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RASSI: A Systematic Approach for On-site Crash Investigations and In-depth Accident Data Collection in India

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Jeya Padmanaban
Ravishankar Rajaraman
Swastik Narayan
C T Arjun
Ajay Patel
Ahamedali M. Hassan
JP Research India Pvt. Ltd.

ABSTRACT

India's growing trend of serious road accidents has created an urgent need to understand the primary factors involved in these crashes and in the resulting severe injuries and fatalities. In order to improve the safety of highways and automobiles for all road users, a consortium of safety researchers and vehicle manufacturers has come together to collect first-hand, detailed and consistent crash and injury data for traffic accidents on Indian roads. After 3 years of pilot studies, a methodology, called Road Accident Sampling System – India (RASSI), has been developed for conducting on-site crash investigations and collecting in-depth accident data on road accidents in India.

The processes developed under RASSI to investigate on-site crashes and collect quality accident data suitable for detailed analysis are described. The program includes all types of traffic accidents with injury outcomes. This paper focuses on the current investigation area of the Coimbatore district in the state of Tamil Nadu in India. The RASSI team consists of trained automotive engineers and injury coding experts who work in collaboration with the State police. To assure that the data collected will serve not only current but unforeseen future research needs, on-site crash investigations include - (1) photographing the crash site and vehicles and creating true-to-scale diagrams of the accident scene; (2) examining crash vehicles, including deformations, intrusions and human contacts; and (3) detailed injury coding of the involved victims. Critical crash information, such as driving and collision speed, Delta-v, is determined from traces at the scene as well as from vehicle deformation patterns for the assessment of energy speed absorption. The possible ways to make calculations and accident reconstructions from the collected data are described, and the benefit of such comprehensive in-depth accident data collection is shown, along with examples correlating technical parameters with injury outcome.

Keywords: ***RASSI, Accident Investigation, Methodology, Road Accidents India, Crash Database***

INTRODUCTION

As per the World Health Organization, India has the highest number of traffic accident fatalities in the world [1] and, hence, there is an urgent need for understanding the road safety issues and mitigating injuries on Indian roads. This requires accident data to be collected in a standardized format which can then be analyzed to identify problem areas and determine solutions.

Currently, India has only one mechanism of collecting road accident data and that is from the police. Police data is collected and analyzed to publish two annual reports. The National Crime Record Bureau's "Accidental Deaths and Suicides in India" [2], and the "Road Accidents in India" [3] report of the Transport Research Wing, Ministry of Road Transport and Highways. Both these reports give a macro level view of the accident situation in India and compare data of various states and cities.

The data from the reports is of good value for a national level understanding of the road accident situation, road users who are most affected in road accidents, states and cities with high accident rates, distribution of road users killed by age/sex and type of vehicle used. These reports are vital sources for understanding the road accident situation and to obtain a status of where India is heading with regard to road safety.

But as we see that the trend of road accident fatalities is only rising, it is now important to start looking deeper into accidents and determine common root causes for the road accident problems. Hence, like many other developed countries, India requires an in-depth data collection system for analyzing accidents scientifically and in more detail.

RASSI: IN-DEPTH ACCIDENT DATA COLLECTION SYSTEM FOR INDIA

Since 2008, a series of small sample studies have been conducted by trained researchers. It began with a passenger car crash analysis study with the support of insurance companies in Chennai [4]. This led to short term accident studies on National Highways in the districts of Kanchipuram and Coimbatore with the co-operation of the Tamil Nadu State police. These initial sample studies not only gave an encouraging experience about police support in accident notification, but also provided good accident data for analysis. The analysis of the accident data from these small studies brought about interesting insights into accidents on National Highways [5] [6] such as problems with gaps-in-median and concrete pole road delineators, misaligned intersection, conspicuity problems in vehicles at night due to absence of reflectors and tail lamps, over-representation of trucks in highway accidents [7], etc. These results have been published and presented in various national and international conferences.

Based on the experience from such sample studies, a robust methodology was developed to perform in-depth accident data collection and research on Indian roads. A relational database was also developed to record the scientific data recorded from each accident investigated by the researchers. Some OEMs came forward to support the continuation of this study on a yearly basis and so, in 2011, the in-depth data collection system was conducted for a one year period in Coimbatore district. This system of in-depth data collection was named as Road Accident Sampling System – India (RASSI).

The sections below discuss how RASSI is being conducted currently in Coimbatore district of Tamil Nadu and describes the accident data collection methodologies used by researchers to collect in-depth accident data. Some preliminary analysis of the 167 accidents studied and case studies are also discussed.

RASSI PROTOCOL

STUDY AREA - The geographical area includes towns and the outer limits of Coimbatore district in the state of Tamil Nadu. The study area involves four national highways and four state highways. The total length of the study stretches is around 150kms which comes under the jurisdiction of 9 police stations, and is manned by two teams of researchers. A map of the study area is shown in Figure 1.

