GEOMETRIC AND STRUCTURAL DESIGN FOR UPGRADATION OF A ROAD: A REVIEW

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Abstract

Geometric and structural design of highway deals with designing of physical visible features of highway those comprise of crosssectional elements, sight distances, alignment, curves, superelevation, and other allied features. India is one of the country having population increases progressively causes traffic volume more. In addition to that sanctioning of funds from government for transportation infrastructure development is not satisfactory. So that it is preferable to plan and design the geometric and structural elements of the road during the initial alignment stage itself by considering future traffic growth. And it is very difficult to improve geometric elements after construction and cause to unwanted capital investment.

1:INTRODUCTION

Boulevard road is one of the prestigious roads in the Srinagar city. The notability of the road lies in the fact that the entire road lies on the banks of Dal Lake. Major tourist spots like Chashmashahi, Parimahal, tulip garden, botanical garden etc are situated on the road. The economy of the people living here greatly depends on tourism. While driving across the road it provides glances of beauty of Dal Lake. In summers people rest on roadside and feel the cool breeze of Dal Lake and also enjoy the charming sunset from the horizon. Due to heavy rush of tourists, this road remains quite busy. In a bid to provide better road communication facilities to tourists, the Jammu and Kashmir government has initiated process of widening the famed Boulevard road along the Dal Lake. Since this road is the main attraction of Srinagar city there is heavy vehicular as well as pedestrian movement. Also this road attracts various cycling events, thus requires a track for cycles. The less width of carriageway of boulevard road usually irks the users. There are frequent traffic jams due to less width and heavy movement of vehicles and pedestrians. Hence, there should be sufficient carriageway width to avoid traffic menace and also sufficient space for on street parking of vehicles. There should also be separate track for cycles and sufficient footpaths for pedestrian traffic. Thus to allow the smooth flow of traffic and pedestrians this road needs upgradation.

In view of the proposed work, it is desired to redesign the pavement, including cycle track and conduct soil/material investigation and traffic survey. This had become necessary due to high level of water table, weak subsoil strata and due to requirement of detailed traffic survey. The Boulevard Road is a world famous road which has Dal lake on one side and Hills, especially Zabarwan Hill Range, on the other side. Post winter period the alignment gets inundated due to high level of water table and rain and snow-melt water from hill catchment. This makes it necessary to raise the level of the pavement proposed towards the hill side, conduct detailed soil/material investigation, carry out detailed traffic survey and design the pavement giving due considerations to drainage and such other site specific special conditions.

Also in view of this work, it is required to get the detailed classified traffic data on this road stretch & on the Habak - Dalgate (via Hazratbal) road to determine the likely shift of traffic from this road stretch after the upgradation is complete and analyze the same for working out parameters required for the structural design of the upgraded road pavement. To calculate

the likely shift of traffic from Habak - Dalgate (via Hazratbal) road to Boulevard road, a Stated Preference (SP) survey has to be conducted also.

Thus keeping above mentioned things in

mind, we have come up with the idea of providing geometric and structural design for its upgradation. We will also try to solve the drainage problems encountered at this road during past.

Samples of sub-grade soil were collected from the field at various RDs of the road, for the determination of their various characteristics. We conducted the geotechnical investigation and pavement analysis at the site and collected information and data on site- specific conditions. We conducted field soil sampling at the proposed site by excavating test pits at regular intervals along the existing road. It was required to test the sub-grade samples for Gradation, Consistency limits and indices, Compaction and CBR characteristics. Samples of Sub-base and base material were also tested for determining their required parameters.

Also, as a part of scope of this work, it was required to get the detailed classified traffic data on this road stretch & on the Habak - Dalgate (via Hazratbal) Road to determine the likely shift of traffic from this road stretch after the subject project is complete and analyze the same for working out parameters required for the structural design of the proposed road pavement. To calculate the likely shift of traffic from Habak - Dalgate (via Hazratbal) Road to Boulevard road, a Stated Preference (SP) survey was also conducted.

1.1. NEED OF STUDY

Boulevard road is one of the busiest road in the Srinagar city; there is heavy vehicular as well as pedestrian movement. Need of this study arises due to various reasons:

- Heavy vehicular traffic causing traffic congestion on this prestigious road,
- Various cycling events take place on this road, thus need for cycle tracks,
- Less width of carriageway of boulevard road usually irks the users. There are frequent traffic jams due to less width and heavy movement of vehicles and pedestrians,
- Pedestrian traffic is much more, thus need for sufficient footpaths for the same.
- Post winter period the alignment gets inundated due to high level of water table and rain and snow-melt water from hill catchment. This makes it necessary to raise the level of the pavement proposed towards the hill side, conduct detailed soil/material investigation, carry out detailed traffic survey and design the pavement giving due considerations to drainage and such other site-specific special conditions.

1.2 OBJECTIVES OF STUDY

Due to the factors mentioned in section 1.2, we are aiming at the following objectives:

- Structural upgradation of the existing road.
- Geometric upgradation of the existing boulevard road
- Suitable solution for the existing drainage problems at the proposed site, due to the high water table and other conditions
- Widening/4-laning of the existing road to overcome the menace of traffic congestion
- Provision of separate cycle tracks and footpaths for cyclists and pedestrian traffic.

