

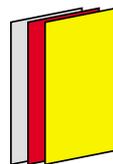


SUGAR MILL ROLLERS THAT LAST A SEASON



*More than 2 million
tonnes crushed ...*
NON-STOP!!!

Exclusive to:-



**ABRASION
RESISTANT
MATERIALS** PTY
LTD

ACN 070 411 522



#01: Bagasse covered section of teeth after 1.0 million tonnes during 1997 at South Johnstone Mill with no maintenance (also see photo #14).



#02: South Johnstone Mill in 1997. Top roll No. 4 Mill. This is the standard chromium carbide hardfacing section (not the A.R.M.* invention) which was re-hardfaced approximately 14 times during the trial, and lost about 25mm in diameter.



#03: The A.R.M.* roll at Tully Mill in 1998, top roll No.2 Mill, after it had completed 1,000,000 tonnes – with no maintenance.



#04: The Standard Chromium Carbide hardfaced No. 4 Mill top roll at Tully Mill in 1998. This roll lost around 25mm diameter during the season and was re-hardfaced about twice each week.



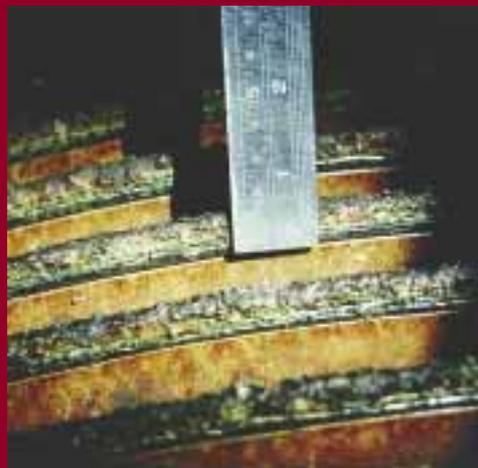
#05: The A.R.M.* Hardfaced top roll No. 4 Mill, Tully 1999-2000. Pictured here at 1.6 million tonnes with no maintenance. It went on to complete both the 1999 and 2000 seasons for a total of 3.2 million tonnes.



#06: The top roll at Tully in 1998 after 1.0 million tonnes. Note that the bottom of the grooves are not worn.



#07: The Top and Delivery rolls at Tully No. 2 mill in 1998. Having completed 1,000,000 tonnes to this point, with no maintenance.



#08: The top roll at Tully Mill in 1998 at 1,000,000 tonnes. At this point the roll had lost 2-3mm in diameter.

SINCE around 1973, the sugar industry has used chromium carbide hardfacing products either applied with electrodes or wire.

This technique has provided a reasonable level of grip, but needs to be constantly “touched up” or maintained.

An article published by the Welding Technology Institute of Australia states that this method (of welding chromium carbide hardfacing onto the mill roll shells) deposits less than 50% of the welding consumable, with the balance being lost as waste.

This wastage of material alone, could amount to approximately US\$25,000 for each sugar mill.

INTRIGUE AND CURIOSITY LEADS TO PATENT-PENDING APPLICATIONS

Initially, it was intrigue and curiosity that led Tim Falkenhagen, the managing director of Abrasion Resistant Materials Pty Ltd (A.R.M.*) to consider whether certain hardfacing processes and welding techniques with which he had been experimenting in other industries, could be combined to manufacture a new type of roll shell, and perhaps be applied via a “plurality of layers” onto existing Gray cast-iron sugar mill rolls.

Tim Falkenhagen came up with some ideas that he felt could overcome the “wear mechanics” that plagued sugar mill rolls during the crushing season, and after filing patent pending applications of his ideas, set out to put them into practice.

Up until this time, there were no products or options commercially available which allowed a sugar mill roll to last a season without needing to be regularly arc-welded for grip.

This was all about to change with the A.R.M.* Hardfacing technique/s that Tim had

A.R.M.* patented mill roll promises huge benefits for sugar industry



Tim Falkenhagen picture

invented and is in the process of refining.

In 1997, an opportunity arose to work with the Sugar Research Institute (SRI) in Mackay on a mill roll project to demonstrate the effectiveness of Tim's invention.

THE 1997 MILL ROLL TRIAL AT SOUTH JOHNSTONE MILL

In the 1997 season, it was decided to trial the A.R.M.* Hardfacing invention by applying it to the centre 42 teeth on the top roll in No.4 mill (a 7ft roll with a 1" pitch) at South Johnstone Mill.

