INTERNATIONAL MATERIALS HANDLING CONFERENCE

BELTCON 3

MATERIALS HANDLING PLANT FOR THE SIMUMA CEMENT WORKS WITH SPECIAL REFERENCE TO THE DESIGN OF A DOWNHILL CONVEYOR

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MATERIALS HANDLING PLANT FOR THE SIMUMA CEMENT WORKS

1. INTRODUCTION

Various interesting aspects of the wide variety of materials handling technology practised at the mountainous site of Natal Portland Cement's new 1450 tons per day cement clinker plant at Simuma, 16 km upstream from the mouth of Natal's Umzimkulu river, are outlined, with special reference to the design of a downhill conveyor.

When the project managers, Anglo Alpha Technical Services were commissioned to build the plant, the terrain presented a real challenge in optimization of route and location especially in regard to the spread out raw materials handling installation. Comparative studies between truck, belt conveyor and aerial ropeway transportation systems culminated in the layout solution shown in Figs. 1, 2 and 3 with:

- The crushing plant located next to the quarry high up on Simuma Hill

- The belt conveyor system down the mountain and across the river to the Works on the South bank nearly two kilometres away

- The coal and additive materials rail intake, the sampling plant and the stacking, reclaiming and preblending facilities for the raw materials forming the "front end" of the Works.

The article highlights some unusual features of the raw materials handling plant at Simuma and the reasons for the conceptual decisions.

2. THE CRUSHING AND SCREENING PLANT (Figs. 4 and 5)

The combination of steel tip bridge and apron feeder utilizes the natural slope of the ground and minimizes immovable concrete structures. In ten years the primary crusher can be relocated close to the receding quarry face with little time and cost (Figs. 6 and 7).

The hard limestone with its sharp crystaline structure ruled out impact or hammer type primary crushers although they are widely used in the cement industry. The scouring abrasion would have worn away the surface areas of a rotary crusher's wearing parts before these surfaces could become work-hardened. A single toggle jaw crusher was selected as primary crusher in preference to a gyratory crusher because the jaw crusher:

- accepts a larger maximum particle feed size

- requires less height and concrete foundations

for a given throughput rate.

By regulating the apron feeder speed an optimum flow rate is maintained, catering for predominantly fine or predominantly coarse run-of-mine material as well as for oversize lumps. It is important to avoid deformation of the apron flights of a primary apron feeder fed by rear dump trucks and handling lumpy ore. At Simuma the following precautions were taken:

- a nuclear low level sensor in the tip bin prevents frequent emptying of the apron feeder to maintain a protective material layer at the tipping point. The tip bin is correspondingly sized.

- the aprons are constructed as deep fabricated sections to increase resistance to bending.

- liberally sized wear resisting steel liners are bolted to the aprons with countersunk huckbolts. The liners are curved to maintain an overlap between aprons even as they pass over the drive and tail sprockets so that no material particles can enter or build up between the aprons and cause bending or deformation.

- in the impact area the apron support rollers are flexibly mounted and bronzelined lubricated sliding surfaces are spaced evenly across the apron feeder width. Upon abnormal impact loads, the aprons in the impact area recede and are supported by the slides to avoid excessive stresses and deformation.

The scalping screen not only relieves the jaw crusher of an unnecessary load to increase the effective throughput rate and reduce wear, but also ensures that large lumps are orientated favourably to facilitate entry into the crusher and minimize blockages with production time loss.

To prevent oversize in the product the secondary and tertiary gyratory crushers work in closed circuit with a product screen. In this way the raw mill grinding media charge is optimized and the mill throughput rate maximized.

3. THE CONVEYOR BELT SYSTEM

Altogether 19 conveyor belts are used at Simuma to transport the various raw material types such as limestone, shale, iron ore and coal though a total distance of some 3000 m. The belt widths vary from 1200 mm down to 750 mm whilst the belt speed throughout is a conservative 1,6 m/s. This allows for a possible 50% uprating of the plant capacity in the future.

Of special interest in the conveyor belt system is the design of the downhill conveyor from the crushing plant in the mountain down to the North bank of the river (Fig. 8).

3.1 Technical Data

Material handled	:	crushed limestone, size 0 - 25 mm
Capacity	:	300 t/h average - 400 t/h max
Belt width/type	:	900 mm type ST 800
Conveyor length between pulley centres	:	750 m
Lift	:	minus 126 m
Installed power	:	3 x 45 kW - 1500 rpm
Gear units	:	Flender type KZA 250 - 3 off
Drive pulleys	:	dia. 750 mm - 3 off

3.2 Drive Configuration

2 drive units shaft mounted on primary drive pulley shaft.
1 drive unit shaft mounted on secondary drive pulley shaft.

