IDENTIFICATION OF VEHICULAR GROWTH AND ITS MANAGEMENT ON NH-163 IN RANGA REDDY DISTRICT

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ABSTRACT:
The statistical evidence showing the existing pavement and traffic conditions for extra widening and conversion of lanes and to identify the traffic growth statistics at particular stretches for management of the roads according to the vehicular growths and its management for the essential of future traffic estimation Hence Detailed traffic surveys have been carried out to assess the base line traffic characteristics on the project road and other major corridors like NH-163, SH-3, SH-17 and SH-9, which come under project influence area. All the data are characterized by a high degree of goods and Passenger vehicular traffic and the analysis of traffic survey data was done for the Identification of Vehicular Growth and Its Management on NH-163 in Ranga Reddy District.

INTRODUCTION:

National Highway 163 (NH 202) is a National Highway in India that links Hyderabad in Telangana and Bhopalpatnam in Chhattisgarh. The road till Warangal was already a state highway. It was extended and upgraded to a NH as the shortest route to connect Chhattisgarh to an important city. In Hyderabad city, the highway passes through Golnaka, Amberpet, Ramanthapur, Uppal Kalan and Ghatkesar areas along the northern banks of River Musi. The highway passes through Ghatkesar, Bhongir, Aleru, Jangaon, Raghunathpalle, Station Ghanpur, Warangal, Atmakur, Mallampalli, Mulug, EturuNagaram, Chandrupatla and Bhadrakali. It is arbitrarily calculated about 280 kilometers, in which the stretch in Telangana is about 244 kilometers and in Chhattisgarh 36 kilometers. The highway joins National Highway 16 (India) at Bhopalpatnam, but there is no bridge across River Godavari at Nagaram village so travellers have to go all the way to Bhadrachalam to get into Chhattisgarh. The highway joins National Highway 7 (India) at Hyderabad.

ROAD SCENARIO IN INDIA

India has a road network of over 4,689,842 kilometers in 2013 the second largest road network in the world. At 0.66 km of roads per square kilometer of land, the quantitative density of India's road network is similar to that of the United States (0.65) and far higher than that of China (0.16) or Brazil (0.20). However, qualitatively India's roads are a mix of modern highways and narrow, unpaved roads, and are undergoing drastic improvement. As of 2008, 49 percent – about 2.1 million kilometers – of Indian roads were paved.

OVERVIEW

The National Highways are the backbone of the road infrastructure and the major roads in India. They carry most of India's

freight and passenger traffic. State highways and major district roads constitute the secondary and interconnecting roads in India. The national highway density in Telangana state are Included for context and comparison are majorroad density of several developed economies.

ROAD NETWORK IN TELANGANA STATE

Telangana is the 29th (the newest) state of India, coming into existence on June 2, 2014. Earlier it was a part of the state of Andhra Pradesh. It comprises of an area carved out of the ten north-western districts of the former state of Andhra Pradesh, which are Adilabad, Nizamabad, Karimnagar, Medak, Warangal, Khammam, Rangareddy, Hyderabad, Nalgonda and Mahbubnagar.

NATIONAL HIGHWAYS IN TELANGANA STATE

Road transport is vital to India's economy. It enables the country's transportation sector to contribute 4.7 percent towards India's gross domestic product, in comparison to railways that contributed 1 percent, in 2009–2010. Road transport has not gained in importance over the years despite significant barriers and inefficiencies in inter-state freight and passenger movement compared to railways and air. The government of India considers road network as critical to the country's development, social integration and security needs of the country. India's road network carries over 65 percent of its freight and about 85 percent of passenger traffic.

NEED FOR PRESENT STUDY

Initial investigation of the study is to evaluate the rating of the pavement condition and to determine functional and structural conditions of a highway section either for purposes of routine monitoring or planned corrective action. Functional condition is primarily concerned with the ride quality or surface texture of a highway section. Structural condition is concerned with the structural capacity of the pavement as measured by deflection, layer thickness, and material properties. At the network level, routine evaluations can be used to develop performance models and prioritize maintenance or rehabilitation efforts and funding. At the project level, evaluations are more focused on establishing the root causes of existing distress in order to determine the best rehabilitation strategies.

