Transportation Engineering

Course Code –CE-422

Contact Hours -3+3

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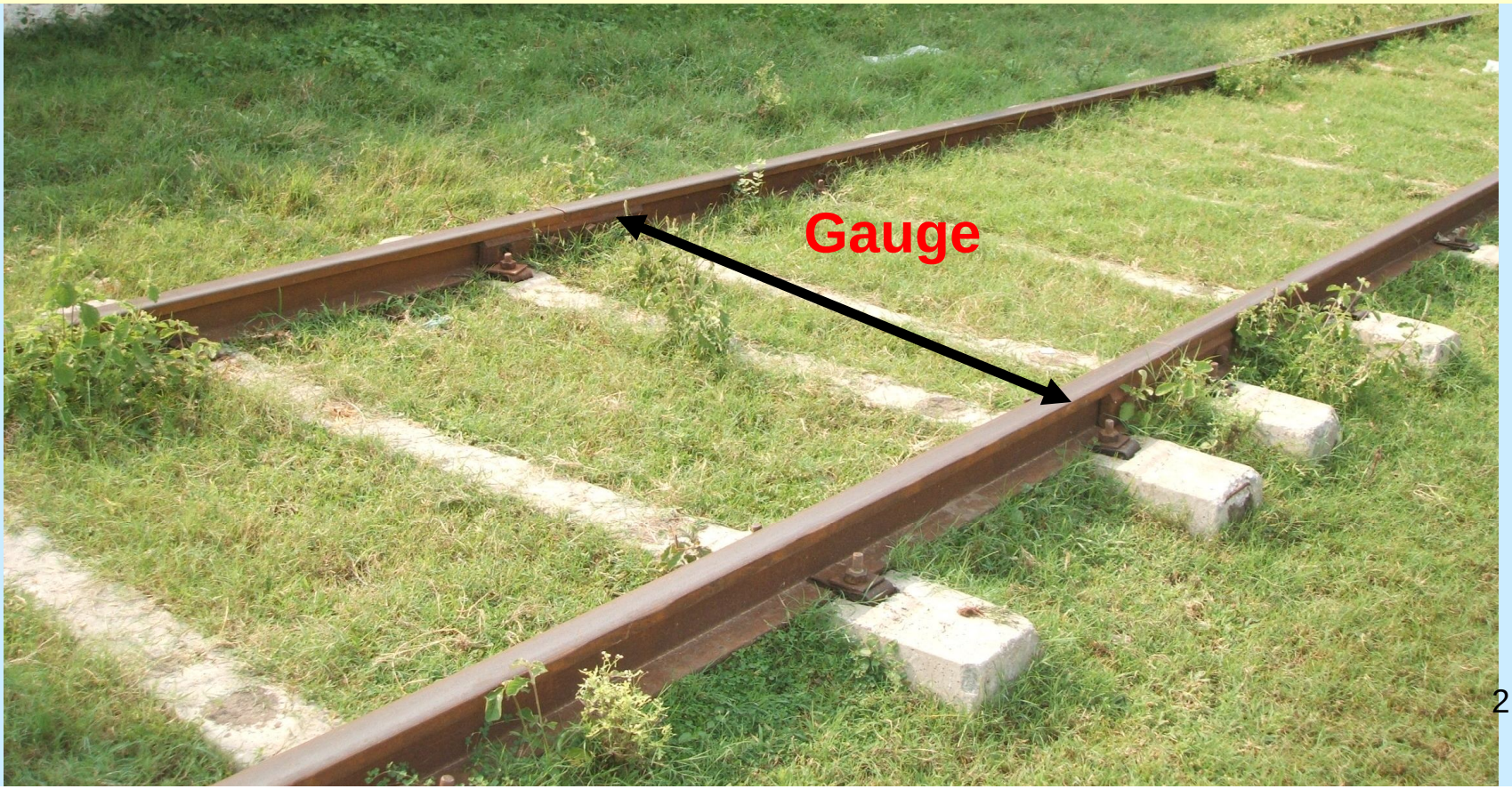
Rail Gauges

- Is defined as the clear distance between the inner or running faces of the two rails forming the track.