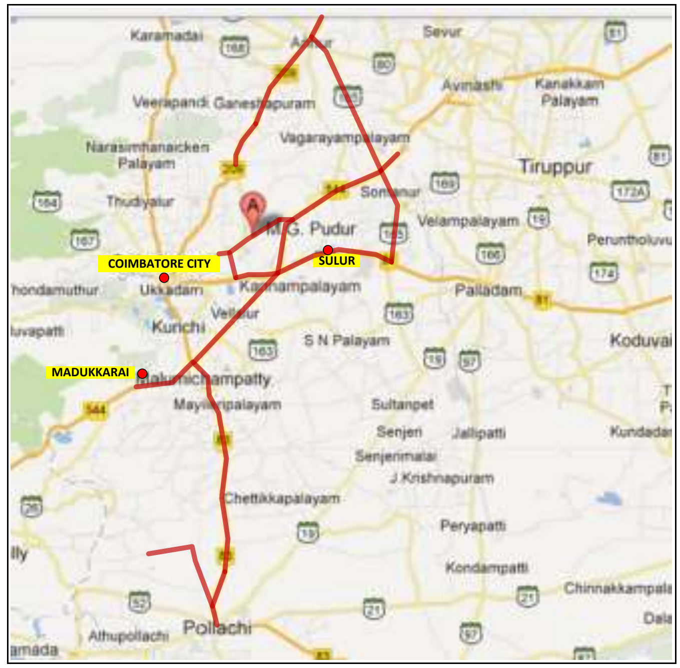


Figure 1. Map of Coimbatore district, with the study stretches marked in red. The location of the JPRI office is also shown (A).

ACCIDENT NOTIFICATION - Notifications about accidents in the study area are obtained from three sources. A toll-free number is manned by researchers 24 hours a day throughout the week for receiving notifications from various sources, as listed below.

1. Police: Calls are made by the police to a designated number for informing researchers about a crash. This also includes calls made by highway patrols. It also considers the notifications obtained from the police when researchers call the police stations regularly.
2. Ambulance: Calls are made by ambulances (EMS) to a designated number for informing researchers about a crash. Notifications of crashes occurring in the study area are also received from Government-operated ambulances as text messages.
3. Self: “Self-notification” refers to crashes seen by researchers when they are traveling by road to a police station, or on way to a crash spot, or while patrolling.

ACCIDENT SELECTION CRITERIA - Only road traffic accidents which satisfy the RASSI accident selection criteria are considered for the RASSI study. The basic criteria to be met for investigating a crash are as follows:

1. Accident must involve at least one motorized vehicle.
2. Crash spot has to be on a public road within the study area.

However, the following provisions also need to be met for an accident to be eligible for RASSI after the crash investigation:

1. The crash spot should be identifiable by:

   a. The vehicle final rest positions (based on scene evidence, photographs taken by police, victim statement, etc.)
   b. Vehicle trajectories (skid marks, brake marks, etc.), or
   c. Any other evidence (debris, damaged fixed objects, eyewitness etc.).
2. The crash spot should also yield measurements of the road, skid marks, and any other evidence.
3. Vehicles should be examined to obtain data such as direct damage details, crush profile, intrusions, contacts, and safety system use, wherever applicable.
4. Make and model of all the vehicles involved in the crash should be known.
5. In case of pedestrian, bicyclist, or motorized two wheeler (M2W) crashes, at least the other vehicle should be available for inspection.
6. In all other crash types, at least the vehicles with highest injury severities have to be available for inspection.

CRASH INVESTIGATION - As soon as a notification is received about an accident in the study area from the above sources, a team of researchers immediately travel to the crash spot in an accident research vehicle, shown in Figure 2, which also houses the investigation kit and other necessary equipment needed by the researchers.

Figure 2. Accident research vehicle used by the researchers.

Researchers working on the scene are also well trained in managing the traffic so that no harm is caused to any researcher by the traffic near the crash spot while performing these tasks. On reaching the crash spot, the following tasks are performed:

1. Scene examination
2. Vehicle examination

These tasks are explained in detail below.

Scene examination - It involves identifying the accident spot, the final rest positions of the vehicles (when vehicles are not available on the spot), recording of GPS co-ordinates, weather conditions etc. Victim or eyewitness statements are also taken and recorded, for which evidences are sought on the scene in order to check their reliability. The evidence is marked using chalk or paint, and scene photographs are taken by the researchers in the direction of travel of the involved vehicle(s). Scene pictures also include pictures of the skid marks, debris, point of impact, objects struck, blood marks, fluid spills, etc. An example is shown in Figure 3.

Figure 3. Scene picture of evidence taken at the crash spot.

The crash spot is measured using a rodometer (shown in Figure 4) along with the final rest positions, tire marks, lane widths and markings, object positions, point of impact etc.

Figure 4. Researchers measuring the scene using a rodometer.

These measurements and evidence are later converted into a to-scale scene diagram by researchers using Microsoft Visio 2010 software. The scene diagram provides a to-scale aerial view of the accident scene. An example of a scene diagram, based on the accident depicted in Figure 3 is shown in Figure 5. This scene diagram is later imported into PC-CRASH software for reconstruction of the accident.

