

# Chapter Two

## Introduction to Railway Engineering



# History of Railway

2

600 BC- Ship Track way in Ancient Rome and Greek



1550's - Hand propelled tubs in Germany



1630- Wagon roads for coal mines pulled by horse carts in Beaumont, England



1776- First cast iron rails on timber ties laid in tram ways in England

# History of Railway

3

📢 Vehicles were moved forward by horses



# History of Railway

4

1807- first passenger train ran from Swansea to Mumbles and first railway station



1830 - The first railway in the United States opens with mostly hardwood rail topped with iron



1857 - Steel rails first used in Britain



1863 - First underground railway opened in London

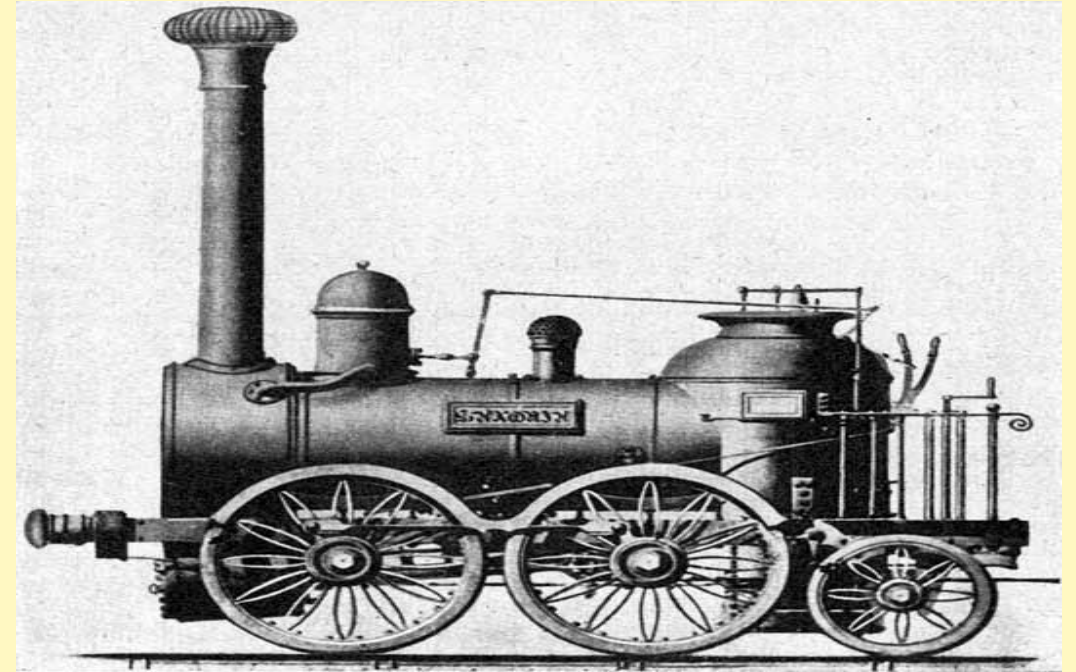
# History of Railway

5

a)



b)



👉 Figure: Railway transportation in the early 19th century (a) freight train (b) steam locomotive

# History of Railway

6

1906- First use of concrete sleepers in Germany



1937-41 - Magnetic levitation (maglev) train patents awarded in Germany



1959- Construction of the Bullet train in Tokyo, Japan



Post WWII- Welded rail, heavier rail-profiles, slab track, innovative elastic fastenings, mechanization of maintenance

# History of Railway

7

- ✎ Most historians agree that the opening of the 48km (30 miles) double track line of metal rails of Liverpool-Manchester Railway in 1830 in the north-west of England
- ✎ The world's first true railway, the prototype of the 'modern railway' had arrived: a combination of
  - Specialized track,
  - The accommodation of public traffic,
  - The conveyance of passengers as well as freight,
  - Mechanical traction, and
  - Some measure of public control.
- ✎ In the second half of the 19th century, the more advanced industrial states engaged in a worldwide contest for strategic advantage, economic fortune and imperial expansion.
- ✎ As industrial empire arose, railways became a means to great power and status.
- ✎ The colonial railways in Africa, Asia and South America were thus an essential part of the spread around the world of the economic processes, ideas, and institutions of the European powers.