History of Rail Gauges

- In Britain, a gauge of 1525 mm was initially adopted.
  - The flanges at that time were outside.
  - The gauge to which first railway track was laid is 4 ft - 8.5 in (1435 mm)
  - The reason for this was the plateways of 18 th century which were 5 ft apart.
- When George Stephenson was building the Stockton to Darlington Railway, he decided the rail gauge should be just over 4 ft 8 ins (1.44m). The reason for this was that was the width of the wagonway.

History of Rail Gauges (cont'd)

- When Isambard Brunel (1838) was building the London to Bristol line, he decided to use what became known as the broad gauge (2.2 m) instead of the standard gauge (1.44m)
- Brunel argued that by using a wider track, he could provide larger and faster locomotives.
- It was also pointed out that the broad gauge was safer and that locomotives would be less likely to leave the rails on sharp bends.

Gauges on World Railways

- Standard Gauge
  - **SG**
  - **1435 mm or 4’ 8.5”**
  - **% 62 of total length**
- Broad Gauge
  - **BG**
  - **1676 mm or 5’ 6”**
  - **15 % of Total length**

- England, USA, Canada, Turkey, China
- Pakistan, India, Brazil, Argentina, Russia

Gauges on World Railways (cont'd)

- Cape Gauge
  - **CG**
  - **1067 mm or 4' 6"**
  - **8 % of total length**
- Meter Gauge
  - **MG**
  - **1000 mm or 3' 3.5"**
  - **9 % of Total length**

- Africa, Japan, Australia and New-zealand
- Pakistan, India, Argentina, France and Switzerland

Gauges on World Railways (cont'd)

- 23 various other gauges
  - **6 % of total length**
- Narrow Gauges
  - **2'6" or 2'**
  - **Development of poor area where there is less traffic**

- Various countries

Choice of Gauge

- The choice of gauge is very limited as each country has a fixed gauge
- However three factor are kept in mind
  - Cost consideration
  - Traffic Consideration
  - Topography of the country

Construction Cost

- There is only a marginal increase in the cost of track if wider gauge is adopted
  - Cost increases proportionally due to land acquisition, earthwork, components of track for wider gauge
  - Cost due to bridges, culvert, buildings and tunnels increases only marginally due to wider gauge

Construction Cost (cont'd)

- Cost of constructing station buildings, platform, level crossing is more or less remains constant
- Cost of rolling stock is independent of the gauge
- Gauge increase – cost of construction increases – speed and carrying capacity increases

Traffic Consideration

- Wider gauge carry more traffic, more revenue generation
- Wider gauge more speed because speed is a function of diameter of the wheel which in turn is limited by the width of the gauge
- Traction and signaling is independent of the gauge

Topography of the Country

- Wider gauge require more space
- Steeper gradient and sharp curves can be provided as compared to the wider gauge
- Mountainous regions narrow gauge is preferred as compared to wide gauge

Problems caused by Change of Gauge

- Inconvenience to passengers
  - Climbing stairs, climbing bridges
  - Find seats in compartment of later trains
  - Missing connection with the later train incase earlier train is late
  - Harassment caused by porters
  - Uncertainty and delay in reaching destination

Problems caused by Change of Gauge (cont'd)

- Trans-shipment of Goods
  - Damage to goods
  - Delay in receipt of goods at destination
  - Theft or misplacement of goods
  - Mishandling due to non-availability or absence of specialized trans-shipment labor
  - Storage facilities

Problems caused by Change of Gauge (cont'd)

- Inefficient use of Rolling Stock
  - Idle wagons of one gauge cannot be used on the other gauge
  - Wagons have to move empty in the direction of transshipment point

Problems caused by Change of Gauge (cont'd)

- Hindrance to fast moving goods and passengers
  - War, floods accident
- Additional Facilities at Station and yards
    - Cost sheds and additional facilities has to be provided for handling large volume of goods at transshipment point
    - Duplicate equipment and facilities e.g yards and platforms for both gauges
- Difficulty in future gauge conversion Projects


