TRIPP BULLETIN
VOL. 11 NO.1 SUMMER 2014
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
INDIAN INSTITUTE OF TECHNOLOGY DELHI

Publications

BOOK

Determinants of construction project success in India. Jha, K. N. (2013). Springer, The Netherlands.

RESEARCH PAPERS

Determining the strain rate dependence of cortical and cancellous bones of human tibia using a Split Hopkinson pressure bar. Teja, C. K., Chawla, A., & Mukherjee, S. (2013). *International Journal of Crashworthiness, 18(1), 11-18.*

Characterization of human long bones using experiments, imaging and inverse finite element techniques. Mike W.J. Arun , Sudipto Mukherjee, Anoop Chawla, Girish Sharma, Parthiv Shah, Christophe Ageorges (2013) *Short note IRCOBI Proceedings 2013*, pp.133.

A method to compare and quantify threat to pedestrian using injury cost measure. Sankarasubramanian H., Chawla A., Mukherjee S., Goehlich D. (2013), *IRCOBI Proceedings 2013, pp 896-910.*

Spline approximations for modeling thoracic and lumbar spinal trajectories for sagittal plane movement in a FE-HBM. Marathe Ratnakar, Chawla Anoop, Mukherjee Sudipto, Rajesh Malhotra. (2013), *International Symposium on Human Modelling and Simulation in Automotive Engineering, May 12-14.*

Closed loop autonomous calibration of tele-operation exoskeleton. Mukherjee, S., Zubair, M., Suthar, B., and Kansal, S. (2013). *In Proceedings of Conference on Advances In Robotics, ACM. P. 1-3.*

Finger gaiting for rotation of sphere by multifingered robot hand. Suhaib, M., and Mukherjee, S. (2013). *In Proceedings of Conference on Advances In Robotics, ACM. p 1-4.*

Dynamic analysis of compliant based pseudo-rigid-body constant force slider crank mechanism using the environment like ansys. Gupta, A., Rattan, S. S., and Mukherjee, S. (2013). *International Journal of Mechanical Engineering and Robotics Research, Vol. 2 No. 3 pp 296-309.*

Urban street structure and safety. Mohan, D. and Bangdiwala, S. (2013). *In Safety, Sustainability and Urban Transport. (Ed. Mohan, D.), Eicher Goodearth Pvt Ltd, 2013.*

Urban transport and climate change. Health, environment and sustainable development:towards the future we want. Mohan, D. (2013). *Washington, DC: Pan American Health Organization.*

Moving around in Indian cities. Mohan, D. (2013). *Economic & Political Weekly, XLVIII, 40-48.*

Safety of children as motorcycle passengers. Mohan, D. (2013). *Proceedings of the Eastern Asia Society for Transportation Studies, 9, 1-10.*

Speed characteristics of road users in work zones on Indian highways. Gupta, S., and Tiwari, G. (2013). *In Proceedings of the Eastern Asia Society for Transportation Studies, vol. 9 p 388..*

Impact of grade separator on pedestrian risk taking behavior. Khatoon, M., Tiwari, G., and Chatterjee, N. (2013). *Accident Analysis & Prevention, 50, 861-870.*

Avoiding, transforming, transitioning: pathways to sustainable low carbon passenger transport in developing countries. Figueroa, M. J., Fulton, L., and Tiwari, G. (2013). *Current Opinion in Environmental Sustainability, 5(2), 184-190.*

Strategies of state and local government in management of urban transport problems–A case of Delhi. Sen, A. K., Tiwari, G., and Upadhyay, V. (2013). *Research in Transportation Economics, 38(1), 11-21.*

Road safety: laws and implementation. Tiwari, G. (2013). *Int J of Injury Control and Safety Promotion, 20(4), 305-306.*

Motorcycle mobility and traffic risk. Tiwari, G. (2013). *International journal of injury control and safety promotion, 20(2), 101-102.*

Calibration of HDM-4 emission models for Indian conditions. Prasad, C., Swamy, A. K., and Tiwari, G. (2013). *Procedia-Social and Behavioral Sciences, 104, 274-281.*

Comparative evaluation of alternate bus rapid transit system (BRTS) planning, operation and design options. *In Proceedings of the Eastern Asia Society for Transportation Studies, Vol. 9, p. 244.*

Binary probabilistic models for pedestrians' crossing behaviour and risk at the free left turn: Delhi, India. Khatoon, M., Tiwari, G. and Chatterjee, N. (2013). *J. Eastern Asia Society for Transp. Studies. 10, pp 1-12.*

