CORRESPONDENCE

RELATIVE TO THE

CONSTRUCTION OF LIGHT RAILWAYS.

PRESENTED TO BOTH HOUSES OF THE GENERAL ASSEMBLY, BY COMMAND OF HIS EXCELLENCY.

WELLINGTON.

1870.

CORRESPONDENCE
RELATIVE TO THE CONSTRUCTION OF LIGHT RAILWAYS.

No. 1.

The New Zealand Commissioners to the Hon. W. Gisborne.

(No. 25.)

Sir,— London, 20th May, 1870.

We have the honor to forward herewith a letter just received from Messrs. Sir Charles Fox and Sons, Railway Engineers, on the subject of cheap lines of railway. There is no time to do more than send the letter, but we hope before next mail to be able to supplement it by further information.

We have, &c.
F. D. Bell,
I. E. Featherston, } Commissioners.

The Hon. Wm. Gisborne.

Enclosure 1 in No. 1.

Sir Charles Fox and Sons to the New Zealand Commissioners.

Gentlemen,— Spring Gardens, S.W., 19th May, 1870.

Herewith we beg to hand you a formal letter upon the subject of railway extension; and should the Government desire to go further into the matter, it will afford us much pleasure to act for them as their Consulting Engineers or Engineering Agents on this side, in concert either with Colonial Engineers or with an Engineer to be sent from here, if necessary.

We believe that from our now extended experience of light railway construction, we can suggest many ways of effecting economy in carrying out the proposed extensions.

If you can spare the time to examine our drawings and samples, we shall be happy to place ourselves at your disposal for the purpose.

We must apologize for the drawings being rather hastily prepared, but the time is rather short.

We have, &c.,
Charles Fox and Sons.

P.S.—The drawings above referred to, shall follow to-morrow.

The New Zealand Commissioners.

Enclosure 2 in No. 1.

Sir Charles Fox and Sons to the New Zealand Commissioners.

(No. 2173.)

Gentlemen,— Spring Gardens, S.W., 19th May, 1870.

Understanding that the Government of New Zealand and the Provincial Governments are again entertaining the question of railway extension, we have the honor to enclose herewith some copies of memoranda, and also two drawings and a photograph of a locomotive, descriptive of the system of light railways, with which we have for some years been identified.

Its main features are so fully described in the memoranda, that we need hardly dwell at length upon them.

We attribute the great success which has attended the system, both on our lines, and on those of the Norwegian Government,—of which Mr. Carl Pikl is the Engineer,—to the fact that the rolling loads and the speeds having been once determined upon, every detail has been specially designed to suit those conditions,—the earthworks, bridges, permanent way on the one hand, and the locomotives and the rolling stock on the other, being properly adapted to each other.

The result has been, that on the railway from Arconum to Conjeveram, in India, which has now been at work for five years, and where, on a gauge of 3′ 6″, iron rails weighing 35½ lbs. to the yard are used for locomotives weighing 14 tons on six wheels, and rolling loads not exceeding 3½ tons on a wheel, it has been found (see the official Reports of the Company) that the line can be safely used up to forty miles an hour, including stoppages, whilst the working speed is only fifteen miles an hour. It has also been found that the permanent way, in consequence of the reduced rolling loads, costs very little to maintain, and the Company have not had to replace any rails since the line was opened. Although the traffic is small generally, during certain festival days in the year as many as 22,000 persons have travelled over the railway. The traffic has been worked cheaply and without accident.

The cost of this line constructed by the Company's officers was £3,200 per mile, including telegraph and stations, or £3,900 per mile including all management and rolling stock.

The Queensland railways, though from the difficult nature of portions of the country and the high price of labour they were more costly, have been equally successful in their working.

In Canada two companies are now engaged in the construction of some 200 miles on this system; and there, profiting by our earlier experience, and using native materials wherever they can, the cost of thoroughly efficient railways, including rolling stock, management, and all other expenses, has been reduced within £3,000 per mile.

The gauge is 3′ 6″; the rate of wages for unskilled men, 4s. 2d. per day, and the country undulating with ravines at intervals of several miles, but with very few bridges.

If for the purposes of the traffic in New Zealand, speeds of fifteen miles an hour, and rolling loads of three tons upon a wheel will be sufficient, then the cost of construction may be again reduced—as an iron rail, weighing 30 lbs. to the yard, properly fastened, and laid upon sleepers not more than 2′ 6″ apart, from centre to centre, will be amply sufficient. We have more than once used locomotives exactly suitable for such a railway, which have given great satisfaction.

The question of gauge is one of great importance, especially if the country to be traversed, as in Queensland, requires the use of sharp curves, when a narrow gauge enables large savings to be effected.

The light system is, however, applicable to any gauge; for instance, it is now being applied to the Indian gauge of 5′ 6″.

