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# MADRAS RECORD OFFICE

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## Government of Madras

Public Works DEPARTMENT

G.O. No. 2224-25 Press ~~Mis.~~

~~B.P. No.~~ 114 to 117

Dated 8 · 9 · 1873 ~~1905~~ .

***Not to be folded or roughly handled***

Read the following papers:—

No. 114. From Lieutenant-Colonel J. H. M. SHAW-STEWART, R.E., Consulting Engineer for Railways, to Colonel G. W. WALKER, R.E., Secretary to Government, Public Works Department, dated Madras, 13th August 1873, No. 427.

In the Proceedings of Government, dated the 26th March 1873, No. 947, I was instructed to obtain from the Agents and Chief Engineers of the Great Southern and the Carnatic Railway Companies an expression of their joint opinion as to the adequacy of the revised estimates to meet the cost of the proposed works on the line from Madras to Cuddalore. I was also instructed to obtain such joint report from the Chief Engineers as should set at rest the doubts as to the designs and estimates of the bridges upon that line, which were entertained by the Government of India on a comparison with those sanctioned for the line from Trichinopoly to Tinnevelly and Tuticorin. With my letter dated the 19th May 1873, No. 277, I laid before Government the opinions of the Chief Engineers as to the strength of the engineering staff required for the construction of the line, and I have now the honour to submit letters* from the Agents of the two Companies, giving cover to reports from the Chief Engineers as to the sufficiency of the revised estimates, as sanctioned by the Government of India, and as to the adequacy of the designs and estimates for the bridges.

* From Agent, Great Southern of India Railway, No. 5,091, dated 3rd July 1873, with enclosures. From Agent, Carnatic Railway, No. 249, dated 2nd August 1873, with enclosures.

2. It will be seen that Mr. Logan agrees generally as to the correctness of the modifications made in the estimate in this office; but he considers that "it will be necessary to allow Rupees 12 per cubic yard for the masonry of the large bridges, especially if the work is to be of stone." The original estimates contemplated brick as the material to be used in the masonry of the large bridges; and the rate as revised in this office, Rupees 10 per cubic yard, ought, in my opinion, to secure work of the best description. The increase of Rupees 2 per cubic yard, suggested by Mr. Logan, will entail an addition of only some Rupees 10,000 to the estimates. From Mr. Dibblee's report I gather that he accepts Mr. Logan's opinion, both as to the general sufficiency of the revised estimates and as to the necessity of a slight addition to the rate for masonry in the large bridges.

3. In paragraph 8 of the note appended to my letter,† dated the 4th October 1872, it was pointed out that Mr. Dibblee's estimates were, in many instances, mere average estimates; and that, in the case of every minor bridge and culvert, an average depth of foundations and an average height of bank had been assumed. Mr. Logan explains that, owing to this defect in the estimates, it is impossible to give a satisfactory opinion as to the sufficiency of the total sum allowed for masonry works. It will be seen from Mr. Dibblee's report that test-pits are now being sunk at the site of each minor bridge and culvert, in order to ascertain the nature and depth of foundation, and that a revision of the estimate in this respect will be submitted as soon as the necessary information has been obtained.

† *Vide* Proceedings of Government, dated 4th December 1872, No 2,851.

4. As regards the suitableness of the designs of the bridges, and their adequacy for passing the flood-waters of the respective rivers, Mr. Logan is of

opinion that the allowances for waterway have been judiciously fixed, but that a more trustworthy estimate will be formed after the Engineers have been posted to their districts, and have had opportunities of watching the various streams when in flood. Mr. Dibblee explains the data upon which his calculations were framed; and he states that, during the severe flood in November 1872, observations were taken at every large bridge on the public road which runs parallel to the proposed railway, with the result of inducing him to raise the level of some of the bridges, and to increase the size of others.

In the case of the Palar river, Mr. Logan shows from figures quoted in his report that, in his opinion, a sufficiently safe allowance of waterway has been made; and Mr. Dibblee explains that, owing to an error in the drawing furnished to Mr. Logan, there is in reality a much larger area of available opening below flood level (by 5,000 superficial feet) than was assumed in Mr. Logan's calculations, and that there is therefore additional assurance of safety.

Mr. Logan alludes to the possibility of the large bridge provided for the Pooniar river being relieved at the expense and to the danger of the smaller bridge over the Guddelum; and, with reference to this, Mr. Dibblee mentions that, during an inspection on which he accompanied me in March last, it was decided to increase the waterway at the latter river by an additional opening of 100 feet.

5. The question of the amount of waterway provided along the line received very careful consideration from me before the submission of the estimates to Government; and I have lately had an opportunity of going over the whole line with the Chief Engineer, and of examining upon the ground the provision made in the case of every river and stream. I do not hesitate to state my opinion that the proposed allowance of waterway is upon the whole ample. The only large bridge to which I suggested an increase was that over the Guddelum river, to which allusion is made above. It is not easy to make a trustworthy comparison between the requirements of the Cuddalore line and those of the Great Southern extension to Tuticorin. There is not only a considerable difference in the climates of the districts through which the two lines run, and in the nature of the soil, as observed by the Government of India, but it must be remembered that all the large rivers which are crossed by the Cuddalore line are relieved of a considerable portion of their waters before they reach the railway, a condition which does not apply to the rivers on the Tuticorin line.

6. The Government are aware that the sanctioned designs provide, in the case of the Palar river, for piers formed of iron cylinders, and, in the cases of the Pooniar and Guddelum rivers, for piers formed of screw piles. The great rise in the price of iron since the estimates were framed makes it more than doubtful whether these arrangements for the piers are the most economical. I have discussed the subject on several occasions with the two Chief Engineers, and we were unanimous in thinking that it would be desirable to substitute masonry wells for the iron cylinders and piles. This point is alluded to in the enclosed reports, and Mr. Dibblee has submitted an estimate showing the comparative cost of bridging the Palar with piers formed of cast iron cylinders having an external diameter of 3 feet 9 inches, and with piers formed of masonry wells having an external diameter of 10 feet; the piers in each case being filled with concrete, and



sunk to reach the hard substratum below the river bed. The estimate shows that, taking iron at the price at which it stood more than a year ago, a saving of Rupees 22,000 would result from the adoption of masonry wells. The present price of iron would increase this sum considerably.

In the cases of the Pooniar and Guddelum rivers, Mr. Dibblee does not think that much economy would be effected by substituting masonry wells for screw piles, and says that it becomes a question of preferring one style of bridge to the other.

Upon the supposition that there is not much difference of cost between the two structures, my opinion is decidedly in favour of using the masonry wells in preference to the screw piles. The consideration mentioned by Mr. Dibblee, that in using wells a much greater proportion of the cost will be spent in India, seems to me entitled to much weight; but, apart from that, I prefer them as offering a more certain and more stable support to the superstructure.

7. Mr. Logan in his report touches upon the question of the ruling gradient, which was fixed by Mr. Dibblee at 1 in 140, and suggests, for consideration, the expediency of modifying it to 1 in 200. In an appendix to his report he gives some calculations, from which he draws the conclusion that by reducing the steepness of the ruling gradient there would be an annual saving, in working expenses on the goods traffic alone, of about Rupees 10,000. He estimates the cost of extra earthwork in flattening the gradients at Rupees 50,000, and of masonry at Rupees 10,000. Allowing for interest at 5 per cent. on the increased outlay, he thus shows that the net annual saving would be about Rupees 7,000. Mr. Dibblee is, however, of opinion that the saving in working expenses would not be so large as estimated by Mr. Logan; and he believes that "by reducing the speed of heavy trains over the top of the steepest inclines it will be found that an engine can take a load so nearly approaching the maximum that working expenses due to additional trains which may be needed will not amount to the interest on the extra cost to the works."

The Agent of the Great Southern Railway makes no allusion to this question; but Mr. Fisher expresses his opinion decidedly in favour of reducing the ruling gradient, provided that the interest upon the additional cost does not exceed the extra working expenses which would otherwise be entailed.

