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The Loco Drill and its application to flat end development

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The South African gold and platinum deposits were formed in very different ways and yet both have many similarities. They are flat dipping tabular orebodies, extremely narrow and located in hard abrasive country rock. The mining methods employed are also similar. Primary access is via shafts or declines; secondary access is via haulages and cross-cuts; and tertiary access is from raises. The proposed solution for rapid access described in this paper is focused on the haulages and cross-cuts.

Introduction

The business of mining is primarily the extraction of minerals and any excavation that does not produce mineral is at a cost that has to be offset by the revenue from mining the mineral. Thus, development is a cost that generates no revenue and every effort is made to minimize the size of these waste excavations. The following are typical dimensions for the various types of development.

- **Haulages.** It is an exception to find a cross-section in excess of twenty square metres. The more usual sizes are between ten and fifteen square metres.
- **Cross cuts** connect footwall drives with the reef. They are typically between seven and ten square metres in cross-section.

In an exercise completed in 1991 it was estimated that the total development in the gold and platinum mines amounted to 1 300 kilometres per year. Today it must be recognized that the gold mining industry has been overtaken by the platinum mining sector. The platinum mines are all embarking on major expansions and total annual development from both sectors is currently about 1 500 kilometres per year.

The vast majority of this development is with handheld drilling and throw shovel loaders for cleaning. Drilling 2.4 metre steel it should be possible to achieve a two metre advance three times per day. In reality, in a high speed single end development, the advance rate is more likely to be less than one hundred metres per month. Development in raises is typically a half to a third of flat development.

Development ends can be developed in two major ways. These are conventional or mechanized methods. The conventional method, as in the past, makes use of handheld pneumatic rock drills, while the mechanized method described in this paper utilizes a Loco Drill. This method utilizes electro hydraulics to power the drilling of the face, roof bolt holes and other holes. The cleaning method used to remove the broken rock is unchanged.

The preferred method for end development depends on the required advance and tonnages as well as the cost incurred. The advantages and disadvantages of the two methods are discussed below.

Conventional method

The conventional method makes use of two rock drill operators at the face using pneumatic rock drills. Assuming a face of 3.5 m by 3.5 m (as in a Lonmin case study), it takes the team an entire 8 hour shift to drill all the face and roof support holes. Each of the holes requires approximately 4.5 minutes to be drilled using the pneumatic drills. The hole depth on average is around 2.4 m deep, depending on the drill steel being used. These holes can give an effective break/advance of 2.1 m to 2.2 m per blast if it is a clean break. During the night shift the broken rock is removed from the development end using a throw shovel loader and loco pushing hoppers. This cycle is achieved about eighteen times per month and results in ± 38 m advance per month.

In a Lonmin case study a detailed cost estimate of all the different costs was compiled. These costs included all the obvious ones and the less obvious ones such as the cost of supplying compressed air. The costs of development incurred during this process can be estimated at R 5 897.41 per metre if a single end is being developed and R 4 924.44 per metre if two ends are being developed simultaneously.

Mechanized method

The mechanized method uses the Lonmin New Era Loco concept based on the conventional 75D battery locomotive. The general shape and dimensions can be seen in Figure 2.

The Loco Drill is electro-hydraulically powered, the energy for which is supplied by a 66 volt, 33 cell battery. The mine rail gauge width on which it can run is 610 or 762 mm (other gauges are also available). The rig has an operating weight of 10 000 kg and can tram at a maximum of 12 km/h. Due to size and speed factors, the minimum turning radius of the rig is 10 m at creep speed and 18 m at full speed. The Loco Drill can also be used to move or pull things around the mine. It has a starting drawbar pull of 2000 kg and a running drawbar pull of 640 kg.

To achieve its function, the Loco Drill is equipped with an H 14 F-NV boom and HLX1 drifter, as seen in Figure 4.

To give some technical details on the B 14 F-NV boom, the boom weighs 1 050 kg without hoses and can cover an area of 27 m^2. This particular boom has an extension of 800 mm and a lift up and down of 45º and 20º respectively. The swing of the B 14 F-NV is ±30° which is symmetric (thus the ± symbol). The boom feed has an extension of 1400 mm and a tilt up and down of 90° and 10° respectively. The feed can also roll over 360° and has a symmetric feed angle of ±95°.

