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SPOTLIGHT
on materials handling in open-pit mines

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Introduction

Rapid and effective handling of run-of-mine, waste, and treated materials is vital to every step of resource development and recovery. Modern mine managements have planned and engineered systems for the handling of ever-larger tonnages. Where traditional methods have not proved to be cost-effective and adequate, managements have pioneered the development of new materials-handling systems in the mining industry. Furthermore, the rising cost of fuel and the other requirements of rear-dump trucks has necessitated the consideration of alternative methods of materials handling. This has led to the viewing of conveyors, together with suitable crushers, in a new and much more favourable light for use in large open-pit mines.

The vehicular transportation of ore represents as much as 50 per cent of the total mining cost.

The two Iscor mines, Sishen for the supply of iron ore, and Grootegeluk for the supply of blend coking coal to the Iscor blast furnaces, are successfully employing in-pit crushing and conveying systems. This article briefly describes the engineering aspects of the systems and their components to illustrate the possible effect of these developments on the mining technology of the future.

Materials-handling Methods

In an economic evaluation of materials handling, various alternatives can be considered. The following were examined for Grootegeluk (Table I):

(a) Rear-dump trucks for the total system
(b) Rear-dump trucks with a pantograph system
(c) Rear-dump trucks and a relocatable crusher
(d) A shovel and a mobile crusher.

A separate cash-flow study is necessary for every different mine because of varying conditions. The travelling distance of the material and the incline out of the pit are factors that could change the whole analysis.

After the cash-flow analysis, a decision was taken to install a mobile crushing system at Grootegeluk because it was the most economical, and because the mine development and layout favoured a mobile crushing and conveying system.

At Sishen, with its throughput of 6 kt/h, the use of a fully mobile crusher was not feasible because the technical development was not sufficiently advanced at that time. However, a semi-mobile crushing system was the solution to the problem of high-cost conveying.

Grootegeluk

After drilling and blasting at Grootegeluk (Fig. 1), broken rock (overburden) is loaded into the feed hopper of the crusher by means of a 17 m³ electric rope shovel. Although the shovel is rated to handle 2,4 kt/h when used with rear-dump trucks, a momentary loading rate of 3 kt/h can be achieved. The crusher unloads crushed material onto a bridge conveyor of suitable length, thereby allowing the erection of the remaining part of the conveyor system at a safe distance from the blasting area.

The conveyor system consists of three movable conveyors, one extendible conveyor, and two overland conveyors. Stacking is done by means of a crawler-mounted slewing and luffing stacker. The total installed power is approximately 4,5 MW.

The technical details of this system are given below.

Crusher (mobile)		
Type		54/74 gyratory
Power		400 kW
Throughput		3 kt/h
Material size		0 to 200/250 mm
Conveying system		
Belt width		1 350 mm
Belt speed		2,62 m/s
(a)	*Bridge conveyor*	
	Belt centres	110 m
	Power	132 kW
(b)	*Movable conveyors*	
	Number	3
	Length/conveyor	410 m
	Drive/conveyor	2 × 132 kW
(c)	*Extendible conveyor*	
	Belt centres	80 to 875 m
	Power	250 to 750 kW
(d)	*Overland conveyors*	
	Number	2
	Total length	Approx. 1 500 m
	Lift	Approx. 61 m
	Drive/conveyor	3 × 250 kW

