BULK HANDLING TODAY

Endorsed by: CMA | LEEASA | SAIMechE | SAIMH

May/June 2020

OVERVIEW OF SEVENTEEN YEARS AT FOUR MINES IN ZIMBABWE

BULK HANDLING TODAY

May/June 2020

On the cover:
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Endorsing Bodies

- CMA (Conveyor Manufacturers Association)
- LEEASA (Lifting Equipment Engineering Association of South Africa)
- SAIMechE (SA Institution of Mechanical Engineering)
- SAIMH (SA Institute of Materials Handling)

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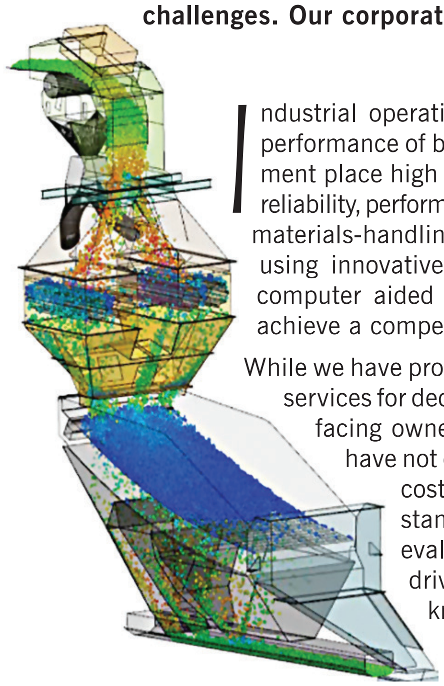
Hatch

Our organisation is passionately committed to the pursuit of a better world through positive change. We embrace our customers' visions as our own and partner with them to develop better ideas that are smarter, more efficient, and innovative. Our global network of 9 000 professionals work on the world's toughest challenges. Our corporate roots extend back more than a hundred years, and our experience spans over 150 countries around the world.



Industrial operations that rely heavily on the performance of bulk materials handling equipment place high demands on the equipment's reliability, performance and productivity. Superior materials-handling facilities must be designed using innovative technology and progressive computer aided design and process tools to achieve a competitive edge.

While we have provided bulk materials handling services for decades, the fundamental issues facing owners and operators of facilities have not changed. Achieving optimum cost per ton and meeting quality standards is the core performance evaluator. We understand these drivers and provide specialised knowledge to enable our clients' facilities to be sustainable, safe, environmentally friendly and more competitive in terms of minimum capital and operating costs per unit of throughput.

Our experience

Our integration of strong process teams, proven systems, and advanced technologies enable us to design and install material-handling facilities to meet aggressive schedules, quicker ramp-up, and enhance operability and maintainability.

For example, conveyors are capable of moving bulk solids at high speeds over long distances which closely follow the terrain by employing horizontal and vertical curves. Minimizing product degradation, dust and noise are prevailing issues, particularly at export terminals. Contemporary chutes (which load belts to minimise wear on belts) are geometrically shaped to minimise impact.

Our bulk materials handling expertise services the mining and metallurgical industry on projects around the globe. We offer a complete list of service offerings, from conceptual studies to full-scale engineering, procurement, construction management (EPCM) projects including bulk materials handling and supporting infrastructure such as major port and marine facilities, and heavy-haul rail components.

We draw on a range of engineering disciplines underpinned by diverse knowledge of resource operations. Our integrated disciplines and holistic approach promote innovative design of metallurgical processes that surpass industry standards.

We are entrepreneurs with a technical soul.
www.hatch.com

From The Chairman's Desk

It is a pleasure to welcome a new member this month and we look forward to a long and mutually beneficial relationship with PTS Conveyor Idlers (Pty) Ltd who are represented by CEO Gys van der Westhuizen.

Sadly, we also bid farewell to our longest serving member Osborn Engineered Products. Osborn has been a member of the CMA since 1981, in those days producing conveyor idlers. Osborn was a major player at the first CMA working group where the idler standards were set by the manufacturers. This work contributed to the very first national standards for conveyor idlers, now known as SANS 1313.

Due to the lockdown, two members' meetings and two social events have had to be cancelled so far and it is not looking promising for the third meeting of the year due to be held in June. The Annual Golf Day and the Annual Dinner will be rescheduled for as soon as the appropriate stage of lockdown has been achieved.

Some members are reporting increased activity now that the mining sector has re-started

Courses

In the meantime, some members are reporting increased activity now that the mining sector has re-started and there is a keen interest in getting the training courses going once again.

Among the CMA training courses that have had to be postponed are the Chute Design and the Design Diploma, both of which will be re-scheduled as soon as it is practicable for delegates and trainers. We will keep you posted on the website www.cmasa.co.za, which in itself is worthy of a browse as there is a wealth of information to be had in the technical documents on the site.

Jay Pillay

Research

Research projects are also listed for post-grads looking to do some research, and the CMA has built two idler rigs that can be used for study purposes. Enquiries in this regard should be addressed to the Secretariat.

Jay Pillay
Chairman

Membership at May 2020

All members subscribe to the CMA Code of Ethics

Acrow Limited
Actom
Afripp Projects
Altra Industrial Motion South Africa (Pty) Ltd
Bauer
Bearings International
Belt Brokers
Belting Supply Services
BMG
Bonfiglioli Power Transmissions
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Conveyor & Industrial Supplies (Pty) Ltd
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DRA Projects SA (Pty) Ltd
Dymot Engineering Company
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Flexco SA (Pty) Ltd
FLSmidth Roymec
Habasit South Africa (Pty) Ltd
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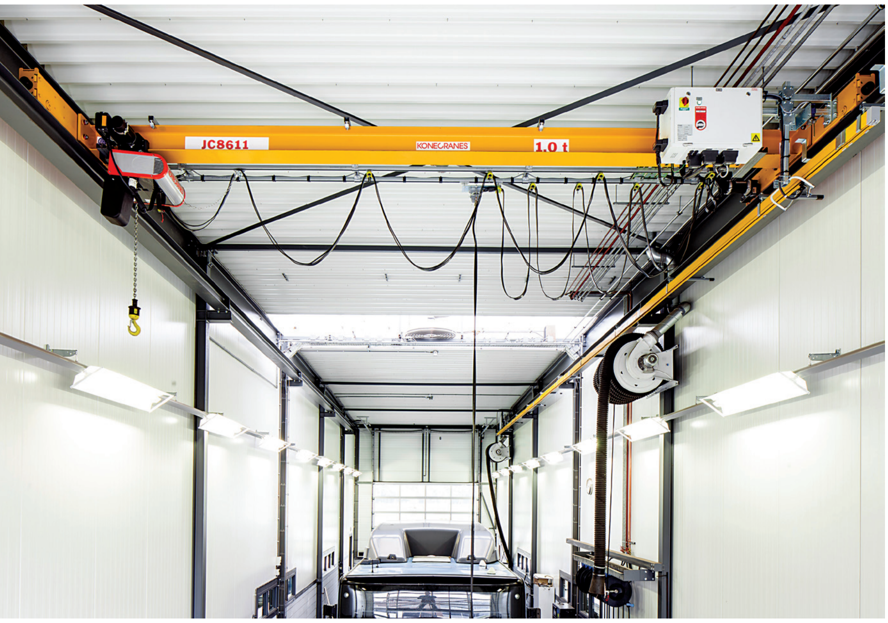
Oriental Rubber Industries SA
Pegasus Industrial Services cc
PTS Conveyor Idlers (Pty) Ltyd
Rema Tip Top South Africa
Ringspann South Africa
Rossi Gearmotors (Pty) Ltd
Rula Bulk Materials Handling
SENET
SEW Eurodrive
Shaft Engineering (Pty) Ltd
SKF South Africa
Tenova Takraf
ThyssenKrupp Industrial Solutions South Africa (Pty) Ltd
Timken South Africa (Pty) Ltd
Transvaal Rubber Company
Voith Turbo
Weba South Africa (Pty) Ltd
WorleyParsons RSA
Zest Electric Motors

World's First Synthetic Wire

Konecranes has launched their new S-series overhead crane which after years of research, development and testing, includes Konecrane's unique synthetic wire rope hoist. The synthetic wire rope hoist gives a barb-free operation, reduced maintenance costs as well as safer handling and easier load carrying.

Emil Berning, Managing Director of Konecranes and Demag (Pty) Ltd says, "Konecranes has always believed that investment into research and development delivers improved performance and enhanced safety to our cranes and associated equipment where it matters most, on the factory floor, so we are exceptionally proud to launch this ground-breaking wire rope hoist and are the first crane manufacturer globally to introduce synthetic rope in our standard serial product.



"The S-series represents the next generation of our company's existing industry benchmarked equipment. It offers customers the latest in technology bringing innovation to, not only the wire rope hoist, but also motor drives, off-set reeving systems, clutches and brakes – all elements that deliver equipment that performs better, lasts longer, delivers greater operational savings, a cleaner and quieter environment, and most importantly adds greater operational safety."

Radical re-design

"The S-series has been radically re-designed. In particular, the stepless hoisting movement and synthetic wire rope will make lifting more precise and powerful with enhanced control," adds Emil.

The new synthetic rope is perfect for reeving and its stable symmetric structure eliminates traditional rope defects. Less surface pressure reduces wear and tear considerably.

A tilted drum and off-set reeving are two first-in-the-world innovations to eliminate peak rope forces and reduce the wear on reeving components. A standardised inverter for hoisting and unique Smart Features enable smooth and accurate load positioning with total control.

The newly-designed main girder is the perfect fit for a runway, and the revolutionary sliding connection allows the end truck to better accommodate itself on the crane runway. "The new integrated Smart

One Million Operations

"Our newly-launched C-series electric chain hoist has been designed using the latest technologies so that an enhanced and safe performance can be delivered, while offering an optimal lifetime value. The unique C-series, is a new generation in electric chain hoists which, through its innovative design, can be used for over one million operations," says Emil Berning, Managing Director or Konecranes and Demag (Pty) Ltd.

Launched late in 2019, the C-series has been 'built smart' with the toughness, precision and reliability of the company's Core of Lifting components. "It is our most advanced electric chain hoist yet, with a lifting capability of up to 5 000kg. Additionally, the C-series brings more control and mobility to working areas due to its new and more compact hoist shape," Emil comments.

The hoist, which boasts a redesigned motor cooling system, offers up to a 50% longer runtime than the previous generation, with a brake built for over a million operations. Safety features such as the operating limit switch and safety clutch have been enhanced for better performance and reliability. The redesigned chain sprocket pairing gives the chain a higher lifetime expectancy and ensures smooth and reliable operation.

Emil adds, "I believe that Konecranes has taken the electric chain hoist to a completely new level of operation through tangible state-of-the-art improvements that will make a major impact and difference to customer's lifting facilities."

Advanced lifting improvements

The C-series features an entirely new tough and durable motor. Less time is spent on servicing, resulting in more hoist uptime. The new motor also offers more effective cooling leading to a reduction in heat and offering greater power. A longer continuous operation with Cycling Duty Factor up to 60% is also a new enhancement.

The new self-adjusting brake system increases the coil life and reduces lifetime costs enabling over one million operations. An improved safety clutch system offers greater reliability while the updated

Features ensures that the new S-series system offers a superior performance comprising of advanced automation and accuracy. Customers can access a real-time view of their crane with Truconnect and see the benefits of our cutting-edge digital services.

Total reliability

"A key criterion of the S-series redesign is that it offers users total reliability. Every component has been carefully assessed during the re-development phase. The new S-series has for example, eliminated over-heating issues and introduces improved cooling systems. The synthetic wire rope hoist gives the customer more versatility between beams or frames and a greater lifting power of up to 6.3 tons, Emil highlights.

"In addition to being barb-free, the new synthetic wire rope requires no lubrication, thereby reducing maintenance costs for the rope drum and sheaves. The revolutionary trolley and reeving arrangement also reduces wheel loads by up to 45% compared with previous hoist models."

The new S-series cranes are equipped with sensors and have the capability to collect and send data. Via the yourKonecranes portal (the digital service for operators, technicians and management) every customer can access all the necessary operational information that will ensure that their equipment is performing optimally, and all importantly, safely.

Advanced technical specifications

- New synthetic rope: The evolutionary synthetic rope is durable but light and doesn't require lubrication. The rope features a strong, symmetric structure for fewer rope defects and safer handling.
- The next generation reeving: the tilted rope drum enables more direct rope angles to decrease the wear and tear of reeving components. Offset reeving means more balanced wheel loads for less stress on the crane structure.
- Independent brake: the re-designed independent brake is safer, quick and easy to maintain, and enables higher hoisting speeds.
- Smart features for advanced handling and crane control: Rope angle measurement allows for the use of Smart Features including Hook Centering, Snag Prevention and Follow Me.
- Hook centering: hook centering greatly reduces side pull during lifting by positioning the bridge and trolley directly over the load.

A tilted drum and off-set reeving are two first-in-the-world innovations to eliminate peak rope forces and reduce the wear on reeving components

- Snag prevention: Snag prevention is designed to stop all crane movement if the hook, sling or load is detected to be caught on an object.

"We believe that our new S-series will re-set the industry benchmark. Its radical re-design sets new standards. It really is not merely an update, it is the new benchmark, and I see major benefits to production industries such as food and beverage, pharmaceuticals, pulp and paper, clean environments and general manufacturing," concludes Emil.

Konecranes' S-series is one of three new lifting products the company has recently launched; the other re-designed and improved equipment ranges are the C-series and the M-series.

fan gives more power. The brake always engages in the case of power loss, thereby increasing safety.

The redesigned sprocket works perfectly with the chain giving a prolonged chain lifetime. The C-series electric chain hoist also has a new top bracket design which is easily installed and multiple hoisting speeds with a 4:1 ratio are available.

The bold new gearbox offers a tested reliability with lifetime lubrication which boosts productivity and lifting speeds. Performance and safety are also enhanced via the new safety clutch design.

