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Effects Of Highway Geometric Elements On Accident Modelling

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ABSTRACT*:-Road accident fatalities have been on an increasing trend for the last decade or so in India. Hence traffic safety management has emerged as a topic of discussion for researchers all over the world. Hence accident modeling on different factors causing them has to be conducted. Accident modeling helps us to know the real causative agents behind an accident to occur. The effect of one cause can be greater than the other. And those causes can only be known from accident modeling. In this paper we have tried to divide this accident modeling techniques into two different categories based on the location of road i.e. accidents on urban roads and on rural roads. In both urban and rural road accident studies it was seen that mainly regression techniques like linear, multi-linear, logit and poisons regression have been used for modeling the road crashes. It was also marked that mostly authors have tried to research on one cause and go deep into it rather considering all factors at a time. From the studies it was found that speed and age along with gender has been the area of study for accident causes in urban areas whereas in rural*

roads mostly all authors have limited their studies to speed on roads and has been noted as the major cause of accidents in rural areas. This paper has tried to review as much papers as possible and various gaps in research along with future scope of study in this area has been indicated. Starting from the basic models like negative binomial/Poisson's model to the logistic and linear regressions to the new modeling techniques involving genetic mining and fuzzy logics have been discussed explicitly in the paper. A series of surveys on accident investigation models show a wide variety of models, dedicated to specific

industrial applications, domains and investigation aspects. In particular the investigation of human factors is exposed to a wide diversity of models. In reviewing such models, the majority proves to be a derivate from the Reason's Swiss Cheese causation model or the Rasmussen model on system hierarchy. Most of the models origin from the process industry and the energy sector. Application in the aviation industry has revealed their conceptual limitations. Due to their simplifications and lay interpretations, their intervention potential in practice is limited to linear solutions. In order to cope with socio-technological interactions in a multi-actor perspective, a full systems engineering design approach should be applied in a mission specific operating envelope. Such an approach is submitted to three paradigmatic shifts in investigation methodology. First; disengagement is required between event modeling and systems modeling. Second; a distinction in two design classes is required. A distinction is made between linear interventions within the existing design envelope and second order interventions focusing on expansion of the design solution space. Third; designing safer solutions in a multifactor systems environment requires prototyping, virtual system model simulation and testing of limit state scenarios. Based on these constraints, a framework for safety enhancement is described, derived from experiences in the aviation industry itself.This paper outlines how geometric design standards for undivided interurban roads have changed over time in response to financial, safety and environmental constraints. Initially, the dimensions of each road element were selected to provide a safe road layout and a desirable level of service.

Key words:: accident analyses, safety , critical, socio-technical systems, systems theory, sociological analysis, organizational theory, systemic accident models, occurrence, incident,

1. INTRODUCTION

Road crashes have been in on an increasing trend in the last decade or so. This has led the researchers to think of this problem and find possible causes and precautionary measures to prevent crashes from happening. This field of transportation engineering is more commonly recognized as traffic safety and management. These researches have led to development and discovery of new models predicting road crashes accurately. This paper combines many important models and discusses the theory involving the discovery to that model. It also compares and contradicts the models developed by different researchers.

Road accidents are very common all over the world and annual global road crash statistics (Association for Safe International Road Travel, 2013) states that, nearly 1.3 million people die in road crashes each year, on average 3,287 deaths a day with an additional 20-50 million are injured or disabled. More than half of all road traffic deaths occur among young adult ages between 15 to 44 years. Road traffic crashes rank as the 9th leading cause of death and account for 2.2% of all deaths globally. Road crashes are the leading cause of death among young people ages between 15 to 29, and the second leading cause of death worldwide among young people ages between 5 to 14 years. Unless action is taken, road traffic injuries are predicted to become the fifth leading cause of death by 2030.

When India is concerned, it is a part of human tragedy. Along with monetary losses it also leads to human sufferings, untimely death, injuries and loss of potential income. During the calendar year 2010, number of road accidents in India is around 5 lakhs and number of deaths due to those accidents is 1.3 lakhs. Number of injuries due to those accidents is 5.2 lakhs. If the age group and the accident data are compared, it is seen that 55% of road accident victims fall in the age group of 25-65 years while out of rest 45%, 40% of road accident victims come from the age group of 16-24 years. It can be concluded that the adolescents are very much prone to and contribute to most of the accidents in Andhra Pradesh.

