

BLACK SPOT IDENTIFICATION FOR NATIONAL HIGHWAY- 47: A CASE STUDY OF GODHRA – GUJARAT MP BORDER STRETCH

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Abstract

Indian National highway network consists of only 2% of the whole road network, but it still carries 40% of the traffic, which might be causing road accidents on National Highways. Even newly constructed National highways getting tolls for their use are also suffering from accident occurrence on them. One such stretch, originating from Godhra and ending in Gujarat- MP border (length 91.91 km), is also suffering from an increase in accidents over the years. This road is connecting Gujarat state with two adjoining states named Madhya Pradesh and Rajasthan. Due to high access density, conflict points have increased on this highway and subsequently cause accidents. It is necessary to find black spots for such roads through available accident records.

In India, the accident data is being recorded by the concerned Police station through First Inspection Reports (FIRs), wherein very minimal details are collected. For identification of Black spots, it is necessary to locate the place where accidents took place. So, before collecting the Accident FIR data from the police station, a field videographic survey of the stretch in both directions was conducted, and all-important locations like median breaks, access points, petrol pumps, restaurants, village access roads, etc. have been noted according to project chainage for determining the exact location of the Accident.

The accident records for the toll road were used to convert the accident locations into proper chainage locations using field book data of the videographic road survey. After deciding the chainage of each accident location, the accident data was entered in excel sheets and arranged chainagewise. Black spots were identified according to the Ministry of Road Transport and Highways (MoRTH) criteria. There were sixteen black spots identified on this stretch from the study.

Keywords: Road safety, Accident location, Black spot, Access density.

I. Introduction

Accidents are continuously increasing in developing countries like India, and also, the World Health Organization (2015) has declared 2010-2020 as the decade of action for road safety. However, still, the accidents in most of the developing countries have been continuously increasing at a scary pace. Indian National highway network consists of only 2% of the whole road network, but it still carries 40% of the traffic, which might be causing road accidents on National Highways. Even newly constructed National highways getting tolls for their use are also suffering from accidents. One such stretch, originating from Godhra (128.117km chainage) and ending in Gujarat- MP border

(215.900km chainage) in Gujarat state of India, is also suffering from an increase in accidents over the years. This road is connecting Gujarat state with two adjoining states named Madhya Pradesh and Rajasthan. Due to high access density, conflict points have increased on this highway and subsequently cause accidents. It is necessary to find black spots for such roads through available accident records.

In India, the accident data is being recorded by the concerned police station through First Inspection Reports (FIRs), wherein very minimal details are collected. For the identification of black spots, it is necessary to locate the place where accidents took place.

An accident blackspot is a location where road traffic accidents have historically been concentrated. It may have occurred for various reasons, such as a sharp drop or corner in a straight road, so oncoming traffic is concerned, a hidden junction on a fast road, poor or concealed warning signs at a cross-road. In other words, the blackspot is that particular place at which maximum accidents take place, or there are more likely chances of more accidents at these locations.

According to Geurts and Wets (2003), there was no universally accepted definition of what should be considered as 'dangerous' location. Some researchers rank locations by accident rate, some use accident frequency, and some use a combination of the two. Geurts, Wets, Brijs, and Vanhoof (2005) suggested using Bayesian estimation values instead of historical count data to rank accident locations, which could overcome the problem of random variation in accident counts and would have a significant effect on the selection of the most dangerous accident locations. The authors generated probability plots, based on estimates from a hierarchical Bayes model to visualize the estimated probability that a location would be ranked as dangerous.

Tegge and Ouyang (2009) proposed a new safety analysis framework. An optimal network design module that estimates the most-probable site for each crash is combined with the standard regression analysis. The authors developed an effective solution algorithm based on Lagrangian relaxation for the network design model and proposed an iterative computation approach location estimation and statistical regression.

Liu (2012), based on a comprehensive analysis of the factors of speed consistency and acceleration, put forward a new method, namely synthesized analysis method of vehicle kinematical parameters, to identify the blackspots of highways in the mountainous district and gave applied technical procedure of the method. The case study indicated that the technique could efficiently identify the blackspots of highways with complex alignment conditions in the mountainous district.

Mohan & Landge (2017) identified the accident-prone locations along Amravati- Nagpur road stretch from Asian highway 46. The top accident-prone spots were selected as black spots based on Weighted Severity Index Method.

