



## ULTIMA™ - HIGH PERFORMANCE SPUN CAST WORK ROLLS FOR ROLLING LONG PRODUCTS\*

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### Abstract

Ultima™ rolls have been designed for intermediate and finishing stands of rod and bar and small and medium section mills. The rolls and rings are spun cast, with a highly alloyed working layer and a tough nodular iron core. Microstructure and hardness level can be adjusted over a wide range, which allows us to adapt the rolls to differing rolling conditions. After introducing the Ultima™ concept, this paper will describe the results of Ultima™ rolls achieved in various mill applications, like finish rolling of rebar, and slitting. Special emphasis is given to performance gains when using Ultima™ rolls, compared to standard rolls. This paper also examines the impact of Ultima™ rolls on mill and roll shop productivity.

**Keywords:** Rolls; Ultima; Intermediate stand; Finishing stand; Rod section; Bar section.

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## 1 WHAT IS ULTIMA™?

Ultima™ is a new family of CC duplex cast work rolls.

The working zone of the roll consists of highly alloyed martensite with a carefully controlled dispersion of high hardness carbides, see fig. 1.

The rolls can be supplied between 65 and 85 ShC, and may be ordered within a 5 ShC range (e.g. 75 – 80 ShC).

The core and necks consist of high strength nodular cast iron. The typical neck hardness is  $45 \pm 3$  ShC.

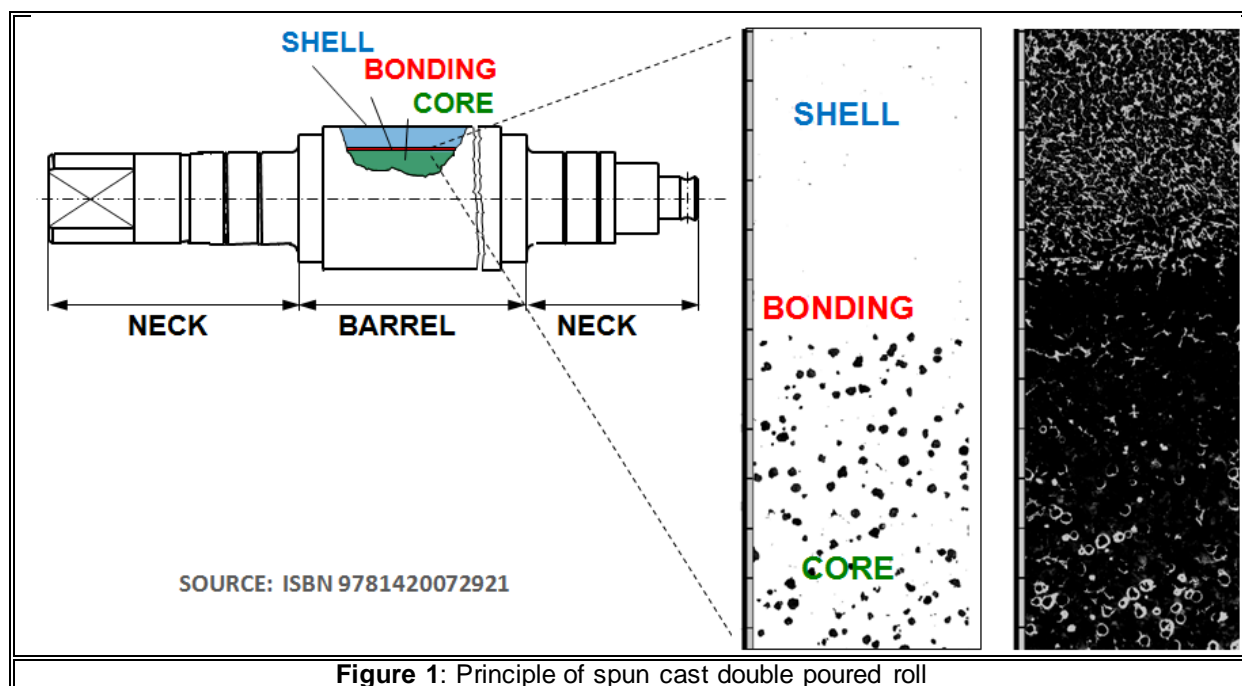


Figure 1: Principle of spun cast double poured roll

## 2 WHAT IS NEW ABOUT ULTIMA™?

All hot mill work rolls have to provide high wear resistance and fire crack resistance at the same time.

