

Ramifications of Roadways Conditions and Traffic Features on Roads Safety : A Safety Perspective for Jalandhar, Punjab

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Abstract

India is in a developing phase and safety on roads is at a premature stage. Accidents are increasing day by day leading to a great loss of life. Some people are disabled, others suffer damage to property and health, and degradation of environment resulting in a situation in India that is at a tocsin stage.

Official records show that approximately 1,42,000 persons were killed and approximately 4,80,000 injured in traffic accidents in India in 2014 (NCRB 2015). However, this is underestimated since many accidents are off the records and all accidents are not reported. The high accident rate is due to inadequacy of highways and GT roads which cannot meet traffic demands or some other reasons like vehicular defect, poor road geometry or road user behaviour. These accidents deal a heavy blow to the economy of a country. Hence, road safety is a necessity for reduction in accidents.

Keywords : Public transport, Punjab, road accidents, road safety, traffic demand

NOMENCLATURE

IPT	Intermediate Public Transport
IPC	Indian Penal Code
PRADMS	Punjab Road Accident Data Management System
FIR	First Information Report
PCU	Passenger Car Unit

I. INTRODUCTION

Developing countries like India have serious issues when road accidents are concerned. These are a havoc around the globe. Approximately 3000 people face death daily around the globe because of road accidents.

Road safety is a serious problem in India. Each year about 1.4 million people face death and about 40 million

get injured in India. If this continues, then traffic accidents will be third among the leading contributors to disease and injury by 2022 [1].

Fatality rates are high and rising. Fatality rate is the ratio of deaths (for example, deaths per thousand) in an area. India can earn a distinction as the fatality rate in our country is quite high as road safety is not much practiced here. It is a major concern not only in India but also around the globe.

Accidents are the reason of draining out the national economy also. As an estimate, World Bank says that about \$1 trillion, that is, about 4% of the GDP (Gross Domestic Product) is lost in accidents [2].

Indian roads carry about 95% of passenger traffic and about 60% of freight resulting in increase in mortality rate per 10,000 vehicles to 15 as compared with less than two for other developed countries due to heterogeneous traffic on the lane. It almost includes all motorbikes, cars,

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buses, trucks, rickshaws, three-wheeler IPT's, bicycles, bullock carts etc. [3].

Inadequate road safety, potholes or ruts formation on road, bad license system which is prone to bribing, drunkards, and underage driving can and should be blamed for these increased accident rates. As an estimate, about 250 people are killed daily [4].

The concern of increasing motor vehicles on roads should also be checked as it is of utmost importance because novice drivers who don't even understand basic motor skills are incapable of facing huge traffic but they drive recklessly. The increase in motor vehicles accidents is because these novice drivers aged 17-20 are provided with cars and bikes by their parents and this keeps road safety at stake. It is a problem seen by developing countries where economies are growing and cars are becoming affordable for people [5].

Punjab on the other hand is a state having 46% fatal accidents on state highways and a total 62,000 km of road network. This state has to work upon safety of people as its records are at an alarming stage. NH-1 was the first national highway constructed and was called the Grand Trunk road in the Mughal period. NH-1 is a major connection between Amritsar and Delhi. It has a length of 456 km and caters to transportation of heavy goods, light goods, and travellers passing through Jalandhar, Phagwara, Ludhiana, Kurukshetra, Panipat, and Sonipat.

The selected stretch of road is a portion of NH-1 for studying and recording data related to accidents and daily traffic. The stretch covers a distance of 9.3 km between Jalandhar Bus Stand to Haveli, Village-Paragpur, NH-1, and Jalandhar. It is 98 km away from Amritsar. The lanes of the road are not uniform. The accident data were collected between this stretch for analyzing black spots where traffic accidents often occur. Data were analyzed using Accident

TABLE I.

