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Best Feasible Transportation Route Analysis for Delivering Ready Mixed Concrete (RMC) - A Geographic Information System (GIS) Approach

Shobhana Jadhav[1], Karthik Nagarajan[2], Raju Narwade[3]

[1]*PG Student, Dept. of Civil Engineering, Pillai HOC College of Engineering and Technology, Rasayani, Maharashtra, India*

[2, 3]*Associate Professor, Dept. of Civil Engineering, Pillai HOC College of Engineering and Technology, Rasayani, Maharashtra, India*

Abstract - *Globally for future cities a huge demand for Ready Mixed Concrete (RMC) in construction is required for fast growing infrastructure industry. From past few decades, research shows that, to fulfil the client's demand for RMC, along with concrete properties, its delay in transportation affect the project economy. Hence a pre-planned well effective and efficient route analysis is the client's requirement. To overcome these drawbacks, the objective of this research is to identify the best feasible route in Mumbai region to optimize the RMC travel time. To achieve this target, data collection and simulation of various routes from RMC plant to construction site is carried out with the application of Geographic Information System (GIS) using toposheet, satellite image, shapefiles etc. This research gives an effective solution in a satellite view format and in-depth analysis to identify best possible route, considering various RMC delay causing parameters*

Key Words: Geographic Information System, Ready mixed concrete, Factors affecting, Simulation, Road Network Analysis

1. INTRODUCTION

Globally in construction industry Ready Mixed Concrete (RMC) is most demanding building materials. RMC is a mixture of Portland cement, water and aggregates [1]. This concrete is manufactured as per customers demand and delivered to construction site by transit truck in workable condition. RMC is preferred to onsite concrete mixing because of the speedy work and precision of the mixture. The first ready-mix factory was built in the 1930s, but then the actual industry starts to develop expressively until the 1960s, and it has sustained to grow since that time [2]. Both the public and the private sectors in India have been investing huge amounts of money in construction. The growth of RMC in any country has a direct co-relation with the growth of its cement industry and consumption of cement by the construction industry.

The demand for higher speed of construction and large volume of concrete, especially for residential apartments, commercial complexes, Bridges, highways, roads, aeronautics etc. in metropolitan and other urban cities of India, demanded implementation of mechanized and semi-mechanized techniques of construction. This was advantageous for the development of RMC. RMC gives uniform and good quality concrete, higher durability, faster construction work, it reduces space required for storage of material as well as wastage of raw materials [10]. Enhancing delivery service of concrete from RMC in cities like Mumbai is major concern. Delivery of concrete within time is more critical, who are feeling impelled to find possible solution. Factors such as traffic density and time remain highly influential in determining total delivery cost. Moreover, delay in fresh concrete delivery affect concrete properties. Onsite concrete scheduling required casting rate, while scheduling and concrete delivery from different batching plant to different construction site, hampered operational efficiency due to operating cost and variable distance. This always critical for ready mix companies and leads to decisions that are not efficient or profitable [4]. There are two types of RMC request from construction site, first the construction site placed order well in advanced and another type is last minute order from construction site, hence actual deliveries at site usually come closer in time. The request of RMC deliveries from different construction site sometimes come close in time. As a consequence, RMC plant become busy at certain working hours [5]. For the study area peak hours of RMC deliveries are around 5am to 7am and 10.30am to 5 am. In general RMC concrete usually needs cast within 1.5 hour after being produced, it is very tough task to RMC plant manager to determine the RMC delivering schedule quickly which satisfied the requirements of client at different construction site [6]. Mobility in construction achieve by speedy transportation from RMC. The main objective of this research is to identify the factor that affect in the selection of the route for RMC in terms of time and cost. Study aims to solve the problem of finding fastest route between source to destination.

1.1 Literature review

Sakchai Srichandum et al. used Bee colony method to get higher quality solution efficiency and faster time to dispatch RMC truck to site [3].

Chung -wei feng et al. find the best dispatching schedule which reduced RMC dispatching time using generic

algorithm. Also analyzed the factor affect during dispatching [4].

O. Al-Araidaha et al. based on type of mix and site information he used an activity-based costing (ABC) model for transportation production and costing of RMC [1]. Ashish H. Makwana et al. suggested a Hierarchy Process for selection RMC for construction site [8].

Ahmad Khartabil et al. focuses on real and daily problem of the concurrent supply of concrete from different locations to construction site while achieving the project's requirements and minimizing the company's operation cost [9].

