TRAFFIC VOLUME AND ACCIDENT STUDIES ON NH-22 BETWEEN SOLAN AND SHIMLA, INDIA

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Abstract

This paper is an attempt to study the basic differences between rigid and flexible pavements based on LCCA, durability, recycling, local preference, and safety features. An observation of the traffic count was conducted at Tuttikandi in Shimla and Chambaghat in Solan and difference in vehicular flow was computed. The process involved making manual count of the vehicles passing by on weekdays and weekends. Vehicle fleet was characterized as cars, buses, trucks and motorcycles. The mean traffic flow throughout the week was computed by considering the average of the number of vehicles observed on weekdays and weekends. The study also involved in identifying the 'black spots' which refers to those stretches on Shimla – Solan highway of NH 22 reported with the most number of accidents. Reconnaissance of these locations was carried out to identify the various causes for these accidents. Further, sample of materials used for construction of the highway was collected from these stretches and material testing was carried out. We calculate the SSD and OSD at the regions of 'black spots' and based upon those results suggest suitable remedial measures to prevent such accidents in future including installing various road furniture like convex mirrors, fluorescent sign boards, light poles.

Keywords: Accident, Overtaking Sight Distance (OSD), Stopping Sight Distance (SSD)

Introduction

Pavements are generally classified as flexible or rigid pavements. While flexible pavements are made of bituminous layer and transfers the load from one layer to the other, rigid pavements are generally made of cement concrete and load transfer occurs through slab action (Khanna and Justo, 2010).

NH-22 area between Solan and Shimla is a highly accident prone area with many black spots and this has been marked and noted by the concerned authorities. The total road length between Solan and Shimla is 50 Km with about 46% of the total stretch in Solan district and the remaining in Shimla district. The NH-22 stretch between Solan and Shimla witnesses a large number of accidents every year. The local police and National Highway Authority of India (NHAI) have demarked it as one of the most accident prone regions of Northern India.

The paper attempts to identify the locations on the NH-22 between Shimla and Solan which are most accident prone, tries to evaluate the causes of such accidents and suggest remedial measures.

Research Methodology

The research methodology involved checking the sustainability of the aggregates used in the construction of NH 22 by performing Aggregate Impact Value, Los Angeles Abrasion Test and Flakiness and Elongation Indices test on the aggregates and comparing them with the values provided in MoRTHs. We identified 'black spots' on the NH 22 on the Solan and Shimla stretch from the data collected. Variation of traffic pattern was also observed on the weekdays and weekends to check the propensity for accidents on weekdays and weekends. Analysis of geometrical design components of roadways including SSD, superelevation and length of curve were calculated. Existing straight stretches of the road were evaluated for OSD and the length of these stretches.

Material Testing of Aggregate used for construction of NH-22

Material testing is the first and the most important component to identify the reasons for accidents on roads. Worn out roads due to aggregates can cause the presence of porous surfaces on roads which can severely affect the skid resistance and the speed of the vehicle. This can reduce the efficiency between tyre road interactions and can lead to increase of accidents (Bullas, 2004). The tests conducted on material aggregates included Aggregate Impact Value Test, Abrasion Value Test and Elongation and Flakiness Index Indices.

Toughness is the property of the material to resist impact due to traffic loads and often the road stones are subjected to the pounding action or impact and there is high possibility of stones breaking into smaller pieces. The road stones should therefore be tough enough to resist fracture under impact. For this purpose aggregate value testing was completed and an aggregate impact value of 25.45% was determined.

