2014 Caernarfon Award Nomination
New Zealand

COAL REMOVAL – FROM SAND

Presented by :

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FOREWORD

Road Metals Co Ltd has been operating in the Quarrying business for 58 years throughout various parts of New Zealand.

Since 2005 Road Metals have been supplying sand and aggregate to Viblock Co Ltd's, Concrete Block and Paving Stone Manufacturing Plant. Once the production of paving stones started during 2007, it came to their attention that there was an issue with coal particles in the sand.

This had not been an issue to any large extent during the production of concrete blocks in the early years. The problem really only became apparent once the pavers were produced and laid. Once they became wet, a dark brown coloured stain (see highlighted photos below) showed up around the small particles of coal that were embedded in the paver's surface.

Concrete Blocks

Pavers

This upset a number of Viblock's valued clients and it became apparent that a solution was required to solve this problem. In the interim sand manufactured using a Barmac crusher was successful but not sustainable in the long term due to the increased processing costs.

Various types of processing plants were looked at including spirals, rising-current classifiers, gold jig type separators and others, to remove the coal. In October 2010 George Kelcher attended the Australian Quarry Conference held on the Gold Coast and incorporated a visit to a Sand Plant on the Sunshine Coast. This plant incorporated a rising-current classifier system within the Plant mainly to remove coal, silts and clays from the raw material that was being dredged from within the site.

He talked to a number of Sand Plant suppliers around the world, the joy of having websites and emails proved very helpful with this research. Overall the costs quoted from suppliers were very high with no guarantee of complete success in removing coal particles once the money was spent.

After much soul searching the process that looked like having the most chance of succeeding was a rising-current type classifier plant with dewatering facilities but 1prices for units to undertake this work started at around $1 million. This was not cost effective for Road Metals given the limited volume of materials processed each year for Viblock Co Ltd.

During his 38 years with Road Metals, George has worked in every part of the business - from mechanic, welder, to truck driver, loader operator, crushing plant operator and manager, plant designer and builder and over the last couple of decades as General Manager.

Building the coal removal plant has been by far George's greatest challenge as he was working in an area where there was little information on plant and process and absolutely no guarantee from anyone that this process would result in removing a high enough percentage of the coal to be able to deem the plant successful.

PLANT DESIGN AND BUILD

After a number of major discussions with our Viblock client regarding the coal, who at this stage was getting to be pretty unhappy, myself and our shareholders decided the most cost effective way to fix this was for Road Metals to build our own rising- current classifier plant and to purchase a few other parts from various suppliers to make it work.

In our usual way, as we have done with a lot of other plant built in house, we started with a blank piece of paper, a pencil and a ruler and proceeded to draw up what would become the new rising-current classifier plant.

The aggregate processing plant comprises the following basic components:

a) Feed bin
b) Feed conveyor with belt weigher
c) Screen to provide for five products;
d) Associated output conveyors)
e) Sand collection and processing. The new Road Metals plant was designed to deal with this sand fraction, and in particular to eliminate coal particles from the sand – by utilising a rising-current classifier plant.

The principle of the rising-current classifiers is that they act on the differences in size and density of particles. Water is injected through perforated pipes, providing a rising up-current of water. Raw feed entering the top of the classifier meets the rising-current. Particles float or sink, depending on their size and density. Fine and low density grains rise over the overflow weir together with the process water. Coarser and higher density grains sink through the fluidised bed to a dewatering section.

The first section of the Road Metals classifier comprised a tub, and its size was decided by some calculations of how many tonnes per hour could be processed per square metre of tub area and the number and diameter of holes drilled in the water distribution system matched the area volume of a four inch water feed line – a pretty basic and uncomplicated theory.

A 2.5 metre diameter tub, 3 metres high was manufactured and a water distribution system was designed and built in the Oamaru workshop. Over flow weirs and a water collection system were added to direct the overflow water across the sieve bend screen.