Sławomir Biruk et al. carried out detailed study about importance of RMC. He worked on various factors affecting production planning and truck allocation and assessed alternate strategies for customer demand and delivery pattern [7].

Ladda Tanwanichkul et al. In this paper GIS software like ArcGIS is used to find time, speed and distance. Two techniques were used to improve the efficiency of the entire RMC process. Production scheduling techniques were used for dispatching of RMC concrete on site. For RMC scheduling Earliest Due Date technique (EDD) and First-Come First-Served technique (FCFS) were used which providing more accuracy and precision in RMC process [7].

Sohail Afzal et al. reviewed various factors like time split, delays, route optimization, distance, traffic condition, late deliveries which affect RMC delivery and also focused on driver time which is newly introduced [2].

2. DATA COLLECTION

With the increasing population of Mumbai region infrastructure plays a crucial role in the development of construction industry. The demand of concrete for future cities is huge, to fulfil this demand more RMC plant come into exits. In this research, work is proposed Mumbai region of Maharashtra state. Fig. 1 shows a location of RMC plant (Source) in study area and construction site (destination). The RMC plant are located in Sion (RMC1), Malad (RMC2) and Bhandup (RMC3) and Construction site is located in Marol, Mumbai. It is residential project with 22 storied in each building. Detailed about RMC plant shows in Table 1. For the study purpose upper requirement of the concrete is taken to fulfil demand. Toposheet with number NE 43-1 taken from survey of India (http://www.lib.utexas.edu/maps/ams/india/) which is used for georeferencing. Shapefile of Maharashtra is used to get road network of study area (Source-https://mapcruzin.com/free-maharashtra-country-city-place-gis-shapefiles.htm). QGIS desktop 2.18.27 were used.

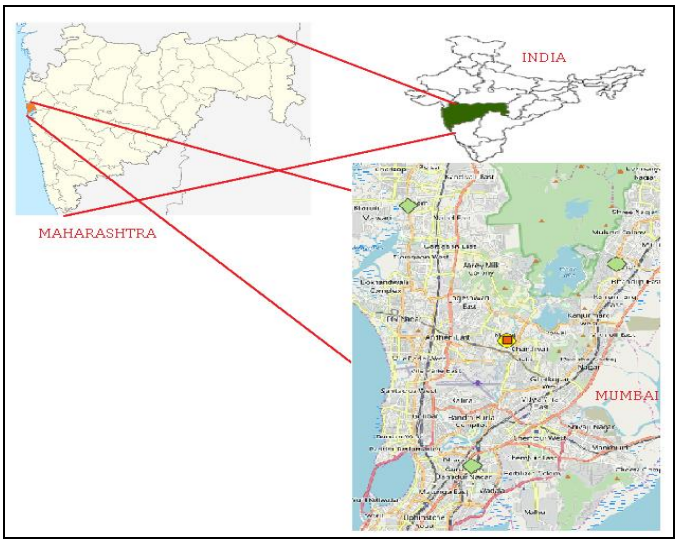


Fig.1: Geographical boundary of Study Area

Detailed about RMC collected from various RMC plant shows in Table.1

Table.1: Detailed about RMC plant

RMC Plant	Capacity (m^3)	Distance from construction site (kms.)	Time required to reach (min)
Sion	75	10.1	40
Malad	75	12.8	39
Bhandup	75	12	41

2.1 Objectives

Following objectives were set based on the literature survey conducted

- To identify best feasible route using GIS approach.
- Effective and efficient deliveries of concrete from RMC to construction site.

2.2 Criteria for Path selection

The road network analysis shows the number of routs for delivery of concrete. Following criteria are considered

- The site should be within 20 kms.
- Travel time should be between ½ hr. to 2 hr.
- Time between 5 am to 5 pm without assuming no entry criteria for RMC truck.
- Average daily demand of concrete 150m^3

3. METHODOLOGY

The methodology for feasible route analysis is shown in Fig.2. As per the above objective the data required for analysis such as latitude and longitude of RMC plant and construction site, capacity, distance from site, detailed about

site were collected. The average daily demand of concrete is considered as 150m³.

