The specification for this work was:—

"The general character of the masonry to be thoroughly strong and substantial without any superfluous finish. . . . In freestone, the beds and joints to be pitched square and punched sufficiently close to ensure good and even joints of not more than ½ inch in thickness. Stones to be dressed to give vertical joints at least 4 inches in depth, square back from the face."

The quantities of masonry and concrete in this bridge are as follows:—

	Cubic Yards.	£	s.	d.
Concrete	222 @ 23/-	255	6	0
Masonry	865 @ 34/-	1,470	10	0
Bedstones	$22\frac{61}{108}$ @ 108/-	121	17	0
Excavation in foundations	278 @ 1/9	24	6	6
Drybacking	30 @ 6/6	9	15	0
Extra lead on stone	.. ..	493	10	0
Cement	612 casks @ 15/-	459	0	0
Total cost	.. ..	£2,834	4	6

The ironwork for the first four spans of the bridge was sent forward from Pietermaritzburg by bullock waggon.

The main girders for the first span were rivetted together on the ground and lifted into position by means of a derrick. The span was then completed and utilised as a platform on which to build the second one. The main girders of the latter were lifted at one end by the derrick and launched forward into place, and the span completed. The remaining spans were built and launched in the same way. Work was commenced on January 3rd, and finished on May 19th, 1899.

The cost of superstructure was as follows:—

	tons.	cwts.	qrs.	lbs.	per ton.	£	s.	d.
13 spans.. .. each	14	11	2	5	@ £11 ..	2,084	11	0
Transport of 4 spans, each	14	11	2	5	@ 15/- ..	33	14	8
Erection of 13 spans, each	14	11	2	5	@ 65/- ..	615	17	7
Cost exclusive of shipping dues					..	£2,734	3	3

Plate Laying.

The original type of permanent way gave 3 inches of ballast under the sleepers, making rail level 1 foot above formation; subsequently, a lift of 2½ inches was adopted. The rails were taken from the main line, and weighed 45 lbs. per yard; they were in 30 foot lengths.

On the straights, and curves of radius greater than 450 feet, old creosoted pine sleepers were put in, 13 to a rail; but on curves of 450 feet radius and less, hardwood sleepers were used, 14 to a rail. Hardwood sleepers were also used for points and crossings, and in wet cuttings.

The rails were laid throughout to break joint, ordinary flat fishplates were used, and the joints were from ¾ to ⅜ inch, except over high banks, where, to provide for settlement and consequent shutting up of the line the joints were from ½ to ¾ inch.

Small flat cast iron chairs weighing about 6 lbs., and with a clip on the inner side to hold the foot of the rail were used. A trenail on the inside and a dogspike on the outside fastened the chair to the sleeper.

No transition curves were put in, the superelevation being extended on the straight and run out to nothing. The minimum length of straight, between reverse curves, was 100 feet.

The superelevation is as follows :—

Radius (feet).	Cant (inches)	Radius (feet)	Cant (inches)
1000	$1\frac{1}{4}$	400	$3\frac{3}{4}$
500	3	350	$4\frac{1}{4}$
450	$3\frac{3}{8}$	300	5

On curves the gauge was increased as follows :—

Radius.	Gauge.	Radius.	Gauge.
2000 to 1000	3′ $6\frac{1}{4}$″	700 to 500	3′ $6\frac{3}{4}$″
1000 to 800	3′ $6\frac{1}{2}$″	450 to 300	3′ 7″

All curves of 450 feet radius and under were checkrailed, the clearance between running rail and check being $2\frac{1}{2}$ inches. Where the minimum straight occurred between two reverse curves, the guard rails were carried on to overlap.

On the severe grades, "creep" is an element of great importance, and on light lines where the speed of trains is low, the following system is adopted :—On the outside of each rail a hole is bored through the foot and the chair beneath, and a $\frac{3}{8}$ inch coach screw screwed down into the sleeper; on the level these screws are also put in. This arrangement has been found to answer very well, though for trains of greater speed and weight, as on the main line, two or three creep screws per rail are required. The cost of drilling the holes and fixing screw was about $1\frac{1}{2}$d. each.