After carefully examining the points at issue, I am inclined to agree with Mr. Dibblee that the saving under the head of Working Expenses, as estimated by Mr. Logan, is somewhat in excess of what may fairly be counted upon. The cost of the additional earthwork and masonry seems to me, however, to be accurately calculated; and I have no doubt that the saving in working expenses will be more than sufficient to cover the comparatively small sum, Rupees 3,000 per annum, which represents the interest upon this additional outlay. Looking to the fact that the ruling gradient proposed by Mr. Logan, 1 in 200, will also be the ruling gradient upon the line between Cuddalore and Tanjore, and bearing in mind the importance of maintaining a uniform ruling gradient upon as long a stretch as possible of continuous line, I have no hesitation in strongly recommending the adoption of the change suggested by Mr. Logan.

8. It does not seem necessary that any application should be made at present for an increase to the sum* sanctioned for constructing the line. Referring to paragraphs 2 and 3 of this letter, I think it would be well to wait for the revised estimate of the bridges, promised by Mr. Dibblee, before proposing an increase in the rate allowed for masonry. In the event of the proposed substitution of masonry wells for iron cylinders and piles being approved of, the change will not be attended with increased outlay. And with regard to the proposed alteration in the ruling gradient, the preparation of revised plans and estimates in detail, for the parts of the line affected, will be necessary in the event of the change commending itself to His Excellency the Governor in Council.

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|---|---|
| * Rupees | 69,10,522 |
| ,, | 83,382 |
| ,, | 69,93,904 |

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From W. S. BETTS, Esq., Agent of the Great Southern of India Railway, to Lieutenant-Colonel J. H. M. SHAW-STEWART, R.E., Consulting Engineer for Railways, dated Negapatam, 3rd July 1873, No. 5,091.

YOUR No. 146.

I have the honour to forward, for the information of Government, copy of letter No. 1,678, from the Chief Engineer, in which Mr. Logan expresses his opinion as to the adequacy of the estimates for the works of the Carnatic Railway, as they stand revised by Government, and of the designs and estimates of the bridges on the same line.

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From D. LOGAN, Esq., Chief Engineer, to W. S. BETTS, Esq., Agent of the Great Southern of India Railway, dated Trichinopoly, 30th June 1873, No. 1,678.

REFERRING to your letter No. 1,082 of 3rd April 1873, enclosing copy of a letter* from the Consulting Engineer, in which, in view of the probability of an amalgamation between the Carnatic and Great Southern of India Railway Companies, he asks for an expression of opinion, first, as to the adequacy of the estimates for the works of the Carnatic Railway, as they stand revised by Government, between Madras and Cuddalore, and, second, as to the adequacy of the designs and estimates of the bridges on the same length of line. I have already, in my No. 1,067 of 4th May 1873, discussed the subject of the Engineer Establishment, and now turn to the remainder of the question under, first, the adequacy of the estimates. I have gone as carefully as possible with the means at my disposal into the matter of the cost of work, and agree generally with the Consulting Engineer in his modifications of the Carnatic Estimate, with the exception that I consider it will be necessary to allow Rupees 12 per cubic yard for the masonry of the large bridges, especially if the work is to be of stone. The masonry in the piers and their cut-waters and quoins requires to be of a superior quality to ensure stability in these comparatively thin structures.

* No. 146 of 29th March 1873, Madras.

2. To arrive at a satisfactory decision as to the sufficiency of the sum total allowed for masonry works, it will be necessary to ask Mr. Dibblee to take out the quantities in the works for every variation in the height of each, instead of assuming one average height for each type of bridge and applying that to the whole line.

3. I presume that for the purposes of departmental check over the expenditure, this detailed information will be taken out in any case.

4. Second, the adequacy of the designs and estimates of the bridges.

The allowances for waterway appear to me to be on the whole as judiciously approximated to as possible in the absence of any close and lengthened observations of the different localities. When the Engineers get posted to their respective districts, and have opportunities of seeing the behaviour of the rivers and nullahs in flood, a better idea will be formed as to the sufficiency of the allowance.



5. Among the large rivers it seemed to me a matter of consideration whether the waterway allowed at the Palar ought not to be such that the normal width of channel is preserved unencroached upon. That is, that the clear aggregate span of the bridge ought not to be less than the clear width of river from bank to bank when in flood. The width of the Palar at the Railway crossing is (taken from Mr. Dibblee's working section) 2,217 lineal feet from bank to bank on the line of flood level of 1872. The aggregate clear span of the proposed bridge is 2,160 (120 × 18), being less than the clear width of the river by 57 lineal feet. Again, on a cross section of the river furnished by the Department of Public Works to Mr. Dibblee, there are two flood levels shown over a causeway about 4 miles above the Railway crossing. These levels record the flood heights during the cyclone of 1st May and of 23rd November 1872, and the area as calculated by me under each is 22,500 and 25,000 superficial feet respectively. The one flood is given at 9 inches higher than the other.

6. The area proposed at the Railway bridge under flood level gives only 21,600 superficial feet, or 3,400 superficial feet less than the maximum recorded in 1872 over the causeway. It must be remembered, however, that at the causeway the bed of the river is paved, whereas at the Railway it is free to scour in sand, and a very little increase in velocity and a slight scour (about 18 inches) over the bed of the river will discharge the maximum recorded at the causeway, and I am inclined to think therefore that a sufficiently safe allowance has been made.

7. As all that can be recorded on this subject is interesting and may be of value, I call attention to the appendix to Colonel O'Connell's paper* on the flood discharge of rivers. In this the flood discharge of the Palar at Arcot is given under a drainage area of 3,700 square miles at 4,160 cubic yards on the authority of Colonel Collyer, R.E., and at 10,000 cubic yards on the authority of tradition. Putting tradition aside as unreliable and taking the rate of discharge reported by Colonel Collyer, which is 30½ cubic feet per second per square mile drained, the discharge from the 6,000 square miles passed through the Railway bridge is 181,500 cubic feet, requiring with a velocity of 8 feet per second an area of 22,687 square feet. The drainage area however calculated from the Ordnance Map of India is about 4,000 square miles above Arcot, and taking this figure the discharge becomes 28 cubic feet per square mile, which gives an area required under the Railway bridge of 21,000 square feet. The results of the foregoing data stand thus :—

* See Proceedings of the Institution of Civil Engineers, session 1867-68, Vol. 27, page 215.

| | Square feet. |
|---|---|
| Area under flood levels at the causeway, square feet 22,500 to ... | 25,000 |
| Do. required at the Railway bridge, taking Colonel Collyer's data... | 22,657 |
| Do. do. corrected as to drainage area .... ... ... ... | 21,000 |
| Do. proposed by Mr. Dibblee ... ... ... ... ... ... | 21,600 |

8. With reference to the river Pooniar, I think it will be necessary to watch and provide against any tendency to "over draw" in times of heavy flood down the branch to the Guddelum ; otherwise the large bridge provided to pass the Pooniar may be relieved at the expense and to the danger of the smaller structure over the Guddelum.

9. Looking to the great increase in the price of iron since his estimates were framed, Mr. Dibblee is considering the expediency of substituting masonry instead of iron cylinders and screw piles for the piers of the large bridges. I think that the result will be one of considerable economy.

10. Although not strictly within the limits to which my attention has been directed by the Consulting Engineer's reference, yet upon the same grounds upon which it was made (the prospect of amalgamation) I take the liberty to suggest, for consideration, the advisability of reducing the steepness of the ruling gradient from 1 in 146 to 1 in 200.

11. I have gone into some approximate calculations (see Appendix A), the result of which shows that a considerable saving in working would be ensured by such a reduction.

12. I estimate that the annual saving in working expenses on goods traffic alone would be about Rupees 10,000. The extra earthwork and masonry would cost about Rupees 60,000 or

Rupees 3,000 per annum in interest at 5 per cent. The net saving therefore to the Revenue Account of the undertaking would be Rupees 7,000 per annum (*i.e.*, Rupees 10,000—3,000).

