

Transportation Engineering

Course Code –CE-422

Contact Hours -3+3

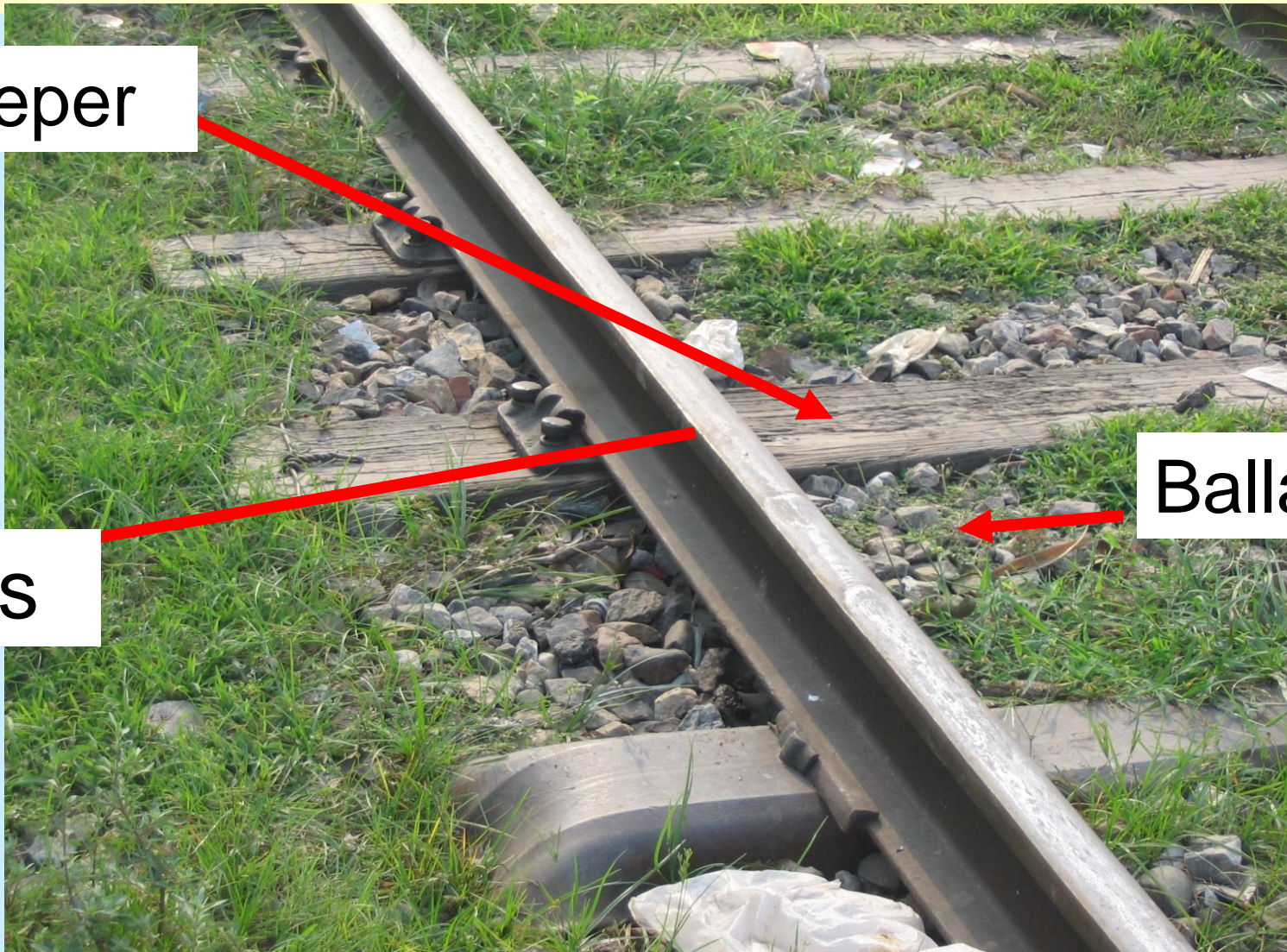
Dr Hassan Mujtaba

Railway Track

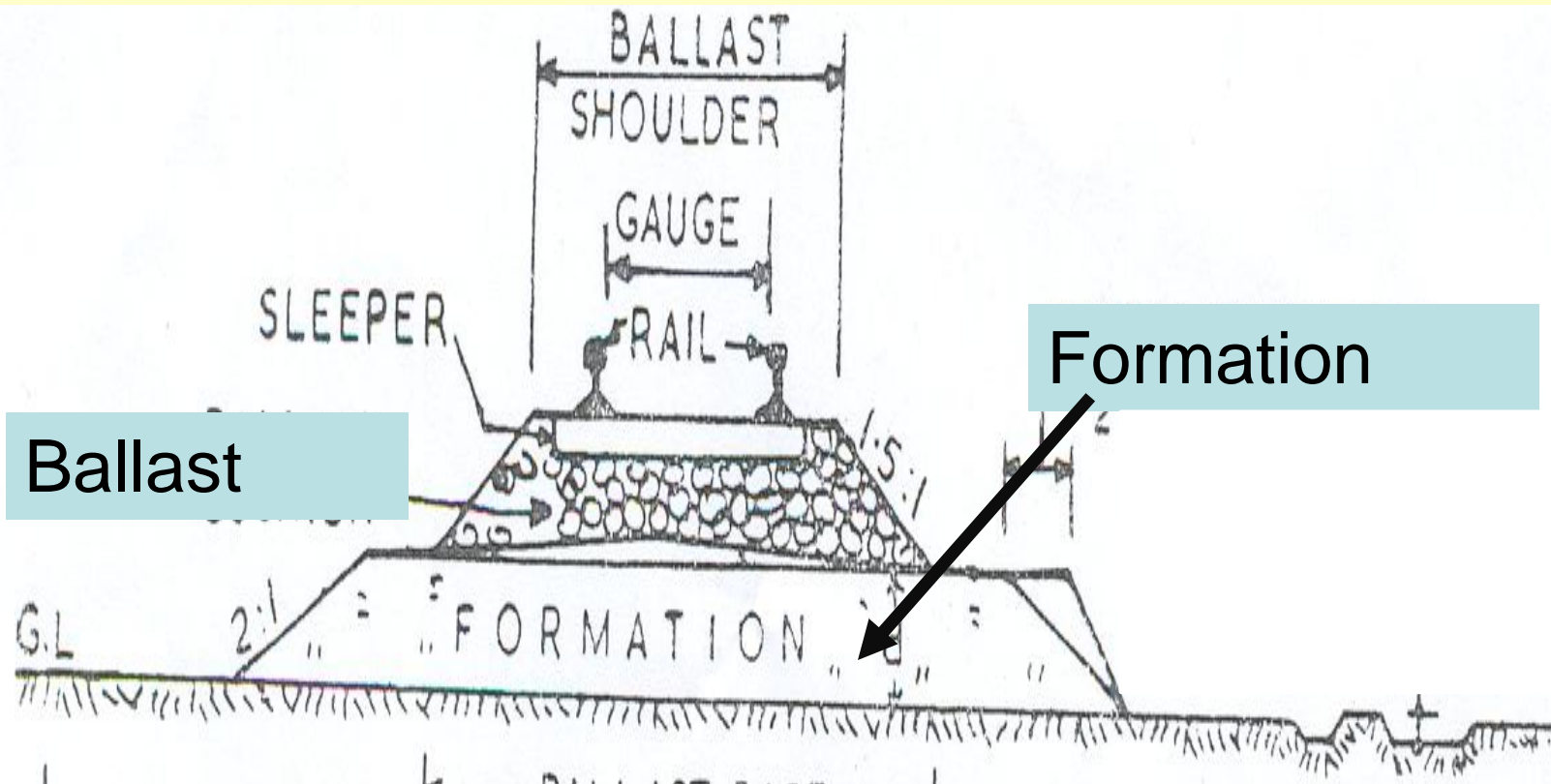
Sleeper

Ballast

Rails



Cross Section of a Railway Track



History of Railway

- Goods are carried by **head load or carts drawn by men or animals** in the past.
- Efforts were made to replace **manual or animal labour** with mechanical labour
- Modern railways **are refined form of tramways and plateways** of eighteenth century.

