CIVIL ENGINEERING

Railway, Airport, Dock,Harbour and Tunnelling Engineering

Comprehensive Theory
with Solved Examples *and* Practice Questions

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1

Railway Track

Section - A

1.1 INTRODUCTION

- Railway engineering is a branch of civil engineering that deals with the design, construction and maintenance of the railway track for safe and efficient movements of the rail transport system (trains).
- The railway is a rapid, reliable and very huge transportation system.

1.1.1 Advantages of Railways

- Due to railways, industrial development is possible, increasing the land values & standard of living of the people.
- During famines, railways have played a vital role in transporting food & clothing to the affected areas.
- Commercial farming is very much helped by the railway network throughout the country.
- Speed movement of commodities is possible through railways.
- Railway provides a convenient & safe mode of transport throughout the country.
- Railways have helped in the mass migration of the population.
- With an adequate network of railways, the central administration has become easy & effective.

1.2 RAILWAY TRACK

- Railway track is a combination of rails, fitted on sleepers and resting on ballast and subgrade.
- Essential function of railway track is to support and guide the vehicles that run over it.
- The conventional railway track consists of two rails located at fixed distance apart. The pressure exerted over by the rails is in turn transmitted to the formation with the help of sleepers and ballast.
- Railway track is also known as permanent way.
- The name permanent way is given to distinguish the final layout of the track from temporary tracks. Temporary tracks are laid for conveyance of earth and materials during construction works.
- In a permanent way, rails are joined in series by fish plates and bolts and then they are fixed to sleepers by different types of fastenings.

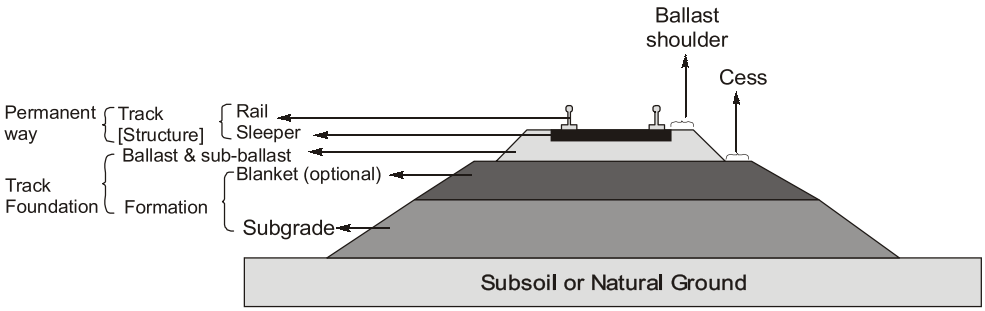

Fig. Typical cross-section of a permanent way on embankment

- The sleepers properly spaced, resting on ballast, are suitably packed and fixed with ballast.
- This layer of ballast rests on the prepared subgrade called the formation.

1.3 REQUIREMENTS OF AN IDEAL PERMANENT WAY

Following are the basic requirements of an ideal permanent way

(i) The gauge should be uniform and correct.
(ii) Both the rails should be at the same level in a straight track.
(iii) On curves, proper superelevation should be provided to the outer rail.
(iv) Track should have enough lateral strength.
(v) Track must have certain amount of elasticity.
(vi) Radii and superelevation, provided on curves, should be properly designed.
(vii) All joints, points and crossings should be properly designed.
(viii) Drainage system should be perfect.
(ix) It should have adequate provision of easy renewals and repairs.
(x) The components of track i.e., rail, fittings, sleepers, ballast must fully satisfy requirement for which they are provided.

1.4 LOAD TRANSFER ON A RAILWAY TRACK

- All the components of a Permanentway are required to transfer the rolling load of the train to the subgrade while maintaining the proper position.
- Rail acts as girders to transmit wheel load to sleeper.
- Sleeper holds the rail in correct alignment and transmit the load to ballast.
- Ballast distributes load over formation known as subgrade and finally to natural soil on ground.

Survey required before laying railway track:
- Traffic survey- Types of train, type of gauge required, future and present traffic.
- Race. survey- Rough survey (Topography, waterbodies, road network).
- Preliminary survey- Instrumental analysis of recase survey and a rough estimate.
- Final location survey- Final work allocation, final estimate, centre line of track.

1.5 GAUGE OF RAILWAY TRACK

The gauge of a railway track is the clear distance between the running or gauge faces of the two rails.

NOTE: These running faces are the inner faces of the rails in India.