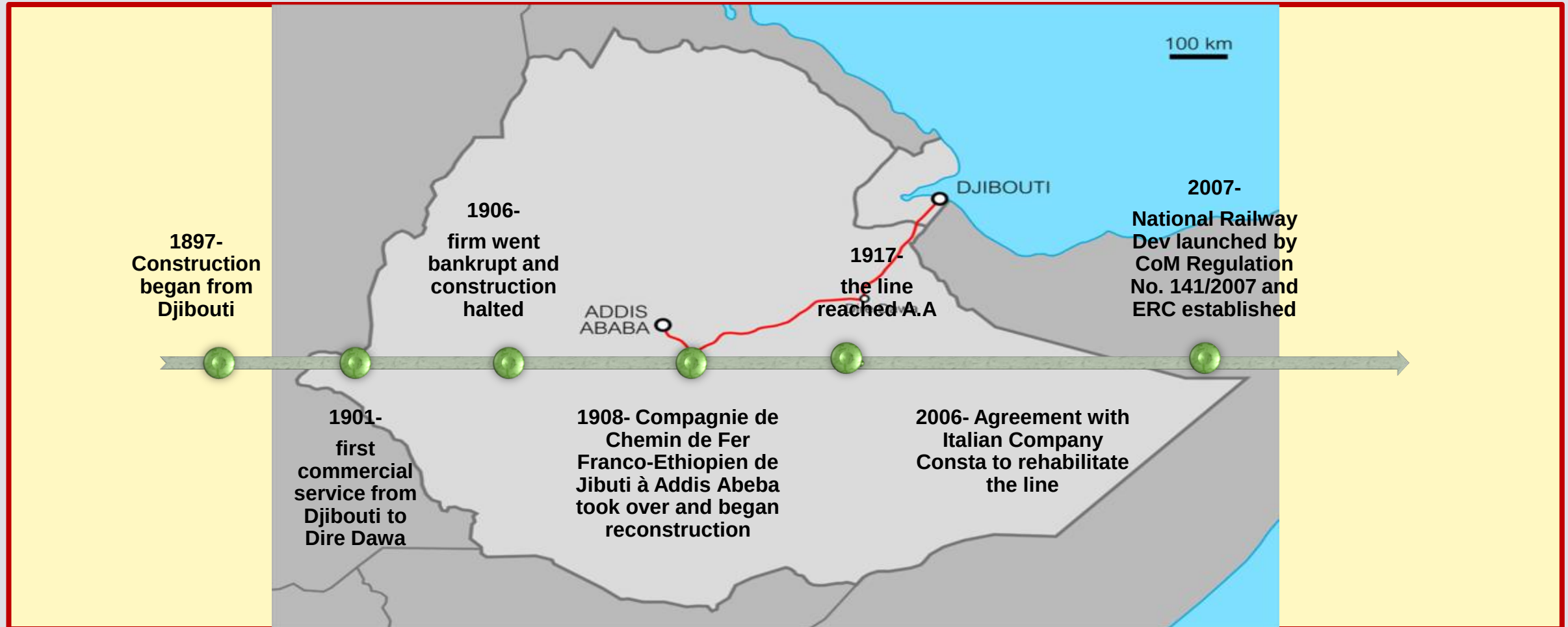
# History of Railway

8

- ✎ The 'great' or 'golden' age of railways – in the sense that they virtually monopolized inland transport – was over in most countries by World War I
- ✎ After a mid of 20th century rationalization of the rail network began and the following activities were taken to compete with other massive mode of transportation
  - Steam locomotives were avoided and replaced with full electrification of the lines.
  - Modernization of passenger coaches
  - Safety system upgrading
  - Freight wagons were also highly improved with the introduction of high capacity and with box containers and fully braked units.