Keymanesh, Ziari, Roudini, and Ahangar (2017) identified black spots without accident information along "Iraanshahr-Sarbaaz-Chabahr" road in Baluchistan, Iran. They divided stretch into eight sections based on the uniformity and homogeneity of each section in terms of geometry and regional conditions. At each section, potential black spots were identified, and questionnaires were prepared to collect opinions from 30 experts who were well-familiar with the road. The collected data was analyzed using SPSS Software, leading to the identification of black spots. Finally, the identified black spots were compared against those obtained by traffic police based on accident information.

According to Washington, Afghari, and Haque (2018), hotspot identification methodologies had been evolved considerably over the past 30 or so years, correcting for methodological deficiencies along the way. Despite vast and significant advancements, identifying hotspots remains a reactive approach to managing road safety – relying on crashes to accrue to mitigate their occurrence. Many factors, including crash severities (e.g., fatal versus injury crashes), random fluctuations of crashes from year to year, different exposure levels (traffic volumes), variation in geometric design and operational features (e.g., signal phasing, shoulder, and median design), variation in weather (e.g., rain, wind, fog) and differences in driving populations (e.g., younger drivers, older drivers) complicated the process of identification of blackspots.

According to Ahmed, Sadullah, and Yahya (2019), errors in accident data errors led to wrong identification of black spots and hazardous road segments and consequently, wrong projection of accident estimates and fatality rates, and detection of wrong parameters responsible for accident occurrence, thereby making the entire road safety exercise ineffective. For Middle-income countries, the error for the light, severe, non-fatal, and fatal injury accident categories varied between 93–98%, 32.5–96%, 34–99%, and 0.5–89.5%, respectively. In comparison, very few studies for low-income countries showed that the error in reporting non-fatal and fatal accidents varied between 69–80% and 0–61%, respectively. The average error in recording information related to the variables in the categories of location, victim's information, vehicle's information, and the environment was 27%, 37%, 16%, and 19%, respectively. Among the causes identified for errors in accident data reporting, Policing System was found to be the most important. The authors recommended that there should be reforms in the policing system, and public awareness should be created to reduce errors in accident data.

Till now, very few studies have been done in India for correctly finding the locations of the Accident and identifying black spots on National Highways in India. In each country, different methods have been prescribed for the identification of blackspots. In India, according to the Ministry of Road Transport and Highways (MoRTH) criteria, a road accident blackspot on National Highways is a road stretch of about 500m in length in which either five road accidents involving fatalities/ grievous injuries took place during the last three calendar years or ten fatalities took place during last three calendar years.

