(Paper No. 2184.)

“English and American Railroads Compared.”¹

By EDWARD BATES DORSEY, M. Am. Soc. C.E.

(Abstracted by W. B. WORTHINGTON, M. Inst. C.E.)

THE first thing which strikes an American railway engineer travelling in England is the inconvenience of the passenger carriages. “Stephenson and his colleagues mounted the old stage-coach body on car-wheels, which became the type of the passenger cars; and coal wagons that were then in use in the collieries were put on the railroad, and became the type of freight cars; and before the conservative English character thought that they ought to be improved, and should be changed, the trunk lines had been built and adapted to this narrow and low type of rolling stock to have made it wider and higher later would have required the removing and reconstruction of the masonry platforms, the raising and widening of bridges and tunnels—in fact, almost a reconstruction of the road.”

Laying out the Line.—English railways are laid out with easier curves and gradients than American railways, and much money and time is spent in attaining this object. Recently English engineers have introduced in their new lines gradients and curves which in the early days of railways would have been considered impracticable. Few English lines attain a greater altitude than 900 feet above the sea, there being no high backbone ranges to be crossed as in America. Probably, the whole of England will compare, as regards the physical features of the country in relation to railway construction, with the United States, after excluding the strictly prairie States. About half the American railways are constructed in country offering no greater advantage than the United Kingdom for cheap construction.

Cost of Land and Right of Way.—This is much greater in England than in America.

Construction.—“This is generally much superior, stronger, more substantial, and a great deal more costly on English” than on

¹ The original article appeared in the Transactions of the American Society of Civil Engineers for January, 1886, and is the Paper referred to by Mr. R. Gordon, “On the Economical Construction of Railways, &c.,” *ante*, p. 54.

American lines. Especially is this so in the case of new lines, the American system of "rushing" the line through and completing it at leisure being unknown in England, where the Board of Trade requirements must be satisfied before the line is opened. The American wooden culverts and trestle-work are almost unknown in England. Embankments are made with flatter slopes, and more attention is paid to foot and side drains than in America.

Passenger Carriages.—English carriages are narrower than American, the Pullman cars used in England being 8 feet 10 inches wide as compared with 10 feet, and being also 13 inches lower. "The English passenger car is cold in cold weather and hot and close in warm weather. If one is seated facing the engine, he is in a gale; if seated on the front seat, is in a corner where no air can reach him. It does not run as smoothly as the American."

All the railways in the United Kingdom, except the Midland, run virtually six classes of carriages, viz., 1st, 2nd, and 3rd smoking and non-smoking; and as it is impossible to fill all these uniformly, there is great loss of room and unnecessary haulage of dead weight.

There is nothing in America corresponding to the workmen's trains, which are run morning and evening by many English companies at very cheap rates.

Goods Wagons and Trains.—The English goods wagon weighs about 5 tons and carries 8 tons, a proportion of 1 to 1·6. The American box freight car weighs 23,000 lbs. and carries 50,000 lbs., a proportion of 1 to 2·13.

English goods trains run at much higher speeds than American, and they do not average one-half the load of American trains; while, considering the better construction of the roads, and the comparatively straight lines and easy gradients, the average train-tonnage should be much larger. By reducing the speed and increasing the load of English goods trains the cost of transportation could probably be largely reduced.

Block System.—The English railways have a great superiority over the American lines in their thorough adoption of the block system.

Baggage Checks.—English railways are behind American in arrangements for dealing with passengers' luggage, the baggage check system being brought to great perfection in America.

Speed.—In England goods trains run much faster than in America. Passenger trains also are generally faster in England than America. The accompanying Table gives the average speeds of some express services:—

[Taken from Table No. 1.]