TO THE
BIRMINGHAM TRAIN

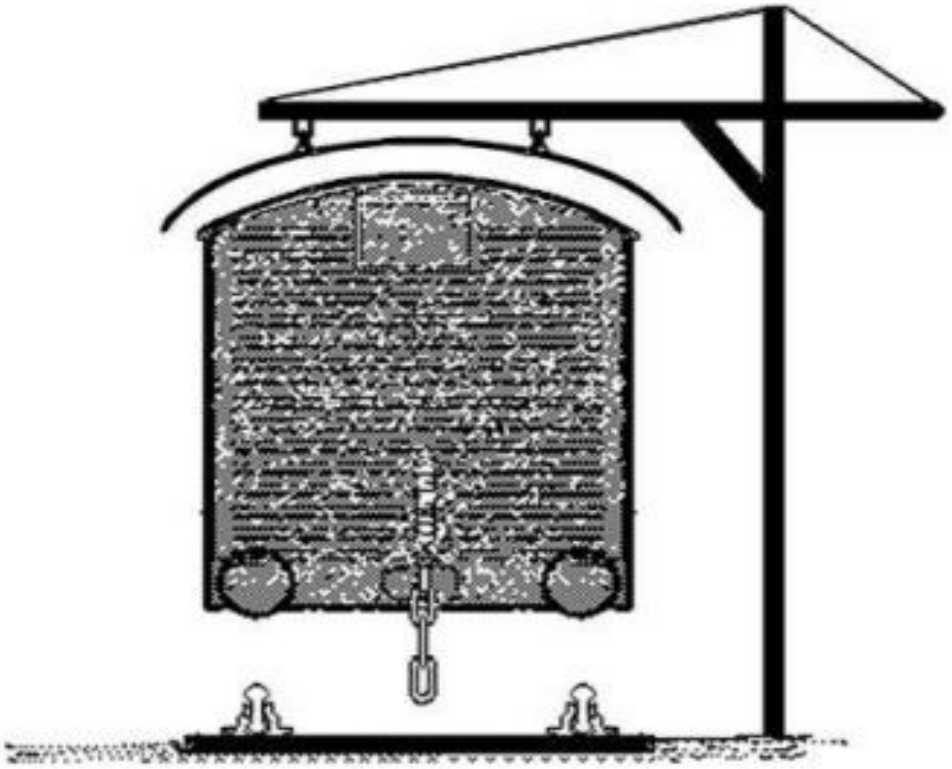
Uni- Gauge Policy

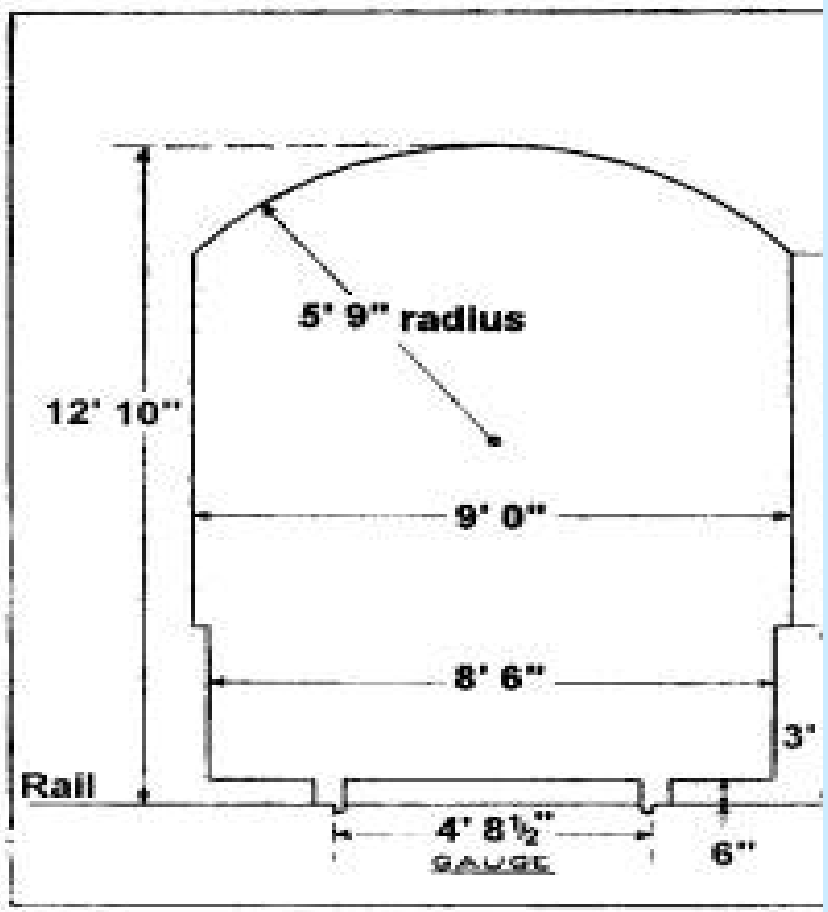
- No transport bottlenecks
- No transshipment hazards
- Provision of alternate route
- Improved Utilization of track
- Balanced Economic Growth

