Public Works (1895) Department.

RAILWAY BRANCH.

G.O., No. 316 R

DATED 6th May

[Despatch Abstract.]

Through Siding at Washermanpet Station.—Estimate amounting to Rs 11,091 for the proposed —Madras Railway, Sanctioned.

Indexed.

[P. W. 28. 1,000—11-8-19.]

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ARSIKERI-MANGALORE RAILWAY REPORT,

1895.

REPORT.

Preliminary.—(*a*) The survey of the Arsikeri-Mangalore Railway was undertaken under the orders of the Government of India conveyed in notification, Public Works Department, No. 416, dated 27th October 1894.

The object is to establish railway connection with Mangalore, a sea-port on the Western Coast, from Arsikeri, a station on the Southern Mahratta Railway (Mysore section), about 100 miles north of Bangalore. The length of the line has been estimated at 137 miles, but this has been obtained from the length of the road and in the final result it is expected to be about 143 miles, the extra length being due to the gradients necessary for an adhesion-line. The origin of the survey is, an application from Messrs. Kirby and Lonsdale for a concession for the construction of a line from Arsikeri through Hassan to Mangalore with branches from Hassan to Mysore and Chickmagalur and an extension from Nunjengod in Mysore territory through Satya-Mangalur to Erode on the Madras Railway, where it would effect a junction with the narrow gauge system of the South Indian Railway. As a result of these negotiations the survey now under submission was taken up as it really forms the main feature in the schemes proposed.

G.O., No. 619 R., 23rd March 1893.
" " 818 R., 6th May 1893.
" " 819 R., 6th " "
" " 152 R., 10th March 1894.

The primary object is to obtain an outlet for the Mysore State to a port and Mangalore has been for ages the port which has served Mysore. From its situation on the West Coast it is liable for three months every year to the full force of the monsoon and the only routes by which either merchandise or travellers can leave involve a long land journey over roads much cut up during the heavy rain. Mangalore contains a large mercantile population and is a wealthy town and is about the northern limit of the Moplah population who are known to be subject to periodical turbulent out-breaks, and were this to occur at Mangalore from where the garrison has been now removed, it would take at least a week before troops could be brought upon the scene.

Further, the province of South Canara is rich in crops irrigated by the Nitravati and other large rivers which never fail owing to the south-west monsoon, and had transport been available much of the distress in Mysore during the disastrous famine of 1876–77 would have been prevented.

(*b*) The previous reports will be found in the Government Orders quoted above and with regard to them it is only necessary to point out that a very serious clerical error has crept into the report by Mr. McFarlane at page 8 which has led to the hope that a gradient of 1 in 84 would be possible. This results from the level of the road at the Frontier being given as 1,733 feet above sea-level instead of 733 feet, and this error has been carried through much of the subsequent notes.

G.O., No. 2043 R., 20th August 1892.

(*c*) From Arsikeri to Hassan the country is much the same as Mysore generally, open rolling plains with deep depressions and high ridges between the valleys. For these 30 miles the line proposed has been located as far as Hassan by the Mysore Government and the attention of the party was chiefly directed to the portion to be done between Hassan and Mangalore. After leaving Hassan the country falls for some 4·9 miles to the Yagatchi river and after crossing another smaller river rises to Palya on the main road. Beyond Palya the rise continues to a place called Barlo at which coffee land is first met. From Barlo to Saklaspur the fall is 360 feet, the whole of which occurs on the road in the first 4 miles from Barlo and the railway has therefore to take a route to the eastward along the ridges dividing the watershed between the

Yagatchi river and the Hemavati which entails increased length to the extent of $3\frac{1}{4}$ miles. At Saklaspur the Hemavati is crossed by the road on an iron bridge of 4 spans of 120 feet supported on screw piles and immediately to the west of the river lies the town of Saklaspur, head-quarters of the Manjarabad taluk. Saklaspur is situated on the end of a ridge branching out from the actual watershed of the Western Ghâts and along this ridge the road runs too close to the Manjarabad hill on which is an old Fort evidently built to command the pass in former days. The actual ridge of the ghâts between the east and west watersheds runs north at about one mile north of Manjarabad and along this watershed the Mudugherry road has been laid out. Mr. Groves' trace crosses this Mudugherry road at a saddle about 3 miles north-east of Manjarabad and measured directly about $1\frac{1}{2}$ miles from Saklaspur. There is, therefore, a very peculiar physical feature at this point in the fact of a river of considerable volume, requiring to span it 4 spans of 120 feet, running parallel to the actual watershed of India only $1\frac{1}{2}$ miles distant and only 83 feet below the saddle, which has been selected for the proposed railway to pass through for the descent to the western plains.

The reduced level of Saklaspur is 2,960
The reduced level of saddle is 3,043 } Difference 83.

The river on the western face is the YettenhaHe and the road circles under the Manjarabad hill until it reaches a point in the valley 6 miles from Saklaspur where it crosses the Yettenhalle at reduced level 2,628. The reason for this is that the road abandons the Yettenhalle valley and rises in 2 miles 300 feet to cross into the Maranhalli valley and so work through easier country. The actual descent of the road begins only at 11 miles from Saklaspur up to which point the total fall has been only 525 feet. The railway trace sticks to the Yettenhalle valley and falls only 533 feet in a distance of $7\frac{3}{4}$ miles from the ridge, or $10\frac{3}{4}$ miles from Saklaspur, and at this point enters a gorge down which the river rushes in a series of falls. The reduced level at the head of the gorge is 2,480. From this point the 1 in 40 carried out by Mr. Groves for some seven miles began and at first sight it appeared hopeless to get a 1 in 40 line down a valley in which the road falls 1 in 20. Before debouching on the plain the fall of the road becomes very gradual and, in the result to be explained more fully hereafter by economising every foot and utilizing every favourable spur, a line has been obtained which will meet the line in the plains without any loss of direction or deviation to the north. The road ghât ends at a place called Kemphole 18 miles from Saklaspur and has on it only one zigzag of about $\frac{1}{4}$ mile in length, its mean gradient being 1 in 27 throughout, but about 1 in 20 on the steepest part of the descent $6\frac{1}{2}$ miles in length. The frontier is at Marlbid 21 miles from Saklaspur and Seradi; the first village in South Canara is eight miles beyond.

The reduced level at the Frontier is 724.
Reduced level at Seradi is 340.

From Seradi to Mangalore the distance by road is $53\frac{1}{2}$ miles and the average fall of the country is only about 6 feet per mile. But the spurs of the ghâts run into the plains nearly as far as Uppinangadi 32 miles from Mangalore and, though of no height, makes the country difficult to work through as it is densely wooded and each line has to be cut and cleared, only to find that some saddle obstructs the trace and a fresh start has to be made. This has been finally settled by breaking through into the valley to the south and putting the bridge over the Nitravati at a point near Uppinangadi. From Uppinangadi to Mangalore the north bank of the Nitravati is obligatory, for a larger tributary, called the Coomodari, comes in from the south, which would require a bridge as large as that of the Nitravati itself, and the subsequent bridge over the Nitravati at Buntwal would be a very long one.

Through South Canara there are no maps of any reliability, the G. T. maps not yet being published; but all existing maps show the main road from Pani-Mangalore to Uppinangadi as on the north bank, whereas it is on the south bank. The country on the north bank has been found from inspection to be well suited for a railway, except near Uppinangadi, where the location being near, the river is necessarily rough the banks being high and steep. From Uppinangadi towards Mangalore the line has been actually located up to near Sirpadi along the bank of the Nitravati. From Sirpadi to Buntwal a ridge runs along the river which will provide a favourable

location and reduce the provision for waterway. A mile from Buntwal, a large stream is crossed which will probably require three spans of 60 feet. Buntwal stands on a hill on the river bank with flat paddy land behind it, and along this the line will run to the Pani-Mangalore ferry. From this to Feringipet, 9 miles from Mangalore, the road rises and falls a good deal owing to the spurs running down to the river; so, as far as can be seen until the work reaches this place, the best alignment will probably be along the river to Feringipet. From thence the whole alignment will be on paddy land to Jeppo, a suburb of Mangalore where extensive coffee works (Morgan and Co.) and tile works (Basel Mission) are situated. It is also an important market centre and the Civil authorities attach importance to its having a station. From Jeppo into the Salt Cotaurs, the line will skirt the river, some little reclamation being required until it reaches the Salt Cotaurs where it is proposed the station should be situated with an extension along the Bunder to meet mercantile requirements.

(*d*) The gauge is proposed to be the metre gauge, that being the gauge of the Southern Mahratta Railway system and also of the South Indian Railway system with which the other branch lines are proposed to connect it. The group of lines thus proposed would therefore form an important link in the metre gauge system of India, while the line now under survey would give a valuable outlet for the produce of the province.

(*e*) The fixed point is the same as that used for the survey already sent in by the Mysore Government of the Arsikeri-Hassan section, namely, the "centre of the passenger platform of the Arsikeri station of the Mysore section of the Southern Mahratta Railway."

(*f*) The total length of the line is expected to be 143 miles, of which 83 miles lie in the Mysore province and 60 miles in South Canara.

Location.—The actual location of the line has been guided by the results of previous work done and has required much modification. The compensation for curvature too involves not only heavier work in the section but greater length. So far, on the line selected, all the curves have, with a few exceptions, been compensated; but without compensation a very much lighter section could be shown. It is a question whether with a ghât gradient of 1 in 40 intervening gradients of 1 in 100 with flatter curves need be compensated. The result of this season's work points very clearly that the ghât if the grade be reduced to, say, 1 in 40 nett, the curves will be easier in consequence of there being more room further down the hill side on each spur and some of the valleys, notably the Kemphole, will yield better crossings lower down the valley.

Division I.—This division extends from Hassan to Saklaspur and has been under Mr. W. P. Milne, Executive Engineer. The work on the ghât proving too much for the limited staff, Mr. Milne was deputed to survey the upper section of the ghât to ensure, as far as possible, a through section. The junction with the work completed by the Mysore Government was made at a point some 49 chains west of Hassan and the station site selected has been retained in the scheme as now submitted. From what can be seen and from what is known to be the wishes of the Durbar, the site of the station will require reconsideration and there will be no difficulty in getting a more convenient site which will interfere less with existing roads and probably afford a better gradient out of the station. The route follows somewhat the line of the main road to Mangalore and at mile $34\frac{3}{4}$ crosses the Yagatchi river about $1\frac{1}{4}$ miles north of the road. The area drained by the Yagatchi is 373 square miles, which would, according to Dicken's formula using coefficient 1,200, require a waterway of 500 feet. A bridge with 4 spans of 40 feet arches has been adopted, as the road bridge $1\frac{1}{4}$ miles lower down consists of 7 spans 25 feet arches and has stood for over 50 years. It has been necessary to deviate from the line of the road and pass through Alur, an important sub-taluk head-quarters, to which a branch road has been made as the route followed by previous survey through Palya on the main road was not feasible at 1 in 100 ruling gradients. It is proposed to investigate a more direct route from Alur to Saklaspur avoiding the Balol saddle and probably shortening the line and saving a considerable rise. The line laid out has ruling gradients of 1 in 100 which do not quite fully compensate the curves for a 12 feet wheelbase, but on revision there is no doubt this will be obtained and the work very much lightened by slight

deviations from the present alignment. At Saklaspur the Hemavati is crossed on a bridge of 5 spans of 100 feet girders. The drainage area is 230 square miles, while the road crosses on a bridge of 4 spans 120 feet. The extra span has been put in to suit the channel and avoid a high bank subject to flood. On the west bank is the station of Saklaspur, the head-quarters of the Manjarabad taluk and an important town, as, near it, roads converge from the Mudugherry and Coorg directions. From Saklaspur to the actual ridge which divides the watershed of India is only 2 miles distant from the Hemavati and the rise only 53 feet.

