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Improvement of Road link between Ladvel Crossing to Pankhiya Junction

D. H. Modi[1], Prof. P. M. Shah [2], Dr. H. R. Varia [3]

[1]M. E. Student, Tatva Institute of Technological Studies, Modasa, Gujarat
[2]Lecturer & Head (I/C) in Civil Engineering Department, Government Polytechnic, Godhra, Gujarat
[3]Principal, Tatva Institute of Technological Studies, Modasa, Gujarat

Abstract —***Over loading commercial trucks in India is a serious problem. Traffic load is dominant function on flexible pavement design because the main function of pavement is to resist traffic load. Some roads are not designed for carry heavy load. In functional behavior visual observed by measuring cracking, rutting, potholes, reveling, patching in deterioration pavement. Traffic volume count is required for calculate the load on road. In the structural evaluation of flexible pavement the pavement deflection is measured by the Benkelman beam. The objective of the present study to evaluate the sub-grade soil parameter, traffic volume, requirement of overlay design for future traffic conditions.***

Keywords-Traffic volume count, CBR test, Benkelman Beam Method, MSA at present and future, Overlay design of pavement.

I. INTRODUCTION

After independence in India there is substantial development in road network compared to railway network. There is tremendous growth in population as well as in vehicle ownership. Due to industrial and commercial development most of the freight transport is shared by trucks on the road network. Heavily loaded truck drivers are mainly using National Highway and State Highway for speedy movements. In the recent trend many toll plaza are installed on National Highway and State Highway for collecting toll charges to recover the construction and maintenance cost by the construction companies. Therefore, the tendency of the truck driver is to divert their routes from the tolled roads. This behaviour results in damaging the untolled road links rapidly. These road links are generally not designed for unexpected diverted heavy truck traffic. Ultimately this links required frequent maintenance, causing higher maintenance cost, whereas toll plaza can't collected the expected toll charges. This situation leads to construct toll plaza on untolled road links also.

The similar type of situation is occurred on state Highway no. 188 (Vadodara-Piplod-Umreth Vasad-Sarsa-Bhalej-Pansora-Ladvel-Chikhlod-Antisar-Bibipura-Modasa road (Break up of Kheda Dist.). At present trucks traffic of Mumbai-Delhi route is moving on National Highway No.8 are diverting from Shamlaji-Modasa-Malpur-Lunavada-Godhra-Vadodara and then joins NH-8. As this Halol-Shamlaji (SH-145) is upgraded into four lane divided highway with 5 toll plaza (Modasa, Malpur, Shahera, Bhediya, Halol) to avoid the excess payment on these toll plazas truck drivers diverting their route on Modasa-Dhansura-Bayd-Pankhiya-Ladvel-Bhalej-NE1/NH-8 road having only 2 toll plaza (less toll charges Approx. 1000 Rs.).

Due to this diversion the weakest link Pankhiya to Ladvel is over stressed by the heavily loaded trucks loaded trucks. This link is totally damaged due to heavy truck loads which requires immediate attention for necessary improvement in pavement overlay design. In this regard this study is aim to suggest the necessary steps for improvement in pavement condition of Ladvel crossing to Pankhiya junction road link (16.5 Km length).

(Source: Google maps)

Fig. 1: Road network between Ladvel crossing to Pankhiya junction

Aim of the study

The aim of this study is to suggest the necessary measures to improve the existing pavement condition of Ladvel crossing to Pankhiya junction link.

Objective of the study

- To determine the existing pavement condition of the selected link.
- To evaluate the sub-grade soil parameter, traffic volume, requirement of overlay design for future traffic conditions.

Scope of the study

- This study is limited to suggest the improvement of pavement condition of the Ladvel crossing to Pankhiya junction link.
- This study will enable to give information regarding existing wheel load repetition (Million Standard Axles-MSA) on the selected link.
- This study will enable to give information regarding existing pavement strength, sub-grade soil parameters, and geometric details.
- This study will also enable to quantify the overlay design parameters for existing as well as future traffic.

