ROAD SAFETY CULTURE IN INDIAN CONTEXT IN ALL THE FACETS OF HIGHWAY DEVELOPMENT – NEED OF THE HOUR

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High rate of road accidents, geographic & demographic expanse, multi-functionality of roads, resource constraints, road safety culture, holistic approach, policy measures, trained safety professionals, data driven, crowd sourcing, solutions to safety concerns, retro-fitting the existing infrastructure.

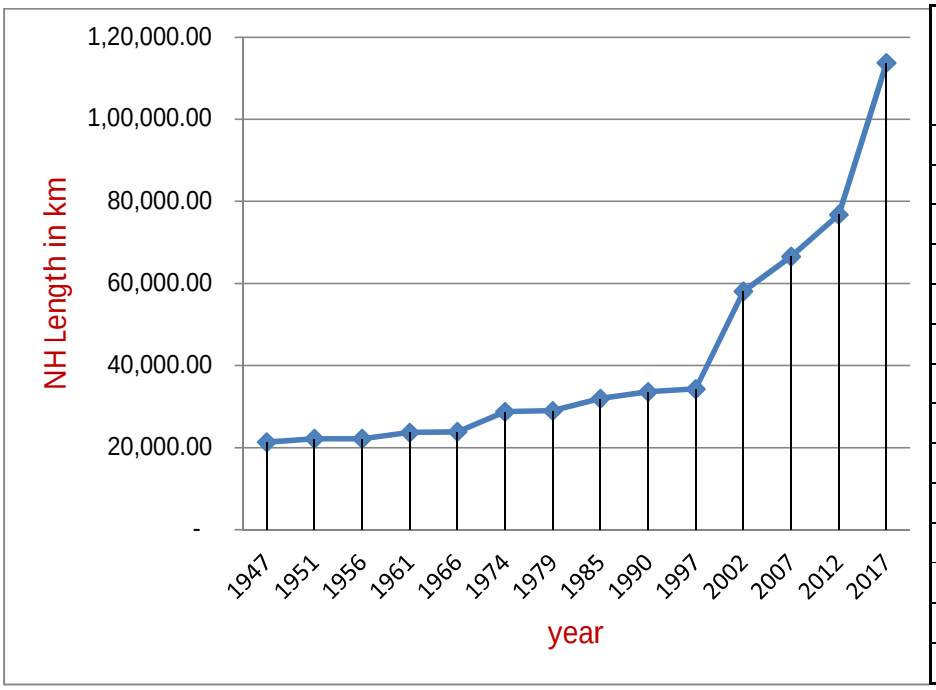
India is one of the countries with high rate of Road Accidents and fatalities. With the vast geographical expanse and demographic variation in the country, the issue of Road Safety becomes still more complex. A few Road Accidents status parameters are as below:

TABLE 1 Road Accident Status Parameters of India [1]

Parameter	Year (Latest available)	Magnitude
Total No. of Road Accidents	2015	5,01,423
Persons killed in Road Accidents	2015	1,46,133
Rural : Urban share of Road Accidents	2015	53.8% : 46.2%
Rural : Urban share of persons killed in Road Accidents	2015	61% 39%
Percentage of Vulnerable Road users &Percentage of other Road users killed Road Accidents killed	2015	48.10% & 51.90%
Percentage share of National Highways & State Highways in total number of persons killed in Road Accidents	2015	35% & 28%
Percentage share of National Highways & State Highways in total number of road accidents	2015	28% & 24%
No. of Road Accidents per 100,000 population	2015	40.00
No. of persons killed in Road Accidents per 100,000 population	2015	11.70
No. of persons killed in Road Accidents per 10,000 vehicles	2013	7.60
No. of persons killed in Road Accidents per 10,000 km of Roads	2013	262.09

1. GENESIS OF PRESENT ROAD SAFETY SCENARIO

National Highways, State Highways, Major District Roads, Other District Roads and Village Roads are the five functional categories of Non-Urban roads presently existing in the country. The highways are generally being developed by upgrading the lower category roads to higher category say Major District Road to State Highway and State Highway to National Highway etc.



