UNIVERSITY OF GONDAR

INSTITUTEOF TECHNOLOGY

DEPARTMENT OF CIVIL

ENGINEEREING

RAILWAY & TUNNEL CONSTRUCTION (CoTM 4203)

Chapter One: Basics of railway

By: Rekik Desta (Msc.)

WELCOME TO RAILWAY ENGINEERING

Course Objective

- ***To introduce the railway system and engineering from civil works perspective.***

The civil engineering sub-course aims to:

- Define the system and distinguish the fixed infrastructure of the system where COTM are mainly engaged
- Tell the story of infrastructure development from historic point of view
- Introduce the preliminary design process of railway components
- Introduce and characterize the components of railroad civil works
- Recognize the design considerations and design technical standards
- Inform the construction process and operation of railway industry

Course Delivery

- **Lecture by power point presentation and group discussion**
- **Supplemented by semester project, assignments, exam**
- Attendance is mandatory!

BASICS OF RAILWAY

Introduction

- ✓ Important of transport
- ✓ History of railroad
- ✓Railway in Ethiopia
- ✓ Comparison of important characteristics of road transport and rail transport

1.1 Railway transport system

Definition :

- ***Rail transport refers to the land tr***
  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”***

Importance of railway

To derive benefits out of the system with respect to:

- Economic aspect
- Cultural and social aspect
- Political aspect
- Environmental aspect

Characteristics:

- Great transport capacity/volume
- Low cost
- Energy saving and environmentally friendly.

The Significance & Drawbacks of Railway

Significance

- It has a high level of passenger or cargo utilization over a limited space
- Most efficient energy consumer (1/3 of road transport and 1/7 to 1/5 of air transport)
- Minimum friction and minimum air resistance/guided movement/
- Environmentally friendly
- Mostly electric powered
- Safest mode of land transport with the lowest accident rate
- It offers comfortable ride options such as meal, sleeping and entertainment

Drawbacks of Railway

Drawbacks

- Huge initial investment and operation costs
- Cannot support severe alignments such as steep slopes and sharp curves
- Low flexibility in terms of network operations
- Severity of accidents is high (but low frequency)
- Security threat as it is prone to attacks

1.2 Historic Development of Railway

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

The 19th Century

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

20th Century and Onwards

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

Kind of Traction and Locomotives

Three kinds of traction in railway industry:

1. Electric traction,
2. Diesel traction and
3. Vapor traction.

Kind of traction energy greatly influences the railway with respect to:

- ✓ Traffic capacity
- ✓ Line standard and
- ✓ Economy

Cont…

Electricity propelled

- **1879 First electric railway demonstrated at the Berlin Trades Fair**
- **1890 First electric London Underground railway opened in London**

