SYNOPSIS

TITLE OF PAPER :

BELT FEEDING SYSTEMS AT RICHARDS BAY COAL TERMINAL

The paper deals with the experience at Richards Bay Coal Terminal relating to chutes, and relates developments from an operational viewpoint in attempting to overcome some of the problems associated with the handling of large tonnages of material. In this respect the use of ceramic tiles as a chute lining material has played a large role, and some factors which are relevant when changing to ceramics are discussed. The paper does not endeavour to produce any definitive results in this field, but uses specific examples to illustrate the operating experiences gained.

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1. INTRODUCTION

The development of Richards Bay Coal Terminal commenced in 1972 following the securing of a contract by the Transvaal Coal Owner's Association for the supply of 27 million tons of low ash coal to the Japanese steel mills over 10 years. On 1 April 1976 the harbour and coal terminal were officially commissioned, with a terminal design throughput of 12 million tons per annum.

The phase 2 development of RBCT was completed in late 1978 and increased the design capacity of the terminal to 20 Mt/a, although subsequent operating experience achieved a throughput of 24 Mt/a.

Further phase 3 development commenced in 1980 to increase the design capacity of the terminal to 44 Mt/a. This involved the upgrading of phases 1 and 2 as well as new phase 3 stockyards. Final commissioning of phase 3 was completed at the end of 1983, and to date a maximum throughput of 40 Mt/a has been achieved.

Following the completion of phase 3, conceptual studies were embarked on to investigate a phase 4 expansion, with various stages to achieve a maximum throughput of up to 100 Mt/a. Economic factors put a stop to any further expansion, however, and at present no further major developments are being done.

The existing terminal consists of the following major equipment:

1	Random Tippler
2	Tandem Tipplers
5	Stacker Reclaimers
3	Stackers
1	Reclaimer
3	Shiploaders

Approximatelty 44 km of belting is installed, comprising a total of 71 major conveyors plus numerous smaller sampling plant conveyors. Belting is presently standardised at 1250/5 fabric, in widths of 1,8m, 2,2m and 2,5m. The largest conveyors are rated at 12000 t/hr, which is achieved by a 2,2m wide belt moving at 6,1m/s.

2. SCOPE

It is intended to trace the operating history of the Terminal in the field of chute wear lining materials, from the time when ongoing replacement of liner plates became a major problem to the present day. In this period the change from metallic to ceramic liners was made, and in more recent times the use of tiles in specific areas has been refined to achieve a better life. This process is dynamic, and by its very nature time consuming, so the presentation finishes on an open-ended note, with latest developments still under test.

3. CHUTE LINING MATERIALS

3.1 HISTORY

As the Terminal expanded and greater tonnages were handled, so problems at transfer points increased. The design of chutes utilised dead boxes wherever possible, but these had a tendency to build up, eventually restricting coal flow. In other areas where dead boxes were not feasible, severe wear of liners was experienced. Where large vertical drops existed, material friction resulted in excessive heat generation.

For example, during commissioning of phase 2, one chute became so hot that all the paint was burnt off, zinc galv.6 primer included.

The basic problem, however, was that conventional abrasion-resistant steels were incapable of giving an acceptable life as the tonnages increased. In extreme wear areas, a life of around 1 million tons of coal throughout was experienced, which may appear reasonable until one considers that this took as little as 3 weeks at the phase 2 level of 24 Mt/a. From 1980 onwards, therefore, numerous tests were initiated to find a superior wear-resistant chute lining material.

3.2 LINER TESTS

The area chosen for the first tests was situated at the bottom of the Shiploader loading horn spout, just below the two-way flop gate. This is a high wear area which is subject to sliding abrasion and relatively little direct impact. It is also easy to monitor and suitable for installing economically-sized test pieces, with the added advantage of having a two-way flop gate just above it, to change over from one side of the chute to the other.

Various 600 x 900 mm wear plates were installed and tested, including Roqlast and Roqtuff (which lasted for 0,5Mt), Wearalloy (1 Mt) and a number of other proprietary steels, the most successful being the Kyle wearplate, which lasted for about 2 Mt before a hole wore through. A polyethylene lining tested was notable for achieving less than 3 hours life before being burnt off due to the heat generated by material friction.

It was at this stage in mid-1981, that ceramic tiles were introduced onto the South African market, and the first test was carried out using weldable 25mm thick tiles in the same loading horn spout area. The trial was not a success, because the tiles cracked up under the impact forces, although most of the pieces still remained in position. The problem was that this fixing method provided little backing support for the tiles due to irregularities in the mounting plate.