To facilitate the erection of the bridge over the Dorp Spruit, the rails were laid as far as the first abutment, in June. Afterwards, for the contractor's convenience in building culverts in unapproachable places, they were carried over the Spruit on a temporary bridge, and extended about half a mile.

A start was not made with the plate laying beyond this, till the 4th October, 1898, and then the progress of linking in only averaged about one-fifth of a mile a day. All linking in was done by train. The engine pushed three trucks, one of sleepers, another of rails, and the third of fastenings. When the end of the track was reached, three lengths of rails were off loaded, together with the requisite number of sleepers and fastenings. These rails were placed in position and spiked down, and the train pushed forward. All rails for curves were bent to correct radius in the yard before being loaded up, but it was soon found that whenever he had the chance, the contractor disposed of straight rails also, slewing them over on the track. An inspector was then put at the head of the rails, when the work progressed more satisfactorily. The small progress was partly due to the heavy grades, which necessitated small loads of material, and partly to "green" banks. These green banks were a source of great inconvenience, for, although to allow for shrinkage, the height of all banks had been increased at the rate of 2 inches to a foot, the greater part of the work had been carried out in the winter, and many banks had received no rain at all. The consequence was that after a shower the settling of the earth threw the rails into all shapes, necessitating the lifting and packing of the line again.

In one or two instances the banks were made only just wide enough on top to carry the rails, and carried out to full width afterwards. Most trouble was experienced with banks of shale mixed with clay ; in these, after a shower, the sleepers sank deeply. The best material used for making up banks was a fine red earth.

The immediate result of the train running over green banks, was that they assumed a concave form, and in the heavy down pours of rain which occurred in the rainy season, the water collected on the centres, and percolating through caused many wash-outs.

The rails were to have reached the Umgeni River by the 7th of January, 1899, but owing to the landslips spoken of before, and the bad state of the road—due to the wet weather—on the 2nd of that month they had only reached the summit of the dividing range, a distance of 50,000 feet or a little more than half way. Here progress was again delayed, owing to the non-completion of a cutting. However, on the 11th, the road was clear right through to the Umgeni. The material was now hauled up to the summit by locomotives, and there loaded on trolleys and run down to the rail head.

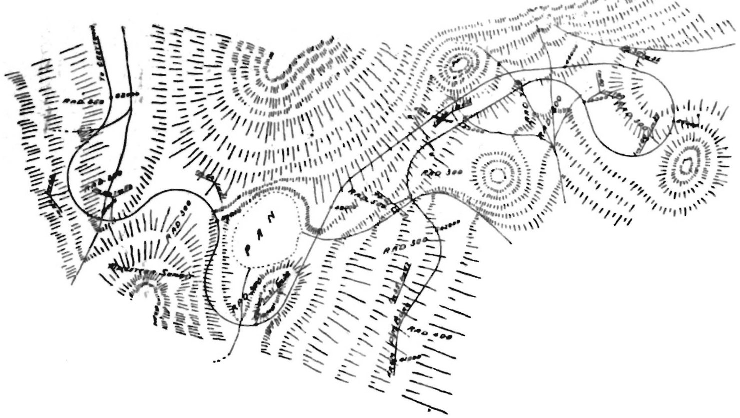
In many of the cuttings in the clay and boulder formation, springs were a great trouble. In the majority of cases, deep drains were cut through from end to end on each side of the line, which was then made good with ashes. In one instance, some large springs broke out in the bottom of the cut, which became a bog ; and after one very heavy storm emitted a stream of water 14 feet wide and 2 feet deep. The bottom of the cut was taken out about 2 feet and filled with boulders, drains were cut through on each side from end to end, and an intercepting drain dug about the middle, at right angles to the line. The road was then lifted with ashes. Difficulty was experienced in getting ballast. At the Pietermaritzburg end of the line a shale quarry was opened, but only about 3,000 yards were obtainable. Later on, another quarry was opened about a mile from the line ; from this ample ballast was obtained.