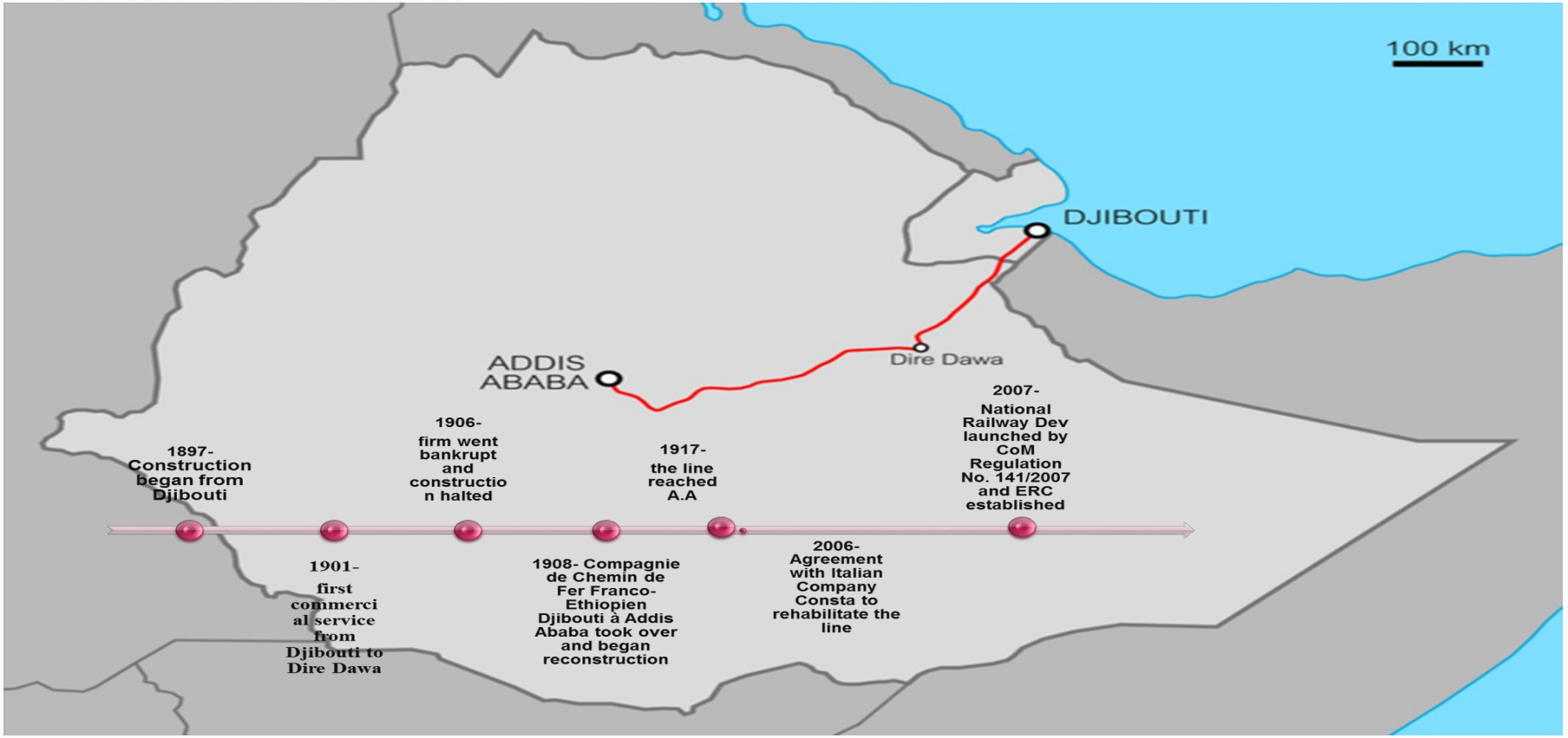
Diesel locomotives

- **1913 First diesel powered railcar enters service in Sweden**

Diesel Electric locomotive

- **1924 First diesel-electric locomotive built in Soviet Union (USSR)**
- **Dominant type of locomotive in the world today**

History of Ethiopian railway



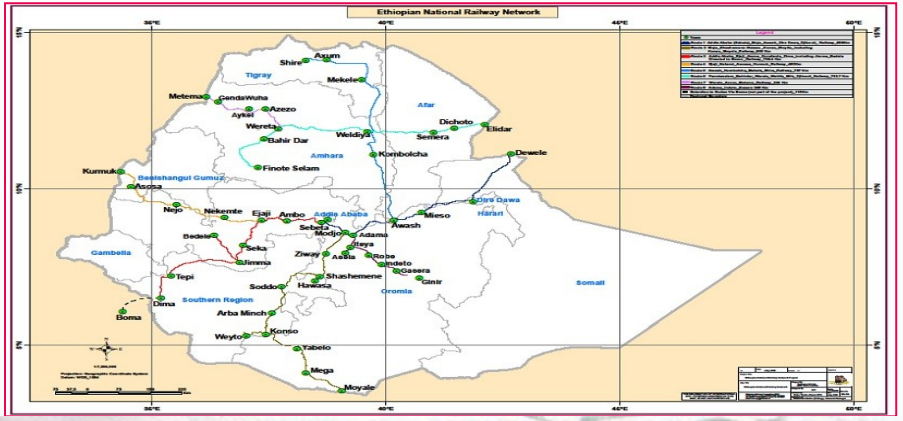
The Legacy Railway

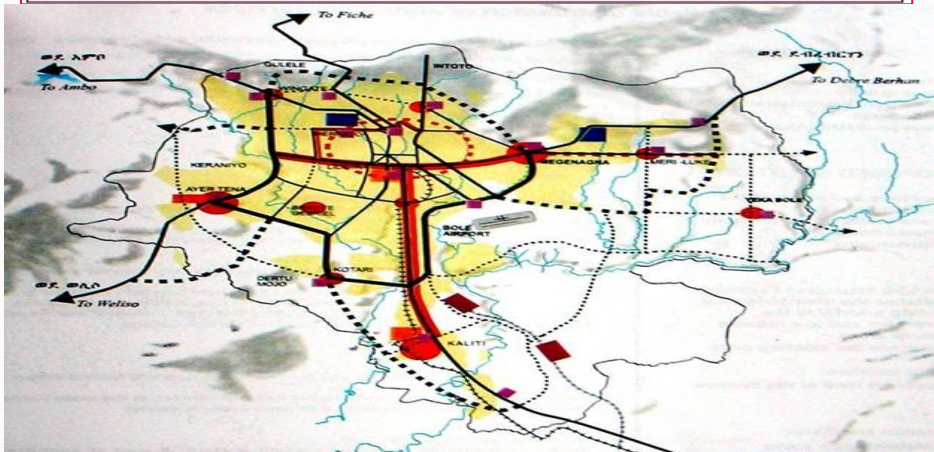
- 1000 mm gauge and diesel traction
- Owned and administered by the governments of Djibouti and Ethiopia
- 781km (681 in Ethiopia and 100 in Djibouti)
- Suffers from old-age, lack of spares, high operating cost, worn out track, no Locomotives, very low capacity