—	From	To	Distance in Miles.	Average Miles per Hour including Stoppages.
<i>English—</i>				
London & North Western	London .	Liverpool .	201½	44·8
" "	" .	Glasgow .	406	40·6
" "	" .	Holyhead .	264	43·4
Great Northern . . .	" .	Glasgow .	444	43·0
" " . . .	" .	York . . .	188½	48·1
Great Western . . .	" .	Bristol . .	118½	45·6
London, Brighton, and } South Coast . . . }	" .	Brighton .	50	46·2
Midland	" .	Nottingham .	125	50·0
<i>American—</i>				
New York, New Haven, } and Hartford . . . }	Boston . .	New York .	234	39·0
Pennsylvania	Jersey City	Philadelphia	89	45·6
" "	" .	Chicago . .	911	36·8
New York Central and } Hudson River . . . }	New York .	Albany . .	143	44·0
" "	" .	Buffalo . .	441	41·0
" "	" .	Chicago . .	980	39·2
Baltimore and Ohio . .	Baltimore .	Washington .	40	53·0

Accidents.—Table showing passengers killed and injured from causes beyond their own control on all the railways of the United Kingdom, and those of the States of New York and Massachusetts, 1884.

[Taken from Table No. 2.]

—	Total Length of Line Worked.	Total Mileage.		Killed.	Injured.
		Train.	Passenger.		
United Kingdom	18,864	272,803,220	6,042,659,990	31	864
New York . . .	7,298	85,918,677	1,729,653,620	10	124
Massachusetts .	2,852	32,304,333	1,007,136,376	2	42
In 1,000,000,000 passengers transported 1 mile . . . }				United Kingdom	5·15
				New York	5·78
				Massachusetts	2·00
					143
					70
					42

—	Average number of Miles a Passenger can Travel without being	
	Killed.	Injured.
United Kingdom .	194,892,255	6,992,662
New York	172,965,362	13,940,754
Massachusetts . .	503,568,188	23,955,630

This comparison is with two of the States in which there are old and completed railways. The Western States would show a much higher proportion of accidents.

[TABLE No. 4.]

NUMBER of PERSONS EMPLOYED ON the RAILWAYS of the UNITED KINGDOM and the UNITED STATES in 1880.

1880.	United Kingdom.	United States.
Engine-drivers and firemen	27,441	67,231
Guards	12,064	12,419
Platelayers	26,156	
Pointsmen, &c.	7,406	122,489
Labourers	42,212	
Other railway servants	120,437	216,818
Total	235,716	418,957
Average employees per 1,000 miles of goods and passenger trains	0.89	1.08
" " " mile of line open	13.0	4.8
" " " 1,000 tons of traffic	0.9	0.7
" " " 1,000 passengers carried	0.38	0.65
" " " £1,000 earned	2.7	0.28

This Table is taken from a report by Mr. J. S. Jeans, Secretary of the Iron and Steel Institute.

TABLE No. 5.

(Compiled by Mr. J. S. JEANS.)

SHOWING the ROLLING STOCK used ON RAILROADS of UNITED KINGDOM and UNITED STATES in 1880.

1880.	United Kingdom.	United States.
Locomotives	14,469	17,412
Passenger carriages	32,304	12,330
Freight cars	446,333	375,312
Other vehicles	12,024	84,613
Totals	505,130	489,667
Vehicles per mile open	2.6	0.24
" " 1,000 tons freight carried	0.5	0.59
" " 1,000 passengers "	1.3	0.53
" " £1,000 capital	1.5	2.3

RAILWAYS of the UNITED KINGDOM and the UNITED STATES COMPARED, 1883.

[Taken from Table No. 16.]