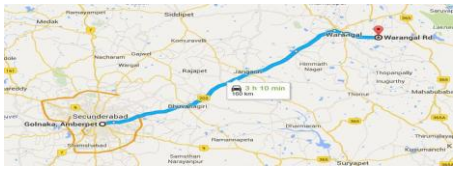

Figure-1.1 Map of National Highway in Ranga Reddy District.

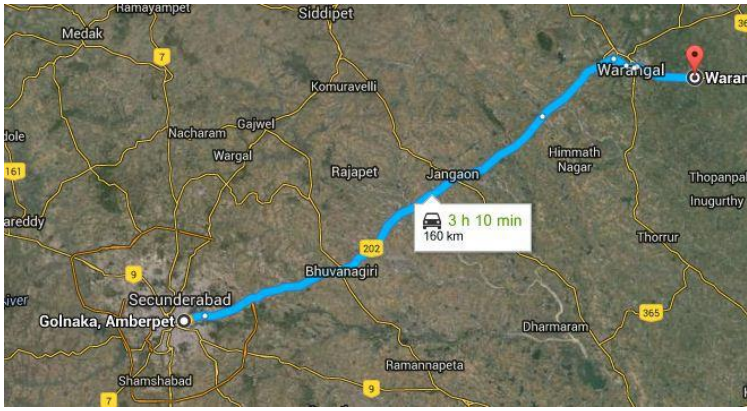

Figure-1.2 Satellite Map of National Highway in Ranga Reddy District.

Factors that should be discussed during pavement design meetings or conferences are outlined in the district standard operating procedure. They include:

- The scope of the project and available funding and pavement design strategies (district-wide policies and project specific considerations)
- Existing pavement history and material and structural analysis. Examples include:
  - ✓ Performance and maintenance history (multi-year trends)
  - ✓ Existing pavement analysis (field and lab testing to characterize functional and structural properties).
- Equivalent single axle loads (ESAL) and the average ten heaviest wheel loads daily review and adjustments data for SALs generated through current data systems may not account for specific truck generators or may overestimate truck loads or percent trucks in the traffic stream.
- Plan for use of recycled and existing materials
- Material selection (including selection of asphalt concrete pavement [ACP], binder type, type of flexible base, stabilization of bases, etc.)
- Pavement design material properties
- Wet Weather Accident Reduction program
- Need for and type of sub grade stabilization
- Alternate pavement designs (Alternate materials selection - not pavement type Alternates to limited competition pavement rehabilitation techniques such as Ultra-thin Lift should be addressed.)
- Alternate pavement types for new or total reconstruction projects
- Pavement design strategies based on ESALs
- Special considerations, such as:
  - ✓ Urban designs
  - ✓ Constructability
  - ✓ Lateral support provided by shoulders
  - ✓ Typical section, front slope,
  - ✓ Project drainage
  - ✓ Special routes such as logging or aggregate haul roads
- Use and methodology for potential vertical rise (PVR) design consideration
- Pavement design development and approval process

OBJECTIVE AND SCOPE OF THE STUDY

- To determine the vehicular growth in the present corridor.
- To determine the Existing pavement history for extra widening and conversion of single lane to double lane.
- To determine equivalent single axle loads (ESAL) and the average ten heaviest wheel loads daily.
- To determine for material selection and reuse of existing pavement materials.

LITERATURE REVIEW

The current literature on urban street network design stresses that two-way streets create higher levels of economic activity. For example, two-way streets are better for local businesses that depend heavily on pass-by traffic. Additionally, traffic signal timing on two-way streets forces vehicles to stop more frequently than on one-way streets, giving drivers more exposure to local businesses."Estimation of Annual Average Daily Traffic for Non-State Roads in a Florida County" Xia, Qing; et al.; Department of Civil and Environmental Engineering, Florida International University, 1999 .

