Study of Delhi-Mumbai Railway Route to be preferred as a Test Trial for every New Train

A dissertation report submitted in the partial fulfillment of requirements for Masters of Business Administration – Energy Trading under the guidance of

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Student Declaration

I hereby certify that the project entitled "**Study of Delhi-Mumbai Railway Route to be preferred as a Test Trial for every New Train**", in partial fulfillment of the requirements for the award of the degree of MBA in Energy Trading, is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person. The project is done by me during the period Oct, 2016 to April, 2017 under the guidance of **Mr. Navdeep Bhatnagar** as my mentor for this project.

Place:

Date: **Anshul Hardas**

Acknowledgement

The success of any project largely depends on the motivation, encouragement and guidelines of many others who are involved directly or indirectly, apart from the efforts of the person working on the project. I take this opportunity to express my earnest gratitude to each and every individual who has been deeply associated from initiating to successful completion of this project.

Firstly, I am very thankful to University of Petroleum and Energy Studies which allowed me to undertake this dissertation program and project. It is with great honour I convey this acknowledgement so as to express my gratitude for the assistance, advice and support I received during the project work.

At the outset, I wish to acknowledge my mentor **Mr. Navdeep Bhatnagar**, Asst. Professor (SS) Dept. of Oil and Gas, UPES for suggesting me in taking this stimulating topic to perform research, to understand the integrities of railway track and signalling system during my dissertation at Univ. of Petroleum & Energy Studies from 1st Oct 2016 to 16 April, 2017 at Dehradun.

I would also like to extend my sincere regards to Mrs Sonal Gupta, Asst. Professor (SS) Dept. of Oil and Gas, UPES for her thoughts and suggestions which has encouraged me throughout and enabled me in learning new aspects and completing the project.

In the end, I wish to thank my parents for their personal guidance and motivation which has encouraged me to work with full devotion and dedication.

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MBA - Energy Trading

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Mentor Certificate

This is to certify that the dissertation report entitled "**Study of Delhi-Mumbai Railway Route to be preferred as a Test Trial for every New Train**", submitted by Anshul Hardas to UPES for partial fulfilment of requirements for Masters of Business Administration (Energy Trading) is a bonafide record of the internship work carried out by him under my supervision and guidance. The content of the report, in full or parts have not been submitted to any other Institute or University for the award of any other degree or diploma.

(Mr. Navdeep Bhatnagar) Date:

Asst. Professor(SS), Dept. of Oil & Gas,

University of Petroleum & Energy Studies,

Dehradun.

Abstract

A lot of factors cross our minds when we talk about the integrities of all the systems installed by Indian Railways for a random, say, 5 kms. Those factors are –

- How the signaling system works?
- What is Track Management System?
- How is the electrification distributed for very long distances?

This report describes all the integrities about the best and fastest route of the country and that is Delhi – Mumbai industrial corridor. Every aspect and advancement of technologies have been studied and explained in this report. Every time when a new train is launched in India it is made to run on this route for the test trial. The answer to the question "WHY" lies inside the report.

The document consists –

- Maximum number of advanced signaling systems installed till date, that includes Automatic Block System (ABS) and Route Relay Interlocking (RRI).

- Complete electrification and maintenance for multisystems traction by TRD and TRO departments for 1386 kms.

- Curves and gradients specifications matches up with the standards governed by Research Developments and Standards Organization (RDSO) Lucknow.

- Advancement of Gate Management Systems.

- Maximum number of high speed regions for the speed test.

- Dynamic and experienced "A" grade Loco Pilots trained at Udaipur Training Center.

This report describes all the technical integrities and working of advanced systems installed, that makes this route feasible and most preferred for the test trial of every new train.

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List of Tables and figures

Chapter 1
Introduction

Indian Railways is a state-owned railway company, responsible for rail transport in India. It is owned and operated by the Government of India through the Ministry of Railways. It is one of the world's largest railway networks comprising 115,000 km (71,000 mi) of track over a route of 67,312 km (41,826 mi) and 7,112 stations. In 2015-16, IR carried 8.101 billion passengers annually or more than 22 million passengers a day and 1.107 billion tons of freight in the year. In 2014–2015 Indian Railways had revenues of ₹1.709 trillion(US$25 billion) which consists of ₹1.118 trillion (US$17 billion) from freight and ₹451.26 billion (US$6.7 billion) from passengers tickets.

