RAPID INSTALLATION OF SUPPORT IN A PARTIALLY RAISE BORED SHAFT USING SKY JACKS.

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Synopsis

Installation of support in known poor ground intersections during reaming operations requires rapid access to stabilize the shaft wall and thus to prevent the loss of the shaft through scaling. This is especially relevant to shafts of long dimension where the duration from time of exposure to time of support installation is lengthy

This paper deals with the innovative methodology employed at Harmony's No. 8 Shaft 17/24 level sub ventilation shaft to rapidly support a shale intersection between 23 and 24 Level by employing a single deck stage suspended from the reamer head by means of Skyjack winches.

Introduction

Murray & Roberts Cementation (Pty) Limited was contracted to drill a raise bore ventilation shaft of 4,5m diameter at Harmony's Evander Gold Mine No. 8 shaft from 17 level to 24 level to serve as a downcast ventilation shaft to serve the expanding operations below the 24 level horizon. The shaft is of approximately 520 metre length. A known intersection of shales in the lower portion of the shaft from 24 level to approximately 60 metres from shaft bottom posed a potential failure of the shaft side wall as support of this portion of shaft would conventionally only be accessed following completion of the remaining and installation of shaft access equipment.

The risk of shaft wall failure due to the conventional methodology prompted Harmony Engineers to approach Murray and Roberts Cementation (Pty) Ltd Mining Division to propose a solution to the problem.

Rock mechanic recommendations required installation of 1,5m x 20mm resin grouted rock dowels on a 1,6m horizontal lx 1,5m vertical spacing covered with a layer of polypropylene fibre reinforced shot crete 100mm thick.

Initial Planning

Several meetings took place to devise a suitable safe method to support the shale intersection as soon as it practically possible following traversing this section of shaft by the reamer head.

At first a method of "blind supporting" the shaft was considered. This entailed attaching a stage to the reamer head on 24 level and raising the reamer head and stage in 3 metre lifts

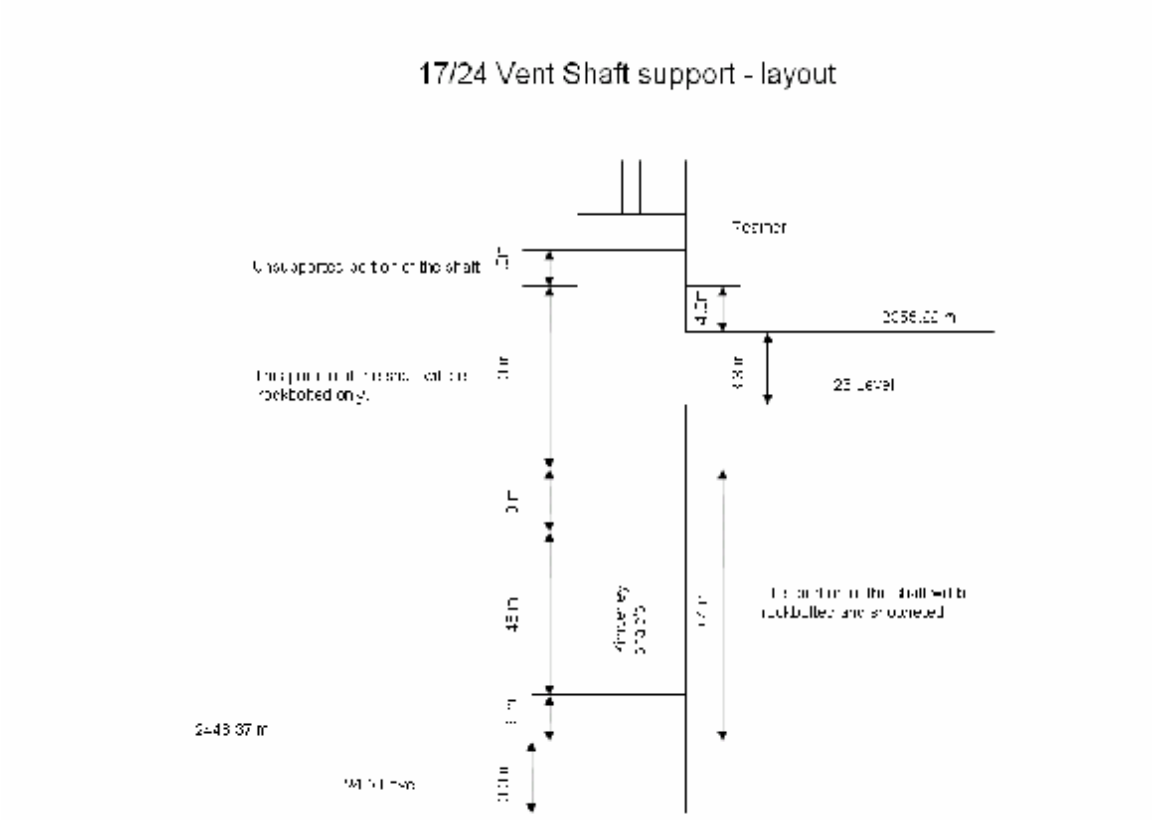
to allow the crew to support the shaft wall from the protection of the reamer head and stage. The idea was discarded due to perceived difficulty in providing ventilation to the stage and the possibility of the shaft collapsing above the reamer head position with the potential of the whole support system falling back to the level below.

