Mechanized relaying of the coal line

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Synopsis
The major portion of the work comprising Aspect Three of the coal line project is the strengthening of the existing track to carry 26 t axle loads. This requires the relaying of the line from Broodsnysplasla in the Eastern Transvaal to the harbour at Richards Bay, some 500 route km consisting of 770 km of track. Due mainly to the limited time available, the decision was made to do this by mechanized means and the track renewal project was born.

Samevalting
Die grootste gedeelte van die werk waaruit Aspect Drie van die Steenkoollynprojek bestaan, is die verstrekking van die bestaande baan om 26 t aselasting te dra. Dit vereis die herlegging van die lyn vanaf Broodsnysplasla in die Oos-Transvaal tot by die hawe op Richardsbaal, 'n afstand van sowat 500 km bestaande uit 770 km baan. Aan die hoofas van die beperkte tyd beskikbaar, is besluit om van geregenseerde metodes gebruik te maak en die Spoorbaan vernuwingprojek is gebore. Hierdie herleggingsprojek is die grootste wat ooit in Suid-Afrika onderneem is.

Introduction
To meet the coal line project dates, 770 km of track had to be relayed within a period of three years. The existing ballast was simultaneously to be screened and the ballast standard increased. All this had to be carried out under daily four hour total occupations of the track; the track was re-opened to coal train traffic at the end of each occupation. It was decided, based on the above, to carry out the work by contract and to use mechanized methods wherever possible. Many recently developed materials and techniques have been used and many more were developed during the course of the work.

Planning of the project
Employees of SATS and of the plateyaling contractors travelled to Europe to study mechanized relaying work there, and returned convinced that the methods could be applied here.

They decided to divide the work into two portions at Piet Retief on the border between the Natal and Northern Transvaal Regions. The tender for the Broodsnysplaslao to Piet Retief called for the use of either a relaying train or relaying gantries to relay the 320 km of track. The successful tenderer was based on using gantries. In the other tender, for the section Piet Retief to Richards Bay, tenders were restricted to the use of a relaying train to relay the 450 km of track.

Relay train depots (RTDs)
While the contractors were mobilizing their plant, RTDs were built at regular intervals along the line, eight north of Piet Retief and 13 between Piet Retief and Richards Bay at roughly 25 km intervals. These depots are used to stage the machines between occupations, to carry out maintenance on the machines, to receive and sort new permanent way materials and to load released materials for despatch in rail trucks. Emergency stockpiles of new materials were also placed here to supplement the regular supplies during relaying.

Track standards
The relaying is done on a production line basis and work at any point in the track is carried out over a number of days. As this work is done during daily four hour track occupations, on completion the track has to be reopened to traffic in a suitable condition. To do this the following track standards were set:

S30 = Track standards safe for trains to pass at 30 km/h.
S60 = Track standards safe for trains to pass at 60 km/h.
Sf = Track standards safe for trains to pass at full speed.

In order to limit the lost running time of trains and the length of uncompleted track with its obvious dangers, a maximum of 10 km of track could be to the S60 and S30 standard, of which 3.3 km could be to the S30.

Production bonus/penalty clause
Although penalties for late completion of the work are not specified, the contract includes a monthly production clause. The production achieved is directly proportional to the number of occupations of the track, and on the assumption that 21 occupations would be given in a month, a production requirement of 15 km for the relay train and 10 km for the gantries was set. These requirements were adjusted by a factor of Docc/21 each month where Docc = the number of days on which a total track occupation was granted.

A bonus is paid, or penalty deducted, monthly, based on the actual production in relation to the required production at the rates of R150 000 per month for the relay train and R90 000 per month for the gantries.

Ballast
Screening of the existing ballast is carried out as part of the relaying contract, although partly financed by the maintenance account of SATS. Contracts for ballast supplies at points 100 km apart were let so that ballast did not have to be transported further than 50 km. The quarries are near Empangeni, Ulundi, Vryheid, Piet Retief, Ermelo and Broodsnysplasla.

To raise the ballast standard to the required minimum depth of 280 mm below sleepers, an additional 500 m³/km of ballast has to be added to the track. Depending on the amount of wastage at screening and the length of track screened, a daily load of up to 20 AYL trucks containing 720 m³ of ballast is offloaded at each of the contracts.