	United Kingdom.		United States.	
	Total.	Per Mile Worked.	Total.	Per Mile Worked.
Single line . . . miles	8,576	..	..	..
Double or more lines ..	10,105	..	..	..
Total miles . . .	18,681	..	110,414 (about 23 per cent. double.)	..
<i>Capital.</i>				
Shares and stock	£588,998,127	£31,529	£741,612,117	£6,152
Loan and debenture stock .	166,563,552	8,916	..	..
Bonds	..	..	691,008,077	5,730
Floating debts	..	..	55,474,069	..
Total	£755,561,679	£40,445	£1,488,094,263	£11,882
<i>Train Service.</i>				
Total mileage of passenger trains	138,176,940	..	193,960,013	..
„ „ of freight trains	127,983,253	..	350,108,255	..
„ „ „ mixed „	2,737,043	..	..	..
„ train mileage	268,897,236	..	544,068,268	..
<i>Freight Traffic.</i>				
Total tons of freight moved	266,382,968	..	400,453,439	3,627
Total ton-mileage	9,288,316,560	..	44,064,923,445	..
Average train-load . . .	71	..	126	..
Total freight receipts . .	£38,701,319	£2,072	£109,951,339	£1,000
Average receipts per ton moved	33·6	..	65·9	..
Average charge per ton per mile	..	1	..	0·505
Average mileage of each ton moved	35	..	110	..
<i>Passenger Traffic.</i>				
Total number of passengers of all classes	684,350,187	36,632	404,811,584	3,666
Total passenger mileage . .	5,969,825,966	..	8,817,684,503	..
Average mileage per pas- senger	7·2	..	22	..

RAILWAYS of the UNITED KINGDOM and the UNITED STATES
COMPARED, 1883—*continued*.

	United Kingdom.		United States.	
	Total.	Per Mile Worked.	Total.	Per Mile Worked.
<i>Passenger Traffic—contd.</i>				
Total receipts from pas- } £	25,742,452	1,378	44,326,616	401
sengers }				
Average receipts from } pence	8·9	..	26·28	..
each passenger . . . }				
Average mileage of each } pence	8·0	..	22·0	..
passenger }				
Average charge per } pence	..	1·12	..	1·16
mile per passenger }				
<i>Earnings.</i>				
Earnings from freight } £	38,701,319	2,072	109,951,339	1,000
traffic }				
„ from passen- } „	25,742,452	1,378	44,326,616	401
ger traffic . . . }				
„ from freight } „	64,443,771	3,450	154,277,955	1,401
and passenger traffic }				
Total earnings from all } „	71,062,270	3,804	164,754,585	1,492
sources }				
Percentage of gross earnings } „	9·05	..	10·99	..
to investment, capital, }				
and bonds }				
Percentage of net earnings } „	4·29	..	4·49	..
to investment, capital, }				
and bonds }				
Working expenses . . . £	37,368,562	2,001	97,372,208	882
Percentage of working ex- } „	53·0	..	59·0	..
penses to receipts . . . }				
Total net earnings . . . £	33,693,708	1,804	67,382,377	610
Percentage of net earnings } „	47·0	..	41·0	..
to gross receipts . . . }				
Passenger earnings } pence	..	44·4	..	54·7
per passenger train- }				
mile }				
Freight earnings per } „	..	72·0	..	74·9
freight train-mile }				
<i>Rolling Stock.</i>				
Total number of engines . .	14,469	0·775	23,823	0·216
„ „ „ passenger } „	32,304	1·73	17,899	0·162
cars }				
„ „ „ baggage, } „	2,024	0·108	5,918	0·054
mail, and express cars . }				
„ „ „ freight cars } „	446,333	23·9	748,661	6·78

Cost of Railways.—The English railways were much more costly than the American. Their expensive construction with straight lines, easy gradients, good road-bed, permanent brick buildings, and brick, stone or iron bridges should make the annual expenses much lighter than those of American lines, where for economical reasons perishable materials, requiring frequent renewals enter so largely into the construction of buildings and bridges.

In order to answer the question: Do the working results compensate for the great additional cost of the English over the American railways? the Author gives a large number of tables based upon information furnished in the half-yearly Reports of the Companies and the Board of Trade Returns in the case of English lines, and upon the Reports of the Railroad Commissioners of the various States in the case of the American lines.

COMPARATIVE PROPORTION OF DIFFERENT ITEMS OF WORKING EXPENSES which are or are not EFFECTED by GOOD or BAD CONSTRUCTION on the AGGREGATE RAILWAYS of the UNITED KINGDOM and UNITED STATES for the YEAR 1880.

[TABLE No 3.]

(Compiled by Mr. J. S. Jeans.)