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*Appendix A. to accompany letter No.* 1,678 *of* 28*th June* 1873, *to Agent.*

To approximate to the relative values of the gradients (between Madras and Cuddalore) of 1 in 140 and 1 in 200 take the length of Railway to be constructed at 128 miles.

Then 128 £ 5,000 a mile = £ 640,000. Ten per cent on £ 640,000 = £ 64,000 gross revenue to pay 5 per cent. on capital expended. Assume half earnings come from goods = £ 32,000, = say, Rupees 3,20,000, and this at one anna per ton per mile gives 5,120,000 ton miles,

$\frac{5,120,000}{128 \text{ miles}}$ = 40,000 tons moved over the whole length of the line.

Say that 40,000 tons of goods involve 40,000 tons dead weight in rolling stock, and the weight hauled is 80,000 tons.

Assuming that the maximum load of an engine is 250 tons gross up 1 in 200 at the rate of 15 miles an hour, the same engine will only take 204 tons up an incline of 1 in 140.

Then $\frac{80,000}{250 \text{ tons}}$ = 320 engines for 1 in 200.

and $\frac{80,000}{204 \text{ tons}}$ = 392 do. 1 in 140.

Difference 72 engines more on account of the steeper gradient.

The locomotive expense on the Great Southern of India Railway amounted for the half-years ending 30th June and 31st December 1873 to 20·16 and 17·11 pence respectively per train mile; say an average for the year of 18·63 pence of 12 annas. Take the cost at Rupees 1 per train mile for the future on account of the great increase in cost of fuel. The above 72 engines extra required on account of grades of 1 in 140 give 9,216 train miles (72 × 128 miles) which, at Rupee 1 per mile, gives Rupees 9,216 in locomotive working.

It will be observed that I deal here with the goods traffic only, leaving out of account the transport of passengers, which is expected to be very large. I have also merely taken into account locomotive working expenses without any allowance for extra hands wanted in the Traffic Department from increased number of trains. I think therefore it may be fairly assumed that in this estimate I am well within the mark when I take Rupees 10,000 as the annual saving in working expenses, and to the adoption of a ruling gradient of 1 in 200.

I have taken out approximately the extra quantities of earthwork involved in flattening the gradients and it comes to 265,000 cubic yards, and this at the rate sanctioned for earthwork in Mr. Dibblee's estimates, Annas 3 per cubic yard, amounts to Rupees 49,687, adding Rupees 10,000 for additional masonry incurred, and in round numbers the extra cost of securing the ruling gradient of 1 in 200 is Rupees 60,000, or in interest at 5 per cent. Rupees 3,000 per annum, so that the saving in working expenses (*i. e.*, Rupees 10,000 saved in working, Rupees 3,000 extra due to construction) would be about Rupees 7,000 per annum taking goods traffic only into account.

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From J. T. FISHER, Esq., Agent and Manager, Carnatic Railway Company, to Lieutenant-Colonel J. H. M. SHAW-STEWART, R.E., Consulting Engineer for Railways, dated Madras, 2nd August 1873, No. 249.

With reference to your letters dated the 31st ultimo, No. 201, and dated the 27th March last, No. 93, I have the honour to submit herewith the copy of a report, dated 31st ultimo, No. 668, which I received yesterday from the Chief Engineer, and which deals with the questions referred to in paragraphs 4 and 5 of your letter No. 93, viz., as to the adequacy of the designs and estimates for bridges between Madras and Cuddalore; there being a practical unanimity of opinion between Messrs. Logan and Dibblee upon these questions, no observations upon them seem called for from me.

2. Incidentally the expediency of reducing the gradients from 1 in 140 to 1 in 200 has been raised, and I understand is recommended by the Chief Engineer of the Great Southern Company



on the ground of economy. Mr. Dibblee in his report appears to differ from the conclusions at which Mr. Logan has arrived on this point, but my experience in the working of Railways with heavy gradients leads me to the opinion that if only for the sake of regularity and convenience in the working of trains, it is desirable in all cases to make the gradients as easy as possible; I should concur therefore on this ground in the recommendation of Mr. Logan if the interest upon the extra cost of the work did not exceed the extra cost which would otherwise be entailed upon the working, and if it can be shown to be less, I am of opinion it should be accepted as a conclusive argument in favour of the proposed change.

3. With reference to paragraphs 7 and 8 of your letter No. 93, I communicated with the Agent of Great Southern Company, so long ago as the 11th March last, suggesting that we should meet to talk over the present and probable future positions of affairs, and subsequently, viz., on the 12th April, I supplied him with sketch plans of the buildings which had been proposed to be provided, for the purpose of enabling him to confer with Messrs. Sheward and Staunton preparatory to submitting the joint opinion called for from us as to any reduction that might be feasible in the buildings, rolling stock, and establishment proposed for this Railway, but I have not since received any communication from Mr. Betts upon these subjects, and in these circumstances I am enabled to submit my own individual opinions only.

4. As respects the buildings, I am of opinion that those proposed for the accommodation of the traffic, that is to say the goods and passenger stations in Madras and at the intermediate places, are as limited as is desirable, and that none can be dispensed with without detriment to the interest and convenience either of the Company or the public, or both. I think a building for the accommodation of stores will be necessary, and I am inclined to the opinion that in any event the head-quarters of the stores establishment should be at Madras, where there are facilities for receiving and purchasing supplies, which do not exist elsewhere in the district.

5. The buildings necessary for workshops will doubtless require revision; but it will be necessary to provide an engine stable with a small repairing shed attached, and I am of opinion that it would be false economy to dispense with the building proposed to provide shelter for a portion of the spare carriage stock, and in which carriages may be cleaned and lifted and small repairs effected.

6. With respect to the carriage and wagon plant, I am of opinion that no reduction is desirable, indeed in presence of the fact that the Company, being confined to its own resources solely owing to the difference of gauge, will be imperatively required ere long to increase the stock sanctioned in order adequately to accommodate the traffic, or else that they must forego a considerable revenue from traffic on festival occasions.

7. Some modifications may eventually be also made in the establishment, but until the lines are constructed and worked as one continuous undertaking, I am of opinion that only a small economy can be looked for.

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From F. L. DIBBLEE, Esq., Chief Engineer, to J. T. FISHER, Esq., Agent and Manager of the Carnatic Railway Company, dated Madras, 31st July 1873, No. 668.

Adverting to the Consulting Engineer's letter No. 93 of the 27th March, and in continuation of my No. 325, I have received from Mr. Logan a copy of his letter reporting further on the points on which an opinion was asked by the Government of India.

2. Mr. Logan's former letter had referred to the division of the line into districts, and to the amount of staff that would be required in my department. The questions now considered appear to be the adequacy of the designs and estimates of the bridges, and the sufficiency of the amount of estimate, as revised, to meet the cost of the work.

3. From the additional information that has been acquired regarding the price of quarrying, and to judge from the offers which I have received from petty contractors who are able to undertake the construction of masonry, I think the price fixed by the Consulting Engineer will be found less than the work will eventually cost, where stone and brick and stone quoins in the larger bridges are employed.

4. For the purpose of arriving at an exact estimate of the quantities required at each bridge and culvert, test pits are now being sunk to ascertain the nature and depth of foundation, and as soon as this information is obtained the correct quantities for each bridge shall be calculated and a revision of the estimate in this respect shall be submitted.

5. When preparing the original estimate all care was taken to collect the fullest information regarding rivers and nullahs and the extent of drainage areas, to ascertain the amount of waterway required in each case; and since then no opportunity has been lost to verify, as far as possible, the conclusions which were arrived at. The Engineer of each district will also hereafter take accurate observation of the effect of every flood that occurs, so that, I think, it will be possible before the works are all completed to have the fullest assurance as to the capacity of the bridges to pass the drainage.

