

HEAVY TRUCK SAFETY IN TASMANIA

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In April, 2005, the Department of Infrastructure, Energy and Resources (DIER) of the State of Tasmania in Australia commissioned TERNZ to undertake an assessment of heavy truck safety in Tasmania with particular reference to vehicle stability.

The project brief specified four tasks. These were:

- 1) Analyse crash data for heavy truck/combinations.**
- 2) Analyse Tasmanian heavy vehicle crash reports and investigate the possible causes.**
- 3) Analyse the inherent stability characteristics of heavy truck/combinations.**
- 4) Recommend measures to reduce the crash risk.**

The report was submitted in July 2005 and has been released publicly. Key findings of the assessment were that overall heavy vehicle safety in Tasmania is no worse than other states in Australia and is better than some. However, some specific categories of heavy vehicle had a significantly higher rollover rate than the fleet in general and this high rollover rate was correlated with these vehicles having a lower level of inherent rollover stability.

Recommendations were made for initiatives to improve the rollover stability of the poorest performing vehicles and, at the time of writing, some of these are being pursued. An industry-based heavy vehicle safety advisory group has been established. A survey is being undertaken to determine the distribution of rollover stability performance in the Tasmanian heavy vehicle fleet with a view to implementing measures to raise the rollover stability of the poorest performing vehicles. Surveys are also being undertaken to measure heavy vehicle speeds through curves. These will be related back to the curve geometry to determine the lateral accelerations generated so that the industry can see how close to the rollover limit some vehicles are operating.

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1 INTRODUCTION

In March, 2005, the Department of Infrastructure, Energy and Resources (DIER) of the State of Tasmania in Australia called for proposals to undertake an assessment of heavy truck safety in Tasmania with particular reference to vehicle stability. Transport Engineering Research New Zealand Limited (TERNZ) was selected as the consultant to undertake the study.

The Request for Proposals outlined a project brief consisting of four tasks. These were:

- 1) Analyse crash data for heavy truck/combinations.
- 2) Analyse Tasmanian heavy vehicle crash reports and investigate the possible causes.
- 3) Analyse the inherent stability characteristics of heavy truck/combinations.
- 4) Recommend measures to reduce the crash risk.

2 ANALYSIS OF CRASH DATA

2.1 Data Sources

Crash data were obtained from two main sources covering time periods between 2002 and 2005. The first was a database of all heavy vehicle crashes while the second was a database of all heavy vehicle-involved crashes attended by the DIER Transport Inspectors. In addition a list of all heavy vehicle-involved road fatalities was provided. Vehicle exposure data were derived from three sources; the Tasmanian vehicle registration database, the Australian Bureau of Statistics (ABS) Survey of Motor Vehicle Use (SMVU) and the DIER Tasmanian Freight Demanders Survey of commodity movements by heavy vehicles for 2003.

2.2 Overall Road Safety in Tasmania

The overall road crash fatality rate on a population basis for Tasmania is a little higher than that of three neighbouring Australian states reviewed (Australian Transport Safety Bureau, 2003) but a little lower than that of New Zealand. However, the truck-involved fatality rate per distance travelled for Tasmania is similar to the other states and better than New Zealand.

2.3 Heavy Truck Rollover Crashes

In the data set with all truck crashes, 16.3% were identified as rollover crashes. When these rollover crashes were analysed in terms of exposure to crash risk, it was found that the rollover crash rate for log trucks, wood chip trucks and stock trucks was significantly higher than that of the rest of the large heavy vehicle fleet.

The other two freight categories which have a significant number of crashes recorded against them were containers and milk. However, these freight categories did not have a higher than expected number of rollovers.

2.4 Vehicle Configuration Factors

A key objective of this study was to determine whether different vehicle configurations have different crash rates and whether the vehicle performance characteristics are likely to be a contributing factor.

