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Original Article

Identification and Improvements of Accident Black Spots on NH-75 (Nelamangala-Hassan section)

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Abstract *- India is a large country, and highways are essential to the nation's progress. National highways have a total distance of 70,548 km, cover 2% of India's total road network, and handle 40% of total traffic. The number of vehicles on the road is increasing as the population rises. As the number of vehicles increases, the number of accidents also increases. So, they have to be safe against accidents. The cause for the accidents is generated from the accident information on the GIS platform and redesigning the highway geometrics for mitigating accidents by proposing long-term measures such as vehicular underpass (VUP). Overspeeding is found to be a major reason for accidents and human negligence at junctions and intersections, and structural widening is proposed where the carriageway is lesser than IRC standards. Finally, the obtained improvements and the existing spots are simulated using PTV Vissim (student). As per studies and investigations on National Highway 75 total of 13 black spots were identified throughout the study area of 84.09 km. Five locations are identified where VUP is proposed as per IRC guidelines. National Highway is thus to be engineered considering all these inputs related to safety and design standards.*

Keywords *- Alignments. National Highways, Black Spots, Road Accidents.*

1. Introduction

National Highways serve as the main vines of the country's Transport network. By addressing people and commodities' transport requirements, the national highway network is responsible for the progression of civilizations and the country's economic development. The national highways in India cover a total distance of 70,548 kilometres, accounting for 2% of the country's total road network and carrying 40% of all traffic [1]. According to estimates, India is responsible for roughly 10% of all fatal road accidents worldwide. As a result, a decision has been made to make concerted measures to improve road safety. Recognizing accident spots and analysing and treating road accident black spots is one of the most effective methods for road accident prevention.

Accidental black spots are described as areas of the road where the risk of an accident is high or where accidents frequently happen on national highways. On highways, speed is one of the key factors contributing to traffic accidents and fatalities [7]. Researchers have also verified that the geometric design of roadways, particularly the horizontal alignment, significantly impacts their quality and safety. The notion of Geometric Design Consistency (GDC) has proven to be the most promising technique for investigating national highway traffic safety requirements. The aspects and qualities of geometric road design are considered in this study, and explanations of how they affect highway safety are offered. The dimensions of radii, the ratio of sequential curves, the dimension of vertical curves, and the sight distance conditions all influence road alignment [2].

Few researchers use Remote Sensing and GIS tools to identify and monitor Accident black spots and conditions of National Highways. The goal of enhancing the efficiency and effectiveness of highway accidents is to develop a system that uses GIS to identify high-rate accident regions and analyse accidents. As a result, GIS will provide a platform for maintaining and updating accident record databases and analysing them. As a long-term measure, VUP is proposed for suggested black spots for the stretch. Given this condition, it isn't easy to estimate the road capacity as they all share the same lane, making it more complex than a homogeneous condition. To overcome such problems, the simulation of traffic parameters is more effective. Several traffic-simulating software's were being developed, among which VISSIM stands out as the most successful traffic-simulating software.

2. Objectives of the Study

- To review the literature on road safety aspects of National highway
- To obtain data related to accidents and road geometry.
- To conduct a detailed investigation on the above selected black spots to arrive at the actual cause of the accidents.

- To suggest long-term measures [VUP] to mitigate accidents at selected black spots.
- To simulate and validate the performance of suggestions using VISSIM.

3. Literature Review

In NH-75, [2] noted that nearly half of the crashes were due to Overtaking, overspeeding, and careless driving, which are common causes of accidents, with improved enforcement of traffic regulations and sufficient lighting at intersections recommended as remedial measures. [1] Due to improper connection of state highway, the traffic jam was commonly observed in peak hours, and many accidents were already recorded at the location.

[8]The major black spots along the national highway were identified based on a study of crash data collected from NHAI and police accident data using the severity index technique.

[6]Almost all previous studies' conclusions indicate that the accident rate is high on horizontal curves at intersections and junctions.

[1] It is observed that constructing an underpass will be easier, more economical and suitable for topographical conditions compared to other methods.

