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MADRAS RECORD OFFICE.

Government of Madras.

Public works **DEPARTMENT.**

G.O. No. 471 Press ~~Mis.~~

186-87

Dated 10- 2 1870.

Not to be folded or roughly handled

Proceedings of the Madras Government, Public Works Department,
10th February 1870.

No. 186. Read the following circular from the Government of India, Public Works Department, (Railway,) dated Fort William, 11th January 1870, No. 1 :—

Carrying capacity of Waggon Stock.

Read again—

Public Works Department Circular, No. 9, (Railway,) of 1867.
Do. do. do. Resolution, No. 648—52-R, of 15th June 1868.
Do. do. do. do. ,, 1,309—13-R, of 5th November 1869.
Do. do. do. Circular, No. 10, (Railway,) of 1869.
Despatch to Secretary of State, No. 93, of 1868.
Do. to do. do. ,, 50, of 1869.

Read also—

Despatch from Secretary of State, No. 68, of 1869.
Office Note, dated 29th November 1869, by the Under-Secretary, (Railway Branch.)

OBSERVATIONS.—Circular No. 9 of 1867 expressed generally the opinions entertained by the Government of India regarding the loss of power entailed by the inappropriate character of much of the waggon stock on Indian Railways, and the Governor-General in Council requested that the proportion between unremunerative and paying load should be seriously considered by the Railway authorities and the defects remedied as soon as possible.

2. This subject has during the past two years been carefully discussed, and the Government of India have noticed with satisfaction that the necessity for improvement has been very generally acknowledged by the Railway Companies, and a proportion of five to eight between dead and paying load is now commonly thought to be attainable; but the Government of India remain very far from satisfied with this result, and are convinced that this vitally important subject has yet to be dealt with in the thorough manner which it deserves. With the view of spreading detailed information and inviting further discussion, copies of the reports on this subject by the Consulting Engineers to Indian Railway Companies lately received from the Secretary of State, should be distributed.

3. The Governor-General in Council would again invite Railway Engineers and Managers to continue to consider what new form of waggon is likely to be most economical, and what modification of their existing waggons is best suited to improve their effective carrying capacity.

4. Mr. Bidder's suggestion to invite the Locomotive Engineers and Managers of Railways in India to furnish specifications and descriptions of the most useful and suitable classes of waggon stock suggested by their experience may be usefully adopted, and the several local Governments should be requested to give effect to it and forward the results to the Government of India when received.

5. The question of the proper loading of waggons calls for increased attention; it is obvious that the reduction of dead weight in the waggon to its minimum may have no useful effect if waggons and trains are not better loaded than they now are. The accounts of the best paying lines in India show that the average loads are not one-half what they would be if the waggons were properly filled; and making every allowance for difficulty in always obtaining full

loads, it is evident that much improvement is possible, and that a serious responsibility for the present unsatisfactory state of affairs rests with Traffic Superintendents and their subordinates.

6. The question of the most economical speed for a goods traffic is closely connected with that of the character of the waggons in which it goes on. The problem to solve is, how to carry the goods at the smallest cost possible compatible with the other conditions involved. Having established what speed gives the most economical result as far as mere haulage is concerned, the question next has to be considered, whether there are any classes of goods which will bear a higher rate for a higher speed or for earlier delivery, and whether the system commonly adopted in Continental Europe of dividing the goods traffic into fast and slow, may not usefully be followed in India, it being understood that the terms fast and slow apply not necessarily to the actual speed of the trains but rather to the time occupied in the despatch and delivery of the goods. It is understood that one of the main difficulties in getting the waggons properly filled arises at the smaller stations where the quantities of goods tendered for despatch do not amount to a full waggon-load. In such cases the system of slower delivery would admit of time being allowed to give the vehicles their full loads. In like manner some modification of the form or size of waggon may be found desirable to suit the different circumstances of a large, full through traffic, and of a scattered pick-up traffic of articles tendered in small quantities. With these remarks the Governor-General in Council will leave the whole question for the further consideration of the highly intelligent officers engaged in the construction of the vehicles and the working of the traffic of Indian Railways.

ORDER.—Ordered that copies of these Observations, of the Reports of the Consulting Engineers to the several Railway Companies, and of the Office Note be forwarded to the Governments and Administrations noted in the margin.

Madras.	N. W. Provinces.
Bombay.	Punjab.
Bengal.	Oudh.
Hyderabad.	

(Signed) E. C. S. WILLIAMS, Major, R. E.,
Deputy Secy. to the Govt. of India.

To the Secretary to the Government of Madras, Public Works Department, (Railway.)

No. 187. ORDER THEREON, 10th February 1870, No. 471.

RAILWAY, No. 17.

COMMUNICATED to the Consulting Engineer for Railways, who will draw the attention of the Agents of the Madras and Great Southern of India Railways to the suggestions of the Government of India, and will obtain and submit the specifications and report called for in paragraph 4.

(True Extract.)

Colonel, R. E.,
Secretary to Government.

To the Consulting Engineer for Railways.

Exd. A. S. Rodgers.

Enclosure to Circular No. 1 *Railway.*

No. 68, dated 6th October, 1869.

From—*The Secretary of State for India,*

To—*The Government of India,*

Upon receipt of the Despatch of His Excellency your predecessor in Council, No. 93, of the 15th June 1868, Sir Stafford Northcote caused copies of its enclosures to be forwarded to the several Railway Companies, with a request that their Consulting Engineers might be invited to state how far in their opinions the most approved English, Continental, or American patterns of wagon rolling-stock, or modifications of the same, are applicable to Indian Railways.

2. I now transmit, for your Excellency's information, copies of the Reports of the several Consulting Engineers, the last of which has only just been received.

Dated 21st August, 1868.

From—G. BERKLEY, Esq.,

To—T. R. WATT, Esq.

I beg to acknowledge the receipt of your letter of the 23rd June 1868, requesting me to communicate with the Consulting Engineer of the other Indian Railways upon the subject of lubricators of axle-boxes, with the view of adopting an uniform system of lubrication, especially upon the Railways where interchange of rolling-stock will be effected, to report my views and recommendation in the matter, and of the accompanying documents as scheduled in the margin.

28th November 1867. Mr. W. Knox, Traffic Manager, to Major-General Rivers.
6th December 1867. Mr. Thomson, Agent's Secretary, to Mr. Curry, Agent to the Bombay, Baroda and Central India Railway.
9th December 1867. Mr. Curry to General Rivers.
17th December 1867. General Rivers to Mr. Charlton, Locomotive Superintendent.
18th December 1867. Mr. Charlton to General Rivers.
23rd December 1867. Mr. Thomson, Agent's Secretary, to Mr. Knox, and copy of Report of Directors of the Madras Company.

2. Also of your letter of the 25th June 1868, instructing me to consider the subject of the carrying power of the rolling-stock of the Company, and to report thereon, with my advice, and such recommendations as might occur to me to submit for the guidance of the Board in disposing of the question, and of the accompanying documents, as scheduled in the margin.

9th March 1868. Colonel Dickens, Secretary to the Government of India, to the Secretary to the Government of Bombay, with copy of documents as to East Indian wagon stock.
21st September 1867. Colonel De Lisle, to the Agent, with copy of Circular No. 9 R, and copy of Government Resolution of 17th September 1867.
25th September 1867. Memorandum to Acting Locomotive Superintendent.
26th " " Mr. Charlton, to General Rivers.
30th " " Colonel DeLisle, to the Agent.
2nd October " Memorandum to Acting Locomotive Superintendent.
5th " " Mr. Charlton, to General Rivers.
1st November " General Rivers, to Colonel DeLisle.
Extracts from Major Bonus's letter of 10th December 1867.
Ditto ditto of 23rd " "
31st December 1867. General Rivers, to Mr. Charlton.
22nd January 1868. Major Bonus, to the Consulting Engineer for Railways.
31st " " Colonel DeLisle, to the Agent.
21st February " Memorandum from the Consulting Engineer for Railways, with Government Resolution of 17th September 1867.
17th March 1868. Secretary to Government of India, to Consulting Engineer for Railways.

3. Also of your letter of 12th August 1868, in reference to the question of the proportion between the dead-weight of rolling-stock and the load carried, and requesting me to prepare a report on the subject to be submitted to the Board on its re-assembling, and of the accompanying documents, as scheduled in the margin.

15th June 1868. Government Despatch, with accompanying memorandum, correspondence, &c.

4. It will be convenient to convey my remarks on the subjects referred to in these three letters in one Report.

5. I have communicated with the Consulting Engineers of the East Indian Railway Company, the Madras and the Eastern Bengal Railway Companies, and the Scinde Railway Company, and I know the views entertained by the advisers of the Bombay, Baroda and Central India Railway Company, on the subject of the lubrication of axle-boxes.

6. There appears to exist an unanimous opinion that oil axle-boxes should be exclusively employed on these lines in preference to those lubricated with grease.

7. I append a copy of a letter on this subject addressed to me by Mr. Hawkshaw.

8. It is, in my opinion, very desirable that an uniform system of lubrication should be established on Indian Railways, especially on those which are likely to exchange the use of wagons.

9. By uniformity, I mean that oil should be used for the purpose of lubricating, and not that identically the same details of axle-box should be adopted by all the Companies, which, though advantages would result therefrom, is, I believe, impracticable on so extensive a system of Railways, consisting of many lines, on each of which the Locomotive Department is under a separate and responsible Superintendent.

10. On the Madras Railway and Eastern Bengal Railway, "Carr's oil axle-boxes" and "Blackman's oil bags" are employed.

On the Scinde Railway, "Beattie's oil axle-boxes" have been adopted.

On the Bombay, Baroda and Central India, Beattie and Blackburn's oil-boxes are used.

On the Great Indian Peninsula Railway, a simpler method of lubricating the journal, by merely placing "waste" saturated in oil under the journal, has been adopted for some time with satisfactory results.

The East Indian Railway Company, I have reason to believe, will adopt one of these plans.

10*a*. Though preferring the oil axle-box on the Great Indian Peninsula Railway, on account of its simplicity and the facility with which any defect can be rectified in any part of India, I do not consider that the adoption of any of the above-named arrangements presents a serious objection to the vehicles to which it is applied being run on other Railways.

11. Upwards of 6,000 vehicles of the rolling-stock of your Company have been, or are being, manufactured with oil axle-boxes, and 1,000 sets of oil axle-boxes have been sent to India to replace grease boxes as convenient opportunities for so doing present themselves.

12. I reccommend that oil axle-boxes should be supplied to re-place all the remaining grease boxes in such proportions and at such times as may be recommended by your Locomotive Superintendent, whose attention should be directed to the subject.

13. The proportion between the "dead-weight" and the "carrying-power" of rolling-stock is a subject of great importance, and, as such, received much and careful attention from me in connexion with the wagons of your Company when I was at Bombay in the early part of 1867.

14. Much valuable information thereon is contained in the documents accompanying your letters of 25th June and 12th August, on which I will comment concisely before making such remarks as occur to me in relation to the stock of your Company.

15. The statements contained in the 6th para. of the observations of Colonel Dickens, dated 15th June 1868, have been written under a misapprehension, inasmuch as—

1st.—I never decided nor concurred in the decision to construct 25 wagons of iron, &c., but, on the contrary, informed the Agent at the Officers' meetings, when the question of so doing was raised, that there were no designs for such wagons then produced as would enable me to form an opinion thereon, and that a full and careful consideration whether it was desirable to construct the Company's wagons of iron, into which I had entered a short time previously, had led me to the conclusion that it was not expedient to do so. I understand that the subject was deferred for such further consideration by me as I considered it deserved. I am not of opinion that it is for the interest of the Company that this experiment should be tried. Were, however, a new rolling-stock now to be designed for your Railway, and having in view the large cost of teak and low price of iron, I am not prepared to say that I should not recommend the adoption of iron underframes.

2nd.—General Rivers has not ordered with my concurrence "an additional pair of wheels to the existing low-sided wagons," nor do I think it wise, nor is it in accordance with the best practice on English Railways that a third pair of wheels should be added thereto. The Locomotive Superintendent represented that he had 100 pairs of wheels of smaller diameter than the rest of the wheels, which might, he thought, be inexpensively and with some advantage put under 100 of the wagons supplied at a very early date, the springs of which wagons were too light. I acquiesced in the decision that these should be so placed under the wagons at the same time that I expressed my opinion that it was not desirable to adopt a six-wheeled wagon stock.

16. I agree with the statements in the 4th and 5th paras. of the letter of Major Bonus, No. 101, dated 22nd January 1868, as to the width of the "brasses" being limited to one-third of the circumference of the journal, and of their being composed entirely of brass. In both respects this is now the practice on your Railway.

17. There appears to be an almost unanimous expression of opinion by the Locomotive Superintendents in India that the dead-weight of the wagon stock cannot be reduced, due regard being paid to the necessary strength. With this opinion I agree.

18. There appears also to be a general concurrence of opinion among the Locomotive Superintendents in India that the weight carried in one wagon cannot be advantageously increased to much above 8 tons.

19. This opinion is, I believe, consistent with the latest practice on English Railways, and, so far as my recollection serves me, the observations I made, while visiting the principal lines of Railway on the Continents of Europe and America, showed that the same is true with respect to them.

20. In the design of wagons the following points appear to me to be those which it is the most necessary to keep in view:—

1st.—The capacity and form of wagons which will most conveniently meet the requirements of the traffic to be accommodated.

2nd.—The strength of the wagon which is necessary to prevent undue wear and tear, or premature destruction, consequent on the severe strains to which it is subjected when loaded and drawn along the line, and especially when shunted at the stations.

3rd.—The number of wheels and the strength and stiffness of springs which are required to support the wagon, and the maximum load which it is designed to carry; and

4th.—The size of axle and journal which will bear the gross load and run without heating.

21. It is desirable that each of these points should be determined by the application of experience and mechanical knowledge.

22. The several capacities (*viz.*, the floor area of low-sided and cubic contents of high-sided and covered wagons) of your stock have been adopted on the recommendation of the Traffic and Locomotive Superintendents or other responsible Officers of the Company in India.

23. Such alterations in the height of sides, or such other detailed arrangements as have appeared desirable for the more convenient conveyance of the commodities forming the goods traffic on your Railway, have been made, and doubtless will continue to be made by these Officers as the necessity presents itself.

24. In the 2nd para. of Mr. Lovelock's communication, No. 1838 G, dated 25th September 1867, addressed to Captain F. S. Stanton, Royal Engineers, it is stated that want of capacity is not the fault of the existing goods wagons on the East Indian Railway. There is some evidence to the same effect contained in other documents with respect to other Indian Railways. Personal experience enables me to express an opinion that the statement is true with respect to the wagon stock on your Railway.

25. By reference to a tabulated statement of the proportionate weights, capacities, and bearing powers of wagons on several lines of Railway, which is appended hereto, it will be seen on the second sheet that the capacity of the wagon stock, which has been for some time past, and is now being sent to Bombay, is considerably in excess of similar classes of wagon stock recently made for the principal English railways.

26. The statement of capacities, &c., of wagons has been compiled from information respecting the most improved wagons, derived from the five best constructors of rolling-stock, and the Superintendents of four of the principal Railways in England.

27. In the 1st para. of the Circular No. 9 R, dated 2nd September 1867, Colonel Dickens states, "it is further believed that since the introduction of Railways into India, great progress has been made in such matters" (referring to the wagon stock) "in England, while the corresponding advance has not extended to this country" (India). The latter part must have been written under a misapprehension as to what had been done.

28. On your Railway, European experience has been brought to bear on the designs of rolling-stock of a capacity suited to the requirements of your traffic.

29. Soon after my return from India in 1867, I addressed a report to the Board (extracts from which I take the liberty of appending hereto), from which it will be seen that arrangements were then suggested by me to make the carrying-power of all the existing wagon stock,

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20. In the design of wagons the following points appear to me to be those which it is the most necessary to keep in view:—

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2nd.—The strength of the wagon which is necessary to prevent undue wear and tear, or premature destruction, consequent on the severe strains to which it is subjected when loaded and drawn along the line, and especially when shunted at the stations.

3rd.—The number of wheels and the strength and stiffness of springs which are required to support the wagon, and the maximum load which it is designed to carry; and

4th.—The size of axle and journal which will bear the gross load and run without heating.

21. It is desirable that each of these points should be determined by the application of experience and mechanical knowledge.

22. The several capacities (*viz.*, the floor area of low-sided and cubic contents of high-sided and covered wagons) of your stock have been adopted on the recommendation of the Traffic and Locomotive Superintendents or other responsible Officers of the Company in India.

23. Such alterations in the height of sides, or such other detailed arrangements as have appeared desirable for the more convenient conveyance of the commodities forming the goods traffic on your Railway, have been made, and doubtless will continue to be made by these Officers as the necessity presents itself.