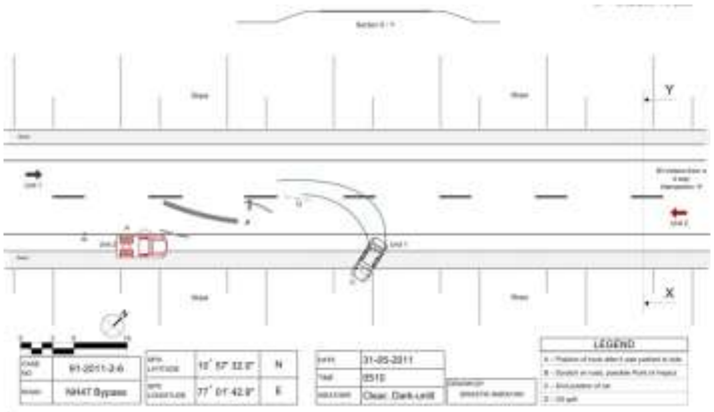


Figure 5. A scene diagram of an accident showing the direction of travel, skid mark and final rest position of accident vehicles.

Vehicle examination **-** The accident vehicles are examined by the researchers at the crash spot and also in the police station. Vehicle examination involves two major sub-parts – Exterior Examination and Interior Examination. Each of these sub-parts is briefed below.

Exterior examination **-** This involves examining the exterior parts of the accident vehicle to check for direct and indirect damages on the vehicle. Direct damages are caused due to the direct contact with other vehicle or object, and are mostly characterized by paint transfers, shape imprints on the body of vehicle. Indirect damages are induced by the direct damage, and are characterized by buckling or soft wavy damage patterns on the body. Photographs of the vehicle are then taken from eight angles (Figure 6a) and also with doors open (Figure 6b), and then of the damages and other contact points, if any, on the exterior of vehicle.

Figure 6a. Photographs of the accident vehicle are taken from eight angles.

Figure 6b. Photographs of the accident vehicle showing the interiors (with doors open).

Direct damage measurements are taken and used to code the Collision Deformation Classification (or CDC) [8] for every crash event on a vehicle. CDC is a 7-character alpha-numeric code that describes the direct damage to a vehicle, and provides engineers, crash investigators and statisticians with a quick snapshot of a crash's configuration and severity. An example is shown in Figure 7 where CDC is coded for the passenger car shown in the picture. In case of trucks, Truck Deformation Classification (TDC) [9] is applied, while for buses and motorized two wheelers only the first three characters of the CDC are coded.

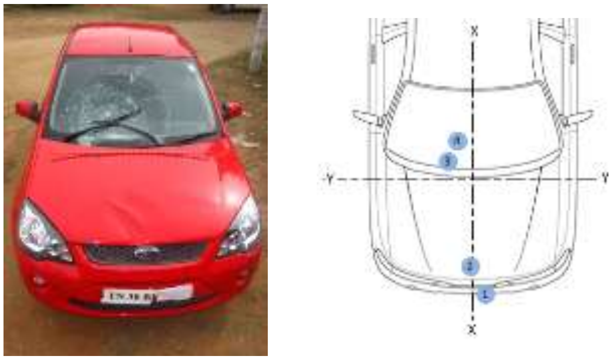
CDC – 01 F Z E W 3

Figure 7. An example case where the CDC has been coded for a car which rear ended a truck.

Researchers also measure the crush profile when the crush is on the stiff member of the vehicle. The crush is measured at six equidistant points along the direct and indirect damage on the stiff member (Figure 8). This crush profile along with the stiffness values of a vehicle can help in deriving the Equivalent Barrier Speed (EBS) of the crash vehicle.

Figure 8. Crush profile being measured on a passenger car using crush jig.

Any occupant contacts on the exterior surface of the vehicle (e.g. motorcycle riders, pedestrians etc.) are recorded on sketches. In case of pedestrian impacts, the contact points made by the pedestrian on the vehicle are mapped on a pedestrian-vehicle mapping sketch. An imaginary horizontal axis is drawn at the base of the windshield, and another vertical axis drawn along the centre of the width of the vehicle. The contact points are then measured along both the axis and are plotted on the sketch along with the respective coordinates. An example is shown in Figure 9.



Contact No.	Component contacted	X-axis	Y-axis
1	Bumper	+87	+5
2	Hood	+66	-12
3	Bottom of Windshield	-10	-37
4	Windshield	-46	-6

Figure 9. Pedestrian contact mapping on a passenger car.

Tire pressures and tread depth are measured and recorded for all wheels of the accident vehicle and any damage or restriction to the tire or wheel rim is noted. In addition to the above, regulatory compliance is also checked for features such as wipers, tail lamps, head lamps, rear view mirrors, indicators, reflective markings, cargo and overloading, etc.

Interior examination **-** The interior of the vehicle is then carefully examined for intrusions into the passenger compartment, any occupant contacts and determination of safety system use.