Year	Cumulative NH Length(km)
1947	21,378.00
1951	22,193.00
1956	22,193.00
1961	23,707.00
1966	23,886.00
1974	28,757.00
1979	28,977.00
1985	31,980.00
1990	33,612.00
1997	34,298.00
2002	58,112.00
2007	66,590.00
2012	76,786.00
2017	**113,764.89**

FIGURE 1 NH length in India (in km) over the years

Improvements and developments are taken up in a phased manner depending upon the availability of resources on the higher category road after the road is declared as higher category road. Due to this approach of developing road network, many a times, the roads which are basically intended to serve the connectivity function are converted to higher category roads to serve mobility function. Due to these conflicting functional objectives, the roads finally end up serving partly connectivity and partly mobility functions thereby making the road safety issues more complex. In the process of phased development, higher visibility improvements like surface improvement, widening for augmentation of the capacity take precedence over safety related improvements like geometric improvements, Improvement of junctions, handling of road side environment etc. This lead to more and more safety concerns getting embedded into the highways making them more difficult to handle at later stage.

Due to the multi-functionality of the roads, highly heterogeneous traffic ranging from pedestrians, slow moving vehicles, non-motorized traffic to high speed heavy vehicular traffic plies on the same road making the safety issues more difficult to handle. In the process of gradual upgradation, land width of the roads is not increased, commensurate with the higher category of the road till a major development project is launched on the stretch. As the developments are taking place in resource constrained environment, safety related components and improvements are compromised vis-à-vis the general capacity augmentation priorities to fit the projects into available resources. This is further adding to the multiplicity of safety concerns. Increase in capacity and mobility in absence of commensurate safety improvements leads to increase in safety concerns in terms of quantum as well as severity. This genesis of present road safety scenario needs to be carefully considered in formulating policy measures towards enhancing road safety in the highway development.

3 COMPLEX TRAFFIC ENVIRONMENT & INADEQUATE ROAD USER AWARENESS

Several factors like road user education, enforcement, road and vehicle engineering aspects together with post-crash emergency care, interact with each other in a complex manner resulting into the road safety scenario depending on the complementarities of actions taken in all these areas. Competency testing of drivers at the time of driving license and its renewal which is basic road user education needs to be strict. Knowledge and skills of prospective drivers in respect of understanding of the road furniture, Road signs, Road markings and the road environment as a whole are to be tested scrupulously. Deficiency in this road user education results in inappropriate use of road infrastructure which is leading to increase in road crashes. This situation puts more demand on the design & development of road infrastructure in a more obvious manner compelling the road users into desirable ways of movements while making the undesirable movements that much more difficult by design. Lack of strict enforcement of traffic rules which in turn might be due to lack of resources including manpower and equipment is leading to widely prevalent violation of traffic rules. This also increases the demand on the design of road infrastructure taking care wherever feasible to make violation of traffic rules more difficult by appropriate design features. Similarly the deficiency in vehicle technology levels and emergency care also needs to be factored in during the design of road infrastructure and its environment, so that safety can be improved within the prevailing constraints. All these aspects have to reflect in nurturing the road safety culture in the development of road infrastructure.

4. MISUNDERSTANDINGS IN ROAD SAFETY ENGINEERING

Safety aspects related to road engineering are more misunderstood than they are understood. Many times, road safety concerns are confused with congestion on roads. Improvement of road safety through engineering measures is not removing congestion on the roads. For obvious reasons, road crashes do not happen in congested conditions and they do happen when the traffic volumes are low in case safety concerns remain unattended. Many times carriageway and turning paths are widened without improving the geometric parameters and without adequate road safety furniture and markings etc. This would lead to more accidents than it reduces in terms of their numbers as well as their severity as the traffic speeds increase on widened carriageway in absence of rectification of the unsafe conditions. Road safety through engineering measures demands a holistic approach and balancing at every stage.

Road safety through engineering measures has close linkages to road user psychology and socio-economic & cultural milieu of the region. Many times road signs & markings are simply treated as minor additions to the road work and are not given adequate attention and thought by the highway authorities. Road signs and Markings alone cannot bring safety without improvement in the basic features of the road infrastructure. They can only supplement the improvements in road infrastructure by way of guiding and warning road users making them use the infrastructure in the intended manner.