Development of Railways

- The original tramways consisted of two lines of slabs of stones or beams made of timber laid flush with an existing road surface to facilitate the haulage of heavy loads by horses.
- The timber beams were subsequently covered with iron straps or plates to reduce wear.

Development of Railways (cont'd)

- These plates were later replaced by angle irons with one edge vertical to keep the wheels on the track. These were known as plateways.
- In 1789, cast iron beams with supports at the ends were used by William Joseph in England and the present permanent way or track gradually evolved.

Development of Railways (cont'd)

- The steam engine was developed after the introduction of tramways.
- Nicolas Cugnot in France and William Murdock in Britian carried out experiments with steam carriages since 1771.
- The first steam locomotive was developed by Richard Trevithick and was used for traction on roads.
- George Stephenson in 1814 produced first locomotive to be used for traction in railways.

Development of Railways (cont'd)

- The first railways in England was
 - the Stockton and Darlington in 1825.
- In America
 - the Mohawk and Hudson in 1833
- In subcontinent (Indo- Pak) in 1853

History of Pakistan Railways

- The idea of first rail network was thought in 1847 with Karachi being the sea port.
- Sir Henry Edward Frere sought permission from Lord Dalhousie to begin survey for Karachi seaport and a railway line in 1858.
 - The proposed railway line was to connect Karachi (city) to Kotri.
 - Stream boat service on the Indus and Chenab river to connect Kotri to Multan
 - From Multan another railway line would be laid to Lahore and beyond.

History of Pakistan Railways

- In January 1886, **North Western State Railways** later on named as (NWR) was formed which eventually became **Pakistan Railway in 1947** by merging four companies.
- **The company names are**
 - **Scinde (Sindh) Railway**
 - Indian Flotilla Company
 - **Punjab Railway**
 - **Delhi Railway**

History of Pakistan Railways

- May 13, 1861 first railway line was opened to public between Karachi city and kotri (105 miles long/ 169 km)
- June 16, 1889 railway line between Karachi city and Kemari was opened
- 1897, line from Kemari to Kotri was doubled.
- 1898, Peshawar to Karachi railway line was proposed.
- During early 20 century, railway line was laid between Peshawar and Rawalpindi and Rawalpindi and Lahore.

History of Pakistan Railways

- In 1947, 3133 km of North Western Railway were transferred to India leaving 8122 km to Pakistan.
- In 1961, Pakistani portion of NWR was renamed as Pakistan Railways