With all the particulars of the proposed route before us, we should be able to advise distinctly upon the question of gauge. We will suppose, however, a gauge of 3′ 6″ to be adopted, with minimum curves of 350 feet, and maximum gradients of 1 in 40.

Taking, then, an average country not involving very heavy bridges, making the earthworks twelve feet wide at formation, fencing the line with native timber, with American cattle-guards at the road crossings, using timber trestle-bridges (as per design enclosed of those which have given great satisfaction in Norway) for crossing ravines, and in all cases, except where large spans are required, in which event light iron lattice-bridges would be used, using native sleepers 6′ 0″ long by 6″ by 3″, 2′ 6″ apart centre to centre, with 30 lb. iron rails, flat-bottomed, properly fished, and secured by one fang bolt at each joint, and intermediately by dogspikes, properly strutted round curves, and ballasted to the extent of 3,000 cubic yards per mile of single line, with a fair allowance of sidings and passing-places, with stations small but neatly designed, and of native materials throughout, except such fittings as may be more cheaply obtained here, with an ample supply of locomotives and rolling stock for a very fair passenger and goods traffic, and with a telegraph throughout, the land being found by the Government, we estimate, approximately, the average cost per mile of single line, for not less than 100 miles, at from £3,500 to £4,000 sterling.

This estimate is upon the assumption that native materials will be used as far as possible, that the earthworks, bridges, and other works, will be let in short lengths and by competition, that cash will be paid for all materials &c., and that proper economy is exercised throughout.

The estimate includes £400 per mile for rolling stock (including locomotives), an ample allowance for management, agency, engineering, &c., and 10 per cent. for contingencies. It is based upon a rate of wages for good unskilled labour at 6s. per diem, and we have allowed £4 per ton upon all materials from this country to cover freight, insurance, and delivery upon the line. If these rates can be reduced, a proportionate saving would be effected. Through level country there would be a saving of £500 per mile.

The railway so estimated for would be thoroughly substantial and well constructed in every detail, and would be capable of being worked and maintained at small cost.

The locomotives would probably weigh about 15 tons, on six wheels, four being driven.

The passenger carriages would be 8 feet wide, and could be arranged either on the English or the American system, as desired. If the latter system were adopted they would probably have six wheels, 31 feet long exclusive of platforms, would seat thirty passengers, and would be fitted with well-tried arrangements, enabling them to pass with ease round sharp curves.

The goods waggons would be 8 feet wide, and on four wheels; their length probably 15 feet. They would thus be light and handy for shunting.

The centre of gravity of the rolling stock would be kept as low as possible. The very best tires, springs, and other fittings would be used throughout.

We shall be happy to prepare for the Government any further information which you may desire.

We have, &c.,

The New Zealand Commissioners, London. CHARLES FOX AND SONS.

Enclosure 3 in No. 1.

MEMORANDA as to LIGHT RAILWAYS, from Sir CHARLES FOX and SONS.

THESE railways are constructed upon the following principles:—

1st. That they shall be suitable for working speeds of 25 miles an hour, including stoppages.

2nd. That they shall carry rolling loads not exceeding a pressure of 4 tons by any wheel upon the rail, being the maximum load upon the wheel of any ordinary railway waggon or carriage in Great Britain.

3rd. That none but the best quality of materials and workmanship be used on them.

4th. That, as far as possible, the materials used be those of the country which they pass through.

5th. That, in designing the rolling stock, the centre of gravity be kept as low and the dead weight reduced as much as possible.

6th. That the gauge be fixed according to the circumstances of each case.

7th. That, subject to the above conditions, rigid economy be exercised throughout.

The following railways, which have been constructed or are in course of construction under our advice, are examples of this system :—

The Queensland (Australia) Government Railways...	...	222 miles.
The Railway from Conjeveram to Arconum, India ...	...	19 „
The Toronto, Grey, and Bruce Railway, Canada, 1st section		90 „
The Toronto and Nipissing Railway, Canada, 1st „		103 „

And also the following, with which we were not connected :—

The Government Railways of Norway ...	... ...	101 „

These railways are all of the 3′ 6″ gauge, which, while economical, gives sufficient width for powerful locomotives, and to insure great steadiness of running to the trains.

To use a narrower gauge than this for a railway to carry passenger traffic, we believe to be a mistake.

A broader gauge is, for speeds of twenty-five miles an hour, and moderate traffic, in our opinion, quite unnecessary, and involves considerable additional expense, especially if the country be a heavy one.

The question of gauge is, however, one which requires careful and independent consideration in each instance, especially if there be already railways in the country, with which the proposed line is likely to be connected; and we would especially call attention to the fact that the light system can be applied to any gauge. Thus the Carnatic Railway Company of India (guaranteed by the Government) are about to construct their railway of 5′ 6″ gauge, and 120 miles long, on this system, under the advice of a member of our firm.