Several important characteristics of road signs & markings like appropriateness of the signs and markings at the given location, uniformity of these features along the route, adoption of standard shapes, colours, quality of the signs & markings, their appropriate position based on the prevailing speeds etc., are highly essential to make the road signs and markings effective in performing their functions. These aspects require thorough understanding of road safety

principles by all the stake-holders like road authorities, highway consultants and construction agencies.

Many times, the road crashes are solely attributed to lack of enforcement deficient road user education etc., thereby attributing only minor role to road & road environment in crashes. In fact road crashes mainly happen due to multiple reasons like inadequate skills and knowledge of driver, violation of traffic rules, factors related to road and road environment, climatic conditions etc. For bringing perceptible improvement in road safety all these parameters are to be improved. Among these factors, road engineering improvements can go an extra mile as they affect the present and future road users alike, once these measures are implemented. Correcting the misconceptions through adequate understanding of the principles of road safety is an important input to the development of road safety culture.

5. ROAD ACCIDENT BLACK SPOTS

Road accidents black spots are short stretches of road in which fatal road accidents take place possibly due to several safety concerns occurring in close proximity to each other. In India, these spots are defined as stretches of length up to 500m in which 5 fatal road accidents or 10 fatalities took place during last three consecutive calendar years. Identification of road accident black spots is a way of prioritizing the serious safety concern or a cluster of safety concerns on the road network leading to repeated fatal accidents at that particular location [2]. In no case every road safety concern on the road should be labeled as black spot, as it would defeat the basic objective of designating the location as a black spot as a way of prioritizing the location for urgent remedial action.

Ministry of Road, Transport & Highways, Government of India circulated the protocol for Road accident black spots on National Highways giving the definition of road accident black spots and a workable time schedule for handling the identified spots. Once identified, the black spot should be properly labeled, investigated and rectified through permanent improvement measures. Temporary measure like signs and markings alone without the follow up of long term measures can't bring about substantial reduction in crashes. However, for cautioning of road users about the existence of the black spot, immediate cautionary measures along with speed control measures should be implemented as soon as the black spots are identified so that road users are adequately warned till the black spots are permanently rectified.

Black spots on road network are formed due to various reasons. Commissions and omissions in the road development projects due to inadequacy in the survey investigations, preparation of detailed designs, cost considerations, land availability constraints etc., sometimes lead to formation of black spots. Changes in road side environment due to activities like installation of utility services close to the roadway, development of commercial / residential establishments close to the travelled way, growth of trees, installation of statues etc., near the carriageway causing obstruction to sight lines/ becoming road side hazards contribute to formation of black spots. Changes in the land use like change of agricultural land use to residential/commercial/ industrial land use cause substantial changes in traffic patterns resulting in formation of black spots. Unauthorized constructions like poles, advertisement boards, buildings, unauthorized access connections contribute to creation of road accident black spots. Therefore, identifying and rectifying black spots is a continuous process towards improvement of safety.

Monitoring of the crashes at the rectified black spot location for at least 3 calendar years is required to ensure that the measures taken are adequate and effective. If these measures are strictly followed in respect of road accident black spots, significant improvement of safety can be brought about by road authorities in their respective jurisdictions. All the road authorities should consider identifying the black spots strictly as per the definition based on thorough study of the network and their permanent rectification as important activities of road safety improvement.

6. ROAD SAFETY AUDITS

Road Safety audits are systematic studies of road stretches with respect to safety concerns related to road and road environment. Even though road safety audits are in vogue, since past many years in India, their implementation especially on roads other than National Highway is leaving much to be desired. These audits have to be carried out at the time of development of stretches as well as on the existing stretches where development projects are neither in progress nor are in the planning stage.

Depending on the category of the road and availability of the resources, a systematic framework for carrying out road safety audits at some or all of the stages like feasibility stage, detailed design stage, construction stage and commissioning stage etc., needs to be kept in place. Many times the road safety audits are carried out as formalities without in depth study of the road and road environment. Before auditing is carried out, all the features of the road including the land boundary, road side developments, road side hazards, junctions, alignment of the road, availability of the sight distance etc., are to be surveyed and mapped accurately to enable identification of the safety concerns in an objective manner.

