

Part — I

Railways

History of Railways

1.1. INTRODUCTION

Transportation has been an essential factor for the development of most societies worldover. One can hardly conceive a society which may exist without any mode of transportation. In fact, the transportation system is a fair index of a country's economical growth.

The transportation has countless specific applications to the man-kind. Its primary function is to move passengers and goods from one place to another. Transportation is largely concerned with the movement of goods. It helps in moving the goods from the place of its growth to the place where it is consumed. By means of transportation we dispatch the goods to the places wherever and whenever these are required. The essential function of transportation with regard to goods, can equally be applied to the movement of passengers.

High productivity of a product is of little value unless the goods produced are utilized and consumed. Transportation is certainly necessary for adequate physical distribution of goods,. In the absence of efficient transportation system, in large country like India, the remote areas may sometime experience famine, despite a bumper crop in other part of the country.

The main factor which contributes to a nation's development is how effectively it utilizes the world's stock of natural resources. Raw materials are seldom consumed at the places where these occur in nature. Timber finds its utility in the consuming areas rather in forests. Most of the wheat consumed in India, is grown in Punjab and Uttar Pradesh. The same is true for coal, petroleum and many other products. By transporting these raw materials to the places of processing and consumption, the commodities are given proper place utility. Transportation also makes possible regional specializations, both in the production of raw materials and finished goods.

New markets are made available by transportation far from the areas of specialization. Only a small percentage of the output can be consumed locally. Transportation provides an opportunity to move surplus production to all parts of the Indian continent and also to sea ports for shipment to the other parts of the world.

Transportation is performing an important role for the delivery of goods and movement of persons at the desired time and place, which has become increasing important. The present day transportation system of the Indian continent, represents an extensive and varied complex industry. Both transportation and transportation industry play a significance role for every Indian citizen. As an engineer one may be called upon to design routes and equipments for transport agencies. As a manufacturer, one is required to select the types of transport for the raw and finished goods to markets. As a military chief one should be aware of essential role of

4 SURFACE TRANSPORT

transportation in national defence. As a town planner one must know the advantages of transportation of the city to save it from traffic congestion. Finally as a student, he has the obligation to obtain an understanding of the fundamental principles of transportation system. The design of stable sub-grades for railways and highways takes into account the principles of soil mechanic engineering and also the mechanics of elastic deformation.

The transportation system may therefore be considered as a coordinating and integrating agency as it unites the nation and makes it essentially the peoples nation. Railways is one of the modern means of transportation of persons and goods from one place to another. In both developing and developed countries, railways play an important role in every stage of advanced civilization.

1.2. MODES OF TRANSPORTS

The various modes of transport for the carriage of passengers and goods, generally adopted world over are:

1. Rail transport. This mode of transport is best suited for the carriage of bulk commodities and large passenger traffic over long distances with greater safety, comfort and convenience.

2. Road transport. This mode of transport is best suited for the carriage of lighter weight commodities of lesser volumes and also small passenger traffic over short distances. However, the road transport has achieved an important position in developing countries. In India, road transport is utilised for the carriage of goods from north to south and east to west throughout the year.

3. Air transport. This mode of transport is best suited for the carriage of valuable goods and important passengers who are required to reach their destinations in a shortest possible period of time.

4. Water-way transport. This mode of transport is best suited for the carriage of heavy and bulky goods over long distances without any consideration of time factor across the seas and also in navigational rivers. This mode of transport is most economical but it is more time consuming.

1.3. MODES OF LAND TRANSPORTS

The following two modes of transport are basically used as land transportation.

1. Road ways
2. Railways

A comparison of road transport and rail transport is given in Table 1.1.

1.4 BRIEF HISTORY OF RAILWAYS

It was in seventeenth century that even idea of pulling the loads by a wheeled vehicle, put on the baulks of timber and drawn by horses, was developed by some body, now un-known even in England. The present day permanent way was thus developed in England. To reduce the friction and also to increase the life of the baulks of timber, the iron plates were put upon the surface of the timber rails. The term "*plate laying*" perhaps originated from the practice of laying iron plates on the timber rails. Later on, cast iron rails were developed by William Jessop of U.K. and were used on stone blocks in 1789. Though, horses could pull reasonably heavy

Table 1.1. Comparison of Road and Rail Transports.

