Improvement of Road Widening & Strengthening From Top To Arwade SH-151

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Abstract- *Transportation infrastructure plays a lead role in economic growth and development of country. The road transport is the ancient and perhaps the most widely adopted mode of transport of mankind. The road transport witnessed a tremendous growth rate after independence of our country. Pavements are the key elements of infrastructure of the country, whose functions are to promote transport activities, economic activities and to improve the standard of living. Flexible pavements undergo the functional deterioration as well as the structural deterioration simultaneously due to the combine effects of climate, environment and traffic loads. The functional deterioration is also indicated by the changes in surface condition of the pavement in the form of distress in the quality, which can be measured by simple methods it is also possible to restore the surface to original condition of the pavement by providing a profile correction course and a re-surfacing the layer and Widening and strengthening of the existing pavement. The high growth number of vehicles will increase the movement and the use of transport infrastructure. Road widening is one of the actions that can be used as the solution. However, this solution also increases the traffic performance. This is because people will switch to use the newly widened and resurface road because they believe this road can accommodate the existing and future traffic volume. For finding out the effects of road widening and strengthening towards the increasing of traffic performance and road capacity, it is necessary to conduct a research and an analysis. The road network of any city is its lifeline and the evaluation of their performance is very necessary for future traffic planning, design, operation and` Maintenance, etc. Traffic flow in most cities of India is a mixed traffic characteristic and also the traffic congestion is the common problem in most major cities in India.*

Keywords- Pavement, CBR, Traffic Survey, Traffic Projection.

I. INTRODUCTION

1.1 SITE OVERVIEW

The Government of Maharashtra through Public Works Department, entrusted to the Authority the Improvement, maintenance and management of State Highway No.151 "PN-43- Improvements to Top Wadgaon Shigaon Aashta Tasgaon Bhivghat Atpadi Dighanchi Road, SH - 151, Km 0/000 to 127/950, District Sangli (Part I -Top to Arwade Km 0/000 to Km 63/000) on HAM."

The scope of the project in PN-43 is Improvement to Top Wadgaon Shigaon Ashta Tasgaon Bhivghat Atpadi Dhighachi Road, SH-151, Km 0/000 to 127/950 (Part I- Top to Arwade Km 0/000 to Km 63/000) on Hybrid Annuity Basis. The main objective of the project is design of flexible pavement for widening carriageway, strengthening of existing carriageway, reconstruction of failed sections, if any.

We conduct necessary field investigations and suggest suitable value Engineering for project PN-43-Improvement to Top Wadgaon Shigaon Ashta Arwade Bhivghat Atpadi Dhighachi Road SH151, km 0/000 to 127/950 (Part I- Top to Arwade Km. 0/000 to Km 63/000) on Hybrid Annuity Basis.

1.2 BENKELMAN BEAM DEFLECTION SURVEY

Benkelman Beam deflection survey is carried out for evaluating residual strength of the existing pavement and assessing the strengthening requirements for the pavement. BBD test have been conducted as per C.G.R.A. method described in IRC: 81-1997.

Since the existing highway is of two-lane carriageway, it was assumed that each of the km stretch as homogeneous section and decided to have BBD deflection measurements at 20 observation points for every km length of the stretch. For better understanding of the pavement structural strength, BBD test was conducted such that, 10 observations were taken on LHS and the remaining 10 observations were taken on RHS of the carriageway in staggered manner. However, the stretches showing distress with excessive rutting, potholes and ravelling were identified and rejected for BBD test as they do not reflect the correct deflection values. Two teams with complete set of equipment and accessories were engaged to take the deflection observations all along the project stretch. Following procedure was adopted during the test as per IRC: 81

1.3 . MARKING FOR BBD TEST

BBD observation points were marked at a distance of 0.9m from BT edge (pavement edge). Two more similar points were taken at distances of 2.7 m and 9.0 m longitudinally from the first point at same transverse distance of 0.9 m from pavement edge and marked with paint. The three points thus marked became a set of points for one observation location. The process of marking set of three points at an interval of 50 m for 10 observation points along the LHS and 10 observation points along the RHS along the project stretch is repeated. After marking the deflection observation points the studies shall be carried out in the following steps: -

The truck is loaded with a rear axle load of 8170 kg and the rear dual tyre is set into inflation pressure of 5.6 kg/cm2.

The truck was slowly driven parallel to the edge and stopped such that the left side rear dual wheel is centrally placed over the first point for deflection measurement.