The next test was done using tiles which were epoxied in place, and was extremely successful, so much so that these original tiles are still in use today, with a maximum wear of 4mm in places.

The test was then extended to 3 sections of the loading horn, with similar good results.

3.3 FURTHER INSTALLATIONS

A limited installation programme on various problem areas in the plant was then undertaken, and on this basis the decision was made to tile all major chutes at the Terminal. This programme started in 1983, concentrating initially on the major problem areas.

Due to the enormous expense involved, tiling was phased in over a period of 5 years and will finally be completed by the end of this year, at a total cost of some R 2 million.

3.4 PROPERTIES OF TWO COMMONLY USED CERAMIC WEAR MATERIALS - BASALT AND ALUMINA

Most tiles in use at the Terminal are of the high alumina type, although some cast basalt tiles have been installed, as will be discussed later.

It is relevant at this stage to examine some of the physical properties of these two materials and how these properties affect chute lining applications.

PROPERTY	ALUMINA	CAST BASALT
Colour	white	charcoal
Type	94% cast	static cast
Compressive strength	2400 MPA	540 MPa
Tensile strength	165 MPa	35 MPa
Bending strength	270 MPa	45 MPa
Water absorption	0%	0%
Porosity	gas tight	gas tight
Specific density	3,6 g/cm^3	3,0 g/cm^3

Both materials have a high compressive strength with a low bending and tensile strength. For this reason ceramics are normally applied to a metal substrate to give them structural strength.

Both alumina and basalt have zero gas and water porosity, properties that are essential when conveying potentially corrosive substances.

From the densities it should be noted that ceramics are slightly less than half the density of the average steels, which is important to consider when replacing existing lining materials which are generally thinner than the tiles.

The co-efficient of friction of the unpolished tiles is generally similar or slightly better than commonly used metallic wear plates, and in applications where sliding contact occurs, polishing of the tiles by material abrasion may reduce this figure further, with basalt showing superior qualities to alumina.

The following table gives figures for impact resistance which were obtained by dropping a 6kg iron ball onto samples which were bedded with epoxy onto a 6mm thick mild steel plate positioned at an angle of 45 degrees. This highlights alumina superiority over basalt in an impact situation.

MATERIAL TESTED	ENERGY REQUIRED TO FRACTURE kgm
25mm alumina	14,4
30mm cast basalt	6,0
10mm glass	1,2

Both materials due to their extreme hardness are relatively brittle and will fail due to brittle fracture removing material by chipping. For this reason neither material should be applied in areas of extremely high impact and these situations should be designed out or avoided completely with ceramics.

4. R.B.C.T. OPERATING EXPERIENCE

4.1 INSTALLATION

Before installation of the tiles, the substrate must be thoroughly cleaned to ensure good adhesion. Standard practice at the Terminal is to sandblast the area thoroughly, followed as soon as possible afterwards by the epoxy layer. Tiling is done by contractors, at an all inclusive cost of about R700/metre for 25mm thick alumina tiles. This figure is on the high side because tiling has to be done on maintenance days, which carries an "inconvenience premium", and the areas to be tiled are generally small.

Basalt tiles have an installed cost (on the same basis) of about R340/metre, so there is a strong incentive to use these wherever possible. Their impact resistance is very poor, so they have only been used where the impact is low, in areas of the silos and hoppers, as well as on the inner skirts of the chutes.

4.2 RETROFITTING

At the Terminal, most tiling was installed on existing equipment, not originally designed for tiles. In these cases there were a number of factors to be considered:

4.2.1 Weight

The density of tiles is about half that of metallic liner plates, but the metal plates originally installed were generally from 6 to 10mm thick, while the alumina tiles are 25mm thick, and the basalt tiles 30mm. The nett effect is an increase in weight, which was a problem in some instances, and modifications had to be carried out to allow for this.

4.2.2 Thickness

The greater thickness of tiles leads to a reduction in effective chute area, but this should not normally be a problem. At RBCT, however, during the phase 3 project, the old phase 1 & 2 routes were upgraded to handle greater tonnages. Structural constraints and cost precluded enlarging of chutes, so the overall effect was that chute sizing was somewhat marginal in places, and when tiles were later added, problems were experienced with blocking up of some chutes under certain circumstances. RBCT handles a large number of grades of coal, some of which flow less easily than others, so the problem is more complex than many other major material handling installations may experience.

4.3 REDUCING EFFECTS OF IMPACT

With their poor impact resistance being the major drawback of tiles, there are a number of methods (other than extensive design modifications) of minimising the effects of impact:

4.3.1 Thicker tiles

The use of 50mm thick tiles is recommended by manufacturers for higher impact situations, but the weight and chute size reduction effects become major concerns with these tiles. In addition, at acute angles of attack the situation may be worsened if one or more tiles are removed due to the greater edge impact area of the thick tiles.