Modelling of pedestrian unsafe road crossing behavior: A comparison at a signalized and a non-3 signalized crosswalk 4. Khatoon, M., Tiwari, G. and Chatterjee, N. (2013). *In TRB 92nd Annual Meeting (No. 13-4086).*

Evaluating safety of urban arterial roads of medium sized Indian city. Prajapati, P., and Tiwari, G. (2013). *In Proc. of the Eastern Asia Society for Trans. Studies, Vol. 9, p-375.*

Study of relation between actual and perceived crash risk. Prajapati, P. and Tiwari, G. (2013). *Procedia-Social and Behavioral Sciences, 104, 1095-1104.*

Pedestrian accident analysis in Delhi using GIS. Rankavat, S., and Tiwari, G. (2013). *In Proc. of the Eastern Asia Society for Trans. Studies, Vol. 9, p. 272.*

Low carbon mobility plans: a case study of Ludhiana, India. Grover, S., Tiwari, G., and Rao, K. R. (2013). *Procedia-Social and Behavioral Sciences, 104, 785-794.*

Multiple classification analysis for trip production models using household data: case study of Patna, India. Gadepalli, R., Jahed, M., Ramachandra Rao, K., & Tiwari, G. (2013). *J of Urban Plann. Dev. 104, 785 – 794.*

Person-based dynamic traffic assignment for mixed traffic conditions. A. Agarwal, M. Zilske, K. Ramachandra Rao, K. Nagel (2013). *Conf. Agent Based Modelling in Transp. Plann. and Operations, Blacksburg, USA, Sep-Oct 2013.*

Construction zone traffic management– a case study on national highways widening in India. K. Ramachandra Rao, and G. Tiwari (2013). *2nd Int Conf Infra Dev in Africa (ICIDA 2013), Johannesburg, South Africa, March 2013.*

Other issues in project coordination and traits of a project coordinator. Jha, K.N. (2013). *In Determinants of Construction Project Success in India. P.193-210.*

Effect of strain rate on constitutive behavior of AA-5052 H34. Sharma, P., Chandel, P., Mangla, V., Mahajan, P. and Singh, M. (2013). *Key Engineering Materials, 535, 60-63.*

A comparative study of turbulence models performance for the study of air flow in helmets. Shishodia, B. S., Sanghi, S. and Mahajan, P., (2013). *1st International Conference on Helmet Performance and Design, Imperial College, London,UK, 15 February 2013, HPD-2013-8.*

PATENT

Apparatus and a method for folding and unfolding a foldable transport container. Chawla, Anoop, and Sudipto Mukherjee (2013). U.S. Patent No. 8,480,552.

The **Transportation Research and Injury Prevention Programme (TRIPP)** at the Indian Institute of Technology Delhi, is an interdisciplinary programme focussing on the reduction of adverse health effects of road transport. TRIPP attempts to integrate all issues concerned with transportation in order to promote safety, cleaner air, and energy conservation. Faculty members are involved in planning safer urban and inter-city transportation systems, and developing designs for vehicles, safety equipment and infrastructure for the future. Activities include applied research projects, special courses and workshops, and supervision of student projects at postgraduate and undergraduate levels. Projects are done in collaboration with associated departments and centres at IIT Delhi, government departments, industry and international agencies.

EXTRACTS FROM "INDIA TRANSPORT REPORT : MOVING INDIA TO 2032"

Transport investment is a response to emerging demand, but it is also an economic driver in itself. Transport planning and provision therefore must be seen as central to the planning process.

