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Design of railway alignment: conventional and modern method

JIGNESH PADAYA [1], JAYESH JUREMALANI [2], INDRA PRAKASH [3]

[1]M.Tech -Transportation Engineering Student, Civil Engineering Department, Faculty of Engineering and Technology, Parul University
[2]Assistant Professor, Civil Engineering Department, Faculty of Engineering and Technology, Parul University
[3]Faculty, BISAG, Gandhinagar

Abstract - Planning of a new railway alignment can be expensive and time consuming process by conventional methods. There are many issues that need to be addressed. The problem is find out a that where the alignment is influenced by the location properties like geographical, topographical, soil and slope variations and lad uses too if we find all this by a conventional method then it can take huge time in this tedious process and take huge expenses too so overcome too this conventional method we want to introduce some Morden techniques which is more time resistant, less expensive and accurate too.

A GIS is a system of hardware and software that is used to capture, store, analyse, manage and distribute spatial data, GIS is a vast array of spatial analysis tools that can be used to perform tasks, such as overlay and proximity analysis. The conventional manual methods were tedious, time taking, lengthy and expensive.in this paper we are discriminating the conventional method and modern methods. The factors that we are concern about it are mainly land use, slope, drainage and soil. The based on GIS thematic maps and network analysis in arc GIS we can get best route out of various alternate alignment based on near services area, less stop, river crossings, and where more in habitants lived etc.

***Key Words*: Railway Alignment, GIS, Network Analysis**

1. INTRODUCTION OF GIS

A GIS is a system of hardware and software that is used to capture, store, analyze, manage, and distribute spatial data. GIS has a vast array of spatial analysis tools that can be used to perform tasks, such as overlay and proximity analysis.
GIS allows spatial information to be attributed with fields describing spatial features, such as a river, having the attribute name. Spatial datasets can be stored in a structured and logical manner within a GIS database.
The spatial data and associated attribute information can be used to perform
Complex analysis. GIS includes mapping tools for high quality cartographic output and distribution tools such as web-based mapping tools. Printing basic maps
Data used within the viewer was displayed from the working and reference Geodatabases to reflect updates and edits made to the Geodatabases.

1.1 GIS System parts

The GIS system used with the Inland Rail project consisted of six main components:
• GIS viewer – software application used to view spatial data
• Geodatabase – spatial data repository
• Maps – generated for reports
• Quantities – summary information for each alignment
•Scripts – programming tools used to automate the generation of
Quantities
• modeling tools – tools used for predicting an outcome based upon a set of rules and procedures.

1.2 Analyze GIS Data

A simple and intuitive interface was established for the design teams to access current spatial information for the entire study area. A simple GIS viewer was supplied to the study teams for use as a decision support tool.

The viewer had the capability to view, explore and print GIS data.
This viewer enabled users to perform basic GIS tasks including:
• measuring distance and area
• querying GIS data
• searching and identifying features and generating basic maps

Data used within the viewer was displayed from the working and reference Geodatabases to reflect updates and edits made to the Geodatabases.

2. Conventional method

In the manual method how we can get generate railway alignment by the following various surveys which consume a huge time and money and sources too.

In order to have a proper and satisfactory new route, various surveys are carried out:

1. ***Reconnaissance Survey***
2. ***Preliminary Survey***
3. ***Location Survey***

2.1 Reconnaissance Survey:

It is the first engineering survey. It is a rough and visual identification about location and check map data to live location.

➢ **Importance of reconnaissance survey:**

- A number of possible alternative routes between two points can be worked out.
- It is not a science but it is an art.
- Personal factors play an important role in the reconnaissance survey.
- The successful conduct entirely depends on the personal qualities of the engineer such as his training and experience, his capacity of observation and interpretation .

➢ **Information gathered in reconnaissance survey:**

- A reconnaissance survey can divided into two parts :

1. Traffic survey
2. Engineering survey

➢ **Traffic survey:**

- This consists of collection of the information regarding the following:
- The general scenario of the location.
- Information of the local industries .
- The general information of agriculture , crop types and any mineral sources are there or not.
- The probable scenario of traffic to divert or used by by new railway alignment.
- General study of existing transportation facilities and which mode is mostly used.
- Planning forecasting of economic and social growth of area that would be covered by this new railway line.

➢ **Engineering survey:**

This consists of collection of information regarding the following:

- Physical features of the country;
- The surface of the ground;
- Types of soil and its classification
- Streams and rivers ,those which will cross the proposed railway line;
- Positions of valleys, mountains and rivers.
- Availability of materials and man power and transportation facilities of material for use during construction.