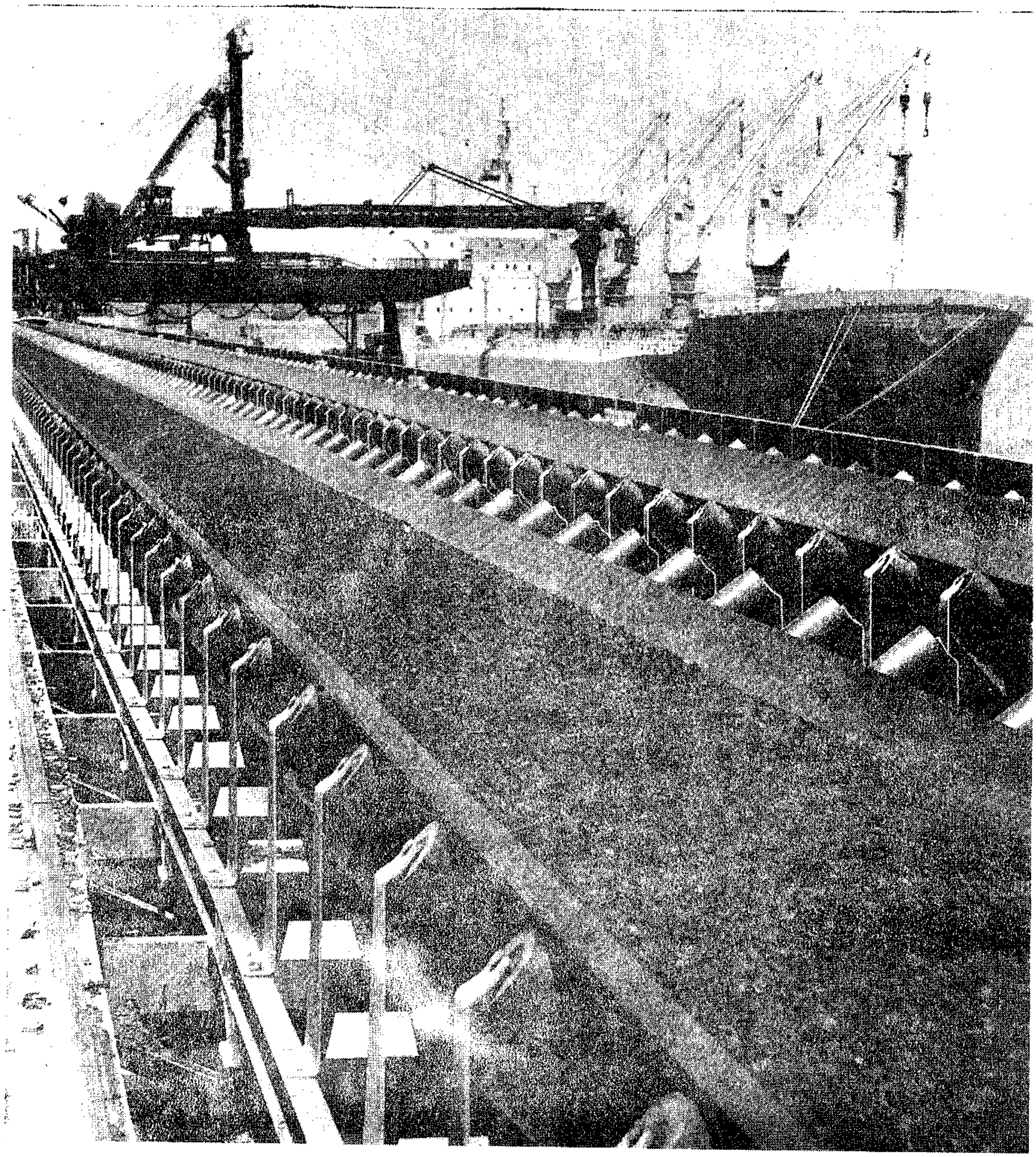
4.3.2 Smaller Tiles

The use of smaller sized tiles other than the standard 228 x 114 mm (9" x 4") size has the effect of reducing the bending stresses and the length of crack propagation.