Due to the movements of traffic, the road stones used in the surfacing course are subjected to wearing action at the top. Resistance to wear or hardness is therefore an essential property for road aggregates especially when used in wearing course. The selected road stones should be hard enough to resist the abrasion due to the traffic. Testing was done using Los Angeles Abrasion Testing equipment and the percentage wear was calculated to be 35.25%

The particle shape of aggregates is determined by the percentages of flaky and elongated particle contained in it. In the case of gravel it is determined by its angularity number. For base course and construction of bituminous and cement concrete types, the presence of flaky and elongated particles are considered undesirable as they may cause inherent weakness with possibilities of breaking down under heavy loads. Rounded aggregates are preferred in cement concrete road construction as this increases the workability of concrete. Angular shapes of particles are desirable for granular base course due to increase stability divided from the better interlocking. When the shape of aggregates deviates more from the spherical shape, as in the case of angular, flaky and elongated aggregate, the void content in aggregate of any specified size increases and hence the grain size distribution of a graded aggregate has to be suitable altered in order to obtain minimum voids in the dry mix of the highest dry density. The angularity number denotes the void content of single sized aggregates in excess of that obtained with spherical aggregates of the same size. Thus angularity number has considerable importance in the gradation requirements of various types of mixes such as bituminous concrete and soil-aggregate mixes. The evaluation of shape of the particles, particularly with reference to flakiness, elongation an angularity is necessary. The flakiness index of aggregates is the percentage by weight of particles whose least dimension (thickness) is less than three-fifths (0.6) of their mean dimension. The test is not applicable to sizes smaller than 6.3 mm. The following observation was made and have been reported in Table 1.

Sieve Size	Retained on IS sieve (mm)	Wt fraction consisting of at least 200 pieces (gm)	Thickness of gauge sizes	Wt of aggregates	Length of gauge size	Weight of aggregates retained on length gauge
63	50	0	23.90	0	-	-
50	40	0	27	0	81	-
40	31.5	0	19.5	0	58	-
31.5	25	0	16.95	0	-	-
25	20	0	13.5	0	40.5	-
20	16	272.25	10.8	72.45	32.4	47.95
16	12.5	526.4	8.55	80.90	25.25	114.65
12.5	10	247.5	6.75	25.25	20.3	65.85
10	6.3	237.3	4.8	33.55	14.7	106.05

Table 1: Sieve Size analysis of aggregates used for construction of NH-22

Using the above information, the Flakiness Index was calculated to be 16.5% and the Elongation Index was calculated to be 26.06%. As per Ministry of Road Transport and Highways (MORTH), the physical requirements of coarse aggregates for water bound macadam for sub base and base courses should have a maximum aggregate impact value of 30%, maximum Los Angeles abrasion value of 40% and the combined elongation and flakiness index should be a maximum of 30% (MORTH, 2000). The tests conducted on the aggregates show that they are within the permissible limits of MORTH guidelines.

Accident Studies on NH-22

The problem of accident is a very acute in highway transportation due to complex flow pattern of vehicular traffic, presence of mixed traffic along with pedestrians. Traffic accident leads to loss of life and property. Thus the traffic engineers have to undertake a big responsibility of providing safe traffic movements to the road users and ensure their safety. Road accidents cannot be totally prevented but by suitable traffic engineering and management the accident rate can be reduced to a certain extent. For this reason systematic study of traffic accidents are required to be carried out. Proper investigation of the cause of accident will help to propose preventive measures in terms of design and control.

Data was collected from the police stations at Kandaghat, Solan and Shimla. The information collected included the number of accidents that took place in District Solan and Shimla over the past 10 years. Based on the data the police authorities have also marked a number of black spots on the highway where the rate of occurrence of accidents has been quite high. We cross-checked the analysis and found that the black spots marked by the police exactly matched our analysis. The details of these black spots have been summarized in Table 2. The exact locations of these places on NH-22 have been shown in Figure 1.