Ethiopian National Railway Program[ENRP]

- 5000 km of national railway line
- Standard Gauge (1435 mm)
- Electric Traction
- High capacity (25 ton/axle)
- High speed (120 -160 km/hr for passenger and 80 -120 km/hr for freight)
- Concrete sleeper

(160cm X20.5cmX22cm)





Addis Ababa LRT

- 34km of Fully electrified LRT for Addis Ababa
- Standard Gauge (1.435 meters) and double track for the whole route
- Capacity: 80,000 PPH (Passenger/hr)
- Headway: 6min with a potential of reducing to 90secs
- Passenger-km based fare system
- A total of 39 rail stations are available for the two lots (E-W and N-S)

Ethiopian National Railway network Project contains

Route 1- *Addis Ababa (Sebeta) – Mojo – Awash – Dire Dawa – Djibouti – Railway =656km*

Route 2 *– Mojo – Shashemene (Awasa) – Konso – Woyito – Including Konso – Moyale Railway = 905km.*

Route 3 *- Addis Ababa – Ejaji – Jimma – Guraferda – Dima – Directed to Boma Railway = 637km*

Route 4 *– Ejaji – Nekemt – Asossa – Kurmuk Railway – 460km*

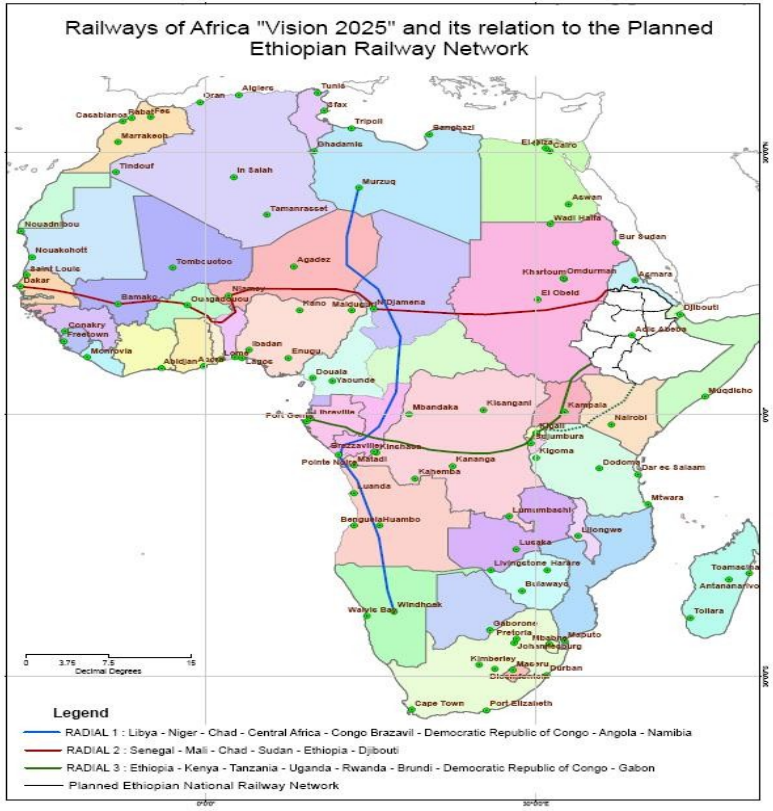
Route 5 *– Awash – Kombolcha – Mekele – Shire Railway = 757km*