4. Problem Statement

4.1. Study Area

The study area was selected in the state of Karnataka, through which National Highway-75 passes. For study purposes, an 84.09 km stretch of road was selected from Nelamangala toll(13.068113, 77.360035) to Devihalli toll plaza (12.958095, 76.623398), which connects Kunnigal (39+100), Amruthur (56+200), Bellur cross (91+000).

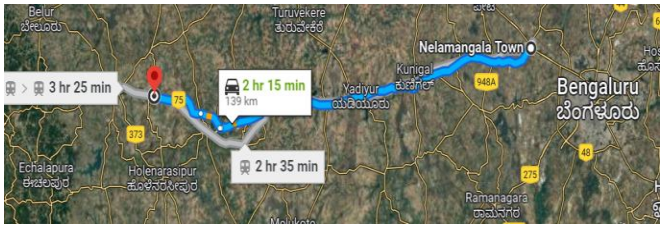


Fig. 1 Study area from 33+100 to 164+160 (Nelamangala to Shanthi grama toll)

Note. The image was created from google maps to show the distance between the preferred study area, i.e. from Nelamangala toll plaza to Shanthi grama toll plaza.
(*https://www.google.com/maps*)

4.2. Methodology

Methodology mainly included collecting existing accident data, visual survey and alignment profile data to identify the black spot and suggest improvements to mitigate accidents along the stretch.

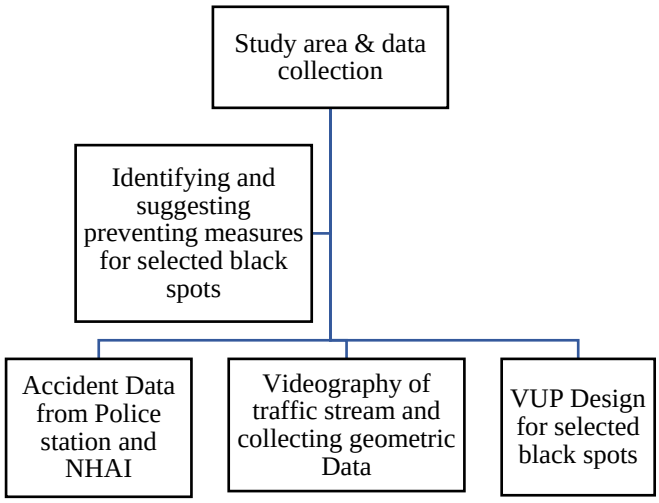


Fig. 2 Flow chart of identification of black spots

4.2.1. Existing Accident Data Collection
Police Station Data

Five police stations manage the chosen stretch: Nelamangala, Kunnigal, and Bellur cross. Accident information from these police stations was collected from 2017 to 2021. Each instance Accident FIR is hand authored in the local language – Kannada – by related police station personnel.

Most police stations have a suitable register for accident records under that police station, while other accident data is recorded on the police station's Accident FIRs. The majority of the details from each such FIR were then converted to the correct excel format for standard data entry. The accidents were classified, and only those that occurred on NH-75 were considered for data entry. From January 2017 to August 2021, there were 365 accidents on NH-75. For accurate identification of the site of the accident on the stretch, project chainage was also provided in excel format. These tasks were completed for each police station's accident data.

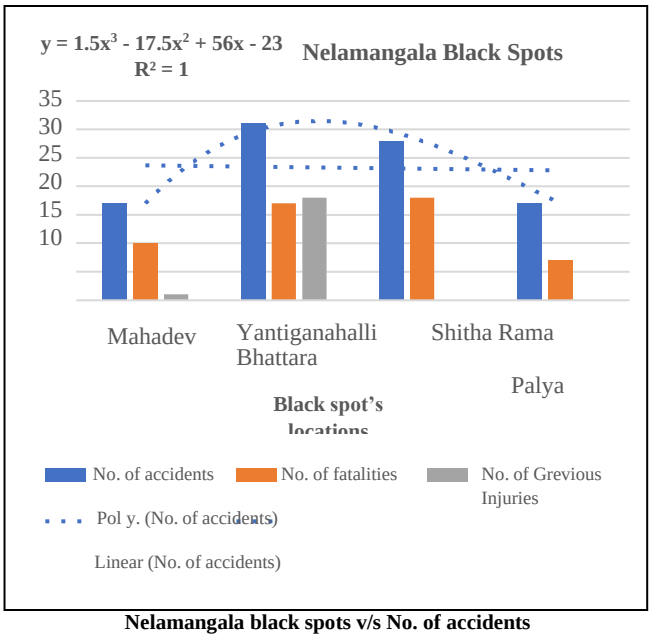
NHAI (National Highway Authority of India)