The probe end of the Benkelman Beam is inserted between the gaps of dual wheel and placed exactly over the deflection observation point, ensuring that the probe touches the pavement surface.

The initial dial gauge reading (Do) is noted when the dial gauge reading is stationary (or) when the rate of change of pavement deflection is less than 0.025mm per minute. Both the needles of dial gauge are set to zero-zero before fitting it to BBD instrument and locked. The readings of both the needles of dial gauge and noted down in specified format. (The least count of the large needle is 0.01mm & that of small needle is 1.0 mm)

After taking initial reading, the truck is moved forward slowly through a distance of 2.7 m from the point and stopped. When the rate of recovery of pavement is less than 0.025 mm per minute the intermediate dial gauge reading (Di) is noted down. The truck is drive forward through a further distance of 9.0 m and the final dial gauge reading (Df) is noted down, when the rate of recovery of the pavement is less than 0.025 mm per minute. The three deflection dial readings Do, Di and Df forms a set of readings at one deflection point under consideration. Similarly, the truck is moved forward to the next deflection observation point, such that insertion of the probe of Benkelman beam and procedure of noting the set of three deflection observations shall be exactly the same as explained above and repeated the same procedure at all deflection observation points. The temperature of pavement surface is also recorded with the help of thermometer by making a hole of 10-mm diameter, 45mm deep in existing B-T surface filled with Glycerol.

Variability of deflection in a given section was considered for deleting spots where extra deflection measurements have been made. For this purpose, highest and lowest values in a group of ten was compared with mean value. Whenever the highest and lowest values differ from the mean the mean by more than one third mean then extra deflection. Measurements were made at 25mm on either side of point where high or low values are observed.

Table 1: The Proposed construction package to be taken up as follows:

Sr No	Name of The Road	From Km	To Km	Length (Km)
01	PN-43 Improvement Section from Top to Arwade	0/000	63/000	53.36(excluding overlap length of 9.64 km)

The proposed configuration of the project is as under Typical Section

Carriageway including paved shoulder: 10 mt.
Earthen Shoulder : 1 mtr x 2
Side slope of Embankment : 2:1
Carriageway Camber : 2.5%
Shoulder Camber : 3.0%

1.4 OBJECTIVES

The objectives of this study are specifically given as following.

1. To study the existing traffic situation for the project corridor. Highway infrastructure projects would also require substantial up-scaling if the sector is to be developed for broader objective of achieving socio-economic development of the country and maintain the targeted growth.

2. To carry out traffic volume survey of stretch.
3. Apart from managing traffic on the road, this study also aims to maintain the road infrastructure in good condition.
4. To study on need of road widening and strengthening for the smooth movement of traffic.
5. While designing and reconstructing the road we have to take care of road safety, pilot schemes to test the efficacy of new technologies and materials.
6. By studying the future growth of traffic we can design the road width and crust of the road to accommodate the future traffic.
7. In this project we consider the value engineering aspect so that by studying the existing road condition we design the road in 3 categories like widening, reconstructing and overlay portions.

II. LITERATURE REVIEW

BHAGAT KUNAL P, et.al (2015) in this literature flexible pavement overlay design was carried out as per IRC: 81- 1997 -Guidelines for Flexible Road Pavement Strengthening using Benkelman beam deflection (BBD) technique. The design thickness is designed as per the evaluated of Benkelman beam deflection is 90 mm of bituminous layer. They have done overlay design as per IRC: 37-2012 base on fatigue and rutting failure of criteria. The various inputs required for the design is computed with the deflection & existing pavement layer thickness as per IRC guidelines. The design is checked with the software of IIT-PAVE for horizontal tensile strain computed at the bottom of layer of bituminous and vertical strain at sub-grade on top. The computed fatigue & rutting strain is 0.0837 micron and 169 micron due to material, which is the lower than strain due to traffic so that the overlay design found safely in both criteria.

MAHENDRAKAR KIRAN KUMAR, et.al (2015) in this Research they have studied on a factor, which causes further concern in Indian is very high and very low pavement temperature in some parts of the country. Under this condition, flexible pavement tends to become soft in summer and brittle in winter. Further increase in road traffic since the last 10years with an un-duly low level of maintenance has contributed to accelerated damage of road surfacing. To prevent this deterioration process, several types of measurements may be adopted effectively such as improved design use of high performance material and effective construction technology. Over the last 20 years, traffic volume and the percentage of heavy truck traffic have increased enormously on the national highway - 18. This pavement is a flexible pavement with bituminous surface.

III. METHODOLOGY

The Methodology involved for the study is as follows.