Some of the common types of gauges are as follows:

(i) Broad Gauge (BG) → 1676 mm (5 ft. 6 inches)

(ii) Metre Gauge (MG) → 1000 mm (3 ft. 3.375 inches)

(iii) Narrow Gauge (NG) → 762 mm (2 ft. 6 inch) 610 mm (2 ft.)

(iv) Feedergauge → 692 mm

(v) Standard gauge → 1435 mm

(vi) Cape gauge → 1067 mm

A larger gauge has the advantage of greater traffic capacity, speed and safety. However, it requires flatter gradients and curves.

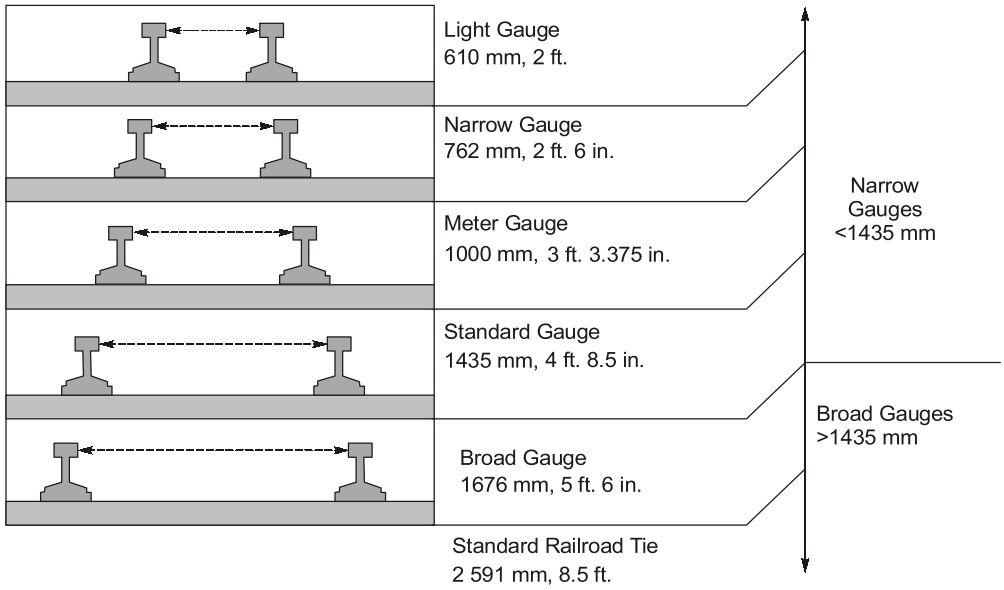

Fig. Guges of Railway Track

NOTE

Small lengths of standard gauge (1435 mm) are used in India for individual projects and short line lengths.

For example: Delhi Metro Rail Corporation.

- On important section in India, Broad Gauge is preferred.
- Gauge should be uniform throughout as far as possible in a country.
- Because transshipping passengers and goods from vehicles of one gauge to another is a cumbersome task.

Factors responsible for selection of gauge are as follows:

(i) Cost of construction
(ii) Volume and nature of traffic
(iii) Development of under developed area
(iv) Physical features of the country
(v) Speed of vehicle movement

1.6 RAILWAY TRACK CROSS-SECTION

The typical cross-section of a railway track have been shown in the figure given below:

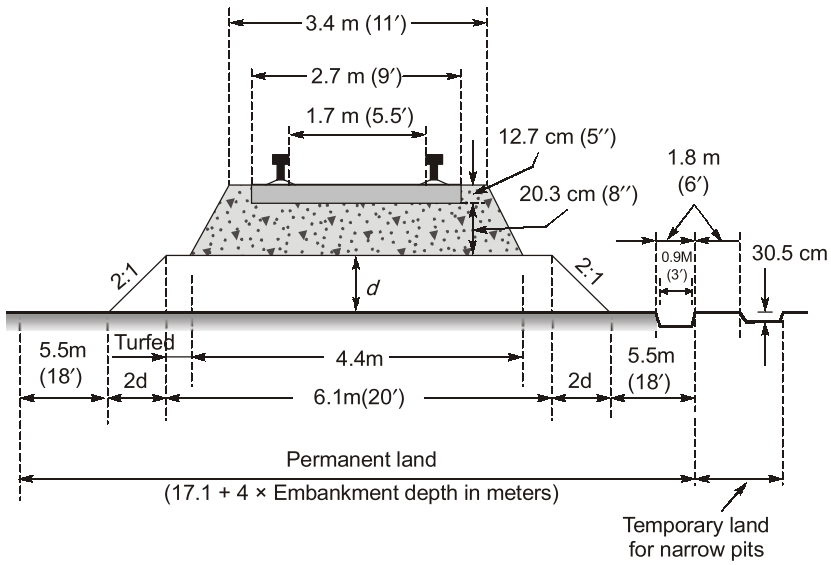

Fig. Cross-section of a Broad Gauge. Track in Embankment (On straight track)

