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Editorial



Dear Readers,

It gives me an immense pleasure to present this issue of "Industrial Safety Chronicle" with a focus on Road Safety. Road safety is a very important subject in today's life. With the increasing number of accidental deaths on roads, much systematic efforts need to be put in by all stakeholders. NSC contributes towards road safety in many ways. You may be aware that NSC had organised the first National Seminar on Road Safety, with a theme of "Enhancing Road Safety through Multi-sectoral Partnership"on 15-16 October 2019 in New Delhi. The Seminar was supported by the Ministry of Road Transport & Highways, Govt. of India; National Highways Authority of India and National Highways Builders Federation. Over 250 delegates including invitees from industries, institutions, associations, and NGOs attended the Seminar. Along with the Seminar an exhibition was organized in association with M/s. Safety Appliances Manufacturers Association. The exhibition was opened at the hands of Prof (Dr.) Walter, President, German Road Safety Council, who was one of the invited Speakers.

Total 24 speakers from various Govt. agencies, institutions, industries and eminent experts including WHO, German Road Safety Council contributed to the deliberations of the Seminar during the six plenary sessions titled as i) Effectiveness of Regulatory Mechanism in Promoting Road Safety; ii) Road Engineering for Improving Road Safety; iii) Road Accident Prevention Strategies; iv) Road Safety Education; v) Safe Transportation of Hazardous Materials and vi) Use of Advanced Technology for Road Safety. These sessions were chaired by the eminent personalities and deliberations were highly appreciated by the delegates.

We have included selected nine seminar papers presented by the speakers, in this issue of the Chronicle. I hope readers will find them to be highly informative.

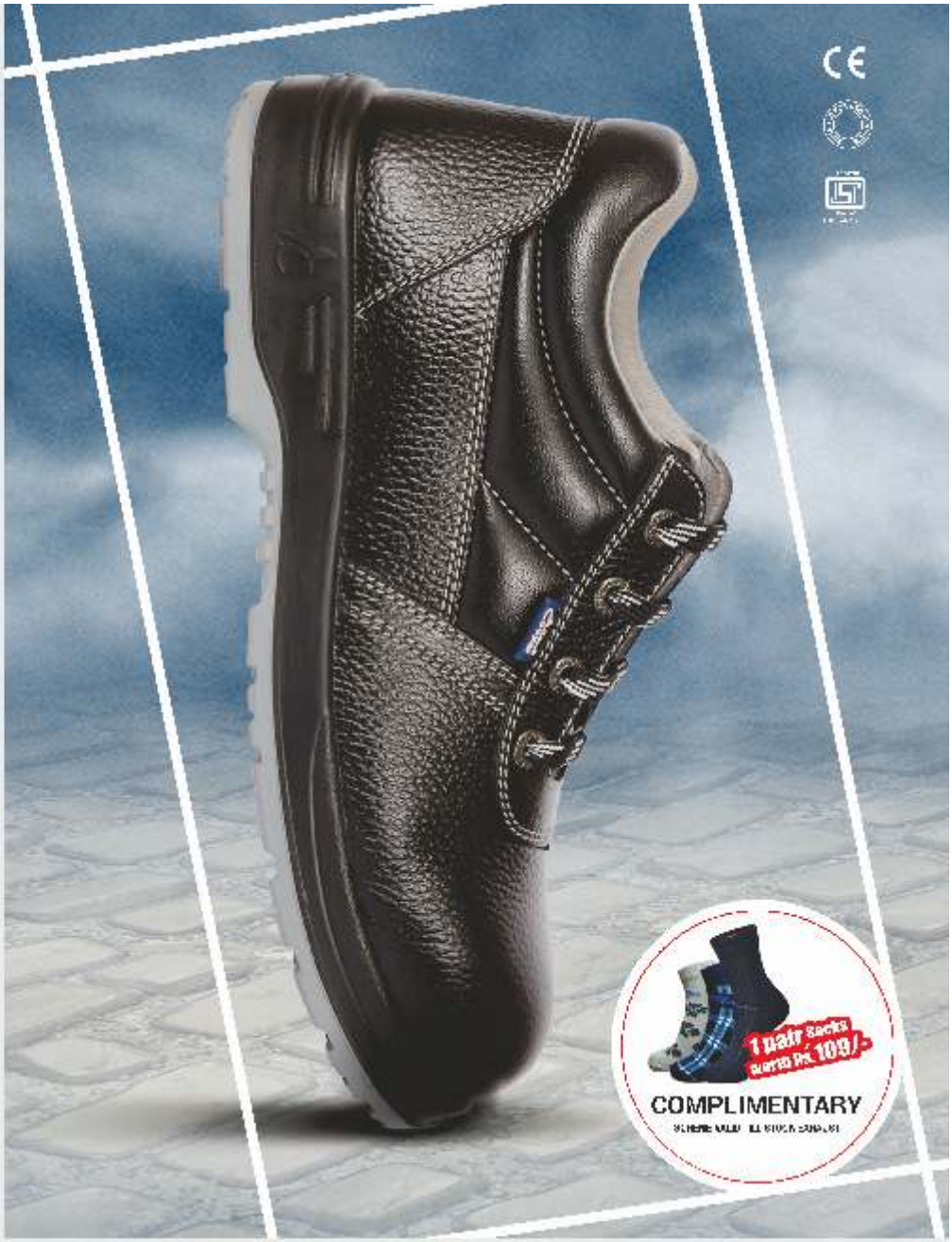
In this issue, we have also included an introductory article on "Process Safety Management – From Conception to Development". I am happy to inform that from the next chronicle issue onwards; we will be publishing CCPS's Risk Based Process Safety (RBPS) Guidelines which will be helpful for implementing Process Safety. The RBPS has four pillars and each issue we will cove one pillar. These RBPS Guidelines will enable an organization to improve its process safety effectiveness, reduce frequency & severity of incidents and improve long term safety, environment & business performance.

Stay safe and healthy.

Lalit R. Gabhane
Chief Editor & Director General

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COMPARATIVE STUDY ON THE ROLE OF REGULATORY MECHANISM IN PROMOTING ROAD SAFETY

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ABSTRACT:

This is an age — of Globalization, of blurring boundaries, of the fusion of wisdom of the East and West. Development in Science and Technology and Research has virtually turned the world into a potpourri. It has helped in transcending the geographical boundaries, cultural context and ideological barriers. However due to rapid socio-economic transformation and technological advancement it has brought an age of high speed roads coupled with modes of fast commutation thereby resulting in a heavy toll of human life and sensitivities. Among the underlying causes of almost all road accidents it has always been human error, the other factors could be related to vehicular defect and fault in road design. The behavior of road users as pedestrian and vehicle driver has been a subject matter of intense debate regarding role of regulatory mechanism in rectifying it. We have to realize that law alone is not enough to transform the behavioral pattern of various types of road users. Not many countries in the world have adequate laws and regulatory mechanisms to address all five risk factors which cause death i.e over speed, drunken driving, helmets, seat belts and child restraints. It is well known that different regulatory methods and tools of Road safety are products of different spatial and temporal variables. However the larger question in contemporary scenario is that how far we have moved closer in ensuring road safety to our people by effective implementation of Regulatory mechanisms. There is no doubt that Multi-sectoral partnership is sine qua non in enhancing road safety.

In the Indian context, Constitutional commitment of Fundamental Right to life Article 21, cannot be fully realized if appropriate regulatory mechanisms are not enforced to meet the commitment of Brasilia declaration which aimed at reducing the death toll by road accidents to half by 2020. It is surprising to know that during 20th century about 20 million people died as a result of road accidents, which is around the same number of World War II casualties. The time is ripe to explore and enforce the regulatory mechanism pertaining to modern traffic management system and practices, improved safety standards in road design, construction, operation and maintenance of roads, beside production and maintenance of safer vehicles.

The study at hand envisions the modalities of Regulatory mechanism by exploring its legal dimensions and the best practices in road safety worldwide. Also Modalities of Regulatory mechanism for road safety needs to be conceptualized in the light of the State and National highway road conditions, regional variations in a vast country like India and guidelines of international community in order to meet the challenge of road safety in modern-day India.

KEYWORDS: Globalization, Regulatory mechanism, spatial, temporal, legal dimensions

1. Introduction:

The citizens of any country are the most valuable assets and their productive years are the most crucial factor in determining the overall growth and development of a nation. Therefore, the role of regulatory mechanism in promoting road safety is indispensable in the social and economic development of the people and nation in particular. India is among the countries having largest road network about 59 lakh Km facilitating about 60% of total good & 85% of passengers. In this age of emerging globalization the scenario of road safety regulation is also changing rapidly, this necessitates keeping pace with the emerging global trends on various aspects of road safety. Not many countries in the world have adequate laws and regulatory mechanisms to address all five risk factors which causes death i.e over speed, drunken driving, helmets, seat belts and child restraints. It is well known that different regulatory methods and tools of Road safety are products of different spatial and temporal variables. Globally road crashes claim more than 1.35 million lives annually. In India almost 13 lakh people lost their lives and 50 thousand injured in road accidents over the last decade. Around 1.5 lakh citizens die every year in road crashes in India alone. This amounts to an annual loss of 3 % to GDP beside loss of productive Human Resource. The road crashes impact our economy and society in a multiple manner as it affects young people the most (18-45) by creating a hole in demographic dividend. Since 2000 road length in India has increased by 39%, while no of vehicle has increased by 158%. Growth of road networks has a limitation on account of physical constraints but constant increase in high speed vehicles on road is a cause of congestion and road fatalities. Share of NH & SH comprises about 5% of total road network but account for 52% of the accident and 63% of road deaths. Road deaths are on rise with

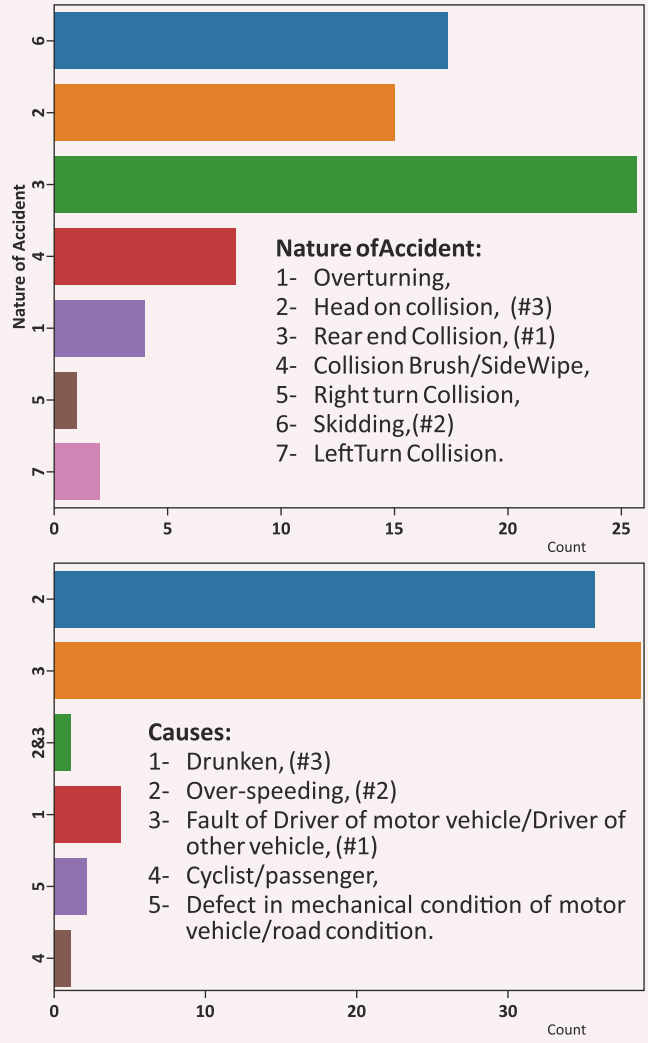
400 deaths every day i.e 17 life/hour. Drivers are held responsible for 78% of accidents, 3% due to neglect of civic bodies while 67% accidents occur between (9 to 9).

In modern age high speed roads are back bone of economic development but old saying speed thrills but kills is equally appropriate. Collection of vast speed data in accident prone areas can be analysed (in relation to time period & type of vehicle) and can be effectively used in enhancing road safety.

India is a signatory to Brasilia declaration of 2015, which intends to reduce road accidents & traffic fatalities by 50% by 2022. It is our commitment to bring about regulation to ensure that all vehicles are equipped with seat belts. A study conducted in 11 cities of India including metro cities reveals that for children's hardly 10% school buses have seat belts indicating low level of awareness for child restraint system. The central MV Act 1988 mandate vehicles equipped with seat belts to be manufactured in India and also mandate use of rear seat belt u/s 138(3). Safety benefits of seat belts needs to be enforced and popularized by awakening campaign. Children's are the most vulnerable section in this regard. There is need for legislative efforts for mandating use of child seat and child helmet. For child as a pedestrian near school and home there is a lack of infrastructure and child specific road safety laws in India. The issue needs to be addressed by prioritizing engineering interventions followed by Education- and enforcement activities. Government -individual-parents-stakeholders and school has a vital role to play in child safety. Mandatory annual road safety audit around school is imperative. Research has also revealed that in metro cities near places of public importance hardly 1.8 % passengers holding important position were found wearing rear seat belts, Delhi topped with 4%. No doubt road safety and Regulatory mechanism forms an integral part of each other with focus on road engineering, traffic management, vehicle regulation, environmental protection and laws governing these domains. An attempt has been made to write this paper in the light of the above discussion, so that critical problem of road safety can be addressed in the light of the best practices world over.

2. A Pilot Study on Morena- Agra Highway:

Since NH & SH comprises about 5% of total road network but account for 52% of the accident and 63% of road deaths. A pilot study was conducted with the help of our team on NHAI project of O& M in Agra-Gwalior section km 8.00 to km 103.000(Length 95 km) by collecting large accidental data of 6 month from (Jan 2019 to Jun 2019) from 07 Police stations spread over 3 States of MP, Raj & UP. The objective of the study was to study nature of accident and underlying causes.



Outcome of study:

- Most cases under category "Fault of Driver of motor vehicle/Driver of other vehicle" followed by "Over-speeding" and "Drunken" driving.
- Over speeding and drunken driving could be reduced by regulation of checks at various speeding Zones after careful identification by the respective Police Stations.
- Most accidents reported in Rear end collisions then Skidding and Head on collision.

3. Road Safety Legislation in India:

Rapid industrialization, urbanization & motorization are intimately related with rising health hazard. With a population of 133.6 cr India is subjected to unprecedented growth. In order to combat the challenge of road safety appropriate Legislative and policy framework is imperative. Regulatory mechanism of Road safety comprises of orderly development & management of roads, manufacturing and maintenance of safer vehicles, holistic medical response to fatal accidents, improved safety standards in design, construction, operation & maintenance of roads and role of enforcement agencies, etc. MV acts of 1988 mandate each state to have a road safety council (SRSC) on the line of NRSC. Other organizations dedicated for road safety are IRC, CRRI, CSIR, CIRT, IRTE, ARAI, NATRIP, BRO, NITHE and various IIT, NIT and NGO active in the field.

The responsibility of road safety is fragmented and diffused since there is no single agency to address the vast issues to be dealt with. Existing institutions are not equipped fully to deal with the enormous problems of traffic volume on roads or to adopt the latest technological advancements that could promote road safety. The GOI has approved a National Road Safety policy with National Road Safety Council (NRSC) as the Apex body in the matter of policy decisions on road safety. The state has been asked to set up (SRSC) & District Road Safety Committees (DRSC). Ministry has formulated a Multi-pronged strategy to address various issues of road safety, guided by principle of 4 'E's i.e Education- Engineering- Enforcement & Emergency of both roads and vehicles. No wonder road safety is an integral part of road design at planning stage and later on road safety audit of select stretches of highway with top priority for identification and ratification of black spots is sine-qua-non.

With unlimited liability, premium for mandatory third party insurance has been increasing rapidly. The recent MV (Amendment) Act, 2019 has following salient features &a penalty has been enhanced for:

(a) drunken/drug abuse driving from ₹2000 to 10000.

(b) Vehicle manufacturers fails to comply standards - upto₹100 Cr or imprisonment up-to one year or both.

(c) Contractor fails to comply with design standards up-to one lakh fine. With the provision that centre can raise the fine by 10% annually. In view of more fatalities due to driver fault to deter a provision of mandatory sentence maximum upto one week is imperative.

Similarly when the average cost of construction of NH per km is around 15 Cr the question is whether a fine of one lakh is enough to deter contractors? Provisions of compensation for road accident victim includes cashless treatment to victim during golden hour coupled with interim relief to claimant seeking compensation under third party insurance in hit & run cases has been increased from ₹25000 two lakhs & in grievous injury from ₹12500 to 50000. Also provision to protect Good Samaritans from civil or criminal case. Beside MV act there are provisions in IPC, CRPC, MORTH guidelines, IRC /IS code etc for enhancing road safety.

In order to exert a favorable impact on road safety appropriate legislation and enforcement in tune with cultural climate and economic realities of a particular country are the factor essential. The legislative efforts needs to be concentrated on certain key risk factors to reduce the menace of road crashes such as road design & maintenance, defective vehicle design, human behavior& acceptance of safety norms, drunken driving, use of seat belts & helmets, & last but not the least to contain speeding as a major contributor for death & injuries. About (50-60)% of road crashes result in brain damages hence compliance of seat belt, rear seat belt & child restraint including distracted driving due to cell phone use needs stricter enforcement. Thus five pillars of road safety which needs focus of legislative & Regulatory efforts are road safety management, safer road infrastructure, safe vehicle, road user behaviour & post-crash care. However enacting and enforcing comprehensive legislation is quite challenging and time absorbing, since the process has many constraints in modern day democratic parlance such as lack of political will, institutional slackness, resources crunch, mind set of people & its redressal at national level. In road safety it is essential for a holistic regulatory & legal frame to be backed up by evidence for a wider acceptance beside appropriate penalties. Advocating for legislative and regulatory change we need to identify issues to be addressed, know political landscape & ideology before setting forth goals and objectives. Thereafter comes creation of an action plan, implementation and close monitoring of progress.

4. International Perspective & Best Practices in Road Safety:

In USA traffic safety legislation was introduced way back in 1966 by US highway safety act. It paved the way for uniform standards in crash reporting & investigation system, traffic control, vehicle

registration, vehicle codes, highway design & maintenance, traffic surveillance systems and emergency services. Later on National Highway Traffic Safety Administration (NHTSA) was established in 1970, to curb fatalities and economic losses as a result of MV accidents. Even USA donors have a single body looking after all aspects of road safety but NHSTA is equipped with adequate power and funds to function as a nodith a set target. Some of the best practices measures are:-

(a) Exercising leadership & Political commitment, the recent Amendment to MV Act 2019, is an example in this direction taken by the present government.

(b) Establishing a close connection between goals, plans, Organization& financing.

(c) Coordinating the activities of various stakeholders & ensuring there accountability.

(d) Countries with success in reducing the death due to road carnage has achieved so by enforcing comprehensive regulatory mechanism based on consistent enforcement & social awareness campaign to bring about change through school education.

(e) Swedish vision zero and Dutch sustainable safety model.

(f) Enforcing advanced seat belt reminder mandatorily.

(g) Promoting use of alcohol interlocks, day time running light and emergency call system.

(h) Road safety information data base is imperative to analyse the causes of accidents.

5. Conclusion and Recommendations:

The essence of Human Resource Development lies in road safety as it play a vital role in socio-economic development of a nation. In road safety what we have currently is a closed box kind of a system within which there are smaller boxes with a little interaction with the outside or with each other. This situation clearly laments that the time is ripe for interdisciplinary approach and collaborative team efforts by peoples of diverse discipline and diverse interest in promoting road safety on our roads. In most of the developing countries including India road safety is a major problem for sustainable human development with wide reaching socio-economic ramification. Unrestricted growth of number of vehicles, poor enforcement of traffic safety regulation, inadequate quality roads and public health infrastructure are some of the problems of road safety in India. Road safety is a social equity issue as it affects the poor and vulnerable section of society the most having limited post-crash care facility. However the present government in India is bent upon to overcome these constraints and has already made a head start in the right direction to curb the menace of road crashes. In order to prevent the accident the nature of government policy must be guided by why do accidents occur? As there are four main causes of accidents i.e Defects in machine, error of driver (man behind machine),environment around roads and defects in roads. The time is ripe for preparing a national road safety strategy & plan of action with allocation of financial & Human Resource to address the issue. While the role of government in upgrading institutional development, policy making, legislation & enforcement of public health and road safety cannot be denied but it is also a sacra-scent duty of vehicle manufacturers, community, civil society & individuals in contributing their bit for a much safer road safety scenario in India. Therefore Roads safety is a cooperative science.

Recommendations:

1. During rainy season under poor visibility on NH /SH presence of stray cattle in abundance on road leads to accidents. For lack of enforcement toll operators n concessionaire be held responsible.
2. Despite of coming up of excellent SH & NH over a period of less than one decade still keeping in view of awareness level & driving behavior of road user electronic monitoring mechanism is imperative to regulate safe speed limit.
3. Tendency of opening Dhabas and hotel in close vicinity of NH / SH is to be curbed & only at select stretches on highways some auto grill kind of joints be allowed to prevent encroachment all along highways with a responsibility for proper parking and entry- exit on high speed roads.
4. Need for social safety legislation in view of stray cattle on road. Space provided by authority along ROW with cow shade, hard surface and fencing on specific and select stretches which are cattle prone areas near a cluster of villages.
5. Provision of stringent fine on violation of road safety with disciplinary action on law enforcement officials and public servants to set an example of role model.
6. Road traffic crashes are predictable and therefore preventable. In order to combat the problem there needs to be close coordination and collaboration, using a holistic and integrated approach, across many sectors and many disciplines.