Of the large heavy vehicle fleet, the most common vehicle is the 6-axle prime mover and semi-trailer combination. These were found to be over-represented in the crash statistics. Because of their numbers in both the fleet and in the crash statistics, any initiative to improve heavy vehicle safety needs to include these vehicles to be effective.

Considering the crash reports in the Transport Inspector (TI) data set we can look at the proportion of crashes where a rollover occurred. For laden large heavy vehicles only, 45% of prime mover and semi-trailer crashes were rollovers, 59% of truck and dog trailer crashes were rollovers while 25% of B-double crashes were rollovers. This suggests that truck and dog trailers have a higher rollover rate than semi-trailers while B-doubles have a lower rollover rate.

When we look at different freight commodities we see that logs are the single largest sector of road freight followed by bulk materials. Log trucks have slightly more crashes than would be expected from their proportion of the traffic volume but the difference is not statistically significant. However, when we consider rollover crashes in the TI data set we find that the rollover rate for log, wood chip and stock trucks is substantially higher than the rest of the large heavy vehicle fleet. Based on calculations using both crash data sets, in my view, the best estimate is that the rollover crash rate for log, wood chip and stock trucks is at least 2.5 times that of the other large heavy vehicles.

3 ANALYSIS OF CRASH REPORTS

3.1 Overview

The scope of this project was limited to large heavy vehicles, i.e. those with a Gross Combination Mass (GCM) greater than 22.5 tonnes. The number of crashed vehicles in the TI data set meeting this criterion and for which there is an identified collision type is 162.

Of the 162 crashed vehicles, 63 were involved in collisions with other road users, 60 involved a rollover, 14 involved loss-of-control, 9 involved a loss-of-load, 8 involved defects or mechanical failures, 7 involved collisions with infrastructure and 1 involved striking a pedestrian. Ignoring the pedestrian crash, there are six crash types to review.

3.2 Collisions with Other Road Users

As noted above there were 63 trucks involved in collisions with other road users. If we consider only the cases where fault was established then in 40% of cases the truck was at fault while in 60% of cases it was not at fault.

There was no statistically significant difference in the crash rate for different freight commodities and no obvious correlations with road geometry, driving conditions or environmental factors. Overall most of the crashes appear to have occurred on reasonable roads and with favourable driving conditions. These collision crashes can be largely attributed to driver errors.

3.3 Rollovers

With respect to load type, only one vehicle was identified as empty. Log, wood chip and stock trucks were proportionately over-represented as has already been discussed.

The vast majority of rollovers occurred in curves on rural roads. No other driving environment factors appear to be significant.

Considering only the rollovers with a determined cause, 50% were due to speed through curves, 27% due to running off the edge of the roadway, 9% due to vehicle defects, 7% due to load shift and only 2% were the result of an evasive manoeuvre. This mix of crashes is quite similar to that found in other countries (Hoogvelt et al, 1997; de Pont et al, 2004).

3.4 Loss-of-Control

Of the 14 loss-of-control crashes, 7 involved empty vehicles. Other load categories are represented by no more than one crash each and there were no log trucks involved in loss-of-control crashes.

In terms of driving conditions, the one factor that stood out was wet roads. Considering only the crashes where the road surface condition was classified we see that for all crashes 27% occurred on wet roads while for loss-of-control crashes 60% occurred on wet roads.

3.5 Loss-of-load

Inadequate load securing was definitely the cause for six of the nine crashes. For two of the remaining three crashes it may also have been the cause but it is not certain. There was no evidence to suggest that load securing problems were specific to any particular load category or vehicle type.

3.6 Defects and Mechanical Failures

Defects and mechanical failures were attributed as causes in 5 rollover crashes and 3 loss-of-control crashes. Most of these cases were related to tyre problems. There were a further 8 crashes which were classified as being the result of a mechanical failure but which did not result in a rollover or loss-of-control. Six of these eight crashes were the result of mechanical failures in the vehicle structure. The proportion of crashes where defects had a causal or contributory role was 9.8%.