Division II.—The second division, Saklaspur to the Frontier, has been under Mr. Lilley, Executive Engineer, but the work was so far in excess of what was possible with the limited staff that Mr. Milne's work was stopped in March and he was sent to run the upper six miles of the ghât from Saklaspur to the Yettenhalle crossing. The Hebsalaridge referred to as the actual watershed carries the Mudugherry road which crosses the railway by an overbridge and the upper descent of the ghât begins. The route down the valley is necessarily tortuous with minimum curves of 10° or 573 feet radius and gradients 1 in 66 and 1 in 51, all fully compensated. The Yettenhalle bridge is reached at mile 64¼ and at a reduced level of 2,627. The main road here ascends and the railway follows the course of the river as far as the 67¾ mile, where it enters a gorge by a tunnel 140 yards rendered necessary by a bend in the stream. At this point the reduced level is 2,480. From this point the lower ghât begins and it has been carried out at a gradient of about 1 in 52, which fully compensates for all curves, so that the gradient should be more properly described as 1 in 40 compensated. From the original trial line run by the Mysore Government it was evident that, without special expedients to gain base, the line would be carried north along the face of the ghât and that owing to the steep beds and continually narrowing valleys the crossing of them would be most difficult. It was therefore arranged to circle two spurs twice, which has resulted in the necessary base being obtained about two miles. The lower ghât contains numerous viaducts and tunnels which the sharp spurs and narrow valleys necessitate. For the viaducts a tentative design has been taken consisting of trestles and 40 feet girders, longer spans being inadmissible on account of the curves. It is clear from this season's work that it would be impossible to cross the Kemphole river at any point further up stream than the crossing now proposed and that the adoption of a steeper grade would place the line more favourably in the valley for crossing. The minimum curve has been maintained at 573 except in a few instances where sharper curves were absolutely necessary. It was considered better to get the line through and establish a good base for the next season's work than to delay trying to get in easier curves which would vastly increase work. The line is now within some 3 miles of the frontier and it will run out close to the Kabbanhalli bridge. The gap at this point unsurveyed, is estimated at 10 miles, of which 8 are on the ghât.

Division III.—The third division, Mysore frontier to Mangalore, has been under Mr. Farewell, Temporary Engineer, who was instructed to begin at Seradi pending the completion of the ghât, as it was doubtful where it would work out. This has proved a very difficult piece of country, there being no maps available of any reliability. One map 4 miles to the inch, dated 1827, is very inaccurate and the more recent surveys are not yet published. The line follows the Kemphole river till it bends to the south when it continues east and crosses the Perisaunty saddle which divides the watershed between the Kemphole and Nitravati rivers. The original trace followed the Ooperhalle, a tributary of the Nitravati, but many trial lines proved it was best to avoid this and tending to the south reach the Nitravati near Uppinangadi, which gives a considerable saving in length and avoids much steep and broken country. The spurs from the hills run out as far as Uppinangadi and the ravines are deep and tortuous, so that a line down the Ooperhalle is not at all a favourable one. The whole country is densely wooded and each line has to be cleared which hampered the work. Crossing the Nitravati about 1 mile above Uppinangadi, the line follows the north bank to Sirpadi, which is about 25 miles from Mangalore, but no map exists from which this can be ascertained. From where the work has stopped near Sirpadi, the country is open and easy and the fall into Mangalore very slight.

The whole project, as now submitted, will, on detailed revision, be much reduced and, where necessary, steps will be taken to secure extra length for compensation of gradients on curves.

Alternative Routes.—The only alternative route which suggests itself is that from Alur to Hulsulige near Belagode about 5½ miles from Saklaspur, but the country does not appear promising as it is much broken. This will, however, be taken up at once.

The other ghâts, namely, the Boon or Charmadi ghât on the north and the Bisley ghât on the south, have been apparently condemned as unsuited to a railway and there is no doubt that two-thirds of the Mangalore trade follows the Seradi route. Arrangements are being made to send out a party at once to see if any improvement can be effected in the alignment already selected by the Mysore Government between Arsikeri and Hassan. In some places the route seems from the section to be unnecessarily tortuous, and it would be perhaps a lasting advantage to straighten some parts, even though it did involve extra work. The portion referred to is at miles 5 to 15, where the plan shows the line running through mountains and the section at these points only exhibits small cuttings. It is quite possible that the plans do not correctly show the depressions of the valleys, but it has been impossible to go over this portion, as the plans were only received from the Mysore Government in July and the whole staff were engaged on their own division till the end of May.

One other point to which attention must be given is the alteration of the site of the station ground at Hassan previously referred to.

Gradients and Curves.—Above the ghât and below the ruling gradient has been taken at 1 in 100 compensated and the minimum curve at 6° or 955. On the ghât the grade is 1 in 40 compensated, which works out to about 1 in 52. On the sections submitted, the compensation has been calculated for each curve on the 12 feet base as given in the published diagram and a through grade shown. It is not considered that this will materially affect quantities and with so many curves the frequent changes of gradient would have greatly increased the work of reduction on the sections. In one case, on the first division, Hassan to Saklaspur, there is a gradient 1 in 100 which is uncompensated, but this will, it is believed, be eliminated by the proposed alternative route.

On the ghâts the gradients have all been compensated; but it adds very greatly to the length, about 4 miles.

The curves have been kept as far as practicable at the minimum radius; but in two cases it was necessary to put in 350 curves, 7 curves 400, 6 curves 500. As before mentioned, with the grade reduced to 1 in 40 or 1 in 45 nett and a minimum curve of 500 feet, a greatly reduced section would result and the tunnels diminished.

On the third division, Frontier to Mangalore, the ruling gradient has, in all but two cases, been compensated and in revision this will be effected. The minimum curve has also been obtained, but on the plans sent in there is one curve of 570 feet radius which will now be altered. Five curves of 716 also appear on an alternative line adopted, which will all become 955 radius on revision. For the remaining 25 miles the curves will all be easy and the gradients very slight.

Construction and Engineering.—(*a*) The general character of the work may be described as heavy both on the Mysore plateau and below the ghât, while the ghât on account of its very sudden fall is much broken up by deep ravines which make the section heavy.

(*b*) The lineal feet of waterway is as below:—

		FEET.
I Division,	Hassan to Saklaspur	59 per mile.
II „	Saklaspur to Frontier	179 „
III „	Frontier to Mangalore	75 „

The total lineal feet of waterway is—

	Minor.	Major.	Total.
I Division	493	1,460	1,953
II „	728	2,080	2,808
III „	987	1,960	2,047

and the average cost per foot run works out—

	Minor. Rs.	Major. Rs.	Rate over all. Rs.
I Division	419	321	346 per ft. run.
II „	585	404	457 „
III „	434	363	400 „

These rates are admittedly high and will probably be reduced. Arches have been adopted wherever possible instead of girders, and except for the larger bridges, the

quantities have been taken from stone's tables. On the ghâts the bridges are very high, the slopes are so steep.

There are in all 21 tunnels which aggregate 6,955 feet or 2,318 yards. No difficulties are expected, as it is believed that all tunnels will be hard and foundations rock except the Hemavati, where wells are proposed.

(*c*) Fencing has only been provided at stations. It is considered that a live fence in the climate, both above and below ghât would be successful, but no provision has been made for through fencing.

(*d*) The permanent-way proposed has followed the proposals of Messrs. Kirby and Lonsdale and is 50lb. per yard above and below ghât and 60lb. per yard between Saklaspur and Seradi. The sleepers proposed are teak, to be obtained either from Karwar or Burma. Timber sleepers, it is thought, are best suited to such a damp climate.

(*e*) Platforms have only been provided at Mangalore and Saklaspur.

(*f*) It is proposed to have running sheds at Saklaspur and Mangalore on the supposition that Saklaspur to Seradi will be worked as a ghât section and each of these will have a small workshop for minor repairs. It is presumed the Southern Mahratta Railway will work the line and effect repairs at Hubli or Bangalore.

(*g*) Water-supply for engine sheds and stations will be from wells except at crossing stations on the ghât where the perennial streams will be led into tanks relieved by an overflow pipe.

(*h*) The engine-changing stations prposed are—

Arsikeri	0	
Saklaspur	57½, run	57½
Seradi	90 „	32½
Mangalore	143 „	53

and it is thought that twelve engines would suffice, four of them being special ghât engines with short wheel base.

Labour and Materials.—Labour will all have to be imported from the Deccan, as what little labour is available is all engaged on the coffee estates. The country is very sparasely peopled in Mysore; on the ghâts the villages are few and from Marnhalli, near the 68th mile to Seradi, there are scarcely any inhabitants, the country is so unhealthy. There will be great difficulty in carrying out the work on this portion, the natives dread the locality so much.

Materials of excellent quality are available, but the leads for stone in South Canara will be long. Gneiss only occurs in places and the laterite has proved useless for building purposes.

Throughout the whole distance there is an excellent road from which most parts of the line could be reached, some will, however, be very difficult of access till the formation is made.

Wood fuel is available in any quantity in South Canara and on the ghât.

It was hoped from the magnificent appearance of the South Canara forests that they might be made to yield a good supply of sleepers, as teak is plentiful in the neighbouring collectorates, but the forest officer's note holds out no hope of this. Sleepers for current renewals of a wood called bhogi, and which is believed to be the same as pyangadu or akin to it, will be always available and by the time renewals are required the development of the forests may have so increased under careful conservation as to yield enough to make South Canara a future source of supply for sleepers.

Arrangement of staff.—It is proposed to locate the head-quarters of the Engineer-in-Chief and Examiner in one office at Bangalore, where accommodation can be obtained, and so avoid more temporary accomodation on the line.

Direction.—

1 Engineer-in-Chief.
1 Assistant Engineer Personal Assistant.
1 Head Clerk.
1 Head Draftsman.
6 Clerks.
3 Assistant Draftsmen.
Jemadars, peons, menials.

For purposes of construction it is proposed to divide the whole length of 143 miles into 3 divisions—

	Length.		Head-quarters.
I.	0 to 58·3 miles	58·3	Hassan.
II.	58·3 to 83·5 „	25·2	Saklaspur.
III.	83·5 to 143 „	59·5	Mangalore.

In each division three sub-divisions are proposed and the head-quarters of the Assistant Engineers would be—

I	II	III
1. Arsikeri.	1. Saklaspur.	1. Siradi.
2. Hassan.	2. Marnhalle.	2. Uppinangadi.
3. Saklaspur.	3. Kemphole.	3. Buntwal.

The subordinates would be—

I	...	...	3 Upper, 6 Lower.
II	...	...	6 Do. 6 „
III	...	...	4 Do. 6 „

The extra subordinate allowed for the III Division will be required at Mangalore for the extra work along the foreshore, where some amount of reclamation will be required in connection with the approaches and Bunder lines.

The office establishment proposed for each division is—

1 Head clerk.	4 Tracers.
3 Clerks.	3 Sub-divisional clerks.
1 Cashier.	3 Time-keeper writers for upper subordinates.
1 Draftsman.	

