Case Study of National Highway-65 from Gotiya to Salasar (Rajasthan)

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Abstract: **National Highway - 65 is an important link connecting Ambala (Haryana) to Pali (Rajasthan). The traffic operation in between Gotiya village to Salasar town of this national highway which lies in Rajasthan state is not satisfactory. Due to Rapid growth in commercial vehicles plying on this stretch, existing carriageway width varying from 6.5 m to 7.0 m is insufficient. The visual inspection regarding the condition of existing flexible pavement showed normal riding quality which causes delay and thus increases operation cost. Looking at the present traffic and expected growth in future traffic, it has been suggested that two lane 7 m wide carriageway with 1.5 m wide paved shoulders on either side should be provided to make traffic operation smooth and safe. For structural design of the road, soil investigations including Modified Proctor test and California Bearing Ratio (CBR) test were carried out. Axle load survey data was used to calculate the vehicle damage factor (VDF) and thus design traffic was calculated. On the basis of design CBR of 12% and design traffic 75 million standard axle (msa), total crust thickness comes out to be 620 mm as per guidelines of IRC: 37-2001.**

***Keywords*— Flexible pavement design, axle load survey, traffic volume and Vehicle Damage Factor (VDF).**

1. INTRODUCTION

Development of a country depends on the connectivity of various places with the adequate road network. Roads are the major channel of transportation for carrying goods and passengers. They play a significant role in improving the socio-economic standards of a region. India has the second largest road network across the world with 4.7 million kilometers road length. Indian road network transports more than 60 per cent of goods and 85 per cent of total passengers traffic. Road transportation has gradually increased over the years with the improvement in connectivity between cities, towns and villages in the country. In India sales of automobiles and movement of freight by roads is growing at a rapid rate.

National Highway (NH)- 65 runs across the state of Haryana and Rajasthan, connecting Ambala (Haryana) with Pali (Rajasthan). It originates at its junction with NH-1 at Ambala and ends at the intersection with NH-14 at Pali. It runs for a distance of 240 kilometers in Haryana and rest 450 kilometers in Rajasthan state. Major built-up areas along NH-65 are Kaithal, Hisar, Rajgarh, Churu, Fatehpur, Salasar, Nagaur, Jodhpur and Pali. The road stretch from Gotiya village to Salasar is congested due to heavy commercial traffic plying on the road. There is also a famous Balaji temple situated at Salasar, so traffic of pilgrims also ply on this stretch. The width of existing road is varying from 6.5 m to 7.0 m with earthen shoulders of 1.0 m to 1.5 m on either sides of the road. The width of road is insufficient to carry the present traffic. Also the riding surface of the road is not satisfactory, hence time and cost of travel is high.

To resolve the above mentioned issues, a study is carried out with the following objectives; (i) To identify the deficiencies in the existing pavement system, (ii) To suggest improvements in the existing pavement to make it structurally capable as per need of the present and future traffic, and (iii) To improve the riding quality of road so that time and cost of travel can be reduced.

2. FIELD STUDIES

In accomplishment of the objectives of the present study, the pavement condition survey of the study stretch was carried out by visual inspection. The average thickness of existing pavement was found to be 425 mm consisting of sub-base, base and bituminous course. The existing pavement was found to be in good condition for approximately 25% of the length of road while other 55 % in fair and rest 20 % in poor condition. The overall pavement condition was not suitable for providing satisfactory riding quality. The width of existing pavement was varying from 6.5 m to 7.0 m without paved shoulders. On the basis of preliminary survey and the intensity of the traffic; classified traffic volume survey, axle load survey and geotechnical investigations on the sub-grade soil were being carried out.

2.1 Traffic Survey

One of the fundamental measures of traffic on a road system is the volume of traffic using the road in a given interval of time (Kadiyali, 1997). The classified traffic volume was counted at Km 69+000 for 24 hours and seven continuous days as per IRC: 9-1972. Traffic volume count data was averaged to determine Average Daily Traffic (ADT). Also Annual Average Daily Traffic (AADT) was calculated by multiplying seasonal factor to ADT. The values of ADT and AADT for different category of vehicles are shown in Table 1.

2.2 Traffic Growth Rates

The traffic growth rate data were collected from various secondary sources (Galfar Engineering & Contracting India Pvt. Ltd. & Salasar Highway Pvt. Ltd.) and are shown in Table 2.

Table 1: Values of ADT and AADT

S. No.	Vehicle Type	ADT	AADT
1	Car	1233	1218
2	Mini-Bus	37	36
3	Bus	202	192
4	LCV	424	403
5	2 Axle	572	544
6	3 Axle	854	812
7	4-6 Axle	340	324
8	>=7 Axle	17	16
9	2W	561	561
10	3W	98	98
11	Tractor with Trailer	64	64
12	Tractor without Trailer	22	22
13	Cycle	63	63
14	Rickshaw	0	0
15	Animal Drawn	8	8
Total		**4495**	**4361**

Table 2: Adopted Traffic Growth rates

Vehicle Type	2012-16	2017-21	2022-26	2027-31	Beyond 2031
Car/Van/Jeep	8.05%	7.05%	6.15%	5.30%	5.05%
Bus/Mini Bus	6.10%	5.35%	5.00%	5.00%	5.00%
LCV	8.15%	7.15%	6.25%	5.40%	5.10%
2A Trucks	6.35%	5.55%	5.00%	5.00%	5.00%
3A Trucks	7.30%	6.40%	5.55%	5.00%	5.00%
MAV	7.25%	6.35%	5.50%	5.00%	5.00%

2.3 Projected Traffic

The base year traffic at mile stone KM 69+000 was projected for the total period (construction and operation) of 22 years with the design growth rates. The projected traffic has been presented in Table 3.