3.7 Collisions with Infrastructure

Seven of the crashes involve collisions with the infrastructure. Apart from one case where the clearance height was incorrectly signposted, the trucks were clearly at fault.

4 VEHICLE STABILITY PERFORMANCE

4.1 Introduction

The third task in this study was to analyse the inherent stability characteristics of heavy truck/combinations paying particular attention to vehicle types with higher crash risks.

The National Transport Commission (NTC) in Australia has initiated a research programme aimed at developing a compliance regime using Performance Based Standards (PBS). As part of this project an assessment of the performance characteristics of the Australian heavy vehicle fleet was undertaken (Prem et al., 2002). For the purposes of this study we were interested in the Tasmanian large heavy vehicle fleet and performance in relation to vehicle stability which is a subset of the NTC set of performance measures.

The Tasmanian large (greater than 22.5 tonnes) heavy vehicle fleet consists of four main vehicle configurations: the 4-axle rigid truck, the prime mover semi-trailer combination, the truck and dog trailer combination and the B-double.

Three of the performance measures in the proposed NTC PBS set relate directly to stability. In addition there are three further performance measures which are not directly related to vehicle stability but which could have an impact on stability-related crash risk.

4.2 Steady Speed Cornering Stability

The most fundamental stability-related performance measure is Static Rollover Threshold (SRT), which measures the rollover stability during steady speed cornering. Some 50% of rollover crashes can be attributed to excessive speed through curves which is essentially travelling too fast for the inherent stability of the vehicle.

There are three key vehicle parameters that influence SRT. These are the tyre track width, the vehicle centre-of-gravity (CG) height and the roll stiffness of the suspension and tyres.

The tyre track width is largely determined by the vehicle width limits but can be increased through the use of wide single tyres instead of dual tyres. For many vehicle configurations this results in a penalty in weight-carrying capacity and so is not practical.

The CG height of most heavy vehicles is primarily determined by the CG height of the payload. There are two ways in which the CG height can be reduced without reducing payload capacity. One is to lower the load bed height and the other is to increase the load length. Legal limits on dimensions and operational requirements may mean that these changes are difficult to achieve for some vehicles.

The third factor that affects SRT is the suspension roll stiffness with greater roll stiffness leading to improved SRT. Generally speaking modern air suspensions have greater roll stiffness than steel suspensions even though they are less stiff vertically.

4.3 Dynamic Stability

Dynamic stability is characterised by two performance measures, Rearward Amplification (RA) and Yaw Damping Coefficient (YDC). RA measures the amount of "whip" that occurs when a

combination vehicle executes a high-speed lane change manoeuvre. If the vehicle also has a poor SRT this "whip" can cause rollover. Generally RA is significantly greater for truck and dog trailer combinations than it is for roll-coupled combinations like semi-trailers and B-doubles.

The YDC measures the rate of decay of the "tail wag" induced by a pulse steer input. It reflects the propensity of the trailer to sway from side-to-side during high-speed travel. Again this is an aspect of performance where truck and dog trailer combinations have poorer performance than roll-coupled combinations. In the NTC study only the poorest performing truck and dog trailers had inadequate performance in this regard.

Typical Tasmanian truck and dog trailer combinations differ from the combinations analysed in the NTC study in having greater overall length and longer trailer wheelbases as well as greater weight. We would expect the RA and YDC for truck and dog trailers in Tasmania to be at the better end of what was found in the NTC study. This is supported by the crash statistics which show very few evasive manoeuvre rollover crashes.

4.4 Road Space Requirements

The final three performance measures considered relate to high-speed tracking and reflect the road width requirements of combination vehicles. Tracking Ability in a straight path (TA) and High-Speed steady Off-Tracking (HSOT) are closely correlated and reflect the road space required during normal high speed operations both on straight roads and through curves. There is little difference between the three types of combination vehicles except that truck and dog trailer combinations appear to require slightly more road width on rougher straight roads.