II. LITERATURE REVIEW

Adu-Gyamfiet al. (2006) have studied ability of a pavement to withstand traffic loads and serve the motoring public in a safe and efficient manner that adversely affected by the observable pavement surface distresses. Therefore, monitoring the performance of pavement will help to objectively determine the current condition of the pavements and, consequently, a management plan for maintenance, rehabilitation, or reconstruction. The current study builds a complete vision system and integrates its output into geographic information systems (GIS) for automated pavement monitoring and management. The system consists of an image retrieval algorithm which increases the sampling of pavement image data and reduces the computational time for processing acquired data. Also, a novel model method for edge detection, called active contours or snakes, is introduced. The active contour models show promise in detecting pavement distresses in very noisy environments. Their ability to split and match different topologies of the image data is essential for accurate crack location and shape detection. Finally, the output of the vision system is successfully integrated into GIS through concepts such as automated georeferencing and vectorization. Overall, the system is designed to overcome challenges associated with platform differences, complete automation, and processing of massive data sets.

Datta (2013) has studied that India's Golden Quadrilateral program aimed at improving the quality and width of existing highways connecting the four largest cities in India. This affected the quality of highways available to firms in cities that lie along the routes of the four upgraded highways, while leaving the quality of highways available to firms in other cities unaffected. This feature allows for a difference-in-difference estimation strategy, implemented using data from the 2002 and 2005 rounds of the World Bank Enterprise Surveys for India. Firms in cities affected by the Golden Quadrilateral highway project reported decreased transportation obstacles to production, reduced average stock of input inventories (by about a week's worth of production), and a higher probability of having switched the supplier who provided them with their primary input. Firms in cities where road quality did not improve displayed no significant changes.

Samanta (2015) has studied that as per the 2011 census, rural areas account for 69 percent of India's total population. Therefore, improved connectivity and accessibility to rural areas will provide a vital impetus to the country's economic growth. Development of rural infrastructure in general and rural transport infrastructure in particular is very crucial in India. Rural road connectivity ensures access to critical services and opportunities, and fosters sustainable poverty reduction programs as well as employment generation through industrialization in rural areas. It is estimated that 20-30 percent of the agricultural, horticultural and forest produce gets wasted because of either inadequate rural road network or poor condition of roads, which creates an impedance for transporting such commodities for the user needs. Rural road accounts for 60 percent of the total road length in India. While the total rural road length was only 3,54,530 kilometres in 1970-71, it has increased to about 24,50,559 kilometres in recent times. These statistics corroborate the importance given to the development of rural roads as part of the overall development of the country. Furthermore, research suggests that public investment in infrastructure, specifically in the rehabilitation of rural roads, improves local community and market development. Studies on rural road development in several countries reported rise in male agricultural wages and aggregate crop indices (Bangladesh), increase in the availability of food, the completion rates of primary school and the wages of agricultural workers (Vietnam), etc. However, studies on Indian rural roads are almost non-existent. Against this backdrop, the present study analyses some past trends and present practices related to rural transport in India. In addition, the study investigates the impact of rural road infrastructure development on socio-economic conditions of the rural population including the overall contribution to the nation.

