



View of 'Endless rope Haulage'

# **MATERIAL INCLINE WINDER EVANDER No 7 SHAFT**

N.T.MAYER  
Engineering Manager

## **SYNOPSIS**

In this modern age we as miners have been challenged to reduce forever increasing cost and increasing productivity.

The cost trends is forcing goldmines towards alternative ways to access deeper lying ore reserves which in turn leads to different way of thinking when looking at new projects and layouts.

This paper describes a new approach to the old endless rope haulage system, by applying modern technology to a concept that has been around since the 18<sup>th</sup> century.

## **INTRODUCTION**

Evander No 7 Shaft is situated about 130 kilometers east of Johannesburg and to the north of the Evander basin. The mine came into operation in 1962. The upper levels of the mine have mostly been mined out and declines are used to access the ore reserves below 15 level, the lowest operating level of the vertical shaft. The sinking of No 1 Decline commenced in 1988 and stoping operations are presently between 16 and 18 level. The sinking of No 3 Decline commenced in 1995 and stoping operations are presently carried out between 16 and 18 levels. It is planned for No 3 Decline to eventually go down to 24 level. The Declines are equipped with conveyor belts for the transport of rock and chairlifts for the transport of men. In No 1 Decline trackless vehicles are being used for the transporting of material, which proves to be extremely costly.

During the equipping of No 3 Decline a monorail system was considered for transporting material down the decline.

At this point in time all indicators were that the monorail is tailor made for the requirements in No 3 Decline. However, closer investigations and visits to various operations revealed that the monorail system had some drawbacks that made it not so attractive.

The cost of a monorail locomotive system proved to be extremely expensive. Another drawback was that a high level of technical expertise would be required to maintain these locomotives.

The only other alternative was an Incline winder. Small hoist inclines has a very bad reputation in the mining industry in respect of safety. The winder we were to install had to address all the negative aspects of the small incline winders as well as the shortcomings of the current layout. One of these aspects that had to be addressed of this design was the 14° inclination of the material decline as well as the flat landings in the decline, to accommodate chairlift landings.

## **DESIGN TEAM**

A design team was formed from a delegation of engineers. The objective of the design team for the winder was to come up with a concept for the winder had to be:

- **safe in its operation,**
- **labour efficient and**
- **cater for our needs.**

The design team came with several concepts but the one that eventually found the consent of all was based on the Venicula system in Sea point, a fully automated endless rope haulage system.

Professional winder engineers was then contracted to do the detail design of an endless rope haulage system that will fit all the requirements of the mine.

Several discussions with the Department of Mineral and Energy affairs were held before the detailed designs commenced. Before the final design was approved a comprehensive, issue based risk assessment was conducted on every aspect of the incline winder. The risk assessment was done with all possible level of participation. Most of the hazards identified in the risk assessment were addressed in the design. An external third party facilitator appointed to facilitated the risk assessment.

## **ENGINEERING DESIGN**

This endless rope haulage is a friction driven Koepé type Winder at an inclination of less than 14°.

The driving motor power is a 200kW DC motor and the winder can run at a maximum speed of 3 m/sec. DC control is obtained from a thyristor converter.

There are 6 failsafe spring applied brakes disks (caliper type) braking on the main winder drum designed to hold double the static out of balance load on the conveyance. Each brake has a brake-ware or clearance monitor.

There is a leaky feeder radio system fitted to the system transmitting signals between the conveyance and the PLC at the winder. This is a fail safe system in that if the signal is lost the winder will no move until the signal is restored. The signals transmitted from the conveyance are the operator bell signal, the marshall switches, overwind and underwind switches and door interlocks.

Over and above a trip wire (Marshall wire) in the shaft the conveyance is fitted with a 2 sets of magnetic switches on the rails monitoring the conveyance in respect of derailment. Any derailment is signaled to the winder via the leaky feeder.

The other advantage of the leaky feeder is the fact that there is radio communication between the driver and the operator in the conveyance during special operation or when repair work is to be done.