New angles in hoisting

Designed for the efficient use of working space. Konecranes C-series is a product that takes into consideration operator requirements and ease of use. There is more comfort due to less vibration and lighter structures that give better working ergonomics. The C-series offers more control and mobility in working areas due to the improved shape and dimensions of the new hoist.

"The C-series is effective simplicity at its best, the hoist can be up and running in minutes due its simple and fast installation. Less downtime always equates to greater efficiencies. The new design offers easy access to all components and adjustments based on production needs and requires minimum effort with the 2/1 reeving by turning the top bracket 180°," Emil elaborates.

"I believe customers will see significant improvements in efficiencies, performance and longevity with the C-series electric chain hoist, which comes with the Konecranes technical support and online data access that we are renowned for," Emil concludes.

Konecranes' C-series is one of three new lifting products the company has recently launched; the other re-designed and improved equipment ranges are the S-series and the M-series.

Konecranes
Richard Roughly
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Valuable Info on Our Market

The first comprehensive survey of the size and complexity of the construction, earthmoving and mining equipment industry in more than 20 years has been released to provide unparalleled market intelligence to stakeholders in the industry.

Compiled by global research company, Off Highway Research, the 220-page report, The Construction Industry in South Africa, is a four year study that details sales by model category, equipment analysis, sizes of equipment and sales by manufacturer.

According to Dr Jim Rankin of Agfacts, the report is an invaluable tool for financial institutions, parts suppliers and service providers, as well as suppliers of components such as tyres, hydraulics and filters, among others. It shows which machines are selling, and which are not, and it gives analysts food for thought when advising or building business plans.

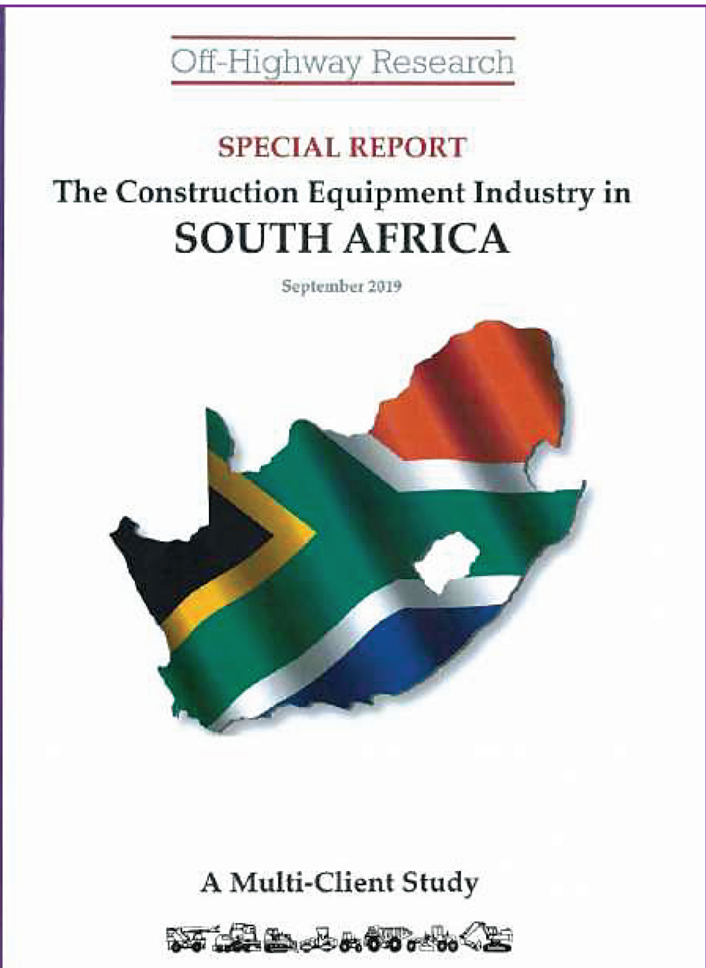
Reliable sources

"Much of the information was transposed from the Construction and Mining Equipment Suppliers Association (Conmesa) for whom we have supplied monthly reports for over 25-years. Other information was taken from complementary associations in agriculture and materials handling where appropriate," says Jim.

Jim Rankin of Agfacts

He adds that the report also provides information on local suppliers which end users can access to ascertain who the role players are and the extent of would-be supplier's information. Based on the statistics, it even provides readers with predictions on the industry and comprehensive forecasts until 2023.

With information such as actual machine populations in South Africa, by type and brand, suppliers can make informed decisions when it comes to the type of equipment, spares and services that they supply.



Six little-known facts about the industry

1. Backhoe loaders are the most sold machines in SA
2. The new equipment sales market was valued at R14,1-billion in 2018
3. Tracked (Hydraulic) excavators make up R2,55-billion of the total market
4. Contractors are the biggest buyers of asphalt finishers, backhoe loaders, excavators, compaction equipment and skid steers
5. Unusually, rental companies bought more motor graders than any other industry in 2018
6. Mines are the biggest market for telehandlers

Reality check

"We have found that, in many instances, perceptions are actually far from reality and actual ownership and supply figures are often different from what even we would imagine. This kind of market research is difficult to come-by and should make up part of any business plan for role players in the market in future," Jim concludes.

The report is conducted in accordance with worldwide standards and is available from Agfacts.

CONMESA, Dr Jim Rankin, Tel: (011) 453 7249
Email: jim.rankin@agfacts.co.za

Durability And Longevity

RGM Cranes has supplied a 30-ton semi-portal crane and two 10-ton single girder cranes to Betterect. The recent purchases stand testimony to the fruitful 20-year relationship between the two companies, which entails the refurbishment of Betterect's existing cranes, as well as the load testing, servicing and inspection of Betterect's four cranes every six months, and of their lifting tackle every three months.

Betterect has extensive experience in the fabrication and installation of structural steel, plate work, mechanical equipment and piping. "We also have broad installation capabilities and often install free issue equipment and steelwork on large projects. "We are able to produce 650 tons of steel/plate work per month with our existing setup and, if required, we have the space and ability to increase this to 750 tons per month for specific projects," says Francois Herbst, project engineer at Betterect.

Superior lifting combination

The single girder cranes supplied to Betterect are configured with a GMD-40 hoist unit and a Guralp pivoting end carriage. The GMD hoist unit has a number of features that ensure durability and longevity, including a monitoring system that records among others:

- the working time of the unit
- average load lifted and total safe working time
- complete operation numbers when the hook is loaded.

Focus heavily on safety in design and operation, which is a critical factor for us given the fact that they are required to undertake heavy lifts in populated workshop areas

Other beneficial features of the GMD 40 hoist unit include:

- A Guralp electronic braking system, achieving one million cycles before adjustment is required
- Guralp rope guides, which are hard-wearing, easy to remove and replace, and are cost effective
- Overload sensor and hoist limit switch for enhanced safety
- Hoist motor/gearbox which has high-precision, long-wearing helical gears; high start and stall torque; PTC thermistor overheat protection
- IP55 and IP65 protection class panels
- Soft start and stop with PLC and variable speed drive control.

The wheels on the pivoting end carriages are manufactured from GGG70 sphero castings to provide high levels of tensile strength and abrasion-resistance. The pivoting pin assists in preventing any premature long travel wheel wear as a result of gantry/rail misalignment.

High standard

"The quality and performance of RGM Cranes' equipment is of such an exceptionally high standard that our uptime on lifts is efficiently maximised. Not only are the cranes characterised by high performance levels, but they also focus heavily on safety in design and operation, which is a critical factor for us given the fact that they are required to undertake heavy lifts in populated workshop areas," Francois concludes.

RGM Cranes provides a full advisory service on fit-for-purpose lifting solutions for a number of industries. Managing Director of RGM Cranes Alex Dowling says, "We have amassed a wealth of experience and expertise in our 30 years of operation and we invite potential customers to put our team to the test."

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A 42-branch Network

Bearings International (BI), part of the Hudaco Group, has embarked on a process to engage more with the group companies so as to unlock synergies in terms of solutions for its diverse client base. With a 42-branch network across South Africa, BI's complex supply chain commences with product flows from its main suppliers to its central warehouse in Parkhaven, Johannesburg.

From here, the stock is picked-and-packed to go out to the various branches. These shipments are consolidated daily before being distributed. Branches also have the flexibility to pull stock from other branches.

Any stock discrepancies are managed by means of a complaint system in order to fix over, under, or incorrect supply of stock. Reverse logistics allows for all product that needs to be returned to undergo warranty inspection at Parkhaven, or to be returned to suppliers.

With a strong affinity for numbers and data, I find supply-chain analytics both exhilarating and fascinating

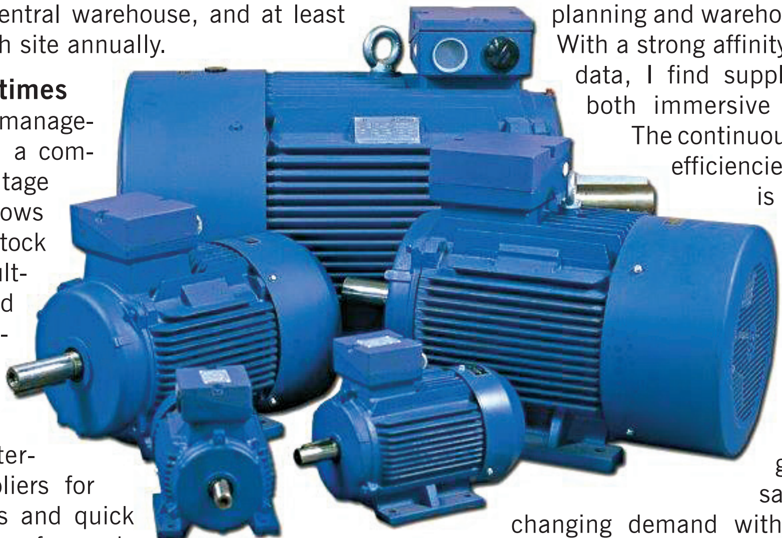
In May last year, BI successfully centralised its national transport service provider as EPX, resulting in major savings due to economies of scale. A comprehensive collaborative sales forecasting process was also deployed mid-2019 to improve forward-looking demand.

Laura van Rooyen

Master data management has also been centralised at the Parkhaven head office to assist with a smoother-running Sage X3 ERP system. Stock control at all sites is maintained through continuous perpetual counts, with at least one annual stock take for the central warehouse, and at least two per branch site annually.

Turnaround times

Supply-chain management gives BI a competitive advantage in that it allows for proactive stock planning, resulting in improved stock availability, improved sourcing of product from local and international suppliers for better margins and quick turnaround times for goods to be moved from the central warehouse to the dispersed branch network.



The system allows for the consolidation of the volumes shipped from the central warehouse to the branches for transportation cost savings, and proactive expediting of stock-outs for improved customer service.

In addition, BI is able to carry out overall data analysis on aspects such as forecast accuracies to highlight any issues for the sales and marketing teams to focus on. Supplier-performance management enables the company to hold its suppliers accountable for delays and shortages which, in turn, drives down lead times. This reduces inventory holding, resulting in less working capital tied down in stock.

Stock control across the entire branch network reduces the risk of pilferage, while overall performance management through KPIs assists the business in focusing on product availability and customer satisfaction.

Complexity

The full supply chain for BI is currently managed by Laura van Rooyen, who was appointed Supply Chain Director in January last year. With over a decade's experience in the supply chain environment, Laura comments that she "loves the complexity and challenges of balancing supply and demand." She received her National Diploma in Logistics and Supply Chain Management from the University of Johannesburg in 2011.

"I have extensive experience and exposure in logistics management, procurement management, demand planning, supply planning, and now distribution planning and warehouse management. With a strong affinity for numbers and data, I find supply-chain analytics both immersive and fascinating. The continuous drive to improve efficiencies and productivity is very exhilarating, and keeps me motivated," Laura highlights.

Dispersed branch network

"Probably the biggest challenge is satisfying the ever-changing demand within our dispersed branch network. Many of our products have very long sales cycles. Furthermore, these products have to either fail or break down first before the customer buys stock again." These are referred to as Maintenance, Repair, Operations (MRO) products.

Inconsistent lead times, and very long lead times in excess of 240 days, from international suppliers also pose a huge challenge that is managed through supplier performance management

Managing inventory levels, product mix, and excess stock management is critical. In this regard, BI uses Sage Inventory Advisor as an add-on tool to assist with its inventory parameters and management.

Inconsistent lead times, and very long lead times in excess of 240 days, from international suppliers also pose a huge challenge that is managed through supplier performance management. "This allows for a very stimulating supply planning perspective, as we are also critically responsible to provide the lowest landed cost of our products," Laura concludes.

Apart from the central warehouse at Parkhaven, BI also has a bond store. This means that for some automotive products supplied exclusively to Toyota South Africa, for example, duties and VAT can be deferred until the stock is actually sold. This impacts positively on cash flow, as the goods are essentially stored tax-free. It also allows for government supervision and security for such products until they are sold.

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Unloading Bulk Materials from Ships

For almost 51 years, stevedoring company, ZHD Stevedores, based in Dordrecht in the Netherlands, has been using Bobcat skid-steer loaders to clear the holds of ships and to move material around so that the grabs on the large unloading cranes on the dockside are kept busy.

This way of working was introduced in order to unload or load a ship as quickly as possible to allow it to sail again, as idle time costs money in shipping. Any part of the load that remains out of reach of the grabs on the cranes is collected and removed by the Bobcat loaders using hydraulic sweeper attachments.

The skid-steer loaders for this work, including the new S770 models that ZHD Stevedores has just purchased, have to undergo many modifications before they are delivered to the company. This work is carried out by Inter-Techno, a Dutch importer of the Bobcat range.

ZHD Stevedores is a family business that provides stevedoring services for a large number of clients in Dordrecht and at three locations on the Moerdijk industrial park. A number of large customers are located on the ZHD site, where they carry out production processes with materials that enter via the port. ZHD takes care of the storage and transfer of the materials for them.

This can vary from steel rolls and scrap to bulk materials such as coal, iron ore, slag sand, pebbles, gravel, sand, sugar, salt and basically anything that can be loaded and unloaded with a grab.