Sleepers
Heavy-duty concrete sleepers are supplied from factories, one at Vryheid and the others on the Reef. The majority of these are FY sleepers fitted with Fisst type fastenings, the remainder being PY sleepers fitted with Pandrol fastenings. The sleepers are loaded at the factories daily and railed directly to the RTDS.

Rails
60 kg/m chrome manganese rails are received on site in 216 m lengths on special rail trucks and are offloaded ahead of the relaying by simply anchoring the one end of the rail to the existing track and pulling the train out from underneath it.

Northern contract
Broodsnysplasla to Piet Retief
The contract was awarded to Railway and Civil Engineering Construction (Pty) Ltd for completion of the 320 km of relaying within 36 months using gantry cranes. The offer included the following equipment:

- two sets of Donelli gantry cranes
- two ballast cleaning machines
- two tamping machines
- one ballast regulating machine

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THE CIVIL ENGINEER in South Africa — March 1985
two on-track lifting and slewing machines

two rail threading machines

SATS is required to supply all DZ wagons required (normally 13) and two locomotives to haul the machines daily.

Method of relaying using gantry cranes

The normal method of relaying using gantry cranes is as follows:

1. Additional ballast is offloaded to form a bed for the service rail on which the gantries run.

2. The end of the new rail, previously offloaded and lying next to the track, is then placed in a frame attached to a DZ wagon and the wagon is pulled along the track by a locomotive, leaving the rail lying on the ballast bed at the correct centres to be used as service rails for the gantries. This operation is carried out ahead of the relaying, normally a few days before the relaying reaches that point.

3. Once the daily occupation is granted, the existing rails are cut into 108 m lengths, loosened from the sleeper fastenings and moved to the outside of the service rails by a gang of labourers.

4. The gantries, which are transported on trucks, are then placed on the service rails where they straddle the sleepers. Once their beams are lowered, labourers hook the chains into the first 21 sleepers and the sleepers are lifted out of the ballast. The gantries move forward a distance equivalent to 21 sleepers, the beams lowered onto the sleepers, hooked up and the gantries beams raised and the 42 released sleepers moved to the empty DZ wagons at the end of the allotted daily work site, where the sleepers are lowered into a DZ and the chains are unhooked by labourers.

The last gantry to leave pulls a ballast plough, much like a farmer’s scarrifier, along the length of ballast now free of sleepers in order to plough the ballast from between the sleepers to the outside. The gantries then move up and straddle DZ trucks containing new sleepers and 42 new sleepers are attached and lifted.

The gantries return and place the sleepers on the ballast bed, again in two stages, after which labourers place the sleeper pads into position. A rail threading machine follows this operation by placing the new rails on the new sleepers, assisted by labourers who then fasten the rails down.

5. A ballast profiling machine thereafter ploughs ballast back from the sides into the track and a tamping machine tamps and aligns the track to the required S30 standard before the line is reopened to traffic.

6. On the following day the ballast in this section of track is screened by ballast cleaner and again tamped and aligned to the S30 standard before reopening.

7. On the subsequent day, additional ballast is offloaded both to replace the wastage and to increase the ballast standard. And the track is then lifted to approximately 20 mm below design level, tamped and aligned and again reopened to the S30 standard.

8. In the following operation at this point, the rails are destressed within the correct temperature range and welded up. The track is reopened at 60 km/h speed limit. No mechanical or artificial destressing has been done on this contract although permitted.

9. The final operation occurs when the finalizing tamper undertakes the final leveling of the track and the ballast profile is adjusted using the ballast regulator.

10. Many variations to this method have been tried but this is the method which was generally adopted. One of these variations was to screen the ballast before the additional ballast was offloaded, thus preventing the screening of new ballast, but this resulted in the new sleepers being placed on a very disturbed ballast bed, often at a level higher than the design level. To correct this the ballast had to be re-screened anyway. Another method used where possible is to cut the rails into 12 m lengths to pick up the section of track as a panel. These panels are then disassembled in the DZ trucks. This method reduces the cycle time of the gantries, but is only permitted where the rails are to be scrapped or are specifically required in short lengths.

Southern contract

Plet Retief to Richards Bay

This contract was awarded to EC Lenning Ltd for completion of the

Offloading chrome manganese rails

A set of Donnell gantries ferrying released sleepers to DZ wagons. Note the new rail on which the gantries are running

450 km of relaying within 30 months using a relaying train. The offer included the following equipment:

- Matisa P811S relaying train
- Two ballast cleaning machines
- Three tamping machines
- Two ballast regulating machines

Once again, SATS supplied the locomotives and rolling stock. 18 DZ wagons were supplied and modified by removing the sides and ends to form flat top sleeper wagons. Along the top edges of these, rails for the mini-gantries were fixed. Closure rails between the sleeper wagons enable the mini-gantries to run the full length of the sleeper train.