Serial No	Name of locality	Distance	Cause of Accident	Problems	Measures adopted
1	Kathleeghat	27 Km from Solan towards Shimla	Rash Driving	Narrow Curve	Curve has been widened by HPPWD
2	Shalaghat	30 Km from Solan towards Shimla	Rash Driving	Narrow Curve	Curve has been widened by HPPWD
3	Kiarighat	21 Km from Solan towards Shimla	Rash Driving	Narrow Curve	Curve has been widened by HPPWD
4	Waknaghat	24 Km from Solan towards Shimla	Rash Driving	Narrow Curve	Curve has been widened by HPPWD
5	Kandaghat	15 Km from Solan towards Shimla	Rash Driving	Poor Visibility	Curve has been widened by HPPWD
6	Kiari bungalow	21 Km from Solan towards Shimla	Rash Driving	Narrow curve	Curve has been widened by HPPWD

Table 2: Summary of accident details at black spots

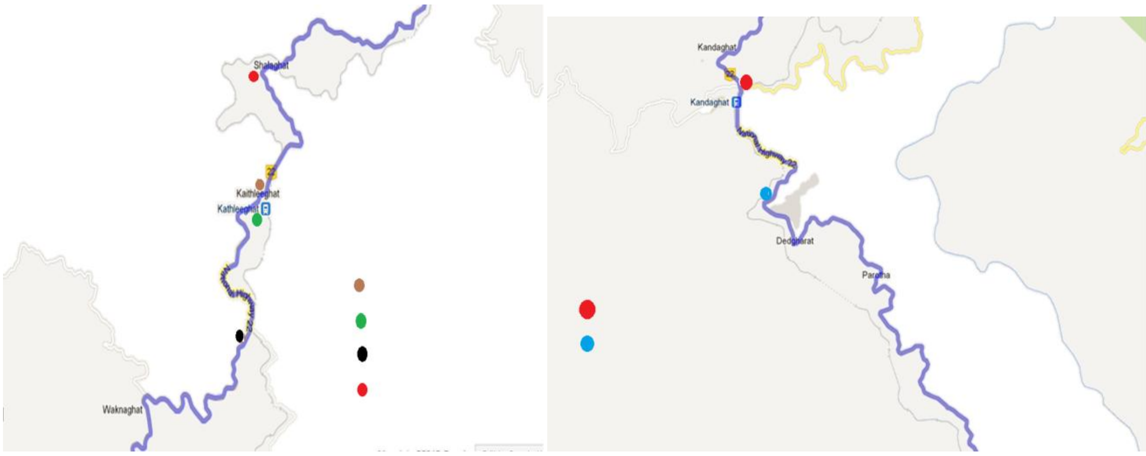

Figure 1: Location of black spots on NH-22 highway between Solan and Shimla

From the data analysis and physical verification of these ‘black spots’ the major reasons for such high probability for accidents are mainly due to the following reasons:

Majority of the drivers have a tendency to overtake on curves which leads to accidents since when the drivers try to overtake on a blind curve the overtaking sight distance (OSD) is almost negligible.

Narrow curves are provided due to the topography of the area. A driver while driving on these curves must slow down the vehicle but in many cases due to inexperience of drivers or any other causes, results in accidents as high speed on these narrow curves often lead to overturning of the vehicle.

The region is in a hilly terrain and experiences heavy fog during winters. Due to fog the shortest sight distance (SSD) is greatly reduced. This causes the reaction time for the drivers to be reduced which lead to collisions.

The region also experiences excessive rainfall. During rainy season the roads become slippery and the coefficient of friction between the tyres and the road surface is greatly reduced. This leads to slipping of vehicles especially two wheelers.

The regions close to Shimla experience lots of snowfall in the months of December and January. The presence of snow on carriageway also poses significant threat to the vehicles. Most of the cases of overturning and slipping of vehicles into gorges are reported during this period of the year.

The region being a hilly area driving in night time depends entirely on the headlight of the vehicle approaching from the opposite direction. This is also another important reasons for accidents as the drivers often do not safely negotiate the curve from the correct driving side by lowering the speed which may lead to collision with crash barriers or other vehicles.