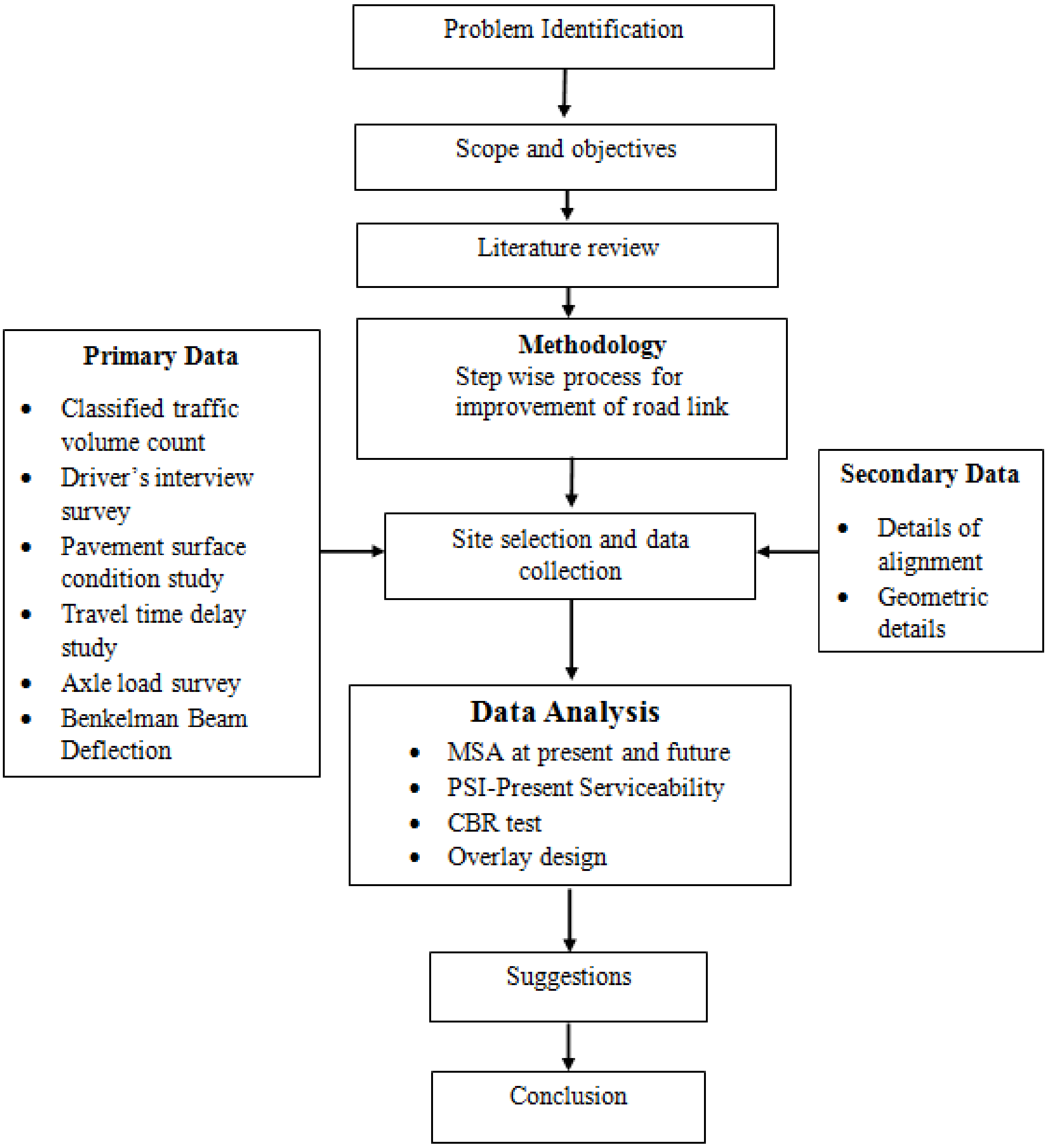
Duggal (2015) has studied to find out the impact of RBI Grade 81 at 2%, 3% and 4% mixed along with pond ash 3%, 6% and 9% on silty and clayey soil and the change in California Bearing Ratio (CBR), Dynamic cone penetration (DCP) Maximum Dry Density (MDD), Optimum Moisture Content (OMC) has been observed through different mixes of RBI Grade 81 and pond ash on soils. . The outcome helps in looking at the change in CBR, DCPT, OMC, MDD value when soils were stabilized by RBI grade 81 and soils stabilized by both RBI Grade 81 and Pond ash. This also helps to get the optimum combination of pond ash and RBI grade 81 which provides least cost technique for constructing pavement.

Cox et al. (2015) have studied for recycling of a high-traffic project (12,000 vehicles per day) on U.S. highway 49 (US-49). Sections built included asphalt emulsion–stabilized cold in-place recycling (CIR), portland cement–stabilized CIR, cement-stabilized full depth reclamation (FDR), and traditional construction. The objective of paper is to present a case study of US-49 construction and performance through approximately 4.5 years of service. Performance was characterized by a distress survey, cored properties, and falling weight deflectometer testing. In particular, findings demonstrated performance and economic trade-offs between cement CIR and emulsion CIR, which could be directly applied to planning decisions. Emulsion CIR exhibited sufficient rutting capacity but reserve cracking capacity, at higher costs relative to cement CIR. Cement CIR, however, was more economical and exhibited excess rutting capacity but not excess cracking capacity. Because there is little need for reserve capacity of one distress when other distresses are past capacity, this paper proposes balanced binder blends (examples might include 2.5% emulsion with 2% cement, or 3% emulsion with 1.5% cement) for future consideration because they can provide sufficient capacity for multiple distresses while balancing economics.

