DESIGN OF RURAL ROAD IN UTTARAKHAND

Naman Agarwal[1]

[1]*M.Tech student, Department of Civil Engg., G.B. Pant University of Agriculture & Technology, Uttarakhand, India*

Abstract

The transportation by the road is the only mode which could give maximum service to one and all. This mode has also the maximum flexibility for travel with reference to route, direction, time and speed of travel etc. through any mode of road vehicle. It is possible to provide door to door service only by road transport. The other three modes, viz., airways, waterways and railways have to depend on transportation by roads for the service to and from their respective terminals, airports, harbors or stations. The road net work is therefore needed not only to serve as feeder system for other modes of transportation and to supplement them, but also to provide independent facility for road travel by a well planned network of roads throughout the country.

The nation's socio-economic and cultural growth is mainly dependent on its speedy, safe, economic and efficient transports system. One of the important functions of transportation is providing accessibility and rural roads to fulfill this. Though this sectors did not get the required attention in the past, the mega projects of Pradhan Mantri Gram Sadak Yojana (PMGSY) addressed this issue and envisaged to provide connectivity to all the habitations having population of more then 500 throughout the country and to the habitations of above 250+ populations in North Eastern States, Hilly States, and Desert Areas. While providing the infra structure for rural connectivity, efforts are being made in working out the details of design and construction for rural roads. The Indian roads congress (IRC) has brought out Rural Roads manual (RRM) IRC SP 20:2002. The design aspects, in addition to planning, construction, quality control, maintenance and source of financing are dealt in the RRM. The important aspect of developing low volume roads in rural areas is to aim at providing basic access at minimum cost covering as many as villages as possible, within the allocated funds. To keep the developmental costs to minimum, yet at appropriate levels of serviceability, choice of material is an important consideration. This paper aims for design of 1.539 Km long rural road in Haridwar district connecting Beldi-village to NH-58. The road serves as a life line for people and need proper metalling. This paper discuss about surveying and levelling of proposed road, Traffic Data survey, Laboratory test of material of construction and designing of road based on codal provision.

Keywords: *PMGSY, Compaction, CBR, Survey, Pavemet design, Geometric design*

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1. INTRODUCTION

Roads are the one of the mode of transportation which could give maximum services to one and all. This mode has maximum flexibility for travel with reference to route, direction, time and speed of travel etc. through any mode of road vehicle. It is possible to provide door to door service only by road transportation.

2. CLASSIFICATION OF ROAD

The roads as classified on various basis.

2.1 Based on Utility

The different types of roads can be classified into two categories, depending on whether they can be used during different seasons of the year:

(a) All-weather roads and
(b) Fair-weather roads.

2.2 Based on type of Carriage Way

(a) Paved roads, if they are provided with a hard pavement course which should be at least a water bound macadam (WBM) layer.
(b) Unpaved roads, if they are not provided with a hard pavement course of at least a WBM layer. Thus earth roads and gravel roads may be called unpaved roads.

2.3 Based on type of Pavement surface provided

Based on the type of pavement surfacing provided; the road types are divided as:

(a) Surface roads, which are provided with a bituminous or cement concrete surfacing.
(b) Un-surface roads, which are not provided with a bituminous or cement concrete surfacing.

2.4 Based on Function

The classification based on location and function can be classified into five categories:

(a) National highways (NH) are main highways running through the length and breadth of India, connecting major ports, other highways, capitals of the states and large industrial and tourist centers including roads required for strategic movements for the Defence of India.
(b) State Highways (SH) are arterial roads of a state, connecting up with the national highways of adjacent states, district head quarters and important cities within the state and serving as the main arteries for traffic to and from district roads.

(c) Major District Roads (MDR) are important roads within a district serving areas of production market and connecting those with each other. The MDR has lower speed and geometric design specifications than NH/SH.

(d) Other District Roads (ODR) are road serving rural areas of production and providing them with outlets to market centers, talukhead quarters, block development head quarters or other main roads. These are of lower design specifications than MDR.

(e) Village Roads (VR) are roads connecting villages or a group of villages with each other to the nearest road of a higher category.

3. DESIGN OF RURAL ROADS

Basically, the design of roads involves geometric design as well as pavement design. The standards for geometric design provide for appropriate parameters as well as the standards for them, keeping in view the functionality of rural roads, with the main objective of providing safe and efficient roads. Though, the geometric standards may marginally affect the economy in the construction, choice is left to the designer for deviating from the standards in order to achieve the objectives namely safety and efficiency on the rural roads.

However, the pavement design controls the economy in road construction with a wide choice of methods of design and materials used in the construction.

3.1 Design Parameters for the Pavement

It is an established fact that the choice of the type of pavements and its design is normally decided based on the initial construction cost, availability of the required material, cost of maintenance or rehabilitation during the service life of the road and technology. Even though, variety of pavements types are available and are technically feasible, flexible pavements are the main choice for the rural roads due to the inherent ease with which they can be designed and constructed. In this context, it is relevant to state that the design of flexible pavement including the surface requires full consideration, keeping in view the likely deterioration and frequency of maintenance required during service life, so as to achieve optimality with respect to pavement crush as well as surfacing. It may be emphasized here that providing only bituminous is not the answer in the construction of rural roads.