ONE-WAY STREET NETWORKS INCREASE VEHICLE FLOW

Opponents of converting one-way streets to two-way operation often cite this decrease in vehicle-moving capacity (in addition to cost and feasibility). Although two-way streets can increase prosperity and livability, decision makers fear that the loss in vehicle throughput will result in longer and more congested peak periods, lower average vehicle speeds, and increased vehicular delay. Thus, reduced vehicle capacities lower network efficiency. Worse yet, congestion arising from the loss in vehicle-moving capacity can cause people to avoid downtown and may contribute to its decline as a center of economic and recreational activity.

METHODOLOGY

Traffic Studies and Forecast

An accurate estimate of the traffic that is likely to use the Project Road is very important as it forms the basic input in planning. Design Operation and financing. A Through Knowledge of the travel characteristics of the traffic likely use the Project Road as well as outer major roads in the influence areal of' the study corridor is therefore. Essential for future traffic estimation Hence Detailed traffic surveys have been carried out to assess the baseline traffic characteristics on the project road and other major corridors like NH-163, SH-3, SH-17 and SH-9, which come under project influence area. 'This Chapter deals with the traffic studies undertaken and the analysis thereafter. All the sections can be characterized by a high degree of goods and Passenger vehicular traffic. The slow nonmotorized traffic consists almost entirely of bicycles with the other types of nonmotorized vehicles being insignificant.

TRAFFIC SURVEYS

In order to identify traffic survey locations on the project affected roads as well as on the likely completing roads as detailed reconnaissance has been carried out for finalizing the locations.

The traffic volume survey locations have been divided accordingly and termed as TC1, TC2, TC3, TC4, TC5, TC6, TC7, and TC8. A map showing the stretch with Traffic Surveys location is enclosed as shown in fig 1. Traffic Volume count stations were selected in such a manner that all-possible movement would be captured on the Project stretch. To capture the Traffic and Travel characteristics of predominant category of vehicles, Origin and destination surveys were conducted. For the opinion sake, willingness to pay survey was also conducted. A schedule of all such surveys conducted is listed and presented in table 1 as shown below.

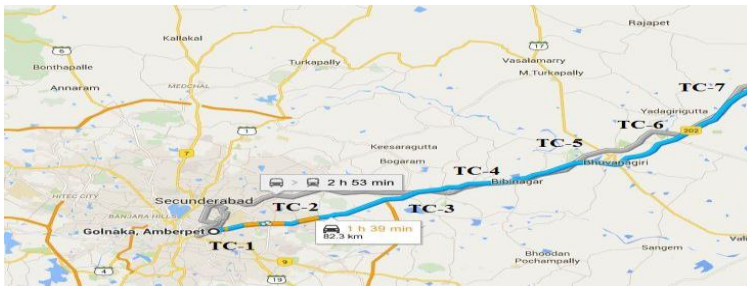

Figure 3.1: Traffic surveys conducted on the project stretch

3.3 Schedule of traffic surveys

TYPE OF SURVEY	LOCAT
Classified traffic volume Count	1. Golnaka
	2. Ghatkesar
	3. Bibinagar
	4. Yadagirigu
	5. Aler
	6. Janagon
	7. Chagal
	8. Kazipet
OD commodity and willingness to pay survey	9. Uppal
	10. Ghatkesar
	11. Aler
	12. Janagon
	13. Kazipet

Table 3.1: Schedule of traffic sur

OBJECTIVES OF TRAFFIC SURVEY

- The primary objectives of these traffic studies are to:
- Determine the characteristics of traffic movement;
- Identification of Zone of influence for the project stretch and the extent of influence based on OD survey;
- Determine the travel pattern as well as type and weight of commodities carried by goods vehicles;
- Determination of vehicle damage factor as an aid to pavement design;
- Cost benefit and sensitivity analysis;
- Environmental impact assessment.

METHODOLOGY OF TRAFFIC SURVEY

Manual counting system was adopted under through supervision of qualified traffic engineers to eliminate errors for volume counts passenger and commodity O-D Surveys.