Zhang et al. (2015) have studied for life-cycle optimization (LCO) model was developed to determine an optimal preservation strategy for a pavement overlay system and to minimize the total life-cycle energy consumption, greenhouse gas (GHG) emissions, and costs within an analysis period. Using dynamic programming optimization techniques, the LCO model integrates dynamic life-cycle assessment and life-cycle cost analysis models with an autoregressive pavement overlay deterioration model. To improve sustainability in pavement design, a promising alternative material for pavement overlays, engineered cementitious composites (ECCs), was studied. The LCO model was applied to an ECC overlay system, a concrete overlay system, and a hot mixed asphalt (HMA) overlay system. The LCO results show that the optimal preservation strategies will reduce the total life-cycle energy consumption by 5–30%, GHG emissions by 4–40%, and costs by 0.4–12% for the concrete, ECC, and HMA overlay systems compared to the current Michigan Department of Transportation preservation strategies, respectively. The impact of traffic growth on the optimal preservation strategies was also explored.

III. METHODOLOGY

3.1. Methodology Chart



IV. STUDY AREA AND DATA COLLECTION

4.1. General

Ladvel crossing is at the 22°54'27.2"N, 73°07'32.7"E and Pankhiya junction at the 23°03'34.0"N, 73°10'58.2"E which is 16.5 km long and on the State Highway No. 188. Ladvel crossing is 12 km apart and Pankhiya junction is 11.5 km apart from the Kapadvanj city.

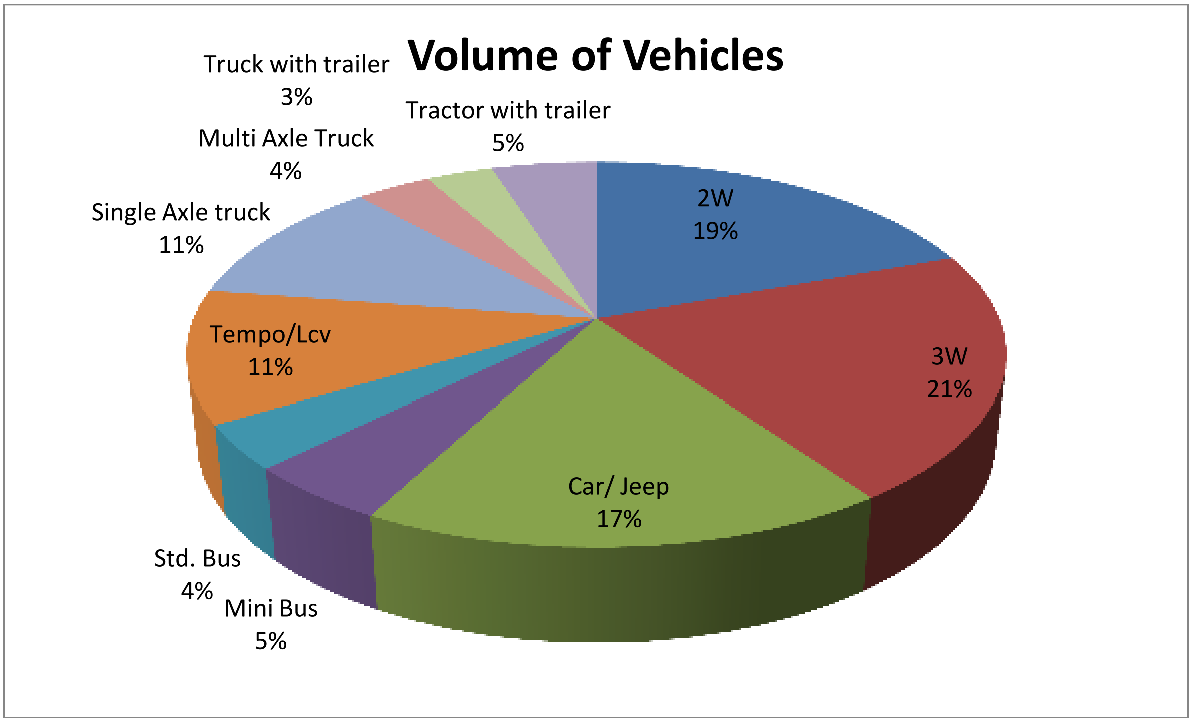
Kapadvanj is a City as well as one of the Taluka of the Kheda district in the Gujarat India. It is located on bank of river Mohar. It is 71 km away from Ahmedabad and 93 km away from Vadodara.