The data was collected from the National Highway Authority of India (NHAI). The data acquired from NHAI was sequentially arranged with a chainage of 1000M. The accidental data were summarized, including the location of the accident, nature of the accident, classification of the accident and the type of causalities, and summary of accidents.

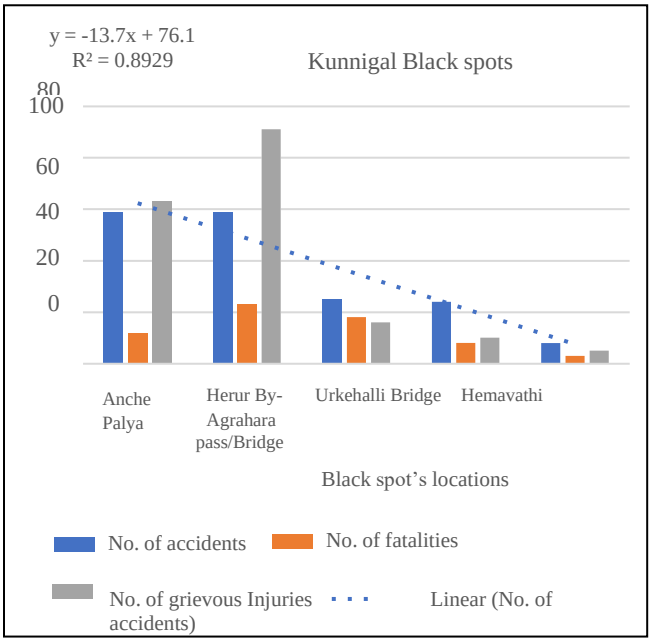
5. Data Collection and Analysis

5.1. Identified Black Spots from Police Data

As per studies and investigation on National Highway 75, i.e. from Nelamangala toll plaza to Devihalli toll plaza total of 13 black spots were identified with no. of accidents, no. of fatalities and no. of grievous injuries throughout the study area of 84.09 km.



Nelamangala black spots v/s No. of accidents

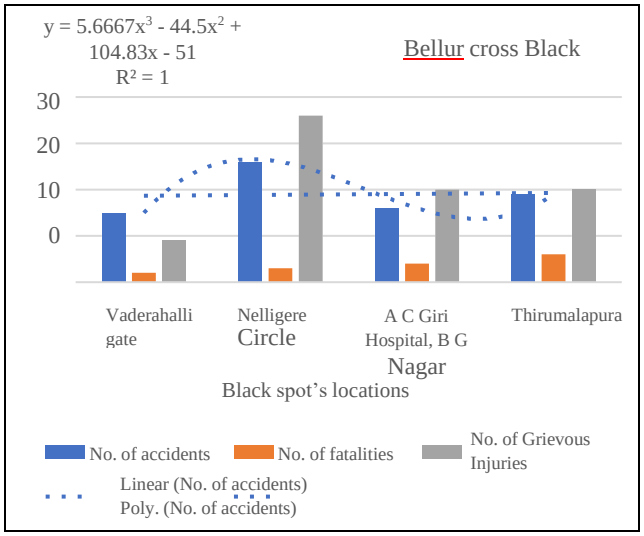


Kunnigal black spots v/s No. of accidents

- The linear trend was observed to be the worst-fit equation with a coefficient determination value below 0.5.
- The polynomial trend was observed to be the best fit with the coefficient of determination 1, i.e. $R^2 = 1$.

5.2. Identified Black Spots from NHAI

Each accident's data, including location, nature of the accident, cause of the accident, chainage of stretch, date of the accident, and so on, was input into excel for determining the chainage-wise location of the accident.