1880.	United Kingdom.		United States.	
	Expenses affected by Good or Bad Construction.	Expenses not affected by Good or Bad Construction.	Expenses affected by Good or Bad Construction.	Expenses not affected by Good or Bad Construction.
Maintenance of way . .	17·70	..	25·31	..
Locomotive charges . .	24·40	..	24·96	..
Repairs of carriages . .	8·40	..	9·39	..
Traffic charges	..	30·00	..	25·31
Rates and taxes	..	5·00	..	4·77
Government duty	..	2·40	..	..
Compensation—passengers	..	0·70	..	0·39
" goods	..	0·60	..	0·59
Legal and parliamentary expenses	..	0·90	..	0·70
Miscellaneous expenses .	..	9·90	..	8·58
Total	50·50	49·50	59·66	40·34

The following Table shows for the chief English railways the percentage of the annual expenditure which is affected by the good or bad construction of the line. This percentage being subtracted from 59·7, the average percentage for American rail-

ways, and the difference multiplied into the total annual working expenses, gives the gross annual saving due to the superior construction of English lines. The fifth column of the Table gives the annual saving per mile, and this, capitalized at 6 per cent., as given in the last column, shows the amount which the engineer would have been justified in expending per mile over and above the cost of the inferior American system.

[Taken from TABLE NO. 17.]

Name of Railway.	Length of Line Worked.	Percentage of Working Expenses.		Annual Saving per Mile by Good Construction as compared with average American.	Annual Saving capitalized at 6 per cent.
		Affected by Good or Bad Construction.	Not Affected by Good or Bad Construction.		
	Miles.			£.	£.
Average of all railways of United Kingdom	18,681	51·8	48·2	158	2,633
London and South Western	721	49·7	50·3	228	3,807
Great Eastern	1,049	53·0	47·0	116	1,932
Great Northern	768	50·7	49·3	223	3,923
Midland	1,381	55·1	44·9	129	2,155
London and North Western	1,793	48·0	52·0	351	5,853
Great Western	2,268	57·2	42·8	42	697
London Chatham and Dover	160	51·5	48·5	299	4,987
Caledonian	897	54·5	45·5	93	1,553
North British	1,006	56·4	43·6	43	720
Average of all railways of United States	110,414	59·7	40·3	..	..

		£.
The average cost of construction of English railways per mile has been (1883)	} 40,445	
The average cost of construction of American railways per mile has been (1883)		12,435
Difference		28,010

The percentage of the working expenses saved by the better construction represented by this amount is 7·9—say 8 per cent. The average annual cost per mile of American railways is £882 per mile; 8 per cent. on this is £71, which would have been the annual saving per mile gained by an increased cost of £28,010 per mile, a return of 0·25 per cent. on the outlay.

Ton- and Passenger-mileage.—No return of ton-mileage is made by the English companies. After careful inquiry the Author decided that the average charge on goods moved in the United Kingdom

is $1\frac{1}{4}d.$ per ton (of 2,240 lbs.) per mile, or, for comparison with American statistics, say $1d.$ per ton (of 2,000 lbs.) per mile. To get the ton-mileage, the receipts from goods traffic, as given by the companies, are multiplied by 240.

The passenger-mileage is obtained by dividing the total receipts from ordinary passengers by the total number carried. This gives the average amount received per passenger. This divided by $1\frac{1}{4}$ (the average rate per passenger-mile on all English railways, 1st, 2nd, and 3rd class included, inclusive of season tickets) gives the average mileage travelled by each passenger. Multiplying that by the number transported gives the total mileage of ordinary passengers. The average mileage travelled for each £1 paid is 206. The average mileage travelled by season-ticket holders for each £1 paid is 600.

The figures for ton- and passenger-mileage of English railways are got by means of these figures from the published half-yearly accounts of the companies. Those for the American railways are taken from the official reports of the companies, or from the reports of the Railroad Commissioners of the different States.

The following Table gives the passenger-mileage and ton-mileage per mile of single line of some of the principal English and American railways:—

TABLE NO. 22.

