THE CONSTRUCTION OF THE OUTER RING ROAD IN BANGALORE

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Bangalore is one of the fastest growing cities in Southern India and is popularly known as the information technology capital of India. To meet the requirements of this rapidly expanding city, the Bangalore Development Authority (BDA) is constructing and expanding the major roads and freeways within the city. To assist the engineers and contractors working on these freeways, Bangalore University (BU) requires civil engineering students to complete their senior design project on this rapid road expansion project. This paper highlights the work conducted by the students from BU on the Outer Ring Road which lies in the southwest corridor of the city. With the assistance of senior field engineers, students helped in the initial site assessments which included surveying the existing conditions of the roads, procuring soil samples from core cutters, conducting geotechnical field tests such as standard penetration tests (SPT) tests and laboratory tests such as tri-axial and consolidation tests and in areas where the roads existed students conducted Dynamic Cone penetrometer (DCP) tests. In addition to working with the engineers students were required to help the botanist move certain protected species of plants to areas which were not to be disturbed. During the design period, students assisted in developing computer aided design (CAD) drawings and surveying out the limits of the freeway. The collaboration of engineers and students resulted in the completion of the outer ring road ahead of schedule and leading to a 5000% increase in the property value of the area encompassed by this road.
Introduction

In recent years, Bangalore located in southern India has gained the title “Information Technology capital of India” due to the vast number of multinational computer engineering firms in the city. Bangalore's economy is US $100 Billion, which makes it a major economic centre in India (GOK, 2006). With an economic growth of 10.3%, Bangalore is the fastest growing major metropolis in India. Apart from just the economic growth of the city the number of engineering colleges has increased exponentially in Bangalore University (BU) and Visvesvaraya Technological University (VTU). There are over 144 engineering colleges with over 7500 students primarily focused on engineering education (VTU, 2010). Due to the economic and academic increase, the population of the city has increased to 5.8 million people and is the 28th most populous city in the world (World Gazetter, 2007). Over the past 10 years Bangalore Development Authority (BDA) with the assistance of numerous privately owned companies has taken the arduous task of developing the infrastructure of Bangalore to meet the overwhelming population demands. Bangalore's vehicular traffic has increased over 35% in the last 10 years with 1.6 million registered vehicles in the city (BTIS, 2010). The BDA has developed over 1800 miles of a road network that consists of ring, arterial, sub-arterial and residential roads. Most of the existing roads in the city are radial and converge to the centre. Ring roads or beltways are circumferential highways which are found in most cities. They connect most inner roads to freeways and were developed to decentralize the traffic from downtown areas to the peripheral areas of the city (Mill, 1981).

The Outer Ring Road (ORR) in Bangalore was constructed from 1992 to 2002. This 62 Kilometer (km) long road was developed primarily by the BDA. In addition to connecting the inner roads to the freeways, numerous national highways are interconnected by the ORR. The ORR was constructed to meet the guide lines as specified by the Ministry of Surface Transport (MOST) of India. To meet the overwhelming demands of this construction project and since they were a large number of engineering colleges in Bangalore, the BDA decided that it would be beneficial to them if they used final year civil engineering students from BU and VTU to assist in various stages of the project. Administrators and faculty members of the two Universities saw that the students would get hands on training while working on this project and the students could smoothly transition into the civil engineering companies which were contracted by the BDA. This paper will highlight the different civil engineering tasks undertaken by the students and the innovations

Project Scope

The ORR is a two directional road with two lanes provided for the traffic to move in either direction. The lane widths for the entire section of the road were maintained at 4 meters with drains on either side with a depth of 1.5 meters. The initial step was the laying out the alignment
of the road. Students played an important role in the alignment of the road; most of surveying activities were undertaken by students.

Drainage was an important design factor as the road passed through certain low lying areas where the groundwater was very close to the surface of the road. Settlement and slope stability was an additional concern due to the high moisture content in the soil. Certain parts of the ORR passed through wetlands and three major lakes. It was necessary to construct a bridge and design pipe culverts to accommodate for the continuous flow of water under the bridge.

In terms of the construction of the pavement one of the major concerns was the level of groundwater which accounted for uneven settling and slope stability. After preliminary investigations it was identified that groundwater was present at a depth of 1 ft from the surface of the ground. Numerous soil exploration investigations where undertaken and various geotechnical tests were conducted. Students assisted in obtaining soil samples and were involved in both the field and laboratory geotechnical testing.

