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Research Study on Construction Management of Highway Project with Special Emphasis on Quality

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ABSTRACT: The most effective way of managing accident risk is through the development of a “safety culture”. A safety culture is the beliefs and ideas shared by all members of an organization about accidents and their risk of happening and proper measure which are to be taken to decrease in the number of accidents. Highways are designed in such a way they would be accommodate traffic volume at that time of design with a forecast on what the possible increment in traffic volume in the future years would be. Due to increase in traffic volume as a result of more vehicle ownership, increase in human activities such as educational activities, business activities and many more constitute the factors which necessarily leads to increase in volume of traffic thus exceeding the capacity of the highway which in turn leads to upgradation of existing highways to more lanes and sometimes to more durable materials such as upgrading from flexible pavements to rigid pavements in order to accommodate the present traffic volume and as well that of considerable future traffic volume.

I. INTRODUCTION

A. CHALLENGES ENCOUNTERED IN UPGRADING EXISTING HIGHWAYS

Highways form a vital role in the economic prosperity of any nation, due to its importance, the Government at all levels desire to have a good road network to facilitate the movement of goods and services, however, the construction of these highways are very capital intensive projects thus leading to the higher cost on the government or the major client of the project, as the cost of upgrading existing highways will not be compared to the initial cost of construction of the highway, this is because the numerous factors to be considered like labour, cost of materials, cost of land acquisition, cost of survey, cost of earth machines, cost of construction etc. keeps increasing and hardly falls. Thus, the Cost will be significantly higher in upgrading existing highways after years of initial construction.

B. SOCIAL CHALLENGES

Due to large number of commercial establishments and dense habitation at some locations, the need of 3 bypasses was necessary in the proposed upgradation of existing Highways. Many families find their livelihood or economic dependency from commercial activities near and around highways, but due to upgradation these activities are affected and suspended temporarily or permanently. This affects the psychological state of individuals and leads to subsequent death.

II. METHODOLOGY

CONDITION OF THE EXISTING HIGHWAY

During my thesis I have been visited site for quite a number of times. The exiting road is in very bad condition. There are very few sign boards on the road and are in very bad condition. All the bridges are having inadequate width. The riding quality on the whole stretch is very bad. There are number of trees, transformers and clusters along the road. There are loosening earthen shoulders and improper toll barrier on the stretch. The parapets are in bad conditions. There are many curves with lot of sight obstruction. Many intersections are not properly designed. The median are with improper dimensions. There are no safety barriers along the existing road of the major portion of the highway. There are no road signs and markings being done on the road. Drains are also improper along the existing highway. Heavy development along both sides of the road. Some are the following pictures which I took during my visits on the site can give the outlook of the highway.

PROJECT QUALITY PLAN

Road Works:

1. Site Clearance
2. True and Proper setting out layout of Work.
3. Construction of Road in urban and rural areas including excavation, construction of high embankment and subgrade, construction of carriageway, service road, shoulders and medians, provision of drainage, turfing etc.
4. Construction of New culverts including widening/dismantling of existing RCC pipe/RCC slab/Arch culverts.
5. Construction of way side amenities and kerbs.
6. Construction and providing road junctions, improvement of existing junctions.
7. Provision of road signs, markings. Delineators, etc. on road and bridges.
8. Maintenance of existing works.

Bridge Works:

1. Site clearance
2. True and proper setting out and layout of work.
3. Erecting the formwork and shuttering required as per the approved Formwork design.
4. Providing Pile, well and open foundations.
5. Providing Piers, Abutments, Retaining walls and Underpasses.
6. Providing super structure in reinforced/pre-stressed concrete.
7. Providing footpath, walkway, median, kerbs, parapet, railing and drainage spouts.
8. Providing expansion joints and bearings.
9. Providing wearing coat with mastic Asphalt.

Others-General:

1. All aspects of Quality Control and Quality Assurance of works including documentation.
2. Providing measures for prevention or migration of negative environmental impacts due to construction activities as per the approved Environmental Compliance Plan.
3. Provision of health and safety measures as per the approved project HSE plan.
4. Provision of laboratory for testing including the supply of equipment and consumables.
5. Handing over the works on completion after site clearance.
6. Submission of as built drawings and other related documents.