Road safety audits are to be conducted by a team of two or more road safety auditors experienced in road safety and traffic engineering fields. Road safety audit needs to be carried out as a joint exercise by the auditing team and the road authorities in order to arrive at implementable recommendations to the safety concerns. Conditions on the road drastically change in different times of the day, especially during night times compared to the day time. Thorough study of the road environment during different times of the day, carefully identifying the safety concerns and recording them with the location references is an essential part of road safety audit to make the safety audit objective.

All the recommendations of the audits have to duly take into account the category of the road, nature of the traffic plying on the road, prevailing budgetary / other constraints and developmental plans of the region including the proposed improvements on the road stretch. Many times road safety audits place too much emphasis on road signs without recommending permanent remedial measures like improvement to the junctions, provision of service roads at semi-urban and urban locations, removal of road side hazards, regulation of speeds etc. Road signs and markings alone in absence of permanent improvements to the safety concerns do not bring significant improvement in safety.

Road authorities have to lay adequate emphasis on scrupulous conduct of road safety audits with commencement meetings, completion meetings and review of audit recommendations before finalization of the audit report. Independent and objective response of the audit team to the observations of the road authority on the initial audit report together with final recommendations,

minutes of the commencement and completion meetings should form part of the final audit report.

Road network needs to be covered through regular road safety audits in a phased manner, so that the important aspects of the road safety are taken care of even in the face of resource constraints. Implementation of the audit recommendations should be carried out immediately as a follow up of the road safety audit. Separate and earmarked funding needs to be established by the road authorities for implementation of audit recommendations. Systematic implementation of the road safety audits is the most efficient way of bringing about safety through road engineering measures and should be made part of all the road development plans for encouraging road safety culture.

7. ROAD SAFETY IN CAPACITY AUGMENTATION

Capacity augmentation by widening the carriageway is implemented especially when the roads are upgraded from lower category to higher category say Major District Road to State Highway and State Highway to National Highway etc. Capacity Augmentation is generally planned for a design traffic volume corresponding to a certain design period of 15 to 20 years. Therefore, much higher levels of service are achieved soon after widening, thereby allowing much higher speeds for a considerable time. As capacity augmentation involves a high degree of surface improvement, it also encourages much higher speeds. Due to this, any unattended safety concerns in the road stretch become much more severe and many safety concerns crop up due to the mismatch between the actual vehicular speeds and the road environment. Therefore, serious attention needs to be paid to safety aspects of the improvements proposed so that safety is not deteriorated after the capacity is increased.

When the Capacity augmentation projects are prepared and reviewed, safety concerns miss the attention as the major thrust goes to capacity at the cost of safety. Therefore, a special team of Road Safety Auditors should carefully audit the capacity augmentation projects avoiding sudden decrease in design speeds ensuring improvement of junctions, segregation of local traffic at the semi-urban and urban locations, provision of adequate facilities for vulnerable road users, adequate sight distance, correction of horizontal and vertical geometry and removal of road side hazards. Provision of appropriate road signs and markings in terms of their location, positioning, shape, colour and quality duly taking the vehicular speeds into account need to be included to bring safety improvement along with increase in capacity.

Handling of safety concerns as part of the project would be more efficient than addressing individual safety concerns in isolated manner. Wherever, improvements in road / road environment could not be achieved to meet the desired design speeds, the actual speeds have to be reduced to appropriate level through traffic calming measures to ensure that the road environment and the traffic speeds match with each other. Culture of assigning higher priority to road safety in reviewing and making decisions in all the capacity augmentation projects has to be encouraged, to reverse the present trend of increasing road fatalities.

8. COORDINATED APPROACH FOR ROAD SAFETY

Road safety is a result of actions in different areas viz., Road user education, enforcement, engineering and emergency care. In most cases of road crashes the incidents take place due to several reasons covering more than one out of four Es rather than due to a single cause. Therefore, the engineering remedial measures and other road safety improvement actions need to be complementary to each other to achieve intended improvement in road safety. Road user education needs to ensure that the road users especially the drivers understand the road rules and meaning of different road signs/markings. In absence of adequate road user education and enforcement, the infrastructure created does not get used in the intended manner, thereby defeating the objective of safety improvements in road infrastructure.