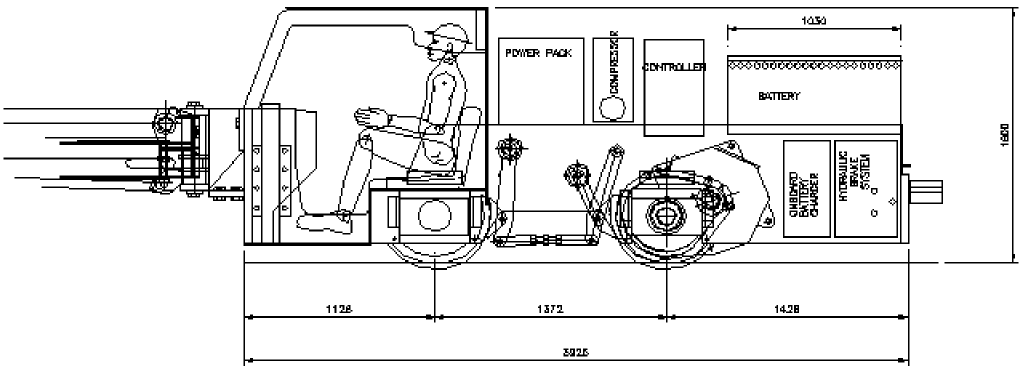

Figure 1. The drill Loco concept

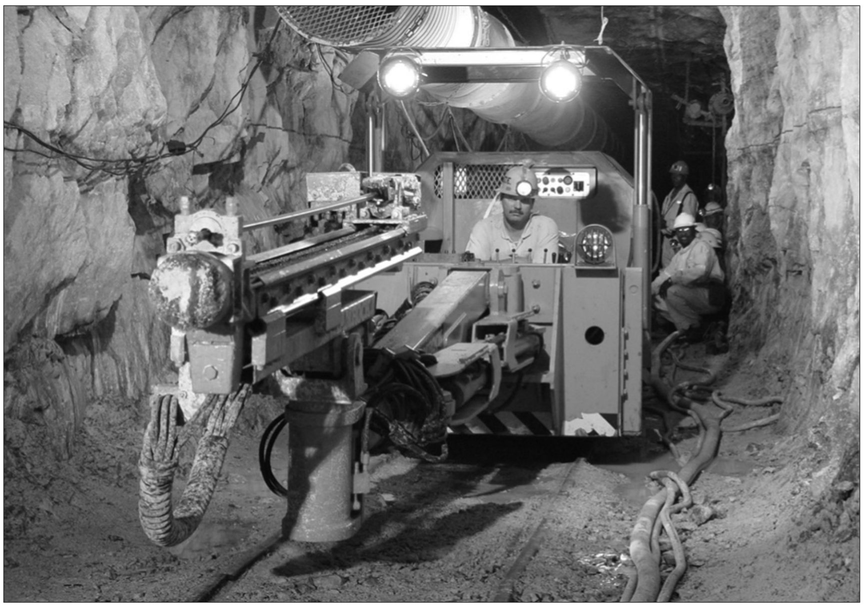

Figure 2. Picture of the Loco Drill

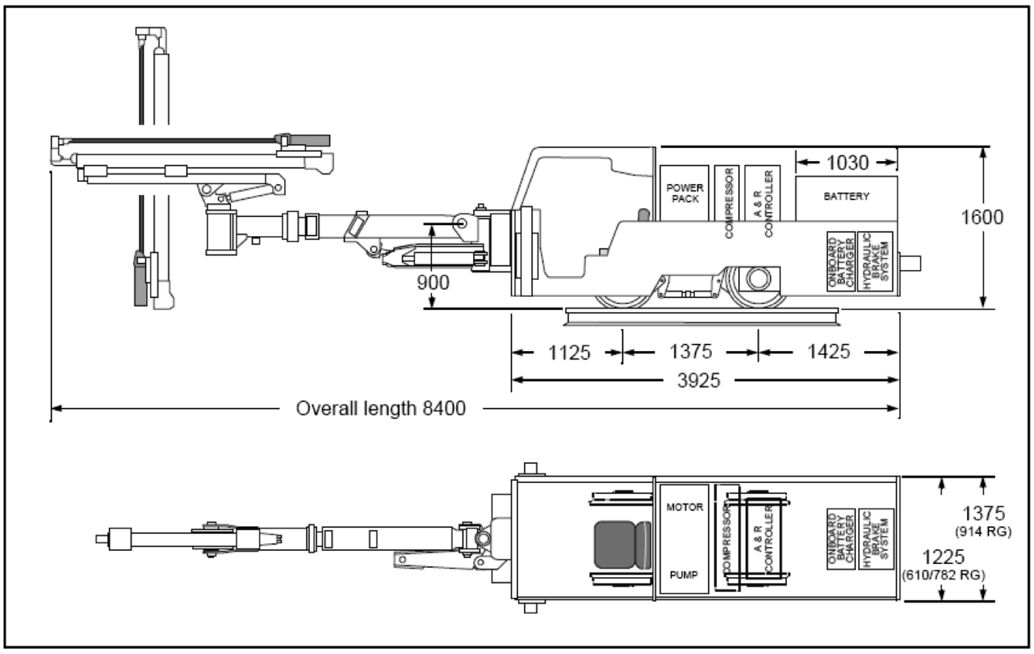

Figure 3. Schematic of Loco Drill

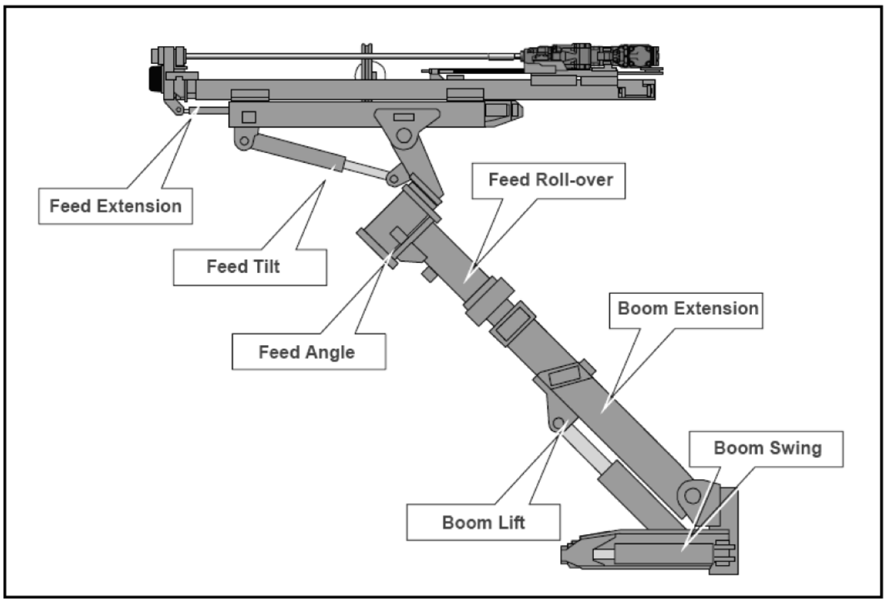

Figure 4. The B 14 F-NV boom with HLX1 drifter

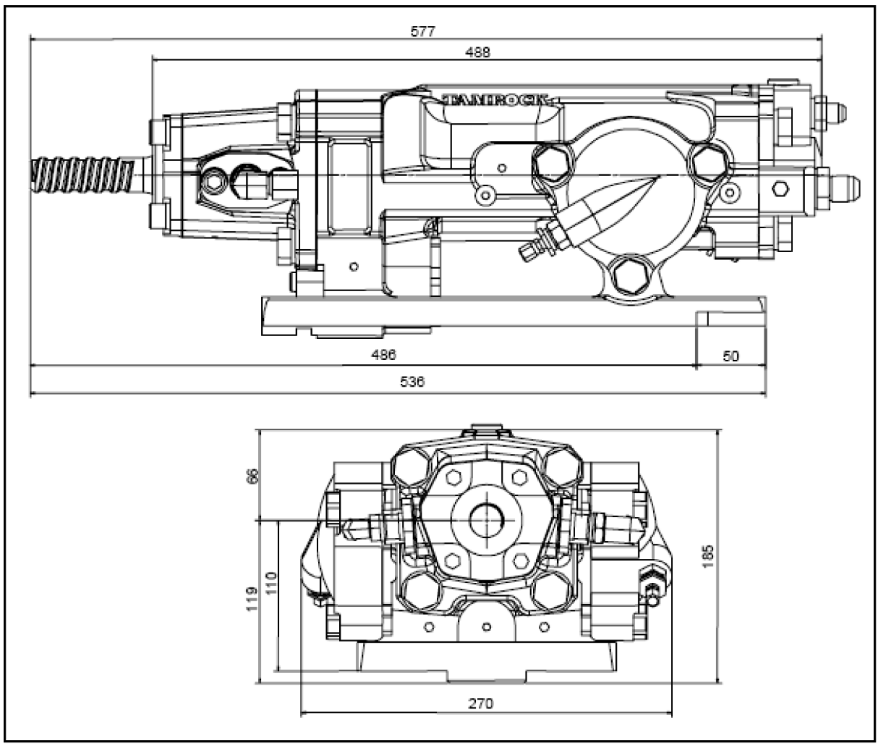

Figure 5. The HLX1 drifter

Mounted to the B 14 F-NV boom is an HLX 1 drifter as depicted in Figure 5. The HLX1 drifter is a rock drill, which has both a percussion and a rotation mechanism in order to drill. The percussion mechanism can deliver between 3 and 6.5 KW and operates between 70 to 88 Hz. In order to do this the drifter requires an operating pressure between 10 and 18 MPa. Depending on the drifter model (OMM32 or OMM50), the rotation mechanism can produce 100 or 160 Nm of torque. With these capabilities, the drifter