A STUDY OF THE MERITS OF INCREASING MASS AND DIMENSION LIMITS OF BUSES AND COACHES IN NEW ZEALAND

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ABSTRACT

In 2000 Transit New Zealand reported an investigation into the possibility of allowing more efficient vehicles to operate on New Zealand's roads, with a focus on heavier trucks (Sleath and Pearson, 2000). While that investigation was taking place, the New Zealand bus industry presented submissions to Transit outlining a parallel case for a review of the vehicle mass and axle mass limits of urban buses and main highway coaches.

This paper reports on a small study to consider the economics of possible limit changes to buses and coaches, with two scenarios being considered.

Optional mass limits resulting in a gross mass of 16 or 18 tonnes for 2 axle vehicles were examined, together with possible increases in length to 14.5 metres in urban areas. These compare with the present limits of 14.2 tonnes on a 2 axle vehicle, and an overall length of 12.6 m.

Impacts upon pavements, bridges, and road geometry were included together with an assessment of the cost savings from operating higher mass on 2 axle units, and the benefits from savings in capital costs and operating fewer buses. Impacts such as compliance costs, and the effects on safety, environmental and accessibility outcomes were excluded from the study.

The results, although subject to scrutiny because of the uncertainty on industry take-up, do indicate an economic case for an increase in allowable length and gross mass for buses operating on current urban routes. Higher mass on the current coach length on state highways was found to be uneconomic, due to the high pavement wear attributed to raising the current 8.2 tonne axle mass limit to either 10 or 12 tonnes.

New Zealand government transport officials are presently considering the findings of the study in light of the recently announced New Zealand Transport Strategy, with its emphasis on social, economic, and environmental issues. It is hoped to conduct further research work of a more detailed nature.

INTRODUCTION

Present limits

The present limits for buses and coaches are given in Table 1 below (Land Transport Safety Authority, May 2002). These have essentially remained unchanged since the last major review in 1988. There is no distinction in current legislation on mass and dimension between passenger vehicles and trucks.

Table 1.	Present	limits	on	buses	and	coaches	in	New	Zeala	and.
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Description	Limit	
Mass limit on a single axle with single tyres (steer axle)	6 tonnes	
Mass limit on a single axle with dual tyres	8.2 tonnes	
Mass limit on a tandem axle that has one axle with dual tyres and the other axle with single tyres	12 tonnes (14.5 tonnes with single large-tyred axle *)	
Resultant gross mass for a bus or coach with 2 axles	14.2 tonnes	
Resultant gross mass for a bus or coach with 3 axles	18.0 tonnes (20.5 tonnes with single large-tyred axle *)	
Overall length on rigid bus	12.6 metres	
Overall length on articulated bus	18.0 metres	

* Means an axle that is fitted with tyres equal to/greater than 330 R 24 or 355 R 19.5

Industry requests

In July 2001 Transit New Zealand (Transit) completed an investigation of the possibility of allowing more efficient vehicles to operate on New Zealand's roads (Sleath and Pearson, 2000). The Heavy Vehicle Limits Project (Transit New Zealand, 2001) examined two scenarios on behalf of the trucking industry that were both found to be economically viable. Proposals were subsequently put before the regulatory authority for land transport in 2001 for its consideration in an Issues Paper (Land Transport Safety Authority, 2001). Recent developments are discussed further in Section 6.0 of this paper.

While the trucking industry study was taking place, the Bus and Coach Association of New Zealand (BCA) presented submissions to Transit outlining a parallel case for a review of the vehicle gross mass and axle mass limits of urban buses and highway coaches. It was suggested that changes to the limits would bring about efficiency gains, and that the benefits thus obtained would outweigh the costs. It was suggested in particular that operator costs would be reduced if axle mass limitations could be increased for 2-axle buses/coaches so that a greater load could be carried without the need for a third axle.

Options analysed

As with the previous truck study, the bus and coach study considered the economics of possible limit changes.

Again, two scenarios have been considered:

- Increased allowable axle and gross mass limits for coaches on New Zealand's principal highways (known as state highways), but with no change in length allowed; and
- Increased axle mass, gross mass, and length for buses on city roads.