The Solution

It was noted that a tunnel excavation on 23 level some 90 metres above 24 level passed approximately 100 metres from the shaft position. It was decided to develop this tunnel to intersect the shaft and to serve as a top access during the support phase.

To negate the necessity to excavate a catwalk and winder chambers for the access equipment it was decided to employ Skyjack winches to suspend a stage below the reamer head. A risk assessment revealed no extraordinary risks and this methodology was chosen and further refined.

Scope of Work to be carried out



Methodology

In order to allow the placing of the 100mm layer of shot crete and to allow the reamer head to be lowered for future cutter changes it was determined that the lower section of

shaft had to reamed to a diameter of 4,8m. This would allow a clearance of 100mm either side of the reamer once the shaft was supported. The stage dimension was designed to be 4,2m diameter.

The sequence would be to ream to 10m above 23 level elevation, develop the 23 level access into the shaft, lower the reamer to 24 level and then to attach the stage ropes to a ring fitted to the reamer head. The stage ropes would be threaded through 6 Skyjack winches installed on the stage. Once attached the raise bore will be employed to raise the reamer and stage up to 23 level for the system to be commissioned for support to commence from the top down.

Safety Considerations

Due to the novelty of the methodology every aspect of safety risk was considered and mitigated. These included;

- The covering of the raise bore head with a protective cover to prevent any loose material in the 1m exposed shaft area above the reamer from falling though the reamer head.
- The lockout of the raise bore machine during support operations.
- Emergency procedures for lowering of the stage during power failures.
- A procedure for accessing the stage by men due to the stage being 4,2m and the shaft 4,8m leaving a gap of 300mm between stage and shaft wall.
- Training of the crew in maintenance of the access system
- A telephone communication system between 23 level bank and the stage.
- Crew selection with suitable shaft experience.
- Designs signed off by professional Engineers
- Test certificates of Skyjack winches and stage suspension ropes.

Hazard identification

EVANDER 8 SHAFT VENTILATION SHAFT SUPPORT HAZARD IDENTIFICATION

The following Actions need to be taken on Hazard Identification by the crew and The Shift Supervisor.

All Items to be inspected on every Shift before using the Sky Jack Stage Arrangement.

Responsible persons:-
Mine Overseer – Nico de Lange
Shaft Foreman – Inspection day Shift & Checklist
Fitter – Daily Inspection & Checklist
Mine Overseer – Planned Inspection once Weekly –Record.