- Volume count locations were selected at all crossing point's of existing major and minor roads. The continuous 24-hours traffic was conducted in 3 shifts for 7 days. I he traffic counts are generally. Conducted in accordance with the Guidelines provided by IRC-9- 1972. Enumerators specially trained for this Purpose record data on the number of vehicles of different categories moving Along the road in both directions. The vehicles are broadly classified into Motorized passenger vehicles. Motorized goods vehicles and non- motorised Vehicles. These groupings are further sub-divided to reflect more realistically the present at traffic pattern.
- The surveyors counting the vehicles were placed at location from where there was clear visibility of the flow of vehicles in the respective direction?

ANALYSIS OF TRAFFIC SURVEY DATA

Traffic data analysis have been carried out as per the stipulation of TOR, to provide the basic input for highway design junction design pavement design environmental impact assessment and investment appraisal.

CLASSIFIED TRAFFIC VOLUME COUNTS

The analysis has been carried out for each location to derive

- Average Daily Traffic (ADT) for fast and slow moving vehicles.
- Average Daily Variation
- Average Hourly Variation
- ADT composition (modal split)
- Annual average daily traffic (AADT) after seasonal correction.

SEASONAL VARIATION FACTORS

Monthly sales data of diesel and pattern for five consecutive years from different petrol pumps were collected on all major cross roads and seasonal factors were calculated. The values of seasonal factors which have been adopted for the present analysis are presents in Table 3.2

S. No	Month	Golnaka	Ghatkesar	Bibinagar
01	Jan	1.067	1.106	8.85
02	Feb	0.992	1.012	1.05
03	Mar	1.030	1.007	1.07
04	Apr	1.065	0.964	1.05
05	May	1.0	0.841	1.23
06	Jun	0.952	0.945	1.14
07	Jul	0.980	0.975	1.09
08	Aug	1.0	1.056	0.99
09	Sept	1.042	1.104	0.90
10	Oct	0.957	1.082	0.88
11	Nov	0.959	0.993	0.82
12	Dec	0.956	0.987	0.92

Table 3.2: Seasonal Variation Fa

The average annual daily traffic at the study location is obtained by multiplying the average daily- traffic with the seasonal correction factor. The traffic surveys have been conducted during the month of March 2013. The seasonal variation actors for the month of March 2013 have been established as given in Table 2. The AADT of vehicles for the year 2013 at the twelve locations are shown in table 3

SAMPLE SIZE

In order to assess the sample sizes and to arrive at the expansion factors for the calculation of present and projected total inter and intra zonal trips on the stretch. Discounts have been conducted on the same day of OD survey for 21 hours. The sample size distribution for locations is summarized and presented in table *5* as shown below.

Table 3.3: Willingness to pay Toll by Vehicle Type (All OD Survey Location)

Willingness to pay Goods vehicles in %							
Vehicle type	Rs.5	Rs. 10	Rs. 20	Rs. 50	Rs > 50	No response total	total
2A truck	10	12	52	11	7	8	100
3A truck	0	20	63	9	3	5	100
MA truck	0	0	66	30	4	0	100
LCV	0	60	30	0	0	10	100
Passenger vehicles in %							
Vehicle type	Rs.5	Rs.10	Rs.20	Rs.50	Rs > 50	No response total	total
Car (old)	6	45	38	6	1	4	100
Car (new)	2	41	44	9	2	2	100

AXLE LOAD SURVEY ANALYSIS

The survey data have been verified: computerized and rechecked. Before the load spectrum analysis, the modal split of commercial vehicles and the percentage sample obtained in load measurements are assessed with necessary data processingThe data with respect to the axle loads as obtained are grouped with 1 tone class interval for each axle of a vehicle are the frequency distribution of axle loads for all types of vehicles has been obtained along with gross vehicle Weight (GVW) for each category of Vehicle. Car (New)

VDF= Total EAL/Number of Vehicles Weighed.

