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Alternate Design Proposal For Rural Infrastructure Development Under MGNREGA

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Abstract

MGNREGA is a labour law that aims at providing employment and ensures livelihood security in the rural areas. Many projects are being implemented under MGNREGA related to civil works in the rural areas, which need to be executed properly under technical guidance. The scenario so far is such that the works are not being executed with proper quality and so the projects are being handed over to the engineering students. Here, in this project we have analyzed the works executed under MGNREGA and accordingly we have given alternative design proposals for road and canal works.

Keywords*-MGNREGADesignRoad;Canal;RuralInfrastructure;Lining;Pavement;*

I. INTRODUCTION

Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) implemented by the Ministry of Rural Development (MoRD), is the flagship programme of the Government that directly touches lives of the poor and promotes inclusive growth. In Gujarat, rural infrastructural works under MGNREGA are being handed over to the BE final year students by GTU so that they can study the technical features and feasibility of the civil works and provide an improved design solutions with quality audit for such works.
The Act aims at enhancing livelihood security of households in rural areas of the country by providing at least one hundred days of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work. Mahatma Gandhi MGNREGA is the first ever law internationally that guarantees wage employment at an unprecedented scale. The primary objective of the Act is augmenting wage employment and its auxiliary objective is strengthening natural resource management through works that address causes of chronic poverty like drought, deforestation and soil erosion and so encourage sustainable development.

In order to provide employment as well as develop the rural areas, MGNREGA has implemented Rural Infrastructure Development Projects(RIDP). Under RIDP, various rural facilities are being developed in many villages of the country like road network, canal systems, sanitation works, flood control works, drought proofing, rain water harvesting, etc.
But, due to lack of availability of skilled and professional workers, the works are not being executed as per the expectations.
Thus, here we have surveyed and analyzed the designs of the works near the coastal area of valsad city located in south of Gujarat

II. DETAILS OF STUDY AREA

The location of our study selected by us is based on the various parameters, mainly which villages are most required to be audited implemented under MGNREGA in district Valsad.

District: Valsad
Taluka: Valsad
Villages: Bhagal, Chharvada, Dandi, Dharasana, Kakwadi Danti, Malvan, Vasan
Area: Coastal Highway

Table 1.Demographical details

Villages	Area (ha)	Population	Nos. of houses	Total workers	Literacy (%)	Sex ratio
Bhagal	915.2	2455	504	845	90.79	936
Chharvada	911.4	3422	792	1282	91.45	941
Dandi	1022.9	3162	619	1307	90.67	948
Dharasana	453.8	2252	560	985	93.47	917
Kakwadi Danti	8785	8785	1665	2549	91.34	914
Malvan	3355.2	5165	1155	2247	90.91	924
Vasan	667.5	2963	682	1220	91.41	893

Table 2.Case study analysis

Village Name	Type Of Work	Expenditure on work		Cost (estimated)			
				Material		Labour	
		Estimated	Actual	Estimated	Actual	Estimated	Actual
Bhagal/Nani Bhagal	WBM	500000	413125	181827.6	189633.6	299917	223491
	WBM	485384	439918	224457.6	230531.1	251523	209387

III. DESIGN OF RURAL ROADS (FLEXIBLE PAVEMENT)

3.1. Design Criteria.

The flexible pavements has been modeled as a three layer structure and stresses and strains at critical locations have been computed using the linear elastic model. To give proper consideration to the aspects of performance, the following three types of pavement distress resulting from repeated (cyclic) application of traffic loads are considered:

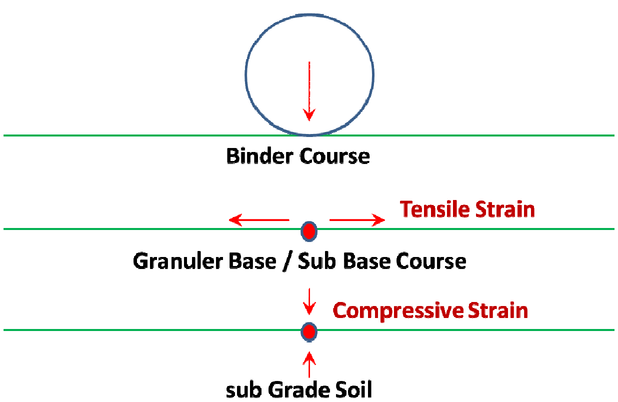

Figure 1.Strains in pavement

3.1.1. Vertical compressive strain.

Vertical compressive strain at the top of the sub-grade which can cause sub-grade deformation resulting in permanent deformation at the pavement surface

3.1.2. Horizontal tensile strain.

Horizontal tensile strain or stress at the bottom of the bituminous layer which can cause fracture of the bituminous layer.