Each drive comprises:
Motor, fluid coupling with flanged on brake drum, thrustor operated brake, shaft mounted bevel helical gearbox - all mounted onto a common bedplate.

3.3 Brake System

3.3.1 Objectives

- During normal operation up to maximum capacity the retardation of the conveyor belt is taken care of by the motor torque at synchronous speed, i.e. no mechanical braking occurs.

- In case of overload on the belt causing a torque greater than the available retarding torque of the motor the resultant overspeed must immediately be brought back to nominal speed in order to safeguard the mechanical drive train and other components.

- Normal braking procedure when the belt conveyor is stopped, must be such that even with maximum conveyor loading the braking tension in the belt is within the safety limits stipulated by the belt manufacturer.

- Emergency braking and/or power failure again must be a controlled procedure to avoid overspeed or overtensioning of the belt.

3.3.2 Configuration

Type	:	Haegglund Caliper type
Supplier	:	Hytec
Operation	:	Fail safe, hydraulic pressure releases brake. Application controlled by "brake control unit"
Disc mounting	:	directly onto primary drive pulley end discs
Disc diameter	:	1300 mm - 2 off
Disc speed	:	ca. 31 rpm
Stopping time	:	ca. 8 sec.
Designed braking torque	:	38 000 Nm

3.3.3 Description of Operation

In order to achieve the above objectives the brake system employed, functions as follows:

- The motor torque available retains the designed belt speed up to a total belt loading corresponding to a rate of 440 t/h (design flow rate plus 10%).

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- When this torque is exceeded the disc brake system installed directly onto the primary drive pulley comes into action as follows:

  - Command is received from the speed monitor that synchronious motor speed is exceeded.

  - Brake calliper advances to stage 1 that is applying immediately a constant small predetermined braking pressure at the brake disc.

- If the motor rpm does not fall back to the nominal level within 3 seconds the system initiates automatically stage 2. Stage 2 increases the brake torque to a value which brings the system to a controlled stand-still within 8 seconds when fully loaded, i.e. within safe limits of belt stress and mechanical overload. At the same time the motor power is cut off.

- At stand-still stage 3 takes over, that is the disc brakes are fully applied with total available torque and acting then as holding brakes.

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- In case of power failure and/or emergency stopping a permanently charged battery system takes over the control of the brake system initiating stage 2 immediately.

4. THE SAMPLING PLANT (Figs. 11 and 12)

To predetermine the raw mix of the kiln feed it is imperative to know the quality of the incoming raw material components. In this way the process technologist knows in advance in what approximate porportions the limestone and addatives will be used and whether the target raw mix can be achieved or whether the mining plan or operations must be modified.

The sampling plant serves to obtain a representative sample of the incoming raw material stream and to prepare it in size and consistancy for speedy and accurate laboratory X-ray analysis. To obtain a representative sample:

- the swing-type sample cutter moves through the full material stream at a conveyor belt transfer point at preset time intervals

- the frequency of cutting is specified in standards depending upon the variability of the sampled material

- the quantity per cut is determined by the cutter slot opening (2,5 x maximum particle size), the travel speed of the cutter and the material flow rate

- from experience for cement plants the sample taken will not be less than 1 to 2% of the material flow rate.

The sample taken by the sample cutter is then:

- crushed in stages to facilitate sample splitting without bias

- split in stages to reduce the quantity to manageable proportions

- dried to facilitate fine grinding

- ground to a powder to facilitate laboratory analysis by X-ray spectrometer.

At each stage of sample splitting a portion of the sample is rejected which is returned to the main material flow.

5. CIRCULAR STOCKPILES

The two circular stockpiles for limestone and for coal serve as a buffer stock ahead of the continuous process plant as well as to homogenize or preblend these two raw materials.

5.1 Objectives

The objectives of homogenizing or preblending are more specifically:

5.1.1 Limestone

- To arrive at and maintain a consistent limestone grade at a level of lime saturation so that the target raw mix can be achieved by proportioning it with a minimum of the more expensive additives such as shale and/or iron ore, whilst keeping other variables such as magnesium and alkali content within acceptable limits.

- In addition to the actual level of lime saturation it is important to achieve already at the preblending stage a high degree of consistency to increase the accuracy of proportioning and the effectiveness of subsequent homogenizing of the raw mix.

- The consistency of the final raw mix determines the steadiness and length of kiln runs, the quality of the end product and the life of the deposit. Relatively lower grade raw materials can be used for the same final product quality.