Table 3.4: VDF values

location	2A truck	3A truck	MA truck	LCV	Buses
Ghatkesar	3.21	2.41	2.5	0.23	0.5
Bibinagar	2.66	3.17	4.92	0.36	0.30
Aler	3.90	2.42	7.60	0.40	0.44
Kazipet	1.50	2.60	2.65	0.14	0.41
average	2.82	2.65	4.44	0.28	0.41

TRAFFIC FORECAST

Net State Domestic Product and Per-capita income on the one hand and the past registration data of different categories of vehicles on the other to determine the Elasticity of Transport Demand with respect to different categories of vehicles. According to IRC-108 of 1996: an econometric model could be derived in the form

Log e P = A0 + A1 Log e (E.1)

Where:

P = number of vehicles of any particular category;

E1 =Economic indicator such as NSDP Per capita income or population

A0= a constant and

AI = Registration coefficient elastic value.

SECONDARY DATA COLLECTION

Design future projection and evaluation of the project stretch. Following secondary information have been collected for analysis.

- Traffic Census (Past Traffic Data)
- Statistical information
- Economic indicators
- Vehicle registration!
- Seasonal Variation

TRAFFIC GROWTH RATE

The most important parameter, on which the future forecast of traffic depends, is the Growth Factor. However, for a neither small stretch where most of the traffic neither originates nor end within the stretch, growth potential of the origin and destination (Zone of Influence) need to be assessed to arrive at the growth potential of the stretch.

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ESTIMATION OF GROWTH RATES

- The Growth trend has been derived for the following categories of vehicles: PV =Passenger Vehicles (Car, Jeep, Taxi, Van, etc) T =Trucks (Mini, 2 axle and Multi axle) B =Bus, Mini Bus
- The following steps have been adopted to derive the Elasticity and Growth Factors,
- Growth rates of NSDPIGSDP, GDP, per Capita Income (at 1993-94 Constant prices) and population are obtained.
- Final growth rate were obtained for horizon years by considering the projected economictrend of the State. Table 3.4 shows the growth rates, which are adopted in finding the future traffic demand estimates.

Table: 3.6 Present and projected volumes along with project corridor

Leg	2006	2011	2016	2021	2026	2031	2036
Leg-1	34931	49267	69489	98010	138236	194973	274997
Leg-2	35450	50000	70522	99466	140290	197870	279083
Leg-3	34672	48903	68974	97283	137211	193528	272958
Leg-4	52136	73534	103715	146284	206324	291006	410445
Leg-5	57655	81319	114695	161769	228165	321811	453893
Leg-6	58305	82235	115988	163593	230737	325439	459011
Leg-7	38276	53986	76143	107395	151474	213644	301331
Leg-8	58761	82879	116895	164872	232541	327984	462601
Leg-9	64463	90921	128238	180871	255107	359811	507490
Leg-10	37924	53489	75443	106408	150081	211679	298560
Leg-11	32583	45965	64830	91439	128968	181901	256559
Leg-12	31861	44895	63263	89145	125617	177009	249427

TRAFFIC FORECAST

The derivation of growth factor from various considerations has been discussed in detailed in

the earlier chapter. While forecasting the growth of the traffic in future for horizon period up to 2032, the same growth rates n.ere considered.

CAPACITY STANDARDS

The volume of different traffic locations influencing the project stretch at this point and the corresponding year in which this is attained is presented in the following table 3.6.

Table 3.7: Capacity Calculation for the Traffic Homogeneous Sections

Traffic homogenous section	Year of attaining volume of nearly 40000 PCU	Corresponding traffic volume	Year ofattaining volume of nearly 96000PCU	Corresponding traffic volume
Leg 1	2008	40459	2021	96126
Leg 2	2008	41269	2021	97636
Leg 3	2008	41274	2021	96126
Leg 4	2008	58603	2015	95301
Leg 5	2008	64251	2014	98535
Leg 6	2008	65667	2014	98311
Leg 7	2008	40937	2021	96491
Leg 8	2006	61378	2014	96008
Leg 9	2006	66305	2013	99016
Leg 10	2007	41738	2022	99108
Leg 11	2009	41252	2024	97727
Leg 12	2009	40009	2025	95820

ANALYSIS

TRAFFIC SURVEYS

An accurate estimate of the traffic that is likely to use the project road is very important as it forms the basic input in planning, design, operation and financing. A thorough knowledge of the travel characteristics of the traffic likely to use the project road as well as other major roads in the influence area of the study corridor is, therefore, essential for future traffic estimation.