Name of Railway.	Mileage per Mile of Single Line.	
	Passenger.	Ton.
North Eastern	137,000	455,138
Midland	181,272	512,714
London and North Western	233,777	473,912
London, Chatham, and Dover	634,036	195,906
London, Brighton, and South Coast	547,328	192,778
Great Western	190,111	308,703
Average	320,587	356,525
Boston and Albany	272,642	609,686
Boston and Providence	492,863	194,772
New York, New Haven, and Hartford	516,694	314,359
New York, Central, and Hudson River	182,680	927,973
New York, Lake Erie, and Western	114,982	1,216,913
Pennsylvania, Pennsylvania Railroad } Division	130,235	1,594,898
Average	285,016	809,767

This Table shows that the six American lines have more than double the goods traffic per mile, and only 11 per cent. less passenger traffic than the six English lines. From this it appears that it is not necessary to run goods trains faster on English than on American lines in order to clear the lines of traffic.

The fast running of the goods trains is one of the main causes of the greater expense of working English as compared with American railways.

Comparing the average of fourteen principal English lines (1883) with ten American lines (1884), the percentages of the total working expenses due to locomotives (running and repairs and renewals) and maintenance of way, &c., are as follow :—

—	Fourteen principal English Railways (1883).	Ten principal American Railways (1884).
Wages of drivers and firemen, and repairs and renewals of loco- motives, and cost of fuel . . . }	22·1	12·7
Maintenance of way	17·9	21·8

In making the comparison of wages of drivers and firemen the American wages are reduced 50 per cent. to bring them to about the English rate, and all the fuel is reduced to the rate of 6*s.* 5*d.* per ton. The amounts as actually paid are 23·6 and 22·8 per cent. instead of 22·1 and 12·7 per cent. respectively.

The English roads in Table No. 26 (see page 337) were selected by the Author as being five of the roads doing the heaviest and largest traffic in the United Kingdom. The American five were chosen from the eastern system of roads, and are, with the exception of the New York, New Haven, and Hartford, constructed through a country more broken physically than that through which the English roads pass.

Supposing that the longer ton- and passenger-haulage of these five American lines influence the result in their favour, the same calculation on the same basis (except that taxes are included in the working expenses) has been made for 1884 on four of the short lines of Massachusetts, where the average haulage is very short (Table No. 27, page 338).

TABLE No. 26.—COMPARISON OF THE AVERAGE ANNUAL COST OF MOTIVE POWER ON FIVE OF THE PRINCIPAL RAILROADS OF ENGLAND AND THE UNITED STATES FOR THE YEARS 1882, 1883, and 1884.

Name of Railroad.	Total Operating Expenses, Steamboat Expenses, Taxes, and Duties.	Fuel.			Wages of Engine-drivers and Firemen.		Repairs and Renewals of Locomotives.		Total Percentage of Fuel, Wages of Engine-drivers and Firemen, and Repairs and Renewals of Locomotives to Operating Expenses.	
		Amount actually paid.	Percentage on Operating Expenses.		Amount actually paid.	Percentage on Operating Expenses.	Amount actually paid.	Percentage on Operating Expenses.	Amount actually paid.	Percentage on Operating Expenses.
			All reduced to English prices.	All reduced to English prices.						
<i>England.</i>	£.	£.	6·6	6·6	£.	8·9	8·9	6·8	22·3	22·3
		132,495	6·6	6·6	177,270	8·9	8·9	6·8	22·3	22·3
		3,253,949	6·8	6·8	317,567	9·8	9·8	12·5	29·1	29·1
		3,607,350	6·3	6·3	425,629	11·8	11·8	9·8	27·9	27·9
		4,845,722	5·6	5·6	453,566	9·4	9·4	7·5	22·5	22·5
<i>United States.</i>	£.	3,512,520	5·6	5·6	315,892	9·0	9·0	10·6	25·2	25·2
		Average . . .	6·2	6·2		9·8	9·8	9·4	25·0	25·0
		1,076,669	13·1	4·2	81,388	7·4	3·7	5·9	28·3	13·8
<i>United States.</i>	£.	841,033	10·2	4·2	50,460	6·0	3·0	2·7	19·8	9·9
		2,619,648	10·3	6·9	222,894	8·4	4·2	3·6	23·5	14·5
		3,669,153	12·1	6·0	271,231	7·4	3·7	4·2	25·1	14·3
		3,476,704	6·4	6·4	247,550	7·1	3·5	6·4	22·0	16·3
		Average . . .	10·4	5·5		7·3	3·6	6·1	23·7	13·8