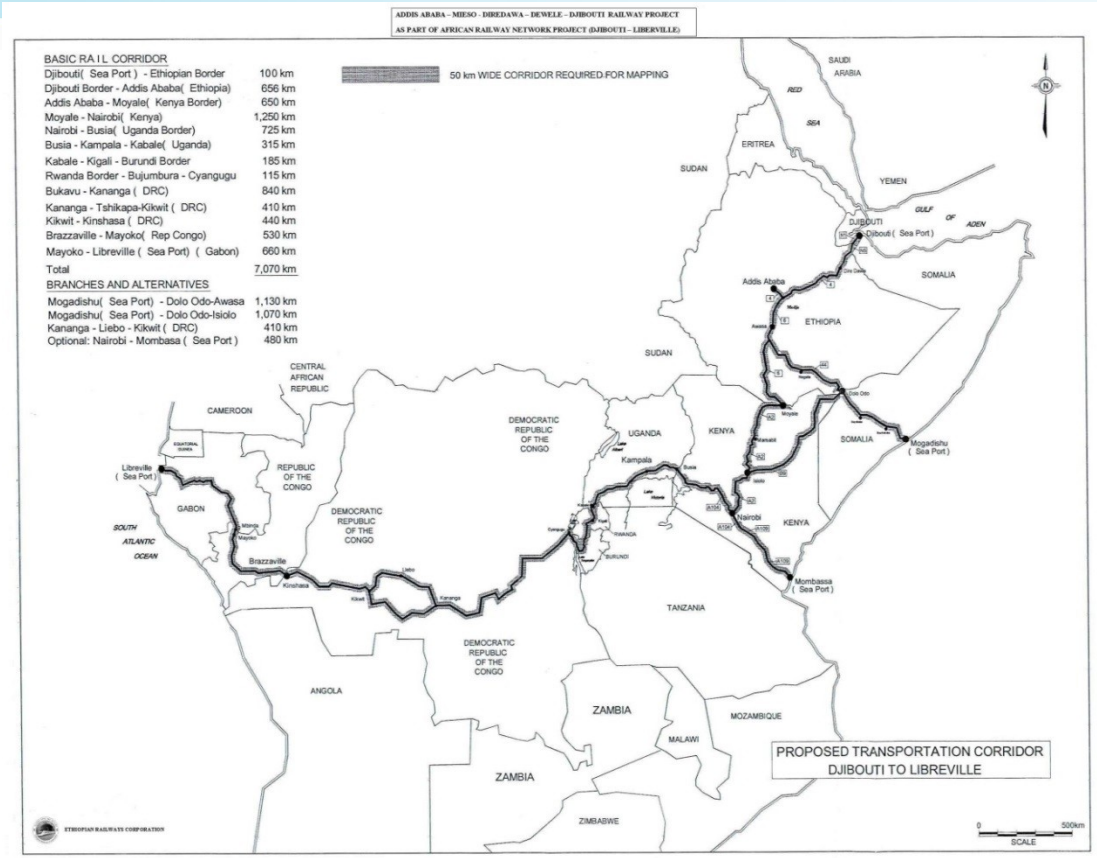
Route 6 *– Fenoteselam – Bahirdar – wereta – Woldeya – Mile – Djibouti Railway =796km*