6. On this subject I will remark that the situation of our line close to an old established public road has afforded facilities for arriving at a tolerably accurate estimate for our requirements, and there having been a most unusual flood in November last, after which notes were taken at every large bridge, has given means of checking information received from the officers in charge of the road and from the inhabitants of the country. The result of those observations had induced me to raise the level of some of the bridges, and to increase the size of others previous to the receipt of the communication now under reference. At the Guddelum crossing near Cuddalore, after an inspection of the country with the Consulting Engineer, it was also decided to add another span of 100 feet; allusion is made to this in the Consulting Engineer's postscript.

7. Mr. Logan has given calculations respecting the River Palar, and has expressed his opinion that the allowance I had made was sufficient; on examining the subject in the manner adopted by Mr. Logan, I found that there was an omission in the information supplied to him from this office: that the highest recorded flood had not been shown on the sections sent to him, so that there is really a much larger area of available opening below flood level (by 5,000 square feet) than was supposed and calculated by Mr. Logan, there is therefore an additional assurance of safety for the bridge.

8. The details of all increased waterways as above mentioned shall be furnished with the revised estimates of bridges.

9. When the design for the bridge over the River Coleroon was being fixed upon, it was found that owing to the enhanced cost of all iron work, as compared with what it formerly was, great economy might be effected by employing brick wells filled with concrete instead of iron cylinders. I therefore prepared a design (submitted with revised estimate for Southern Extension) for piers of brick wells, sunk to the hard substratum and finished off at the level of low water, to be finished with iron columns on top. I would now suggest, for consideration, whether a similar style of bridge might not be erected for the Palar river.

10. I send herewith a comparative estimate of a bridge with iron cylinders and with wells of brick work, from which it will be seen that there is a saving in using the wells even at the price of iron work originally entered, and which will be increased by the additional rise in price of iron which has since taken place.

11. With regard to the other large bridges over the Pooniar and Guddelum, where screw piles were proposed, I do not think much economy will be effected by substituting brick wells, and although on the Southern Extension I have recommended the wells where the bridges are in salt water, being really within reach of the tide, I think in the situations of the bridges above named it becomes a question of preferring one style of bridge to the other, with the consideration that in using wells a much greater proportion of money will be expended in the country.

12. Tracings of station arrangements and accommodation both at the terminus and on the line were forwarded to the officers of the Great Southern for their information and report, and I propose to defer any remarks that may be expected from me until they have considered the question.

*Proceedings of the Madras Government, Public Works Department,*
*8th September* 1873.

13. Mr. Logan has, in his report, suggested for consideration the propriety of reducing the ruling gradient from 1 in 140 to 1 in 200. When fixing the gradient on my original plans I was guided by the inclination and nature of the country in one or two places, and from a desire to reduce the first cost of the line and works to their lowest amount I introduced that gradient in all places where a saving could be effected by so doing. By more expenditure it certainly would be quite feasible to lower the limit of gradient, and, as Mr. Logan indicates, make the extreme load which a given engine can draw greater than at present. I do not, however, in calculating it, make the saving in working expenses so large in proportion to the extra cost of the work as Mr. Logan has done, and I think, by reducing the speed of heavy trains over the top of the steepest inclines, it will be found that an engine can take a load so nearly approaching the maximum that working expenses due to additional trains, which may be needed, will not amount to the interest on the extra cost to the works.

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*Summary of estimate for a bridge across the River Palar, consisting of* 18 *spans of* 120 *feet clear, each resting on* 19 *piers of two masonry cylinders* 10 *feet outside diameter, centre* 15′ 8″ *apart.*

| | | | Tons. | Total. |
|---|---|---|---|---|
| Wrought Iron— | | | | |
| 18 spans, superstructure at | ... ... ... ... | | 45·39 | 817·38 |
| 18 sets of Rollers and Frames | ... ... ... ... | | ·32 | 5·76 |
| In piers ... ... ... ... ... ... | | 4·85 × 19 | 92·15 | |
| | | | | 915·29 |
| Cast Iron— | | | Tons. | Tons. |
| In Piers ... ... ... ... ... ... ... | | 12 × 19 | 271·13 | |

| Quantities. | Description of charges. | Per. | Rate. | Amount. | Total. |
|---|---|---|---|---|---|
| | | | Rs. A. P. | Rs. A. P. | Rs. A. P. |
| 915·29 | Wrought Iron ... ... | Ton. | 300 0 0 | 2,74,587 0 0 | |
| 239·63 | Cast Iron ... ... ... | ,, | 200 0 0 | 47,926 0 0 | |
| 1,186·42 | Cartage over 45 miles ... | Ton a mile. | 0 5 0 | 16,684 0 6 | |
| 40 Feet. | Sinking 38 wells ... ... | Foot. | *18 0 0 | 27,360 0 0 | |
| 2,984 C. ft. | Teak sleepers (12″ × 8″) | C. feet. | 4 0 0 | 11,936 0 0 | |
| 1,247 ,, | Teak platform (18′ × 12″) | ,, | 4 0 0 | 4,988 0 0 | |
| 2,093·23 | Masonry ... ... ... | C. yd. | 8 0 0 | 16,745 13 5 | |
| 5,928 C. ft. | Covering Stone ... ... | C. feet. | 1 0 0 | 5,928 0 0 | |
| | | | | | 4,06,154 13 11 |

* Includes concrete filling.

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*Summary of estimate for a bridge across the River Palar, consisting of* 18 *spans of* 120 *feet clear resting on* 19 *piers of two cast iron cylinders,* 3′ 9″ *outside diameter.*

| | | | Tons. | Total. |
|---|---|---|---|---|
| Wrought Iron— | | | | |
| 18 spans, superstructure at | ... ... ... ... | | 45·39 | 817·38 |
| 18 sets of rollers and frames | ... ... ... ... | | ·32 | 5·76 |
| In Piers ... ... ... ... ... ... | | 1·26 × 19 | 23·87 | |
| | | | | 847·01 |

| | | Tons. | Total. |
|---|---|---|---|
| Cast Iron— | | | |
| In Piers 19 sets at ... ... ... ... ... ... | | 31·33 | 595·29 |

| Quantities. | Description of charges. | Per | Rate: Rs. | A. | P. | Amount. Rs. | A. | P. | Total. Rs. | A. | P. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 847·01 | Wrought Iron ... ... | Ton. | 300 | 0 | 0 | 2,54,103 | 0 | 0 | | | |
| 595·29 | Cast Iron ... ... ... | ,, | 200 | 0 | 0 | 1,19,058 | 0 | 0 | | | |
| 1,442·32 | Cartage over 45 miles ... | Ton a mile. | 0 | 5 | 0 | 20,282 | 10 | 0 | | | |
| 40 feet. | Sinking 38 cylinders ... | Feet. | *12 | 0 | 0 | 18,240 | 0 | 0 | | | |
| 2,984 C. ft. | Teak sleepers (12″ × 8″)... | C. ft. | 4 | 0 | 0 | 11,936 | 0 | 0 | | | |
| 1,247 ,, | Teak platform (15′ × 12″) | ,, | 4 | 0 | 0 | 4,988 | 0 | 0 | | | |
| | | | | | | | | | 4,28,607 | 10 | 0 |

* Includes concrete filling.

(Signed) F. L. DIBBLEE,
*Chief Engineer.*

No. 115. From Lieutenant-Colonel J. H. M. SHAW-STEWART, R.E., Consulting Engineer for Railways, to Colonel G. W. WALKER, R.E., Secretary to Government, Public Works Department, dated Madras, 14th August 1873, No. 441.

ADVERTING to my letter dated the 13th instant, No. 427, I have the honour to request that the instructions of the Government upon the points therein dealt with may be communicated to me with as little delay as possible, in order that no unnecessary time may be lost in sending to England the indents for the ironwork of the bridges.

No. 116. ORDER THEREON, 8th September 1873, No. 2,224.

RAILWAY, No. 20.

ORDERED that these papers be forwarded for the consideration of the Government of India.

(Here enter No. 2,225, dated 8th September 1873.)

(True Extract.)

Colonel, R.E.,
*Secretary to Government.*

To the Consulting Engineer for Railways.

