spread Coefficient :	1.00	1.00	1.00	1.00	1.00	1.10	1.20	1.25	1.30	1.30	1.40							
! OBSERVATIONS !			.T+F															
Flow stress N/mm²	96	100	109	114	112	131	148	158	175	190	206	215	231	223	233	228	237	225
H.T.C.(Roll) W/m²°C	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	
H.T.C.(Air) W/m²°C	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	

Clear 1   ☑ SQ 130   ☑ BX 1   ☑ BX 2   ☑ BX 3   Size

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Figure 8: The result of the simulation of Round 5.50 as rolled in the WICON mill (18 of 27 passes)

The picture included in Figure 8 shows the first rolling sequence and how the grooves are filled. The grooves are displayed upon one another in the way the bar enters into the next groove in order to better understand the spread conditions. The red lines in the grooves are the free bar edge and the red square is the billet.

ORDER of Calculation:
1:   Spread calculation =
     Function (Geometry, Grade of rolled material, Temperature, Tension.....)
     Purpose: To find the Dimensions of the exiting bar, Forward slip, Effective roll
               diameter and Angle of bite for each pass.
     Direction: From billet to finishing dimension.

2.   Calculation of Speed – Roll/Motor revolution =
     Function (Finishing speed, Area of the bar, Roll diameter, Tension & Forward slip....)

     Purpose: To set the right motor rpm.
     Direction: From Finishing dimension to billet.

3:   Load, Torque & Power =
     Function (Geometry, Grade of rolled material, Temperature, Tension....)
     Purpose: For new mills and revamping which requires new or additional stands:
               To find suitable dimension of stands, gear boxes, motors etc.)
               For existing mills:
               To check the load distribution of the stands and motors as well as input
               data for the EMPTY gap and temperature calculations.
               Direction: From billet to finishing dimension

4.   Calculation of temperature =
       Function (Power, Dimension & Heat transfer coefficients)
       Purpose: To find the entry temperature into next pass.
       Direction: From billet to finishing dimension.

5.   Calculating the EMPTY gap =
       Function (Load, Dimension, Mechanical roll deflection & Oil film factor)
       Purpose: To find the Empty gap setting in order to get the desired Active

gap

              for the loaded stands. Of greatest importance for stands with oil

film

              bearings e.g. finishing blocks.
       Direction: From billet to finishing dimension.

All the calculations above are complicated and are nested in a way that requires a more than a simple spread calculation program. Many of the calculations require a loop calculation of 100 times to find the most exact result. An example is the calculation of the bar dimension of stands under tension.

The spread calculation is based on equivalent rectangles applied on an improved and developed spread formula.

Each groove consists of a number of elements (lines and arcs) between the coordinates C0- C1, C1-C2 ….. in the groove drawing above. The equivalent rectangles require a subroutine which is searching for the intersection points between the entry and exit groove of the pass. This is done by checking which element of the entry groove is intersecting which element of the exit groove. After finding the 2 intersecting elements (line – line, line – arc, arc – line, arc –arc etc.) the subroutine calculates the coordinates for the intersecting point.

In the next step the exit width of the bar is calculated taking into account also the influence of applied tension between the stands. The calculation is based on constant volume, which means that the exit area from a stand 2 has to decrease to the same amount as the increase of the speed of the stand 2 compared to stand 1. Figure 9 shows the speed – area relations when rolling without and with tension between two stands.

The exit area A2T from stand 2 in Figure 9 can only **decrease by reduced exit width.** When the width changes then also the Effective roll diameter (Working diameter at the neutral point * the Forward Slip) changes. That requires a step by step loop calculation to find the balance of altered width and altered Effective Diameter to give the constant volume condition.
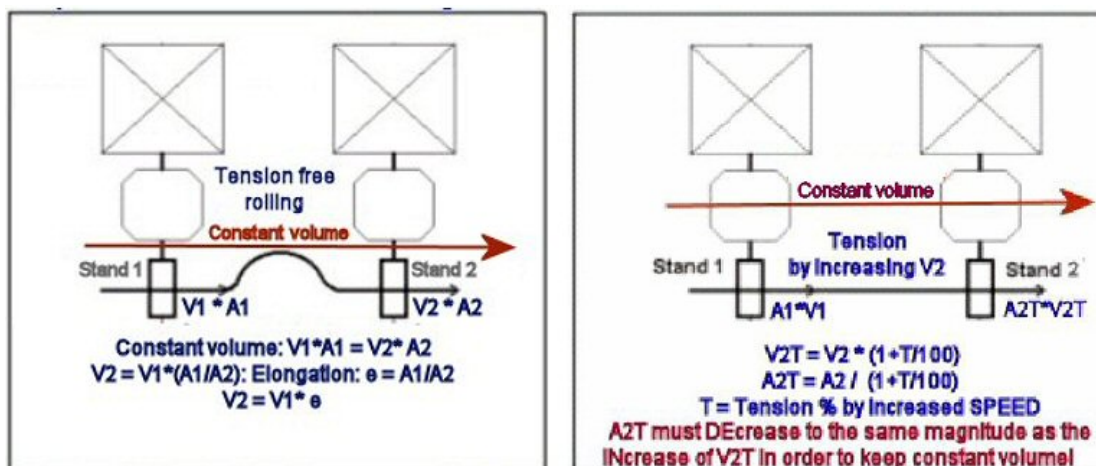
Figure 9: The influence of the tension between two stands on the exiting width from stand 2.