Route 7 *- Woreta – Azezo – Metema Railway =244km*

Route 8 *– Adama – Indeto – Gasera Railway = 244km*

Regional Integration in Africa





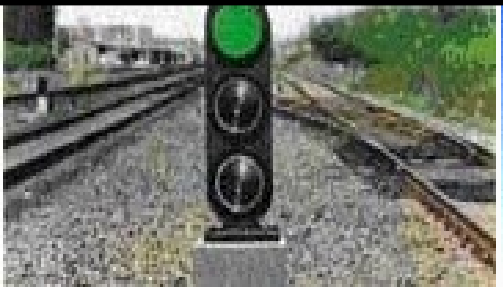
Progress to Date

1.3 Components of Railway

Rolling Stock

Permanent Infrastructure

Signal and Communication

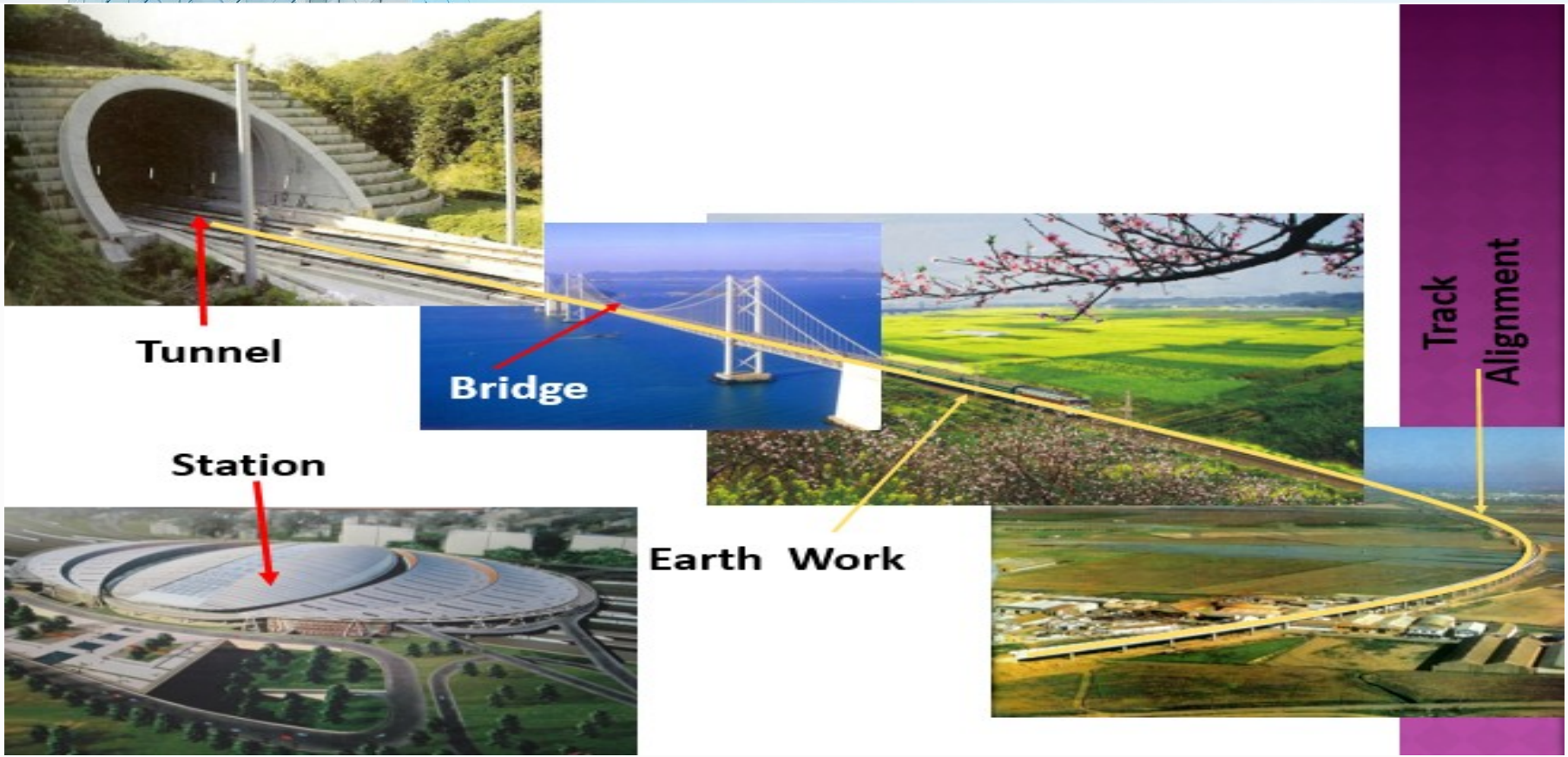


Power Supply

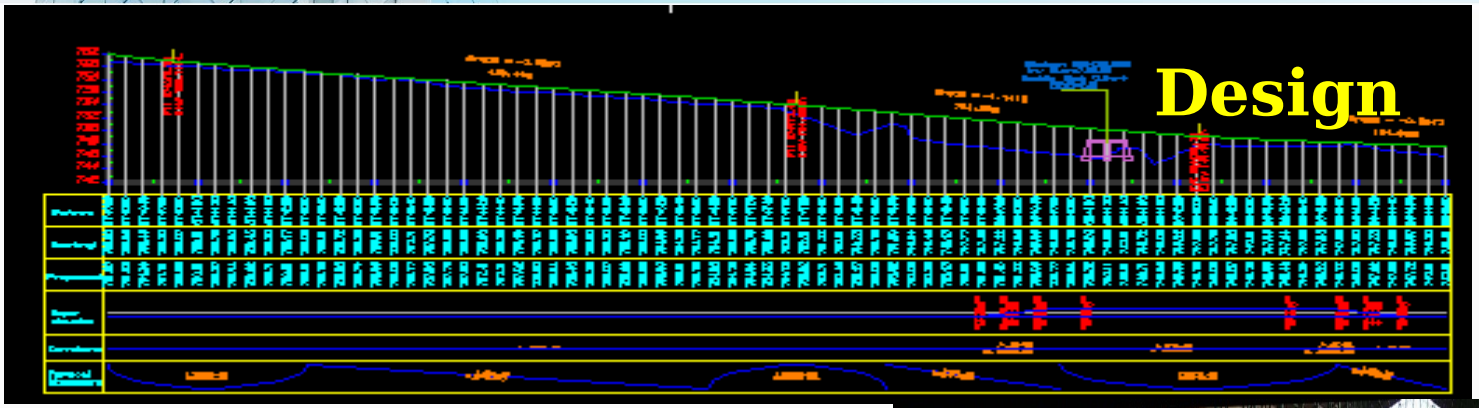
Components

- Railway is a ***permanent way*** composed of *subway, bridge ,culvert, tunnel ,track, station, switches etc.*
- In order to provide smooth and stable geometry state, earth structures shall be built by ***cutting and filling the ground***.
- For spanning rivers or gorges, *bridges* or culverts shall be built.
- For pass through mountains, mountains shall be excavated to construct *tunnels*.

Major components



What types of Civil Works?



Design

Operation and maintenance

Construction

1.4 General Principle for Railway Construction and Development

Generally, Rail infrastructure development is dependent on:

- The strategies of national economy and social development
- Demands of territorial development
- National defense

Cont…

The planning phase shall also be aimed:

- To highlight key points and strengthen weak links,
- To facilitate coordinated development with other traffic and transport modes and relevant industries such as energy industry.

Feasibility Study of Railway Projects

Why undertake a feasibility study?

- Determine whether and under what conditions, a project will be technically, financially and economically viable.
- Demonstrate to potential donors that project will produce acceptable commercial rate of return.
- Demonstrate social-impact of project

1.5. Railway Classification & Main Technical Standards

Railway is classified according to:

- Its role in railway network
- Properties
- Volume of passenger traffic
- Goods traffic volume
- Maximum allowable axle load
- Design speed, etc.

1. Railway Line for Passenger Traffic

- With design speed of passenger car not less than 200km/h. Further classified as:

a. High-speed railway :

- with maximum design speed of 250km/h and over
- play trunk parts in railway network
- built in a developing region where is densely populated and
- has a heavy volume of passenger traffic.

Cont…

b. Rapid -speed railway