The Delhi-Mumbai Industrial Corridor Project is a pre-planned development project between India's capital Delhi to its financial hub, Mumbai. It is one of the largest infrastructure projects with an estimated investment of US$90 billion, and is planned as a hi-tech industrial zone spread across seven states, along the 1,500 km long Western Dedicated Freight Corridor which serves as its backbone.

Administration and management of Indian Railways is coupled with the Railway Board – a top executive body- under the Minister of Railways. Railway Board adopts powers of Central Government in respect of regulation, construction, maintenance and operation of the Railways.

Railway Board is headed by a Chairman, Financial Commissioner and 5 members each representing a major department of Indian Railways – Member Staff, Member Electrical, Member Mechanical, Member Traffic, Member Engineering. Financial Commissioner for Railways is having full powers of the Government of India to sanction Railway expenditure and is ex-officio Secretary to the Government of India in the Ministry of Railways in financial matters.

Railway Board is assisted by Director General/ Railway Health Services, by Director General/Railway Protection Force & Security and some advisors. Railway Board establishment is organized as functional directorates, each under an Executive Director who is responsible for the day to day technical and professional business of the Indian Railways as the per the policy guidelines laid out by the Board.

The entire secretariat is supervised by Secretary, Railway Board who is the co-ordinating officer between different directorates. Executive Directors are in Senior Administrative Grade(SAG), Directors/Joint Secretaries in Selection Grade, Join Directors/ Dy. Secretaries in Junior Administrative Grade(JAG) and Dy Directors/ Under Secretaries in Senior Scale. In 2003 Government of India through a notification made Railway Board a completely independent body which empowered it to take decision on projects without going through the Railway Ministry. Necessary checks have been made in the form of a body comprising of existing Board members, expenditure secretary and Secretary, Planning Commission.

This corridor mainly covers two sections Western division and Northern division. Every time when a new train such as high speed bullet train, Talgo etc is planned to launch or a project is proposed, this route is selected on the first go. Delhi – Mumbai corridor is an express route stretched over 1384 kms. This route has 6 major divisions. 4 zones and 229 major and minor railway stations.

Currently, the route is serving 76 passenger trains along with a rough estimate of 45 goods trains per week. The Delhi - Mumbai broad gauge line routed via Mathura Junction, Kota, Ratlam, Vadodara and Surat. Fully electrified and upgraded to the standard of high speed Rajadhani Express trains (130 kmph); this line serves as the principal route for movement of passengers and freight between Delhi and Mumbai.

To add to this, the railways follow a strict order of priority which relegates freight services to the lowest priority. This results in their slow and sluggish movement, frequent detentions for providing precedence to passenger services, high operating cost and poor productivity. The state of freight operations on the Indian Railways as a whole can be judged from the fact that goods trains achieve an average speed of only 25 kmph and a goods wagon is on run for merely 25% of the day.

Freight traffic is the major source of revenue for Indian Railways. Only one-third of the 13000 trains running daily on IR are freight trains, but it accounts 65% of total revenue of IR.
Railway Freight traffic is vital for economic and industrial progress of the country.
Raw materials from producing centers to factories and finished/semi-finished products from factories to consumption areas or ports for export has to be carried.
Eg: Coal reserves from Bengal and Bihar has to be transported to thermal and steel plants all over the country.

Indian railways had undergone many changes since its inception. They are listed below-

- Modernisation of 19,000 km of track.
- Strengthening of 11,250 bridges.
- Eliminating all Level crossings.
- Automatic signaling
- Cab signaling system .
- GSM based mobile train control system on A,B,C routes.
- Introduction of new generation locos – electric locos of 9,000 and 12,000 HP and High Power diesel locos of 5500 HP.
- Introduction high speed LHB coaches with 160/200 kmph.
- Introduction of high haul freight bogies.
- Modernisation of 100 major stations.
- Development of 34 multi modal logistic parks.
- To set up real time information system.
- Internet access at 342 railway stations.
- To attract private investment through PP models for freight terminals, high speed railway lines, leasing wagons, coach and loco manufacturing renewable energy generation etc.
- Mission mode approach for 15 focus areas – track and bridges, signaling, rolling stock, stations, dedicated freight corridors, High speed trains, review of existing and proposed projects, ICT, indigenous development, safety, funding and human recourses.
- Construction of Eastern and Western Freight Corridors.
- Construction of high speed Railway line between Ahmedabad and Mumbai with a speed of 300 kmph.
- Establish Indian Institute of Railway Research.