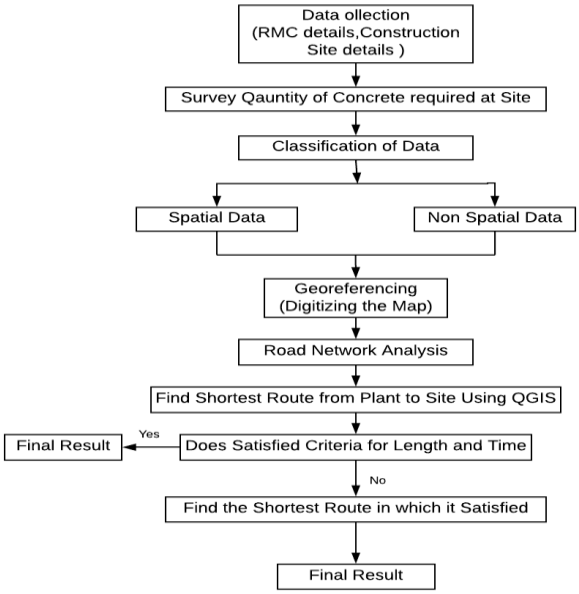
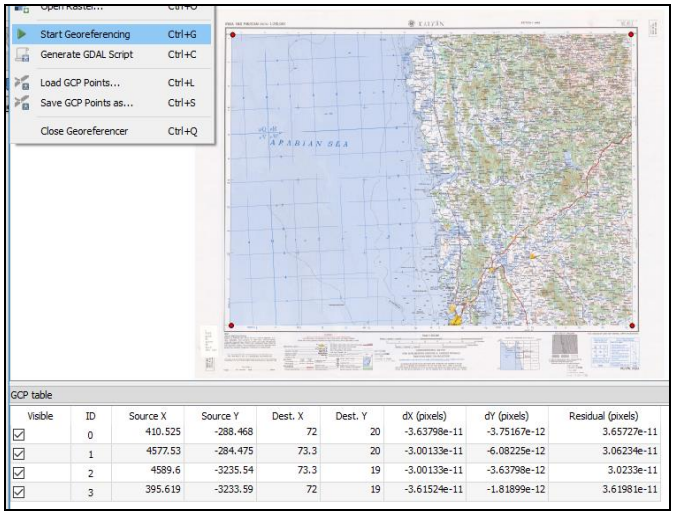


Fig.2: Flow Chart

Georeferencing is done for said area by overlaying spatial and non-spatial data in QGIS shown in Fig.3 in which assigning real-world coordinates to each pixel of the raster. 'Georeferencer GDAL' plugin is installed for georeferencing. Corner points of the map shows the coordinate after georeferencing. Spatial data such as road network which is included in base map created in shapefile layer. The non-spatial data consist of attributes that are complementary and related to spatial data. Based on the co ordinate point taken from google earth the location of RMC plant and site are mapped accurately on map and created a shapefile layer shows in Fig 4.



. **Fig.3:** Georeferencing

Fig.4: shapefile of study area
(Source- https://mapcruzin.com/free-maharashtra-country-city-place-gis-shapefiles.htm)

After the digitization detailed road network is carried out to get all possible route from RMC to construction site shown in Fig.5.

Fig.5: Road network analysis

Clicking on road graph plugin a shortest route panel is opened on left site shown in Fig.6. System will generate shortest route map based on the road length.

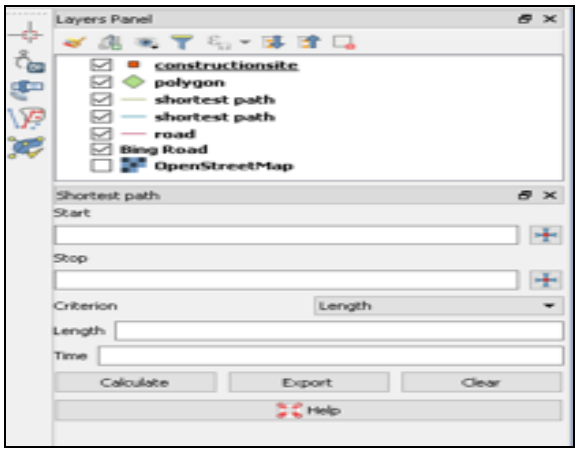


Fig.6: Road Graph Panel

4. RESULT

System generated shortest route map based on the road length shown in Fig 7,8,9. The line shows the shortest route from RMC plant to construction site for the proposed study area.

