Headgear Upgrade over an Operating Shaft

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SYNOPSIS

IMPALA PLATINUM LIMITED decided to increase the tonnage on Number 11 shaft as part of an overall plan to meet production targets. To achieve this objective, the original headgear had to be upgraded to handle the bigger payload skips. At the outset of the design phase, the most important criteria was to design the "new" headgear such that stiffening and upgrading could be done without disruption to production and shaft operations. The upgraded headgear was designed with the aid of 3-D modelling to ensure ease of installation in an operating shaft without excessive downtime and cost. Additionally, the headgear had to be completed by September 2000 to allow the production rate to be increased.

It was decided that as much stiffening and upgrading as possible should be done during normal operating hours without any compromise to safety. There would also be two shutdown periods available, namely the Christmas 1999 shutdown and an additional period during September 2000, to allow installation of all major steelwork for the stiffening / upgrading.

Upgrading of the headgear started early December 1999 and by December 28, 1999, some 75% - 80% by mass of the steel upgrade had been installed. During the period January 2000 to September 2000 further

work was carried out over weekends in preparation for the final changeover.

A new 4,0 MW rock winder also had to be installed to cater for the production increase to 235 000 tonne per month. The shaft bottom loading station was also upgraded with new flasks plus associated steelwork being installed during scheduled short shutdown periods.

The final changeover of the headgear to accommodate the new rock winder was carried out during an 8-day shutdown at the end of September 2000. By October 1, 2000 the headgear had been successfully completed, the new 58mm ropes and the new skips had been put into operation.

INTRODUCTION

Impala Platinum Limited is a platinum producing mine, situated in the North West Province, with an annual production rate in excess of 15 million tonnes. To maintain these production rates, management decided to extend the third generation shafts via declines. Impala 11 shaft is presently developing its decline system so as to increase the shaft's production from 145 000 metric tonnes per month to 235 000 metric tonnes per month.

To hoist this increased tonnage, the skip capacity had to be increased from 11 tonne to 18 tonne, hoisting ropes had to be increased from 49mm diameter to 58mm diameter and a new rock winder was required. With this increase in payload, increase in overall length of skip and higher breaking strain ropes, the resultant forces in the original headgear were calculated to be far in excess of the design capability of the original headgear. Initial investigation indicated that the increased forces could be accommodated by upgrading, strengthening and increasing the height of the original headgear structure. Several upgrade options were proposed and a design evolved that was easy to construct and did not require a lengthy shutdown. It also allowed pre-shutdown work to be done and was cost effective. Three dimensional (3-D) modelling was successfully employed during the design phase to ensure that the new structure could be fitted to the existing headgear and that problem areas could be identified and addressed during the design phase.

It was decided to involve a Steel Fabrication and Erection Contractor early in the design stage to obtain practical construction advice, and this proved to be a very wise decision. Due to the volume of steel that had to be installed in short time periods, the successful Steel Fabrication and Erection Contractor made use of several sub-contractors to assist in the manufacture and fabrication process. This ensured that all the required steel for the height increase and strengthening of the first phase of the upgrade was on site before the planned shutdown period over Christmas 1999.

Much of the work was completed before the planned shutdown by using planned downtime (e.g. long weekends) on the operating shaft without affecting production. A major problem was encountered during the Christmas shutdown when it was found that the overlay rope of the man winder fouled on one of the new headgear girders. This was due to a survey error in the existing headgear, which was not identified during the cross check surveys that were carried out. The Consultants had their designers on standby during the shutdown period and a solution was quickly found and implemented. This prevented standing time by the Steel Erection Contractor.

A digital camera was used to record the progress of the headgear upgrading and to relay pictures via e-mail to the designers when problems on site needed their input. This enabled quick solutions to be effected without the time and expense of getting the designer to site.