- To offer Graduate programme in Railway Technology in IITs and Railway Management in IIMs.
- Revamping accounting system on business lines.
- Empower Zonal Railways in investment decision with accountability for return on capital, transport output, safety and profitability.
- Total funding requirement for implementation of committee report will be Rs.8,22,671 crores for next five years. It proposes this from Rs. 2,50,000 crore from budgetary support, Rs. 2,01,805 crore from Internal generation and rest by leasing/borrowing, dividend rebate, road safety fund.

Chapter 2
Literature Review

- http://www.business-standard.com/article/economy-policy/talgo-trial-runs-conducted-without-safety-clearance-116082401554_1.html
  This article deals with the processes and the challenges that were faced when **TALGO** was made to run at a speed of about 180 kmph.

- http://timesofindia.indiatimes.com/india/Indias-fastest-train-completes-final-test-run-in-record-time/articleshow/47534278.cms

- http://www.financialexpress.com/india-news/talgo-indian-railways-trial-delhi-mumbai-rajdhani-interior-coach-preview/335486/
  This article focuses on the technical integrities of the coach and engine of **GATIMAAN EXPRESS** which made the train run at such a high speed.

- http://www.thehindu.com/news/cities/Delhi/delhiagra-semihigh-speed-train-to-be-named-gatimaan-express/article6493500.ece

- http://indianexpress.com/article/india/india-news-india/indias-fastest-train-shatabdi-express-gatimaan-express/
  This 2 articles describes the journey of **GATIMAAN EXPRESS** as it was able to beat the speed of Shatabdi express.

- http://timesofindia.indiatimes.com/india/Delhi-to-Agra-in-99-minutes-train-hits-160-kmph-on-trial-run/articleshow/37732774.cms
  This article describes the first trial of Bhopal Shatabdi express as it was the first one to achieve a speed of 160kmph.

Chapter 3
Objective of Study

The objective of this study to analyze and explore the Delhi – Mumbai corridor to be preferred as a route for test trial of every new train. It includes –

- The study of the track conditions laid for 1386 kms.
- To determine the factors on the basis of which the LOCO PILOTS of KOTA DIVISION are treated as the best.
- To describe the integrities of the SIGNAL and TELECOM department to record the least number of failures.

Chapter 4
Research Methodology

Research Gap-
This research is being carried out because many previous records state that this is the preferred route but why this the only choice left, is the point of importance. This research will share the parameters of study to provide some successful results.

Research Methodology –
The research methodology used in this project is **Exploratory Research** where the in-depth study of the Delhi-Mumbai railway track will be done, to find out the parameters on the basis of which every new train is made to run on this route for the first test trial.

Research Design –
The research design is descriptive in nature as each every component will be focused because of which this route is preferred.

Chapter 5
Analysis

Data collection from primary sources and study of technicalities coupled with observational study of operations taking place in Delhi- Mumbai railway route provides me with the information for the preference of this route for test trial.

- Maximum number of advanced signaling systems installed till date, that includes Automatic Block System (ABS) and Route Relay Interlocking (RRI).
- Complete electrification and maintenance for multisystems traction by TRD and TRO departments for 1386 kms.
- Curves and gradients specifications matches up with the standards governed by Research Developments and Standards Organization (RDSO) Lucknow.
- Advancement of Gate Management Systems.
- Maximum number of high speed regions for the speed test.
- Dynamic and experienced “A” grade Loco Pilots trained at Udaipur Training Center.