The following extra skilled establishment is proposed:—

2 Permanent-way platelayers.
6 Permanent Sub-Inspectors.
2 Girder erecting foremen.

The Accounts Establishment—

1 Deputy Examiner.	3 Divisional Accountants.
4 Accountants.	3 Do. Accountant's clerks.
8 Clerks.	

The Stores Establishment—

1 Storekeeper, Arsikeri.	3 Divisional Storekeepers.
1 Assistant Storekeeper, Mangalore.	1 Permanent-way Storekeeper.
2 Sub-Storekeepers, Mangalore.	10 Clerks.

The Medical establishment will, owing to the unhealthy nature of the climate, be as follows:—

	Apothecaries.	Hospital Assistants.
I Division	3	1
II „	3	1
III „	3	1

(*a*) For traffic no special provision during construction will be necessary, except a few signallers and pointsmen, who would be charged to works—

(*b*) The estimate contains provision for temporary quarters and offices for each division with the exception of those stationed at Mangalore, which being an abandoned cantonment, contains a number of bungalows now vacant which could be

utilized for residences and offices. At none of the other stations through which the line passes is there any accommodation available. The only place where European bungalows exist is at Hassan and these are now fully occupied by the Native officials of the State. Hutting for workmen where necessary will be charged to works. This is only likely to be required on the ghât.

(*c*) The plateau of Mysore, that is as far as Saklaspur, is healthy, but the ghât is very feverish and at Kemphole the foot of the ghât reduced level 876·62 travellers were always warned against sleeping there. The Survey Staff suffered severely and had to be withdrawn to a higher level in April. Down as far as Uppinangadi the whole country is feverish and unhealthy, and this is the reason for including such a large Medical staff. During the monsoon all work on the ghât will necessarily be suspended, the rainfall being as heavy as 290 inches at Marnhalle, where the rain breaks on the face of the hills; 10 miles inland it is only 80 to 90 inches. During this season therefore and during the most unhealthy months the labour would be probably withdrawn to work on the Mysore plateau and in the lower plains of South Canara. The upper and lower sections of the line could be rapidly completed, but the ghât will require three to four years for completing. The Medical staff will be supplied with temporary quarters, dispensaries and shed hospitals charged to works.

Relations with the Public, &c.—(*a*) The route selected passes through no military cantonments or camping ground and in no place does it interfere with any public buildings, temples or mosques. At the very end of the current season's work a small Mussulman graveyard is passed through, and it is unfortunately at a place where it is difficult to avoid it. This will have consideration in the revision of the line. The only bridge which might be made available for artillery if considered necessary is the Nitravati near Uppinangadi which would save guns having to cross two ferries, but would entail a longer route through Beltinangady.

(*b*) The index plan through Mysore has been submitted to the Durbar, who state that they have no suggestions or criticisms to offer. At Mangalore the Collector was consulted and he approved of the site selected for the station. The original site was in the heart of the cantonment, a mile further on and 100 feet higher, which would have meant a heavy grade and an expensive line. The new site is in every way more convenient and less expensive. The districts of both Mysore and South Canara are well supplied with good roads and well bridged and no adaptation of railway bridges for cart or passenger traffic seems to be required.

(*c*) No case of interference has yet occurred with religious edifices and none are expected to occur.

Land.—The line passes through a poorly cultivated country alternating between waste, dry cultivation and a little rice under irrigation until mile 47 is reached where coffee cultivation begins and down as far as mile 68 the line runs through occasional patches of coffee. The lower ghât is all forest and so is the country down to Uppinangadi where there is a good deal of rice. From thence to Mangalore the land is about half waste, half rice. A through rate has been taken of Rs. 40 per acre, which it is thought, will cover all compensation.

Traffic and statistics.—(*a*) The traffic statistics of the Arsikeri station on the Southern Mahratta Railway are given in the report submitted with the estimates for the Arsikeri-Hassan section by the Mysore Government, and the station contains ample accommodation for the proposed branch. The stations proposed are—

Talur at 3¾ *miles.*—This is the site of the Harnhalli gold mine and is close to the Harnhalli village. The mine so far has not been very successful.

Bagde at 15¼ *miles.*—Is a moderately large village with an old fort.

Dudda at 19 *miles.*—A large village with an important market.

Hassan at 30 *miles.*—Is the head-quarters of the district and contains the Deputy Commissioner's Court. It is not a town of mercantile importance, but is the suggested junction for the branch to Chickmagalur and the connection to Mysore.

Allur at 37¾ *miles.*—A market town and taluk head-quarters.

Barlo at 47 *miles.*—An unimportant village at the beginning of the coffee tracts and the junction of a road from the south leading to many coffee estates. This may be left out if the new alignment from Alur to Hulsulige be successful, in which case Belgod would be the site for a station instead of Barlo.

Hulsulige at 53 *miles.*—A coffee siding to serve the important group of estates near this. The position is not quite the most convenient for the planters, but it has been placed here on account of the grading. This will be adjusted on revision.

Saklaspur at 58 *miles.*—Taluk head-quarters, is a small town on the banks of the Hemavati and is expected to be the most important station between Arsikeri and Mangalore. It is proposed as a changing station for engines, and full provision has been made for staff quarters. Its elevation is 2,960 and the site of the staff quarters will be about 3,000 feet. For traffic it will be the centre for the coffee from Mudgere direction and the Coorg frontier.

Hebsala at 60¼ *miles.*—This is only a coffee siding for the receiving of coffee and delivery of manure, &c.

Yettenhalli at 64⅓ *miles.*—This also is only a coffee siding to suit the estates on the Marnhalli and Manjerabad spurs.

These coffee sidings would only be open during the busy season and would be worked under the Saklaspur station.

Marnhalli Gorge at 67¾ *miles.*—This is a proposed ghât-changing station, but it might be left out as it propably would be better to work the ghât engines right into Saklaspur.

Kardamonihole at 74½ *miles.*—This is a proposed siding for watering and crossing. The stream is perennial and the ascending train could back into the siding and water, while the descending train passed on.

Kemphole at 79¼ *miles.*—Watering station.

Seradi at 90½ *miles.*—A small unimportant village; proposed engine-changing station.

Golitattu at 101½ *miles.*—The station is about 1½ miles south of the village. It is expected to afford a considerable grain traffic.

Uppinangadi at 111½ *miles.*—The station is situated on the north bank, while the village is on the south bank, but the civil authorities do not consider this a disadvantage. A considerable grain traffic is expected. Putthur, the Tahildar's head-quarters, is 7 miles south.

Serpadi at 120 *miles.*—A large village with extensive cultivation at present entirely dependant on board carriage, there being no roads.

Buntwal and Pani Mangalore at 127½ *miles.*—These two villages are on the north and south banks, respectively, and are where the ferry is across the Nitravati. Large boats ply from here to Mangalore and are likely to compete with the railway for traffic.

Feringipett at 134½ *miles.*—A large village in the middle of much cultivation.

Jeppoo at 141½ *miles.*—A large village where the Basil Mission tile works are situated and also Messrs. Morgan's very extensive coffee cleaning works. It is also a large market and the civil authorities attach importance to a station being placed here.

Mangalore at 143 *miles.*—The terminus has been fixed at the Salt Cotaurs. A separate note on the port is in the appendix.

(*b*) The statistics regarding coffee, which is the principal product, have been treated separately and the general traffic prospects has been kept as low as possible to avoid any chance of over-estimating. The bulk of the traffic will certainly be towards the port, but if the improvements in the port are carried out an inwards traffic from Bombay by sea may be certainly expected. European merchants who have been consulted think differently. Some believe the opening up of Mangalore will change the direction of traffic, while others do not. North Mysore planters say that it will not benefit them, but there is a general idea among them all that unless the railway pass through their own estate it is to their advantage having once loaded in carts to cart the coast. Others think differently, but it is a fair assumption that so surely as the cart has with the improvement in roads entirely superseded the pack-bullock, so will the railway supersede the cart.

Local traffic is all that has been considered in the estimate, through traffic cannot be estimated, but the steamer agents feel very certain that it will be a very large one.

The pilgrim traffic to Sringeri is stated to be very large, but until the Chickmagalur line is made it must be regarded as a very doubtful factor in considering the passenger traffic, as pilgirms would be more likely to travel *viâ* Kadur on the Southern Mahratta Railway and walk to Sringeri.

From all that can be learnt there is no doubt that this line is much desired and that it is a line which will gradually grow in importance and become in time a remunerative line. It will never be an important trunk line and the ghât section may therefore be constructed with sharper curves and steeper gradients and worked as a special section without any risk of its hampering in the future by reason of this, the financial results of a great system. It must be regarded as an important outlet to the sea for the Province of Mysore and part of the Presidency of Madras, and when all the connections are made, an important link in the narrow gauge system of India.

General Remarks.—The only railway with which this can be compared is the Holkar Railway, the ghât is longer and more difficult and the rise very much greater, but the estimate as submitted compares favourably with the published statement of the cost of that railway. It is also to be remembered that, while the ghât section is heavier than the Vindhya ghât, the sections in the plains above and below ghât also are heavier than any portion of that railway.

The plans now submitted show all but the 10 miles gap at the foot of the ghât which has been fully allowed for in the estimate, and the 25 miles to Mangalore from Serpadi which has not yet been completed. The point on which the cost of the line chiefly depends is the ghât and if the grade be steepened, say, to 1 in 40 net and a curve of 450 or 400 feet radius adopted and it be made a special ghât section with special engines, its cost will be vastly reduced. Taking the length of the ghât over the lower section, beginning at 67·75 and ending at 88·4, a distance of 20·65 miles, the compensation for curves on the assumption that it will be 1 in 52 throughout the whole length gives an increased length of 5·63 miles. Above this section the compensation does not affect the length at all, until the 1 in 100 section is reached.

Staff.—The staff employed have been most zealous, and Mr. Lilley especially deserves all praise for his indomitable perseverance in the Kemphole valley, where day after day, the whole camp was fever-stricken and work was quite impossible. Messrs. Milne and Farewell were more fortunate, but all were out until the end of May. The staff was far too weak numerically for such an undertaking, and temporary men would not accept work in the Malanad district. Of the four permanent subordinates sent, two were in bad health, but all worked excellently well. Sergeant Blakebrough came in April quite unfit for work. For the next season's work two Assistant Engineers, either permanent or temporary, are necessary for the ghât and three more subordinates.

If it be desired that work begin, it could be opened out over 80 miles at least in January and the rest in a few months later.

A revised estimate is under submission for the entire completion of the survey and preparation of the final estimate.

The Rack.—It has been impossible to take up the rack section alternative this season owing to deficient staff, nothing but a very sketchy trial line has been run which gives a very heavy section. This must be gone over carefully before any report can be made or estimate framed. In length it will not save much and in cost but very little. It will consist of about $2\frac{1}{4}$ miles of 1 in 10 and $3\frac{1}{4}$ miles of 1 in 25 and cease at or near Kemphole, where it will probably join in with the past season's line. The maintenance of a rack line with such rainfall is a serious consideration.

Note on Estimate.

The estimate submitted amounting to Rs. 1,69,62,253 represents the probable cost of constructing the 143 miles of railway from Arsikeri to Mangalore or Rs. 1,18,617 per mile. The increased cost of the line is due to the ghât section 25·2 miles in length which is estimated at Rs. 2,36,047 per mile. The estimate includes the work from Arsikeri to Hassan already estimated for by the Mysore Government.