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25. By reference to a tabulated statement of the proportionate weights, capacities, and bearing powers of wagons on several lines of Railway, which is appended hereto, it will be seen on the second sheet that the capacity of the wagon stock, which has been for some time past, and is now being sent to Bombay, is considerably in excess of similar classes of wagon stock recently made for the principal English railways.

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28. On your Railway, European experience has been brought to bear on the designs of rolling-stock of a capacity suited to the requirements of your traffic.

29. Soon after my return from India in 1867, I addressed a report to the Board (extracts from which I take the liberty of appending hereto), from which it will be seen that arrangements were then suggested by me to make the carrying-power of all the existing wagon stock,

except the cotton wagons (which are exceptional), equal to 7 tons of net load per wagon, and an increase was then decided on to the strength of the springs and axles of all wagon stock to be supplied in future, which would make them capable of carrying a net load of 8 tons.

30. An examination of the statement of proportionate weights, &c, hereinafter referred to, will show that the wagon stock being provided for your Railway compares favorably with wagon stock of the most approved descriptions recently constructed for English, European, and other Railways, inasmuch as generally its capacity and the bearing powers of its springs and axles are greater, and the proportion of its dead-weight to its capacity and bearing power is less.

31. It will also be observed in this statement, which comprises information respecting many thousands of wagons designed by the experienced Superintendents of several of the most important English and European Railways, that four wheels are invariably adopted in preference to six, or any other number of wheels.

32. In considering this subject, it should be remembered that the wagon axles supplied for your Company are of Bessemer steel, which makes an axle which is much stronger, and which will run cooler than axles made of iron.

33. After the most careful consideration of this important subject, I am not prepared to recommend the Board to adopt any material deviation from the present design of the wagon stock of your Railway, nor can I admit the correctness of the supposition "that a serious loss of money is occasioned by the inappropriate character of your wagon stock."

Dated 26th June, 1868.

From—JOHN HAWKSHAW, Esq.,
To—G. BERKLEY, Esq.

With reference to your enquiry as to the use of oil axle-boxes on the Madras Railway, I beg to inform you that I have sent out several of "Carr's oil axle-boxes," and a few of "Blackburn's oil bags." I am not able to give you the precise number of each. Better results have been obtained from oil than from grease, and with a saving in cost. The end sought to be obtained is to use oil, instead of grease, throughout the whole of the stock on the Madras Railway and I believe this will be accomplished before very long. I enclose you, for your information, a copy of some recent correspondence that has been sent me by the Secretary of the Madras Railway relative to the use of oil axle-boxes.

P. S.—I am also trying oil axle-boxes on the Eastern Bengal Railway, and with satisfactory results.

Extract from Locomotive Superintendent's Report, dated 13th February 1868.

I have modified the axle-boxes of most of the engines and tenders, and am altering the whole of them. A saving of Rs. 1,600 per month has been already effected in the consumption of oil by this modification, to say nothing of an almost perfect immunity from hot axles, and a marked improvement in the free running of the engines, and I feel convinced that the alteration of the whole of the axle-boxes of all vehicles, so as to allow of the use of oil, instead of grease, would not only be productive of great saving in reducing the expense of lubrication, but would also so much reduce the resistance due to the friction on the journals, as to lead to a great saving in fuel, and at the same time enable the trucks to carry with safety an increased weight of from 30 to 40 per cent. of freight.

Dated 23rd January, 1868.

From—W. B. WRIGHT, Esq., *Locomotive Superintendent,*
To—Agent and Manager, Madras Railway Company.

With reference to the Order of Government, dated 11th January 1868, No. 96, I beg to state, for your information and that of the Government, that the wagon referred to in the 9th para. of my letter No. 186 of the 3rd October 1867, as having been fitted up with a set of Carr's patent oil axle-boxes, has, since that time, been running on the line, and has carried loads of from 8 to 9 tons without showing the slightest tendency to run hot.

The bearing springs and general structure of our good stock being sufficiently strong to carry this weight with safety, I would beg to suggest, for the consideration of the Government and the Board of Directors, the expediency of altering or modifying our axle-boxes in such manner as to enable them to carry loads of from eight to nine tons.

I can so modify our present axle-boxes, by simply removing the keys, so that the expense will not be great, whilst the great increase of freight that our goods stock will then be able to carry will, in a very short time, re-pay the expense involved in the alteration.

Dated 26th March, 1869.

From—W. B. WRIGHT, Esq., *Locomotive Superintendent,*
To—Agent and Manager, Madras Railway Company.

With reference to the Consulting Engineer's letter No. 25, dated 28th January, on the subject of the cost of fitting up 100 wagons with Carr's patent oil axle-boxes, I beg to inform you that it will not, in my opinion, answer our purpose to make this alteration to a portion only of our stock, as such special arrangements would have to be made to give these few vehicles the attention they would require as would suffice for the whole of our rolling-stock were it altered.

The outlay that would be involved by the discarding of our present box, and the substitution of Carr's patent oil axle-boxes, would be very considerable, perhaps Rs. 60 or Rs. 70 per wagon; but I believe that an alteration can be effected that will answer equally well, by the substitution of an altered keep, which should not cost more than Rs. 15 or Rs. 20 per wagon.

I am about to try an experiment with a wagon, which I am having fitted up on the latter principle, and I am also trying experiments with the patent oil bags recently sent out by the Board, and will, in due course, let you know the result.

Statement of proportionate Weights, Capacities, and Bearing-Powers of Wagons on several Lines of Railway. (Sheet No. 1.)

Name of Railway.	Class of Vehicle.	Dimensions of Body. Inside. Length.	Width.	Height at the Centre.	Height at the Side.	Capacity. Area of the Floor.	Cubical Contents.	Wheels. Number of.	Journals. Length.	Diameter.	Product of the Length × the Diameter.	Springs. Distance Centre to Centre of Spring Shoes.	No. of Plates.	Width of Plates.	Thickness of Plates.	Product of the Total Thickness × the Width.	Weight. Total Weight when empty.	Averages. Weight. When empty.	Capacity. Area of Floor.	Capacity. Cubical Contents.	Journals. Product of the Length × the Diameter.	Springs. Distance from Centre to Centre of Shoes.	Springs. Product of the Total Thickness × the Width.
(*4 ft. 8½ in. Gauge*).		Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.		In.	In.	In.	Ft. In.	No.	In.	In.	In.	Tons. Cwt.	Tons. Cwt.	Ft. In.	Ft. In.	In.	Ft. In.	In.
London and North-Western								4															
Ditto	Low-sided, open	15 0	7 1½	0 9	0 9	107 0		4	6	3	18	3 6	14	3	5 5/16	15 15/16	3 15						
Ditto	Ditto	15 0	7 1½	1 8	1 8	107 0	...	4	6	3	18	3 6	14	3	5 5/16	15 15/16	4 0						
Ditto	Ditto	15 1	7 2	0 8½	0 8½	108 1	...	4	6	3	18	3 6	12	3	4⅛	13⅛	4 1	4 0⅝	107 6⅜	...	18	3 6	14 7/8
Ditto	Ditto	15 1	7 2	1 9	1 9	108 1	...	4	6	3	18	3 6	13	3	4 1/16	12 3/16	4 2						
Ditto	Ditto	15 0	7 2	1 10	1 10	107 6	...	4	6	3	18	3 6	12	3	4⅛	13⅛	4 4						
Ditto	Covered	12 10	6 6	6 2	5 6	83 5	486 9	4	6	3	18	3 6	14	3	5 5/16	15 15/16	4 10	4 15½	94 1	548 10⅛	18	3 6	14 3/8
London and South-Western	Ditto	15 4	6 10	6 2	5 6	104 9	611 0	4	6	3	18	3 6	12	3	4¼	13¼	5 1						
Ditto	High-sided, open	15 0	7 2	5 3	3 3	107 6	456 10	4	7	3½	24½	3 2	11	3	4¼	12¾	5 18						
Ditto	Ditto	14 8	7 0½	4 9½	2 9½	103 3	395 9	4	6	3	18	3 6	11	3	4¼	12¾	5 2	5 10½	104 5⅜	415 4½	20⅙	3 4⅔	12¾
Great Northern	Ditto	14 8	7 0	4 9½	2 9½	102 8	393 6	4	6	3	18	3 6	11	3	4¼	12¾	5 11						
Ditto	Covered	15 9	7 1½	6 1	5 6	112 2	654 4	4	8	3½	26	3 6	14	3	5½	16½	5 6	5 6	112 2	654 4	26	3 6	16½
Ditto	High-sided, open	14 7	7 1	2 11	2 11	103 3	301 2	4	8	3	24	3 6	12	3	4 9/16	13 11/16	5 0						
Ditto	Ditto	14 7	7 1	2 9	2 2	103 3	258 1	4	8	3¼	26	3 6	12	3	4 9/16	13 11/16	4 10	4 16	103 3	289 8	24⅔	3 6	14⅝
London, Brighton, and South Coast	Ditto	14 7	7 1	3 0	3 0	103 3	369 9	4	8	3½	28	3 6	14	3	5½	16½	4 18						
Ditto	Covered	16 0	7 1	5 11	5 8	113 4	661 1	4	8	3½	28	4 3	9	3½	3 5/16	13 2/32	6 2	6 2	113 4	661 1	28	4 3	13 2/32
Ditto	High-sided, open	15 6	7 5	4 2	2 3	115 0	373 9	4	8	3½	26	3 6	13	3	4½	14¼	5 11	5 3	112 0	427 7	27	3 5½	15
Midland	Ditto	14 10½	7 4	5 9	3 0	109 0	481 5	4	8	3½	28	4 5	12	3	5¼	15¼*	4 15						
Ditto	Low-sided, open	13 6	6 11	1 9	1 9	93 4	...	4	6	3	18	3 1¼	11	3	4⅜	12⅜	4 0						
Ditto	Ditto	13 6	6 11	1 9	1 9	93 4	...	4	6	3	18	3 2	12	3	4⅜	13⅜	4 13	4 9⅔	94 8	...	18	3 1¾	12⅞
Ditto	Ditto	13 7	7 2	1 9	1 9	97 4	...	4	6	3	18	3 2	11	3	4⅜	12⅜	4 13						
Ditto	Covered	13 0	6 7	6 2	5 2	85 7	499 4	4	6	3	18	3 2	12	3	4⅜	13⅜	4 18	4 18	85 7	499 4	18	3 2	13⅞
Ditto	High-sided, open	13 5	6 11	6 0	3 9	92 9	409 7	4	6	3	18	3 2	12	3	4⅜	13⅜	5 0						
Great Western	Ditto	13 7	7 1	3 0	3 0	96 2	288 6	4	8	3½	28	3 2	12	3	4⅜	13⅜	5 14	5 7	94 5½	349 0½	23	3 2	13 11/16
Ditto	Low-sided, open	17 6	7 2	0 11	0 11	125 5	...	4	7	3½	24½	3 6	11	4	4¼	17	5 6						
Ditto	Ditto	17 6	7 2	1 6	1 6	125 5	...	4	7	3½	24½	3 6	11	4	4½	17	5 8	5 1½	120 8	...	24½	3 6	16½
Ditto	Ditto	15 0	7 0	0 11	0 11	105 0	...	4	7	3½	24½	3 6	10	4	4	16	4 7						
Ditto	Covered	17 6	7 3	0 10	0 10	126 10	631 6	4	7	3½	24½	3 6	11	4	4¼	17	5 5						
South-Eastern	Ditto	17 4	6 10	5 6	5 1	118 5	544 8	4	7	3½	24½	3 6	11	4	4½	17	5 18	5 11	111 1	588 1	24½	3 10½	19⅜
Ditto	Ditto	15 0	6 11	5 6	5 0	103 9	612 10	4	7	3½	21½	4 3	19	3	7¼	21¼	5 4						
Ditto	High-sided, open	14 0	7 3	6 6	6 2	101 6	464 8	4	8	3½	26	3 4	12	3	4 9/16	13 1/16	5 5	5 5	101 6	642 10	26	3 4	13 1/16
Great Eastern	Ditto	15 1	7 3	5 8½	2 8½	109 4	434 8	4	8	3¼	26	3 4	12	3	4 9/16	13 1/16	5 0						
Ditto	Ditto	15 1	7 3	5 8½	2 8½	109 4	338 0	4	8	3¼	26	3 4	12	3	4 9/16	13 1/16	5 10	5 5	109 4	464 8	26	3 4	13 1/16
Lancashire and Yorkshire	Ditto	15 8	6 10	4 0	2 3	106 9	370 0	4	8	3½	28	3 8	11	3½	4	14	5 2						
Ditto	Low-sided, open	15 7	7 6	4 0	2 3	116 10		4	8	3½	28	3 6	11	3	4⅛	13½	4 3	4 4	111 8	...	18	3 6	13½
Ditto	Ditto	15 7	7 2	0 8½	0 8½	111 8	...	4	6	3	18	3 6	12	3	4¼	13¼	4 5						
Manchester, Sheffield, and Lincolnshire	Covered	15 7	7 2	1 6	1 6	111 8	625 7	4	6	3	18	3 6	12	3	4½	13½	4 18	4 18	115 6	625 7	18	3 6	13½
Ditto	Ditto	15 9	7 4	6 0	4 10	115 6	519 7	4	8	3½	26	3 6	12	3½	4⅜	16 1/16	5 3	5 3	103 11	519 7	26	3 6	16 5/16
London, Chatham, and Dover	High-sided, open	14 6	7 2	5 3	4 9	103 11	275 10	4	8	3¼	26	3 6	12	3½	4⅜	16 3/16	4 12	4 12	110 4	275 10	26	3 6	16 3/16
Pembroke and Tenby	Ditto	15 7	7 1	2 6	2 6	110 4	447 11	4	8	3¼	28	3 6	12	3	4½	13½	5 8	5 8	107 6	447 11	28	3 3	13½
Ditto	Covered	15 0	7 2	5 1	3 3	107 6	682 6	4	7	3¼	24½	3 3	10	3½	3½	13⅛	5 12	5 12	105 0	682 6	24½	3 0	13½
Spalding and Bourne	High-sided, open	15 0	7 0	6 9	6 1½	105 0	299 3	4	6	3	18	3 0	11	3	4⅛	12⅜	3 19	3 19	94 6	299 3	18	3 2	12 3/8
Ditto	Low-sided, open	13 8	6 11	3 4	2 11	94 6		4	6	3	18	3 2	11	3	4⅛	12⅜	4 13	4 13	96 2	...	18	3 2	12 3/8
Caledonian	Covered	13 7	7 1	1 9	1 9	96 2	466 8	4	6	3	18	3 2	11	3	4⅛	12⅜	4 16	4 16	93 4	466 8	18	3 2	12 3/8
Ditto	Low-sided, open	13 6	6 11	5 3	4 9	93 4	...	4	8	3¼	26	4 3½	10	4	3½	15½	5 5	5 5	105 0	...	26	4 3½	15½
Ditto	Covered	15 0	7 0	1 6	1 6	105 0	510 9	4	8	3¼	26	3 2	10	3¾	5	18¾	5 15	5 15	88 10	510 9	26	3 2	18¾
Mid Wales	High-sided, open	13 8	6 6	6 0	5 6	88 10	307 1	4	8	3¼	26	3 3	10	4	5	20	4 10	4 10	94 6	307 1	26	3 3	20
Ditto	Covered	13 10	6 10	3 7½	2 9	94 6	581 9	4	7	3¼	26	3 4	12	3	4⅜	13⅜	5 5	5 5	98 4	581 9	22¾	3 4	13⅜
Mauritius	High-sided, open	14 9	6 8	6 1	5 7½	98 4	261 7	4	7	3¼	22⅝	3 4	12	3	4⅜	13⅝	4 10	4 10	101 3	261 7	22¾	3 4	13⅞
Ditto	Low-sided, open	15 0	6 9	2 10	2 3	101 3		4	9	3¼	29¼	3 6	11	3	4 3/16	12 9/16	4 2	4 2	98 0	...	29¼	3 6	12 9/16
Ditto	Covered	14 0	7 0	0 9	0 9	98 0	574 10	4	9	3¼	29¼	3 6	11	3	4 3/16	12 9/16	5 13						
Ditto	Ditto	13 10	6 10	6 8	5 5	94 6	598 6	4	9	3¼	29¼	3 6	11	3	4 3/16	12 9/16	5 15	5 17⅔	94 6	390 10	29¼	3 6	12 9/16
Ditto	Ditto	13 10	6 10	6 8	6 0	94 6	598 6	4	9	3¼	29¼	3 6	11	3	4 3/16	12 9/16	6 5						
Ditto	High-sided, open	14 0	7 0	3 2	2 8	98 0	285 10	4	9	3¼	29¼	3 6	11	3	4 3/16	12 9/16	5 15	4 15	98 0	285 10	29¼	3 6	12 9/16

Gross Averages.