For the design of flexible pavement, the main parameters identified are the type soil subgrade as reflected in its strength or load bearing capacity and expected traffic on the road during its design period intense of annual average daily traffic(AADT), particularly the commercial vehicles, normally referred to as CVPD ie. Commercial Vehicle Per Day. One should always keep in mind that due consideration is to be given for the environmental factors at the location of the roads while finalizing the design of flexible pavements. The main issues that required that to be understood and to be addressed, while designing the flexible pavements are the number of layers and the constitution of each layer with different materials, so as to achieve the objectives of pavement design namely load bearing capacity, load dispersion, elastic deformation, riding quality and the durability. It is worth stating here that rural road is an engineering structure and is to be designed taking care of all factors in preventing in premature failure. The issue in this context, perhaps, is the appropriate design selecting the material for different layers in the light of number of alternatives and options open to the designer.

3.2 Codes for Design

3.2.1 IRC SP:20

It give the idea about designing the rural road which tend to have distinctly different road conditions with regard to usage, management and funding. The guide contain by this IRC SP:20 are based on current knowledge and experience. This was initially prepared by the Indian Roads congress secretariat and considered by Rural Road Committee in their meeting held on 17th October 1975 at Madras, 3rd January 1976 at Hyderabad, 3rd November at New Delhi and finally approved by them in their meeting held on the 19th December 1977 at Calcutta.

3.2.2 IRC 37:2001

This IRC gives guidelines for the design of flexible pavements for Expressways, National Highways, State Highway, major District Road and other all type of road predominantly carrying motorised vehicles.

4. AREA UNDER STUDY

The location of our study is a rural road connecting NH-58 to Beldi village. The Beldi village inhabit about 500 people. The road is about 1.5 km long. The road start near by mile stone no. 8 from Roorkee city. The mile stone lies at about 1 km from kaliyar mod. Important building nearby is Montfort School.

Fig -2: Shows the google map image of road under study. The road strech is almost straight and does not required any cross drainage work.

5. EXPERIMENTAL PROGRAMME

The ground leveling is done with the help of Autolevel. For the design of pavement the value of predicted commercial vehicle per day (PCVPD) is needed. The value of PCVPD is calculated from traffic data survey of road.72 hr or 3 days continuous traffic data is collected from the site. The vehicle crossing per 6 hour duration is average for 3 days and multiplied with percentage car unit to get the value of cumulative PCU. Maximum dry density (MDD) and optimum moisture content (OMC) of soil was determined by standard proctor tests as per IS:2720 (Part VII)-1980. In present investigation CBR test was determined as per recommendations in IS:2720 (Part 16)-1987.

6. RESULTS AND DISCUSSION

6.1 Survey

The ground over which the road is proposed is highly undulating. Fig- 3 shows an average variation of 3 m height in total sketch of road. Sufficient cutting and filling is needed which require the leveling surveying of site.

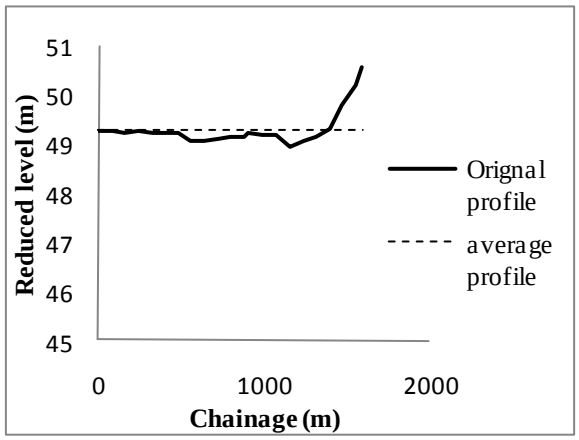

Fig -3: Variation of Reduce Level with Chainage

6.2 Compaction

The optimum moisture content of soil is 17% and maximum dry density of soil is 1.995 x 10^{-3} Kg/cm^3 by standard proctor test.

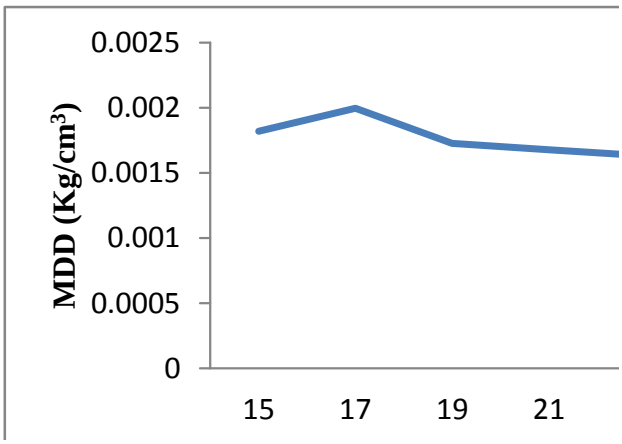

Fig -4: Graph obtained for Calculation of O.M.C and M.D.D

6.3 California bearing ratio test (CBR)

This is a penetration test developed by the California Division of Highways, as a method for evaluating the stability of subgrade and other flexible pavement materials. The test results have been corrected with flexible pavement thickness requirements for highways and air field. Fig- 5 shows CBR at 2.5 is 4.2% and CBR at 5.0 is 4.0%. Since CBR at 2.5 is greater than CBR value at 5 so we have to design pavement keeping CBR 4.2%.