1. Study of the advanced signaling system implemented, to record least number of failures.

Major railway accidents takes place subject to the signal failures. This route has recorded least number of failures because of the advancement of the signalling systems installed.
Two major technologies that implemented are-

1. Automatic Block Signalling System.
2. Route Relay Interlocking System.

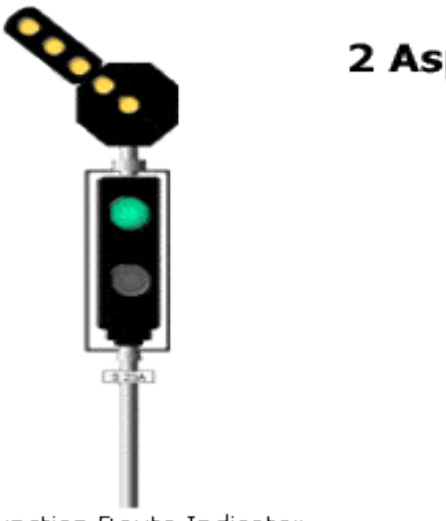
This is one of the major reason that the installations of these systems is highest in this region across the country which allows the test trial of any new train at a throttling speed without the risk of accidents.

To ensure a train shall proceed safely from one station to other there are various systems adopted in Indian Railways. The system adoption depends upon the density of traffic, more the number of trains the more costly the system adopted. Among this system, any one is followed for running of trains between two stations. These systems are:

1. ABSOLUTE BLOCK SYSTEM
2. AUTOMATIC BLOCK STSTEM

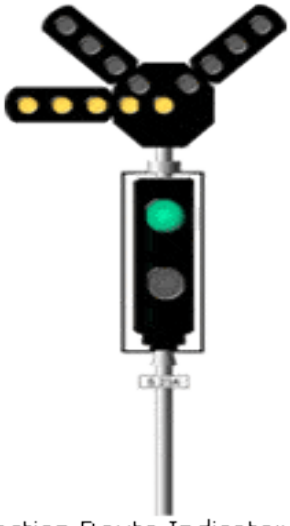
This major railway route between Delhi and Mumbai has the automatic block system which is monitored from the divisional headquarters of different zones.

The system controls the movement of trains between the blocks using automatic signals. ABS operation is designed to allow trains operating in the same direction to follow each other in a safe manner without risk of rear end collision. The introduction of ABS helped railways in reducing costs and increased their capacity. Older manual block systems required human operators.



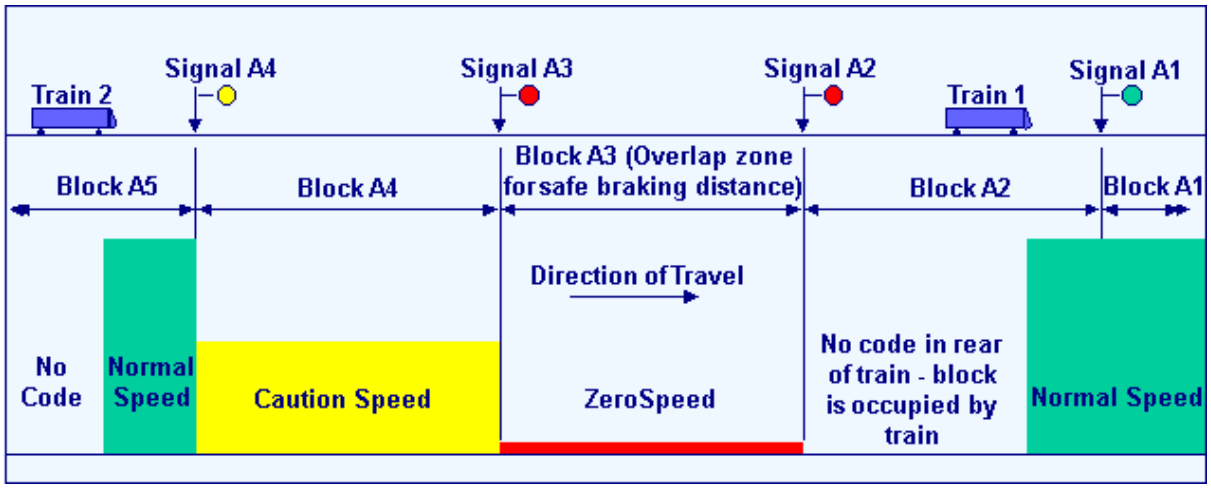
Junction Route Indicator,
choosing one among two routes.
The indication is for the tracks to the left

2 Aspect CL



Junction Route Indicator,
choosing one among four routes.
The indication is for the tracks to the left

IR uses several kinds of signals. Apart from 2 CL and 3CL there is MACL system. This is Multiple-aspect colour-light signalling and adds another yellow light to the 3-aspect system. The additional yellow light can be placed above the green lamp in a 4-lamp signal. In this case, the lower yellow light alone is lit to show the caution indication, and both yellow lights are lit to show the attention indication. Alternatively, a different kind of 3-lamp signal may be used (e.g., for distant signals), where the top and bottom lights are yellow and the middle one is green. Again, both yellow lights light up to indicate the attention indication.