- Roads should not be looked at in isolation, but as part of an integrated multi-modal system of transport. The planning and development of the primary road network must tie up with planning of the railways' dedicated freight corridors and other segments of the rail network, connectivity with ports, airports, special economic zones, logistic hubs, major tourist centres and linkage with neighbouring countries.
- The current programme of PMGSY should be expanded to achieve universal connectivity to all habitations on a time-bound basis.
- There is need for continuous upgradation of technology in the auto industry, especially the commercial vehicle sector, to meet the objectives of better comfort, productivity, energy efficiency, safety and emission standards in line with international practices and standards.
- Private sector financing in the highways will remain confined to the commercially viable and high traffic density stretches. It will be prudent, therefore, to enhance the availability of public sector funding.
- The existing network of National Highways and state highways may be expanded in tune with the economic growth and development of industrial hubs, special economic zones, ports, tourist centres and connectivity to international routes—Asian Highways and the European Road Network.
- For capacity augmentation of state highways, every state should formulate and implement programmes on the lines of NHDP.
- The accruals to the CRF may be enhanced by making levy of cess on fuel on ad valorem basis rather than the current system of a fixed amount of Rs 2 per litre, which was fixed in the year 2005. This may be enhanced to Rs.4 per litre to enhance accruals to the CRF.
- There is need for review of the current policy of user fees (tolls) on National Highways. A two-lane road should be considered a minimum facility to be provided out of government budget in respect of primary roads (National Highways and state highways) with no direct user charge. Toll should be levied on multi-lane highways, both access-controlled and non- access controlled, as also spot improvement projects such as bridges, tunnels, flyovers, bypasses.
- Special needs of connectivity to ports, air- ports, mining areas and development of power plants should be factored in development of the road programmes.
- There is a compelling need for a dedicated road design institute for the road sector that should function under the umbrella of MoRTh. it should have around 400 to 500 professionals at various levels covering various disciplines such as transport planning, traffic and safety engineering, trans- port economics, pavement design, bridge structure design, maintenance technology, geotechnical engineering, material engineering, iT-related interventions, tunnel engineering, social and environment engineering, etc.
- Similar institutes should be set in each state PWD and rural roads agency. Every state should have at least 40 to 50 professionals covering various disciplines.
- States should encourage citizen and user oversight through undertaking road user satisfaction surveys.
- The MoRTH should entrust all National Highways and National Expressways to NHAI, and only planning, policy and budget functions should remain with the MoRTH.
- Establish Road Safety and Traffic Management Board as recommended by the Sundar Committee, within the 12th Plan period.

Hospitalisation and death due to injuries and violence are major threats to health across the world. It is estimated that more than five million people die each year as a result of some form of injury and many more are disabled for life.

The country's transport system will affect and be affected by various 'known unknowns' in the coming decades, including variation over time and across regions in economic growth, urbanisation, energy use and energy markets, and technology change.

India needs to have a single unified ministry with a clear mandate to deliver a multi-modal transport system that contributes to the country's larger development goals including economic growth, expansion of employment, geographic expansion of opportunities, environmental sustainability, and energy security.

The existing ministries should become departments focused on delivering effective transport infrastructure and services for each mode. Each would be led by a Minister of State with support from a Secretary and a technical staff. Each of these departments must have the technical ability and procedural standing to make a credible case for investment and policy in its mode of transport to meet the broader framework set at the Ministry level. This distribution of authority and technical expertise is important to maintain an ongoing, constructive discussion of various means for meeting transport development goals.

India's transport governance must move toward five significant changes over the next decade:

i Creating a consolidated Transport Ministry to focus on systemic performance;

ii Setting up an Office of Transport Strategy (OTS) to coordinate transport policies at the national level.

Iii Clearly decentralising policy and planning authority including urban transport to the constitutionally recognised urban and metropolitan governments;

iv Building a comprehensive regulatory environment to govern transport flows, and?

v Building an interdisciplinary cadre of transport experts.

Transportation-related death and injuries constitute a significant proportion of this. For young adults and working age males, road traffic accidents have become a leading cause of death in most countries including India. Given current trends, the global burden of injuries and violence is expected to rise considerably in the coming decades, particularly in low- and middle-income countries like India.

It is road transport that sees the highest number of fatalities, and the number has been increasing continuously for the past few decades. The rate of increase in deaths per year shows a marked upward trend starting in the mid 1990s. Since then, the annual fatality rate has increased at a rate of about 6-8 per cent a year, and shows no sign of decreasing. Two modelling exercises have attempted to predict the time period when we might expect this rate to start to decline in India. Kopits and Cropper used the experience of 88 countries to model the dependence of the total number of fatalities on fatality rates per unit vehicle, vehicles per unit population, and per capita income. They predicted that fatalities in India would continue to increase before starting to decline in 2042. Koornstra, using a cyclically modulated risk decay function model that incorporates the cyclically varying nature of a society's concerns for safety, predicted an earlier date of 2030 for peak traffic fatalities in India. If fatality rates continue to increase at the present level then we can expect about 260,000 fatalities in 2030. Neither of these projected dates (2042 and 2030) can be accepted as road safety goals for the country.

Research activities regarding transportation safety are organised in different ways across nations. This activity is carried out at four levels:

1. Regional international agencies where intercountry cooperation and coordination is essential
2. National agency
3. State level agencies
4. University departments and civil society organisations

In some countries, a national research department is included within the lead agency for each transport sector, and in others, stand alone safety institutions have been established.