4.2. Classified traffic volume count

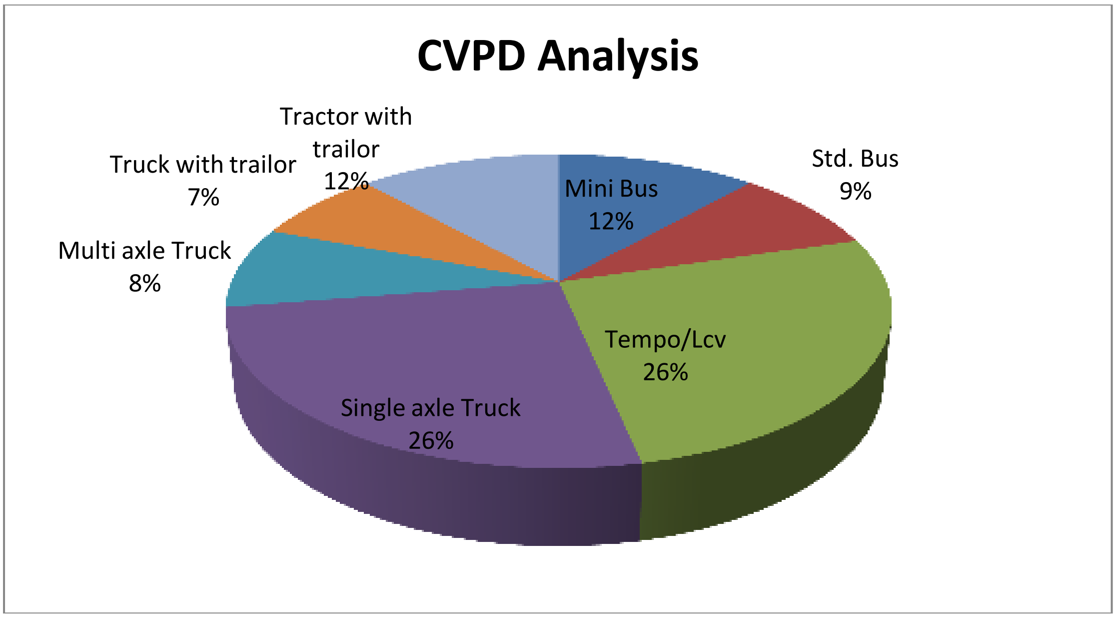
The classified traffic volume count survey has been carried out at two locations on the road link, one location at pankhiya junction and second location at ladvel crossing. Traffic counts have been recorded continuously for three consecutive days for 24 hours on each day. For carrying out the counts; the vehicles have been grouped under the following categories shown as in table

Table: Number of total vehicles of 3 day on road link

Time period				Fast Vehicles											Slow Vehicles				
FROM		TO																	
Date	Hours	Date	Hours	2W	3W	Car/ Jeep	Mini Bus	Std. Bus	Tem po/ Lcv	Single Axle truck	Multi Axle Truck	Truck with trailer	Tractor with trailer	Total of Fast Vehicles	Cycle	Cycle Rickshaw	Animal Drawn Vehicles	Other Specify	Total of Slow Vehicles
19/10/2016	6.00 A.M	19/10/2016	6.00 P.M	1645	1283	1331	358	229	760	871	185	152	412	7166	36	0	9	0	45
20/10/2016	6.00 A.M	20/10/2016	6.00 P.M	797	1452	813	209	210	608	635	316	255	295	5530	5	3	5	9	22
21/10/2016	6.00 A.M	21/10/2016	6.00 P.M	1326	1314	1272	383	281	796	613	192	205	434	6756	33	0	9	0	42
Total for 3 Days				3768	4049	3416	950	720	2164	2119	693	612	1141	19452	74	3	23	9	109
Average daily Traffic for 3 Days				1256	1350	1139	317	240	721	706	231	204	380	6484	25	1	8	3	36



No.	Type of Vehicle	Number of vehicle	Standard PCU of vehicle	Total PCU
1	2W	1256	0.5	628
2	3W	1350	1	1350
3	Car/ Jeep	1139	1	1139
4	Mini Bus	317	3	951
5	Std. Bus	240	3	720
6	Tempo/Lcv	721	1.5	1082
7	Single Axle truck	706	3	2118
8	Multi axle Truck	231	3	693
9	Truck with trailer	204	4.5	918
10	Tractor with trailer	320	4.5	1440
11	Cycle	25	0.5	13
12	Cycle Riksha	1	2	2
13	Animal Drawn Vehicles	8	6	48
14	Other Specify	3	3	9
			Total PCU of Vehicles	**11110**



4.2. Benkelman Beam Deflection Method

This test procedure covers the determination of the rebound deflection of a pavement under a standard wheel load and tyre pressure, with or without temperature measurements.