History of Pakistan Railways

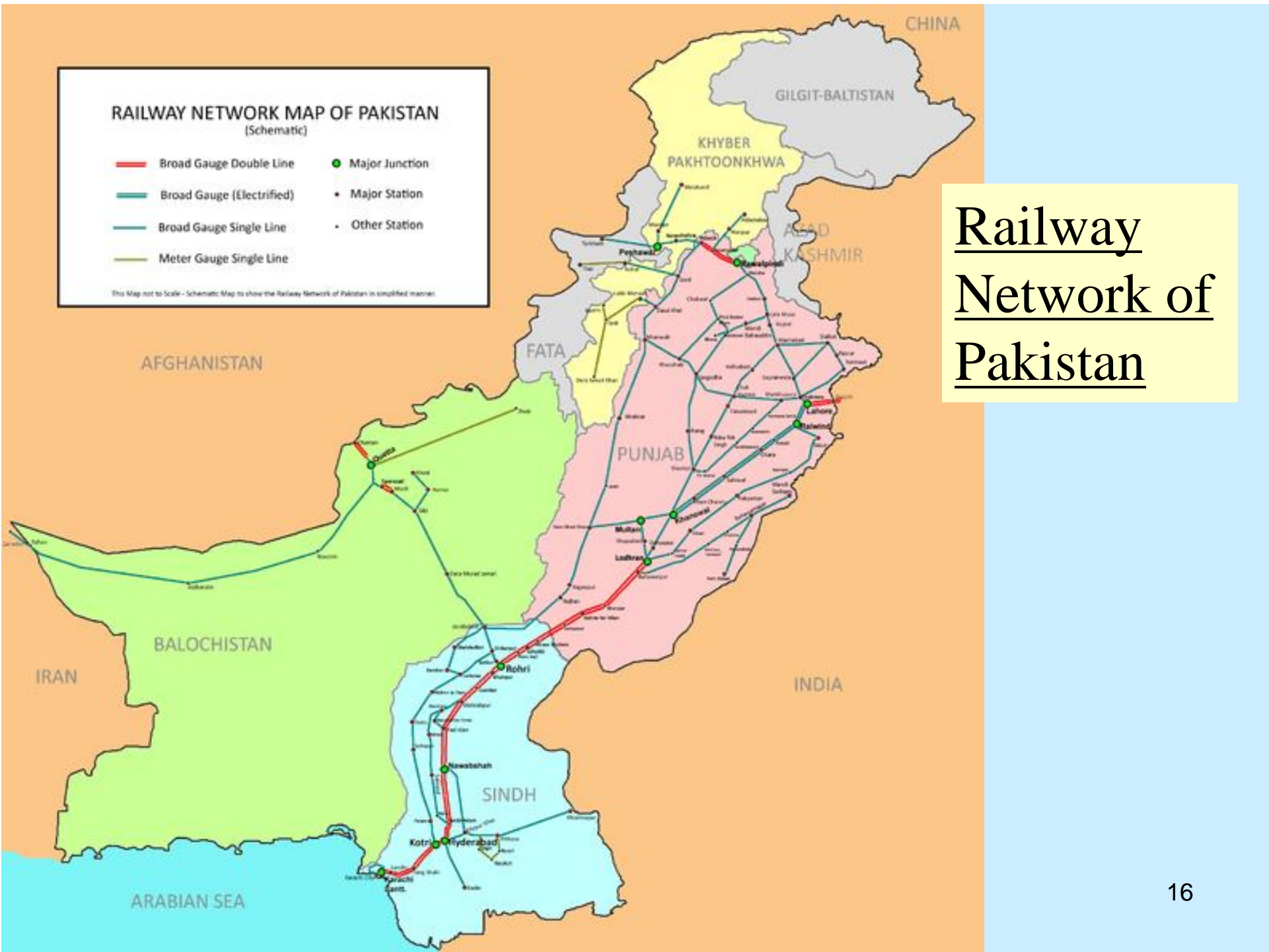
- In 1954, railway line was extended to **Mardan and Charshadda**
- In 1956, Jacobabad- Kashmir **2 ft 6 in (762 mm)** was converted into Broad Gauge.
- **Kot Addu- Kashmir line** was constructed between **1969 to 1973**.

Pakistan Railways

- Total length of the rail track in Pakistan is about 9000 km.
- Major Routes (Domestic)
 - Peshawar-Karachi
 - Peshawar-Quetta
 - Lahore- Sialkot
 - Lahore- Faisalabad
 - Faisalabad- Khanewal

Pakistan Railways

- Proposed Routes are
 - Karachi – Gawadar
 - Quetta – Gwadar
 - Bostan – Zhob
 - Rawalpindi - Sost



Railway Network of Pakistan

International Routes

- Iran
 - A broad gauge (BG) railway track runs from Zahedan to Quetta.
 - There is a break -of- gauge between Islamic Republic of Iran Railways (SG) and Pakistan Railways (BG).

International Routes

- India
 - Thar Express to Karachi
 - Samjhauta Express (Lahore to Amritsar (Attari) and Delhi, India)
- China
 - There is no rail link with China
 - Feasibility study for rail line between Havelian via Khunjerab Pass to Kashgar has been awarded.

International Routes

- Afghanistan
 - No rail link exist
- However, Pakistan has extended his help to built Afghan Rail network in three phases
 - Chaman to Spain Boldak
 - Extend this line to Khandar
 - Finally, to Herat

International Routes

- Turkey
 - Istanbul – Tehran – Islamabad rail service was proposed recently.
- Turkmenistan via Afghanistan is also proposed

Track Doubling

- **Lodhran – Multan – Khanewal line (121 km)** was dual tracked. (2003 – 2007)
- **Khanewal – Raiwind line** is currently in progress.