The first phase of the upgrade involved the installation of some 75 - 80% by mass of steelwork, and this upgrading of the headgear was successfully completed during the planned Christmas shutdown period with two days to spare. The new 18 foot sheaves were also installed during this period. The final changeover to the new rock winder was successfully implemented during the planned second shutdown period of 8 days during September 2000. During this time the original rock winder sheaves, plus crash steelwork was removed and the new crash steel, arrestors, guide extensions and associated operating platforms were installed.

Safety was a key issue during both the design and construction phases. The entire project was completed without an accident. As a final check on safety, each of the new 18 Tonne skips were hoisted to within 100 - 150mm of the jack catch positions. Actual measurement then confirmed the design positions of skips under crash conditions.

It must be pointed out that employees of Impala 11 shaft worked additional shifts prior to the planned shutdown periods during December 1999 and September 2000. This then allowed the headgear upgrade to be carried out without any loss of production or shaft disruptions.

DESCRIPTION OF HEADGEAR UPGRADE

The original programme set in October 1998 required the headgear and new winder installation to be commissioned in September 2000.

The decision was made in July 1999 to schedule the headgear upgrade reconstruction so that as much preparation and construction work could be done prior to any shutdown. Only two short duration shutdown periods would be available viz. Christmas 99 and September 2000.

Choice of Headgear Design

As part of the design, Impala and their Consultant evaluated two concepts:

Original design

Original design (Figure 1) was for a plate girder 'A' frame over the existing headgear with interfacing at existing sheave deck levels. The disadvantages of this design being:

- Lengthy shutdown due to interfacing steelwork between existing headgear beams.

- Length of plate girders resulting in very deep and heavy plate girders.
- The existing back leg would have to be removed up to the counterweight level.

- Erection difficulties were identified - namely, ropes would have to be removed, lengthy downtime would be required at each deck level interface.

- The estimated mass of the original design was 305 tonnes.
- Estimated cost of R 6.1 million.

It was therefore proposed that an alternative design be looked at.

Alternative Design

The alternative design (Figure 2) was a lattice construction based on the theory that the horizontal load could be equally shared by adding a leg of equal stiffness opposite to the existing backleg. The main advantages being:

- The new rock winding load together with the man winding and counterweight loads would be equally shared.
- The existing front legs would be stiffened making the support of the new rock winding sheave deck easier, and the structure more aesthetically pleasing.
- The estimated mass of this system was 205 tons.
- Estimated cost of R 4.5 million.
- Shorter shutdown period.
- Portions of the headgear stiffening and new backlegs could be erected around and over the operating headgear and shaft.
- Original 49mm rock winder ropes and sheave decks remained unaffected until final shutdown.

Based on the above it was agreed to pursue the lattice design.