Hence, traffic accidents and their safety is a major area of research. So, in this paper, some important models developed for traffic safety along with researches done on the topic are studied and are reviewed thoroughly. At first the general factors affecting the road crashes and general models developed for predicting road crashes are discussed in brief. It follows the literatures of road crashes in urban and rural roads and then a discussion involving comparison and contradiction of models. Also the future scope of the study is discussed in detail. This paper has the following structure. In Section 1, we present the factors responsible for crashes; in Section 2, we present some models for traffic safety; In Section 3, we present a discussion of the accident models.

Accidents have been broadly defined as: a short, sudden and unexpected event or occurrence that results in an unwanted and undesirable outcome … and must directly or indirectly be the result of human activity rather than a natural event'. Accident prevention is the most basic of all safety management paradigms. If safety management is effective, then there should be an absence of accidents. Conversely, if accidents are occurring then effective safety management must be absent. Therefore, understanding how accidents occur is fundamental to establishing interventions to prevent their occurrence.

A simple nexus it would seem, yet the reality is accidents are complex events, seldom the result of a single failure, and that complexity has made understanding how accidents occur problematic since the dawn of the industrial revolution. In an attempt to unravel the accident causation mystery, over the years authors have developed a plethora of conceptual models. At first glance they appear to be as diverse and disparate as the accident problem they purport to help solve, yet closer scrutiny reveals there are some common themes. There are linear models which suggest one factor leads to the next and to the next leading up to the accident, and complex non linear models which hypothesise multiple factors are acting concurrently and by their combined influence, lead to accident occurrence. Some models have strengths in aiding understanding how accidents occur in theory. Others are useful for supporting accident investigations, to systematically analyse an accident in order to gain understanding of the causal factors so that effective corrective actions can be determined and applied. Accident models affect the way people think about safety, how they identify and analyse risk factors and how they measure performance. they can be used in both reactive and proactive safety management and many models are based on an idea of causality. accidents are thus the result of technical failures, human errors or organisational problems.

Road traffic accidents, deaths, and injuries occur worldwide. The estimated figure comprised of about over 1.2 million people died each year on the world roads as a consequence of road traffic accidents. According to the study by WHO, more than 3,200 people get dead and over 130 000 injured in traffic every day around the globe. Besides, nearly half of all fatal accidents involve pedestrians, cyclists, and power two wheelers collectively called vulnerable road users . When considering the population figures into account, developing nations in Sub-Saharan Africa bears the highest frequency of various accidents worldwide . Currently, developing countries contribute to over 90% of the world's road traffic fatalities and overall road injury, disability-adjusted life year (DALYs) increased by 2.5% between 1990 and 2010, with pedestrian injury DALYs increasing by 12.9%, more than any other category . In Africa over 80% of commodities and people are transported by roads while in India road transport accounts for over 90% of all the interurban

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freight and passenger movements in the nation . Road traffic crashes pose a substantial burden in India, as is the case for other developing countries' because India was one of the developing countries in the world and road is the major transport scheme. Car ownership has grown rapidly at approximately 7.0% per annum on average .

A post-crash approach was the method used in this paper to determine the relationships between road geometry parameters and crash rate. Furthermore, the analysis examines the cases of collapses that most influenced by the critical road parameters. The road traffic accident hazard is believed to be much higher than the indicated statistics by the traffic police record because of under-reporting. The report of road traffic accident showed the occurrence of correct frequency in the study area was high from the other districts. The survey tracked the major road of Addis Ababa to Mekelle passing the three districts of Guntur, Ongole and Amaravathi. The length of the path is about 116.24km. In addition to the traffic accident related to geometric design, this project also focused on assessing the general characteristics of road traffic accident, major causes and factors contributory to traffic accidents, its effect, and its countermeasures to reduce the severity of road traffic accident.