The trial was a SRI-syndicated project involving all sugar mills in Australia, with SRI nominated by A.R.M.* to report the outcome of the trial as it found them.

A.R.M.*'s preparation included transporting over 300kms, more than three tonnes of specialised welding equipment, and involved a specific procedure developed by A.R.M.* to apply the now-patented Hardfacing.

Part of the procedure involves machining the mill roll teeth to a particular profile, prior to the welding of the Hardface material to the teeth.

It was during this machining process that the special lathe tool became broken and was inoperable. It would take two weeks for the lathe tool to be replaced.

However, the A.R.M.* crew were able to use this "occurrence" to improvise, and the breakdown turned out to be a blessing in disguise, as it allowed extra scope for experimentation.

During this trial A.R.M.* evaluated seven (7) different combinations of tungsten carbide hardfacing applied to a Gray cast-iron roll shell.

All of the seven options lasted with good grip, up till about the 300,000 tonne mark. It was at about this point that some teeth started to polish smooth, and began losing grip.



LEFT: The typical mill roll tooth profile used at South Johnstone Mill on the 1" pitch rolls. It was clearly not suitable to be used with the now patented A.R.M.* Hardfacing process.



The patented A.R.M.* ally to allow a "Plur" to be applied and y

However, one trial section of the A.R.M.* teeth lasted the entire season of 1,092,627 tonnes, with very little wear (see photo #14). There was no doubting that particular option could have gone on to last a lot longer.

Statistics showed in the 1997 trial the A.R.M.* Hardfaced centre-section of the mill roll only lost around 5mm in diameter, with the side of the teeth wearing only approximately 3mm.

The other sections of the mill roll (which used the standard chromium carbide hardfacing) were arc-welded at least fourteen (14) times, and lost around 25mm in diameter.

The results from this first test proved to be very encouraging, and led to a larger project being approved for the Tully Mill in 1998.

THE TULLY MILL PROJECT... 1998 - 1999 - 2000

The Tully Mill project was another syndicated project funded by the Australian Sugar Mills and A.R.M.*. SRI was again nominated by A.R.M.* to report the results as it found them.

The 1998/99 projects were coordinated and reported by Dr Sander Kroes from SRI (now at Fiji Sugar). His paper was published in the 1999 ASSCT notes and is a true account of the trial.

SUMMARY OF THE TULLY MILL ROLL TRIALS IN 1998, 1999, 2000

The A.R.M.* Hardfacing applied in 1998 was of a greater depth on the mill roll compared to the 1997 trial.

All three rolls used in the 1998 trial lasted up to about the 1.2 million tonne point without any welding maintenance for grip.

The Feed and Delivery rolls were maintenance free for the entire season of 1.9 million tonnes. The diameter loss on all A.R.M.* Hardfaced rolls was around 5mm.

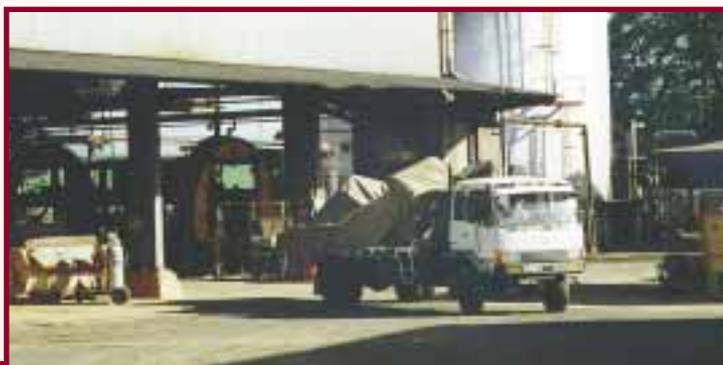
The top roll in the 1998 trial suffered a higher wear rate and lost material from the side of the teeth, just below where the A.R.M.* Hardfacing stopped. This resulted in an "undercut" wear on the roll teeth, which at a point of approx. 4mm thick, the A.R.M.* Hardfacing would break off.

To overcome this problem, in the 1999 trial a new top roll was installed in No.2 mill with additional A.R.M.* Hardfacing applied.

The delivery roll used in the 1998 trial was re-used for the 1999 season. A new A.R.M.* Hardfaced top roll was also installed in the No.4 mill (which has a 7ft roll with a 1.5" pitch).

The top roll in No.2 mill lasted the entire 1999 season with about only 10% of the A.R.M.* Hardfacing being detached.

The undercut wear (or more correctly - roll



RIGHT: The A.R.M.* truck used to ship the large quantity of welding equipment to South Johnstone Mill in 1997 to complete the welding of the top roll No. 4 mill.



