Scientific Crash Investigations and Data-Driven Analysis

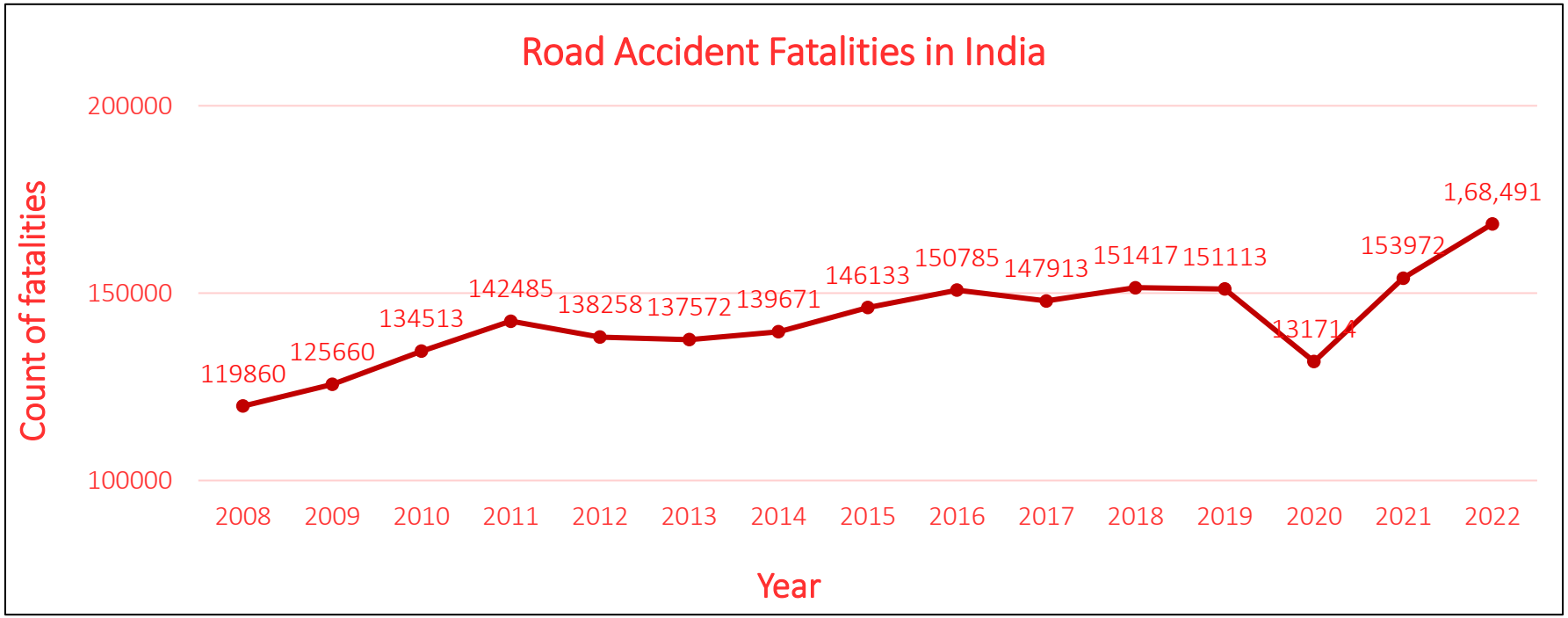
31 May 2024

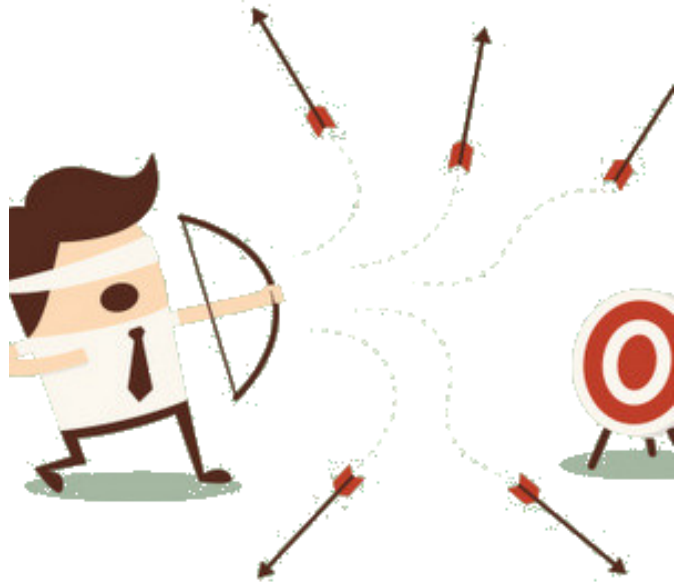
International Road Federation – India Chapter (IRF-IC)

Jigar Soni, JP Research India Pvt. Ltd.

ROAD SAFETY IN INDIA: A CONCERN

With billions of rupees being spent each year, why is India unable to reduce fatalities?





Source: Road Accidents in India, 2022, MoRTH, GoI

ABOUT JP RESEARCH

JP Research, Inc. is a safety research and engineering consulting firm headquartered in California, USA.

JP Research India Pvt. Ltd. (JPRI) is a wholly owned subsidiary of JP Research, Inc.