Loading Gauge

- Maximum width and height to which a rolling stock i.e locomotive, coach or wagon can be loaded or built
- It is generally located at the exit of the goods yard
- It ensures that wagons are not over loaded and the top and width of the load will clear all the structures e.g bridges, tunnels along the route

Loading Gauge





England (Average).
Gauge, 4 ft. 8½ ins.

Construction Gauge

- Is decided by adding necessary clearances to the loading gauge so that the vehicle can move safely with infringement
- It fixes the width and height of bridges and tunnels along the route.
- It is more than loading gauge

Loading Gauge

Gauge	Height above Rail	Width
British Railway (4’8 ½”)	**13’6”**	**9’6”**
European Railway (4’8 ½”)	**14’-0”**	**10’2”**
American Railway (4’8 ½”)	**16’ –0”**	**11’-0”**
BG	**15’ 6”**	**12’ 0”**
MG	**11’ 3”**	**8’6”**
NG	**10’6”**	**7’6”**

Gradient

- Rise or fall in the track level per unit length of the track is called gradient.
- The track is normally divided into sections such that the gradient between sections is the same.
- It is not practicable to have same gradient through out the length of track since longitudinal slope of the country is not uniform.

Gradient (cont'd)

- When a train moves along a rising gradient extra pull is required
- The extra pull required is the same as would be required to lift the train up the height through which it rises in every foot it traverses.
- If a train rises 1 foot in 100 feet, the gradient is called 1 in 100 or 1%

Gradient (cont'd)

- Train weighing 500 tons is moving over a rising slope of 1 ft in 150 ft.
- What is the additional force required.

$$1/150 * 500 = 3.33 \text{ tons}$$

Types of Gradient

- Ruling Gradient
- Momentum Gradient
- Pusher gradient
- Station Yard Gradient

Ruling Gradient

- The steepest slope at which the track is laid without causing reduction in speed or load carrying capacity of train is called ruling gradient.
- A ruling gradient limits the maximum weight of a train, which can be hauled over the section by the locomotive.
- For broad gauges, ruling grade of 1 in 100 or 1 in 200 is quite common.

Momentum Gradient

- The gradient steeper than ruling gradient provided over the section of track without reduction in speed or load carrying capacity
- If falling gradient is followed by a rising gradient. While the train goes down, it gains momentum. The gain in momentum is utilized in negotiating the gradient.

Pusher Gradient

- In Hilly areas gradient steeper than ruling gradient are called pusher gradients.
- They are provided in hilly areas.
- It becomes impossible to provide normal gradient because it increase the length of the track considerably.
- In such conditions if engine designed for ruling gradient is used load has to be reduced drastically or speed has to be reduced.
- This difficulty is overcome by providing an extra engine.

Station Yard Gradient

- The grades in the station yards have to be sufficiently low in order so that
  - Boggies left standing on the tracks do not start moving automatically due to effect of gravity combined with a strong wind and or a gentle push.
  - Locomotives at starting have to overcome a resistance which is twice as much as when they are already on the move, should not encumbered with a further resistance due to grade.
- In Pakistan, the upper limit of gradient for station yards is 1 in 400 while a gradient of 1 in 1000 is recommended.