The bus industry requested an evaluation of proposals to increase the allowable gross mass for two-axle buses to either 16 tonnes or 18 tonnes. Therefore, two mass options have been evaluated:

Option 1: maximum gross mass of 16 tonnes with the maximum allowable mass in a dual-tyred single axle increasing to 10 tonnes; and

Option 2: maximum gross mass of 18 tonnes with the maximum allowable mass on a steer axle increasing up to 7 tonnes and on a dual-tyred single axle increasing up to 12 tonnes.

In addition, the bus and coach industry requested an evaluation of proposals to increase the allowable length of buses from the current limit of 12.6 m to 14.5 m on selected routes in urban areas. The options evaluated are therefore subdivided with an identifier "A" which is taken to mean no increase in length, or "B" which is taken to mean an increase up to 14.5 m. In fact, two length increase options have been considered, and "B" is taken to mean a length of 13.5 m and "B'" a length of 14.5 m. The options for two-axle buses are shown in Table 2 below.

Option	Application	Maximum Length (m)	Maximum Gross Mass (t)
Base Case	All routes	12.6	14.2
Option 1A	All routes	12.6	16.0
Option 1B	Excluded	13.5	16.0
Option 1B'	Excluded	14.5	16.0
Option 2A	State highways	12.6	18.0
Option 2B	Urban routes	13.5	18.0
Option 2B'	Urban routes	14.5	18.0

Table 2. Limits considered in the study.

For state highways, Options 1A and 2A were the only options considered (i.e. no increase in length). In urban areas, Options 1B, 1B' and 2A were excluded from the evaluation as it was concluded that these vehicles would not be attractive to the bus industry because they would be more expensive, but no more productive for operators than other options. All options allow for the inclusion of three-axle buses with the current length and mass limits.

Further details of the mass and dimension limits selected for the investigation may be found in Appendix A to this paper.

Study structure

A similar approach to that of the Heavy Vehicle Limits Project has been taken to the potential costs and benefits, i.e. to consider the detrimental effects of the increased mass on bridges and pavements as costs, and gains in operator economics as benefits. Safety and environmental effects were assumed to be of a lesser order of magnitude and hence excluded from this pilot study. The cost of changes required in road geometry (corner, intersection, roundabout) and bus infrastructure has been included for the case of longer buses on city roads. The overall study was led and coordinated by Opus International Consultants Ltd of Wellington (Opus International Consultants Limited, 2002). Other consultants carried out detailed studies for this investigation as follows:

Pavement Costs:	Montgomery Watson Harza NZ Ltd, Christchurch
Bridge Costs:	Infratech Systems and Services, Brisbane, Australia
Geometrics Costs:	Opus International Consultants Ltd, Auckland
Turning Circles:	Phillip Brown of Traffic Planning Consultants, Auckland

STUDY METHODOLOGY

The approaches taken to the evaluation of the costs and benefits are discussed below.

In the state highway case (tour coaches), the evaluation was carried out for the tour network over the country using data on coach travel in different areas. In the city case (buses), the evaluation was simplified by using Auckland City alone as a pilot area. It was presumed that similar costs and benefits would apply in the other cities.

Pavement wear

Pavement costs were included in the evaluation, and take the place of Road User Charges (known as "RUC", see also Land Transport Safety Authority, April 2002). The latter charges are a tax that is intended to recover road costs from the user. In the approach adopted in this study, a direct assessment has been made of the additional road costs, and RUC costs do not enter the evaluation.

The estimation of wear to pavements is based on a calculation of the number of Equivalent Standard Axle (ESA) loadings to pavements. The ESA concept involves calculating the wear given by the range of axle groups and range of loads carried by each axle group, as a multiple of the wear conferred to the pavement by a Standard Axle. The Standard Axle is defined as a single axle with dual tyres carrying a mass of 8.2 tonnes.