7. There is a need for cohesive legislation with binding effect on policy maker (govt dept.)-Consultant-concessionaires-police-and other stake holders in enhancing road safety.
8. Since fatalities due to road accidents are alarming so the budgetary allocation for road safety needs to be increased.
9. Need for promoting more research in road safety for future course of action. Systematic data analysis to provide a basis for sound road safety policy & legislation.
10. A missionary mode is imperative by equipping safety council with adequate statutory backing & budgetary resources.
11. Intensive annual road safety research needs to be taken up in accident prone areas of various police stations on highways.
12. School curriculum in India to include road safety awareness. Although traffic police do impart road safety education to children from time to time.
13. Since NH & SH comprises about 5% of total road network but account for 52% of the accident and 63% of road deaths. This is an area of focus for reducing drastically the road fatalities by appropriate regulatory mechanism and enforcement.

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* * *

ROAD SAFETY THROUGH DESIGN AND TECHNOLOGY

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Abstract

Road Safety Audit (RSA) is formal and independent safety performance review of a road transportation projects by an experienced team of safety specialists, addressing the safety of all road users. RSA helps in reducing the number and severity of crashes. It also helps reduce costs by identifying safety issues and correcting them before projects are built. Noida - Greater Noida (NGN) Expressway is an eight lane divided carriageway connecting Noida and Greater Noida, the two major residential cum industrial / commercial township developments located in the state of Uttar Pradesh, India. This Expressway has witnessed high crash rate and therefore, a comprehensive RSA was conducted and suggestions for improving safety on this expressway were recommended.

These included replacement of concrete guard post on median by double row metal beam crash barrier, redevelopment of entry and exit points as per Indian Standards, marking and road studs on each of the traffic lanes and particularly near exit/entry points of auxiliary lanes. The Speed Enforcement Cameras and Close Circuit TV with Variable Message Signs were also implemented at every 2 km.

This paper discusses the effect of these measures on rate on the Expressway, the total crashes after RSA has exhibited 84 percent reduction. At the same time, the fatal crashes exhibited a significant reduction 91 percent. The average speed of all types of vehicle in general, has improved after implementation of RSA recommendations, even with annual increase in traffic.

1 Introduction

Road crash scenario on the Indian roads continues to account for the highest fatalities in the world. More than 150000 persons died in road accidents during the year 2016. This phenomenon is going unabated since 2011 with the number of road deaths rising 3 - 5 % per annum despite the fact that India is a signatory in the present Decade (2011-2020) of Action for Road Safety of the United Nations Convention to bring down the road crashes every year. According to data published by Ministry of Road Transport and Highways (MoRT&H) Government of India, the state of Uttar Pradesh recorded the maximum number of road deaths (17,666) and it continues to occupy the dubious distinction of being in top 3 road crash prone states in the country (MoRT&H Statisties 2016). The situation is well recognized by all state governments and individual states are embarking upon road safety audit of their road network. The Road Safety Audit (RSA) is a formal examination of proposed or existing roads and road related areas from the perspective of all road users with the intention of identifying road safety deficiencies and areas of risk that could lead to road crashes.

2 Road Safety Audit

Road Safety Audit (RSA) is defined as the systematic checking of the safety aspects proposed either in the case of new or an existing project road coupled with the review of traffic management schemes, including evolving appropriate modifications to the existing layouts. After the implementation of the recommended measures emerging out of RSA, it is expected that the new or existing road projects would operate as safely as possible as the RSA would strive to mitigate the present and future safety issues commensurate with the increasing traffic. In this regard, it shall be realized that investments on the conduct of RSA and its subsequent implementation shall be considered as a necessary cost, and not considered as an additional expense implying thereby the need to carry out RSA through the entire cycle of design, construction and pre-opening of any project facility and also during operation and maintenance of the highway depending on the requirements. Taking cognizance of the above aspects, the Indian Roads Congress (IRC) had brought a document titled, “Manual on Road Safety Audit IRC-SP-88 (2010)”. Includes of the following stages of RSA which need to be carried out during RSA depending on the status of any road project:

a. Safety Audit during the Feasibility Study
b. Safety Audit during the Preliminary Design
c. Safety Audit on Completion of Detailed Design

d. Safety Audit at the Construction Stage

e. Safety Audit on Completion of Construction (i.e. Pre-opening Audit)

f. Safety Audit of Existing Roads

The first five stages of safety audit is applicable to the road projects either proposed for construction or in the process of construction and the last one is applicable specifically for the existing roads. It is to be borne in mind that in many of the road up gradation and maintenance projects undertaken in India including major urban roads and even expressways, safety devices are included in the designs, but seldom implemented on the ground in totality. Moreover, road maintenance is limited to fixing potholes and cleaning of drainage facilities, without replacing missing traffic signs, damaged guardrails, dilapidated road markings and more importantly, the provision of safety measures commensurate with the traffic growth which are essential to create a safe road network. The above aspects can be effectively addressed through the conduct of RSA on the existing roads which are faced with increasing road crash records.

3 Road Safety Audit of Existing Roads

From the above discussion, it is obvious that RSA procedure can be applied to both new roads as well as existing roads. On new projects, RSA is primarily carried out to avoid / prevent the building of road crash prone situations whereas in the case of existing road, RSA are carried out aimed at mitigating the road crash prone locations by enhancing the safety features. Hence, it is obvious whenever an existing road is subjected to safety audits; it provides ample scope to improve / enhance safety both from the operation and maintenance viewpoint of roads. The aspects that are monitored during the course of the RSA of the existing road shall normally conform to IRC-SP-88 (2010) and other international norms if not listed in the above IRC document:

- Does the prevailing speed correspond to the design speed?
- Are the visibility criteria still satisfied?
- Have any changes been made which could affect road safety?
- For carriageway and paved shoulders examine things like any breach or blockade, roughness value, pot holes, cracking, rutting, skidding, damage to pavement, edge drop at shoulders.
- Check the roadside furniture including road signs and markings damage to their shape or position, loss of retro-reflectivity
- Street lighting
- Rest areas cleaning, including defects in electrical, water and sanitary installations.

4 Case Study

Noida - Greater Noida (NGN) Expressway is a eight lane divided carriageway connecting Noida and Greater Noida, the two major residential cum industrial / commercial township developments located in the state of Uttar Pradesh. Since both these cities have grown rapidly over the years due to their proximity to New Delhi and also due to the fact that they are falling under the National Capital Territory (NCT) of Delhi, the above expressway was constructed in 2002 to provide fast track road connectivity between the above two major townships and an additional connectivity to Delhi. This expressway also connects to Yamuna Expressway, which now extends up to Lucknow, the state capital. The expressway witnessing increasing rate of road crashes from 11 crashes for year in 2010 to 16 crashes for year in 2013. Therefore the State of Uttar Pradesh in northern part of India decided to get the RSA of NOIDA – Greater NOIDA Expressway to identify the block spots on the road and subsequently to remove them through engineering interventions.

The road safety audit of NGN expressway was conducted in the year 2013. The RSA recommendations were implemented by the Authority during the year 2013. This paper presents the outcome of the study implementation on change in traffic accident scenario on the expressway.

5 Data Collection

Traffic studies such as Classified Volume Counts (TVC), Spot speed survey and travel time assessment studies were conducted during the year 2013 to understand the traffic characteristics on the study corridor. 24-hour TVC studies were carried out at strategically two locations namely near Mahamaya Flyover (Bus Stop No. 1) and near the end of the expressway (Bus Stop No. 8 and 9) to cover both directions of travel. As part of RSA, road crash statistics for the Project Corridor were compiled from First Information Records (FIRs) of the police records from 2008 onwards. At the same time, road crash data for the state of Uttar Pradesh were collected from Ministry of Road Transport and Highway (MoRT&H) for the same period.

As the RSA recommendations were implemented in the year 2013 by the concerned stakeholders, an analysis has been carried out to understand whether the measures have contributed towards the reduction in road crashes or not during the years 2014, 2015 and 2016, the above crash data have been compared with those collected for the period from 2008 - 2012 which is period prior to the implementation of RSA action plan (refer Figure 1). As may be seen, the number of crashes on the project corridor has reduced after 2013 which shows the effectiveness of RSA. Further analysis of these data to arrive at crash reduction factor is presented in later part of this paper.

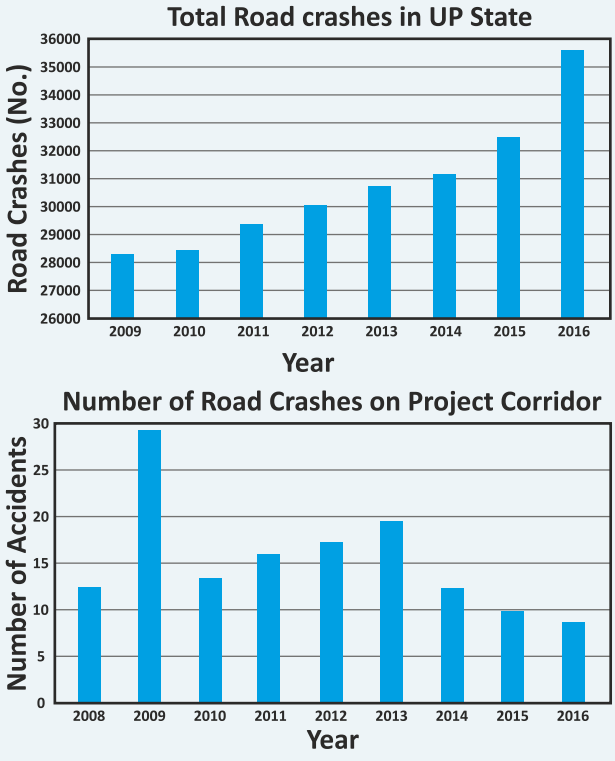


Figure 1 : Trend of Year-wise Road Crash Statistics in the State of Uttar Pradesh and Project Corridor

6 Profile of Road Safety Audit (RSA) Implementation Scenario

Several safety associated recommendations were implemented on the study corridor conforming to the RSA recommendations. Some of the typical scenarios depicting 'before' and 'after' scenarios of RSA implementation are briefed here.

6.1Implementations of safety recommendations

RSA was conducted as per the procedure given in IRC: 88 (2010). Some of the observations made to the agency are given below;

(i) The central verge (median) was having concrete guard post fenced with barbed wire fencing before RSA which was identified to be hazardous for the errant vehicles in case of road crash. Further, intermittent openings provided on the above fencing system prompt various road users including motorized two wheelers as well as pedestrians to use the same for illegal crossing. It was recommended to remove the guard rails and install the double row metal beam crash barrier as shown in Figure 2.



Figure 2 - Before and After condition of Central Verge

(ii) Three entry / exit points were located on the Project Corridor without proper entrance angle as well as absence of acceleration or deceleration lanes. As a result many road crashes were taking place due to haphazard movement of vehicles. The entry/exit points were redeveloped conforming to IRC:SP:87 (2013) leaving no space for confusion and thus improving the safety. Typical treatment is shown in Figure3.



Figure 3 - Redesign of Entry and Exit Points

(iii)There were no road markings, lane markings, mixing zone area markings at entry/exit points of the auxiliary lanes. The audit recommended for the placement of all types of relevant markings (including lane demarcation as emergency lane at every 2 Km on the Left most lane as well as lanes for Heavy vehicles, Two Wheelers and cars), installation of road studs on each of the traffic lanes for enhanced visibility during night time as per IRC:35 (2015). These provisions were also implemented (Figure 4).

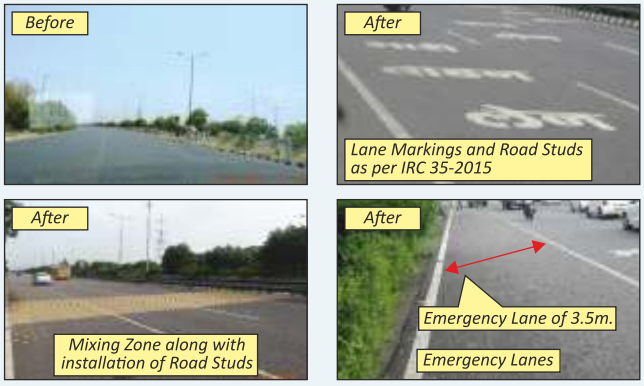


Figure 4 - Road Markings and Road Studs for better nigh visibility

(iv) The audit team observed improper placement of road signs. The locations and size of the signs were not meeting the operating speed requirements. All the irrelevant signs were replaced by proper signs as per IRC: 67 (2012). Some of the traffic signs before and after the implementation are presented in Figure 5.



Figure 5 - Traffic Signs as per IRC:67 (2012)

(v) There were no form of Intelligent Transportation System (ITS) for managing the high speed traffic before RSA. Subsequent to RSA Speed Enforcement Cameras and Close Circuit TV with Variable Message Signs were implemented at every 2 km as shown in Figure 6.



Figure 6 - Intelligent Transportation Systems application on Expressway

7 Cost Incurred for the Project Implementation

Almost all recommendations of the RSA were implemented by the Expressway owning agency. The details of cost incurred for safety implementations including the overlay and service road augmentation are presented in Table 1.

Table 1 : Road Safety Project Cost details for 20km of NOIDA Greater NOIDA Expressway

S.NO.	Description of work	Amount (in Rs crore)
1	Cost of Overlay and Traffic Control Devices such as Road Signs, Road Marking, Studs, Removal of Redundant Signs, Km Stones, OHMs, for the Entire Road Stretch	120
2	Cost of Service Road Strengthening / Augmentation	28
3	Provision of Auxiliary Lanes for facilitating Entry and Exit movements (including geometric design Improvements)	13.8
4	Foot over Bridge	2.5
5	Improvement of Central Verge	31
6	Cross Drainage Works	2
7	Provision of Intelligent Transport System	28
8	Others (Junction Improvements, Watering of Plants, Road Maintenance, and Gantry Boards Cost etc.)	7.5

8 Impact of Safety Implementation

The parameters evaluating the impact of RSA implementation included the quantum of traffic flow, speed characteristics, number of road crashes, and the severity of road crashes before and after RSA scenarios. In this regard, duration of 5 years is taken as the time period for before RSA and 3 years of duration after RSA implementation.

8.1Number of Road Crashes

The road crash data (FIRs) were collected from various police stations along the study corridor. The data was collected for before and after RSA implementation period as explained earlier. The summary of road crashes on the study corridor is presented in Table 2. The crash Rate after implementation of RSA reduced but the injury rate has drastically increased because of a bus to bus collision in 2014 leaded to increase in the injury rate, whereas the fatal crashes have decreased considerably after implementation of RSA.

Table 2: Road Crash Scenario on the Study Corridor

Year	Total Road Crashes	Persons Killed	Persons Injured
2008	10	15	10
2009	24	24	23
2010	11	14	13
2011	13	16	10
2012	14	15	12
2013	16	7	10
2014	10	11	27
2015	8	6	9
2016	7	5	8

8.2Traffic volume

Traffic volume data collected on study corridor during road safety audit and after implementing the road safety recommendations indicated that traffic on the road has increased at the rate of 5 percent per annum.

8.3Traffic speeds

Spot speed surveys were conducted for 24 hours at two locations before RSA implementations. The survey was repeated at same locations after RSA recommendations were implemented. The speeds observed for different types of vehicles are compared in Table 3.

Table 3: Speed percentile data before and after

Direction of flow	Mode	April 2013, kmph		
Mahamaya to Pari Chowk	**Percentiles**	**15**	**50**	**85**
	Car	52	73	88
	Bus	45	55	70
	LCV	40	50	70
	Two wheeler	40	55	80
Direction of flow	**Mode**	**August 2016, kmph**		
Mahamaya to Pari Chowk	**Percentiles**	**15**	**50**	**85**
	Car	61	75	88
	Bus	52	65	78
	LCV	45	55	65
	Two wheeler	45	56	69
Direction of flow	**Mode**	**% increase or decrease**		
Mahamaya to Pari Chowk	**Percentiles**	**15**	**50**	**85**
	Car	17	3	0
	Bus	16	18	11
	LCV	13	9	-8
	Two wheeler	13	2	-13
Direction of flow	**Mode**	**April 2013, kmph**		
Pari Chowk to Mahamaya	**Percentiles**	**15**	**50**	**85**
	Car	68	85	105
	Bus	50	65	80
	LCV	45	55	70
	Two wheeler	45	55	75
Direction of flow	**Mode**	**August 2016, kmph**		
Pari Chowk to Mahamaya	**Percentiles**	**15**	**50**	**85**
	Car	66	79	91
	Bus	70	59	79
	LCV	48	58	68
	Two wheeler	43	57	74
Direction of flow	**Mode**	**% increase or decrease**		
Pari Chowk to Mahamaya	**Percentiles**	**15**	**50**	**85**
	Car	-2	-7	-13
	Bus	40	-10	-1
	LCV	8	5	-3
	Two wheeler	-4	4	-1

As may be seen, the average speed of all types of vehicles in general, has improved after implementation of RSA recommendations. The posted speed limit on the study corridor is 100 kmph for light vehicles (car and two wheelers) and 60 kmph for bus and Light Commercial Vehicles (LCV). The 85th percentile speed of all vehicles (except for bus in direction from Mahamaya to Parichowk) has reduced after RSA.

8.4 Travel time

The journey time of a vehicle to travel from starting point to ending point was determined using floating car method. Many runs were conducted on the study corridor to acquire the average travel time. With the comparison of before and after data, it was observed that the travel time reduced by about 29.73% in the direction Mahamaya to Pari Chowk and 22.28% in the direction Pari Chowk to Mahamaya.

9 Evaluation of Crash Reduction Factor (CRF) and Crash Modification Factor (CMF)

Crash reduction factors (CRFs) are used in road safety studies to predict safety benefits due to reduced number of crashes. NCHRP Report 162 emphasises the necessity of the CRF studies. A crash reduction factor (CRF) is the percent crash reduction that might be expected after implementing a given countermeasure at a specific site. Before-and-after method is used for calculating the CRF. In this method; the effects of interventions on safety are determined by number of crashes occurred on the study stretch before and after implementations using CRF. The methods of estimation of CRF are discussed in detail in the subsequent sections.

9.1 Method-1: CRF by number of crashes

This method is simple for calculating the crash reduction factor for the safety improvements of a study area. The formula used for calculating the crash reduction factor is as follows:

$$CRF = 1 - \frac{N_a}{N_b} \quad (1)$$

N_a= Number of road crashes after implementation

N_b= Number of road crashes before implementation

9.2 Method-2: CRF by exposure of crashes

It is based on the assumption that if nothing has changed, the crash experience before improvement is a good estimate of what would have happened during the after period without improvement (Albert Gan, 2005). The basic formula for deriving a CRF in actual

application, exposure to crashes is often considered in order to account for any changes in crash exposure that may have occurred between the before and after period. Accordingly, the CRF is calculated based on crash rates as follows:

$$CRF = \frac{(CR_b - CR_a)}{CR_b} = 1 - \frac{CR_a}{CR_b} \quad (2)$$

Where CR_a and CR_b are the crash rates at a treated site before and after improvement.

$$\text{Crash Rate} = \frac{\text{Total No. of Crashes}}{\text{Exposer}} \quad (3)$$

$$\text{Exposure} = \frac{(\text{TOTAL KILOMETERS}) X (\text{NO. OF DAYS}) X (\text{Mean AADT})}{1{,}000{,}000} \quad (4)$$

$$\text{Mean AADT} = \frac{\text{Sum AADT from each crash}}{\text{Total No. of Crashes}} \quad (5)$$

9.3 Test of significance

Statistical test is necessary to determine whether crash reduction is significant or negligible. The Poisson comparison of Mean Test is used to determine if the crash reduction is statistically significant (i.e. significantly better, significantly worse, or no significant change). The formula for the Poisson Test based on a 95% confidence level is given by Eq-(6).

$$R = \frac{2.326 X \sqrt{b-0.16}-0.35}{b} \quad (6)$$

Where,

R = Minimum significant percent reduction, and

b = Total number of crashes before project implementation.

A CRF is said to be significant when it is equal or higher than R. When a positive CRF is greater than R, it is said to be "significantly better" on the other hand, when the absolute magnitude of a negative CRF is greater than R, it is said to be "significantly worse". A CRF is said to result in "no significant change" if its absolute value is less than R.

1.1Impact of RSA on Crash Reduction

The crash reduction factors calculated by two methods are given in Table 4. The CRF values using method-1 are constantly lower than those calculated by method-2. It is due to the number of parameters considered in two methods while calculating the CRF. Method-1 relies on number of road crashes in before and after scenario, while method-2 considers parameters like traffic volume and exposure. Therefore method-2 provides more realistic and higher values of CRF.

Table 4 Comparison of CRF Methods

Para meter	Total Number of Road Crashes		Persons Killed		Persons Injured	
	Method-1	Method-2	Method-1	Method-2	Method-1	Method-2
CRF	0.58	0.84	0.62	0.91	-0.03	-0.55
CMF	0.42	0.16	0.38	0.09	1.03	1.55
Values of R	0.346	0.346	0.338	0.338	0.382	0.382

Crash Reduction Factor (CRF) for total road crashes is computed as 0.84 which indicates that the total crashes have exhibited 84 percent reduction subsequent to implementation of RSA recommendations. At the same time, CRF values for fatal road crashes or persons killed was found to be 0.91, which implies that the fatal crashes exhibited a significant reduction trend of 91 percent. The CRF value for persons injured has registered a negative sign which indicates the increase in number of persons injured. This is attributed to the one major crash occurred in 2014 involving rear end collision of a Truck and a Bus, resulting in injuring to 12 persons. Table 4 also shows values of R, the R values for the total number of road crashes is 0.346 and persons killed is 0.338 which are lower than the CRF values of respective crash types. The R value reinforces the fact that the reduction of road crashes as compared to the trend of road crashes before RSA is significant implying the fact that the total and fatal crashes have declined after RSA on the project corridor.