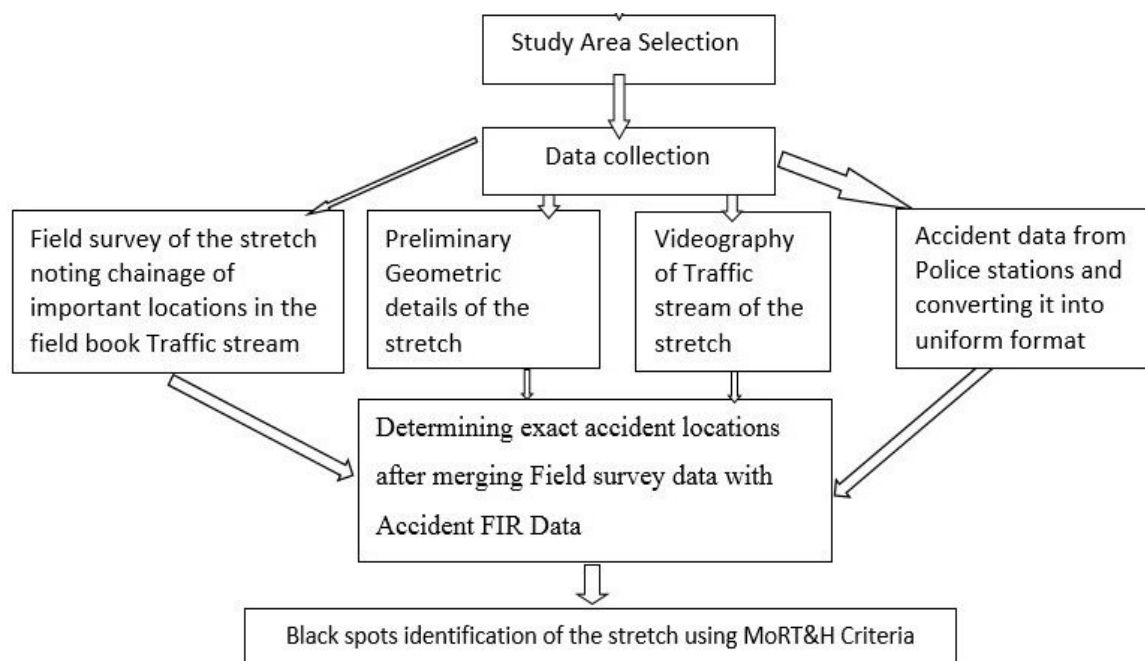


Figure 1: Study Methodology

The main objective of the paper is to determine the exact location details of all the accidents, which are in the form of FIRs recorded for each Accident in the local language, and subsequently, find blackspots for the stretch. The accident FIR data for five calendar years from 2012 to 2017 was collected from concerned police stations and their location. From the videographic field survey of the stretch, the location for each Accident according to toll road project chainage for the stretch determined. These accident data were then arranged according to chainage, and MORT&H criteria for identification of black spots will be used to determine black spots on the stretch. From the above such refined data filtered according to location for three calendar years 2015, 2016, and 2017, sixteen

black spots were identified. The methodology has been suggested to determine the exact location from the accident records available with police through Accident FIRs.

II. Study Area

NH-47 connecting Ahmedabad with Indore is one of the vital highway corridors of the country. It serves as an essential link to connect Indore - Ahmedabad important cities with its rich hinterland part of Gujarat, Rajasthan, and Madhya Pradesh. NH-47, which originates from Ahmedabad and ends at Indore. The starting point of the selected stretch is the Godhra bye-pass (chainage 128.117 km), and the endpoint is Gujarat-MP Border (chainage 215.900 km) on this National Highway. The length of the stretch is 91.91 km. The stretch is connecting two districts – first, PanchMahals having 1210 villages and 14% Urban population, while the second, Dahod having 696 villages with 9% urban population as per the 2011 Census of India. Due to so many villages coming across this National Highway, there are several median access points and access points on the sides of NH merging with villages.