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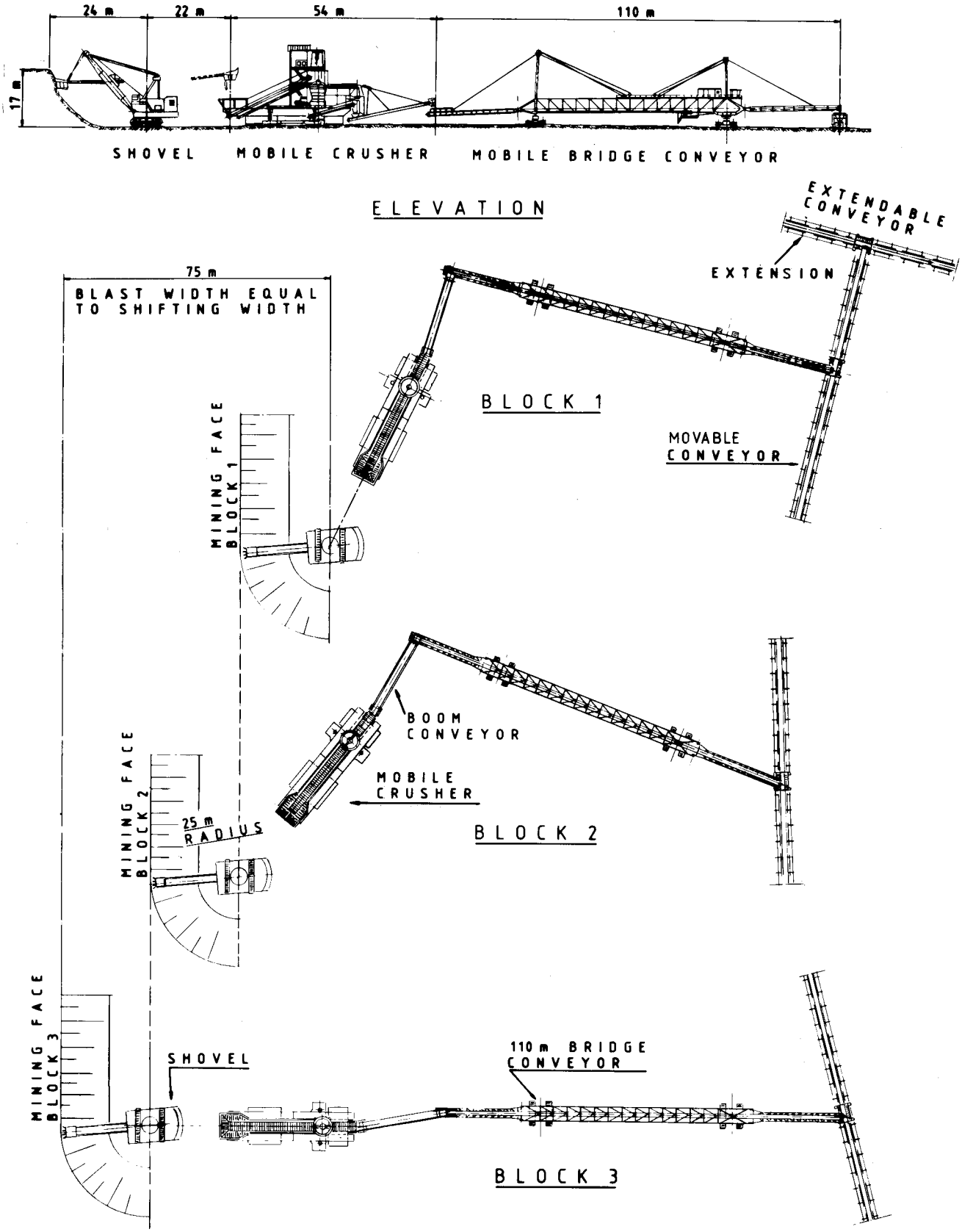

Fig. 1—Relative position and movements of the main components during overburden stripping at Grootegeluk

TABLE I

CASH-FLOW ANALYSIS FOR GROOTEGELUK

All values in rands per ton Alternative	A	B	C	D
Total capital	0,089	0,129	0,222	0,289
Operating and maintenance cost	0,203	0,128	0,117	—
Fuel	0,203	0,128	0,117	—
Tyres and belting	0,094	0,094	0,078	0,041
Other	0,158	0,168	0,160	0,198
Total	0,455	0,39	0,355	0,259
Replacement costs and remaining value	−0,020	−0,031	−0,112	−0,149
Total costs	0,524	0,488	0,463	0,379