**CAUSES OF ACCIDENTS BY ROAD ACCIDENTS
REPORT IN INDIA (2012)**

Causes of accidents	Percentage
Accidents due to defects in vehicle	15%
Accidents due to driver fault	78%
Accidents due to fault of pedestrian	1.5%
Accidents due to bicyclists	1.3%
Accidents due to weather condition	2.4%
Other accidental causes	Less than 1%

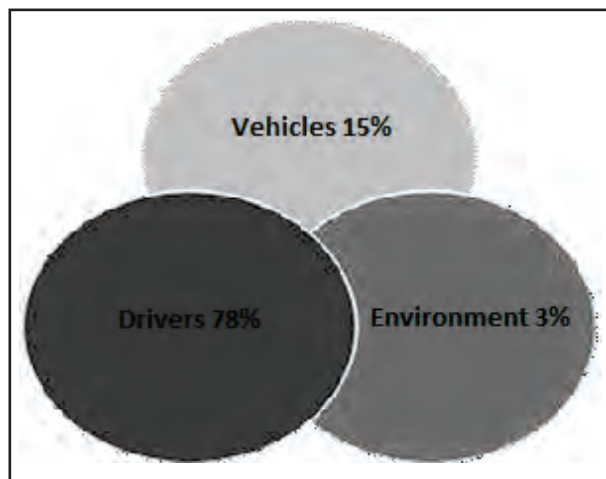


Fig. 1. Causes of Accidents

Frequency and Accident Severity Index method. Further deficiencies were dealt with and suggestions were given for further improvement.

Causes of accidents are variable. There are different causes described in the statistics of road accidents in India in 2012 [4].

A. Causes of Accidents

Since Indian roads have heterogeneous traffic, road safety strategy of the driver should be prevention of fatal crash and death. Safe road geometrics can help ensuring

TABLE II.

VARIOUS FACTORS CAUSING ACCIDENTS

Vehicle related factors	
Overload	Tyre failure
Lights defects	Steering defects
Brake defects	Inappropriate wheel aligns
Driver related factors	
Unsafe speed	Distraction
Alcohol and drugs	Non-use of restraint
Fatigue	Sickness
Drowsing	Disregard to traffic controls
Inappropriate turning or passing	Cell phone use
Environment related factors	
Inappropriate traffic control	Water ponding
Fixed objects	Ruts and holes
Faulty shoulder	Garbage and debris
Road side hazards	Smog, fog or smoke
Vision obstructions	Glaring

vehicle speed within human tolerance if any conflicting points exist.

Accidents happen due to various causes because of the following factors (Fig. 1) :

(a) Vehicles

(b) Driver

(c) Environment

The details of various factors affecting and causing accidents are shown in Table II.

B. Position of Vehicles, Types of Accidents, and Consequences

Accidents inflict indescribable and indisputable costs. Details are further explained in Table III.

II. LITERATURE REVIEW

Factors that exhibit influence of driver behavioral issues and road safety on four lane highways are limited to :

(i) Traffic factors which include traffic speed, traffic density, traffic volume, mixing of traffic, and variations in laning.

(ii) Humanitarian factors including inappropriate judgment due to influence of alcohol and drugs, uneducated, and inexperienced drivers etc.

(iii) Deficiencies in vehicles including non-working and defective braking systems, inappropriate headlights, tyres etc.

(iv) Condition of roads including slipping, skidding surface, ruts etc.

(v) Condition of weather like rainfall, smog, snow etc.

(vi) Several other causes including law enforcements, inappropriate display of road signs and signals, road side advertisements etc.

A. Characteristics of Drivers

(i) Perception : Derry [10] concluded that hazard perception among novice drivers needs to be developed. Sagberg Bjornskau [9] conducted video hazard perception tests and concluded that young male drivers have an extended time of reaction than normal reaction time.

(ii) Drugs and alcohol : According to Shivkumar and Krishnaraj [11], alcohol causes deteriorated driving even when having low levels, which increases the probability of accidents. The alcohol is not digested, instead it is absorbed in the blood stream. After drinking alcohol, the judgment of a driver gets impaired. This makes him take more risks resulting in longer reaction time.