Changing the Direction of Locomotive

- Turntable
- Triangles

Turntable

  - This consists of a rectangular platform with a track on a pair of girders, braced and supported on or suspended from the central pivot.
  - It is installed in a circular pit and two or more track radiate from the edge of this pit.
  - The level of track on the turntable and the radiating track is kept same.

Turntable

Turntable

- For turning the engine, the turntable is revolved on the pivot till the track on it comes in line with the track on which the engine stands.
- Thus the turntable is locked in position and the engine is moved on to it. The locking bolt is removed and the turntable is rotated manually or by power.
- The bottom of the pit is sloped towards the center where a sump and drain is provided to drain off the rainwater. Turntables are provided on all the main junctions.

Triangle (Arrangement)

- Stage 1
  - ABC
    - Forward
- Stage 2
  - CBD
    - Reverse

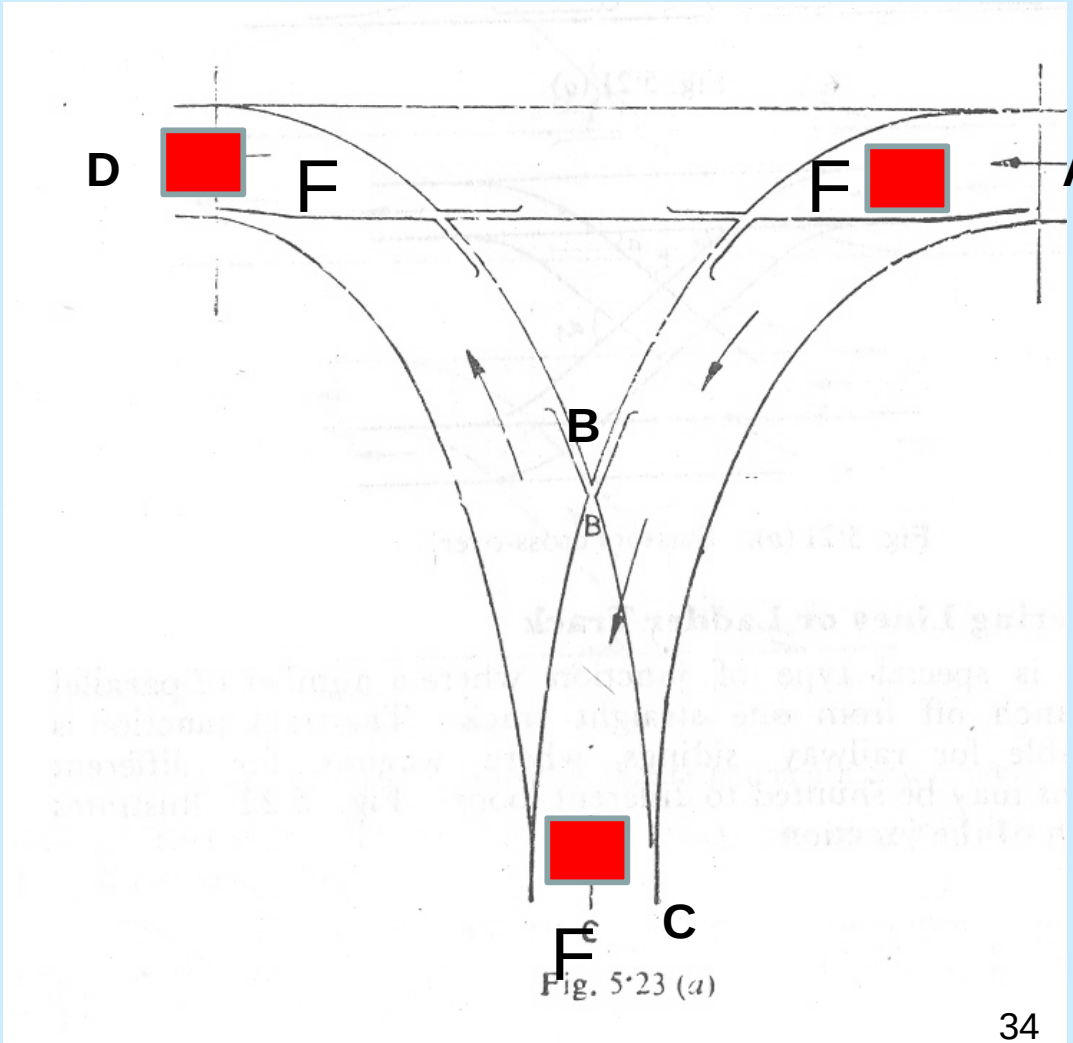


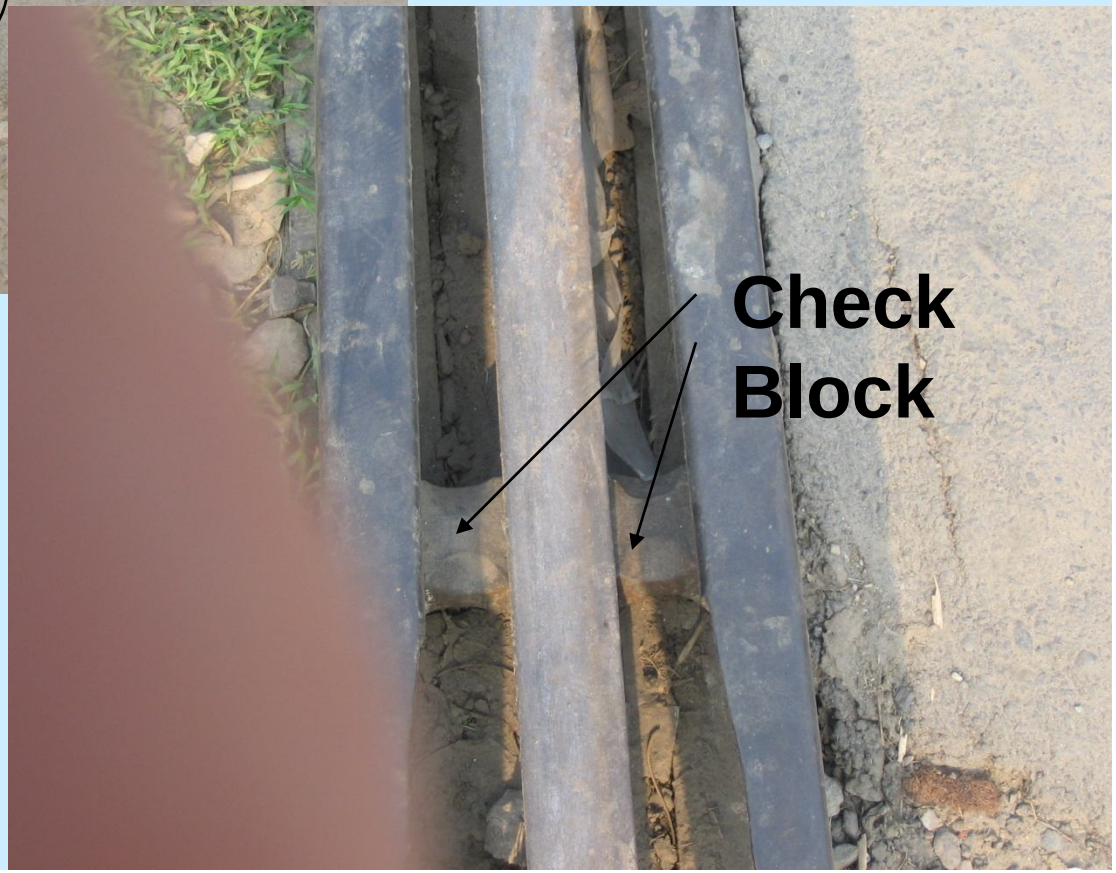
Fig. 5·23 (*a*)

Level Crossing

Level Crossing

- Is an arrangement of the crossing of a railway track and a highway at the same level
- Grooves are left in the roads along the inner edge for the wheel flanges
- These grooves are provided by guard rails