The final measure, High Speed Transient Off-tracking (HSTO), reflects the additional road space used during an evasive manoeuvre. For this measure, truck and dog trailers are worse than roll-coupled combinations although, again, the Tasmania combinations because of increased overall length will be better performing than the equivalent combinations considered in the NTC study.

5 CONCLUSIONS, RECOMMENDATIONS AND PROGRESS

5.1 Statistics

The crash statistics available for Tasmania were difficult to work with and of mixed quality. The forms used for reporting crashes were largely free-form data entry and so there were inconsistencies in how information was recorded. Without good data it will be impossible to determine whether any road safety initiatives that are introduced are effective or not.

It was recommended that Tasmania should take steps to improve the quality and usability of its road crash data and in particular that they should look at the CrashStats database operated by VicRoads in the neighbouring state of Victoria which can be accessed on-line and does provide much of the information required. It was noted that a new crash data system came into operation while the report was being prepared and some changes have been made. However, this was designed to provide better information of road crashes in general rather than the specific information requirements relating to heavy vehicle crashes.

5.2 Overall Road Safety

Traffic safety for all vehicles in Tasmania, as indicated by road fatalities, is slightly worse than that of the neighbouring Australian states of Victoria, New South Wales and Queensland. It is significantly better than New Zealand. If we consider the other Australian states and territories, then based on an Australian Transport Safety Bureau study, Tasmania has a similar fatality rate per head of population to South Australia and Western Australia and is considerably safer than Northern Territory. ACT has a fatality rate that is considerably lower than any of the other states.

If we consider the fatality rate for heavy-vehicle involved road crashes we find that Tasmania is similar to the three neighbouring states reviewed. Because the overall fatality rate is slightly worse this indicates that, in relative terms, heavy vehicle road safety is slightly better in Tasmania than in the other three states. These differences are small but there is no evidence to suggest that the heavy vehicle safety situation in Tasmania is out of line with the rest of Australia.

Nevertheless, heavy vehicles are substantially over-represented in the fatal crash statistics as they are everywhere else in the world. This is because crashes involving heavy vehicles are much more likely to have a fatality or serious injury outcome than crashes not involving heavy vehicles. In multiple vehicle crashes involving a heavy vehicle, the driver of the other vehicle is at fault more often than the truck driver. The occupants of the other vehicle are also more likely to be killed or suffer serious injury.

5.3 Specific Heavy Vehicle Safety Issues

A major focus of the study was to identify specific heavy vehicle performance characteristics that are contributing to crash risk. The relatively small size of Tasmania and hence the relatively small number of crashes means that differences in crash risk between different vehicle configurations can only be identified if they are relatively large. Modest differences in crash risk are hidden in the normal statistical variations that will occur with small numbers. This does not mean that these differences are not present just that they cannot be identified.

5.3.1 Rollover Stability

One major vehicle factor that was clearly identifiable from the data was that log, wood chip and stock trucks as a group have a rollover crash rate that is at least 2.5 times higher than that of the rest of the large heavy vehicle fleet. When we look at the performance characteristics of these vehicles we find that their inherent rollover stability is poorer, on average, than other vehicles in the fleet. If we look at research undertaken in New Zealand and the United States (Ervin, 1983, de Pont et al, 2000), this high rollover crash rate is entirely consistent with this level of rollover stability.

It was recommended that Tasmania take steps to increase the rollover stability of the poorest performing heavy vehicles. These measures should not be limited to log, wood chip and stock trucks as there are poor performing vehicles in other sectors – most notably some container vehicles.

Various options were discussed. An interim measure that had been proposed is to impose a load height restriction on log trucks and wood chip bins. This approach is rather crude because it

addresses only the issue of payload CG height and singles out particular sectors in a way that may be unfair. This approach was not recommended as a long-term solution.