B. Vehicular Characteristics

Defective vehicles are also a major cause of many accidents. These are caused due to defective wheel alignment, failing of brakes, overloaded vehicles etc.

(i) Brake Failures : Oduro[13] concluded that approximately 80% of brake failures result in mishaps. Inappropriate braking efficiency is caused by uneven tyre pressure, inappropriate brakes adjustments, leaking of brake fluids or cracked brake drum.

(ii) Overloading : Osama[14] concluded that overloaded vehicles can cause much damage and increase in maintenance cost.

TABLE III.

POSITION OF VEHICLES, TYPES OF ACCIDENTS, AND CONSEQUENCES

Position of vehicle	Types of accident
Vehicles from same direction	Rear end collision
Vehicles from opposite directions	Head on collision
Vehicles from adjacent direction	Angular collision and turning
While overtaking	While backing, or parking
Off-path roads	Run-off road
Off-path curves	Fixed objects like trees and poles
On-curve turning	Bikes and bicycles
Head on collision	Pedestrians crossing
Head on collision	Animal crossing road
Consequences	
Sprains (ankle/Joint twist)	On-spot deaths
Vision/speech/hearing impairments	Loss of consciousness
Head or neck injury	Abrasion
Chest pain or respiratory impairment	Property losses

C. Environment Characteristics

(i) **Elements of road** : Shinar and Basat [15] concluded that guard rails, shoulder width, and geometry of road have a significant effect on safe speed.

(ii) **Road side features** : Somchainuek [16] concluded that over speeding of vehicles involves them more in road side crashes. About 32% of total road side crashes were caused due to trees on sides of road.

(iii) **Fog and smoke** : Mohmed [17] concluded that crashes due to obstruction in visibility can be caused due to smog in Florida (USA).

He analyzed that smog obstructed crashes happen in night likely due to improper lighting. Head on collisions and rear end collisions were most prevalent.

III. DATA COLLECTION

Data for this study were collected from the accident studies which were collected from FIRs lodged in police stations and through a new type of information system called Punjab Road Accident Database Management System (PRADMS). The data were collected for five years (2010-2015) and were extracted from PRADMS. Also, FIR records filed under IPC 279, 337, 338, and 304(A) were considered for data collection.

A. Selection of Stretch

Two lane and four lane roads from Jalandhar bus stand to Haveli, Village-Paragpur, NH-1, Phagwara on

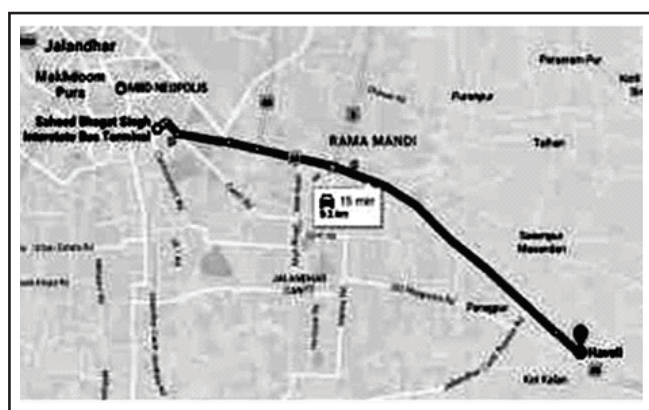


Fig. 2. Selected Stretch for Study

Source : Google.com

NH-1 were selected as the required stretch. Locations with higher probability of accidents are selected below and are shown in Fig. 2 :

(i) Jalandhar bus stand to PAP (Punjab Armed Police) Chowk

(ii) PAP chowk to Rama mandi

(iii) Rama mandi to Dakoha fatak

(iv) Dakoha fatak to Haveli, Village-Paragpur, NH-1, Phagwara

B. Data Collection From FIR and PRADMS

The following data were collected from the PRADMS and are displayed in Table IV.