2.4 Vehicle Damage Factor (VDF)

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. The value of VDF varies with the vehicle axle configuration, axle loading, terrain, type of road and from region to region. It was calculated by the equations of section 4.4 of IRC: 37-2012. Vehicle Damage Factor of Rajasthan Border to Salasar direction and Salasar to Rajasthan Border direction are shown in Table 4.

2.5 Geotechnical Investigation

Detailed investigation on the existing sub-grade soil was carried out. The characteristic of sub-grade soil was found sandy in nature on the basis of sieve analysis. California Bearing Ratio (CBR) value ranges from 12.18% to 12.70%. Therefore CBR of 12% was considered for the pavement design. Test results carried out on soil sub-grade are shown in Table 5.

Table 3: Projected Traffic at Km 69+000

Type of Vehicle	In Base Year	After 22 Years
Car	1218	4591
Mini Bus	36	109
Bus	192	590
LCV	403	1547
Truck 2 Axles	544	1698
Truck 3Axles	812	2782
Truck 4-6 Axles	324	1101
Truck ⩾7Axles	16	55
2 Wheeler	561	1642
3 Wheeler	98	287
Tractor	86	253

Table 4: Vehicle Damage Factor (VDF)

Type of Vehicle	Raj. Border – Salasar (VDF)	Salasar - Raj. Border (VDF)	Adopted VDF
LCV	**0.75**	0.26	0.75
2-Axle Truck	2.82	**4.36**	4.36
3-Axle Truck	**5.25**	4.29	5.25
Multi Axle Truck	5.66	**6.13**	6.13
Bus	0.75	0.75	0.75

Table 5: Test Results of Sub-grade Soil

Sample No.	OMC (%)	MDD (gm/cc)	Soaked CBR (%)
	IS:2720 Part 7-1980	IS:2720 Part 8-1983	IS:2720 Part 16-1987
S – 1	11.3	1.86	12.41
S – 2	11.2	1.87	12.7
S – 3	11.4	1.86	12.18
S – 4	11.5	1.87	12.41
S – 5	11.4	1.87	12.18

3. DESIGN OF PAVEMENT

Pavement design consists of determining thickness of individual layers in order to serve traffic for an anticipated design period. The design depends on various factors such as intensity of traffic wheel loads, repetitions, sub-grade soil strength, criteria of mix design and economic considerations (Kumar R. Srinivasa). The thickness design of the proposed road is carried out as per guidelines of IRC:37-2001. The flexible pavement has been designed for a period of 20 years.

Based on the vehicle damage factor and the projected traffic, the traffic loading in terms of cumulative number of equivalent 8.16 Ton standard axle loads comes out to be 75 million standard axle (msa). The California Bearing Ratio (CBR) value of the sub-grade soil was 12% which satisfies the minimum requirements of 8% CBR (MORTH, 2013). As per provisions of IRC: 37-2001, the maximum permissible CBR of 10% was adopted in the design. The pavement composition of various layers as per IRC: 37-2001 for proposed new pavement are shown in Table 6.

Table 6: Thickness of component layers of proposed pavement

Layer	Thickness
Granular Sub-base (GSB)	200 mm
Wet mix macadam (WMM)	250 mm
Dense Bituminous Macadam(DBM)	120 mm
Bituminous Concrete (BC)	50 mm
Total Thickness	620 mm

4. CONCLUSION

The following conclusions can be drawn, from the present study:

1. On the basis of pavement condition survey and traffic study, it is proposed that two lane carriageway with paved shoulder 1.5 m wide on either side i.e. 10 m wide new pavement should be constructed in the study area.
2. Geotechnical investigations classified the sub-grade as sandy soil.
3. The design traffic for the study area based on classified traffic volume data and Vehicle Damage Factor (VDF) comes out to be 75 msa for a design life of 20 years.
4. Total crust thickness for design CBR 10% and design traffic 75 msa comes out to be 620 mm as per IRC: 37-2001. The crust composition of various layers for the proposed highway is Granular Sub-base (200 mm), Wet Mix Macadam (250 mm), Dense Bituminous Macadam (120 mm) and Bituminous Concrete (50 mm).
5. The proposed flexible pavement of width 7 m having two lane carriageways with paved shoulder 1.5 m wide on both sides would be able to make traffic management efficient. Also the proposed pavement will be structurally capable of withstand the present and anticipated future traffic load.

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