Jeya Padmanaban, President and Founder

- Statistician and Product Safety Expert.
- Specialization in Automotive Safety

Ajit Dandapani, CEO

- Computer Scientist
- Database Expert

JP RESEARCH INDIA EXPERTISE

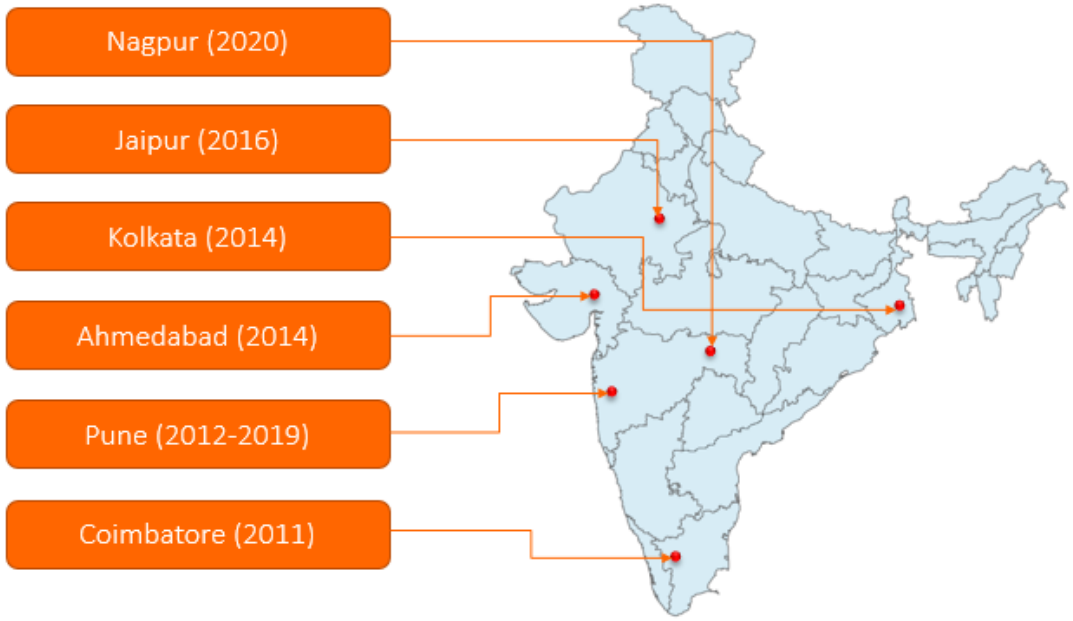
- Crash investigation and in-depth crash data collection
- Forensic crash reconstruction services
- Road Safety Engineering
- Data analytics
- Training

VISION

RASSI

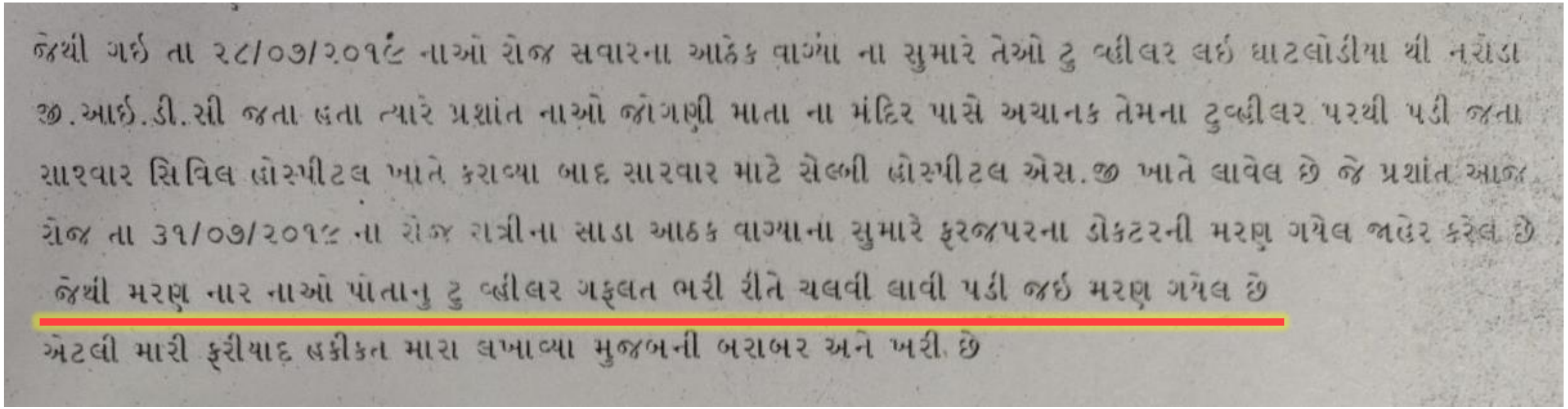
FUELLED BY SCIENCE.DRIVEN BY DATA.

www.rassi.in



- In-depth-crash data collection from 2011 through on-site crash investigations.
- A state-of-the-art nationwide in-depth crash database unique to India.
- Analytical/technical capabilities to identify India's crash experience relating to road infrastructure, vehicle design and human behavior.
- 7,000+ crashes collected from 6 data centers in different geographic regions across India.

