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An Analytical Review of Road Accidents due to Undisciplined Intersections/Junctions

Mahipal Singh[1], Ranadip Mandal[2]

[1]M.Tech Student, Dept. of Civil Engineering, CBS group of Institutions, Jhajjar, Haryana
[2]Asst. Professor, Dept. of Civil Engineering, CBS group of Institutions, Jhajjar, Haryana

ABSTRACT: The abysmal number of road fatalities and statistics globally indicating that human error accounts for 80-95% of road accidents, their impact instigates an urgent need for all possible measures to enforce driver compliance to road safety regulations. This paper sought to establish the effect of Road communication technologies (RCTs) and driver compliance in India. It discusses RCTs and their implementation towards enforcing driver compliance to safety regulation in developed countries and how they can be provide support to the road safety regulation enforcement unit(s) in India to mitigate road accidents.

Keywords: Road communication technologies, Driver compliance, Roads.

1. INTRODUCTION

Road crashes are a major cause of deaths, injuries, property damages, and disabilities, in current society of a country. They have negative impacts on individuals, families and communities, as well as the Government of a country. Now a days almost every country is facing many social issues such as gun violence, domestic violence, drug abuses, HIV/AIDS, and after the end of war, people were not only disabled due to unexploded ordnance, but now also to road accidents. Currently, bad impact of traffic accidents is, too, one of the obstacles for the country's development. Even though, the Government of a country has prioritized and encouraged the implementation of road safety plans, traffic law and behavior change, the rate of accident is still high. Therefore, in order to reduce the rate, there must be active participations of all people and stakeholders, or the success is not expected. The Government cannot play the role alone in solving the problems. Traffic accidents is a complicated issue that affect not only lives, but very often, they also result in the loss of human resources, public orders as well as an enormous amount of private and public properties.

Traffic Rotary: Traffic Rotary at road intersections is special form of grade change of lanes to channelize movement of vehicles in one direction around a central traffic island. With rapid growth of traffic it is experienced that widening of roads and providing flyovers have become imperative to overcome major conflicts at intersections such as collision between through and right- turn movements. In this way, major conflicts are converted into milder conflicts like merging and diverging. The vehicles entering the rotary are gently forced to move in a clockwise direction. They then weave out of the rotary to the desired direction. The crossing of vehicles is avoided by allowing all vehicles to merge into a stream around the rotary and then to diverge out to the desired radiating road. Thus the crossing conflicts eliminate and convert into weaving maneuver or a merging operation from right and a diverging operation to the left. In this paper, designing rotaries at road intersections is discussed and a software package is developed to be used in road works.

Road Accident: A road accident is an unplanned and unfortunate event involving at least one vehicle within the road environment that results in damage to property and/or injury or death to a road user. Based on the report format of the traffic police and MPWT, accidents are classified into four severity categories: fatal, serious injury, slight injury, and property damage only. These are defined in the following paragraphs. A fatal casualty in a road accident is one in which the victim dies within 30 days of the accident. A seriously injured casualty is one who has suffered injuries such as a fracture, concussion, internal lesion, crushing, severe cuts, or severe general shock requiring medical treatment or hospitalization such that the person is unable to perform ordinary pursuits for at least 7 days. A slightly injured casualty is one who is conveyed to a hospital from the scene in an ambulance or otherwise, one who requires subsequent medical treatment entailing hospitalization and medical leave of no more than 4 days .Accidents are assigned the severity group according to the most seriously affected casualty in the accident. All reported accidents not involving injuries are classified as property damage only accidents.

Figure 1

Road Traffic Crash and Injury Data: Recording of crashes As in most countries, traffic police are the source of official government statistics related with road traffic injuries in India. The main sources of traffic crash data at the national level are the annual reports published by the National Crime Record Bureau (Ministry of Home Affairs) and the annual publication of the Ministry of Road Transport & Highways (MoRTH) titled Road Accidents In India. The basic information for both these reports comes from all the police stations in the country based on the cases reported to them. A brief description of the process through which statistics are compiled at the national level is as follows. When the occurrence of a traffic crash is brought to the notice of a police station (by anyone involved in the crash; anyone who knows about the crash; or a police officer who comes to know about the crash) the information reported is recorded in a First Information Report (FIR). This sets the process of 'criminal justice' in motion and the police take up investigation of the case. After an FIR has been filed the contents of the FIR cannot be changed except by a ruling from the High Court or the Supreme Court of India. After the investigation is complete a case file is prepared which records the details of the crash as determined by the police department (which need not necessarily tally with those in the FIR) and the 'offending party' (as determined by the investigation) is charged with offences under provisions of the Indian Penal Code and the Motor Vehicles Act of India 1988 (Ministry of Road Transport and Highways, 1988).