A very high content of hard carbides and highly alloyed martensite can provide maximum wear resistance.

This has consequences for the mills.

Advanced roll materials must be adequately cooled if they are to return maximum performance. They require relatively high water volumes, delivered at the correct pressure. Additionally, the water must be directed, using precisely positioned nozzle arrangements, to guarantee the optimum angle of incidence of the spray.

State of the art cooling arrangements would provide the ideal working situation for a high performance roll. Unfortunately it is not available in many mills, and actual rolling conditions can be far removed from ideal.

This sets a limit for many mills, when it comes to trials with advanced high performance roll grades.

The Ultima™ concept provides a solution for rolling mills trying to increase performance and output, but suffering from shortcomings in the cooling system.

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By variation of the carbide/martensite ratio in the shell, the Ultima™ rolls can be perfectly adjusted to the prevailing working and cooling conditions in the individual mill stand. We recommend starting “on the safe side” with moderate carbide content, and hardness. After gaining experience with the Ultima™ rolls, the amount of carbide in the microstructure and/or the roll hardness can be increased step by step, until the target performance level has been reached.

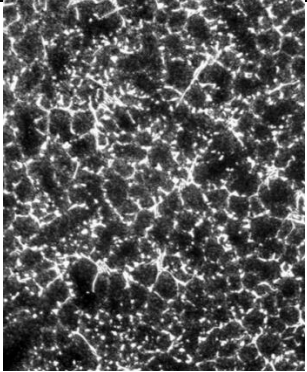
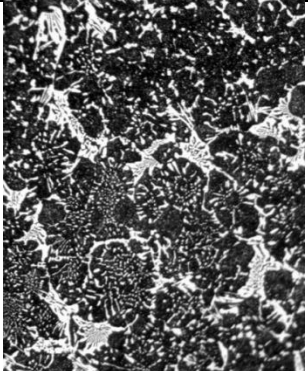
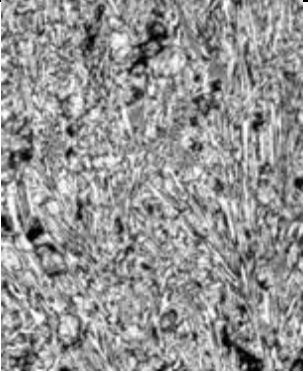
### 3 THE ULTIMA™ CONCEPT IN DETAIL

Fig. 2 shows the microstructure of 3 types of Ultima™, providing a wide variation of carbide content (Ultima 1: 6 - 8%, Ultima 2: 12 – 14%, Ultima 3: 20 – 24%) and hardness levels.

The complex carbides found in Ultima™ rolls exhibit high hardness (above 1400 HV), and differ significantly from the carbides present in conventional cast iron rolls.

The hardness level of all Ultima™ variations can be adjusted to the actual mill requirements. The range is from 65 to 85 ShC, which is 714 to 830 Ld.

The hardness adjustment is obtained during a complex heat treatment process. For production, we need a range of 5 ShC which needs to be specified in the roll order.

	ULTIMA™ 1	ULTIMA™ 2	ULTIMA™ 3
microstructure M = 100x			
80 – 85 ShC	Available	available	x
75 – 80 ShC	Available	available	available
70 – 75 ShC	Available	available	available
65 – 70 ShC	X	available	available

**Figure 2:** 3 different ULTIMA™ types and their hardness range

### 4 INTRODUCTION OF ULTIMA™ TO THE MILLS

The first Ultima™ rolls were shipped in 2010. The main focus at the beginning was rod and bar mills, mainly dog bone, slitting and finishing.

The rolls designed for slitting and finishing of rebar were also used for earlier stands, with round and oval passes. The experience of most mills showed that rolls that work for slitting and finishing, may not be ideal for round and oval. For “simple” passes, higher wear resistance is required. This led to the development of various Ultima™ types as described previously.