5.1.2 Coal

- To ensure a consistent quality coal feed to the kilns to increase steadiness and length of kiln runs and improve product quality.

- In the future, if need be, to enable the use of various grades of coal for the most cost effective energy sourcing whilst still maintaining an even coal quality feed to the kilns.

5.2 Stockpile Configuration

Each of the circular stockpiles has a diameter of 66 m. Stacking is achieved by means of a slewing and luffing stacker, mounted on a slewing ring in the upper portion of the central column. Stacking is to the PEHA-Chevcon system, which was pioneered and developed by PHB Weserhutte and is a combination of the Chevron and Coneshell stacking methods.During stacking

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the slewing stacker performs a continuous, combined slewing and luffing motion over a pre-set arc of the circle. The stacker's travel path is advanced by an adjustable increment after each slewing traverse,resulting in a constant forward development of the full stockpile cross-section.

Reclaiming is achieved by means of a bridge type scraper reclaimer which rests on a second slewing ring at the lower part of the central column as well as on rail-mounted travel drives which run on the circular outer rail. During reclaiming the reclaimer advances at a controlled speed in the direction of the full stockpile cross-section whilst the triangular rake reciprocates continuously, allowing the material from all the various layers to trickle down in controlled fashion into the reclaimer blades. Each reclaimer blade, attached to the continuous double stranded chain, is gradually filled during its horizontal passage across the width of the stockpile until it discharges into the conical chute at the centre of the plant. In this way an optimum homogenizing effect is achieved.

Each circular homogenizing plant is controlled by a programmable logic controller (PLC) and works completely automatically from the central control.

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5.3 Advantages of Circular Stockpiles

The major advantage of the circular homogenizing system is that the reclaimer is confronted by an endless homogenized bed. This ensures that there is always a full cross-section of stockpile in the form of fully homogenized limestone available even when stocks are quite low. There is no need to re-position the reclaimer and no detrimental effect of cone ends.

In addition the circular stockpiles for limestone and coal could be advantageously integrated into the plant layout and difficult topography, because:

- the specific space utilization of circular stockpiles is high as the net effective storage capacity is 78% of gross storage capacity

- the circles are best fitted into the available space and the relation between direction of inflow and outflow is completely flexible over 360°.

It is imperative to ensure that the size of the stockpiles selected is adequate for the degree of variability in the quality of material mined. The operator very often finds in practice that the storage capacity and therefore the capacity of the "tail" over which homogenizing takes place, is not large enough. The initial marginal cost of increasing the storage capacity of a planned facility is not high and justifies a liberal approach.

6. LONGITUDINAL STOCKPILES (Fig. 18)

The longitudinal stockpiles for raw material addatives such as shale, iron ore, boiler ash and gypsum (future) serve mainly as a buffer storage and to a lesser extent to obtain a degree of homogenizing or preblending of these raw materials. It is therefore a stockyard operation where a number of materials are stockpiled and reclaimed separately and consecutively in relatively small quantities and flow rates using a common facility and equipment. These stockpiles are served by a non-slewing stacker operating along the length of one side of the stockpiles and a side scraper reclaimer (Fig. 19) operating along the length of the opposite side of the stockpiles. The side scraper reclaimer is ideal for this application as:

- the reclaimer can transfer freely and successively obtain access to different material types

- the side scraper reclaimer is a relatively inexpensive and simple machine for use on smaller stockpiles up to 25 m base width

- for larger stockpiles and higher flow rates a portal scraper reclaimer would be used with largely similar mode of operation.

Stacking is to the Coneshell mode whilst during reclaiming the reclaimer travels continuously up and down the length of the stockpile section being reclaimed. At the start the scraper boom is in the upper position making contact with the side of the triangular stockpile and scraping the material down towards the reclaim conveyor. After each traverse the boom is lowered by a pre-set increment which determines the depth of cut.

At Simuma the longitudinal stockpiles are not roofed in. During reclaiming the reclaimed face becomes shallower all the time. This allows rain water to penetrate more readily. In addition the first material to be reclaimed after a rain storm is the upper layer which was exposed to the rain. This may prove disadvantageous when this stockpile concept is selected to handle material which becomes sticky when wet. In such cases the facility may have to be partly or fully roofed in.

7. CONCLUSION

The raw materials handling plant or "front-end" at the Simuma works represents a most interesting study in raw materials handling technology not only due to the very difficult topography, but also the wide variety of materials handling concepts, techniques and equipment types which are applied. The effectiveness with which the best solutions were found and applied is a tribute to the expertise of the Project Managers, Anglo Alpha Technical Services, as well as to the materials handling engineers concerned. Small wonder that Simuma could already achieve a kiln run of over 200 days in its first year of operation since beginning 1984.