➢ **Factors need to concern during reconnaissance survey:**

Following factors should be kept in view; otherwise, the results are likely to be misguiding:

a. **Area:** A reconnaissance survey should be carried out for the whole area not for particular site.

b. **Existing highways :** The survey should not in under favor of road condition cause roads and railways have different criteria's.

c. **beginning route:** The engineer should not reject a specific route because it start by difficulties.

d. **Assumptions:** The assumptions should be attempt carefully cause it is not always correct.

e. **Survey of alignment**

f. **Visual identification:** visual identification and its results area vary with person cause its own idea and own perception so some common mistake are not attempt by engineer like counting wrong length and soil type and bearing capacity of soil too.

g. **estimate:** The probable estimate or lumsump must be carried out for alignment.

2.2 Preliminary Survey:

➢ **Object of preliminary survey**

- To conduct the survey work along the alternative routes found out by reconnaissance survey and;
- To determine with greater accuracy the cost of the railway line along these alternative routes.

➢ **Importance of preliminary survey**

- It decides the final route and recommends only one particular route in preference to other alternative routes
- Thus, should be carried out with great precision as on it depends the alignment of the final route.

2.3 Location Survey:

➢ **Object of location survey**

- To carry out the detailed survey of the selected route to find whether it is economical and feasible? From preliminary surveys data.

- It the center-line of the alignment track to be laid.
- As soon as the location survey is completed, the construction work is started.

➢ **Work of location survey**

It is carried out in two stages:

1. **Paper location**

- The final route selected is put up on paper and details such as gradient, curves, contours, etc. are worked out;
- All the working drawings are prepared, even of minor structures such as signal cabins.
- After the paper location is over, the field work is started and the centre-line of the track is fixed.

2. Field location:

- The field location transfers paper location on the ground.
- It gives all the requirements of the construction engineer such as bench-marks, levels, measurements, etc.
- The centre-line pegs are driven at every 300 meters along the centre-line of the track.
- Every change of direction, the beginning and end of the curve and also the intersecting points are clearly marked.
- In addition to the fixing up of the centre-line of the track, the centre-lines of bridges, culverts, tunnels, station buildings, signal cabins, etc. should also be fixed.

This how we can get fixed railway alignment by conventional method

3. Modern methods of designing of railway alignment

3.1 GIS study

This how we can generate various thematic maps for any particular area

Figure 1 shows a how GIS work in sequential manner.

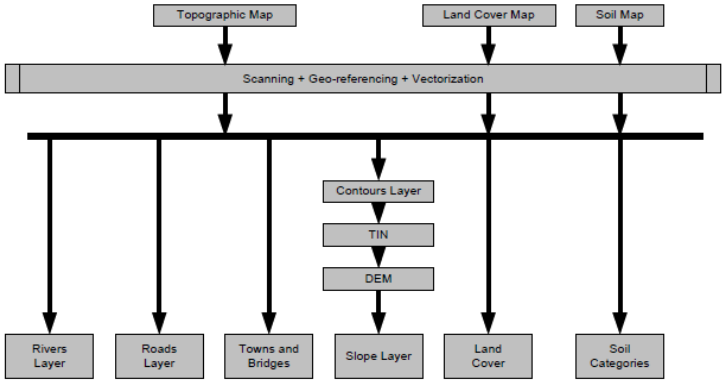

Figure 1 layout of GIS study

3.2 PLANNING OF PROPOSED RAILWAY ALIGNMENT WITH THE HELP BY GENERTAING THEMEATIC MAPS

An ideal railway route should fulfill the following basic requirements (Saxena and Arora, 1981):

- **Safety**. The track should be aligned so as to ensure that goods and passengers are transported with minimal chances of accidents and derailment.
- **Aesthetic aspect.** The railway line should be constructed to provide a memorable and pleasant railway journey to train passengers by keeping the track within beautiful natural surroundings.
- **Economy.** The track should be as short and direct as possible with minimal construction, maintenance and operating costs from an engineering perspective.
- **Linking of centers**. A new railway line should connect and inter link important town centers and cities so as to provide the necessary transportation services.

In view of the above alignment requirements, minimal evaluation factors and constraints are identified as follows:

❖ **Slope Factor**

The slope of terrain is considered very critical in railway routing as it directly influences the construction and operating costs. The higher the slope, the higher the costs and vice-versa

❖ **Soil Factor**

Soils that are susceptible to erosion and unconsolidated materials cost more to construct a railway line on. Poorly drained soils are also undesirable for railway line construction. It is therefore comparatively cheaper to construct a railway on ground with soil that is unconsolidated and well drained. Rocky grounds should be avoided as they increase construction costs due to heavy excavation of rocks.