9.5 Crash Modification Factor

A Crash Modification Factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The main difference between CRF and CMF is that CRF provides an estimate of the percentage reduction in crashes, while CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given improvement. It is important to note that the CMF represents the long-term expected reduction in crashes.

CMFs are used by several groups of transportation professionals for various reasons. The primary user groups include highway safety engineers, traffic engineers, highway designers, transportation planners, transportation researchers, and managers and administrators. CMFs can be used to:

- Capture the greatest safety gain with limited funds
- Compare safety consequences among various alternatives and locations
- Identify cost-effective strategies and locations

- Check reasonableness of evaluations (i.e., compare new analyses with existing CMFs)
- Check validity of assumptions in cost-benefit analyses

Crash Modification Factor is used to calculate the number of accidents occurred after implementation of safety measures at specified length of road. The CMF is calculated according to the reduction of the accidents before-and-after the implementation. The CMF's are calculated as follows:

$$CMF = 1 - CRF \quad (7)$$

Here, CRF = Crash Reduction Factor

If the CMF is greater than "1.0" then it is considered as crashes have increased, while CMF less than "1.0" indicates that crashes have increased. The values of CMF for three cases are given in Table 4. As may be seen, the CMF for the persons injured is morethan one indicating the increase in this type of crashes. However CMF for total number of accidents and total persons killed 9s a 0.16 and 0.09 respectively.

10 Conclusions

NOIDA-Greater NOIDA Expressway is an important connection between twin cities of NOIDA and Greater NOIDA in the state of Uttar Pradesh. It also provides connectivity to New Delhi. Road crashes on this expressway had been on raise and therefore Authority to take-up the work of road safety audit. The recommendations of RSA were implemented in 2013. These recommendations included replacement of concrete guard post on median by double row metal beam crash barrier, redevelopment of entry and exit points as per Indian Standards, marking and road studs on each of the traffic lanes and particularly near exit/entry points of auxiliary lanes. The Speed Enforcement Cameras and Close Circuit TV with Variable Message Signs were also implemented at every 2 km. It is observed that total number of road crashes and persons killed are steadily reducing after implementation of these recommendations.

Crash Reduction Factor (CRF) for total road crashes is computed as 0.84 which indicates that the total crashes have reduced 84 percent subsequent to implementation of RSA recommendations. At the same time, CRF for fatal road crashes or persons killed was found to be 0.91, which again implies a reduction in fatal crashes. However, CRF value for persons injured has registered a negative sign which indicates the increase in the number of persons injured. This is attributed to one major crash which occurred in 2014 injuring 12 persons involved rear end collision of truck with bus, resulting in about 12 persons. The Crash Modification Factor (CMF) was observed to vary between 9 and 16 percent. Statistical test was conducted to understand whether the reduction in CRF values is significant or not. The R values for the total number of road crashes is 34.59 % and for persons killed is 33.83% which are lower than the CRF values of respective crash types. It supports the fact that the reduction in road crashes as compared to the trend of road crashes before RSA is not significant implying that the total and fatal crashes have declined after RSA on the project corridor.

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ROAD ACCIDENT ANALYSIS: A CASE STUDY OF NATIONAL HIGHWAY NO-06 SIX LANE OPERATED BY ASHOKA DHANKUNI-KHARAGPUR TOLLWAY LTD.

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Abstract

Road accidents are considered as an unplanned and unfortunate event which is a serious concern to the community as well as the authority. An accident-counter measure can reduce the rate of road accidents by initially identifying critical locations. In India total 4,64,910 road accidents have been reported by States and Union Territories (UTs) in the calendar year 2017, claiming 1,47,913 lives and causing injuries to 4,70,975 persons as per the Ministry of Road Transport & Highways (MoRTH) published Road Accident Report 2017. In terms of accidents on road categories, the National Highways accounted for 30.4 per cent of total road accidents and 36.0 per cent of deaths in 2017. Accidents on State Highways and other roads constitute 25 per cent and 44.6 per cent respectively. In case of fatality, State Highways and other roads have accounted for 26.9 per cent and 37.1 per cent, respectively. This research aims to identify factors that may contribute to the cause of accidents such as road features, road geometry, type of vehicles, age of road users and weather condition on road accidents. In this paper, National Highway No. 06, six laning of Dhankuni (Km: 17.600) to Kharagpur (Km: 129.000) were selected as the section wise study based on variety of accidents in which each location has different road characteristics. During the study, road geometry observations are studied to evaluate influence of road designs upon road accidents. The extracted data were analyzed on different variables to evaluate the relationship between accident weightage point and other dependent variables that were considered to have considerable effects upon road accidents such as road side, nature of accident, classification of accident, causes, road feature, road furniture, road condition, intersection type and control, weather condition and type of Vehicle. After road accident data analysis, this study showed that Ashoka Dhankuni Kharagpur Tollway Limited (ADKTL) reduced the road accident by 85% and fatalities by 62% in 2019 compared to base year 2014 i.e. in last five years.

1. Introduction

Road traffic accident (RTA) is defined as “An accident that as accident which took place on the road between two or more objects; resulted in one or more persons being fatal or injured, and at least one moving vehicle was involved [1, 2]. Thus, RTA is collisions between automobiles & pedestrians; between road vehicles and animals; or between road vehicles and geographical orarchitectural obstacles. Road traffic accidents (RTAs) have turned out to be a huge worldwide public health problem causing loss of human life nearly 1.2 million people yearly and injuring about 4 times this number throughout the same period of time [3]. Almost 85% of all road accidents that have caused loss of lives in the world occurred in developing countries [4].

To top it all, the number of injuries could be as high as 50 million – a combined population of five large cities in the world[5]. In India, road accident is one of the top contributors in fatal injuries. The past ten years there is rapid development in construction of national highway and therefore the number of road users as well vehicles has increased over the period. Amidst a large volume of heterogeneous traffic on the road, accidents involving different kinds of vehicles unfortunately happened.

Many research studies that incorporated different aspects of road traffic accidents have been performed by various road engineers at different durations across the world. According to the official statistic of Ministry of Road Transport & Highway (MoRTH) in 2017, over-speeding contributes to 70.4% of total accidents and 66.7% of total fatalities. This case study is conducted to investigate and refresh the issues that cause traffic road accidents on NH-06 from Dhankuni to Kharagpur stretch. This study will also be concentrating on the relationships between road side, nature of accident, classification of accident, causes, road feature, road condition, intersection type and control, weather condition and type of vehicle which needs treatments as well as a ranking on the black spot locations along the stretch.

1. Analysis of Accident Data

The data for this research were collected from Traffic Police Station and ADKTL'S incidence Management

Team. The accident records were collected from the year 2014 to 2019 (5 Years). The purpose of the preliminary analysis of the traffic accident data is to determine the nature of accident problem.

At this stage, the general trends and statistics of accidents were established as shown in the Figure 1.

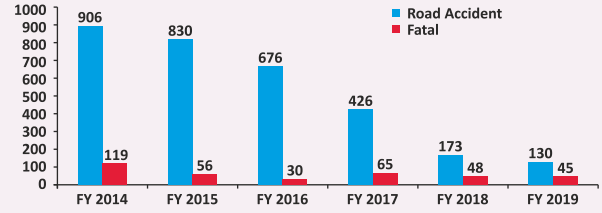


Figure 1:Road accident frequency at NH-06, ADKTL Section total 112 km.

The total number of road accidents occurred along ADKTL stretch between Year 2013-14 toYear 2018-19 i.e. last six years was summed tototal 3060 road accident cases.

Year	Year 2013-14	Year 2014-15	Year 2015-16	Year 2016-17	Year 2017-18	Year 2018-19
Accidents	906	830	676	426	173	130
% of reduction	100%	92%	75%	47%	19%	14%

Table: 1 A: Comparative chart of road accident cases.

The total number of fatalities in road accident occurred along ADKTL stretch between Year 2013-14 to Year 2018-2019 i.e. last six years was summed to total 363 road fatalities cases.

Year	Year 2013-14	Year 2014-15	Year 2015-16	Year 2016-17	Year 2017-18	Year 2018-19
Fatal Count	119	56	30	65	48	45
% of reduction	100%	47%	25%	55%	40%	38%

Table: 1 B: Comparative chart of Road fatalities.

Figure 1 shows the highest number observed was in year 2013-14 with 906 cases with 119 deceased road users, followed by the year 2014-15 and year 2015-16 with 830 and 676 accident cases respectively. The lowest number of accidents is in the year 2018 - 19 with 130 cases with a total of 45 persons lost their lives. Year 2013 -14 recorded the highest number of fatalities of road users i.e. 119, the second highest is in the year 2016-17 and 2015-16 with 65 and 56 fatalities of road users respectively. It could be concluded from the graph that there was decrease in the number of road accidents.

NH-06 Road accident yearly comparative chart showing on severity count such as fatal, serious and minor injuries is as below:

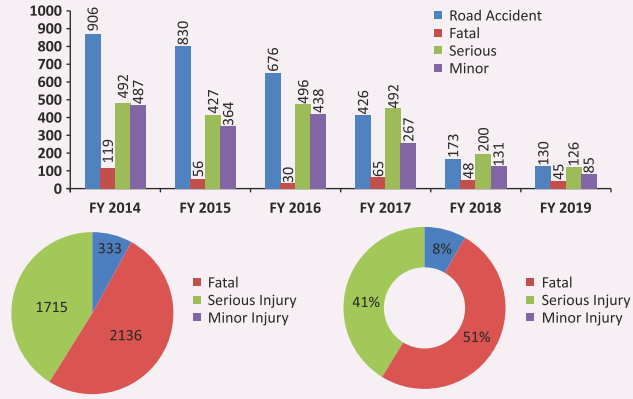


Figure 2: Analysis of type of injuries and its frequency at ADKTL -NH-16 during year 2013-14 to year 2018-19

As per Figure 2, accidents that have caused serious injuries accounts for 51%, while those that have caused fatalities and non-serious injuries accounts for8% and 41% respectively.

We have studied, road accidents for last two years on causes of accidents, duration of accident, geometry of road, nature of road and weather conditions.

1.1 Percentage of road accidents according to cause of the accident

Road Accident are analyzed for cause of accidents and factor considered are 1- Drunken, 2- Over speeding, 3- Vehicle out of control, 4- Fault of driver of motor vehicle / Driver of other vehicle / cyclist / pedestrian / passenger and 5 - Defect in mechanical condition of motor vehicle / Road condition

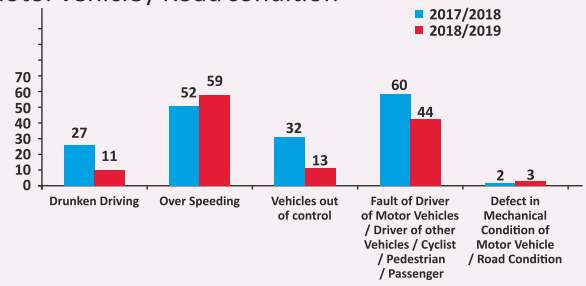


Figure 3: Numbers of accidents and its cause at ADKTL - NH-16 during year 2017-18 and year 2018-19

Figure 4: Causes of accidents at ADKTL -NH-16 during year 2017-18 and year 2018-19



Figure 4 shows the percentage of road accidents during year 2018 &year 2019 according to causes of the accidents. Most accidents i.e. 37% are due to over speeding; that equals to 111 cases followed by fault of driver of motor vehicle, driver of other vehicle including accidents of cyclist, pedestrian and

passengers which accounts for 34 % of the total number of accidents; that equals to 104 cases.

1.2 Road accidents frequency according to the nature of accident

During year 2017-18&year 2018-19trend of nature of accident shows rear end collision contributes to 48% that equals to 144 cases. Generally, due to over speeding and vehicle out of control leads to rear end collisions and also cause of most number of fatal and serious injuries.

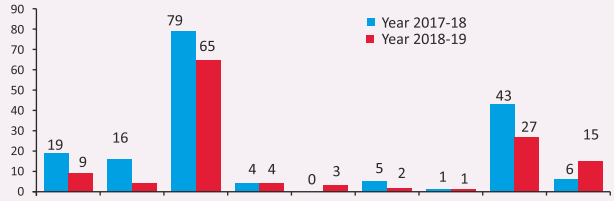


Figure 5: Road accident statistics for nature of accident

1.3 Road Accidents Analysis in relation with day time and night time

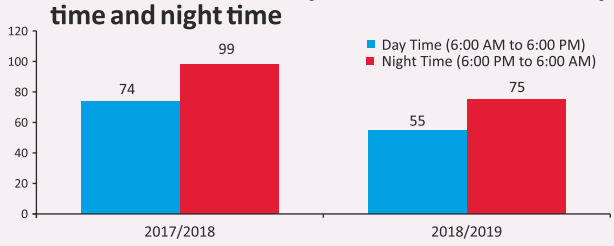


Figure 7: Road accident statistics for respect to timing of accident

1.4 Road Accidents Analysis in relation with road conditions

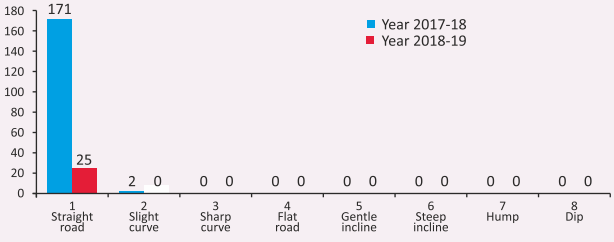
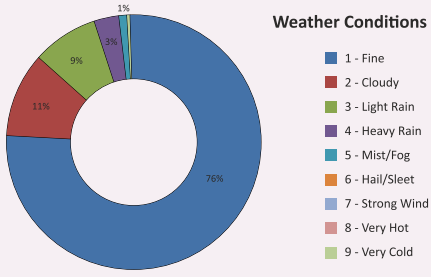


Figure 8: Road accident statistics for respect to road conditions



1.5 Road Accidents Analysis in relation with weather conditions

Figure 9: Road accident statistics for respect to weather conditions

1.6 Road Accidents Analysis in relation with No's of vehicle travelled Per Count Unit (PCU)

PCU	3143 3461	3150 2324	3439 0551	3746 1297	3793 0407	3904 2873
Total accident /10,0000 PCU	0.29	0.26	0.20	0.11	0.05	0.03
Fatality /10,0000 PCU	0.04	0.02	0.01	0.02	0.01	0.01

During the year 2018 - 19 lowest accident per 10,000 PCU which equals to 0.01 are observed in last five years and highest is recorded in 2014 which is equal to 0.29.

Table 2: Road Accidents Analysis in relation with No's of vehicle travelled Per Count Unit (PCU)

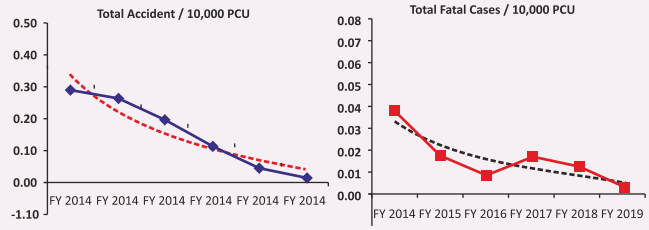


Figure 10: Analysis of road accidents and fatal cases as per PCU for Year 2013-14 to year 2018-19.

1.7 Ranking of the Black spot

Table 1 represent ten black spot sections at ADKTL calculated as per the MoRTH guidelines. The identification of black spot is on the basis of last 03 years data i.e. from year 2015-16 to year 2018-19 was based on the data compiled over five years starting from 2014 to 2018 as per notification of Ministry of Road Transport and Highway. Definition of road accident black spot on national highways as per MoRTH Circular no: RW/NH/15017/109/2015/P&M (RSCE) dated 28.10.2015 is road accident black spot is a stretch of national highway of about 500 m in length in which either 5 road accidents (in all three years put together involving fatalities / grievous injuries) took place during last 3 calendar years or 10 fatalities (in all three years put together) took place during the last 3 calendar years as per

Combined Three Calendar Years (2016-2018)							
Sr. No.	Chainage No. from	Chainage no. To	Accident	Fatal	Grievous	Minor	Non-Injured
1	33+600	34+100	24	2	25	7	0
2	37+600	38+100	22	4	17	7	0
3	36+600	37+100	21	4	19	43	0
4	34+100	34+600	19	2	16	9	0
5	30+100	30+600	20	6	15	2	0
6	35+100	35+600	20	3	17	10	0
7	34+600	35+100	17	2	12	8	0
8	36+100	36+600	17	2	17	10	0
9	28+600	29+100	14	1	16	7	0
10	26+100	26+600	13	3	12	6	0

Black Spot details				Calendar Year								
				January to December, 2016			January to December, 2017			January to December, 2018		
Sl. No.	Code	Black Spots	Location	Accident	Fatal	Grievous	Accident	Fatal	Grievous	Accident	Fatal	Grievous
1 & 2	ID-WB-014 & 015	27+000 to 28+000	Ankurhati	13	0	8	4	3	2	3	3	0
3	ID-WB-013	34+800 to 35+200	Dhulagarh	15	2	11	3	1	2	4	0	4
4	ID-WB-028	76+000 to 79+000	Deulia	1	0	3	0	0	0	1	0	1
5	ID-WB-026	117+200 to 117+750	Basantpur	3	0	4	1	0	1	2	0	2
Total				**32**	**2**	**26**	**8**	**4**	**5**	**10**	**3**	**7**

Table 4: Comparison of Black Spot locations identified by NHAI on ADKTL stretch

During the black spot analysis on site, factors considered for the cause of accident are identified and corrective measures as suggested. Site observations found during black spot investigation mainly include unauthorized median openings, missing of road furniture like of warning signs, absence of speed reduction devices like rumble strips at required locations, uncontrolled and sudden pedestrian crossings, blind spots, issue of night visibility etc.

2 Road Accident reduction best practices implemented

ADKTL maintenance team is actively working on the road accident reduction strategies and also focused on preventive measures which need to be taken to avoid any type of road mishaps. The efforts taken by the team is result into reduction of 85% of road accidents in 2019 compare to year 2014.

Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Accidents	906	830	676	426	173	130
%	100%	92%	75%	47%	19%	14%

Table 5: Comparative chart of accident and frequency of reduction

Initiatives Adopted to reduce the Road Accident

ADKTL project team has taken following initiatives for reduce the accident in last 5 years and every year they are monitoring the effectiveness of these initiatives

Control Mechanism	Initiatives adopted at Site
Engineering	1) Rambler Strip with markings 2) Cat—eyes at Curves 3) Installation of Solar blinkers 4) Foot Over Bridge (FOB) 5) Better Highway lighting for Night Visibility 6) Work zone safety measures while Working on Road
Enforce-ment	1)Closing of Unauthorized Median Opening 2)Removal of Encroachment and Unauthorized Parking 3)Removal of Hoardings 4)Zigzag
Engineering	1) Internal Monitoring & Review on Pot Hole, Road Furniture and Signage 2) Advance Warning Boards & Awareness posters for Black Spot 3) Black Spot Identification and Investigation 4) Compulsory trainings by Incident Management teams to local truck drivers 5) Major Incident controlled by Incident Management team 6) Road

1) Online Accident Reporting and Analysis Software by Ashoka Highway Research Center

Ashoka Highway Research Center has prepared software for Road Accident Investigation on eleven parameters as per the guidelines of IRC: 53-2012. ADKTL team reporting every incident on Online Accident Reporting and Analysis Software where all the required detailing of incident is get captured in the software which further help to analyze the data as per the cause road accident.




1) Rumble Strip with markings and cat-eyes

The identified locations for cause of accident due to the over speeding are provided with the rumble strips to reduce the speed of the vehicle and control the road accidents. In the year 2018-19, total of 37 locations are provided with Rumble strips with clear markings and cat-eyes



1) Advance Warning Boards and Road safety awareness posters



The black spots are provided with clear warning sign before the location in advance to alert the road users about the accident locations on the road. This advance sign boards are provided to all the locations. In year

2018-2019, total of 83 nos. of sign boards and 215 awareness posters are provided in the stretch.

4) Provision of Foot Over Bridge (FOB)

NHAI, Independent Engineer Aravee Associates and ADKTL management has constructed two FOB at the congestion area and Accident black spot locations which are At Ch. 26+300 and Ch. 49+500 with help to reduce the accidents of pedestrians.







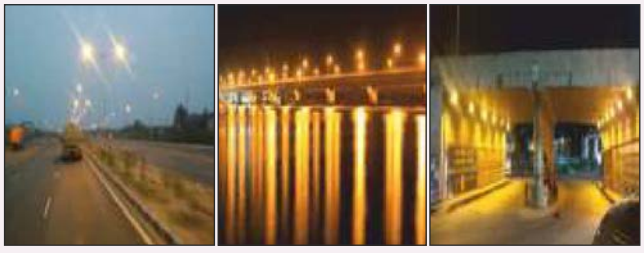
5) Installation of Solar blinkers

Solar blinkers are provided at 85 locations on major junctions and identified black spot to alert the road users in advance. The solar blinkers alert visually to the road users and instruct them to control the speed of vehicles



6) Better Highway lighting for Night Visibility at Vehicular Under Pass & bridges

Lights are provided at underpass area which helps the road users and pedestrians to use the road.