Traffic Crashes On Indian Highways: Highway safety remains a major concern after nearly 50% of completion of NHDP projects. The proportion of RTI fatalities on different categories of roads and the proportion of road length for each category (MoRTH, 2015, Transport Research Wing, 2015). NH comprises only 15% of the total length of roads in India but account for 33% of the fatalities. Fatality rate per km of road is the highest on expressways (1.8 deaths per km per year) and NH come next with 0.58 deaths per km annually. The relatively high death rate on NH could be because they carry a significant proportion of passenger and freight traffic (MoRTH, 2015, Transport Research Wing, 2014). However, since details of vehicle km travelled on various categories of highways are not available, it is not possible to make a comparison based on exposure rates. Expressways had a length of only 1,000 km in the country in 2014 but a high death rate of 1.8 per km per year. This should be a cause for concern.

PROBLEMS WITH EXISTING INTERSECTIONS

1) Loss of time: The public is acutely aware of the needless delay at red lights, when we have to wait while no one is using the green. Requests to the Department for Transport, and local authorities under the Freedom of Information Act have failed to establish a justification for needless delays. (If a passenger loses 1 minute per day, the total annual loss is 700000 years). The needless delay at a red light is an obstruction, an offence for which citizens get fined. To forbid licensed motorists to cross a road against red when an 8-year old school kid is allowed to do so is an insult to the

intelligence and a sign of contempt for our civil right to use the road without getting endangered and obstructed by a system that was meant to assure safe and expeditious travel.

2) **Loss of fuel:** It is quite obvious that there will be a considerable amount of loss of fuel at traffic junctions and intersections. At an average, a vehicle loses 1.6 liters of fuel at traffic intersections daily. An official report attributed 40% of fuel consumption in US urban areas to the inefficiencies of the traffic signals.As fuel is considered to be the non-renewable source of energy it is our concern to reduce the wastage of fuel, at least to some extent.

3) Accidents at traffic lights: Road accidents are a human tragedy. It involves high human suffering and monetary cost in terms of premature deaths, injuries, loss of productivity etc. Most deaths and injuries due to road accidents are invisible to society. They are a hidden epidemic. In the last few years traffic on the National Highways/State Highways increased manifold and so have the accidents. Every year more than 1.00 Lacs fatal accidents occur on Indian roads, more than 4.00 Lacs persons are injured and the economic loss due to road accidents is estimated to be over Rs. 36,000 crore. 40% of these accidents take place on National Highways. It will be pertinent to compare the number of people murdered and the people who die in accidents every year. About 20,000 people are murdered in a year in India. It is evident that the number of people killed in accidents is five times more than that those are murdered. On the National Highways/State Highways passing through the State of Haryana, more than 4,000 persons are killed and nearly 8,000 injured every year. The vehicular population in the country has also increased manifold. Thus, it is very much necessary to regulate the traffic movement on National Highways.

The traffic light turned out to be one of those medicines that cures one disease and gives you another. It was known by the mid-1930s that traffic lights increased accident frequency. They compress an hour's traffic into half an hour of green time and thereby halve all headways. They then make drivers go fast and keep close to the vehicle in front for fear of missing the green light, with their eyes up in the air rather than on the road. The combination of high speed, tailgating, diverted attention and sudden stops causes front-to-rear crashes. The Highway Code calls for moderate speed and extra care at junctions, and for safe following distance at all times. Like the major road, the traffic light encourages a disregard of the most elementary safety rules. The RSGPG says that traffic signals cause accidents to pedestrians, particularly in congested conditions, and advises their use should be avoided where possible. In London, 19% of road accidents occur at signaled junctions. An Australian study called signalized intersections the most dangerous sites on the road.

4) Loss of capacity: Less obvious to the public than the needless delay is the reduction in junction capacity and the resulting congestion caused by traffic lights. The system severely reduces capacity just when we need more of it in heavy traffic. The greater the proportion of right-turners, the lower is the vehicle-carrying capacity of a junction. The right-turn problem originates from the rule that gives the through-driver from the opposite direction priority and obstructs the right-turning vehicle from leaving the junction, so that those who want to go straight ahead get blocked behind it. The remedy of installing traffic lights makes the problem worse, more so when right-turn lanes and multi-phase signals are added. If the opposing traffic stream gave way to the right-turners, the problem would be gone. That's how roundabouts work.