LIST OF FIGURES WITH CAPTIONS

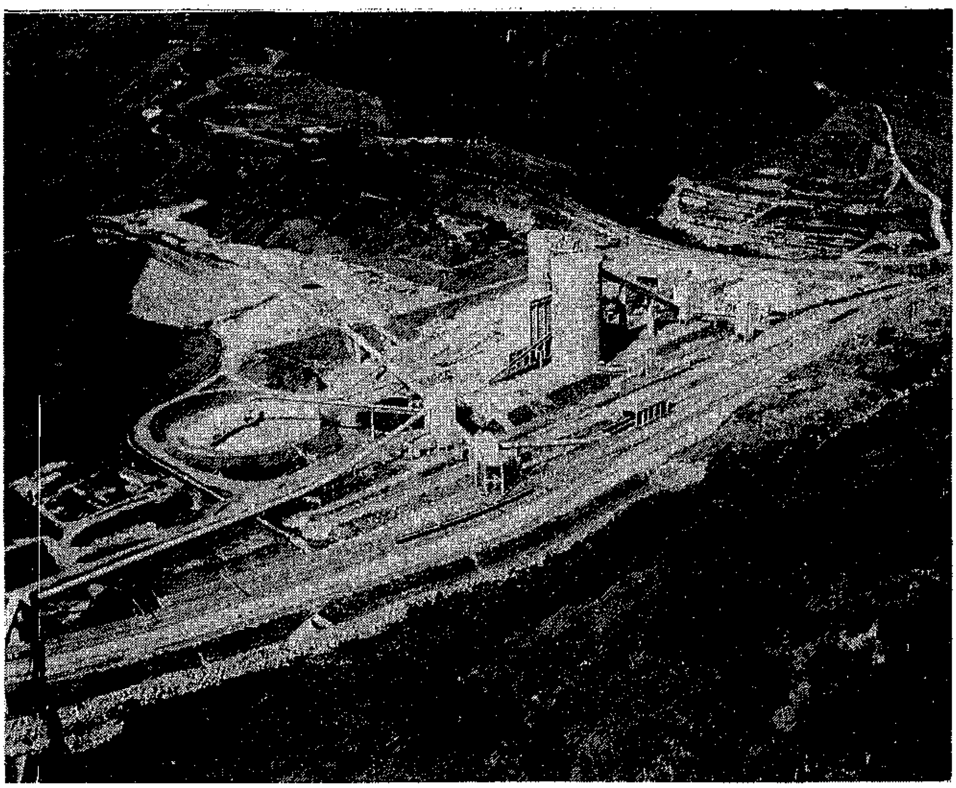


Fig. 2 Aerial view of Simuma works

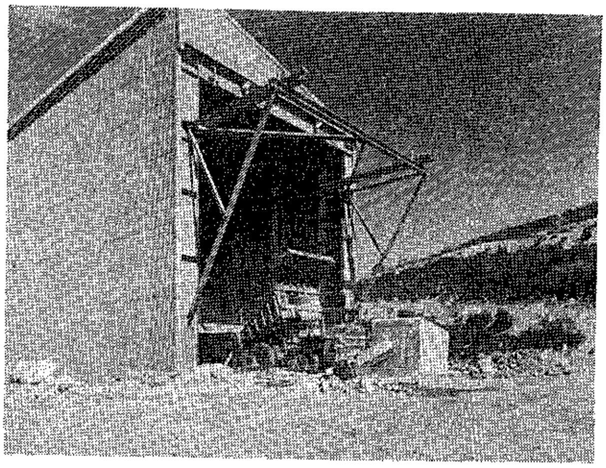
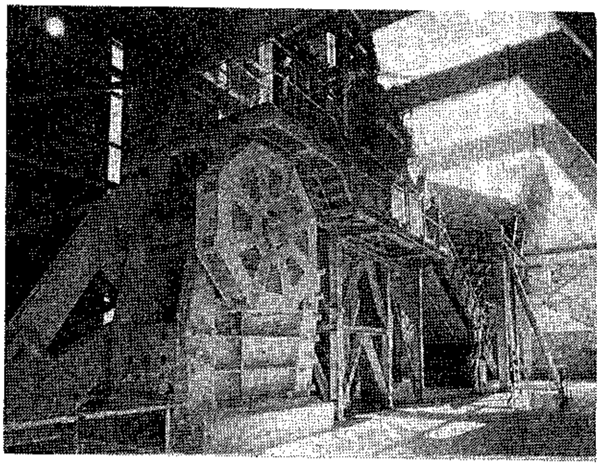