The leading end of the bar will always be rolled without tension, as the tension only can work when the bar is in contact with at least two stands at the same time. That means that the leading end and also the tail end will have larger width than the rest of the bar which has been rolled in a steady state condition, see Figure 10.

The difference in width along the bar will be larger the larger tension and the more stands controlled by Low Tension Control in separate driven stands or the more stands there are in a block. The length of the width difference is depending on the distances between the stands and the reductions in each stand.
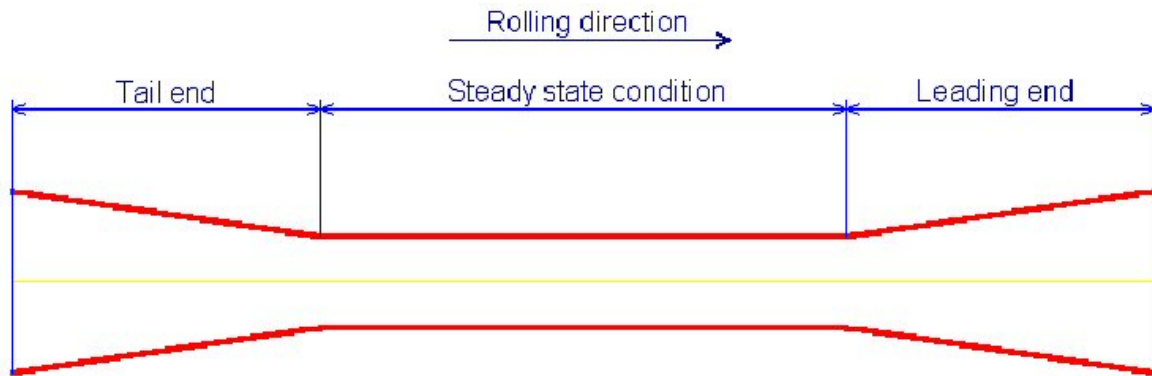
Figure 10: The influence of tension between stands

The following description is an example of a "revamping project", in which the existing billet of square 130 mm in the WICON mill is exchanged with a round 145 mm billet, which requires a new pass design in the 3-high stand. The calculations are carried out in the PASS DESIGN program module:

Step 1:   Load the WICON layout and the existing Rolling Schedule RD5.50-1. Change the billet shape and size to RD145 and make the calculation in the existing grooves. The result is shown in Figure 11, which indicates that the 2 first grooves of sequence 1 are overfilled.
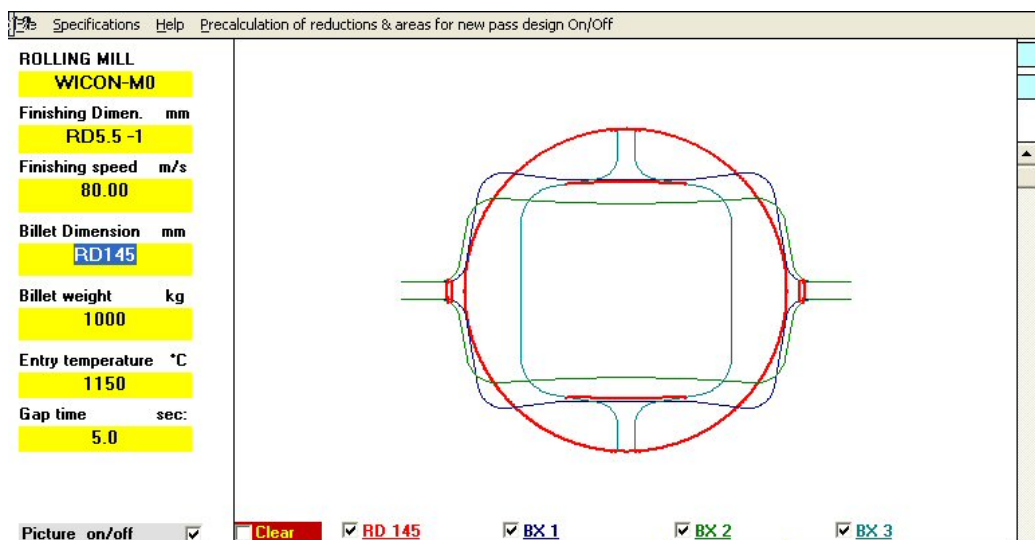
Figure 11: The new round billet rolled in the existing grooves of the first sequence