Low-sided	...	Mean of 14 sets of vehicles for 7 Railways	...	...	...	...																	
Covered	...	„ 17 „ „ „ 13 „	...	...	...	...																	
High-sided	...	„ 20 „ „ „ 12 „	...	...	...	...																	

4 ft. 8½ in. Gauge.

...	...	...	...	...	...	...	...	...	4	10½	104 9 1/10	...	21 9/14	3	6 6/28	14
...	...	...	...	...	...	...	...	...	5	6 3/13	101 4	582 5½	23 3/13	3	5 5/16	14 1/2
...	...	...	...	...	...	...	...	...	4	18	102 9½	343 1⅜	21 5/6	3	4½	14⅜

N. B.—Each "set of vehicles" represents the number of the particular vehicle returned by one of the Railway Companies for whom the same has been manufactured, or by the wagon-maker by whom it has been manufactured.

Statement of proportionate Weights, Capacities, and Bearing

Name of Railway.	Class of Vehicle.	Dimensions of Body. Inside. Length.	Width.	Height at the Centre.	Height at the Side.	Capacity. Area of the Floor.	Cubical Contents.	Wheels. Number of.
5 ft. 6 in. Gauge.		Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	
Great Indian Peninsula	Low-sided, open ...	18 7	8 1	1 2½	1 2½	150 3	...	4
Ditto	Ditto ...	18 7	8 1	2 0	2 0	150 3	...	4
Ditto	Ditto ...	16 8	8 1	1 2½	1 2½	134 8	..	4
Ditto	Covered ...	16 6	7 8	6 6	5 3	124 6	736 7	4
Ditto	Ditto ...	16 6	7 8	6 6	5 3	124 6	736 7	4
Ditto	Cotton van ...	23 6	9 0	8 0	6 8	211 6	1,551 0	4
Ditto	Ditto ...	19 6	9 0	8 0	6 8	175 6	1,287 0	4
Ditto	High-sided, open ...	16 8	7 8	4 11	3 1½	127 9	521 8	4
Ditto	Ditto ..	16 8	7 8	4 11	3 1½	127 9	521 8	4
Delhi	Covered ...	15 5½	7 9½	7 2	6 4	120 5	812 10	4
Ditto	Ditto ...	15 4	7 8	7 2	5 6	117 6	744 2	4
Ditto	Ditto ...	15 6	7 10	7 4½	6 5	121 5	839 9	4
Ditto	High-sided, open ...	15 6	7 8	5 0	3 6	118 10	505 0	4
Ditto	Ditto ...	15 8	7 10	5 0	3 6	122 9	521 8	4
Bombay and Baroda	Covered ...	15 4	7 8	7 1	5 2	117 6	724 7	4
Eastern Bengal	Ditto ...	18 3	8 0	7 5	7 0	146 0	1,058 6	4
Ditto	High-sided, open ...	15 7	7 10½	3 1½	2 7½	122 9	358 0	4
Tudela and Bilbao	Covered ...	15 10	8 5	7 0	6 10½	133 3	932 9	4
Ditto	High-sided, open ...	14 8	7 8	4 9	3 0	112 5	440 3	4
Ceylon	Low-sided, open ...	15 7	7 9	1 1	1 1	120 9	...	4
Ditto	Covered ...	15 5	7 7	6 3	5 10	117 0	711 9	4
Ditto	Ditto ...	14 5	7 7	6 3	5 10	109 4	665 1	4
Ditto	High-sided, open ...	15 7	7 9	2 11½	2 11½	120 9	357 1	4
Ditto	Low-sided, open ...	15 7	8 1	2 4	2 4	126 0	...	4
Ditto	Covered ...	15 4	7 9	8 0	7 2	118 10	901 1	4

Gross Averages of the 5 ft. 6 in. Gauge.

Low-sided, open ...	Mean of 2 sets of vehicles for 2 Railways	
Covered ...	Ditto 9 ditto 6 ditto	
High-sided, open ...	Ditto 5 ditto 4 ditto	

Mixed Gauges.								
Irish ... ... 5 ft. 3 in.	Covered ...	13 3	7 3	6 10	5 1	96 1	576 6	
Ditto	Ditto ...	15 0	7 6	6 10	5 1	112 6	675 0	
Ditto	Ditto ...	13 4	7 3	6 10	5 0	96 8	572 0	
Ditto	High-sided open ...	13 8	7 2	3 3	2 0	98 0	294 0	
Russian ... ... 5 ft.	Covered ...	20 10	8 5	7 10	7 4	175 4	1,329 7	
Ditto	Ditto ...	20 7	8 7	4 4	6 11½	176 8	1,266 1	
Ditto	High-sided, open ...	20 8	8 8	5 8	3 3½	179 1	805 10	

Abstract o

Name of Railway.	Class of Vehicle.		In Tons, Cwts., Feet. Weight Empty.	Area of Floor.	Cubical Contents.
			Tons Cwt.	Ft. In.	Ft. In.
4 ft. 8½ in. gauge	Low-sided ...	Mean of 1¼ sets of vehicles on 7 Railways	4 10⅝	104 9 1/10	...
	Covered ...	Ditto 17 ditto 13 ditto ...	5 6 3/16	101 4	582 5
	High-sided ...	Ditto 20 ditto 12 ditto ...	4 18	102 9½	348 1
Great Indian Peninsula, 5 ft. 6 in. gauge	Low-sided ...	Ditto 3 ditto	5 12	145 0⅜	...
	Covered ...	Ditto 2 ditto	5 16	124 6	736 7
	High-sided ...	Ditto 2 ditto	5 11	127 9	521 8
	Cotton ...	Ditto 2 ditto	6 9½	193 6	1,419 0
5 ft. 6 in. gauge, excepting the Great Indian Peninsula ...	Low-sided ...	Ditto 2 ditto 2 Railways	5 1	123 4½	...
	Covered ...	Ditto 9 ditto 6 ditto ...	6 10½	124 9	850 6
	High-sided ...	Ditto 5 ditto 4 ditto ...	5 3¼	119 2⅛	417 2

N. B.—Each set of "Vehicles" represents the number of the particular vehicle returned by one of the Railway

Powers of Wagons on several Lines of Railway. (Sheet No. 2.)

Journals. Length.	Diameter.	Product of the Length × the Diameter.	Springs. Distance Centre to Centre of Spring Shoes.	Number of Plates.	Width of Plates.	Thickness of Plates.	Product of the Total Thickness × the Width.	Weight. Total Weight when empty.	Average. Weight. When empty.	Capacity. Area of Floor.	Capacity. Cubical Contents.	Journals. Product of the Length × the Diameter	Springs. Distance from Centre to Centre of Shoes.	Springs. Product of the Total Thickness × the Width.
In.	In.	In	Ft. In.	No.	In.	In.	In.	Tons. Cwt.	Tons. Cwt.	Ft. In.	Ft. In	In.	Ft. In.	In.
9	3½	29½	3 6	12	3	4⅜	14½	5 17	5 12¾	145 0⅜	...	30	3 6	14⅛
9	3½	31½	3 6	13	3	5⅛	15⅜	5 18						
9	3½	29½	3 6	12	3	4¼	14¼	5 3						
9	3½	29½	3 6	12	3	5⅛	15⅜	5 17	5 16	124 6	736 7	30⅜	3 6	14⅛
9	3½	31½	3 6	13	3	4¾	14¼	5 15						
9	3¾	29½	3 6	12	3	5⅜	16⅛	6 1½	6 9½	193 6	1,419 0	30⅜	3 6	16⅛
9	3½	31½	3 6	14	3	5⅛	15⅜	6 5						
9	3¾	29½	3 6	14	3	5⅜	16⅛	5 8	5 11	127 9	521 8	30⅜	3 6	14 1/16
9	3½	31½	3 6	13	3	5⅛	15⅜	5 14						
9	3¾	29½	3 6	12	3	4¾	14¼							
9	3¾	29½	3 6	13	3	5	15	6 15	6 9	119 9⅜	798 11	29¼	3 6	15
9	3¾	29½	3 6	13	3	5	15	6 15						
9	3¾	29½	3 6	13	3	5	15	5 17						
9	3¾	29½	3 3	13	3	5	15	5 5	5 5	120 9½	513 4	29½	3 3	15
9	3¾	29½	3 3	13	3	5	15	5 5						
9	3¾	29½	3 3	13	3	4	12	6 5	6 5	117 6	724 7	31½	3 6	12
9	3½	31½	3 6	10	3	5	15	7 0	6 0	146 0	1,058 6	29½	3 6	16½
9	3½	29½	3 6	14	3	5½	16⅜	5 0	5 0	122 9	358 0	29½	3 6	15⅝
9	3¾	29½	3 6	13	3	5⅜	15⅝	6 10	6 10	133 3	932 9	29½	3 4	16⅜
9	3½	29½	3 6	13	3	5⅜	16⅜	5 5	5 5	112 5	440 3	26	3 4	15
9	3½	26	3 4	14	3	5	15	5 5	4 14	120 9	...	29½	3 6	14
8	3¾	26	3 4	13	3	5	15	4 14						
8	3½	29½	3 6	10	3½	4	14	6 5	6 4	113 2	688 5	29½	3 6	14
9	3½	29½	3 6	10	3½	4	14	6 3						
9	3¼	29½	3 6	10	3½	4	14	5 5	5 5	120 9	357 1	29½	3 6	14
9	3¼	29½	3 6	10	3½	4	14	5 5	5 8	126 0	...	28	3 6	16 3/16
9	3¼	29½	3 6	12	3½	4⅜	16 3/16	5 8	6 15	118 10	901 1	28	3 6	16 3/16
8	3½	28	3 6	12	3½	4⅜	16 3/16	6 15						

excepting the Great Indian Peninsula.

... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	5 1	123 4½	...	28⅝	3 6	15 5/16
... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	6 10½	124 9	850 6	28⅜	3 5½	15
... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	5 3¼	119 2⅛	417 2	28 7/16	3 4½	14 3/16
6	3	18	3 6	13	3½	5	17½	5 10	5 14⅓	101 9	607 10	20½	3 3½	17⅛
6	3¼	19½	3 4	13	3½	5	17½	5 18						
8	3	24	3 0	12	3½	4⅝	16 5/16	5 15						
6	3	18	3 6	13	3½	5	17½	5 0	5 0	98 0	294 0	18	3 6	17⅛
6½	3½	23	3 6	8	3	4	12	5 0	6 5	176 0	1,297 10	22 1/16	3 6	12
6½	3½	21⅞	3 6	8	3	4	12	6 15						
6½	3½	21⅞	3 6	8	3	4	12	5 5	5 5	179 1	805 10	21⅞	3 6	12

Gross Averages.

And Inches. Journals. Area. Product of the Length × the Diameter.	Springs. Length. Centre to Centre of Spring Shoes.	Springs. Sectional Area. Width × the Total Thickness.	In per cent., taking Great Indian Peninsula as 100. Weight Empty.	Area of Floor. Square.	Cubical Contents. Cubical.	Proportions. Journals. Area.	Springs. Length.	Springs. Sectional Area.	Of Weight in Tons to Floor Area.	Of Weight in Tons to Cubical Contents.	Of Weight in Tons to Area of Journal.	Of Weight in Tons to Length of Springs.	Of Weight in Tons to Sectional Area of Springs.
In.	In. Ft.	In.	Tons. Cwt.	Ft. In.	Ft. In.	Sqr. In.	Ft. In.	Sqr. In.					
21 9/15	3 6 5/16	14	80·59	72·22	...	72·21	100·40	95·72	33·07	...	2 1/16	1/27	3 1/14
23 9/13	3 5 13/16	14 1/16	91·56	81·39	79·07	77·23	98·97	99·70	18·05	1/05 58	2 1/11	1/25	2 7/16
24 5/8	3 4½	14⅛	83·28	80·36	66 7/16	81·74	100·	100·	33·05	71·05	3 1/06	1/26	3 1/25
30	3 6	14⅜	100·	100.	...	103·	100·	100·	33·25	...	3 3/31	1/13	3 1/26
30⅜	3 6	14 1/16	100·	100·	100·	100·	100·	100·	31 1/06	132 99	3 1/33	1/06	3 1/13
30⅜	3 6	14 1/16	100·	100.	100·	100·	100·	100·	33·05	93·09	3 1/27	1/25	3 1/06
30⅜	3 6	16⅛	...	...	...	...	...	...	33·00	310·31	4·05	1/15	3 1/09
28⅜	3 6	15 3/16	89·65	85·05	...	95·41	100·	103·20	34·13	...	3 1/05	1/06	3 1/05
28⅜	3 5½	15	112·50	100·20	115·46	95·06	99·20	101·27	18 1/13	130·14	3 1/27	1/23	3 1/28
28 7/16	3 4¼	14 27/34	93·46	93·27	79·96	93·59	97·00	100·21	33·07	80·13	3 1/28	1/05	3 1/26

Companies for whom the same has been manufactured, or by the wagon-maker by whom it had been manufactured.

Extracts from J. BERKLEY'S *Report, dated 12th June,* 1867.

"Some portion" (of the wagon stock), "about 400 low-sided wagons which were sent to India upwards of ten years ago, were fitted with weaker springs than have subsequently been sent from this country, and these old springs have also lost some of their original elasticity by long continued use.

"These wagons were therefore incapable of carrying in them a net load of more than 5 tons; unfortunately, the load which each wagon will carry has not been written thereon, and a general instruction that 5 tons was to be put into the wagons had been misunderstood by the Station Masters along the line, and consequently this weight had been adopted as the maximum that any of the wagons could carry.

"In order to avoid the continuance of this practice, I arranged with the Locomotive Superintendent that the capability of each of the classes of wagon stock should be tested by him; that a modification of the springs, at a very small amount of cost, should, where necessary, be introduced, so that the capacity of all the existing wagon stock, except the cotton wagons, should equal a net load of 7 tons per wagon; and that the net load which the wagons can carry should be written on each wagon.

"The cotton wagons were an important subject for consideration. I append hereto a statement drawn up by Mr. Swan, one of the Assistant Traffic Managers, which shows the quantity of cotton (pressed, half-pressed, and loose bales) carried in the low-sided wagons and cotton vans, with the earnings per truck of each of these descriptions of bales.

The process of half-pressing cotton seems to be on the increase, the rates for this class, and the number of bales which can be carried in a wagon are therefore subjects of importance to submit any remarks. With respect to the latter, it seemed desirable that, as the net load in the existing wagons amounts to little more than 3 tons, their size and consequent capacity should be increased, provided that this could be done without a corresponding increase of weight, or reduction of the strength, of the wagons.

"After much consideration and discussion between Messrs. Glover, Kelly, General Rivers and myself, it was determined that, with the sanction of the Board, wagons other than cotton wagon should, in future, be made capable of carrying 8 tons, which alteration involves an increase of strength in the axles, axle-boxes, springs, and some other minor parts, and the raising to a height of 24 inches the sides of the low-sided wagons, which have hitherto been 16 inches, and that the covered cotton wagons should be made 24 feet long instead of 20 feet long.

"By these alterations of the existing and new rolling-stock, it will be seen that its capacity will be very largely augmented."

Dated 29th August, 1868.

From—J. HAWKSHAW, Esq.,

To—J. T. WOOD, Esq.

I herewith return you the papers L 982, sent with your's of the 14th instant, relative to the practicability of reducing the dead-weight of the wagons in proportion to their carrying-power.

I reported to you fully on this subject, both as to carriages and wagons, on the 15th January last.

I have again re-considered the subject, and I find that that report expresses my present views, and nothing occurs to me which I should desire, as far as the wagon stock is concerned, to add. I beg therefore to refer you to that Report, a copy of which I send you herewith for convenience of reference. Also a tracing of the sketch which accompanied it, in case you have it not in your possession.

P. S.—Although opinions are not sought to be elicited as to the carriage rolling-stock, yet as regards this, it may not be out of place to say that since my Report of the 15th January last above referred to, Mr. Hindmarsh stated in a letter to Mr. Prestage of 30th March last (a copy of which you sent me), alluding to some carriages he had made with wheels, 15 feet 6 inches centre and centre. "You will observe from the wheel-base of the above carriages, that they could not be turned on our turn-tables, but as they have been running some time with success, and as I have had no complaint whatever from the Traffic Superintendent, it would appear that it is not necessary to turn the passenger stock on this line."

If, therefore, the carriages are not required to be turned, it is clear that their wheel-base may be increased beyond what I have stated in my Report of 15th January last, if it is found desirable to do so.

Dated 15th January, 1868.

From—J. HAWKSHAW, Esq.,

To—J. T. WOOD, Esq.

As requested in your letter of the 16th ultimo, I have had under consideration the questions relating to the practicability of reducing the dead-weight of the Railway vehicles in proportion to their carrying power.