Importance of Choice of Fabrication & Erection Contractor

It is important to identify early in the project and to involve a Steel

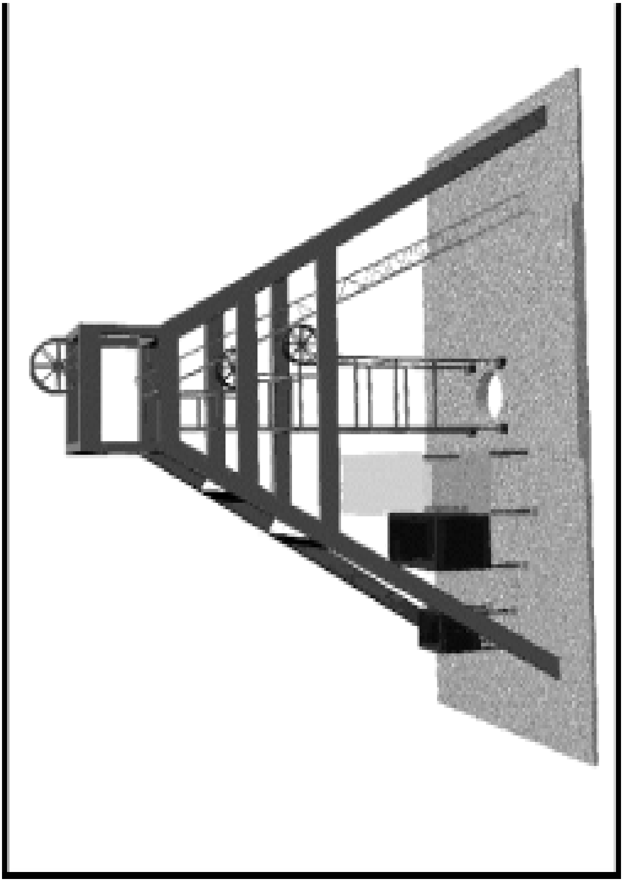

Figure 1
Three-dimensional plate girder design

Fabrication and Erection Contractor with infrastructure large enough to handle the many facets of the job.

Items scrutinised during the evaluation phase included:

- Design and detailing capability.
- Suitably qualified and experienced personnel.
- Available cranage - amongst the cranes used during erection was a 400 tonne crawler mounted crane, which allowed the erection process to be accelerated.
- Manufacturing ability.
- Transport to site of pre-assembled structures.
- Company's past track record and ability to meet the construction programme.

Minimisation of Production Downtime

With the lattice design, minimal interfacing with the original headgear was required, ropes would not have to be removed and a large amount of the erection could be done prior to the shutdown period. Also interfacing points were not critical and it was possible to supply packing for adjustment or to use loose plates, which could be welded at erection.

The majority of the headgear stiffening and upgrade (some 75 to 80% by mass) could be completed during the planned 10 day Christmas shutdown period.

Infrastructure / Accommodating of headgear footings

The original plate girder design would have resulted in the headgear leg footings landing on existing pipe ducts, cable racks and bulk air cooler duct. This could not be accommodated.

With the lattice design this was avoided making a much neater and

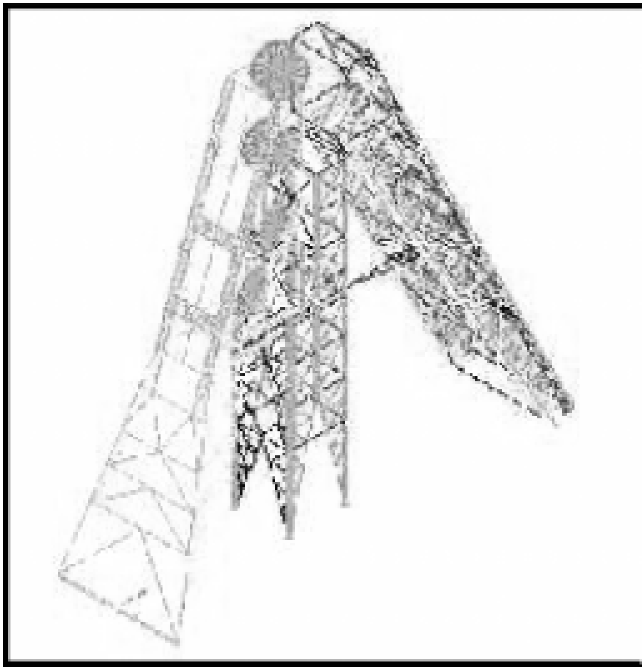

Figure 2

Three-dimensional lattice headgear design

Figure 3

Original Impala 11 Shaft headgear as at Dec 1, 1999 easier construction for the civil contractors.

It was necessary to take into account all the surrounding infrastructure. The design accommodated such problem areas so as not to affect the operating shaft and personnel.

A method statement was compiled in conjunction with the Steel Erection Contractor and this was studied to ensure that layout and details were compatible with the erection procedure.

Interfacing with other Contractors

The construction site was laid out with particular care to allow easy access to the various areas of work for the respective contractors. Not only were the headgear being upgraded but other surface civil construction and steel erection was being carried out.

The following had to be taken into account:

- Steel Erection Contractor had to be positioned in the right place to effectively pre-assemble the new headgear sections.
- Hardstand area was required for the Contractor's 400 tonne crawler crane.
- The 400 tonne crawler crane had to be strategically positioned to allow lifting and positioning of the pre-assembled sections - it should be noted that the heaviest single lift amounted to some 35 tonne to the highest point of 49.5 m, being the new sheave deck height (Figure 8).