Step 2:   The reduction calculator (Figure 12) opens by clicking "Precalculation of reduction & areas for new pass design On/Off" in the menu bar. By clicking the up and down arrows the number of existing finishing passes is settled in this case the last 22 passes will be kept.

The total number of passes is also kept, which means that the first 6 passes will be redesigned. The calculator is closed by clicking "Precalculation …" again. The name of the mill is now changed to XXXMILL in order not to destroy the original layout table if changes of e.g. gear ratio have to be carried out.
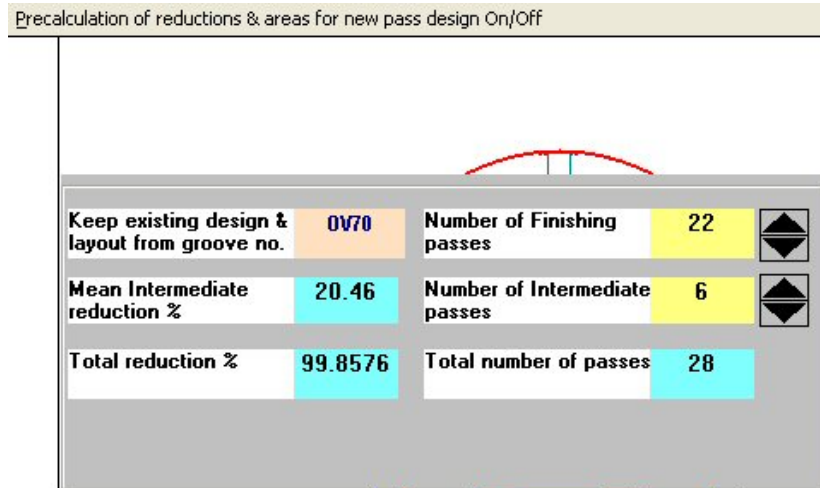
Figure 12: The reduction calculator

Step 3:   The required data for making the new pass design of the first rolling sequence is inserted as seen in Figure 13. The groove combination is decided to be Round – Diamond – Round as an example of the many groove combinations that the program can handle. The design parameters of the bar are entered in the yellow section and are at this stage only given for the entry and exit bar of the sequence.
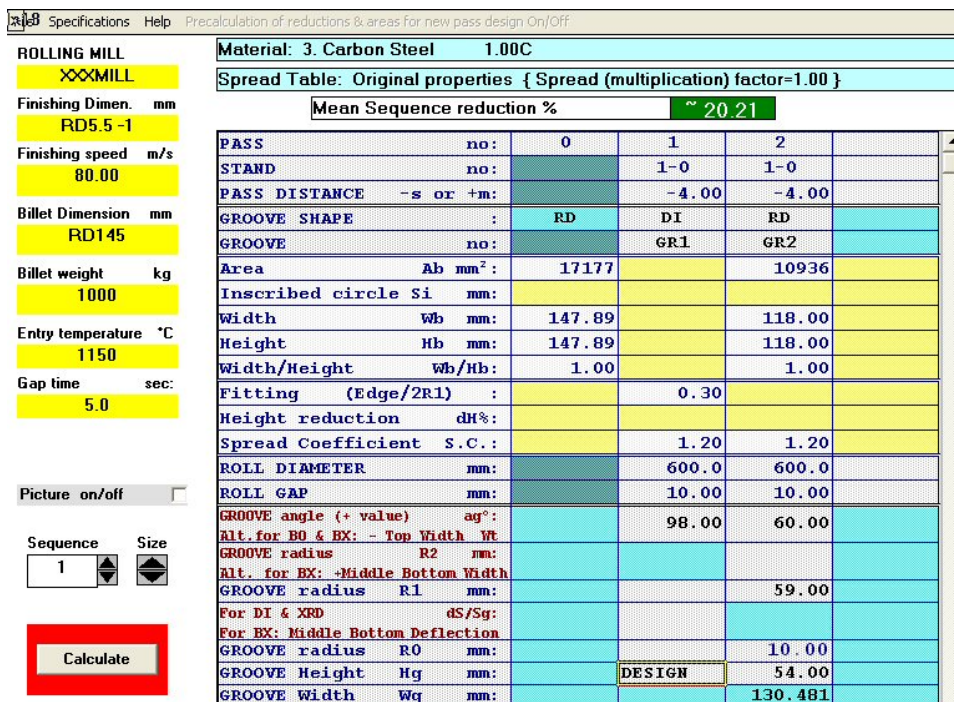
Figure 13: Input data for the new pass design of the first sequence.