Bellur black spots v/s No. of accidents

Table 2. Accident data from the Police station

NH-75 Accident Data For the Last 5 Years from 2018-2022					
S.L. No	**Year**	**No. of Accidents**	**Fatal-(Members)**	**Major Injury-(Members)**	**Minor Injury -(Members)**
1	**2018**	183	47	85	164
2	**2019**	211	37	126	244
3	**2020**	217	62	121	236
4	**2021**	209	75	94	196
5	**2022**	258	16	165	83
	Total	1078	237	591	923

Note. This table represents the total no. of accidents for the last five consecutive years collected from the National Highway Authority of India.

Table 3. Chainage-wise accident data

Chainage	**Nature of Accident**	
	Fatal	**Non-Fatal**
109+500 to 115+000	8	4
115+000 to 120+000	10	14
120+000 to 125+000	12	21
125+000 to 130+000	3	5
130+000 to 135+000	10	13
135+000 to 140+000	8	3
140+000 to 145+000	9	13
145+000 to 150+000	6	2
150+000 to 155+000	7	3
155+000 to 160+000	12	3
160+000 to 165+000	22	28

Note. Illustration of chainage-wise accident data collected from the National Highway Authority of India.

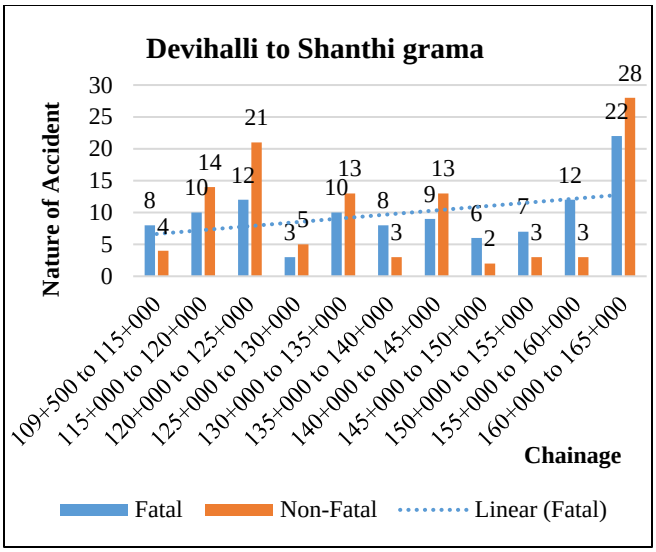


Fig. 4 Regression analysis of accident data

Note. The regression model was developed to analyze the relation between no. of accidents and fatal accidents occurring on identified black spots.

5.3. Visual Survey

Videography of the entire stretch was done in a floating car using a smartphone for both directional traffic for two runs on 25-06-2021. The Android app "Travel Distance" was used to record the latitude and longitude coordinates at key points throughout the route. All details were also noted down in the field book along the stretch from Nelamangala toll (Chainage 33+100 Km) to Devihalli toll plaza (117+109 Km) and back to Devihalli toll plaza (117+109 Km) to Nelamangala toll (Chainage 33+100 Km). Various land uses along the highway stretch were noted down, such as merging village roads, hotels, restaurants, key structures (schools, police quarters, training institutes, etc.), bus stops, fuel stations, and so on, where access control was merging with toll road stretch of NH-75.

Fig. 5 On-site location with latitude and longitude positions

Note. The image shows the latitude and longitude points of identified black spot-on National highway 75 in the visual survey.

6. Implementation of vehicular Underpass for selected Black spots

Location: - Talekere Hand Post

Chainage:- Ch 63+400 to 63+700

The Blackspot location is a three-arm junction. The primary short-term measures like pavement marking, illumination works etc., are already adopted. The visibility during night time is very low; due to this, it is resulting in frequent fatal accidents. The aerial view of the approach road and the junction is shown in the figure below.