Fig. 6 Reardump truck tips via [illegible]



[illegible]

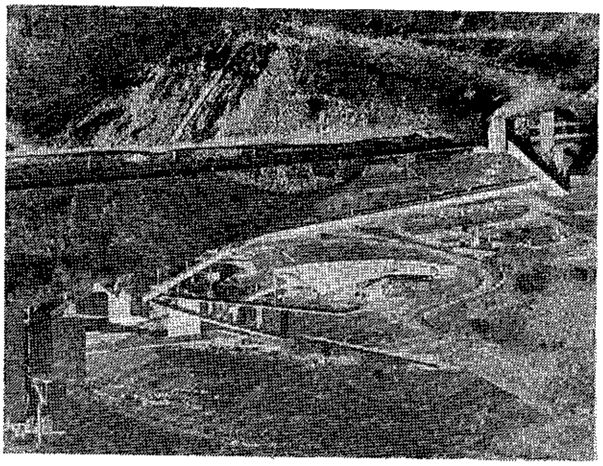


Fig. 8 The lower end of the downhill [illegible]

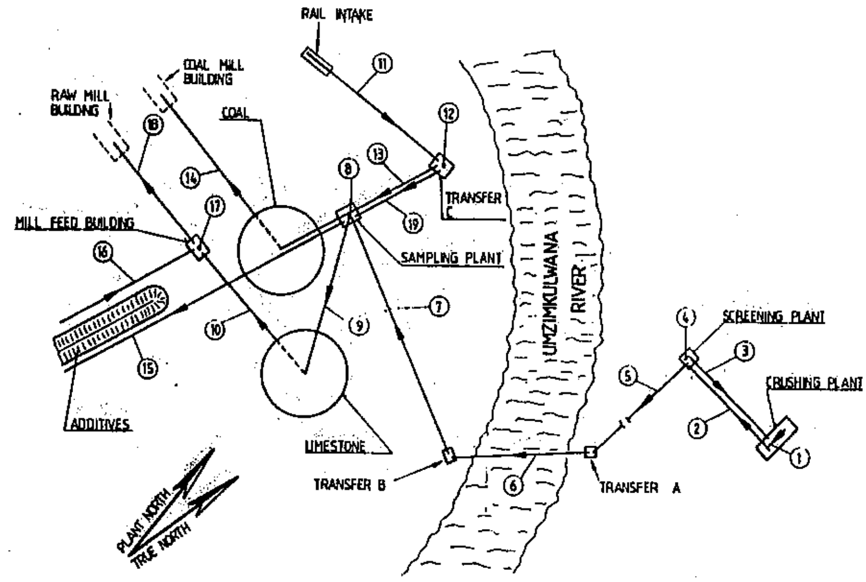


Fig. 3 Plant schematic

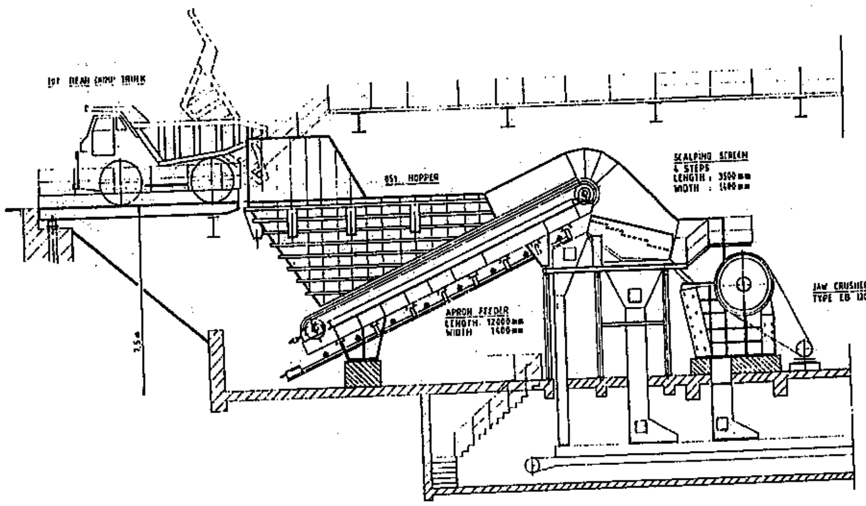