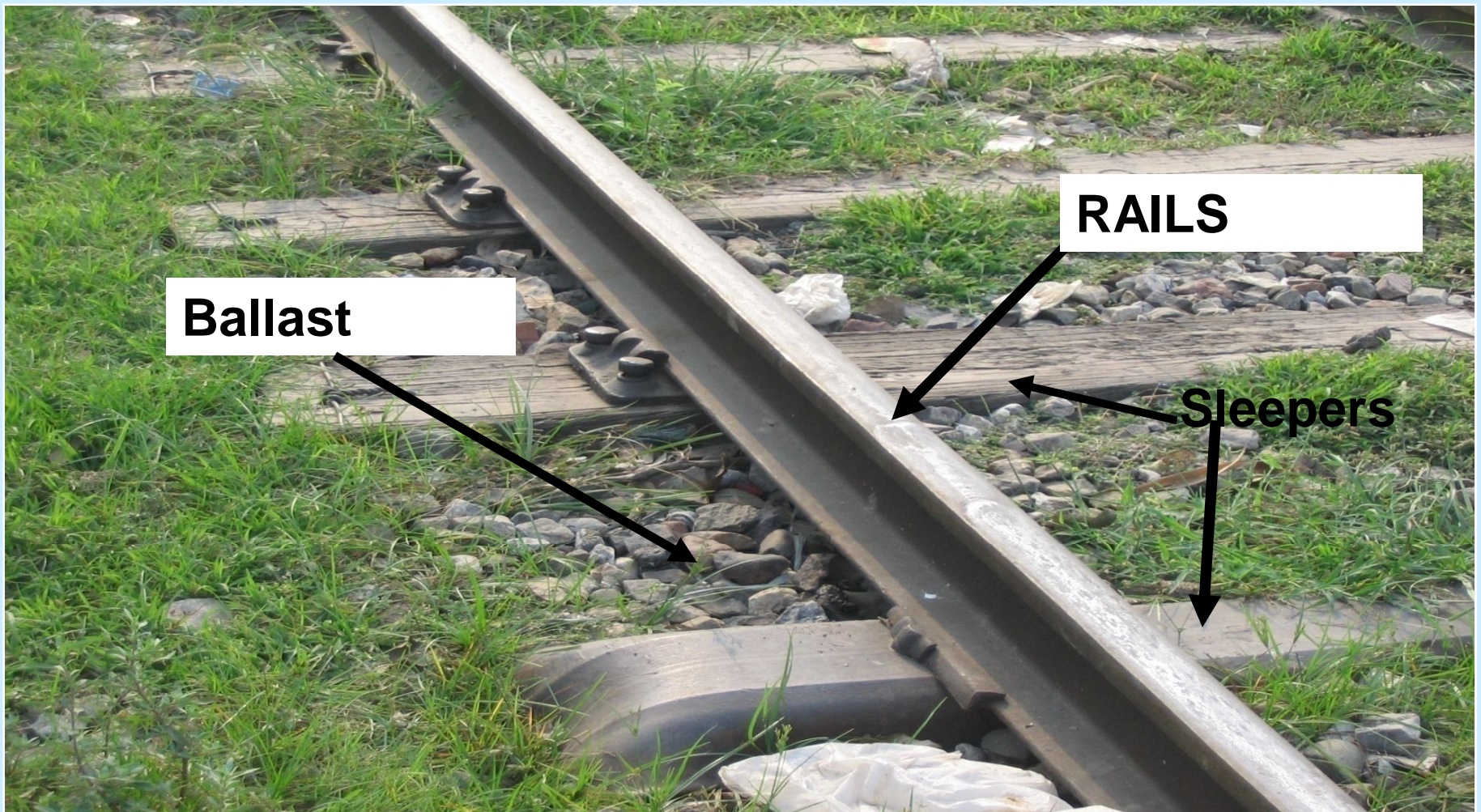
Track Doubling Proposed

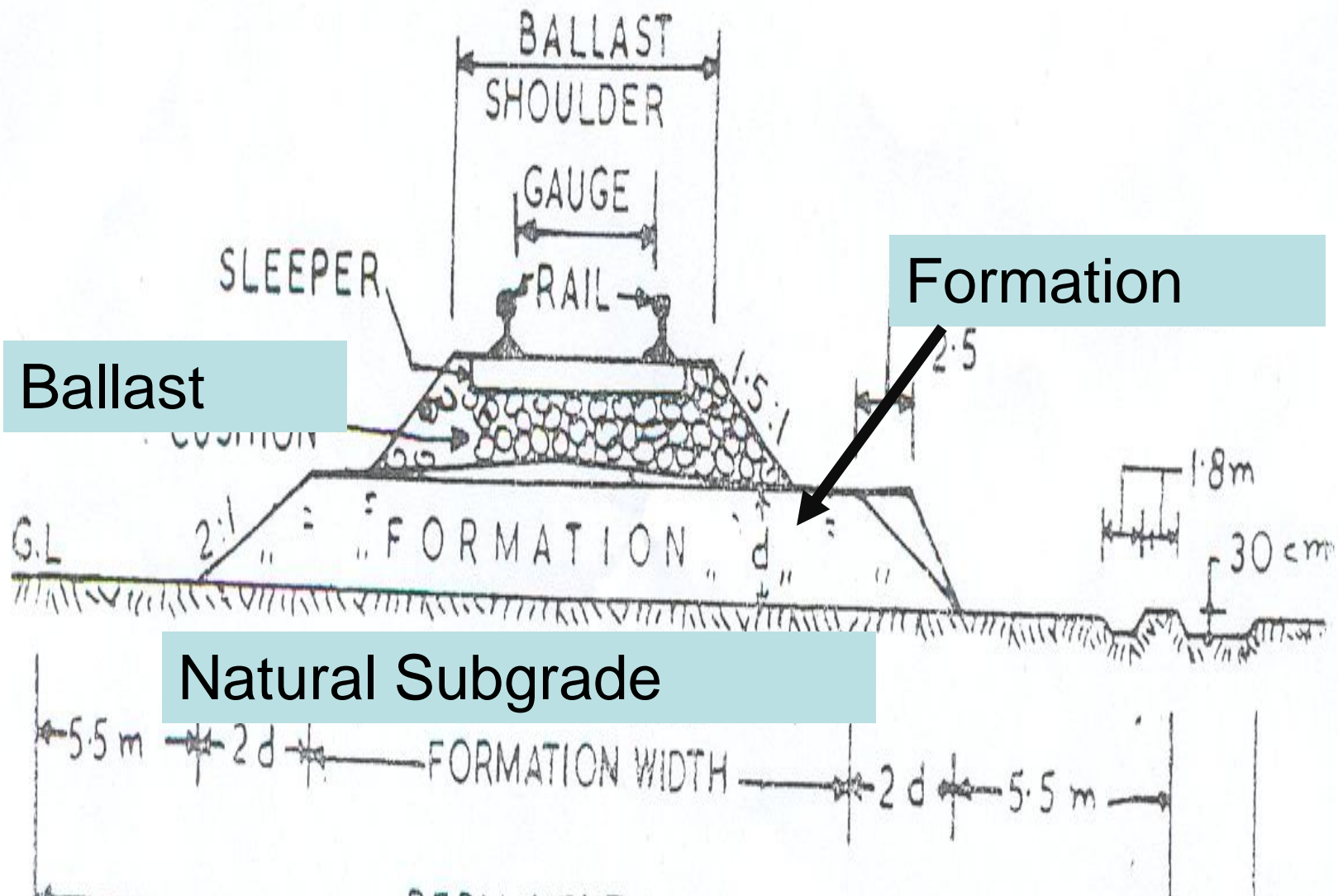
- Shahdrabagh – Lalamusa (126 km)
- Shahdrabagh – Faisalabad (135 km)
- Lalamusa – Chaklala (152 km)
- Golra Sharif – Peshawar Cantt (160 km)

Track or Permanent Way

- The combination of rails, sleepers, fittings, ballast etc is known as a track or permanent way.
- In other words, railway locomotives, coaches or wagon need a path to run over it
- The name of permanent way is given to the track to distinguish the final track constructed for the movement of trains from the temporary track laid for the conveyance of earth material for constructing formation of a railway track.

