Geometric Design of Roads In Hilly Areas

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Abstract- *The roads constructed in mountainous regions of a country are known as hillroads or ghat roads. These roads present great difficulty in their alignment, design, construction and maintenance. Curves, sharp bends, steep gradients and limited width of roadway make hill roads more liable to accidents. Also, the effects of heavy rainfall on the construction and maintenance of a hill road are serious. At many locations on the hill roads, the landslides and slips may occur during heavy rainfall. Therefore, much care is needed during their layout and construction so as to provide a stable and safe road. Moreover, a large number of streams cross the road and hence a suitable facility for cross drainage is needed. In this project we are designing a hill road connecting Wagamon with Pulinkatta through a distance of 4 km.*

Keywords- Geometric design, Hill roads, Cross sectional elements, Gradients

I. INTRODUCTION

Rural Road Connectivity is not only a key component of Rural Development by promoting access to economic and social services and thereby generating increased agricultural incomes and productive employment opportunities in India, it is also as a result, a key ingredient in ensuring sustainable poverty reduction. Notwithstanding the efforts made, over the years, at the state and central levels, through different Programs, about 40 % of the habitation in the country is still not connected by All-weather roads. It is well known that even where connectivity has been provided, the roads constructed are of such quality (due to poor construction or maintenance) that they cannot always be categorized as All-weather roads. With a view to redressing the situation, Government has launched the PradhanMantri Gram SadakYojanan on 25th December, 2000 to provide all-weather access to unconnected habitations. The PradhanMantri Gram SadakYojana (HSD) is earmarked for this Programme.

Planning and design of a road which connects Wagamon and Pulinkatta is done in this project. The factors to be considered during project preparation to avoid/address environmental concerns through modifications in project design and incorporation of mitigation measures

Effective pavement design is one of the more important aspects of project design. The pavement is the portion of the highway which is most obvious to the motorist. The condition and adequacy of the highway is often judged by the smoothness or roughness of the pavement. Deficient pavement conditions can result in increased user costs and travel delays, braking and fuel consumption, vehicle maintenance repairs and probability of increased crashes.

The pavement life is substantially affected by the number of heavy load repetitions applied, such as single, tandem, tridem and quad axle trucks, buses, tractor trailers and equipment. A properly designed pavement structure will take into account the applied loading.

II. LITERATURE REVIEW

The road construction in hilly terrain is risky and challenging as it includes reconnaissance survey, due alignment, formations, laying subgrade layers and blacktopping with other structures. The procedure needs selection of appropriate men, materials and machineries in time during construction phases considering the tangible and intangible aspects to optimize the benefits within limited available resources of the agency. The anomalies faced in the hill road construction has resulted many legal issues and disputes between the owner and the contractor in contract administration and construction management in a ≈90% hilly state Kerala India. Appropriate ground survey, improper design and poor contract documentation urges for the DPR drawings to be discarded and superseded by revised/ new drawings. The provisions in codes and contract policies have not been updated to cater to the needs of hill road construction or up gradation of existing roads. Present study probes to the short comings and ascertaining ameliorative measures in construction procedure in hill road construction problems in Kerala state both for the government and the contractor.

Road development and its geological consequences

District Spatial Plan / District Urbanisation report is prepared in each district of Kerala as part of preparation of State Perspective Plan of Kerala. District Urbanization Report of Idukki prepared under this programme primarily addresses

the trend and magnitude of urbanisation of the district while analysing various indicators of development like land use pattern, occupational structure, hierarchy of settlements, future urban profile, connectivity and activity pattern to arrive at the spatial structure of the district.

Road maintenance expenditure in Kerala

While maintenance of State Highways and Major District Roads is the responsibility of PWD, the State Government acts as the agent of the Union Government for carrying out maintenance works on National Highways. In respect of Corporations and Municipalities, all roads falling within their jurisdiction are to be maintained by them with the exception of certain specified roads in each Corporation or Municipality or Panchayats which Government have ordered the P. W D. to maintain. Even when roads are constructed to the highest quality, over a period of time the road will show signs of distress due to the effects of increase in vehicular traffic, climatic effects and other reasons. Traffic on most of the roads have exceeded their capacities, and do not cater to the needs of modern multi axle heavily loaded vehicles. Moreover, reclassification to higher categories is done without properly designed up gradations. Hence, this has resulted in poor condition of roads which in turn causes loss to the economy by way of increased fuel consumption, wear and tear to vehicles, accident costs and increased travel times. The need of the hour is to create a road network of desired level of service for which up gradation of existing roads shall be done in a phased manner.

Min-Wook Kang et al. (2013). A fuel consumption model is developed based on highway geometric characteristics like grades, length and location of crest& vertical curves, speed& road surface type& condition. The output of fuel consumption model is the amount of fuel consumed by the vehicle while it travels along a highway at cruising speed.

Fuel consumption model limitations:

- It is only for passenger car units. It will be update with consideration of other type of vehicles.
- It is does not yet consider the effect of intersections& junction points with existing roads.
- It is not suitable for vehicle travelling along highway curved sections where acceleration and deceleration are needed due to variety design speeds.

Asok Kumar et. al (2015). They stated that for designing geometric elements designing MX ROAD software is high design precision and saving time.