CASE STUDY: WHY CI IS IMPORTANT

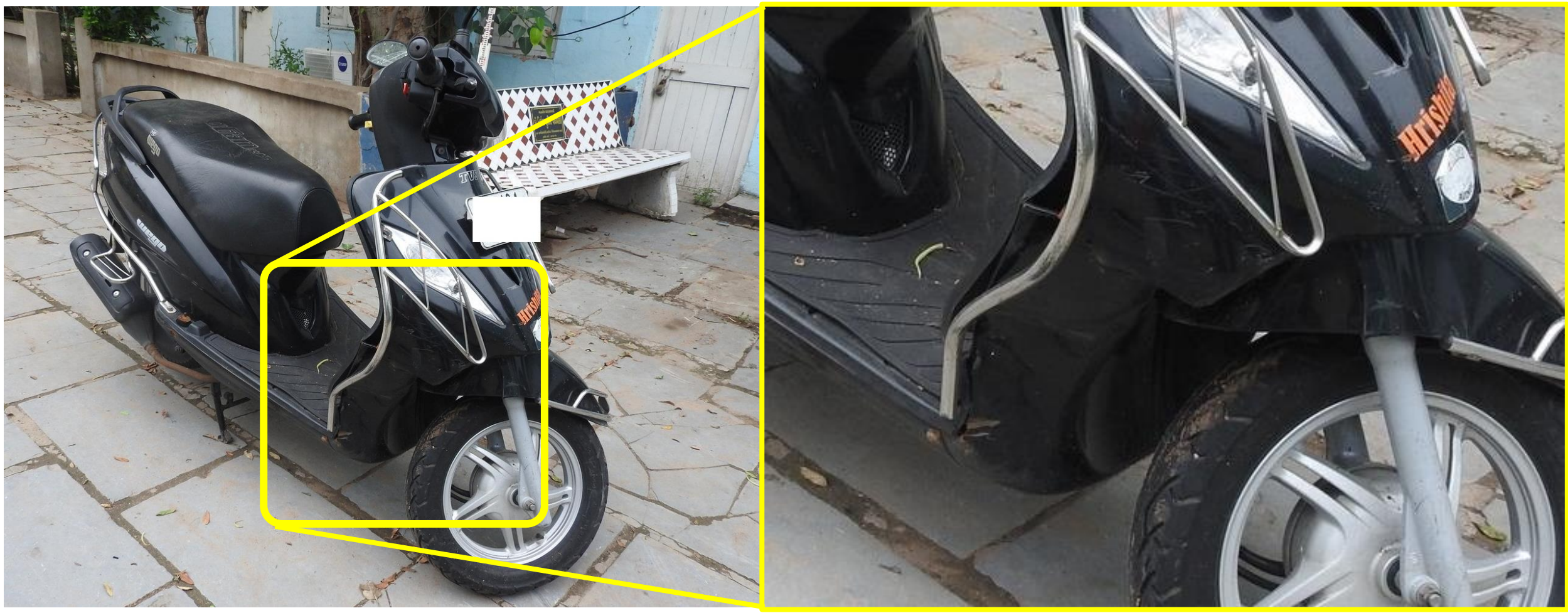


જેથી ગઈ તા ૨૮/૦૭/૨૦૧૮ નાઓ રોજ સવારના આઠેક વાગ્યા ના સુમારે તેઓ ટુ વ્હીલર લઈ ઘાટલોડીયા થી નરોડા જી.આઈ.ડી.સી જતા હતા ત્યારે પ્રશાંત નાઓ જોગણી માતા ના મંદિર પાસે અચાનક તેમના ટુવ્હીલર પરથી પડી જતા સારવાર સિવિલ હોસ્પીટલ ખાતે કરાવ્યા બાદ સારવાર માટે સેલ્બી હોસ્પીટલ એસ.જી ખાતે લાવેલ છે જે પ્રશાંત આજ રોજ તા ૩૧/૦૭/૨૦૧૮ ના રોજ રાત્રીના સાડા આઠેક વાગ્યાના સુમારે ફરજપરના ડોકટરની મરણ ગયેલ જાહેર કરેલ છે જેથી મરણ નાર નાઓ પોતાનુ ટુ વ્હીલર ગફલત ભરી રીતે ચલવી લાવી પડી જઈ મરણ ગયેલ છે એટલી મારી ફરીયાદ હકીકત મારા લખાવ્યા મુજબની બરાબર અને ખરી છે

FIR reads: The Motorcyclist was travelling negligently and rashly, lost control and fell off his bike. The crash is captured as a single vehicle accident with no influence of other vehicles or factors.

CCTV FOOTAGE

VEHICLE INSPECTION



SCENE INSPECTION

ROAD SAFETY IMPROVEMENT REQUIRES

Good quality road accident data

from on-site scientific crash investigations.

Use of the data

by road safety practitioners to determine solutions.

Continuous monitoring and measurement

through crash data collection and analysis to realize benefits.

EVIDENCE GATHERING

- It involves crash scene examination and crash vehicle examination.

HOW TO IDENTIFY & CLASSIFY ROAD SAFETY ISSUES?

NEED OF THE HOUR!
USE OF HADDON MATRIX

- Commonly used paradigm for injury mitigation.
- Developed by Dr William Haddon in 1970.
- Looks at factors related to personal attributes, agent attributes and environmental attributes.
- Helps evaluate relative importance of different factors to design interventions.