Intrusion is the displacement of the interiors of a vehicle towards the occupants, thus compromising the survival space of the occupants inside the vehicle. The intruding component is identified and measurements are taken with respect to the seating position. These measurements are then compared with the respective measurements in an exemplar vehicle to get the intrusion magnitude. The direction of intrusion if it is longitudinal, lateral, or vertical is also noted. Intrusion locations would also be marked on a deformation sketch for better clarity.

Occupant contacts inside the vehicle are recorded by collecting the evidences like spider web on windshield, stretch marks on the dash board, loading of the steering wheel, loading of seat backs etc. Analysis of the occupant contacts helps in understanding the kinematics of occupants during the time of the crash, and also helps in finding the injury sources to the injured victims. Since the occupants move in a direction opposite to the principal direction of force, the contacts are more likely to be on the components in this direction. All the occupant contacts are marked on a vehicle interior sketch and photographs are taken from future reference.

Seat belt usage by occupants is also checked for during interior examination. The seat belts are checked for any marks on the webbing (due to the sudden stretching) if used. There may also be melting of the seat belt buckle (Figure 10) which indicates seat belt use by the occupant in that seat. Seat belts are also checked to see if the pre-tensioners (if available) have fired during the crash.

Figure 10. Seat belt webbing found stretched (left), and melting of the seat belt buckle seen due to usage by the occupant (right).

Deployment of air bags (if available) is recorded, and tear points are observed to see if the airbag compartment has torn along the tear points (Figure 11). Any damage to the airbags are also recorded and photographed.

Figure 11. Deployment of airbags (left); Tear points being inspected (right).

ACCIDENT RECONSTRUCTION **-** Reconstruction of an accident is done based on the accident data collected during the examination of the crash scene and the crash vehicles. Accident reconstruction helps to estimate pre-impact vehicle speeds, heading angle, acceleration/deceleration rate, Delta-V, EES and other variables. The accident data collected combined with the vehicle specification data is used for crash reconstruction using PC-Crash, accident-simulation software developed by DSD (Dr. Steffan Dattentechnik). In some cases empirical formulas, in combination with laws of physics are used for reconstruction.

Not all accidents are good candidates for reconstruction using PC-Crash. Reliable crash investigation data is very important for reconstructions and information such as impact location and final rest positions are very crucial. Measured scene evidence such as brake marks, skid marks, scratch marks, blood marks, etc. is also beneficial for a reliable reconstruction. Make, model, trim and specifications of the crash vehicles should be known and crush profile data should be available where applicable.

PC-Crash can prove very challenging while reconstructing accidents involving motorized two-wheelers or pedestrians, heavy trucks underride-override, sideswipes and rollovers. Due to unavailability of some Indian vehicle models and non-standardized heavy vehicle body work in India, underride accidents (for e.g. car & truck) is difficult to reconstruct. In case of sideswipes, the overlap being very small, a large number of collisions are recorded by the PC- Crash software in the simulation. Delta-V is also very small and, hence, it is very difficult to ensure reliable vehicle pre-impact velocities. Rollovers are also a complicated process where different parts of a vehicle make contact with the ground during the roll requiring different frictional coefficients at different points.

A trained team of reconstructionists assess each accident case and reconstruct those cases which are a good candidate for PC-Crash. After the reconstruction is completed, the output is stored in two formats:

1. A PC-Crash report summarizing the inputs and outputs.
2. A 3D simulation of the accident as shown in Figure 12.

Figure 12. An example of a 3D Simulation in PC-Crash using the scene diagram shown in Figure 5.

The report is analyzed and the data such as Delta V, EES, and velocities before and at the time of impact are coded in the RASSI database.

INJURY CODING AND CORRELATION **-** The injuries sustained by crash victims (vehicle occupants, pedestrians, etc.) are collected from the police or from the hospitals.

Data collection procedure – Based on the crashes examined, researchers follow up with the police stations or hospitals for the injury reports of the victims involved in the accident. This data is then anonymized (removal of names and personal identification information) to ensure privacy of the victims and then given to a team of trained injury coders for coding the type of injury and its severity.

Coding **-** The injuries are then coded using Abbreviated Injury Scale (or AIS) [10] developed by the Association for the Advancement of Automotive Medicine (AAAM). Researchers trained by AAAM perform the injury coding in RASSI. The AIS code for each injury not only describes the location and the level of injury, but also the severity of that injury in terms of the mortality or risk to life to the victim. The AIS severity is a scale from 1 to 6, where 1 denotes minor injury and 6 denotes an unsurvivable injury. The AIS injury severity scale is shown in Table 1.

Table 1. AIS Injury Severity Scale.

1 – Minor
2 – Moderate
3 – Serious
4 – Severe
5 – Critical
6 – Currently Untreatable

The maximum severity of all the injuries sustained by an occupant is called as the Maximum Abbreviated Injury Severity (or MAIS). An example is shown in Table 2 below.

Table 2. Example of injury coding using AIS.

Injury Description	AIS	Injury Source
Left side ribs 1st to 5th found fractured on its anterior aspect	450203.3	Steering Wheel
Laceration 4cm over right wrist	710602.1	Dashboard
MAIS – 3		

Injuries are also coded using the International Statistical Classification of Diseases 10th Revision (or ICD-10) [11] developed by World Health Organization (WHO). An example is shown in Table 3 below.