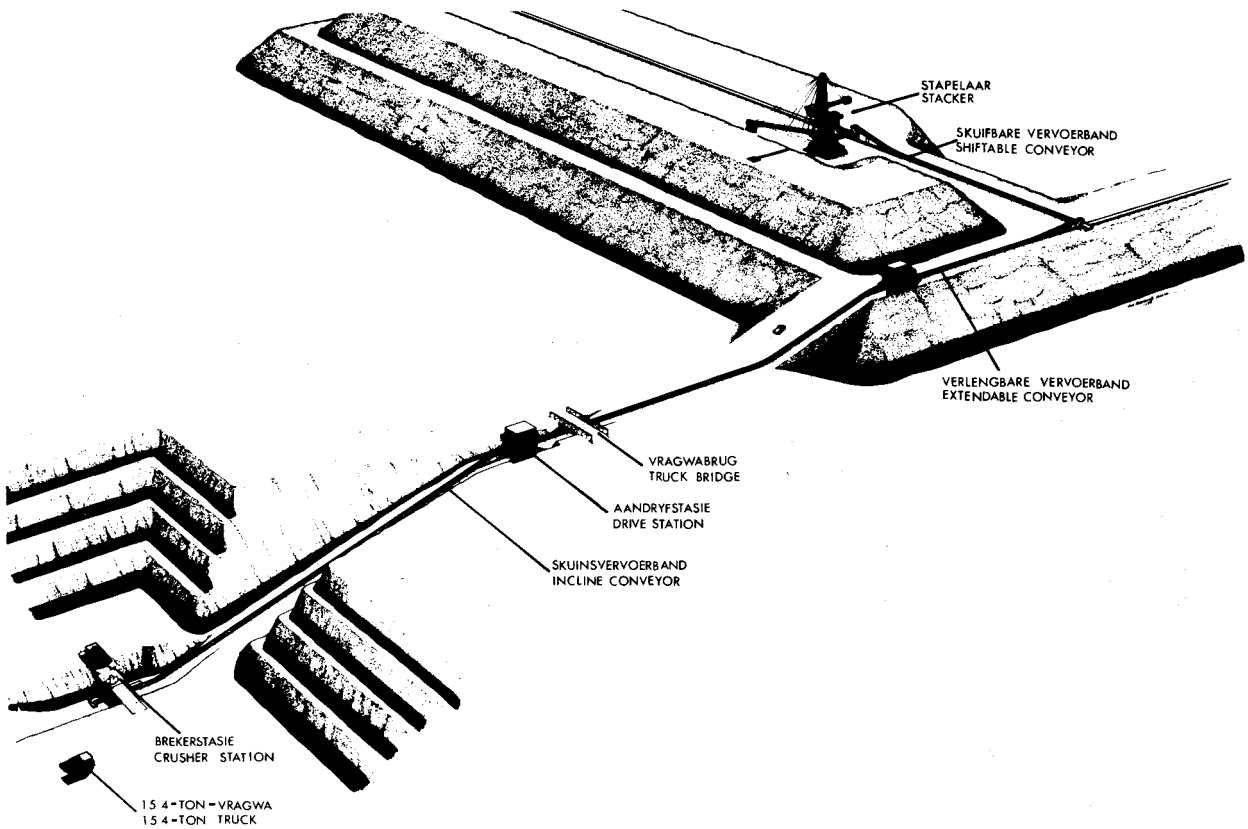

Fig. 2—Sishen in-pit crushing and conveying system

Sishen

At Sishen (Figs. 2 and 3), the rock after blasting is transported by means of 150 t dump trucks to a nearby in-pit crusher. This permits the desired flexibility of mining operations. The crushed material is then moved by means of a discharge conveyor, two incline conveyors, and a stacking system consisting of an extendible conveyor, a movable conveyor, a tripper bridge conveyor, and a crawler-mounted stacker. The total installed power of the crushing system is 11 MW.

The technical details are as follows.

Crusher (semi-mobile)	
Type	60/109 gyratory
Power	2 × 450 kW
Throughput	6 kt/h
Material size	0 to 300 mm
Conveyor system	
Belt width	1 800 mm
Belt speed	3,9 m/s

Fig. 3—The crushing system at Sishen

a)	*Bridge conveyor*	
	Belt centres	60 m
	Power	200 kW
(b)	*Movable conveyor*	
	Belt centres	1 097 m
	Power	3 × 500 kW
(c)	*Extendible conveyor*	
	Belt centres	143 to 943 m
	Power	1 500 kW
(d)	*Overland conveyors*	
	Number	2
	Total length	Approx. 650 m
	Total lift	Approx 70 m
	Drive/conveyor	3 × 500 kW

Conclusion

After both plants had been commissioned and operated for a certain period, the capital outlay was clearly higher than for a dump-truck system with the same capacity, particularly one with electric-trolley assistance. The lower operating and maintenance costs make in-pit crushing systems economically viable in the long run. The latest developments indicate an increasing awareness of the value of testing in solid-rock and ore-mining operations and the introduction of continuous conveyor-belt transportation in combination with mobile crushing plant for the complete replacement of trucks.