Dr William Haddon

HADDON MATRIX APPROACH

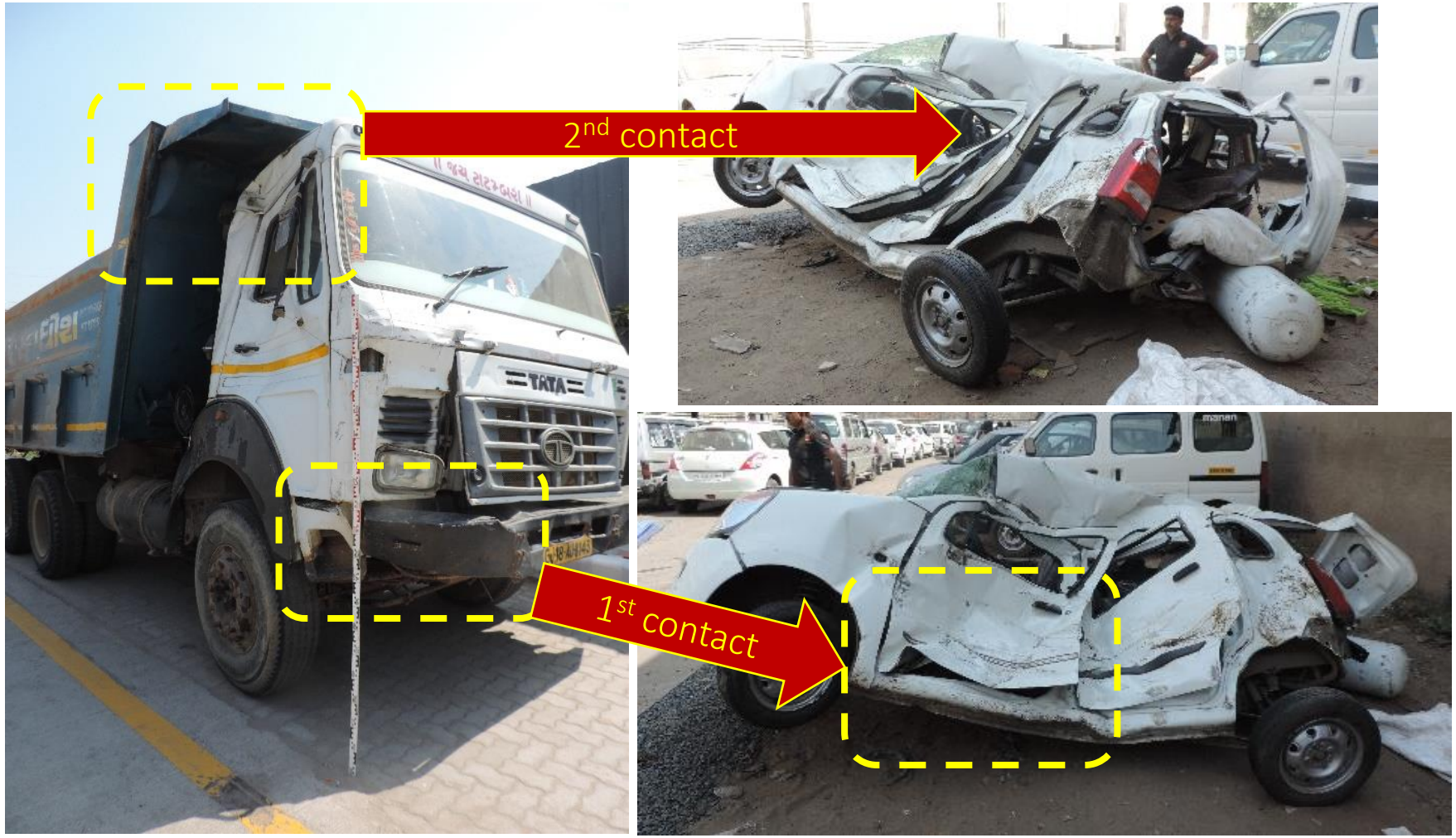
		FACTORS		
PHASES		HUMAN	VEHICLE	INFRASTRUCTURE
PRE-CRASH	Crash prevention	1 • Information • Attitudes • Impairment • Police enforcement	2 • Roadworthiness • Working lights • Good brakes • Handling • Speed control	3 • Road design and layout • Speed limits • Pedestrian Facilities
CRASH	Injury prevention during the crash	4 • Use of safety systems	5 • Crash worthiness • Crash protective design • Occupant restraints • Other Safety devices	6 • Crash protective roadside objects
POST-CRASH	Life Sustaining	7 • First-aid skill • Access to medics	8 • Ease of access • Fire risk	9 • Rescue facilities • Congestion

Purpose of crash investigation is to identify all the failures in each of these 9 cells.