DESIGN TRAFFIC

Table 4.1: Present and Projected traffic volume (PCUs) along the project corridor

Leg	2006	2011	2016	2021	2026	2031	2036
Leg-1	34931	49267	69489	98010	138236	194973	274997
Leg-2	35450	50000	70522	99466	140290	197870	279083
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IRC: 37-2001

Flexible pavement design has been carried out using the IRC: 37 2001 and AASHTO design methods. IRC: 37 - 2001, a modification to IRC: 37 - 1984 has been revised to incorporate the mechanistic design approach. In the new code pavement design has been extended to cover up to traffic loading of 15 Msa. Design was also carried out using the AASHTO pavement design guidelines.

DESIGN PERIOD

A 20 years design period (2009-2029) is assumed for the design of flexible pavement.

VEHICLE DAMAGE FACTOR

Vehicle damage factor (VDF) is a multiplier to convert the number of commercial
vehicles of different axle loads and axle configuration to the number of standard axle load repetitions.

$$VDF = \frac{\text{Total equivalent axle loads}}{\text{Number of vehicles}}$$

Table 4.2 Summary of vehicle damage factors

Location	2 axle truck	3axle truck	M axle truck	LCV	BUSES
Shamshabad	3.21	2.41	2.57	0.23	0.50
Amberpet	2.66	3.17	4.92	0.36	0.30
Medchal	3.90	2.42	7.60	0.40	0.44
Patancheruvu	1.50	2.60	2.65	0.14	0.41
Average	2.82	2.65	4.44	0.28	0.41

COMPUTATION OF DESIGN TRAFFIC

Axles (in the lane carrying maximum traffic) to be carried during the design life of the road. This can be computed using the following equation.

$$N = \frac{365x\ ((1+r)n-1)\ \ AxDxF}{r}$$

Where.

N = the 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.

D = Lane distribution factor

F = Vehicle damage factor

N = Design life in years

r = Annual growth rate of commercial vehicle

Table 4.3: Design Lane MSA

S.No	Stretch	MSA as per IRC:37-2001	MSA as per Observed VDF	Suggested Value MSA
1	Shamshabad to APPA	101	66	100
2	APPA to gandipet	99	65	100
3	Gandipet to patancheru	101	68	100
4	Patancheru to narsapur rd	154	105	100
5	Narsapur to kandlakoya	179	120	100
6	Knaldoya to shamerpet	158	110	100
7	Shameerpet to keesara	106	71	100
8	Keesara to ghatkesar	160	71	100
9	Ghatkesar to amberpet	172	108	100
10	Amberpet to bangulur	86	52	100
11	Bangulur to sinagar	75	47	100
12	Srinagar to shamshabad	72	44	100

DESIGN LANE MSA

The base year traffic, traffic growth rates and the projected traffic for the Design period for each category of vehicles have been extracted from the "traffic Studies & forecast". The new facility is expected to be opened for traffic in the year 2010 and for a design period of 20 years, the horizon year is 2029. Keeping in view The potential of the Outer Ring Road, and the amount of traffic that could be Diverted on the ORR, the pavement design was carried out for a 100 Msa. The New pavement will be constructed on a sub - grade with minimum soaked CBR of 10%.

FUNCTION OF SUB BASE IN ROAD CROSS SECTION

- It enables traffic stresses to be reduced to acceptable levels in sub-grade in the Road Cross Section.
- It acts s as a working plate form for the construction of upper pavement layers.
- Acts as a drainage layer, by protecting the sub-grade from wetting up.

CHARACTERISTICS OF MATERIALS USED IN SUB BASE

- Well graded uniformity coefficient (D6/lD10) should not be less than 3.
- Fraction passing sieve #200 shall not be greater than 2/3rd of the fraction passing sieve #40.

- Should have a L.L not greater than 25%.