Method of relaying using the relaying trains

The procedure used is similar to that for the gantries:

1. No additional ballast is required at this stage and the rails are laid upright on the heads of the sleepers ahead of the relaying train.

2. Before the start of the occupation, three out of every four sleeper fastenings are removed. Once the occupation is granted, the last sleeper fastenings are removed and the P811-S is brought to the starting point where a specially prepared section of track is cut out and the rails and sleepers removed.

The mechanism for picking up the existing sleepers and the ballast plough are then lowered into the gap. A supporting skid replaces the central bogey of the train and travels along the seats of the old sleepers.

Finally the old and the new rails are fitted into guides and the train begins to move forward.
3. As the P811-S moves forward it continuously feeds the old rails out, picks up the old sleepers and loads them onto a conveyor belt, ploughs out the ballast to form a flat bed, drops the new sleepers onto the ballast at the correct spacing and while 2 labourers place the sleeper pads in position, feeds the new rail onto the new sleepers. Labourers following the train fasten the rail down.

4. As the P811-S moves forward it propels the sleeper wagons ahead of it and the mini-gantries ferry loads of released sleepers to empty sleeper wagons and return with loads of new sleepers.

5. The subsequent operations follow the same procedure as for the gantries except that no tamping is required immediately behind the P811-S since the plough, which is fixed to the machine and adjustable, leaves the ballast bed in an undisturbed condition which is within the S30 track standard.

6. An added feature of this contract is the spraying of bitumen emulsion on sections of poor formation in order to seal and stabilize it, as part of the ballast cleaning operation. This is done using a transverse pipe with spray nozzles, slung behind the ballast cleaner's cutter bar at the point where the formation is exposed. The bitumen is applied to prevent moisture ingress into the formation and appears to be working successfully.

Initially both contractors proceeded slowly in their learning periods, but once they had settled down they progressed steadily. The gantries have relayed 100 km of track in 15 months and at the time of writing had a record month during which 9 km was completed. The relaying train relayed 137 km in the same 15 month period but on three consecutive months relayed 15, 14 and 15 km respectively.

**Replacement of turnouts**

Existing turnouts in the coal line were manufactured from 48 kg/m rail section, which are not strong enough to carry the heavy loads. The replacement of these was included in the relaying contracts although the work is far more labour-intensive. In all, some 170 turnouts have to be replaced on the northern contract and 320 on the southern.

Initially, 57 kg/m rail section turnouts were used but since the first 60 kg/m turnouts came off the production line in mid-1984, these are being used. An additional 60 turnouts in the Vryheid-East and 100 in the Ermeio marshalling yards are to be replaced and will be relayed under a separate contract.

**Tunnels**

Excluded from the relaying contracts were the relaying of the 24 tunnels, totalling 17.5 km in length, which will be carried out under a separate contract.

The S60 rails require the newly developed E3338 chair which is fixed to the track slab on epoxy mortar pedestals. This chair has an eccentric ferrule around the holding down screw, enabling fine horizontal adjustments of 10 mm to either side to be made to the rails.

**Rail planing machine and long rail recovery unit**

Initially it was planned to recover the rails by the traditional method of cutting them into 12 m lengths for loading into DZ wagons and taking them to the flash butt welding depots for reconditioning and re-welding into long lengths. However, by hiring a Passler SBM 140 rail planing machine and a specially constructed long rail recovery unit, a substantial saving is effected. The planer re-profiles the rail crown in the track continuously ahead of the relaying contract, so that when released, the rails can be reused without having to pass through the rail welding depots for reconditioning.

Behind the relaying the recovery unit drags the rails in 106 m lengths on to rail trucks, and these rails are then consigned directly to users who then fit them into continuous lengths again, in secondary lines.

**Conclusion**

Many new materials and techniques have been developed and improved on this project, producing the very high standard of track required for the very long trains and high axle loads planned for this line for the future.

The decision to undertake the track renewal project using the methods described above was a very brave one by the departments concerned, and has been vindicated by the results achieved.

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THE CIVIL ENGINEER in South Africa — March 1985