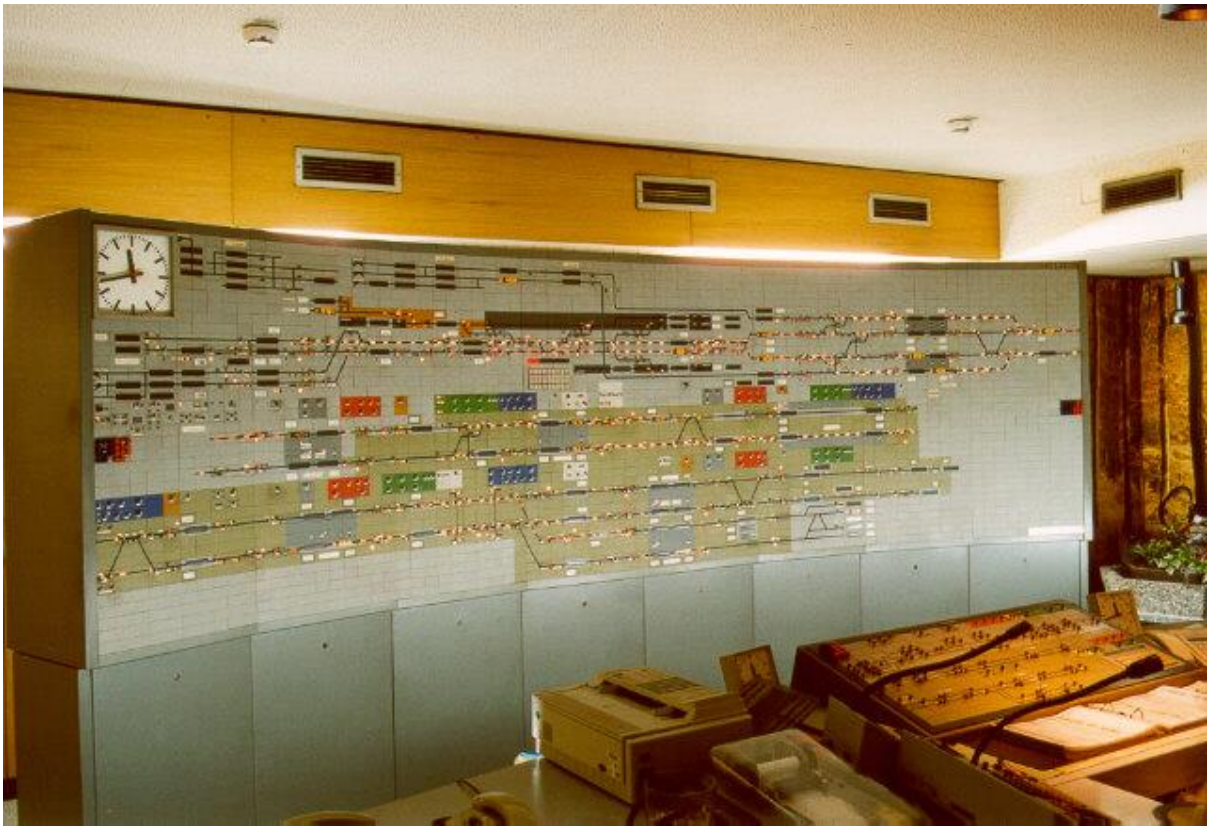


In Automatic Block System, every signal convey the aspect of next signal to the driver. For example, if a signal is ONE-YELLOW, it provides the awareness to the driver that the next signal is RED. If it is DOUBLE-YELLOW, then next signal is DOUBLE-YELLOW or ONE-YELLOW, and if it is GREEN, then next signal is either GREEN or DOUBLE-YELLOW.