TYPE OF BASE COURSES:

A mixture of soil particles ranging in size from coarse to fine. Processing involve crushing oversized particles and screening where it is necessary to secure the desired grading. The requirements of a satisfactory soil Aggregate surface.

TRAFFIC LOADS

- Tire loads
- Axle and tire configurations
- Typical axle load limits
- Repetitions of axle loads
- Traffic distribution (by direction and lane)
- Traffic projections (growth rate).

AXLE AND TIRE CONFIGURATIONS

At this point, the design characteristic of concern is no longer the single isolated tire load, but the combined effect of all the interacting tire loads. Therefore, axle and tire arrangements are quite important.

Tire-axle combinations are typically described as:

- Single axle – single tire (truck steering axles, etc.)
- Single axle – dual tires
- Tandem axle – single tires
- Tandem axle - dual tires.

DATA COLLECTION

The data were collected by video filming technique except at sections given, where manual method was adopted. A longitudinal trap of 25-30 m was made on the road and recording was done for 3-4 hours during morning/evening hours of a typical weekday. To study the effect of shoulder condition on placement of vehicles, the data on speed, placement and volume of vehicles was collected manually at each section. The pavement width was divided in sections of 10 cm using white self adhesive cloth tape.

Section No.	Speed (km/h) of car during crossing a			Speed (km/h) of LCV during crossing a			Speed (km/h) of during crossing a		
	Car	LCV	H V	Car	LCV	H V	Car	LCV	H V
01.	62.0	61.1	58.5	50.1	49.5	47.6	45.2	44.3	42.5
02.	53.4	52.0	50.1	45.2	44.0	41.7	41.5	41.1	38.3
03.	48.0	47.8	45.3	40.5	39.9	38.7	40.2	38.3	34.0
04.	58.9	57.8	55.4	49.5	48.2	45.3	44.2	41.5	40.3
05.	55.4	54.1	51.2	48.2	47.1	43.3	42.1	41.0	38.2
06.	52.6	49.8	47.6	42.5	41.6	39.3	37.7	36.0	32.1
07.	60.1	59.0	56.2	54.2	53.1	50.6	46.3	44.2	41.9

One Way Lane

EFFECT OF SHOULDER CONDITION

It is assumed that vehicles will make use of full width of pavement if good types of shoulders are provided on either side of the road. Although, the data were collected at locations where shoulders were damaged, some data were collected at locations having good condition of shoulders also. The 9 sections as given in Table-4 were selected for data collection. The pavement riding quality was almost same at all the

sections but they were varying in shoulder conditions.

LOSSIN WIDTH OF CARRIAGEWAY

With average condition of shoulder about 50 per cent of cars and 50 per cent of HVs had their placement within 115 cm and 65 cm respectively, from pavement edge while for bad condition of shoulder, only 29 per cent cars and 10 per cent HVs had their placement within these limits. **Loss in width of carriageway** Physical condition of shoulders plays an important role for the development of full traffic capacity of a highway. The lateral placement of vehicles and thus utilization of full carriageway width depends upon the width of carriageway and type and condition of shoulder. The field data given in Tables-5 and 6 indicate that the vehicles preferred to lower down their speed rather than coming on to the shoulders, which are poorly maintained. The loss in width of carriageway for different conditions is given in Table-18.

REDUCTION IN SPEED DURING PASSING/OVERTAKING MANEUVERS

Spot speeds of vehicles were measured during passing/overtaking maneuvers and during single free moving vehicle to estimate the average speed of each type of vehicle on a section. The percent reductions in speed of individual vehicle during above condition. Two wheeler and bicycles were found to be unaffected by crossing vehicles due to their small size but other vehicles were forced to reduce their speed due to poor maintenance of shoulders. **Effect of Road Roughness**

The roughness was measured using British Towed fifth wheel bump integrator on the following sections of the two-lane highways.

(a)National Highway (NH) – 73 in the state of U.P.

(b) State Highway (SH) – 59 in the state of Uttaranchal

18 km length of NH-73, 5 km of SH-59 and 33 km of NH-7 was selected for roughness and speed measurements.