Skid-steer loaders undergo a number of important modifications, which are mainly dictated by the environments in which the machines must operate

To meet this demand, ZHD Stevedores has more than 100 grapples at its disposal. Over the years, the company has invested heavily in flexible mobile and floating cranes with a high capacity to optimally serve its customers in Moerdijk, Dordrecht and Rotterdam. The showpiece machines include a self-built 50-tonne self-propelled floating crane (gripper company, general cargo 100t), a 170-tonne hydraulic tyre crane and another two self-propelled 25-tonne floating cranes (40T general cargo) in Antwerp, Belgium.

The floating cranes are used to load big sea-going vessels including the largest Capesize ships or to transfer their cargo to inland vessels and coasters.

Operators' request

The method of discharging ships using skid-steer loaders has been around since the 1960s. It has proven to be the most flexible solution as the circumstances and the materials involved make it impossible to use other methods such as conveyor belts or suction systems.

Initially, Bobcat skid-steer loaders were almost always used for this work at ZHD, with the exception of the period between 2000 and 2009.

"When new skid-steer loaders had to be ordered in 2008, our operators were able to try out a new Bobcat S330 model with air conditioning. This worked much better than the skid-steer loaders of another brand that were in use at that time. At the request of the operators, we switched back to Bobcat skid-steer loaders in 2009," says Jan Elferink, material management manager at ZHD Stevedores.

In 2009, the first Bobcat machine to be purchased was given the number 28. Currently, there are 16 machines in use; with numbers from 36 up to 51. At the end of January 2020, two new Bobcat S770 skid-steer loaders were delivered to ZHD Stevedores to replace the machines with the numbers 36 and 37. ZHD has kept one of the two older models and the other one has been sold at auction.


Modification and maintenance

Before they can be used for unloading work, the skid-steer loaders undergo a number of important modifications, which are mainly dictated by the environments in which the machines must operate. All modifications are made at Inter-Techno in Apeldoorn, after which the machines are delivered ready for use in the corporate colours of ZHD Stevedores.

Regular maintenance and repairs are carried out by ZHD Stevedores itself. While a dedicated engineer is responsible for the maintenance work within the material management department, ZHD has also added extra Protection Plus warranty for the machines, which offers an extended warranty period of three years to provide extra security in case the company's engineers are faced with a problem they cannot handle.

In this way, ZHD has ensured that the loaders are up and running again quickly with little or no downtime.

Protective cab

"The modifications on the machines include the treatment of plugs and cable harnesses with a special moisture-resistant coating. The moist and dusty environment is not good for the electronics on board," Jan Elferink explains. "The adjustments to the cabs are also important. Drivers used to work in an open cab with a cage construction, but the requirements for working conditions and safety have become increasingly strict. To protect the driver against dust, overpressure cabs have been used for around 12 years to keep the dust out.

"The air that is blown into the cab goes through a P1 and P3 filter that captures very fine particles. P3 filters remove particles up to 50 x WNG (Legal Dutch Limit Value) so drivers no longer need to wear air masks."

The standard cab on these skid-steer loaders is both ROPS (Roll-Over Protection Structure) and FOPS (Falling Object Protective Structure) certified, but to protect the driver even more, instead of the glass in the door of the machines, this is replaced by Bobcat-Lexan, a very strong plastic material that is very difficult to break or damage.

In order to give the driver even better all-round visibility, a special ZHD rear-view camera is mounted on the rear hood.

Made even tougher

A number of modifications have also been made on the outside of the loaders. Four additional tie down points have been added, two on either side of the upper structure, to which hoisting straps can be attached. This allows the Bobcat to be lifted in and out of ship holds.

To make them more robust, the loaders are weighted at the front and steel plates are welded to the lifting arms to protect the hydraulic cylinders. A heavy steel bumper is welded to the rear, protecting the engine and the cover against collisions with the walls of the hold.

P3 filters remove particles up to 50 x WNG so drivers no longer need to wear air masks

All modifications together ensure an extra weight of around 600kg, which gives the loader even better stability and more load capacity.

The engines have to comply with special requirements because the loaders work in almost completely enclosed spaces. Because of the stricter requirements with regard to working conditions and emissions legislation, the older models have been equipped with soot filters or Adblue is mixed with the diesel.

Jan Elferink concludes, "The new generation of these skid-steer loaders have Stage V engines, but in the long run, electric Bobcat machines might be a very good alternative."

Bobcat
www.bobcat.com

Use of General-Purpose Winches

Ian Plunkett of Iptron Technology, draws attention to the limitations and potential problems of using general-purpose winches for control of conveyor tension. Some customers complain that, every one of these, suffers from rope entanglement and rope jamming. This is highly dangerous, difficult to clear, and usually leads technicians to conclude incorrectly, and unfairly, that the electronic controller has reversed the winch direction even though this is an astronomically impossible occurrence.

Conveyor tension control by means of a take-up winch is potentially the most versatile and best performing method. For decades, general-purpose winches have been widely used for this purpose but come with major complications. The following are the reasons:

1) General-purpose winches are intended for manually controlled and observed, ad hoc, haulage applications, eg, recovering vehicles.

General-purpose winches have the same 'safe speed' of +/- 6 metres per minute. This is too fast for short conveyors and too slow for long conveyors. Fast-winches are difficult to control requiring a wider 'dead band' and the consequent poor control.

Slow winches are the principal cause of extreme tension transients and rough starts. Locked take-up starts cause the highest possible stress during conveyor start-up. The take-up speed of the winch must exceed the conveyor's peak rate of elongation by at least 10% during acceleration.

Warning! Never manually operate a take-up winch without observing the winch!

Conveyor tension control is an automatic process which operates 'unattended'; this is acceptable provided that there are no rope problems.

The contrasting peculiarity of conveyor tensioning winches is that the rope tension varies from zero on the first turn of the winch drum, increasing with every turn up to the high tension required for conveyor starting. In addition dynamic tension transients generated during conveyor start-up and stopping, cause extreme tension transient stresses on the winch. These are primarily associated with a take-up system that is too slow.

When the high-tension rope overlays a low-tension rope, the latter is damaged and displaced during the control process. Each time a new rope layer is formed, the inner layers are repeatedly damaged and displaced. When the rope is paid out manually, and unattended, for maintenance, the rope reaches the point where the jam occurred and cannot release it.

This results in the rope now being drawn back into the winch in the wrong direction and renders all and any tension control system inoperable and dangerous, particularly because the technician is not watching what is happening. Warning! Never manually operate a take-up winch without observing the winch!

Winch manufacturers spool the rope tightly prior to supply to prevent rope-entanglement. However, the rope has to be spooled out for installation and the manufacturer's initial tensioning is to no avail.

Rope Jamming

1) Winch design

Rope jamming is caused by the combination of varying rope tension and rope-overlaying. Conveyor take-up winches should accommodate the entire working length of the rope on a single layer on a wide, plain grooved drum. Note that, even 'lebus screw' grooving will not prevent rope jamming when the tension varies widely. A wide drum may require a greater distance to the first rope sheave or a diamond screw rope layer control where space is limited.

2) Detecting a rope jam

A jammed rope is dangerous and often extremely difficult to clear. Every winch used for conveyor tension take-up that cannot accommodate the rope on a single layer should have a safety bar located in front of the winch drum that will trip an emergency stop switch linked to a safety contactor in the event of the rope changing sides following a rope jam.

3) Minimising the possibility of a rope jam

a) Fit safety bar to front of winch.

b) Design take-up winches with wider drums.

c) Do not include unnecessarily long displacement in the take-up system.

d) Keep the length of rope on the winch drum to an absolute minimum.

e) Do not store 'spare rope' on the winch drum; keep it behind the tension transducer (load cell).

f) Operate with two falls of rope if possible.

Correct characteristics

a) Take-up winches should be rated in tension only.

b) Manufactured in tension intervals of √2. Final gear should be epicyclic.

d) Helical/bevel gear motor chosen to provide required speed and tension.

e) Operation of winch with starting level at or below 50% of winch rating.

f) Optional integral low-inertia slip-clutch set to slip at 125% of winch rating.

g) Provision for drum-position by proximity switches.

h) High Speed AC brake where possible for small winches.

i) Variable-speed dynamic control for all long, heavy and extendable conveyors.

j) Rope-jam safety-switch linked to a safety-contactor.

k) Optional drum width specified for the particular conveyor.

l) Optional diamond screw rope layer control.

The performance and reliability of any conveyor tension control system, depends on having a take-up winch matched to the conveyor needs under proper electronic control together with mechanical design for minimal friction.

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The result is an affordable crane and hoist combination for every lifting business.

Up to 600t Tensile Load

With a new model of the road-rail robot Vlex, Vollert in Weinsberg, Germany has extened its compact solution to shunting operations up to 600 tons. Twice as strong, but only 500mm larger, the new Vlex 40 is also suitable for fast track changes in confined spaces. A swing axle guarantees permanent ground or rail contact of all four wheels, even on uneven ground. And thanks to the emission-free electric drive, operation in closed storage and production areas is also possible.

The extremely maneuverable shunting solution is used, for example, in the South Korean metro in Seoul: for moving tank wagons at Lanxess in Leverkusen; or for loading lime at Rheinkalk Grevenbrück GmbH.

The new model with a tensile load of 40kN and a weight of 10 tons doubles the range of application of the compact, manoeuvrable and emission-free road-rail solution from 300 tons for the Vlex 20 to 600 tons now, thus increasing flexibility when moving freight wagons or internal transport wagons. In one-man operation, the radio-controlled all-round vehicle changes quickly and easily from the track to the road and vice versa.

Its ingenious vehicle geometry with articulated steering and four individually controlled wheel hub motors make it extremely manoeuvrable and economical. They enable tyre-friendly turning radii of only 7.2m up to 360° turns on the spot. Solid rubber tyres and the high dead weight ensure optimum traction. A swing axle guarantees the safe continuous ground and rail contact of all four wheels, so that potholes, height differences in the track or smaller obstacles can be overcome without loss of traction. In addition, track guide rollers are lowered hydraulically for rail travel.

"Companies often have several shifting areas in logistics or production. If so, the Vlex offers the necessary flexibility in shunting operations. By extending the range of application to 600 tonnes, we are also responding to numerous customer enquiries that require the shunting of four to five wagons at a time," explains Jürgen Schiemer, head of shunting systems at Vollert.

We are also responding to numerous customer enquiries that require the shunting of four to five wagons at a time

In-plant use

Two years ago, Vollert launched its innovative road-rail robot Vlex for the first time. Since then, the robust solution has successfully proven itself in rough railway operations on sidings, in tram and underground railway depots and in industry. An important aspect is the possible use of the battery-powered Vlex outdoors and indoors, especially given internationally increasing diesel emission protection regulations in closed halls.

For the metro in Seoul, the state-owned South Korean railway company Korail relies on a Vollert Vlex 20 to move wagons in various halls for maintenance.

The Swiss rail vehicle manufacturer Stadler uses the Vlex solution for pushing double-deck wagons up and down in combination with a transfer table in its new plant in St. Margrethen. Already during the construction phase, the versatile application possibilities and the high flexibility when shunting and avoiding obstacles were brought to bear.

Indoors and outdoors

The road-rail robot is also suitable for uneven and unpaved floors. At a chemical company Lanxess in Leverkusen, Germany, a Vlex is used to move tank and freight wagons outside of regular shunting operations. Rheinkalk Grevenbrück GmbH also relies on the robustness of the robot in its lime plant under difficult conditions, because the moist lime acts like soft soap on the tracks.

Nevertheless, the Vlex brings four empty wagons each to the loading station with turnouts, curves and an ascending slope on the track. The previous solution could only move and shunt one wagon. The use of the Vlex shunting device therefore optimises the shunting process in terms of time.

www.vollert.de

Stacking Efficiencies and Performance in the Digital Space

thyssenkrupp is an industry pioneer and world leader in the manufacture of stackers, drum reclaimers and other stockyard machines. Moving with the Industry 4.0 tide, the global engineering specialist has introduced new technology that improves stacker efficiency and performance.

Thyssenkrupp stackers are responsible for stockpiling an extensive range of materials at mines, quarries and ports across the African continent. The company recently delivered a locally designed and manufactured 2 000tph, 100m long (including the tripper), 300t stacker to a coal mine operating in South Africa's Waterberg region.

The availability of this massive amount of data allows for a completely automated stockyard system which results in better planning and consequently a more efficient plant

"We have invested substantially in our stacker design to ultimately provide cost and time saving benefits to our customers across Sub-Sahara Africa," notes Jacques Steyn, General Manager: Materials Handling at thyssenkrupp Industrial Solutions Africa. The company locally designs and builds stackers with capacities from 50 to 20 000tph, in boom lengths from 10m to 65m and in an assortment of shapes and sizes such as fixed, travelling, luffing, slewing as well as a combination of the aforementioned.

The company also offers customised stacker solutions to customer specifications. "Local design, manufacture and customisation illustrate our commitment to providing customers with best-in-class products in the shortest turnaround time."

Jacques observes that stackers play a pivotal role in continuous stacking processes with stacking critical for efficient reclaiming and homogenous blending. "The basic operation of these machines and the mechanics of stacking and reclaiming have not changed significantly over the past five decades. However, with the advent of the digital age, manual control systems have given way to automation and most modern stackers are fully or semi-automated."

Massive amount of data

Machines are now controlled from remote on- and off-site offices. Changes are also seen in the way in

which information is fed to and from the equipment. Automation of the entire process provides stockyard managers with vital information such as knowing exactly where the stackers and/or reclaimers are, how they move, what quality and quantity of material they are processing as well as the grade of material that is being conveyed. The availability of this massive amount of data allows for a completely automated stockyard system which results in better planning and consequently a more efficient plant.

"We have designed and developed online analysers that provide analytical process controls for stockyard blending and homogenisation as well as scientific control of mineralogy of stockpiles," shares Jacques.

Through online analysis, the presence and amount of a large number of different elements can be determined, eliminating the need for taking samples to the laboratory thus saving time and costs. Using this information as input, the thyssenkrupp stacker and stockyard management system achieves an optimal blend of mineral stockpiles and subsequently ensures a constant mineralogy feed to process plants.