The mode of construction adopted on these various lines being very similar, though not identical, may be summarized as follows :—

1st. Fencing, on both sides, of either wire or native timber.

2nd. Earthworks, having a width at formation level, in cuttings from 15′ 6″ to 12′ 6″, on embankments 13′ 0″ to 12′ 6″, with maximum gradient of 1 in 40, and minimum curves of 350 feet radius.

3rd. Bridges. 1. With masonry piers and abutments. 2. With timber framing. Strong timber trestle work for crossing ravines not exceeding fifty feet deep, does not, where timber is plentiful, cost more than 45s. per foot run for a single line.

The superstructures of the bridges of large span generally consist of iron girders, and of the smaller spans of timber trusses, but in some cases timber has been successfully adopted for spans of 80 feet and upwards.

The bridges are calculated for rolling loads of three-quarters of a ton per lineal foot of single line.

The weight of iron in main and cross girders and bracing is as follows for a single line :—

50 feet span	...	...	...	...	14 tons.
60 „	...	...	...	...	20 „
100 „	...	...	...	...	43 „

4th. Permanent way. Flat-bottomed iron rails, 35 to 40 lbs. to the yard, or steel rails 35 lbs. to the yard, laid on transverse hard wood sleepers, generally measuring 6′ 6″ x 8″ x 6″ rectangular, laid from 2′ 6″ to 3′ 0″ apart, centre to centre, well fished and secured by fang-bolts at the joints, and elsewhere by dogspikes; ballasted with gravel or coarse sand to the extent of 3,000 c. yards per mile of single line.

5th. A telegraph erected throughout.

6th. Stations, in some cases of iron, but generally of timber, of neat but economical design.

7th. Locomotives. Of these three types are now used, viz., goods engines and tenders, the engines weighing 20 tons in running order, and having eight wheels, of which six are coupled. Passenger engines and tenders, the engines weighing about 16 tons in running order, and having six wheels, of which four are coupled. Tank engines, weighing about 13 tons in running order, and having six wheels, of which four are coupled. And there are now in course of construction goods engines having six wheels, all coupled, with side play to leading and trailing wheels, and weighing about 19 tons in running order. All materials used in the locomotives are of the very best quality.

8th. Rolling stock. The outside width of carriages varies from 6′ 6″ to 8′ 0″, and either the English or American arrangement of the interior is adopted. The stock is made light but of the best materials, the centre of gravity is kept low, and all is arranged for passing round sharp curves with ease. For this purpose the American bogie, or still better, Clark's radial system for six wheels, is adopted. All springs and tires are of the best steel.

9th. The working speed varies from 12 to 25 miles an hour, including stoppages; but, when required, trains have been run for distances of 60 miles and upwards, at an average speed of 30 miles an hour, including stoppages.

10th. The cost of the railways is as follows, including in each case stations, rolling stock, engineering, and all management expenses :—

The Queensland railways—
Skilled labour, 10s. to 12s. per day.
Ordinary labour, 6s. to 7s. per day.
Materials chiefly sent from England.
Average cost per mile (exclusive of mountain incline), £6,550.

The railway from Conjeveram to Arconum—
Land and portion of roadbed given by Government.
Materials chiefly sent out from England.
Average cost per mile, £3,900.

The Canadian railways—
Ordinary labour, 4s. 2d. per day.
Only rails, fastenings, locomotives, portion of rolling stock, and a few fittings sent from England.
Average cost per mile, including land, and steel rails, £2,900.
The Government railways of Norway—
Rails and many other materials sent from England.
1st. Through easy country, per mile, £3,270.
2nd. Through heavy country, per mile, £4,660 to £5,382.

11th. The cost of working these lines is very much the same per train mile, or per ton, as on ordinary railways; but in consequence of the low speeds and light rolling loads, there is on these light railways a most important saving in wear and tear, both of permanent way and rolling stock.

Having given these few facts, which we think cannot fail to interest those who desire the spread of railway communication in countries yielding but a light traffic, we would simply repeat that the light system of construction which we advocate, and which we shall be happy to co-operate in extending as far as possible, is not limited to any particular gauge, but consists in adapting the construction to the necessary speed, and to the requirements of the traffic in each case, at the same time using the best materials and workmanship.

Our experience shows that through country of any ordinary character, where land is cheap and heavy bridges are not required, and where labour is obtainable at moderate rates, thoroughly efficient railways of the 3′ 6″ gauge can be completed, including everything, for £3,000 per mile.

CHARLES FOX AND SONS,
Civil Engineers,
8, New Street, Spring Gardens, London.

22nd March, 1870.