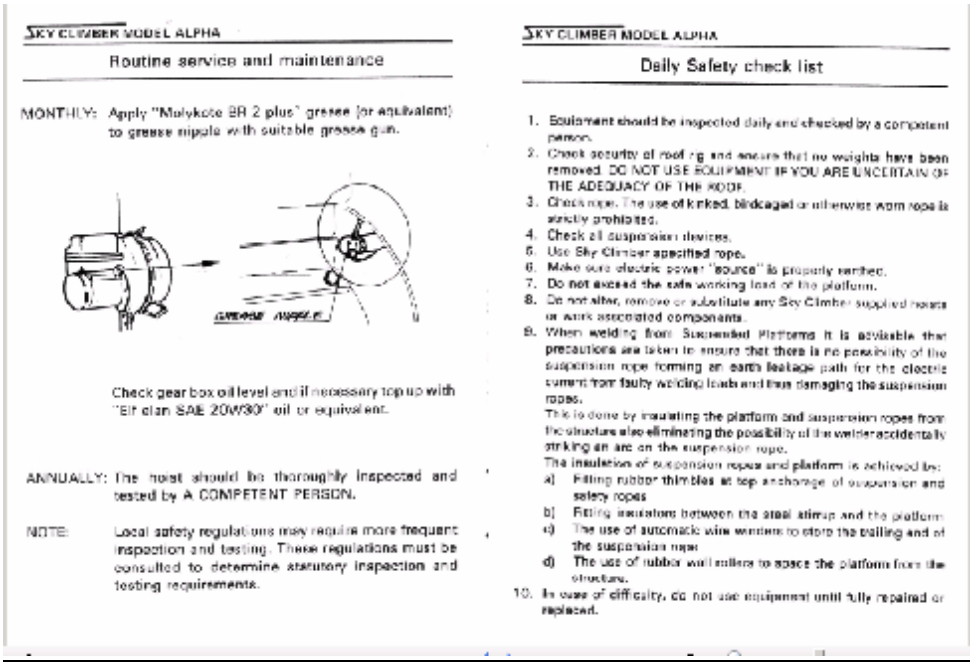
Hazard	Immediate Action	Remedial Action
Sky Jack Rope damage	**Stop all Work**	**Record, Report to Mine Overseer**
Stage Bolts suspension bolts loose	**Fitter to tighten**	**Record**
Electrical feeder cable damage	**Stop all work**	**Record, Report to Mine Overseer**
Stage assembly bolts loose	**Fitter to tighten**	**Record**
Sky Jack Winch failure on Bank	**Stop all work**	**Record, Report to Mine Overseer**
Sky Jack Winch failure below Bank	**Release Clutch on failed unit, raise stage to bank. Stop all work**	**Record, Report to Mine Overseer**
Power failure	**Release Clutches on all Sky Jack Winches. Lower stage to 24 level.**	**Record, Report to Mine Overseer**
Loose Rocks/material on bank area	**Remove to safe place**	
Shot crete Build up on Stage	**Clean Stage at end of every shift**	
Overloading of Stage	**Shift boss to Oversee and sign off**	**Record**
Lighting failure on Stage	**Repair at end of Shift**	**Record, Report to Mine Overseer**
Fire on Stage	**Extinguish with Fire Extinguisher provided**	**Record, Report to Mine Overseer**
WB Temp above 31,5 C	**Raise Stage to bank, Withdraw**	**Record.**
No Compressed air	**Raise Stage to bank**	**Record**
Bad Ground conditions in Shaft	**Raise Stage to above position, Bar down**	**Record**

Loose Pipe suspension Clamps	**Inspect every shift. Tighten**	

MAXIMUM STAGE EQUIPMENT ALLOWED

ITEM	MASS
4 x S21 Rock drills, Air legs	**216 kg's**
6 men	**480 kg**
10 x 1,8m Drill Stems	**45kg**
45 x 1,8m Rock bolts	**113kg**
1 x Shot crete Nozzle	**15kg**
Hoses, Fittings & Tools	**75kg**
Grout pump **Grout** **Total Mass Allowed**	**66kg** **150kg** **1160kg**

Skyjack manuals



SKY CLIMBER MODEL ALPHA

Routine service and maintenance

MONTHLY: Apply "Molykote BR 2 plus" grease (or equivalent) to grease nipple with suitable grease gun.

Check gear box oil level and if necessary top up with "Elf elan SAE 20W/30" oil or equivalent.

ANNUALLY: The hoist should be thoroughly inspected and tested by A COMPETENT PERSON.

NOTE: Local safety regulations may require more frequent inspection and testing. These regulations must be consulted to determine statutory inspection and testing requirements.