Location of test point	Dial guage reading			Measured deflection	Correction for temperature	Correction for season	Corrected deflection	Mean deflection	X-X'	$(X-X')^2=y$	Deviation	Standard deviation	Charecteristic deflection
	Initial	Intermediat	Final										
0.00	0	9	12	1.1966	0.02	1.9	2.25354	1.8045	0.449	0.2016	1.6483	0.0868	1.98
1050.00	0	18	23	0.751	0.02	1.4	1.0314	1.1858	-0.1544	0.0238	1.264	0.0665	1.32
2050.00	0	8	22	1.2548	0.02	1.5	1.8622	1.4628	0.3994	0.1595	1.7991	0.09	1.64
3050.00	0	10	20	0.9820	0.04	1.06	0.9985	1.0614	-0.0629	0.0040	0.7864	0.0414	1.14
4050.00	0	9	20	1.0402	0.04	1.06	1.0602	1.1203	-0.0601	0.0036	0.5259	0.2768	1.18
5050.00	0	8	20	1.0984	0.04	1.06	1.1219	1.1140	0.0790	0.0001	0.4868	0.0256	1.17
6050.00	0	8	21	1.1766	0.06	1.06	1.1836	1.2297	-0.0461	0.0021	0.9316	0.0490	1.33
7050.00	0	10	20	0.9820	0.06	1.06	0.9773	1.0990	-0.1217	0.0148	0.5811	0.3058	1.16
8050.00	0	7	18	1.0002	0.06	1.06	0.9966	1.1490	0.1524	0.0232	0.4785	0.0252	1.20
9050.00	0	8	21	1.1766	0.06	1.06	1.1836	1.0827	0.1009	0.0102	0.6060	0.0319	1.15
10050.00	0	6	19	1.1366	0.08	1.06	1.1200	1.1144	0.0056	0.0000	0.4290	0.2258	1.16
11050.00	0	10	26	1.4512	0.08	1.06	1.4535	1.1652	0.2883	0.0831	0.7955	0.0419	1.25
12050.00	0	10	21	1.0602	0.07	1.06	1.0496	1.0941	-0.0445	0.0020	0.9158	0.0482	1.19
13050.00	0	8	20	1.0984	0.07	1.06	1.0901	1.1448	-0.0547	0.0030	0.4159	0.0219	1.19
14050.00	0	8	19	1.0202	0.05	1.06	1.0284	1.2043	-0.1759	0.0309	0.4853	0.0255	1.26
15050.00	0	6	22	1.3712	0.05	1.06	1.4005	1.1980	0.2025	0.0410	0.7032	0.0370	1.27
16050.00	0	10	23	1.2166	0.05	1.06	1.2366	1.2470	-0.0104	0.0001	0.2789	0.0398	1.33

4.3. CBR Method

The CBR test is one of the most commonly used methods to evaluate the strength of a sub grade soil, sub base, and base course material for design of thickness for highways and airfield pavement.