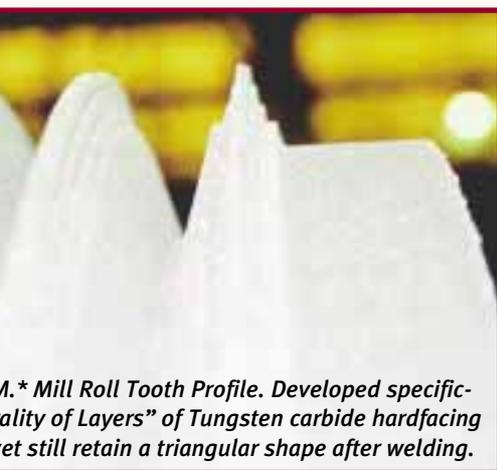
Manufactured with the rolls used at Tully Mill in 1998.



#12: The A.R.M.* No. 1 mill roll (6ft – 1.5” pitch) in use at Rocky Point Mill, 2001. Tramp iron has broken a section of the top roll.



#13: This is the same mill roll section after it was repaired, which was completed insitu. (Patent license required).



A.R.M.* Mill Roll Tooth Profile. Developed specific “Quality of Layers” of Tungsten carbide hardfacing yet still retain a triangular shape after welding.

teeth side wear) was still of concern, and the roll was not re-used.

The No.4 top roll was modified in the coating and went on to last the entire 1999 and 2000 seasons, consisting of about 3.5 million tonnes in total.

The diameter loss for the A.R.M.* No.2 mill top roll was around 5mm for the 1999 season.

Usually, standard mill rolls used at the Tully Mill would lose about 40mm over this period.

In 1998, with the three A.R.M.* rolls in No.2 mill, the crushing rate was able to be increased by 23%, from 615 tonnes per hour up to 800 tonnes per hour, with zero percent slip on the A.R.M.* Hardfaced rolls.

The trials finished at Tully with A.R.M.* more than satisfied that they had developed an invention that could deliver mill rolls which were able to last for more than 2,000,000 tonnes of sugar cane crushing – and required no maintenance.

It became apparent that further improvements were possible, particularly with a more wear-resistant roll shell material.

A.R.M.* were also seeking to analyse further data which was only available from an individual hydraulic drive. The opportunity for this eventuated with a trial at the Rocky Point Mill, south of Brisbane.

**A.R.M.* MILL ROLL TRIALS
ROCKY POINT MILL – 2000, 2001**

The trial at the Rocky Point Mill utilised the 6ft top roll in the No.1 mill, which has a 1.5” pitch. All rolls are driven by individual hydraulic drives.

(The trial was on-going at the time of this brochure going to press. Total tonnage crushed to this stage was just over 400,000 tonnes. See Photo #16).

The projected total life of the A.R.M.* Hardfaced mill roll is three seasons, or around 1.2 million tonnes. (It is yet to be established if this time can be extended with simple minor “touch ups” to the mill roll).

It was interesting to note that the standard Feed and Delivery rolls in the No.1 mill (arc-welded with the standard chromium carbide style of hardfacing) were being driven 12% faster than the A.R.M.* Hardfaced top roll.

This would suggest that these standard mill rolls are experiencing a 12% slippage compared to the A.R.M.* mill roll.

This is the first time hard evidence has been available to A.R.M.* to determine the level of extra grip that is delivered by an A.R.M.* Hardfaced roll.

Also noteworthy was the occurrence of some “tramp iron” going through the mill rolls which resulted in the breaking-off of some small sections of the A.R.M.* Hardfaced roll teeth. See photos #12 and #13.

As evidenced in the photos, an easy “insitu repair” was conducted, which resulted in the teeth on the A.R.M.* Hardfaced mill roll being restored back to an “as new” condition.

**HOW CAN THE A.R.M.* HARDFACED
MILL ROLL INCREASE PROFITS?**

As per the example overleaf the commercial impact to sugar mills as a result of converting to the A.R.M.* hardfaced mill rolls has been estimated to be US\$445,000 for every million tonnes crushed.

No doubt this figure will vary, but clearly the net revenue increase will be significant.

The A.R.M.* Hardfaced mill rolls have demonstrated that they can maintain consistent grip for more than two million tonnes of cane crushed.

By consistently delivering optimum extraction, the net increase in juice extraction is simply the difference between the top extraction rate, and the lower level extraction rate, as evidenced when the standard (non-A.R.M.* hardfaced rolls) wear and start to slip. (These rolls would require re-arcwelding to bring them back to maximum performance).