3.1.3. Pavement deformation within the bituminous layer.

While the permanent deformation within the bituminous layer can be controlled by meeting the mix design requirements, thickness of granular and bituminous layers are selected using the analytical design approach so that strains at the critical points are within the allowable limits. For calculating tensile strains at the bottom of the bituminous layer, the stiffness of dense bituminous macadam (DBM) layer with 60/70 bitumen has been used in the analysis.

3.2. Fatigue Criteria.

Bituminous surfacing of pavements display flexural fatigue cracking if the tensile strain at the bottom of the bituminous layer is beyond certain limit. The relation between the fatigue life of the pavement and the tensile strain in the bottom of the bituminous layer was obtained as

$$N_f = 2.21 \times 10^{-4} \times \left(\frac{1}{\epsilon_t}\right)^{3.89} \times \left(\frac{1}{E}\right)^{0.854}$$

in which, Nf is the allowable number of load repetitions to control fatigue cracking and E is the Elastic modulus of bituminous layer. The use of equation 28.1 would result in fatigue cracking of 20% of the total area.

3.3. Rutting Criteria.

The allowable number of load repetitions to control permanent deformation can be expressed as

$$N_r = 4.1656 \times 10^{-8} \times \left(\frac{1}{\epsilon_z}\right)$$

Nr is the number of cumulative standard axles to produce rutting of 20 mm.

3.4. Design procedure.

Based on the performance of existing designs and using analytical approach, simple design charts and a catalogue of pavement designs are added in the code. The pavement designs are given for subgrade CBR values ranging from 2% to 10% and design traffic ranging from 1 msa to 150 msa for an average annual pavement temperature of 35 C. The later thicknesses obtained from the analysis have been slightly modified to adapt the designs to stage construction. Using the following simple input parameters, appropriate designs could be chosen for the given traffic and soil strength:

- Design traffic in terms of cumulative number of standard axles; and
- CBR value of subgrade.

3.5. Design traffic.

The method considers traffic in terms of the cumulative number of standard axles (8160 kg) to be carried by the pavement during the design life. This requires the following information:

3.5.1. Initial traffic in terms of CVPD

Initial traffic is determined in terms of commercial vehicles per day (CVPD). For the structural design of the pavement only commercial vehicles are considered assuming laden weight of three tonnes or more and their axle loading will be considered. Estimate of the initial daily average traffic flow for any road should normally be based on 7-day 24-hour classified traffic counts (ADT). In case of new roads, traffic estimates can be made on the basis of potential land use and traffic on existing routes in the area.

3.5.2. Traffic growth rate during the design life

Traffic growth rates can be estimated (i) by studying the past trends of traffic growth, and (ii) by establishing econometric models. If adequate data is not available, it is recommended that an average annual growth rate of 7.5 percent may be adopted.

Initial traffic volume in terms of commercial vehicles per day	Terrain	
	Rolling/Plain	Hilly
0-150	1.5	0.5
150-1500	3.5	1.5
More than 1500	4.5	2.5

3.5.3. Design life in number of years

For the purpose of the pavement design, the design life is defined in terms of the cumulative number of standard axles that can be carried before strengthening of the pavement is necessary. It is recommended that pavements for arterial roads like NH, SH should be designed for a life of 15 years, EH and urban roads for 20 years and other categories of roads for 10 to 15 years.

3.5.4. Vehicle damage factor (VDF)

The vehicle damage factor (VDF) is a multiplier for converting the number of commercial vehicles of different axle loads and axle configurations to the number of standard axle-load repetitions. It is defined as equivalent number of standard axles per commercial vehicle. The VDF varies with the axle configuration, axle loading, terrain, type of road, and from region to region. The axle load equivalency factors are used to convert different axle load repetitions into equivalent standard axle load repetitions. For these equivalency factors refer IRC:37 2001. The exact VDF values are arrived after extensive field surveys.

The design traffic in terms of the cumulative number of standard axles to be carried during the design life of the road should be computed using the following equation:

$$N = \frac{365 \times [(1+r)^n - 1]}{r} \times A \times D \times F$$

Where,

N = Cumulative number of standard axles to be catered for in the design in terms of msa.

A = Initial traffic in the year of completion of construction in terms of the number of Commercial Vehicles per Day (CVPD).

D = Lane distribution factor

F = Vehicle Damage Factor (VDF).

n = Design life in years.

r = Annual growth rate of commercial vehicles in decimal (e.g., for 5 per cent annual growth rate, r = 0.05).

3.5.5. Distribution of commercial traffic over the carriage way

A realistic assessment of distribution of commercial traffic by direction and by lane is necessary as it directly affects the total equivalent standard axle load application used in the design. Until reliable data is available, the following distribution may be assumed.