Table 3. Example of injury coding using ICD-10.

Injury Description	ICD-10	Injury Source
Left side ribs 1st to 5th found fractured on its anterior aspect	S22.4	Steering Wheel
Laceration 4cm over right wrist	S61.8	Dashboard

These injuries are later correlated to the occupant contacts found inside the vehicle during interior examinations (or exterior examinations in case of pedestrian, bicyclist or two wheeler accidents). This gives an understanding of the injury sources which cause injuries to the occupants and can help in improving their design to mitigate injuries.

RASSI DATABASE MANAGEMENT

The data collected by researchers as described in the previous sections are coded by researchers in the RASSI database. This analytical database is a comprehensive database designed for Indian conditions, but based on international databases such as the German In-Depth Accident Study (GIDAS) of Germany and National Automotive Sampling System (NASS) of USA.

To ensure correct interpretation and understanding a coding manual has also been developed so that researchers and other RASSI database users have a common understanding of the data coded.

Each accident case is provided a unique case id with the format: Country Code – Year – Location – Case Number that describes the country, year, sampling location and the case number for that sampling location in that year. For e.g.: 91-2011-002-0001 represents the first case in location 2 (Coimbatore) for the year 2011 of the country India (country code 91).

Researchers anonymize the data and make it a point that no personal data involving any names, addresses of victims, vehicle numbers, etc. are collected in this database in order to respect the privacy of victims involved in the accidents. Measures are taken to remove all details from the system that can lead back to the identification of an accident vehicle or a victim of an accident.

After the data is coded in the RASSI database, it undergoes a technical review by another researcher following which a number of system validations are conducted to check the quality and reliability of data entry. Once the case is reviewed and validated, it is considered as completed and signed off by the researcher in charge of the case as ready for delivery. The entire process involving crash investigation, accident reconstruction, injury coding and correlation, reviewing and quality control is completed within 70 days from the day of notification of the accident.

SAMPLE ANALYSIS FROM RASSI 2011-12 DATA

In the year 2011-2012 a total of 167 accidents in the study area of Coimbatore district have been investigated and coded in the RASSI database. Two case studies have been provided in Appendix A.

Figure 13 shows the percentage distribution of the 167 accidents based on the highest injury severity of the accident. 80% of the accidents investigated involved either fatalities or serious injuries. Figure 14 shows the percentage distribution of the 167 accidents by time of occurrence. A 3-hour time period has been considered in this analysis. The time period of 15:00 to 17:59 hours shows the highest incidence of accidents (22%) followed by the time period of 09:00 to 11:59 and 18:00 to 20:59 (15%).

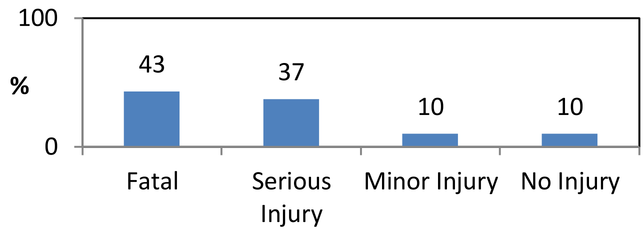


Figure 13. Percentage distribution of the 167 accidents as per highest injury severity.

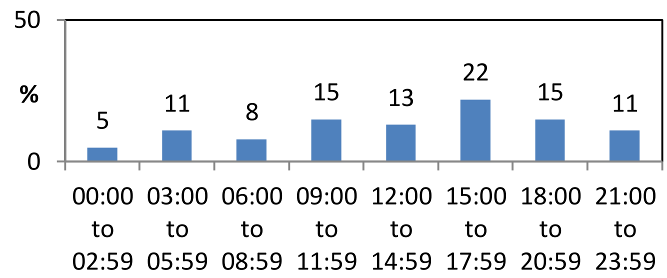


Figure 14. Percentage distribution of 167 accidents as per time of occurrence.

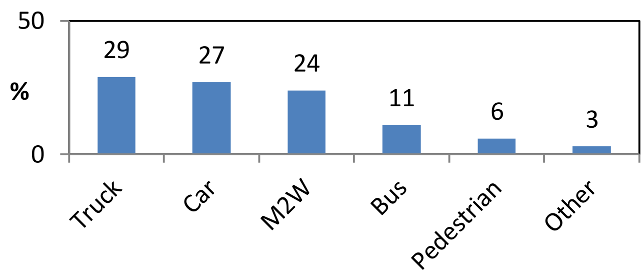


Figure 15. Percentage distribution of the 332 road users (311 vehicles and 21 pedestrians) by road user type. (Other includes motorized three-wheelers).

