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Rural Road Pavement Performance Evaluation and Design– A Case Study

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Abstract: In this work, a rural road is constructed and considered under the project of PMGSY from Utterbani to Marikhui, Purmandal Taluka, Samba District, Jammu and Kashmir State, and India for Pavement Performance Studies. The objective of the work was to conduct Pavement Performance Studies and on this road which includes Structural and Functional Evaluations and design of pavement. Road inventory survey included the findings relating to properties of bitumen and soil, rainfall, temperature, properties of shoulder material, subbase, base and type of adjoining land etc. In periodic survey surface drainage rating, roughness value, subgrade moisture content has been investigated. In pavement condition survey, rut depth, longitudinal depression, cracking of bituminous layer, the percentage of traveling, the severity of potholes and area of patching has been measured. In the traffic survey, different types of vehicles including commercial vehicles have been recorded for 24 hours X 3 days for the computation of MSA. In the axle load surveys, type of vehicle, a number of axles and load on each axle will be recorded to determine the vehicle damage factor (VDF). In the non-destructive structural evaluation, deflection studies would be done. The distresses observed on this road are a few percentages of traveling, road cutting, patching, potholes, and roughness. The comparison has been done considering pavement condition index (PCI). This paper attempts to address the issues relating to the design of such village road through which all-round development of the district can be achieved.

Keywords: Pavement, Roughness, Inventory, Shoulder, Bitumen, Potholes, Raveling, Axle Load, MSA.

1. INTRODUCTION

The primary objective is to stipulate the unconnected inhabitant's all-weather road access. The Sub-project road UTTERBEHANI to MARIKHUI is a link road with Code {L025} in {Purmandal} block of {Samba} District. This road directly connects the habitations of {Marikhui} with populations of {1250} respectively. Thus this link road serves the total population of {1500}.The road passes through a hilly tract of land.The road provides connectivity to Village Marikhui, Protection works and CD Works are to be provided through the road. Utterbehani latitude 32 degrees 34 minutes 30-second longitude 75 degrees 15 minutes Marikhui latitude 32 degrees 34 minutes 30-second longitude 75 degrees 13 minutes. The soil is typically alluvial and average annual rainfall is 1328.60 mm.

2. METHODOLOGY

The details of surveys including inventory studies and investigations carried out during the feasibility study are:

1. Topographic survey

Traversing: Traverse was done prismatic compass having an angular measurement accuracy of ± 1 sec.
Leveling: Leveling was carried out by auto level. Cross Section & Detailing: Cross sections were taken at 25 m interval and at a closer interval in the curved portion of the proposed road. All physical features of the area were recorded.

2. Soil and material survey

The potential sources of borrow areas for soil and quarry sites will be identified. Soil samples will be collected along and around the road alignment at three (3) locations per km, from the adjoining borrow areas, as well as one sample is collected from the existing road. Soil Classification tests like grain size analysis and Atterberg's limit were conducted for all the samples collected. Standard Proctor test and the corresponding 4 day soaked CBR test were conducted either for a minimum of one test per km for soil samples of the same group or more tests due to the variation of soil type.

3. Traffic survey

Traffic surveys were conducted on the project road and traffic volume counts were conducted for 3 days, and the number of vehicles plying on the road was recorded. From the classified traffic volume counts, the number of commercial vehicles (>3T} were considered in the pavement design. The details were tabulated about the number of commercial vehicles per day at present playing on the road and the estimated number of vehicles that will play on the road at the end of design life.

S.no	From	To	Length in km	Present CPVD	Projected CPVD
1.	Utterbhani	Marikhui	1.00km	46	74

4. Hydrological survey

The hydrological survey is necessary for the design of adequate and safe Cross Drainage Structures so that the rain water can pass as per natural slope. Hydrological survey of the proposed road is based on the following observations:

- Rainfall Data
- Catchments Area
- Time of Concentration

Existing Cross Drainage Structures

5. Design Geometrical standards

The geometric design standards for this project in accordance with PMGSY guidelines and the guidelines as stated in IRC-SP 20:2002. Recommended design standards vis-à-vis the standards followed for this road are described below

Terrain: The classification of a tract of land was selected from plain/rolling/hilly/steep classification for which following criteria will be applicable.