These police stations had records of past decade. The data were extracted for prior five years from the FIRs filed under IPC no. 279, 337, 338, 304 (A).

Accidents during 2012-2016 on this stretch are shown in Table V. Yearly accident data were collected from PRADMS and accident records from police stations.

C. Data Collected From PWD Records

Public Works Department (P.W.D) records are the

TABLE IV.

NAME OF POLICE STATION AND ROAD SECTION COVERED

Police stations	Road sections
Jalandhar bus stand	Km 0 to Km 2.1 on NH-1
PAP chowk, Jalandhar Bus stand	Km 2.1 to Km 5.6 on NH-1
Rama mandi	Km 5.6 to Km 7.7 on NH-1
Village-Paragpur, NH-1	Km 7.7 to Km 9.3 on NH-1

TABLE V.

ACCIDENT DETAILS BETWEEN THE STRETCH OF ROAD

Year	Fatal	Major injury	Minor injury
2012	0	3	12
2013	1	2	9
2014	0	2	6
2015	1	1	8
2016	2	1	7
Total injury	4	9	55

TABLE VI.

ACCIDENT DETAILS IN THE STRETCH OF ROAD

Points	P1	P2	P3	P4
Carriageway width	17.2m	17m	21m	22m
Formation width	19m	20m	24m	24m
Land width	29m	26m	36m	31m

TABLE VII.

TRAFFIC INTENSITY AT THE SELECTED TWO POINTS IN MORNING

LOCATION	Total traffic		Morning peak hours			
	Vehicles	PCU	Vehicle	% of total traffic	PCU	% of total PCU
PAP Chowk	57574	50478	5172	8.983	4717	9.344
Rama Mandi	61349	60143	4988	8.130	4790	7.929

TABLE VIII.

TRAFFIC INTENSITY AT THE SELECTED TWO POINTS IN EVENING

Evening peak hours				LOCATION	Total traffic	
Vehicle	% of total traffic	PCU	% of total traffic		Vehicles	PCU
6541	11.36	5273	10.44	PAP Chowk	57574	50478
7544	12.29	6894	11.46	Rama Mandi	61349	60143

TABLE IX.

. ROAD-SIDE FEATURE DATA

Location	ADT	Qmax (PCU/s)	Access roads	No. of trees	No. of poles	Lighting conditions	Condition of shoulder
PAP Chowk	57574	0.584	5	4	22	Good	Poor
Rama Mandi	61349	0.70	6	0	16	Average	Poor

main source of details of roads.

The points P1, P2, P3, and P4 in table VI represent the location. P1 represents road connecting Jalandhar Bus Stand. P2 represents PAP chowk. P3 represents road connecting Rama Mandi chowk. P4 connects Haveli, Village- Paragpur.

D. Traffic Properties

Traffic volume survey was carried out for the volume and peak hour traffic flow of vehicles moving across the selected point in both directions. The survey was done on a fair weather day in the generalized peak hours. The vehicular counts were converted in PCUs (Passenger Car Units). Values as per IRC are shown in Table VII and Table VIII.

This 12-hour volume count was done consecutively for seven days starting from Tuesday to Monday under the aegis of Jalandhar Development Authority. Peak hour volume count was manually done as per IRC (Indian Road Congress) guidelines.

E. Road-side Features

Traffic data were collected from the distant two points having ADT (Average Daily Traffic) and PCU per second.

TABLE X.

ACCIDENTAL RATE ANALYSIS FROM SUM OF ACCIDENTS

Name of stretch	Length	Sum of accidents (2012-16)	Accident rate
Jalandhar Bus stand-PAP Chowk (1)	2.1 km	13	6.19
PAP Chowk- Rama Mandi (2)	3.5 km	21	6.00
Rama Mandi- Dakoha Fatak (3)	1.1 km	6	5.45
Dakoha Fatak- Haveli, Village- Paragpur, NH-1 (4)	2.6 km	15	5.76

TABLE XI.