In India road traffic accident is a perennial problem, specifically in bombay road section. This incidence has long been affected the people and damages vast amount of property threatening the social – economic impact to the surrounding region in the country. In this research study, it was set out to assess the road traffic accident spatially and temporally considering its relevance to planners, policy makers, stakeholders and the community as a whole. Therefore; the research had been used differently engineering techniques and design to ensure the geometric design and construction of road safety would become reliable.

Accident models form the basis for investigating and analyzing accidents, preventing future ones, and determining whether systems are suitable for use (risk assessment). In accident investigation they impose patterns on the accidents and influence both the data collected and the factors identified as causative. They also underlie all hazard analysis and risk assessment techniques. Because they influence the factors considered in any of these activities, they may either act as a filter and bias toward considering only certain events and conditions or they may expand activities by forcing consideration of factors that are often omitted.

Most accident models view accidents as resulting from a chain or sequence of events. Such models work well for losses caused by failures of physical components and for relatively simple systems. But since World War II, the types of systems we are attempting to build and the context in which they are being built has been changing. This paper argues that these changes are stretching the limits of current accident models and safety engineering techniques and that new approaches are needed. The changes include:

Functional Resonance Accident Model(FRAM)

Accident Analysis

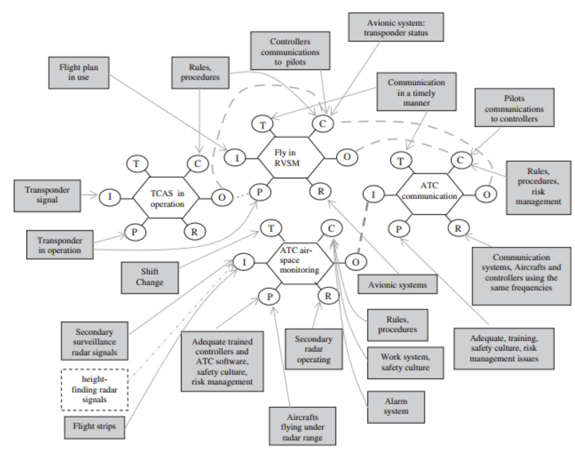

Fig. 12. FRAM describing the essential functions to fly in RVSM.

Characteristic of Geometric Design Element on Road Traffic Accident

presented vehicle collision distributions by roadway alignment. There were 32% collisions occurred in escarpment sections and similarly 24 % at a tangent, 22% of the mountainous terrain, 12% of the rural area and 10% of the urban area. This

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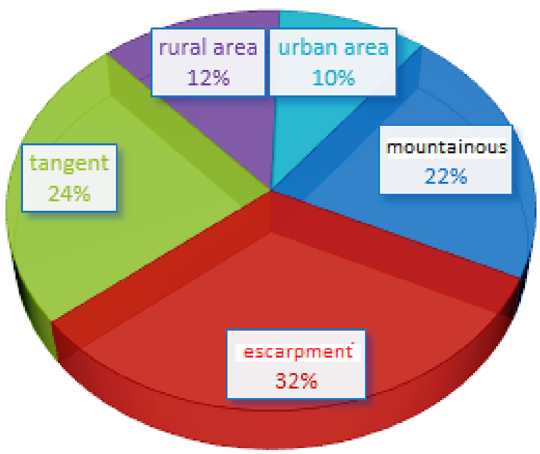
incidence revealed that the highest collision was happening in the escarpment and followed at the tangent section. Mountain sections were composed of many curves and gradient, which makes difficult to provide a sufficient road right of way and cut the grade at the desired level. To this point, it has also affected the sharp curves which tend to restrict sight distances and the required Super elevation.



CONCLUSION

After reviewing on the many studies which are related the safety of cross-section and alignment elements can be concluded the following:

- The presence of a median has the effect of reducing specific types of accidents, such as head-on collisions. Medians, particularly with barriers, reduce the severity of accidents

- Fixing the cameras everywhere and if the reaction of the traffic police works accordingly may create fear in the drivers then they also follow the rules it leads to decrease in the accident rate.