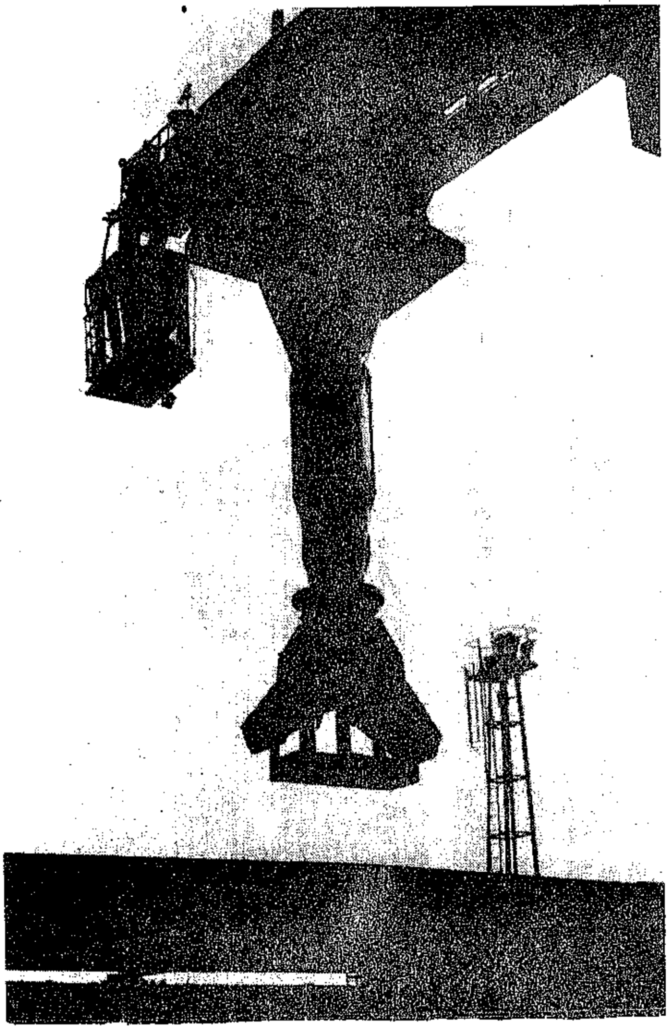
4.3.3 Banding

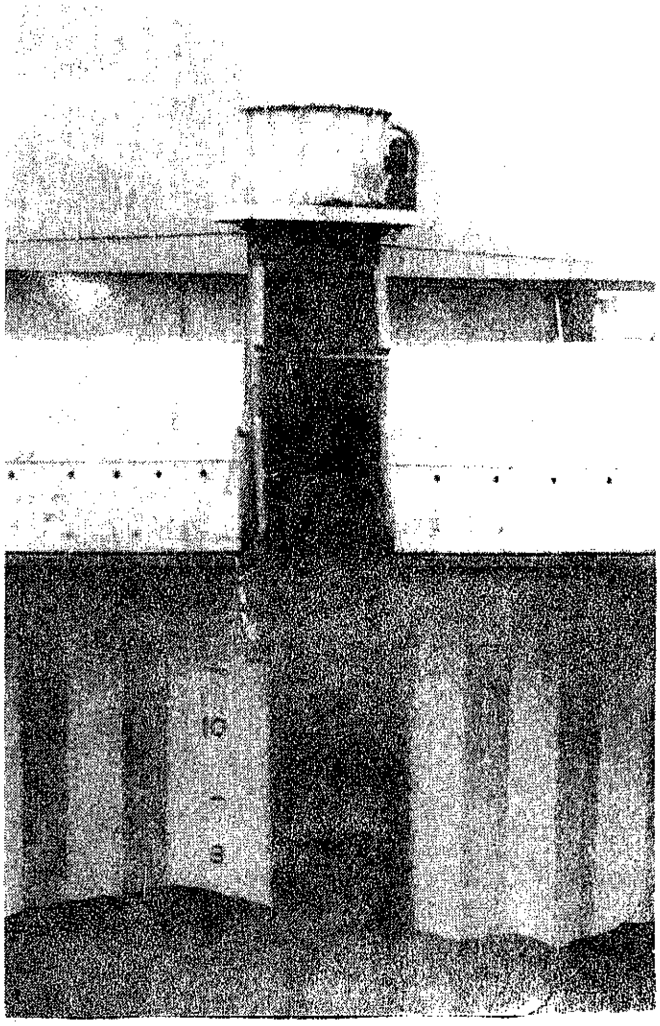
Banding by the use of flat bar to surround the tiled area is being tested together with smaller tiles on the Shiploader trimmer chute flop gate, a particularly strenuous area, where the coal undergoes a free fall of some 13 m before striking the flop gate at an angle of about 30 degrees to its surface. Experience with normal tiles has been that the tile removal starts in the area of highest impact, then continues down to the bottom of the gate. Tiles 150 x 50 mm in size were installed with the short side vertical, and 6 mm flat bar was welded on to the backing plate to band the whole gate. In addition horizontal strips were installed at 350 mm spacings, resulting in compartments 7 tiles high and the width of the flop gate. The trial has only recently been installed, and it is too early to judge the effectiveness of the changes.