A variety of lead agency models can be effective in road safety management, and countries must create a lead agency appropriate to their own circumstances. The lead agency may take the form of a designated, stand alone entity with a coordinating committee representing partner government agencies. It may also be part of a larger transport organisation or be part of a Prime Minister's department. The agency might undertake much of the work itself or it might delegate aspects of work to other organisations, including provincial and local governments, research institutes or professional associations. All agencies have complex organisational structures and processes, and many partners and stakeholders. Most agencies perform all or most of the following functions:

- Set evidence-based national, regional and local safety policies, strategies and targets
- Establish systems for monitoring of progress regarding targets set and effectiveness of safety interventions
- Set performance standards for vehicles, equipment and infrastructure
- Conduct/commission safety audits of vehicles, equipment and infrastructure
- Identify subjects and institutions for research in different areas of safety, and commission and fund research projects and publish research findings, create linkages between research institutions at the local, regional and national levels
- Establish Centres for Excellence and fund safety research and education
- Establish the methodology for multidisciplinary crash investigation, data collection, reporting and analyses
- Establish procedures and systems for data collection, transmission and analysis at appropriate levels and define the role of different agencies involved in the process, and maintain comprehensive databases on safety-related issues
- Establish policies and framework for capacity building and skills among personnel of concerned government agencies, NGOs and other relevant organisations dealing with safety
- Liaise with all concerned government ministries, educational institutions, health service providers, NGOs, international agencies and organisations in other countries working in any area related to safety and transport management
- Promote best practices in safety and transport management, undertake safety and traffic management education programmes, and conduct campaigns to create awareness on matters relating to safety
- Establish guidelines for upgrading trauma care systems at all levels and create a grid of medical, allied medical and rehabilitation facilities to provide first aid, care during transportation, emergency care in the hospital and rehabilitation
- The agency should not only set standards but also monitor their adoption and implementation. If standards are not adhered to, the agency should have powers to take corrective action.

Ministry of Road Transport and Highways in the Government of India is the administrative ministry responsible for road safety efforts in the country. National Road Safety Council (NRSC), headed by the Union Minister for Road Transport and Highways is the apex advisory body. It includes the ministers in-charge of transport in the state governments and various official and non-official members. NRSC does not have adequate statutory backing, budgetary resources, professional expertise, or the mandate to be an effective organisation for executing road safety plans. The Transport Development Council chaired by the Union Minister of Transport, with the Union Ministers of Commerce, Industry, Railways and Member in-charge of Transport in Planning Commission as members, is a high level forum for the formulation of common policies for the development of road transport. It also includes all the Lt Governors/ Chief Commissioners of Union Territories and all ministers in charge of transport in the state governments. The Transport Division of the Department of Road Transport and Highways deals with matters relating to safe movement of vehicles on roads and safety awareness among users. The Road Transport Division has three sections dealing with motor vehicle legislation, transport-related matters and administration of road safety schemes.

NCRB collects data of fatal and non-fatal road traffic accidents as reported to the police stations across the country and publishes a consolidated annual report. This is the only source for national data. However, the data is of a very rudimentary nature and as a result, we do not even have a reliable estimate of different types of road users killed. The data is not adequate for informed evidence-based detailed road safety policymaking.

Many states have taken initiatives in promoting road safety at the local level, but none have established a professional road safety agency. Examples of initiatives include those in the states of Kerala, Punjab and Tamil Nadu, where data collection and safety programmes have been stepped up with financial assistance from the World Bank. However, there is no evidence of any significant advances yet in controlling road traffic crashes.

At present, existing institutions are not well equipped to deal with the increasing traffic on the roads or to adopt the advancements made in techniques and technology that would promote road safety. There are hardly any trained road safety professionals employed at the central or state government level or in academic institutions. Responsibility for road safety is diffuse and there is no single agency to deal with a range of problems associated with it. There is also no effective mechanism for coordinating the activities of the different agencies dealing with the issue.

Http://planningcommission.nic.in/sectors/index.php?sectors=National%20Transport%20Development%20Policy%20Committee%20(NTDPC)

TRIPP BULLETIN
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
VOL 11 NO.1 SUMMER 2014

News

Improving Global Road Safety

Selected Extracts from the United Nations General Assembly Resolution (Sixty-eighth session, 10 April 2014)