Fig. 6 Aerial View of Black Spot location

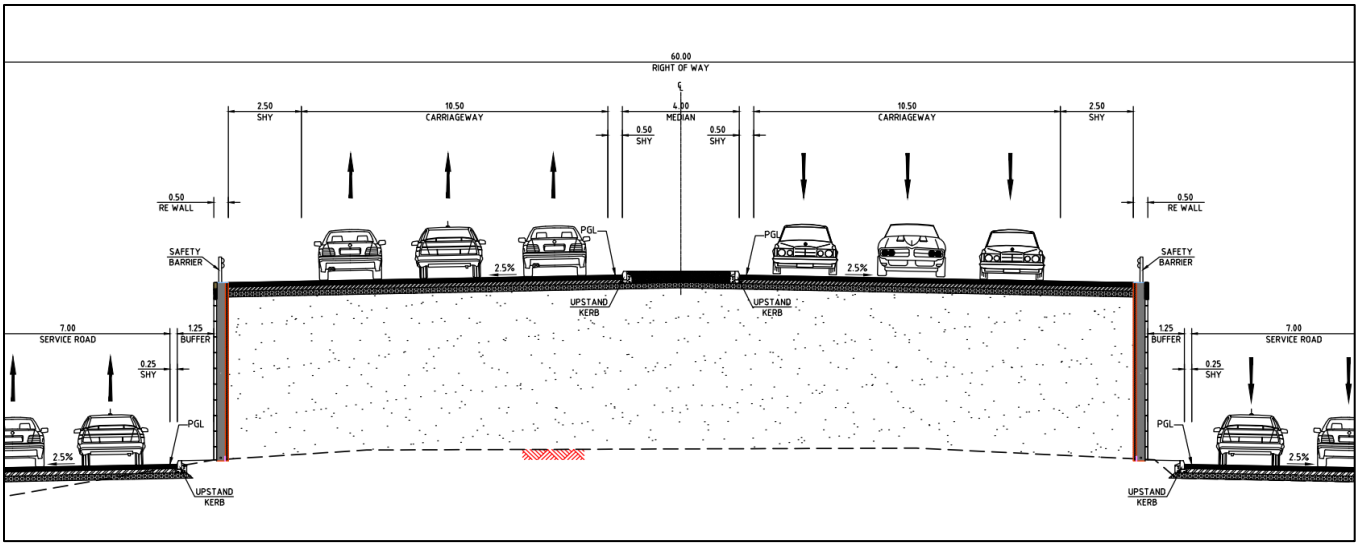


Fig. 7 Typical Cross-Section VUP Approach

6.1. Recommendations for Long-term Improvements

The junction is a three-arm Junction, and the no-traffic speed calming measures are adopted with low acuity of vision during night time due to the non-adoption of illumination facilities and having connectivity to major district roads. The committee recommended providing double vent VUP of size 25m x 5.5m, i.e. (each/single vent size is 12.5m x 5.5 m) as a permanent solution/rectification to this Black spot.

6.2. Safety Concern & Audit Findings

- The highway is a four-lane divided road and has a 30m ROW. The ROW of the crossroad is 7 m.
- The turning radius of the junction is also very low and has very less visibility.
- The road leads to a densely populated residential colony housing more than 500 houses.
- The traffic on the main highway is 19123 vehicles (34241 PCUs), and traffic on the main highway is 19123 vehicles (34241 PCUs).

6.3. Detailed Estimate for VUP and service road

NATIONAL HIGHWAYS AUTHORITY OF INDIA PROJECT IMPLEMENTATION UNIT - HASSAN			
Permanent rectification (construction of VUP) of identified Black Spot KA (02)-057 at Ch 63.400 to 63.700 (Talekere Hand Post), including its approaches, road safety measures etc., on Nelamangala - Devihalli section of NH-75 in the state of Karnataka.			
Sl. No.	**Description of Item**	**SOR Details**	**Total Cost**
1	Main Carriageway with Service Road	NH-Bengaluru-2021-22	**22,81,19,403.05**
2	RCC Drain	NH- Bengaluru-2021-22	**3,06,05,708.03**
3	Road Furniture	NH-Bengaluru-2021-22	**10,01,678.40**
4	VUP at Talakere Junction	NH-Bengaluru-2021-22	**2,75,41,118.15**
		AMOUNT IN Rs.	**28,72,67,907.63**

Fig. 8 Detailed Estimate of LVUP & Service road at Talakere Junction

7. Validating the Performance of Suggestions using VISSIM

7.1. Modelling of VUP suggested Black spot

Modelling of identified black spots is done by assigning simulation parameters, i.e. vehicle types, vehicle compositions, vehicle routes, and routing decisions.