# Railway History of Ethiopia

9



# Railway History of Ethiopia

10

- ✎ The challenges in the progress of early railway developments were:
- Strong Ethiopian opposition of fearing in losing territory on family of the King
  - French need of colonial interest and hope of taking monopolistic position
  - The financial difficulties and finally bankruptcy (in 1909) of the former firm

## Characteristics of Old Ethiopian Railway

- 1000 mm gauge and diesel traction
- Owned and administered by the governments of Djibouti and Ethiopia
- 781km – 681 in Ethiopia and 100 in Djibouti)
- Suffers from old-age, lack of spares, high operating cost, worn out track, no Locomotives, low capacity

# Railway History of Ethiopia

11

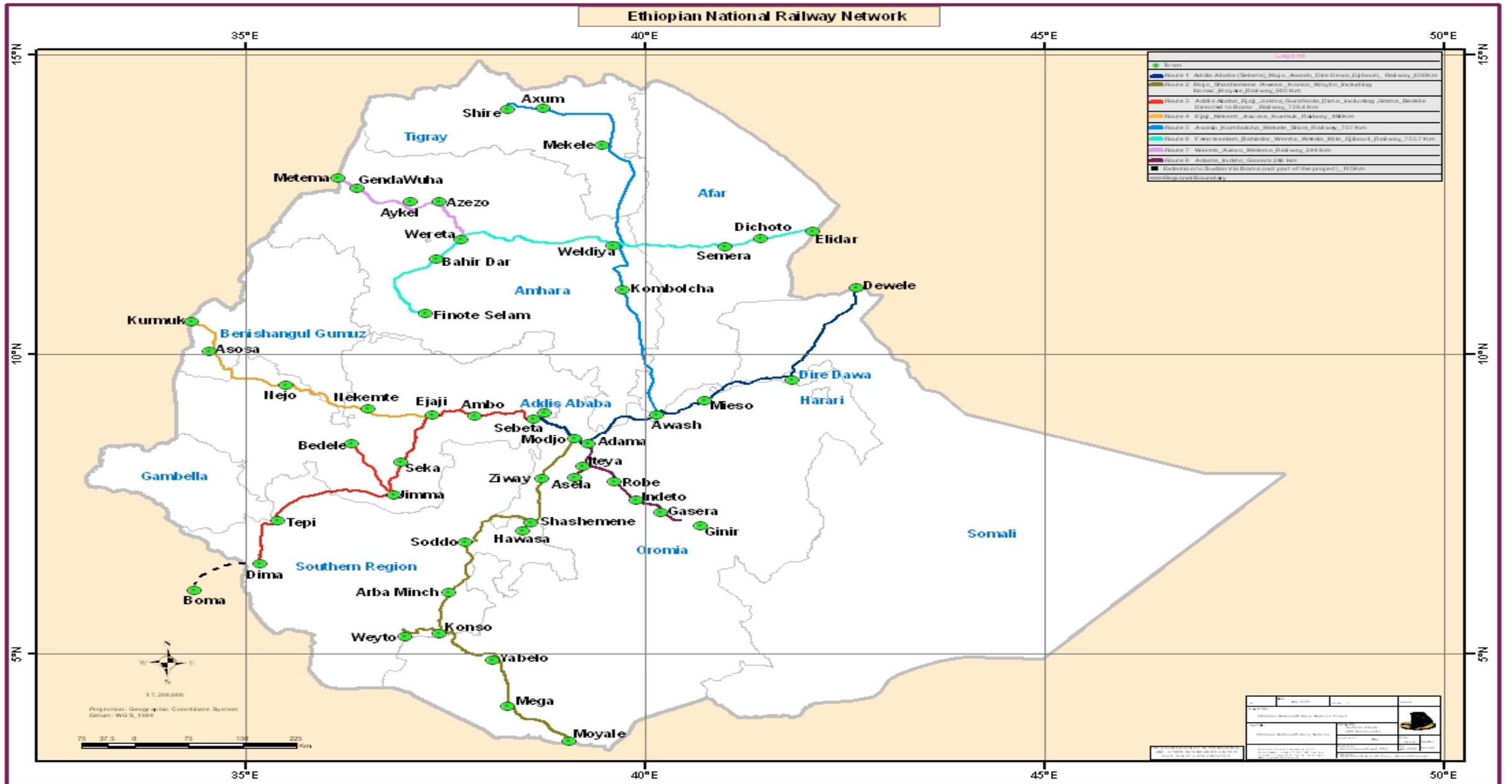


# Current and Future Ethiopian Railway Network

12

✎ Ethiopian Railway Corporation (ERC) has further studied the proposed national railway network and based on the developmental goal of the government of Ethiopia, prioritized the lines.

| Route # | Route Name                                                   |
|---------|--------------------------------------------------------------|
| 1       | Addis Ababa-Modjo-awash-Dire Dawa-Dewanle                    |
| 2       | Modjo- Shashemene/Hawasa-Konso-Weyto(Including Konso-Moyale) |
| 3       | Addis Ababa- Ijaji-Jima-Guraferda-Dima                       |
| 4       | Ejaji_Nekemt_Asossa_Kurmuk                                   |
| 5       | Awash_Kombolcha_Mekele_Shire                                 |
| 6       | Fenoteselam_Bahirdar_Wereta_Weldia_Semera_Elidar             |
| 7       | Wereta_Azezo_Metema                                          |
| 8       | Adama_Indeto_Gasera                                          |



# Current and Future Ethiopian Railway Network

14

## Phase I Projects

- ✎ As part of the Growth and Transformation Plan (GTP) of the Government of FDRE.
- ✎ 2500 Km of the proposed railway network has been given a first priority to be implemented between 2010/11 to 2014/15. The projects selected in the first phase are:
  - Addis Ababa/Sebeta – Mieso – Dewele
  - Mekele – Hara Gebeya – Tadjourah
  - Awash – Kombolcha – Hara Gebeya
  - Addis Ababa/Sebeta – Jimma – Bedele
  - Modjo – Boditi - Weito