General maintenance

Stackers are normally designed for the life of mine but Jacques points to the importance of general maintenance to ensure that the machine remains in good working order to maximise its life cycle.

"If these machines are properly maintained, they will continue working for 40 years plus."

To assist customers in safeguarding the health of their stackers, thyssenkrupp offers best-in-class service which includes a structural inspection and analysis, an aspect often overlooked by customers who tend to focus on servicing easy-to-replace mechanical, hydraulic and electrical components. Jacques warns that failure of a stacker's main structural component can result in protracted downtime and exorbitant repair or replacement costs, making regular inspections crucial.

Solid argument for automation

In today's global economy, improved productivity, production, efficiencies and safety are critical to the operational survival of a mine or plant. Carbon emission management is another factor that no longer can be ignored. "Automation certainly ticks all these boxes," says Jacques.

"Operations are often daunted by the initial Capex involved in automating equipment but research shows that over the life of a mine or plant, automation maximises factors that contribute to profitability and minimises factors that drive up Opex, presenting a solid argument for investing in this technology.

"These technological additions to our stackers place us firmly in the digitalisation space and bring these machines into the modern age. There can be no doubt that stackers will continue to play a fundamental role in the future of modern mechanised and autonomous bulk materials handling, making a valuable contributing to an operation's sustainability," concludes Jacques.

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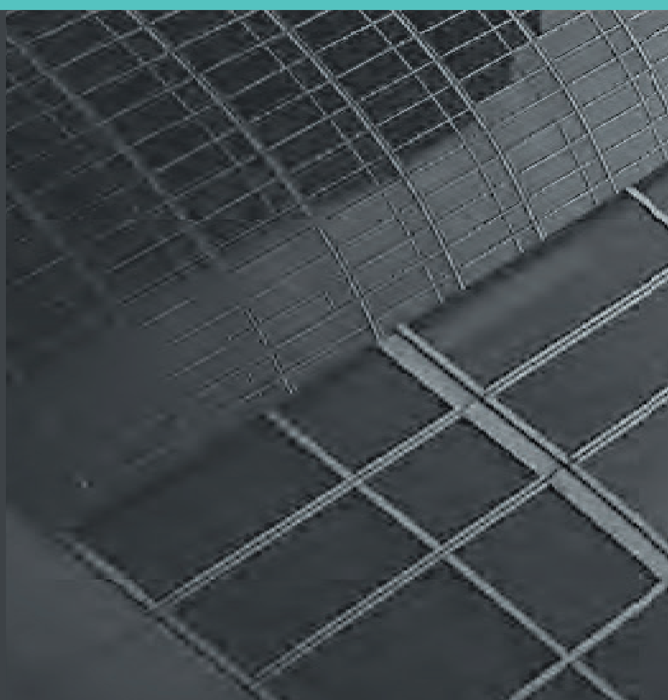

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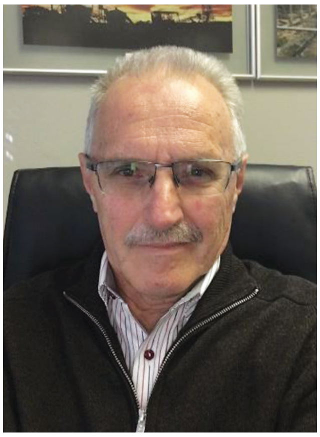
Crushing and Materials Handling at Ngezi Platinum Mines Zimbabwe



Livio Talocchino

Ore crushing, storage and materials handling systems are used extensively in the mining and minerals industry. These systems are employed in both underground and surface mining operations and in downstream processing facilities. In this paper an attempt is made by the writer to record the scope of the work completed, lessons learned, and the improvements implemented at the various stages of the design and construction of these systems over a period of seventeen years at four platinum mines and at the concentrator facility at Ngezi in Zimbabwe.

The mineral rights owned by Zimbabwe Platinum Mines (PVT) Limited (Zimplats) on the Ngezi tenements forming part of the Great Dyke in Zimbabwe are located approximately 120 km Southwest of the capital Harare and extend over a distance of some 30 km in a Southerly to Northerly direction with the ore body dipping slightly towards the North.

Mining commenced at Ngezi in the late 90's with an open-cast mining operation in the Southern part of the ore body. As this ore body was depleted mining continued towards the North with the development of underground mines at Portals 1 to 4. Currently Zimplats is in the process of developing a new mine at Portal 6.

Our team under the banner of Exclusive Technical Services (ETS) at the time commenced working on the Ngezi projects in 2002 with the award of a feasibility study to investigate the use of overland conveyors vs trucking for linking several proposed underground mines along the strike owned by the client to a future concentrator. At the time ten portals were envisaged along the thirty-kilometre strike length with a concentrator situated roughly at the centre.

Before Crushing Size (mm)	% Retained	Cum % Passing
800	0.00	100
650	4.04	96
500	11.2	88.8
300	29.4	70.6
250	44.2	55.8
150	58.6	41.4
50	66.1	33.9

Table 1. ROM size distributions

Figure 1. Aerial view of Portal 2 – Rukodzi Mine

Following the study, work by the project team continued with the design and construction of an in-pit primary crushing and conveying facility at Portal 2. This plant is built at the bottom of the mined-out section of the existing open pit and is fed from the underground mine (decline) developed from the bottom of the open pit. The ore is trucked to surface, crushed and conveyed to an existing ore stockpile (built previously by others) which loads road trains (105t capacity) that transport the ore seventy kilometres to an existing concentrator plant at Selous (SMC).

Immediately after the completion of Portal 2, the team continued working at Ngezi as a part of Sandvik Materials Handling (SMH), this work included the development of the surface crushing and conveying system at Portal 1, the underground and surface primary crushing and materials handling systems at Portals 3 and 4, and the secondary and tertiary crushing and screening facility feeding the Ball Mills at the Ngezi Concentrator.

Ngezi - site data

Plant location

- Country : Zimbabwe
- General Location : ± 160km South West of Harare
- Site Altitude : 1275m above MSL
- Access : Tarred Road to Mine entrances

Ngezi - rom ore characteristics

Results from test work performed on a bulk sample from Portal 2 indicated that the ore was reasonably hard and abrasive, when broken it also tended to be "slabby" and have sharp edges.

- Top size 800mm
- Bulk Density (In Situ) 3.24t/m^3
- Bulk Density (Broken) 1.79 – 1.99t/m^3
- Uniaxial Compressive Strength Max = 300 MPa
- Abrasiveness Index (Pennsylvania) 0.45 – 0.54
- Crushing Work Index (Bond) 17.8 – 19.4 (Max 26.6)
- RoM Moisture Content 5 – 8%

Mining

Typically the underground mines use a mechanised board and pillar mining method, the distance between the mines is approximately 3.0 km along strike. Maximum depth at the existing mines is expected to reach +- 350 m below surface.

Access to the underground workings is gained via a box cut and decline system. When conveyors are utilised to bring crushed ore to surface three declines consisting of two mining and one conveyor decline are used. The mining declines fall on dip (West to East) to the sink line (bottom of reserve) with the conveyor decline running below the mining declines.

Thirty tonne trucks are loaded by load haul dump vehicles (LHD's) in the mining sections, the trucks haul the ore to surface crushing tips (Portals 1 and 2) and to underground ore passes or crushing tips (Portals 3 and 4). Tipping at underground ore tips is generally from two sides to increase the availability of the system. A static grizzly over the top of each tip stops oversize RoM ore from entering and a hydraulic rock breaker is employed to break the oversize material.

Ore transport from underground is by truck to a surface crushing station. The crushing and conveying system is designed for a throughput of 1.0Mtpa.

Run of mine tipping/scalping/crushing/conveying:

- Hours of operation : 6 300 hours per annum
- Nominal Feed Rate : 160 tph.
- Peak Feed Rate (System Availability) : 275 tph.
- Design Feed Rate : 400 tph.
- Equipment design duty : 24hours/day, 365 days

The crushing station is built in a concrete structure which retains the earth fill for the tip approach ramp, it is open on one side to allow for the exit of the crushed ore sacrificial conveyor. Trucks tip from one side into an 80t steel bin through a static grizzly mounted at the top which has 0.6m square openings, a hydraulic rock breaker mounted on a concrete base alongside the bin breaks the oversize on the grizzly.

Ore is discharged from the bin by apron feeder onto a vibrating grizzly which scalps off the -140mm material and feeds the oversize to a single toggle 30x55 jaw crusher. The crusher product (-150mm) and scalped undersize from the vibrating grizzly discharge onto a 900mm wide sacrificial conveyor, the crushing plant throughput (apron feeder speed) is controlled by a belt scale mounted on the sacrificial conveyor.

A fly-wheel on the high speed side of the drive keeps the conveyor running for approximately 12 seconds to avoid the ore in the crusher chamber, the vibrating grizzly and the undersize chute flooding the conveyor during power trips.

The head chute on this conveyor is designed to contain the surge and provide a controlled withdrawal onto the downstream conveyor. A tramp iron magnet on the head chute protects the subsequent conveyor belts from possible belt damage.

The ore from the sacrificial conveyor is transported by three 750mm wide conveyors in series, the first in the series transports the ore out of the pit and feeds onto a downhill decline conveyor which discharges onto the next conveyor in the series that feeds an existing (upgraded) 1200mm wide conveyor which delivers the ore to the existing road train load out stockpile. The downhill decline conveyor has a brake mounted on the tail pulley to control the regeneration of power by the motor (+- 16kW for 60 sec) when the conveyor is loaded.

Ore transport from underground is by truck to a surface crushing station similar to that at Portal 2. Production from this mine is 1.5Mtpa and the crushing and materials handling system is sized as follows:

- Hours of operation : 6 300 hours per annum
- Nominal Feed Rate : 240 tph.
- Peak Feed Rate (System Availability) : 421 tph.
- Design Feed Rate : 550 tph.
- Equipment design duty : 24hours/day, 365 days

The mine is positioned at the top of a rise and the crushing station is built in a concrete structure excavated into the side of the Northern embankment.

Trucks tip from one side into an 120t steel bin which has static grizzly mounted at the top similar to that at Portal 2 and a hydraulic rock breaker mounted on a concrete base alongside the bin which breaks the oversize on the grizzly.


Figure 2. Portal 2 (Rukodzi) Crusher station under construction


Figure 3. Portal 2 (Rukodzi) Crusher station completed


Figure 4. Aerial view of Portal 1 (Ngwarati) Mine

Portal 2 Conveyor Data	Width mm	Length m	Lift m	Belt Speed m/s	Installed kW	Soft Start	Add. Equipment
Sacrificial	900	56	3	2.0	22	VSD	Flywheel, Self Cleaning Tramp Magnet
Pit Transfer	750	454	53	2.2	2 x 75	VSD	Motor Encoders
Downhill Decline Transfer	750	440	- 22 + 13	2.2	45	VSD	Tail Brake
Transfer to Exist.	750	191	21	2.2	55	VSD	Hammer Sampler
Exist. to Stockpile	1200	123	12	2.5	75	Fluid Coupling	Drive upgraded (Speed & kW's)

Table 2. Portal 2 conveyor data

Portal 1 Conveyor Data	Width mm	Length m	Lift m	Belt Speed m/s	Installed kW	Soft Start	Add. Equipment
Sacrificial	1200	57	3.5	2.5	45	VSD	Flywheel, Self Cleaning Tramp Magnet
Overland	1200	2413	+52 -17	2.5	2 x 160	VSD	Brake
Transfer to Exist. Tip	1200	51	5.4	2.5	45	VSD	Flywheel, Product Sampler

Table 3. Portal 1 conveyor data

Discharge from the bin is by apron feeder feeding a vibrating grizzly feeder scalping at -180mm and feeding the oversize to a JM1211 single toggle jaw crusher. The crusher product and the vibrating feeder undersize is transported via three conveyors in series to the existing Open Pit/Road Train Stockpile Tip.

The crusher product (-212mm), scalped undersize from the vibrating grizzly and apron feeder dribble discharge onto a 1200mm wide sacrificial conveyor, the crushing plant throughput (apron feeder speed) is controlled by a belt scale mounted on the sacrificial conveyor. A fly-wheel on the high-speed side of the drive keeps this conveyor running for approximately 15 seconds (normal stop = 7 seconds) to avoid the flooding of the conveyor by the ore remaining in the crusher chamber, the vibrating grizzly and the undersize chute during power trips. The head chute on this conveyor also provides for a controlled withdrawal onto the downstream conveyor. A tramp magnet fitted on the head chute protects the downstream conveyors from possible belt damage.

Figure 5. Portal 1 (Ngwarati) Crusher Station

Figure 6. Aerial view of equipment and services common to Portals 1 and 2

The sacrificial conveyor transfers onto a 1200mm wide overland conveyor which is 2400m in length, inclines from the tail for 1400m to a height of 52m, it dips 17m to the head and has two horizontal curves. Existing overland stringer modules and concrete footings (sleepers) from two unused conveyors at SMC mine in Selous were re-located and utilised to build the conveyor.

The head, tail and take-up systems were redesigned to suit the new layout conditions and new drives, pulleys, idlers and belting were procured to suit the new design. The conveyor has a drive station at the head end with 2 x 160kW drives, (VSD) soft starts and a brake on the primary the drive. Under a controlled stop condition the VSD's slow the belt down to a stop in approximately 17 seconds, once stopped the brake unit engages to prevent forward movement of the conveyor if the decline portion of the conveyor is loaded. In the event of an emergency stop or loss of power the brake engages and stops the belt in 17 to 20 seconds (un-assisted coasting time with a full belt is about 37 seconds), under this condition the brake is utilised to assist the flywheel on the last conveyor in the series to prevent flooding.

The last conveyor in the series discharges into the existing open pit tip bin, it is 1200mm wide and has a fly-wheel on the high-speed side of its drive so that it can clear the over-run material from the overland. Samples to determine head grade from the Portal are taken three times per shift by a hammer sampler installed on this conveyor.