Track





Cross Section of a Railway Track

TEMPORARY LAND

Track Components

- Rails
- Sleepers
- Fittings and fastening
- Ballast
- Formation

Functions of Track Components

- Rails
 - Rails are the **steel girders** over which the **train moves and transmit** the wheel loads of the trains to the sleepers below.
- Sleepers
 - **The sleepers hold the rails at exact distance or gauge throughout with the help of fittings and fastening and transfer the load from the rails to the ballast below.**

Functions of Track Components

- Ballast

- Ballast holds the sleeper in position and provides a uniform level surface.
- Ballast act as an elastic bed to absorb the blows and shocks of the moving train.
- They also provide drainage to the track and transfer the load to larger area of the formation below.

Functions of Track Components

- Fittings and Fastening
 - They provide a grip between the rails and the sleepers.
 - The rails are fastened with the sleepers by fittings and fastening.
- Formation
 - Formation is the foundation of the railway track made up of locally available earthen material.
 - It distribute the load over wider area of the natural ground.

Requirement for an ideal track

- The gauge of the track should be **uniform and correct**.
- The alignment of the track should be correct.
- **In straight reaches the rail level should be the same while** on curves proper transition curves should be provided **between straight and the curves**.
- The rails should have **perfect cross level**. On the curves the outer rail should have **proper super elevations** to take into account the centrifugal forces.

Requirement for an ideal track

- The gradient should be **uniform and as gentle as possible**. Too **steep gradient** should be avoided.
- **The drainage system of the track should be perfect.**
- The friction between the wheels of the rolling stock and the rail should be minimum.
- **The track should be designed in such a way that the load of the train should be uniformly distributed over it.**

Requirement for an ideal track

- Adequate provision of **repair , replacement and renewal** of the damaged portion should be provided.
- **The track should possess** high resistance to the damage **at the time of derailment.**
- **Joints, points and crossing** should be designed and maintained properly.
- **The track should possess antitheft qualities.**
- The **structure of the track** is less so that not only its **initial cost as well as the maintenance cost** should be low.

Capacity of railway Track

- **Maximum number of trains** that can run safely on any given **length of the track per hour**.
- **In actual practice it is somewhat less due to safety considerations as speed of train, signaling and control system etc.**
- **Maximum number of the trains which can be handled in a yard per day** is known as **terminal capacity**.

Measures to Increase Track Capacity

- The track speed of all the trains should be kept same. This can be achieved by providing uniform gauge and traction. The speed of trains can be achieved using diesel or electric traction.
- To alert the driver regarding the position of the section ahead, multi aspect signaling may be adopted.

Measures to Increase Track Capacity

- The speed of the trains can be increased by making suitable modification in the existing tracks and removing the speed restrictions.
- Reduction in stoppage time of the trains will increase the track capacity.
- To meet the present requirements, existing yard facilities should be improved.
- For quick shunting operations, additional operating facilities should be provided

Comparison of Roads and Railways

- Nature of Track
 - Flexible or rigid pavement
 - Track is considered as a beam on elastic foundation
- Service to user
 - Door delivery is possible
 - Delivery is at the railway station

Comparison of Roads and Railways (cont'd)

- Transportation cost
 - Economical for short distances because of saving time and money in transit to and from station
 - Economical for long distances because of reduced operating expenses
- Nature of traffic
 - traffic ranging from pedestrian to heavy trucks
 - Track is reserved for scheduled trains

Comparison of Roads and Railways (cont'd)

- Stresses
 - transmitted to subgrade through pavement and formation
 - Heavy concentrated loads of locomotives, wagons and coaches come on the track
- Speeds
 - Speed is restricted due to variety of traffic
 - Comparatively higher speed can be achieved because there is no obstruction on the track

Comparison of Roads and Railways (cont'd)

- Frictional Resistance

- between the **tyres and the road surface** is high
- **Between the steel rails and the steel wheel.** Frictional resistance is about 20% of the road resistance.

- Cost of construction

- Comparatively less
- **The rails has to be carefully laid and rigidly fixed at fixed distances hence heavy cost**

Comparison of Roads and Railways (cont'd)

- Cost of maintenance
 - Comparatively less
 - Even slight change in distance would result in derailment.
- Change of track
 - Change from one highway to another is done by junctions and crossings
 - The lateral movement of trains wheels is restricted because of wheel flange fixed to the rails. Moreover to move from one track to another is done through points and crossings.