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Challenge and Innovation of Freeway Safety - Australian Approach

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Abstract: Global economic growth since 1990s especially in Asia countries like China, India, has not only brought a significant spreading of their high speed road network, also encourage a wave of immigrants and commercial investment from Asia into nearby countries such as Australia and Canada. Therefore the building industry broom and traffic congestion appears in all major cities of these countries as result because of the design capacity of old freeway in these countries will not be able to accommodate these changes. When mobility and road safety both challenge the road system, Australian community update their philosophy of road safety and apply innovation of road infrastructure to embrace these opportunities. This article uses major freeway upgrade works in Melbourne, the second largest city in Australia to demonstrate some recent innovation and approach to improve road safety and mobility.

Keywords: Fereeway management system, Road safety, Innovation, Road Infrastructure

I. Introduction

China's economy has been considered a new super power to be reckoned with since 1990s. Since the Global Financial Crisis, China's economy has boomed and Australia has been a major benefactor of that wealth. Australian businesses have profited from free trade deals with the economic giant, particularly permanent immigrant, tourists, housing broom, investment and trade within the mining and agriculture sectors. The changes are not always opportunity, but also coming with challenges.

The expanding population and increased motor vehicle usage often result in the freeway being loaded to capacity within its design life. This is especially true of the older freeways located within the larger cities [1].As the freeway become more congested, the problems created by an acident on the freeway become more serious. In Austrlia, Transport Accident Commission (TAC) announced Towards Zero campaign in 2016 with a vision for a future free of deaths and serious injuries on our roads. This emphasis is following step from Swedish Parliament's Road Traffic Safety Bill founded on Vision Zero in October 1997. Towards Zero is a philosophy of responsibility for road safety, in all current road transport systems, the road user has almost total responsibility for safety; if an accident occures, at least one road user has, by definition, broken the general rule and the legal system will therefoe act [2].

In Towards Zero campaign, it explicitly states that the responsibility is shared by the systm designers and the road user; therefore the road transport system should be designed in a way that such events do not occur. with this principal erected and accepted, the innovation on road infrastructure have been applied to whole road network in Melbourne, Victoria and contribute to great benifacotr to human life and health.

II. Road Safety - Towards Zero

Although freeways comprise only a small fraction of metropolitan transportation network mileage, they form the backbone of the urban transportation network, carrying more than a third of all vehicle travel [3]. The annual cost of traffic congetion, based on the costs associated with private and commercial time delay, car operation cost such as fuel, and additional air pollution increase dramatically.

Houston, an USA city reported the congetion cost was estimated in a order of $1.28 billion in 1989 with projected increasing rate of 3% per year [4]. In 2013 traffic congestion cost Americans $124 billion in direct and indirect losses, and this number will rise to $186 billion in 2030 [5]. Similar trends could be observed in Australia. The 'avoidable' cost of congestion (where the benefits to road users of some travel in congested conditions are less than the costs imposed on other road users and the wider community) for Australian capital cities is estimated to be around $16.5 billion in 2014– 15, having grown from about $12.8 billion in 2010 [6].

Even though such costs due to less mobility in the road transport system are high, Towards Zero states that the loss of human life and health is unacceptable and therefore safety is a more important area than other issues, safety and mobility can not be traded against each other.