1. The detailed site investigation in which road inventory data, test pit investigation, geotechnical investigation, traffic flow condition and identify the traffic circulation pattern in & around project corridor.
2. The traffic survey & Analysis: A Collected data has analysed to identify roadway segment capacity, based on the IRC Guidelines we design the road for widening, reconstruction and overlay areas.
3. Preparation of a conceptual design: A Next step has to propose section specific inventions to be identified and design the road crust. Design is for 10 MSA.
4. Carried out all the lab tests for material used for road construction.

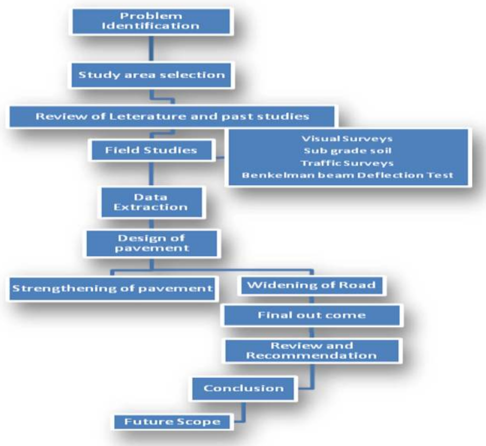

Fig 1: Flowchart

IV. TRAFFIC SURVEY AND CHARACTERISTICS

4.1 Traffic Surveys and Characteristics

Classified Traffic Volume Count Surveys were carried out on April'2019 for 24 hours for 7 days continuously at locations @ 9+000, @ 27+000 for 24 hours x 7 days. The information on Hourly Variation of Traffic, Average Daily Traffic, Peak Hour Traffic and Composition of Traffic were analysed. The counts observed at the various locations have been analyses for the following:

The counts observed at the toll locations have been analyses for the following:

- Average Daily Traffic (ADT)
- Temporal Variation
- Daily Variation

- Hourly Variation
- Peak Hour Factor (PHF)
- Directional distribution
- Traffic composition H
- Annual Average Daily Traffic (AADT)

4.2 Average Daily Traffic (ADT)

The Traffic Volume data collected during the surveys was averaged out to arrive at the Average Daily Traffic (ADT) on the Project Road. The summary of ADT in terms of vehicles and PCU is presented in Table 1.4, 1.5 & 1.6. A Detailed Daily Traffic Volume Count Survey Data attached as Annexure-I.

Table 2: Summary of Average Daily Traffic at Ch.: 9+000

Description	Top to Ashta		Ashta to Top		Both Direction	
	ADT	PCU	ADT	PCU	ADT	PCU
Car	618	618	630	630	1248	1248
Van/Jeep/Sumo	195	195	166	166	361	361
Two-Wheeler	2057	1029	1988	994	4045	2023
Three-Wheeler/Auto Rickshaw	54	54	55	55	109	109
Mini Bus	13	20	12	18	25	38
Standard Bus	19	57	17	51	36	108
LCV-Passenger	55	83	51	77	106	159
LCV-Frieght-3-wh	49	74	60	90	109	164
LCV-Frieght-4-wh	239	359	241	362	480	720
2- Axle	216	648	175	525	391	1173
3- Axle	65	195	67	201	132	396
MAV(4to6Axle)	27	122	31	140	58	261
MAV(>6Axle)	0	0	0	0	0	0
Tractor with Trailer	15	68	10	45	25	113
Tractor without Trailer	10	15	8	12	18	27
Cycles	50	25	56	28	106	53
Cycle Rickshaws	0	0	0	0	0	0
Hand Cart	0	0	0	0	0	0
Bullock cart	0	0	0	0	0	0
Horse	0	0	0	0	0	0
Toll Exempted Car/Jeep	0	0	0	0	0	0
Toll Exempted BUS	0	0	0	0	0	0
Toll Exempted Truck	0	0	0	0	0	0
Total Motorised Vehicle	3632	3534	3511	3365	7143	6898
Total Commercial Vehicle	**683**	**1556**	**654**	**1463**	**1337**	**3018**

Table 3: Summary of Average Daily Traffic at Ch.: 27+000

Description	Top to Ashta		Ashta to Top		Both Direction	
	ADT	PCU	ADT	PCU	ADT	PCU
Total Non-Motorised Vehicle	50	25	56	28	106	53
Total Vehicle	3682	3559	3567	3393	7249	6951