B

This can conveniently be done by increasing the size of the vehicles to the extent to which it can be accomplished without altering the existing arrangements; and on the Eastern Bengal Railway this will, I think, be determined by the size of the carriage and wagon turn-tables. These are of two kinds, some being 15 feet diameter, and others 13 feet diameter, and the former can turn a vehicle, the wheels of which are 13 feet apart centre and centre, and the latter, a vehicle of which the wheels are 11 feet apart, centre and centre, these being about the extreme limits for turn-tables of those sizes; the larger turn-table fixes the maximum dimension 13 feet of the wheel centres, and it will not be desirable to overhang the vehicle more than 6 feet at each end, which gives 25 feet as the extreme length of the longest bodies.

The modifications which could be effected would be as follows:—

1*st.*—*In the carriages.*—The present carriages are 21 feet long in the bodies, and the first class carriages are divided into three compartments, the second class into four compartments, and the third class into five compartments; the first class will hold 24 passengers, the second class, assuming 5 on each side, 40 passengers, and the third class, on the same assumption, 50 passengers. With a vehicle having a body increased to 25 feet long, I propose the following compartments:—

1st class	4 compartments.
2nd „	5 „
3rd „	6 „

And each of these vehicles will hold respectively, assuming five on a seat—

1st class	32
2nd „	50
3rd „	60

or an increase of—

1st class	8 passengers.
2nd „	10 „
3rd „	10 „

Accompanying this is a sketch explanatory of my views.

I do not know whether the first class carriages on the Eastern Bengal Railway are usually well filled with passengers, but it is obvious that, if desirable, you might, instead of fitting up all the four compartments in these carriages with first class accommodation, convert the vehicle into a composite carriage, the two centre compartments being first class, and each end compartment second class.

2*ndly.*—*In the wagons.*—Any of the wagons, it is obvious, may be made of the same length as the carriages, or any less length that might be more convenient.

For carrying light goods, such as cotton and jute, a wagon of or approaching the maximum length might, if considered necessary, be adopted, but for heavy goods of the nature of stone and iron, it would not be desirable to make the vehicles long.

All the goods wagons, excluding the covered goods wagons last sent out, have their wheels 9 feet apart centre and centre, and this would probably still be a convenient wagon for carrying goods of a certain class, but even if increased to 11 feet centres, the 13 feet turn-tables would still be available for such increased size of vehicle.

In no case should the limit of 3½ tons, or at the outside 4 tons gross weight on a wheel be exceeded.

If the designs of some of the future vehicles be increased in size within the extreme limit described herein, such would give a carrying capacity which would bear a more favourable comparison with the dead-weight than at present, supposing the vehicles to be generally well filled, and the modifications would not interfere with existing station or other arrangements. Moreover, with the exception of a few pieces, the design of the carriage and wagon iron-work would be generally similar to that already supplied, and any of the work that is in India, and not used, might be adapted without any trouble and without any waste to the new design if carried out.

Dated 13th October, 1868.

From—G. B. BRUCE, Esq.,

To—H. W. NOTMAN, Esq.

I have given careful attention to the documents transmitted to you from the India Office, dated 10th August 1868, relative to the carrying capacities of the wagon rolling-stock on the Indian Railways. These documents contained Reports from the Officers of various Railway Companies in India, describing the character of the stock in use upon each, with the weight of the wagons and the load usually carried. They describe also the plans which are being followed with the view of increasing the capacity of the vehicles, without increasing relatively the dead-weight. There are further Minutes and orders of the Government summing up the information which had been gathered, and calling attention

to the importance of going carefully into the means of reducing the dead-weight of the wagons. It is stated in these Minutes:—"The existing form of wagon was originally adopted from the English pattern, and appears to be unsuited to the character of the bulk of the goods carried on Indian Railways. It is further believed that, since the introduction of Railways in India, great progress has been made in such matters in England, while the corresponding advance has not extended to this country." The Government of India conclude by stating that, if they are rightly informed, the present state of the wagon stock is wasteful, and ought not to be permitted to continue a day longer than can be helped.

With the view of arriving at a fair comparison of the stock of the Great Southern of India Railway with that used in England and upon the Continent, I have procured data with regard to the ordinary stock used in England, and also from drawings in my possession, and statistical documents prepared by the Government of Prussia, I have arrived at a knowledge of what is done there. From these, put into a tabular form, I have been enabled to make a fair comparison between the result of working in Prussia, in England, and in India.

The gauge of the Indian Railway being 5 feet 6 inches, instead of 4 feet 8½ inches, and the standard height of the wagon frames in India being higher than it ordinarily is in England, and the wheels being 6 inches larger necessarily, throws a certain amount of dead-weight into the Indian wagons, for which there is no corresponding return in the weight carrying capacity of the wagon. This should always be borne in mind in making such comparisons.

As a rule, the proportion of covered goods wagons used in England, as compared with open ones, is very small, whereas on the Great Southern we have a much larger proportion, but I observe that on the Madras Line, from Mr. Wright, the Locomotive Superintendent's Report, they are using very few covered wagons, and are adopting nearly entirely the high-sided open wagon. If they can guard against fire sufficiently where a proportion of wood is used in the locomotives without having covered wagons, of course there is necessarily here a saving in weight.

I find that in England a large proportion of the recently constructed wagons carry 8 tons each, and the dead-weight of such a wagon is about 4 tons 16 cwts. Some are made to carry 9 tons, the weight being about the same as that now stated. The proportion of the maximum load carried to the weight of the wagons themselves, in the instances the details of which I have obtained, vary from 1·33 to 1·98 times the weight of the wagon. It may be taken at an average as a little more than 1½ times the dead-weight; these wagons are all open and on four wheels.

In the case of the Prussian rolling-stock, the weight of the covered wagon, which is considerably larger than those in use in England, though still on four wheels, is 5 tons 16 cwts. 3 qrs., and the maximum load is 7 tons 11 cwts. 3 qrs., being 1·3 times greater than the weight of the wagon. The open wagon in Prussia weighs about 4 tons 19 cwts. 3 qrs., and the maximum load is 8 tons 3 cwts., or the load is 1·64 times the weight of the wagon itself.

In ordinary working, however, of miscellaneous goods, trains are not actually loaded to anything like their maximum amount, and the Prussian Government returns give the average load actually carried as $\frac{10}{17}$ths of the dead-weight of the wagon. This, however, includes empty wagons, the running of which is avoided in Prussia as much as possible, irrespective of delay in the transmission of goods. From the examination I have made of trains on the North-Eastern Railway carrying miscellaneous goods, the average load actually carried in practice, exclusive of empty wagons, is only 2½ tons, whereas the weight which they are authorized to carry would average 7½ tons. This does not refer to the coal traffic, where, of course, the wagons, when loaded at all, are loaded full, and generally run empty one way. The wagons in Prussia are considerably larger than those in England. The distance between their wheels, centre to centre, is 13 feet 6 inches, whereas in England it is not more than 9 feet, but the addition in favour of the loads carried in practice in Prussia, as compared with the loads in England, is not due to any superiority of the stock, or to any advantage which is gained from the increased size of the wagons, but only to the traffic arrangements, which in England are conducted much more with a regard to the interests of the public than they are in Prussia, where they will frequently detain wagons until there are goods enough to load them, whereas in England goods are always forwarded at once, irrespective to a great extent of the load in the wagons. The maximum load carried upon English Railways, in proportion to the weight of wagons, is quite as large as it is in Prussia.

It may be interesting to give here the result of an examination of the Prussian Government returns upon some of their lines during a recent half-year, taking the whole traffic in passengers and goods during that period, and seeing the percentage of each as making up the gross total—

	Per cent.
Passenger carriages, dead-weight	9·9
Passengers	1·4
Goods wagons, dead-weight	42·2
Goods carried	24·5
This will leave locomotive and tender	22·0
	100·0

The above is the mean result of work actually done, and from this it appears that the usual paying load carried was 32·2 per cent. of the total weight of the train, exclusive of engine and tender, and 25·9 per cent. inclusive of the weight of the engine and tender. It thus appears that, on an average, the passenger carriages and goods wagons together carry one-half of their dead-weight.

From Notes which I took when in America, I find that the maximum load carried by their large platform cars is just about 1½ times the dead-weight of the cars.

In comparing the stock of this Company with that already referred to, I have gone upon the assumption that the Great Southern of India wagons are calculated to hold 8 tons in each, and, comparing them with the English stock, there is no reason why they should not do this, excepting for the difficulty very properly alluded to by Mr. Wright, of the Madras Railway, which is experienced in preventing the bearings of the wagons from heating in an Indian climate. I hope and expect, however, that by the introduction of the modifications in the axle-box for the use of oil, that this will have been overcome, and when it has been overcome, there is no reason why this Company's wagons should not carry 8 tons each.

By the table it will be seen that the weight of the covered goods is 5 tons 10 cwt., and the maximum load of 8 tons would give a proportion of paying load to the weight of the wagon as 1·45 to 1. The high-sided open goods, however, is likely to be more generally used, and the weight of that wagon is 5 tons; the load carried of 8 tons would be 1·6 times the dead-weight, which is about the average upon English Railways. I do not think that you can, in wagons for ordinary merchandise, calculate upon more than that long-sided wagons, carrying heavy goods in small bulk, no doubt would carry a larger proportion of paying weight, but this would be exceptional to the general traffic.

One question for consideration is, whether the axles are sufficient to bear this load. I have, as will be seen in the table, compared the journals of the axles of this Company's stock with those in England and in Prussia, and the load resting upon each square inch of a journal in Prussia is 2·25 cwt., whereas in England it varies from 1·47 to 2·43 cwts., the common average being about 2¼ cwts. upon each square inch of the journal, measured in its longitudinal section. The wagon of this Company, carrying 8 tons, would in no case have a greater weight on the journal than 2 cwts. per square inch. The maximum load, after allowing for the wheels and axles, that is, resting on each axle, in the Prussian stock, is 119 cwts.; in England, in the cases which I have examined, it goes up as high as 129 cwts. on each axle, but the usual weight may be stated as 110 cwts. on each axle. The Great Southern of India covered wagon, with a load of 8 tons, would have on each axle 118 cwts., which is not excessive, and is under the weight frequently in use here; the high-sided open goods wagon would have a weight of 113 cwts. on each axle, so that I do not think it would be necessary to make any alteration in the axles to carry the load of 8 tons. The limit of the load, however, should in no case exceed 118 cwts. on each axle, and this cannot be satisfactorily attained until the difficulty of heated axles has been overcome.

Then as to the strength of the springs. The last stock which was sent out had an extra plate put into the springs, at the suggestion of Mr. Sheward, and a number of springs with the additional plate were sent out as duplicates. Mr. Sheward is putting an additional plate into the springs already in India. With this additional strength, the springs will be equal to the weight now proposed to be put upon them. I had them tested before they were sent out, and with a weight on each spring of 3 tons, which is rather more than would come upon them in practice, there was still a camber of $\frac{3}{8}$ inch, which would leave ample margin for any additional strain due to the load being in motion.

I do not think that, for ordinary traffic, there would be any advantage in making the wagons of this Company any larger than they are. The bulk of goods carried I see, by the Agent's report, are of a heavy kind, principally grain and salt, and the capacity of the wagon is sufficient to give room for the maximum load of 8 tons. If the Company should require to carry light goods, such as cotton, it would then become important to increase the size of the platform of the wagons, which can very easily be done so as to afford room for getting the full weight, or as near it as possible, upon each axle in the train. But so long as you can get that weight by means of a small wagon with a moderate size platform and height of sides, there is no object in making them larger.

The turn-tables upon the Great Southern of India are all 16 feet in diameter, so that if the character of the goods should change, there would be no difficulty in making wagons with a considerably wider wheel-base than we have got at present; but up to this time the necessity for this has not arisen.

The conclusion at which I have arrived after every careful and extensive examination, which is only partly stated on the appended tabular form, is that the wagon stock on this Company's line in India is as good as the wagon stock in England or on the Continent, in so far as it is capable of carrying as large an amount of paying-weight compared with the dead-weight of the vehicles. I am satisfied that you could not reduce the dead-weight of the frames without seriously affecting the strength and necessary solidity of the wagon, and any alteration that can be effected in the sides or upper frame-work would be of every little moment. There has been no change of any importance introduced into the wagon stock in

Europe since the rolling-stock of the Great Southern of India was made, except the application of oil instead of grease on many Lines, and that change this Company has long adopted. It will, of course, be for the Traffic Department to keep the Board informed as to the nature of the traffic for which they wish to provide in indenting for any new rolling-stock, and then care will have to be taken in constructing it to suit any particular class of traffic which may be sufficiently important to require a special class of vehicle; but for the ordinary traffic in grain and salt, I do not think that the wagons can be materially improved beyond the modifications at present being made.

Statement of Weight, Capacity and Dimensions of Wagons.

Description.	Area of Floor, Superficial Feet.	Contents, Cubic Feet.	Weight of Wagon.	Maximum Load, Cwts.	Maximum Load to Tare of Wagon.	Average Load actually Carried.	Maximum Load on each Axle.	Size of Journal.	Maximum Load on each Square Inch of Journal.	Size of Springs.			Weights of Wheels and Axle.
						Cwts.	Cwts.	Inches.	Cwts.	Ft.	In.	In.	Cwts. About
Prussian Stock:—													
Covered ...	170·44	1,189	116·6	151·6	1·3	67 6	119·1	8 × 3½	2·29		...		30
Low-sided, open ...	166·00	150	99·0	163·0	1·64	57·4	116·0	8 × 3½	2·23		...		30
High-sided, „ ...	169·46	419											
Ballast	158·87	212	...	...	...	...	...	...	...		...		...
North-Eastern:—													
Double Chaldron Coal	...	198	67·75	120	1·78	120	82·87	8 × 3½	1·47		...		22
Single ditto ...	...	100	34·00	53	1·55	53	34·5	...	...	3	10×4×5½		18
Large Hopper ditto	...	270	99·00	160	1·62	160	118·0	8 × 3½	2·10	3	10×4×5½		22
Coke wagons ...	100·7	425	120·00	160	1·33	160	129·0	8 × 3½	2·30	3	10×4×5½		22
Ditto	101·3	...	118·00	160	1·35	160	128·0	8 × 3½	2 28	3	10×4×5½		22
Very high-sided, open, G	120·0	430	101·00	140	1·35	...	109·5	8 × 3½	1·95	3	10×4+5½		29
High-sided, open, L	113·7	256	100·00	160	1·60	...	119·0	8 × 3½	2·12	3	10×4×5½		22
Low-sided, „ K	108·7	163	96·00	160	1·66	50	117·0	8 × 3½	2·08	3	10+4×5½		22
Ditto „ M	106·9	107	97·50	140	1·44	...	107·7	8 × 3½	1·92	3	10×4×5½		22
Great Northern:—													
High-sided, open	103·8	315	95·00	180	1·89	...	126·5	8 ×3½	2·43	3	6×3×5½		22
Madras:—													
High-sided, open ...	127·9	...	103·7	126	1·11	...	97·8	9 × 3½	1·67	3	6+3×5½		31
Great Southern (assuming the load to be 8 tons per waggon):—													
Covered	106·0	618	110·0	160	1·45	...	118·0	9 × 3½	2·01	3	0×3×4½		34
High-sided, open ...	111·7	280	100·0	160	1·60	...	113·0	9 × 3½	1 92	3	0×3×4½		34
Low-sided, „ ...	111·7	110	90 0	160	1·77	...	108·0	9 × 3½	1·84	3	0×3×4½		34
Ballast	100·0	169	92 0	160	1·73	...	109·0	9 × 3½	1·86	3	0×3×4½		34
Salt	106·3	497	105 0	160	1·52	...	115·5	9 × 3½	1·97	3	0×3×4½		34

13*th October*, 1868. (Sd.) G. B. BRUCE.

For Report by Consulting Engineer, O. and R. Railway Company, see Collection of papers at end.

Dated 23rd November, 1868.

From—J. Hawkshaw, Esq.,

To—J. Byrne, Esq.

I return you the copy of a Despatch with enclosures from the Government of India, sent with yours of the 30th September, relative to the carrying capacities of the wagon rolling-stock of Indian Railways.

Before reporting on this question, it was considered desirable that I should see Mr. Wright, who was then on his way from India. This I have now done, and I have discussed the question with him.

I stated my views on this subject, dealing with carriages as well as wagons, on the 15th January last. I then showed the limits within which the carrying capacities of the vehicles might be increased without interfering to any material extent with the general character of the design of the stock, or of the existing parts, or of the station and other arrangements, and I stated that the limit of 3½ tons, or at the outside 4 tons, gross weight on a wheel, should in no case be exceeded.