Exd. S. T. Austin.
Spare Copies.

PUBLIC WORKS DEPARTMENT,
OOTACAMUND, *8th September* 1873.

No. 117.

No. 2,225.

FROM

COLONEL G. W. WALKER, R.E.,
*Secretary to the Government of Madras,*
*Public Works Department.*

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,
*Public Works Department.*

RAILWAY, No. 21.

SIR,—The Government of India having in their letter No. 306 G. R., dated 25th February 1873, expressed doubts as to the adequacy of the designs of bridges and the sufficiency of the estimates submitted for the line of Railway from Madras to Cuddalore, His Excellency the Governor in Council, having in view the approaching amalgamation of the Carnatic and Great Southern of India Railways, remitted the subject for the consideration and joint report of the officials of the two Companies. The papers herewith transmitted are the result of that reference.

2. It will be observed that the general sufficiency of the estimates as revised by the Consulting Engineer is admitted, with an increase to the rate for masonry in the large bridges involving a total addition of Rupees 10,000 to the cost of those works.

3. With regard to waterway it will be noticed that, as far as previous experience has enabled a judgment to be formed, the general opinion is that the allowance has been judiciously fixed, but that a thoroughly reliable estimate can only be obtained after the Engineers shall have had more opportunities of watching the action of the streams to be crossed.

4. Attention is invited to the proposed substitution of masonry wells for iron cylinders and piles in the construction of the bridges over the Palar, Pooniar, and Guddelum rivers, a measure of probable economy rendered desirable by the enhanced price at which iron is now selling in the home markets. And the proposal to reduce the ruling gradient of the line from 1 in 140 to 1 in 200, suggested by the Chief Engineer of the Great Southern of India Railway, seems to His Excellency the Governor in Council, under the circumstances represented by the Consulting Engineer, to be worthy of adoption.

5. Finally, it is explained that, pending the preparation of revised estimates for bridges, and the revision of the estimates in detail for the portions of the line which will be affected by the proposed alterations of the gradients, no increase to the sum of Rupees 69,93,904 already sanctioned need be made.

I have the honour to be,
Sir,
Your most obedient servant,

Colonel, R.E.,
*Secretary to Government.*

Exd. S. T. Austin.
Spare Copies.

# Great Southern of India Railway.

## Letter from the Chief Engineer to Agent dated Madras 30th June 1873 No 1678.

Referring to your letter No 1082 of 3rd April 1873 enclosing copy of a letter from the Consulting Engineer, in which, in view of the probability of an amalgamation between the Carnatic and Great Southern of India Railway Companies, he asks for an expression of opinion first, as to the adequacy of the Estimates for the works of the Carnatic Railway as they stand required by Government between Madras and Suddatore, and second as to the adequacy of the designs and estimates of the bridges on the same length of line. I have already in my No 1067 of 4th May 1873 discussed the subject of the Engineer Establishment, and now turn to the remainder of the question under, first the adequacy of the Estimates.

I have gone as carefully as possible with the means at my disposal into the matter of the cost of work, and agree generally with the Consulting Engineer in his modifications of the Carnatic Estimate, with the exception that I consider it will be necessary to allow Rupees 12 per Cubic yard for the Masonry of the large bridges especially if the work is to be of stone. The masonry in the piers, and their cut, wales and quoins requires to be of a superior quality to ensure stability in these comparatively thin structures.

To arrive at a satisfactory decision as to the sufficiency of the sum total allowed for all masonry works, it will be necessary to ask for Details to take out the quantities in the works for every variation

x No 146 of 29th March 1873 Madras.

in the height of each, instead of assuming one average height for each type of bridge and applying that to the whole line.

I presume that for the purposes of departmental check over the expenditure, this detailed information will be taken out in any case.

Second. The adequacy of the designs and estimates of the bridges.

The allowances for waterway appear to me to be on the whole as judiciously appropriated to as possible in the absence of any close and long-continued observations of the different localities. When the Engineers get posted to their respective districts, and have opportunities of seeing the behaviour of the rivers and nullas in flood, a better idea will be formed as to the sufficiency of the allowances.

Among the large rivers it seemed to me a matter of consideration whether the waterway allowed at the Polar ought not to be such that the normal width of channel is preserved unencroached upon. That is, that the clear aggregate space of the bridge ought not to be less than the clear width of river from bank to bank when in flood. The width of the Polar at the Railway Crossing is, (taken from the Pibbles working section) 2,217 lineal feet from bank to bank on the line of flood level of 1872. The aggregate clear space of the proposed bridge is 2,160 (120 × 18) being less than the clear width of the River by 57 lineal feet. Again, on a cross section of the river furnished by the Department of Public Works to the Pibbles there are two flood levels shown over a Causeway about 4 miles above the Railway Crossing. These levels record the

flood

the flood heights during the Cyclone of January and of 23rd November 1892 and the areas as calculated by me under each is 22,500 and 25,000 superficial feet respectively. The one flood is given at 9 inches higher than the other.

The area proposed at the Railway bridge under flood level gives only 21,600 superficial feet or 3,400 superficial feet less than the maximum recorded in 1892 over the Causeway. It must be remembered however that at the Causeway the bed of the river is paved while at the Railway it is free to scour in sand; and a very little increase in velocity and a slight scour (about 18 inches) over the bed of the river will discharge the maximum recorded at the Causeway, and I am inclined to think therefore that a sufficiently safe allowance has been made.

As all that can be recorded on this subject is interesting and may be of value I call attention to the appendix to Colonel O'Connell's paper on the flood discharge of the rivers, &c. where the flood discharge of the Palar at Arcot is given under a drainage area of 3,700 square miles at 4,160 cubic yards on the authority of Colonel Colleys R. E. and at 10,000 cub. yards on the authority of Tradition. Putting tradition aside as unreliable and taking the rate of discharge reported by Colonel Colley which is 30¼ Cub. feet per second per square mile drained, the discharge from the 6000 square miles passed through the Railway Bridge is 181,500 Cubic feet, requiring with a velocity of 8 feet per second an area of 22,687 square feet. The drainage area however calculated

from

x See Proceedings of the Institution of Civil Engineers session 1867. 68 Vol. 27 Page 216.

from the Ordnance Map of India) is about 4,000 square miles above Attock, and taking this figure the discharge becomes 38 Cubic feet per square mile, which gives an area required under the Railway Bridge of 21.000 square feet. The results of the foregoing data stand thus:—

| | 67 ft. |
|---|---|
| Area under flood levels at the Causeway | 22.500 to 25.000 |
| Do required at the Railway Bridge taking Colonel Pollyer's data | 22.657 |
| Do Do corrected as to drainage area | 21.000 |
| Do proposed by Mr Delisle | 21.600 |

With reference to the river Poonar I think it will be necessary to watch and provide against any tendency to "overdraw" in times of heavy flood down the branch to the Cuddalam; otherwise the large bridge provided to pass the Poonar may be relieved at the expense and to the danger of the smaller structure over the Cuddalam.

Looking to the great increase in the price of iron since last estimates were framed Mr Gibbs is considering the expediency of substituting masonry instead of iron Cylinders and Screw piles for the piers of the large bridges. I think that the result will be one of considerable economy.

Although not strictly within the limits to which my attention has been directed by the Secretary's reference, yet upon the same grounds upon which it was made (the prospect of Amalgamation) I take the liberty to suggest for Consideration the advisability of reducing the steepness of the ruling gradient from 1 in 146 to 1 in 200.

Chairs

I have gone into a rough approximate Calculation (see appendix A) the result of which shows that a considerable saving in working would be ensured by such a diversion.

I estimate that the annual saving in working Expenses on goods traffic alone would be about Rupees ten thousand. The extra Earthwork and Masonry would cost about Rupees 60,000. or Rupees 3,000 per annum at 5%. The net saving therefore to the Revenue account of the undertaking would be Rupees 7,000 per annum (ie Rupees 10,000 - 3,000).