Knowledge of the current ESA loading and that expected over the next fifteen years with the existing bus/coach types allows a pattern of maintenance/rehabilitation costs to be calculated (when calibrated against existing records). Further knowledge of how the ESA loadings will change with the introduction of the proposed heavier axles on buses allows changes in maintenance/rehabilitation costs to be evaluated.

The life of a pavement is a function of its strength and the traffic loading imposed on it. Information from the Heavy Vehicle Limits Project was used to give a relationship between pavement strength and its condition. Remaining life and ongoing cost have then been related to this condition and to the ESA loads in the base case and the options.

In the state highway case, pavements strength and condition varies over the different parts of the country, and the ESA loading has been apportioned to the fourteen Transit regions according to the coach vehicle kilometres travelled (VKT) in each. In the city case, the pavement condition and road costs for the Auckland Transit region have been used.

Bridges

The economic impact of alternative mass limits on bridges has been evaluated by using the assumption that small increases in vehicle loads lead to reductions in the overall service life of bridges. The evaluation has been made by determining the cost of replacing bridges earlier than expected due to this reduction in service life. These calculations have been undertaken for bridges on the state highway network for Option A vehicles, and on the Auckland City area for Option A, B, and B' vehicles.

The use of standard or prescribed values in determining bridge strength leads to overly conservative estimates. The approach adopted by the bridge consultant is based on the application of a proposed bridge-testing programme (BTP), which would be expected to indicate reserves of strength above the theoretical values calculated by the conventional bridge manual factors (BMF). This approach indicates significantly lower but more realistic costs for the effects of heavier vehicles on the bridges.



Figure 1. Typical short span reinforced concrete bridge.

Road geometry

The costs of changes to the road geometry apply only to the city case, i.e. to the Auckland City pilot area. The coverage was based upon a map of current bus usage supplied by the industry (Figure 2 below). This, however, included part of the motorway system. For this system, it was assumed that the existing roading geometry was suitable for the larger buses. The only areas within the motorway system requiring consideration were the interchanges (approximately 32). For each interchange, 1:500 aerial photos were

obtained, and the tracking curves have been overlain on these. Any resulting deficiencies have been identified and rough order costs to eliminate these deficiencies have been estimated.



Figure 2. Auckland City bus routes.

For the Auckland City road network, the areas requiring consideration were:

- Intersections where buses turn, or roundabouts (approximately 35); and
- Bus stops.

Relevant 1:500 or 1:1000 aerial photos have been obtained from Auckland City Council for the intersections. The tracking curves have been overlain on these to identify deficiencies. Where possible the intersections have been grouped by common deficiencies and rough order costs for each assessed.

Bus stops were evaluated using an on-site measure up. The impacts fell into three typical categories: do nothing, road marking changes only, and physical works. An allowance was made in the estimates for the preparation of traffic resolutions for bus stops requiring alteration.

Benefits

The benefits have been determined from information in the submissions made by the BCA, and by consultation with operators. The consultation included a questionnaire sent out through the BCA to members on present bus and coach numbers, distances travelled, and likely take-up of the proposed new options.

Aspects taken into account in assessing the net bus benefits include:

- The capital cost decrease in purchasing a heavy load bus or coach with two axles instead of three axles;
- The reduction in total bus fleet operating cost brought about by the lesser number of buses required to transport the same total passenger number, and by an increase in passenger loadings;
- Reduced driver costs, commensurate with the reduction in bus numbers required to transport the same total passenger number; and
- Benefits associated with additional luggage space described in the BCA submission as "improved flexibility in door placement and seat spacing".

Economic analysis

The results of the component studies were combined in a cost-benefit framework. For each scenario and mass option the components were grouped into costs or benefits in accordance with the definition that costs are impacts that affect the roading authority, whereas benefits are impacts that affect the road user or others external to the roading authority. Totals of costs and benefits (relative to the base or "continuation of existing" case) were evaluated in each option, as has the option benefit/cost ratio.

The costs or benefits associated with each impact occur over time, and were therefore discounted to give net present values (NPVs). Results are presented for the case of resource costs and a discount rate of ten (10) per cent, in New Zealand Dollars (currently 1 NZ = 0.66 US).