The only question that would arise in respect of carrying these heavier weights, would be as to whether the existing journals would be strong enough, and also the existing springs. As regards the springs, it would not become a matter of much moment, as a plate might readily be added, which would not interfere with other parts of the vehicles, but if the journals had to be strengthened, the axle-boxes would require to be re-modelled, and this would involve alterations of parts of the iron-work, and would become a somewhat serious question. Fortunately, the introduction of oil instead of grease has not only reduced the cost considerably, but it has also, owing to the more perfect lubrication obtained, rendered the vehicles capable of carrying greater loads without heating the journals, and Mr. Wright thinks, and I concur with him, that the journals are sufficiently large for these heavier loads.

This being the case, I am strengthened in the views expressed in my Report of the 15th January last, and I should deprecate any change that would, to any material extent, alter the general design of the vehicles, or of the parts, or of the existing station and other arrangements, more especially as I believe that the general character of the rolling-stock is fitted for the requirements of the traffic on the Madras Railway. Indeed, I may say if the stock had to be designed afresh, I should be unable to suggest vehicles of a character that would in my mind be more suitable for the line.

P. S.—Although the question now under consideration is confined to the wagons, yet I may remark that Mr. Wright informs me that he has added a second storey for third-class passengers to some of the carriages. This interferes with no existing patterns, and will probably be found to be a desirable addition.

Dated 15th January, 1868.

From—J. Hawkshaw, Esq.,

To—J. Walker, Esq.

As requested in your letter of the 17th ultimo, I have had under consideration the questions relating to the practicability of reducing the dead-weight of the Railway vehicles in proportion to their carrying power.

This can conveniently be done by increasing the size of the vehicles to the extent to which it can be accomplished without altering the existing arrangements, and on the Madras Railway this will, I think, be determined by the size of the carriage and wagon turn-tables. These are 15 feet diameter, and can turn a vehicle the wheels of which are 13 feet apart, centre and centre, this being about, or nearly about, the extreme limit for a turn-table of that size. This, therefore, fixes this dimension, and it will not be desirable to overhang the vehicle more than 6 feet at each end, which gives 25 feet as the extreme length of the bodies.

The modifications which could be effected would be as follows:—

1*st. In the Carriages.*—The present carriage are, I believe, 20 feet long in the bodies, and the first class carriages are divided into three compartments, and the second and third classes into four compartments. The former will hold 24 passengers, and the latter (assuming five on each side) will hold 40 passengers.

With a vehicle having a body increased to 25 feet long, I propose the following compartments:—

1st class	...	...	...	...	4 compartments.
2nd „	...	...	...	...	5 „
3rd „	...	...	...	...	6 „

and each of these vehicles will hold respectively—

1st class	...	...	32
2nd „	...	...	50 } assuming five on a seat,
3rd „	...	...	60 }

or an increase of—

1st class	...	...	...	...	8 passengers.
2nd „	...	...	...	...	10 „
3rd „	...	...	...	...	20 „

Accompanying this is a sketch explanatory of my views.

I do not know whether the first class carriages on the Madras Railway are usually well filled with passengers, but it is obvious that, if desirable, you might, instead of fitting up all the four compartments in these carriages with first class accommodation, convert the vehicle into a composite carriage, the two centre compartments being first class, and each end compartment second class.

2*nd. In the Wagons.*—Any of the wagons, it is obvious, may be made of the same length as the carriages, or any less length that might be more convenient. For carrying light goods, such as cotton and jute, a wagon of or approaching the maximum length might be adopted, but for heavy goods, similar to stone or iron, it would not be desirable to make the vehicles so long. In no case should the limit of 3½ tons, or at the outside, 4 tons gross weight on a wheel be exceeded.

If the designs of any of the future vehicles be increased in size within the extreme limit described herein, such would give a carrying capacity which would bear a more valuable comparison with the dead-weight than at present, supposing the vehicles to be generally well filled, and the modifications would not interfere with existing station or other arrangements. Moreover, with the exception of a few pieces, the design of the carriage and wagon iron-work would be generally similar to that already supplied, and any of this work that is in India and not used might be adapted without any trouble and without any waste to the new design, if carried out.

I am not sure whether the particulars I have given herein of the existing carriage-stock are quite right, as I have never been supplied with proper drawings of any of the vehicles as completed. These were not originally designed by me, but I believe these particulars to be generally correct.

I return you the documents you sent me.

No. 1703, dated 22nd December, 1868.

From—J. P. KENNEDY, Esq.,

To—J. A. BAYNES, Esq.

I have earnestly inquired into the opinions and practice common in England as regards the carrying capacity of goods wagons on Railways, and find that the conviction is general as to the advantage and economy in working of moderate sized wagons over those of larger dimensions.

Where the radii of curvature are small, through which trains must pass, six-wheeled trucks are palpably inadmissible, and a Government rule exists in India which obliges every train stopping at any station on single lines to pull up on the siding, thus passing in and out through the sharp switch curves in each such case.

Single lines being the rule in India, six-wheeled goods trucks for that country are out of the question.

It is equally clear that elongated four-wheeled wagons are objectionable. Every increase of wheel-base that is given to four-wheeled trucks must be attended with a largely proportional increase in the strength of materials used in constructing the vehicle, and in its consequent proportional dead-weight to the maximum load.

The greatest practical source of a large proportion of dead-weight at present in working traffic is not merely in the ratio that exists between the weight of the wagon itself and that of its possible maximum load. The dead-weight of the wagon must, on the contrary, be compared with the average load which in practice it carries, and which is notoriously far below a full load. This is the most serious cause of dead-weight, and it will increase as the size of the wagon becomes increased.

I believe that a 10-feet wheel-base for four-wheeled wagons, with a total length of about 16 feet, and a width for our Indian gauge of 8 feet, will be found best suited for economical working, and most in conformity with the best recent English and Indian experience.

The proper dimensions and *proper lubrication* of journals has much more effect upon reducing dead weight than the mere cubical dimensions of the upper carriage or stowage accommodation of a wagon. If these be right, and the Traffic Department will insist upon the moderate sized wagons being properly filled with a full load, the best results will be obtained.

Our wagon journals have a length of 9 inches and a diameter of $3\frac{1}{2}$ inches, giving a product of length multiplied by a diameter of $31\frac{1}{2}$ inches. And with proper oil lubrication, *applied through axle-boxes capable of excluding grit* and dust, our wagons are fully capable of carrying a paying load equal to twice the dead-weight, both as regards our axles and our bearing springs, to the flanged or Wharton pattern.

Dated 14th July, 1869.

From—A. M. RENDEL, Esq.,

To—D. J. NOAD, Esq.,

I have yours of the 3rd July, referring to the subject of the carrying capacity of wagons, on which my report was requested so far back as August last.

I deferred reporting at that time, because we were just constructing a passenger train on the American principle, to which the papers you sent me alluded, and I wished to know the opinion formed of it, and because I had to a certain extent moved in the matter generally whilst in India, as I stated in my report of my visit; but mainly because I have long been of opinion that iron might be advantageously substituted for wood in the construction of our stock, and wished to consider the subject maturely. I had, therefore, settled with Mr. Pearce whilst I was in India that I would do so, and would prepare a design if I arrived at a satisfactory conclusion. I have only now to regret that I did not take the subject immediately in hand, but, knowing that the Board did not intend to increase their stock at once, and that we were either doing or had done all that was possible to increase its capacity, I let the question rest for a time.

The ordinary methods of employing iron are not, I think, satisfactory. They retain the separation of the under-frame from the body which characterizes the timber wagon, and which greatly increases its dead-weight. To obtain a light wagon in iron, each must be made part of the other. Mr. Prestage, of the Eastern Bengal, had taken up the subject upon this principle, and has produced a very light wagon, though one not quite suited to the East Indian traffic. I am now engaged on a design which I think would be more generally useful to the varied character of our traffic, and which I hope soon to lay before the Board.

To enable our present stock to carry greater weights, all that is required is heavier axles. Those originally sent out were of the strength usually adopted in this country at the time. Greater weights being now carried, heavier axles are employed, and those in use on the East Indian have been successively increased from $3\frac{5}{8}$ inches diameter in the middle to 4 inches and $4\frac{1}{4}$ inches, and we are now sending out Bessemer steel axles $4\frac{5}{8}$ inches diameter in the middle, with journals also enlarged from $3\frac{1}{4}$ inches to $3\frac{1}{2}$ inches.

These axles will be substituted for those now in use, as the latter require renewal.

In regard to the six-wheeled wagon. When in India I found some in course of construction as an experiment, that is to say, a third pair of wheels was being added to existing wagons. Neither Mr. Pearce nor I liked them. They added about 25 cwts. to the weight of the wagon, and I doubt if they have carried on the whole an addition to their previous live-load sufficient to pay for this increase of weight and cost, and it was agreed, unanimously, as I understood, that the experiment should not be extended.

Their construction, however, seems to have been resumed since I left, but I still doubt their giving a satisfactory result.

I believe that I shall be able to produce an iron wagon, weighing not more than, if as much as our present timber wagon, and, on two pair of wheels, capable of carrying 12 tons at least.

The springs and axle-boxes sent out for some years past are quite strong enough for this load, and the capacity of our present wagon is also sufficient for it, of whatever of the goods we usually carry it may be composed. It requires, at all events, but a very small increase, which can be easily given.

I have alluded to the American passenger carriages, which were put in hand before I left India. They have since been tried. The Traffic Manager does not, however, seem to like them, and they are apparently kept for soldiers, for whom they are said to be suitable. I am still of opinion that they are specially suited for our ordinary traffic, and I hope they will be thoroughly tried, and not abandoned without special reasons fully stated and discussed.

Dated 13th August, 1869.

From—G. P. BIDDER, Esq.,

To—W. P. ANDREW, Esq.

I have considered at your request the documents forwarded to you by the Secretary of State for India, with the view of forming an opinion as to how far the most approved English, European, or American patterns, or modifications of them, are applicable to Indian Railways.

I regret that some delay has occurred in completing this report; but it has afforded me the opportunity, not only of comparing the weights of wagon stock in use on the principal Railways in Great Britain, on the Continent, and in some of our Colonies, but also of examining the most recent papers on American Railways, and the drawings and other documents relating to the rolling-stock in use in Europe, contained in the library or read at the meetings of the Institution, Civil Engineers.

The result of this comparison is, in round numbers, that the weight of a wagon itself almost always exceeds one-third of the gross weight when fully loaded, but that, with the exception of coal wagons, which almost always run full one way and return empty, the exigencies of traffic in this country seriously interfere with, if not preclude, the adequate filling of the wagons; and even in Prussia, where wagons are often detained in order to secure as much as possible full loads, the actual paying load hardly exceeds 35 per cent. of the gross load.

The subject of the weight of the wagon itself to meet the requirements of traffic at a minimum cost, has taxed the ingenuity and engaged the serious attention of Engineers and Traffic Managers unremittingly for the last 30 years; and looking at the serious losses Companies sustain by the destruction of rolling-stock, and the penalties arising out of accidents, the necessity has been forced upon them, as the facts show that wherever stock has had to be repaired or renewed, the alteration or improvement made has always been in the direction of increased strength (and necessarily of weight) in framing, draw-gear, wheels and axles, springs, &c.

The cause of this increase and the controlling circumstances do not appear to be understood in connexion with this inquiry, in reference to Indian Railways, into the alleged unfavourable ratio between the dead-weight and paying-load of wagon stock.

If the speed of trains were limited to 15 miles an hour, and still more, if there were no marshalling of trains at stations involving the destructive operation of shunting, no doubt a considerable reduction in strength might be effected, though, as will be hereafter shown, at a small comparative reduction of weight; but under the circumstances which exist, and must exist, in order to afford every possible facility to the traffic by interchange with other lines, to the running of goods wagons in passenger trains, and to offer conveniences for carrying different kinds of goods in the same class of vehicle, it is clear that nothing less than a uniformly strong and substantial class of stock can be safely used.

The circumstances of the traffic in India, the speed at which trains run, and the relation of the lines of Railway to one another, are not such as in any material way to modify the principles laid down in reference to English rolling-stock, which have been established by long and costly experience.

An illustration or two may be useful in exhibiting the effects of shunting. Thus it has been stated on reliable authority that the wear and tear of the wagons by shunting at Rugby alone costs 6*d.* per ton upon the goods carried, or is about equivalent to the running wear and tear of 200 miles; and again, comparing the strength of the couplings used in a train with that absolutely necessary, we find that whereas the maximum pull of a locomotive engine does not exceed 5 tons as applied to a train, it is found to be absolutely necessary to provide chains, &c., in addition to couplings, which themselves are capable of sustaining a pull of 20 to 25 tons to meet the exigencies of traffic.

But the most important and destructive strain, which has to be provided against in the framing of the wagon is "crushing," and to resist this, it is of great consequence to have breadth as well as depth in the sides of the framing exposed to it.

This has led in this and other countries, and even in India, to the extensive use of hard-wood timber, which possesses many advantages, and theoretically is well adapted for resisting the kind of strain just mentioned.

On mechanical grounds, however, it is not possible, assuming for a moment that it was desirable to reduce the weight of the wagon, to make any substantial saving in this respect for a reduction of weight, of say 1 ton in a wagon weighing 5 tons would involve a loss of strength of one-half, a result out of all proportion to any advantage gained.

There are some effects of the climate of India upon timber in its application to wagons and other rolling-stock, which have been, I think, somewhat overlooked.

The frequent occurrence of hot axles alluded to by Mr. Bocquet, your Locomotive Superintendent for the Punjab and Delhi Railway, in the letter, a copy of which is appended to this Report, was brought to my notice some four years ago when engaged upon the designs for the Delhi rolling-stock, and finding that, by an increase of some 2 or 3 cwts. only upon the weight of the wooden wagon, we could employ iron under-frames, I was induced to recommend their adoption, and I am happy to draw attention to Mr. Bocquet's testimony to the advantages which he has had an opportunity of observing.

Another advantage in addition to the greatly diminished cost of maintenance is, that in case of a collision or very rough usage, a timber-framed wagon would be destroyed, whereas, the iron-frame, though perhaps put out of shape, could be readily straightened and restored to its proper form.

This is the actual result of an accident which occurred to some of the wagon-stock at Calcutta belonging to your Company soon after erection.

With regard to the use of oil axle-boxes frequently mentioned in the official correspondence, I may observe that the whole of the Delhi carriage and wagon stock, comprising nearly 1,500 vehicles, have been fitted with them.

It is clear from the foregoing observations that, beyond an approximation to the ratio of the tare of the wagon to the gross load of 1 to 3, my opinion is that, even under very favourable circumstances, improvement in rolling-stock cannot be carried; that nothing material in the designs of Continental or American stock, worthy of adoption, have been brought to my notice since completing the drawings for the rolling-stock now running on your lines, but that in India, where the lines are capable of greatly increased traffic, the most careful attention should rather be given to the loading of wagons, so as to prevent the running of empty and half-filled trucks, and to mitigate the evils of shunting as much as possible.

For this purpose, and to secure economy in working, the stock should consist of as few classes as possible, with but few varieties of form and size of axles, journals, draw-gear, couplings, &c., so as to facilitate to the utmost practicable extent the interchange of traffic; and, in the interests of the Indian lines generally, as tending to the speedy development of their traffic and to harmonious and economical working, I cannot too strongly urge the removal of all restrictions as to the passing of engines and stock over all the different Railways of the country.

In this country, where so many different Railway interests prevail, we notice carriages and wagons from the north penetrating to remote districts in the south and west; and in India, where the Railway system ought to be regarded as a grand whole, there can be no good reason why an arrangement, which in England is compatible with vested interests, keen competition, and many restrictions, should not be applicable to a far greater extent, with advantage alike to the State and the community at large.

One suggestion in conclusion I will make, that if the Indian Government were to invite the Locomotive Engineers and Managers of the Railways in that country to furnish specifications and descriptions of the most useful and suitable classes of wagon stock, suggested by their experience, a selection might then be made, and the data obtained upon which to invite the intelligent and experienced builders of this country to send in designs,—a suitable premium being offered for the best design. By this mode a more general system applicable to all the Railways would be initiated, and another step taken in the direction of simplicity and efficiency.

Dated 12th August, 1869.

From—R. Bocquet, Esq., *Locomotive Superintendent*,

To—W. Kingsbury, Esq.

With regard to the Delhi Railway rolling-stock, I have great pleasure in stating that taken altogether, it is the best of its description in India.

There are certainly a few small items in detail that will bear alteration, but those that I have recommended, in respect to the locomotives, only alter the parts to which they are applied, and do not affect the description of engines which are well adapted for the work they have to perform, and I feel perfectly satisfied with them.

The iron-work supplied from England, for the carriage and wagon stock, is of the best material, and the workmanship all that can be desired. The iron under-frames, though somewhat heavier than the timber, will last, I should say, treble the time, with comparatively slight cost in maintenance.