When the plans and estimates were received from the Mysore Government in July no detailed estimates were sent, but it was apparent from the printed estimates that under the head of bridge-work, a serious error had crept in. Applying the test of cost per foot run it was found that—

Major bridges 1,188 feet run cost Rs. 68·5 per foot.

Minor bridges 1,064 feet run cost Rs. 141 per foot; in order therefore to bring the bridging up to its probable cost, the estimate has been increased up to Rs. 250 per foot run in each case which gives an increase of Rs. 3,31,503.

Ballast and permanent-way have been increased by Rs. 1,34,881 to provide 50 lb. rails instead of $41\frac{1}{4}$ lb. in accordance with Messrs. Kirby and Lonsdale's proposals. Under other heads the cost has been increased to assimilate it with the portion now under survey. The whole increase is Rs. 7,73,967 which increases the cost per mile of this Arsikeri-Hassan section from Rs. 66,049 to Rs. 91,803.

The estimate for the remainder has been calculated from the plans and sections submitted and the two gaps not yet surveyed taken into the estimate at a proportionate cost head by head. Excluding the ghât section, the cost averages Rs. 97,478 per mile.

Preliminary Expenses.—This amounts to Rs. 2,02,522 and includes Rs. 22,602 already spent by the Mysore Government as well as the estimated cost of completing the survey. The original estimate was Rs. 643 per mile, but the country was not known by those who prepared the estimate and the greater portion has been assumed to be open plain country, whereas it is not.

Land.—Land has been taken at 20 acres per mile at a rate of Rs. 40 per acre which, considering the large amount of waste land, will, it is believed, allow a sufficient margin to compensate for interference with coffee land.

Formation.—The cost of formation is Rs. 61,07,850 or Rs. 42,702 per mile, which is due to the heavy work on the ghât on which division the formation alone costs Rs. 1,29,271 per mile. This will undoubtedly come down on revision, but it would be vastly reduced if the ghât were made a special section with curves of 400 feet and a gradient of 1 in 40 net as suggested in the report.

The rates by sections are:—

	Per mile. Rs.
Arsikeri to Hassan	28,254
Hassan to Saklaspur	21,153
Saklaspur to Frontier	1,29,271
Frontier to Mangalore	23,558

On the ghât there are 6,955 lineal feet of tunnels which works out to Rs. 63,160 per mile.

Bridge-work.—As before explained, the original estimate for the first section has been increased and this gives the mileage rates—

	Per mile. Rs.
Arsikeri-Hassan	18,734
Hassan-Saklaspur	16,330
Saklaspur-Frontier	55,981
Frontier-Mangalore	27,977

These rates per mile seem fairly to follow the feature of the country and the rainfall.

Fencing.—No remark.

Electric Telegraph.—Construction purposes only.

Ballast and Permanent-way.—The estimate follows the proposals of Messrs. Kirby and Lonsdale for 50 lb. rails above and below ghât and 60 lb. rails on the ghât, the mileage rate for which averages throughout Rs. 21,674.

By sections the rates are :—

	Per mile.
	RS.
Arsikeri to Hassan	21,832
Hassan to Saklaspur	21,815
Saklaspur to Frontier	25,671
Frontier to Mangalore	19,830

The rates have been calculated on the assumption that it would be better to land the permanent-way material at Marmagod for the first three sections. The slight difference between the first and second is due to length of sidings proposed, which, in the absence of the details of the estimate, have not been altered as it is trifling. The third section difference is due to the 60 lb. rail which is to be landed at Marmagod as it appears better to lay the ghât with the lead down hill. The markedly smaller cost of the last section is due to the material being landed at Mangalore and consequent saving in railway transport.

Stations and Buildings.—The total cost under this head amounts to Rs. 6,98,763, or a mileage rate of Rs. 4,886. This provides for third-class stations throughout, except at Mangalore where a larger station is proposed for which Rs. 50,000 has been assumed. Each station has a third-class waiting shed and watering arrangements. Saklaspur has been selected as the principal engine-changing station on the supposition that the ghât would be worked as a special section. At Seradi a running room has been provided. Staff-quarters of the double unit type have been provided for guards and drivers at Saklaspur and Mangalore and adequate accommodation at all stations for the working staff of the arched roof pattern in use on the Rajputana-Malwa Railway.

Plant.—The figures under this head have been obtained by a *pro rata* deduction from the published figures of the cost of the Southern Mahratta Railway.

Ferries.—Nil.

Rolling-stock.—In the estimate sent in for the Arsikeri-Hassan section no provision was made for rolling-stock on the supposition that it would be worked by the Southern Mahratta Railway. Admitting this it seems that an additional branch of 143 miles must have its equipment and that more rolling-stock will be required. The figures have been obtained by deduction from the Southern Mahratta Railway mileage rates under this head and divided proportionately among the two heads.

General Charges.—The general charges have been calculated as detailed in the report for a period of three years for the work above and below ghât and for four years for the ghât section.

ARSIKERI-MANGALORE RAILWAY (METRE GAUGE).

1ST DIVISION (34·29 MILES).

Gradient Abstract.

Inclination.	Number of each.	Total length.	Percentage of total length of line.
		MILES.	
1 in 51 } Ghât .. .. {	1	2·50	7·30
1 in 66 }	1	1·57	4·58
1 in 100 Net	1	5·82	16·97
1 in 109 }	1	1·09	3·18
1 in 110 } $\frac{1}{100}$ Comp .. .. {	4	10·73	31·30
1 in 115 }	1	1·74	5·07
1 in 124	1	0·93	2·71
1 in 200	1	0·68	1·98
1 in 250	2	2·47	7·20
1 in 750	1	1·29	3·76
Level	9	5·47	15·95
Total ..	23	34·29	100·00

2ND DIVISION (16·174 MILES).

Gradient Abstract.

Inclination.	Number of each.	Total length.	Percentage of total length of line.
		MILES.	
Level	2	·84	5·19
1 in 225, or ·44 per cent. ..	1	1·49	9·21
1 in 40 compensated. 1 in 52, or 1·92 ,, ..	1	1·10	6·80
1 in 53·3, or 1·88 ,, ..	1	2·43	15·03
1 in 50, or 2·0 ,, ..	1	6·93	42·86
1 in 47, or 2·13 ,, ..	1	3·38	20·90
Total ..	..	16·17	99·99

3RD DIVISION (27·14 MILES).

Gradient Abstract.

Inclination.	Number of each.	Total length.	Percentage of total length of line.
		MILES.	
1 in 100, or 1 per cent. 2 compensated ..	4	5·79	21·33
only	1	·94	3·46
1 in 111, or 0·9 per cent.	1	1·42	5·23
1 in 114, or 0·88 ,, ...	1	·78	2·88
1 in 117, or 0·85 ,, ...	1	1·33	4·90
1 in 200, or 0·5 ,, ...	1	·41	1·51
1 in 217, or 0·46 ,, ...	1	·61	2·25
1 in 229, or 0·44 ,, ...	1	·45	1·66
1 in 300, or 0·33 ,, ...	1	1·18	4·35
1 in 310, or 0·32 ,, ...	1	·99	3·65
1 in 400, or 0·25 ,, ...	1	·85	3·13
1 in 450, or 0·22 ,, ...	1	·94	3·46
1 in 500, or 0·2 ,, ...	1	1·34	4·93
1 in 700, or 0·14 ,, ...	1	3·64	13·41
1 in 1,200 or 0·08 ,, ...	1	2·27	8·36
1 in 1,500 or 0·06 ,, ...	..	4·20	15·48
Level	..	27·14	99·99
Total ..			

NOTE.—Mile 27·14, actual length graded.

1ST DIVISION (34·29 MILES).

Curve Abstract.

Angle of curvature or radius.	Number of each.	Total length.	Total curvature.
		MILES.	DEGREES.
1°—0′ (radius 5,730 feet)	5	0·64	34·0
2°—0′ (,, 2,865 ,,)	7	1·20	127·0
3°—0′ (,, 1,910 ,,)	25	3·55	562·30
4°—0′ (,, 1,432 ,,)	3	0·51	107·0
5°—0′ (,, 1,146 ,,)	16	2·08	548·0
6°—0′ (,, 955 ,,)	28	5·91	1,873·30
8°—0″ (,, 716 ,,) } ghât ..	1	0·08	32·30
9°—0′ (,, 636 ,,) } ..	1	0·09	44·30
10°—0′ (,, 573 ,,) } ..	20	2·37	1,254·0
Total ..	106	16·43	4,583°·0

Ratio of curvature to total length of line 47·92.
Average amount of curvature per mile 133·65.

2nd Division (16·174 miles).

Curve Abstract.

Angle of curvature or radius.	Number of each.	Total length.	Total curvature.
		MILES.	DEGREES.
2°—0′ (radius 2,865 feet)	1	·05	5°
5°—0′ (,, 1,146 ,,)	2	·08	21°
6°—0′ (,, 955 ,,)	1	·06	18°
10°—0′ (,, 573 ,,)	87	7·65	4,042°
11°—28′ (,, 500 ,,)	6	1·32	798°
14°—19′ (,, 400 ,,)	7	·85	642°
16°—22′ (,, 350 ,,)	2	·46	401°
Total ..	..	10·47	5,927°

Ratio of curvature to total length of line 64·7 per cent.
Average amount of curvature per mile 366·54.

3rd Division (27·27 miles).

Curve Abstract.

Angle of curvature or radius.	Number of each.	Total length.	Total curvature.
		MILES.	DEGREES.
1°—0′ (radius 5,730 feet)	1	·45	23°·8
2°—0′ (,, 2,863 ,,)	13	1·47	155°·2
3°—0′ (,, 1,910 ,,)	14	1·84	291°·5
4°—0′ (,, 1,433 ,,)	7	·75	158°·4
5°—0′ (,, 1,146 ,,)	1	·22	58°·1
6°—0′ (,, 955 ,,)	29	3·37	1,067°·6
8°—0′ (,, 716 ,,)	5	·61	257°·7
10°—0′ (,, 573 ,,)	1	·11	58°·1
Total ..	..	8·82	2,070°·4

Ratio of curvature to total length of line = 32·34 per cent.
Average amount of curvature per mile = 75·9 degrees.

1st Division (length 34·29 miles).

Bridge Abstract.

Type of bridge.		Total number of spans.	Waterway. Lineal feet.
Class.	Spans.		
Slabs	2 feet	4	8
Arched bridges.	3 ,, ...	44	132
	5 ,, ...	27	135
	6 ,, ...	8	48
	10 ,, ...	11	110
	20 ,, ...	3	60
	30 ,, ...	2	60
Girder bridges.	40 ,, (a)	4	160
	40 ,, (b)	16	640
	100 ,, (c)	6	600
	Total for whole line ..	125	1,953
	Average per mile ..	..	57

(a) Yagachi, 4 spans 40 feet.
(b) Mile 31, 4 ,, ,,
,, 33, 2 ,, ,,
,, 62, 5 ,, ,,
,, 68, 5 ,, ,,
(c) Hemavats, 5 spans 100 feet.
Yettinhalla, 1 span ,,

2nd Division (16·174 miles).

Bridge Abstract.