7) Black Spot Identification and Investigation

ADKTL team carried out black spot identification and investigation study on regular period and took the corrective measures as per the causes identified during the investigation. Investigation study helps to identify the main root causes of accident and suggest corrective measures in terms of geometry, road furniture, warning signs etc.



8) Internal Monitoring & Review on Pot Hole, Road Furniture and Signage

ADKTL has formed internal team for identify and rectify the potholes on highways. Incident management team is taking daily observation road to check any potholes and immediately informed to road maintenance team for rectification. During year 2018-19, team has repaired total 1793 nos. of potholes



9) Closing of Unauthorized Median Opening

The unauthorized openings identified during the round and found responsible for any road accident is immediately get closed by maintenance team on

priority basis. In year 2018-19, team has closed total 54 nos. of unauthorized median closings.




10) Removal of Encroachment and Unauthorized Parking

Due to road side encroachments and unauthorized parking, road users face difficulties in using the road and it may lead to road accidents. Incident management team is actively involved in removal of encroachments and parking on road sides during the daily rounds.





11) Removal of Hoardings

Road side and Median Hoardings are distracting the driver's behavior & creating obstruction in the vision of road users hence as and when found on the stretch by the incident management team removing. This is routine activity and closely monitored by the IMT and maintenance teams. In year 2018-19 there 78 numbers of big hoardings removed.




12) Zigzag Barricading at Junctions

Zigzag barricading provided near to approach road of junctions which help to reduce the speed of the vehicle and alert the road users about the pedestrians crossing the roads. In year 2018-19, total 09 nos. of junction locations are provided with police zig zag barricading. This initiative carried out in collaboration with City Traffic Police Department.





13) Compulsory Trainings by Incident Management teams to Local Truck Drivers at Dhabas and Truck Terminals

On Regular basis, Compulsory trainings are provided to Local Truck Drivers at Dhabasabout the traffic rules & regulations and road safety awareness. In this campaign, drivers are educated with audio -video aid about the understanding of Road Safety rules and regulations. In the year 2018-19 such trainings are conducted at 15 locations and around 700 drivers are educated about the road safety.




14) Road Safety Awareness Trainings to Schools & Colleges in Nearby Areas

Road Safety awareness trainings are provided to nearby schools and colleges on Road safety by the site team along with incident management team. During the awareness training campaign, school children are educated on Road crossings rules and road safety signs. In the year 2018-19, Around 76 schools are covered where more than 6,000 students are educated on road safety.




Summary of key road maintenance activities carried out by ADKTL is summarized below:

Nos.	Description	2017-18	2018-19
1	Pot holes repaired	1272	1793
2	Solar Blinkers installed at required junctions	60	85
3	Cat eyes installed	2000	3200
4	Hazard markers installed	142	96
5	Median Opening closed	39	54
6	Police Zig Zag barricades provided	5	9
7	Safety signboard damaged and replaced	39	83
8	Awareness Posters displayed	180	215
9	10 strip lines with thermoplastic paint	22	37
10	Speed Breakers on service road	10	15

15) Major Incident controlled by Incident Management team

A leaked LPG bulker was handled by the ADKTL patrolling team by evacuating around 2500 people in the area which may have blast if not properly handled. The team alerted the area for the possible hazard and announced the precautionary measures which helped to successfully controlled the impact and save the national loss.

Description	Impact	Photographs
On NH-06, Near RanihatiArea & Major Junction area. INDANE LPG Bulk carrier started leakage of LPG from rear flange nut & bolt area. Which was observed by ADKTL's Patrolling Team members	Bulker may blast which would have impact on Approx. 2500 Community staying near Accident spot and National Loss	
Team ADKTL spread awareness to all local public from CH 17.600 to 73.000 through IMT team before Cyclone Fani makes a landfall	It was a very severe cyclonic storm, Eastern Costal area of India like Digha in West Bengal and specially Odisha wreaks havoc. Then also through this awareness we help many people to move in safe place with their pet animals	
Training provided to West Bengal Howrah Rural Civic Police on Traffic Rules & Regulations	Through This training we tried to safe many people life in Road Accident; due to improper way of giving traffic hand signals to the moving vehicles those who are in speed by the Volunteers. Accordingly proper awareness on Traffic Signals and its rules has been provided through training	
Eviction of Encroachment	Removed Unauthorized Occupation in Government Lands of an around 16 acres.	
BLS Training provided to all staff with the Help of Sanjiban Hospital	Through this training we tried to aware that the people who know basic life support have the skills to take action no matter where they are or when it is	

Appreciation letter to ADKTL Team from Superintendent of Police (Howrah District)



भारतीय राष्ट्रीय राजमार्ग प्राधिकरण
(सड़क परिवहन और राजमार्ग मंत्रालय, भारत सरकार)
National Highways Authority of India
(Ministry of Road Transport and Highways, Govt. of India)

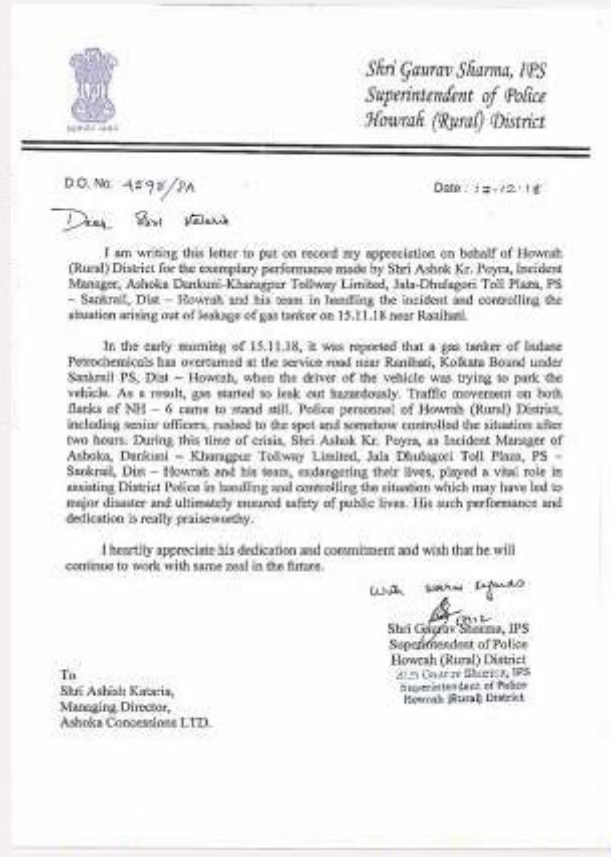
Office of the Project Director
Project Implementation Unit, Kolkata
NHAI Campus, Near Joypur Bill
NH - 6, Bally, Howrah - 711 205

TO WHOM IT MAY CONCERN

GM (Tech) & Project Director

Copy for information to:
1. Shri Apurba Kr Chatterjee, Sr GM, M/s. ADKTL, Ankuhali, Howrah.
2. The Team Leader, M/s. Aarvee Associates, IE, Howrah.

Appreciation letter to ADKTL Team from Superintendent of Police (Howrah District)



Shri Gaurav Sharma, IPS
Superintendent of Police
Howrah (Rural) District

D.O. No: 4598/PA

I am writing this letter to put on record my appreciation on behalf of Howrah (Rural) District for the exemplary performance made by Shri Ashok Kr. Poyra, Incident Manager, Ashoka Dankuni-Kharagpur Tollway Limited, Jala-Dhulagori Toll Plaza, PS – Sankrail, Dist – Howrah and his team in handling the incident and controlling the situation arising out of leakage of gas tanker on 15.11.18 near Ranihati.

In the early morning of 15.11.18, it was reported that a gas tanker of Indane Petrochemicals has overturned at the service road near Ranihati, Kolkata Bound under Sankrail PS, Dist – Howrah, when the driver of the vehicle was trying to park the vehicle. As a result, gas started to leak out hazardously. Traffic movement on both flanks of NH – 6 came to stand still. Police personnel of Howrah (Rural) District, including senior officers, rushed to the spot and somehow controlled the situation after two hours. During this time of crisis, Shri Ashok Kr. Poyra, as Incident Manager of Ashoka, Dankuni – Kharagpur Tollway Limited, Jala Dhulagori Toll Plaza, PS – Sankrail, Dist – Howrah and his team, endangering their lives, played a vital role in assisting District Police in handling and controlling the situation which may have led to major disaster and ultimately ensured safety of public lives. His such performance and dedication is really praiseworthy.

I heartily appreciate his dedication and commitment and wish that he will continue to work with same zeal in the future.

Shri Gaurav Sharma, IPS
Superintendent of Police
Howrah (Rural) District

To
Shri Ashish Kataria,
Managing Director,
Ashoka Concessions LTD.

16) Work zone safety measures while Working on Road

During road maintenance work, safety measures are taken for safety of workers working on road and the performance are monitored. Work zone barricading includes advance warning signs, zig zag barricading, buffer zone, transition zone, fully fenced work zone and termination zone.











During road maintenance work, best safety measures are taken for safety of workers working on road and the performance are monitored as follows:

Nos.	Description	2017-18	2018-19
1	Daily Tool Box Talks	1526	2419
2	Road Permit To Work	941	750
3	Identify Immediate Danger to life and Health (IDLH)	131	168
4	No of HSE Training	499	279
5	No of Training Participants	1639	2918
6	Memo raised against HSE violations	56	68

Road Work Barricaing Permit (PTW) and Tool Box talks (TBT) implemented at site for operation and maitenance activities before the state of the work.






17) Environment Protection through 4R Policy

ADKTL Team has implemented 4R Policy during the construction activities which avoid the depletion of natural resources and save the environment. 4R Policy includes Reduce, Reclaim, Recycle and Reuse of natural resources.



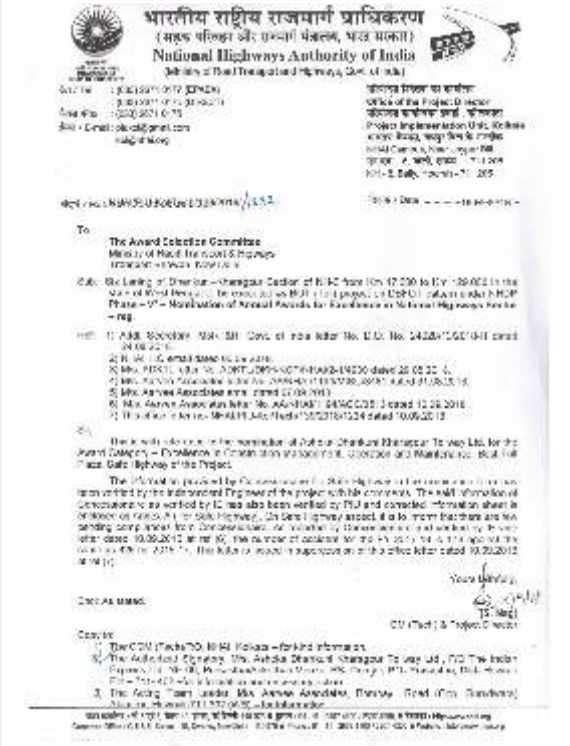
During the construction activity, preference is always given to reduction of resource through 4R policy, use of technology and without compromising the quality of the work. Milling material reclaimed from old road is again recycled in HMP and reused in BC laying work




Use of fly ash for the road construction activity not only helps to control the soil pollution but also preserve the natural resource by replacing it with waste material.

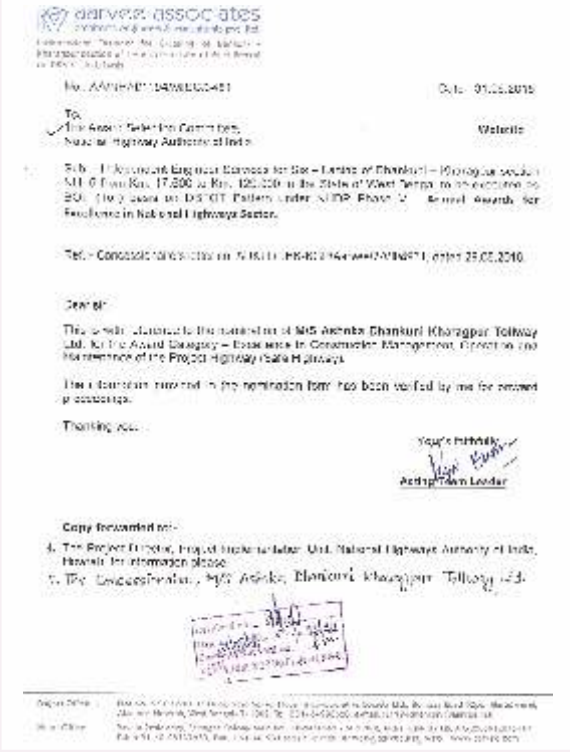
During the mining activity, it is ensure that the material get reuse and avoid the excessive mining of resources

Appreciation letter from NHAI



भारतीय राष्ट्रीय राजमार्ग प्राधिकरण
(सड़क परिवहन और राजमार्ग मंत्रालय, भारत सरकार)
National Highways Authority of India

Appreciation letter from Consultant for nomination of annual awards



darvesh associates

Guinness World Record registered for
Largest Road Safety Lesson



Conclusions

This study found successful in achieving its aim to study the cause of accidents and effectiveness of black spot investigation. This research has established a relationship between road accidents with road features and nature of collision along selected stretch of ADKTL.

Further, the variable factors taken for analysis of road accidents during last two years have help to identify major contributing factor and their frequencies. Major contributory factors includes over speeding of vehicles, fault of drivers/ other vehicle driver/pedestrians/ passengers in cause of accidents, rear end collisions in type of accident and night time accidents in duration of accident etc.

Key Highlights

1. At Ch. 26+300 and Ch. 49+500 Foot over Bridge. it has been recorded that there 27% Reduction in Accident and 16 % in fatalities
2. O&M Work Safety i.e Road Work Zone Methodologies & Measures taken during road work there is reduction of 72 % in near miss cases

and 41 % Incident cases of Ashoka Operation and Maintenance division.

3. Light Maintenance at Underpass, Parking area and Junction reduce the 24 % Road Accidents
4. Rumble Strips & Police barricading provided at each intersection results the reduction of 13 % of Road Accidents
5. Road Safety Awareness program for road users and drivers at truck terminals and junctions
   - 5.1) Drunken drive cases reduced by 59 % of road accident
   - 5.2) Fault of driver of vehicle/ driver of other vehicle/ cyclist/ pedestrian/ passenger cases are reduced by 26 % of road accident.
6. Over speeding accidents are increased by 12 % as comparative to last year 2017-18. ADKTL Management has donated the speed Guns in year-2016-17 as well as requested to traffic police to monitor and penalize the Violator. So Accident due to the Over-speeding will reduce.

In this study, it is also found that ADKTL site management has significantly manage to reduce the road accident during the last 05 years through corrective measures taken on cause of road accident like black spot investigations, police zig zag barricading, speed breakers at junctions, advance alert sign boards at accident prone areas, awareness campaigns for drivers and nearby schools, safe work zone practices for working on road and on-time maintenance activities.

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Figure 8: Road accident statistics for respect to road conditions

Figure 9: Road accident statistics for respect to weather conditions

Figure 10: Analysis of road accidents and fatal cases as per PCU for year 2013-14 to year 2018-19.

* * *



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TRANSPORT PLANNING BASED ROAD ACCIDENT PREVENTION STRATEGIES AND POLICY IMPERATIVES IN URBAN AREAS

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Abstract

Rapid urbanization in developing countries presents tremendous challenges to the transport systems of expanding cities if they are to meet the access and mobility needs of their communities and provide them with a sustainable, safe and healthy environment. To meet this expansion many developing world cities are increasing the capacity of their road networks, but often at the expense of the safety of the vulnerable road users. As a result many people die and are injured unnecessarily in road crashes, with the consequently social, economic and health burdens imposing heavy constraints on sustainable development. The present paper highlights the road accident scenario at the country and city level in India and discusses road safety environment in various contextual situations .The paper highlights various issues and possible road accident prevention safety strategies based on transport planning .

1. Introduction

In most developing countries including India the urban sector accounts for at least 50 percent of the gross national product GNP); in some countries that number is over 70 percent. Cities in developing countries often devote 15 to 25 percent, and sometimes much more, of their annual expenditures to their transport systems. About one-third of all city infrastructure investment needs is for the transport sector. It is estimated that urban population in developing countries will grow at more than 6% per annum and that within a generation, more than a half of the developing world of the developing world's population will live in cities. To meet this expansion many developing world cities are increasing the capacity of their road networks, but often at the expense of the safety of the vulnerable road users. As a result many people die and are injured unnecessarily in road crashes, with the consequently social, economic and health burdens imposing heavy constraints on sustainable development. Road accidents are serious problem, an important cause of death and injury and a considerable waste of scarce resources. Road safety is an issue of immense human importance. It is an issue of economic and social proportions and very much affects poor people. The role of local authorities in reducing road accidents is crucial.

Road accident is an outcome of various factors and their interplay such as land use, road network, vehicular population, population of the respective area and adherence or enforcement of road safety regulations etc. Road accident causes injuries, fatalities, disabilities and hospitalization with severe socio-economic costs across the country. Consequently, road safety has become an issue of concern both at national and international level. It is estimated that one million people were killed and over 20 million people were injured in road accidents every year. Over 75 per cent of these casualties occur in developing and transition countries. As per WHO (2004), the number of fatalities per 1,00,000 population in the developing world is expected to grow from 13.3 in 2000 to 19.0 in 2020. For the countries in development and transition stage, their share of this economic loss is estimated to be close to 2% of GDP, nearly US$ 100 billion. The United Nations has rightly proclaimed 2011-20 as the Decade of Action on Road Safety. India is also signatory to Brasilia Declaration and is committed to reduce the number of road accidents and fatalities by 50 per cent by 2020 (Ministry of Road transport & Highways 2015). A study by the Planning Commission in India in 2002 estimated the social cost of road accidents in India at Rs.55,000 crore annually (2000 prices), which constitutes about 3 per cent of the GDP

2. Road Safety Scenario in India

Road traffic accidents constitute 32 per cent of all accidental deaths in India, out of 1.25 million deaths worldwide every year, 8-10 per cent of all road deaths are in India. The total number of accidents in the country has increased from 1,14,100 in 1970 to 4,64,910 in 2017 and the number of fatal accidents has gone up from 14500 in 1970 to 1,47,913 in 2017. Around 15% of the total road traffic fatalities in the country occur in the metropolitan cities in which the two wheelers accounts for nearly 70% of the vehicle population accounts for a share of 20-30% in the road fatalities.

During 2016, a total of 4,80,652road accidents were reported by all States/Union Territories. Of which 1,36,071 were fatal accidents while the number of persons killed in road accidents were 1,46,133. The NHs while constitute 2% of total road network accounted for 29.6 % of total road accidents & 34.5% of total number of persons killed. The SHs accounted for 25.3 % of total accidents and 27.9% of the total number of persons killed in road accident. The major cause of road accident and fatalities is over speeding which accounts for 66.5 per cent (3,33,446) and 61 per cent (89,141) respectively. Other cause of accidents is like head on collision (20.1 per cent), overloaded vehicle (12.8 per cent), hit & run cases (11.6 per cent), overtaking (7.3 per cent), alcohol & drugs (3.7 per cent) and mobile phone accounts for 1 per cent of total accident happened. Other than the above mentioned reasons for accidents, bad road condition is also the major cause of accident.

In context of urban areas, it is observed that, 50 Million-Plus Cities accounted for 18.7 per cent in total road accidents 11.8 per cent in total persons killed in road accidents and 16.7 per cent in total persons injured in road accidents respectively. With the rising purchasing power of average Indians, motorized vehicle ownership is growing at a fast pace and, in some cities, vehicle ownership has reached a level comparable to that of the developed countries. The poor and inadequate public transport services in cities, particularly the non-metropolitan cities, have compelled many residents to use private modes more often than should have been necessary. As a result, the use of private modes is very high resulting in need for increasing capacity of road networks, but often at the expense of the safety of the vulnerable road users

Vulnerable Road Users (pedestrians, bicyclists, and motorized two-wheeler riders) accounted for 34.8% Two-wheelers, 10.5% Pedestrian and 1.7% Bicycles total 47% respectively who were killed in 2016. Pedestrians are vulnerable road users (VRUs) comprise a significant proportion in the overall road fatalities. The major cause behind this the poor safety along arterial roads due to higher speeds achievable, poor enforcement and inadequate facilities for non - motorized modes and pedestrian movement on these roads. Nearly 70% of the subways in Delhi lacked in terms of access signages and about 40 percent were not clean and had inadequate lighting levels (SPA,2007). As per Wilbur Smith Report (2008), there is significant number of trips in Indian cities made by foot i.e., 16-58 per cent, whereas the basic requirement to promote walkability, the pedestrian infrastructure, amenities and services are neglected and not given adequate focus.

3. Challenges in Road Safety Environment

The high speed roads in urban areas create conflict between functions & hierarchy, which needs to be resolved, over speeding facilitated by improved road conditions and better vehicle technology on one hand and poor enforcement and traffic management practices on the other. Poor road signages, markings and illumination levels are major contributory factor for the deteriorating safety environment. The road system and the traffic operations in Indian cities are deficient in road safety management. Weak institutional arrangements, non-availability of good quality authentic data bases and poor financial resources are impediments in achieving improved road safety.