The oil axle-boxes, as supplied to the Punjab Railway, reduced the frequency of "hot boxes" considerably, but the adaptation of iron under-frames, combined with the oil axle-boxes (on the Delhi Railway), have rendered the occurrence of "hot boxes" unknown. I ascribe this to the rigidity of the iron-frames in keeping the centres of the axles always square with the line of traction, which in the timber-frames were known to deviate with each change of temperature, consequently throwing undue strains or weights upon some of the journals.

I prefer the iron panelled wagons on account of their less cost in maintenance and danger from fire, and I also desire that a sufficiency of sheet iron, about 16 B. W. G., be sent out with stores to enable me to replace the ends and sides of the wood-panelled wagons as they come in for repairs.

In conclusion, I would remark, in reference to recent correspondence on the part of the Indian Government regarding the description of wagons for different freights, and the loading of wagon-stock generally, that, as far as my experience goes, it is a mistake having more than one or two builds of wagons in a place like India where freight varies in description and bulk three or four times in the year. The probability is, that one description of wagon has to be idle for some months, or that the unenlightened native puts 20 tons of sugar into a wagon that is only designed to carry 7 tons of impressed cotton.

On the East Indian Railway, I know that there are long wagons and short wagons, wagons on four wheels, and wagons on six wheels, wagons opening at the sides, at the ends, at the top, and the bottom, with sliding doors, folding doors, and flap doors (the two latter sometimes combined), and with dozens of different methods of fastening them, and what with different descriptions of wheels, axle-boxes, springs, &c., &c., must, I am sure, be more expensive to maintain than our wagon-stock (which I consider equal to the exigencies of any traffic) ever will be.

From experiments I do not think it would be safe to carry more than twice the weight in freight of the wagon (exclusive of wheels and axles). With a load of 6 tons in a covered wagon, I found that there was a spring or camber measured in the centre of the axle of from $\frac{1}{32}$" to $\frac{1}{16}$" full, and this camber continually taking place, at each movement of the axle, must have a seriously deteriorating effect upon the iron.

Thirty years' experience has shown that a certain amount of strength is required in a wagon to enable it to stand the great amount of wear and tear that it is subjected to, and strength represents weight, at least when wood, iron, and given speeds are concerned. I do not see clearly how dead-weight can be materially decreased, and paying load materially increased at one and the same time, and consider that if it could have been done, it would have been accomplished long ere this.

There is no doubt that more vigilance should be employed in the loading of wagons, in seeing that they carry their full load, and that such load is properly distributed on the four-wheels. There is plenty of room for improvement in this respect in India, still it is often the case that there is a run of freight in one direction only, and when it becomes actually necessary to work wagons back over a long length of line empty, contingencies of the sort even occur in England sometimes.

It has long been my idea that we must rely upon ourselves for the quick development of the resources of the country by catering for traffic, by carrying everything at the least possible rate (money is an object to a native, time none), and teaching the native that he cannot do without Railways.

When we get a steady supply of freight, then will our wagons be regularly and properly laden.

Dated 20th October, 1868.

From—J. M. HEPPEL, Esq., *Consulting Engineer,*
To—Managing Director, Oudh and Rohilkhund Railway.

In reference to your letter of the 12th August, forwarding printed Reports on Indian Rolling-stock, communicated to you by the Right Honorable the Secretary of State for India, for the opinion of your Consulting Engineer on certain questions involved in them, I now beg to state that I have carefully considered these questions, and to lay before you such conclusions as I have been able to draw.

The precise degree of financial importance attaching to the proportion of Tare to Load in goods stock, is a matter which it does not appear necessary for the present purpose to discuss. I will presume that it is not contemplated to carry attempts in this direction to an extent which should in any way impair the strength or durability of the vehicle, because it is my strong impression that if this point were once reached, the limit would be very closely approached where the remedy for one evil would be more than counterbalanced by the introduction of others. Within this limit every one must agree that anything which can be done to render the proportion in question more favourable, must conduce directly and effectually to economical working.

The question to which attention is especially drawn is the applicability of the most approved English, European or American patterns, or modifications of them, to Indian Railways.

To this I would at once reply that, to the best of my own observation, and from the enquiries I have been able to make, there is much to be learned from the most recent English practice, and but little from Continental or American.

As regards the Continent of Europe, my reason for this belief is, that from all the information I can obtain, the best models appear to be founded on English ones, and although my means of enquiry are necessarily far less in respect of foreign countries than at home, I think that if there had been any remarkable instances of success in this particular, they would hardly have failed to reach me in some way.

In America the case is different. The type usually adopted is original and altogether unlike either of the others, but I have still been unable to find any instance of more successful results than those obtained in this country.

I am indebted for information on this point to our Locomotive Engineer, Mr. Cooke, of whose valuable assistance I have had the advantage in this enquiry. The stock of the Mexican Railway, in which he formerly filled a similar post, consisted partly of English and partly of American wagons.

The English wagons were built by the Ashbury Company and weighed 4¼ tons, with a carrying capacity of 8 tons, giving a proportion of Tare to Load of 1 to 1·88.

The American wagons were much larger and were carried on two bogie frames, each having four wheels. Their weight was from 7 to 8 tons, and their carrying capacity from 11 to 12 tons, giving a proportion of about 1 to 1·5.

Mr. Cooke tells me that he considers these wagons to be about the best specimens of their respective classes. In the course of long Railway journeys in America he never observed any merchandize trucks the arrangement of which struck him as superior.

Independently of this, it appears to me that there would be some strong objections to the introduction of the American pattern in India. The great length of the wagons would prevent their being turned on the ordinary turn-tables, and although this might not at first seem to be a great inconvenience, as they would run equally well in either direction, still as the turn-tables frequently offer the readiest communication between different lines of rails in stations, a great deal of addition of time and labour might be required from the necessity of always shunting them by the points. Another thing is, that the wheels must necessarily be of much smaller diameter to admit the bogie frame above the axle, and the velocity of revolution, and consequent liability to heat, is proportionally increased.

In connection with this point, I would beg to state that in India especially, in my opinion, the wheels ought to have as large a diameter as is consistent with convenience. Any moderate increase of weight consequent upon this, strikes me as of very small importance, as the weight of the wheels and axles contributes in a very insignificant degree to the resistance of the train: the axle friction, which is the main element, being quite independent of it and simply due to the weight carried on the journals.

It is true that on ascending inclines the wheels and axles contribute their share of the resistance of gravitation, but this is exactly compensated by the aid they give in descending the same inclines, at least so long as those are below the limit requiring the use of breaks. The mere resistance of rolling, except in sharp curves, is exceedingly trifling.

For these reasons, it appears to me that in comparing the tare of wagons with their load, it would be more proper to omit the wheels and axles altogether, but as this might lead to confusion in the comparison of results, I have preferred taking an average weight of ¾ tons per each pair, bearing in mind that a variation of a few cwt. one way or the other, so far as they are concerned, is pratically of very little importance.

In the designing of goods wagons, the most important practical problem seems to be now to devise the best four-wheeled truck for the lightest kind of goods, or those which require the greatest capacity for their weight, because this problem being once solved, is the key to all the rest. If a given ratio of tare to load has been obtained in this case, it may be confidently inferred that in any other a better one will be obtained, for in all heavier classes of goods, the same weight may be carried in a smaller, and, therefore, a lighter truck, while amongst goods of the same class, whatever they may be, a six-wheeled truck may be always made to carry more in proportion to its own weight than a four-wheeled one. This is obvious from one very simple point of view.

Suppose two four-wheeled trucks of the best possible sort to be put together so as to form one with eight wheels, two of the ends and the corresponding draw-springs, couplings and buffers might at once be removed, and after all, the eight-wheeled truck so formed would probably not be the best possible. Still more advantageous then would be the result if the best possible eight-wheeled trucks were designed in the first instance, and the same reasoning applies in its degree to a six-wheeled one.

In commencing the design of the four-wheeled wagon, the first point to be considered is the weight to be placed on the journals. This should be as great as is consistent with safety of running, chiefly in respect of non-liability to heat. It is evident that the greater the weight on each axle, the more advantageous must be the result, since even supposing it to be necessary to enlarge the carriage body, its weight will never be increased in so great a ratio as its carrying capacity, while the weight of the wheels and axles themselves will either remain constant, or if slightly increased, will, for the reason before given, be of very little importance.

The safe limit of the load on the journals becomes, therefore, the first point of enquiry. In this country, the general practice varies from 2½ to a little over 3 tons on the narrow gauge, and goes up even to 4 tons in the broad gauge. Now, is there any apparent reason why, with well-constructed axle boxes and sufficiently strong axles, especially if the latter are of steel, the last mentioned load should not be quite safe?

Looking, however, to the statements and opinions in the papers before me in reference to increased liability to heat arising from special conditions of the climate of India, I think that 3 tons on each journal should be taken as the basis of calculation, and this, I am convinced from careful enquiry, may, with good oil boxes, be adopted with the most perfect safety. At the same time, I should, at least in the case of a new line, recommend that the axles and springs should be made of sufficient strength to bear 3½, or, perhaps, even 4 tons, so that advantage might be taken of their greater carrying power if it should subsequently be found desirable to do so.

The load on the axles being thus fixed, it will be found that the problem of the design of a wagon is brought within narrow limits. We have only next to take the lightest description of goods, the trade in which is sufficiently considerable to make them worth a special study, and design the lightest body capable of carrying a full load of such goods, subject to the condition, that the body and load together must not exceed 12 tons in weight.

It is evident that in dealing with the lightest goods, the largest capacity is required, and to obtain this, we must begin by giving the largest floor-area consistent with the limits imposed by the general conditions of the working of the line. It will probably be found that in this we cannot in general conveniently exceed 128 square feet, which is given by Mr. Wright as that of the Madras wagons, and taking 5 feet as the average depth of loading, this would give a capacity of 640 cubic feet. The weight of the body of such a wagon open at the top and with sides 5 feet high, could hardly be expected to turn out under 3½ tons, leaving 8½ useful load, to bring which load into the capacity of 640 cubic feet, the material must not be more bulky than 75 cubic feet to the ton. Adding the weight of the wheels and axles to the tare, the proportion of the latter load comes out at 1 to 1·7.

Taking now an article largely carried and very low down in the list given by Mr. Cecil Stephenson—fire-wood—such a truck would carry only 4·57 tons, giving a proportion of 1 to 0·9.

Similarly, cotton screwed to 24 lbs. gives 1 to 1·4, and cotton full screwed, which has exactly the above-mentioned bulk of 75 cubic feet per ton, 1 to 1·7.

The result of this is, that with all kinds of goods equal to, or heavier than, cotton full screwed, a truck constructed as above will carry a full load of 8½ tons, with a ratio of tare to load of 1 to 1·7.

With regard to lighter goods than these, I must confess that I do not see the means of obtaining so favourable a proportion; perhaps something might be done in the case of any particular article—such as loose cotton or fire-wood—being of sufficient importance to make it worth while to construct wagons in special reference to it, but even then the improvement to be effected would be found to lie within very narrow limits.

I believe, therefore, that as regards light goods, all that we can hope to attain by any known construction is a wagon capable of carrying about once and three quarters its own weight of merchandize, not more bulky than full-screwed cotton, and lighter articles in a less advantageous proportion down to its own weight, or even less. In reference to these last, the only remedy appears to be that of mixed loads adopted on the Eastern Bengal Railway, and noticed in para. 3 of the Observations of the Government of India. It is entirely a matter of Traffic management, but must unquestionably, where found practicable, be perfectly effectual.

Having now obtained the proportion of 1 to 1·7 for goods of 75 cubic feet to the ton, a better proportion still may be obtained for any of greater specific gravity if the traffic is sufficient to justify a special construction.

This may be done in two ways—either by diminishing the size, and, consequently, the weight of the body of the wagon, or by adding a third pair of wheels, leaving the wagon unaltered.

Cotton full screwed would require to be loaded to a depth of 5 feet to give a full load of 8½ tons, but if we take the article salt, it will be found that 9 tons will only occupy a depth of 3 feet. The sides may therefore be reduced to this height, and the wagon thereby probably reduced to 4½ tons weight, giving a proportion of tare to load of 1 to 2, and this proportion, or a better one, may be obtained for every article heavier than salt.

Taking now bricks, of which 9 tons occupy only 2 feet of depth, if a third axle were added, the load on the journals might be increased to 18 tons, and the case would stand thus:—

	Tons.
Body and load	18
Wheels and axles	2¼
Total ...	20¼
Wagon alone before addition of third axle ...	4½
Third axle with all accessories	1
Tare ...	5½
Load ...	14¾

giving a proportion of tare to load of 1 to 2·7, and this proportion would apply to all articles heavier than bricks.

If still heavier classes of goods, such as granite blocks, or iron, were subjected to similar investigation, it would be found that about 1 to 3 would be the extreme limit which could be attained by special construction.

The general result to which all the above discussion appears to point is, that the basis of the design for goods wagons should be a four-wheeled truck for the lightest kind of goods the traffic in which is important that this truck may be so designed as to give a ratio of tare to load of about 1 to 1¾ for all goods of greater specific gravity than 75 cubic feet per ton, or that of full-screwed cotton, and that this ratio may be improved to 1 to 2 for all goods heavier than salt, by reducing the sides of the wagon, and further improved for all goods heavier than bricks by the addition of a third axle.

Having stated this view, it is perhaps desirable that I should notice one or two particulars of the papers before me, which may not at first appear to be in unison with it.

Mr. Carroll says in reference to the Bombay, Baroda and Central India Railway, that the adoption of a third axle would be of no advantage, but the reason for this is contained in another sentence, where he says:—

"The difficulty we experience is to crowd a full load on four wheels."

The important articles of merchandize must, therefore, be of a light description, and in such a case, it is quite consistent with the foregoing that no advantage should arise from the third axle, unless, indeed, the wagon itself were at the same time considerably enlarged, which is, of course, beside the question.

On the other hand, the whole purport of Mr. Cecil Stephenson's Note on the East Indian wagons is to shew that their capacity is too great for their weight and carrying power, and this is exactly the state of things where the third axle becomes advantageous

It does not appear from Mr. Wright's Report on the Madras stock, whether, or not, his attention had been specially drawn to this point. I should rather infer that it had not, as I cannot help thinking that if it had, it must have struck him that his own argument points to the conclusion that the third axle might, at any rate for a portion of the stock, be useful. Take the condition of things to which he looks forward after the introduction of oil boxes, that is a proportion of tare to load of 1 to 1·5.—

	Tons.	Cwt.	Qrs.	lbs.
The tare of the wagon is	5	3	3	0
The third axle with its appendages would weigh	1	1	2	22
Giving increased tare	6	5	1	22
Of which wheels and axles are	2	8	3	0
Leaving load in journals	3	16	2	22
This would therefore admit of useful load	12	3	1	6
To make up ...	16	0	0	0

The gross load on the journals to give $2\frac{3}{4}$ tons on each, which Mr. Wright appears to regard as the safe limit, at any rate for Madras.

The proportion of tare to load would thus become 6 tons 5 cwt., to 12 tons 13 cwt, or 1 to 2, and this would be obtainable for all goods of which $12\frac{1}{2}$ tons could be loaded, and some advantages would continue to obtain for all goods of which 9 tons or more could be loaded, so that the question would appear to hinge upon whether, or not, a sufficiently important portion of the traffic consisted of materials of such specific gravities that 9 tons or more could be loaded within the capacity of the wagon.

I need hardly remark that, before adding a third axle, there should be good reason for believing not only that the possible usefulness of the wagon will be increased, but that loads will be obtained sufficient to derive advantages from it. If this is not the case, either the evil must be submitted to, or a smaller class of four-wheeled trucks must be constructed for heavy goods.

The following short table embodies the results of the above enquiry in reference to some of the principal articles enumerated in Mr. Cecil Stephenson's list :—

	Article.	Load Tons.	Bulk C. ft.	Depth of Load Feet.	Proportion of Tare to Load.
6 Wheels, sides 3 feet high ...	Cast-iron and zinc	14·75	74	0·6	1 to 2·7
	Granite	14·75	192	1·5	1 to 2·7
	Bricks	14·75	442	3·5	1 to 2·7
4 Wheels, sides 3 feet high ...	Saltpetre	9·	306	2·4	1 to 2·
	Salt	9·	387	3·0	1 to 2·
	Flour	8·5	425	3·3	1 to 1·7
	Barley	8·5	467	3·7	1 to 1·7
	Cotton full-screwed ..	8·5	640	5·0	1 to 1·7*
4 Wheels, sides 5 feet high ...	Jute and cotton screwed to 24 lbs.	6·9	640	5·0	1 to 1·4
	Firewood	4·6	640	5·0	1 to 0·9
	Chillies, dried	3·	640	5·0	1 to 0·6

* Cotton full screwed. This important article of traffic being in loose bales might, perhaps, be packed to a considerably greater height than the sides of the wagon, 9 tons of it would occupy 675 cubic feet, and would require a depth of 5·3 feet. If this could be placed in a truck with 3 feet sides, a proportion of 1 to 2, instead of 1 to 1·7, would be obtained.