❖ **Proximity to Rivers Factor**

Railways should be constructed as far away from rivers as possible because of the following
Reasons:

- To avoid constructing many bridges that may arise because of the meandering of the rivers.
- Rivers have the propensity to flood and this could cause damage to the railway line.
- Rivers often change their course and this could cause rerouting of the railway which is a very expensive affair.

❖ **Important Towns and Cities constraint**

Town centers form important obligatory nodes and the track should pass through important town centers for economic, social and political reasons. Quarries and human habitats are found in the neighborhood of town centers and therefore construction materials and labour are easily available.

Even though a town centre may neither be economically nor industrially active, socio-political considerations may still constrain the construction of a railway line through it.

❖ **Areas the Route must not pass through constraint**

These are areas in which the railway track must be completely avoided since they result in very high construction and operation costs. They also pose a danger to the safety in operations of the rail vehicles. Such undesirable areas include:

- Areas with ground slopes greater than 4.5%.
- Areas within 100m of the centerlines of rivers.
- Flood plains or swampy grounds.
- Areas within 50m of the centers of existing roads (to avoid accidents).

3.3 Multi-Criteria Evaluation

A MCE technique is a multi-criteria method which combines different data of different variable in to one indexed form and make fair decision with more alternatives in consistent and precise way. The main use of it is a rather than doing differently calculation for different parameter we can do it in to a one way with combination of different variables in to one indexed form and by MCE and AHP method.

3.4 The importance of network analysis in GIS

Networks are all around us. Roads, railways, cables, pipelines, streams, arteries, metro and etc.

Networks are used to transport freight, people, goods and communication and water too, even network of retail markets to home and from retail markets to sources, networks are everywhere.

Network analysis enables you to solve problems, such as Finding the most efficient travel route, generating travel Directions, finding the closest facility, defining service areas Based on travel time, travel cost and traffic too.

Figure 2 is showing the circumstances of line passing.

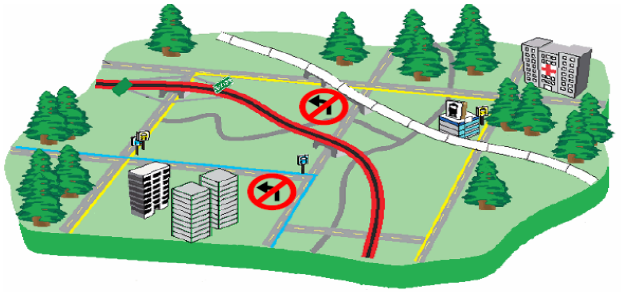

Figure 2 image of alignment passing through various aspects

➢ **What is network analysis arc GIS used for design of railway alignment**

- Finding the best route in order of consume less time and money through passing of various stops.
- Finding the closest facility in order to minimize travel cost between incidents and multiple facilities.
- Driving direction in order to generated closest facility and consumes less time path.
- Finding and origin and cost o-d matrix.
- On basis of all this thematic maps and generated data in network analysis we can generate an alignment which is best and accurate comparatively on conventional methods.

3.4 Conclusion

Conventional methods used to generate quantities for projects would involve manual identification and classification of quantities from hard copy maps and field verification. For example, to identify and evaluate water and road crossings, would traditionally involve:

• overlaying the route sections on topographic base maps

• Visual identification and classification of potential and existing road and water crossings, stops, drainage, water depth, soil identification and is bearing capacity, topography of area etc.

for ex- Manual data entry of road crossings, and identification of soil and slope data and put in to into a spreadsheet for further analysis by experts, and supervisors and surveyor and whole team carry out this process for the More than 10 roads, water crossings and drainage, different soil types and slopes variations this all within the project area would amount more than 30 days for a single alignment and it is huge time taking process and expensive too.

On other hand if we can do all work by GIS and network analysis arc gis , after collection data and simultaneously generating thematic maps and verified data by superimposition of arc gis spatial data and geo database in to a satellite images it would take 10 days to identify, classify and manually enter each crossing for single alignment. Identification of other quantities such as land use, track upgrade, ground condition, terrain and flooding would increase this estimated time significantly.

These tasks could not be undertaken within the budget and the year time frame for this component of the project. Overall we have showed differences between conventional and annual method for design of railway alignment. So overall the best method is to do design of railway alignment or highway or pipeline layout GIS is a comparatively less expensive, time saver and accurate than conventional method.

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