Many times even after safety oriented improvements in road infrastructure are implemented, the road users continue to use the road in the same way as was being used before improvements. This phenomenon reduces the efficiency of the road infrastructure improvements aimed at improving the road safety. For example, the local traffic may not use the service road and may continue to use the main highway even after the service roads are constructed. The improved junction with right turn storage lanes may not get used properly by the traffic, thereby continuing the unsafe ways of traffic movement even after the junctions are improved. In such cases coordinated approach with enforcement function would play major role in modifying the behavior of road users' in line with the infrastructural improvements. Inadequate display of emergency care facilities and related infrastructure like ambulances, emergency rescue vehicles etc., may also reduce the efficiency in handling post crash care. Adequate informatory signs and use of communication technologies like mobile applications, emergency telephone numbers etc., are important inputs in achieving coordinated road safety improvements in different areas of road user education, road engineering and emergency care.

Several issues related to general district administration and regulation play a significant role in the area of road safety. Unauthorized constructions and encroachments along the roads, unauthorized median openings, installation of illegal and unauthorized advertisement boards along the road, theft of road signs and other road furniture are the issues which have a close relation between district administration and safety related to road infrastructure / traffic regulation. Road safety needs to be made an important agenda item of development in the regular reviews with all the stake holder departments like road authorities, enforcement authorities, transport authorities and district administration to facilitate the implementation of road safety improvement measures. Such a coordinated approach brings synergy in faster reduction of road crashes and fatalities.

9. ROAD SAFETY AS PART OF MAINTENANCE OPERATIONS

All actions and inactions on Highways affect Road Safety to a lesser or greater extent. Certain road damages like missing manhole covers, damaged footpaths, damaged crash barriers, isolated big potholes etc., cause serious safety concerns apart from hindering smooth flow of traffic. Such aspects need specific and special attention to ensure safety through engineering interventions.

In usual maintenance operations of Highways attention generally goes to repair of the damaged pavement surface, damaged cross drainage structures etc., leaving out the other aspects related to

safety. Inspection and assessment of the road stretch with respect to safety issues require the inputs of personnel specially qualified and experienced in Road Safety Engineering. Therefore, it would be appropriate if Road Safety Engineering inspections which can also be called operational Road Safety audits are carried out to identify safety concerns which can be remedied through short term measures. These Road Safety Engineering inspections/operational Road Safety audits can be carried out at least twice a year (say towards close of monsoon and during foggy winter period). These activities should preferably be carried out by a team of trained Road Safety Auditors developed within the Road Authority or can be through an outsourced team of auditors till adequate in-house capabilities are developed.

The cost of carrying out the operational Road Safety audits and the implementation of the short term remedial measures can be met from the maintenance & repairs (M&R) resources. To ensure availability of funds for these important Road Safety Engineering actions a portion of M&R funds say 10% to 15% can be earmarked for these operations. These earmarked funds can be amalgamated with the general M&R funds with the approval of senior authorities in the department in the last quarter of the year in case those are not utilized for the intended purpose of Road Safety actions.

TABLE 2 M&R funds during the past years for National Highway maintenance in India [2]

Year	M& R funds in Rupees million	Funds for Road safety with 10% earmarking under M&R in Rupees Million
2012-13	14779	1478
2013-14	18025	1803
2014-15	25220	2522
2015-16	25279	2528
2016-17	25032	2503
Total	**108335**	**10834**

Giving emphasis to the safety related aspects in all the phases of road development including maintenance operations is highly essential to nurture Road Safety Culture in the development and operation of Highways.

10. ROAD ACCIDENT DATA BASE AS CORNER STONE OF ROAD SAFETY

Road accident data base is an important input to effective actions in all the areas of Road Safety namely road user Education, Enforcement, Road Engineering and Emergency Care. Presently First Information Reports (FIRs) recorded by police authorities are the sources of the road accident data which are collected and compiled for use of different stake holders. FIRs, many times do not capture the causes of crashes, especially those related to Road and Road environment, contributory factors to the crashes etc. Many of the nonfatal accidents do not get captured in police records there by making the data partial.

The campaigns for road user education need to be data driven in order to be effective. Depending on the concentration of different types of traffic rule violations, appropriate road user awareness campaigns should be planned. After the campaigns are organized, feedback on the

results of safety improvement should also be monitored on the basis of time series data of accidents.