Similar considerations are applicable to any article which may be loaded above the sides of the truck. It is obvious that with all such, a better proportion may be obtained than with those which require the sides to have the full height of the load.

I now come to the question of the materials of construction.

It is greatly to be doubted if any more advantageous material than teak could be selected for building the under-frames of wagons, since for its weight it is superior in strength, on the one hand, to pitch pine, and on the other, to iron.

The following table shews a comparison of the resistance of bars of pitch pine, teak, iron and steel, all 20 feet in length, the pine being taken at a scantling of 9 inches by 4 inches, the teak having its dimensions reduced so as to bring it to the same weight, and the iron and steel being of an I section in each case, the most advantageous possible consistent with their having the same weight as the timber.

The results for timber are calculated by Professor Barrow's rules, and those for iron and steel by those given by Mr. Eaton Hodgkinson.—

Bars 20 feet long.

	Pitch Pine.	Teak.	Iron.	Steel.
	9" by 4"	$8\frac{1}{2}$" by $3\frac{3}{4}$"		
Resistance to direct tension, lbs...	432,000	480,000	154,400	231,600
Transverse strain ...	3,917	4,924	5,000	5,000
Direct compression	10,253	15,697	5,000	10,000

It would not seem from inspection of these figures that any great advantage in point of lightness is to be expected from the substitution of iron, or even steel, for timber in the under-frames, at least as long as the present general plan is adhered to.

It has, however, been tried, though as yet with no decided success, to suppress the under-frame as a distinct and separate member, and make the sides and ends themselves form the frame. It was found, however, in the base of the wagons constructed on this plan for the Oudh and Rohilkhund Railway Company, that the expected saving in weight was not obtained, chiefly from the difficulty experienced in keeping the steel down to the specified thicknesses.

One great objection, however, independently of this, seems to me to be against this plan—that the wagon is necessarily weakened in the plane of traction, where it is exposed to all the shocks of starting and stopping and partial collision consequent on any change of velocity. In the case in question, this was obviated by making the system of drawbars and buffers continuous throughout the train, so as to form a vertebrated spine with which each carriage was individually connected by its own draw-springs.

Whatever may be said in favour of this arrangement, (and no doubt much may be said), it has the unquestionable disadvantage of insulating any line on which it is adopted from interchange of rolling-stock with others. To introduce it on a working line would be, I should think, out of the question, as carriages on this plan would not run with the rest of the stock.

The concentration of the main strength of the framing at the level of the draw-bars and buffers strikes me, then, at any rate in the present state of things, as indispensable—and if this be so, there seems little reason for believing that, for equal strength, as light a frame may not be constructed of teak as of pine, and of either of them, as of iron or steel; and if this be true in general, the consideration is doubly cogent in reference to India, where the material is comparatively cheap and abundant, and well suited to the skilled labour of the country.

Probably the best way of settling this important question would be to have a certain number of carriage frames built of the several materials in question, under the conditions of equal floor area and a maximum of weight, and to have them carefully tested for strength and stiffness in every direction, and ultimately broken by compression. The experiment would be costly, no doubt, but it seems to me that the information would be well worth the outlay.

In order to test the correctness of some of the foregoing views, I requested the Railway Carriage Company, Oldbury, to examine the following specification of requirements, and to prepare a drawing as nearly as possible in accordance with them :—

Requirements.

Oudh and Rohilkhund Railway—Gauge 5 feet 6 inches.

Framing and body of wagon to be entirely of teak with iron fastenings, but steel may be substituted for any of them if the substitution should be considered advantageous.

The floor area to be 128 square feet, and the sides 3 feet high, and the body to be so designed as to be capable of being placed either on two axles or on three. In the first case, the weight, inclusive of everything but the wheels and axles, not to exceed 3 tons; in the second case $3\frac{1}{4}$ tons.

The sides to be capable of being raised to 5 feet in height by means of movable pieces. This addition not to exceed half a ton in weight.

The axles to be steel, and the axle boxes for oil on Lightner's patent, or some equally good plan.

The axles and springs to be designed in reference to a gross load of 3 tons on each journal.

The weight of the wheels and axles themselves is not specified, but it is expected that each pair will weigh about $\frac{3}{4}$ ton.

It is suggested for consideration, whether lightness in the under-frame might not be promoted by making the floor in two layers of planks crossing each other diagonally.

Stern's patent buffers, as used on the Metropolitan Railway, are also suggested for consideration. My object in procuring this design has been not so much to obtain absolutely the ultimate term in lightness, as a good, safe, generally useful vehicle, applicable by slight and easily applied modifications to a wide range of goods, and giving in all of them a fair proportion of tare to load, without in any degree sacrificing strength or substantial and durable construction. In commencing a new stock for a large system of lines where the character of the traffic will have to be first learned by experience, no other course appears so safe. If special kinds of merchandize should be found to require special construction, this can easily be introduced as the occasion arises, while the original stock still being the best adapted for ordinary traffic, will always find full employment as sections are successively completed and opened.

One step in special construction, for instance, would on every account be desirable at the earliest possible stage—that is, to fix the height of the sides in reference to the various kinds of merchandize, so as to obviate the necessity for movable pieces, which, however useful in a model wagon, would be inconvenient as applied to any large portion of the stock.

The following table gives the ratio of tare to load of such a wagon in reference to the nine articles enumerated by Mr. Cecil Stephenson as forming the most important branches of traffic on the East Indian Railway :—

Coal	... 1 to 2
Ironmongery	... 1 to 2·7
Piece goods, (probably) ...	... 1 to 2
Salt	... 1 to 2
Wines	... 1 to 2
Grain	... 1 to 1·7
Rice	... 1 to 2
Seeds	... 1 to 1·7
Cotton full-screwed ... or ... screwed to 24 lbs. ...	... 1 to 1·7 ... 1 to 2 if carried in a wagon with 3 feet sides, ... 1 to 1·4

Taking now the last Report of the traffic on the Lucknow and Cawnpoor Line, three articles are specially enumerated, which therefore probably form the most important articles of traffic. These would give the following proportions :—

Salt	1 to 2
Grain	1 to 1·7
*Timber	
Sâl wood	1 to 2
Teak	1 to 2

* Timber in bulk would require special construction, but at least the above proportion would be obtained. In accordance with my request, the Oldbury Company prepared a design and worked it out in sufficient detail to enable the exact particulars of its weight to be ascertained. These are as below :—

OPEN GOODS' WAGON.

	Tons.	Cwt.	Qrs.	lbs.
Wheels and axles	1	0	0	0
Axle-boxes ond springs	0	8	1	0
Under-frame, including floor and draw-springs	1	10	0	0
Buffers	0	4	0	8
Work above floor	0	16	2	0
Total weight of body with 3 feet sides	2	18	3	8
Movable top to raise sides to 5 feet	0	8	2	10

It will be seen that these weights are somewhat less than those specified in the requirements, and the proportions of tare to load will consequently be rather more favourable than those shewn in the preceding table.

On discussing the matter further with the Oldbury Company, it appeared that these results might be further improved. It was suggested that the length should be slightly increased, and a foot added to the distance between the wheel centres. I requested them therefore to make drawings of three wagons,—1, a covered wagon; 2, high-sided open one; 3, a low-sided wagon, keeping in view the general requirements, but making such modifications as they considered desirable. Tracings of these designs are sent with this report. The following are the particulars :—

	Weight with 2 axles.				Weight with 3 axles.				Capacity.
	Tons.	Cwt.	Qrs.	lbs.	Tons.	Cwt.	Qrs.	lbs.	Cubic feet.
No. 1	5	5	2	8	6	5	2	8	672
No. 2	5	1	2	8	6	1	2	8	690
No. 3	4	3	0	8	5	3	0	8	173

It will, perhaps, be sufficient to examine in detail the carrying capacity of No. 2, bearing in mind that the results for No. 1 will be a little less favourable; and those for No. 3 considerably better for all goods within its capacity.

No. 2—HIGH-SIDED GOODS' WAGON.

Full load with 6 wheels ... ... 14·32 Tons ... Tare 6·08 Tons.
„ „ 4 „ ... ... 8·52 „ ... „ 5·08 „

Article.	Load. Tons.	Bulk. Cwt.	Depth of Load. Feet.	Proportion of Tare to Load.
Cast-iron and zinc	14·32	72	0·5	1 to 2·36
Granite	14·32	186	1·4	1 „ 2·36
Bricks	14·32	430	3·1	1 „ 2·36
Saltpetre	14·32	487	3·5	1 „ 2·36
Salt	14·32	626	4·5	1 „ 2·36
Flour	13·80	690	5	1 „ 2·30
Barley	12·55	690	5	1 „ 2·06
Cotton full-screwed	8·52	639	4·6	1 „ 1·68
Jute and cotton screwed to 24lbs. ...	7·42	690	5	1 „ 1·40
Firewood	4·93	690	5	1 „ 0·97
Chillies, dried	3·24	690	5	1 „ 0·64

It will be seen that these proportions do not differ on the average materially from those previously given, being a little more favourable in certain articles, and a little less so in others. These designs confirm my opinion, that the proportions already stated admit in general of no great improvement consistent with substantial construction.

The following memorandum given to me by the Railway Carriage Company, Oldbury, gives some particulars of Foreign as well as English Stock built by them. In most of these it would appear that there is considerable room for improvement. To this the grain wagon for the Varna Railway forms an exception, and offers an example of the advantage to be obtained by special construction in reference to a particular article. The cotton wagon for the Great Indian Peninsular Railway also shews a good proportion as compared with the average of existing stock :—

For whom built.	Description of wagon.	Weight of empty wagon. Tons.	Cwt.	Qrs.	lbs.	Load to carry tons. Tons.
Russia	Covered goods	5	14	3	0	7
Varna Railway	Covered grain.	5	1	3	0	10
London and South Western Railway	Open goods ...	5	17	3	0	7
London, Brighton, and South Coast Railway	Open goods ...	5	10	2	0	7
London, Chatham, and Dover Railway	Open goods ...	5	8	0	0	7
Egyptian Banking Company ...	Covered specie	5	8	2	0	8
Great Indian Peninsular Railway...	Cotton wagon...	6	13	1	8	10

In conclusion, I will recapitulate the chief points which it has been the object of the foregoing investigation to establish :—

1. That without departing from the dimensions of Rolling-stock usually adopted in Indian Railways, and especially those determined by the joint Memorandum of the Consulting Engineers, of 5th February 1856, but merely by attention to the proper proportions of the parts, the proportions of the tare of goods wagons to their load may be rendered considerably better than those now generally prevailing without any prejudice to their strength or substantial and durable construction.

2. That if 3 tons be regarded as the limit of safe load on a journal, the following proportions of tare to load may be obtained :—

For any goods whatever	1 to 0·6
For all goods as heavy as, or heavier than, cotton full-screwed ...	1 to 1·7
For all goods as heavy as, or heavier than, salt	1 to 2·
For all goods as heavy as, or heavier than, bricks (by means of a third axle)	1 to 2·7
For all goods as heavy as, or heavier than, bricks	

3. That if a greater load than 3 tons can be safely placed on a journal, these proportions may be generally improved—and it is therefore recommended that, at least on new lines, the axles and springs should be calculated for a greater load, so that advantage might be derived from it if found practicable; and this the more that, for reasons given, the mere weight of the wheels and axles themselves is comparatively unimportant.

4. That there is no reason, in reference to the present subject of enquiry, for regarding teak timber as inferior to any other known material of construction.

Note 1.—In connection with the subject of this report, I would beg to be allowed to suggest a mode by which the Government might be supplied from time to time with precise information as to the progress made in this country and elsewhere.

It would be to have a printed form of queries translated into French, German, or any other language that might seem desirable, and circulate it in England, through the Board of Trade, to the principal manufacturing establishments—and in Foreign countries, through the British Ministers, to their several Public Works Departments, and through them to the best sources of information.

It would be, in fact, simply extending to a range beyond the power of a private individual the means which I have adopted to obtain the information on which I have based my report.

I subjoin a list which would be at once answered with ease by any Manager of an establishment of the kind, and which would give all the information which is essential.

I take for example an open goods wagon which is the present subject of enquiry, but a similar course might evidently be adopted in reference to any other.

In case of any return showing superior results, more detailed information and drawings might be applied for through the same channels:—

Open Goods wagon.

	4 Wheels.	6 Wheels.	8 Wheels.
Weight of wheels and axles			
Axle-boxes, springs, horn plates, and their appurtenances.			
Under-framing, including floor			
Buffers, drawbars, drawsprings, and their appurtenances.			
Breakwork			
Body of truck above floor			
Total Weight ...			
Interior dimension of floor			
Height of sides			
Greatest load which can be carried			
Average load actually carried			
Materials of construction			
Under-frame			
Body			
Axles			
Wheels			
Tyres			
Fastenings			
Buffers			
Drawbars			
Chains			
Gauge of line			
Cost			

Note 2.—After the above report was completely drafted, a letter from Messrs. Brown, Marshall, & Co., of the Britannia Works, Birmingham, to Mr. Cooke was put into my hands. This letter, with a second in answer to a request from myself for further explanation on a particular point, are both so full of valuable information, that I avail myself of the permission to quote them. It will perhaps be thought satisfactory to see to how great an extent the views entertained by this eminent Firm are in consonance with those expressed in the report.

Dated 6th October, 1868.

From—Messrs. Brown, Marshall & Co., and D. Archer,

To—T. G. Cooke, Esq.

Replying further to your letter of 1st instant on the subject of Railway wagons, we are quite of opinion that it is very possible, and would be profitable, to make considerable reduction in the dead weight of our various open and covered wagons so as to render the proportions of *gross* to paying weights less objectionable than they seem to be; but we are not very sanguine of accomplishing the result aimed at, *viz.*,—to make wagons in all cases carry twice their own weight. This would be less difficult—might be easy of accomplishment—with low-sided wagons adapted for weighty, not bulky goods, such, for instance, as coal or iron, but in building wagons of large capacity for the carriage of more bulky goods, we have to increase the floor area considerably, lengthen the centres of wheels and raise a superstructure of sides, ends and roof, which needs to be strongly supported and stayed. Thus, a coal wagon, for instance, with a floor area of 100 feet, and cubic measure of about 320 feet, would weigh about 5 tons, and carry 10 tons of load; but a covered wagon to carry compressed or half compressed cotton to, say, 60 feet to the ton, would require a floor area of about 150 feet, and would weigh about 6 tons, or even 6¼ tons. In the one case, a comparatively short wagon suffices, in the other, as width is limited, the wagon has to be considerably lengthened, the wheel centres increased, and, on the whole, additional scantling and boarding is involved; the conditions, in short, are quite different. Even if no increase of floor area took place, the very fact of increased height and covered roof would alone add from 20 to 30 cwts. to the gross weight of wagon. Thus, while there would be no doubt of a coal wagon carrying twice its own weight, it is doubtful if a cotton wagon could be made to do so. There is a minimum strength necessary to every wagon, and it does not appear to us that very much reduction in weight, particularly as regards timber, is possible in our modern wagon under-frames. It is very important the under-frames should be rigid and strong to resist the violent blows to which they are always subjected, and the only possibility of effecting a light *body* is by having substantial under-framing. Another point is, that 6·8 and 10-ton wagons run indiscriminately in the same trains, and draw gear of uniform strength, and other conditions besides are necessary for all alike. Axles and springs should always be adopted with special regard to the loads to be carried, and there appears no valid reason why they should be otherwise. Axle-boxes, too, if possible, should be uniform for the easy interchange of bearings; and when 6, 8, 10 and 12-ton wagons are employed, one size of journal for 6 and 8 tons, and another for 10 and 12 tons, would be ample. This is, however, more a point of economic working and facility, rather than one of gross and carrying weights.