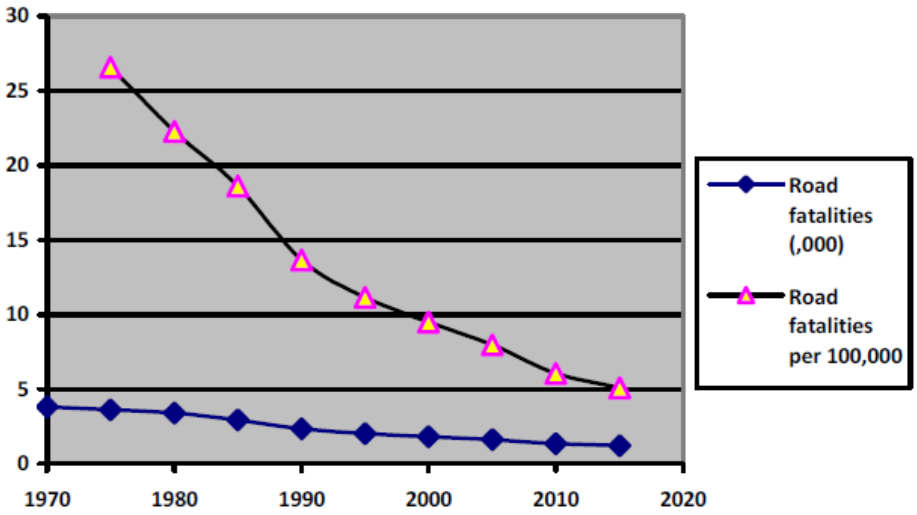

Fig. 1. Motor vehicle deaths in Australia by year

Figure 1 above shows the trend of motor vehicle deaths reduced dramatically from 26.59 per 100,000 in 1970 to 5.08 per 100,000 population in 2015, this is a great achievement which is contributed by improved road design, car safety performance, driver behaviors and enforcement of regulations. However, in today's world, about 1.4 million people still die each year in traffic accidents globally, making it one of the most common cause of death. There is still room to be improved. Figure 2 below presents traffic related death rates in some major countries, per 100,00 inhabitants in 2015.

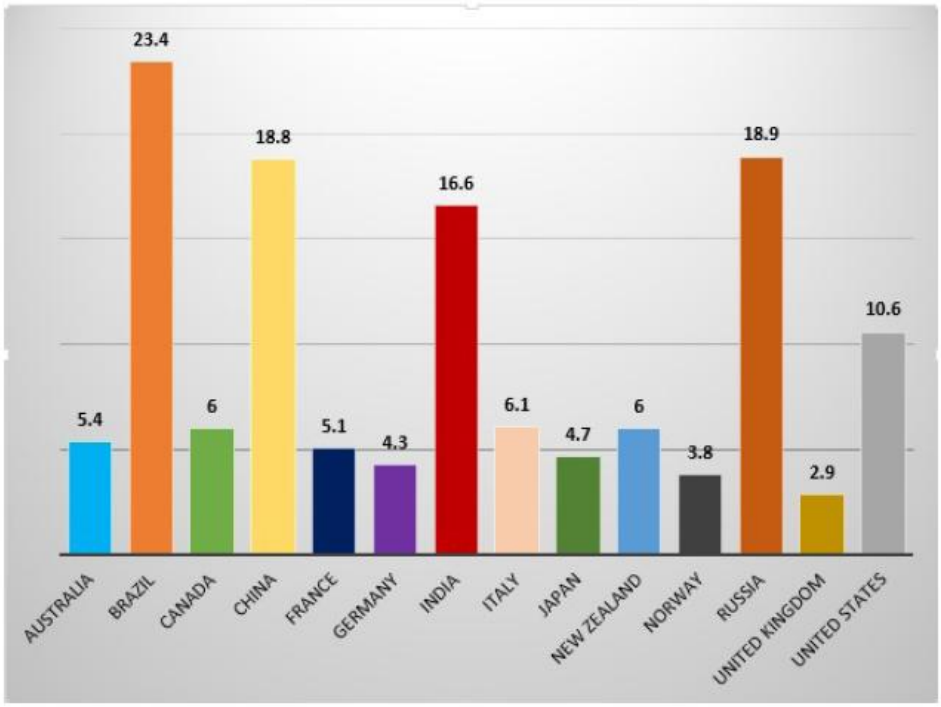

Fig. 2. Traffic-related death rates worldwide (per 100,000 inhabitants

Since then, Australian adopted the Towards Zero campaign national wide in 2016. In Victoria, improving road infrastructure is a vital part of the Towards Zero approach, $1 billion is being invested into making Victoria roads safer for people to use. This will transform some of Victoria's riskiest roads into our safest roads. The investment on world class safety improvements to more than 2,500 kilometres of rural and regional roads across the state.

These improvements mainly include wire rope safety barrier (WRSB Flexfence TL4), guardrail (Ezyguard smart), audio tactile profiled road markings (Rumble strips), etc.

Fig. 3. Wire Rope Safety Barrier

Flexfence TL4 has gained popularity as an approved median crash barrier for the prevention of cross-median accidents. Cross-median accidents are typically violent collisions with a high probability of multiple serious injuries and death. Thus, the design trend for the approved crash barrier is towards providing positive vehicle containment in wider median applications for which road safety barriers have not historically been warranted.