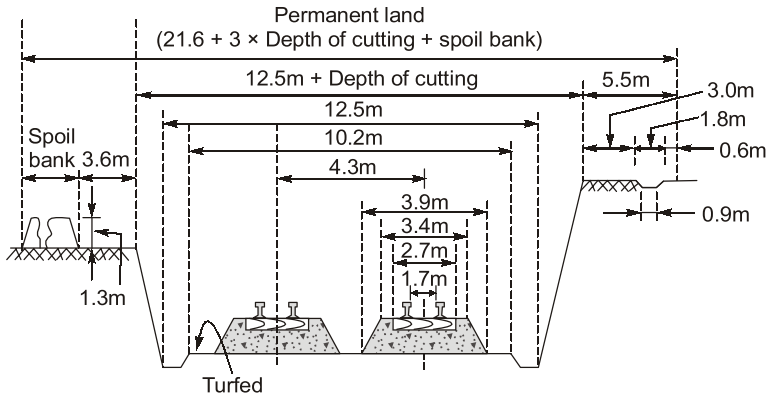

Fig. Cross-section of a Broad Gauge Track in cutting for double line (On straight track)

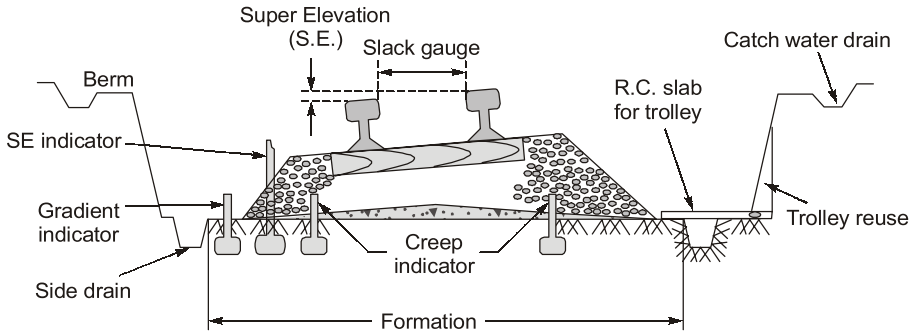

Fig. Cross-section of a Broad Gauge track for a single Line (curved track)

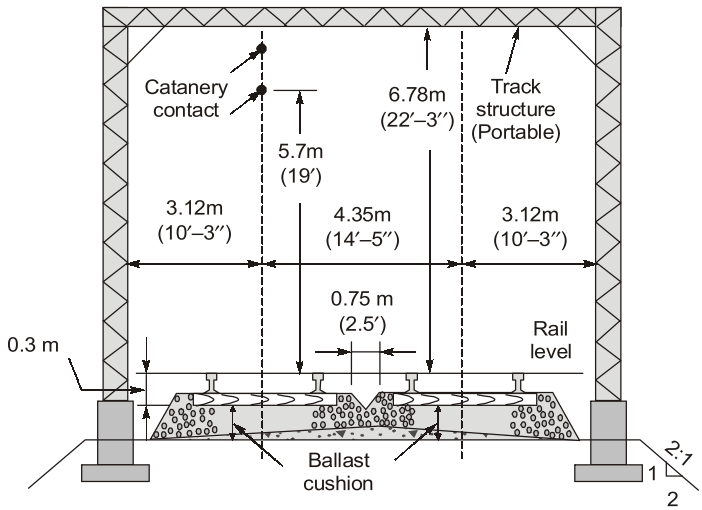

Fig. Cross-section of a Broad Gauge. Track for double line with electric-traction