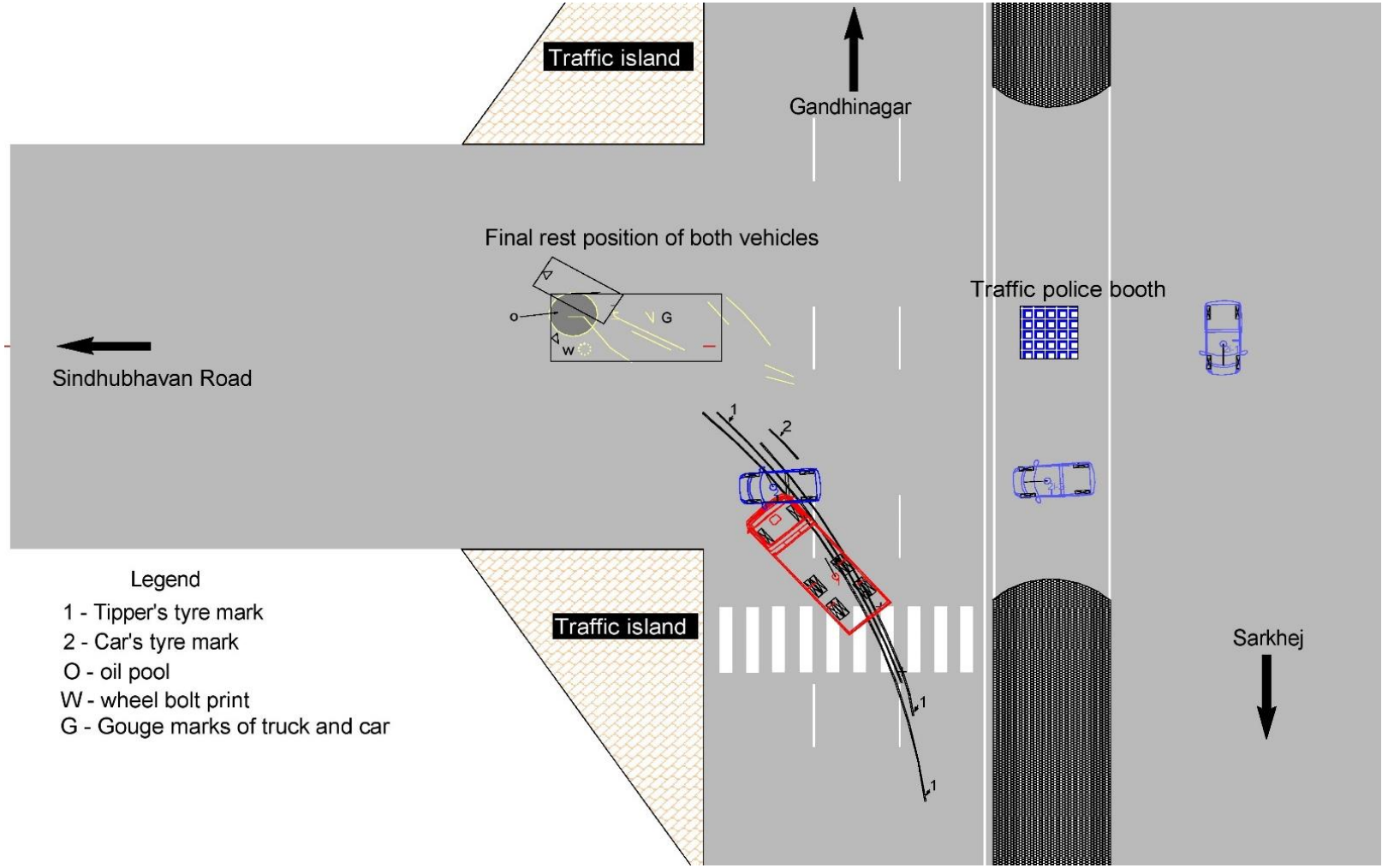
CASE EXAMPLE: CRASH AT AN INTERSECTION


CAR
TRUCK
Google
Imagery ©2019 DigitalGlobe, Map data ©2019 Google
India
Terms
Send feedback
20 m
2D