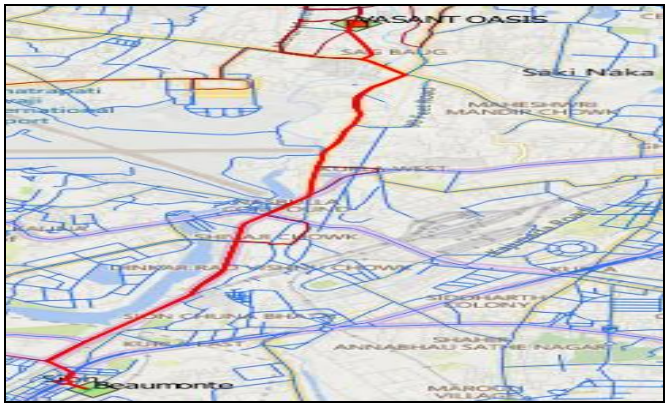


Fig.7: Shortest route Sion RMC Plant to construction site

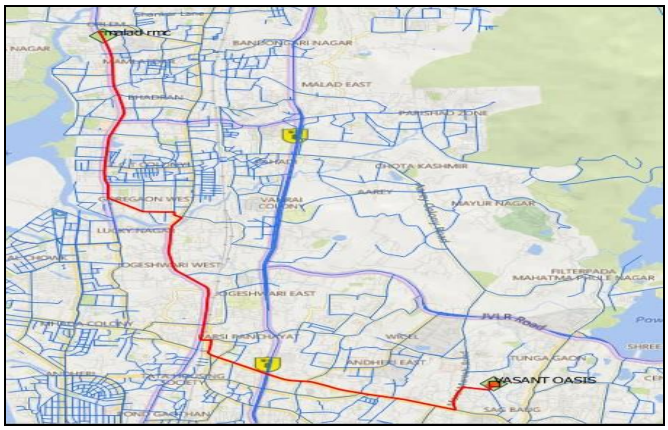


Fig.8: Shortest route from Malad RMC Plant to construction site

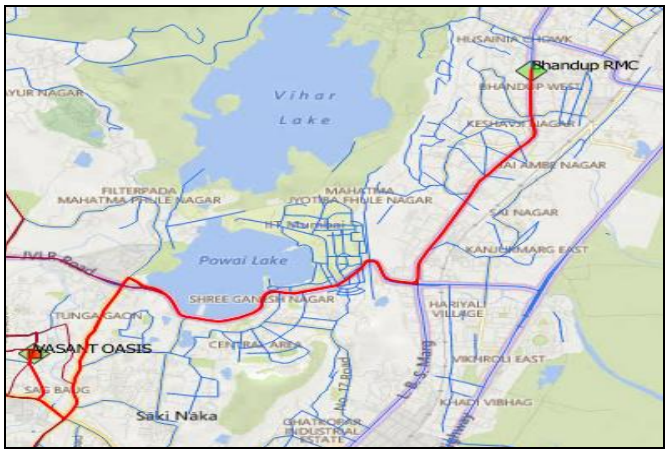


Fig.9: Shortest route Bhandup RMC Plant to construction site

5. CONCLUSION

This study finds the shortest possible route from RMC at Sion, Malad and Bhandup to construction site at Marol. QGIS Software is used to digitize the map into the road network. Network analysis for all possible network is carried out. This will help RMC supplier while selecting route for delivery in the given area. The criteria decided for the delivering concrete from RMC to site is satisfied.

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BIOGRAPHIES

Ms. Shobhana Jadhav
Bachelor of Engineering degree in Civil Engineering from the DR Babasaheb Ambedkar Technological University lonere, Raigad in 2013. Master`s Degree in Construction Engineering and Management from Pillai HOC College of Engineering and Technology Rasayani.

Mr. Karthik Nagarajan
Associate Professor, (PG & UG Level), Civil Engineering Department, Pillai HOC College of Engineering & Technology, Rasayani. Pursing Ph.D. in Water Resources with application of Remote sensing and GIS. Network Coordinator of IIRS, ISRO Outreach Centre, PHCET Areas of Interest are Remote Sensing, GIS, Water resources, Structural Engineering etc.

Mr. Raju Narwade
Associate Professor, Department of Civil Engineering, Pillai HOC College of Engineering and Technology. PhD (Pursuing) Mumbai University Departmental advisor of Students' Chapter IEI (India), ASTR Areas of Interest are Structural Engineering, Hydrology, Remote Sensing and GIS.