FREQUENCY ANALYSIS FROM SUM OF ACCIDENTS

Distance	No. of accidents (2012-16)	Frequency	Total frequency
0-2.1 km	13	23.63	23.63
2.1-5.6 km	21	33.19	61.82
5.6-6.7 km	6	10.90	72.72
6.7-9.3 km	15	27.28	100
Total	113	100	

IV. DATA ANALYSIS AND DISCUSSIONS

A. Accident Rate and Frequency

From Tables X and XI, it can be observed that frequency and rate of accidents is more for stretch 2 (PAP Chowk-Rama Mandi) followed by stretch 1 (Jalandhar Bus stand-PAP Chowk), stretch 4 (Dakoha Fatak-Haveli, Village- Paragpur), and stretch 3 (Rama Mandi-Dakoha Fatak) respectively.

B. Variation of Accidents

It is observed that percentage of accidents increases every year in the selected stretch. Reasons that can be seen are increasing number of vehicles and vehicular movement, traffic conditions, and population increment. Since it can be observed that maximum number of accidents occurred in between stretch 4 connecting Dakoha Fatak, Jalandhar and Haveli, Village-Paragpur, NH-1, Jalandhar followed by accidents that occurred in Stretch 1 (Jalandhar Bus stand-PAP Chowk), stretch 4 (Dakoha Fatak-Haveli, Village- Paragpur), and stretch 3 (Rama Mandi-Dakoha Fatak) respectively.

C. Monthly Variation of Accidents

Peak season for occurrence of most accidents is from April to July. The extreme summer season hits this time. Problems that could be related with it were glare effect, fatigue, and improper heat effects. Also, another set of accidents happened in the winter season from November to January when most accidents happened due to fog conditions, lesser visibility, and cold environment.

D. Hourly Variation

Increased number of accidents occurred between 8 a.m. -12 p.m. due to high traffic activity on the selected stretch. Also in the night, especially 1 p.m - 3 a.m., more number of accidents happened due to visual blocking or in-appropriate lighting, over-speeding, or dangerous passing. Sadly, none of the figures can show the data as minor accidents also happen in the course of time which were not recorded.

E. Involvement of Vehicles in Fatalities

Results indicate that cars and jeeps have the highest share of 34.6%, followed by 2-wheelers having 26%, buses, trucks, and lorries share about 36%. Most fatalities were due to consumption of alcohol while driving which results in more reaction time and over-speeding on the highway.

V. ANALYSIS OF ACCIDENTS

Accident no. 1

Location: Rama Mandi, Dakoha

Date and time: November 22, 2015 20:10 pm

Vehicle included: Ford Figo (PB 08 A 1298) and Tata bus
Fatalities/injuries: 2 dead and 2 severely injured

Description: On November 22, 2015, a Ford Figo had a head-on collision with a Tata bus coming from the other lane. The car Ford Figo had four passengers who were returning from an event held in Haveli, Village-Paragpur, NH-1. Around 20:10 PM when the car reached near Dakoha, it went out of control due to over speeding. The car lost control and jumped the other side of road and rammed the bus coming from the other side.

Two persons died at the spot while other two were admitted to Johal hospital in Jalandhar in serious condition. According to police reports, crushed bottles of beer were found in the car. Drinking and over-speeding were the cause of the accident. The tyre and skid length was around 11m. The accident pictures are shown in Fig. 3.

Accident no. 2

Location: Haveli, Village-Paragpur, NH-1, Jalandhar

Accident type: Head-on collision, Angular collision



Fig. 3. Accident Investigation 1



Fig. 4. Accident Investigation 2

TABLE XII.