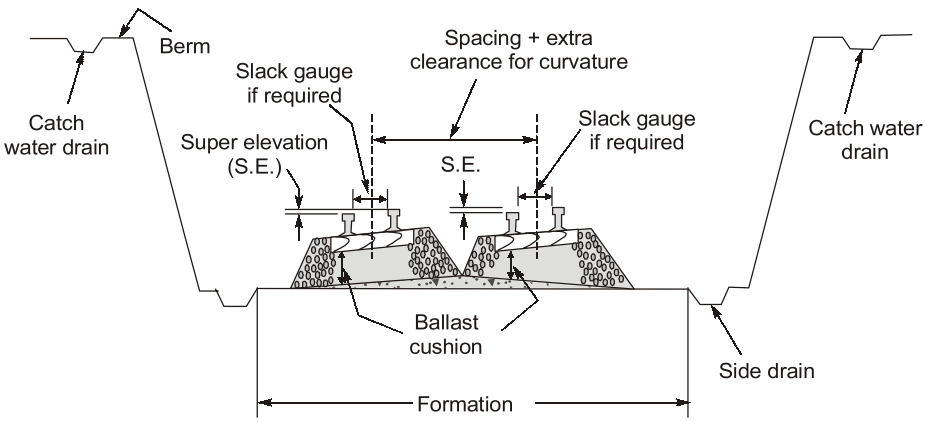

Fig. Cross-section of a Broad Gauge. Track for double line in Cutting (On Curved Track)

1.7 CONING OF WHEELS AND CANTING OF RAILS

1.7.1 Coning of Wheels

- The tread or rim of railway vehicles are not made flat but are sloped and this sloping surface along the circumference forms part of a cone (with a slope of about 1 in 20). This is known as coning of wheels.
- On straight and level track, the wheel remains central and circumference of treads of both wheels are equal.
- On the level track as the axle moves towards one rail, the diameter of wheel tread over the rail increase while it decreases over the other rail. This prevents the further movement of axle and it retreat back to original position with equal diameters and equal pressure on both rails.

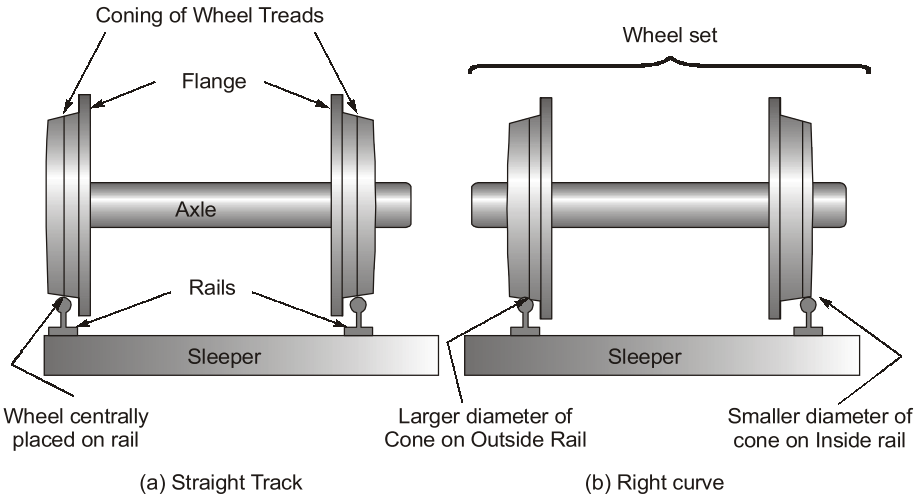

Fig. Coning of Wheels

- On curved track, outer wheel has to travel greater length than the inner wheel. Vehicle on a curve has the tendency to move sideways towards the outer rail, so the circumference of the tread on the outer rail towards inner edge of the wheel becomes greater than that on the inner rail. This helps outer rail to cover a greater distance than the inner rail.
- Conicity of wheel is the angle between wheel tread and horizontal axis of axle.

1.7.2 Advantages of Coning of Wheel

- It helps vehicle to negotiate curves smoothly.
- It keep the train just in central position in a level track.
- It provide for possibility of lateral movement of axle with its wheels.
- It prevent wheels from slipping to some extent.
- It reduces wear and tear of the wheel flanges.

1.7.3 Disadvantages of Coning of Wheel

- The pressure of the horizontal component of the force near the inner edge of the rail has a tendency to wear the rail quickly.

- The horizontal component of the force tends to turn the rail outwards and hence the gauge is widened sometimes.
- If no base plates are provided, sleepers under the outer edge of the rail may get damaged.

1.7.4 Canting of Rails

- In order to minimize the disadvantages due to coning of wheels, canting of rails is done which means that rails are not laid flat but are tilted inwards.
- This reduces wear of the rail as well as of the tread of the wheel.
- The slope of the base plate is 1 in 20 which is also the slope of the wheel flange.
- Tilting of rails can be achieved by
  (i) Adzing of sleepers
  (ii) Use of canted base plate

1.7.5 Adzing of Sleepers

- A groove (having angle of 1 in 20) is being cut on the top of the sleepers. The rail is being seated into this groove in such a manner that it remains fixed in this location.
- This sort of angle making in sleepers so as to seat the rail is known as adzing of sleepers.