<i>Sl. No.</i>	<i>Item</i>	<i>Road transport</i>	<i>Rail transport</i>
1.	Tractive resistance	<ul style="list-style-type: none"> ● Pneumatic tyres on road experience tractive resistance five times as compared to that of the railways. 	<ul style="list-style-type: none"> ● Tractive resistance is less and hence hauling capacity is more.
2.	Right of way	<ul style="list-style-type: none"> ● It is open to all types of vehicular vehicles including pedestrians. 	<ul style="list-style-type: none"> ● The track being defined by two rails, it is suitable to trains designed for the track.
3.	Cost analysis	<ul style="list-style-type: none"> ● Cost of construction and maintenance is less. 	<ul style="list-style-type: none"> ● Cost of construction and maintenance is more.
4.	Gradients/ curves	<ul style="list-style-type: none"> ● Steeper gradients upto 1 in 30 and relatively sharper curves may be provided. 	<ul style="list-style-type: none"> ● Flatter gradients $\frac{1}{100}$ and curves upto 10° on broad gauge tracks, are generally provided.
5.	Flexibility of movement	<ul style="list-style-type: none"> ● Being more flexible it may even serve door to door. 	<ul style="list-style-type: none"> ● Being less flexible the movement of trains is restricted between fixed stations.
6.	Pollution	<ul style="list-style-type: none"> ● It pollutes the environment more. 	<ul style="list-style-type: none"> ● It pollutes the environment less on electrified sections.
7.	Organisation	<ul style="list-style-type: none"> ● Road transport is controlled mostly by private sectors. 	<ul style="list-style-type: none"> ● Railways are controlled and managed by the Govt. organization.
8.	Suitability	<ul style="list-style-type: none"> ● It is suitable for lighter goods and for passengers traveling over short distances. 	<ul style="list-style-type: none"> ● It is suitable for the carriage of heavy goods and for passengers travelling over long distances.

loads without much difficulty, they were replaced by locomotives as tractive power after the invention of the steam engine. Richard Trevithick successfully designed and constructed a steam locomotive in 1804. This locomotive was found suitable for traction on roads only. The credit of perfecting the design finally goes to George Stephenson who in 1814 produced the first steam locomotive used for traction on railways.

The first public railway in the history of the world was opened for traffic on 27th September 1825 in England between Stockton and Darlington. The planning and design for the rail line was carried out by Stephenson. Various types of locomotives were designed and a competition was held to select the most suitable locomotive for railways in 1829. The Clumsy Eveready 'Rocket' of Stephenson was finally selected as it fulfilled all the conditions of the competition. In its trail, the Rocket attained a speed of 24 miles p.h. (38.6 km p.h.). Thereafter, the idea of running railways with steam power was finally rooted to start a new era of railways.

6 SURFACE TRANSPORT

The first opening of the railways in some important countries of the world are as under:

<i>Country</i>	<i>Date of opening</i>
England	27 th Sept, 1825
France	1824
U.S.A	1833
Ireland	1834
Germany	1835
Belgium	1835
Austria	1838
Neither lands	1839
Italy	1839
Yugoslavia	1846
Switzerland	1847
Denmark	1847
Spain	1848
India	16 th April, 1853
Norway	1854
Africa	1854
Sweden	1856
Japan	1872
China	1875
Burma	1877
Turkey	1888

1.5. HISTORY OF INDIAN RAILWAYS

The first railway line was constructed in India between Bombay (Mumbai) and Thane 21 miles (34 km). On 16th April 1853 it made its maiden trip with 14 coaches and was driven by 3 engines. The important events for the development of Indian Railways have been chronologically listed below:

<i>Year</i>	<i>Event</i>
1853	On 16 April 1853, the first Indian Railway line was opened for passenger traffic between Bombay (Mumbai) and Thane 21 miles (34 km) apart.
1854	A railway line between Howrah and Hoogly was opened for passenger traffic (24 miles).
1856	The railway line which was first proposed in 1831 between Veyasarpady