Equipment/Services common to Portals 1 and 2

Dust suppression - Installed at the apron feeder discharge, vibrating grizzly feeder discharge, crusher discharge and conveyor transfers.

Fire detection/suppression - Heat detection and alarms in the sub stations and MCC rooms, fire suppression is by hand held CO2 cannisters. The crushing stations have hand held powder and CO2 cannisters placed on all floor levels, hand held powder cannisters are placed at 50m intervals along the conveyors and close to all drives, take ups and pulleys.

Plant control is by Programmable Logic Controllers (PLC's) installed in the Tip Substations. A Remote I/O unit is located in the transfer tower at the head-end of the Portal 1 overland conveyor and the Portal 2 open pit decline conveyor. A Human Machine Interface (HMI) is located in the crusher area near the apron feeder at both crusher stations to enable operating personnel to monitor the systems.

The PLC software stops and starts the plant under normal operating and emergency conditions. It monitors all onboard safety devices (conveyor pull switches, belt slip/breakage (zero speed) switches, alarm sirens/lights, belt rip detection and blocked chute detection). The PLC also monitors and controls the operation of the tips (bin levels), apron feeders, vibrating grizzly's, jaw crushers, over band magnets, conveyors, belt scales, dust suppression systems and it communicates with other associated plant PLC's.

Level detection devices at the tip bins warn the rock breaker operator of filling conditions and stop the apron feeder from fully emptying to avoid damage on restart from large rocks.

Figure 7. Portal 1 Ore tip

Figure 8. Portal 1 Overland conveyor

Figure 9. Portal 4 (Bimha Mine)

The pull-wire switches on all the conveyors are hard-wired into the PLC to affect a "controlled stop" of the crushing circuit in case of an emergency induced stop.

A "Dupline" intelligent pull key system is employed on the Portal 1 overland conveyor to identify trips on the individual pull keys along the length of the conveyor.

Original underground facilities prior to mine re-development

The original underground material handling facilities were designed to handle 2.4Mtpa of ore in order to feed the new concentrator at Ngezi. The flowsheet/design was based on a dynamic simulation study that was undertaken of the overall system which included, mining, ore pass storage, conveying, primary crushing, surface storage at the Portal, overland conveying to and storage at the concentrator, closed circuit secondary/tertiary crushing and screening and ball milling.

The mine layout (mining plan) comprised of three declines (two mining and one conveyor). The mining declines fell on dip at approximately 9 deg. West to East to the sink line with the conveyor decline running below the mining declines. Within the "spine" (area between the mining declines), four 700t capacity

Portal 4 U/Ground Conveyors to Surface Crushing Data	Width mm	Length m	Lift m	Belt Speed m/s	Installed kW	Soft Start	Add. Equipment
Sacrificial Conveyors	1500	22	3	1.5	37	VSD	Impact Bed, Self Cleaning Tramp Magnet
Decline 405	1350	450	55	2.0	2x200	VSD	Auto T/UP Winch + Load Cell & Anti Run Back Idlers
Decline 404	1350	498	80	2.0	2x200	VSD	Auto T/UP Winch + Load Cell & Anti Run Back Idlers
Decline 403	1350	770	120	2.0	2x315	VSD	Anti Run Back, Belt Pulling Winch, Idlers/Belt Grab
Surface Transfer 413 - to Crusher	1350	164	18.5	2.0	110	VSD	Belt Grab

Table 4. Portal 4 underground conveyors to surface crushing data

No. of Conv. belts in series	Availability %	Utilisation %	Over-all Utilisation %	Belt capacity required for 200ktpm tph	Belt equipment rating (plus 25%) tph
Sacrificial	97	90	87.3	509	636
405	97	90	76.2	583	729
404	97	90	66.5	668	835
403	97	90	58.1	764	955
413	97	90	50.7	876	1095

Table 5. Conveyor availability and utilisation factors

(one shift for two mining sections) ore passes equally spaced at approximately 220m apart were constructed. The ore was transported by underground truck from the mining faces and tipped into the ore passes.

Based on the RoM sizing (blasting fragmentation) data from the mine static grizzlies with 400mm square openings were installed at the top of the ore passes and hydraulic rock breakers mounted alongside the ore passes broke the oversize on the grizzlies.

At the bottom of each ore pass the ore was fed by vibrating feeder onto a 1500mm wide sacrificial conveyor and then conveyed up the decline by four 1350mm wide conveyors running in series (405, 404, 403, 413) to a surface crushing facility. Hydraulic radial gates were employed on the ore pass discharge chutes for vibrating feeder maintenance and emergency shut off.

Belt widths on the decline conveyors were selected based on three times anticipated maximum lump size and a safety factor for belt start under load and the occasional slabs larger than 400mm. To avoid possible spillage from vibrating feeder surges the sacrificial conveyors were run slower and belt width was increased.

Vibrating feeder throughput was controlled by a belt scale mounted on the decline conveyor after the sacrificial conveyor transfer chute. A tramp magnet on the sacrificial conveyor head chute was installed to remove tramp metal and protect the upstream decline belts from damage.

To absorb the impact from the large material and the additional height required above the belt for the passage of material from the down-stream ore passes, heavy duty drop box type transfer chutes were utilised and heavy-duty impact roller beds and skirts mounted on independent steel supports were used to protect the conveyors.

Level monitors in the ore-passes linked to the plant SCADA system controlled the filling and withdrawal sequences of the ore-passes which ensured that the conveying system was utilised to its optimal capacity and that the trucks were not delayed at the tips.

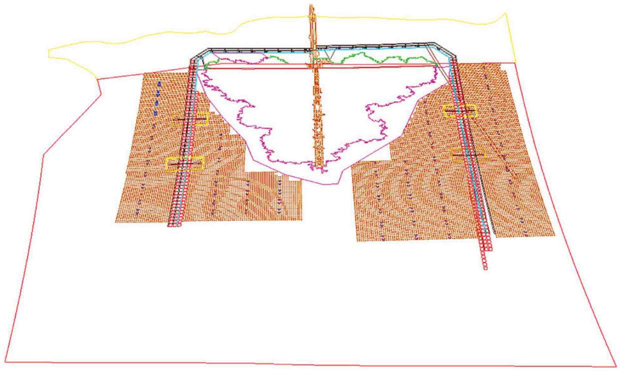


Figure 10. New design for Portal 4 conveyor access routes

The inclination of the decline conveyors varied from 5° to 9° in accordance with the dip of the reef. Conveyor components (pulleys, drives, idlers, belting) were standardised as much as practical. Steel cord belts were utilised on the decline conveyors and fabric belts on the sacrificial conveyors, all decline conveyors were equipped with sensor guard rip detection systems.

The conveyor design was based on a 2.4 Mtpa operation. Availability and utilisation factors were agreed with the client and incorporated into the designs.

The mining cycle dictated that trucks were capable of tipping into the ore-passes for 15 hours per day (5400 hours per annum) which results in a conveyor capacity of 444 tph (for 200ktpm over 30 days). This together with a cumulative allowance for both utilisation and availability of 5 conveyors running in series (4 U/G and 1 surface) resulted in the theoretical design capacity for the conveyor system of 1,095 tph up to surface crushing.

Surface facilities

Ore from the main decline conveyor (403) is delivered from underground onto a surface transfer conveyor (413) that feeds a 100t capacity elevated steel bin, the bin feeds the crusher station and has an overspill arrangement so that it can also discharge onto an emergency stockpile.

Material from the stockpile is fed back into the bin by FEL via a receiving bin and vibrating feeder. Control of feed back onto the transfer conveyor is by VSD on the vibrating feeder and a belt scale on the transfer conveyor.

Ore is withdrawn from the 100t bin by an apron feeder which feeds a vibrating grizzly feeder scalping at -180mm, the oversize is fed to a C140 single toggle jaw crusher.

The crusher is supported on a raised concrete foundation and the crushing station is serviced by a 30t overhead crane. The vibrating grizzly and jaw crusher throughput combined is 1100tph max. and the crusher produces a -212mm product to suit the Ngezi concentrator secondary/tertiary crushing circuit.

The scalped undersize from the vibrating grizzly and crusher product discharges onto a 1200mm wide sacrificial conveyor, a belt scale on this conveyor controls the apron feeder throughput via its hydraulic variable speed drive.

The drive on the sacrificial conveyor has a fly-wheel on the high-speed side which keeps the conveyor running for up to 17 seconds to avoid the flooding of the conveyor by the ore remaining in the crusher chamber, the vibrating grizzly and the undersize chute during power trips. A tramp magnet fitted at the head end of the conveyor protects the downstream conveyors from possible belt damage.

Portal 4 Surface Conveyors Data	Width mm	Length m	Lift m	Belt Speed m/s	Installed kW	Soft Start	Add. Equipment
Sacrificial Conv. 402	1200	64	3	1.5	45	VSD	Brake, Self-Cleaning Tramp Magnet
Silo Feed 401	1050	506	38	2.5	250	VSD	Hyd. Diverter Chute
Silo By-Pass 410	1050	38	0	2.0	15	VSD	Tail Drive & Hyd./Screw T/UP
Stockpile Load Back 412	1200	65	7	1.5	55	VSD	Auto Winch & Load Cell T/UP
Reversable Load Out 411	1500	128	10	1.5	90	VSD	Brake, Rotating Feed Chutes

Table 6. Portal 4 surface conveyors data

The sacrificial conveyor feeds the ore onto 1,050mm wide conveyor which discharges into an ore storage silo (5,500t capacity), a radial gate on the head chute of this conveyor can divert the feed either into the silo, or onto a 1050mm wide silo by-pass conveyor to form an emergency stockpile (1000t capacity) adjacent to the silo.

Material from the emergency stockpile is fed back by FEL to a 60t bin c/w vibrating feeder and 1200mm wide load-back conveyor onto a 1500mm wide reversable conveyor which can feed either a road train load-out station or a 900mm wide overland conveyor.

The silo has four bottom outlets each equipped with vibrating feeders (fixed throughput) which feed directly onto the reversable conveyor. Two alternate feeders simultaneously feed the conveyor at pre-determined intervals in order to maintain an even draw down of material in the silo to minimise wear. The vibrating feeder discharge chutes can be rotated to suit the direction of the reversable conveyor and radial gates are installed on the silo discharge chutes prior to the vibrating feeders for shut off.

The reversable conveyor is rated at 1400 tph to suit the maximum capacity of 2 vibrating feeders. The overland conveyor starts at Portal 3 (Mupfuti Mine), it passes underneath the reversable conveyor and the load-out station and transports ore from both mines (Portals 3 and 4) to the 15000t concentrator feed silo.

The reversable conveyor operates under load and intermittently when feeding the weigh flask and continuously in the opposite direction when feeding the overland conveyor, the drive is at the head and is fitted with a brake on the high-speed side to stop the conveyor overfeeding the weigh flask.

Load cells mounted on the weigh flask measure the mass and control the starting and stopping of the reversable conveyor when it feeds the weigh flask. The weigh flask has two sets of hydraulic clam shell gates which discharge into 105t road trains (3 x 35t trailers).

The road train load out facility was utilised continuously to transport ore to the Ngezi concentrator prior to the completion of Portal 3, the overland conveyor and the Ngezi concentrator feed silo which were all part of the concentrator 4Mtpa upgrade. The Portal 4 ore is now transported by the overland conveyor which also receives 2.0Mtpa of ore from Portal 3. The road train facility is now only used during breakdowns and maintenance.

No. of Conv. belts in series	Availability %	Utilisation %	Over-all Utilisation %	Belt capacity required for 184ktpm tph	Belt equipment rating (plus 25%) tph
Sacrificial	97	90	87.3	467	584
1st. dip	97	90	76.2	535	669
Diagonal dip	97	90	66.5	614	768
Strike	97	90	58.1	702	878

Table 7. Conveyor availability and utilisation factors

Portal 4 Re-Development Conveyors Data – North	Width mm	Length m	Lift m	Belt Speed m/s	Installed kW	Soft Start	Add. Equipment
Sacrificial Conveyor	1500	26	2.5	1.3	22	VSD	Impact Bed, Tramp Magnet
1St. Dip Conveyor 455	1350	655	89.6	2.0	2x185	VSD	Auto Winch & Load Cell T/UP, Anti Run Back Idlers, Belt Grab
Diagonal Dip Conveyor 456	1350	156	25.3	2.0	110	VSD	Auto Winch & Load Cell T/UP, Anti Run Back Idlers, Belt Grab
Strike Conveyor 457	1350	850	1.0	2.0	110	VSD	Auto Winch & Load Cell T/UP, Brake

Table 8. Portal 4 re-development conveyors data - North

Portal 4 Re-Development Conveyors Data – South	Width mm	Length m	Lift m	Belt Speed m/s	Installed kW	Soft Start	Add. Equipment
Sacrificial Conveyor	1500	26	2.5	1.3	22	VSD	Impact Bed, Tramp Magnet
1St. Dip Conveyor 475	1350	670	91	2.0	2x185	VSD	Auto Winch & Load Cell T/UP, Anti Run Back Idlers, Belt Grab
Diagonal Dip Conveyor 476	1350	123	12.5	2.0	1x75	VSD	Auto Winch & Load Cell T/UP, Anti Run Back Idlers, Belt Grab
Strike Conveyor 477	1350	681	-19	2.0	75	VSD	Auto Winch & Load Cell T/UP, Brake

Table 9. Portal 4 re-development conveyors data - South

Underground mine re-development

Due to a geological fault unsafe ground conditions were detected by the mine in 2014 in the existing mining areas at Portal 4 and all mining activities were suspended.

After extensive geotechnical work by Zimplats, Portal 4 mine was re-designed in order to gain access to the remaining ore body not affected by the fault. The design proposed the development of new North and South access ways on strike (two access ways for mining and one for the conveyors) to go around the affected areas in the middle. The conveyor access ways run approximately 900m and 700m on strike and then turn through 90 degrees and run on dip (West to East) to the sink line (bottom of reserve).