- Single lane roads: Traffic tends to be more channelized on single roads than two lane roads and to allow for this concentration of wheel load repetitions, the design should be based on total number of commercial vehicles in both directions.
- Two-lane single carriageway roads: The design should be based on 75 % of the commercial vehicles in both directions.
- Four-lane single carriageway roads: The design should be based on 40 % of the total number of commercial vehicles in both directions.
- Dual carriageway roads: For the design of dual two-lane carriageway roads should be based on 75 % of the number of commercial vehicles in each direction. For dual three-lane carriageway and dual four-lane carriageway the distribution factor will be 60 % and 45 % respectively.

3.6. Pavement thickness Design Charts.

For the design of pavements to carry traffic in the range of 1 to 10 msa, use chart 1 and for traffic in the range 10 to 150 msa, use chart 2 of IRC:37 2001. The design curves relate pavement thickness to the cumulative number of standard axles to be carried over the design life for different sub-grade CBR values ranging from 2 % to 10 %. The design charts will give the total thickness of the pavement for the above inputs. The total thickness consists of granular sub-base, granular base and bituminous surfacing. The individual layers are designed based on the recommendations given below and the subsequent tables.

3.7. Pavement Composition.
Sub-base materials comprise natural sand, gravel, laterite, brick metal, crushed stone or combinations thereof meeting the prescribed grading and physical requirements. The sub-base material should have a minimum CBR of 20 % and 30 % for traffic up to 2 msa and traffic exceeding 2 msa respectively. Sub-base usually consist of granular or WBM and the thickness should not be less than 150 mm for design traffic less than 10 msa and 200 mm for design traffic of 1:0 msa and above.

The recommended designs are for unbounded granular bases which comprise conventional water bound macadam (WBM) or wet mix macadam (WMM) or equivalent confirming to MOST specifications. The materials should be of good quality with minimum thickness of 225 mm for traffic up to 2 msa an 150 mm for traffic exceeding 2 msa.

The surfacing consists of a wearing course or a binder course plus wearing course. The most commonly used wearing courses are surface dressing, open graded premix carpet, mix seal surfacing, semi-dense bituminous concrete and bituminous concrete. For binder course, MOST specifies, it is desirable to use bituminous macadam (BM) for traffic up to 5 msa and dense bituminous macadam (DBM) for traffic more than 5 msa.

IV. DESIGN OF LINED IRRIGATION CANAL

Estimate n or C for specified lining material and S_0

Compute the value of section factor $AR^{\frac{2}{3}} = nQ/\sqrt{S_0}$ or $AR^{\frac{2}{3}} = Q/(C\sqrt{S_0})$

Solve section factor equation for yn given appropriate expressions for A and R .This step may be required with assumptions regarding side slopes, bottom widths, etc.

If hydraulically efficient section is required, then the standard geometric characteristics (click) are used and yn is to be computed.

Check for
1. Minimum permissible velocity if water carries silt and for vegetation
2. Froude number

(Check Froude number and other velocity constraints such as (for non-reinforced concrete linings $V \leq 2.1$ m/s and Froude number ≤ 0.8. For reinforced linings $V \leq 5.5$ m/s)).
Generally, Froude number should be as small as possible for Irrigation canals and should be less than 0.35. Higher Froude numbers is permitted as in the case of super critical flows such as in chutes, flumes. Decide the dimensions based on practicability.

IV. RESULT

The design proposed here is for the coastal rural areas near Valsad city.
The present scenario in these areas, as being executed by the MGNREGA employees, is as follows:

- Estimate carried out is very inaccurate and high as compared to the works executed.
- The designs made are of poor quality and simple WBM class roads and unlined canals.
- The works executed at present need proper alternative solutions for executing quality works.

The design proposed here, if implemented properly, would result into following:

- The estimates would be calculated more accurately and economy would be maintained.
- Roads of bituminous class would be developed in almost the same cost as that used for WBM roads at present.
- Lined canals could be provided at nominal cost.
- Quality assuring works of good durability could be provided.

V. CONCLUSION

From the case study, we can conclude that the alternate design proposal mentioned here would prove to be more sustainable and cost effective for the government.
The design provided for roads is based on IRC37:2001, which includes detailed study of almost each and every parameter required for designing a flexible pavement. This design would definitely improve the efficiency of rural transport system. Moreover, it would also prove to be cost effective, thus providing better quality roads in an economical cost.
Also, the canal design is provided for lined canals. So if implemented, it would improve the conveyance efficiency, reduce the water losses of the canals and again provide an economical and more sustainable structure requiring less maintenance.

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