SKY CLIMBER MODEL ALPHA

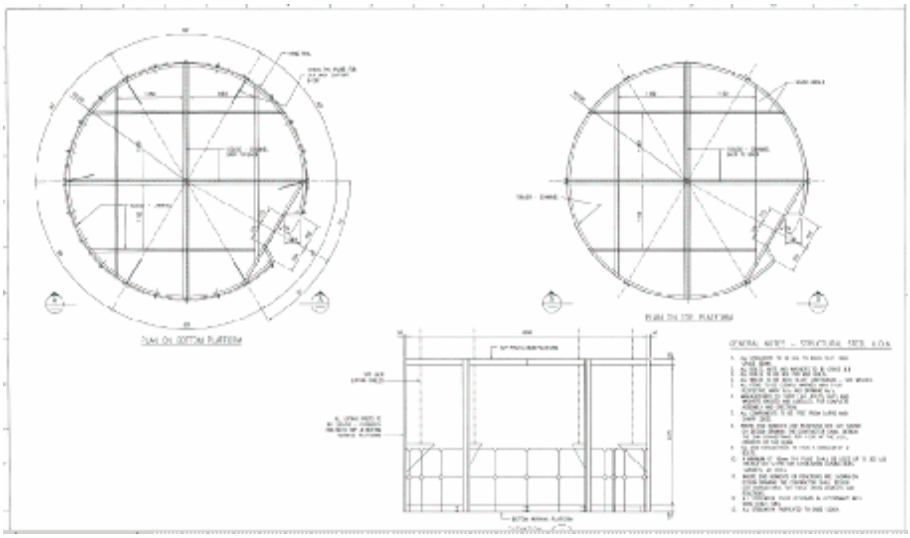
Daily Safety check list

1. Equipment should be inspected daily and checked by a competent person.
2. Check security of roof rig and ensure that no weights have been removed. DO NOT USE EQUIPMENT IF YOU ARE UNCERTAIN OF THE ADEQUACY OF THE ROOF.
3. Check rope. The use of kinked, birdcaged or otherwise worn rope is strictly prohibited.
4. Check all suspension devices.
5. Use Sky Climber specified rope.
6. Make sure electric power "source" is properly earthed.
7. Do not exceed the safe working load of the platform.
8. Do not alter, remove or substitute any Sky Climber supplied items or work associated components.
9. When welding from Suspended Platforms it is advisable that precautions are taken to ensure that there is no possibility of the suspension rope forming an earth leakage path for the electric current from faulty welding leads and thus damaging the suspension ropes.
   This is done by insulating the platform and suspension ropes from the structure also eliminating the possibility of the welder accidentally striking an arc on the suspension rope.
   The insulation of suspension ropes and platform is achieved by:
   a) Fitting rubber thimbles at top anchorage of suspension and safety ropes
   b) Fitting insulators between the steel stirrup and the platform
   c) The use of automatic wire winders to store the trailing end of the suspension rope
   d) The use of rubber wall rollers to space the platform from the structure.
10. In case of difficulty, do not use equipment until fully repaired or replaced.

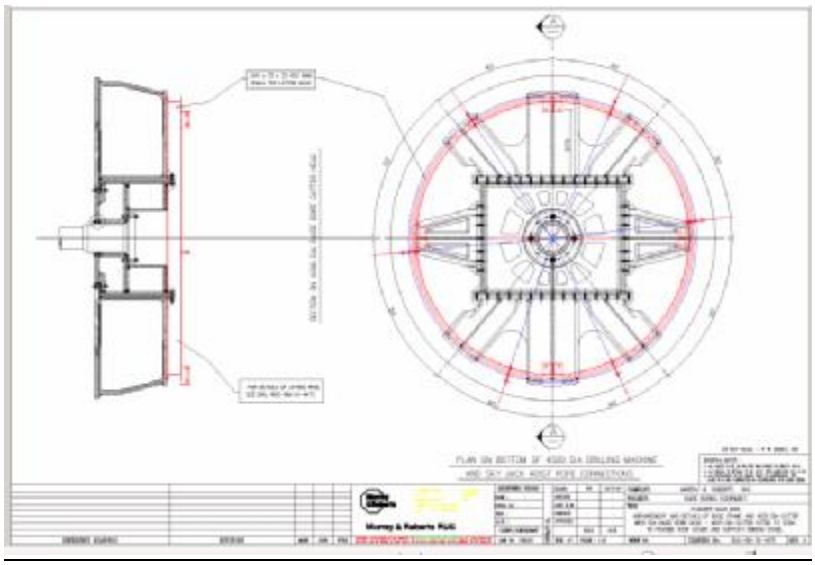
Stage Design

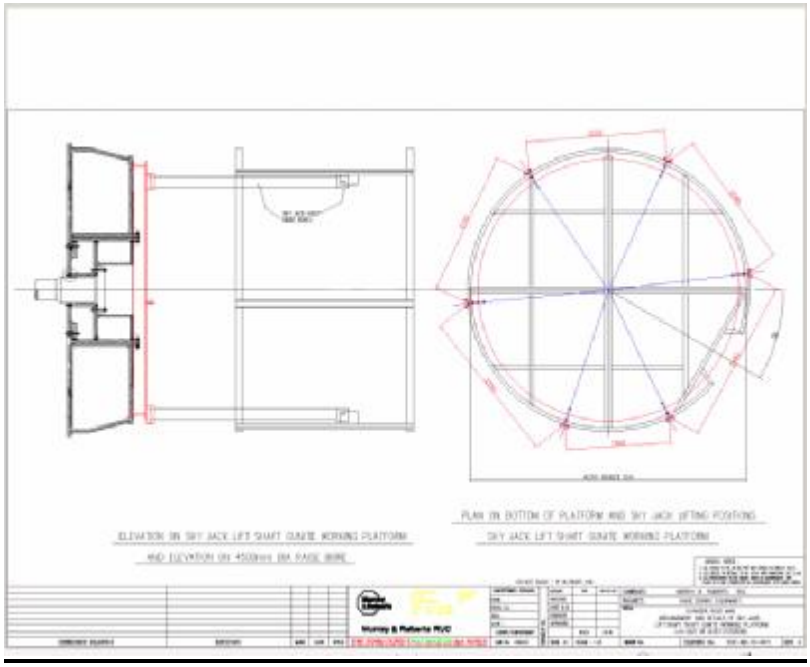
The stage was designed to be a lightweight structure 4,2m diameter. Stage mass was 1060,2 kg with maximum permissible load of 2000kg.