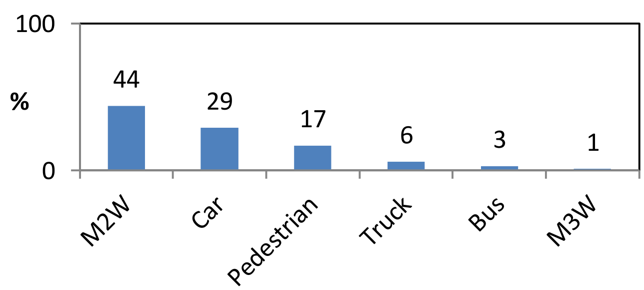


Figure 16. Percentage distribution of the 99 fatal victims by type of road user.

The 167 accidents involved 311 vehicles and 21 pedestrians. Figure 15 shows the percentage distribution of road users, while Figure 16 shows the percentage distribution of the 99 fatal victims by road user type. As can be seen, trucks are highly involved in road accidents, while motorized two wheelers are the most affected road users in road accidents followed by car occupants. Pedestrian accidents are less as the study area covers largely rural areas and few urban areas.

The distribution of the 167 crashes by crash configuration is as shown in Figure 17 below.

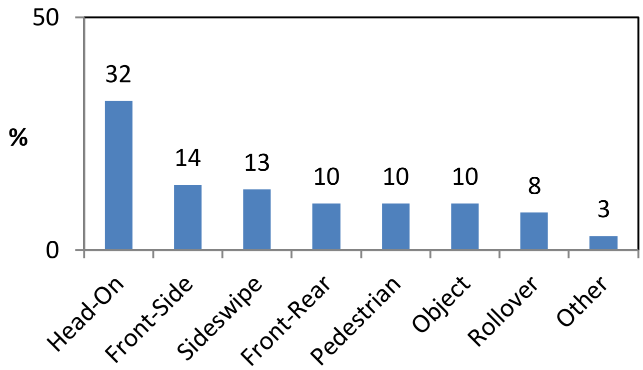


Figure 17. Percentage distribution of 167 accidents by crash configuration.

REPRESENTATIVENESS

Most in-depth accident data collection programs are sample studies. Hence, representativeness of the sample of data collected through these in-depth accident data collection programs is of utmost importance. RASSI aims for representativeness in its sample for the study area being covered. This is a challenging activity in India considering that representativeness requires a more detailed and reliable database of all road accidents to be made available. Unfortunately, this is a problem as the agencies such as the District and State Crime Record Bureaus do not code variables such as crash configuration, single or multiple vehicle crashes, details of vehicle body types involved, road structure, etc. in their database.

To address this issue, researchers visit the police stations in the study area and manually code the details of all police reported road accidents every month from their case files. The details include date and time of accident, date and time of reporting, vehicle types involved, road type and structure, injury severity, number of casualties, crash configuration, pre-crash event and the highest injury severity road user. It is envisaged that this data collected for a year can then be used to obtain an idea about the representativeness of the RASSI sample of accidents and for refinement of RASSI accident selection criteria in the future.

CONCLUSIONS

RASSI has been developed to a stage that is comparable with international in-depth accident databases from around the world. The methodologies discussed above are well established in other studies such as CCIS (UK), OTS (UK), NASS (USA) and GIDAS (Germany). Currently, in its second year of operation, the RASSI protocol and data collection activities show a great potential to become a reliable source of scientific in-depth accident data for India. While the national accident database provides general idea of road safety issues and status, a representative RASSI sample data will help all stakeholders, including vehicle manufacturers, highway developers, enforcement agencies, emergency medical services, insurance companies, etc. understand the root cause(s) and determine cost-effective solutions to improve road safety.

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CONTACT INFORMATION

Mr. Ravishankar Rajaraman
Chairman – RASSI Steering Committee
JP Research India Pvt Ltd
583/1, 1st Floor, Sri Kumaran Salai, Civil Aerodrome Post, Avinashi Road, Coimbatore – 641014 Tamil Nadu, India
Tel: +91 (422) 4400100
Email: reachus@jpresearchindia.com

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APPENDIX A: CASE STUDIES

CASE STUDY 1 – (TRACTOR-TRAILER AND CAR)

Accident Description – A 2005 Tata tractor-trailer LPS 3516 EX with 2 occupants was travelling southwards on L&T Bypass. The driver, for overtaking another vehicle on its lane, went on the oncoming lane. The tractor-trailer collided head-on with a 2007 Maruti 800 car travelling towards him. The Maruti 800 went under the tractor-trailer (underride). The unbelted driver of the Maruti 800 (Male, 36 years) sustained fatal injuries.

Scene Diagram – The scene diagram of this accident is as shown in Figure 18.

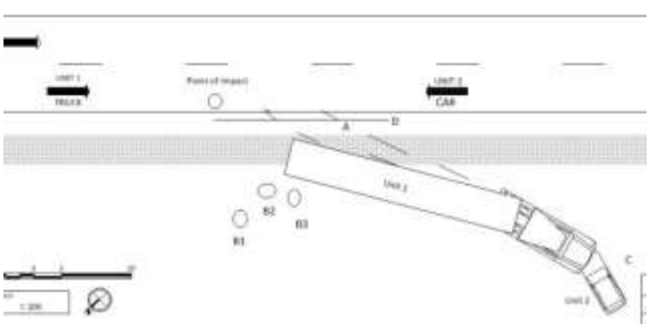

Figure 18. Scene diagram of the accident.