Appendix A to accompany letter No 1678 of 28 June 1893 to Agent

To approximate to the relative values of the gradients (between Madras and Luddalore) of 1 in 140 and 1 in 200 take the length of Railway to be constructed at 128 miles

Then 128 £ 5000 a mile = £ 640,000

Ten per cent on £ 640,000 = £ 64,000 gross revenue to pay 5 per cent on Capital expended. Assume half Earnings come from Goods = £ 32,000 = say Rs 320000 - and that at one anna per ton per mile gives 5,120,000 ton miles.

$\frac{5120000}{128 \text{ miles}}$ = 40,000 tons moved over the whole length of the line

Say that 40,000 tons of Goods involve 40,000 tons dead weight in rolling Stock and the weight hauled is 80,000 tons.

Assuming that the Maximum load of an Engine is 250 tons gross up 1 in 200 at the rate of 15 miles an hour, the same Engine will only take 204 tons up an incline of 1 in 140.

Then $\frac{80,000 \text{ tons}}{250 \text{ tons}}$ = 320 Engines for 1 in 200

and $\frac{80000}{204 \text{ tons}}$ = 392 do 1 in 140

Difference 72 Engines more on account of the steeper gradient

The Locomotive expenses on the Great Southern of India Railway amounted for the half years ending 30th June and 31st December 1892 to Rs. 16 and 17-11 pence respectively per train mile - Say an average for the year of 18-83 pence or 12 annas. Take the Cost at Rs 1/- per train mile for the future

&c

on account of the great increase in cost of fuel. The above 72 lugnies extra required on account of grades of 1 in 1140 give 9216 train miles, (72 x 128 miles) which at Rs 1/- per mile gives Rs 9216 in Locomotive working.

It will be observed that I deal here with the Goods traffic only leaving out of account the transports of passengers which is expected to be very large. I have also never taken into account the Locomotive working expenses without any allowance for extra hands wanted in the Traffic Department from increased number of trains. I think therefore it may be fairly assumed that in this Estimate I am well within the mark when I take Rs 10000 as the annual saving in working expenses and to the adoption of a rising gradient of 1 in 200.

I have taken out approximately the extra quantities of Earthwork involved in flattening the gradients and it comes to 2,65,000 Cubic yards and this at the rate mentioned for earthwork in Mr Dobbie's Estimates comes 3 per Cubic yard amounts to Rs 49687 adding Rs 10,000 for additional Masonry incurred and in round numbers the extra cost of securing the rising gradient of 1 in 200 is Rs 60000 on which interest @ 6% Rs 3600 per annum so that the saving in working expenses (ie Rs 10,000 saved in working. Rs 3000 extra due to Construction) would be about Rs 7000 per annum taking Goods traffic only into account.

(True copy)
Wm Cathcart
Chief Clerk

Carnatic Railway Co (Ltd)

Summary of Estimate for a bridge across the River Palar consisting of 18 spans of 120 ft clear each resting on 19 Piers of two Masonry Cylinders 10 ft outside diameter centre 15' 8" apart –

| | | | |
|---|---|---|---|
| Wrought Iron | | Tons | Total |
| 18 spans superstructure | @ 45.39 | | 817.38 |
| 18 sets of Rollers & frames | | .32 | 5.76 |
| In Piers | Tons 4.85 × 19. | | 92.15 |
| | | | 915.29 |
| Cast Iron | | | |
| In Piers | Tons 12 × 19 | | Tons 271.13 |

Carnatic Railway Co (Ltd)

Summary of Estimate for a bridge across the River Palar consisting of 18 spans of 120 ft clear each resting on 19 Piers of two Cast Iron Cylinders 3'-9" outside diameter –

| | | | |
|---|---|---|---|
| Wrought Iron | | Tons | Total |
| 18 spans superstructure | @ 45.39 | | 817.38 |
| 18 sets of Rollers & frames | | .32 | 5.76 |
| In Piers | Tons 1.26 × 19 | | 23.87 |
| | | | 847.01 |
| Cast Iron | | | |
| In Piers 19 sets | @ | Tons 31.33 | 595.29 |

| Quantities | Description of Charges | Rate Per | Rate Rs | as | Amount Rs | as | Total Rs | as |
|---|---|---|---|---|---|---|---|---|
| 915.29 | Wrought Iron | Ton | 300 | — | 27,458 | — | | |
| 595.29 | Cast Iron | " | 200 | — | 47,926 | — | | |
| 1442.32 | Cartage over 45 miles | Ton miles | " 5 | — | 16684 | 6 | | |
| 40 ft | Sinking 38 Wells | Foot | × 18 | — | 27,360 | — | | |
| 2984 Cft | Teak Sleepers (12" × 8") | Cft | 4 | — | 11,936 | — | | |
| 1247 " | Teak Platforms (18" × 2") | " | 4 | — | 4,988 | — | | |
| 293.23 | Masonry | Cyd | 8 | — | 16,745 | 3 5 | | |
| 928 Cft | Covering Stone | Cft | 1 | — | 5,928 | — | | |
| | | | | | | | 4,06,154 | 13 11 |

× includes Concrete filling –

| Quantities | Description of Charges | Rate Per | Rate Rs | as | Amount Rs | as | Total Rs | as |
|---|---|---|---|---|---|---|---|---|
| 847.01 | Wrought Iron | Ton | 300 | — | 254,103 | — | | |
| 595.29 | Cast Iron | " | 200 | — | 1,19,058 | — | | |
| 1442.32 | Cartage over 45 miles | Ton miles | " 5 | — | 20282 | 10 | | |
| 40 ft | Sinking 38 Cyl | Ft | × 12 | — | 18,240 | — | | |
| 2984 Cft | Teak Sleepers (12" × 8") | Cft | 4 | — | 11,936 | — | | |
| 1247 " | Teak Platforms (18" × 12") | " | 4 | — | 4,988 | — | | |
| | | | | | | | 4,28,607 | 10 |

Fredk Dobbs
Chief Engineer

× includes Concrete filling –

Carnatic Railway Company, Limited,

AGENT'S AND MANAGER'S OFFICE,

MADRAS, 2nd August 1873

17

No. 249.

From

I. I. Fisher Esqre.

Agent & Manager.

Carnatic Railway Coy.

To

Lieut Col. J. H. M. Shaw Stewart R.E.

Cons. Engr. for Railways.

Madras.

Sir.

With reference to your letters dated the 31st Ulto No. 201. and dated the 27 March last No. 93: I have the honor to submit herewith the copy of a report dated 31st Ulto. No. 668. which I received yesterday from the Chief Engineer and which deals with the questions referred to in paras 4 and 5 of your letter No. 93. viz: as to the adequacy of the designs and estimates for Bridges between Madras & Cuddalore; there being a practical unanimity of opinion between Messrs. Logan & Dibblee upon these questions no observations upon them seem called for from me.

Incidentally the expediency of reducing the gradients from 1 in 140. to 1 in 200. has been raised, and I understand is recommended by the Chief Engineer of the G. P. Coy on the ground of economy; Mr. Dibblee in his report appears to differ from the conclusions at which Mr. Logan has arrived on this point. but my experience in the working of Railways with heavy gradients leads me to the opinion that if only for the sake of regularity and convenience in the working of trains, it is desirable in all cases to make

the

the gradients as easy as possible; I should concur therefore on this ground in the recommendation of Mr. Logan if the interest upon the extra cost of the work, did not exceed the extra cost which would otherwise be entailed upon the working, and if it can be shown to be less I am of opinion it should be accepted as a conclusive argument in favor of the proposed change.

With reference to paras 7 & 8 of your letter No. 93 I communicated with the Agent of G.S. Co. so long ago as the 11 March last suggesting that we should meet to talk over the present and probable future positions of affairs, and subsequently viz on the 12 April I supplied him with sketch plans of the buildings which had been proposed to be provided, for the purpose of enabling him to confer with Messrs Steward & Stanton preparatory to submitting the joint opinion called for from us as to any reduction that might be feasible in the Buildings, Rolling Stock, and Establishment proposed for this Railway but I have not since received any communication from Mr. Betts upon these subjects, and in these circumstances I am enabled to submit my own individual opinions only.