	and Waliah was completed in 1854 and opened to traffic in 1856.
1855-60	The following eight railway companies were established in India for the development of railways. <ol style="list-style-type: none"> 1.The East Indian Railways. (E.I.R) 2.The Great Indian Peninsula Railways. (G.I.P.R) 3.The Madras Southern Railway. (M.S.R) 4.The Bombay-Baroda and Central Railway (BB. and C.I.R). 5.The East Bengal Railway. (E.B.R) 6.The South Indian Railway. (S.I.R) 7.The Calcutta and South Eastern Railway. (C. and S.E.R). 8.The Scindia Railway. (S.R).
1862	The British Government approved the construction of feeder lines in Northern India.
1869-1881	The Government took the responsibility to construct the railways and decided not to give any fresh contract to any company.
1901	Mr. Thomas Robertson was appointed as an Administrator for the Indian Railways.
1905	A railways board consisting of one president and two members was established under the Department of Commerce and Industries.
1907	The Mckay Committee was appointed to investigate the causes of financial losses to railways.
1908	The railway board was reorganized.
1914-21	In the period of world war, more lines of strategic importance were constructed.
1922	The railway board was reorganized.
1925	The Government took over the management of East Indian Railway and Great Indian Peninsular Railway. Harbour branch line of G.I.P. was the first line developed in India.
1928	Suburban section of Bombay (Mumbai) was developed.
1930	The Indian Railways attained a total kilometrage of 66,300 kms.
1931	The Madras suburban was developed.
1930-31	A sum of 11 crores from the Railways Reserve was withdrawn and credited to General Revenue.
1937	On separation of Burma, 3200 km of railways were taken out from Indian railways
1939-42	During Second World War, 26 branch lines were closed and the track

8 SURFACE TRANSPORT

materials, locomotives and wagons were spared for construction of railways in Middle East.

- 1942 A war transport board was established.
- 1947 On Separation of Pakistan, the railways in Pakistan were taken out.
- 1947-51 After independence, regrouping of railways was done and six zones were formed.
- | | |
|----------------------|---------------------------|
| 1. Central Railways | 2. Eastern Railways |
| 3. Northern Railway | 4. North Eastern Railways |
| 5. Southern Railways | 6. Western Railways |
- 1988 Indian Railways are now the main artery of the nation's inland transport system. As on 31.3.1987, Indian Railways nation wide network has a total length of 1,15,000 kms. It is Asia's largest and the World's Second largest railway system under a single management. From the inception, Indian Railways have helped in the nation's industrial development as well as national integration.

Rapid Growth of the Indian Railways system may be visualized by referring to Table 1.2.

Table 1.2. Growth of Indian Railways.

Year	Traffic		Total number of passengers
	Revenue earning	Total	
1950-51	73 million tonnes	93 million tonnes	1284 million
1986-87	278 million tonnes	307 million tonnes	3580 million

1.6 VARIOUS GAUGES ON WORLD RAILWAYS

Gauge of a railway track may be defined as the minimum distance between the running faces of two rails of the track. Different countries in the world have adopted different gauges due to historical and other considerations. The British railways adopted a gauge of 5'00", having the flanges of the wheels outside of the rails. Subsequently, it was decided to provide the flanges of wheel on the inner side of the rails. Thus, the gauge was changed to 4' 8½" as the top width of the rails in those days was 1¾". The 4' 8½" gauge now popularly known as 'Standard Gauge' was adopted by most of the European Railways.

The Various gauges adopted on the world railways are shown in Table 1.3.

Table 1.3 Gauges of the World railways.

Type of Gauge	Gauge (mm)	Gauge (feet)	Countries
1. Standard gauge	1435	4' 8½"	England, Canada,, Turkey, U.S.A., Persia and China
2. Broad gauge	1676	5' 6"	India, Pakistan, Argentina Ceylon and Brazil
3. Broad gauge	1524	5' 00"	Russia and finland, Japan

4. Cape gauge	1067	3' 6''	Africa, Java, New Zealand and Australia
5. Metre gauge	1000	3' 3 $\frac{3}{8}$ ''	India, France, Switzerland and Argentina.

1.7. GAUGES ON INDIAN RAILWAYS

The Indian Railways have adopted three gauges to suit the public demand and general topography of the area.

1. Broad Gauge (B.G). The broad gauge is kept 1676 mm (5' 6''). It has been adopted essentially on main and trunk lines across the country.

2. Metre Gauge (M.G). The metre gauge is kept 1000 mm (3' 3 $\frac{3}{8}$ ''). It has been adopted mostly on feeder lines.

3. Narrow Gauge (N.G). The narrow gauge is kept 762 mm or 610 mm (2' 6'' or 2' 0''). This gauge is limited to only difficult terrain such as mountainous regions.

The gauge-wise route length of the Indian Railways as on 31st March 2012 is shown in Table 1.4.

Table 1.4. Gauge-wise route length of railways.