Effect of roughness on free speed

Free speed of Car Vffsc = 66.9 – 0.0034 * UI R2 = 0.91 (Eqn. 6)

(43.05) (23.28)

Speed of HV Vffshv = 51.6 – 0.0019 * UI R2 = 0.84 (Eqn. 7)

(41.95) (16.38)

Effect of roughness on capacity

Table -PCU for Different Types of Vehicle on Various Sections

Section	UI (mm/ (km)	PCU								
		Bus	Truck	LCV	MAT	Tractor Trailer	2-wheeler	3-wheeler	Cycle	ADV
I	2890	5.38	4.88	4.2	14.00	13.49	0.36	1.59	0.72	8.66
II	3490	5.16	4.31	3.78	12.00	9.73	0.38	1.58	0.75	8.26
III	4580	5.62	4.45	3.17	8.62	6.64	0.28	1.33	0.54	8.48
IV	4910	4.63	3.51	2.68	4.54	6.30	0.26	1.4	0.65	6.60
V	5670	4.72	3.74	2.78	4.68	6.20	0.27	1.42	0.72	7.20
VI	3050	5.47	4.75	3.91	13.32	11.85	0.38	1.57	0.71	8.56
VII	4200	5.24	4.29	3.22	9.06	8.86	0.33	1.48	0.67	7.98
VIII	5150	5.00	3.92	2.65	5.50	6.39	0.29	1.41	0.63	7.44

CONCLUSIONS

Due to road widening of the existing pavements whose width cannot carry the traffic volume there would be significant help for the vehicle movers .As the road which is a state highway connecting many important centers of the state road widening helps to decrease the number of accidents occurring on the pavement.

- Despite good performance of the road transport sector it is best with slow technological development, low energy efficiency, pollution and slow movement of freight and passenger traffic. The step-up in freight and passenger road traffic during the past years as to done with the alternate growth paths provides an opportunity for technological up gradation, capacity augmentation and replacement of over aged rolling stock.
- Greater the share of commodity-producing sectors like agriculture and

manufacturing, higher is the demand for transport.

- However, the share of buses and trucks in the vehicle population at 1 per cent and 5 per cent respectively is much lower compared to other areas.
- With a rising income and inadequate urban public transport system, in particular, the personalized mode of transport is likely to grow in importance in the coming years.
- The amount of damage caused due to overloading to the road infrastructure and the life expectancy of the road far outweighs any short term again.
- Based on CBR values of 7 % the different layers of road pavement are layed according to their thickness
- Based on traffic volume studies the existing single lane is not sufficient to cater the traffic volume so the single lane is converted to two lane
- As per visual condition Survey notified that the pavement at different chainages must be retrofitted
- Establishing soil properties and characteristics to be used in pavement design. In particular, determination of soil strength, applicable modulus (its stiffness), and matrix stability descriptive of a pavement project, a portion of a project, or materials respectively, will be the result of the analysis.
- Determining the influencing site characteristics that might require modifications to the pavement structure or adjacent works to accommodate those characteristics.
- Laboratory mechanical, physical, and chemical properties (obtained through coring, Shelby tubes, and trenching), of the soil.
- Visual inspection of pavement layers through coring and trenching was done at articular

chainages.

RECOMMENDATIONS

- Road design and traffic management along with specifications need to be reviewed to

Follow the best practices in the world

- Promote road design/layout which has a beneficial impact on the road users. A case in

Point is segregation of motorized and Non Motorised Transport traffic as in Bangladesh

- Strengthen bus mode by: making subsidized loans or alternatively Providing concession.

Interlink regional & District Transport Authorities through computer network.

- Innovative approaches for separating pedestrians from road traffic should be developed.

Public should be made aware of benefits of Non Motorised Transport, viz, bicycling and

- Install weigh in motion (WIM) at select points on National Highways, Inter State Check

Posts, industrial areas etc on a selective basis installation.

- Train students in technological institutions on all aspects of road safety and review

Enforcement of traffic rules and regulations Establish Regional Centres of Excellence in Various aspects of road safety.

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