- •Expressing its concern that the number of road traffic deaths still remains unacceptably high with an estimated 1.24 million lives lost in 2010, and that only 7% of the world's population is covered by adequate laws that address all behavioural risk factors, including the non-use of helmets, safety belts and child restraints, driving under the influence of alcohol and drugs, inappropriate and excessive speed, and inappropriate use of cell phones, including texting, while driving,
- •Also expressing its concern that worldwide half of all road traffic deaths involve pedestrians, motorcyclists and cyclists, and that in some developing countries there are inadequate infrastructure and insufficient policies in place to protect these vulnerable road users,
- •Acknowledging the continued efforts of the Multilateral Development Banks Road Safety Initiative, coordinated by the World Bank's Global Road Safety Facility, and their collective actions to scale up road safety management capacity and infrastructure safety, improve safety performance measures and scale up resources, through the development of systematic country projects in low- and middle-income countries,
- •Commends Member States that have developed national plans that are in line with the Global Plan for the Decade of Action for Road Safety 2011–2020, and encourages Member States that have not yet developed these plans to do so, paying special attention to the needs of all road users, in particular pedestrians, cyclists and other vulnerable road users, as well as issues related to sustainable mobility;
- •Invites Member States that have not yet done so to nominate, as appropriate, national focal points for the Decade of Action for Road Safety to coordinate and facilitate national activities for the Decade of Action;
- •Encourages further the implementation of new car assessment programmes in all regions of the world in order to improve availability of consumer information about the safety performance of motor vehicles;
- •Invites further Member States to raise awareness of serious road traffic injuries, in particular brain and spinal cord injuries, and to encourage investment in scientific research aimed at effectively treating such injuries;
- •Encourages Member States and the international community to take road safety into due consideration in the elaboration of the post-2015 development agenda, while recognizing the importance of a holistic and integrated approach to sustainable transport;
- •Welcomes the offer by the Government of Brazil to host the second global high-level conference on road safety to be held in 2015, to bring together delegations of ministers and representatives dealing with transport, health, education, safety and related traffic law enforcement issues, to review progress in implementing the Global Plan for the Decade of Action for Road Safety and in meeting the goal of the Decade, and provide an opportunity for Member States to exchange information and best practices.

[Full text: http://www.who.int/roadsafety/news/2014/Final_draft_UN_General_Assembly_resolution_improving_global_road_safety.pdf?ua=1]

Transport For Health: The Global Burden Of Disease From Motorized Road Transport

This report reaffirms the need for safe and clean transport for achieving global health and development goals. It calls for a multisectoral collaboration that includes the transport, health, and urban sectors, among others, to help achieve beneficial and sustainable development. In particular:

- •Road injuries are a major contributor to the Global Burden of Disease. Thus, rapidly scaling up road safety programs alongside the expansion of transport is vital for saving lives while promoting development. Mitigating the health risks requires a long-term investment strategy to build the capacity of national institutions so they can actively manage safety and mobility performance through targeted interventions. This is necessary given the multisectoral complexity of road safety and demands a systematic approach rather than isolated efforts with specific interventions.
- •While malnutrition, diarrhea, and many infectious diseases occur in settings of extreme poverty, the health burden associated with road transport spreads with economic growth and rapid motorization. This need not be the case, provided countries, aid agencies, and donors develop comprehensive and country-specific policy frameworks for investing in the health and well-being of populations. It took developed countries 70 years to reverse negative health trends from road transport, but developing countries can accelerate this process through strategic investments and collaboration across sectors.
- •Due to limitations of available data and methods, we have likely underestimated the effects of pollution from vehicles. Additional research is needed to obtain more detailed geographic information on human exposure to air pollution in rapidly motorizing regions and to better understand the health effects of exposure to traffic-related pollutants. In addition, a comprehensive accounting of the burden of road transport requires research to quantify the loss of physical activity due to motorization, which is not possible with currently available data and methods.
- •There is an urgent need for better tracking of the health impacts of road transport. Statistical systems need to be expanded and improved to collect key indicators to monitor and evaluate these effects. The absence of reliable accounting of health impacts not only endangers effective multisectoral action, it can waste government resources or lead to development aid funding being targeted at ineffective solutions.

Global Road Safety Facility, The World Bank; Institute for Health Metrics and Evaluation. 2014. Transport for Health : The Global Burden of Disease from Motorized Road Transport. Seattle: Institute for Health Metrics and Evaluation. © World Bank. *[Full report: https://openknowledge.worldbank.org/handle/10986/17613]*

Establishment funds have been received from
Ministry of Industry, Government of India
Asian Institute of Transport Development
Tata Motors, India
Volvo Research and Educational Foundations (VREF), Sweden

Endowments for perpetual Chairs
CONFER, India: TRIPP Chair for Transportation Planning
Ford Motor Co., USA: Ford Chair for Biomechanics and Transportation Safety
Ministry of Urban Development India: MoUD Chair for Urban Transport & Traffic Planning
MoUD Chair for Urban Transport and Environment
VREF: Volvo Chair for Transportation Planning for Control of Accident and Pollution

Transportation Research and Injury Prevention Programme
Room MS 815 (Main Building)
Indian Institute of Technology Delhi
Hauz Khas,
New Delhi 110016, India

Phone: 91-11-26596361, 26596557
Fax : 91-11-26858703, 26851169
Email : ird10165@cbme.iitd.ernet.in
http://tripp.iitd.ernet.in