There are various challenges faced by pedestrian which discourages their movement and causing fatal accidents (Gupta, 2016)

- Crowded footpaths: In too narrow streets footways crowding conditions appear and deteriorate the walking experience substantially and exclude certain user groups.
- Poorly maintained footways: Lack of maintenance results in broken pavements, lack of street lights etc.
- Unclear pedestrian network: Only few significant walking routes and the connections between them are poor.
- Parking on footways: Footways are frequently used for parking often forcing pedestrians onto the road.
- Difficult crossings: Compromises have been made in the pedestrian landscapes To increase capacity for the congested vehicular traffic.
- Lack of public seating: It is essential that ample opportunities to sit and rest provided.

A number of issues emerge out of the existing road safety scenario in the country. Some of the prominent issues relevant are-

i. Incomplete and inaccurate accident information.
ii. Absence of data on travel patterns of road user.

iii. Non-involvement of police organization in accident data collection and its updation.

iv. Absence of coordination amongst various organizations responsible in some ways to road safety such as traffic police, PWD, MORTH, NGO's etc.

v. Safety not considered as an important responsibilities of road authorities unlike developed countries.

vi. Weak institutional arrangements for issues related to traffic safety at city level.

vii. Lack of awareness of traffic regulations and attitudes towards road safety.

viii. Lack of adequate trauma care/hospitals for accident victims.

ix. Lack of focused education on road safety in academic institutions.

x. There is also a general public apathy and resistance towards issue of road safety.

xi. Road safety as a sector is highly fragmented with responsibilities diffuse amongst consisting sub-sectors.

xii. Lack of institutions capacity and adequately trained staff for managing road and safety problems.

xiii. Inadequate funding or resources to initiate programs for improving road safety.

xiv. Road safety is highly dependent on centralized administration.

4. Contributing Components of Traffic Accidents

Hughes et al. [11] provide the following traffic accidents contributing components and factors that must be managed and coordinated by a Safety Management System:

i. Human (driver/pedestrian/passenger)

- Compliance to traffic rules (overtaking, speeding, etc.), Impairment (drugs, alcohol, etc.), Abilities and capabilities (license, vision, etc.), Attitude and attention (emotion, phone distraction, etc.), Helmets and protection clothing utilization, Seatbelt utilisation.

ii. Vehicle(s)

- Maintenance, inspections, damage, Condition of wheels and tires, Condition of brakes, Condition of steering, pedals, levers, lights and suspension, Design standards, Overloading.

iii. Road infrastructure

- Surface (friction, shoulders, potholes, etc.), Geometry (gradient, lanes, no shoulder, curves, etc.), Poor maintenance, Traffic volumes , Inadequate signs, reflectors, signal, lighting, etc., Obstacles (intersection type, crosswalk, island, etc.), Poor road system (entry and exist of vehicles).

iv. Transport and land use

- Transport alternatives, other modes, Spatial arrangement, co-location, Accessibility - remoteness, location, service levels, Transport integration.

v. Environmental

- Weather (fog, rain, etc.) , Smoke .

vi. Socio-economic circumstance

- Economics (finance, funding), Employment structure ,Population growth , Politics and government, Social norms and background , Travel purposes and activities , Legal (regulation, liability, insurance).

5. Transport Planning based approaches for Accident Reduction

The importance of an efficient and effective transport system to support and promote rationale development of urban areas need hardly be stressed. Urban mobility in India in recent decades has witnessed dominance of motorization and particularly private motor vehicles as the preferred means of mobility. Cars and two wheelers make up to 85% of vehicles on Indian roads, but account for only 29% of the trips . Meteoric increase in the number of motor vehicle population demonstrate a skewed distribution of mobility and consequentially access possibilities. The average distance travelled per vehicle is also increasing as a consequence of urban sprawl . This growth exceeds the ability to increase road space, and the major impediment to the efficient working of the urban economies in large-size cities, and particularly in mega cities, is the level of road traffic congestion. Travel speeds are decreasing and the travel environment for pedestrians and people-powered vehicles is deteriorating. The dependence of private vehicle usage for their increased travel requirements has resulted in number of negative externalities such as traffic congestion, air pollution, accidents, etc. which are threatening the economic well being of urban centers.

In order to prevent accidents happening in the our areas it is imperative that besides adopting the

conventional approaches of 3E's , namely engineering, enforcement and education measures in accident prevention it is also equally important to adopt transport planning based measures to promote safe mobility environment in urban areas. Some of the salient such measures include :

i. Adopt integrated land use transport planning approach: Compact development and limiting urban sprawl with focus on high degree of self - containment will enable shorter travel distance of commute in urban areas thereby minimizing exposure levels to unsafe mobility environment.

ii. Provide priority to people than vehicles in planning decisions: As also reiterated in the National Urban Transport Policy (2006) of India it is important to give priority to movement of people which can be facilitated through community transport modes rather than personalized vehicles. There is a need to promote shared mobility services in urban areas through facilitative measures and policies which not only benefit the users but also the service providers for sustainable operations.

iii. Encourage more public transport operation across cities: It is globally known that efficient public transport operations can not only result in socially and environmentally sustainable mobility environment but can also result in higher safety due to decrease in personalized modes and thereby conflict situations owing to heterogeneity and erratic driving behavior of personalized vehicles. Efforts need to made to promote multi-modal public transport through seamless interchange facilities at terminals as well as last mile connectivity

iv. Adopt Avoid-Shift-Improve (ASI) approach in traffic management: It is now being recognized as a global norm to adopt ASI approach. While land use transport planning, ICT etc. could avoid unnecessary travel, the shift of modes from motorized to mass transit and NMT through demand management measures can facilitate reduced personalized movement. Proper inspection and operation along with improved vehicular technology could result safer mobility conditions.

v. Ensure segregated operations of NMT and motorized modes: It is imperative that the motorized and NMT traffic is segregated on urban corridors to minimize conflict situations between the two. In this regard special emphasis needs to laid on developing tracks/operational areas for bicycle users, public bike sharing users or hired NMT modes for promotion of road safety.

vi. Adopt Mobility Management approaches: Mobility Management (also called Transportation Demand Management) consists of policies and programs that result in more efficient travel behavior, including changes in trip mode, destination, route and time. Mobility management can provide multiple economic, social and environmental benefits including potential enhanced safety. Some of these approaches include parking management, car pooling, land use management, TOD, congestion pricing etc. These approaches are more economical to adopt than conventional supply based approaches and often use ITS to optimize travel opportunities and transport network productivity.

In addition to the above transport planning measures it is equally important to adopt various Traffic Calming Strategies particularly at neighborhood level. These are as under:

i. Raised crossing: this crosswalk serves as traffic calming measure by extending the sidewalk across the road and bringing motor vehicles to the pedestrian level. Raised crossing also improve accessibility by allowing a pedestrian to cross at nearly a constant grade without the need for a kerb ramp and makes the pedestrian more visible.

ii. Pedestrian crossing/ refuge islands: the provision of pedestrian refuges and traffic islands is a useful traffic management technique on pedestrian routes near junctions or roundabouts enabling the pedestrian to deal with one lane particular direction of traffic at a time. Pedestrian refuges are, an effective way to help disabled and elderly pedestrian.

iii. Guard rails/ pedestrian barriers: guard rails in the vicinity of zebra crossing should ne of sufficient length to deter pedestrian from crossing the road at any arbitrary point along the road. Night time visibility of zebra crossing is of vital importance and this can be achieved through proper lighting of the intersection area.

iv. Barrier kerb footpaths: Barrier kerbs are steep-faced and are designed to prevent vehicle

encroachment on the roadside. Their main functions are-

- To discourage vehicles from using areas outside the travelled way, not intended for vehicular travel; control drainage; control parking of vehicles; and educe the risk to pedestrians

v. Bollards: often used to stop vehicles from entering the footpath and to keep pedestrian away from vehicular traffic. Unless positioned carefully, they can form a barrier to wheelchair users and are a particular hazard for persons with visual impairments.

vi. Raised intersections: create a safe, slow-speed crossing and public space at minor intersections. Similar to speed humps and other vertical speed control elements, they reinforce slow speeds and encourage motorists to yield to pedestrians at the crosswalk.

vii. Chicanes: offset curb extensions on residential or low volume downtown streets create a chicane effect that slows traffic speeds considerably. It increase the amount of public space available on a corridor and can be activated using benches, bicycle parking, and other amenities.

viii. Speed cushions: they are either speed humps or speed tables that include wheel cutouts to allow large vehicles to pass unaffected, while reducing passenger car speeds. They can be offset to allow unimpeded passage by emergency vehicles and are typically used on key emergency response routes.

6. Policy Imperatives for Improved Road Safety Environment

A road safety management strategy needs to developed which focuses on reducing the number and severity of road crashes within the context of the development and transport goals of the local authority. There is a need to formulate a Comprehensive Road Safety Policy which integrates all elements of the proposed urban safety management strategies as building blocks of the policy.

Some of the suggested strategies to improve the safety environment in urban areas in general and along urban arterials in particular would be :

1. The development of speed management strategy is a common strand of road safety policy in cities with high motorization rates. There is a need to evolve effective speed management strategies in urban areas on priority. Speed zones in different parts of the city taking into account local area physical characteristics , network attributes and operational characteristics of traffic including safety issues need to be scientifically evolved and enforced.
2. Road safety audits and accident and casualty databases are important tools for road safety policies. There is a need to carry our road safety audit for urban roads aimed at formal examination of the planning, design and construction of a road project, characteristics and operations of an existing road and to identify potentially unsafe feature or operational arrangement that may adversely affect the safety of road user. There is also an urgent need to evolve a comprehensive road design and standards policy for different levels of roads in order to ensure desirable road safety environment along urban arterials.
3. Safety of non-motorised modes of transport and more generally of vulnerable road users should be strengthened. This can be done through better transport infrastructure provisioning meeting cyclists and pedestrians needs improved legislations and through training and education. Special attention should be paid to the safety of more vulnerable persons such as children, older people and people with disabilities. Appropriate modifications to the physical road environment and setting up a supportive policy framework for VRU's needs priority.
4. In the absence of scientific investigation, the real causes are not adequately understood leading to arbitrary actions for accident reductions. There is a need for proper recording, collection and handling of data on accidents which would not only help in creating data base for policy planning but also help in assessing contributing factors for collisions
5. There is a need to strengthen traffic management practices incorporating Intelligent Transport System (ITS), set up City Road Safety Councils (CRSC's) in cities and establish an Urban Road Safety Fund in the city to facilitate improved safer environment on urban roads.
6. It is imperative to increase public awareness regarding road safety through various public communication tools such as public information in the media, road side information, road safety events, educational measures (driver education,

traffic schools for children) etc. As regards driver education there is an urgent need to draw upon the experiences of developed countries in this field, assess various pitfalls in teaching methods, and identify appropriate methods incorporating all aspects related to driver, vehicle and environment which have relevance to situations in our cities.

7. Good governance tools, such as efficient management structures and procedures, and a knowledge based approach are required to accomplish a successful local road safety policy. Co-operation with other authorities and policy levels, with judicial and police services, effective partnerships with schools and different traffic user groups, should make sure that the safety issue is dealt with in an integrated way and the needs of different road users are taken into account.

7. Summing Up

Road accidents are on rise with the number of road fatalities in India amongst the highest in the world. Rapid urbanization, greater reliance on motorized transport, growing income disparities and lax enforcement are among the factors that account for rising traffic fatalities. As the developing world is urbanizing rapidly, urban mobility becomes a critical issue and along with it the safe mobility environment. Urban mobility impacts not only the safety, health and well-being of urban residents, but also is key to the economic and energy efficiency of urban areas. There is an urgent need for effective and efficient planning of urban transport that addresses the challenges of growing travel demand in a way that is equitable, safe, sustainable, and affordable. Keeping in view the emergent problems of mobility in India, both in terms of passenger and freight traffic, it is imperative that transport planning must be given its due importance at all levels of decisions making in an effort to evolve holistic scientifically based short, medium and long term transport development policies and achieve safe and sustainable mobility environment in India consistent with best practices worldwide. In this context a coordinated land use and transport policy together with mobility management approach needs to be emphasized in all transport sector investment decisions best addressed through the process of transport planning which shall go a long way in improving road safety environment in urban areas.

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ROAD ACCIDENT PREVENTION STRATEGIES

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ABSTRACT :

Road transportation plays an important role in the logistics for delivering petroleum products. While, there are many modes of transportation of petroleum products, generally the last mile connectivity for the retail network is through road transportation which forms a sizable quantity. This paper provides insight to different issues experienced in the transportation of the hazardous petroleum products. All road accident involving Petroleum Road tanker are investigated and root cause analysis established. It is observed that Accident Investigation reports often revels the root cause as over speeding, hit by another vehicle, stray animal crossing road, bad weather, bad roads, error of other vehicle driver, etc. However the underlying Human behavioural causes are never established. The systematic Behaviour Based Organisation safety (BBOS) theory when deployed as a strategic tool reduced road accidents. In the past four years, in spite of increase in volumes, increase in traffic density on the roads there were reduction of petroleum road tanker accidents. This paper enumerates the experiential learning on the deployment of BBOS as key for Road accident prevention strategy.

Introduction

In the Oil Industry, the last mile connectivity for delivery of the fuel products like Petrol, Diesel, LPG etc., is always through petroleum Tank Trucks (TTs). The transport TTs are generally contracted by the Oil Companies which have all the inherent deficiencies. The petroleum TTs have higher rate of risk due to the hazardous nature of the cargo being carried, which if toppled, can spill on the roads and with the slightest ignition, can create a fire hazard engulfing other vehicles and passerby. It is observed that with the growth in the economy, the fuel needs also increases, which requires more road TTs on the roads. A back up envelope calculation indicates that on an average 1 million Tons of hazardous petroleum products of the Oil Industry is on the wheels on any given day.

Perhaps India is among one of the few countries where petroleum road accidents frequency, magnitude and loss is the highest. Till last year, it was approximately 2-3 accident a day for the Industry. The post accident emergency services and trauma handling facilities are not well equipped, as compared to the developed world. Most of these happenings are the direct consequence of the prevailing driving culture in the country. While the requisite road safety regulatory provisions exist, enforcement needs improvement. This is further compounded by the fact, that the regulatory mechanism for certification of the vehicles for its road worthiness and licensing the drivers, method of endorsement of hazardous goods transportation also needs substantial improvement. It is common knowledge, that the stringent penalties for the errand drivers have not really impacted the driver's community. Thus, the overall road safety for all stake holders, has been a continuous challenge, due to increase in the frequency of accidents and also the co-lateral damages to life and property.

Road Accidents

The total numbers of TTs on Indian roads is estimated to be around 115000. IndianOil was therefore saddled with this problem of increasing numbers of TTs and also increasing numbers of road accidents, which was increasing at average rate 25 % between 2013 to 2016.

Year	TT Accidents	% Variation
2013-14	129	24 %
2014-15	162	26 %
2015-16	204	26 %

Year	TT Fatalities	% Variation
2013-14	45	10 %
2014-15	50	11 %
2015-16	59	18 %

Road Accidents- Root Cause Analysis

In the recent past, continuous efforts have been made to reduce the Road accidents through training and education of drivers. **The focussed efforts included Training of the drivers & TT crew members on all topics as per OISD 154** and implementation of Anti Lock braking system (ABS) & GPS based Vehicle tracking system (VTS) in all possible TTs

In spite of the training the behaviour patterns of drivers changed marginally. The Accident report investigations established the root cause of accidents and classified the reasons as given below:

- Hit by another vehicle 24%
- Over speeding 20%
- Avoiding collusion 20%
- Loss of control 12%
- Mechanical failure 9%
- Bad Road conditions 7%
- Misc 8%

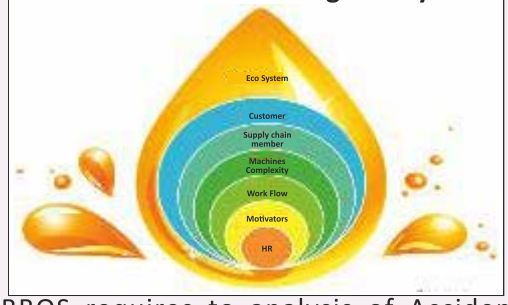
Often in any given situation if normal training is not reducing accidents, then there could be many hidden reasons for the accidents. It's like a floating iceberg, one third is visible the rest is below water. There no pointers to unsafe driving behavior in root cause analysis.

Road Accident prevention strategy

Behavioral aspects leading to the apparent root cause of accident is difficult to establish, however

Behaviors Based Organizational Safety model (BBOS) can be useful tool to analyse and directionally establish the probable behavioral causes.

Behavioral Based Org. Safety



The BBOS requires to analysis of Accidents in Petroleum TTs based on following aspects:

1.Eco system	- For supply chain
2.Human Resources	- Mainly focusing on drivers
3.Motivation	- Drivers current stage of motivation
4.Work flow	- At Oil installations/ Retail outlets
5.Machines configuration	- Trucks viewed as machine
6.Supply chain members	- Transporters, Dealers
7.Customers	- Retail outlet

BBOS is analyzed in the form of a decision matrix for each component as detailed in separate journal, not covered in this paper. For details ref pages 63-76, article published by BS Giridhar, in Forum for Behavioral Safety, 3rd Annual conference, of Jan 19.

In the context of Road Accidents if the Behavioral aspects are analyzed as per BBOS, the following emerges:

Eco system

- Nobody cares
- Neither Contractor / Clients care for Drivers
- No black listing of delinquent drivers
- No health check/ record for any driver
- No skills checks (hazardous goods trg certificates)
- No skills test for correct driving
- On road enforcement poor
- No accountability
- Drugs / alcohol abuse not checked
- TT check done by Client for formality
- Vehicle tracking installed for formality
- Min. training OISD 154 for formality
- Letter issued to transporter for speed / other violation
- TPT cautions Driver
- Accident RCA by Co no feedback

HR factors

- Immature behavior on road
- Drive, hit & scoot
- Drunken driving
- Drug abuse
- Personal habits prone to AIDs
- Family not important
- Stopping without authorization
- TPT maintenance only if breakdown
- Not accountable to loss / damage
- Driver health issues
- Driver eye sight issues
- Driver working hours issues
- Drivers skill issues

Motivation levels analysis

- No self worth
- No rewards system
- No penalty for Product loss / TPT accidents
- No penalty for vehicle damage
- No penalty for rash driving
- No penalty for drunken driving
- No penalty for drugs abuse
- No family pressure for safety

Work flow analysis

- Truck parking located far away
- Multiple trips to S&D office
- Bullies could break Q
- Drivers confused
- No road signs for traffic
- No FIFO
- Out of turn for dealers TT
- Drivers on daily contract

Machines analysis

- Manual filling of TT causes anxiety
- Automated TT loading reliable
- Loading arms not easy to operate

Supply chain analysis

- Dealer not sure about loading
- Transporter not sure about loading
- Driver not sure about loading

- Quality & Quantity issues
- Drivers not under control of dealer
- Locking and Sealing mistrust

Customers Analysis

- Dealer conducts extra checks if TT is from non automated terminal
- Unscrupulous dealer seeks product from non automated terminal
- Dealer suspects driver for quality & quantity
- Always doubts Co, transporter and driver
- Transporter attributes all failures to Driver

Based on above BBOS analysis and the cause of accidents as per investigation report the Strategic action plan is developed. The action plan ensures that the preventive action for all types of accident causes and behavioral issues are addressed.
The typical Strategic Plan could be as explained in table below:

Causes of accident	Probable Root cause	Action
Hit by another vehicle	Bad weather, Unsafe Driving Eye Deficiency - poor eyesight Health issues	Safe Driving Campaign Eye testing Campaign Cataract / eye surgery Health check up Defensive driving training
Over speeding	Lack of Training, Over confidence, Intoxicated driving Use of Mobile phone	Safe driving techniques training Alcohol Breath-Analyzer Test Tool Box Talk & Family picture on vehicle / cabin
Avoiding collusion	Improper technique, unsafe driving, poor eyesight	TT Crew Training, Tool Box talk & Eye Test Safe driving Campaign- street play
Loss of control	Sudden appearance of person, vehicle, animal etc. Unsafe Driving, Driving when intoxicated, Use of Mobile phone Sleep overpowering	Defensive driving training Tyre condition monitoring Tool Box Talk Advise for maintenance of vehicle Eye check up Regulated driving time
Mechanical failure	Maintenance of vehicle, Bad Road condition	Preventive maintenance/ servicing
Negligence by others	Unsafe Driving, poor eyesight	Defensive driving training, Eye testing
Negligence by TT Crew	Unawareness, poor eyesight	Tool Box talk Eye testing Driving skill enhancement on simulators
Misc - Bad weather, Road condition, No helper	Unsafe Driving, poor eyesight	Safe driving campaign Safe driving tips Journey Risk Management

Safe Driving campaign

Based on the Action Points a detailed Safe Driving campaign was designed and systematic actions were initiated. Details of Safe driving campaign are as per Annexure -1.

The driver's eyesight check and health check was conducted at periodic intervals at all the operating locations which are the base for the truck drivers for reporting.

The summary of the findings is as given below –

Total Nos of the Location	No. of Drivers partici-pated	No. of Drivers found Deficient	Cataract	Vision / Retina	Colour / Eye Blind-ness	Other (Conjun-ctivitis etc.)
86	9348	3176	147	2191	87	758
Deficient Drivers %		33.34	1.57	23.44	0.93	8.11

From the above table, it can be seen that there were approx. 33% drivers with defective eyesight. As a part of the campaign, for eyesight correction, the eye glasses supplying companies were contacted and it was agreed to sponsor the cost of the eyeglasses, for driver's eye sight correction. Further the Ophthalmic hospitals were engaged and it was agreed to sponsor the minor eye surgery cost for the drivers. Thereafter, these drivers were taken back and were allowed to drive the vehicles.