Fig. 4 Primary crushing plant layout

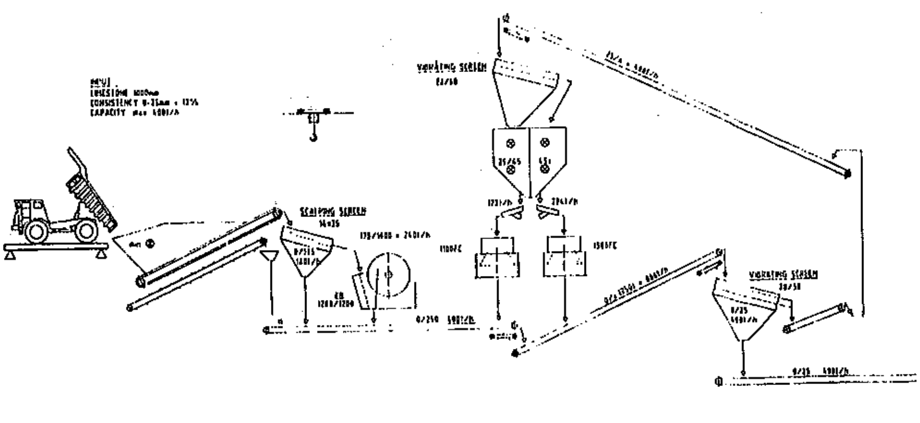


Fig. 5 Flowsheet Limestone crushing and screening plant

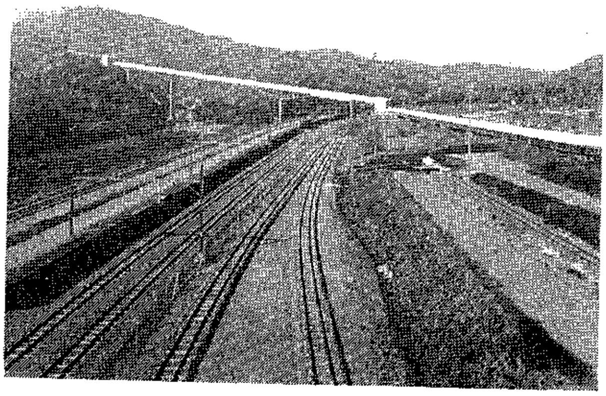
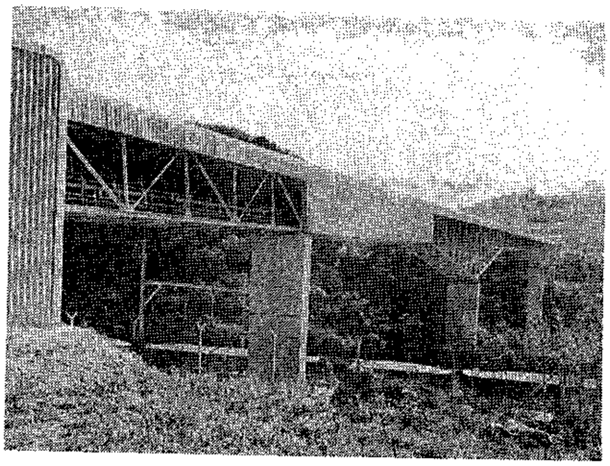
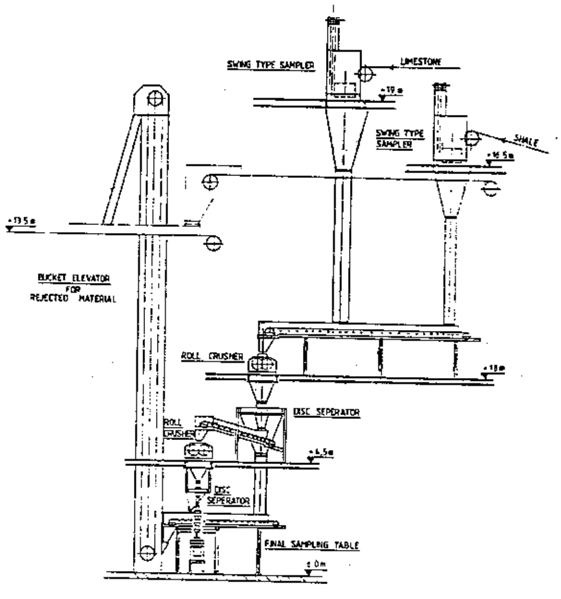