Type of bridge.			Total number of spans.	Waterway. Lineal feet.
	Class.	Spans.		
Cost Rs. 585 per foot.	Open tops ..	2 × 2 feet	32	128
	Slab drains ..	2 × 2 feet	30	120
	Arched ..	5 feet	32	160
	,, ..	10 ,, ...	11	110
	,, ..	15 ,, ...	2	30
	,, ..	20 ,, ...	8	160
Cost Rs. 728 per foot.	Girder ..	20 feet	1	20
Cost Rs. 404 per foot. 2,080	Viaduct ..	2 × 40 feet (1)	2	80
	,, ..	3 × 40 ,, (3)	9	360
	,, ..	5 × 40 ,, (3)	15	600
	,, ..	6 × 40 ,, (3)	18	720
	,, ..	8 × 40 ,, (1)	1	320
		Total for whole line ..	..	2,808
		Average per mile ..	..	173·6

3rd Division (27·27 miles).

Bridge Abstract.

Type of bridge.			Total number of spans.	Waterway. Lineal feet.
	Class.	Spans.		
	Open tops ..	2 feet	3	6
	Flat tops ..	2 feet	7	14
		4 ,, ...	4	16
	Arched culverts.	4 feet	14	56
		5 ,, ...	5	25
		6 ,, ...	11	66
		8 ,, ...	2	16
		10 ,, ...	31	310.
		15 ,, ...	10	150
		20 ,, ...	12	240
	Girder bridges ..	12 feet	4	48
		20 ,, ...	2	40
		40 ,, two of one span	2	80
		60 ,, three of one span	3	180
		100 ,, one of one span	1	100
		100 ,, one of seven spans	7	700
		Total for whole line ..	..	2,047
		Average per mile ..	..	75·06

Coffee Cultivation.

In the original orders for the survey, the Government of India directed that a map be prepared "to show the tract in which coffee is grown, the alignment of the railway and of the roads leading from the coffee tracts to the coast." To carry this out the assistance of three of the oldest and most important European planters was called and the area coloured in represents the coffee zone of Mysore and inside this area are situated all the coffee estates. The green portions represent the principal sites of gardens and the sepia coloured roads represent the routes to the coast.

The entire area of the "Zone" amounts to 1,862 square miles or 1,191,605 acres, of this there are registered as coffee gardens 164,785 acres or, say, about one-seventh.

It must however be understood that the entire area of each estate is not under coffee; a great deal is still uncultivated, some is paddy or rice land, a good deal is forest land and much of the land under cultivation is represented by new plantations which do not produce any crop for four years and are exempt during that period from assessment.

From information received from the Planters' Associations it appears that extension of the coffee industry is possible in North Mysore to a considerable extent, but in South Mysore the whole available land has been absorbed and the only possible extension will be under irrigation. The figures supplied by the Planters' Associations and the Civil authorities agree in quantity very accurately and from these it seems that the total number of estates is as follows: —

North Mysore.

				ACRES.
European	559	aggregating		40,318
Native	11,747	„		65,796
Total	12,306			106,114

South Mysore.

				ACRES.
European	286	aggregating		21,637
Native	16,369	„		36,983
Total	16,675			58,620
Grand Total	28,981			164,734

There are therefore 28,981 gardens which represent an acreage of 164,734 or sub-dividing it—

			ACRES.
European	865	representing	61,955
Native	28,116	„	102,779

The maximum estate held by any one proprietor is returned by the Civil authorities—

	ACRES.
North Mysore	3,240
South „	8,825

The minimum is given as ·10 of an acre and are Native holdings, of which there are a very large number. The South Mysore Planters' Association have given an approximate proportion between coffee, cardamom and jungle in South Mysore which is—

	PER CENT.
Coffee	31
Cardamom	18
Forest and other	51

No such proportion has been suggested by the North Mysore Association, but it is assumed that no serious error would result in applying the same proportion to the entire province and would obtain then the following result:—

	ACRES.	
Coffee	19,206	
Cardamom	11,147	
Forest, &c.	31,602	
		61,955

and for Native estates—

	RS.	
Coffee	31,861	
Cardamom	18,500	
Forest, &c.	52,418	
		1,02,779

Between the European and Native estates the difference is most marked; for, while the one may be ranked with high class gardening, the latter are left very much to chance. Some are however reported to be maintained in a high state of efficiency.

The outturn on an average on a European estate may be taken at from 3 to 4 cwt. per acre and on a Native estate from $1\frac{1}{2}$ to 2 cwt. per acre. Applying in each case the lower figure to the acreage under actual coffee, as obtained above, we get the coffee crop as follows:—

	TONS.	
European	2,881	
Native	2,389	
		5,270

The actual export from Mangalore during 1893–94 was 6,000 tons, of which some 2,000 came from Coorg and 4,000 from Mysore and about 3,000 tons of this came down the Siradi ghât. It is then safe to assume that with the railway, before the branches are opened, not less than 4,000 tons of coffee may be expected to travel 80 miles, while the remainder will probably for some time continue to come to Bangalore; when the branches are made, this will cease. Under present arrangements carts are contracted for at a rate which varies from Rs. 21 in North Mysore to Rs. 24 in South Mysore per cart for a double trip to Mangalore and back so that the cost of carriage of a ton of coffee and a return trip with one ton of manure engages two carts at a rate of about Rs. 45.

Taking the present cost of carriage of one ton of coffee and one ton of manure at Rs. 45 and the rail charges at ·75 of an anna per ton mile for 80 miles we get—

	RS. A. P.	RS. A. P.
Carriage coffee	3 12 0	
Carriage manure	3 12 0	
		7 8 0
Present cost of carriage		45 0 0
Which leave a balance of		37 8 0

in favour of the railway carriage, which taking the cost of manure at Rs. 50 per ton enables the planter without increasing his present expenditure to purchase 75 per cent. more manure per ton of coffee which, while increasing outturn of crop, must increase the railway earnings.

The Secretary, North Mysore Planters' Association, states that, on his own estate and on many others, as much as 1 ton of manure per acre is used annually on half the estate in alternate years or an average of $\frac{1}{2}$ ton of manure per acre annually.

On the above figures therefore the following estimate for coffee is based:—

	TONS.	
Coffee annually	4,000	
Manure as at present	4,000	
Extra manure at 75 per cent.	3,000	
Food for 70,000 coolies at 2 lb. per diem for 300 days	18,750	
Machinery building materials, &c.	5,000	
		34,750

The North Mysore Planters' Association consider that ·75 ton per acre represent the average export and import for coffee estates and ·50 of a ton is about the figure for native estates. This being the case we obtain from the foregoing acreages:—

	TONS.
European 19,206 acres at ·75 ton	14,405
Native 31,865 „ at ·50 „	15,930
Total	30,335

It appears therefore that it is quite safe to assume that the coffee industry represents not less than 30,000 tons and that in carrying into the traffic estimate 20,000 tons as due to coffee alone places the estimate at a figure which is fully certain of realization.

The figures now put forward have been submitted to the Secretaries of the North and South Planters' Associations and they consider that they fairly represent the coffee statistics. The Secretary, North Mysore Association, considers the proportion of coffee,

cardamoms and forest too low for North Mysore and would estimate the area under coffee at 50 per cent. of the gross acreage. This would increase the estimate considerably but the figures have not been recast to meet this; because until the Chickmagalur branch is made the railway will only affect South Mysore at first and North Mysore in the more adjacent parts gradually. When the branches are made there is no doubt all the coffee except that grown near Kadur will find its way by rail to the coast and only a small proportion come to Bangalore for shipment at Madras. In Mangalore there are three immense coffee clearing works—Messrs. Morgan, Messrs. Arbuthnott, Messrs. Saldanha. The Coorg coffee chiefly goes to Tellicherry, but of the North Coorg coffee at present comes in at Manjerabad and passes down the Siradi ghât.

Manure is procured chiefly from Mangalore and Bangalore and consists of fish manure, bone dust and other patent chemical manures for which there is a great demand and the present tendency of the planters is to increase the manure. There is little doubt that with the railway, the Coast agents would establish manure dopôts at Saklespur.

Traffic.

Coffee as the great product of Mysore has been treated separately and, as before stated to be well within the margin of a safe estimate, only 20,000 tons due to the coffee industry is brought forward in this estimate, which when branches to Chickmagalur and perhaps Coorg are established will certainly be doubled.

Enquiries at the toll bars were fruitless they declined to give any information as to the number of carts or what they stated was manifestly unreliable. The usual reply was "I pay Rs. 3,600 for this toll bar and I know nothing more," their fear being that any accurate returns being published would lead to increased rents. Taking Rs. 3,600 at As. 4 per cart, it represents 14,400 carts or net 7,000 tons without allowing any profit to the contractors. Taking the Feringipett toll bar the nearest to Mangalore its rent seems to have ranged from Rs. 3,800 to Rs. 4,300 or an average of Rs. 3,962 over five years and through this gate passes the concentrated traffic of three routes—Chamardi, Siradi and Bisly ghât. If the contractors' profits be assessed at the Maruhalli toll bar as low as Rs. 100 per month, this would give the number of carts at As. 4 each to 19,200, so that the present traffic of the Siradi ghât is not less than 10,000 tons and is more probably 20,000 tons.

Mr. Purniya, Deputy Commissioner at Hassan, in his estimate (G.O., No. 152 R., dated 10th March 1894), gives a grand total of 24,812 tons, which Mr. Muirhead comments upon in his report No. 583 R.E., to the Agent, Southern Mahratta Railway, and he estimates the total imports and exports at 4,707 tons and it is clear how he was misled. He and Colonel Lindsay passed down the Siradi ghât in May after all the season had closed and reached Mangalore when the weather was so bad that they caught probably the last boat before the port closed. The coffee season ends in March and during December, January, February and March the strings of carts travel in constant trains of 20 and 25 up and down by night and day. To get carts to come up during May and the monsoon months very high rates have to be paid for all the bullocks are then employed above and below the ghât in agricultural work. One other point on which Mr. Muirhead has been led away is in regard to the statistics collected by Mr. Palmer, Agent to the Bank of Madras at Mangalore, where he has been in his present position for 25½ years and whose daily business puts him in a better position than any one else to form a reliable estimate. He gives the very low figures of—

	TONS.
Exports	2,538
Imports	4,073
Total ...	6,611

which the Collector considers too low and proposes a cautious increase of only 25 per cent. For the reasons stated under the head of coffee these figures seem all to have erred on the side of being too low.

Taking the Deputy Commissioner's figures—

	TONS.
Total export to Mangalore	14,907
Import to Mysore	9,905

and reducing the export by the items due to coffee industry, *i.e.*, 2,600 tons and similarly reducing the imports by 1,400 the amount shown as contingent on coffee, tools, manure, &c., we get the following as representing exports and imports exclusive of the coffee industry.

	TONS.
Total export	12,307
Import	8,505
Total ...	20,812
	20,000
Add amount due to coffee industry	
Total ...	40,812

which will be taken into the estimate at a mileage of 90 miles.

But this is not the whole traffic which must be looked for. South Canara contains forest land at the foot of the hills of some 300 square miles not yet fully conserved, from which the Forest officer expects the railway would obtain at once 10,000 tons of firewood and other produce over an average mileage of 50 miles. In this it should be noted that the firewood reserves of Mangalore have lately failed. Besides this the forests expect to produce annually 750 tons of wood pavement for export. The Forest Department are now engaged in organizing these forests and expect great development up to 40,000 tons per annum.

The internal traffic of South Canara may be put down at 10,000 tons per annum, which is now carried by cart and boat. Between Uppinangadi and Pani Mangalore, the river is navigated by small canoes which carry about 1½ tons and are poled down the rapids and the navigation is most dangerous on account of the rocky bed. All this would be usurped by the railway, say 10,000 tons per annum for an average of 32 miles.