The layout of the surface area was therefore carefully planned and monitored.

Programme

In July 99 it was recognised that the stiffening and upgrade of the headgear was on a tight schedule and that the programme needed to incorporate all aspects of manufacture, delivery and erection.

It was necessary to ensure complete integration of all the various programmes - design, manufacture, erection as well as interfacing the multi-discipline contractors such as that of the civil works.

All the programmes had to be aligned to each other and to this end the involvement of the Steel Fabrication and Erection Contractor at an early stage were of utmost importance.

The programme catered for the scheduling/delivery of steel to site and included a detailed list of tasks planned for the shutdown periods.

It was essential that the programme be constantly updated to account for actual work. This enabled proactive decisions to overcome problem areas.

Value Added

The design for upgrading the headgear took into account:

- Optimisation of design with due regard to steel tonnage, ease of construction and overall programme.

- Total life of project.

- Hazard analysis implemented at design stage, and risk assessments carried out prior to work being done on site.

- Safety was a major consideration and was not compromised by cost.

Use of Modern Technology

The use of technology on this project was invaluable:

- Simulation and design studies were carried out on the winding system.

- 3D design and drawing tools were used.

- Digital photographs, which were taken and immediately e -mailed to the design office ±150km away for evaluation and design purposes.

- Telephone conference facilities to discuss site problems with designers so that alternate designs could be immediately tackled.

All the above tools made for efficient and speedy resolution to design problems.

MANAGEMENT

The success of the project can only be guaranteed if all parties work together. This is where the management and co-operation of the various role players can make or break a project.

To ensure the success of the upgrade at Impala Number 11 shaft, the following was strictly adhered to:

- Regular design review meetings between Impala and the Consultant design team.

- Weekly Contractors meeting.

- Control of activities during shutdowns.

- Designers on standby over shutdowns.

- As shutdown time was limited, it was a project requirement that no delays could be entertained. The design personnel of both the Consultant and Steel Erection Contractor were on standby throughout the period. Senior Management supervised all major lifts - there were six lifts ranging in mass from 25 tonne to 35 tonne.

    - When it was detected that the man ropes were fouling the new steel, modern technology was used to assist in the finding of a solution to the problem. Digital photographs were taken on site and e-mailed to the designers. Using two way telephone conference facilities, site personnel and designers were able to communicate while designers were redesigning the problem area and talked the Steel Erection Contractor through the remedial work.

- This paid off in that problems were identified rapidly and with the relevant personnel available at such short notice no standing time occurred.

SAFETY

Five incidents were recorded during the construction phase:

- A pipe that was supporting a screen was cut and fell to the ground narrowly missing a spectator that was watching the erection of a section of the headgear.

- The rope of the lattice boom crane dislodged from its pulley, wedged itself between the side of the pulley and lattice steel causing the fly jib to be pulled over and dropping the attached load.

- A hot bolt fell from a high working area in the headgear and went through the banksman's cabin window resulting in a small fire.

- The radio communications between the steel erector and the crane driver failed as a beam was being lifted from the headgear. The steel erector managed to re-establish visual communication with the driver before the steel fouled.

No injuries or lost time accidents occurred during the erection of the headgear.

A baseline risk assessment was done before the work commenced and continuous risk assessments were done on a daily basis. Impala had a foreman dedicated to supervise the construction work.

At the weekly contractors meeting, safety aspects were treated as the first item on the agenda and the contractor's site manager would report back. Progress as well as problem areas were thereafter addressed.

A large portion of the erection was completed before the main shutdown of Christmas 99. This involved careful planning between the Impala

No 11 Shaft's Project Engineer and Shaft Operations Engineer to ensure that suitable time slots could be arranged to execute this work and that all safety aspects were addressed. The slinging of a large pre-assembled section into position over the original backleg while the ropes were still in position required extreme precision and very close supervision- (Figures 4, 5 and 6).