### **CONTROL METHODS**

Speed control, as well as deceleration to and stopping at the desired destination level, are fully automated.

Speed control protection is done with a single governor Lily controller while a digitizer is responsible for the accurate speed control and distance indication (level indicator).

Rope slip is also monitored by means of a digital tacho recorder on the rope, which is interlocked with the speed (main) digitizer.

All signals from the conveyance are being transmitted via a leaky feeder communication system.

The winder can operate in three (3) modes. In manual mode the winder is operated from the driver's desk by a hoist driver and receiving signals from a onsetter. Then there is auto mode where there is no driver and the operator rings his signals to the PLC that in turn operates the winder. The desired destination (level) is selected by ringing the level signal on an electronic locked-bell system. The operator then travels in the conveyance, starting the winder from the conveyance. Thirdly there is a semi auto mode where the operator can dispatch the conveyance to any destination without travelling with the winder, in this mode 2 operators are required.

The operator may also stop the winder from the conveyance in the event of an emergency.



**Rope Slip Tacho**



**Failsafe – Spring Applied Brakes**



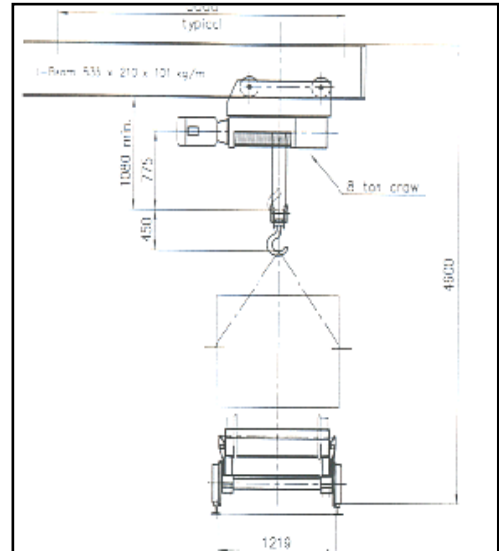
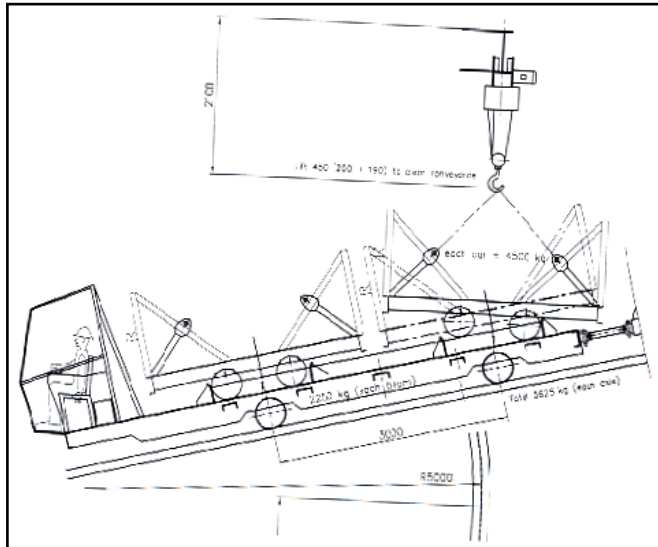
**Operators controls inside conveyance**