An option is described as "viable" if the benefit/cost ratio is equal to or greater than the cut-off threshold of 4 currently operated by the New Zealand government road funding agency Transfund New Zealand (Transfund).

STUDY RESULTS

The costs and benefits, and the benefit/cost ratio for each option relative to the base case are tabulated below. In both the State Highway and urban cases the costs assume that a bridge-testing programme will be carried out to better target bridge renewals and minimise bridge costs.

State highways

Option	1A	2A
	12.6m 16t	12.6m 18t
	Benefits (NZ\$M)	
Capital	6.8	24.8
Operating	14.2	32.9
Driver	26.8	62.0
Luggage Space	3.8	15.0
TOTAL	51.5	134.7
	Costs (NZ\$M)	
Pavements	19.5	49.3
Bridges	1.7	6.8
TOTAL	21.2	56.1
Benefit/Cost Ratio	2.4	2.4

Table 3. Benefits, costs, and benefit/cost ratios for the state highway case.

Urban areas

Table 4. Benefits, costs, and benefit/cost ratios for the urban case.

Option	1A	2B	2B'
	12.6m 16t	13.5m 18t	14.5m 18t
	Benefits (NZ\$N	A)	
Capital	-2.8	2.9	-0.06
Operating	6.7	11.8	13.7
Driver	12.2	22.8	26.9
TOTAL	16.1	37,.6	40.5
	Costs (NZ\$M)	·
Pavements	3.1	5.3	5.0
Bridges	0	0	0
Geometrics	0	0.3	0.4
TOTAL	3.1	5.6	5.3
Benefit/Cost Ratio	5.3	6.7	7.5

STUDY CONCLUSIONS

The results show that the urban case is viable i.e. it meets the benefit/cost cut-off threshold of 4 that is currently operated by Transfund. The state highway case is economic i.e. it has a benefit/cost ratio greater than 1, but does not meet the Transfund cut-off threshold. It could be said, however, that if, -

- the main cost is pavement wear; and
- RUC charges fairly recover all associated costs,

then the benefit/cost ratio can be seen as a commercial decision by operators, who may choose to invest in options that are somewhat below the government road funding agency's threshold level.

OBSERVATIONS

Comparison with a similar study in Australia

A major study of mass and dimension limits for buses and coaches was undertaken in Australia in 1999/2000 (Roaduser International P/L and Saturn Corporate Resources P/L, 2000). The study examined possible changes in gross mass from the present limit of 16 tonnes to 18 tonnes, an increase in length to 14.5 metres and an increase in width to 2.6 metres. The report was made available to Transit by the National Road Transport Commission (NRTC).

The Australian study was more comprehensive that the present New Zealand study and had some significantly different findings, such as:

- a mass increase from 16 tonnes to 18 tonnes had a benefit/cost ratio of only 1.3, and then only for route buses and not for highways, with a net present value (NPV) of NZ\$0.4 million over 12 years using a five (5) per cent discount rate; and
- the NPV for the length options was close to NZ\$0.

Benefits were low partly because a large number of buses already operated above the allowable limits in times of peak demand. In addition, there was significant variation between operators as to the value of the possible changes and the take up was expected to be low. The report recommended that 2 axle buses should be permitted a gross mass of 18 tonnes but with no general increase in width or length. Another recommendation was that longer buses should be considered for operation under permit.

The recommendations were not adopted in Australia due to the relatively small benefits, and due to uncertainties about the implications of such a mass increase on pavements and infrastructure such as culverts. A further study was carried out in Australia for the NRTC (Youdale and Donald, 2002). This study found that there would be few problems with a mass increase on the main arterial urban road network, but that an increase to 18 tonne gross vehicle mass for two axle buses would cause undue road wear on feeder routes, particularly at local area traffic management sites. The issue is still under consideration in Australia.

Observations on the New Zealand study

The findings of the Australian study suggest that the benefit/cost ratios reported here are high. However, a number of general observations about the study can be made.