1.3 LITERATURE SURVEY

Highway engineering is an engineering discipline branching from civil engineering that involves the planning, design, construction, operation, and maintenance of roads, bridges, and tunnels to ensure safe and effective transportation of people and goods. Highway engineering became prominent towards the latter half of the 20th Century after World War II. Standards of highway

engineering are continuously being improved. Highway engineers must take into account future traffic flows, design of highway intersections/interchanges, geometric alignment and design, highway pavement materials and design, structural design of pavement thickness, and pavement maintenance.

The beginning of road construction could be dated to the time of the Romans. With the advancement of technology from carriages pulled by two horses to vehicles with power equivalent to 100 horses, road development had to follow suit. The construction of modern highways did not begin until the late 19th to early 20th century. The first research dedicated to highway engineering was initiated in the United Kingdom with the introduction of the Transport Research Laboratory (TRL), in 1930. In the USA, highway engineering became an important discipline with the passing of the Federal-Aid Highway Act of 1944, which aimed to connect 90% of cities with a population of 50,000 or more. With constant stress from vehicles which grew larger as time passed, improvements to pavements were needed. With technology out of date, in 1958 the construction of the first motorway in Great Britain (the Preston bypass) played a major role in the development of new pavement technology.

Design policies standards used in the United States are typically based on publications of the American Association of State Highway and Transportation Officials as well as research formulated by the Transportation Research Board, the Institute of Transportation Engineers, the Federal Highway Administration, and the Department of Transportation

The **geometric design** of roads is the branch of highway engineering concerned with the positioning of the physical elements of the roadway according to standards and constraints. The basic objectives in geometric design are to optimize efficiency and safety while minimizing cost and environmental damage. Geometric design also affects an emerging fifth objective called "livability," which is defined as designing roads to foster broader community goals, including providing access to employment, schools, businesses and residences, accommodate a range of travel modes such as walking, bicycling, transit, and automobiles, and minimizing fuel use, emissions and environmental damage.

Geometric roadway design can be broken into three main parts: alignment, profile, and cross-section. Combined, they provide a three-dimensional layout for a roadway.

- The alignment is the route of the road, defined as a series of horizontal tangents and curves.
- The profile is the vertical aspect of the road, including crest and sag curves, and the straight grade lines connecting them.
- The cross section shows the position and number of vehicle and bicycle lanes and sidewalks, along with their cross slope or banking. Cross sections also show drainage features, pavement structure and other items outside the category of geometric design.

Geometric design of roads is a complex task. Getting to a satisfactory design, that meets all the constraints calls for much skill and experience. There is often a lot of trial and error, and the final design is likely to be a compromise. The standards are defined precisely but there is some scope for modifying them in order to achieve an appropriate design for a specific problem. One of the basic assumptions is that driver behavior can be influenced by the appearance of the road and the road environment. It is vital that everything be done to give drivers clear clues and messages about how they should negotiate each section of road – and, particularly, how fast they should travel.

1.4 Drainage system design: Designing for proper drainage of highway systems is crucial to their success. Regardless of how well other aspects of a road are designed and constructed, adequate drainage is mandatory for a road to survive its entire service life. Excess water in the highway structure can inevitably lead to premature failure, even if the failure is not catastrophic.

Each highway drainage system is site-specific and can be very complex. Depending on the geography of the region, many methods for proper drainage may not be applicable. The highway engineer must determine which

situations a particular design process should be applied, usually a combination of several appropriate methods and materials to direct water away from the structure. Erosion control is a crucial component in the design of highway drainage systems. Surface drainage must be allowed for precipitation to drain away from the structure. Highways must be designed with a slope or crown so that runoff water will be directed to the shoulder of the road, into a ditch, and away from the site. Designing a drainage system requires the prediction of runoff and infiltration, open channel analysis, and culvert design for directing surface water to an appropriate location.

For evaluating and ascertaining the suitability of the material to be used in the pavement design and construction of the widening portion of the road, samples of sub-grade soil were collected from the field at various RDs of the road for the determination of their various characteristics. Geotechnical investigation and pavement analysis was also conducted at the construction location. The tests were conducted as per the relevant IS code procedures:

- Gradation was done by dry and wet sieve analysis as per guidelines of IS:2720-IV**.**
- Atterberg Limit tests were conducted as per the requirements of IS:2720-V.
- Compaction tests were conducted following guidelines as given in IS: 2720-VIII**.**
- CBR test as per guidelines given in IS:272O-XVI**.**

For proper designing of boulevard road, different IRC's are to be considered:

- IRC 86-1983**:** It provides information regarding geometric design parameters.
- IRC-37-2001**:** It provides various data regarding the design of flexible pavements (lane distribution factor, vehicle damage factor, pavement thickness etc.)
- IRC-81-1997**:** It also provides us with data like annual growth rate of commercial vehicles, design life of road in years etc.
- IRC-9-1972**:** The traffic survey has been done in accordance with this IRC.

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6. IRC : 9-1972 (TRAFFIC CENSUS ON URBAN ROAD**)**

7. IRC : 37-2001 **(**GUIDELINES FOR THE DESIGN OF FLEXIBLE PAVEMENTS)

8. IRC : 86-1983 (GEOMETRIC DESIGN STANDARDS FOR THE URBAN ROADS IN PLAINS)

9. IS : 1498 – 1970 (CLASSIFICATION AND IDENTIFICATION OF SOILS FOR GENERAL ENGINEERING PURPOSES)

10. IS : 2720 - IV

11. IRC : 81 – 1997

12. IS: 2720-V

13. IS: 2720-VIII