Sample No.	Chainage in Km	LHS/RHS	Classification of Soil						Soil Group	OMC%	MDD gm/cc	Moisture Content	Soak CBR %
			Grain Size Analysis			Atterberg Limit							
			% Gravel	% Sand	% Silt & Clay	%L.L	%P.L	%P.I					
S-1	0/00	RHS	0	46	54	36.3	16.4	19.8	CL	16	1.644	4.16	2.54
S-2	1/00	LHS	0	50	50	31.3	17.5	13.7	ML	10	1.73	7.16	3.34
S-3	2/00	RHS	0	60	40	30	19.2	10.8	ML	12	1.73	6.38	3.47
S-4	3/00	LHS	0	9	91	31.3	17.8	13.5	ML	12	1.627	7.14	2.27
S-5	4/00	RHS	0	10	90	40	16.1	23.9	CL	16	1.666	4.16	2.94
S-6	5/00	LHS	0	17	83	38.8	16.1	22.6	CL	16	1.728	6.38	3.21
S-7	6/00	RHS	0	31	69	36.3	18	18.3	CL	16	1.778	5.63	3.87
S-8	7/00	LHS	0	12	88	37.5	16.2	21.3	SC	16	1.791	6.38	4.14
S-9	8/00	RHS	0	18	82	37.5	7.53	20	CL	11	1.765	5.26	3.74
S-10	9/00	LHS	0	24	76	32.5	17.4	15.1	ML	14	1.646	6	2.67
S-11	10/00	RHS	0	26	74	40	16.3	23.7	CL	12	1.783	4.16	4.01
S-12	11/00	LHS	0	38	62	36.3	17.6	18.7	CL	15	1.594	5.63	2.14
S-13	12/00	RHS	0	44	56	35	17.4	17.6	CL	16	1.65	6.38	2.81
S-14	13/00	LHS	0	48	52	27.5	17.6	9.87	SC-ML	13	1.631	7.14	2.4
S-15	14/00	RHS	0	36	64	37.5	15.1	22.4	CL	10	1.796	4.16	4.27
S-16	15/00	LHS	0	20	80	30	19.2	10.8	ML	14	1.689	5.63	3.07
S-17	16/00	RHS	0	43	57	36.3	18	18.3	SC	12	1.748	7.14	3.61
S-18	16/400	LHS	0	8	92	30	18	12	ML	11	1.802	6.38	4.41

4.4. MSA at present

$$N_s = \frac{365 \times A[(1+r)^x - 1)]}{r} \times F$$

Where,

N_s = The cumulative number of standard axle to be catered for in the design
A = Initial traffic in year of completion of construction in term of the number of CVPD
F = Vehicle damage factor
x = Design life in year
r = Annual growth rate of commercial vehicles in decimal

The traffic in the year of completion is estimated using following formula :

$A = P\ (1+r)^x$

Where,

P = Number of commercial vehicles as per last count
x = Number of years between the last count and the year of completion Construction

Here,

$A = 2739\ (1+0.07)^1$
A = 2930 com. veh.

Now,

$$N_s = \frac{365 \times 2930\ [(1+0.07)^{10} - 1)]}{0.07} \times 4.5$$

$$N_s = 67\ \text{msa}$$

4.4. MSA at future

Traffic growth rate as per IRC: 108-1996,
Traffic growth rate = 1.8976 x Rate of growth of GDP
Where, 1.8976 is elastic coefficient of traffic growth.
Traffic growth rate 2017-2027 = 1.8976 x 8
= 15.18 per cent
MSA at future for designing 10 year road

$$N_s = \frac{365 \times A[(1+r)^x - 1)]}{r} \times F$$

$$N_s = \frac{365 \times 2930\ [(1+0.1518)^{10} - 1)]}{0.1518} \times 4.5$$

$$N_s = 98.57\ \text{msa}$$

V. OVERLAY DESIGN OF PAVEMENT

Design curves relating characteristic pavement deflection to the cumulative number of standard axles are to be used.
The Deflection of the pavement after the corrections i.e., Characteristic Deflection is to be used for the design purposes.
The design traffic in terms of cumulative standard number of axles is to be used.
The thickness obtained from the curves is in terms of Bituminous Macadam construction.

If other compositions are to be laid then As per IRC:81-1997 Para 7.4,
1 cm of Bituminous Macadam = 1.5 cm of WBM/Wet Mix Macadam/BUSG
1 cm of Bituminous Macadam = 0.7 cm of DBM/AC/SDBC
Design of future traffic = 98.57 msa
Mean of Characteristic deflection =

$$\frac{(1.01+1.03+1.17+1.14+1.18+1.17+1.33+1.16+1.20+1.15+1.16+1.25+1.19+1.19+1.26+1.27+1.33)}{17}$$

Therefore,

Characteristic deflection = 1.19 mm

Thickness of overlay in terms of BM from the chart = 170 mm

Thickness in terms of DBM/AC = 170 * 0.7 = 119 mm

The overlay of the road link is should provide of 40 mm AC and 80 mm

VI. CONCLUSION

1. The road link of Ladvel crossing to Pankhiya junction is not designed for the over loading commercial truck load.
2. The overlay design of flexible pavement is required for the road link that calculated after Benkelman Beam Deflection method.
3. Soil capacity of less at the some portion in the road link which require improvement of capacity.

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