**Winder and drivers desk**

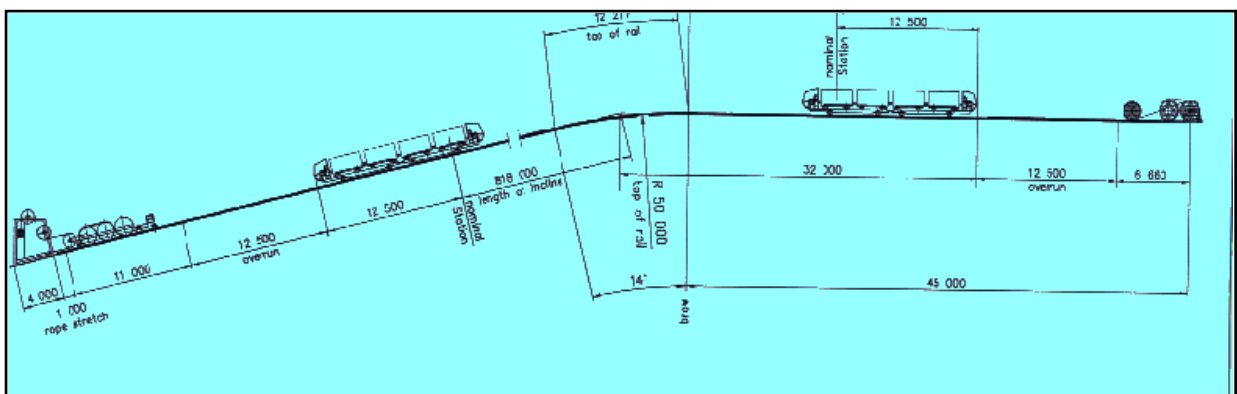
## CONVEYANCE

The conveyance or “gondola” is permanently attached to the rope. Material cars that are to be transported up and down the incline are loaded onto the gondola by means of an 8 ton electric overhead crane.



The Gondola transports 4 material cars or 6 explosive cars at a time. The conveyance is designed to transport 64 material cars per shift using only one operator.

The material and explosive cars are specifically modified with lifting lugs for safe lifting. The cars are lifted by a dedicated spreader bar to make the operation safe and efficient.







**Material Cars modified for overhead crane**



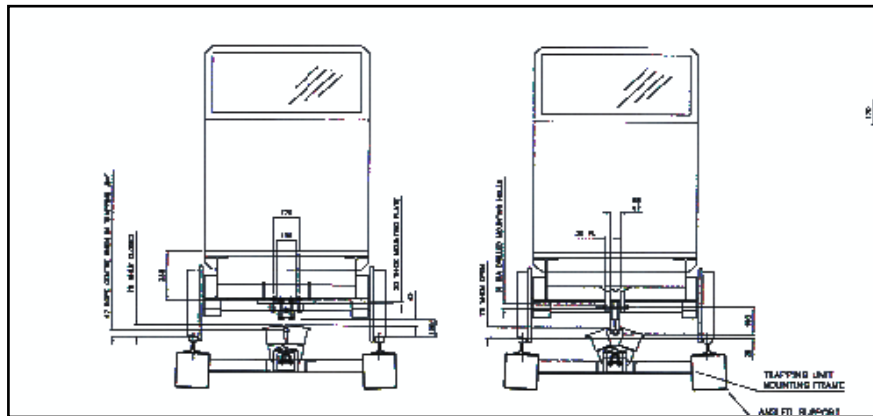
**Operator loading a material car**



**View of overhead crane**

## SHAFT (INCLINE)

One of the advantages of this haulage system is that it can start on the horizontal, travel up and down, over and around both vertical and horizontal curves. In order to accommodate vertical or horizontal curves special entrainment rollers are being used.

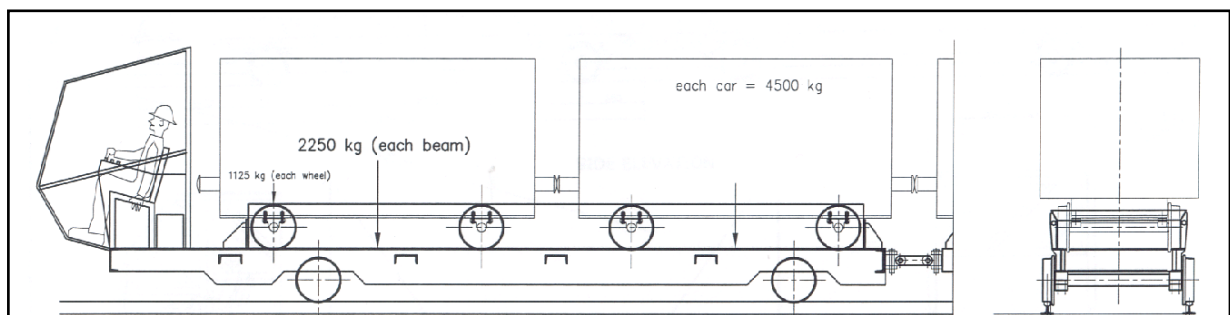


The Evander installation is designed to transport material cars, explosive cars, pipes, rails and an eight ton locomotive up and down a 14° incline that starts on the level and reduces to 6° in some places.