Crash Scene Pictures – The pictures from the scene of the accident are shown below in Figure 19.

Figure 19. Pictures showing the final rest position of the vehicles (top) and a gouge mark indicating the point of impact (bottom).

Vehicle Examination – The crash vehicles were examined on-scene. The damage measurements and TDC/CDC obtained are shown below in Table 4.

Table 4. Damage measurements and TDC/CDC.

	2005 Tata 3516 EX	2007 Maruti 800
TDC/CDC	12 F Z L W 6	01 F D H W 7
Direct Damage Width	177 cm	144 cm
Field L Width	190 cm	144 cm

During interior examination of the car, heavy intrusions were observed and noted on the front right side of the vehicle pushing the A-pillar, the steering wheel and the roof towards the driver. The right side B-pillar and left side A-pillar also show intrusion due to impact. Hair sample and blood were seen on the windshield indicating head contact by the driver. Figure 20 shows the intrusions of the car and the cause of those intrusions.

Figure 20. Intrusions of the car caused due to underride with the truck.

Accident Reconstruction – The accident was reconstructed using PC-Crash. Figure 21 shows the simulation sequence and Table 5 shows the results.

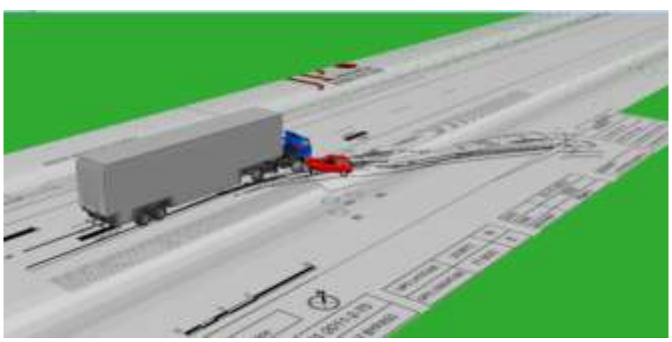

Figure 21. PC-Crash reconstruction of the accident.

Table 5. PC-Crash reconstruction output.

	Tata Tractor-Trailer 3516 EX	**Maruti 800**
Delta- V (kmph)	4	86
Collision angle (deg)	-179	179
EES (kmph)	19	69
Driving Speed (kmph)	Unknown	62
Collision Speed (kmph)	60	43

Injury Coding And Correlation – The injuries sustained by the fatal and unbelted car driver are as shown in Table 6 below:

Table 6. Injury coding and correlation for car driver (unbelted, fatal).

Injury Description	AIS	Injury Source
Diffuse SDH right occipital lobes	140442.4	Seat Back
C-4 to C-5 cervical vertebra found fractured with underlying cord partially contused	640224.5	Right B-pillar
Right side ribs 4th to 8th found fracture on its posterior aspect	450203.3	Right B-pillar
Multiple laceration of varying size and shape noted over all lobes of right lung	441414.3	Right B-pillar
Right femur found fractured on its upper 1/3rd	853000.3	Steering Column

Although the driver sustained injuries in different body regions, the most severe injury was to the cervical spine. The unbelted driver hit his head on the windshield. The head also contacted the seat back support of the driver seat due to reflex action, hair sample were seen on the seat back support.

Observations **-** The following problem areas can be identified from this case.

1. There is clear evidence of incompatibility between the two vehicles due to a higher ground clearance of the truck. This excess ground clearance prevents the

structural members of the car from engaging during impact.

2. Due to heavy intrusions in the passenger compartment, the effectiveness of safety systems such as seatbelts and airbags are also reduced.
3. “Overtaking” another unknown vehicle is the event leading to the crash, which is also noted to be an overrepresented event in the RASSI database.

CASE STUDY 2 – (FARM TRACTOR WITH TRAILER AND TRUCK)

Accident Description – A Hindustan 50 farm tractor hauling a trailer was travelling northwards on L&T Bypass. When it approached an intersection, the driver braked to avoid an unknown vehicle/person. Due to hard braking, jackknifing occurred and the tractor turned clockwise. The driver lost control and had a head-on collision with an oncoming Ashok Leyland haulage truck. The driver of the tractor and the co-passenger of the truck sustained minor injuries and were treated as outpatients. Nobody sustained serious injuries in the accident.

Scene Diagram – The scene diagram of this accident is as shown in Figure 22.

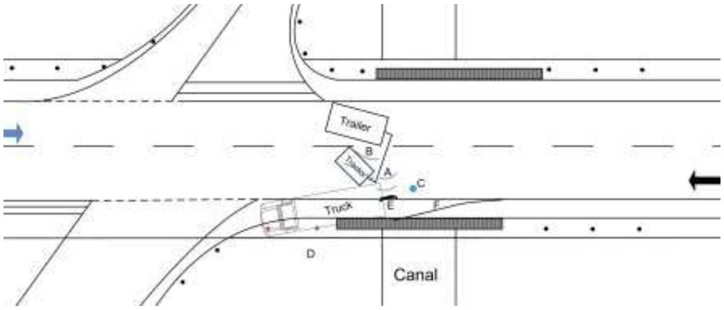

Figure 22. Scene diagram of the accident.