A more comprehensive approach that was discussed was to use regulation to require heavy vehicles to achieve some minimum level of rollover stability. This is already done in many jurisdictions for some sectors, such as dangerous goods vehicles and buses, and in New Zealand for all large heavy vehicles. The recommendation was that if this approach were to be considered in Tasmania some further investigation would be required including an analysis to determine the productivity loss that would result from reducing the payload capacity of some vehicles. This would then need to be weighed up against the expected safety benefits. Secondly the implications of imposing such a requirement in isolation from the rest of Australia would need to be assessed.

A third approach suggested was to facilitate the establishment of industry-based safety advisory groups to undertake research and promote safety initiatives. Providing vehicle operators and designers with good information on the critical factors affecting stability will lead to improved vehicle design and operations resulting in reduced rollover crash rates. The activities of these industry-based safety advisory groups should not be limited to vehicle stability issues but should cover all aspects of transport operations. This approach has been proven to be very successful for the log transport industry in New Zealand.

5.3.2 Vehicle Maintenance

9.8% of crashes involved a vehicle defect as either a cause or a contributing factor. Although this proportion is similar to the rate quoted for Victoria and in line with figures from other jurisdictions, it is not insignificant and there is potential for safety gains by reducing the number of heavy vehicles with defects on the road.

Tasmania has not yet adopted the Maintenance Management module of the National Heavy Vehicle Accreditation Scheme (NHVAS) and there do not appear to be many Tasmanian-based members of the Australian Trucking Association's Trucksafe scheme.

It was recommended that Tasmania should investigate ways of encouraging operators to adopt best practice vehicle maintenance procedures. Accreditation to a recognised scheme demonstrates that this is being achieved. In some other states, maintenance management accreditation under NHVAS exempts the operator from periodic vehicle inspections and so there are some commercial benefits from participation. Tasmania does not have a periodic vehicle inspection regime and it was not recommended that one should be introduced. Periodic inspections are no substitute for a proper maintenance programme. A more effective approach is to target the roadside inspection programme to focus on those operators with poor safety and traffic offence records. Accredited operators could be subjected to fewer inspections but there would still need to be random inspections on all operators to ensure that standards are maintained.

5.4 Driver Issues

5.4.1 Curve Speed Selection

Although truck drivers were at fault in fewer than half of multiple vehicle crashes, they were at fault in most single vehicle crashes. About half of the rollover crashes were the result of going

too fast for the stability of the vehicle through a curve. A further quarter of rollover crashes were the result of the vehicle running off the edge of the roadway. Both situations are usually the result of errors of judgement by the driver. This phenomenon is not unique to Tasmania. Rollover crashes in New Zealand and in the Netherlands have the same causes in similar proportions.

The recommendation was that truck speeds through curves need to be reduced particularly for those vehicles with lower rollover stability. Reducing truck speed limits to 80km/h had been proposed by some commentators. Although reducing all vehicle speed limits to 80km/h would almost certainly improve road safety as was demonstrated in many countries during the 1970's oil shock, it would increase travel times and hence impose economic costs so there is a trade-off. Tasmania, like many other jurisdictions in Australia, currently has a speed limit of 100km/h which represents a balance between safety, energy use and economic efficiency. Reducing the speed limit for trucks or specific truck types in isolation does not necessarily result in the same safety benefits. In the first place it does not address the issue of speed through those curves where the desirable speed is less than 80 km/h. Secondly having differential speeds between different groups of road users introduces additional safety risks as there will be more overtaking and, if passing opportunities are limited, increased driver frustration which can lead to poor driving behaviour. A third problem is that differential speed limits are more difficult to enforce but this can be overcome. Hence a speed limit reduction that targets only trucks or specific categories of trucks was not recommended.

The lack of an adequate safety margin in curve speed selection by the drivers of the less stable trucks is not the result of an inherent recklessness in the nature of these drivers. The keys to improved driver behaviour in this regard are increasing the awareness of drivers of the performance limitations of their vehicles and the need to take a conservative approach in curve speed selection and increasing the safety culture of the transport industry. Although government agencies can contribute to this through support and incentives, the main drivers for these changes need to come from the industry and the proposed industry-based safety advisory groups should have a major role in developing the initiatives to achieve these goals.