Traffic Volume Studies on NH-22

Traffic volume is the number of vehicles crossing a section of road per unit time at any selected period. Traffic volume is used as a quantity measure of flow. The commonly used units are vehicles per day and vehicles per hour. A complete traffic volume study may include the classified volume study by recording the volume of various types and classes of traffic, the distribution by direction and turning moments and the distribution on different lanes per unit time. There are variations in traffic flow from time to time. Daily traffic volume varies considerably during the week, the peak weekend volume may be much higher than average weekday volume. In classified traffic volume study, the traffic is classified and the volume of each class of traffic i.e. buses, truck, passenger cars, other light vehicles, rickshaws, bullock carts, cycles and pedestrians is found separately.

Traffic volume counts maybe done by manually and by mechanical counters. Due to unavailability of mechanical counters the traffic volume study was done manually.

The method employs a field team to record traffic volume on the prescribed record sheets. By this method it is possible to obtain data which cannot be corrected by mechanical counters, such as vehicle classification, turning moments and counts where the loading conditions or number of occupants are required. However it is not practically feasible solution particularly if the data has to be collected for 24 hours over the entire year.In our study manual counts were made on Wednesday and on Sunday representing weekday and weekend respectively

For Solan district manual counts were made at Chambaghat. Traffic counts were recorded from 9.00 AM in morning till 6.00 PM in evening. Counting was done and vehicle fleet distribution was done to include like cars, motor cycles, buses, trucks, tractors, cycle and others which included JCB and trailers. Similar methodology was followed for weekend count of traffic data. The change in traffic flow between weekdays and weekends were calculated. Similar methodology was followed for Shimla. Records of traffic counted for both weekdays and weekends for Solan and Shimla have been shown in Table 3 and 4 respectively.

Traffic	**Weekdays**			**Weekends**		
	Count	**VDF**	**Traffic in MSA (10^{-6})**	**Count**	**VDF**	**Traffic in MSA (10^{-6})**
Cars	1273	1	1273	1817	1	1817
Two-wheelers (MC and scooter)	366			424		
Buses	249	1	249	256	1	256
Trucks	213	4	852	143	4	572
Tractors	5	4	20	0	4	0
Cycles	7			2		
Others (JCB and trailers)	3	3	9	1	3	3

Table 3: Vehicle fleet distribution at Solan for weekdays and weekends

Traffic	**Weekdays**			**Weekends**		
	Count	**VDF**	**Traffic in MSA (10^{-6})**	**Count**	**VDF**	**Traffic in MSA (10^{-6})**
Cars	1112	1	1112	1317	1	1317
Two-wheelers (MC and scooter)	179			237		
Buses	216	1	216	244	1	244
Trucks	356	4	1424	193	4	772
Tractors	1	4	4	0	4	0
Cycles	0			0		
Others (JCB and trailers)	1	3	3	0	3	0

Table 4: Vehicle fleet distribution at Shimla for weekdays and weekends

The traffic volumes were calculated in terms of Million Standard Axles (MSA). For Solan on weekdays the MSA value was calculated to be 0.002403 MSA and on weekends it was calculated to be 0.002648 MSA. Similarly for Shimla, the MSA values calculated on weekdays were found to be 0.002759 MSA and and on weekends it was 0.0023 MSA. The average traffic flows at Solan and Shimla were calculated to be 0.002507 MSA and 0.002552 MSA respectively. There is an increase in total number of vehicles traversing on weekends as compared to weekdays at Chambaghat junction in Solan. There is a substantial increase in number of cars and motor cycles which can be attributed to the number of tourists visiting Shimla during the weekends. It is also observed that there is a sharp decrease in the number of commercial vehicles i.e. trucks and buses primarily due to holiday in schools and colleges on Sunday.

Geometric design parameters for black spots on NH-22

We have already determined the six black spots on the NH-22 stretch of road lying between Solan and Shimla. In this section, we evaluate the different road geometric parameters at these black spots. The road geometric design parameters evaluated were length of curve, SSD and superelevation. Standard formula prescribed by IRC (IRC:37 -2001) were used to evaluate the data.