Student Activities and Innovations

Students were involved from preliminary investigations to all aspects of design and construction of the road. One of the initial activities was to survey the existing ground surface and make sure that the road blend into the existing ground. Certain parts of the road were laid out previously however the road had to be modified to meet the existing requirements as set by MOST. Students were involved in all surveying activities; a rotary level was used to determine the ground surface elevations. Once the elevations were identified and tied to the existing bench marks, the next step was to lay out the horizontal and vertical curves. The center line elevations were used to lay out remaining parts of the road using a robotic total station and global positioning systems (GPS). Students were exposed to various surveying equipment and to surveying software which facilitated the progress of the project. One of the major roles that the students played was helping the Computer Aided Drawing (CAD) technicians in developing the drawings that were required for the completion of the project.

Figure 1: Surveying Activities and Drawings Conducted By Students
As a part of the preliminary investigations, the students were an integral part of the team and assisted in various geotechnical tests. The students conducted various laboratory and field tests. The field tests included the students conducting moisture content and optimum density tests on samples obtained from Standard Penetration Tests (SPT). The students assisted in identifying the soil samples and the samples were classified using the Burmeister Soil Classification system. The laboratory tests consisted of the California Bearing Ratio Test (CBR), Consolidation Test, and Shear Tests.

As the road needed to be maintained at a specific grade which ranged from 2 to 4 %, large excavation equipment and different rollers were used. One of the important facets of this project was to balance the cut and fill. Throughout the construction of the road the cut and fill was balanced however some material was transported into the site as fill. In addition to the soil that was transported to the site, to increase the strength of the soil a wet mix macadam (WMM), which consisted of quarry dust, was used instead of sand and cement. To increase the stability of the sub grade, 500 mm of gravel earth with two layers of 350 mm WMM was used. The actual pavement was made constructed with 150 mm of bituminous macadam and 25 mm of a surface seal which was placed to prevent infiltration into the pavement. During the construction of the road to maintain the optimum compaction and field density vibratory rollers and pneumatic rollers were used.

As the ORR was constructed through marshy lands and wetlands, wetland replication was one of the important activities that the students conducted on a regular basis. Students accompanied botanists to identify the endangered species of plants. The endangered species of plants were then moved to different locations where they could thrive.

Figure 2: Before the Construction of ORR
As stated earlier the ORR passed over a three lakes and therefore 3 bridges were to be constructed. Students were involved in the design and the construction of the bridges. Along with the surveyors the students identified the different levels of the bridge using a robotic total station. Students played an important role in the quality control (QC) of the material used for the construction of the bridge. One of the important tasks that the students undertook was checking the quality of the aggregates which were used for the construction of the pavement over the span of the bridge. They conducted elongation index tests, abrasion tests and crushing strength of all the aggregates that were to be placed in the pavement.

For the final construction of the ORR, students observed the working of the mechanized paving machines and assisted in estimating the amount of water proofing that was placed on the pavement. As a part of the QC, the students tested the temperature of the bitumen that was placed on the sub grade and used guided wires to test the level of the asphalt that was placed.

Conclusion

One of the successes of involving students in projects such as the one described in this paper was that students developed a “Hands On “experience. Courses such in pavement design, soil mechanics, highway design and environmental engineering were encompassed in this project.
When BU and VTU conducted alumni surveys, students who participated in this project were successful and some were running their own firms. The students described this project as very insightful and they could visualize all that they had learned in the classroom. Based on these surveys, the faculty and administrators of BU and VTU have decided to collaborate with the BDA and other government agencies to work on large scale projects.

In terms of the area around the ORR, there was an exponential increase in the economic development of the property around the road. The square footage of the land increased from 50 Indian Rupees (INR) to 3500 INR, this accounted for a 5000% increase in property value. The commute for the professionals working in and around the city was relatively smooth and free from traffic congestion. Overall the construction of the ORR was extremely beneficial to the economy of Bangalore and this lead to the construction of more roads and flyovers which facilitated the software boom in India.

References

1) Bangalore Transportation Information System (2010), Web link http://www.btis.in/

2) Bangalore University., (2010), “About Bangalore University” Web link http://www.bub.ernet.in/Sub/about/bu.html


6) Visvesvaraya Technological University (2010) weblink: http://www.vtu.ac.in/

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