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Next step was the introduction of Ultima™ in small section mills. Small angles are rolled successfully in various plants, and now trials with stainless steel angles 1.5" x 1.5" are underway.

Up to now, more than 500 Ultima™ rolls have been shipped. The rolls are well established in long product rolling, and compete successfully even with carbide rolls and rings.

## 5 ROLLING AND COOLING CONDITIONS

Some high tech roll and ring materials only work well, under particular operating conditions. Usually, they require complex cooling systems with high water pressure (6 bar or more) and bespoke spray systems.

When low rolling speeds are used, many high performance materials do not work to maximum effect. When designing the BRC range of Ultima rolls, we have paid special attention to mills with low rolling speeds and low pressure water cooling systems.

The following table shows some of the applications where Ultima rolls are in service, and gives an idea about the rolling speed and the water pressure of the cooling system.

Table 1.

Pressure of cooling water pass shape	2 - 3 bar	3- 4 bar	4- 6 bar	>6 bar
Round	3 m/s	2,5 m/s	2 m/s	1, m/s
Oval	3 m/s	2,5 m/s	2 m/s	1 m/s
Dog bone and slit		3,6 m/s		
Rebar finishing		3,1 m/s		
Flat		3 m/s	2,5 m/s	
angles		7,5 m/s	5 m/s	4 m/s

Ultima rolls have been used successfully at low rolling speeds, with very moderate water cooling as well. This data does not necessarily represent the lower limits. Our research in this area continues,— maybe we can go below the mentioned rolling speeds. Time will tell.

## 6 MILL EXPERIENCE WITH ULTIMA™ ROLLS IN VARIOUS ROLLING APPLICATIONS

The following examples show the results of Ultima rolls in different mills, operating a wide range of both rolling conditions and product size. We will compare surface finish, wear characteristics and campaign length achieved with Ultima and conventional grades like SG (nodular iron) and AIC (Indefinite chill).

First example:

→ Bar Mill stands no. 10 to 12 – round / oval pass, rebar finishing - roll size: 400 x 650 mm

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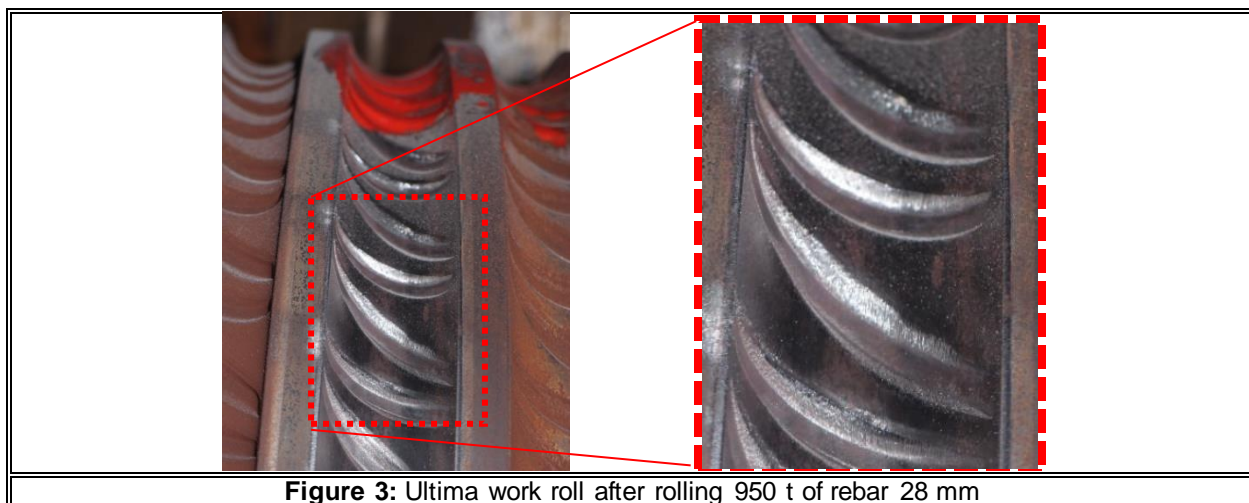
→ General conditions: stands 10 to 12 - cooling water pressure: 4,5 bar (ca. 65 psi), volume flow: 350 l/min (ca. 12,4 cfm), rolling speed: 2.6 to 3.1m/s (ca. 9,2 to 10,2 ft/s)