In the rural (state highways) situation, increases in pavement wear will certainly result. In addition, an increase in gross mass limits would lead to a slight increase in tare mass due to a greater number of seats and possibly stronger chassis and more powerful engines. Therefore, even when empty some minor additional road wear will occur. In New Zealand the Road User Charges (RUC) mechanism automatically recovers the additional costs that ensue from higher mass. RUC for 2 axle vehicles are given in Table 5 below (including 12.5% Goods and Services Tax).

Therefore, the comment made by the consultants in the New Zealand study that any take up would be a commercial decision by operators does have merit.

Gross Mass (t)	NZ\$ per 1000 km
14.0	\$262
16.0	\$414
18.0	\$631

Table 5. Influence of road user charges.

In the urban situation, the assumption that increased capacity leads to fewer buses has greatest validity during peak demands. An increase in allowable gross mass will give a greater capacity for standing passengers without additional cost (provided the safety ratings of the various manufacturers are not exceeded). Similarly, an increase in both length and gross mass would allow more productive buses during peak demand. Again, it could be seen to be an operator's choice whether to take up the larger and heavier vehicles.

It should be noted that an increase in length without an increase in mass is not a viable option and was not included in the project. As the compliance with present limits by buses was not investigated, no conclusions can be drawn in relation to overcoming present compliance difficulties. Some additional work in that area may be warranted. Given these observations, it appears that the strongest case is for an increase in allowable length (on suitable routes) and mass to allow more productive buses in urban areas.

DEVELOPMENTS POST-STUDY

In 2001 the New Zealand Land Transport Safety Authority released an Issues Paper (Land Transport Safety Authority, 2001) covering the proposals put up following Transit's earlier study of possible increases in truck size and mass (Transit New Zealand, 2001). Following public consultation on this Issues Paper, the New Zealand Ministry of Transport asked for a detailed review of the Transit proposals, particularly addressing the criticisms made about assumptions and methodology. This review, managed by the Ministry of Transport, commenced in 2002 and is currently still proceeding.

The New Zealand government released its New Zealand Transport Strategy (NZTS) in December 2002 (New Zealand Government, 2002). This strategy describes the contribution transport makes to achieving social, economic and environmental outcomes. While the theme of 'ensuring New Zealand's competitiveness' is not neglected, the factors to be considered when funding transport or developing transport policy have been broadened and are listed as the five key objectives of the strategy:

- Assisting economic development;
- Assisting safety and personal security;
- Improving access and mobility;
- Protecting and promoting public health; and
- Ensuring environmental sustainability.

The NZTS emphasises the need to progress all five outcomes in parallel. Significantly more emphasis is, however, given to social and environmental issues than has been the case in previous transport policy statements.

At the time of preparing this paper, New Zealand government transport officials are considering the findings of the Transit study of bus and coach limits in light of the NZTS. It is hoped to conduct further research work of a more detailed nature.

Transit intends to publish a more detailed report covering the bus and coach study during 2004.

Below are some illustrations depicting overseas bus types currently under consideration. Gross vehicle mass varies with local regulations.



Figure 3. 14.5 m rigid three axle Scania coach at Mangalore, Victoria.



Figure 4. 25 m double articulated Van Hool low floor bus at Delft, Netherlands.

ACKNOWLEDGEMENTS

Thanks are due to Dr R J Dunlop, Chief Executive Officer, Transit New Zealand, for permission to publish this paper.

The use of extracts from the study report has been made with the kind permission of the following consultants:

- Infratech Systems and Services Pty Ltd, Brisbane, Australia
- Montgomery Watson Harza NZ Ltd, Christchurch
- Opus International Consultants Limited, Auckland and Wellington
- Phillip Brown, Traffic Planning Consultants Limited, Auckland

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APPENDIX A

Mass and dimension options considered in the study

The options to be evaluated are summarised as follows:

- Options 1A and 2A: Increase in mass with no increase in length (Figure 1)
- Options 1B and 2B: Increase in both mass and length (Figure 2)



Figure 1. Illustration of buses for evaluations in Options 1A and 2A.



Figure 2. Illustration of coaches for evaluations in Options 1B and 2B.