Fig. 9 This 220 m conveyor bridge spans [illegible] river





LAYOUT LIMESTONE AND SHALE SAMPLING PLANT

Fig. 11 Limestone and shale sampling plant layout

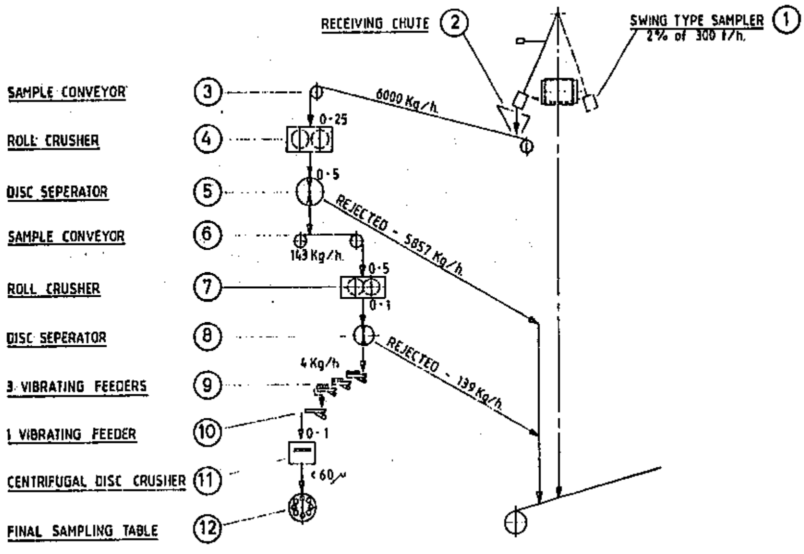


Fig. 12 Limestone and shale sampl[illegible]