can drill a hole of 35 mm diameter and 2.1 m length in ± 1.5 minutes. This enables the rig to finish a face in 2.5 hours. This, coupled with a set-up time of only half an hour allows it to finish two faces per shift. This results in ± 80 m advance per month.

Due to the design of the boom, the parallelism of the holes is better than that of the conventional handheld drills. This results in a cleaner and better break as well as a better wall finish. The capabilities of the boom and drifter are illustrated in Figure 6.

From the same Lonmin case study mentioned previously, the costs incurred during this process can be estimated at R 6 304.80 per metre if a single end is being developed and R 5 763.87 per metre if two ends are being developed simultaneously. These costs are marginally more than those

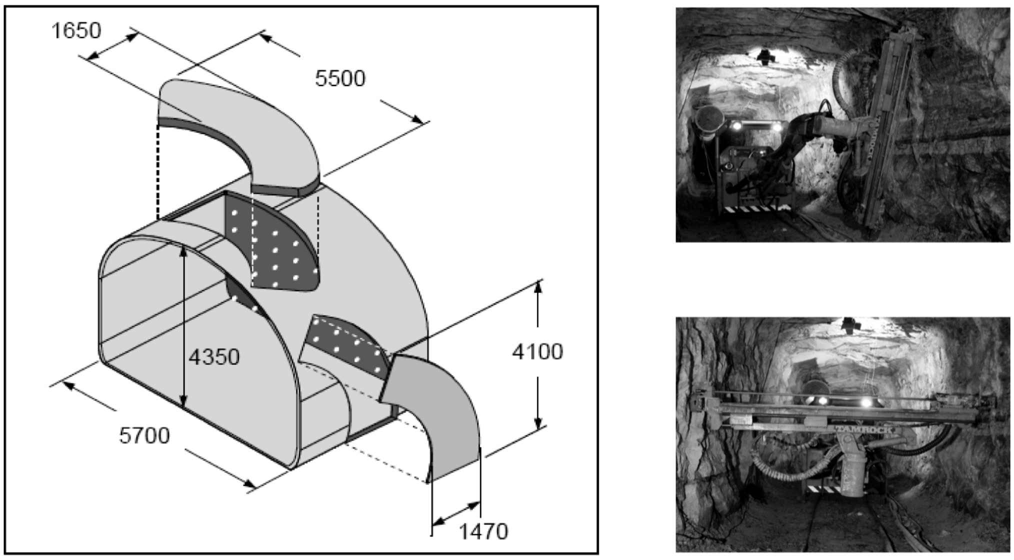

Figure 6. Boom capabilities

for the conventional method, but coupled with these costs are the advantages of having more accurately drilled holes, reliability and, more importantly, a safer working environment for the operator.

Comment and conclusion

The narrow reef gold and platinum mining industry carries out about 1 500 kilometres of flat end development. Most of it with dimensions of around 3.5 m × 3.5 m. Most of that development is mined with handheld drills and cleaned with throw shovel loaders. The solution presented in this paper makes it possible to mechanize the round drilling and the roof bolt drilling. Thus support installation can be kept up with the development heading; the drilling of the development heading is more accurate and hence the blast does less damage to the surrounding tunnel rock. This concept delivers a safer, more productive method and, importantly, removes the worker from danger, hard and, arduous work.