Procedures were established to limit the stage mass to below this capacity.



Reamer Suspension Ring Design

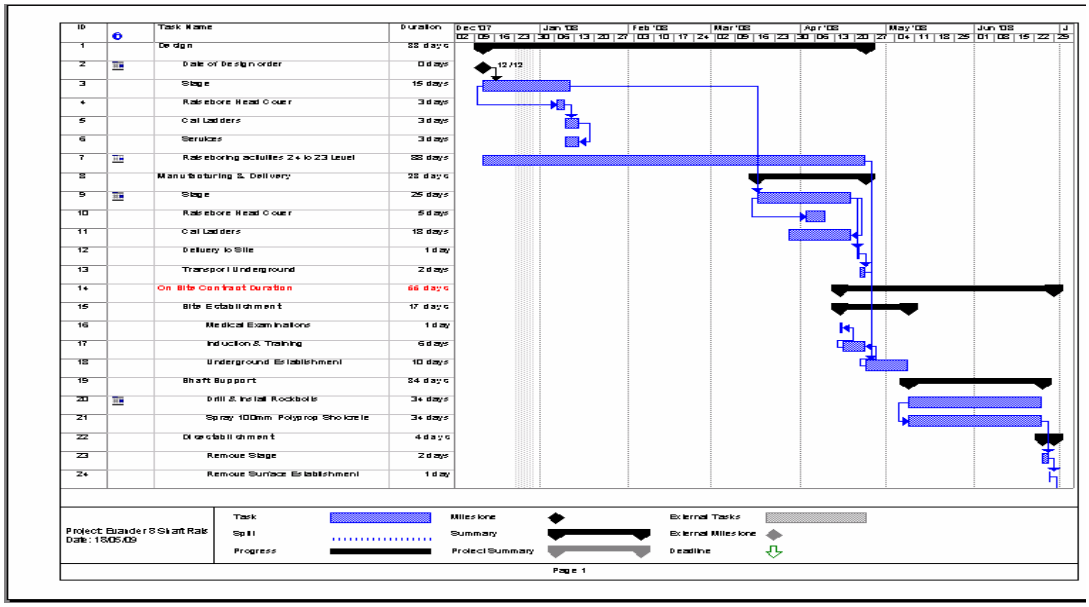




Working hours and Schedule

Two x 10 hours shifts were worked 23 days per month. During the latter stage of the project the project schedule was changed to 24 hours per day to make up lost time due to material delivery constraints initially.

Programme of work



Crew Size

The crew comprised of the following shaft sinking personnel

Master Sinker	1
Shaft Foreman	2
Stage Hand/Miner	2
Electrician	1
Skyjack Technicians	2
Stage Team Leader	2
Rock drill Operators	4
Shot crete Nozzle men	2
Bank Labourers	4

Equipment

A wet/dry crete machine of 2m3/hour capability feeding via an 80mm HDPE flanged pipe attached to the shaft wall was employed for shotcreting. The rigid pipe fed directly into the placing hose on the stage.

Rock bolt holes were drilled pneumatically with s21 rockdrills powered by compressed air via a 50mm compressed air pipe. Water was delivered via a 2nd 50mm column.

Holes were drilled to 28mm to maximize the strength of the resin capsules around the 20mm rock bolts.

Actual Performance

Shotcrete placed	1350 m2 in 34 days at average 39m2/day
Bolts installed	565 in 34 days @ average 16 per day
Agreed Scope changes	11 days
Contractors delays	4 days
Total Support days	49 days

Safety Statistics

The project was executed with no accidents or safety related incidents.

Acknowledgements

Marius Pelser	Harmony
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