VEHICLE EXAMINATION



SCENE EXAMINATION
CREATE TO-SCALE ACCIDENT SCENE DIAGRAM



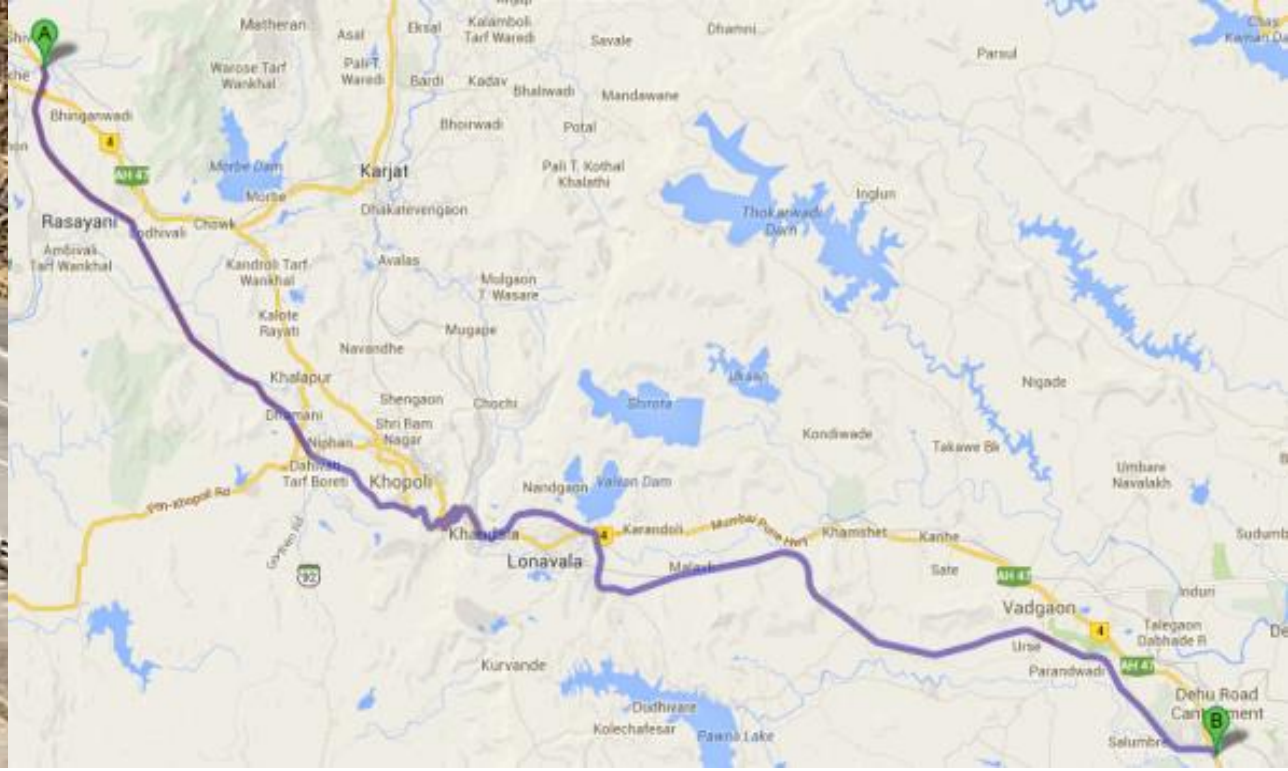
CRASH RECONSTRUCTION

HADDON MATRIX APPROACH
APPLIED TO INTERSECTION CRASH

		FACTORS		
PHASES		HUMAN	VEHICLE	INFRASTRUCTURE
PRE-CRASH	Crash Prevention	*Car: Violation of right of way* *Tipper: Overloading* *Tipper: Speeding at Intersection*	• Roadworthiness • Working lights • Good brakes • Handling • Speed control	*Vision obstruction due to median plantation*
CRASH	Injury prevention during the crash	• Use of safety systems	*Car: Passenger Compartment Intrusion*	• Crash protective roadside objects
POST-CRASH	Life Sustaining	*Car: Improper crash management*	*Car: Occupant Entrapment*	• Rescue facilities • Congestion

CRASH RECONSTRUCTION
TO DETERMINE CONTRIBUTING FACTORS

Median fencing and plantation obstructed the view of the drivers
and hence the two drivers could not see each other approaching the intersection in prior.



MUMBAI PUNE EXPESSWAY

A CASE STUDY

DETERMINATION OF ROAD SAFETY PRIORITIES
MUMBAI-PUNE EXPRESSWAY

Human (55%)	Vehicle (81%)	Infrastructure (36%)
Seat belt not used (52%)	Passenger Compartment Intrusion – Other (54%)	Object impact – roadside/median - manmade structures (24%)
Speeding (30%)	Seatbelts not available/usable (18%)	Roadside – Steep slope/Drop off (8%)
Driver sleep / Fatigue (29%)	Passenger Compartment Intrusion – Underride/Override (17%)	Sharp curvature (8%)

Source: JP Research Mumbai-Pune Expressway Road Accident Study Report 2012-2014

CAUSAL ANALYSIS USING RASSI DATA
MPEW - INFRASTRUCTURE FACTORS (2012-2014)

S. No	Contributing factor	No. of Fatal Victims (Average per year)	No. of Injured Victims (Average per year)
1	Narrow/No shoulder	19	66
2	Roadside/Median concrete structure	9	24
3	Poor/ineffective road signage	6	17
4	Roadside steep slope/drop-off	5	24
5	Sharp road curvature	5	18
6	Unguarded bridge pillar	4	2
7	Unguarded Bridge/Jersey wall	3	5
8	Gaps-in-median	2	16
9	Unguarded underpass	2	5
10	Entry/Exit road	2	1
11	Driver vision obstruction	1	4
12	Roadside trees	1	2
13	Curb stones	0	6
14	Guardrail end taper	0	2
15	Flower pots in the median	0	1

Guardrails are a solution for the 4 problems identified.

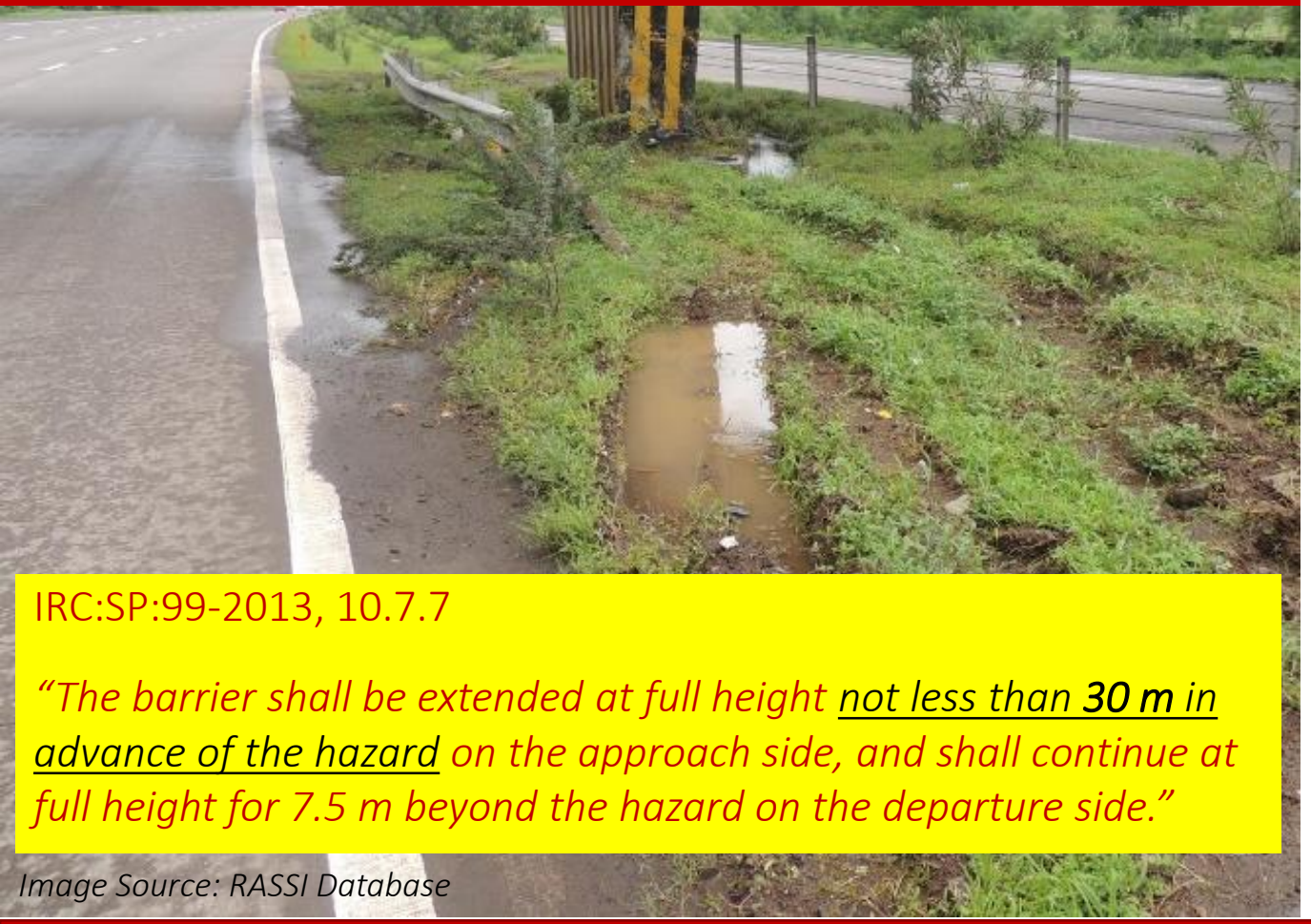
But some locations with guardrails did not show effectiveness.