Fig. 4. Ezyguard smart Guardrail

Ezy-Guard Smart guardrail crash barriers impose lower forces to the impacting vehicle than traditional guardrail crash barriers. As the crash barrier deflects, vehicle impact energy is dissipated which as a result,

reduces occupant risk. The lightweight, ductile Z-posts provide a forgiving impact, reducing ride-down deceleration forces and minimising vehicle damage [7].

Fig. 5. Installation practice of audio tactile profiled line markings

Audio-tactile lines can be used to delineate the edge of a road where driver fatigue is known to cause crashes. As well as providing visual delineation, rumble strips can also be heard and felt by drivers and riders. When a tyre runs over the rumble strips a noise and vibration is produced. This tells a sleepy or distracted driver that their vehicle is starting to leave the road.

Towards Zero is not a figure, it is a shift in philosophy. It requires the road system should tolerate mistakes, and utilises safety measures to ensure human body has not exceeded its crash tolerance limits. As soon as the driver loses control, the infrastructure should take over to mitigate the seriousness of the crash, and decrease the fatalities and serious injuries.

III. Freeway Management System

There is always one parameter that can be used ot dramatically increase safety: that is to reduce mobility. Freeway management system has been engaged since 2006 in Australia national wide, as secondly approach to improve road safety, but more improtantly, to breakdown the deadlock of congetions and economic growth.

The freeway management system is a mix of:

- lane use management signs
- stop / go lights on freeway entry ramps
- CCTV/speed cameras
- travel time information signs
- electronic variable message signs
- automatic incident detection systems

These new technologies can be used independantly or combined to achieve better performance. Under normal travel circustomtance, freeway lane use management signs (LUMS) and speed camera will displace and reinforce the speed limit, travel time information signs and electronic variabl message signs could provide

weather, notice, and travel tiem to various destinations. Under emergency situation, automatic incident detection systems will bring up alarm to control room once traffic congetion detected, CCTV cameras will assist the operator in control room to confrim the nature and location of the incident. LUMS will be changed to diver traffic away from the incident effected lane/s and keep clear for emergency services, stop/ go lights on entry ramp will be activated and limited entry to freeway incident affected area to reduce further congetion.

A. M1 upgrade project

M1 upgrade proejct is improving safety and reliability along the Monash Freeway as part of the $5.5 billion Western Distributor Project in Melbourne Australia.

Fig. 6. Monash upgrade freeway management system

The Monash Freeway Upgrade will create faster, safer and more reliable journeys along the 44 kilometres of road. Widening the freeway from four to five lanes each way and upgrade theramp with control signals.

The project means faster, safer and more reliable journeys for 200,000 motorists every day.

B. CityLink Tulla Widening

The CityLink Tullamarine corridor is one of Melbourne's most heavily used roads, carrying approximately 210,000 vehicles per day in its busiest section, with population growth, traffic numbers on this section of the freeway are expected to increase to approximately 235,000 vehicles per day by 2031.

Citylink Tulla widening is a $1.28bn project improving safety, reducing congestion and cutting travel times in central Melbourne. The project will increase the road's capacity by up to 30 per cent, ease congestion and improve safety.

A new freeway management system will be installed, including:

- Overhead electronic speed limit signs to
- communicate speed limits and lane availability,
- Stop and go signals for entry ramps for safer
- merging,
- Variable message boards to notify road users of
- planned changes or disruptions, and
- CCTV cameras to monitor traffic and incidents.

Fig. 7. Tulla freeway management system

C. Hume Freeway

Hume freeway installed the innovation point-to-point cameras since 2012. Point-to-point cameras calculate the average speed of a vehicle by determining the time taken to travel between 2 points. If the calculated average speed exceeds the speed limit, the incident is accepted and sent for verification. Cameras positioned at each 'point' take a set of digital images and also measure the speed of a vehicle at that location.

Fig. 8. Hume freeway point-to-point camera system

IV. Conclusions

More and more innovations of road system and new approach promoted recently worldwide including Australia, and the trend is to improve the current measures, infrastructure and community culture.

Towards Zero is not a figure or target, it's a long-term strategy in which the system and its use are gradually integrated. The actual idea for it is this: serious injuries and deaths on the road should not be tolerated, both road infrastructure and culture need to be improved, until then, we have a long way to go.

Further research also focusing on the different impact of safety barrier to each individual user catalogues, small vehicle, motorcyclists, truck. These interesting research certainly will develop devices that suit the various user catalogues better and better.

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