**Table 2.**

stand	pass	rolling speed	number of passes	tons per pass	tons per campaign	redressing	tons per set of rolls
10	round 33 mm	2,6 m/s	10	6.400	64.000	7,0 mm	500.000
11	oval 48x24 mm	3,1 m/s	10	4.800	48.000	5,5 mm	530.000
12	finish rebar 28 mm	3,6 m/s	16	950 400	15.200 6.400	5,0 mm 7,0 mm	185.000 51.000*

\*: SGP 65 ShC

Figure 3 shows the surface of a Ultima stand 12 bottom roll after rolling 950 t of rebar 28 mm. The surface still looks good, with moderate wear.



**Figure 3:** Ultima work roll after rolling 950 t of rebar 28 mm

Second example:

→ Bar Mill dog bone and slitting 2 x 2 3/4" (ca. 19mm) rebar - roll size: 340 x 500 mm

→ General conditions: stand 9 dog bone, stand 10 slitting, cooling water pressure: 4 to 5 bar (ca. 58 to 73psi), volume flow: 350 l/min (ca. 12,4 cfm)

A first step of performance improvement was done by changing from standard static cast SGA to double poured CCduplex SGA 68 – 72 ShC, which improved the average campaign length from 960 to 1.500 tons per pass in both stands.

The introduction of HSS led to a significant further improvement:

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Table 3.

Stand	roll Type	number of passes	tons per pass	tons per campaign	redressing	total roll life	campaigns during roll life	tons per set of rolls
dog bone: 2 x 2 3/4"								
9	CC duplex SGA	6	1500	9000	6 mm	60 mm	10	90.000 t
9	ULTIMA TM	6	4800	28800	4,2 mm	60 mm	14	> 400.000 t
slitter: 2 x 2 3/4"								
10	CC duplex SGA	6	1500	9000	6 mm	60 mm	10	90.000 t
10	ULTIMA TM	6	4800	28800	4,2 mm	60 mm	14	>400.000 t

For an annual production of 500.000 tons, this lead to the following calculation:

Table 4.

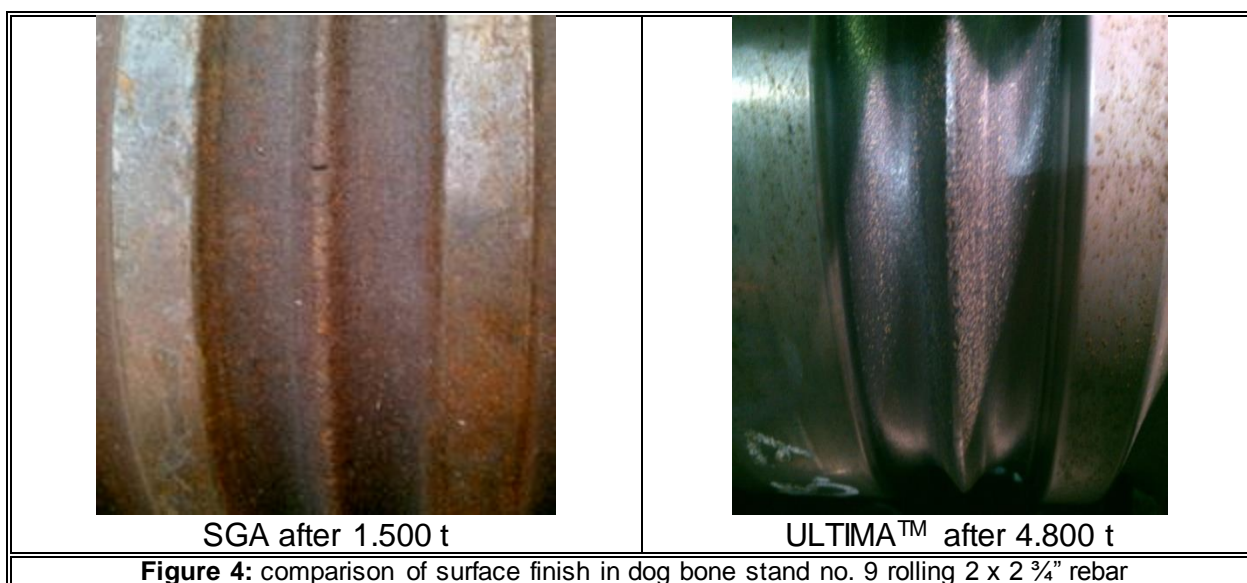
	roll passes used for 500.000 t production in stands 9 and 10	roll changes and dressing operations per year for stands 9 and 10	Roll consumption per year for stands 9 and 10	Annual time consumption for pass and roll changes (pass: 15 min, roll: 25 min)
CCduplex SGA	666	111	22	185 hours
ULTIMA	208	35	4,8	58 hours
SAVINGS	-	76 roll changes	18 rolls	127 hour mill down time