5) Environmental problems and increase in stress: Most intensive exposure to air pollution happens at traffic junctions. It is mainly due to the 'stop and go' nature of the traffic flow. This severely affects the health of the people. It may also lead to major respiratory problems. One other major issue which often goes unnoticed is Noise pollution. Noise pollution, such as jack hammers or constant tapping, can cause stress, headaches, impair hearing, and disturb everyday life. These days, mental stress on human beings is increasing in many ways. Traffic Jam is one of the root causes for increased stress levels in humans. Such problems exist predominantly in many cities like Mumbai, Bangalore and Delhi. During peak hours, it takes a couple of hours to drive a stretch of 10 to 20km. Traffic jams appear at almost every kilometer in major cities. Most people increase stress levels while waiting at traffic jams on their way to work, meetings, trainings or interviews.

6) Problems with traffic junctions with statistical analysis: Generally to avoid traffic congestions and accidents traffic junctions are provided. Traffic junctions are generally controlled by traffic policemen or traffic sensing signal lights. Consequently, there is a huge loss of time, loss of fuel. It also results other problems like pollution and increased stress levels. This could be partially reduced by introducing flyovers and underpasses. But it is still restricted only to a minimum number of intersecting lanes.

TRAFFIC CRASHES ON INDIAN HIGHWAYS

Highway safety remains a major concern after nearly 50% of completion of NHDP projects. Figure 22 shows the proportion of RTI fatalities on different categories of roads and the proportion of road length for each category (MoRTH, 2015, Transport Research Wing, 2015). NH comprises only 15% of the total length of roads in India but account for 33% of the fatalities. Fatality rate per km of road is the highest on expressways (1.8 deaths per km per year)

and NH come next with 0.58 deaths per km annually (Figure 23). The relatively high death rate on NH could be because they carry a significant proportion of passenger and freight traffic (MoRTH, 2015, Transport Research Wing, 2014). However, since details of vehicle km travelled on various categories of highways are not available, it is not possible to make a comparison based on exposure rates. Expressways had a length of only 1,000 km in the country in 2014 but a high death rate of 1.8 per km per year. This should be a cause for concern. Recent research studies have reported fatal crash rates (fatalities per km) for three NH (NH-1, NH-8 and NH 2) as 3.08 crashes/km/year on six-lane NH-1, followed by 2.54 crashes/km/year on four-lane NH Figure 22. Proportion of RTI fatalities in 2014 on different categories of roads and the proportion of road length for each category (Source: MoRTH, 2015, Transport Research Wing, 2015). Figure 23. RTI fatality rate per km of road per year for different category of roads (Source: MoRTH, 2015, Transport Research Wing, 2015).

Figure 2

Figure 3

Intersections

An intersection is the junction at-grade (that is to say, on the same level) of two or more roads either meeting or crossing. An intersection may be three-way (a T junction or Y junction – the latter also known as a fork if approached from the stem of the Y), four-way (often in the form of a crossroads), or have five (a 5-points) or more arms. Busy intersections are often controlled by traffic lights and/or a roundabout.

Uncontrolled Intersections

An uncontrolled intersection is a road intersection where no traffic lights or signs are used to indicate the right-of-way. Mostly, uncontrolled intersections are unmarked. However, in some locations, motorists may be warned by road signage or a warning light. They are found in either residential neighborhoods or in rural areas.

Types of intersections: One way to classify intersections is by the number of road segments (arms) that are involved.

a) 3-way intersection – A junction between three road segments (arms) is a T junction (two arms form one road) or a Y junction.
b) 4-way intersections usually involve a crossing over of two streets or roads. In areas where there are blocks and in some other cases, the crossing streets or roads are perpendicular to each other. However, two roads may cross at a different angle. In a few cases, the junction of two road segments may be offset from each when reaching an intersection, even though both ends may be considered the same street.
c) 5-way intersections are less common but still exist, especially in urban areas with non-rectangular blocks. An example of this is the intersection for which the Five Points district in Atlanta is named.
d) 6-way intersections usually involve a crossing of three streets at one junction; for example, a crossing of two perpendicular streets and a diagonal street is a rather common type of 6-way intersection.

Road Junction

A road junction is a location where multiple roads intersect, allowing vehicular traffic to change from one road to another.