About 4% of the drivers had health related issues like blood sugar, diabetes, hearing defects, heart ailments and nerves system issues leading to seizures. Such drivers were provided medical advice and put on regular medication, thereafter some these drivers were allowed to drive the vehicles.

After initiating above measures in 2015-16, considerable reduction of accidents was observed:

Year	TT Accidents	% Variation
2013-14	129	+ 24 %
2014-15	162	+ 26 %
2015-16	204	+ 26 %
2016-17	198	-3 %

Year	TT Fatalities	% Variation
2013-14	45	10 %
2014-15	50	11 %
2015-16	59	18 %
2016-17	90	53%

From the above it can be observed that the 25% growing trend of accidents was arrested and reduction in accidents was to the tune of 3%. However the fatalities increased in spite of reduction in accidents.

Encouraged by the results, the campaign was intensified and mass contact programme was organized with the road transport authorities and the

common problems of the drivers, while on road were discussed. This initiated the motivational rejuvenation as the drivers felt that their voice is heard and they can look for better times ahead.

The drivers were then made to interact with the vehicle tracking system suppliers, the truck manufacturers, representatives who provide training and this initiated their curiosity to learn more on safe driving and the risk associated with poor maintenance. This initiative thus provided the drivers the sense of being empowered for safe driving. Further the drivers were also provided hands of training on the simulators and were provided feed back by the computers on their wrong driving habits which were taken positively by the drivers.

The drivers having addictive habits like excessive smoking, drug abuse, and tobacco chewing and alcohol consumption were exposed to motivational speakers from nearby NGOs, spiritual centers. Street plays were organized at the Locations to animate the consequence of wrong habits to enhance their learning. This had a very positive effect on the drivers and the all speakers provided the inputs required for improving the self worth and thus enhancing their motivational levels to do better in life.

Finally to improve the driving skills training was imparted on defensive driving techniques by Truck Manufacturers (OEM) and then they were sent to simulators to access and correct their driving techniques.

The interaction of the HSE Officers at the Locations was enhanced during the safe driving campaign and the drivers were given rewards after the port training quiz. This further bridged the knowledge gap of the drivers which led to skills enhancement.

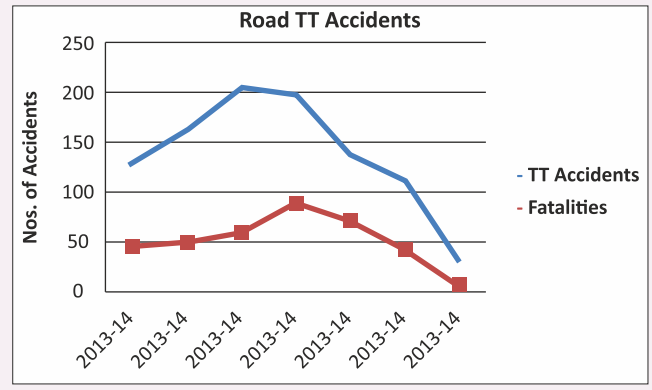
As all these initiatives, were concurrently taken up in phases across the country and the accidents continuously showed a decline.

Some of the glimpses of the Road Safety campaign are as per Annexure 2

The summary of the last 7 years is as given below:

Year	TT Accidents	% Variation	Year	TT Fatalities	% Variation
2013-14	129	+ 24 %	2013-14	45	10 %
2014-15	162	+ 26 %	2014-15	50	11 %
2015-16	204	+ 26 %	2015-16	59	18 %
2016-17	198	- 3 %	2016-17	90	53%
2017-18	138	- 30 %	2017-18	71	-21%
2018-19	112	- 19 %	2018-19	42	-41%
2019-20	30 (Sept 19)	- 73 %	2019-20	7 (Sept19)	-83%

The graphical representation the results:



The Safe Driving campaign was implemented in Dec.2015 and is still ongoing. At the end of 2018-19 results show that successfully reduced the road TT accidents by 54% compared to the high of 2015-16. In terms of exact numbers, in 2015-16, there were 204 of accidents with118 fatalities which in 2018-19 has reduced to 112 accidents with 40 fatalities. In the current year 2019-20, till date of publication of this paper, the reduction in accidents continues.

CONCLUSION :

From the foregoing, it can be concluded that in the Indian context, the key strategy for reduction of road accidents remains the Behavior based safety corrections of drivers. This has improved the safety on the roads with these motivated drivers. The intangible benefits of safe driving campaign includes the reduction in cost associated with emergency handling on the roads due to oil spills, traffic hold ups, insurance claims, loss of life on the roads and cost associated with hospitalization, rehabilitation and legal expenses of accidents victims. Thus the benefits of deploying this strategy for enhancing road safety far exceeds the cost associated with this campaign and has added value to Society.

Safe Driving Campaign

1. Banners to be displayed at Locations announcing "SAFE DRIVING CAMPAIGN", "सुरक्षित ड्राइविंग अभियान".
2. The tool box talk in local language with drivers on daily basis. Mementos to be given to Drivers who had volunteered for tool box talk on weekly basis.
3. Every morning tool box talk to ensure safe driving must be given by Location in charge or Shift in charge before the first truck leaves the location. One driver to be selected in first batch to deliver the tool box talk to second batch of drivers and so on till the last batch of TT leave the Location. Talk must be repeated even if driver has undertaken multiple trips.

4. The entire tool box talk volunteer drivers name is to be displayed on the S&D office commending their efforts. At the end of tool box talk, commitment from the drivers was taken for safe driving.
5. Screening of Film "एक रास्ता है ज़िंदगी" must be played as frequently as possible near S&D office.
6. Eye testing camp to be organized at location to check colour blindness and vision, etc
7. Training for all drivers and the Location in charge to give feedback on the campaign held during the month and advise all drivers that the spirit and tempo must be maintained throughout the year.
8. HSE officers to check the effectiveness of campaign and shall also see CCTV footage for daily tool box talk.
9. On 1st December also being "Worlds Aid Day", a talk & Health awareness Camp, free medical camp to be organized.
10. Audio message on safe driving to be played in TT Parking area.
11. Where feasible locations to organise organized street play to deliver safe driving message.
12. Special talk conducted by RTO & VTS officer on regulation of speed and following of specific route.
13. Emphasis was laid upon the Do's and Don'ts of Safe Driving.
14. Drivers were also educated on maintenance of special safety fittings & electrical fittings
15. Training on simulators
16. Organise talks from OEM vendors on tips for safe driving and Truck maintenance

Glimpses of the Safe Driving Campaign & Eye test camps

Glimpses of the Safe Driving Campaign & Eye test camps








Training By Motor Vehicle Inpspector On Safe Driving Practices

Transporter Meet To Sensitize Their Drivers And Installation Of Vts & Tool Box Talk




Transporter Meet To Sensitize Their Drivers And Installation Of Vts & Tool Box Talk




Transporter Meet To Sensitize Their Drivers And Installation Of Vts & Tool Box Talk




Transporter Meet To Sensitize Their Drivers And Installation Of Vts & Tool Box Talk




* * *

CHALLENGES IN MANAGEMENT OF HAZMAT INCIDENTS

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Abstract: *India is one of the fastest growing economy in the world with rapid industrial growth. Millions of tons of hazardous materials are transported through road every day. Hundreds of road accidents involving the release hazardous material happen in our country every year. As there is no specialised HAZMAT emergency group available, the first responders are usually the local fire brigade and police personnel. With limited knowledge about the properties of the chemical, lack of specialised equipment, inadequate preparedness, improper hazard warning, inadequate training, etc. leads to mostly mismanagement of the incident affecting the first responders and general public at large. Proper planning and preparedness can minimise the damages and loses after an accident. Collective efforts in empowering the emergency responders and equipping them with modern gadgets can help in effective management of these incidents to a large extent.*

Introduction

Dangerous goods means the goods that have been identified as hazardous for transport and present risk to people, property and environment and specified in Tables I, II, and III of rule 137 of the Central Motor Vehicle Rules 1989. These include volatile and toxic chemicals, combustible liquids, radioactive materials, oil, explosives, disposed medical waste etc. India is in a faster trajectory of economic growth and so is its industrial activity. As a result of this increased industrial activity, millions of tons of hazardous materials are transported through road every day. Industries receive many hazardous raw materials and dispatches dangerous finished products through road transport across the country. Majority of these hazardous material are petroleum products whose properties are well known to the emergency responders as flammable and explosive. However, there is wide variety uncommon / unknown chemicals also in the cargo being transported through road. The UN recommendations on the Transportation of Dangerous Goods contains 3548 chemical listed with specific UN numbers. There are over 85,000 chemicals listed under the US EPAs Toxic Substance Control Act. Safety during road transportation of the hazardous material is very important as it involves the risk of injury to people, damage to property and environment.

Stringent rules and regulations are available in our country to prevent road accidents. Proven design codes and practices are also available to prevent the release of the materials from the containers, in case it involves in an accident. In spite of all these, several road accidents involving hazardous materials are reported every year leading to fire, explosion, release of toxic liquids and gases injuring people and damaging environment. Unlike other fire department calls, a HAZMAT incident is a low probability, high threat, mammoth resource, huge consequence, multi jurisdictional situation. Once occurred, the management of these incidents are a challenge due various factors discussed below.

1.0 Legal Framework

The legal provisions for control of the movement of hazardous chemicals by road are prescribed in various acts and rules in the country. The main provisions related to transportation of hazardous materials by road are covered Under Section 129 to 137 of the Central Motor Vehicle Rules 1989. Various rule such as Petroleum Rules, Gas Cylinder Rules, SMPV Rule etc. are also prominent in controlling the road movement of such materials. However, these rules are hardly sufficient to ensure safety and probably not fully appropriate to tackle many issues related to management of an incident. Though we have many acts and rules framed to ensure the safe transportation of these chemical by road, many a times we fail to enforce the requirement in letter and spirit.

1.1 Drivers Educational Qualification:

The drivers are the first responders during any road accidents and can do great initial measures before the arrival of emergency services like police and fire service. The basic knowledge about the hazardous properties of the material is very important in managing the emergencies. However, as per Rule 9 of then CMVR 1989, the drivers educational qualification is not specified other than his ability to read and write English and one Indian language. The basic education

standard and literacy of our country have progressed over the years and hence it is time to mention the minimum educational qualification of the drivers carrying hazardous material cargo.

The driver shall also possess a certificate of having successfully passed a 3 days course from a state Government recognised institute consisting of the syllabus mentioned in the Rule 9. There are many institutes in the country offering the course; however ensuring equal standard of the course and institute is a challenge for getting full benefits of the intend of the rule.

Having mentioned these concerns regarding driver qualification, we have numerous experiences with drivers of the hazardous cargo whose initial responses helped in mitigating the incidents at its incipient stage or saving lives of people which otherwise could have lost. On 28 August 2012, an LPG tanker met with a road accidents during midnight hours near Kannur district of Kerala. The driver alerted the sleeping residents all around the locality which helped in evacuation during the golden moments before the explosion of the container.

2.0 Hazard Communication

The hazard communication during the transportation of the hazardous materials is governed by Rule No 134 of the Central Motor Vehicles Rules 1989. This is by way of an Emergency Information Panel on three sides of the vehicle which gives the correct technical name, UN Number, HAZCHEM Code, Hazardous Class Label and contact number of the emergency services to be contacted in case of emergency. The enforcement of these labels are to be ensured by the transport department during registration and periodic fitness checking of the carriers. However, it is noticed that many of the information given in the emergency information panel are either generic in nature or incorrect. Also, when the carrier is transporting a different chemical, the correctness of the emergency information panel is not verified. Though, both consigner and the transporter are responsible for ensuring the correctness of the information, many a times it is not followed due to various reasons. The enforcement agencies shall conduct periodic check and penalise the erring drivers in this aspects too.

Wrong or incorrect information in the emergency information panel will endanger the first responders due to incorrect identification of the hazard. The HAZCHEM code given in the emergency information panel gives the immediate measures for responding to an incident involved by the consignment. However, even today the code is not easily understood by many emergency responders. It is time we should think of other easy methods of hazard communication such as the one given in NFPA diamond. It is better to give the basics knowledge on hazard warning pictograms and labels in the school curriculum, so that we can ensure that the chemicals are handles and transported safely and the community respond to HAZMAT incidents in a better way in future.

2.1 Use of Technology

Understanding the chemical and its dangerous properties is the first challenge for the emergency responders. The details provided in the emergency information panel would be a starting point for this identification. However, this is not adequate for response planning and mitigation during major road accidents involving unknown chemicals. The emergency responders shall be further supported through modern communication gadgets. Here is the important of the mobile applications such a CAMEO Chemical, ERG2016 etc. which gives valuable information regarding health hazards, fire hazards, reactivity profile, fire fighting measures, non-fire response, evacuation, protective clothing, first aid etc. which are very critical for response planning and mitigation.

2.2 National Chemical Response Centre

We have many emergency call centres in the country; however we have no national call centre numbers for providing response planning guidance over phone during chemical accidents. The LPG emergency number 1906 is limited to domestic LPG emergencies. It is very essential to start a 24 x 7 national chemical emergency call centre which can provide critical response guidance during hazardous material incidents anywhere in the country. This will help in developing better informed first responders and managing the emergencies in a better manner. This will also help to improve public awareness, evacuation etc. so that further casualties can be minimised.

3.0 First Responders

One other challenge in the site of accidents involving hazardous material road accidents is the lack of coordination between various emergency responders. Though District collector is the Chief Incident

controller during offsite incidents, many a time it is difficult for him to be physically present at the incident site. The usual first responders are Police and Fire Force. However, personnel from other agencies like State Revenue Department, State Factories Department, District Disaster Management Authority, Fire Brigades of mutual aid groups etc. also respond to these incidents. This leads to crowding of personnel at the scene, without much mutual coordination. This has seen as affecting the pace of the mitigation measures. Even if a Site Incident Controller is available, many a times he is not been identifiable by the agencies involved in emergency mitigation. This causes delay in planning and arranging resources for early mitigation of the incident. It is suggested to identify a site incident controller during the absence of district collector with designated temporary site control room or with suitable uniforms such a reflective vest.

4.0 Emergency Equipment

Successful resolution of a HAZMAT incident involves the right equipment and the education and training to use it effectively. My experience in handling three major Ammonia transportation incidents are worth mentioning here.

The first one was in the city of Kozhikode in northern Kerala on 21st December 2001. None of us were prepared and equipped to handle an ammonia leak of that sort happened due to the collision of an ammonia truck with another lorry. The police and emergency services were quick in responding to this mid night accident and evacuated the crowded neighbourhood. We managed to fabricate some special clamps extrapolating the already available mechanical chlorine tonner leak arresting kit equipment. It was time consuming activity, but we did arrest the leak in a crude way.

Having learned lessons from this incident, we acquired some specialised tools for hazardous material leak arresting and containment from some of the best known international hazmat emergency equipment manufacturers. We trained our crew in using these equipment regularly and empowered them to handle future incidents.

On early hours of 11 December 2009, an ammonia truck carrying over 18 tons of liquefied ammonia overturned near our refinery in Kochi. This lead to profuse ammonia leak through the broken liquid nozzle of the bullet tanker jeopardising the refinery operations and endangering the lives of people around, especially affecting our housing colony. Our team swung into action immediately with all our specialised equipment and learning from past incident. We were successful in arresting the leak using specialised pneumatic leak plugging equipment and averted a major disaster.

This success gave us lot of confidence and laurels to our team. We have put in lot of efforts and research to become one of the best chemical emergency management teamsine then. This lead to the acquisition of a state of the art HAZMAT Emergency and Rescue Vehicle in the year 2017. The highly sophisticated vehicle, imported from Austria, is one of its kindly in the country today holding more than 300 types of emergency equipment in varying quantity. The vehicle has a fully equipped emergency control room, atmosphere monitoring equipment, leak containment equipment, leak arresting equipment, hazardous material transferring pumps, rescue tools, personal protective equipment etc. for managing all types of HAZMAT Emergencies in addition to various rescue operations.

Even with all training, preparation and availability of most modern equipment, failures can occur if we fail to know the use our knowledge properly and understand the limitation of each these equipment. There is no single solution / universal equipment available for handling HAZMAT emergencies. Each equipment is to be used based on situation depending on the nature and hazard of the chemical.

The third incident took place in an ammonia storage facility in an island in Kochi on 27 January 2018. An ammonia truck, which was loading liquefied ammonia, inadvertently driven out by the driver without disconnecting the filling hose. The filling nozzle uprooted from the vessel leading to profuse leak of ammonia. Our emergency team responded to this emergency with our most modern vehicle and specialised team. In our efforts to plug the leak, the gas tight chemical suit cracked due to exposure to cryogenic storage temperature of the liquid ammonia, injuring one of our engineer with frost bite. Our incident investigation revealed that the suit was not designed to handle temperatures below -20 degrees whereas the contact temperature of the liquid ammonia was -33 degrees. This mistake was a big

learning for all of us. Today we acquired cryogenic chemical suits, rechecked the operational limitations of all other equipment and trained our crew further to empower them for handling greater challenges.

The equipment and preparedness of our first responders are many a time inadequate to handle chemical emergencies. Learning from each of these incidents highlights the need for specialised equipment and specially trained hazmat team in our country for effective management of road accidents involving hazardous materials. The equipment and facilities in our fire services are mainly concentrating in rescue operations and fire fighting. Their knowledge and experience in handling chemical emergencies are also limited. It is suggested to create specialised HAZMAT Emergency Team among our fire services in all our States and equip them with modern gadgets for effective management of HAZMAT emergencies.

5.0 The changing scenario

Conventionally, petroleum companies produces transportation fuels. However with the newer threat of Electric Vehicle replacing fossil fuels run vehicle, the expansion plans of the companies are now focusing into petrochemicals. The sign of this transformation is already seen in our country too. This will bring in newer chemicals on our road with unfamiliar properties than the conventional petroleum products. This poses further challenge for the emergency responders for their preparation and handling of road accidents involving chemicals.

6.0 Decontamination

Post arresting a leak and containment of a hazardous material incident, the next challenge is to safely decontaminate the area, equipment and emergency responders exposed to chemicals. Efforts shall also be taken to ensure that the hazardous material involved in the accidents does not contaminate the water bodies as well the soil around. Proper disposal of the contaminated material shall be included in the emergency response plan. Unfortunately, our planning and execution of hazmat decontamination is limited to water washing of the area for dilution in many instances.

7.0 Hospitals Preparedness

As discussed, the list of hazardous materials are innumerable and their exposure can have both acute and chronic health issues. It is very necessary for hospitals to participate in emergency planning for HAZMAT incidents. Additionally, emergency medical services and coordinators have critical roles in the planning and execution of an emergency response plan. The plan for each locality varies depending on the types of industries involved, chemicals used and transported, and resources available. The hospital employees must be trained to use the PPE and how to perform decontamination. Incidents of hospital workers becoming ill as a result of chemical exposure when caring for a contaminated patient have been reported. Hospital care for a person exposed to hazardous materials should begin with adequate planning well before the incident occurs. Failure to have an adequate plan to attend to a HAZMAT situation can result in injury to hospital employees

8.0 Conclusion

The road accidents involving hazardous material cargo can happen anywhere on our roads. Though it is low probability accident, it can have huge consequence, especially when it happens in densely populated localities. The management of such incidents requires trained personnel, specialised equipment and coordinated efforts by all agencies.

With increased movement of unfamiliar chemicals on road, the emergency responders need to be empowered for using modern technologies, in understanding the hazards of each chemicals and effective response planning during incidents.

It is very important to set up a national chemical emergency control centre who can provide telephonic guidance to the emergency responders. As management of hazardous material emergencies requires specially trained team, we need to set up specialised HAZMAT emergency teams in all our States. We need to equip these team with modern equipment suitable for management of all chemical emergencies. Our emergency plans in all level shall plan for chemical emergencies also and shall check the preparedness of hospitals to handle patients contaminated with chemicals.

With better preparation, modern equipment, trained personnel we can overcome the challenges posed by chemical accidents on road and reduce lose to people property and environment.

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AN INITIATIVE TO IMPROVE BEHAVIOURAL & TECHNICAL SKILLS OF THE TANK TRUCK CREW 'SAFETY ON WHEELS'(SOW) TRAINING

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Abstract: *Transportation of petroleum products to customer and dealer premises by Tank Trucks* and trucks *is one of the major function of Hindustan petroleum Corporation Limited (HPCL). Any kind of road accidents may cause revenue loss, human loss and damage to brand image. Driver's awareness, behaviours and Road condition are major contributing factors for the road incidents. Influencing driver's behaviours could bring* sea *change in incidents prevention. HPCL's initiative to improve behavioural & Technical Skills of the Tank Truck Crew thru Two day 'Safety On wheels'(SOW) Training, aims reduction in the road incidents. The training comprises* of *four sessions, covers: 1) Standard Operating Procedures (SOP) at locations, defensive driving skills, accident causes and analysis by in-house faculty, 2) Understanding road safety rules, provisions of CMV Rule 9 & documentation by local RTO / local Police 3) Stress/ anger management thru spiritual teaching and meditation by Prajapita Brahma Kumaris.* (ऽ *Vehicle health management, Fuel efficiency and brakes emergency operation by OEM Ashok Leyland. Over two years of intensive training covering around 3000TT crew, we witnessed declining trend in accidents.*

1. Introduction

HPCL is one of the largest Public Sector Oil Marketing Company handling over 38.7 Million Metric Tonnes Per Annum Petroleum products. On an average daily around 10,000 Tank trucks / trucks carry products to retail outlets, customer premises and LPG dealer premises. The major concerns are road accidents causing fatalities, injuries, damage to environment and property. Major reasons for the road incidents are driver's behaviours, poor awareness of traffic rules, over speeding, lack of judgment, addiction, poor vehicle maintenance etc. Self-awareness, positive behaviour and stress management of drivers can improve compliance to Traffic rules and regulations. It is felt that respect, caring and bringing behavioural changes in this unorganised driver community can be a great contribution in Road Safety.