Rising Current distribution system **Upper section of tub with overflow weir.**

Frames were built to hold the approximate 40 tonnes that the final plant would weigh when in operation. Some components were ordered from Road Metal's suppliers.

A New Zealand based company, Rocktec was asked to research and come up with the best option for a dewatering screen. Les Ward and his team at Rocktec put in considerable effort, resulting in a 10' by 5' Eral Dewatering Screen being imported and upgraded to our requirements by Rocktec.

Various components being manufactured in the Oamaru workshop.

A second hand Sieve Bend Separating Screen came from Index Machinery, Australia. Load Cells and Weigh Control System obtained from Si-Lodec, Belt Weigher from Loadrite and Air Operated Pinch Valves, Flow Meter and various other parts through Asmuss Steel.

The main frame to support the classifier tub was constructed with enough clearance underneath to be able to position the Eral dewatering screen directly below the three outlet valves. The tub itself was mounted on four load cells which weigh the tub and product inside, the output signals from this being used to control the opening and shutting of the discharge valves.

An adjustable distribution tub was designed and built so that the incoming sand could be evenly distributed throughout the classifier and a mechanism to lift and lower the tub and the outlet slots depending on whether there may be an advantage to discharge above, at or below water level.

Above the distribution tub a 26” linatex cyclone, which was part of the original screening plant, was mounted to provide the source of raw feed for the classifier system. The material that feeds the cyclone comes from a three deck 16’ x 6’ inclined screen via a 6” linatex sand pump to the cyclone.

Access steps and walkways were added to the main frame to gain access to the various levels of the plant right up to the 12.5m height of the cyclone and incorporated all safety aspects to meet the required standards for access-ways.

EQUIPMENT THAT MEASURES AND CONTROL THE SCREENING AND CLASSIFYING SYSTEM.

The fresh water supply to the classifier has an electronic flow meter that measures water flow and the pressure of water entering the classifier water distribution system.

Total flow is controlled by a simple ball valve tap. The main feed belt had a Loadrite Belt Weigher system installed that has an electronic real time readout so as to show the tonnes per hour of raw feed that is going to the main screen. This is matched against the measured water flow to achieve classification consistency.

Load Cells measuring the weight of the tub

Pinch Valves that control sand discharge

Load Cells under the main classifier tub mounts were wired to three on/off air switches that control the opening and closing of the tub discharge pinch valves that control the emptying of the classifier.

Having the opening and closing weights on a variable control allows the sand being classified in the tub to be run at various levels – the lower or lighter the level the less time the sand spends in the tub, and the higher or heavier the level the more time the sand spends in the tub.

The water pressure and flow meter controls the rate of rise within the water current in the tub thus creating the uplift and controlling how much of the finer or lighter material is lifted out of the tub and over the weir system.

The weir system is channeled to the inlet of the sieve bend screen and this separates the plus 300 micron size material (including the lighter coal fraction) to waste from the minus 300 micron sand which is returned to the dewatering screen.

Dewatering Screen with variable speed control and fines cyclone discharge pipes.

The Eral Dewatering Screen was fitted with a variable speed control unit to allow the screen vibrating speed to be adjusted for optimum dewatering, regardless of the quantity of material being passed over the screen. This has proved to be a very successful addition for the control of dewatering the sand.

Recovery of Fines

Once the classifier, along with the rest of the plant, was operational it was found that the sand produced was lacking in the minus 300µm size range and especially the minus 150µm and 75µm ranges.

It was discovered that this occurred in two areas of the plant. The 80µm and 100µm panels on the dewatering screen let a reasonable amount of fine sand escape through the panels to waste. There was also a certain amount of fines lost with the water flowing over the top of the tub, into the weir system and not being fully recovered by the sieve bend screen. These fines lost via the sieve bend screen in particular, are difficult to recover without reintroducing the coal particles back into the final sand product.

Like every good quarry operator Road Metals has some “spare parts” in the back yard and amongst these there was a pod of small cyclones.