If the extraction increase was only +0.5% (half of one percent) over the entire season, this could deliver an additional US\$200,000 p.a. for every 1.0 million tonnes crushed.

**COST SAVINGS AND BENEFITS
ARE MULTI-FACETED**

Cost savings and benefits are evidenced in the following ways...

- Lower labour costs.
- Elimination of mill roll arc-welding during the crushing season.
- Re-shelling frequency is reduced.
- Increased crushing rate improves factory production throughput.
- Feeding problems eliminated.
- Reduced crushing season duration due to less down-time.
- Reduction in welding consumable costs (estimated at 50%).
- Out-sourcing of all milling train maintenance (under a patent license).

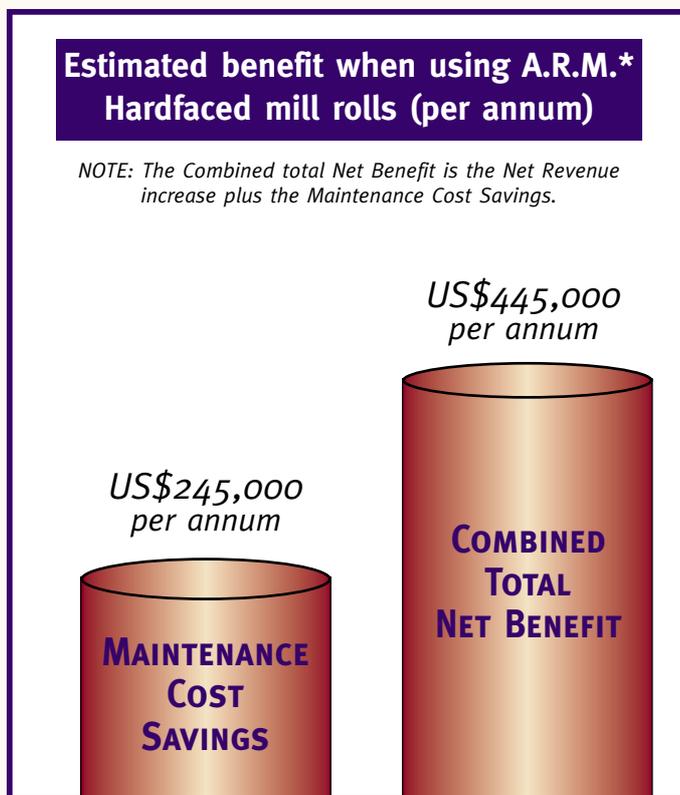
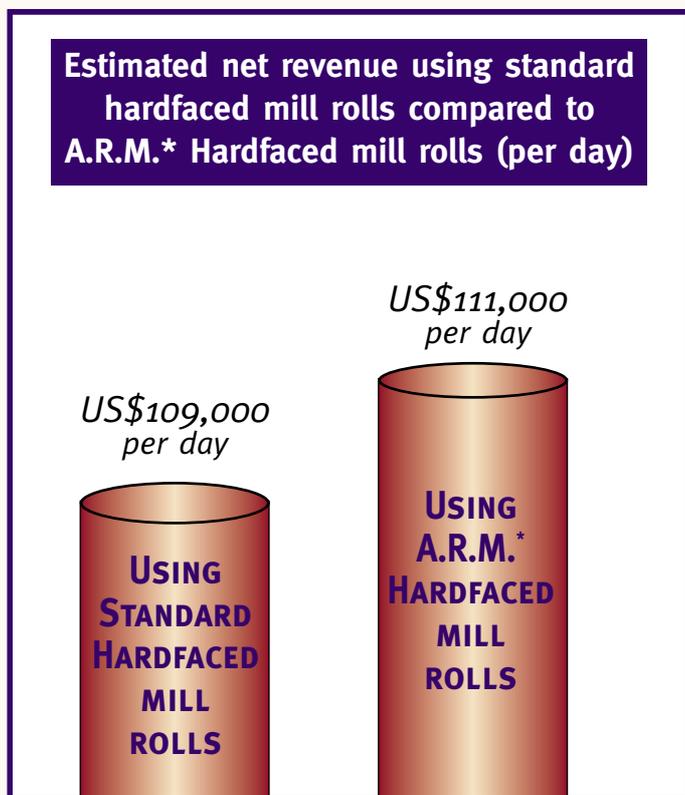
**HOW CAN YOU ACCESS THE A.R.M.*
PATENTED MILL ROLL TECHNOLOGY?**

Presently, where patents are both granted and/or pending, the only option is to purchase a mill roll directly from Abrasion Resistant Materials Pty Ltd, as there have been no other parties licensed to make, or sell the invention.