The passenger traffic has been taken at 300,000 passengers yearly and this does not seem an excessive estimate, when the Planters in South Mysore estimate that they employ 20,000 coolies from below ghât, who travel four times a year. The railway would load to great deal of extra passenger traffic impossible to estimate, but it must be remembered that Mangalore for four months is closed as a port and the only egress is by a long land journey to Calicut or Arsikeri. It is an important mercantile centre and will certainly require a considerable traffic. It is intended to carry forward 300,000 third-class passengers with 70 miles each on an average. First and second class passengers are left out of the estimate and nothing taken for mails specie and other small items.

Abstract.

	RS.
40,812 tons at ·75 annas × 90 miles	1,72,175
10,750 forest produce at ·75 annas × 50 miles	25,195
10,000 tons local at ·75 annas × 32 miles	14,062
300,000 passengers at ·16 annas × 70 miles	2,10,000
Total ...	4,21,432
Working expenses at 60 per cent. ...	2,52,859
Net profit ...	1,68,573

This would represent as gross earnings Rs. 58 per mile per week or say a return of 1 per cent.

Port of Mangalore.

The Port of Mangalore is situated on the West Coast in Latitude 12·54 North Longitude 74·50 East and is an open roadstead with an inner harbour now only navigable by native craft. Steamers lie off at anchor and are served by cargo boats,

The lines of steamers calling there are the British India Steam Navigation Company two steamers weekly, one bound north, the other south, and the Bombay Steam Navigation Company (Shepherd and Company) who send two steamers weekly from Bombay, Mangalore being the southern limit of their traffic. Until lately Messrs. Shepherd's steamers used to enter the inner harbour but since one of them grounded on a shoal, they lie off in the roadstead. The inner harbour is a long lagoon about 7 miles long and $\frac{1}{2}$ a mile wide formed by the river Ghorpuri on the north and the Nitravati on the south. The sand bank which encloses this lagoon is about 400 feet wide and about 7 feet above high water level and form a substantial natural breakwater. There are two bars, one on the north which is always closed and the other on the south which is the mouth of the Nitravati. The silting up of the inner harbour has been going on gradually for years due chiefly to the Ghorpuri river bringing down silt and having lost its force by expanding into a wide estuary and being of insufficient force and volume to maintain its bar open, it brings silt down the whole length of the harbour which at the slack water intervals between tides is deposited. The Nitravati on the south is much larger river, its drainage area being 1,410 square miles against 352 square miles for the Ghorpuri river or say four times the volume. The fall of these rivers is very slight and the tide ebbs and flows for about 7 miles above Mangalore. To make the port efficient it is proposed to shut out the Ghorpuri river by a bund across the Lagoon near the Sultan's Battery and leave it to find its way to sea through its own bar and by a system of groynes and training walls to concentrate the full force of the Nitravati upon its own bar. This would leave the inner harbour almost a still water basin and it could be easily dredged to any extent required. A quay wall could be built with a loading jetty capable of berthing two coasting steamers. In the dry season the reflux of the tide concentrated on the bar would clear any silt brought in, and if two pier heads were built, say 500 feet apart, no attrition need be feared and a channel permanently navigable except during the monsoon would be assured. The question of the harbour is under investigation and it is a matter which should be carried out at the same time as the railway for the efficiency of the port will be an important factor in the success of the railway. Besides being an important port and mercantile centre, Mangalore is the seat of a very large and important tile manufacture, there being no less than ten manufactories of the well known Mangalore tile which is so rapidly making its way in India, and there are large weaving establishments also here. When communication by rail is established these industries will receive a great impetus, as at present, they are unable to find carts sufficient to meet the demands on them for tiles. All over Mysore the Mangalore tile is replacing the old half round tile even in Native houses.

(Signed) W. G. GILCHRIST,
Engineer-in-Chief.

ARSIKERI-MANGALORE RAILWAY ESTIMATES,

1895.

ARSIKERI-MANGALORE RAILWAY SURVEY.

METRE GAUGE (143 MILES).

Abstract of cost of Railway.

Heads of accounts.	Total cost in rupees.			
	Sub-heads.		Main heads.	
	Total cost.	Rate per mile.	Total cost.	Rate per mile.
	Rs.	Rs.	Rs.	Rs.
I. Preliminary expenses	2,02,522	1,416	2,02,522	1,416
1. Survey expenses	..	..	..	..
2. Plant	..	..	..	..
3. Establishment	1,13,295	792	1,13,295	792
II. Land	..	..	61,07,330	42,712
III. Formation	45,15,182	31,575	..	..
1. Earth-work	15,92,648	11,137	..	..
2. Tunnel	..	..	41,00,405	28,675
IV. Bridge-work	23,12,303	16,170	..	..
1. Large bridges	17,88,102	12,505	..	..
2. Minor bridges	..	..	1,98,099	1,385
V. Fencing, &c.	49,507	346	..	..
1. Fencing	1,42,342	995	..	..
2. Road crossings	6,250	44	..	..
3. Mile and gradient posts	14,300	100	14,300	100
VI. Electric telegraph	..	..	33,56,257	23,471
VII. Ballast and permanent-way	2,56,912	1,797	..	..
1. Ballast	30,99,345	21,674	..	..
2. Permanent-way	..	..	6,98,763	4,886
VIII. Stations and buildings	2,13,451	1,493	..	..
1. Stations and offices	23,764	166	..	..
2. Workshops, store buildings, &c.	1,76,221	1,232	..	..
3. Staff quarters	2,85,327	1,995	43,756	306
4. Station machinery	..	..	..	..
IX. Plant	16,159	113	..	..
1. Engineering	23,166	162	..	..
2. Locomotive, carriage and wagon	4,433	31	..	..
3. Station and office furniture	..	..	..	..
X. Ferries, &c.	..	..	..	..
1. Ferries	11,44,000	8,000	11,44,000	8,000
2. Floating bridges	..	..	..	..
XI. Rolling-stock	..	..	9,83,624	6,874
1. Locomotive	..	..	..	..
2. Carriage and wagon	1,33,584	934	..	..
XII. General charges	6,94,640	4,857	..	..
1. Direction	52,800	369	..	..
2. Engineering	88,000	621	..	..
3. Stores	13,200	92	..	..
4. Audit and account	..	..	..	..
5. Medical and sanitation	..	..	..	..
6. Locomotive	..	..	..	..
7. Traffic	..	..	..	..
Total	..	..	1,69,62,253	1,18,617

Total expenditure Rs. 1,69,62,253.

Total rate per mile Rs. 1,18,617.

III.—Formation.

Abstract of cost.

Sections.	Embankment.			Cutting. Soft.			Cutting. Hard.			Cutting. Rock.			Revetment.			Tunnel.			Total cost.	Contingencies 5 per cent.	Grand Total.	Cost of each section.
	Quantity.	Rate.	Cost.	Quantity.	Rate.	Cost.	Quantity.	Rate.	Cost.	Quantity.	Rate	Cost.	Quantity.	Rate.	Cost.	Quantity.	Rate.	Cost.				
		Rs.	Rs.		Rs.	Rs.		Rs.	Rs.		Rs.	Rs.		Rs.	Rs.		Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Section I ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8,08,596	40,430	8,49,025	8,49,025
Section II ..	735,000	5	3,675	6,113,039	8	48,904	6,335,239	15	95,029	4,803,094	50	2,40,155	..	..	..	..	..	..	5,68,916	28,446	5,97,362	5,97,362
	30,192,187	6	1,81,153	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Section III..	23,542,647	8	1,88,341	3,176,255	8	65,410	17,450,410	15	2,61,755	16,044,897	50	8,02,245	100,180	8	8,147	6,955	200	13,87,000	27,84,780	1,39,239	29,24,019	..
	11,980,286	6	71,882	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Add for three additional miles unsurveyed at Rs. 1,11,895 per mile.																			..	..	3,35,685	32,59,704
Section IV ..	50,940,864	6	3,05,646	3,529,757	8	28,236	9,275,438	15	1,39,134	1,804,724	40	72,188	137,713	6	8,263	..	..	..	5,65,739	..	..	..
Side drains.	..	..	..	..	..	12,272	..	..	..	..	..	..	..	..	..	..	..	..	2,66,000	..	..	..
Add for four miles from Frontier to Kubbinhulla at Rs. 66,500 per mile.																			1,20,000	..	..	..
Add for three miles from Kubbinhulla to Siradi at Rs. 40,000 per mile.																			4,50,000	..	14,01,739	14,01,739
Add for twenty-five miles from Surpadi to Mangalore at Rs. 18,000 per mile.																						
																				Grand Total, Arsikeri to Mangalore, 143 miles ..		61,07,830
																				Rate per mile Rs. 42,712.		

IV-I.—Major Bridges.

Section.	Number of bridge.	Description and span.	Excavation of foundations.	Concrete.	Masonry.	Ashlar.	Wrought iron girders.	Petty iron.	Timber.	Total cost, Indian.	Total cost, English.	Total cost.	Contingencies.	Cost of each bridge.	Cost of each section.	Rate per mile.
										Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
I.	..	....	..	1,188 lineal feet major bridges at Rs. 250 per lineal foot ..						..	..	..	..	..	2,97,000	9,883
II.	1	4 × 40 girders	29,540	7,385	78,621	334	36·16	7·57	302	29,528	7,232	36,760	1,835	38,598	..	..
	5	2 × 40 ,, ...	32,487	8,122	81,864	342	18·08	3·39	150	28,937	3,616	32,553	1,628	34,181	..	..
	..	4 × 40 arches	70,851	..	75,232	2,683	Arch.	5.040	..	29,071	..	29,071	1,454	30,525	..	..
	..	2 × 30′ ,, ...	51,730	..	31,210	1,386	..	1,960	..	12,390	..	12,390	619	13,009	..	..
	..	5 × 100′ girders	68,640	20,564	75,741	2,628	358·20	1,047·00	450	1,19,978	82,386	2,02,364	10,118	2,12,482	..	..
		Total, II Division ..	253,248	36,071	43,490 342,668 43,490	7,373	54·24 358·20	1,057·96 7,000	902	..	..	..	..	..	..	..
		Rate ..	Rs. 10	Rs. 25	Rs. 30 ,, 80	Rs. 75	Rs. 70 Rs. 105	Rs. 15 ,, 75	Rs. 3	..	..	..	..	..	..	..
		Cost ..	2,532	9,018	102,800 34,792	5,530	3,797 37,611	15,870 5,250	2,705	2,19,904	93,234	3,13,138	15,657	3,28,795	3,28,795	11,643
III.	92	5 × 40 girders	8,184	..	31,348	242	110·805	..	663	23,292	25,485	48,777	2,439	51,216	..	..
	93	5 × 40 ,, ...	10,100	..	51,088	277	114·621	..	663	29,659	26,363	56,022	2,801	58,823	..	..
	99	1 × 100 ,, ...	42,641	..	13,941	675	71·640	..	92	12,913	16,477	29,390	1,469	30,859	..	..
	143	5 × 40 ,, ...	8,421	..	29,825	238	143·445	..	663	27,815	32,992	60,807	3,040	63,847	..	..
	144	3 × 40 ,, ...	4,675	..	14,068	198	60·364	..	397	12,698	13,884	26,582	1,329	27,911	..	..
	151	3 × 40 ,, ...	3,399	..	6,439	159	49·132	..	397	8,797	11,300	20,097	1,005	21,102	..	..
	154	5 × 40 ,, ...	5,966	..	12,431	182	118·427	..	663	19,017	27,238	46,255	2,312	48,567	..	..
	158	3 × 40 ,, ...	3,950	..	53,372	282	85·382	..	397	29,207	19,638	48,845	2,442	51,287	..	..
	160	6 × 40 ,, ...	11,800	..	56,221	282	186·873	..	795	42.084	42,981	85,065	4,250	89,318	..	..
	175	2 × 40 ,, ...	8,485	..	63,312	297	45·430	..	264	28,103	10,449	38,552	1,927	40,479	..	..
	181	8 × 40 ,, ...	10,930	..	21,471	202	310·570	..	1,061	43,618	71,431	1,15,049	5,753	1,20,802	..	..
	201	6 × 40 ,, ...	11,366	..	49,659	272	191·768	..	795	40,287	44,107	84,394	4,219	88,613	..	..
	209	5 × 40 ,, ...	9,202	..	37,061	252	148·340	..	663	30,880	34,118	64,998	3,250	68,248	..	..
	214	6 × 40 ,, ...	9,102	..	26,863	227	186·873	..	795	31,727	42,981	74,708	3,735	78,443	..	..
		Total, III Division ..	153,221	..	370,732 96,377	2,591 1,194	1,823·676	..	8,308	..	..	..	..	..	..	..
		Rate ..	Rs. 10	..	Rs. 35 ,, 80	Rs. 100 Rs. 75	Rs. 105	..	Rs. 3	..	Rs. 230	..	..	..	..	..
		Cost ..	1,532	..	158,669	3,487	1·91485	..	24,924	3,80,097	4,19,444	7,99,541	39,974	8,39,515	..	..
									Add for three miles unsurveyed at 37·789 per mile ..					1,13,367	9,52,882	37,789
IV.	..	1 × 60 girders	21,641	..	28,088	696	21·08	..	87	12,480	4,216	16,696	..	..	..	..
	..	1 × 100 ,, ...	19,530	..	34,529	1,364	71·64	..	187	21,923	16,477	38,400	..	..	..	..
	..	1 × 60 ,, ...	82,606	..	49,036	737	21·08	..	87	21,306	4,216	25,522	..	..	..	..