Location: - Talekere Hand Post
Chainage: - Ch 63+400 to 63+700

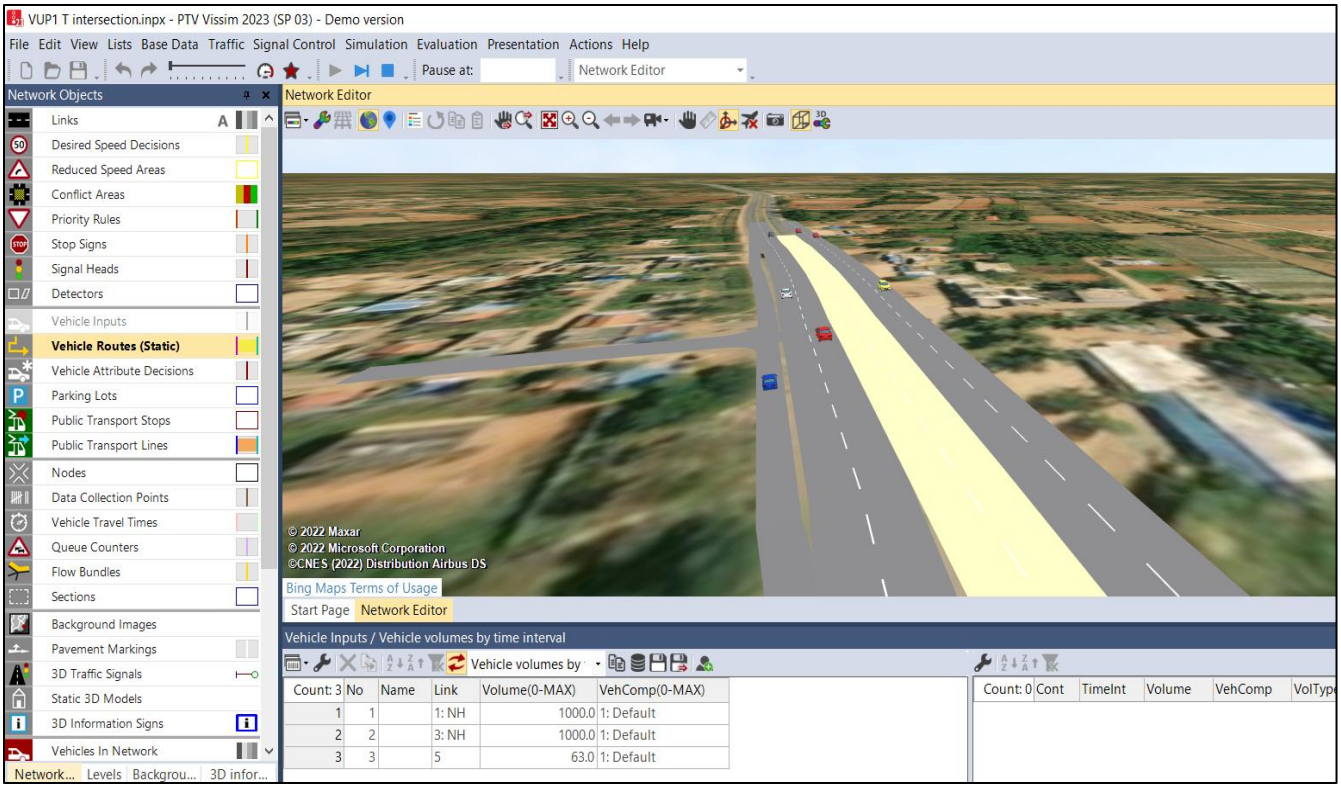


Fig. 9 Modelling of the proposed condition of the Black spot.