# General Overview of Railway System

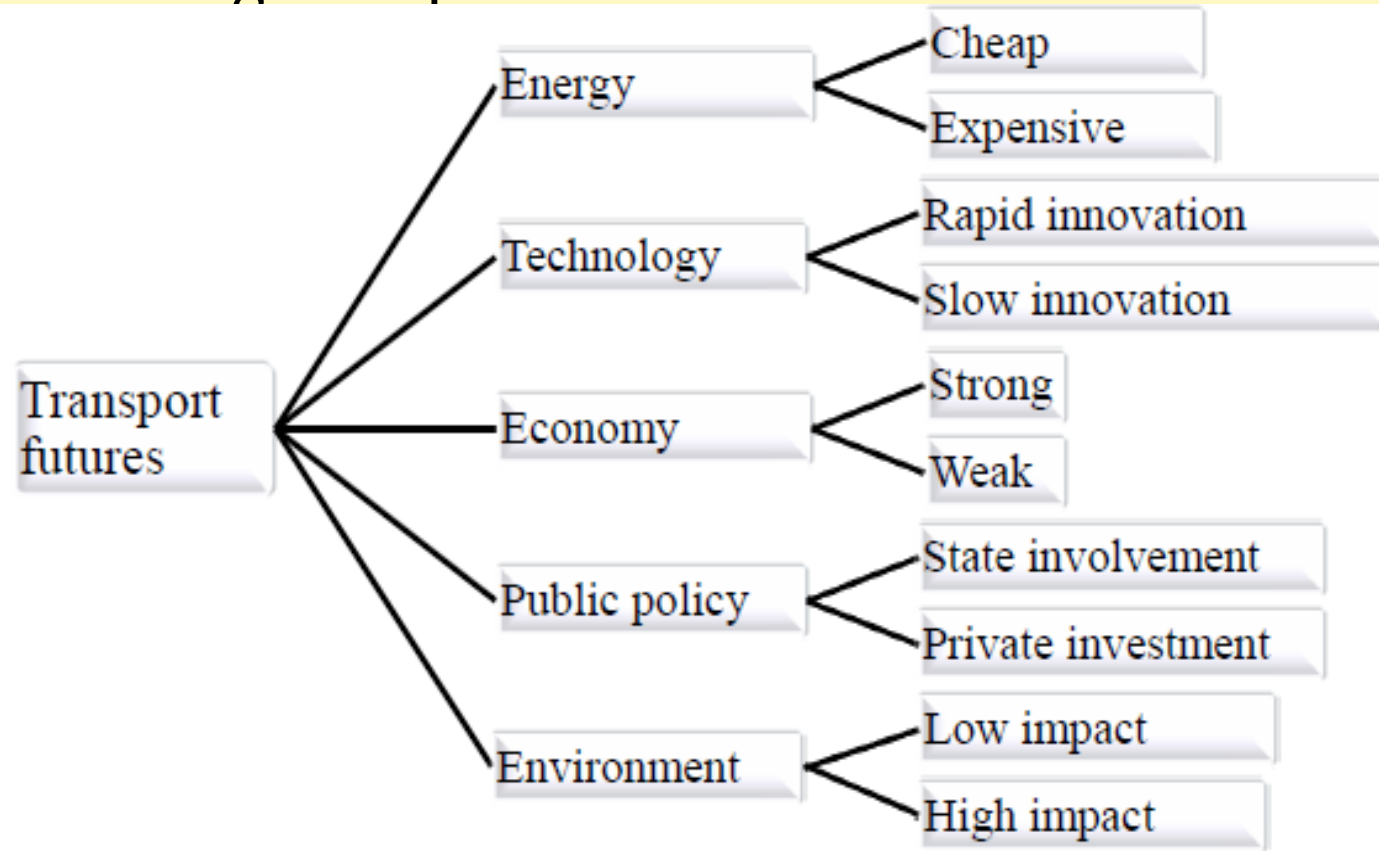
15

- ✎ Rail transport refers to the land transport of people or goods along guided paths called railways. A railway consists of two parallel rail tracks at a fixed distance (gauge) apart, usually made of steel and mounted upon cross beams called ties or sleepers”
- ✎ The railway technology is mainly based on two physical principles
  - The guidance of wheel on rail (adhesion of steel on steel)
  - An operational technique, the convoy
- ✎ It allows a one degree of freedom movement; the choices are binary:
  - The movement is either forward or backward along the rail
  - The section of the track is either free or occupied
- ✎ Road transport has more flexibility in the movement (two dimensional space)

# General Overview of Railway System

16

## 📌 The factors influencing transport future



# General Overview of Railway System

17

- ✎ The energy policy and environmental aspect will be the largest
  - In relation to energy, the price of oil has some influence
  - On the other side congestion and greater pollution accompanying rising vehicle numbers fundamental changes in transport solution
- ✎ Railway has the capability to play a key role in any sustainable transport system
  - Offering efficient transport
  - Low environmental impact
- ✎ In order to stay economically competitive and act socially responsible towards the environment
  - Railways must use smart and cost efficient technology
  - Railways must increase their energy efficiency

# General Overview of Railway System

18

- 📢 Demand for railway infrastructure is driven by
- Higher speeds and higher axle loads
  - Higher availability and fewer disturbances
  - Lower Life Cycle Cost (LCC)
  - Satisfy environmental demands
  - Higher reliability and safety

# General Overview of Railway System

19

- ✎ In the industrialized nations, due to insufficient capacity of existing infrastructure and to reduce environmental pollution due to road and air traffic, there is a high demand for:
  - High quality railways
  - Fast passenger rail services; for a maximum operational speed of 300km/h or more
  - Competitive rail freight transport; axle load of 32.5 tonnes or more
- ✎ In developing countries, there is an enormous need for newly built railway infrastructure

