The tailings dam at Consolidated Murchison Limited

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SYNOPSIS

The history of tailings dam operations at Consolidated Murchison Limited is briefly recounted, and a mechanical method of dam-wall construction is described and illustrated in some detail.

SAMEVATTING

Die geskiedenis van uitskotdambedrywighede by Consolidated Murchison Beperk word kortliks beskryf en 'n meganiese metode om 'n damwal te bou word taamlik breedvoerig uiteengesit en geïllustreer.

INTRODUCTION

The tailings dam at Consolidated Murchison Limited was started in 1942, and initially covered an area of 67 500 m². The area was enlarged to the south by 47 500 m² during 1950, and to the west by 73 175 m² in 1965. The approximate layout is shown in Fig. 1. Up to the end of 1970, a maximum of 27 200 tonnes per month (30 000 short tons) were deposited; growth rates were therefore low, and no special attention had to be devoted to wall construction. Furthermore, the three areas of the dam were always treated as three individual dams, with dividing walls between them and separate penstocks. The tailings were gravitated from the mill through a single mild-steel pipeline of 15,2 cm diameter and were deposited onto the north-west corners of dams 1 and 2, and onto the north-east corner of dam 3.

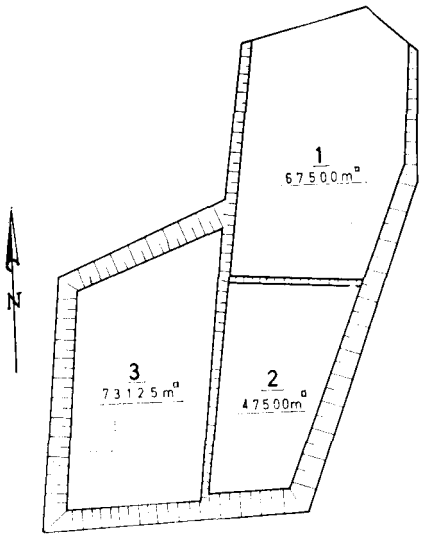

Fig. 1—Plan of slimes dam

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The tailings then flowed southward and, owing to natural segregation, the coarsest material would be deposited on the north walls of the dams, the finest tailings being deposited on the south walls.

Towards the end of 1970, a major expansion programme was completed, and, from then on, 50 000 tonnes per month had to be accommodated. It was then realized that the deposition of tailings as described above would be unsafe, and two alternatives were considered:

(a) improvement of the existing dams, accompanied by a change in the practice of tailings deposition, or
(b) abandonment of the old slimes dams and the construction of a new dam.

After due consideration it was decided to implement (a), and the following steps were taken.

(1) Because of the diminishing difference in height between the plant and the surface of the dam, the tailings were pumped to the dam.
(2) All three dams were raised to the same level.
(3) A spigotted ringmain was laid round the dam.
(4) The feed line to the dam and the ringmain were lined with rubber.
(5) All three dams were treated as one unit so that a safe growth rate could be achieved.

Pumps

Two pumps were installed, each 15,2 cm by 15,2 cm, running at 780 rev/min, and driven by 50 h.p. motors. The volume of tailings is approximately 1300 l/min, the speed of the tailing therefore being 1,5 m/s.

Raising of the Level

The level was difficult to achieve, since there was a difference of some 15,24 m between the heights of dams 2 and 3, dam 2 being the higher. Tailings were therefore deposited on dam 3, regardless of the growth rate, and the dam was level with dam 2 after two years. This proved, as a side effect, that a growth rate of some 7 m per annum is feasible at Consolidated Murchison.

Spigotting

Some experimentation showed that spent 15,2 cm valve bodies inserted after every two lengths of 6,1 m rubber-lined piping were cheaper than spigotted piping.

Rubber Lining

This involved the purchase and installation of 230 lengths of rubber-lined piping, each of 6,1 m. Plate I gives an idea of the type of terrain this pipe line had to traverse. The initial cost of the spigotted ringmain and the fence line was R20 200, excluding installation.

Growth Rate

It was estimated that all three dams would be level by January 1973. The estimate proved correct, and the following basis was used as a forecast of future growth:

Tailings deposition rate	50 000 tonnes per month
Wall slope	33°
Year 0	January 1973
Area at Year 0	177 500 m²
Tailings density (compacted)	1,937

Table I gives the estimated growth rate for the tailings dam up to the year 1995, and shows that the dam should be adequate for at least a further fifteen years.