SURVEY WORK

Alignment Fixing:

1. The control points of GPS (Global Positioning System) pillar are fixed at every 5 km interval by NHAI for execution of survey works. The same GPS pillars are also having the value of coordinate and levels.
2. Keeping the same GPS pillar as a reference, traversing of coordinate has been fixed at 250 m intervals between GPS pillar to GPS pillar. Closing error of traverse has been adjusted by bow-ditch method in between two GPS pillars. The traverse closure was less than 1:2000.
3. Horizontal angle was observed by taking minimum of two sets of rounds from different locations in clockwise and anti-clockwise. All the observations were logged and the spread between observed rounds of horizontal angle did not exceed 5 seconds.
4. In between GPS pillars at every 250 m interval, along the road alignment, the sub control pillar(Bench mark pillar(BMP)) is fixed at the end of ROW. The location of benchmark pillar is marked at site by paint identifying location. Benchmark pillars are concrete pillars. Size of concrete pillar is 150×150×450 mm. 12 mm rod is embedded inside and projected 15mm above the concrete pillar. During the time of traversing the bearing was recorded on the punch point of rod projected over the benchmark pillar. The coordinate value of each benchmark pillar was arrived after traverse adjustment by bow-ditch method.
5. The Project alignment coordinate given by client-NHAI for a length of 65 km is fixed over the existing road by 1 second accuracy of total station. The alignment point is marked at every 20 m interval on the straight portion and 10m interval on the curve portion by round head nail. The same point is marked with yellow point and location written on the road for quick reference.



Benchmark fixing:

1. For every 250m interval the concrete bench mark pillar is fixed along the project alignment at the end of ROW. Location and Chainage is marked at site with paint.
2. During benchmark level transferring maximum observing distance was 100m, keeping the foresight and back sight distance equal.

Toe-Line Fixing:

The toe line is fixed for every layer by means of calculating the thickness of pavement layer multiplied by percentage of given formation slope. The toe distance will be measured from given alignment nail.

Equipment Used:

1. Auto Level
2. Total Station

III.RESULTS & DISCUSSION

CONSTRUCTION DETAILS OF NH-353J [4 LANE]

Project Details

1. Proposal No. : FP/MH/ROAD/36701/2018
2. Name of Project for which Forest Land is required : Rehabilitation and Up-gradation of Nagpur-Katol National Highway 353 J from existing KM 13+000 (Outer Ring Road, Nagpur) to 62+900 (Katol bypass) two/ four lane with paved shoulders in the state of Maharashtra
3. Short narrative of the proposal and Project/scheme for which the forest land is required : The proposed Project is starting from Junction with Outer Ring Road, Nagpur to New Katol by pass end NH 353 J. The total length is 49.900 KM. The alignment passes through Nagpur district of Maharashtra; via Kalmeshwar, Katol.
4. State : Maharashtra
5. Category of the Proposal : Road
6. Shape of forest land proposed to be diverted : Linear
7. Estimated cost of the Project(Rupees in lacs) : 135000
8. Area of forest land proposed for diversion(in ha.): 13.761
9. Non-forest land required for this project(in ha.): 0
10. Total period for which the forest land is proposed to be diverted(in years): NIL

Details of land required for the Project

Table No.3.1 Village wise breakup

S.No.	Village	Forest Land (ha.)	Non-Forest Land (ha.)
1.	Yerla	0.6	0
2.	Dahegaon	0.0113	0
3.	Amnergondi	2.64	0
4.	Borgondi	7.78	0
5.	Pardi Gotmare	0.02	0
6.	Chargaon	0.21	0
7.	Peth Budhwar	0.59	0
8.	Sonkhamb	0.06	0
9.	Methpanjra	0.59	0
10.	Tarabodi	0.82	0
11.	katol	0.43	0
	Total	13.7513	0

IRC suggests following design procedure:

Step (1) Find e for 75 percent of design speed, neglecting f ,
i.e $e_1 = (0.75v)^2/gR$.

Step(2) If $e_1 \leq 0.07$, then $e = e_1 = (0.75v)^2/gR$, else if $e_1 > 0.07$ go to step 3.

Step(3) Find f_1 for the design speed and max e ,
i.e $f_1 = v^2/gR - e = v^2/gR - 0.07$.

If $f_1 < 0.15$, then the maximum

$e = 0.07$ is safe for the design speed, else go to step 4.

Step(4) Find the allowable speed v_a for the maximum $e = 0.07$ and $f = 0.15$,
 $v_a = \sqrt{0.22gR}$

If $v_a \geq v$ then the design is adequate, otherwise use speed adopt control measures or look for speed control measures.