Road Way Width: Roadway width for this road is given as:

Terrain Classification	**Roadway Width (m)**
Plain and Rolling	7.5
Mountainous and Steep	6.0

Carriageway Width

The width of the carriageway for this project road is 3.75m. Carriageway width may be curbed to 3.0m, where traffic intensity is less than 100 motorized vehicles per day and where the traffic is not likely to increase due to situation, like dead end, low habitation and difficult terrain condition

Sight Distance

Design Speed (km/hr)	**Safe Stopping Sight Distance (m)**
20	20
30	30
40	45
50	60

Camber & Super Elevation

A chamber adopted on this road section is given below. The maximum superelevation is 5.0% for this project road

Surface type	Camber (%)	
	Low rainfall (Annual rainfall <1000mm)	High rainfall (Annual rainfall >1000mm)
Earth road	4.0	5.0
WBM Gravel road	3.5	4.0
Thin bituminous road	3.0	3.5
Rigid Pavement	2.0	2.5

3. COST ESTIMATE

Cost Estimate of project has arrived on the following basis

- Selection of Items of work
- Estimation of item wise quantities
- Analysis of Rates

Terrain classification	Cross slope of the country	
Rolling	10-25%	1 in 10 to 1 in 4
Mountainous	25-60%	1 in 4 to 1 in 1.67

Estimation of Quantities

All the pertinent road and structure work Items will be identified as per survey, design, and drawings. Following item of works considered are given below:

- Site clearance, dismantling, and earthwork
- Pavement works (GSB, WBM, Bituminous layers)
- Cross drainage structure works
- Drainage and protective works
- Utility relocation
- Road safety and furniture
- Maintenance works

The quantity of earthwork will be derived from the proposed cross section drawings. The volume of cut and fill will be obtained directly using the design package software. Quantity conjugated from software will be manually verified. There are same stretches of the road in a cut section. All other quantities will be computed from the drawings of finished road, miscellaneous drawings. In addition to this, the use of waste and recycled materials in construction applications has many environmental welfares including cost saving in terms of their disposal, dumping and potential recyclability. Examples of such waste materials include recycled crushed brick, construction demolition materials(C&D), factory- waste roof shingles, reclaimed asphalt shingles (RAS), cement kiln dust (CKD), etc. The need to manage these materials has led to environmentally- friendly actions that promote the reuse and recycling of this type of waste. The use of secondary (recycled) materials instead of primary (virgin) materials helps abatement landfill pressures and reducing demand of extraction.

CONCLUSION

Based on the field work, traffic studies and reviewing various IS codes for rigid and flexible pavement design, subgrade, and CBR and keeping the economy in consideration, the following composition has been suggested for the project under study.

Flexible pavement composition

S.no	Road Reach	Present	GSB(mm)	WBM(mm)	Surface(mm) OGPC
1.	Km 0 – 1	84	250	150	20

Rigid pavement composition

S.no	Road Reach	Present	WBM(mm)	CC(mm)
1.	Km 0 – 1	84	0	200

Rigid pavements have a higher compressive strength which tends to distribute the load relatively over a wide area of soil. Other advantages include long life span, extreme durability; High value as a base for future resurfacing with asphalt, decreasing base and sub base requirements.

On the other hand, the Flexible pavements consist of a series of layers with the highest quality material at or near the surface. These are not so rigid and can corrugate over heavy traffic. But they are advantageous to stage construction and can be easily maintained.

At last, the choice of pavement has always been considered as a complicated and tricky decision as it involves not only tedious field work, laboratory calculations etc but also on the economic and geopolitical influences on the project at the time of designing and constructing the road.

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