5. VISUAL PRESENTATION

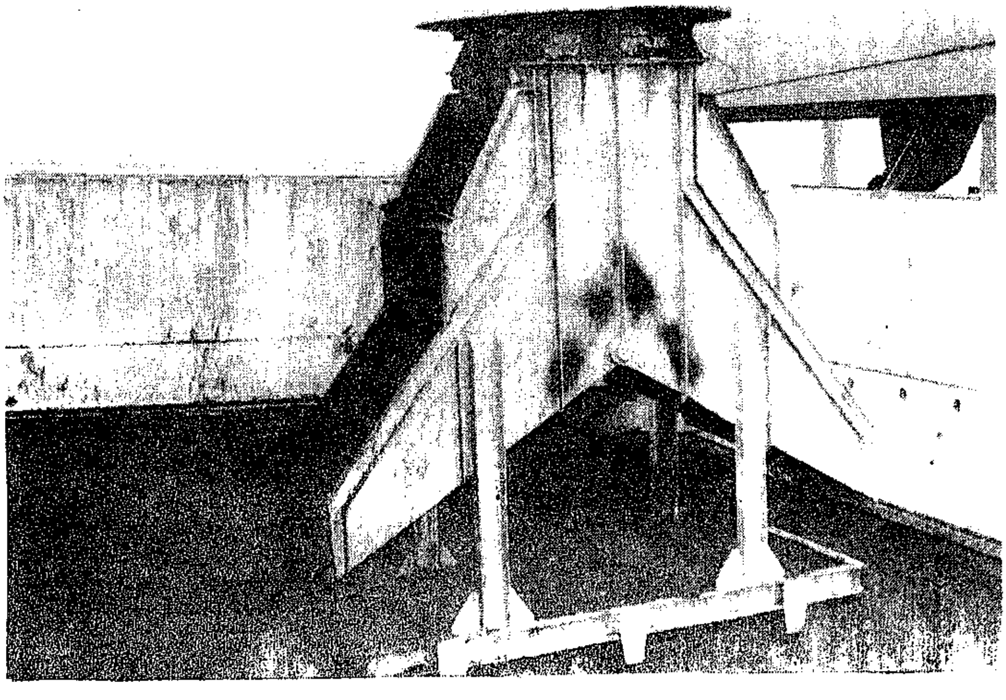


OVERALL VIEW OF SHIPLOADER, WITH WHARF CONVEYORS IN THE FOREGROUND



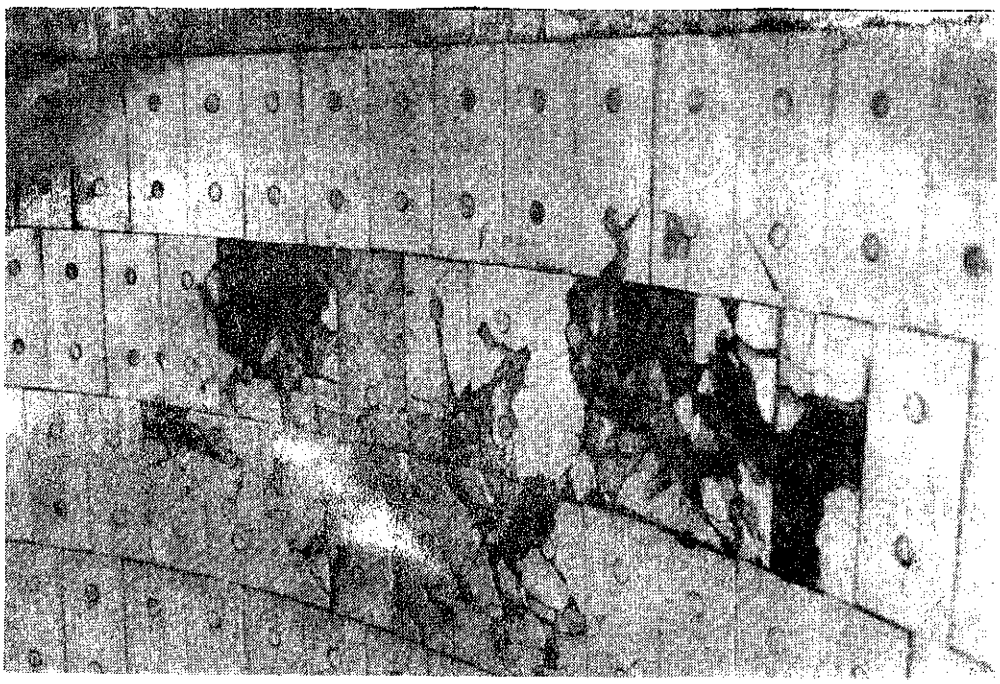


SHIPLOADER TRIMMER CHUTE : THE FIRST TESTS
WERE CARRIED OUT IN THE EXIT AREA
BELOW THE FLOP GATE