<i>Gauge</i>	<i>Route Kilometres</i>	<i>Total track kilometres</i>
Broad gauge (B.G)	49,820	93,386
Metre gauge (M.G)	10,621	13,421
Narrow gauge (N.G)	2,886	3,198
Total	63,327	1,10,005

1.8. STATE-WISE ROUTES

Route Kilometres of rail lines in Indian states as on 31-3-87 are:

<i>State</i>	<i>Route kms</i>
Andhra Pradesh	4,957
Assam	2338
Bihar	5362
Gujrat	5553
Harayana	1500
Himachal pradesh	256
Jammu and Kashmir	77
Karnataka	3027
Kerala	921

10 SURFACE TRANSPORT

Madhya Pradesh	...	...	5781
Maharashtra	...	...	5433
Nagaland	...	...	9
Orissa	...	...	1982
Punjab	...	...	2139
Rajasthan	...	...	5614
Tamil Nadu	...	...	3894
Tripura	...	...	35
Uttar Pradesh	...	...	8889
West Bengal	...	...	3761
Chandigarh	...	...	11
Delhi	...	...	168
Goa	...	...	79
Pondicherry	...	...	27
Total	...	...	61813

1.9. RAILWAY ZONES OF INDIAN RAILWAYS

Due to operational and managerial considerations and administrative convenience the Indian Railways are now divided into 16 zones with their respective Head Quarters and route kilometers traversed by them as on 31st March 2011 are shown in Table 1.5.

Table 1.5. Zonal head quarters.

<i>Railway zone</i>	<i>Head Quarters</i>	<i>Route Kilometres</i>
1. Northern Railway (N.R)	Delhi	6968
2. North East Frontier Railway (N.E.F.R)	Guwahati	3908
3. Eastern Railway (E.R)	Kolkata	2435
4. North Eastern Railway (N.E.R)	Gorakhpur	3721
5. Western Railway (W.R)	Mumbai	6440
6. Central Railway (C.R)	Mumbai	3905
7. South Eastern Railway (S.E.R)	Kolkata	3632
8. South Central Railway (S.C.R)	Secuderabad	5810
9. Southern Railway (S.R.)	Chennai	5102
10. South Western Railways (S.W.R)	Hubli	3177
11. North Western Railways (N.W.R)	Jaipur	5464
12. West Central Railways (W.C.R)	Jabalpur	2965
13. North Central Railway (N.C.R)	Allahabad	3151
14. South East Central Railways (S.E.C.R)	Bilaspur	2455
15. East Coast Railways (E.C.R)	Bhubandeshwar	2646
16. East Central Railways (E.C.R)	Hazipur	3656

Note : (i) Kolkata Metro was declared as the zonal status on 29-12-2010

(ii) Konkan Railways has been declared as a zone only for administrative purpose.

1.10. ADVANTAGES OF RAILWAYS

The main advantages of railways may be discussed under three heads, *i.e.* political, social and economical.

1. Political advantages. The political advantages of railways are as under:

- (i) Railways help to unite the people of different religions, castes, customs and traditions.
- (ii) Railways network has enabled the central administration to become more easy and effective.
- (iii) Railways have helped in the migration of the population from one region to the other for employment opportunities.
- (iv) Railways have contributed a lot for developing the national integration.
- (v) Railways have helped during wars for transportation of war equipments and armies.

2. Social advantages. The social advantages of railways are as under:

- (i) Railways provide a convenient, safe and cheap mode of transport for the *passengers* through out the country.
- (ii) Railways have enabled the Indian villagers to feel an integral part of India.
- (iii) Railways have broadened the social out-look of the people.
- (iv) Railways have enabled the masses to visit religious places and tourist stations throughout India.
- (v) Railways have eradicated the untouchability as passengers of different castes *travel* in the same compartments of the train.

3. Economical advantages. The economical advantages of railways are as under:

- (i) Railways help in transporting the labour from the places of unemployment to industrial centres
- (ii) The finished products and the goods can be speedily transported by the railways to the places of their consumption.
- (iii) Industries have been developed even far from the places of the raw materials.
- (iv) During famines, floods and earthquakes the railways play a vital role of transporting the food grains and clothes to the affected areas.
- (v) Railways have provided employment to millions of people and thus, railways have helped in solving the unemployment problem.
- (vi) The land cost increases due to opening of new railway lines.
- (vii) Railways have helped in fair distribution of population.
- (viii) Railways have improved the general standard of living of Indian people.