A small tub was added to the classifier section of the plant to take the underflow from the dewatering screen. A pump and three small steel cyclones were added in a closed circuit system to attempt to retain the minus 150µm fines that were being lost. The sand recovered from the cyclones was fed directly back on top of the product on the dewatering screen and thus to the product conveyor.

This worked relatively well (except for the fact that the steel cyclones wore out in a remarkably short time – over a period of about three weeks!). I asked around our various suppliers and found a Company that could source polyurethane cyclones from Malaysia, similar to those being used to recover fines from waste water as part of drilling operations in the oil industry.

Polyurethane Cyclones to enhance fine sand retention.

Fine Sand tank, pump and overflow weir area to retain minus 300 micron sand

A new 100mm x 75mm pump was added along with six 100mm cyclones to replace the steel cyclones and at the same time a new extended weir system was incorporated into the small underflow tub which increased the percentage of the finer sands retained. A tub surface area of approx. 1200mm by 1000mm was turned into an overflow weir length of around 22 metres which assisted in retaining fines within the small pump and cyclone circuit.

The quantity of fine sand that is now being retained has improved remarkably. Sand can now be produced to the grading required with effectively no coal particles being apparent in the concrete block and paving products.

SPECIAL CONTROLS

As described earlier, there is a fine balance between eliminating coal particles to waste while retaining sufficient of the minus 150µm fines (light weight material). The controls that we have included with the processing to manage this aspect include the following-

- Scales with live read out on the feed belt to measure material throughput.
- Water flow meter to measure volume of water going into rising current.
- Water pressure gauge to measure pressure going into rising current.
- Weigh cell system on the classifier tub to enable the changing of the height of the sand level in the tub which in turn affects how much coal is removed. These weigh cells also control the discharge valves remain open and closed. They can be altered by spreading the open and closing weights.

THE COMPLETE PLANT

- Feed Bin – approx. 100 tonne capacity.
- 900mm main feed conveyor complete with belt weigher.
- 16' x 6' – 3 deck screen configured to provide five different products.
- Five output conveyors for different size aggregates.
- Sand collection tub under 16' x 6' screen.
- 6" Linatex sand pump to pump minus 5mm to main cyclone on top of classifier.
- 26" Linatex cyclone – overflow return goes back to main screen tub. Underflow is discharged to rising-current classifier.
- Adjustable distribution tub to allow controlled feed of sand into classifier tub.
- Classifier tub complete with rising current water flow system.
- Sieve Bend screen fitted with 300µm polyurethane screen that handles the tub water overflow.
- 3 x air operated 100mm pinch valves - these are controlled by the load cells that weigh the sand classifier tub.
- Eral 10' x 5' dewatering screen.
- Sand product discharge conveyor.
- Dewatering screen underflow tub complete with 100mm x 75mm sand pump.

- Cyclone pod – comprises 6 of 100mm cyclones to recover fine sand which is discharged back on top of the sand product that is being dewatered over the Eral screen
- 220kva Gen Set and associated Switchboards.

Please note: A schematic layout of the rising-current classifier and associated components is attached separately for your information (an A3 hard copy is suggested for clarity).

Plant throughput capacity ranges from between 50 tonnes to 200 tonnes per hour depending on the size and makeup of the raw feed. The quantity of sand that can be classified to have coal removed is up to 50 tonnes per hour.

Complete Plant showing the five output conveyors.