By clicking the "Calculate button" in Figure 13 the design of the intermediate DI-groove is carried out by means of equivalent rectangles and spread calculation. The depth and angle of the DI-groove is step by step altered to find the final result of getting the right width of the exit bar as well as fulfilling the desired Fitting parameter. It might require 100 looped calculations to reach the required result.

The result is presented in Figure 14, which includes a picture that shows how the grooves are interacting as well as the dimensions of the grooves. The picture is in this case covering the yellow section where the dimensions of the bars are presented. Under the blue part with the dimensions there are also other important process parameters presented. Each value has to be thoroughly examined and evaluated before the final acceptance of the design.

ROLLING MILL
XXXMILL

Finishing Dimen. mm	RD5.5 -1
Finishing speed m/s	80.00
Billet Dimension mm	RD145
Billet weight kg	1000
Entry temperature °C	1150
Gap time sec:	5.0

Picture on/off ✓

Sequence 1   Size

Calculate

		RD 145	DI GR1	RD GR2	
GROOVE angle (+ value) ag°:			122.00	60.00	
Alt.for BO & BX: – Top Width Wt					
GROOVE radius R2 mm:					
Alt. for BX: +Middle Bottom Width					
GROOVE radius R1 mm:			59.00	59.00	
For DI & XRD dS/Sg:					
For BX: Middle Bottom Deflection					
GROOVE radius R0 mm:			10.00	10.00	
GROOVE Height Hg mm:			48.00	54.00	
GROOVE Width Wg mm:			203.705	130.481	
Area reduction %:			28.39	11.25	
Angle of Bite °:			23.50	24.80	
Bar length m:		7.88	11.00	12.39	
Loop Growth m:					
SPEED m/sec:			4.18	3.75	
Motor revolution rpm:			1050.00	1050.00	
Entry temperature °C:			1150	1143	
H.T.C. (Roll) W/m²°C:			3000	3000	
H.T.C. (Air) W/m²°C:			30	30	
LOAD kN:			1609.14	847.87	
TORQUE kNm:			148.17	71.17	
POWER kW:			2062.10	990.40	
PASS no:		0	1	2	

Figure 14: The result of the new pass design for sequence 1

Step 4:   After the first sequence in Figure 14 is approved the pass design work continuous with the next sequence. By clicking the up arrow of the sequence label the exit groove of the first sequence is moved to become the entry groove of the second sequence as shown below.
The required data for making the new pass design of the second rolling sequence is inserted in Figure 15. The groove combination is also here

decided to be Round – Diamond – Round. The design parameters of the bar is entered in the yellow section and is at this stage only given for the exit bar of the sequence as the entry bar data is transferred from the design of the first sequence.

Figure 15: Input data for the new pass design of the second sequence.

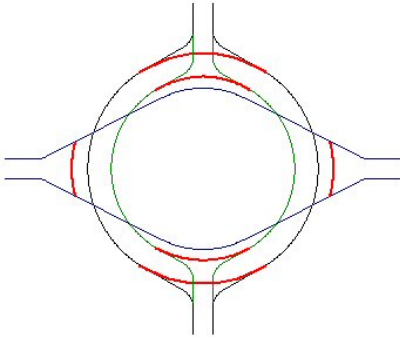By clicking the "Calculate button" again the design of the intermediate DI-groove of sequence 2 is carried out the same way as for the first sequence and the result is shown in Figure 16.