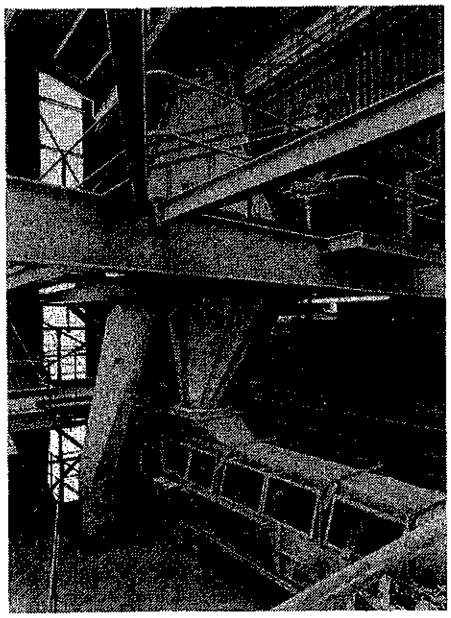


Fig. 13 Swing-type sample cutter in material flow stream

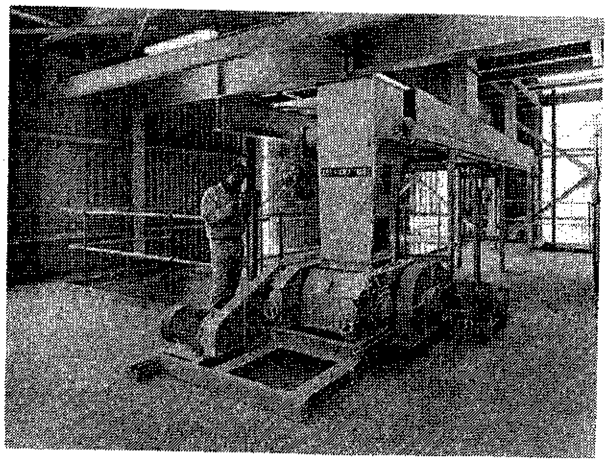


Fig. 14 Roll crusher to facilitate sample splitting

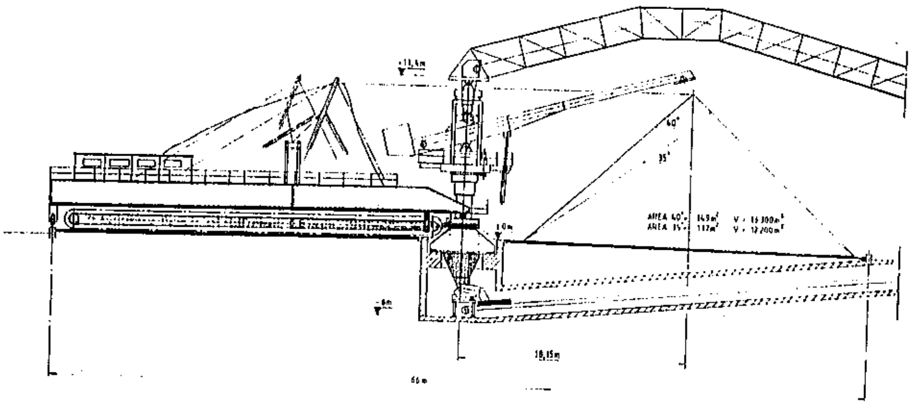


Fig. 15 Arrangement of circular stockpiles

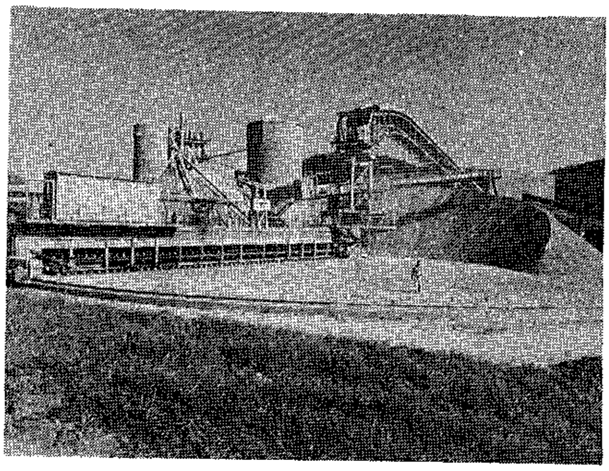


Fig. 16 Circular stockpile for Chevcon stacking

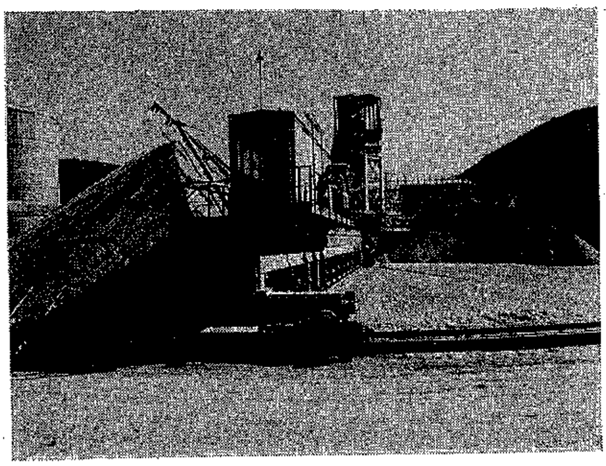
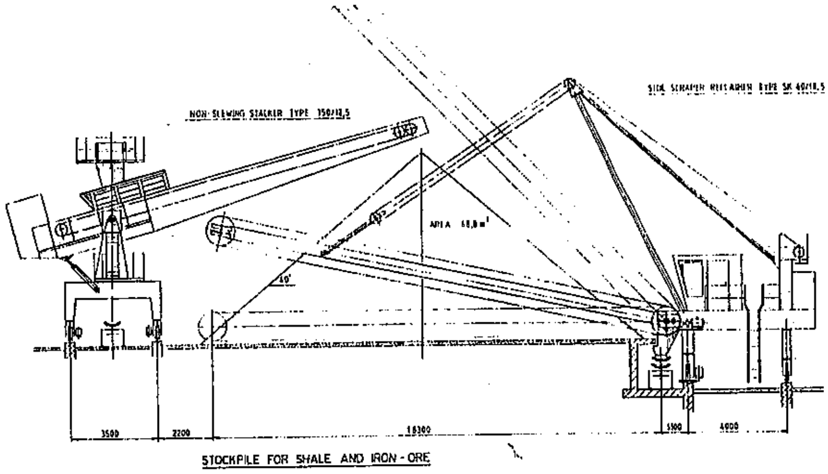


Fig. 17 "Endless bed" reclaiming



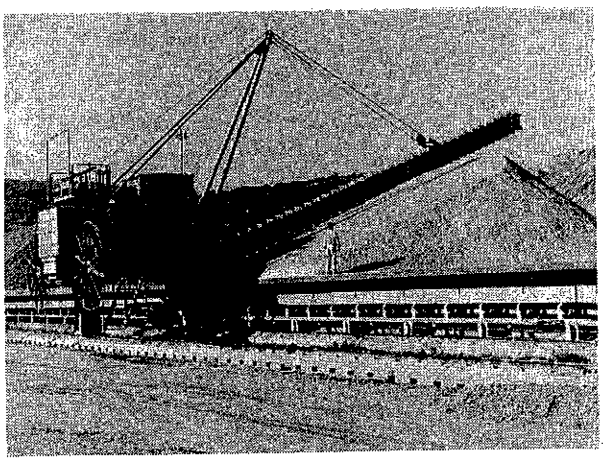


Fig. 19 Side scraper reclaimer for addatives