2. About Safety On Wheels Training

Corporate HSE Department designed intergrated behavioural beased two day Safety training program and delivering since last two years covering almost 3000 TT Crew. A specially designed T shirt and cap with HP-SOW logo is issued to all participants making them a unique amoungst all. For both the days during the training, good lunch, tea and snacks are provided by the location enabling them total worriless climate for traspformation. Accordingly Safety on Wheels training was designed with Brahma kumaries, OEM Ashok Leyland and inhouse faculty. The two day Safety on wheels(SOW) training comprises of:

I. Session-1 (In-house faculty)

a) In-plant safety SOPs & compliance
b) Accident Statistics
c) Defensive driving film
d) Accident case studies & cause analysis
e) Driving skills during night, monsoon, hilly areas, city area, highways
f) Importance of driver in meeting supply chain logistics

II. Session-2 (RTO / Traffic Police interaction)

a) CMV Rule 9 provisions
b) Traffic rules & Penalties
c) Documentation
d) A friendly and supportive approach

III. Session-3 (Behavioural session by Prajapita Brahma Kumari)

a) Spirituality - Mindfulness : Safety Starts with Me
b) Family and social responsibility
c) Self-awareness, Mental and Physical signs of stress, Stress management (Causes, effects and handling of Stress)
d) Self-Realization: Harmonizing internal conflicts.
e) Attributes of God Consciousness, Spiritual strength, energetic life.
f) Meditation, Yoga, channelizing internal energy, developing positive attitude
g) De-addiction, money saving habits

IV. Session -4 (OEM Ashok Leyland)

a) Drivers dress code, health & hygiene

b) Technical knowhow and Importance of Vehicle maintenance

c) Emergency brake Management - live demo with hand brake

d) Changing road conditions and driving habits

e) Fuel efficiency while on wheels

3. Implementation:

The programme is scheduled basis location convenience ensuring maximum participation. Also coordination is maintained with location to ensure advance loads to dealers maintaining sufficient inventories dealers' premises during training time, no location goes dry of product.

A specially designed T shirt and Cap with HP-SOW Logo, is issued to all participants making them a unique amongst all and during training their food requirement is also taken care by corporation enabling them total worriless climate for imparting training.

The two day drivers training course comprises of three session of class room training and one live demo session on tank truck explaining the safe features and defensive driving during brake failure emergencies.

During Q&A, every crew is given an opportunity to clarify doubts on life, safety, technical aspects, rules and regulations and concern faculty imparts necessary inputs. A special session on consequence of drunk and drive and de-addiction methodologies explained. Upon completion of training every participant is awarded with a Certificate and also a useful memento towards appreciation to his dedicated participation and respect.

Corporate HSE Department designed integrated behavioural based safety training programme and delivering since last two years covering almost 3000 TT Crew.

4. Outcome of Training

After covering around 3000 Tank truck drivers thru 25 programs in last two years, we measured the outcome. From 2016-17 to 2018-19 there is a 30% reduction in number of accidents, 50 % reduction in injuries and 12% reduction in fatalities. Despite increase in sales volume by 10% (from 35.2 to 38.7 million metric tonne), the rate of accident reduction from 4.6 to 3.2 Accidents per one lakh trips in year.

TT Road Incidents	2016-17 (Nos.)	2018-19 (Nos.)	Reduction in incidents %
Accidents	177	124	30
Injury	135	68	50
Fatality	68	60	12

Apart from the incident reduction, we observed intangible behavioural changes such as

a) Increased compliance to SOPs

b) Maintained vehicle in good condition

c) Increase housekeeping and hygiene

d) Increased Drivers morale

e) Increased self-awareness

f) Drivers Joining Brahma Kumaries for spiritual help

A person is transformed from an ordinary driver to 'SAFETY AMBASSADOR' who not only assures and ensures safety on wheel, but also spreads safety awareness amongst other crew members, identifying their faults and improving techniques.

This unique self-awareness is created which enables him to control his behaviour, anger management, change in food habits, and change in driving habits.

We are targeting all 10,000+ drivers and a continual efforts towards prevention of Road incidents.

* * *

SAFETY DRIVEN BY TECHNOLOGY – FIRST THING FIRST

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Abstract

Mobility through Road Transportation is Central to our Lives, yet sustainability of this Industry is under threat in India as we continue to loose a City's population every Year. Does Technology has an answer? Will Masses on the street ready to believe in "Science of avoiding Road Crash" or they will continue to consider a Road Death as "God's Curse" or "Bad Luck"? In a country where one instantly stops when a Black Cat comes on our way, whereas stopping at a Red signal still seems to be safe if violated smartly, we even buy millions of #Nimbu-Mirchi to safeguard ourselves from a Crash, is there a way for "Cause & Effect" principle to work or its too complex for any concurrent Technologies to prove to the masses that it works. The Author belives that caefully chosen technologies with "Local for Local" application rather than blindly following technology models of western world, prioritised based on its percieved power to save lives among Indian masses, its affordibility & enforcibility will start a chain reaction for deep-tech deployement driven by pull from Road Users. Like India eradicated Polio & reduced Child Moratlity significantly, A First Thing First approach must be adopted to utilise the power of Public Participation in bringing Breakthrough Safety Technologies on our Roads. In absence of a Public Movement & stakeholder's engagement, traditional approach of Just Regulating Automotive Technologies at the time of Vehicle manufacturing is not able to show any visible positive impact. The paper describes a possible mix & prioritisation matrix of technolgies, along with concurrent mass awareness, enforcement & Road Engineering drive to trigger a visible reduction of India's ever increasing Avoidable Road Deaths.

Problem Statement

In India and World over, increasing no. of Road Deaths are not only killing the young & the productive, not only it brings a tragic end to their life and leave the family and friends in a traumatic pain, it pushes the dependent family members into an economic distress and into social backwardness.

In India, we lose an Indian every 4 minute and an accident every minute. In last decade we have lost more than a Million Indians to Road Deaths, it remains the biggest cause of Unnatural Death for Indians. India loosing a City every Year (Source TOI) is unsustainable for the Automotive Industry.

Millions of Indians drive home every day and close to 400 never come back home. How long and how much



economic, social & humanitarian price we have to pay for solving our mobility needs.

Do Disruptions Caused by Technology?

Today Technoligical Companies have grown exponentially and has filled the top slots in creating wealth. Just few hundred thousands employees of top 3 Tech Companies are worth Millions of employees at top dozen of traditional corporates. With Artificial Intelligence, Machine Learning , Block Chain and many pathbreaking technology making way into our lives, with buzzwords like "Software is eating the world", "AI is going to Eat Software" and Bill Gates wants to tax Robots, The World has now a continious threat of Disruptions. Whether technological advancements causes Disruptions to Industries , societies & our day to day lives or something else. What is the driver of these disruptions. We as consumers are the prime movers of Disruptons and the need of the society causes it to happen. More than the Technology, its breakthrough applications, its ultra fast adoption among its intended & sometimes "Need-Ignorant" consumers & innovative buisness models for wider adoptions, causes disruption. Usage of technology is prioritised by Society at large. Example of a simple Pulley Technology below states that it can be used for various needs of the society like Trekking, Construction or taking water from the well etc. Same pulley put to use for rescue operation during Kerala Floods might reflect to a much higher purpose and hence an example of what decides the impact. The higher purpose direction to Technology is causing the Disruption.





Technology for Societal Good

As the world is full of huge Technological advancements, it will be a missed opportunity if these are not put to appropriate usage in a manner most needed to advance human development on this earth and solve its real life problems. Blind copy of how western world is using technology may not be the right application for Arresting Alarming Road Deaths on Indian Roads.

Technology not "Put to Use"
= Missed Opportunity



Challenges to Technological Breakthrough for Zero Crash?

Answer lies with the Road Safety Leadership of the country. Currently our approach to drive Safety Technologies through Regulation has not shown any evidence of a significant drop in Road Crashes. Neither there is enough evidence to understand we have come to few conclusions on "Cause & Effect" relationships on Indian Roads and hence a clear business case of these regulations. Most of the Automotive Regulations & hence its associated Technological applications have been adopted from the best practices in Europe with a time delay, with the hope to get similar results in curbing Road Crashes. This has grossly failed. In many cases, India has invested Public & Private investments , consumers money to fulfill these safety regulations, but Road Users are not even aware about how to use them or how to benifit from them. This approach of only relying on pushing Safety Technologies via Regulations has failed the Business Case of Safety. There is hardly any budgetry allocation in the Industry on mass communication to transform the Public Perception & hence Pull factor to these Technologies, as either there is none to communicate as quantified percieved Value to consumer or its not worth as Regulations have made it anyway a common denominator among all market players. Example of high glare on our Roads is ovbious, though usage of Head Lamp Beam Levelling switch (depending on the Loading of the vehicle) is missing largely, even though its regulated and all consumers have paid for it.



Pre-Condition for Technology to Safeguard Crash

There are 3 Pre Conditions for any Safety Technology to make an impact.

1. It Must be an outcome of a Local Accident Research finding the root causes based on Local4Local.
2. It Must be affordable
3. It must be enforcable. This will need majority of the population self enforcing the same if the value communication succeeds.

All these Pre-consditions hints the Road Safety Leadership to comeup with most appropriate Prioritisation of Safety Technologies for India, rather than blindly copying the Road Map of Westeren World.

Safety Driven by Technology – Put First Things First

This brings us to the conclusion that we must propose the introduction of Safety Technology with a Road Map which reflects the need of our Country. Prioritisation has to happen based on Scientific Accident Data & Scientific Cause & Effect modelling. This will not only safeguard Price point of Indian Consumers & help the mobility movement further, this will bring "Business Case" approach to its introduction and hence stop any wastages of Public & Private investments. This will also impact the Marketing Communication and bring a „"Pull Factor" among consumers as it will have Specific, Measurable & Quantified benifits being communicated, as more and more Accident Data will mature. More Public Investment will go in Data capturing, its quality & Analysis. This is a must if we believe in the scientific process of 1st defining the Problem, Measuring it, Analysing it and then only intervene to improve, unlike today where we just "Spray various Technologies on Indian Roads & Pray for results". The proposed approach will transform the buying behaviour among consumers towards safety than any other criteria, as credibility of Technological intervention will improve when Road Users are able to relate to it better & understand than forced in a black box.

Scientific Cause & Effect Modelling – Put First Things First

To bring the framework of scientific "Cause & Effect" modelling, we picked up all the Safety Critical Technologies in Indian Regulations, which is defined

under AIS037 and created its application value stream mapping, keeping the Driver in the centre. India accounts majority of Crash Cause to its Drivers and we continue to have an attitude to blame, shame & penalise them, whereas its commonsense that if we take them in confidence and transform their actions towards safety, wonders canbe achieved. Just like the overall Leadership of Road Safety in the country Lacks the depth of Accident Reaserch Data & Analysis to privide Vision to its interventions, our drivers are expected to act & save lives on their own judgement.

When we put the "Road Users" as central to the solution & declare it as "Wanted Constraint" (rather than central to the problem), we were able to get a framework below, which puts "1.Recognition of Traffic & Objects around him/her 2.Reaction by Drivers and 3.Injury Avoidance efforts if a crash still happens" in a scientific sequence. This 1-2-3 Recognition-Reaction-Injury Avoidance or "Dekho-Ruko-Bacho" Once put in the pictorial, it seems so obvious to every common man on the road.



This framework needs to prioritise every resource allocation in assisting the drivers for each stages in sequence. As said, Precaution is better than Cure, One needs to heavily prioritse importance of 1st phase of this model, which is object predictibility on Indian Roads or the Recgnition phase and ensure basics are maintained in next 2 phases. Most critical starting point in 1st phase is Design & Engineering of Roads & its surrounding infrastructure.

Vehicle Safety Technolgies – Put First Things First

Then comes assiting & alarming the Drivers with Vehcile Technologies. Below diagram tries to segment AIS037 safety critical Technologies into proposed 3 Phases for its prioritisation, in the background of limited Purchasing Power of Indian Consumers, as the Goal of Arresting the Biggest Crash numbers in the world is extremely complex & challanging in Indian context. Its obvious that whatever investment we commit to phase 2 & 3 , in absence of 1st phase , we will be far from our Goal. If we create billions of Crash chances by compromising in Phase1 of the Driving Value Stream, whatever we invest in next phases will be suboptimised.

Now, when we look around on our highways, its

RECOGNITION	REACTION	INJURY AVOIDANCE
1	2	3
Safety Glass	Brake Hose	Air Bags
Horns	Braking	Safety Belt
Bulbs	Devices	Door Locks
Rear View Mirror	Tyre	Door
Lighting	Speed	Retention
Light signaling devices	Limiting	Components
Retroreflectors	Devices	Fuel tanks
Warning triangle	Wheel	
Reflective tapes	Rims	
	ABS	

obvious that our Driving envoiranment is one of the most complex and unpredictble in the world. No wonder why we have the highest no. Of Road Crashes.

One of the easy example can be missing inexpensive reflecting & signalling devices on our Trucks, cycles or other slow moving traffic on Indian Roads. As we just explained before, recognising moving Traffic and stationary objects while driving is a crucial 1st step to drive on Roads, whether to move ahead or stop or take a turn or overtake etc. Any reaction while driving can be as accurate as it is to recognise the traffic. This is enabled by simple technologies like Light Signalling devices for day and night and additional Reflective Tapes, Lighting equipment's for night driving. Crashes like below is but obvious.



Pictures like below is a common scene on Indian Roads



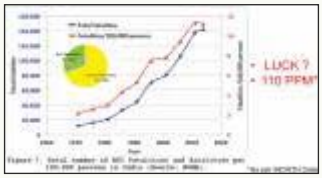
These can be solved by applying existing technologies to make a "Poke-Yoke" on our Roads. Once prioritised, India will solve the problem.

With the above example and model, our proposal is to create the Technological Vision for saving Lives on

Indian Roads with central theme of "Putting First Things First".

Will Technology be Enough – Road Crash is a Science or Chance Factor?

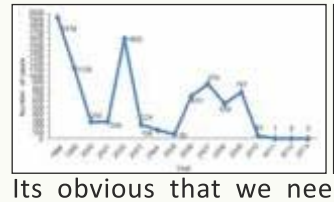
With 100 People dying per Million in a billion plus country and prevalance of supersitious beliefs among masses, its but obvious that Road Users relate Road Crash to "Chance Factor or Bad Luck" more than the science of Mobility. Hence, only prioritising Safety Technology will never be enough. Millions of people purchasing lemons & Chillies - "Nimbu-Mirchi" everyday to safeguard from Road Crash, stop instantly when a Black cat – "Kali Billi" come in their way and be easy going to cross the signal when its red, how can we convince that IOT & AI will better guide them to safeguard themselves. This is the challenge bigger than even innovating the safety technologies for our country.













Its obvious that we need massive Awareness & Education among masses to treat Road Crash as Scientific Problem than just a bad luck.India has proven to itself the same in Polio Eradication and Child Moratlity rates in past

It is only then a Public Movement can be fueled against Road Crash and we can dream of ""Zero Fatality" through Safety Technologies by First Thing First.

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NATIONAL SAFETY COUNCIL OF INDIA LAUNCHES

COVID-19 AWARENESS POSTERS

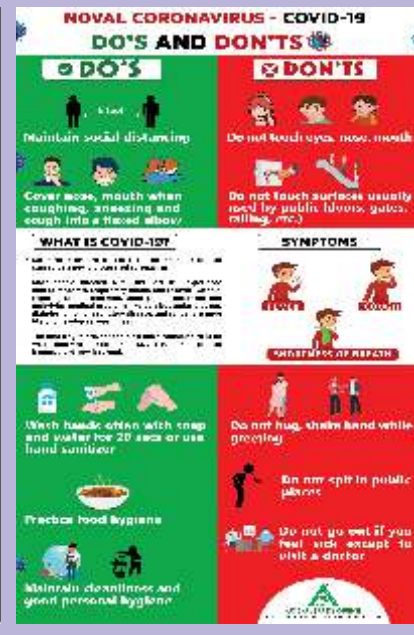
The National Safety Council has come up with additional varieties of Poster on "Covid-19".

These posters are useful for displaying in any Industries / Establishments.

The eye-catchy posters help in creating awareness among all the employees, workers and remind them to follow safe practices when around others.

The Posters are readily available in English (Size 75cm X 50 cm). For Regional languages, Kindly E-mail your requirements on ***poster@nsc.org.in.***





NATIONAL SAFETY COUNCIL OF INDIA
www.nsc.org.in

"Protect Yourself and Others"

TECHNOLOGY ENABLING SAFER ROADS WITH WET REFLECTIVE OPTICS

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Abstract

A major cause of accidents on highways and expressways is not maintaining lane discipline due to the poor visibility of pavement markings, particularly at night time and during rain fall. Studies have shown older drivers over 60 years age require approximately two times higher pavement marking brightness than younger drivers in their twenties in order to recognize the markings. Controlled studies have found increasing the initial marking reflectivity by 16% to 67% and increasing the interventional levels by 0.75X to 1.5X resulted in 15% to 28% crash reductions. Further, by adding wet reflectivity performance to expressway and undivided multi-lane highways resulted in crash reductions of between 14% and 25%.

In India, an additional factor of high durability is essential for pavement markings due to significantly more traffic hits on the markings, attributed to driving behavior. This paper presents advanced pavement marking systems including high index optical elements as the critical material for both liquid pavement marking solutions and pre-fabricated pavement marking tapes. It describes the science and technology behind high index optical elements and their impact on retroreflection in dry and wet conditions. The initial data on coefficient of retroreflected luminance (RL) indicate superior performance of the advanced marking systems over the benchmark system under both dry and wet weather conditions.

Introduction

The United States Auto Insurance Center (AIC) found "failure to stay in the lane kills the most people in the majority of US States." The AIC compiled and analyzed data on every fatal car accident in the US recorded by the National Highway Traffic Safety Administration's (NHTSA) Fatal Accident Reporting System (FARS) over five years from 2009 to 2013[1]. Pavement Markings provide the visual cues to the drivers to help navigate the vehicles along the roadways, without that the risk of vehicles going off the lane and the road increases as is the risk of fatal crashes.

Study[2] indicates night time driving comprises approximately 20-25% of the daily traffic, yet the road fatalities at night may make up to 50% of all traffic fatalities. Further rain and the wet road surfaces not only create a hazard to drivers in terms of reduced visibility and stopping distances, the pavement marking lines are likely to disappear in the wet conditions. One study by Qiu[3] et al. in 2008 found rainfall increases the relative risk of crash and injury rates by 71% and 49%, respectively. Combining rain and night time driving, Saha[4] et al. reported an "odds ratio" of 1.08, analyzing 18 years of US crash data from 1994 to 2012. The odds ratio is the odds of the risk factor being reported in a fatal crash which happened during adverse weather conditions when compared to the odds of the risk factors occurring without the adverse weather condition.

The evidence is overwhelming that driving at night and in rainy conditions poses significant higher risk of crashes, injuries and fatalities than in good weather and day time. Numerous studies documents that the visibility of road markings at night is controlled by the retroreflective efficiency of the pavement marking system and hence when a specific pavement marking system is being chosen, it is important to understand the underlying technology that makes it effective. The visibility properties of any marking system are the result of a combination of three basic components: the optics, the structure, and the binder. All three components must be designed to work together to create an effective marking.

The objective of this paper is to show that having functional pavement marking lines improves traffic safety in adverse weather conditions by means of improved visibility and the solution to visible pavement marking lines in rainy conditions is readily available.

Safety Improvement of Functional Pavement Markings

Research into age-related traffic crash, injury and fatality is widely available in the US. One such report by Lombardi[5] et al. published in 2017 reviewed four years of NHTSA FARS data, among the reported 120,809 fatal accidents over 2011-2014 that were related to two-vehicle fatal crashes (76,391 crashes or 63% to total). The study found the crash involvement factors were approximately 25%, 38%, 56% and 92% higher for

drivers in 70-74, 75-79, 80-84 and 85+ age groups than drivers in 20-24 age group. Focusing on pavement marking, an early study by Zwahlen[6] reported that a driver of 60 years of age requires twice as bright marking lines for recognition within 3.65 seconds driving at 60-65 mph speed.

Pavement marking brightness is specified by the "coefficient of retroreflected luminance, R_L" in a 30-meter geometry. A study by Carlson[7] found that boosting the initial R_L performance from 300 mcd/m^2/lx to 350 mcd/m^2/lx for white lines and 200 mcd/m^2/lx to 225 mcd/m^2/lx for yellow lines, while also boosting the intervention levels from 100 for both white and yellow lines to 175 for both lines, the number of crashes was reduced by ~15%. Boosting the initial R_L further to 500 mcd/m^2/lx for white and 350 mcd/m^2/lx for yellow lines, intervention levels at 250 for white and 175 for yellow lines, the crash reduction was 28.3%. Clearly, brighter lines reduce crashes and save lives.