Each signal provides the information to the driver the aspect of next signals that helps the driver to run the train at more speed and helps him to control the speed when required.

2. Route Relay Interlocking-

Route Relay Interlocking (RRI) is the system implied in busy junctions that need to handle high counts of train movements. In this, an entire route around the station can be selected and all the inter-related points and signals along the route can be set at once by a switch for receiving, holding, blocking, or dispatching trains.

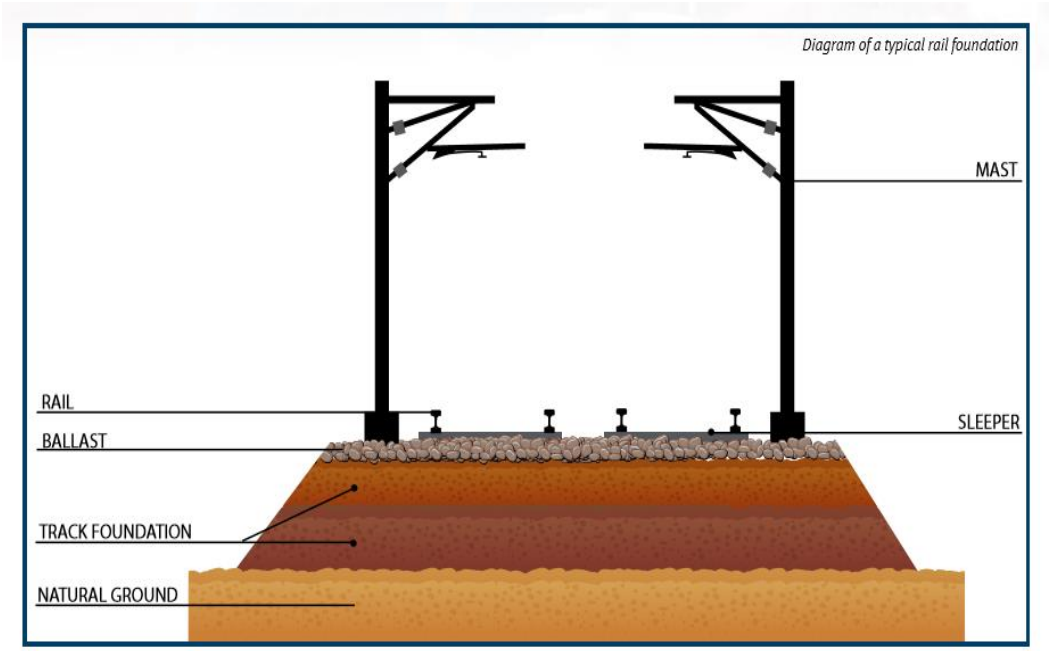


3. Features and specifications of the rail line-

This segment provides the study of the rails and associated factors that executes smooth and fast trial for new trains.
The factors are-

1. Rail line foundation.
2. Maximum speed limit.
3. Curves and gradients.
4. Traffic Density.

- **Rail Foundation**



Rail construction is completed over six major stages which include:

Stage one - Embankment and bridge construction – Much of the rail alignment is built on earth embankment which forms the rail foundation. Bridges and culverts are needed to carry the rail line over prevailing roads, water courses and station facilities.

Stage two - Laying concrete sleepers – concrete rail sleepers are placed as a support for the rail. Sleepers are placed by a front end loader with a sleeper 'grab' carrier that picks up sleepers and place them in the configuration for the rail tracks to be attached.

Stage three - Laying the rail tracks – the rail is placed on top of the sleepers and clipped into place by a track mountable machine. The rail is then welded using 'flash butt-welding' which melts two rail pieces together forming a seamless rail track.

Stage four - Ballast – ballast is a kind of rock used for supporting the sleepers and rail track, keeping them in place while trains run. A ballast machine rides the new tracks and places the ballast over the sleepers and between the tracks.

Stage five - Settling the rail – a track mountable machine called a tamping machine rides along the new track, lifting the tracks, to then vibrate the ballast into place. It then sets the track into its final position. This method is repeated numerous times to ensure the rail line settles and is ready for operation.

Stage six - Installing over-head equipment – masts are installed along the rail alignment to support the equipment which provides electricity to operate trains. Signalling structures are also installed along the rail route.