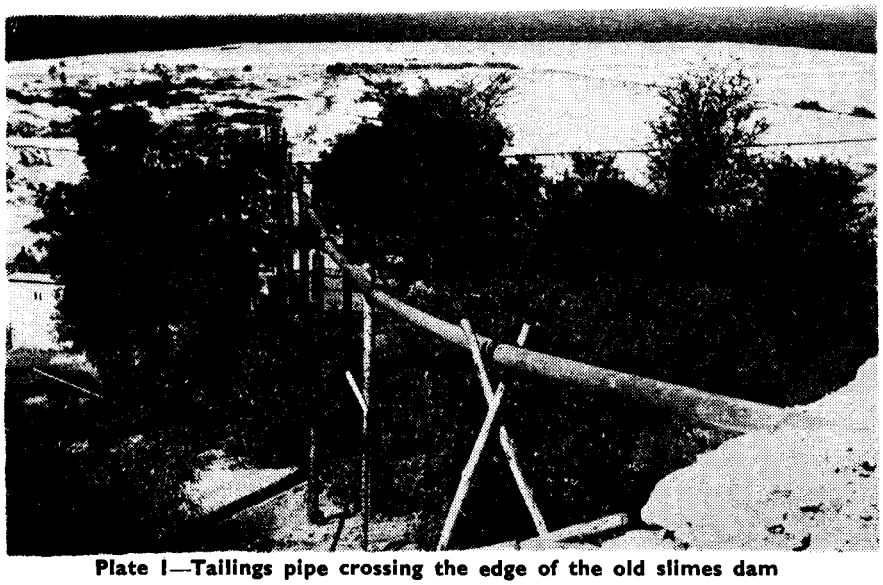


Plate I—Tailings pipe crossing the edge of the old slimes dam

TABLE I
ESTIMATED GROWTH RATE OF THE DAM

Calendar year	Numerical year	Estimated growth rate, m/a
1973	1	1,7
1974	2	1,8
1975	3	1,9
1976	4	2,0
1977	5	2,0
1978	6	2,1
1979	7	2,1
1980	8	2,2
1981	9	2,3
1982	10	2,5
1983	11	2,7
1984	12	2,8
1985	13	2,9
1986	14	3,1
1987	15	3,4
1988	16	3,8
1989	17	4,0
1990	18	4,5
1991	19	5,2
1992	20	6,1
1993	21	7,6
1994	22	9,0
1995	23	