In another study by Lyon[8] et al., sponsored by the US Federal Highway Administration (FHWA), it was found that wet reflective pavement markings on US freeways (termed expressways/motorways elsewhere) gave a 14% crash reduction and a benefit to cost ratio of 1.45. The crash reduction was larger at 25% if wet reflective pavement markings are applied on multi-lane undivided roads. The benefit vs. cost ratio in this case was over 5 times.

Design of Pavement Markings

The retroreflective properties of conventional markings are achieved by glass beads partially exposed to vehicle headlights while partially embedded into the markings for durability. Typically, the beads are dropped onto a white or yellow binder right after the binder is applied onto the roadway surface. The design of markings regardless of the binder type, factory pre-fabricated or formed on the road surface, can be categorized as follows, also illustrated in Figure 1:

A) Conventional liquid marking commonly enhanced with glass beads of 1.5 refractive index,

B) Highly efficient dry-condition markings enhanced with approx. 1.9 refractive index ceramic beads and,

C) True-wet reflective markings that function in continuous rain or water immersion having approx. 2.4 refractive index ceramic beads.

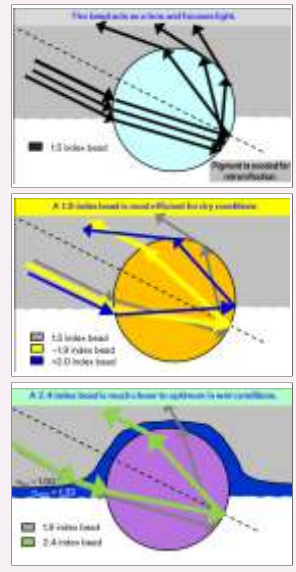


Figure 1

(A) Conventional 1.5 refractive index glass beads;

(B) High efficiency dry-condition 1.9 refractive index ceramic beads; and

(C) True-wet condition 2.4 refractive index ceramic beads in pavement marking lines interacting with vehicle headlights

Conventional marking system with 1.5 refractive index glass beads is a low-cost solution, but is a non-optimal design from the physical optics analysis of the 30-m driver geometry. There are some glass bead types that offer up to about 1.7-1.8 refractive index, however they tend to be flint glass that is less common, requires higher processing costs and gives a lower abrasion resistance than the commonly available soda-lime crown glass. In the ceramic world, different composition of materials can be treated with heat in order to synthesize the required optimal refractive index that is also highly abrasion resistant. 3M Company has commercialized such ceramic optics for pavement marking application for over 10 years. The microcrystalline ceramic beads are lumped together into a composite "optical element", attaching microcrystalline ceramic beads to an element core[9]. This approach helps to yield structured pavement markings having large granules that allow for fast draining of water during rain.

The review by Burn[10] et al also taught us that there is no one refractive index system for the surface drop optics that will work optimally for dry and true-wet conditions. When the markings are wet, a portion of the headlight skips forward with the water film acting as a partial mirror and rather than being returned to the same vehicle, it causes glare to the oncoming vehicles. The portion of headlight that is refracted into the surface dropped optic is retroreflected. However, the wafer film causes an effective index change (by the water refractive index 1.33) such that the bending power of the 1.5 optic is insufficient to direct the return light towards the driver. With the ceramic platform, the refractive index of microcrystalline ceramic beads can be synthesized appropriately to hit

the 2.4-2.6 sweet spot in the true-wet condition (2.5 index modified by 1.33 water index gives an effective index of 1.9). Having two constituent components – all-dry 1.9 index and all-wet 2.4 index microcrystalline ceramic beads, the commercial solution merely requires mixing of the appropriate dry vs. wet element ratio to yield the required dry weather and wet weather (i.e., all-weather conditions) performance specifications in a single marking. This is illustrated in Figure 2(a) and (b) for all-weather optical elements in liquid pavement marking and structured pavement marking tapes, respectively.

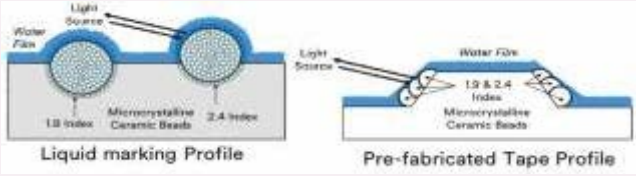


Figure 2 (a-left) All-weather optical elements dropped into liquid PM binders and (b-right) Structured All-weather PM Tape Profiles

In this paper, the authors share the results of road trials carried out with dual-optic drop-on elements system and pre-fabricated pavement marking tape designs on Indian roads with local traffic and driving characteristics.

Field Study of Advanced Marking Systems

A study has been carried out to establish the performance and relationships between the optics, and structure of pavement marking systems and their retroreflective efficiency under nighttime driving conditions. Five different pavement marking systems, four prototypes and one commercially available marking system, were tested (Table 1). The prototypes consisted of hot-applied thermoplastic coupled with dual-optic drop-on elements system, a unique technology that provides high retroreflectivity in both dry and wet weather conditions, and a pre-fabricated structured tape of two different designs. Benchmark is a standard commercial marking that consisted of hot-applied thermoplastic paint with AASHTO M247 Type 1 surface-drop glass beads. The markings were 4- inch-wide non-continuous lines for center lines and 6-inch-wide continuous lines for edge lines. The markings were white-colored and applied at about 2.5mm thickness.

TABLE 1
Description of Pavement marking systems used in Field Study

Marking	Marking System	Optics
Prototype A	Hot-applied Thermoplastic	
Prototype B	Hot-applied Thermoplastic	
Prototype C	Pre-fabricated structured tape Type I	
Prototype D	Pre-fabricated structured tape Type II	
Benchmark	Hot-applied Thermoplastic	

Following variables were considered in the field study:

- Pavement Surfaces – Asphalt and Cement-concrete
- Pavement Marking Configurations – Side/Edge lines and Center/Skip lines
- Traffic Conditions – Low to High ADT (Average Daily Traffic)
- Vehicle Type – Passenger and commercial vehicles

The coefficients of retroreflected luminance (R_L) at standard CEN 30-meter geometry were measured according to ASTM E1710 under dry conditions (R_L-dry) using internal beam retro reflectometer and according to ASTM E2177 under wet-recovery conditions (R_L-wet Rec) using external beam retroreflectometer. The coefficients of retroreflected luminance (R_L) under rainy conditions (R_L-wet Cont) were measured according to EN 1436 using a rain simulator set-up generating artificial rainfall at an average intensity of 20mm per hour.

The R_L values reported in Table 2 are an average of about 20 measurements, each measured at about 25 meter distance.

Results

Table 2 summarizes the initial coefficient of retroreflected luminance (R_L) for all the five pavement marking systems. All prototypes have 2.5 to 5 times higher R_L-dry values compared to benchmark system. R_L values for both wet recovery and wet continuous conditions are significantly higher by more than 10 times for prototype A, B and C compared to benchmark marking system. Nighttime visibility under dry and wet weather conditions are also captured in the photographs 1 to 6.

TABLE 2 Initial coefficient of retroreflected luminance (R_L)

Marking	R_L CEN 30-m Geometry (mcd / m² / lx)		
	Dry	Wet Recovery	Wet Continuous
Prototype A	787	582	441
Prototype B	865	442	326
Prototype C	848	391	340
Prototype D	521	44	42
Benchmark	184	36	17



Photograph 1 -Nighttime visibility under wet weather condition – Prototype A



Photograph 2 -Nighttime visibility under dry weather condition – Prototype B



Photograph 3 -Nighttime visibility under wet weather condition – Prototype C



Photograph 4 -Nighttime visibility under wet weather condition – Prototype D



Photograph 5 -Nighttime visibility under dry weather condition – Benchmark



Photograph 6 -Nighttime visibility under wet weather condition – Benchmark

Summary and Conclusions

Though the performance of prototypes over longer period is subject to further monitoring, on average, prototype marking systems have relatively high level of initial retroreflectivity under both dry and wet weather conditions and much brighter nighttime visibility.

The nighttime visibility of a pavement marking system is a function of many factors like driver's age and eyesight, headlamp intensity, windshield quality and cleanliness and retroreflective efficiency of pavement marking system. Of these factors, the only factor road agency can control or maintain is the retroreflectivity of the pavement marking system. Having fields trials conducted in India allows the road agency to witness enhanced performance of advanced marking systems versus conventional pavement markings and helps in making the right choice that best serves the purpose of on-road safety by means of enhanced nighttime visibility under all-weather conditions.

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PROCESS SAFETY MANAGEMENT – FROM CONCEPTION TO DEVELOPMENT

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Background:

For many years industry focused their accident prevention efforts on improving the technology and human factors (mostly behaviors). In mid 1980s, following a spate of serious chemical industry accidents around the world, company's industry bodies and the governments began to identify management systems as the underlying cause for the accidents. Companies were already implementing management system approaches regard to product quality, as evidenced by various Total Quality Management initiatives with considerable success. Companies developed policies, industry groups published standards and government issued regulations, all aimed to establish process safety in the management system framework. Thus, hazard analysis & equipment integrity were gradually incorporated into integrated management systems. Later inclusion of manufacturing excellence concepts has focused efforts and deeply embeds process safety management practices. The American Institute of Chemical Engineers Center for Chemical Process Safety CCPS was established in 1985 as one of US chemical industry's response to the major chemical accident in Bhopal, India. In 1988, the CCPS published a motivational advertisement – Chemical Process Safety Management – A challenge to commitment. It was primarily to educate & motivate chief executives of the industry to adopt and implement the process safety elements into the existing management systems. From 1989, CCPS began to publish series of guidelines and over 100 such guidelines were published since then, to enable the industries to pursue accident prevention by more proactive, integrated and holistic means.

Table 1: CCPS guidelines & tools for Chemical Process Safety Management (PSM):

- Guidelines for Technical Management of Chemical Process Safety, 1989
- Plant guidelines for Technical Management of Chemical Process Safety, 1992.1995
- Guidelines for auditing process safety management systems, 1993
- Guidelines for implementing Process Safety Management System, 1994
- Guidelines for integrating process safety management, Environment, Safety, Health & Quality, 1996
- Pro Smart: Performance measurement of process safety management systems, 2001

Going forward over the past 20 years, government in Europe & US also elsewhere has prompted widespread implementation of a management systems approach to process safety management. However various studies across organizations globally indicated that after an initial surge of activity, process safety management appears to have stagnated within most organizations. Incident investigations continue to identify inadequate management system as a key contributor to incidents. And audit trail reveals a history of repeated findings indicating chronic problems whose symptoms are fixed again & again with effectively addressing the root causes. Some of the reasons on why the process safety management system may have declined could be:

- It is not a regulatory requirement for many countries
- Process safety management system was developed by & for big companies. Smaller companies may not have the required capability & resource to implement it.
- Process Safety management was implemented as a separate, stand -alone system that was not integrated into the organizations overall management system.
- Since worker injury rates are steadily declining at most facilities, management assumes it is also indicative of lowering of process risks.
- Inconsistent financial support
- The legal system inhibits & the management does not understand or apply risk-based decision process.
- Mergers, acquisitions & divestitures have decreased organization stability
- Management systems are over emphasized whereas the technical aspects of process safety, which actually control the process or risks, are neglected.

Such reasons can do more harm than stagnation; they can lead organizations susceptible to losing their focus on process safety, resulting in a serious decline in process safety performance or a loss of emphasis on achieving process safety excellence. These reasons had prompted the Center for Chemical Process Safety (CCPS) to articulate the Risk Based Process Safety (RBPS).

Purpose of RBPS:

The purpose of the RBPS guidelines is to help the organizations design and implement more effective process safety management system (PSM). The risk base approach allocates the resources as per the severity of the risks therefore optimizing the precious resources reasonably. This approach is a paradigm shift which can benefit the organizations enormously who handles hazardous chemicals or manufacture or consume them by:

- Evolve the approach to accident prevention from compliance-based to a risk based strategy
- Continuously improve management system effectiveness
- Employ process safety management for non-regulatory processes using risk based design principles
- Focus the resources available on higher risk activities
- Integrate the process safety business case into company business processes.

The new framework is built upon the original process safety model published by CCPS in the late 19 80s. It has integrated industry lessons learned over the years, applies the management principles of "plan do check act", useful for all organizations including those with relative lower hazard activities.

RBPS Management System Accident Prevention Pillars:

- Commit to process safety

  Commitment to process safety is the key to success. Management commitment is of paramount importance. Organizations do not improve without strong leadership and solid commitment. Once the workforce is convinced that the leadership fully supports safety as a core value will tend to do right things, in the right way even without supervision. This behavior should be continuously nurtured & celebrated throughout the organization.
- Organizations that understands hazard & risks are better able to allocate limited resources in the most effective manner. Industry experience has demonstrated that business using hazard & risk information to plan, develop & deploy resources are greatly benefitted and enjoy long term success.
- Managing risks focus on 3 issues. (1) Aptly operating and maintaining the processes that pose the risk. (2) Managing changes to the processes so that risk remain tolerable. (3) preparing for, responding to the incidents that do occur.
- Learning from experience involves monitoring, and acting on, internal and external sources of information. The least expensive ways of learning from experience are (a) apply best practices to make the most effective use of available resources (b) correct deviations exposed from internal incidents and near misses (c) apply lessons learned from other organizations.

Focusing on these four aspects or pillars of RBPS should enable an organization to improve its process safety effectiveness, reduce frequency & severity of incidents and improve long term safety, environment & business performance.

These guidelines offer strategies on how companies can succeed in applying these above principles:

- Use RBPS criteria to design, correct or improve process safety management elements.

  Review the work activities associated with each element and update them based on a) an understanding risks associated with the facilities & operations b) an understanding of demand for process safety activities and the resources needed and c) comprehending how process safety activities are influenced by the process safety culture within the organization.
- Focus on process safety effectiveness as a function of performance & efficiency

Using metrics to measure performance and efficiency so that finite resources can be deployed in a prioritized manner to the large number of competing process safety needs.

To help companies implement these strategies the RBPS guidelines offer a new set of improved technical approaches. The Table -2 illustrates the key improvement done in RBPS over original PSM elements:

Table 2:

RBPS ELEMENT	Original PSM ELEMENT
Commit to process safety Process safety culture Compliance with standards Process safety competency Workforce involvement Stakeholder outreach	Accountability: Objectives & goals Enhancement of process safety knowledge
Understand hazards & Risks process knowledge management Hazard Identification & Risk Analysis	Process knowledge & documentation Project review & design procedures
Manage Risk Operating procedures Safe work practices Asset integrity & Reliability Contractor management Training & performance assurance	Training & performance Human factors Process & equipment integrity

Table 2:	
RBPS ELEMENT	Original PSM ELEMENT
Management of Change Operational readiness Conduct of operations Emergency management	Management of Change
Learn From Experience Incident investigation Measurement of metrics Auditing Management review & continuous Improvement	Incident investigation Audits & corrective actions

The listed issues below in the table 3 has been the most key issues while designing, developing, installing, revising, operating, evaluating & improving a process management system. A company may choose to address one or more of these issues in element to element basis or may choose a single issue can be the sole focus of the element.

Table3:
• Purpose & scope
• Personnel roles & responsibilities
• Tasks & procedures
• Necessary input & information
• Anticipated results and work products
• Personnel qualification & training
• Activity triggers, desired schedule, and timelines
• Necessary resources & tools
• Metrics & continuous improvement
• Management review
• Auditing

Application of RBPS guidelines:

In general the RBPS management system is meant to address process safety issues in all operations involving the manufacture, use or handling of hazardous substances or energy. The companies must decide on which physical areas and phases of process life cycle should be subject to RBPS, using risk based thought process to decide the depth of its use for process need. The following paragraph describe issues that are addressed within or kept out of scope of RBPS:

- ***Total life cycle:*** The RBPS elements are meant to apply to the entire process life cycle. Some of the elements may or may not be active in early life cycle stages. Other elements may be active. Information available in the early stages may not be detailed therefore work performed in that element would be more basic.

  For other elements, however, the early life cycle stages provides an unique opportunity to minimize risks by identifying and incorporating safer process characteristics.

- ***Fixed facilities, not transportation:*** The RBPS management system is applied to fixed facilities. Transportation activities are only within this scope when cargo vehicles, such as trucks, rail cars, containers are connected to a fixed facility during loading and unloading or used as a storage vessel.

- ***Processes, not products:*** The RBPS management system is meant to be applied to process safety related situations and not for product safety issues. Some elements and activities may be relevant to product safety situations, but such issues were not considered when RBPS guidelines were being laid.

The RBPS management system focuses on process safety issues. Recognizing potential overlaps, companies may want to integrate on possible situations. However, these guidelines addresses process safety as a single issue and do not include the following:

1) *Occupational health & safety*
2) *Environmental protection*
3) *Product Stewardship*
4) *Product distribution*
5) *Security*
6) *Quality*

Many companies use management systems approaches to address complex issues. In some cases, companies, promote the integration of the management system into one system to achieve the goals more efficiently. For example the Environment Health & Safety (EHS) management system. It is also seen some organizations integrate similar activities across the EHS domain at an element or work activity level, example management of change applies to changes that could impact the environment as well as process safety.

REFERENCES:

I) Center for Chemical Process Safety, PSM- A challenge to Commitment" 1988

II) Guidelines for Risk Based Process Safety – CCPS

This is an introductory article on Risk Based Process Safety (RBPS). The entire subject shall be covered into 5 articles comprising of the following four pillars of RBPS. These articles shall be published in the chronicle in a series.

1. Commit to Process Safety
2. Understanding Hazards & Risk
3. Manage Risk(2parts)
4. Learn from Experience.

The Managing Risk forms the core of the PSM and has many elements, so shall be covered in 2 parts for the ease of the readers to comprehend it.

* * *



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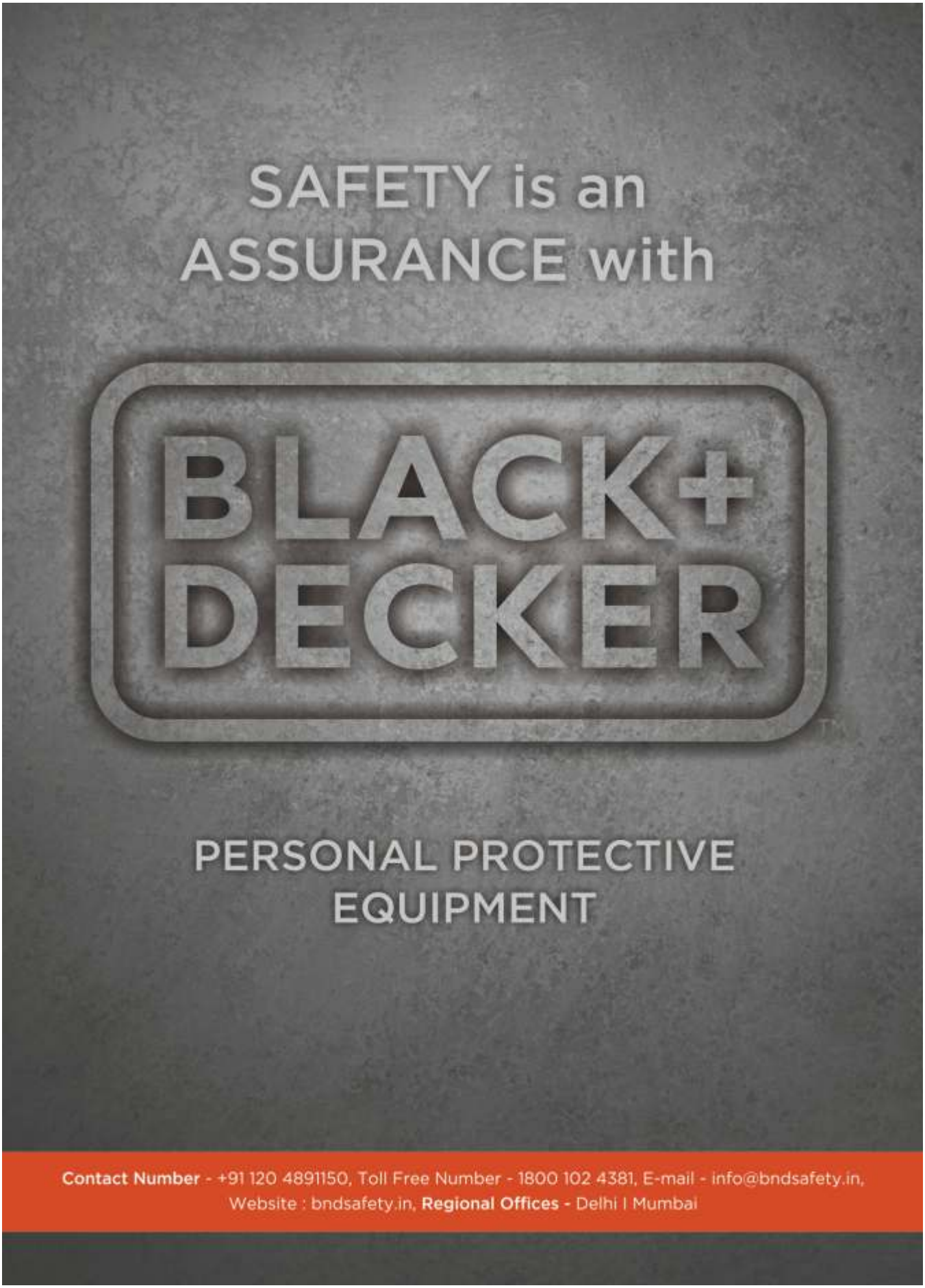
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