Road versus rail - Facts sheet number 1 – Capacity, average flow, density of use

Updated September 2005

This facts sheet provides information on capacity, average flows, density of use and some anecdotal illustrations of the use that rail makes of its rights of way. Sources and calculations are appended.

Capacity

The line haul

At Waterloo 50,000 crushed passengers alight in the morning peak hour. They could all find seats in 1,000 50-seat motor coaches. Those coaches would occupy no more than one lane of a motor road. At Waterloo there is room for 3 or 4 lanes in each direction. The waste is lamentable.

At Euston, 60,000 passengers alight all day. They would require no more than 3,000 coaches each with only 20 people aboard. 3,000 coaches could pass in 90 minutes in the space available on the approaches to the terminal but the railway has run out of capacity all day.

In the peak 3 hours some 500,000 passengers enter central London by surface Rail spread over 25 pairs of tracks. If half the passengers arrive in the peak hour the average flow per inbound track is 10,000 passengers. They could all fit in 200 50-seat coaches, sufficient to fill one fifth of the space available.

The Americans, particularly Don Morin, Head of Public Transport, US Department of Transport, concluded in the 1970's that there is no movement corridor in the world where demand cannot be satisfied by one lane of a motor road dedicated to coaches.

Terminals

Neither British Rail nor Railtrack would provide plans that would enable the areas of London terminals to be estimated and we have not enquired of Network Rail. However, at Waterloo probably the 21 platforms occupy an area 250 metres square, or thereabouts, a total of 6.25 hectares. If 50,000 alight in the peak hour the density of use is 8,000 passengers per hour per hectare.

In contrast (a) Victoria Coach station is said to be able to handle 10,000 passengers per hour, many with baggage, on one hectare. (b) The area in front of Victoria Rail terminal used to handle 280 buses an hour on 0.2 hectare's. If each bus had 50 people alighting the density of use was 70,000 passengers per hour per hectare.

Hence it appears likely that the nimble bus would use terminal space very much more efficiently then can the cumbersome train.

If at Waterloo as many as 1,000 buses an hour were to arrive and if each needed to stand for as long as 6 minutes then there would need to be 100 bus bays. If they were spread over 3 levels there would be 33 bays per level. That does not seem unreasonable. Perhaps the number could be halved if half the buses drove onwards, so avoiding the need for some of the passengers to alight.

Average Flow

The calculations appended show that national rail carried an average flow equivalent to only some 300 buses plus lorries per day per track in 2004 - a flow which is so small that it is fair to say that the network was, and is, substantially disused as it lies there basking in the sun of government subsidy.

Density of use

The calculations appended provide the following densities of use for rail and the motorway and trunk road systems.

For freight:

National Rail	0.68 million tonnes-km per km of track
M'ways and trunk roads	1.8 million tonnes-km per km of running lane
Motorways	2.5 million tonnes-km per km of running lane

For passengers:

National Rail	1.30 million passenger-km per km of track
M'ways and trunk roads	4.26 million passenger-km per km of running lane
Motorways	5.27 million passenger-km per km of running lane

Despite the rail network occupying corridors of intense demand and penetrating to the hearts of our towns and cities the density of use is a fraction of that achieved by the strategic road network, where over 90% of the passenger movement is by car and light van.

Anecdotal illustrations

Anecdotal illustrations of the inability of rail to make reasonable use of track include:

Welwyn Viaduct on the East Coast Main Line. That viaduct has one track in each direction and carries 14 trains towards London in the peak hour (Letter from Railtrack dated 8th December 1999). Those trains are equivalent to not more than 150 buses and coaches, enough to fill one sixth of one lane of a motor road. Despite that trivial flow the viaduct limits the capacity of the entire route.

The Ouse Viaduct**,** Balcombe and **St Germains Viaduct Cornwall** . These immense pieces of engineering feature in the 1996 Network Management statements by Railtrack. Railtrack were not been able to identify the use to which the structures are actually put but flows are likely to be much below those for the Welwyn viaduct. Hence it is fair to say that the structures achieve little for the nation beyond photo opportunities.