All work was carried out during daylight hours due to the high risk.

The excellent safety performance was achieved by the following process:

- Thorough risk assessments.
- Regular over inspection by Senior Management.
- Close site supervision.
- Use of an experienced contractor.
- Using suitable equipment, especially cranage.
- Careful planning of the work.
- Impala's management of safety aspects via daily and weekly meetings.

CONCLUSIONS / RECOMMENDATIONS

- It is possible to upgrade an existing headgear of an operating shaft without incurring long shutdown periods.
- Modern technology must be employed during the design and construction phases. Simulation and design studies to optimise winding systems is essential. Three-dimensional modelling is of tremendous benefit in the design process. Digital cameras and the use of e-mail facilities can facilitate the speedy resolution of on site construction problems without the designer coming to site.

Figure 4

First pre-assembled section being lifted

Figure 5

First pre-assembled section being manoeuvred into position

Figure 6

First pre-assembled section in position

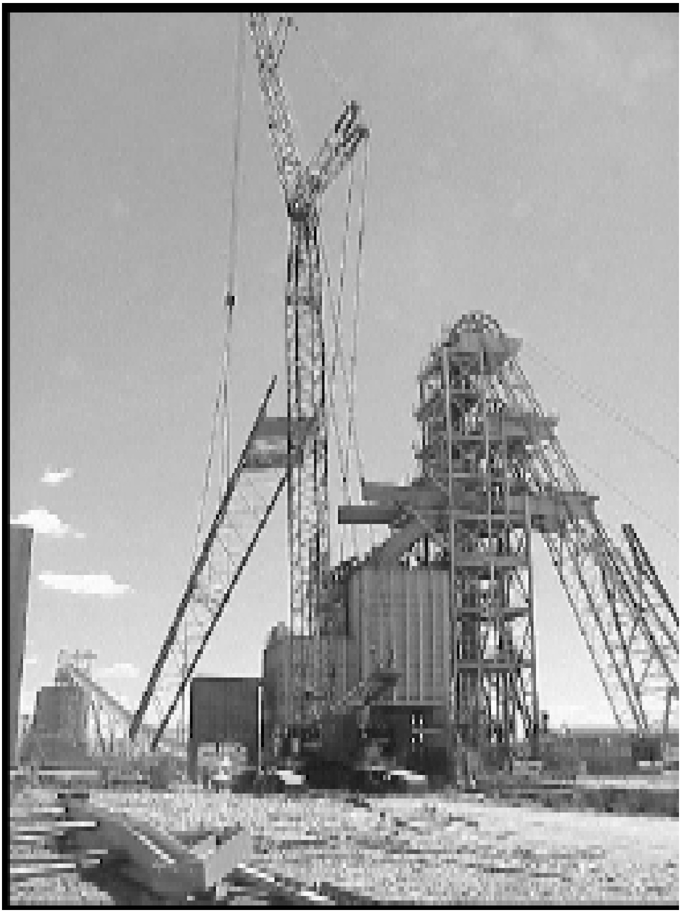

Figure 7

Sections of new front legs being manoeuvred into position

- Involving the contractor at an early stage in the design process is worthwhile.

- It is important to choose a contractor who has the correct equipment and experienced personnel to handle a big job like this.

- Existing structures need to be re-surveyed to ensure that accurate information is used in the design.

- Close site supervision and detailed planning is essential to ensure that the construction is completed safely.

- Delivery of steel to be scheduled to ensure it arrives in the correct sequence.

- Ensure that adequate time is allowed to get the engineering drawings done.

- Daily and weekly progress / planning meetings to be held to ensure that problem areas are dealt with timeously.

- The design must be adaptable to existing infrastructure.

- The laydown area for the steel must be carefully identified so that the steel can be easily assembled and erected with the crane.

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Figure 8

New sheave deck being maneuvered into position

Figure 9

Impala 11 Shaft upgraded headgear