- providing underground transportation facilities in the highly traffic areas decreases the waiting time and the transportation time. Rates of ROR and OD accidents decrease with increasing lane and shoulder width. However, the marginal effect of lane and shoulder width increments is diminished as either the base lane width or shoulder width increases.

- On multilane roads, the more lanes that are provided in the traveled way, the lower the accident rates.

- Shoulder wider than 2.5m give little additional safety. As the median shoulder width increase, accidents increase.

- From the limited information available, it appears that climbing lanes can significantly reduce accident rates.

- Lane width has a greater effect on accident rates than shoulder width.

- Horizontal curves are more dangerous when combined with gradients and surfaces with low

coefficients of friction. Horizontal curves have higher crash rates than straight sections of similar

length and traffic composition; this difference becomes apparent at radii less than 1000 m

This paper has described a new accident model, STAMP, based on system theory. Each level of the socio-technical structure of a system can be described in terms of levels of control. Each level exercises control over emergent properties, in this case safety, arising from

(1) component failures,

(2) dysfunctional interactions among components,

(3) unhandled environmental disturbances at a lower level.

Managing safety requires identifying the constraints on process behavior necessary to ensure safety and imposing these constraints (through design or operations) to limit the behavior

of the process below to safe changes and adaptations. STAMP focuses particular attention on the role of constraints in safety management. Instead of defining safety in terms of preventing component failure events, it is defined as a continuous control task to impose the constraints necessary to limit system behavior to safe changes and adaptations.

Accidents are seen as resulting from inadequate control or enforcement of constraints on safety-related behavior at each level of the system development and system operations control structures.

Accidents can be understood, therefore, in terms of why the controls that were in place did not prevent or detect maladaptive changes, that is, by identifying the safety constraints that were violated at each level of the control structure as well as why the constraints were inadequate or, if they were potentially adequate, why the system was unable to exert appropriate control over their enforcement.

The use of control structures and process models in STAMP allows incorporating non-linear relationships reflecting the behavioral dynamics controlling the behavior of the entire technical and organizational structure over time. Control software, which contributes to most accidents in complex systems by satisfying incorrect requirements rather than failing to satisfy its requirements, is treated as contributing to an accident by not enforcing the appropriate constraints on behavior or by commanding behavior that violates the constraints, presenting a clear path to dealing with the safety of software-enabled systems. Finally, human error is treated as part of an ongoing process that is influenced by context, goals, motives, and mental models

Each of the explanations for the incorrect FMS input of *R* in the Cali American Airlines accident described in Section 2, for example, appears in the analysis of that accident using STAMP, but they appear at the different levels of the control structure where they operated. The modeling also helped us to understand the relationships among these factors. Modeling the entire control structure and its participants helped in identifying differing views of the accident process by designers, operators, managers, and regulators—and the contribution of each to the loss. Recommendations for changes to prevent future accidents were easy to identify and rank as to importance using the final STAMP model of the accident.

While STAMP will probably not be useful in law suits as it does not assign blame for the

accident to a specific person or group, it does provide more help in understanding accidents by forcing examination of each part of the socio-technical system to see how it contributed to the loss (and there will usually be contributions at each level). Such understanding should help in learning how to engineer safer systems, including the technical, managerial, organizational, and regulatory aspects.

STAMP should be useful not only in analyzing accidents that have occurred but in developing system engineering methodologies to prevent accidents. Hazard analysis can be thought of as investigating an accident before it occurs. Traditional hazard analysis techniques, such as fault tree analysis and various types of failure analysis techniques, do not work well for software and system design errors.

STAMP provides a direction to take in creating new hazard analysis and prevention techniques that go beyond component failure and are more effective against system accidents, accidents related to the use of software, accidents involving cognitively complex human activities, and accidents related to societal and organizational factors.

A system accident model could also point the way to very different approaches to risk assessment. Currently, risk assessment is firmly rooted in the probabilistic analysis of failure events. Attempts to extend current PRA techniques to software and other new technology, to management, and to cognitively complex human control activities have been disappointing. The arguments in this paper suggest that this way forward leads to a dead end. Significant progress in risk assessment for complex systems may require innovative approaches starting from a completely different theoretical foundation. STAMP could also be used to improve performance analysis.