#14: The 1997 South Johnstone trial – these teeth have crushed 1,092,627 tonnes without having to be hardfaced for the entire season. (See photo #01).



Estimated revenue increase when using A.R.M.* mill rolls



NOTE: The above estimates are based on standard industry calculations.

The example used for the net revenue increase is based on a 0.5% extraction gain, with 1 million tonnes crushed in 100 days.

THERE has been discussion recently on estimating the Net Benefit delivered to a sugar mill as a result of using the A.R.M.* Hardfaced mill rolls.

The input and output values when doing this exercise will vary according to each mill's situation.

Some of these include:

- Increased revenue by a lift in the average juice extraction.
- The extension of the total roll shell life.
- Reduced labour costs.
- A reduction in the crushing season length.
- Welding equipment capital cost reduction.
- Welding consumable costs reduced.
- Labour savings.
- Freight costs reduced.
- Workplace Health and Safety risk reduction.

- Reduction in the frequency of disassembly of the milling train.
- Increase in crushing production rates.

These are just some of the costs incurred in a sugar mill which could be affected by the A.R.M.* invention.

The actual amount of increase in terms of net revenue and cost reductions cannot be exactly determined until a complete milling train has been converted and in use for a some time.

Until this occurs, A.R.M.* have estimated these to be as follows (based on a single train 20 x roll mill which crushes 1,000,000 tonnes in 100 days.)

Net Juice Extraction Gain (+0.5%)	= US\$200,000
Roll Shell Life doubled	= US\$100,000
Reduction in roll shell arcing consumable costs =	US\$ 25,000
Welding capital equipment costs	= US\$ 20,000
Labour savings	= US\$100,000



#16: The A.R.M. Hardfaced top roll at Rocky Point Mill after 400,000 tonnes crushed, in the 2001 trials.*

As per the figures above, there could be a net benefit delivered in the vicinity of US\$445,000 per annum (or US\$0.445 per tonne).

A.R.M.* is looking for a sugar mill (preferably a double train mill) to assist in conducting further research to confirm these estimates.

This could be conducted in any sugar mill (including those outside Australia) and where possible, convert the existing mill roll shells.



#17: The new A.R.M.* Hardfacing profile used on the top roll No. 2 mill at Tully Mill in 1999. This went on to complete 1.7 million tonnes without any maintenance. See photo #18.



#18: The A.R.M.* top roll at Tully, No. 2 mill in 1999. Pictured at 1.6 million tonnes crushed, with nearly all of the coating intact, and required no maintenance for the entire season.



#19: The profile of the A.R.M.* Hardfacing which was used at Tully Mill in the 1998 tests. These are 7'6" rolls with a 1.5" pitch. A deeper coating was subsequently applied in 1999. See above photo #17.

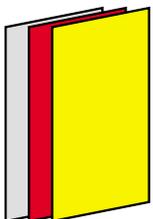


#20: A.R.M.*'s Research & Development jig. This rotating device was developed to enable the application of the A.R.M.* Hardfacing.

Increase profits... reduce costs

FEATURES & BENEFITS OF A.R.M.* HARDFACED "MAINTENANCE-FREE" SUGAR MILL ROLLS

- ✓ A.R.M.* Hardfaced mill rolls can last an entire season (now proven over 2.0 million tonnes)
- ✓ Delivers far superior grip than rolls using standard chromium carbide hardfacing.
- ✓ Increases mill crush-rates (the demonstrated increase available so far is +23%).
- ✓ Can double the life of the roll shells.
- ✓ Minimises roll shell diameter loss (as little as 5mm per season).
- ✓ Eliminate roll arcing labour costs during the crushing season.
- ✓ Benefit from consistent juice extraction rates (record of optimum extraction shown whenever used during mill trials).
- ✓ Reduces welding consumables and welding equipment costs.
- ✓ Estimated net benefit to be over US\$200,000 p.a. for each million tonnes crushed.
- Access to this technology is available only from Abrasion Resistant Materials Pty Ltd via various patents, and patent licensing. A.R.M.* currently holds patents for the Hardfacing invention in Australia; South Africa; Thailand; Pakistan; U.S.A., and the Philippines. Patents are also pending in Brazil; Mexico; and India.



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