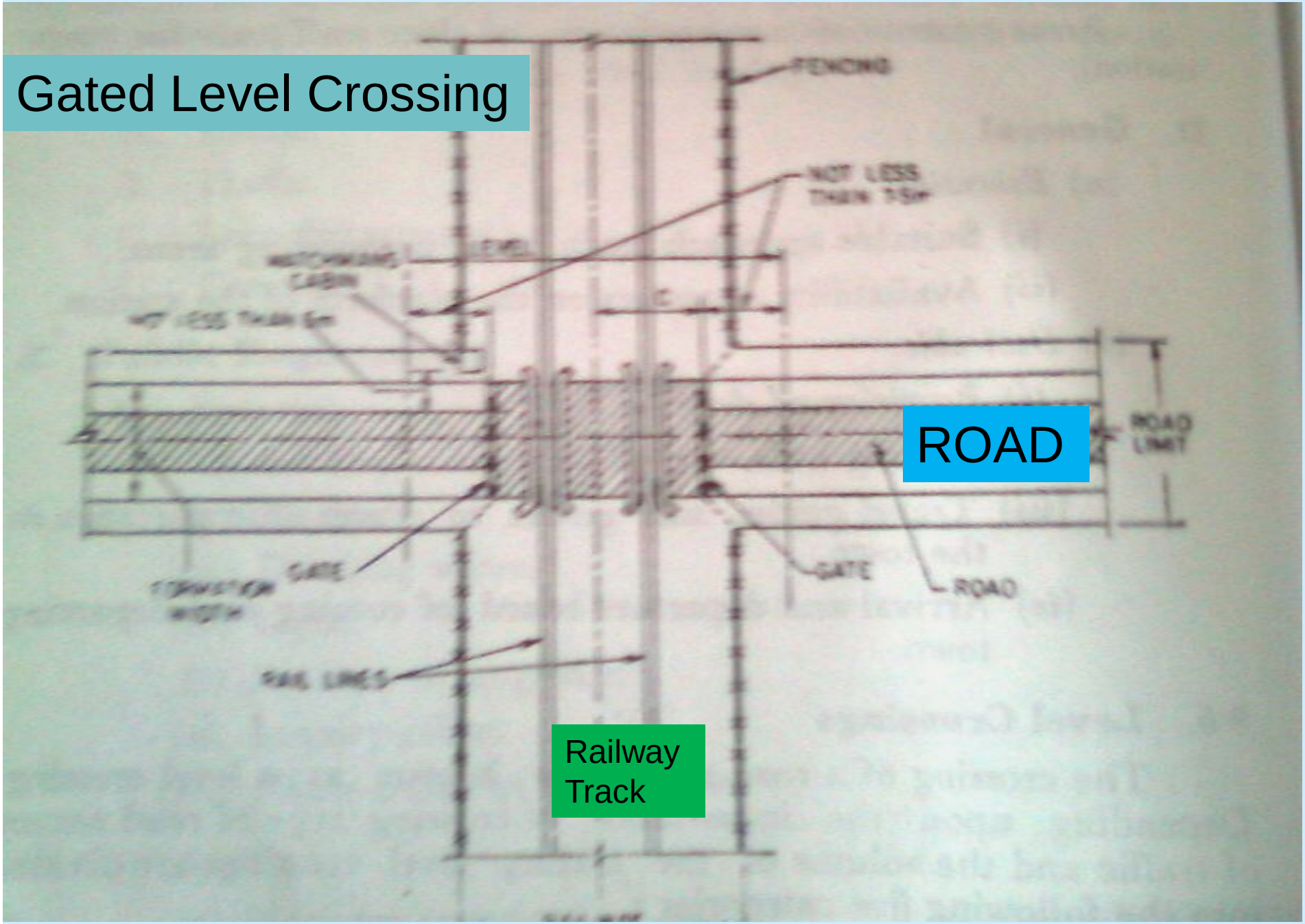
LEVEL CROSSING



Level Crossing (cont'd)

- For smooth entry or exit for the wheel flanges, the guard rail is widened at the end.
- This gradual widening is called end flare.
- Level Crossing
  - Guarded or gated
  - Unguarded or ungated

Gated Level Crossing




6007
6007


248


Portaloo
Markworth


WARNING
DANGER
13D
14D
15D
16D