Description	Ashta to Tasgaon		Tasgaon to Ashta		Both Direction	
	ADT	PCU	ADT	PCU	ADT	PCU
Car	835	835	891	891	1726	1726
Van/ Jeep/ Sumo	280	280	266	266	546	546
Two-Wheeler	2640	1320	2816	1408	5456	2728
Three-Wheeler/ Auto Rickshaw	72	72	66	66	138	138
Mini Bus	16	24	18	27	34	51
Standard Bus	30	90	32	96	62	186
LCV - Passenger	49	74	53	80	102	153
LCV - Frieght-3-wh	54	81	79	119	133	200
LCV - Frieght-4-wh	323	485	323	485	646	969
2 - Axle	281	843	222	666	503	1509
3 - Axle	74	222	83	249	157	471
MAV (4 to 6 Axle)	34	153	39	176	73	329
MAV (> 6 Axle)	0	0	0	0	0	0
Tractor with Trailer	20	90	14	63	34	153
Tractor without Trailer	9	14	11	17	20	30
Cycles	24	12	23	12	47	24
Cycle Rickshaws	0	0	0	0	0	0
Hand Cart	0	0	0	0	0	0
Bullock cart	1	6	2	12	3	18
Horse	0	0	0	0	0	0
Toll Exempted Car/Jeep	0	0	0	0	0	0
Toll Exempted BUS	0	0	0	0	0	0
Toll Exempted Truck	0	0	0	0	0	0
Total Motorised Vehicle	4717	4582	4913	4607	9630	9188
Total Commercial Vehicle	861	1971	849	1896	1710	3867
Total Non-Motorised Vehicle	25	18	25	24	50	42
Total Vehicle	4742	4600	4938	4630	9680	9230

4.3 Daily Variable Traffic

Daily Variation of Traffic during the survey duration for the count location on the project road is analysed. The Location wise Daily Variation of Traffic for various modes is presented in Table and graphically shown in Figure. Daily Variable Traffic & PCU Count Report at Ch.: 9+000

Day	Date	VEHs	PCUs
Tuesday	05-01-2021	7219	6872
Wednesday	06-01-2021	7718	7301
Thursday	07-01-2021	7506	7619
Friday	08-01-2021	6947	6596
Saturday	09-01-2021	7213	6960
Sunday	10-01-2021	7186	6946
Monday	11-01-2021	7029	6632

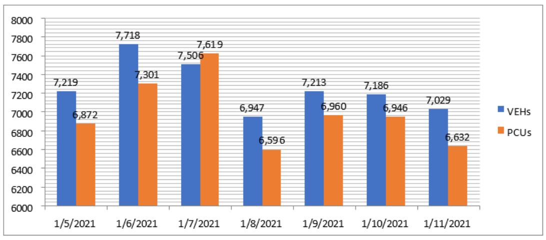

Fig 4: Daily Variable Traffic & PCU Count Report at Ch.: 27+000

Day	Date	Total Vehicles	PUCs
Tuesday	12-01-2021	8954	8571
Wednesday	13-01-2021	10032	9253
Thursday	14-01-2021	9541	9199
Friday	15-01-2021	9250	8887
Saturday	16-01-2021	9586	9288
Sunday	17-01-2021	10337	9843
Monday	18-01-2021	10071	9566

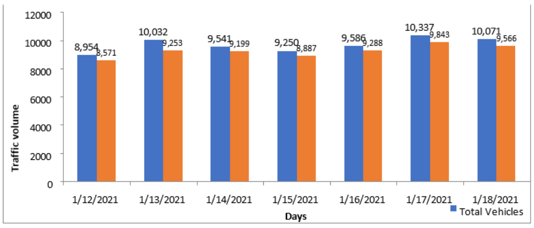

Fig 5

V. PAVEMENT DESIGN AS PER IRC: 37-2012

5.1 PAVEMENT DESIGN AS PER IRC: 37-2012

The parameters used in the design of new pavement are tabulated below Inputs for the Pavement Design: -

Design Inputs		
Design Life		
Wearing Course		15 Years
Sub-base and Base Course		15 Years
Design MSA		
Wearing Course	HS-1 (Km. 0+000 to Km. 5+000 &Km.6+300 to Km.22+400)	10 MSA
	HS-2 (Km. 23+400 to Km. 45+360 &Km. 51+300 to 51+500)	10 MSA
	HS-3 (Km.52+900 toKm.63+000)	10 MSA
Sub-base and Base Course	HS-1 (Km. 0+000 to Km. 5+000 &Km.6+300 to Km.22+400)	10 MSA
	HS-2 (Km. 23+400 to Km. 45+360 &Km. 51+300 to 51+500)	10 MSA
	HS-3 (Km.52+900 toKm.63+000)	10 MSA
CBR for Entire Stretch=		10 %

5.2 METHODOLOGY FOR PAVEMENT SECTIONS

Pavement design procedures for the total stretch were accomplished using the principles of mechanistic design and were in general accordance with the postulates of IRC: 37-2012.The IITPAVE software was used for this evaluation.