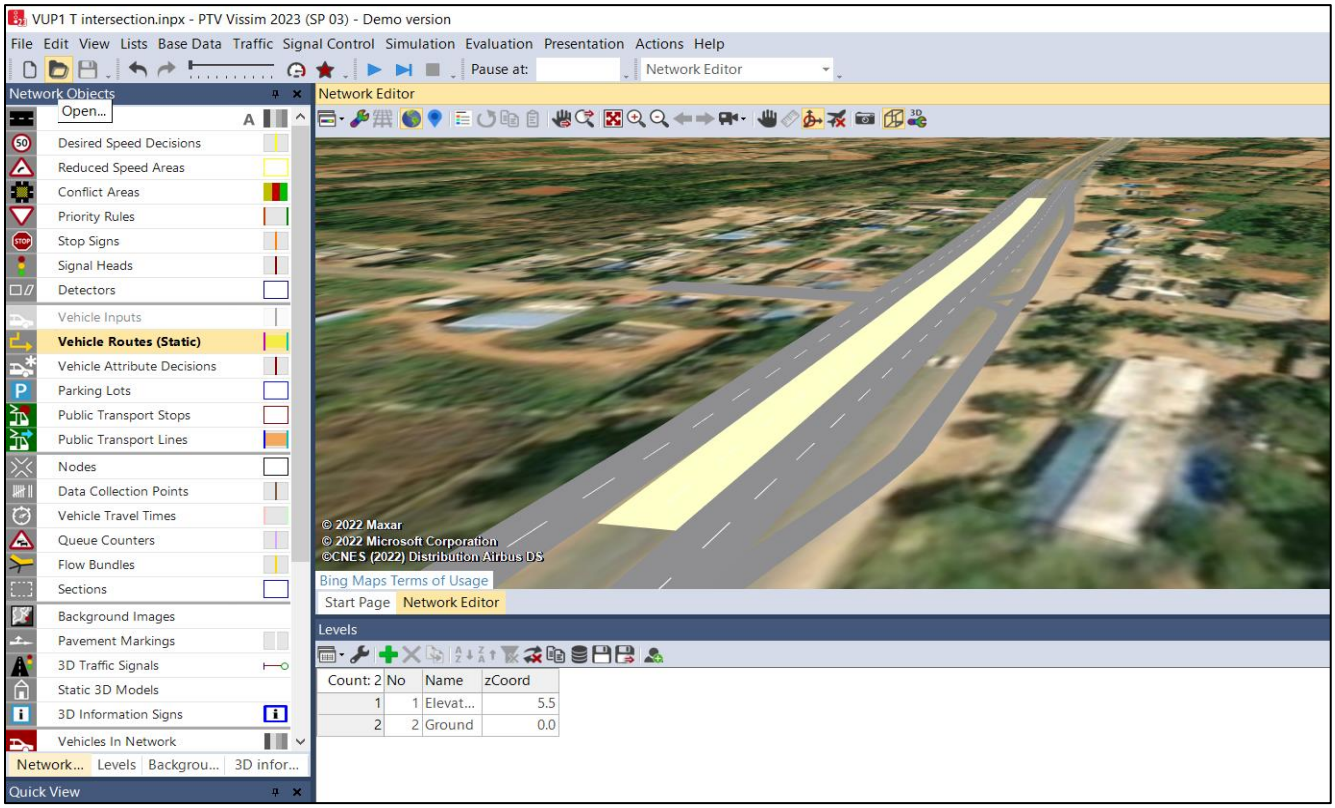


Fig. 10 Drawing the network with links and connectors with lane data and levels.