Figure 4: Traffic junctions account for half of road deaths in India

According to the figures, 56,868 deaths were recorded at uncontrolled junctions having no traffic light or traffic police. For the first time, the report also highlights how bad road conditions, particularly potholes, caused 9,700 crashes and claimed 2,600 lives. Maximum such deaths were reported in Uttar Pradesh where 760 people died. Though Madhya Pradesh reported a maximum of 2,888 crashes due to potholes, but the number of fatalities was 383.The report shows about 25,800 people died at T-junctions while 13,500 fatalities took place at Y-junctions. Four-arm junctions registered nearly 10,800 fatalities and about 7,800 people lost lives at staggered junctions. "Four-arm junctions have 32 conflict points. So, improper design and no regulation increase probability of crashes in case someone does a mistake. The distance between two points becomes the main conflict point," said transport planner Prof N Ranganathan. He added turning radius and waiting lanes are not properly designed. Even the intersections are not properly designed so that one can see traffic coming from all sides and weaving length is very short where traffic merges.

But traffic safety expert Rohit Baluja questioned the credibility of such data since there is no scientific data collection and investigation than just relying on police reports. "Police usually relates most of crashes to the nearest junction whereas the incident may have happened 100 meters or so away from the intersection," he added. Another revealing aspect of the latest report is the non-compliance of traffic rules lead to many fatalities. Over 19,000 people died in crashes at junctions with traffic signals, traffic cops or signals on blinker. The recent death of former Cabinet minister Gopinath Munde is an example of how drivers are careless at crossings when the traffic signal is on "blinking" mode.

METHODS FOR CONTROLLING ROAD ACCIDENTS ON INTERSECTIONS/ JUNCTIONS

A) **Traffic Controls:** Another way of classifying intersections is by traffic control technology:

a) Uncontrolled intersections, without signs or signals (or sometimes with a warning sign). Priority (right-of-way) rules may vary by country: on a 4-way intersection traffic from the right often has priority; on a 3-way intersection either traffic from the right has priority again, or traffic on the continuing road. For traffic coming from the same or opposite direction, that which goes straight has priority over that which turns off.

b) Yield-controlled intersections may or may not have specific "YIELD" signs (known as "GIVE WAY" signs in some countries).
c) Stop-controlled intersections have one or more "STOP" signs. Two-way stops are common, while some countries also employ four-way stops.
d) Signal-controlled intersections depend on traffic signals, usually electric, which indicate which traffic is allowed to proceed at any particular time.

B) Lane design

a) A traffic circle is a type of intersection at which traffic streams are directed around a circle. Types of traffic circles include roundabouts, 'mini-roundabouts', 'rotaries', "STOP"-controlled circles, and signal-controlled circles. Some people consider roundabouts to be a distinct type of intersection from traffic circles (with the distinction based on certain differences in size and engineering).
b) A box junction can be added to an intersection, generally prohibiting entry to the intersection unless the exit is clear.
c) Some (unconventional or alternative) intersections employ indirect left turns to increase capacity and reduce delays. The Michigan left combines a right turn and a U-turn. Jug handle lefts diverge to the right, then curve to the left, converting a left turn to a crossing maneuver, similar to through bouts. These techniques are generally used in conjunction with signal-controlled intersections, although they may also be used at stop-controlled intersections.
d) Other designs include advanced stop lines, parallel-flow and continuous-flow intersections, hook turns, quadrants, seagull intersections, slip lanes, staggered junctions, superstreets, Texas Ts, Texas U-turns and turnarounds.
e) Roundabout and its variants like turbo roundabouts, bowties and distributing circles like traffic circles and right-in/right-out (RIRO) intersections.

C) Turns:

At intersections, turns are usually allowed, but often regulated to avoid interference with other traffic. Certain turns may be not allowed or may be limited by regulatory signs or signals, particularly those that cross oncoming traffic. Alternative designs often attempt to reduce or eliminate such potential conflicts.

D) Turn Lanes:

At intersections with large proportions of turning traffic, turn lanes (also known as turn bays) may be provided. For example, in the intersection shown in the diagram, left turn lanes are present in the right-left street. Turn lanes allow vehicles to cross oncoming traffic (i.e., a left turn in right-side driving countries, or a right turn in left-side driving countries), or to exit a road without crossing traffic (i.e., a right turn in right-side driving countries, or a left turn in left-side driving countries). Absence of a turn lane does not normally indicate a prohibition of turns in that direction. Instead, traffic control signs are used to prohibit specific turns.