VikasGolakoti (2015). His thesis includes geometric factors of road and data collection and analysis of geometric parameters. The aim of this study is to find the role of the geometric factors of road on accident rate in the case of plain terrain and also find the extent to which these factors affect the accident rate for rural areas. The study aims to find the impact of factors like extra widening, horizontal radius, sight distance, K-value, super elevation, horizontal arc length, vertical arc length, vertical gradient on the accident rate and aims to study the significant factors causing accidents and to find the values for future design of roads.

American Association of State Highway and Transport Officials (2005): This policy states standards for highway designing elements. In addition to that vertical clearance, cross-section, structural capacity of bridges and about tunnels.

Government of the People's Republic of Bangladesh, Ministry of Communications Roads and Railways Division (2000). It states design standards for different road classifications, traffic volume and capacity, design speed, and sight distances along with design procedure.

Indian Road Congress 73:2005. It gives specifications of highway geometric elements, terrain classification, and design speed for different types of highways and design traffic and capacity.

United Nations Highway Safety Information System (1999) gives basic methodology involved the development of cross- sectional models. For each State, individual models predicting crash rate per kilometer for typical sections of two-lane, four-lane undivided, and four-lane divided (non-freeway) roadways were developed. Over-dispersed Poisson models were fitted to the data. Crash rate per kilometer differences between pairs of road classes were then calculated as a measure of safety effect.

Mohammad A. Hadi et al. (1994). They used negative binomial regression analysis to estimate the effect of cross- section design elements on total fatality and injury crash rates for various types of rural and urban highways at different traffic levels. The results show that depending on the highway type investigated increasing lane width, median width, inside shoulder width, are effective in reducing crashes.

Abo El-Hassan M. Rahil et al. (2014). They got three approaches to relate accident rate to geometric characteristics and traffic related explanatory variables: Multiple Linear regression, Poisson regression and Negative Binomial regression. Various models have been intensively tested and

validated. The adjustment of the models is based on historical accident data and on the characteristics of experimental sections selected from the road network. For example, Multiple linear and Poisson regression were used. In order to estimate accident rates using traffic and geometric independent variables. Moreover, developed a model to identify the most significant traffic and geometric elements in predicting accident frequency. They used both the Poisson and negative binomial regression models. It should be pointed that, in using such models for future forecast one has to be careful as this entails extrapolating outside the range where the real observations were made. These models can be used for short-term forecast of 1–3 years. It is advisable that whenever data is available, these models should be updated through recalibration.

Matthew G,Karlaftis and IoannisGolias (2001): They focused on relationship between rural road geometric characteristics, accident rates and their prediction, using a rigorous non-parametric statistical methodology known as hierarchical tree-based regression. Their goal is twofold; first, it develops a methodology that quantitatively assesses the effects of various highway geometric characteristics onaccident rates and second, it provides a straightforward, yet fundamentally and mathematically sound way of predicting accident rates on rural roads. The results show that although the importance of isolated variables differs between two- lane and multilane roads, 'geometric design' variables and 'pavement condition' variables are the two most important factors affecting accident rates.

Ali Aram (2010). He had studied safety factors on horizontal curves of two lane highways and added that Horizontal curves have higher crash rates than straight sections of similar length and traffic composition; this difference becomes apparent at radii less than 1000 m. The increase in crash rates becomes particularly significant at radii below 200 m.

Kay Fitzpatrick et al. (2008). The objective of their study was to develop Accident Modification Factors (AMFs) for median characteristics on urban and rural freeways and on rural multilane highways. A series of negative binomial regression models was used to determine the effects of independent variables on crashes. Variables considered in developing the base models included average daily traffic, left-shoulder width, barrier offset, median (with shoulder) width, and pole density. This approach for AMF development assumes that first each AMF is independent because the model parameters are assumed to be independent, and second the change in crash frequency is exponential. AMF equations were developed for urban and rural medians with rigid barriers, urban medians without barriers, and rural medians without barriers.

ManojK.Jha and Paul Schonfeld (2004). They stated that Highway alignment optimization based on cost minimization requires comprehensive formulation of costs sensitive to alignment and development of efficient solution algorithms.

in order to solve real-world problems, the optimization algorithms should work directly with a Geographic Information System (GIS) which stores relevant geographic information, such as land boundaries, environmentally sensitive regions, and topographic dataand presented a model for highway alignment optimization that integrates a GIS with genetic algorithms, examines the effects of various costs on alignment selection, and explores optimization in constrained spaces that realistically reflect the limits on road improvement projects.

III. TEST ON MATERIALS

- California Bearing Ratio Test Value = 10%
- Aggregate crushing value test = 25%
- Los Angeles abrasion test value = 32.2%
- Aggregate impact value = 19%
- Ductility on bitumen value = 78.5cm
- Mean penetration value = 84mm

IV. DESIGN PARAMETERS

- Design speed = 45km/h
- Cumulative number of standard axel to be catered for design = 10msa
- Stopping sight distance = 58m
- Overtaking sight distance = 205m

Horizontal alignment

- Widening of payment on horizontal curve = 1.10m
- Total payment with on curve = 8.10m
- Length of transition curve = 40.5m

Vertical alignment

- Length of valley curve for comfort condition = 29m
- Headlight site distance = 62m

V. CONCLUSIONS

- The geometric design of the proposed road is done as per IRC to carry a traffic volume of 10msa
- Soil material of CBR value 13% is used
- Total pavement thickness is 540mm with a cross slope of 2%
- The pavement is designed for a life of 15 years

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