Image Source: RASSI Database

Table Source: MPEW Road Safety Survey Report (2015), http://savelifefoundation.org/wp-content/uploads/2016/12/V3_MPEW-Road-Safety-Survey-Report_SC2-1.pdf

CAUSAL ANALYSIS USING RASSI DATA
MPEW - WHY ARE GUARDRAILS INEFFECTIVE?

Guardrail run-out length too short



IRC:SP:99-2013, 10.7.7

*"The barrier shall be extended at full height not less than **30 m** in advance of the hazard on the approach side, and shall continue at full height for 7.5 m beyond the hazard on the departure side."*

Image Source: RASSI Database

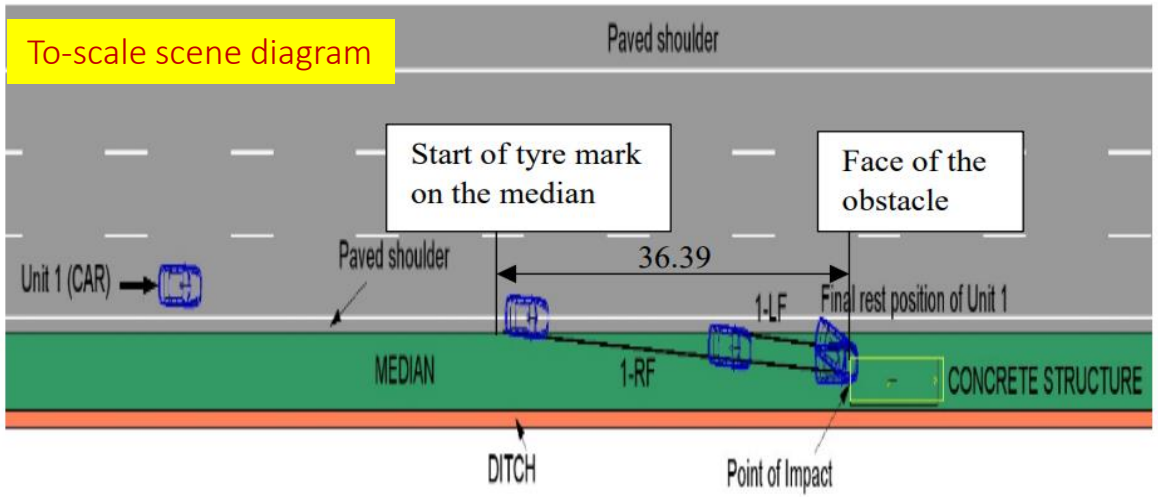
Guardrail-end tapers can launch a speeding vehicle into air

IRC:SP:99-2013, 10.7.5.b

"End treatment shall be such that it does not spear, vault or roll a vehicle for head on or angled impacts. The end treatment shall be as per manufacturer's system and satisfying the test standards as perEN1317 or NCHRP350."

CAUSAL ANALYSIS USING RASSI DATA
MPEW - EFFECTIVE GUARDRAIL RUNOUT LENGTH

To-scale scene diagram



Determination of crash barrier runout lengths for expressways in India based on crash data analysis.
Vernon Chinnadurai, Ravishankar Rajaraman, Muddassar Patel

Source: "Determination of crash barrier runout lengths for expressways in India based on crash data analysis.", JP Research, IRF World Road Meeting 2017

CAUSAL ANALYSIS USING RASSI DATA
MPEW – BEFORE/AFTER ANALYSIS

Run-out length improved

Bull-nose type end treatment

Contributing Infrastructure Factors (Mumbai-Pune Expressway)	2016		2017		2018	
	Killed	Serious	Killed	Serious	Killed	Serious
Roadside/Median Concrete Structure	15	28	0	0	0	6
Unguarded Overhead Bridge Pillars	4	2	0	0	1	2
Unguarded Bridge/Jersey Wall	3	5	1	3	0	0
Unguarded Underpasses	6	9	0	0	0	0

