GIS Based Roadway Construction Planning

Gawade, Prathamesh[1], Mhaske, Sumedh[2]

[1]Student, M.Tech Construction Management,
Veermata Jijabai Technological Institute (VJTI), Matunga (E),
H.R.Mahajani Road, Mumbai-400019, MH, India

[2]Associate Professor and Head, Civil and Environmental Engineering Department,
Veermata Jijabai Technological Institute (VJTI), Matunga (E),
H.R.Mahajani Road, Mumbai-400019, MH, India

Abstract: *Roadway construction involves number of simultaneously dealt activities & information. A large amount of information regarding design, construction methodology to be followed, quantities, unit costs & production rates.etc is to be continuously processed & refined. Doing this manually is time consuming & cumbersome as the size of the projects today has increased manifold. Geographic Information System (GIS) is a very effective tool for integrating & managing various types of information required for roadway construction planning as it portrays the entire process graphically in front of us. This piece of work applies GIS for making roadway construction planning process easier by creating a system which can help construction planners to make proper, efficient & timely decisions.*

Keywords: Roadway, Construction, Planning, Methodology, Design, GIS.

1. Introduction

Heavy industrialization, subsequent urbanization and changes in the lifestyle of human beings are all the outcomes of alarming growth in the population of the world This requires quick & efficient set up of urban infrastructure. Roads are normally called as the measure of the development of any country as for all other forms of infrastructure to be established, we need to construct roads first. Many a times, Roads are the initiators in the process of development of a region. However this kind of development model can be implemented only if the roads are properly planned and their construction is executed in time. For this, skilled workforce & technological advent are required.

Inspite of the major technological changes in construction industry, it still remains highly labor intensive, decentralized, and dependent on uncertain economic and working environments. As far as roadway construction is concerned, it is basically a linear type of repetitive project involving number of activities & equal number of crews working on it. Apart from it, huge amount of information regarding design, construction methodology to be followed, quantities, unit costs & production rates.etc is to be continuously processed & refined with time. Doing this manually by conventional methods is time consuming & cumbersome as the size of the projects today has increased manifold. Also, the sorting & retrieval of data becomes difficult.

In a developing country like India, where continuous efforts are being made to improve road connectivity as well as improvement in the quality of existing roads through nationwide programmes like Pradhan Mantri Gram Sadak Yojana (PMGSY), GIS based roadway construction planning has enhanced utility.

Geographic Information System (GIS) is a computer based tool which can be used for capturing, storing, analyzing, querying and displaying the geographic information.

Although the two terms, data and information, are often used indiscriminately, they both have a specific meaning. **Data** can be described as different observations, which are collected and stored. **Information** is that data, which is useful in answering queries or solving a problem. The components of a GIS are pictorially represented in Figure 1.
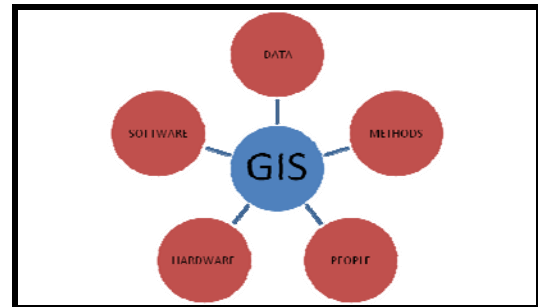

Figure 1: Components of GIS

2. Roadway Construction

The major stages involved in the construction of any road can be generalized to clearing and grubbing, removal of unsuitable soil, excavation, dumping of borrow earth, dozing of borrow earth, grading and rolling of the borrow earth, dumping, grading and rolling of granular sub-base, laying and compaction of premix bituminous macadam, application of tack coat and finally laying and compaction of dense bituminous macadam (DBM) to get the finished surface.

These number of activities have related information in several spatial (drawings, layouts and blueprints) and non-spatial (schedule, cost estimate, specifications, etc.) forms that are maintained separately by various project members using different commercially available tools. The overlaps and lack of consistency among such information may often lead to the construction errors, which results in miscommunications which may be expensive and time-consuming in nature. The softwares from various disciplines

(architecture, construction, structural and civil engineering) are being used to maintain and analyze such information throughout the life-cycle of a construction project. Drafting groups generally use CAD tools; planners use Primavera and Microsoft Project whereas construction and operations group use blueprints or printed paper, etc.

Information flow between various groups working in a project is not through well-defined standards and procedures, which results in an inefficient process characterized by data redundancy, redundant processes and poor information quality. If both, spatial and non-spatial information are maintained in a single environment and changes are made to these documents at one place only, drawings, schedule, cost estimate and specifications of a construction project will be consistent to each other. This is the very aim of development of this application using GIS software, GRAM++ as a platform.

3. Method of Development of the Application

The database required for development of this application was referred to from a 30 km long stretch of Pen –Panvel section of NH 17 which is being four laned from Pen to Indapur, Raigad district, Maharashtra.

Figure 2: Study area, Raigad, Maharashtra, India
(Source: Feasibility report, NHAI)

The application was developed in GIS software Gram ++.To begin with, the original CAD file was converted into a bitmap image. The geographical co-ordinates of the stretch were known and entered in the software. This image was then imported to the input output module of Gram ++.The entire map is then digitised to get a replica of the same in gram++. This replica forms the basis of the entire development of the application.Now, layers as per the requirement are formed in Map-Edit module of Gram ++ (file is now a .vec file).

Different layers of work are formed so that information of varying nature can be linked to them. The basic operations are then carried out in the vector analysis module. The desired database is then created by using add field and modify field to database options available in Operations

menu of vector analysis module.(database file formed is a .mdb file).