Enforcement is an important activity to support the actions in the areas of Road user education and infrastructural improvements towards improvement of Road Safety. The ratio of number of police personnel to population is very low in the country compared to many developed countries. Further, there is severe pressure of law and order related duties on the police force there by lowering the attention to road accident data collection and compilation. In such a situation, it is all the more important to carefully plan the enforcement drives based on the accident data by suitably randomizing those drives to create the required effect of fear of being caught in the violating road users. Deploying the enforcement at most appropriate locations can be done only through well managed road accident data. Close monitoring of the effects of enforcement drives on the road user behavior to keep the motivation high in the enforcement personnel also requires accurate Road accident data. Efficient use of resources depends on the quality of road accident data base.

Road safety engineering improvements to infrastructure are capital intensive, time taking and are important contributors to improvement of Road Safety. Therefore, they should be based on Road accident data especially the data related to causative factors of accidents at a particular location to make the interventions cost effective. For example, identification and rectification of the road accident black spots should be based on Road accident data base so that only the critical locations where concentration of fatal accidents take place are only designated as black spots. The effectiveness of the engineering interventions also needs to be monitored based on post implementation road accident data. Accurate and wide road accident data base is a valuable input to the design of engineering remedies to Road Safety concerns. As per the international experience, the benefits of road accident data base are many times the cost of maintaining such data base and as such should be paid serious attention to encourage road safety culture.

Both, Collection of extensive road crash data with at least minimum basic parameters of the crashes as well as collection of intensive data at selected crash locations are important to meet the requirements of various stake holders including Road Safety Engineers, researchers etc. Specially trained man power units in different regions could be established to assist in in-depth study of selected major crashes to facilitate design of remedial measures and also help research aimed at working out preventive measures/policies.

Due to the prevailing manpower shortage, other possible approaches like use of mobile communication technologies, automatic data capturing equipment, crowd sourcing etc. could be used to facilitate collection of crash data with wider coverage. Uniformity of data parameters, automatic data transmission to relevant authorities, cross checks on the data for authentication, unified data base, appropriate compilation, analysis and Data base management including sharing of data with all stake holders need to be given due emphasis to support the Road Safety initiatives.

11. MANPOWER DEVELOPMENT FOR ROAD SAFETY ENGINEERING

Safety is an important aspect of all Road development. Due to several reasons, safety did not get the attention it deserves vis-à-vis other parameters of mobility (faster transportation) and capacity augmentation (reducing congestion) which led to accumulation of safety concerns on all

categories of road networks. Therefore, concerted efforts in this area are urgently needed by way of carrying out Road Safety audits, implementation of engineering interventions to safety concerns and identification/rectification of Road accident black spots. Presently there is severe shortage of Road Safety professionals in public as well as private sectors especially for retro-fitting the existing road infrastructure which is more complex than creating new infrastructure.

To handle the present condition of safety on the road network within the prevailing resources constraints, specialized knowledge and experience in Road Safety is very much required in both public and private sectors. As the custodian of Road network is mainly the concerned government, appropriate safety related actions cannot be ensured without development of specialized expertise among the highway engineers available in the public sector. Close coordinated working between the outsourced private sector agencies and road authorities is essential for working out effective, feasible and efficient solutions to the safety concerns. At the same time the availability of well trained safety professionals in private sector should also be pushed by public sector by placing appropriate premium on such expertise.

As development of manpower resources for a complex area like Road Safety Engineering would take time, all actions like organizing awareness workshops, training workshops, short/long term training courses within the country as well as in other developed countries and in-house sharing of knowledge within Road departments are all required in different areas like Road Safety Audits, design of road safety remedial measures, data base management, feedback monitoring etc. As there is a natural resistance to work in this complex area within the organizations, suitable incentives and encouragements need to be built into to draw talented professionals to the field of Road Safety Engineering.

12 Any change in most of the organizations including public sector road authorities is generally top driven. Hence, senior authorities in all the stake holder departments have to share the views and concerns through brain storming sessions, awareness workshops and reviews exclusively devoted to Road Safety. Such sustained efforts only can bring about the shared Road Safety culture which is urgently required to achieve perceptible improvement in the present Road Safety scenario in the country.

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