TRIPP BULLETIN
VOL 11 NO.1 SUMMER 2014
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
INDIAN INSTITUTE OF TECHNOLOGY DELHI

Excerpts from three publications: A TRIPP BULLETIN INSERT

Impact of Grade Separator on Pedestrian Risk Taking Behavior

As per the accident data, among all road users in Delhi, the ones who are most exposed to risk are the pedestrians. Pedestrian deaths in Delhi are about 4 times the national average. As per Delhi Traffic Police Accident Report, 2009 indicate that share of pedestrian fatalities in Delhi from 2001 to 2009; it indicates that pedestrians have the largest share in total fatalities and the share remains the same over the years, which is about 50% of the total fatalities. It is therefore important to study pedestrian behavior in order that the risks faced by them can be minimized while the transportation facilities are improved for motorized traffic. Pedestrians are mainly exposed to risk when crossing a road in urban areas as non-crossing accidents generally represent a small proportion of pedestrian accidents. A common phenomenon in Delhi is that a pedestrian has to fight for space on the road, because of a lack of safe and convenient pedestrian paths. In Delhi, a significant investment has been made for the construction of flyovers/grade separators to increase the speed of motorized vehicles, to reduce their delay, and to make arterial roads in Delhi signal free. As new grade separators are constructed the signalized crossings are converted into signal free crossings, causing more problems for pedestrians. Although a pedestrian often has the option of crossing the road using the subway/foot over bridge most often they do not use it. Rather, they prefer to cross the roads on the surface.

However, earlier studies have not attempted to quantify the risk faced by pedestrians after providing free flow facilities to motorized vehicles. In this study we analyzed the risk taking behavior of pedestrians when a signalized intersection is converted into a signal free intersection (grade separated). This study also examines the combined impact of influencing variables to provide a better estimate of pedestrian risk taking behavior.

The aim of the study is to analyze the risk taking behavior of pedestrians before and after the construction of a grade separator. Data have been collected at an intersection when it was a four-way signalized intersection in 1998 and was changed to a signal free intersection by constructing a grade separator in 1999. Pedestrians had an option of crossing the road at the signalized crossing safely or unsafely at grade when the intersection had a signalized operation.

Risk taking behavior can be defined objectively (for example, epidemiological data may show certain behaviors to be more likely to result in injury than others) or subjectively (i.e. an individual's own perception of whether, or to what extent, a behavior is risky). The risk taking behavior of a pedestrian varies with different type of road and traffic environments, their demographic, socio-economic profile and personal and social values (for example, a pedestrian may become more conscious of risk taking after experiencing or witnessing a crash).

In this work, we studied the subjective probabilities in risk taking behavior of pedestrians. The behavior studied was that of pedestrians crossing a road against the moving traffic. It is assumed that each pedestrian intended to cross the road safely but their perceptions about the chances of safely crossing a road is assumed to be related to their characteristics, the gap size of oncoming vehicles, etc.

The construction of the grade separator has resulted in the removal of the traffic signal and provided an uninterrupted flow for motorized traffic. This has led to the disappearance of safe at grade crossing time for pedestrians, which was available before the construction of the grade separator. A signal cycle provides green time for pedestrians to cross the road without exposing them to risk. But after construction of grade separator, all pedestrians who are crossing the road at grade face the risk with continuous flow of traffic. The absence of signals make pedestrians behave independently, leading to increased variability in their risk taking behavior. The removal of signals also results in increased variability in speeds of all categories of vehicles. At the starting point of crossing, the pedestrians' waiting time has increased after the construction of grade separator and it is found that higher pedestrian delays result in a higher number of unsafe crossings. After the construction of the grade separator, the critical gap size increases from 6 s to 11 s. Before the construction of the grade separator the probability of road crossing by a pedestrian depended on the gap size; however after the construction of the grade separator it also depends on sex, age and vehicle types. Male and young adults have higher probability of road crossing as compared to female and older persons. Probability of road crossing reduces when faced with a heavy vehicle (bus), whereas it increases in the case of two-wheelers.

The results are basic inputs to the road crossing simulation, needed to design well structured intersections. It highlights human behavior and risk taking owing to road geometry and operations. Often traffic facilities are designed to ease the movement of motorized traffic. This creates difficult and unsafe conditions for pedestrians. Ideally traffic facilities must address the needs of all road users equally. Traffic engineers and safety planners while designing grade separators must ensure safe signalized crossings in addition to subways or foot over bridges.