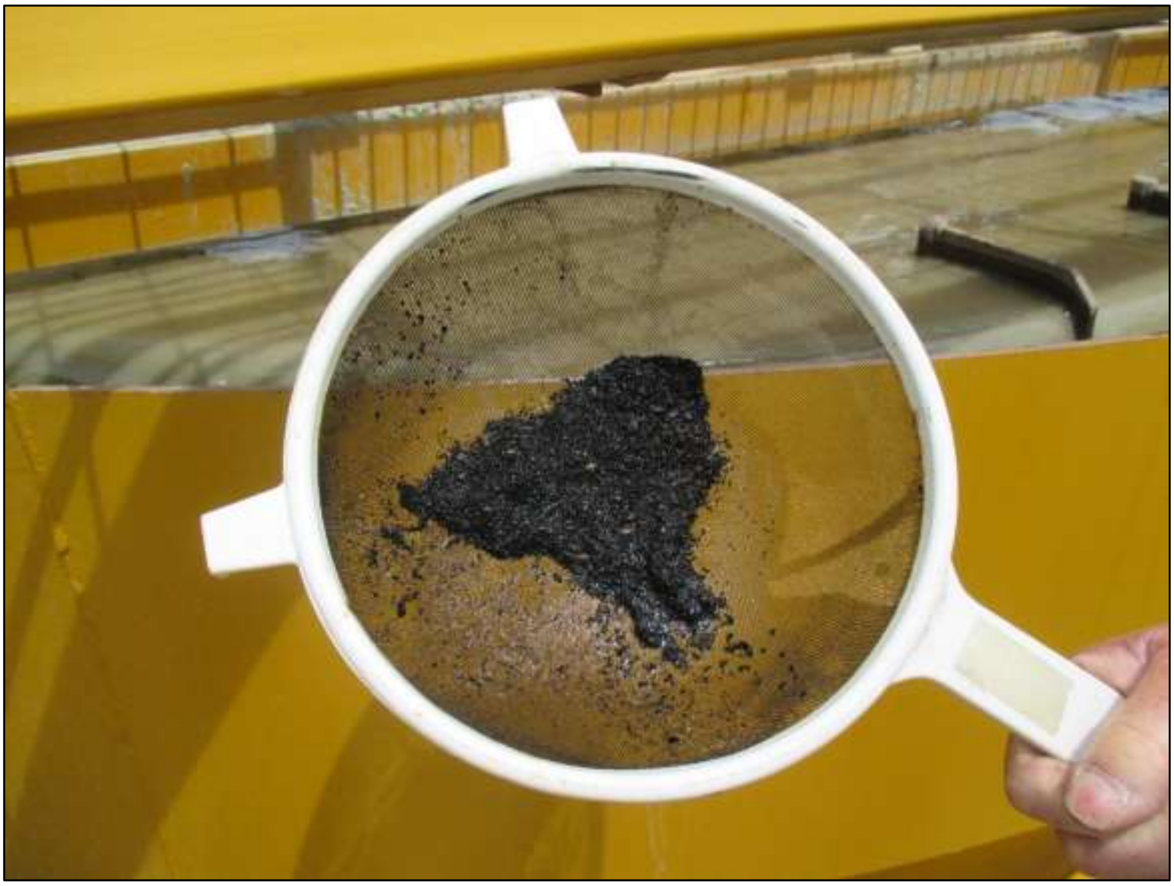
The total cost to undertake the building and modification of this classifying plant has been around $300,000, this being compared to the prices offered from outside suppliers of around $1 million, which would have come with no guarantee of meeting the requirement of close to nil coal particles required.

As part of further plant trials, 5mm to 8mm aggregate has been successfully processed through the classifier to remove coal particles from that product as well.

The combination of that Kiwi ingenuity, good management and the engineering department at Road Metals has proved you do not always have to purchase off-the- shelf plants to meet your customer's needs. The Road Metals team needed to be resourceful, very adaptable and forward thinking in designing, sourcing, building and commissioning this plant to carry out what is a very difficult process.

There are many areas where controls can be adjusted to handle variations in feed materials, yet still achieve the required outcome of nil or close to nil coal particles in the sand.

The reason for spending all this time, effort and expense? – eradication of the dreaded coal particles that have caused the product issues.



The pavers and masonry blocks are now successfully manufactured from coal free sand with the overall result that Road Metals now has a happy client.

Success comes out of perseverance.