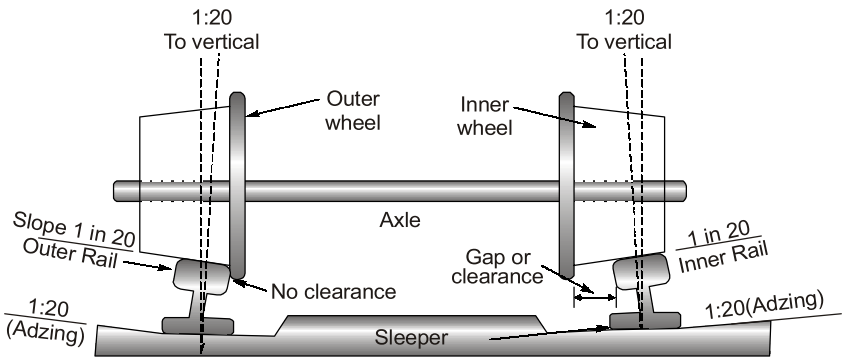

Fig. Adzing of sleepers

OBJECTIVE BRAIN TEASERS

Q.1 Which of the following factors govern the choice of the gauge?
(i) volume and nature of traffic
(ii) speed of train
(iii) physical features of the country
(a) only (i) (b) both (i) and (ii)
(c) both (ii) and (iii) (d) (i), (ii) and (iii)

Q.2 For developing thinly populated areas, the correct choice of gauge is
(a) Broad Gauge (b) Metre Gauge
(c) Narrow Gauge (d) any of the above

Q.3 The formation width for a single line metre gauge track in embankment as adopted on Indian Railways is
(a) 4.27 m (b) 4.88 m
(c) 5.49 m (d) 6.10 m

Q.4 The side slope of embankments for a railway track is generally taken as
(a) 1 : 1 (b) 1.5 : 1
(c) 2 : 1 (d) 1 : 2

Q.5 The formation width for a double line Broad Gauge track in cutting (excluding drains) as adopted on Indian Railways is
(a) 6.10 m (b) 8.84 m
(c) 10.21 m (d) 10.82 m

Q.6 The tread of wheels is provided an outward slope of
(a) 1 in 10 (b) 1 in 15
(c) 1 in 20 (d) 1 in 25

Q.7 Wheels of rolling stock are provided flanges on
(a) outer side (b) inner side
(c) both sides (d) neither side

Q.8 Coning of wheels is provided
(a) to check lateral movement of wheels
(b) to avoid damage to inner faces of rails
(c) to avoid discomfort to passengers
(d) All the above

Q.9 For providing the required tilt of rails, adzing of wooden sleepers, is done for
(a) bull headed rails
(b) double headed rails
(c) flat footed rails
(d) any type of rails

Q.10 Check rails are provided on inner side of inner rails if sharpness of a B.G. curve, is more than
(a) 3^o (b) 5^o
(c) 6^o (d) 8^o

Q.11 The rail section which is not used on Indian Broad Gauge tracks, is
(a) 35 R (b) 40 R
(c) 45 R (d) 55 R

Q.12 The rail section which is not used on Indian metre gauge tracks, is
(a) 25 R (b) 30 R
(c) 35 R (d) 40 R

Q.13 In India the rails are manufactured by
(a) open hearth process
(b) duplex process
(c) both (a) and (b)
(d) neither (a) nor (b)

Q.14 In Indian railways, the ratio of axle load and weight of rail, is
(a) 312 (b) 412
(c) 512 (d) 600

Q.15 Match **List-I** (Railway zone) with **List-II** (Headquarters) and select the correct answer by using codes given below the lists:

List-I	List-II
A. N.E.R.	1. Calcutta
B. E.R	2. Gorakhpur
C. S.C.R	3. Maligaon (Guwahati)
D. N.E.F.R	4. Secunderabad

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	2	1	4	3
(c)	3	2	1	4
(d)	4	3	2	1

ANSWER KEY

1. (d)	2. (c)	3. (b)	4. (c)	5. (c)
6. (c)	7. (b)	8. (d)	9. (c)	10. (d)
11. (b)	12. (d)	13. (c)	14. (c)	15. (b)

■■■■