What is the result of these savings?

- 127 hours of additional production time in the mill increases the mill output
- 76 roll changes less means less work load on the roll shop
- 152 roll machining operations in the roll shop
- Preparation of 76 roll stands

In addition to this cost saving potential, we could observe an increase of product quality due to less wear and improved surface condition especially in the dog bone stand, see fig. 4.

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### Third example:

- Dogbone – 4strand slitter – leader – finisher of rebar #3 (3/8", ca. 9.5mm) - roll size: 340 x 500 mm
  - General conditions: stands 15 - 18, cooling water pressure: 5 to 6 bar (ca. 73 to 87 psi), volume flow: 500 l/min (ca. 17,7 cfm )
  - Standard rolls in service: AIC alloy indefinite chill 70 – 75 ShC
  - Trials were made with: Ultima 75 – 80 ShC
- The following results were achieved: product rolled: #3 rebar (3/8", ca. 9.5mm)

**Table 5.**

stand	roll grade	tons per pass	number of passes	tons per entry	average redressing (mm)	roll life (mm)	campaigns per roll life (estimated)	total tons (estimated)
dogbone (4 strand)								
15	AIC	600	8	4800	3,5	55	15	72000
15	Ultima	1800	8	14400	2	45	22	>316800
slitter (4 strand)								
16	AIC	600	8	4800	3,5	55	15	72000
16	Ultima	1800	8	14400	2	45	22	>316800
leader (flat pass)								
17	AIC	700	7	4900	3	55	18	88200
17	Ultima	2000	7	14000	2	45	22	>308000
finishing (notching pass)								
18	AIC	300	8	2400	3,5	55	15	36000
18	Ultima	1200	8	9600	3,5	45	15	144000

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The higher performance of the Ultima rolls is evident.

The use of such rolls has an impact on mill and roll shop operations, and on profitability of the whole plant. Also in this case, a rough estimation was made to calculate savings through use of Ultima rolls.

*Roll shop:* The roll shop has to remachine about 700 AIC rolls per year. Changing to Ultima would reduce the annual grindings to 210.

→ Savings: 2000 hrs machining time

The same applies to the number of mill stands that have to be assembled per year.

210 instead of 700 stand assemblies would reduce the workload on the roll shop by another 2.500 hours!

*Mill:* 210 roll changes instead of 700 would reduce the mill down time by about 750 hours per year, resulting in about 50.000 t additional production!

## SUMMARY

Ultima™ rolls have been developed for intermediate and finishing stands of long product mills. Since the introduction in 2010, more than 500 rolls have been delivered, most of them to rod and bar mills. The rolls have proven to be reliable in operation, without the sensitivity exhibited by other high tech products.

Ultima™ rolls can yield serious performance gains in various applications of long product rolling by:

→ Significant reduction in roll changes per week/year, and number of machining operations in the roll shop.

→ Increase of mill availability.

→ Reduction of roll inventory.

→ Improved product yield by the reduction of downgraded bars due to chipping of slitting rolls

Existing pass designs can be used, and there are no changes required in the roll machining operations.

Ultima™ rolls represent a breakthrough in many long product rolling applications.

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