The allowable strains in pavement layers were calculated in terms of two primary pavement distress criteria: fatigue cracking and rutting. The actual strains arising in the pavement layers due to traffic loading were then calculated, assuming suitable thickness values for different pavement layers. The assumed pavement crust was deemed to be safe for the design loads if the actual strains were less that the allowable strains.

5.3 ACTUAL STRAINS IN THE PAVEMENT CRUST

The actual tensile strains were calculated using the various pavement design parameters as inputs in the IITPAVE software. The actual strains are computed using various trial pavement structural layer combinations. The tyre pressure used in the analysis was 0.56MPa.This result single tyre load of 20, 000N.Thepoisson's ratio of bituminous layer, granular layer and subgrade layer is taken as 0.35.

5.4 RESILIENT MODULUS & POISSON'S RATIO OF DIFFERENT PAVEMENT LAYERS

Pavement Layer	Resilient Modulus(Mpa)	Poisson's Ratio(μ)	Remarks
Subgrade(10%)CBR	M_{RSUB}(Mpa) =17.6x 0.64(CBR)	0.35	
Subgrade (5%) CBR	M_{RSUB} (Mpa) = 10 x (CBR)	0.35	
Granular Layer (GSB & WMM))	M_{RGRA} (Mpa) = 0.2 x h0.45 x M_{RSUB}	0.35	
Bituminous Layer (VG-30 at 350C)	1700	0.35	

5.5 CALCULATION OF PAVEMENT COMPOSITION FOR WIDENING/NEW/RE-CONSTRUCTION

The proposed crust thickness, corresponding allowable strains from fatigue/rutting models and computed strains from IITPAVE software are given below:

Table 4: Pavement Composition for HS-1, HS-2 & HS-3

Section–HS-I,HS-2&HS-3	
Design MSA	10
Design CBR (%)	10
Grade of Bitumen	VG-30
Pavement Crust Thickness	
Granular Sub-Base	200 mm

Wet Mix Macadam	250 mm
Dense Bituminous Macadam	90mm
Bituminous Concrete	40 mm
Resilient Modulus(MPa)	
Resilient Modulus of Subgrade M_{RSUB}	76.83
Resilient Modulus of Sub-Base &Base Layer M_{RGSB}	240.15
Resilient Modulus of Bituminous Layer M_{RBT}	1700
Allowable Strains from Fatigue and Rutting model	
Horizontal tensile strain at bottom of BT layer(E_t)	298.2 $*10^{-6}$
Vertical strain at top of subgrade(E_v)	577.7 $*10^{-6}$
Achieved Computed strains from IITPAVE software	
Horizontal tensile strain at bottom of BT layer(E_t)	250.7 $*10^{-6}$
Vertical strain at top of subgrade (E_v)	330.3 $*10^{-6}$

The computed trains from IITPAVE software are less than the allowable strains from fatigue and rutting models. Hence, adopted crust thickness is safe. The input data and output from IITPAVE software are given below:

Fig 6: input data and output from IITPAVE

Fig 7: Pavement Composition

VI. CONCLUSION

1. As the traffic is increasing day by day in state highways and most of the highways width is around 7 mts i.e. two lane with earthen shoulders but with this widening and Strengthening work methodology with the minimum budget we can reconstruct road with earthen shoulder and embankment, Subgrade & granular layers and convert this earthen shoulders in to paved shoulders so that the width of the carriage way will be 10mts with 1 mts earthen shoulder on both sides so that the formation width of the road will be 12 mts.
2. Due to Widening of carriage way so it can accommodate more traffic and by strengthening the existing pavement with BM, DBM and BC will increase the strength and maintain the profile of the road with minimum maintenance cost.
3. With this methodology we can minimise the financial impact of the project with good quality and increased road life.
4. As the carriage way width increases hassle free traffic moment which leads to save time and fuel cost.
5. As the access increases the industrial and commercial market is developed so the commercial growth of the town and local farmer’s standard of living will increases.
6. As its sugar cane belt so the moment of traffic will be smooth and less chances of road accidents.
7. By widening and strengthening of Existing Pavement we are adopting and continuing the practice of Value Engineering.

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