It may happen that we need to add certain non-spatial data which cannot be added in the database for e.g maps, cross sections or L-sections.etc.In such a circumstance, the child map feature is utilized. Care has to be taken that all our work i.e.vec file, .mdb file and image to be attached (.jpg file) should be in the same single folder.

Queries (Query is a condition put to get the desired and precise information out of the huge database) are then run to get the desired information out of the database and images attached as a child map.
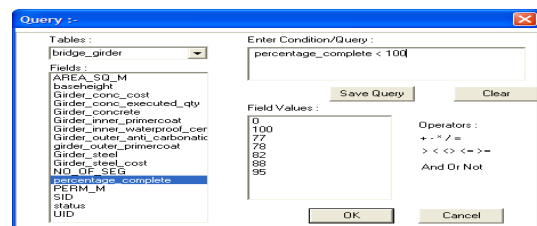

Figure 3: Running a query in Gram ++
(Source: Screenshot, licensed copy available with VJTI)

The process of Running Simple Query in Vector Analysis involves selecting the Vector Analysis module, opening of the.vec format file. Then we need to activate the layer for which database was created. Go to "Tools" menu in the top tool bar and select "Query" for the selected layer. A menu pops up containing three options as shown below. Select "Simple query" option. Click Ok.Select (double click) a field for which the query is to be run.

The selected field will be shown in the "Enter Condition/Query" window. Enter the desired operators. Then double click on the "Field Values" to select a value. This value will also be shown in the "Enter Condition/Query" window. Click Ok.The results of the query will be shown highlighted on the layer for which query is run.
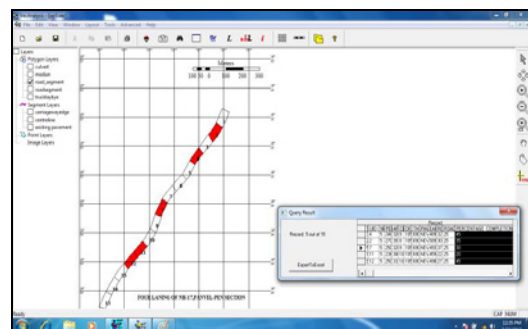

Figure 4: Results of the query run
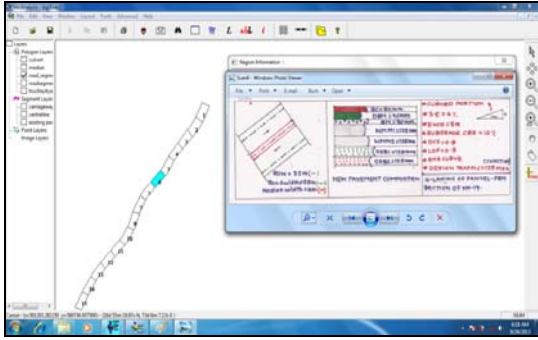(Source: Screenshot licensed copy available with VJTI)

Figure 5: Results of the query run
(Source: Screenshot, licensed copy available with VJTI)

4. Results and Discussions

The screenshot shown in fig 4 above shows us the result of the query run to display sections of road wherein the work completion in % is less than 50.This can help the planning personnel to know the current status of an activity. At the same time, he may take the necessary step to accelerate the work if required. Fig 5 shows us the child map attached to the database and vector file which gives us all the details related to section 6.Such number of queries can be run so as to get the desired information out of the database. In general, this application can prove to be of great use to construction planners as well as executors.

5.Future Scope

If real time monitoring of the work which can be achieved by linking the actual construction site, the planners office and the graphical interface provided by this application is accomplished, the resultant product will be very helpful not only for construction planning but also for the scheduling and real time monitoring of the project.

References

Sanghyeok and Jongwon, S.2005, GIS-Based Roadway Construction Planning. www.iaarc.org/publications.
Hassanein, A, A. and Moselhi, O.2003, Planning & Scheduling Highway Construction, Journal of Construction Engineering and Management, ASCE, ISSN 0733-9364/2004/5-638-646
Snorre, N. and Roar, N. Towards a GIS-based system for roads & transport planning in Norway, ESRI user conference, 2008.
Loukes,D. and McLaughlin, J.GIS & Transportation: Canadian perspective, Journal of surveying Engineering, ASCE, ISSN 0733-9453/91/(X) 03-0123.
Cheng, M. and Yang,S. GIS based cost estimates integrating with material layout planning, Journal of Construction engineering & Management, ASCE, ISSN 0733-9634/01/0004-0291–029.
Abkowitz, M. Walsh, S. Hauser, E. and Minor, L. Adaptation of GIS to highway management, Journal of transportation Engineering, ASCE, ISSN 0733-947X/90/0003-0310
Rao, A. Durai, B. Jain, P Sikdar, P. Geographical Information System for Planning and Management of Rural Roads.,
http://www.gisdevelopment.net/application/utility/transport/mi04164.htm

Author Profile

Prathamesh P.Gawade has received the B.E degree in Civil Engineering from K.K Wagh College of Engineering, Nashik, Maharashtra in year 2008.Presently, he is pursuing (2011-2013) his M Tech in Civil Engineering with specialization in construction management from VJTI, Matunga, Mumbai, India.

Dr Sumedh Mhaske is currently an Associate Professor and Head, Civil and Environmental Engineering Department, Veermata Jijabai Technological Institute (VJTI), Matunga (E), Mumbai-400019, India.Kindly visit *http://www.vjti.ac.in/index.php/academics/civil* for his detailed profile.