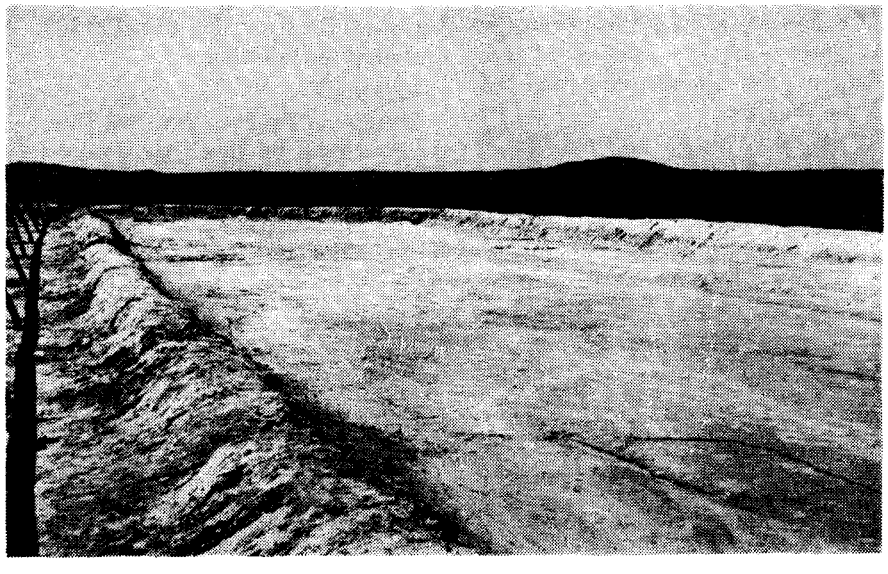


Plate II—A conventional slimes dam, showing the outer and inner walls

CONSTRUCTION OF THE DAM

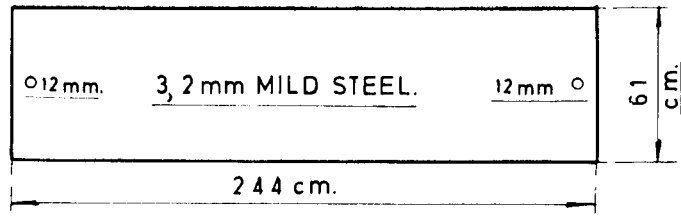
Background

The three tailings dams of Consolidated Murchison (Fig. 1) had been constructed in the usual way for gold-tailings dams: an outer wall was raised during the day, and at night the tailings were channelled through an inner wall to the centre of the dam (Plate II).

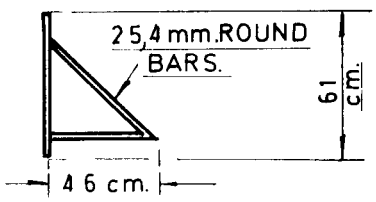
This way of building a dam is very expensive, and was especially so for Consolidated Murchison, where three independent dams had to be maintained. At one stage, the labour allocation for the dam alone was 36 Bantu. A breakdown of this labour force revealed that by far the larger part was employed on physically raising the walls by shovel. The ringmain and the incorporation of all three dams into one reduced this labour somewhat, but the labour was still too high when compared with that required for high-tonnage operations. Thought was then given to mechanical raising of the walls.

Present Practice

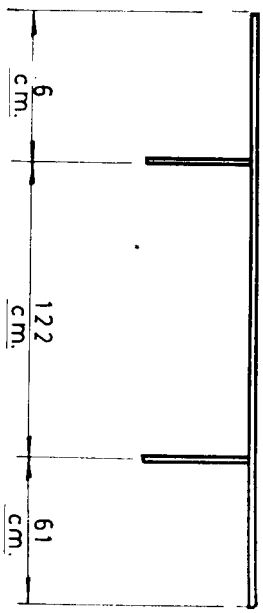
The surface of the dam is sloped considerably towards the centre or penstocks. Alongside the walls are mild-steel plates, 244 cm long, 61 cm high, and 3,2 mm thick. These plates overlap each other by about 7,6 cm and are bolted together with a single bolt. The plates are supported by two 25,4 cm round bars welded to the back of the plates. The details are shown in Fig. 2. The tailings are now tapped out of the ringmain by flexible hoses 10,1 cm in diameter and 4,6 m in length, whose outlet is positioned about 1,5 m away from these plates. Coarse tailings are then deposited against the plates, while the fines flow towards the centre of the dam. The hoses are moved from time to time so that an even height of slimes deposition is achieved, and the whole operation moves continuously round the dam as hoses and plates where the prescribed height of wall has been reached are disconnected, and those at the front, where wall construction is about to start, are connected. Every new round is started by moving the plates towards the centre by 45,7 cm and aiming for a wall rise of 30,5 cm,



(A) Front View



(B) Side View



(C) Top View

Fig. 2—Details of steel plates

thus ensuring a dam-wall slope of 33°. These steel plates are shown in Plates III and IV.

Critical Review of Operation

At the outset there was some doubt about whether this method of dam construction would be possible without prior classification of the tailings. Classification would not only involve the purchase and installation of classifying equipment, but a second pipe line of different diameter would have to be laid round the entire dam. The high initial cost would make the operation at Consolidated Murchison uneconomical. These doubts proved to be unfounded, since the unclassified tailings settled very well and did not leak out between the plates. The plates thus proved to be better than hand-built walls.