5.4.2 Load Security

A second driver-related issue that arose from the crash data was that there were a number of crashes (9 out of 162) relating to load security. The load securing requirements are clearly spelled out in legislation and there is a comprehensive Load Restraint Guide which provides detailed information on the load restraint requirements and good practice for all common load types. Thus there is no excuse for inadequate load restraint.

The recommendation was that compliance with the load restraint requirements needs to be improved and that this is an area where additional targeted enforcement should make a difference. Detailed information on load restraint requirements and practice is readily available and there is no good reason why compliance levels should not be high.

5.4.3 Fatigue and Driver Licensing

Other driver issues that have been suggested for consideration are fatigue and driver licensing. Although relatively few crashes (3 out of 163) were attributed to fatigue, it is likely that the true level of fatigue as a contributing factor to crashes is higher (Leggett, 1988, Haworth, 1998).

No specific new measures relating to fatigue were recommended. Compliance with driving hours requirements should continue to be enforced and programmes to improve driver awareness of the need for adequate sleep and the effect of lifestyle factors such as exercise, diet and stress on fatigue should continue. The industry-based safety advisory groups proposed in previous recommendations should have a major role in promoting fatigue awareness.

With respect to driver's licensing, semi-trailers and truck and trailer combinations require an HC class driving licence while B-doubles require an MC class licence. These driver licence requirements are nationally-based and not specific to individual states. It has been suggested that because truck and dog trailer combinations in Tasmania are allowed to operate at higher mass limits than in most other Australian states it might be appropriate to require an MC class licence for these vehicles or alternatively to have a new specific licence class for these vehicles. As noted in the statistical analysis there is no evidence that truck and dog trailer combinations are over-represented in the crash statistics although there are indications that they have a greater proportion of rollover crashes. Requiring the drivers of these vehicles to hold an MC licence is a feasible option and would provide a mechanism for ensuring a more advanced level of driver education for truck and dog trailer drivers. An in-depth analysis of driving licensing and driver training requirements was beyond the scope of the study and was not undertaken.

5.5 Road Related Issues

A significant proportion of the rollover and loss-of-control crashes were the result of vehicles running off the edge of the roadway. Although most of these were primarily the result of driver error, the margin of safety is affected by the available road width.

It was recommended that DIER review the seal width, lane width and shoulder requirements in the current road design standards to ensure they are satisfactory for the large heavy vehicles that are operating in Tasmania. This review should also determine whether the existing network meets these standards. If the current situation is not adequate a remedial works programme should be developed and implemented.

5.6 Enforcement Issues

Several of the recommendations above (specifically in driver fatigue, vehicle maintenance and load securing) identify areas where additional or more targeted enforcement is desirable.

Thus it was recommended that Tasmania should review its heavy vehicle enforcement resources to determine whether they are sufficient to meet its enforcement requirements and whether they are being deployed in the most effective way.

5.7 Progress

DIER have followed up on a number of the recommendations and have made substantial progress in implementing them. An industry-based safety advisory group has been established and are working towards improved vehicle rollover stability. A survey has been commissioned

to establish the distribution of rollover stability within the Tasmanian heavy vehicle fleet with a view to achieving a minimum level of rollover stability in the longer term. The purpose of the survey is to provide information to the industry on the current state of the fleet and to determine the potential costs that the industry might incur in achieving a minimum standard. A survey to monitor heavy vehicle speeds through curves has also been commissioned. The analysis will determine the resulting lateral accelerations which will then be used to show the industry how close to rollover the poorer performing vehicles are. It is expected that these results will be used by the industry safety advisory as part of a driver education and awareness campaign. It has also been proposed that DIER will implement rollover stability calculation software on their web-site with free access so that operators and vehicle builders can evaluate the rollover stability of their vehicles.

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