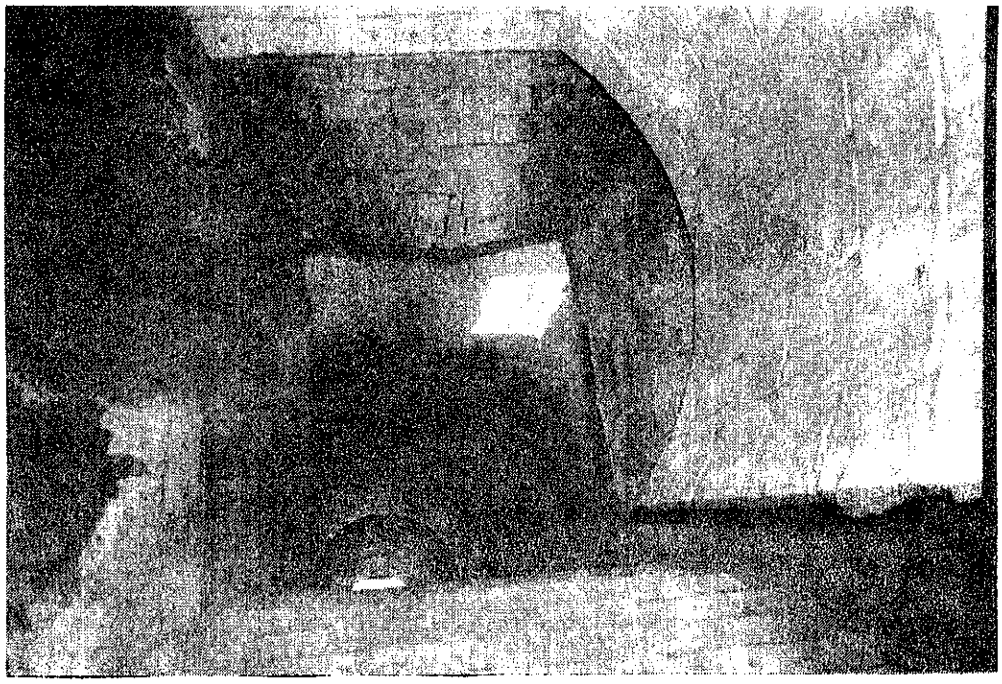
SHIPLOADER BOOM BELT HEAD CHUTE, FEEDING INTO LOADING HORN

In the foreground is the boom belt (2,2m wide, 5,9m/s) with the tiled bash plate behind.



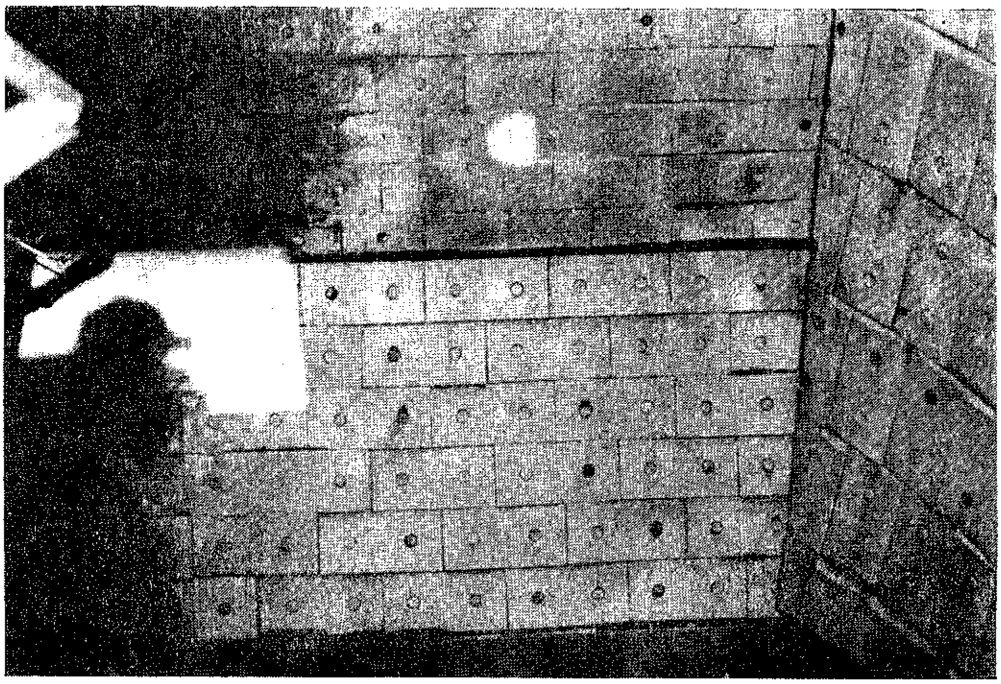
CLOSE UP OF BASH PLATE, SHOWING CRACKED TILES.