The materials handling facilities currently comprise of two ore passes, one in the North section (2000t capacity) and one in the South (1200t capacity) at the head end of each strike conveyor access way. The difference in capacity is dictated by their position on dip relative to the existing decline conveyor. To save on haulage costs the construction of the ore passes was completed early on the project (commenced as soon mining had moved a safe distance away) so that mined ore could be transported to surface crushing with the existing main decline conveyor.

The uncrushed ore is tipped by underground trucks through a 450mm square static grizzly at the top of each ore pass. Each ore pass is equipped with a hydraulic rock breaker for breaking oversize.

Once the North and South crushing and conveying facilities were completed the main source of feed to the ore passes are the strike conveyors which discharge crushed ore via a dead box through side entry points below the grizzly. The tips are now mostly used during crushing/conveyor maintenance and breakdowns.

The ore pass outlets each have discharge chute, radial shut-off gate, vibrating feeder and a sacrificial conveyor (1500mm wide) that feeds onto the existing decline conveyor (1350mm wide). The decline conveyor belting, pulleys, idlers, chutes and safety equipment have been replaced. The drives and take up were refurbished and the support structures repaired and upgraded as required.

Two underground crushing stations (1 x North and 1 x South) have been built and crushed ore is transported from each by four conveyors in series (sacrificial, 1st dip, diagonal dip and strike) to the ore passes. The conveyor design is based on a 2.2 Mtpa operation for each of the North and South sections, which results in a theoretical conveyor capacity of 408tph based on a mining cycle of 5400 hours. Crusher station availability and utilisation is ignored as the trucks can tip directly into the ore passes if required.

Conveyor availability and utilisation factors are as per the original underground pre-development design. The conveyor systems are each designed to handle 1000tph to include for catch up when required.

Each crusher station comprises of an 80t bin, static grizzly with 640mm square openings, hydraulic rock breaker, variable speed apron feeder, vibrating grizzly feeder scalping at -180mm and a C140 single toggle jaw crusher which produces a -212mm product. Based on the simulation of the crushing circuit flowsheet the system throughput was calculated to be 1000tph.

Apron feeder dribble, scalped undersize from the vibrating grizzly and crusher product are collected by a short 1500mm wide sacrificial conveyor. A belt scale mounted on the 1st dip conveyor after the transfer chute controls the apron feeder throughput via its hydraulic variable speed drive. A fly-wheel on the high-speed side of the sacrificial conveyor drive keeps it running for up to 17 seconds to avoid the flooding of the conveyor by the ore remaining in the crusher chamber, the vibrating grizzly and the undersize chute during power trips.

A tramp magnet is fitted at the head end of the sacrificial conveyor to protect the downstream conveyors from possible belt damage. From the sacrificial conveyors three 1350mm wide conveyors running in series (455, 456, 457) in the North and (475, 476, 477) in the South feed the North and South ore passes respectively.

The use of 1350mm wide conveyors was dictated at the design stage when on-reef tips (handling -400mm uncrushed ore) were utilised to load onto the conveyor system. These were subsequently replaced with crushing stations at a late stage in the project (after the delivery of the conveyor equipment) by the client who decided to expand the mine footprint by 1.5km in the North. The expanded mine justified the use of crusher stations in terms of cost and avoided mining through a serious fault during the development of the future Portal.

Underground mine

Portal 3 (Mupfuti) was developed to provide 2.0Mtpa of crushed ore to the Ngezi concentrator. The ore is delivered from a 13000t (live capacity) surface stockpile at Portal 3 to a 15,000t storage silo at the concentrator by a 5.8Km long overland conveyor.

The underground mine comprises of a box-cut, two portal entrances (mining and conveyor) and three access declines (two mining and one conveyor), the mining declines fall on dip at between 5 and 9 deg. in accordance with the dip of the reef and the conveyor decline dips below the mining declines. An underground crushing station positioned approximately 450m from the portal entrance and built between the mining declines feeds an 800t capacity ore pass that feeds a 1050mm wide decline conveyor.

The underground rock transport in the plane of the reef is by underground 30t trucks which tip onto a horizontal static grizzly mounted on top of an 85t tipping bin from two sides. The static grizzly has 640mm square openings and a hydraulic rock breaker mounted alongside breaks the oversize rock.

Ore is withdrawn from the bin by an apron feeder which feeds onto a vibrating grizzly feeder. The vibrating grizzly oversize is fed to a C140 single toggle jaw crusher which discharges the crushed ore directly into an 800t storage capacity ore-pass. Undersize from the vibrating grizzly feeder is fed by a discharge chute directly into the ore pass and dribble from the apron feeder is collected on a 7m long x 900mm wide conveyor that also feeds into the ore pass.

The crusher is mounted on concrete beams spanning the ore pass and the top of the ore pass is fully enclosed by a concrete slab. A chamber with a movable trolley for access to the crusher discharge liners is provided between the beams for inspection and maintenance.

Dust suppression (spray nozzles) is utilised on the apron, vibrating grizzly and crusher feed chutes and a dust extraction system (wet scrubber type) extracts from the top of the ore pass.

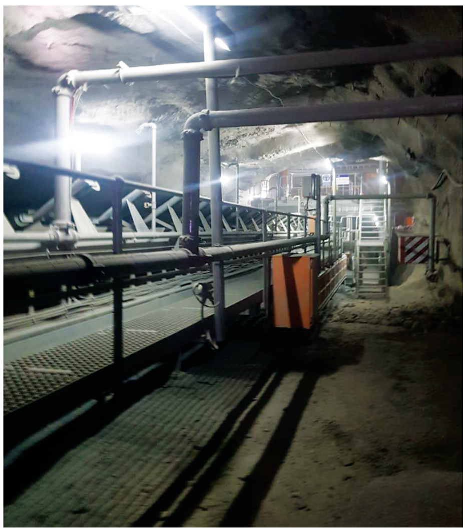


Figure 11. Portal 4 (Bimha Mine) sacrificial conveyor

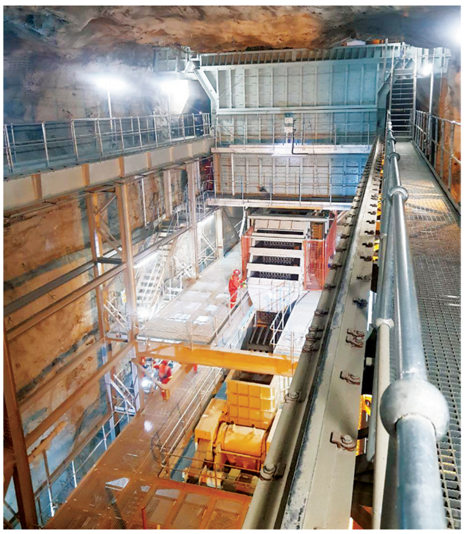


Figure 12. Portal 4 (Bimha Mine) crushing station

The crusher station is equipped with a 30t overhead crane for initial erection and for maintenance once the crusher is operational. A 5t jib crane is used for rock breaker and static grizzly maintenance.

At the bottom of the ore pass the crushed ore passes through a chute onto a vibrating feeder that feeds a 1500mm wide sacrificial conveyor. The chute has a radial gate for maintenance and emergency shut-off.

The vibrating feeder has a variable speed drive (VSD) for controlling throughput, the VSD is controlled by a belt scale mounted on the decline conveyor after the transfer chute from the sacrificial conveyor. A tramp magnet is mounted above the sacrificial conveyor head pulley to protect the main decline conveyor.

The conveyor design caters for four conveyors in series. A second decline conveyor and crusher station will be added as the mine expands towards the East.

The conveyor design is based on a 2.0 Mtpa operation which results in a theoretical conveyor capacity of 463tph based on a mining cycle of 5400 hours and includes a crusher station availability and utilisation factor. A cumulative allowance for both utilisation and availability for four conveyors in series and a 25% (catch-up) results in a required design capacity for the conveyor system of 996 tph. The conveyor system is designed for 1100tph.

Selection of 1050mm wide decline conveyor belt width was based on the crushed ore size analysis performed at Portal 4 which also produces a -212mm product and generates occasional slabs of 350 x 350 x 150mm.

Surface facilities

Ore from the decline conveyor (306) is delivered from underground onto a surface crusher feed conveyor (309). This conveyor together with a surface tip, crushing station and radial stockpile were built at an early stage of the project so that trucked RoM ore from underground could be crushed and delivered to the concentrator during the development of the mine and the construction of the underground crushing station.

The surface tip includes a reinforced earth/concrete panel retaining wall, 80t capacity steel tip bin, static grizzly, hydraulic rock breaker and vibrating feeder. The vibrating feeder feeds onto conveyor 309 which was built with an extended tail section and a transfer tower for transferring ore from decline conveyor 306 in the future.

Conveyor 309 has a 1500mm belt width in order to cater for the -400mm ore passing through the surface tip static grizzly and a belt scale mounted after the vibrating feeder discharge chute which controls feeder throughput via its VSD. The vibrating feeder discharge chute is raised above the belt so that underground ore from conveyor 306 can pass underneath. to reduce belt and structural damage by the large RoM ore. Independently supported impact cradles with heavy duty impact idler strings and skirts are employed at the feed points to reduce belt and structural damage by the large RoM ore. Tramp metal is removed by a self-cleaning magnet fitted across the conveyor.

The surface crusher station design is based on the Portal 4 surface unit with minor layout changes. It also consists of a 100t capacity elevated storage bin which feeds the crusher station and an overspill chute to discharge onto an emergency stockpile. Overspill material from the stockpile is fed back to the crusher station bin by FEL and truck via the surface tip and conveyor 309.

As in Portal 4 ore is withdrawn from the 100t bin by an apron feeder which feeds a vibrating grizzly feeder that scalps at -180mm and feeds the oversize to a C140 single toggle jaw crusher. The vibrating grizzly and jaw crusher throughput combined is 1100tph max. and the crusher produces a -212mm product to suit the Ngezi concentrator secondary/tertiary crushing circuit. The apron feeder fines dribble, vibrating grizzly scalped undersize and the crusher product discharge onto sacrificial conveyor 310 (1200mm wide).

A belt scale on this conveyor controls the apron feeder throughput via its hydraulic variable speed drive. A fly-wheel on the high-speed side of the sacrificial conveyor drive keeps it running for up to 17 seconds to avoid the flooding of the conveyor by the ore remaining in the crusher chamber and the vibrating grizzly undersize chute during power trips. A self-cleaning tramp magnet is fitted at the head end of the conveyor to protect the downstream conveyors from possible belt damage.

The sacrificial conveyor delivers the ore to a diverter chute (operated by motorised hydraulic cylinder) that can feed either a radial slewing stacker conveyor (318) or a cantilevered stacking conveyor (311) that feeds a 13000t live capacity stockpile.

The radial stacking conveyor (318) is 1050mm wide, it pivots about its tail terminal and is supported on two gear driven rail mounted bogeys which provide the slewing motion. It is used to create a 24000t emergency stockpile which keeps the mine in operation when the overland conveyor and the 13000t stockpile are shut down. The radial motion is controlled by a level sensor mounted at the head of the conveyor which signals the machine to move when the pre-set maximum stockpile height is reached, limit switches stop the machine when it reaches its travel limits. Wind speed is monitored by an anemometer and the machine is locked down in the event of high wind speeds. Radial stockpile material is fed back to the to the overland conveyor stockpile by FEL and truck via the surface tip and the crushing station.

Stacking conveyor (311) is 1050mm wide, it deposits ore in the centre of the stockpile and has a 38m cantilevered section. The stockpile has a 13000t live capacity and a 45000t overall capacity, level detectors mounted on the conveyor stop the feed from the up-stream plant when the stockpile is full. A concrete tunnel under the stockpile houses two expanded flow outlet flasks, each flask has two outlets with vibrating feeders that discharge onto a 1200mm wide overland feed conveyor (313), the concrete tunnel is above ground and covered by earth fill, a ramp alongside provides access to the base of the stockpile so that dead material can be “dozed” into the expanded flow outlets. Vibrating feeder throughput (700tph each max.) is controlled by VSD’s on each machine and a belt scale mounted on conveyor 313.

Conveyor 313 is fitted with a self-cleaning magnet at the head pulley prior to feeding onto overland conveyor (317). The overland conveyor is 900mm wide and 5.8km long, it has two horizontal curves (2.1km and 3.5km radius) and a vertical curve that takes it through a cutting along the side of a hill. Two major road crossings (Portal 4 and the management village) and three vehicle cross-overs provide access over the conveyor. Independent stringer modules mounted on concrete sleepers and resting on profiled compacted fill are utilised to follow the ground profile, box gantries and galleries are used on the elevated sections. The conveyor has two drives, dual primary drive units and a single secondary drive unit, the drives are positioned under the conveyor as it rises towards the 15000t silo. Disc brakes mounted on the high-speed side of the primary drives stop the belt in approximately 60 seconds.

The conveyor take-up is positioned at the tail (closest to the 2.1km horizontal curve) so that it stabilises the tensions in the curve. Belt turnovers are provided at both ends of the conveyor to minimise spillage. The conveyor carries crushed ore (1400tph max.) from either the Portal 3 stockpile or the Portal 4 silo and feeds a diverter chute at the top of the 15000t silo that discharges either into the centre of the silo or onto a 1200mm wide silo by-pass conveyor (320) that feeds a 2500t live capacity emergency stockpile which is utilised during silo maintenance.

As well as a "Dupline" intelligent pull key system, belt tracking, under-speed detection and blocked chute detection, safety and condition monitoring systems on the overland conveyor include; belt tear detection (embedded loop) and splice and cord condition monitoring. The overland conveyor system including the Portal 3 stockpile, Portal 4 silo discharge, feed into the 15000t silo and the feed to the by-pass stockpile is controlled from the Portal 3 control room.

Phases 1 and 2

The Ngezi concentrator consists of two 2.0Mtpa modules which require a -13mm mill feed and produce a concentrate that is transported to an existing smelter at SMC. Each module contains a ball mill and a flotation circuit, they have common thickening, filtration, tailings disposal and water recovery facilities. The current plant was built in two phases, phase one comprising of module 1 plus the common facilities with the second milling and flotation module being built in phase two.