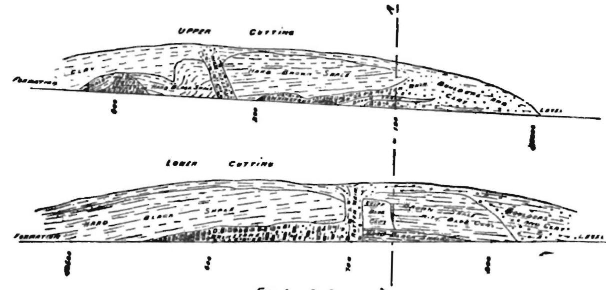
At 13 miles, a seam of ironstone grit was met with, and it was decided to use this as ballast, some 9,500 yards being taken out. The quality however varied greatly, and though the greater part stood well, some became very spongy in wet weather, owing to the presence of clay. After being wet, the whole of this ballast set quite hard. It was used mostly for ballasting on banks over 10 feet in height.

As temporary ballast over banks, sand was used in some instances, but it was found that though standing well in the dry weather, it was quite useless in the wet, the sleepers sinking right through it.

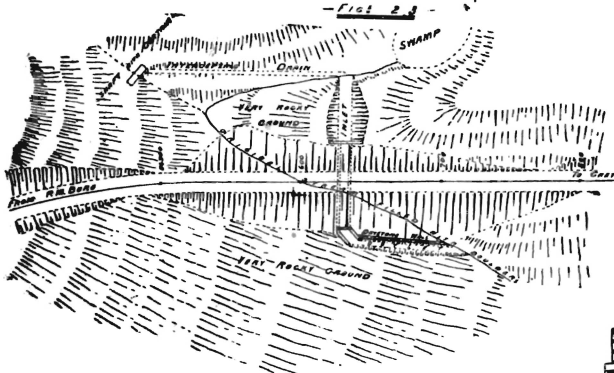
At 15½ miles, another shale quarry was opened up, and provided enough ballast for the remainder of the work. Practically, the whole of the line from Pietermaritzburg to Melsetter Summit, a distance of