As respects the Buildings I am of opinions that those proposed for the accommodation of the traffic, that is to say the goods and passenger stations in Madras and at the intermediate places, are as limited as is desirable, and that none can be dispensed with



with without detriment to the interest and convenience either of the Co. or the public or both. I think a building for the accommodation of Stores will be necessary, and I am inclined to the opinion that in any event the head-quarters of the Stores establishment should be at Madras where there are facilities for receiving and purchasing supplies which do not exist elsewhere in the district.

The buildings necessary for workshops will doubtless require revision, but it will be necessary to provide an Engine Stable with a small repairing shed attached and I am of opinion that it would be false economy to dispense with the building proposed to provide shelter for a portion of the spare carriage stock, and in which carriages may be cleaned and lifted and small repairs effected.

With respect to the carriage and wagon plant I am of opinion that no reduction is desirable indeed in presence of the fact that the Co. being confined to its own resources solely owing to the difference of ~~gauge~~ guage, will be imperatively required ere long to increase the stock sanctioned in order adequately to accommodate the traffic, or else that they must forego a considerable revenue from traffic on Festival occasions.

Some modifications may eventually be also made in the Establishment, but until the lines are constructed and worked as one continuous undertaking, I am of opinion that

that only a small economy can be looked for.

I have the honor to be
Sir
Your most Obedt. Servant.

Jos. D. Fisher
Agent & Manager.

From
The Agent Manager
Con. Ry. Co.

To
The Comr. Engr.
for Railways.

Dated 2 Aug. 1873.
Rec'd 4. Aug. 1873.

No. 2449.

Forwards the further report upon the estimate &c. for the Iron Bridges Mussaoo & Caddalore prepared in view of the Annaji anicut with the P.W.D. Engr.

P.W. 4578 B/73.
P.C. 20. 2244 of 1873.
Ex. 1873.

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No 25

Railway Department.

Consulting Engineer's Office.

No. 441.

From

Lieut.-Colonel J. H. M. SHAW STEWART, R.E.,

*Consulting Engineer for Railways,*

To

Colonel G. W. WALKER, R.E.,

*Secretary to Government,*
*Public Works Department,*
*Fort Saint George.*

Sir,

Adverting to my letter dated the 13th instant, No. 427, I have the honour to request that the instructions of the Government upon the points therein dealt with may be communicated to me with as little delay as possible, in order that no unnecessary time may be lost in sending to England the indents for the iron-work of the bridges.

I have the honour to be
Sir
your most obedient Servt

J. Shaw Stewart Lt. Col. R.E.
Consg. Engineer for Railways

Madras
18th August 1873

Sec. Circulation
18/8/1

49

P. W. 1873 Depart.
Pro. offg Sec. for Dept.

RAILWAY DEPARTMENT.

1873.

From No. 4588.

The Consulting Engineer
for Railways,

To

The Secretary to Government,
P. W. Department,
Fort Saint George.

Dated 18th Augt. 1873.

Recd. 19 Augt. 1873.

No. 441

Requesting early instructions on Cons. Engineer's No 427 dd 13 Augt 1873, as that no time be lost in the transmission of the minute of Sylvand.

No. 2224-2225- Dt Sept

Ltr 115

Sent to Col. Walker 19 Sept 1873 Ord. Dept

Railway Department. CONSULTING ENGINEER'S OFFICE.

No. 427.

From

LIEUT.-COLONEL J. H. M. SHAW STEWART, R.E.,

*Consulting Engineer for Railways,*

To

COLONEL G. W. WALKER, R.E.,

*Secretary to Government,*

*Public Works Department,*

*Fort Saint George.*

SIR,

In the Proceedings of Government dated the 26th March 1873 No. 947, I was instructed to obtain from the Agents and Chief Engineers of the Great Southern and the Carnatic & Railway Companies an expression of their joint opinion as to the adequacy of the revised estimates to meet the cost of the proposed works

works on the line from Madras to Cuddalore. I was also instructed to obtain such joint report from the Chief Engineers as should set at rest the doubts as to the designs and estimates of the bridges upon that line, which were entertained by the Government of India on a comparison with those sanctioned for the line from Trichinopoly to Tuticorin with my letter dated the 19th May 1873, No 277. I laid before Government the opinions of the Chief Engineers as to the strength of the Engineering staff

From Agent G.I.P.Ry. No 3091 of 3rd July 1873 with enclosures
" do " 2449 " 2nd Sept 1873 — do —
" do Carnatic Ry. —

staff required for the construction of the line, and I have now the honour to submit letters from the Agents of the two Companies, giving cover to reports from the Chief Engineers as to the sufficiency of the revised estimates, as sanctioned by the Government of India, and as to the adequacy of the designs and estimates for the bridges.

2. It will be seen that Mr. Logan agrees generally as to the correctness of the modifications made in the estimate in this office; but he considers that it will be necessary to allow Rs 12 per cubic yard for the masonry

of

of the large bridges, especially if the work is to be of stone.

The original estimates contemplated brick as the material to be used in the masonry of the large bridges; and the rate as revised in this office, Rs 10 per cubic yard, ought in my opinion to secure work of the best description. The increase of Rs 2 per cubic yard, suggested by Mr. Logan, will entail an addition of only some ~~Rs 10,000~~ to the estimates. From Mr. Dibblee's report I gather that he accepts Mr. Logan's opinion both as to the general sufficiency of the revised estimates, and as to the

necessity



necessity of a slight addition to the rate for masonry in the large bridges.

3. In paragraph 8 of the note appended to my letter dated the 4th October 1872, it was pointed out that Mr. Dibblee's estimates were, in many instances, mere average estimates; and that, in the case of every minor bridge and culvert, an average depth of foundations and an average height of banto had been assumed. Mr. Logan explains that, owing to this defect in the estimates, it is impossible to give a satisfactory opinion as to the sufficiency

of

× Vide Proceedings of Govt. of Beng. 18th Dec. 1872. No 2851

of the total sum allowed for masonry works. It will be seen from Mr. Dibbles report that test-pits are now being sunk at the site of each minor bridge and culvert, in order to ascertain the nature and depth of foundation; and that a revision of the estimate in this respect will be submitted as soon as the necessary information has been obtained.

4 As regards the suitableness of the designs of the bridges, and their adequacy for passing the flood waters of the respective rivers, Mr. Logan is of opinion that the allowances for waterway have been judiciously fixed;



fixed, but that a more trust-
worthy estimate will be formed
after the Engineers have been
posted to their districts, and
have had opportunities of
watching the various streams
when in flood. Mr. Dibble
explains the data upon which
his calculations were framed;
and he states that during the
severe flood in November 1872
observations were taken at every
large bridge on the public
road which runs parallel to
the proposed railway, with the
result of increasing them to raise
the level of some of the bridges,
and to increase the size of others.

In

In the case of the Palar river, Mr. Logan shows from figures quoted in his report that in his opinion a sufficiently safe allowance of waterway has been made; and Mr. Dibblee explains that, owing to an error in the drawing furnished to Mr. Logan, there is in reality a much larger area of available opening below flood level (by 5000 superficial feet) than was assumed in Mr. Logan's calculations, and that there is therefore additional assurance of safety.

Mr. Logan alludes to the possibility of the large bridge provided for the Ponnai river being relieved at the S. expense and to the danger of the smaller bridge over the Cuddelum; and with reference to this, Mr. Dibblee mentions that, during an inspection on which he accompanied me in March last, it was decided to increase the waterway at the latter river by an additional opening of 100 feet.