The crushing and materials handling facilities were designed as modular 4Mtpa units so that additional units could be added for future expansions. The existing 15000t silo feed (overland conveyor 317) head chute design allows it to divert the feed directly into the silo or onto a transfer conveyor (currently utilised as the silo by-pass) which will discharge into a second 15000t silo (fed by the future North Portals expansion). The layout of the silos and crushing plant feed conveyors allows the feed from both the North or South Portals to be diverted to either silo and to be fed to either of the crushing/screening modules.

As stated above, a 2.0Mtpa concentrator module requiring a -13mm feed to the ball mill was built in phase 1 of the project. The crushing/screening plant module to feed it consisted of a three compartment road train off-loading station receiving ore from Portal 4 and a closed circuit secondary/tertiary crushing and screening plant module comprising: 1 x secondary crusher, 1 x secondary double deck screen, 2 x tertiary crushers (one stand-by), 2 x tertiary single deck screens, a 6000t mill feed storage silo, a variable speed belt feeder and a mill feed conveyor.

In order to cater for the phase 2 and 3 expansions the secondary crushing feed conveyors were sized to handle 8Mtpa. The secondary/tertiary crushing and screening circuits were designed as 4Mtpa modules, however in phase 1 only the equipment items required to achieve the 2Mtpa throughput were installed. These were added in phase 2 and included 1 x secondary and 1 x tertiary screen which together with the full time use of the existing stand-by tertiary crusher completed the 4Mtpa module. A diverter chute and transfer conveyor were added at the top of the existing 6000t mill silo to feed a new 7000t mill feed silo which feeds the second mill via variable speed belt feeder and a mill feed conveyor.

No. of Conv. belts in series	Availability %	Utilisation %	Over-all Utilisation %	Belt capacity required for 168ktpm tph	Belt equipment rating (plus 25%) tph
Sacrificial	97	90	87.3	530	663
Future Decline Conveyor 307	97	90	76.2	608	760
Decline Conveyor 306	97	90	66.5	696	870
Surface Crusher Feed 309	97	90	58.1	797	996

Table 10. Conveyor availability and utilisation factors

Portal 3 Underground Conveyor Data	Width mm	Length m	Lift m	Belt Speed m/s	Installed kW	Soft Start	Add. Equipment
Sacrificial Conveyor	1500	15	2.5	1.1	37	VSD	Impact Bed, Tramp Magnet
Future Decline Conveyor 307	1050	440	35	2.0	2x132	VSD	Auto Winch & Load Cell T/UP, Anti Run Back Idlers, Belt Grab
Decline Conveyor 306	1050	670	94	2.0	3x200	VSD	Auto Winch & Load Cell T/UP, Anti Run Back Idlers, Belt Grab
Surface Crusher Feed 309	1500	187	24	2.0	132	VSD	Impact Beds, Self-Cleaning Tramp Magnet

Table 11. Portal 3 underground conveyor data

Current facilities forming part of the concentrator plant include a 15000t concentrator feed silo which has four bottom outlets each equipped with vibrating feeders (variable throughput) which feed directly onto transfer conveyor (122). To maintain an even draw down of material in the silo in order to minimise wear two alternate feeders simultaneously feed the conveyor at pre-determined intervals.

Transfer conveyor 122 is equipped with a belt scale that controls the feed rate of the vibrating feeders and a self-cleaning magnet is mounted across the conveyor to remove tramp metal. The tail end of transfer conveyor 122 extends into the emergency stockpile tunnel and is also fed by the two stockpile vibrating feeders during silo maintenance. The conveyor crosses over the main access road from Selous and feeds onto transfer conveyor 102 on the concentrator plant side.

Should conveyor 122 be shut down conveyor 102 can also be fed at a rate of 2Mtpa from the road train tip by conveyor 101. This tip has three-compartments (capacity 65t each) with three variable speed vibrating feeders installed under each compartment that feed onto tip withdrawal conveyor 101. Conveyor 101 is equipped with a self-cleaning magnet for tramp removal and a belt scale for controlling the feed rate of the vibrating feeders.

Transfer conveyor 102 feeds onto transfer conveyor 103 which in turn feeds secondary crusher feed conveyor 106 which discharges into a 400t secondary crusher feed bin. Conveyor 106 also receives oversize material from the top deck of the secondary screens for recirculation back to the secondary crusher.

A variable speed vibrating feeder withdraws material from the 400t bin and discharges onto crusher feed conveyor 104 which feeds the CS660 secondary cone crusher. Level detection in the crusher bowl controls the feed rate of the vibrating feeder. The secondary crusher delivers a -60mm product at a fresh feed rate of 800tph for Phase 2 (4Mtpa).

The secondary crusher product is fed onto the secondary screens feed conveyor 105 which feeds two secondary screen feed bins via a hydraulically operated diverter chute controlled by level detectors in the bins. Vibrating feeders withdraw material from the bins at a pre-set rate and deliver it to the secondary double deck screens. Oversize from the top deck of the screens reports back to the secondary crusher via the secondary crusher feed conveyor 106. Oversize from the bottom decks is transferred to the tertiary crushers by tertiary crusher feed conveyor 107.

Conveyor 107 feeds a moving diverter chute system (hydraulically controlled by level detectors in the bins) that feeds two 120t bins. The bins discharge onto two retractable belt feeders F 101 & F 102 (variable speed) which feed the CH870 tertiary crushers.

Level detection in the crusher bowl controls the feed rate of the belt feeders into the crushers. In order to protect the crushers metal detectors on the belt feeders warn the plant operator and stop the feeders when tramp metal is detected.

The tertiary crushers discharge onto tertiary screen feed conveyor 113. A fly-wheel on the high-speed side of the conveyor drive keeps it running for up to 10 seconds to avoid the flooding of the conveyor by the ore remaining in the crusher chambers during belt trips/power outages. Conveyor 113 feeds the tertiary screen bins belt feeder system (114 & 115). The system consists of two belt feeders, feed chutes and a centre chute mounted on a common support frame on rails. The system is mounted on top of and feeds three 120t secondary screen feed bins, movement of the system is by hydraulic cylinder controlled by bin level detection and limit switches.

Belt feeders (F103, F104, F105) together with profile chutes withdraw from the bins and feed onto the single deck tertiary screens. The oversize from the tertiary screens (re-circulating load) is added to the oversize from the bottom deck of the secondary screens onto tertiary crusher feed conveyor 107.

The undersize (product) from the secondary screens together with the undersize of the tertiary screens bottom deck is transferred by a series of four conveyors 119, 120, 121 & 126 to two mill feed silos. Conveyor 119 collects -13mm material from the secondary and tertiary screens and feeds onto conveyor 120. It is designed for fitting a moving head in the future in order to feed a second conveyor product stream to future silos.

The current length of conveyor 120 allows it to be fed from two future crushing/screening modules. It feeds onto conveyor 121 which delivers the material to a diverter chute that feeds either into the 1st mill feed silo or onto conveyor 126 which feeds into the 2nd mill feed silo.

The layout of the conveyors as it currently exists also makes allowance for feeding future mill feed silos with conveyors running parallel to conveyors 120, 121 and 126.

The product silos each have two bottom outlets with profile chutes and hydraulic shut off gates. The feed to the mills is via hydraulically driven variable speed belt feeders FEB 121 & FEB 220 and mill feed conveyors 151 & 251.

Belt scales mounted on the mill feed conveyors control the feed from the belt feeders onto the mill feed conveyors. A

Figure 13. Portal 3 (Mupfuti Mine)

Figure 14. Portal 3 (Mupfuti Mine) underground crushing station

Figure 15. Portal 3 overland conveyor with silo by-pass

ball loading facility is provided at the tail end of the mill feed conveyors. Ball discharge is controlled by the belt scales mounted on the mill feed conveyors so that balls can only be loaded with material on the belt to avoid run-back.

A hammer sampler is installed on each mill feed conveyor after the belt scale. No sampling takes place when mill balls are fed onto the mill feed conveyor. Scats from the mills are fed back onto the mill feed conveyors by FEL via a 5t bin and vibrating feeder after the sampler.

Portal 3 Surface Conveyor Data	Width mm	Length m	Lift m	Belt Speed m/s	Installed kW	Soft Start	Add. Equipment
Surface Crusher Sacrificial Conv. 310	1200	106	10.5	2.0	75	VSD	Brake, Tramp Magnet
Radial Stacking Conveyor 318	1050	50	38	2.5	75	VSD	Rail Mounted Bogeys, Level Detection, Positioners, Anemometer
Cantilevered Stacking Conveyor 311	1050	290	31.3	2.5	200	VSD	Product Sampler, Level Detection
Overland Feed Conveyor 313	1200	173	4.0	2.5	75	VSD	Self-Cleaning Tramp Magnet,
Overland Conveyor 317	900	5800	33	4.0	3x400	VSD	Belt Turn Overs, Anti Run Back Idlers, Belt Grab, Brake
Silo By-Pass Conveyor 320	1200	36	0	2.0	22	VSD	Tail Drive, Fly-Wheel

Table 12. Portal 3 surface conveyor data

• Changes/ Improvements made to date:

• Static grizzly's with 400mm square openings in place of 550mm square at the ore pass tips to reduce slabs and oversize material.

• Rock breakers with greater impact energy to maintain throughput into the ore passes due to the smaller grizzly openings.

• Strain gauge system level detection mounted on the ore pass discharge support steel in place of ultrasonic level detection at the tips which proved unreliable due to dust and moisture.

Concentrator Conveyors and Belt Feeders Data	Width mm	Length m	Lift m	Belt Speed m/s	Installed kW	Soft Start	Add. Equipment
15000t Silo Discharge Transfer Conv. 122	1200	246	9.7	2.5	132	VSD	Vert Gravity T/UP, Tramp Magnet
Road Train Off-Loading Conv. 101	1050	147	7.8	1.5	55	VSD	Hor. Gravity T/UP, Tramp Magnet
Transfer Conv. 102	1200	77	13.6	2.5	160	VSD	Vert Gravity T/UP, Tramp Magnet
Transfer Conv. 103	1200	175	5.6	2.5	90	VSD	Hor. Gravity T/UP,
Sec Crusher Bin Feed Conv 106 (Fresh & Recirc.)	1200	218.5	18.9	2.5	200	VSD	Vert Gravity T/UP, Tramp Magnet
Sec Crusher Feed Conv. 104	1500	10.7	0	10	11	VSD	On rails, Winch Moveable, Screw T/UP
Sec Crusher Product Conv 105	900	214.2	25.1	2.0	132	VSD	Vert Gravity T/UP
Tertiary Crusher Bins Feed Conv 107	900	227.3	18.9	2.0	132	VSD	Vert Gravity T/UP, Tramp Magnet
Tertiary Crushers Belt Feeders F101 & F102	1500	14.2	0	0.46	45	VSD	Adjustable Feed Chute, On rails, Winch Moveable, Screw T/UP
Tertiary Crushers Product/ Sec Screen feed Conv 113	900	211.4	25.1	2.5	160	VSD	Vert Gravity T/UP, Drive Fly Wheel
Tertiary Screen Bin Belt Feeder Convs.114 & 115	1500	5.2	0	1.0	11	VSD	On rails & Hyd. Moveable, Drive Fly Wheel
Tertiary Screens Belt Feeders F103,104,105	1500	8.9	0	0.46	45	VSD	Adjustable Feed Chute, Screw T/UP
Sec & Tertiary Crushers Product Conv. 119	900	203.5	8.0	2.0	75	VSD	Future Moving Head Design, Hor. Gravity T/UP
Product Transfer Conv 120	1050	64.1	0	2.5	30	VSD	Product Collection from Current & Future Modules, Hor. Gravity T/UP
1St Mill Silo Feed Conv 121	1050	157.7	36	2.5	160	VSD	Hyd. Diverter Head Chute, Hor. Gravity T/UP
2nd Mill Silo Feed Conv. 126	1200	46.0	4.9	2.5	75	VSD	Enclosed Gallery. Screw T/UP
Mill Silo Discharge Belt Feeders FEB 101 & 220	1500	13.75	0	0.1	22	VSD	Variable Speed Hyd. Drive
Mill Feed Convs. 151 & 251	900	131.7	11.8	1.0	37	VSD	Hor. Gravity T/UP

Table 13. Concentrator conveyors and belt feeder data

- DEM modelling for transfer chute designs (drop box design, material flow)
- Increased chute plate thicknesses and better liner fixing methods (hardened CSK bolts, dome washers, lock nuts).
- Work hardening "Cruesabro 8000" (higher manganese content) liners in high wear areas.
- Heavy duty impact beds with series 40, 159mm dia., 5 roll impact roller strings, mounted on independent support structures to avoid conveyor stringer damage and subsequent belt damage.
- Static tramp magnets supported on crawl beams with an automated trolley system for tramp removal. Replacing belt over-band magnets which were constantly subject to belt tears due to mining roof bolts.
- Wherever possible underground conveyors are suspended from the hanging wall, (±900mm from underside stringers to the foot wall) to facilitate footwall cleaning of spillage.
- Automatic load-cell controlled take up winches on underground conveyors (minimise tensions in the belt during start up).
- Belt rip detection on all conveyors with loops embedded in the belt and monitoring/tripping systems linked to the plant control SCADA system. Monitoring of cord and splice condition on the overland conveyor.
- Fire retardant anti-static conveyor belting (SANS 971:2013), independent conveyor belt fire testing.
- Anti- roll back idlers and belt break grabs on carry and return at points of maximum tension on elevating conveyors.
- Electrically operated belt pulling winches for conveyor belt replacement on conveyors longer than 30m.
- Cameras installed at RoM tips, transfers and in areas of high risk, reporting to the Plant Control Room and the Emergency Control Centre.
- Use of underground crushing stations in place of RoM ore passes and tips. Conveyor system fed with – 250mm material in place of -400mm. Use of 1050mm conveyor width in place of 1350mm. Less impact damage and wear at ore passes and transfer chutes. Height decrease of transfers and roof height in conveyor access ways. Additional capital costs mitigated by the saving on conveyor and mining capital expense and major reduction in long term maintenance costs and an increase in conveyor system availability.
- Safety systems improvement: Fire retardant low halogen cables with the 11kV cables kept out of conveyor access ways and dry type mini substation. transformers.
- Fire system detection and alarm which sets in motion an escape strategy for personnel in the conveyor declines and ore pass discharge areas and reports via fibre optic cable to the SCADA and an Emergency Control Centre. The fire system on the conveyors has linear heat cable detection and infrared flame detectors in parallel with deluge fire suppression split into individual zones, substations and MCC rooms have automatically actuated clean agent inert gas fire extinguishing systems.
- The "Leaky Feeder" mine radio communication system was upgraded to include man and machine tracking, vehicle collision warning and gas monitoring.
- Sheeting of all conveyors and the overland conveyor stockpile to avoid flooding and down time at the concentrator crushing and screening circuit during the rainy season.