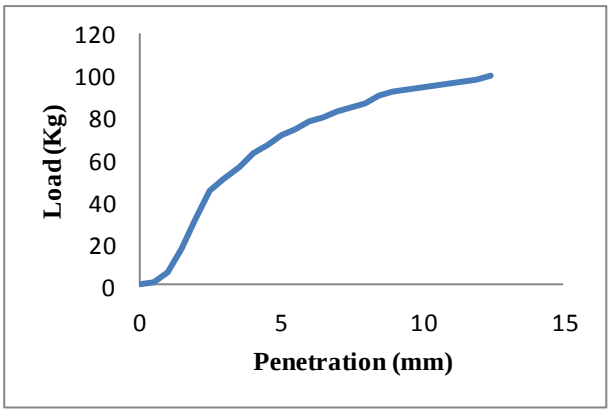

Fig -5: Variation of load with penetration for C.B.R test

6.4 Geometric Design as per IRC SP 20:2001 Recommendation

6.4.1 Design Speed

Table -1: Design speed Recommended and taken

Road Type	Design speed		Taken design speed (kmph)
	Plane terrain		
	Rolling design speed	Minimum design speed	
Rural road	50	40	45

6.4.2 Road Land Width

Table -2: Road Land Width recommended and taken

Road Type	Road land width -m				Taken land width (m)
	Plane and rolling terrain				
	Open areas		Built up areas		
	Normal	range	Normal	range	
Rural road	12	12-18	10	10-15	15

6.4.3 Width of Roadway in Plain and Rolling Terrain

Table -3: Width of Roadway in plain recommended and taken

Road Type	Roadway width	Take roadway width(m)
Rural road	7.5	7.5

6.4.4 Carriageway Width

Table -4: Carriageway width recommended and taken

Road Type	Carriageway width	Taken carriageway width(m)
Rural road	3.00	3.75

6.4.5 Camber (cross fall)

Table -5: Recommended Camber and taken

S.No.	Surface Type	Camber (%)	Taken camber (%)
1	Thin bituminous surfacing	2.0 – 2.5 (1 in 50 to 1 in 40)	2.5 (1 in 40)
2	Water bond macadam, gravel	2.5 – 3.0 (1 in 40 to 1 in 33)	1 in 36
3	Earth	3.0 – 4.0 (1 in 33 to 1 in 25)	4 (1 in 25)

6.4.6 Slope of Cut

Table -6: Slope of Cut recommended and taken

Type of soil	Slope	Taken slope
Ordinary soil	1:1 to ½:1	2:1

6.5 Pavement Design

The pavement can be either flexible i.e. bituminous or concrete. For our case we are considering only the case of flexible pavement. The thickness of pavement is designed on the basis of projected number of commercial vehicles for the design life the subgrade strength value in term of CBR. It is expected that rural road will not have more than 15 cvpd.

The design chart may be referred to obtain the total pavement crust thickness (granular crust thickness) required over the subgrade for the design life of the pavement. Based on the strength of granular materials that are used, the total design thickness is divided into base and sub-base thicknesses. However, any other higher type of bituminous layer can be part of the designed thickness, with the exception of thin bituminous surfacing (PMC>MSS etc.). In case of rural roads, with low volume of traffic, structural layer of bituminous mix need be provided. The Design Crust thickness is based on CBR values, Traffic Values and CBR curves. The formula for predicting future traffic as per IRC : SP20:2002 clause 5.2.4 is $A= [P(1+r)^{n+x}]$

7. CONCLUSION

The various results obtained can be summarized as:-

1) Geometric design of road sections.

Formation Width 3.75 m
Embankment Height 0.6 to 0.8 m
Carriage way width 3.75 m
Camber in carriage way 3%
Camber in shoulders 4%

2) Pavement design of road sections include table.

Table -7: Pavement design

Road Length in km	Design thickness in mm	Proposed thickness in mm	GSB –I Layer in mm	GSB –II Layer in mm	G-2 in mm	G-3 in mm	PC in mm
1.595	250	250	150	0	50	50	20

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BIOGRAPHY

Currently pursuing M-Tech in Civil Engineering with major in Soil Mechanics & Foundation from G.B Pant Nagar University. Completed graduation in Civil Engineering from College of Engineering Roorkee (2009-2013). Worked on civil projects with L&T and World Bank funded project as a trainee