Figure 16: The result of the new pass design for sequence 2

The design of the sequence 3 is carried out in the same kind of operation but for the groove combination RD – OV –RD. The exit groove of sequence 3 is the connecting groove to the oval OV70 in sequence 4. By the design of sequence 3 connected to sequence 4 the there is

a new complete Rolling Schedule available for the simulation in the ROLLING module.

By clicking File – Save – Sequences all geometrical data of the simulated Rolling Schedule is saved to be available for the PLOT ROLL "CAD" program. That program is used for making groove drawings, roll drawings and groove plans and has also an interface to other common CAD programs.

Figure 17 shows the groove plans of the first three sequences of the original and the new pass design in the 3-high mill.
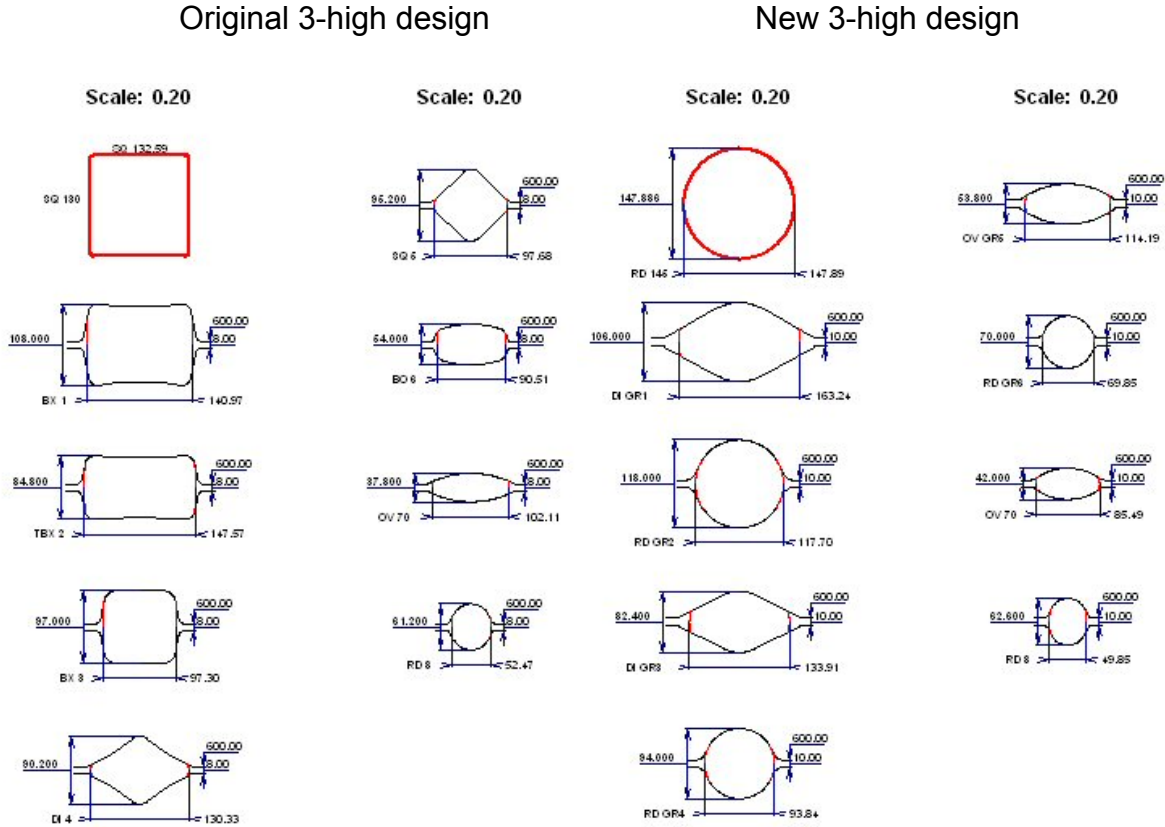
Original 3-high design   New 3-high design

Figure 17: The groove plans of the first 8 passes

This is very short description of the capability of the WICON Rolling Library. A more comprehensive description is found on the website www.wicon.se or in the promotion CD, which is available by an E-mail contact to wicon@morgardshammar.se .

WICON with the products the "Rolling Library" (the computer program library for billet, bar and rod mills) and the "Rolling On-line" for level 2 process control, is now incorporated in Danieli Morgårdshammar, completing the range of products and services offered by the company.