- play a linking and auxiliary part in railway network for passenger traffic
- with designed speed of 250km/h or lower.

2. Railway line for mixed passenger and freight traffic

- With design speed of 160km/h or lower (passenger train) and 120km/h (fright train).

Class I Railway:

- Play a trunk part in railway network, and
- volume of short-term traffic is no less than 20 million tons.

Cont...

Class ⅡRailway:

- Play a linking and auxiliary part in railway network
- the volume of short-term traffic is less than 20 million tons.

Class Ⅲ Railway:

- Give service to a local zone
- the volume of short-term traffic is less than 20 million tons and larger than 5 million tons.

Cont...

Class Ⅳ Railway:

- Give service to a local zone, and
- the volume of short-term traffic is less than 5 million tons.

Items of Main technical standards

Railway technical standards are broadly classified into:

compulsory standards

- which stipulate safety and so forth;
- design standards which complement the compulsory standards;

Optional standards

- which aim at the enhancement of production efficiency,
- elimination of trade barriers, and so forth.

Why railway technical standards?

- Ensuring of safety
- Maintaining of railway network and ensuring of railway transport characteristics
- Ensuring of convenience for users
- Environmental counter measures
- Reduction of production cost

1. 5 Railway Signals, Communication and control

Elements

- Signals
- Track Circuits
- Points
- Slots

1.5.1. Signals

Signaling is Mechanism by which the station master conveys information to the Loco driver to:

- Stop
- Go with Caution or
- Proceed

Types of Signaling Systems in Railways

- Time Interval Method
- Space Interval Method

Color Light Signals

- Color lights are used to convey information to the Loco driver.

This has many advantages:

- The day and Night aspects are the same,
- Visibility can be available for Longer ranges,
- The Signals are Placed at drivers Eye Level.
- No Mechanical Transmission and no moving parts.

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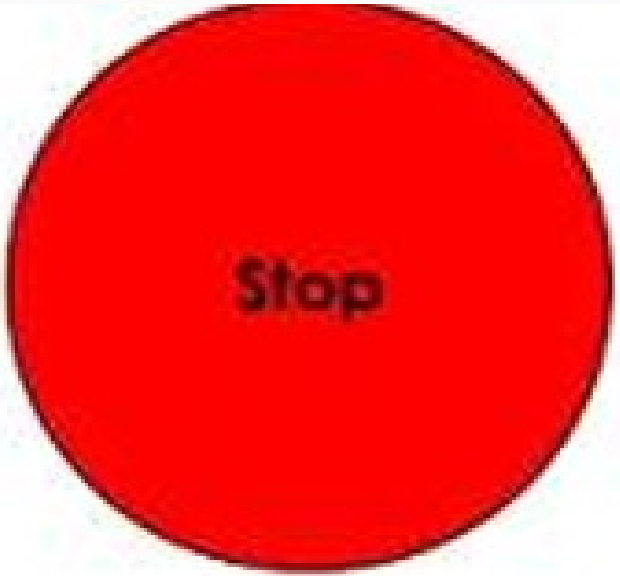

Colour of signal	Interpretation
Red	Stop dead
Yellow	Pass the signal cautiously and be prepared to stop at the next signal
Two yellow	Pass the signal at full speed but be prepared to pass the next displayed

Cont...