IV-I.—*Major Bridges*—cont.

Section.	Number of bridge.	Description and span.	Excavation of foundations.	Concrete.	Masonry.	Ashlar.	Wrought iron girders.	Petty iron.	Timber.	Total cost, Indian.	Total cost, English.	Total cost.	Contingencies.	Cost of each bridge.	Cost of each section.	Rate per mile.
										Rs.	Rs.	Rs.		Rs.	Rs.	Rs.
IV.	..	1 × 60 girders	35,392	..	26,511	564	21·08	Archwork.	87	11,934	4,216	16,150	..	..	..	..
	..	7 × 100 ,, ...	266,829	17,304	135,132	12,575	501·48	696	1,309	1,26,638	1,15,340	2,41,978	.. *	..	..	..
	..	1 × 40 ,, ...	24,971	6,243	54,112	286	9·04	..	58	21,843	1,808	23,651	..	..	..	..
	..	1 × 40 ,, ...	23,870	5,968	50,916	278	9·04	..	58	20,637	1,808	22,445	..	..	..	..
		Total, IV Division ..	105,874 368,965	29,515	378,374	16,500	152·96 501·48	696	1,373	..	..	..	..	..	..	..
		Rate ..	Rs. 10 Rs. 20	Rs. 25	Rs. 35	Rs. 100	Rs. 70 Rs. 105	Rs. 75	Rs. 3	..	..	..	..	..	..	..
		Cost ..	3,439	7,379	132,431	16,500	65,871	522	5,619	2,36,761	1,48,081	3,84,842	..	3,84,842	..	..
										Add for 7 miles at Rs. 11,112 per mile ..			..	98,784	..	12,330
										Add for 25 miles at Rs. 10,000 per mile ..			..	2,50,000	7,33,626	
		Grand Total, Major Bridges, Arsikeri to Mangalore, 143 miles ..											..	..	23,12,303	16,170

Minor Bridges.

Section.	Description.	Excavation.	Concrete.	Masonry.	Ashlar.	Arching.	Ironwork.	Timber.	Girders.	Total.
		CUBIC FEET.	CUBIC FEET.	CUBIC FEET.	CUBIC FEET.	CUBIC FEET.	CWT.	CUBIC FEET.	TONS.	Rs.
I	1,064	L. feet of bridging at Rs. 250 per foot.			....	....	....	....	....	2,66,000
II	Costing under Rs. 4,000 ..	145,464	73,290	1,62,035	4,746	18,802	2·80	45½	..	
	,, over Rs. 4,000 ..	39,884	16,671	85,614	807	11,969	..	..	..	
	Total quantities ..	185,348	89,961	2,47,649	5,553	30,771	2·80	45½	..	
	Rate	Rs. 10 per 1,000	Rs. 25 per 100	Rs. 30 per 100	Rs. 75 per 100	Rs. 75 per 100	Rs. 15 per cwt.	Rs. 3 per c. foot.	..	1,26,059
	Cost	1,853	22,490	74,295	4,165	23,078	42	136	..	6,314
								Add contingent at 5 per cent. ..		
								Grand Total ..		1,32,373
III	Costing under Rs. 4,000 ..	304,507	156,221	222,160 91,651	6,925 2,285	36 389	15·68	434·67	2·37	
	,, over Rs. 4,000 ..	218,768	87,726	360,215 50,272	3,593 496	40,277	..	..	..	
	Total quantities ..	523,275	243,947	582,375 141,923	10,518 2,781	76,666	15·68	434·67	2·37	
	Rate	Rs. 10 per 1,000	Rs. 25 per 100	Rs. 35 per 100 Rs. 30	Rs. 100 per 100 Rs. 75	Rs. 75 per 100	Rs. 15 per cwt.	Rs. 3 per c. foot.	Rs. 270 per ton.	
	Cost	5,233	60,967	2,03,831 42,577	10,518 2,086	57,500	236	1,303	640	3,84,911
								Add contingent at 5 per cent. ..		19,241
								Total ..		4,04,152
								Unsurveyed 3 miles, at Rs. 18,192 ..		54,576
										4,58,728
IV	Costing under Rs. 4,000 ..	181,192	91,479	234,918	5,936	25,371	7·03	177·17	7·82	
	,, over Rs. 4,000 .	301,035	118,810	580,374	6,130	67,758	2·10	42·67	2·86	
	Total quantities ..	482,227	210,289	815,292	12,066	93,129	9·13	219·84	10·68	
	Rate	Rs. 10 per 1,000	Rs. 25 per 100	Rs. 35 per 100	Rs. 100 per 100	Rs. 75 per 100	Rs. 15 per cwt.	Rs. 3 per c. foot.	Rs. 270 per ton.	
	Cost	4,822	52,574	285,353	12,066	69,848	138	660	2,884	4,28,345
								Unsurveyed 32 miles, at Rs. 15,708 ..		5,02,656
								Grand Total ..		9,31,001
								Grand Total of Minor Bridging ..		17,88,102
								Rate per mile ..		12,505

V.—*Fencing.*

Section.	Number of miles.	Fencing.	Road crossings.	Mile and gradient posts.	Total of section.	Rate per mile.
		Rs.	Rs.	Rs.	Rs.	Rs.
I	30·05	14,420	19,475	12,66	35,161	1,170
II	28·24	7,836	21,900	1,100	30,836	1,092
III	25·21	2,766	10,827	1,034	14,627	580
IV	59·50	24,485	90,140	2,350	1,17,475	1,975
Total ..	143·00	49,507	1,42,342	6,250	1,98,099	1,385

PERMANENT-WAY.

DETAILS OF COST OF ONE MILE, 50 lb. RAIL.

Section I.

		Rs.
Rails	78·57 tons, at Rs. 80 per ton f.o.b.	6,286
Fish plates,	4·51 tons, at „ 98 „ „	442
Fish bolts,	0·62 ton, at „ 164 „ „	102
Spikes,	4·16 tons, at „ 216 „ „	899
Add—		
87·86 tons.	Total ...	7,729
Freight to Portuguese Frontier at As. 3–3 per maund	... ...	488
Port and customs dues	...	210
Carriage from Frontier to Arsikeri at 1 anna per ton per mile	...	1,446
Unloading and stacking in depôt in Arsikeri, Rs. 2 per ton	...	176
	Total ...	10,049
2,220 sleepers at Rs. 3–8–0 each		7,700
Total cost at Arsikeri (167 tons)		17,749
Store charges, loading, &c., 2½ annas per ton		26
Haulage, 15 miles, 1⅛ annas per ton mile		209
Laying at 4 annas per yard		440
Maintenance, at Rs. 100 per mile per month, for six months		600
	Total ...	19,024

	MILES.		
Length of section ...	30·05		
Sidings	2·794		
Total ...	32·844 miles at Rs. 19,024 per mile ...		6,24,824
	Contingencies, 5 per cent. ...		31,241
	Grand total ...		6,56,065

Cost per mile ... ... Rs. 21,832

Section II.

	Rs.
Total cost at Arsikeri as per section I	17,749
Store charges, loading, &c., at 2½ annas per ton	26
Haulage from depôt to rail-head, 45 miles, at 1⅛ annas per ton per mile	626
Laying, &c., per mile	440
Maintenance, six months, at Rs. 100 per month	600
Total per mile ...	19,441

	MILES.		
Length of section	28·24		
Sidings	1·94		
Total ...	30·18 miles at Rs. 19,441 ...		5,86,729
	Contingencies at 5 per cent.		29,336
	Grand total ...		6,16,065

Cost per mile ... ... Rs. 21,815

COST OF 1 MILE OF 60 lb. RAILS AT ARSIKERI.

Section III.

		Rs.
Rails,	94·28 tons, at Rs. 80 per ton	7,542
Fish plates,	5·00 ton, at „ 98 „	490
Fish bolts,	0·62 ton, at „ 164 „	102
Spikes,	4·16 ton, at „ 216 „	899
Bearing plates,	0·97 ton, at „ 166 „	161
	Total ...	9,194
Freight to Portuguese Frontier at As. 3–3 per maund		582
Freight to Arsikeri at 1 anna per ton per mile		1,726
Loading, &c., at Rs. 2 per ton		210
Port and customs dues		210
		11,922
2,200 sleepers at Rs. 3–8–0		7,700
Cost of one mile at Arsikere (185 tons)		19,622
Loading and unloading at 2½ annas per ton		29
Haulage, 72 miles, at 1⅛ annas per ton per mile		1,249
Laying per yard at 4 annas		440
Maintenance, six months, at Rs. 100 per month		600
		21,940

	MILES.		
Length, Section III ...	25·216		
Sidings	1·060		
26·276 miles at Rs. 21,940			6,16,495
Contingencies at 5 per cent.			30,825
Grand total ...			6,47,320

Rate per mile ... ... Rs. 25,671.

Section IV.

		Rs.
87 86 tons permanent-way, as section F		7,729
2,200 sleepers at Rs. 3–8–0		7,700
		15,429
Loading, &c., 167 tons, at 2½ annas		26
Haulage, 167 tons, 30 miles, at 1⅓ annas		418
Laying, As. 4 per yard		440
Maintenance, Rs. 100 per month, for six months		600
		16,913

	MILES.		
Length, 50 lb. rails ...	52·5		
Sidings	4·86		
	57·36 miles at Rs. 16,913	... ...	9,70,130
Length, 60 lb. rails	7·00 „ at Rs. 21,940	... ...	1,53,580
			11,23,710
	Contingencies at 5 per cent. ...	...	56,185
	Grand total	...	11,79,895

Rate per mile ... ... Rs. 19,830.