The tiles are the original weld-in type, hence the plugs, but have been epoxied in position. Note the "micro dead box" effect, which protects the area with pieces of tiles missing.



VIEW DOWN LOADING HORN

The curved bash plate is on the right, with the head pulley out of picture on the left. The square to round part of the structure is coated with alumina filled epoxy, consisting of ceramic beads in an epoxy base. This is moderately successful, but the epoxy tends to wear around the beads, which then come loose.

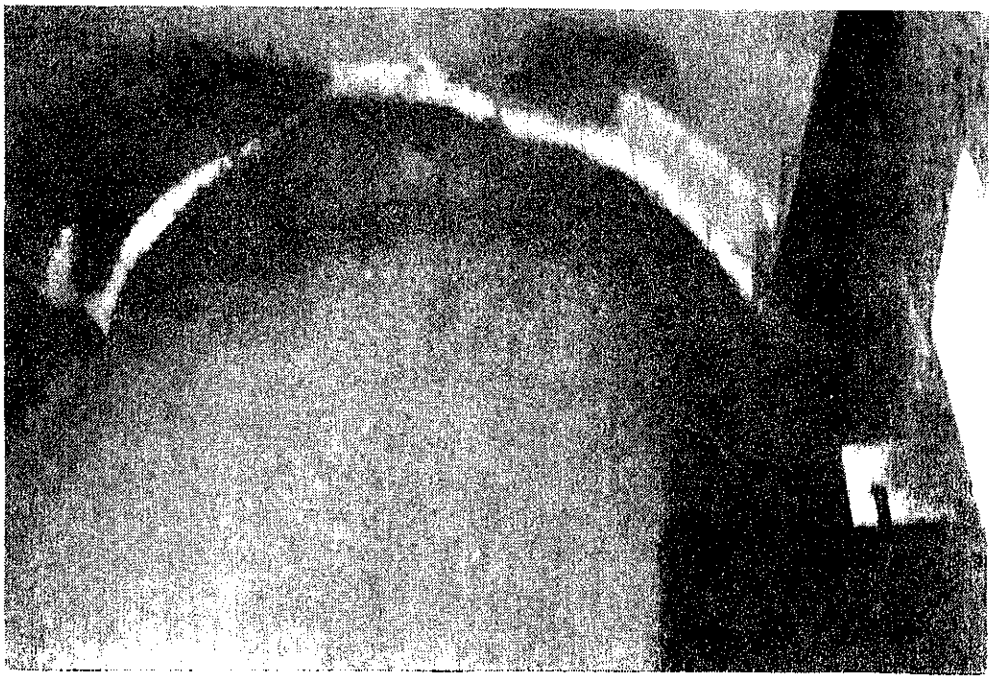


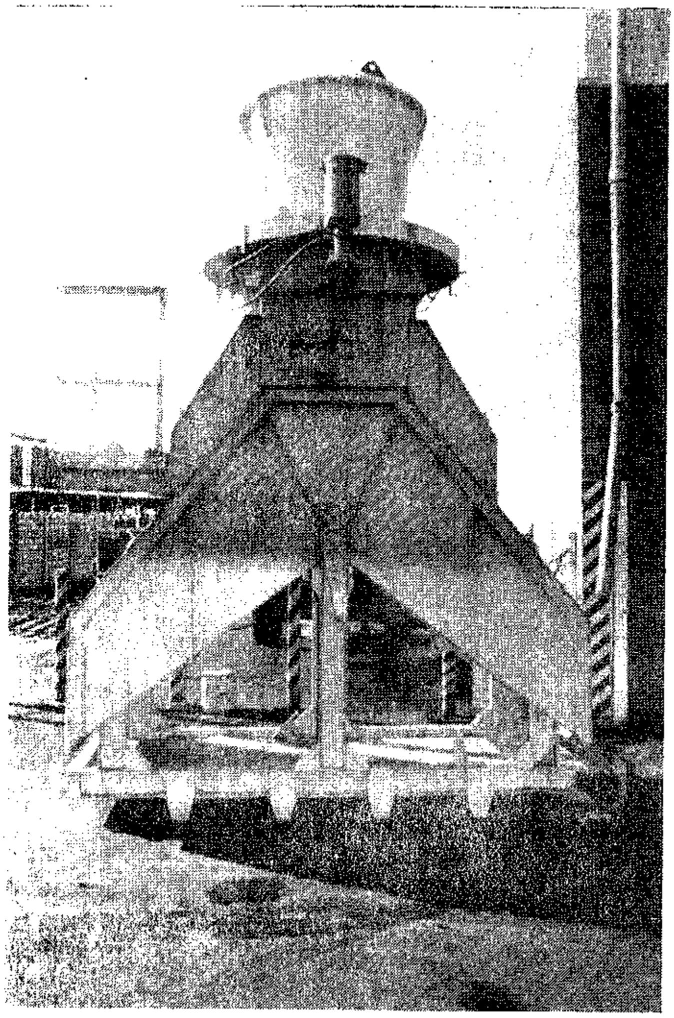
CLOSE UP OF UPPER LOADING HORN

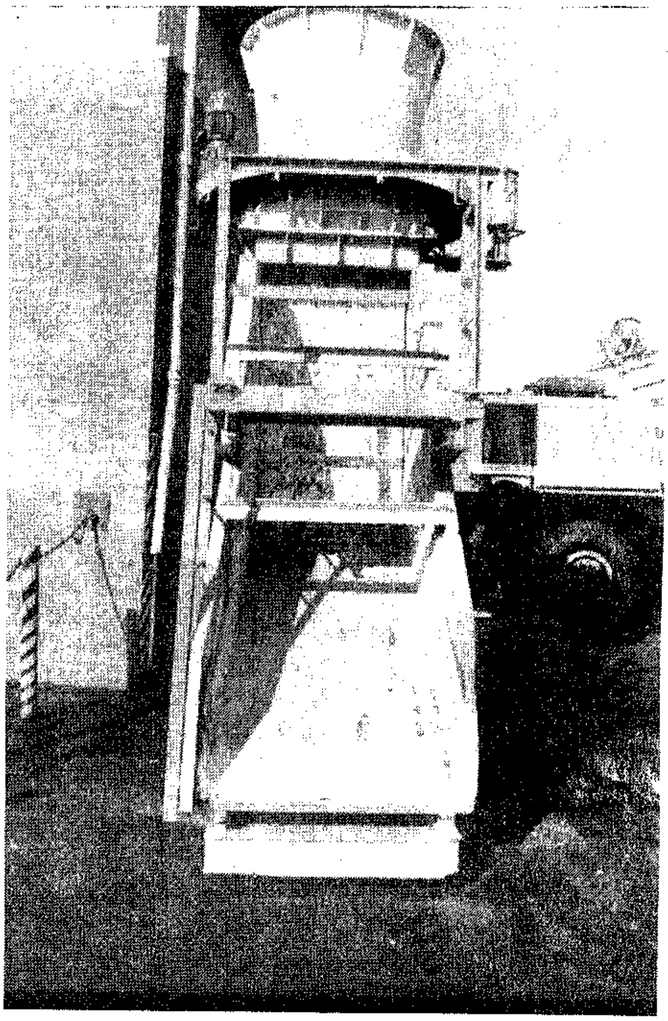
The bash plate is on the right, showing minimal wear after about five years in service.

TWO VIEWS OF COAL FLOW ONTO THE BASH PLATE

Note the build up of coal on the bash plate, which tends to remain static while the material flow is uninterrupted.







<u>SPARE TRIMMER CHUTE AFTER RETILING OF DAMAGED AREAS</u>

The high impact in this area has required that some changes be made in the tiling, as shown overleaf.

SMALLER (150 X 100 MM) TILES IN THE AREA BELOW THE FLOP GATE

CLOSE UP OF FLOP GATE

Here 150 x 50 mm tiles have been installed, banded at 350 mm intervals with 6 mm flat bar. This is an attempt to avoid tiles "peeling off" due to the high impact and acute angle of attack in this area.

6. REFERENCES

Eyres R.E. An Introduction to Wear Resistant Ceramics and their Application to the Coal Processing and Preparation Industry.