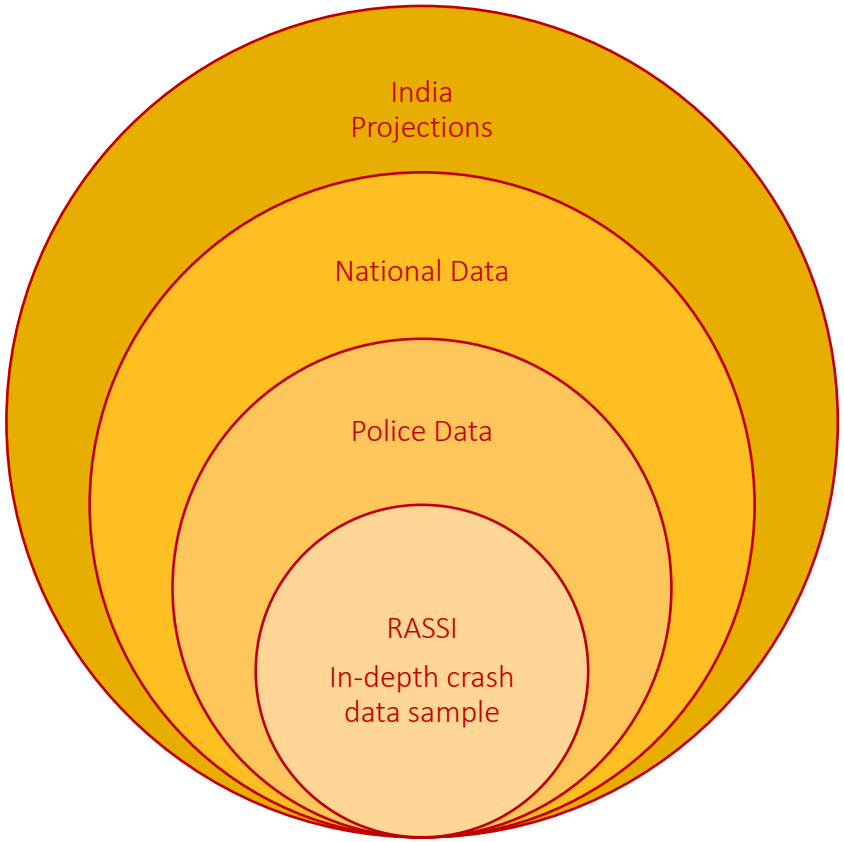
Source: RASSI Database

Effect on overall fatalities on MPEW

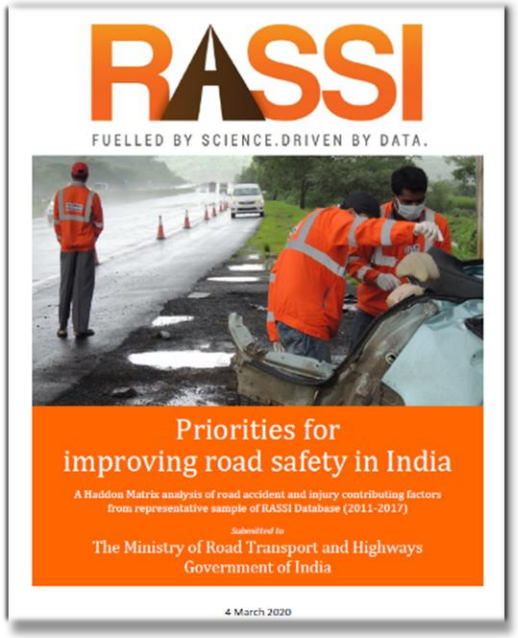
Year	Killed	% Reduction from 2016
2016	151	-
2017	105	30%
2018	110	27%
2019	92	39%

Source: Maharashtra State Highway Police
https://highwaypolice.maharashtra.gov.in/en/reports/

COMBINING RASSI AND POLICE DATA FOR NATIONAL PROJECTIONS



RASSI in-depth sample data projected to the Nation
using police-reported crash data and national crash data reports



Padmanaban, J., Rajaraman, R., and Dandapani, A., "Methodology to Derive National Estimates of Injuries and Fatalities in Road Traffic Crashes in India," SAE Technical Paper 2017-26-0016, 2017, https://doi.org/10.4271/2017-26-0016.

RASSI PROJECTIONS FOR INDIA (2011-2019)

PHASES		FACTORS		
		HUMAN	VEHICLE	INFRASTRUCTURE
PRE-CRASH	Crash Prevention	1 94.4% • Information • Attitudes • Impairment • Police enforcement	2 6.5% • Roadworthiness • Working lights • Good brakes • Handling • Speed control	3 55.2% • Road design and layout • Speed limits • Pedestrian Facilities
CRASH	Injury prevention during the crash	4 26.8% • Use of safety systems	5 35.1% • Crash worthiness • accident protective design • Occupant restraints • Other Safety devices	6 6.9% • Crash protective roadside objects
POST-CRASH	Life Sustaining	7 0.1% • First-aid skill • Access to medics	8 2.4% • Ease of access • Fire risk	9 0.1% • Rescue facilities • Congestion

Source: RASSI Database

COIMBATORE

“Without data, you're just another person with an opinion.”

~ Dr. W. Edwards Deming

PUNE

THANK YOU!

JIGAR@JPRI.IN

8866104898

JP RESEARCH INDIA PVT LTD

www.jpri.in

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