Turn lanes can increase the capacity of an intersection and/or improve safety. Turn lanes can have a dramatic effect on the safety of a junction. In rural areas, crash frequency can be reduced by up to 48% if left turn lanes are provided on both main-road approaches at stop-controlled intersections. At signalized intersections, crashes can be reduced by 33%. Results are slightly lower in urban areas. Turn lanes are marked with an arrow bending into the direction of the turn which is to be made from that lane. Multi-headed arrows indicate that vehicle drivers may travel in any one of the directions pointed to by an arrow.

E) Turn signals

Traffic signals facing vehicles in turn lanes often have arrow-shaped indications. Green arrows indicate protected turn phases, when vehicles may turn unhindered by oncoming traffic. Red arrows may be displayed to prohibit turns in that direction. Red arrows may be displayed along with a circular green indication to show that turns in the direction of the arrow are prohibited, but other movements are allowed. In some jurisdictions, a red arrow prohibits a turn on red,while in others, it does not.

Disadvantages to turn lanes include increased pavement area, with associated increases in construction and maintenance costs, as well as increased amounts of storm water runoff. They also increase the distance over which pedestrians crossing the street are exposed to vehicle traffic. If a turn lane has a separate signal phase, it often increases the delay experienced by oncoming through traffic. Without a separate phase, left crossing traffic does not get the full safety benefit of the turn lane.

F) Lane management

Alternative intersection configurations can manage turning traffic to increase safety and intersection throughput. These include the Michigan left, "superstreet" and continuous flow intersection.

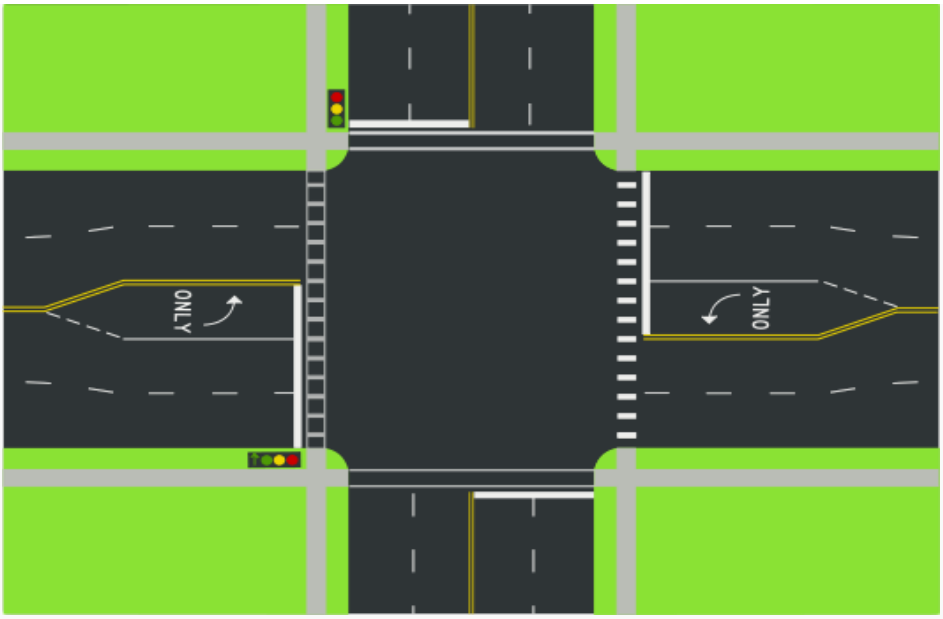

Figure 5

Diagram of an example intersection of two-way streets as seen from above (traffic flows on the right side of the road). The East-West Street has left turn lanes from both directions, but the North-South street does not have left turn lanes at this intersection. The East-West street traffic lights also have green left turn arrows to show when unhindered left turns can be made. Some possible markings for crosswalks are shown as examples.

G) Intelligent Traffic Management Systems:

i. Tracking of public transport vehicles through satellite navigation system or mobile communication system.
ii. Synchronization of traffic signals along the stretches, using road sensors for ascertaining traffic volumes.
iii. Tracking of criminals and automated penalty to the undisciplined road users, through satellite navigation system or a CCTV network.
iv. Advance notice to drivers, before reaching the critical point, through display boards / public address system.
v. Toll collection before entering busy roads / special roads

CONCLUSION

Road crashes are a major cause of deaths, injuries, property damages, and disabilities, in current society of a country. In order to reduce the rate, there must be active participations of all people and stakeholders, or the success is not expected. The Government cannot play the role alone in solving the problems. Traffic accidents is a complicated issue that affect not only lives, but very often, they also result in the loss of human resources, public orders as well as an enormous amount of private and public properties.

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