Crash Scene Pictures - The pictures from the scene of the accident are shown below in Figure 23.

Figure 23. Pictures showing the final rest position of the vehicles.

Vehicle Examination – The crash vehicles were examined on-scene. The TDCs for the crash vehicles, based on measurements, are shown in Table 7 below.

Table 7. TDCs of the crash vehicles.

	Hindustan 50 (Farm Tractor)	Ashok Leyland (Truck)
TDC (1st event)	01 F	01 F Z M W 7

The evidences on the accident spot clearly showed that the farm tractor lost control and yawed before impacting with the haulage truck. This yawing occurred due to jackknifing effect. The truck driver braked and tried to avoid the collision by steering left, but due to very little time to react, the crash was unavoidable. The truck also had an impact with the side bridge wall before coming to rest.

Accident Reconstruction – The accident reconstruction was done using PC-Crash and Figure 24 shows the simulation sequence and Table 8 shows the results.

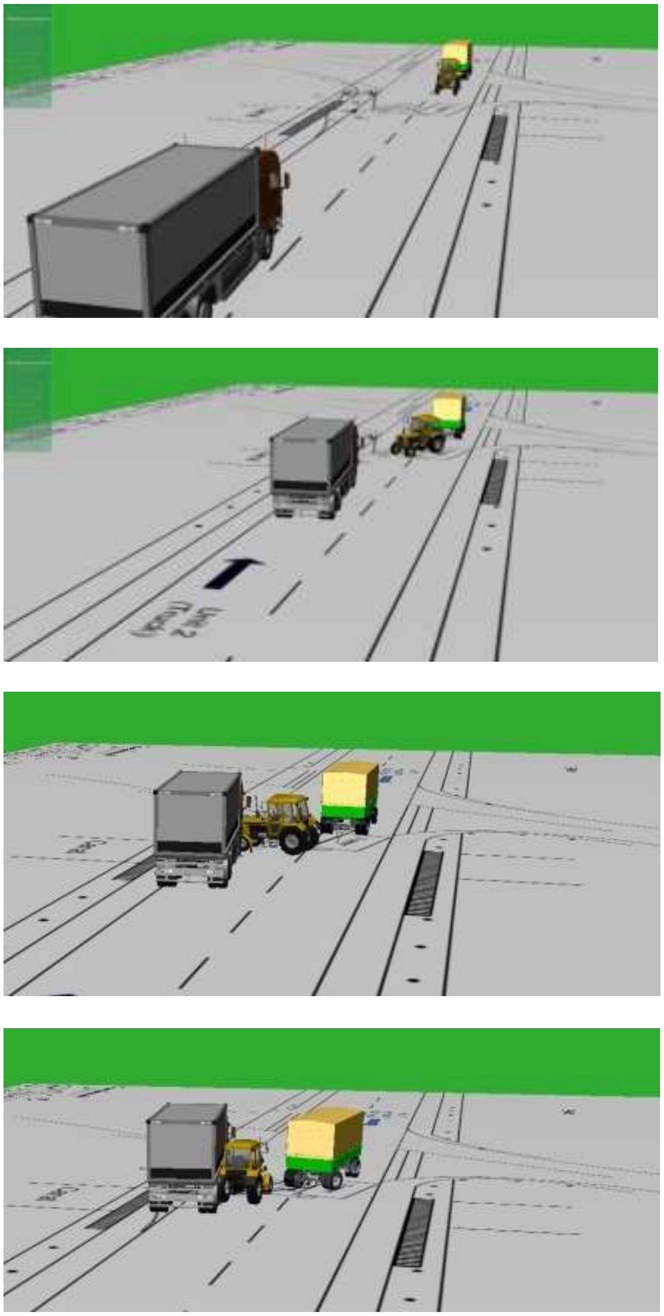

Figure 24. PC-Crash reconstruction of the accident.

Table 8. PC-Crash reconstruction output.

	Hindustan 50 (Farm Tractor)	Ashok Leyland (Truck)
Delta- V (kmph)	18	16
Collision angle (deg)	-139	139
Driving Speed (kmph)	30	50
Collision Speed (kmph)	10	34

<u>Injury Coding And Correlation</u> - The driver of the tractor and front passenger of truck sustained minor injuries and were not admitted to a hospital.

<u>Observations</u> - The following problem areas can be identified from this case.

1. This case shows how misaligned intersections create problems for driver judgment and reaction.
2. In addition, it also shows how non-regulatory vehicles are highly susceptible to accidents due to poor stability and control. The trailer is much heavier than the tractor. When the tractor braked, the inertia of the trailer caused the tractor to be pushed in front of the oncoming truck.
3. A look at the final position of the truck shows that had the truck moved further, it would have landed in the ditch causing serious injuries to the occupants. Although there are no serious injuries in this case, poor road side furniture, offering very little crash protection, is a problem often seen on Indian highways.