— Fig. 1 —

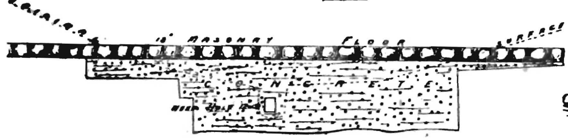


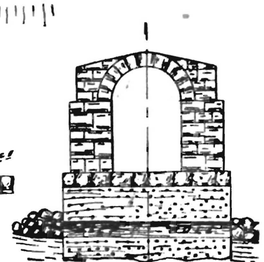


— Fig. 2, 3 —

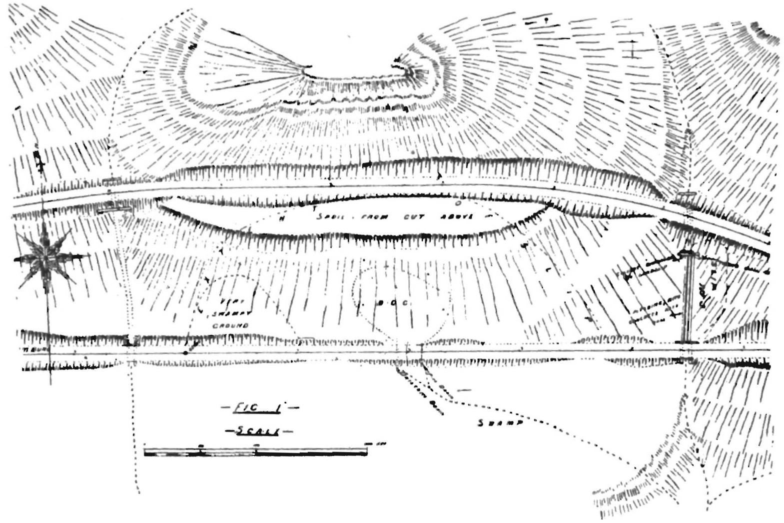


— Fig. 6 —



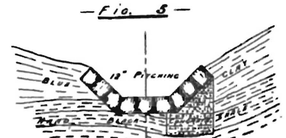


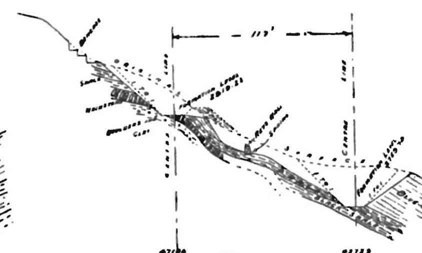
— Fig. 7, 8 —



— Fig. 2, 3 —

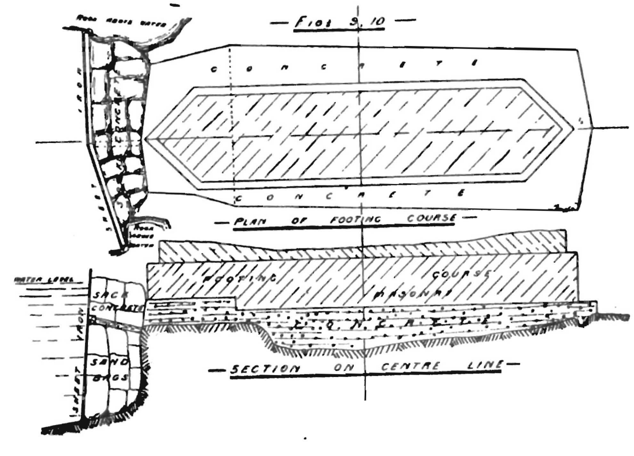
— Fig. 5 —





— Fig. 4 —

— Fig. 9, 10 —



10 miles had to be ballasted with material from the quarry at Pietermaritzburg, and in consequence of the heavy grades, only small loads could be taken up.

The line was opened for traffic on May 10th, 1899, although there still remained some 5 miles of unballasted work, which was ballasted afterwards.

GENERAL.

Water Supplies.

Throughout the route water is plentiful, and no difficulty exists in obtaining efficient supplies. There are two gravitation schemes, with 3 inch pipes, one mile long each, and one pumping scheme, the power being derived from the falls on the Umgeni River, to drive an hydraulic ram.

Stations.

All buildings are of the cheapest kind; wood and iron. At small places a shelter 10 × 8 feet only is built. The platforms are of earth, hardened with shale, and the platform walls are of old sleepers on end, let into the ground, with a 9 × 3 inches deal cap running along the top.

Speed of Trains.

The speed of trains is limited to about 10 miles an hour, 8 up and 12 down. The engines are of a light type, weighing 25 tons; the gross load hauled is 90 tons, and when it is considered that, as before mentioned, from the Dorp Spruit to the summit is a climb of 856 feet in $6\frac{3}{4}$ miles, and of these $6\frac{3}{4}$ miles about $2\frac{1}{2}$ miles are curves of from 300 to 400 feet radius, eight miles an hour is a fair speed.

Grades.

The most severe pull is that leading to the summit. Here, after about $\frac{3}{4}$ mile of a grade of 1 in 30, is a semicircular curve of 300 feet radius on a grade of 1 in 31.

At 4 miles there is a reverse curve of 300 feet radius on a grade of 1 in 30. This is $\frac{1}{2}$ a mile from end to end, but owing to a flatter grade leading up to it, the engine is enabled to rush this curve.

The Author was Junior Assistant Engineer from commencement to conclusion of this work.

The Author's thanks are due to Mr. Cobley, Superintendent Engineer for Construction, and to Mr. Bradford, Engineer in Charge, for their kind assistance in supervising this paper; to the latter he is also indebted for the photograph shewing the trains on the "loop."