1.11. CLASSIFICATION OF RAILWAY LINES

According to Indian Railway specifications, the railway lines are classified as under:

1. **B.G. routes.** All the B.G. routes of Indian Railways have been classified, based on speed criteria in the following five groups:

12 SURFACE TRANSPORT

<i>Group</i>	<i>Sanctioned speed</i>
A	160 kmph
B	130 kmph
C	Suburban sections of Mumbai and Calcutta
D	100 kmph
E	Other sections and branch lines

2. **Metre Gauge routes.** All the M.G. routes of Indian Railways are classified, based on their importance, the type of traffic carried and the maximum permissible speed, in the following three main categories.

- (i) Trunk Routes
- (ii) Main lines
- (iii) Branch lines

In 1984, these metre gauge routes are re-classified as under:

- (i) **Q routes:** The routes on which traffic density is more than 2.5 GMT with maximum permissible speed more than 75 kmph.
- (ii) **R routes.** The routes on which traffic density is more than 1.5 GMT with a speed potential less than 75 kmph.
- (iii) **S routes.** The routes on which traffic density is less than 1.5 GMT with a speed with a speed potential less than 75 kmph.

1.12. CORPORATE PLAN

To achieve a long term perspective of the railway development, in an environment of rapid technological change, the railways have adopted a 15 years period upto 1988-89. The second corporate plan covering the period for 1985-2000 has now been prepared. The total out-lay of the second as a corporate plan is Rs. 46,150 crores.

1.13. LOCOMOTIVES

The Indian Railways own a power fleet on 31 March 1987 as under:

Steam locomotives	4950
Diesel locomotives	3182
Electric locomotives	1366
Total	9498

The steam locomotives are now-a-days being gradually phased out of service giving place to diesel and electric locomotive. It is expected that steam traction may be completely eliminated by 2000 A.D. In 1963-64, the Indian railways possessed 10,810 steam locomotives whereas current holding is less than 500.

1.14. FASTEST TRAIN IN INDIA

The Gatimaan Express Train is the first semi-high speed train which was flagged off at 08:10 AM at Hazrat Nizamuddin railway station, Delhi to Agra Cantonment railway station to cover a distance of 188 km in 100 minutes with a speed of 160 kmph on 5th April 2016. This train is remembered as the first high speed train in the history of Indian Railways. The photograph of a Gatimaan train in the yard is shown in Fig. 1.1

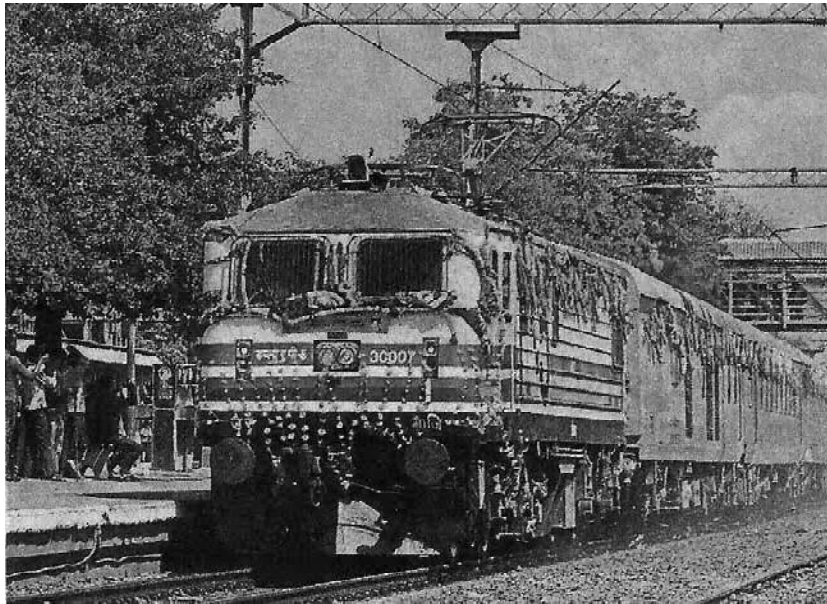


Fig. 1.1. A Gatimaan train

EXERCISE 1

1. Enumerate the advantages and disadvantages of railway transport over other modes of transport facilities.
2. Give a detailed specific application of transportation to mankind.
3. Describe in short the historical development of Indian Railway.
4. Give a classification of transportation. Discuss in brief.
5. Discuss the advantages of railways.