Mariya Khatoon, Geetam Tiwari, Niladri Chatterjee (2013). Impact of grade separator on pedestrian risk taking behavior. *Accident Analysis and Prevention, 50, 861-870.*

A Comparative Study of Turbulence Models Performance for the Study of Air Flow in Helmets

Flow prediction using CFD in a flow geometry becomes a complex issue when the flow is in the transition zone. The motivation for this study is to find the best turbulence model for predicting air flow in the gap between the head and the helmet. In CFD if the flow is known to be turbulent then any standard turbulence model such as the k– εmodel does a reasonable job of predicting the mean flow quantities. As a first step this study aims to find the optimum turbulence model for near transition flows. Using simple flows such as pipe and lid driven cavity we show that even in these simple cases if the flow is laminar and a turbulence model is used in the CFD simulations, the results with most turbulence models are erroneous. If the model were to perform well under a laminar condition it will predict a laminar profile and nearly zero eddy viscosity. We also show that for pipe flows the one equation Spalart Allmaras (S-A) model shows these trends. Its relevance to helmets is because when we carry out CFD for a helmet the flow domain is large and most of it includes the region outside the helmet where the flow is known to be turbulent. The boundary conditions are prescribed on this outer domain. The gap between the head and the helmet is thin and since we do not know the velocity at the inlet of this region we do not know apriori if the flow is laminar or turbulent or in the transition zone. Thus it becomes important to work with a turbulence model which will perform well in laminar as well as turbulent conditions. The numerical experiment on simple pipe flow shows that S-A model performs better than the standard two equation models when the flow is in the laminar or transition regime and performs almost the same as the other two equation models in the turbulent regime. The flow between the head and the helmet is not a standard geometry for which the Reynolds number at which the flow becomes turbulent is well established and hence the need for a proper model performing well in all regimes. Having established this, we then tried to match the results of the S-A model with experimental results and found that for 3D flows the S-A model does a better job than the two equation k– ε models.

The aim of this work is to compare the various turbulence models for the study of near wall internal flows. Computational analysis is performed to assess the performance of the turbulence models. The motivation for this study is to find the best turbulence model for predicting air flow in a helmet. Flow prediction using CFD in a new flow geometry becomes a complex issue when the flow is in the transition zone. If the flow is known to be turbulent then any standard turbulence model such as the k– ε model does a reasonable job of predicting the mean flow quantities. The eventual aim of this study is to carry out the CFD simulations for predicting the flow of air in the air gap between head and helmet. Since the flow takes place at low speeds in a thin gap it cannot be established apriori whether the flow has become turbulent or not. As a first step this study aims to find the optimum turbulence model for near transition flows. In such situations this is achieved by means of CFD simulation of various benchmark problems such as pipe flow and lid driven cavity. The best model for predicting the turbulence in each problem is determined after comparing the

TRIPP BULLETIN
VOL 11 NO.1 SUMMER 2014
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
INDIAN INSTITUTE OF TECHNOLOGY DELHI

results with the standard data available. This model is then used for predicting air flow in the gap between the head and the helmet surface. The results indicate that as the Reynolds number decreases, the one equation S-A model predicts the flow quantities better then two equation k-e models for internal flows driven by a stream wise pressure gradient. However in case of shear driven flows almost all the models show a similar performance with the Realizable k– ε model showing the best results. Simulations are performed on a 2-dimensional hemispherical head-helmet model and results are compared with experimental data. The results of the simulations indicate that the S-A model shows an acceptable agreement with pressure data at holes on central plane for different inlet velocities. Simulations for a 3-dimensional hemispherical head helmet model show that the S-A model predicts the flow better then two equation k– ε models.

The results support our finding that the one equation S-A model predicts the flow better than two equation k– ε models in the near transition region for pressure driven near wall internal flows such as pipe flows. In the fully turbulent region, the performance of this model is almost identical to that of the standard k– ε models. This is a significant finding because the S-A model was initially developed for open flows past a body (i.e. a semi-infinite domain) with one end being the wall and the other 'end' being open. The S-A model is found to provide a better matching with the experimental results as compared to the k– ε models in 2-D cylindrical and 3-D spherical helmet geometries.