Axles as commonly used in this country have been made of scrap iron; of late, steel has been introduced, but not so extensively for axles as for tyres. For 8-ton wagons upon our English lines, axles of 4 inches diameter prevail, but it is also a noteworthy, fact, that axles of a like size are common for 6-ton wagons. In some cases of modern practice, 4¼ inch axles find place for 8-ton wagons, and our opinion is, that they are none too strong; axles of 3¾ inches diameter were at one time extensively used for 6-ton wagons, but these have all given place to axles of 4 inches diameter. Thus for the English gauge, it may be taken that 4 inches axles for 6-ton wagons, and 4¼ inches for 8-ton wagons, are found in practice to be of the proper strength. Wagons of 10 tons we have made on many occasions with 4¼ inches axles as the 8 tons, and they are much used, the only difference being that while in the one case they are 4½ and 4⅝ through the naves—in the other they are slightly increased to, say, 4¾ inches through, and 5 inches at back of naves. Our opinion is, that all 10-ton wagons on English gauge lines would do very well with 4¼ inches axles, provided they are made of the sizes we have indicated at the back of and through the naves. Wagons of 12 tons are very uncommon, and we are not in a position to speak definitely with regard to them, but they would doubtless require a 4½ inches axle. From this it appears that 4 inches by 4¼ inches axles prevail on English Railways for 8 and 10-ton wagons, and 4½ inches would suffice for 12-ton wagons: but considered with regard to Indian lines, where the gauge is 5 feet 6 inches, as against 4 feet 8½ inches, 8½ inches, and a consequent increase in the length of the axles, the same conditions hardly apply. We should ourselves recommend 4¼ inches for 8 tons 4½ inches for 10 tons and 4¾ inches for 12-ton wagons, for Indian gauge. The corresponding sizes to these instead would seem to us to be 4 inches, 4½ inches, and 4⅝ inches to 4¾ inches. The journals are in this country as various in size and length as the axles themselves, 6 inches by 3 inches prevails for 6 tons—7 inches by 3½ inches, 7 inches by 3½ inches, 8 inches by 3 inches and 8 inches by 3¾ inches for 8 tons—and 8 inches by 3¼ inches, 8 inches by 3½ inches, and sometimes 8 inches by 3¾ inches for 10 tons. The journals on most Indian Railways are 9 inches by 3¼ inches, and 9 inches by 3½ inches. On Russian Railways they are 6½ inches by 3½ inches for their large 10-ton wagons. We would consider 8 inches by 3¼ inches a very good 8-ton journal, and 8 inches by 3½ inches a very good 10-ton journal.

We are not much in favour of wagons for 12-ton loads, especially on 4 wheels. There might be economy in making six-wheeled wagons for carriage of cotton goods or other bulky goods generally, but at best they are clumsy things on a Railway, and unless full load could at all times be depended on, they could not be worked with advantage. We believe that an 8-ton wagon judiciously constructed, would be the handiest and cheapest in actual work. In this country, our leading Railways such as the South Eastern, London and Brighton, London and South Western, and Great Western N. Gauge use chiefly 8 ton wagons. The London and North Western, on the other hand, abide by 6 and 7 tons. In the last mentioned, the weight of their low and high-sided open wagons are 2¾ and 4 tons, and carry 7 tons, their covered wagons weigh 4¼ tons, and carry only 6 tons. The South Eastern, South Western, and London and Brighton open goods wagons weigh 5 tons and carry 8 tons, their covered wagons weigh 5¼ tons, and carry only 6 tons. The Great Western modern N. G. open goods wagons weigh 5¼ to 5½ tons, and carry only 8 tons their covered wagons weigh 5¾ to 6 tons, and carry only 8 tons. The Midland Railway Company's covered wagons weigh about 4⅞ to 5 tons, and carry only 6 tons, their open goods wagons 4½ to 4¾ tons, and carry only 6 tons.

For general merchandize such as yours, averaging from 40 to 50 cubic feet per ton, we think it very possible to make a wagon to carry twice its weight, or very nearly so, on four wheels, *i. e.*, an open wagon, but as a covered wagon, we do not suppose that it would be possible, due regard being had to stiffness of frame, to come nearer than 1⅝, ¾ to 1. In other words, a wagon to carry 10 tons (covered) would weigh about *six* tons, with wheels and axles all complete, perhaps 5¾ tons, but not less.

We should be happy if you would give us your Indian address to prepare and send after you tracings of an open goods and covered goods wagon. They would shew you much better than we can describe in the brief space of a letter the principal parts, and offering you best services at all times.

P. S.—We should strongly recommend you to have strong axles at whatever sacrifice. If an error is made at all, it is far better it should be on the right side, and axles that yield in the slightest degree produce incalculable mischief.

Dated 12th October, 1868.

From—Messrs. Brown, Marshall & Co., and D. Archer,
To—Consulting Engineer, Oudh and Rohilkhund Railway.

We have before us your letter of 9th instant, on the subject of wagon loads, and with regard to the question of six-wheeled wagons, we beg to say, that in cases where it is desirable to load an average sized truck up to its full *bulk* with heavy goods of the character and after the manner you describe, the third axles would doubtless be an advantage, indeed could not be avoided in view of the conditions imposed as regards the weight to each journal and the weight to be carried, but we are not sanguine that a wagon constructed to meet such a contingency would necessarily be an economic wagon. Such a wagon, for instance, running in one direction with a load of 12·8 tons, would possess advantages, but if it carried only nine tons on the return journey (taking 45 feet per ton), then it would be but performing the work of an ordinary four-wheeled wagon, and consequently would work at a loss. By all means, if the traffic is of a kind to require it, a few six-wheeled wagons might be advisable, but unless the conditions for which they were created were likely to prevail to a considerable degree so as fully to employ them, we think it would be better and least objectionable to work some traffic of an exceptionable character at a loss (as regards load to weight), than to establish six-wheeled wagons at all. If it is imperative to carry 12 tons load with 3 tons limit to each journal (which we think a wise provision), then there is no alterative but to introduce the third axle and design the wagon with the view to obtain the full advantage of the increased cost and capacity which this arrangement would entail. But as we before stated, and as is confirmed by the practice of our large English Railway Companies, we are of opinion that four-wheeled wagons are under all, save very rare and exceptional cases, the best for any Company.

You are at full liberty to make whatever use you think proper of this and our previous letters, and offering you our best services on all occasions.

Note by the Under Secretary to the Government of India, in the Railway Branch of the Public Works Department, on the Reports of Consulting Engineers to Indian Railways, on the subject of wagon-stock, received with Despatch No. 68 *of* 1869 *from the Right Hon'ble the Secretary of State.*

These reports are extremely valuable, and every carriage and wagon builder in India would be glad to have a copy. Mr. Bidder's suggestion regarding prizes to be offered for approved designs on fixed data deserves special consideration.

A comparison between tare and load requires discrimination in respect of railway stock. It would be literally just if the weights were not hauled, but were lifted vertically, but the weight above the journals does not act in the same way as the weight below, and is much more disadvantageous. What is required is a wagon of such form and material as shall necessitate the least expenditure of power in drawing a ton of net load on a certain curve at a certain speed, having due regard to prime cost, cost of renewals and of lubrication.

The bogie wagon or swivelling truck has not received, in the reports, the full attention to which its extensive use in America entitles it, but it has advantages. Fuel in America is comparatively cheap, and some extra weight in the wagon is not of much importance. The introduction of this device is claimed by English Engineers, who appear rather to regard it as an expedient to remedy some of the bad results of a defective permanent-way, than as having much inherent merit. Wrought-iron wheels are generally used in England, but in America cast-iron is economically adopted, and it may be well to try if these peculiar durable wheels can be cast at Roorkee.

A low wagon with small wheels on a narrow gauge railway might easily be designed to show a favourable proportion between tare and load, but a heavier wagon with long bearings, large journals, and large wheels, would be cheaper to haul; to show a timber truck or fibre wagon to carry a small quantity of heavy or large quantity of light material, is not to touch the problem set by the Government of India.

The ordinary four-wheeled covered goods wagon to contain the general products of the country is that which it is important to deal with, and it seems to be generally allowed that—

1st.—Each journal should carry less than 3 tons, and that the permanent-way should not be subjected to a much greater weight than 3 tons per carriage wheel.

2nd.—That the goods do not measure more than 75 cubic feet per ton.

3rd.—That the main strength of the vehicle must lie in the horizontal plane through the line of traction.

Considered in this way, a wagon consists of four parts:—

1st.—The wheels, axles and journals.

2nd.—The springs, brasses and axle-boxes.

3rd.—The main frame and floor.

4th.—The box to contain the goods resting on the frame.

First.—Wheels, axles and journals—which now weigh 1½ tons in a wagon which weighs altogether 5 tons, and carries 7 tons, to be increased shortly to 8 tons.

The axles are admittedly too light, as also are the journals. That part of the axle which passes through the boss or nave must be strengthened, and the boss must be slightly increased to permit this. The spokes may probably remain as they are, but the tires will be thicker to allow of their being turned true when they wear irregularly.

We shall obtain no diminution in weight in the first division.

Second—Springs, brasses and axle-boxes.—Axle-boxes for oil will be heavier than those for grease with tallow in it. The brasses and springs must be heavy in proportion to the load. It may be said that, when the traffic is straightforward, neither draw-springs, wheel-springs, nor buffer-springs are absolutely necessary, but it is certain that when the station shunting is heavy, all these springs are essential; as the power of free interchange of rolling-stock is declared to be necessary,—all wagons should be equally good. Without a change of gauge, it is difficult to see how any diminution of weight can be effected under this head.

Third.—Main frame and floor.—In some calculations made last year in this country as to the relative strength of teak and iron for wagon building, taking the iron wagon of the Delhi, and the wooden wagon of the East Indian Railway, and comparing those parts which are capable of comparison, it appeared in every case that, weight for weight, teak-wood was in all strains stronger than iron. Steel was not at the same time considered, but Mr. Heppel's parallel calculations recorded in this correspondence show that steel is also inferior in this respect to teak: the resilient qualities of teak-wood make it an admirable material to use when strains lengthwise, cross-ways, tensile, compressive, and torsile, are constantly acting. The principle of having the strength of the vehicle in the horizontal plane through the line of traction, appears to be very important, but it is possible that some reduction of weight may be effected by combining the frame with the enclosure above it, and by making the combination strong enough to resist the hard usage a wagon must be subjected to.

Fourth.—The box to contain the goods.—Here there is fair field for difference of opinion. It may be well to use a light box and rack it quickly to pieces, or a stronger and consequently heavier enclosure which will wear longer. If 8 tons be considered to be the load, and if 75 cubic feet be allowed for a ton, then 600 cubic feet will be the internal capacity of the average wagon. The calculations mentioned above showed that, in the sides as well as the roof, teak-wood still held its place; it was stronger and lighter than the thinnest iron an Engineer would recommend as an enclosure, even including the thick and heavy coats of paint on the wood; but for the enclosure, except for the floor, iron has superiority over wood, being not inflammable.

The general tendency of this rough analysis is to show that, probably, in future the rolling parts of an 8-ton wagon will be heavier; that the frame cannot economically be lightened, but that at a loss of durability, the enclosure may be decreased in weight; and that, with slow, light, rough traffic springs may possibly be dispensed with. The last saving, if effected, almost necessitates a concurrent break of gauge. Doubtless numerous improvements may be made, but it is difficult to see how any radical change for the better is to be effected while the present form of wagon is used, and a better form of wagon is unknown.

The whole enquiry as to reducing the dead-weight may be rendered nugatory if Station Masters do not load up their wagons and trains better than they now do. Assuming, and it may be fairly assumed, it being the rule on the East Indian Railway, that the maximum gross load of a goods engine behind the tender is 400 tons, and deducting 7 tons for the break-van, to ascertain the paying-load, we have $\frac{1}{7}^{2} = \frac{1}{7}\frac{2}{3}\frac{3}{6}$: the freight paying-load is 230 tons, and this, at one penny per ton, or $\frac{1}{8}$ pie per maund, the lowest rate for general traffic is 19*s.* 2*d.* The best paying lines in India do not take one-half this amount as their average gross receipts per train mile, and the obvious inference is that the trains are not half loaded.

It is impossible to ensure a full load both ways, but except in the mineral branches, the total balance of trade in one direction has scarcely been proved, and it is difficult to believe that with care better loads could not be obtained.

In this respect the usage on Prussian and other European Continental Railways, though irritating to the public, and unfitted to the keen competition of England, deserves imitation in India.

P.W. 28/70

All replies should be addressed to the Secretary.

CIRCULAR No. 1 RAILWAY.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

RAILWAY.

FORT WILLIAM, JANUARY 11, 1870.

Carrying capacity of Wagon Stock.

Read again—

Public Works Department Circular No. 9 (Railway) of 1867.
" " " Resolution Nos. 648—52 R of 15th June 1868.
" " " " " 1309—13 R of 5th November 1869.
" " " Circular No. 10 (Railway) of 1869.
Despatch to Secretary of State, No. 93 of 1868.
" to " " " 50 of 1869.

Read also—

Despatch from Secretary of State, No. 68 of 1869.
Office Note, dated 29th November 1869, by the Under Secretary (Railway Branch).

OBSERVATIONS.—Circular No. 9 of 1867 expressed generally the opinions entertained by the Government of India regarding the loss of power entailed by the inappropriate character of much of the wagon stock on Indian Railways, and the Governor General in Council requested that the proportion between unremunerative and paying load should be seriously considered by the Railway authorities, and the defects remedied as soon as possible.

2. This subject has, during the past two years, been carefully discussed, and the Government of India have noticed with satisfaction that the necessity for improvement has been very generally acknowledged by the Railway Companies, and a proportion of five to eight between dead and paying load is now commonly thought to be attainable; but the Government of India remain very far from satisfied with this result, and are convinced that this vitally important subject has yet to be dealt with in the thorough manner which it deserves. With the view of spreading detailed information and inviting further discussion, copies of the reports on this subject by the Consulting Engineers to Indian Railway Companies, lately received from the Secretary of State, should be distributed.

3. The Governor General in Council would again invite Railway Engineers and Managers to continue to consider what new form of wagon is likely to be most economical, and what modification of their existing wagons is best suited to improve their effective carrying capacity.

4. Mr. Bidder's suggestion to invite the Locomotive Engineers and Managers of Railways in India to furnish specifications and descriptions of the most useful and suitable classes of wagon stock suggested by their experience, may be usefully adopted, and the several Local Governments should be requested to give effect to it, and forward the results to the Government of India when received.

5. The question of the proper loading of wagons calls for increased attention; it is obvious that the reduction of dead weight in the wagon to its minimum may have no useful effect if wagons and trains are not better loaded than they now are. The accounts of the best paying lines in India show that the average loads are not one-half what they would be if the wagons were properly filled; and making every allowance for difficulty in always obtaining full loads, it is evident that much improvement is possible, and that a serious responsibility for the present unsatisfactory state of affairs rests with Traffic Superintendents and their subordinates.

6. The question of the most economical speed for a goods traffic is closely connected with that of the character of the wagons in which it goes on. The problem to solve is, how to carry the goods at the smallest cost possible compatible with the other conditions involved. Having established what speed gives the most economical result as far as mere haulage is concerned, the question next has to be considered, whether there are any classes of goods which will bear a higher rate for a higher speed, or for earlier delivery, and whether the system commonly adopted in Continental Europe, of dividing the goods traffic into fast and slow, may not usefully be followed in India, it being understood that the terms fast and slow apply not necessarily to the actual speed of the trains, but rather to the time occupied in the despatch and delivery of the goods. It is understood that one of the main difficulties in getting the wagons properly filled arises at the smaller stations where the quantities of goods tendered for despatch do not amount to a full wagon load. In such cases, the system of slower delivery would admit of time being allowed to give the vehicles their full loads. In like manner, some modification of the form or size of wagon may be found desirable to suit the different circumstances of a large, full through traffic, and of a scattered pick up traffic of articles tendered in small quantities. With these remarks the Governor General in Council will leave the whole question for the further consideration of the highly intelligent Officers engaged in the construction of the vehicles and the working of the traffic of Indian Railways.

ORDER.—Ordered, that copies of these Observations, of the Reports of the Consulting Engineers to the several Railway Companies, and of the Office Note be forwarded to the Governments and Administrations noted on the margin.

Madras.	N. W. Provinces.
Bombay.	Punjab.
Bengal.	Oudh.
Hyderabad.	

Major, R. E.,
Deputy Secretary.

To
The Secy. to the Govt. of Madras
Pub. Works Deptt. (Railway)

P. W. 1870 Dept
(Proc. Govt. for Feby)

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

RAILWAY.

To No. 280

CIRCULAR No. 1 RAILWAY.

Dated January 11, 1870.

Received — 22 —

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P. 1845

No. 471 — 18: Febry/70.

Carrying capacity of Wagon Stock.

P. W. D. Press.—11-1-70—182.

P.: 26 Jany/1870 R. 3 Feby/70

Public Works Department

No. 471

Proceedings of the Madras Government.

Under date the 18th Febry/70

Read the following

From the Dy. Secy: to the Govt. of India. P.W.D. (P.W. Cir. No. 1 of 11th Jany/70)

Communicated to the Consulting Engineer for Railways, who will draw the attention of the Agents of the Madras and Great Sn. of India Railways to the suggestions of the Govt. of India, and will obtain and submit the specifications and report called

Cue 280

Govt. of 1870: Mdrs.

PUBLIC WORKS.

The Consulting Engineer
for Railways

No. 186-187