ANALYSIS OF BLACK SPOT

Conflicting Point	Problems	Safety Enhancements
PAP(Punjab Armed Police) chowk	Unsignalized bypass road, Obstructed vision due to girders, self-created bus stand (Fig. 5)	Flyover construction, Signalized flow, Clearance of girders, improvement of junction, Installation of speed breaker on the bypass road.
Rama Mandi chowk	Unsignalized T- point, Shops and school, Under construction site (Fig. 6)	Signalized flow, Construction of conflicted flyover
Dakoha Fatak	Unsignalized flow, On-street parking, Vision obstructed due to trees on shoulders (Fig. 7)	Junction improvement, signalized flow for oncoming traffic to highway, road marking



Fig. 5. The Marked Conflicting Point on PAP Chowk

Date and time: December 14, 2016 2:30AM

Vehicles included: Tata Indica Xeta (PB 08 C 1868), Truck

Fatalities: 3 dead and 1 seriously injured



Fig. 6. The Marked Conflicting Point on Rama Mandi Chowk



Fig. 7. The Marked Conflicting Point on Dakoha Fatak, Rama Mandi Chowk

On December 14, a Tata Indica car rammed a truck during night time around 2:30 AM due to foggy conditions and over-speeding. The persons in the car were students from Haveli, Village-Paragpur, NH-1 and were going to Phagwara railway station for dropping off one of the deceased. The skid mark recorded by police station, Phagwara was around 17 metres. The pictures of the accident are shown in Fig. 4.

The inflicted point or spot where frequency of accidents is higher is called a black spot. These conflicting points should be removed for better traffic safety.

From Fig. 5 and 6, it can be seen that mostly the point is unsignalised starting from PAP chowk to Dakoha Fatak, Rama Mandi. Upon visual inspection it was found that these were the conflicting points that can be black spots if remedies are not provided.

VI. CONCLUSION AND RECOMMENDATIONS

(i) The available literature shows that 77% of accidents

occur due to driver's unawareness, drinking, and driving etc.

(ii) Cars/jeeps/vans are the most accident causing on the stretch. Accidents involving these vehicles are estimated to be 35% followed by 2-wheelers (26%), trucks (18%), and buses (18%).

(iii) Stretch-2 has the highest number of accidents, about 21%. The accidents can be minimized by maintaining the shoulder and starting the obstructed construction.

(iv) Stretch-4 has second highest share of 27.28% of total accidents. This rate can be minimized by signalized flow, starting the leftover construction of the flyover, and providing speed-breakers on the oncoming traffic flow towards the highway.

(v) Stretch-1 is the third highest with 23.63% of total accidents. This rate can be reduced by providing speed limit on junctions, installing speed-breakers, and removal of trees if any on the shoulder width.

(vi) Stretch-3 has lowest share as the accident rate is much lower due to shorter distance between the points, but even then the rate is alarming. Proper measures that can be taken are starting the flyover construction on the Rama Mandi region. Signalized flow is of utmost importance here. Speed-breakers before the junction are important for the oncoming traffic on the highway area.

(vii) Proper lighting conditions should be provided at the junctions as well as on roads.

(viii) Higher amount of traffic inflow towards the city should be maintained by widening the road and signalizing the flow of traffic.

(ix) Proper enforcement measures should be taken and checking of drunk drivers and not allowing them to drive should be considered.

(x) Along the whole stretch, patrolling police cars and ambulance services should be provided.

(xi) Old trees and poles on the shoulder of the road should be removed. The shoulder should be maintained from time to time.

(xii) Construction of flyovers at PAP chowk and Rama Mandi Chowk is of utmost importance which will lead to reduction in congestion of roads at PAP chowk.

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He has a wide experience in the field of civil engineering and has worked for SMEs and various startups. Being from a university of repute, he has worked in different experimental and testing conditions held in the university. About the idea of the thesis work, he has tried to put light on the accident conditions prevailing nation-wide as well as in a particular city of India. Further work will still be inculcated by him soon in the field of transportation engineering and planning.

Nitin Bhardwaj was Assistant Professor with Civil Engineering Department, Lovely Professional University, Jalandhar, Punjab, India. He has now been selected in Water Resources Department in Punjab Government as Assistant Engineer with PWD, India.