5 The question of the amount of waterway provided along the line received very careful consideration from me before the submission of the estimates to Government; and I have lately had an opportunity of going over the whole line

line with the Chief Engineers and of examining upon the ground the impressions made in the case of every river and stream. I do not hesitate to state my opinion that the proposed allowance of waterway is upon the whole ample. The only large bridge to which I suggested an increase was that over the Guddelum river, to which allusion is made above. It is not easy to make a trustworthy comparison between the requirements of the Cuddalore line, and those of the Great Southern extension to Tuticorin. There is not only a considerable difference in the

climate



climates of the districts through which the two lines run, and in the nature of the soil, as observed by the Government of India; but it must be remembered that all the large rivers which are crossed by the Cuddalore line are relieved of a considerable portion of their waters before they reach the railway, a condition which does not apply to the rivers on the Tuticorin line.

6. The Government are aware that the sanctioned designs provide, in the case of the Palar river, for piers formed of screw cylinders, and, in the cases of the Ponnair and Guddelum rivers, for piers formed of screw

piles.

piles. The great rise in the price of iron since the estimates were framed makes it more than doubtful whether these arrangements for the piers are the most economical. I have discussed the subject on several occasions with the two Chief Engineers and we were unanimous in thinking that it would be desirable to substitute masonry wells for the iron cylinders and piles. This point is alluded to in the enclosed reports and Mr Dibblee has submitted an estimate showing the comparative cost of bridging the Polar with piers formed of cast iron cylinders having an external diameter of 3 feet 9 inches, and

with



with piers formed of masonry wells having an external diameter of 20 feet; the piers in each case being filled with concrete and sunk to reach the hard substratum below the river bed. The estimate shows that, taking iron at the price at which it stood more than a year ago, a saving of Rs 2,2000 would result from the adoption of masonry wells. The present price of iron would increase this sum considerably.

In the cases of the Poonar and Cuddelum rivers, Mr Dibblee does not think that much economy would be effected by substituting masonry wells for

screw

screw piles, and says that it becomes a question of preferring one style of bridge to the other: upon the supposition that there is not much difference of cost between the two structures, my opinion is decidedly in favour of using the masonry piles in preference to the screw piles. The consideration mentioned by Mr. Dibble, that in using piles a much greater proportion of the cost will be spent in India, seems to me entitled to much weight; but, apart from that, I prefer them as offering a more certain and more stable support to the superstructure.

7. Mr. Logan, in his report, touches



touches upon the question of the ruling gradient, which was fixed by Mr. Dibble at 1 in 140, and suggests for consideration the expediency of modifying it to 1 in 200. In an appendix to his report he gives some calculations from which he draws the conclusion that by reducing the steepness of the ruling gradient, there would be an annual saving in working expenses, on the gross traffic returns, of about Rs 17,000. He estimates the cost of extra earthwork in flattening the gradients at Rs 50,000, and of masonry at

Rs

£10,000. Allowing for interest at 5 per cent on the increased outlay, he thus shows that the net annual saving would be about £7000. Mr Dibble is however of opinion that the saving in working expenses would not be so large as estimated by Mr Logan; and he believes that by reducing the yield of heavy trains over the top of the steepest inclines it will be found that an engine can take a load so nearly approaching the maximum that working expenses due to additional trains which may be needed will not amount to the interest on the extra cost to the work."

The Agent of the Great Southern



28

Southern Railway makes no allusion to this question; but Mr Fisher expresses his opinion decidedly in favour of reducing the ruling gradient, provided that the interest upon the additional cost does not exceed the extra working expenses which would otherwise be entailed.

After carefully examining the points at issue, I am inclined to agree with Mr Dibble that the saving under the head of working expenses, as estimated by Mr Logan, is somewhat in excess of what may fairly be counted upon. The cost of the additional earthwork and masonry seems to me however to be

be accurately calculated; and I have no doubt that the saving in working expenses will be more than sufficient to cover the comparatively small sum, Rs 3,000 per annum, which represents the interest upon this additional outlay. Looking to the fact that the ruling gradient proposed by Mr. Logan, 1 in 200, will also be the ruling gradient upon the line between Coddalore and Tanjore, and bearing in mind the importance of maintaining a uniform ruling gradient upon as long a stretch as possible of continuous line, I have no hesitation in strongly recommending the adoption



adoption of the change suggested by Mr. Logan.

8. It does not seem necessary that any application should be made at present for an increase to the sum sanctioned for constructing the line. Referring to paragraphs 2 and 3 of this letter, I think it would be well to wait for the revised estimate of the bridges, promised by Mr. Dibble, before proposing an increase in the rate allowed for masonry. In the event of the proposed substitution of masonry wells for iron cylinders and piles being approved of, the change will not be attended with increased outlay. And with

× 16,69,522
83,382
1,06,39,044

1 in 200

with regard to the proposed alteration in the ruling gradient, the preparation of revised plans and estimates in detail, for the parts of the line affected, will be necessary in the event of the change commending itself to His Excellency the Governor in Council.

I have the honour to be,
Sir,
Your most Obedt Servant,

[signature]
Lieut Coll R.E.
Cons. Engr. for Railways

Madras
13 Augt 1873

RAILWAY DEPARTMENT.
1873.
No. 4506.
From
The Consulting Engineer for Railways,
To
The Secretary to Government, P. W. Department, Fort Saint George.
Dated 13 August 1873.
Recd 19 [illegible]

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No. 2224

Proceedings of the Madras Government.

Read the following

From the Cons Engr for Rys H.E. No. 427 d/ 13 Aug/73
Do — do — do — H.E. No. 441 d/ 18 [illegible]

Ordered that these papers be forwarded for the consideration of the Government of India.

To
The Cons. Engr. for Railways.
S.C. [illegible] 15/9/73

H.E. No. 7

No. 2225

To
The Secretary to the Government of India.

Sir,

The Government of India having in their letter No. 306 G.P. dated 25th February

February 1873 expressed doubts
as to the adequacy of the
designs of Bridges and the
sufficiency of the Revised
estimates submitted for the
line of Railway from
Madras to Cuddalore, His
Excellency the Governor in
Council having in view
the approaching amalga-
mation of the Carnatic
and Great Southern of India
Railways, remitted the sub-
-ject for the consideration
and joint report of the Offi-
-cials of the two Companies.
The papers herewith trans-
-mitted are the result of
that reference.

It will be observed
that



that the general sufficiency
of the Estimates as revised
by the Consulting Engineer
is admitted with an in-
-crease to the rate for mid-
-dowry in the large bridges
involving a total addition
of Rupees 10,000 to the
cost of those works.

With regard to
waterway it will be no-
-ticed that as far as pre-
-vious experience has ena-
-bled a judgment to be
formed the general opinion
is that the allowance had
been judiciously fixed, but
that a thoroughly reliable
estimate can only be
obtained after the Engineers
shall have

have had more opportunities of watching the action of the streams to be crossed.

Attention is invited to the proposed substitution of masonry wells for iron cylinders and piles in the construction of the bridges over the Palar, Ponnar and Guddelur rivers, a measure of probable economy rendered desirable by the enhanced price at which iron is now selling in the home markets. And the proposal to reduce the ruling gradient of the line from 1 in 140 to 1 in 200 suggested by the Chief Engineer of the Great Southern



Southern of India Railway seems to His Excellency the Governor in Council under the circumstances represented by the Consulting Engineer to be worthy of adoption.

Finally it is explained that pending the preparation of revised estimates for bridges, and the revision of the estimates in detail for the portions of the line which will be affected by the proposed alterations of the gradients no increase to the sum of Rs 69,93,904 already sanctioned need be made.

G.O.M.

No 6

G.O. dated with the previous Para - 15/9/13

4588
4506

Govt. of {1873}. Madras.

PUBLIC WORKS.

To The Commissioner of Railways
& The Secretary to the Govt of India

Dated

Recd. Encl. 5

G. O. 8th Sept. 1873, No. 2224-2225

Nos. 114 & 116 117

Railway from Madras to Cuddalore

The reports submitted by the Consg: Engrs. on the Estimates &c. for the line of Railway from Madras to Cuddalore, ordered to be forwarded for the consideration of the Govt of India.

Resubmitting Estimates for bridges &c. on the line of Railway from Madras to Cuddalore