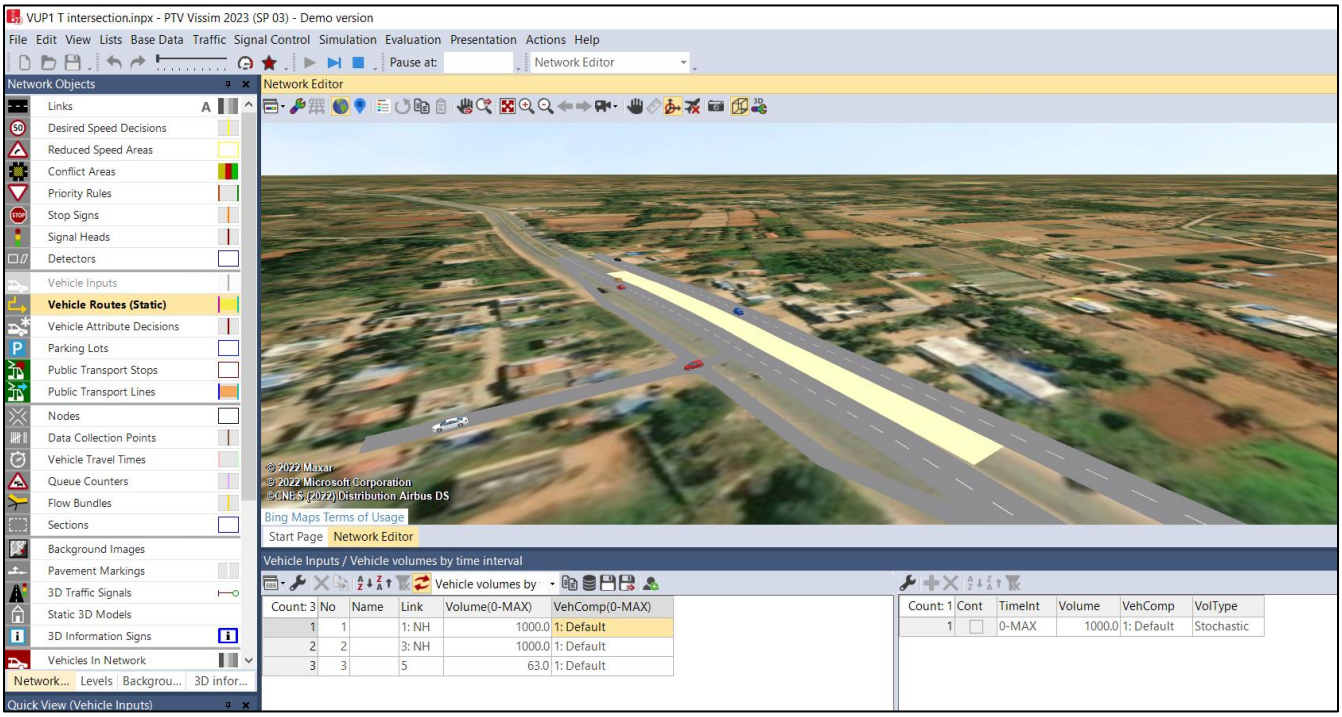


Fig. 11 Vehicle Input and Vehicle Routing.

Conflict areas at junctions/intersections between vehicles from the national highway to state highways are modelled by providing VUP at junctions of the suggested black spot. Here national highway is given vertical clearance at 5.5 m elevation from ground level. And for movement of vehicles from state highways is given at zero level, followed by village roads, service roads etc., to avoid head-on collisions and rear-end collisions of vehicles.

8. Summary and Conclusion

Overspeeding and human negligence at junctions and intersections were major reasons for accidents. Most of the intersections along the highways were unsignalized and uncontrolled. The major safety issue noticed at the straight segments was the reckless driving of the vehicles. The main advantage of using QGIS for identifying accident black spots on roads is that it requires very less additional data other than the road network map. Suggestions and Improvements are given for identified black spot locations for National Highway-75. The long-term measures involve widening the pavement and shoulders, provision of road humps and the underpass are proposed as mitigation measures. The underpass is very economical compared to the flyover, and the time consumed to construct the underpass is much less, which will be convenient for the traffic flow during construction. The provision of an underpass will reduce fuel costs by nearly up to 58%. The provision of the underpass at this junction reduces traffic congestion, and as a result, a lot of timeand fuel are saved. Also, air pollution at this junction is minimized.

Acknowledgement

I want to thank the National Highway Authority of India for providing the required existing alignment data of NH-75 and for all the timely response and coordination.

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