# General Overview of Railway System

20

## **Railway safety**

- Safety must be not jeopardized and must be the top agenda for the railway authorities at the design and implementation stages, and in the maintenance and operation
- Accidents could occur due to human error, equipment fault, improper technology, etc.
- Training of railway personnel
- Work on risk assessment and safety at the planning stage, to assess potential hazards
- Regular maintenance
- Improved technology for inspection and failure detection
- Incident analysis to understand a root cause and to improve the safety further in the line

# General Overview of Railway System

21

## Advantages of Railways

- Limited use of space compared to large transport capacity
- Better reliability and safety
- High degree of automation and management
- Low energy consumption
- Moderate environmental impact

# General Overview of Railway System

22

## Effect of Train Speed-up

- For short range distance  $< 100$  km car is more comfortable
  - For travel distance 100-300 km – conventional train with practical speed 160kph is more appropriate to compete with cars
  - For travel distance 300-600 km – high speed train with practical speed 320 kph
  - For travel distance  $> 600$  km – very high speed train with speed 400 kph is appropriate to compete with airplanes
-  French TGV – on the line Paris to Lyon the travel time reduced from 3 hours and 44 min to only 2 hours → the number of passengers doubled

# General Overview of Railway System

23

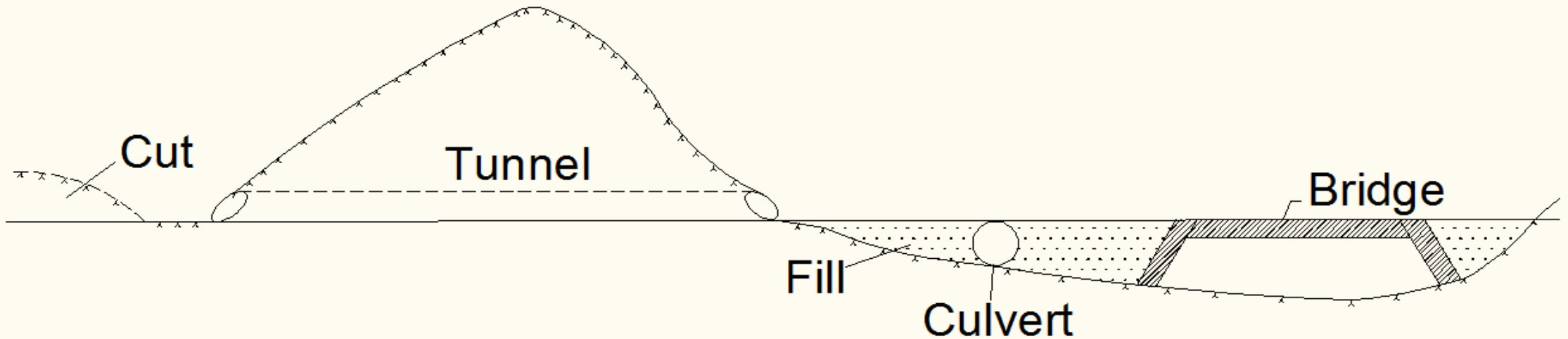
## Disadvantages of Railways

- Cost of railway infrastructure is expensive; (ca. \$ 4 - 20 million US/km)
- High speed railway lines are more expensive; (ca. \$ 20 - 45 million US/km)
- Out of the total cost, 50% of the cost is for track construction such as track superstructure including switches and crossings, electrification, tele, etc
- The remaining cost is for track substructure, such as bridges, tunnels, embankments, subgrade improvement, etc;
-  Railway companies are often unprofitable, government have to support financially to operate trains – high operation and maintenance cost

# General Overview of Railway System

24

- ✎ Very difficult terrains requires many special civil structures (tunnels and bridges) which increase the cost rapidly
  - Railway construction in tunnels can cost up to \$ 40 million US/km
- ✎ The cost for a double track is about twice that of a single track



# Components of Railway System

25

**Rolling Stock**



**Signal and Communication**



**Permanent Infrastructure**



**Power Supply**



# Civil Engineering works

26