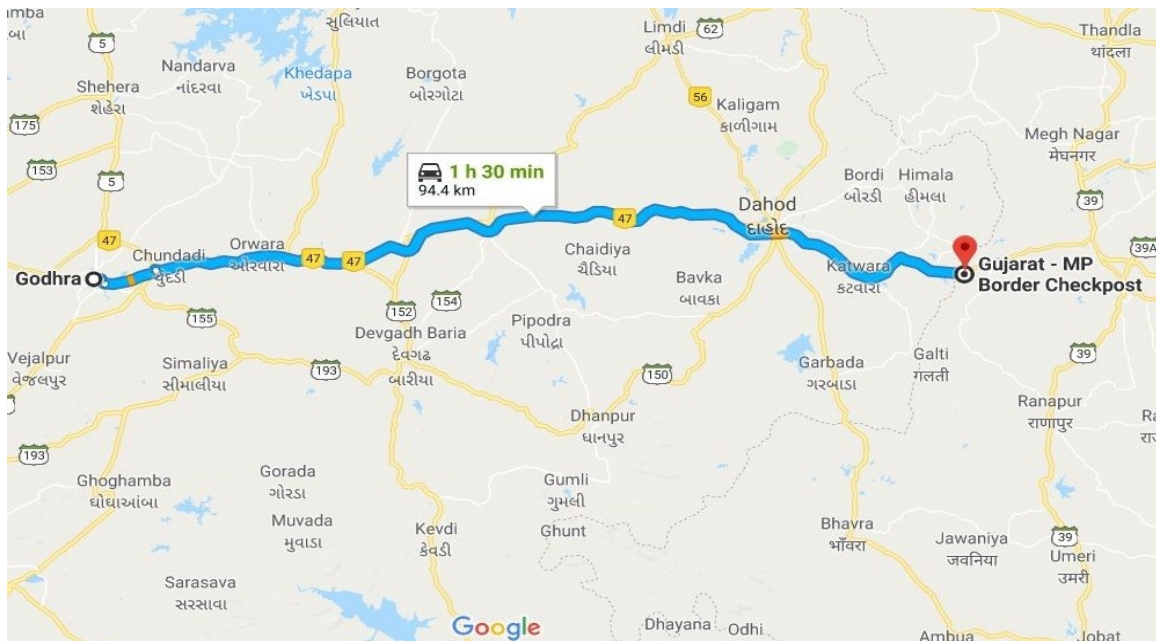


Figure 2: The selected stretch of NH-47

This National Highway stretch is a four-lane divided carriageway, with starting chainage as km 128.117 to ending at km 215.900 in Gujarat state. It has four flyovers, 4 number of railways over bridges. It has three bypasses, comprising 11.09km, six major bridges, 16 minor bridges, 32 minor culverts coming across the NH. The cross-section of the highway consists of a four-lane divided carriageway (2 x 7.00m), 1.5m wide paved shoulder on either side of the carriageway, and a median of 1.50 width.

III. Data Collection and Analysis

I. Accident data Collection

The selected stretch comes under the jurisdiction of five police stations, namely Godhra A – Division police station, Godhra taluka police Station, Limkheda police Station, Rabdal (Dahod Rural) police station, and Katwara police station.

The accident data from these police stations from the year 2012 to 2017 were collected. Each typical Accident FIR is written manually in the local language – Gujarati by concerned police station staff. At most police stations, the proper register is maintained for accident records under that police station while at other accident data entered on Accident FIRs of the police station. In all the accident FIRs / Registers of police stations, the nearest locations or place of Accident was mentioned, but the exact location of the Accident was missing.

Most of the time, it is very much challenging to decipher the accident details from such FIRs. From each such FIR, most of the details were then converted to proper excel format for uniform data entry. The accidents were filtered, and those which occurred on NH-47 were considered for data entry. There were 365 accidents, which occurred on NH-47 from the year January 2012 to December 2017. For identifying accident location on the stretch, project chainage was also included in the excel format for proper identification of the location. These steps were completed for each accident data of all police stations.

II. Infield surveying of the stretch through Videography

Videography of the whole stretch was done in a floating car on 10-08-2018 through mobile for both directional traffic for two runs. The Android application named "Travel Distance" was used to note the chainage at critical locations along the stretch. All details were also noted down in the field book along the stretch from Godhra Bye-pass (Chainage 128.117km) to Gujarat-MP Border (215.900km) and back Gujarat-MP Border (215.900km) to Godhra Bye-pass (Chainage 128.117km). Various land use along the stretch such as merging village roads, hotels, restaurants, important buildings (schools, police quarters, training centers, etc.), bus-stops, petrol pumps, etc. was noted down along the stretch, where control of access was merging with toll road stretch of NH-47.

III. Access density

During the field surveying on the stretch, all access points on the Left-hand side, Right-hand side, and median were observed, and their chainage was also noted down. However, it is a toll road; it has 31 median access points, 41 left side carriageway access points, and 53 access points on the right-side carriageway, so overall, the stretch is having an access density of 1.36/km, so that factor is also increasing conflicting movements on the stretch.

IV. Black Spot Identification

Each accident data FIR record consisting of its location, chainage, nature of Accident, cause of Accident, date of Accident, etc. were entered in excel (Sample for Excel sheet in Figure. 3) for determining the chainagewise location of the Accident.

Road Accident Report (3 Year Accident data - Chainagewise, Accident type and Nature of Accident)