[NOTE.—With reference to this Table it is to be noted that the reduced percentages are no longer correct percentages of the total working expenses, and that the total working expenses are not reduced to English rates.—W. B. W.]

TABLE No. 27.

Name of Railroad.	Percentage of Locomotive operating expenses all reduced to the prices paid in England.			
	Coal.	Wages.	Repairs and Renewals of Locomotives.	Total.
Boston and Lowell . . .	4·2	3·7	4·7	12·6
Boston and Maine . . .	4·0	3·3	4·2	11·5
Boston and Providence . .	3·1	3·5	5·0	11·6
Old Colony	3·3	3·7	3·6	10·6
Average	3·6	3·6	4·4	11·6

These results show still more favourably to the American system.

Cost per Train-mile.—Owing to the imperfect returns of the cost of motive power made by the English companies, no distinction being made between the goods-mileage and passenger-mileage, comparisons of cost per train-mile are not of much value. A number of Tables are, however, given by the Author which show that although the American average train-load both in goods and passenger trains is much greater than the English, yet the average train-mile costs in motive power less on American than on English railways.

Locomotive Earnings.—More work in a year is got from the locomotives on American railways than on those of Great Britain, as shown by the following Table, which is taken from the reports for 1884:—

[Taken from Table No. 39.]

Name of Railway.	Total Number of Locomotives.	Annual Mileage.	
		Total.	Average.
Great Northern	789	16,978,030	21,498
Great Western	1,577	30,457,257	19,314
Midland	1,697	33,261,729	19,600
London and North Western	2,476	38,184,328	15,422
Totals and average of 13 British railways including the above . . }	11,320	209,735,248	18,528
Pennsylvania (Pennsylvania division) .	815	20,791,778	25,511
Baltimore and Ohio	603	11,405,777	18,915
New York, Lake Erie, and Western . .	805	17,092,582	21,233
Boston and Albany	243	4,960,185	20,407
Totals and average of 16 American railways including the above . . }	4,479	98,918,986	22,085

The following Table gives the annual traffic earnings per locomotive for 1883 :—

[Taken from Table No. 40.]

Name of Railway.	Total Number of Locomotives.	Earnings from Traffic.	
		Total.	Average per Locomotive.
		£.	£.
Great Northern	733	3,522,035	4,805
Great Western	1,577	7,817,742	4,957
Midland	1,629	7,363,217	4,520
London and North Western	2,451	10,362,520	4,228
Totals and average for 14 British railways including the above . }	11,554	54,402,781	4,709
Pennsylvania (Pennsylvania division) .	795	6,403,563	8,055
New York and New England	151	675,260	4,472
New York, Lake Erie, and Western . .	785	4,408,119	5,615
Boston and Albany	244	1,620,391	6,643
Totals and average of 14 American railways including the above . }	3,738	27,426,683	7,337

This Table shows that though the average charges for both goods and passengers are lower in America than in England, the average earnings of the American locomotives are much greater than those of the English.

The Author, in conclusion, suggests that English passenger rolling-stock might be improved by the general use of the bogie-truck, which would do away with the jarring caused by the rigid wheel base; and also by warming the carriages in winter; that the comfort of passengers might be much increased, and a saving of portage staff be effected by the introduction of the American baggage-check system; and that the cost of motive power might be economized by running heavier goods trains at a lower rate of speed. The English road-bed, permanent-way, and block-signaling system he considers to be all that could be desired.

The Paper is accompanied by forty-one statistical Tables and some gradient sections of American railways.