At Kathleeghat, the length of curve was measured to be about 151m. Using the provisions of the IRC code the length of the curve was calculated to be 27 m assuming a speed of 40 km/hr which is well within the permissible limits. Similarly, the SSD was measured to be 34.5 m. The SSD value calculated for different speeds of 20, 30 and 40 km/hr and was computed to be 24.39 m, 34.37 m and 69.8 m respectively. Hence, it was observed that the SSD was apt for speed of about 25km/hr which is less than the design speed (40 km/hr) at Kathleeghat. IRC: 37-2001 suggests that the superelevation values for hilly regions should be 0.1. The superelevation calculated was found to be 0.016 which was appropriate for speed of 20 km/hr

At Waknaghat, the length of curve was measured to 139 m. Using the same assumptions as above, the length of the curve was computed to be 37 m and was well within the permissible limits. Similarly, the SSD was measured to be 34 m. The SSD values remain the same as the previous case because we assume similar velocity conditions. Hence, SSD values were apt for speed of about 25km/hr which is less than the design speed (40 km/hr) at Kathleeghat. The superelevation calculated was found to be 0.034 which was appropriate for speed of 18 km/hr

Similar evaluation of geometric design parameters were carried out and have been presented in table 5

Place	SSD (m)	Length of curve (m)	Superelevation
Waknaghat	34	139	0.12
Shalaghat	37.5	51.62	0.31
Kathleeghat	34.5	151	0.06
Kiarighat	34.6	134.9	0.10
Kiaribungalow	30.3	63.8	0.085
Kandaghat	27.5	65	0.27

Table 5: Summary of geometric design parameters for black spots location on NH-22

Similarly length of straight stretches was determined at Kathleeghat and Shalaghat. It was assumed that the speed of overtaking vehicle was 50 km/hr and speed of approaching vehicle was 20 km/hr. The requirements of OSD at these two locations have been shown Table 6.

Place	Speed of overtaking vehicle (km/hr)	Speed of approaching vehicle	OSD available (m)	OSD required (m)(As per IRC:37-2001)
Shalaghat	50	20	135.6	248.16
Kathleeghat	50	20	78.5	248.16

Table 6: Summary of OSD for straight stretches on NH-22 between Solan and Shimla

Remedial Measures

The following remedial measures are suggested to reduce the number of accidents on NH-22 between Solan and Shimla. These include erection of signboards on turns and at blind spots.

Further, to ease the drive conditions during night time and to make them aware of the curves ahead fluorescent signboards must be used. The authors suggest provisions of installing convex mirrors on the curves. The convex mirrors installed on all the blind sports or sharp curves will give visibility of the approaching vehicle from the other side. Lack of retaining walls along the carriageway leads to landslides from the hills especially during the rainy seasons causing accidents. As such, retaining walls should be provided at all such blind spots and sharp curves. Finally, the authors suggest installation of light poles of suitable height must be installed to enhance the visibility of drivers at night. Care must be taken that there is sufficient light on the carriageway so that visibility is increased.

Conclusion

The paper attempts to analyze the main reasons for the occurrence of accidents on NH-22 stretch between Solan and Shimla. Identification of black spots were done using the information collected from various police stations in Kandaghat, Solan and Shimla. Data analysis of these black spots revealed the main reasons for accidents on the black spots on NH-22 were poor visibility, rain and snow, insufficient SSD and OSD on curves, late reaction time of drivers, heavy traffic at night, distance between headlights, narrow curves and inexperience of driving on hilly terrains. Interestingly, no design details exist for this highway as it was constructed in the pre-independence era of India. Further, there have been no amendments that have been done on this stretch of the highway (from Solan to Shimla) for the last decade. However, keeping in mind the safety of the travellers serious thoughts need to be given to driver safety to prevent accidents. The authors on their part suggest installations of various road furniture's like convex mirrors, fluorescent sign boards, light poles and where possible provisions of retaining walls to reduce the risk of accidents

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