Shishodia, B. S., Sanghi, S. and Mahajan, P., (2013). A comparative study of turbulence models performance for the study of air flow in helmets. *1st International Conference on Helmet Performance and Design, Imperial College, London,UK, 15 February 2013, HPD-2013-8.*

A Method to Compare and Quantify Threat to Pedestrian Using Injury Cost Measure

Since pedestrians have the lowest level of protection amongst Vulnerable Road Users (VRUs), they are known to have a higher injury and fatality risk from automobiles than motorcyclists and cyclists. Vehicle crash trends in India show pedestrian fatalities to be substantially more than that in higher income countries. Globally approximately 22% of the road crashes involve pedestrians. With these crash trends, it becomes important to design a vehicle for protection of pedestrians. Studies on the regions of a passenger car interacting with a pedestrian during a pedestrian-automobile crash have shown the bumper, bonnet, windscreen and the cowl region to be prominent contact points affecting the kinematics of the struck pedestrian. The kinematics can be correlated to the different injuries sustained. Through input of contact stiffness data, phenomenon like enhanced injury risk to the head from contact with "A" pillars and the windscreen lower region can be captured. Analysis of threat from car profiles has shown that passenger cars (sedan) pose a lesser threat than a SUV or light truck profile.

Crash reconstruction studies use multi-body pedestrian models to estimate the pre-impact configuration and kinematics that best correlate with the known impact locations. Rigid body modelling technique is seen to be sufficient for replicating the kinematics in a crash and can be used for estimating some of the injury indices. A vehicle-front designer can predict the kinematics of a pedestrian in a vehicle crash, given the vehicle profile. It would be ideal if one could define a criterion to evaluate the vehicle profile for a particular pedestrian and then use it to assess the suitability of a profile to a known statistical pedestrian population. In this work, an attempt is made to develop a methodology to provide such a measure. The objective of this study is to develop a way to quantify the suitability of a vehicle profile to a known pedestrian population through evaluations using single pedestrian impacts. Demonstration through comparison of potential threat from two different vehicle profiles is targeted.

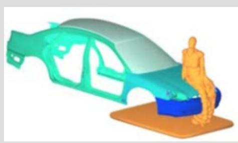
Existing estimates of threat posed by a car front is based on the perceived threat to a particular anthropometric size of the pedestrian model. We go on to show through simulations that threat perceptions are not uniformly graded with change in the anthropometry across car front profiles. Hence, threat estimates for a pedestrian population as opposed to a specific anthropometry become relevant. Design of a profile that is optimal for a whole pedestrian population must necessarily consider a weighted measure that is biased towards safety of more frequently occurring configurations. With the best known knowledge of distribution of pedestrian crash impact (CI) configurations, a threat perception can be estimated for the population, knowing the CI of the individual configurations.

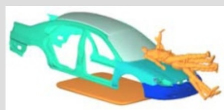
Pedestrian crash data from the Department of Transportation, Michigan, USA were considered for this study. The data were interpolated linearly between the intervals to operate on similar data ranges as with the data range available from US census on population height and weight. The gender distribution of the data were 64% for males and 36% for females. This ratio is assumed to carry across within each range when correlating with census data.

From the injury indices of the simulations, a potential AIS level for the injuries sustained was obtained. With these AIS levels as input, MAIS and potential ISS were calculated for comparing the threat levels to a pedestrian from the vehicle profile. The ISS value was calculated with available AIS values and not strictly with the codes of AIS primarily due to the limitations in models chosen for simulation. The value levels of MAIS and ISS shows the same for all adult pedestrian models. In both profiles, taller pedestrians tend to have higher threat as shown in 95M and 50M ISS values. The 5F model has least perceived threat from both profiles.

The MAIS/ISS measures present potential injury severity to a pedestrian but an IC-based measure was able to provide more direct information on vehicle threat to a pedestrian in terms of potential cost implications. A cost scale with higher cost indicating severe threat to a population was proposed as WIC/EIC. All the above mentioned secondary measures were computed from AIS values obtained from computer simulations. The procedure adopted for IC calculation had similarity to the methodology used in the Euro-NCAP rating system for the initial injury measure, but it provides better insights into implications of a crash with a pedestrian. The injury indices considered in this study were not exhaustive. The limitations of the chosen pedestrian model stipulated the limit to the injury measures chosen. To represent threat to pedestrians using better injury indices, a better validated pedestrian human body FE model would provide a more accurate starting point. Within the constraints of simulations and limited accuracy in pedestrian modelling, the WIC measure was able to provide better information of the threat to a pedestrian from a vehicle profile, taking into account specific population distributions. In our study, Profile 2 can be concluded to be of a lesser threat to a pedestrian population than profile1.

Hariharan Sankarasubramanian, Sudipto Mukherjee, Anoop Chawla, Dietmar Göhlich(2013). A Method to Compare and Quantify Threat to Pedestrian Using Injury Cost Measure. *Proceedings IRCOBI Conference 2013, Paper No. IRC-13-106 pp. 896-910.*


Profile 1 - 55ms after initial impact


Profile 1 - 180ms after initial impact


Profile 2 - 55ms after initial impact


Profile 2 - 180ms after initial impact