In future, design standards are likely to incorporate climate change and carbon content considerations and also intelligent transport systems for achieving balanced road networks and safer roads.

After reviewing on the many studies which are related the safety of cross-section and alignment elements can be concluded the following:

- _Lane and shoulder conditions directly affect run-off road (ROR) and opposite direction (OD) accidents. Other accident types, such as rear-end and angle accidents, are not directly affected by these conditions.
- _The presence of a median has the effect of reducing specific types of accidents, such as head-on collisions. Medians, particularly with barriers, reduce the severity of accidents

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- _Rates of ROR and OD accidents decrease with increasing lane and shoulder width. However, the marginal effect of lane and shoulder width increments is diminished as either the base lane width or shoulder width increases.
- _On multilane roads, the more lanes that are provided in the traveled way, the lower the accident rates.
- _Shoulder wider than 2.5m give little additional safety. As the median shoulder width increase, accidents increase.
- _From the limited information available, it appears that climbing lanes can significantly reduce accident rates.
- _Lane width has a greater effect on accident rates than shoulder width.
- _Larger accident rates are exhibited on unstabilized shoulder, including loose gravel, crushed stone, raw earth or turf, than on stabilized (e.g. tar plus gravel) or paved (e.g. bituminous or concrete) shoulders.
- _The probability of an accident two-lane rural roads is highest at intersections, horizontal curves and bridges. The average accident rate for highway curves is about three times the average accident rate for highway tangents.
- _Horizontal curves are more dangerous when combined with gradients and surfaces with low coefficients of friction. Horizontal curves have higher crash rates than straight sections of similar length and traffic composition; this difference becomes apparent at radii less than 1000 m. the increase in crash rates becomes particularly significant at radii below 200 m. Small radius curves result in much shorter curve lengths and overall implications for crashes may not be as severe as would first appear.
- _There is only a minor decrease in the speed adopted by drivers approaching curves of radii which are significantly less than the minimum radii specified for the design speed. However, curve radii below 200 m have been found to limit the mean speed to 90 km/hr.
- _The average single vehicle accident rate for highway curves is about four times the average single vehicle accident rate for highway tangents. Regarding general terrain descriptions it was found that accident rates in mountainous terrain can be 30 percent higher than in flat terrain.
- _Crashes increase with gradient and down-gradients have considerably higher crash rates than up gradients. However, the overall crash implications a steep gradients may not be severe since steeper gradients are shorter. The geometry of vertical curves is not known to have a significant effect on crashes severity.
- _There appears to be little erosion of safety resulting from the use of sight distances below the minimum values specified in geometric design standards, although there is a significant increase in the accident rate for sight distances below 100 m.

Many developed nations have started a campaign with the motto of “vision zero” that predicted zero deaths on roads. Thus, there is so much research made on traffic accidents in developed countries. However, in India there is not enough research or study on this issue. It is suggested that more importance should be given to the Road Safety issue considering all accident causing factors and a highway safety system should be developed.

Consequently, both models do not comply with the needs of accident investigation theory and practices and systems engineering design needs in the aviation industry. Consequently, engineering design methodology may provide an alternative for improving the safety performance of complex systems at a socio-technical level. The potential for systems engineering design in providing safer solutions requires to:

Identify inherent properties before they manifest themselves as emergent properties

Deal with complexity and dynamics by focusing on functions rather than on factors

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- Focus on design principles and properties rather than optimizing performance

- Introduce systems dynamics by synthesizing interrelations into accident scenarios

- Apply a proof of concept by testing solutions in a dynamic simulation environment

Therefore, it is necessary to:

- develop event scenarios separated from systems models

- develop prototypes of safer solutions

- create dedicated virtual systems models, representing their specific characteristics

- facilitate testing and validation in these models, parallel to the real system

This research study carried out two critical data, one was road geometric, and the other was a road traffic accident. These data are used to describe the general characteristics of the road traffic accidents, identify the major causes using the collected road traffic accident, and to verify from a wide range of road geometric design elements and its effect on the motorists. Road safety audit on existing roads was conducted using ERA standard checklists to collect factual data in the project area. Based on the results and discussion, the survey demonstrated that the frequency and occurrence of road traffic accidents in study area revealed dramatic variations because of the impact of various factors such as temporal variation (i.e. Hourly, daily,) alignment effect (i.e. Tangent, mountainous and escarpment areas), driver characteristics. Therefore, the road traffic accidents randomly dispersed in the field of study in terms of time and place.