Pictures as previously

The capacity sections of The West Coast Main line

Page 3-2 of the Environmental Statement of Main Report supporting Railtrack's case at the Public Inquiry into the West Coast Main Line Modernisation Programme provides the flows at the capacity sections**.** During the 18 hours 6 am to midnight these carry some 110 passenger trains and 55 freight trains, together equivalent to perhaps 2,500 buses plus lorries per day. Despite that relatively trivial flow the limitation on capacity forces 35 to 40 other goods trains to operate from midnight to 6 am. There are 3 running tracks at two of the capacity sections and two tracks at the third. If the 18 hour flow, equivalent to 2,500 buses plus lorries, is split between just two tracks the directional 18 hour flow is 1,250 vehicles per track, sufficient to fill one lane of a motor road for about 75 minutes.

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Apendix: Sources and calculations

Sources are the Transport Statistics Great Britain 2004 edition (TSGB) and the SRA's year book 2004-05, (SRAYB)

Average Flow

Passenger kilometres and tonne-kilometres can be converted to equivalent bus plus lorry flows by:

(a) Dividing passenger-km by a bus occupancy of 20 (5 less than claimed as the occupancy of coaches leaving Victoria coach station) or 16 to obtain equivalent coach flows
(b) Dividing tonne-km by 15 (half the capacity of a 44 tonne lorry) to obtain equivalent lorry flows.
(c) Adding the results of (a) and (b) and dividing by (i) the days in the year, 365 and (ii) the track length, 32,000 km yields the average flow per track.

The following table provides the data for the years 1999 to 2004 where the Passenger and Tonne-km are from the SRAYB.

Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Pass km (bn)	38.5	38.2	39.1	39.7	40.9	42.4
Tonne km (bn)	19.0	19.0	20.6	19.9	20.1	22.0
Equivalent daily bus plus lorry flows						
(a) 20 passengers per bus	273	272	285	284	290	307
(b) 16 passengers per bus	314	313	327	326	334	352

Density of use

Densities of use are calculated by dividing the Passenger-km and Tonne-km by track or lane length.

As previously, the track length of the national rail network is 32,000 km. The lane length for the motorway and trunk road systems are estimated below where the route length for 2003 is from Table 7.8 of the TSGB and where the lane lengths assume (a) motorways average 6 lanes and Trunk roads 2 lanes and (b) motorways average 7 lanes and Trunk roads 3 lanes. In calculations the higher lane lengths have been used, namely 24,300 km for motorways and 52,000 km for motorways and trunk roads.

	Route Length Km	Lane Lengths, km	
		(a)	(b)
Motorways	3,477	20862	24339
Trunk Roads	9,340	18680	28020
Total	12,817	39542	52359

For rail freight we have from the SRAYB 22 billion Tonne-km in 2004. Dividing by the track length provides 0.69 million tonne-km per km.

For road freight we have from TSGB table 7.4 that, in 2003, 62% of Lorry-km were are carried by the motorway and trunk road network and 40% by the motorways. Applying those numbers to the 152 billion tonne-km of freight carried on the road system as a whole (TSGB 4.4) yields 94 and 61 billion tonne-km respectively. If we set the lane lengths to 52,000 km for motorways plus trunk roads and 24,300 km for motorways so as to produce low estimates of density we obtain:

(a) 94/52 = 1.8 million tonne-km per km for motorways and trunk roads (2.6 times the rail value)
(b) 61/24.3 = 2.5 million tonne-km per km for motorways (3.6 times the rail value).

For rail passengers we have from the SRAYB 42.4bn passenger-km per year in 2004. Dividing by the track length of 32,000 km provides a density of 1.30 million Passenger-km per km.

For road TSGB table 7.4 provides the vehicle-km data (billions) in the first 3 rows of the table below. Multiplying by the occupancy data also in the table yields the passenger-km. The occupancy of 1.5 for cars and vans may be obtained by dividing the 678 bn passenger-km in cars

and vans from TSGB table 1.1 by the 451 bn car plus van vehicle-km from TSGB table 7.2. The occupancy for buses and coaches is set to 16. That compares with the national average of 9 and with the occupancy of 25 for coaches leaving Victoria coach station London.

	Cars	Buses	Vans	Total
Motorway	70.3	0.46	10.21	
Rural Trunk	46.2	0.34	6.76	
Urban Trunk	5.1	0.04	0.7	
Totals	121.6	0.84	17.67	
Occupancy	1.5	16	1.5	
Total passenger km	182.4	13.4	26.5	222.3
Passenger-Km M'ways	105.4	7.3	15.3	128

Hence the densities are:

(a) 222/52 = 4.27 million passenger-km per km for motorways and trunk roads (3.3 times the rail value)
(b) 128/24.3 = 5.27 million passenger per km for motorways (4.05 times the rail value).