Extra widening (W_e):

Extra widening due to psychological reasons. (W_{ep})

While negotiating a horizontal curve, the driver has a tendency to follow the inner of the pavement. This reduces the effective width of the pavement at curves. In order to have a smooth operation at curves, you need to provide an extra widening at the curve of the road.

The IRC recommended a value of extra widening formula for psychological reasons

$$W_{ep} = V / 9.5 \sqrt{R}$$

Mechanical Widening (W_{em})

While negotiating a curve, rear wheels have a tendency to follow the inner track. To accommodate this, there will be a widening is provided called mechanical widening have to be provided. This is due to the offtracking of the vehicle.

The off-tracking in a highway is one the main criteria during curve widening design.

The IRC value for the mechanical widening is given by

$$W_{em} = nl^2 / 2R$$

Therefore;

Total extra widening formula is= $W_{ep} + W_{em}$

$$W_e = V / 9.5 \sqrt{R} + nl^2 / 2R$$

Where;

n =Number of lanes

l =Length of the curve

R =Radius of curve or curvature

Stopping Sight Distance (SSD):

$$1. SSD = vt + (1/(2fg))v^2$$

Here, v is the speed in m/s^2 , t is the reaction time taken, f is coefficient of friction, g is the acceleration due to gravity.

$$2. SSD = vt + (v^2 / (2g(f \pm 0.01n)))$$

Here, v is the speed in m/s^2 , t is the reaction time taken, f is coefficient of friction, g is the acceleration due to gravity & n is the gradient.

5. Intermediate Sight Distance (ISD):

It is the sight distance required to provide frequent opportunities of overtaking on highways. Its value is equal to twice S.S.D (stopping sight distance)

Therefore, I.S.D = 2 x S.S.D

$$I.S.D = 2 \left(V.t + \frac{V^2}{2gf} \right)$$



FIELD DATA ON SPEED

Speed data for the present study were collected on six sections of four-lanes divided inter urban highways, three with earthen shoulders and three with paved shoulders, and two sections of six-lane highways with paved shoulders. The site for data collection was chosen such that there is no effect of access point, intersection or any other side friction. A longitudinal trap of 60 to 80 m was made on one side of carriageway and video recording was done on typical weekdays for 10-16 hours on each highway. The video film was later replayed on a wide screen monitor in laboratory and speed data with classified volume count was extracted. The speed of a vehicle was determined by noting the time taken by the vehicle to cross the longitudinal trap length using a stop watch of 0.01s accuracy. Extracted data were decoded into a spread sheet for further analysis. Traffic on Indian highways is mixed in nature and even within the same category of car, there are several models on the road with varying operating conditions. All vehicles were therefore, divided into four categories namely standard car (CS), big utility car (CB), heavy vehicle (HV) and motorized two-wheelers (TW). The standard car in the present study is defined as a passenger car having 3.6 m length and 1.5 m width, and engine power up to 1400 cc. The big utility car (CB) is the one having length 4.45 m and width 1.8 m, and the engine power up to 2500 cc. The dimensions of different vehicle types and their average proportions in the traffic stream are given in Table 3.2.

Table 3.2: Vehicle, categories and traffic composition observed in field

Vehicle type	Vehicle designation	Length (m)	Width (m)	Average proportion in flow (%)	Average proportion in flow (%)	Average proportion in flow (%)
					Four-lane Shoulders (Paved)	Six-lane
Standard car	CS	3.60	1.50	40	42	55
Big utility	CB	4.45	1.80	17	15	27



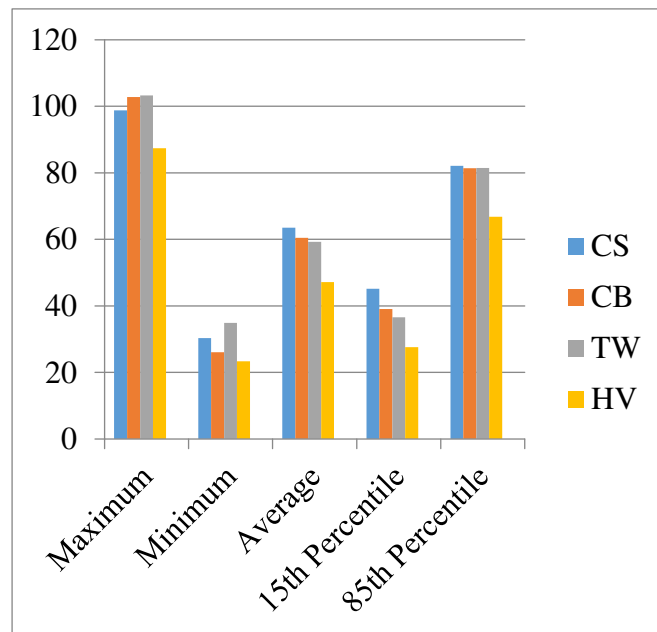
car						
Motorized 2-wheeler	TW	1.87	0.64	05	13	13
Heavy vehicle	HV	10.10	2.50	38	30	05