STATIONS AND BUILDINGS.

Stations and Offices.

Name of station.	Class.	Miles.	Distance apart.	Station buildings.	Goods shed.	Passengers platform. Length rail level.	Passengers platform. Length 1·3 above rail.	Goods platform.	Latrine.	III Class shed.	Remarks.
			Miles.	Sq. Ft.	Sq. Ft.	Ft.	Ft.	Ft.	Sq. Ft.	Sq. Ft.	
Talur	III	3¼	3¼	757	1,742	600		250	200	1,500	
Bagade	III	16¼	13	757	1,742	600		250	200	1,500	
Dudda	III	19	2¾	757	1,742	600		250	200	1,500	
Hassan	..	29¾	10¾	1,500	1,742	..	600	250	400	1,500	
Alur	III	37¼	7·50	757	..	600	..	..	200	1,150	
Balol	C.R.	47	9·50	757	..	..	..	..	..	..	
Masralli	C.S.	52¾	5·75	757	1,742	600	600	250	200	1,500	
Saklespur	III	58¾	5·75	1,500	..	..	..	..	..	..	
Hebsala	C.S.	60¼	1·75	757	..	..	..	..	..	..	
Manzarabad road	III	64¼	4·25	757	..	..	..	..	..	..	
Maranhalli Gorge	III	67½	3·25	757	..	..	..	..	..	..	
Kadnani	III	74½	6·75	757	..	..	..	..	..	..	
Kempkul	Water.	79	4·50	..	1,742	600	600	250	200	1,150	
Siradi	III	90½	11·50	757	..	..	..	..	..	..	
Golitatn	III	101¼	11·00	757	1,742	600	600	250	200	1,150	
Uppinangadi	III	111½	10·00	757	..	..	..	..	..	..	
Sooripadi	III	120	8·50	757	..	..	..	..	..	..	
Bantwall	III	127½	7·50	757	..	..	..	..	..	..	
Feringipet	III	134½	7·00	757	..	..	..	..	..	..	
Jeppoo	III	141½	7·00	757	..	..	..	..	..	..	
Total ..	..	..	..	15,869	19,678	8,200	1,800	2,250	2,000	13,950	
Rates ..	..	..	..	Rs. 2·7	Rs. 2	Rs. 1·5	Rs. 6	Rs. 6	Rs. 1	Rs. 2·3	
Cost ..	..	..	..	42,846	39,356	12,300	10,800	13,500	2,000	32,085	
Mangalore ..	..	..	..	50,000	..	..	..	..	400	..	
Grand Total ..	..	..	..	92,846	39,356	12,300	10,800	13,500	2,400	32,085	

	Rs.
Total	2,02,287
Contingencies 5 per cent. ..	10,164
Grand Total	2,13,451
Rate per mile	1,493

Rupees 50,000 includes also goods shed and platforms.

Staff Quarters.

Name of station.	Class.	Mileage.	Distance apart.	Station Masters' quarters.	Assistant Station Master or signaller's quarters.	Menial's quarters.	Loco-motive Foremen.	P.W. Inspector.	A.P.W. Inspector.	Running room.	Guard's and Driver's.	Gangmen's quarters.	Loco-motive menial's quarters.	Remarks.
			MILES.	SQ. FT.	SQ. FT.	SQ. FT.	SQ. FT.	SQ. FT.	SQ. FT.	SQ. FT.	SQ. FT.	SQ. FT.	SQ. FT.	
Talur	III	3¾	3¾	240	..	320	..	2,000	..	..	..	..	..	
Bagade	III	15¼	11½	240	..	320	..	..	..	..	..	..	..	
Dudda	III	19	3¾	240	..	320	..	..	..	..	..	..	..	
Hassan	..	29¾	10¾	900	240	480	..	..	240	..	..	..	..	
Alur	III	37½	7·50	240	240	320	..	..	..	..	..	..	..	
Balol	C.S.	47	9·50	..	240	320	..	..	..	..	..	..	..	
Masralli	C.S.	52¾	5·75	..	240	320	..	..	..	..	..	..	..	
Saklaspur	III	58½	5·75	240	240	480	3,000	2,000	240	5,000	7,500	..	960	
Hebsala	C.S.	60½	1·75	..	240	320	..	..	..	..	..	..	..	
Manzarabad road	III	64½	4·25	..	240	320	..	..	..	..	..	..	..	
Maranhalli Gorge	III	67½	3·25	..	240	320	..	..	240	..	..	..	..	
Kadmani	III	74¾	6·75	..	240	320	..	..	..	..	..	..	..	
Kempkal	Water.	79	4·50	..	..	..	..	..	..	..	..	..	..	
Siradi	III	90½	11·50	240	240	480	..	..	240	..	2,500	..	960	
Golitattu	III	101½	11·00	..	240	320	..	..	..	..	..	..	..	
Uppinangadi	III	111½	10·00	240	240	320	..	..	..	..	..	..	..	
Seerpadi	III	120	8·50	..	240	320	..	..	..	..	..	..	..	
Buntwall	III	127½	7·50	..	240	320	..	..	240	..	..	..	..	
Feringipet	III	134½	7·00	..	240	320	..	..	..	..	..	..	..	
Jeppoo	III	141½	7·00	240	240	480	..	..	..	..	..	..	..	
On line	..	..	..	..	..	..	..	..	..	..	..	9,600	..	
Total ..	..	..	..	2,820	3,840	6,720	3,000	4,000	1,200	5,000	10,000	9,600	1,920	
Rates ..	..	..	..	RS. 2·7	RS. 2·4	RS. 2·0	RS. 2·7	RS. 2·7	RS. 2·7	RS. 2·7	RS. 2·7	RS. 1	RS. 2	
Cost ..	..	..	..	7,614	9,216	13,440	8,100	10,800	3,240	13,500	27,000	9,600	3,840	
Mangalore	..	..	..	6,000	580	2,400	6,000	4,000	..	13,500	27,000	..	2,000	
Grand Total ..	..	..	..	13,614	9,796	15,840	14,100	14,800	3,240	27,000	54,000	9,600	5,840	

	RS.
Total	1,67,830
Contingencies 5 per cent.	8,391
Grand Total ..	1,76,221
Rate per mile ..	1,232

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Station Machinery.

Name of station.	Station sahpits.	Water columns. Number.	Water columns. Diameter.	Piping. Length.	Piping. Diameter.	Water tank. Capacity.	Weighing machine.	Carriage Examining pit.	Switches. Feet.	Crossing. No. 1 in 9½.	Crossing. No. 1 in 6½.	Main signals.	Distant signals.	Weigh bridge. Number.	Weigh bridge. Capacity.	Engine shed. Area.	Engine turntable.	Platform crane.	Washing out apparatus.	Buffer stops.	Hand pump.	Steam pump.	Tank house and well.	Remarks.
	No.	No.	In.	Feet.	In.	Cub. ft.	No.	No.	No.	No.	No.	No.	No.	No.	Tons.	Sq. feet.	No.	No.	No.	No.	No.	No.	No.	
Talur	..	..	..	..	..	..	1	..	..	2	1	1	2	..	..	..	..	..	..	1	..	..	..	
Bagadi	2	2	6	700	6	512	1	..	..	2	1	1	2	..	..	..	..	..	..	1	1	..	1	
Dudda	..	..	..	..	..	..	1	..	..	2	1	1	2	..	..	..	..	..	..	1	..	..	..	
Hassan	2	2	6	700	6	512	1	..	..	2	6	1	2	1	25	..	..	..	..	3	1	..	1	
Alur	1	2	6	700	6	512	1	..	..	2	1	1	2	..	..	..	..	..	..	1	1	..	1	
				60	2																			
Balol (coffee siding).	..	..	..	..	..	..	1	..	..	1	..	1	2	..	..	..	..	..	..	1	..	..	..	
Masralli (coffee siding).	..	..	..	..	..	..	1	..	..	1	..	1	..	..	..	..	..	..	..	1	..	..	..	
Saklaspur ..	2	2	6	750	6	1,024	1	..	..	2	5	1	2	1	25	3,000	1	..	1	3	..	1	1	
				900	2																			
Hebsala (coffee siding).	..	..	..	..	..	..	1	..	..	1	..	1	2	..	..	..	..	..	..	1	..	..	..	
Manzarabad road ..	..	2	6	700	6	512	1	..	..	2	..	1	2	..	..	..	..	..	..	..	1	..	1	
				100	2																			
Maranhalli (crossing).	..	2	6	700	6	512	1	..	..	2	..	1	2	..	..	..	..	..	..	..	1	..	1	House only.
				100	2																			
Kadamani (crossing).	..	2	6	700	6	512	1	..	..	2	..	1	2	..	..	..	..	..	..	..	1	1	1	House only.
				2,600	2																			
Kempkul (water only).	..	1	6	350	6	512	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
				300	2																			
Seradi	4	3	6	900	6	1,024	1	..	..	2	5	1	2	..	..	3,000	1	..	1	3	..	1	1	
				1,200	2																			
Golitattu (crossing).	..	2	6	700	6	512	1	..	..	2	..	1	2	..	..	..	..	..	..	..	1	..	1	
				400	2																			
Upinangady ..	2	2	6	700	6	512	1	..	..	2	1	1	2	..	..	..	..	..	..	..	1	..	1	
				600	2																			
Seerpadi ..	..	2	6	700	6	512	1	..	..	2	..	1	2	..	..	..	..	..	..	..	1	..	1	
				600	2																			
Buntwall ..	..	2	6	700	6	512	1	..	..	2	..	1	2	..	..	..	..	..	..	..	1	..	1	
				600	2																			
Feringipet ..	..	2	6	700	6	512	1	..	..	3	2	1	2	..	..	..	..	..	..	2	1	..	1	
				600	2																			
Jeppoo	1	1	6	500	6	512	1	..	..	5	15	1	2	1	25	3,000	1	1	1	6	..	1	1	
				600	2																			
Mangalore ..	4	3	6	1,000	6	1,024	1	1	..	5	15	1	2	1	25	3,000	1	1	1	6	..	1	1	
				1,000	2																			
Total quantity ..	18	32	..	11,200	6	9,728	20	1	..	41	38	20	38	3	..	9,000	3	1	3	26	13	3	16	
				9,660	2																			
Rate	RS. 600 each.	RS. 800 each.	..	Rs. 3·2 for 6 inches piping Rs. 3·4 per foot for 2 inches.	..	RS. 1·3 per foot.	RS. 200 each.	RS. 1,700 each.	..	RS. 450 each.	RS. 450 each.	RS. 300 each.	RS. 275 each.	RS. 3,500 each.	..	RS. 4·3 per square foot.	RS. 6,200 each.	RS. 3,430 each.	RS. 250 each.	RS. 35 each.	RS. 550 each.	RS. 2,550 each.	RS. 2,350 each.	
Cost	10,800	25,600	..	25,840	..	12,646	4,000	1,700	..	18,450	17,100	6,000	10,450	10,500	..	38,700	18,600	3,430	750	910	7,150	7,650	37,600	
				3,864																				

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	RS.
Total cost	2,71,740
Add—Contingencies at 5 per cent, ..	13,587
Total ..	2,85,327
Rate per mile	1,996

(Signed) W. G. GILCHRIST,
Engr.-in-Chief, Arsikeri Mangalore-By. Survey