| Sr | Date | Time of Acc. (am/pm) | A | | Black Spot No. | B | C | No of affected persons | | | |
|----|------------|----------------------|-------------------|----------|----------------|---------------------------|-----------------|------------------------|----------------------------|-------|----------|
| | | | Accident Location | Chainage | | | | Nature of Accident | Classification of Accident | Fatal | Grievous |
| 1 | 18-06-2015 | UNKNOWN | PARWADI CHOKADI | 129.700 | 1 | Overturning | Fatal | 1 | 0 | 0 | 0 |
| 2 | 08-07-2015 | UNKNOWN | PARWADI CHOKADI | 129.700 | 1 | Right turn collision | Fatal | 2 | 0 | 0 | 0 |
| 3 | 06-08-2015 | UNKNOWN | PARWADI CHOKADI | 129.700 | 1 | Collision brush/Side Wipe | Fatal | 4 | 0 | 0 | 0 |
| 4 | 06-11-2015 | UNKNOWN | PARWADI CHOKADI | 129.700 | 1 | Skidding | Fatal | 1 | 0 | 0 | 0 |
| 5 | 20-09-2017 | UNKNOWN | PARWADI CHOKADI | 129.700 | 1 | Overturning | Fatal | 3 | 0 | 0 | 0 |
| 6 | 19-03-2015 | UNKNOWN | PARWADI CHOKADI | 129.700 | 1 | Overturning | Grievous Injury | 0 | 1 | 0 | 0 |
| 7 | 30-11-2016 | UNKNOWN | PARWADI CHOKADI | 129.700 | 1 | Overturning | Grievous Injury | 0 | 1 | 0 | 0 |
| 8 | 10-05-2017 | UNKNOWN | PARWADI CHOKADI | 129.700 | 1 | Collision brush/Side Wipe | Grievous Injury | 0 | 1 | 0 | 0 |
| 9 | 25-09-2015 | UNKNOWN | PARWADI CHOKADI | 129.700 | 1 | Head on collision | Minor Injury | 0 | 0 | 4 | 0 |
| 10 | 04-02-2016 | UNKNOWN | PARWADI CHOKADI | 129.700 | 1 | Right turn collision | Minor Injury | 0 | 0 | 1 | 0 |
| 11 | 14-05-2015 | UNKNOWN | GADH CHUDANDI | 130.000 | 1 | Overturning | Fatal | 1 | 0 | 0 | 0 |
| 12 | 28-05-2016 | UNKNOWN | GADH CHUDANDI | 130.000 | 1 | Overturning | Fatal | 1 | 0 | 0 | 0 |
| 13 | 29-09-2017 | UNKNOWN | GADH CHUDANDI | 130.000 | 1 | Collision brush/Side Wipe | Fatal | 1 | 0 | 0 | 0 |
| 14 | 23-02-2015 | UNKNOWN | GADH CHUDANDI | 130.000 | 1 | Overturning | Grievous Injury | 0 | 2 | 0 | 0 |
| 15 | 15-03-2016 | UNKNOWN | GADH CHUDANDI | 130.000 | 1 | Head on collision | Grievous Injury | 0 | 1 | 0 | 0 |
| 16 | 13-05-2017 | UNKNOWN | GADH CHUDANDI | 130.000 | 1 | Overturning | Grievous Injury | 0 | 1 | 0 | 0 |
| 17 | 11-02-2015 | UNKNOWN | GADH CHUDANDI | 130.000 | 1 | Overturning | Minor Injury | 0 | 0 | 1 | 0 |
| 18 | 09-10-2016 | UNKNOWN | GADH CHUDANDI | 130.000 | 1 | Head on collision | Minor Injury | 0 | 0 | 2 | 0 |
| 19 | 02-10-2016 | UNKNOWN | UDAY HOTEL | 131.830 | | Overturning | Grievous Injury | 0 | 2 | 0 | 0 |

Black Spots_Chainage_Acctype

Page 1 of 10

Figure 3: Sample Excel sheet for determining Accident location chainage

In Excel, the accident FIR data was sorted chainage wise, and different accident classification year-wise was obtained. Table 1 shows the yearly trend of accidents on the stretch for the past five years. The accidents have been increasing every year since toll road became operational in the year 2014.

Table XVI: Accident Trend for the Stretch

| Year | Accident Nature | | | | Total |
|---------|-----------------|-----------------|--------------|------------|-------|
| | Fatal | Grievous Injury | Minor Injury | Non-Injury | |
| 2012 | 11 | 22 | 25 | 0 | 58 |
| 2013 | 18 | 6 | 27 | 0 | 51 |
| 2014 | 9 | 32 | 11 | 2 | 54 |
| 2015 | 26 | 27 | 10 | 5 | 68 |
| 2016 | 16 | 34 | 11 | 0 | 61 |
| 2017 | 31 | 29 | 12 | 1 | 73 |
| Total | 111 | 150 | 96 | 8 | 365 |
| % value | 30.41 | 41.1 | 26.3 | 2.19 | |

Table I indicates that fatal accidents are continuously increasing after the opening of the toll road. The fatal accident share is 30.41%, and the grievous injury accident share is 41.10%.

The accident data was sorted chainagewise – year-wise to determine black spots for the whole stretch, which satisfied the MoRTH [9] criteria of blackspot. The three-year accident data was filtered according to chainage, Accident classification wise and year wise.