ANALYSIS OF SPEED DATA

The parameters such as mean, standard deviation and percentile limits were estimated from these profiles on four-lane and six-lane highways. These speed parameters for four-lane highways as calculated from cumulative curves are given in Table 3.3.

Table 3.3: Speed parameters for four-lane divided highways

Shoulder type	Vehicle type	Speed parameters (km/h)				Percentile speed	
		Maximum	Minimum	Average	Sigma	15 th	85 th
Earthen	CS	98.8	30.3	63.5	12.	4	82.
	CB	102.8	26.1	60.5	2	5.	1
	TW	103.3	34.9	59.3	14.	2	81.
	HV	87.4	23.4	47.2	3	3	4
					15.	9.	81.
				1	1	5	
				13.	3	66.	
				1	6.	8	
					6		
					2		
					7.		
					6		
Paved	CS	103.0	32.2	67.7	11.	5	85.
	CB	102.2	34.4	66.0	7	0.	2
	TW	100.3	36.8	68.7	11.	1	82.
	HV	80.1	18.5	50.4	5	4	9
					7.8	8.	80.
				8.6	3	3	
					4	63.	
					7.	3	
					0		
					3		
					7.		
					6		



[Graph 3.2: Speed parameters for different vehicle types on six-lane divided highway]

Speeds of vehicles on four-lane and six-lane divided highway are compared to know if there is any significant improvement in speed on wider roadway or if provision of paved shoulders on a four lane road has any effect on speed of vehicles. Two-tailed t-test was conducted to compare the mean speed of cars on four-lane divided highways with earthen and paved shoulders. The null hypothesis is that mean speed is not influenced by the shoulder type. Table 5.3 shows the results of t-test performed for comparing mean speeds of standard, big utility cars and heavy vehicle. The calculated value of t statistics is 2.8 against the critical value of 1.96 at 95 % level of confidence. It implies that the speeds of cars are different on sections with earthen shoulders and paved shoulders, and hence the null hypothesis is rejected. But no significant difference is observed in average speed of heavy vehicle on highways with earthen or paved shoulders.

IV.RECOMMENDATIONS

- Proper speed limit signs should be provided at the black spots
- Service roads need to be provided at some of the locations.
- Good quality materials should be used so as increase the life of the roads
- Proper shoulder width, median width should be provided.
- Proper co-ordination of horizontal and vertical curve should be done.
- Vertical curve length should be provided as per IRC standards.
- Adequate horizontal curve length should be provided as per IRC 73 guide lines curve length should be at least 150m for a deflection angle of 5 degree, and this should be increased by 30m for each one degree decrease in deflection angle.
- All the auditors should follow the checklists for access checklist for layout, location and access to Fuel Stations and Properties along national highway.

V. CONCLUSION

The existing road geometric design of two-lane divided carriageway from Nagpur to Katol stretch (NH-353J) has been studied. The analysis of the existing geometric condition of road under varying roadway and traffic conditions is conducted for every major junction present in the study area for various roadway and traffic conditions. Based on the studies carried out in this study, an attempt has been made to develop capacity of National highway for two lane divided carriage-way by upgrading it to four lane carriageway with optimum width of shoulder and medians as per IRC specifications.

From the study following conclusion can be drawn o Road Safety Audit is very important for controlling accidents and for the proper design and maintenance of the Highways-

- There are three locations which are located as the black spots since the value of ASI of these locations is more than average ASI.
- Total horizontal curve length provided generally less than required w.r.to degree of curvature.
- Vertical curves length are inadequate for safe sight distance for 100kmph at many locations.
- Checklist for layout, location and access to Fuel Stations and Properties along national highway has been prepared with the latest notifications of MORTH.

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