Warning signals

- They provide a pre-hand warning to the driver about the controlling signals ahead.
- These signals are similar to stop signals with the exception that
- at their free end V notch is cut to distinguish it from stop signals.

Cont...

Indications

1. Inclined Position

- Track is clear and driver can proceed with confidence.

2. Horizontal position

- Driver can take his train up to stop signal cautiously.

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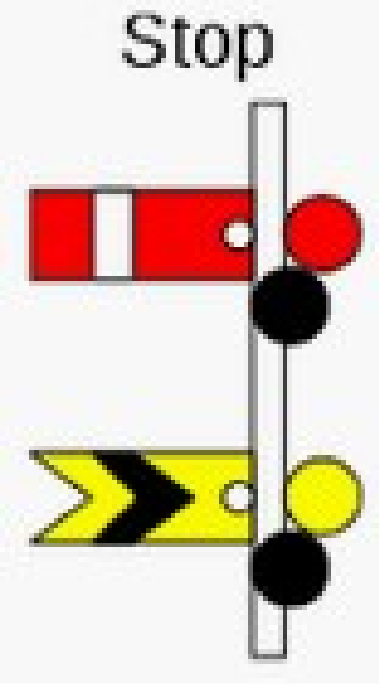

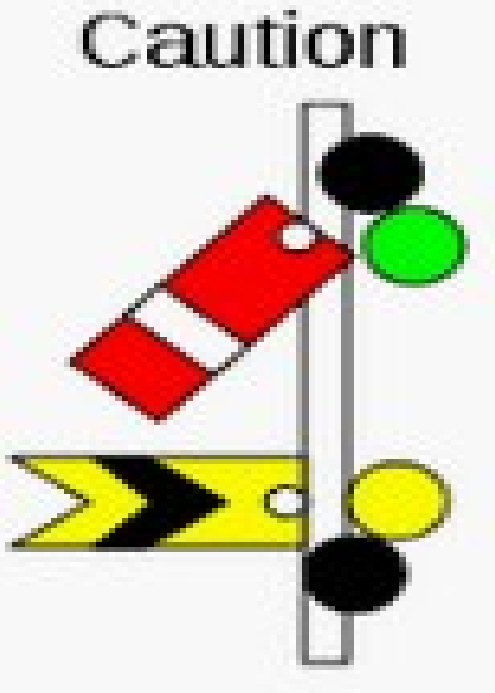

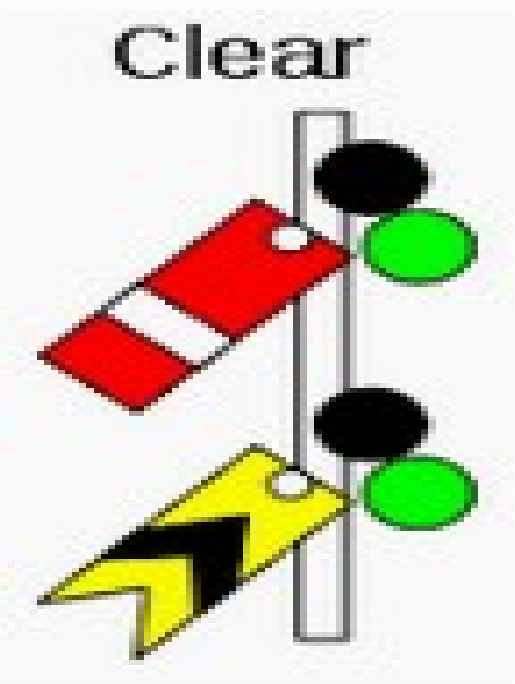

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d. Shunting signals

- These are dwarf or miniature signals and are mostly used for regulating the shunting of vehicles in station yards.