For blackspot identification, according to MoRTH, road accident blackspot on National Highways is the road stretch of about 500m in length in which either five road accidents involving

fatalities/grievous injuries took place during the last three calendar years or ten fatalities took place during three calendar years.

Out of a total of 202 accidents on the stretch for the years from 2015 to 2017, 165 accidents had taken place on the identified black spots.

After sorting chainagewise, year-wise accidents for the stretch, following blackspots, were determined based on the MoRTH criteria, as shown in Table II.

TABLE XVII: Number and Nature of Accidents at Black Spots

| Black Spot No. | Fatal | | | Grievous Injury | | | Minor Injury | | | Non Injury | | | Total accidents at Black-spot |
|----------------|-------|------|------|-----------------|------|------|--------------|------|------|------------|------|------|-------------------------------|
| | 2015 | 2016 | 2017 | 2015 | 2016 | 2017 | 2015 | 2016 | 2017 | 2015 | 2016 | 2017 | |
| 1 | 5 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 18 |
| 2 | 1 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 7 |
| 3 | 2 | 1 | 3 | 2 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 12 |
| 4 | 1 | 0 | 3 | 0 | 3 | 3 | 0 | 1 | 2 | 0 | 0 | 0 | 13 |
| 5 | 1 | 1 | 1 | 1 | 4 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 11 |
| 6 | 0 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 7 | 1 | 0 | 2 | 1 | 3 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 11 |
| 8 | 1 | 0 | 0 | 3 | 2 | 3 | 0 | 0 | 1 | 1 | 0 | 0 | 11 |
| 9 | 1 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 1 | 0 | 1 | 8 |
| 10 | 1 | 0 | 0 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 6 |
| 11 | 0 | 1 | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 9 |
| 12 | 0 | 1 | 1 | 1 | 0 | 4 | 1 | 0 | 3 | 0 | 0 | 0 | 11 |
| 13 | 1 | 2 | 6 | 3 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 15 |
| 14 | 1 | 1 | 1 | 3 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 10 |
| 15 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| 16 | 1 | 0 | 2 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 8 |
| Total | | | | | | | | | | | | 162 | |

The chainage and locations of these 16 black spots were finalized, which are shown in table III as under:

TABLE XVIII: Blackspot location details for the stretch

| Sr. | Chainage (km) | Location | Sr. | Chainage (km) | Location |
|-----|---------------|------------------|-----|---------------|----------|
| 1. | 129.700 | Parwadi Chokadi | 9. | 184.580 | Rampura |
| 2. | 132.440 | Chanchelav | 10. | 190.000 | Rabdai |
| 3. | 139.000 | Orwada Bus Stand | 11. | 196.360 | Punsri |
| 4. | 164.300 | Limkheda | 12. | 199.620 | Jalat |
| 5. | 169.200 | Dhadhela | 13. | 201.280 | Gamla |
| 6. | 178.880 | Dabada | 14. | 203.000 | Katwara |
| 7. | 179.350 | Kamboi | 15. | 208.580 | Kathla |
| 8. | 180.220 | Rozam | 16. | 213.310 | Khangela |

All these sixteen black spot locations have been tagged on the google earth map and represented in figure 4.



Figure 4: Blackspot locations on Google earth

V. Discussion and Conclusion

In India, accident data is mostly being collected and maintained through registers or Accident FIRs by the police department in the local language without noting proper locations of the accidents. Hence, it becomes difficult for Road safety authorities to determine the exact accident locations and take suitable measures for their improvement. Hence, for identifying black spots on the selected stretch of NH-47, raw Accident data from police stations were collected for the years from 2012 to 2017. Infield survey and videography were used simultaneously for deciding the location of each Accident from the FIRs, and the accident data was compiled in proper excel format with the most important details related to each Accident event along with its chainage. Then all these data were sorted chainagewise and year wise for identification of black spots according to MoRTH criteria. In the end, 16 black spots have been identified on this stretch. This methodology can help the road safety authorities to determine the exact location of the accident occurrence and subsequently determine black spots for such National highways in developing countries like India, where the exact GIS/GPS location of the Accident is not recorded properly as in other developing/ developed countries. This methodology will help the Traffic regulation authority in taking suitable measures to know the black spot locations and subsequently to carry out suitable engineering measures and planning measures. A user questionnaire survey can also be conducted to decide the causative factors for every critical location. Further, based on the users' feedback, it is easy to take preventive steps in reducing accidents on the highway.

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