Some of the physical characteristics of the tailings at Consolidated Murchison are listed below:

Specific gravity of dry solids 2,8
Pulp density 1550 g/l

Screen analysis, per cent by weight

+ 48 Tyler mesh	9,4
+100 Tyler mesh	28,1
+200 Tyler mesh	43,3
−200 Tyler mesh	56,6

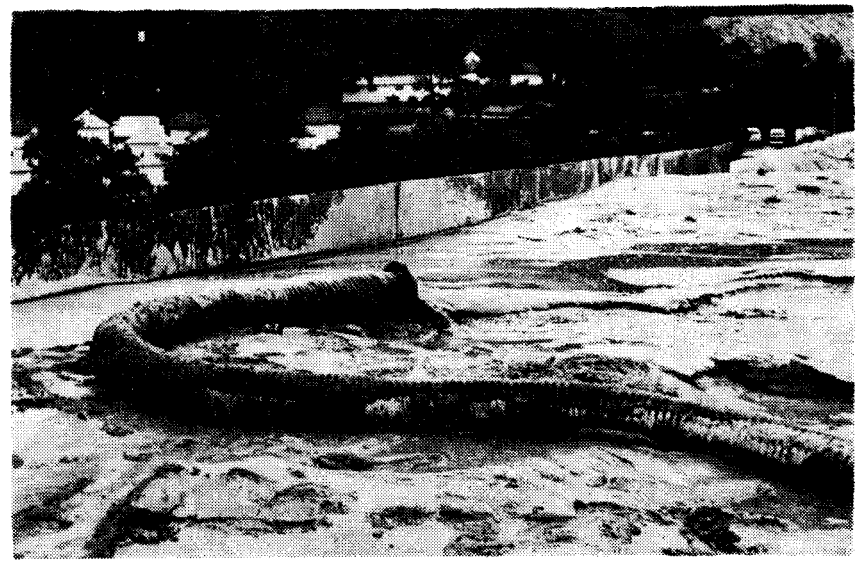


Plate III—Deposition of slimes against the steel plates

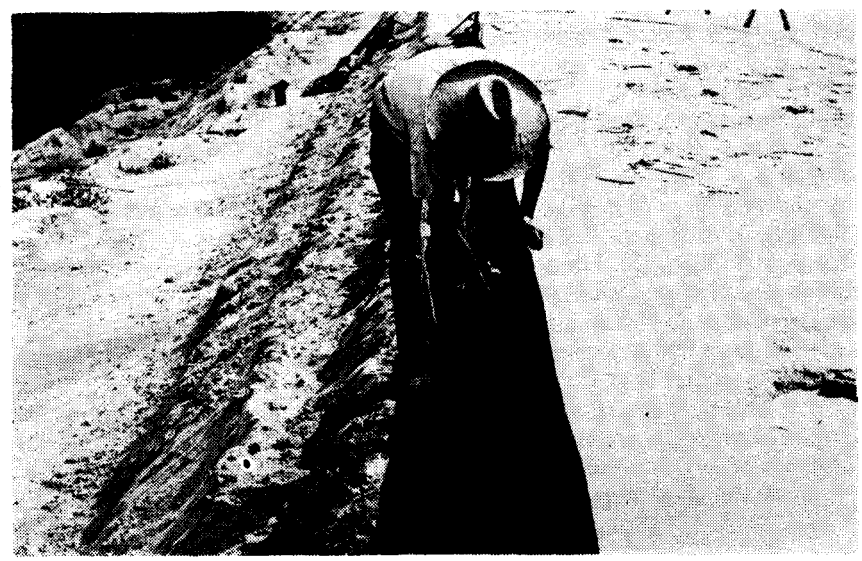


Plate IV—Disconnecting the steel plate

Labour was reduced from 36 to 25 Bantu while, at the same time, the tonnage was increased from some 27 000 to 50 000 tonnes per month. At the time of writing this paper the consolidation of the dams was complete, and the author feels confident in saying that a further labour reduction to, say, 20 Bantu should be feasible. The safety of the dam is better than that of the old dams, and the settling of the dam walls seems to yield a very well compacted dam wall.

FUTURE DESIGN CONSIDERATIONS

The largest cost factor at present, with regard to both labour and materials, is the constant raising of the ringmain. Ten Bantu are continuously occupied in raising the ringmain by about 1,83 m at a time. The pipe is supported by Bluegum poles (2,44 m long and 10,16 cm in diameter), which are buried after each cycle. The author feels that it could be of advantage to lay the ringmain on the ground and pump the tailings up the dam walls through flexible hoses, which could be lengthened as the need arose.

ACKNOWLEDGEMENTS

The author wishes to thank the Management of Consolidated Murchison Limited and the Consulting Metallurgist of Johannesburg Consolidated Investment Company for permission to write this paper.

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