## PRODUCTIVITY

The biggest advantage of the system is that it can be controlled and operated by only one operator, who not only drives it but does all the loading and unloading as well, hence a major improvement in productivity.

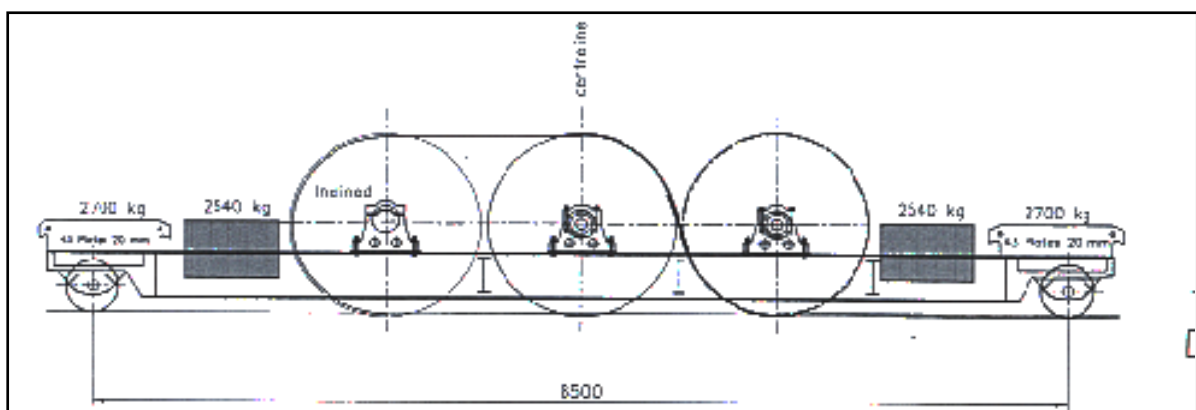
The drivers all received a basic onsetter and rigger training. As a result of the comprehensive plc program monitoring all safety operations, the operator is checked all the time except during the loading process.





## TECHNICAL SPECIFICATIONS

INCLINATION	14°, 6°, 0°
LENGTH OF WIND (current)	900 m
LENGTH OF WIND (future)	1200 m
PAYLOAD MASS	18 000 kg
MASS OF CONVEYANCE	7400 kg
MASS OF TENSION CARRIDGE	15 000 kg
RAIL GUAGE	1200 mm
WINDING SPEED (max)	3 m/s
MOTOR	200 kW DC
VOLTAGE	460 V
DRIVE SHEAVE	1800 mm
ANGLE OF WRAP	360°
ROPE DIAMETER	32 mm
MODE OF OPERATION	1. Fully Automatic 2. Shaft side automatic 3. Manual



Tension car

## **CONCLUSION**

Due to the shallow incline at No. 3 decline and the fact that for the first 20 metres of the shaft runs on the level, meant that the use of a single drum winder was not an option in the design approach. The answer was a modern friction driven endless rope machine.

Then there were the three aspects for compliance

Safe in operation: The winder design is one of the safest means of transporting material considering the history of small incline shafts. The possibility of a runaway is virtually impossible due to the control of the conveyance. The next aspect of safety is the PLC monitoring all the control processes. Finally this small hoist is a licensed winder and therefore all statutory examinations are done on the winder similarly as a main winder on the vertical shaft.

Labour efficient: The loading and offloading methods adopted for this winder is so mechanised that one operator can manage the normal loading of material.

Cater for our needs: No 3 Decline requires 45 cars per day and the current rate far exceeds our requirements.

## **ACKNOWLEDGEMENTS**

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