- **Speed Limit-**

Major Junctions	Speed	Elevations
NEW DELHI	130 KMPH	218 m
MATHURA	160 KMPH	250 m
KOTA	120 KMPH	318 m
RATLAM	140 KMPH	430 m
VADODARA	120 KMPH	250 m
SURAT	130 KMPH	120 m
MUMBAI	130 KMPH	50 m

- **Zone Details-**

Divisional Headquarter	Zone	Zonal headqaurter
New Delhi	Northern Railway	New Delhi
Mathura	North Central Railway	Allahabad
Kota	West Central Railway	Jabalpur
Ratlam	Western Railway	Mumbai Central
Vadodara	Western Railway	Mumbai Central
Surat–Bhavnagar Division	Western Railway	Mumbai Central
Mumbai Central	Western Railway	Mumbai Central

The minimum railway curve radius is the shortest design radius for railway tracks under a particular set of conditions. It has an important bearing on constructions costs and operating costs and, in combination with super-elevation (difference in elevation of the two rails) in the case of train tracks, determines the maximum safe speed of a curve. Minimum radius of curve is one parameter in the design of railway vehicles.

- **Track categories-**

Track Type	Radii
Type 1	3400-10000 m
Type 2	1800-8000 m
Type 3	1500-6000 m
Type 4	800-2000 m

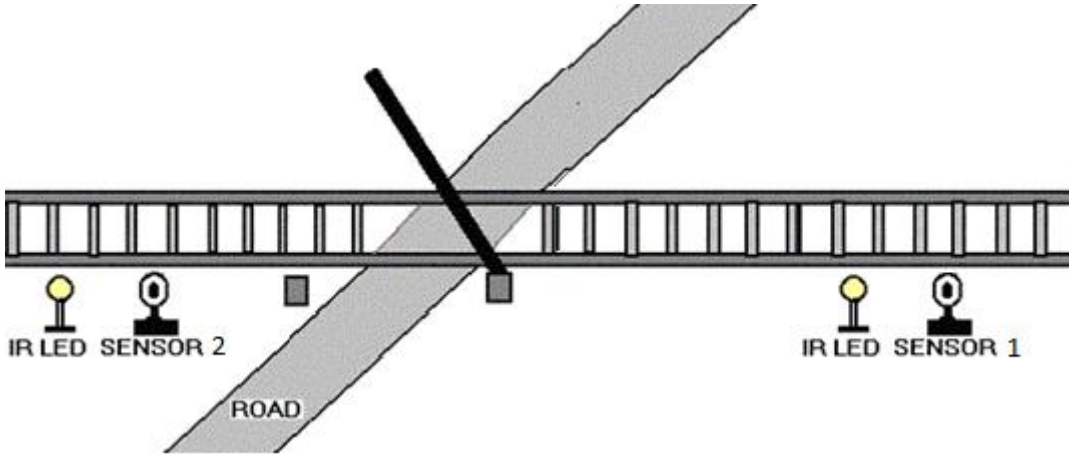
Indian Railways follows the standards governed by RDSO, Lucknow and it follows track type - 4. The curve radii for this type of track is mentioned in table below.

Curves in same direction	Type	Curves in opposite direction
100 m	1	80 m
70 m	2	65 m
70 m	3	65 m
50 m	4	50 m