Stop

proce

1.5.2. TRACK CIRCUITS

Track Circuits are devices that convey the presence of a train on a specified length of a track

There are many types of track Circuits :

1. DC Track Circuits
2. High Frequency Track Circuits (HFTC)
3. Audio Frequency Track Circuits (AFTC)
4. Axle Counters (Digital & Analog)

Cont…

Truck circuits

1.5.3. POINTS

- Points also referred to as switches are mechanical devices in the railway to change the path that trains may take through a junction.
- These mechanical switches can be manually or Electrically Operated to Change From Normal to Reverse or Vice Versa

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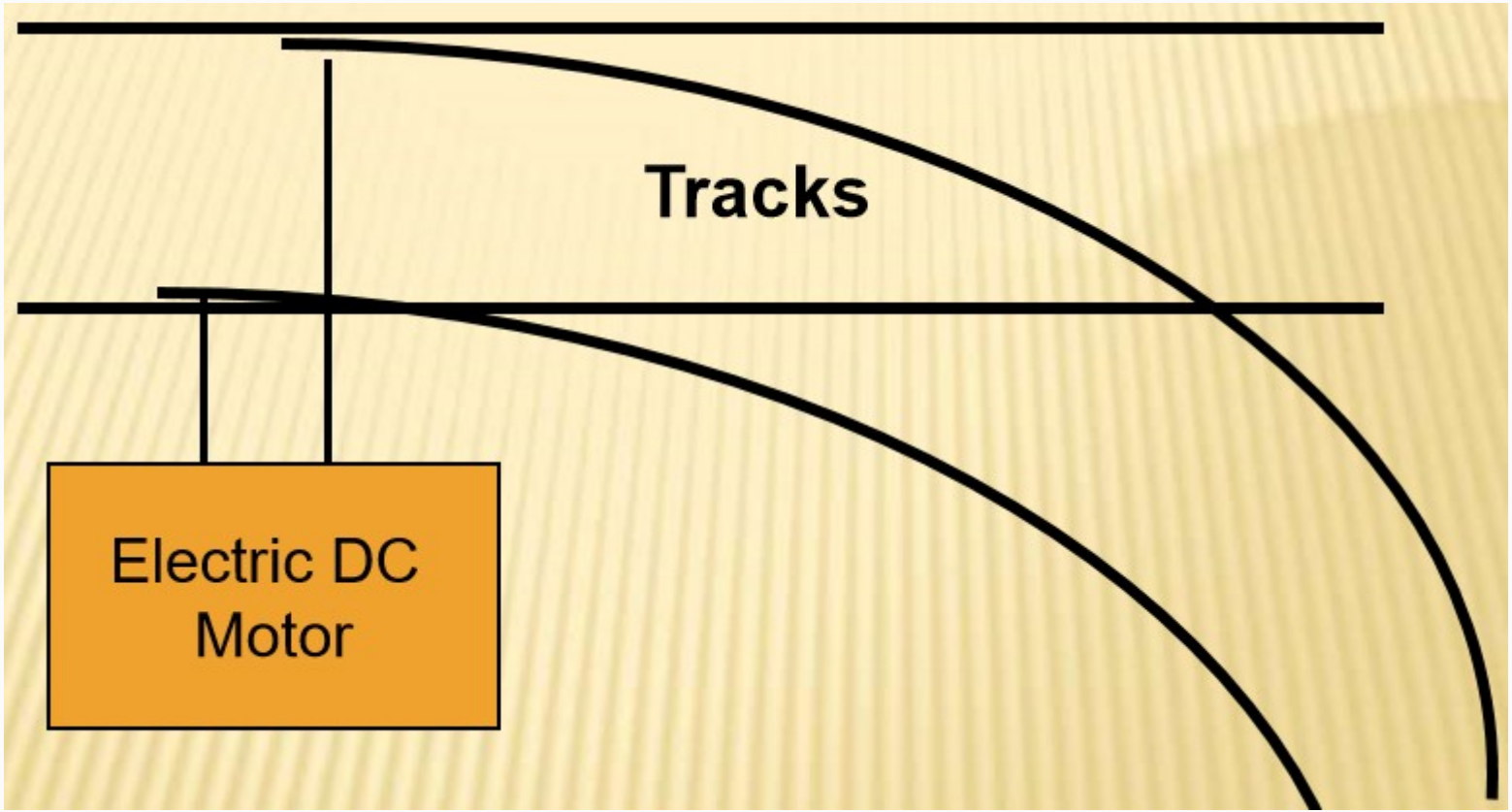

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Switches

1.5.4. SLOTS

- A slot is an element of a Yard, which as Dual Control, i.e. An Element of the Yard which can be operated by Two or More Means.

Example:

- Normally a Point is operated by means of Electric Motor but whenever the motor is failed,
- the field staff Can go and manually operate the point and lock it.

Thank You!