Road fatalities are one of the most important problems in our society, causing thousands of victims every year. To contribute with the improvement of the road safety, this paper presents a new design consistency model that may be used as a surrogate measure for road safety evaluation of two-lane rural roads. The consistency model has been developed from the regression analysis between several speed-measures variables and crash data. The used speed-measures include not only variables related to operating speed but also related to deceleration and posted speed. All of them have been obtained from operating speed profiles built with the operating speed and deceleration/acceleration speed models developed in previous research

REFERENCES

[1] AASHO. A Policy on Geometric Design of Rural Highways. American Association of State Highway Officials. Washington DC, 1965.

[2] Leebody, J.W. Bog or Peat Roads. Paper presented to the Second Irish Road Congress. 1911

[3] Highway Capacity Manual. Highway Research Board. Washington DC. 1965.

[4] O'Cinneide, D. et al. A Comparison of Road Design Standards and Operational Regulations in Europe. Procs. Seminar K. The 22nd European Transport Forum. PTRC Educational and Research Services. London, 1994

[5] O'Cinneide, D. et al. The Effects of Geometric Elements on Interurban Accident Rates. 3rd International Symposium on Highway Geometric Design. Compendium of Papers CD-ROM. Transportation Research Board. Washington DC, 2005.

[6] Seymour, J. and D. O'Cinneide. A Safety Assessment of Roundabouts in INDIA. Roads and Traffic Section. The Institution of Engineers of INDIA, Dublin, 1997.

[7] O'Cinneide, D. The Relationship between Geometric Design Standards and Safety. International Symposium on Highway Geometric Design Practices. Boston 1995. Conference Proceedings. Edited by Texas Transportation Institute, College Station, Texas, 1998.

[8] INDIA Design Manual for Roads and Bridges. http://www.standardsfor highways.co.INDIA/dmrb/index.htm

[9] National Roads Authority Design Manual for Roads and Bridges. http://www.nra.ie/Publications/RoadDesignConstruction/NRADesignManualforRoadsBridges.

[10] Douglas, W., Joseoh, E., and Kelth, K., "Operational and Safety Effects of Highway Geometrics at the Turn of the Millennium and Beyond ", TRB, National Research Council, Washington, D.C, 2000.

[11] Lamm, R., Psarianos, B., Choueiri,E.M., and Soilemezoglou, G., "A Practical Safety Approach to Highway Geometric Design International Case Studies: Germany, Greece, Lebanan, and The United States ", Transportation Research Record, 1994.

[12] Deo, Chimba, "Evaluation of Geometric and Traffic Characteristics Affecting The Safety of

[13] Six-Lane Divided Roadways", M.Sc., The Florida State University College of Engineering, 2004.

[14] Department of Transportation, "Safety Handbook for Secondary Roads", USA, 2007.

[15] O'Cinneide, D., "The Relationship Between Geometric Design Standards and Safety", University of College-Cork, 1995.

[16] Finch, D.J. etal., "Speed, Speed Limits and Accidents", PR58, Transportation Research Laboratory, Growthorne, 1994.
[17] 16.Aeronautica Civil of the Republic of Colombia, 1995. Control Flight into Terrain: American Airlines Flight 965, Final Report of Aircraft Accident: American Airlines Flight 965, December 20.
[18] Ashby, W.R., 1956. An Introduction to Cybernetics, Chapman and Hall, London. Ayres, R.U. and Rohatgi, P.K., 1987. Bhopal: Lessons for technological decision-makers, Technology in Society, 9:19–45.
[19] Bachelder E., Leveson, N.G., 2001. Describing and probing complex system behavior: A graphical approach, Aviation Safety Conference, Society of Automotive Engineers, Seattle, September.