- **Improvement suggestions for the future:**
- Improve mine blasting patterns to reduce number of large boulders and long slabs arriving at the underground tips which can save on rock breaker energy and grizzly and apron feeder wear.
- Use of modular/movable crushing stations during mine development (prior to the underground crushing stations being constructed) which can be utilised at the other mines when needed.
- Use of lower profile crushers at the underground crushing stations to reduce mining excavation heights (cost and time).
- Use of covered stockpiles with maintenance by-pass outlets in place of silos for the -250mm material. The additional expense is mitigated by the fact that silos generally need to be re-lined more frequently and need to be taken off-line during the re-lining process (3 to 4 weeks) depending on size unless a by-pass facility is incorporated in the system (by-pass stockpile).

Figure 16. Ngezi Concentrator materials handling

Figure 17. Ngezi Concentrator secondary crushing and screening

This paper was first presented at the Beltcon Conference in 2019.

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Post-lockdown deliveries

Surface mining industry association, Aspasa, has called on miners to use the lag between the opening of surface mines and the delivery of products wisely, by preparing smart stockpiles, internal roadway systems and traffic separation measures to deal quickly and safely with the tide when markets reopen.

Aspasa director, Nico Pienaar, says that while surface mines have been allowed to operate at 50% of capacity since relatively early in the lockdown period and 100% after 1May 2020, markets for the products including commodities, construction products and others, will remain closed until further restrictions are lifted.

Carefully planned stockpiles should be prepared to meet large demands when markets return to trading

"It is foreseeable that a mine operating at 100% capacity will need to stockpile products until markets reopen. We are therefore advising mine managers to do their research upfront and carefully plan for reopening, while also bearing in mind safety and speed of movement.

"At this point it will also pay to take heed of upcoming legislation that will require separation of traffic, including mine vehicles, road vehicles and pedestrians to avoid collisions. In this way smaller-scale surface mines can reduce the risk of collisions and thereby avoid the requirement for potentially costly Proximity Detection Systems (PDS),"Nico concludes.

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Laboratory contract

Automated laboratory leader FLSmidth has had its Operate and Maintain (O&M) contract at the Saldanha Iron Ore Terminal on South Africa's west coast renewed for another three years.

The company has successfully operated the quality control laboratory at Saldanha which is Africa's largest iron ore export facility, for the past eight years according to Martin Matthysen, Director, SPA (sampling, preparation and analysis), Sub Saharan African and Middle East at FLSmidth.

"An average of approximately 8 500 tonnes of iron ore per hour pass by conveyor from the rail head to the ship during loading," says Martin. "Our automated laboratory located above the conveyor must sample and test from this ore stream, delivering accurate and precise data timeously to stakeholders."

It is the only laboratory with ISO 17025 accreditation for the iron ore sector, complying with standards ISO 9516 for chemical analysis, ISO 4701 for particle size determination, ISO 3087 for moisture analysis, ISO 11536 for loss of ignition analysis and ISO3082 for sampling.

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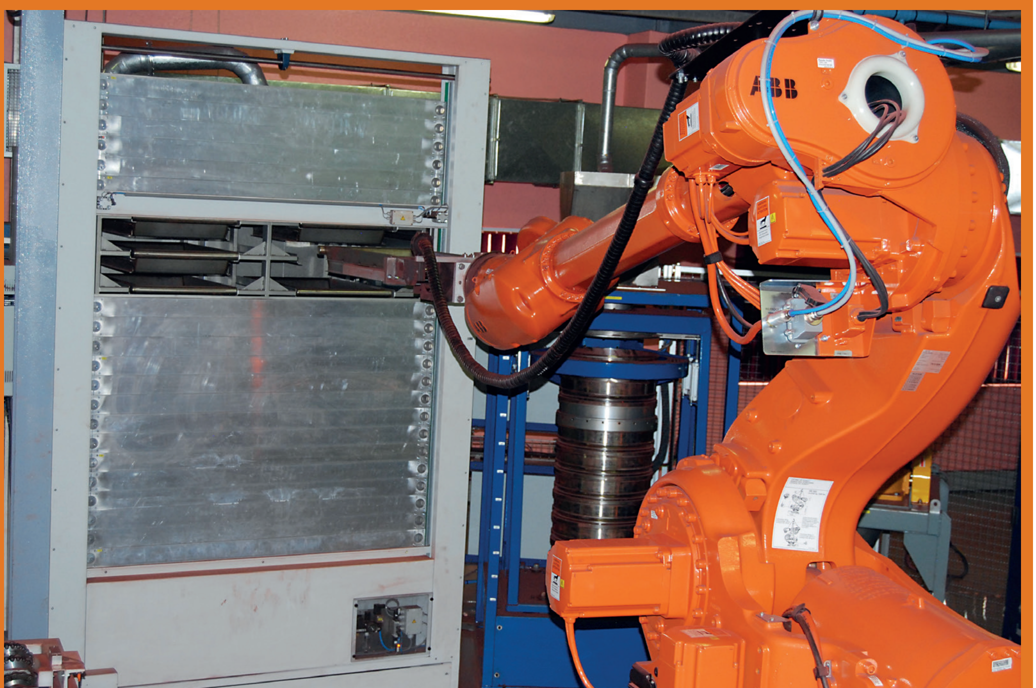

NDT on ropes

Lubrication Engineers (LE) South Africa is now an agent for the TST FDSys.P Flaw Detection System – a portable steel-wire-rope inspection solution that enables 100% accurate non-destructive inspection of wire ropes with diameters ranging from 6 to 70mm.

"We're very excited to have added the TST products to our stable," says LE South Africa Managing Director, Colin Ford.

"They allow the instant, real-time, portable detection of wire rope flaws, such as broken wires, corrosion, pitting, abrasion and fatigue. The tester is ideal for inspecting wire ropes on mine hoists, cranes, elevators, cableways, power grids, suspended bridges and drilling platforms."

Colin explains that the tester uses magnetic inductive sensing technology and MFL (magnetic flux leakage) wire rope inspection techniques. Essentially, fault events leave a magnetic signature, which the detector can pick up. "This allows for high-speed, accurate, user-friendly inspections," he concludes.

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Boosted by upgrades

A range of upgrades at OMV's aggregate and sand plant at Stilfontein in North West province has led to a 40% capacity growth over just 18 months.

OMV's plant processes quartzite rock dumps generated from shaft-sinking in the area to produce road construction material. While production capacity could previously be pushed to about 1 000 tonnes a day, the plant's daily output now regularly reaches some 1 400 tonnes.

One of the first improvements was the installation of a 100 metre overland conveyor extension from the dump to the feed box. This improved productivity overcame the loading constraints experienced previously with the use of front-end loaders.

A new feed box was also installed, with its own six metre conveyor belt, to feed the overland conveyor. This addition reduced excessive wear and tear, improving uptime on that part of the plant.

Production has also been improved with the incorporation of a vibrating pan feeder on the secondary crushing plant, regulating the flow of material onto the conveyor belt. Supplied by Weir Minerals Africa and installed by the OMV team, the feeder was the first step in the automation of the secondary crushing process.

OMV .
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Loaders for gold project

A service provider to the gold-mining industry based in Klerksdorp has taken delivery of two Sany SYL956 front-end loaders, reports Goscor Earthmoving (GEM) salesperson Klinton Kane. With an operating weight of 17 000kg, a 3.2m^3 bucket and a 2 200rpm engine, the loaders are ideal for such an arduous and demanding application.

Shakgapickle Trading & Projects Director Gaoarabe (Bobo) Lesupi, who has an engineering background, explains that she and her husband decided to start their own company in 2014 after having worked for a major gold producer for many years. "Our combined experience allowed us to offer a niche service for both underground and opencast mining," she explains.

The new Sany SYL956 machines will be deployed for loading operations at a major gold-mining project in the Klerksdorp area. The project involves the relocation of an old mine dump to a new area, from which the material will be conveyed to a minerals-processing plant.

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Intermodal Tipper Bins

Specialised Container Agencies (SCA), suppliers of niche market container products, has developed an intermodal side tipper bin, that provides efficient bulk handling rail solutions, encouraging greater utilisation of rail wagon container haulage.

"SCA's intermodal tipper bins ensure quick, safe and cost-efficient bulk handling in rail and road applications. What's notable is this intermodal side tipper bin system increases payload on rail wagons, from 54 metric tons to 60 metric tons. A single tipper bin is able to hold 30 metric tons for road transport," explains Ken Mouritzen, director, Specialised Container Agencies.

"Robust intermodal side tipper bins are easily handled onto container rail wagons and road trucks by a container handler.

"Side tipper bins have been designed for rapid and efficient off-loading of materials from both rail wagons and road trucks, using specially designed hydraulic tipping cylinders.

"An important feature of these intermodal side tipper bins , which are able to be stacked two-high for storage, is that they can be used across different modes of transport, including road and rail, without the need for investment in double handling cargo.

"This system is boosting the utilisation of rail infrastructure, which significantly reduces transport costs, decreases national road congestion and minimises product damage," Ken concludes.

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Pick-and-place solution

When a local Original Equipment Manufacturer (OEM) of concrete brick, block, and paving machinery had the unique opportunity to build a Greenfield plant for a longstanding customer in the East London area, it turned to SEW-Eurodrive (Pty) Ltd for its easily-configurable HandlingKinematics pick-and-place solution.

The handlingKinematics application module allows for machine control at a higher level by means of a lower-level Configurable Control Unit (CCU) for carrying out precision path movements. During start-up, all the end user is required to do is enter the relevant mechanical data for the initial configuration of the motion parameters.

During production, the trajectory positions necessary for commencing movement are simply transferred to the CCU, which coordinates the path movement in real-time. It even allows for 'wait' points to be defined in the trajectory.

The system is so flexible that during palletising and stacking, the target position can be adapted immediately during the runtime by the CCU, without higher-level controller intervention.

Even greater flexibility can be allowed for by incorporating the freely-programmable Movi-PLC in the HandlingKinematics application module. This provides for exactly the same functionality, and completely repeatable configuration.

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Tower crane safety

Constant design improvements in tower cranes is making work sites safer, along with strict compliance with local safety regulations.

Tower crane leader Potain innovates continuously to raise safety levels, according to David Semple, senior vice-president at Manitowoc, Potain's owners. It does this by working with other industry players to develop world-class standards. The safety features on its cranes are guided by these standards, ensuring safer working conditions.

As important is the ability to safely deploy and operate the tower crane on site, in line with the applicable safety regulations, says Crane & Hoist Equipment SA managing director Brenden Crous. As the local Potain distributor, he says there is no room for compromise when it comes to safety.

"This means always meeting OEM specifications in whatever work we do with Potain tower cranes. As a highly experienced team, we are also registered with the Department of Labour as a lifting machine entity, he concludes.

Crane & Hoist Equipment SA (Pty) Ltd
www.che-sa.co.za

PALIFENCE

High security welded mesh   Pallisade   Gates   Gate Automation   Razor wire and more ....

What is High Security Weld Mesh

HIGH Security Weld Mesh is wire fused and welded at a Horizontal distance of 76.2mm and a vertical distance of 12.7mm also known as 35B/3510 where 3 denotes 3”(distance between vertical wires), 5 denotes 0.5” (distance between horizontal wires), and B or 10 denotes gauge of wire

Salient Features

- **Difficult to Climb:** The spaces between the Horizontal wires are too narrow for fingers to have grip
- **Impregnable:** Extremely difficult to cut with a hand cutter as the beak of a wire cutter will not be able to penetrate the horizontal wires
- **Excellent Replacement option to Solid Wall as:**

1. More economical than a solid wall
2. Faster to install than a solid wall
3. CCTV Camera has a clear view

- **Further upgrade possible with electric security system**
- **Anti-corrosive & low maintenance**

Standards

- Manufactured according to BS EN 10016-2
- Wire Sizes in accordance with BS EN 10218-2
- Tolerance on Mesh Size in accordance wiht EN 10223-7
- Tolerance on Panel Size in accordance with EN 10223-4
- Welding Strength in accordance with BS EN 1461
- Zinc Coating in accordance with EN 10245-1
- Anti Corrosion in accordance with BS En 3900 E4/F4

Tensile Strength

- Wire has a tensile strenght of min 550 MPA

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performance requires speed, agility and endurance

STRATEGY	INFRASTRUCTURE	OPERATIONS
Planning strategic direction benchmarked to world-class standards	Development of world-class infrastructure from concept to realisation	Development of operations to best practice and world-class standards

Supply Chain Strategy

- Supply Chain network analysis & design
- National & Regional DC strategy development
- Facility Sizing and OPEX estimates
- On-line fulfillment
- Slow vs. Fast movers network set-up
- A Supply Chain that supports business strategy
- Site development strategies
- Technology, IOT and digitilisation strategy

Facility Design & Development

- Greenfields site development planning
- Brownfields site development planning
- Functional building requirements specification
- Technical liaison to professional / development team
- Facility sizing requirements (short to long term)
- Design to execution
- Procurement, program and vendor management

Process & Operations Design

- Operations assessment and benchmarking
- WMS / WCS review
- WMS / WCS functional requirements
- Process and operations optimisation
- Long term operational development strategies
- Process audit
- Labour standards and incentive programs

In today's competitive business world you need to focus on every opportunity to advance your company mission

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