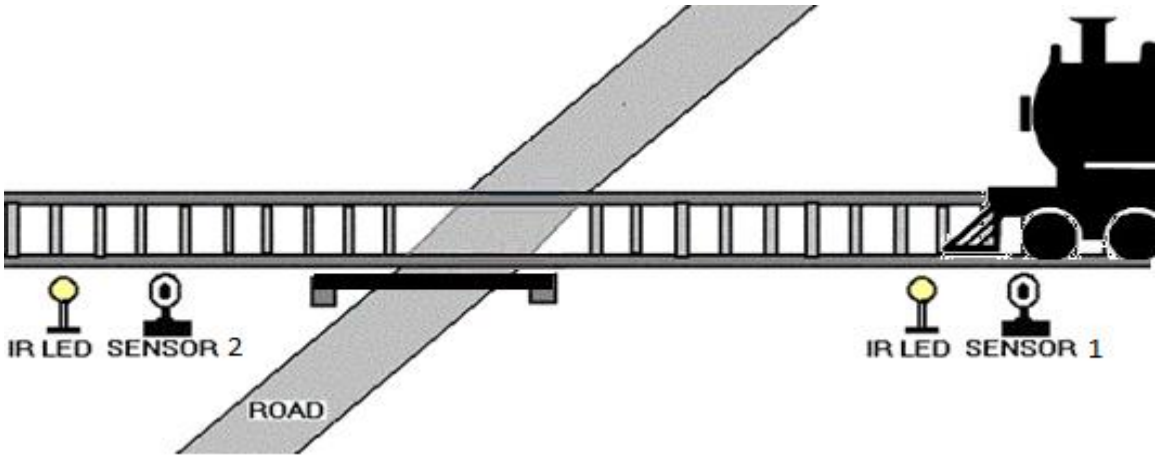
- **Multisystems Traction System**
  Because of the variety of railway electrification systems, which vary within a country, trains have to pass from one system to another. One way to accomplish this is by changing locomotives at the switching stations. These stations have overhead wires that can be switched from one voltage to another and so the train arrives with one locomotive and then departs with another one attached. Often, this is inconvenient and time-consuming, another way is multi-system locomotives that can operate under several different voltages and current types.

- **Automatic Railway Gate Controller with High Speed Alerting System**
  The working of the project is very simple and is explained here.

  Practically, the two sensors are placed at left and right side of the railway gate. The distance between the two sensors is dependent on the length of the train. In general, let us consider the longest train in that route.
  Now we'll see how this circuit actually works in real time. In this image, we can see the real time representation of this project

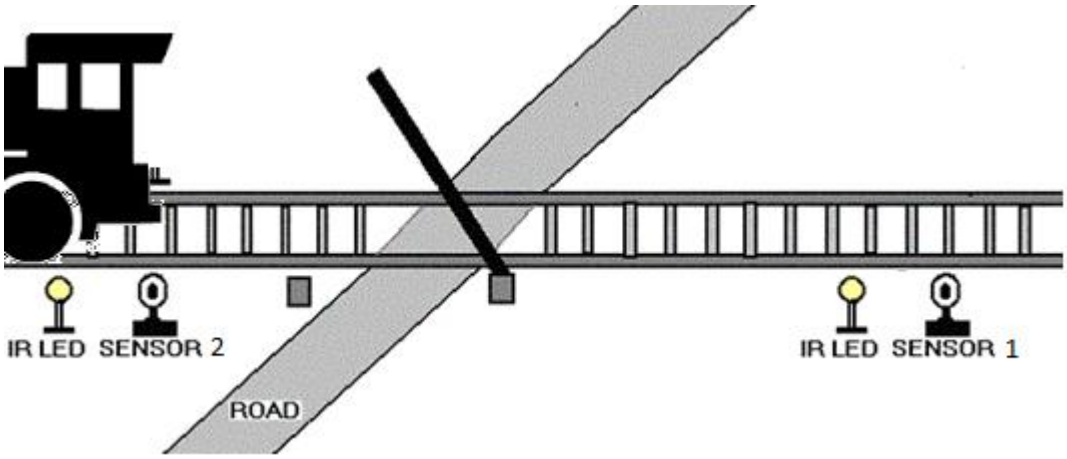


If the sensor 1 detects the arrival of the train, microcontroller starts the motor with the help of motor driver in order to close the gate.



The gate remains closed as the train passes the crossing.

When the train crosses the gate and reaches second sensor, it detects the train and the microcontroller will open the gate.



Chapter 6
Conclusion

1) The signalling systems explained above i.e. Route Relay Interlocking and Automatic Block Signalling System has the maximum number of installations on this route and hence it allows the train to catch as much speed it can, without risk of accident.

2) Curves and gradients within this 1386 km route approximately matches the regulations and standards of RDSO, Lucknow. Hence, test trial on this route allows the train for the inaugural run on any other route throughout the country.

3) Maximum divisional headquarters on this route allows the train to cross the limit of 140 KMPH, which leads to successful speed test.

4) The Loco Pilots of Kota division are trained in the Udaipur training center, which has a record of providing the best training in the country.