ROAD USER CHARGES AND LIMITS ON VEHICLE WEIGHTS AND DIMENSIONS

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SYNOPSIS

The paper addresses legislative factors affecting heavy vehicle design, namely its heavy vehicle weight and dimension limits.

From 1982 to 1984 Road User Charges were subjected to an intensive review by a working party representing government and road transport industry representatives. The paper discusses the most important matters covered by the review, and aims to clarify the role of the fourth power rule and load factor assumptions upon which the charges are based.

In 1984 the road transport industry made submissions to the government requesting increased weight and dimension limits for heavy vehicles. The merits of such charges, which have yet to be agreed upon, are evaluated.

1. INTRODUCTION

During the past three years the author has been closely associated with the review of Road User Charges, as an adviser to the N.Z. Road Transport Association's representatives on the working party that presented its final report to government in October 1984 (Reference 1). Road User Charges are intended to have a strong influence on vehicle design and selection. Section 2 of the paper describes the more important matters addressed by the working party.

In 1984 the N.Z. Road Transport Association made representations to the government seeking increases in the maximum allowable weights and dimensions for heavy vehicles. Early this year the author was commissioned by the National Roads Board to prepare an appraisal of the proposed changes. Without disclosing the recommendations made, Section 3 sets out some of the pros and cons of relaxing weight and dimension limits.

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2. ROAD USER CHARGES

2.1 The Motivation for Road User Charges

The Government's reasoning behind Road User Charges was simple. The price paid for using the road should equate with the cost of providing the road. Road users should bear the costs of their travel and neither be encouraged to use roads extravagantly, due to underpricing, nor be dissuaded from profitable utilisation of roads, due to overpricing. The new system,based on hubodometers recording distance travelled, would be much better than the mileage tax system it would replace. Mileage tax had been levied on returns submitted by operators - virtually an "honesty box" system. Being an island nation with no across-border truck travel New Zealand could impose a hubodometer system without problems that would otherwise arise, such as in Europe.

The Government saw the benefits of Road User charges as coming from the following sources:

(a) Distance recording using the hubodometer would be enforceable, unlike mileage tax.

(b) The charges would be specific to each vehicle type and would be the sum of three separate components, paying for:

  i. Driver costs which comprise the costs of traffic services,such as giving guidance to the man in control

  ii. Space costs which relate to the provision of traffic capacity, the road space needed to move the volume of traffic.

  iii. Pavement wear/strength costs which determine the pavement life, each axle travelling over the pavement reducing its life by a quantum amount.

(c) The transport operator could choose a licensed weight according to his needs and pay Road User Charges accordingly. This was significant since the wear/strength costs were said to have a fourth-power relationship with wheel loading. Doubling the wheel-loading increased pavement wear

2^4, or sixteen times, whilst trebling the wheel-loading increased wear 3^4, or 81 times. Under Road User Charges a quarry truck could license to maximum weight whereas a truck delivering only light manufactured goods, for example, could choose to license for less than maximum axle loads and pay correspondingly less in Road User Charges.

(d) Road User Charges would reveal to each transport operator the cost his travel imposes on the road system, thereby encouraging him to consider adding on extra axle to reduce his Road User Charges (to his benefit) and reduce road wear (to the nation's benefit). (For example, if instead of a single axle carrying 8 tonnes the same load was borne by a tandem axle, the pavement wear would be reduced by 90% due to the effect of the fourth-power rule.)(1)

(e) By placing heavy road transport on a "user pays" basis and by subsidising the Railways loss-making social services from the public purse, there could be open competition between road and rail. It was seen to be in the nation's overall economic good for the customer to choose whichever mode best suited his requirements. Customers would no longer be forced to use an uneconomic or unsuitable mode of transport through an arbitrary distance limitation on competition between road and rail.

These were the advantages that were sought from the change from mileage tax to Road User Charges. What, then, have been the effects of the change?

2.2. Road User Charges in Practice

Due to the fourth-power rule, heavy vehicles collectively pay more than 99% of road wear costs. The fourth-power rule calculation assigns light vehicles only

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(1) If a vehicle is licensed at or near its maximum legal weight, most of the cost built into Road User Charges is for "wear" - "driver" and "space" comprising little of the total cost. Very substantial reductions in Road User Charges could therefore be gained by spreading the weight over more axles, unless the 39 tonne maximum gross laden weight limitation became a constraint. If 39 tonnes was a constraint an extra axle would reduce an operator's Road User Charges but reduce his revenue by even more, due to the decreased payload if the tare weight were increased by the addition of an axle.

5 million EDA-km[1] annually compared with 700 million EDA-km for Road User Charges vehicles. Depending upon how the National Roads Board spends its income, road wear can account for anything up to half the Board's budget. Of course, many so-called heavy vehicles are really quite light and do not cause much pavement wear. Thus, a minority of heavy vehicles contribute a major slice of National Roads Board's funding.

Because of the high costs involved and due to the ease of evasion it is generally considered that a substantial amount of cheating is undertaken, probably by a minority of operators. Since the National Roads Board levies road users to cover its costs, the Board does not lose money from this evasion. Rather, honest road users pay more to cover those who cheat. This exacerbates their competitive disadvantage when quoting freight rates to customers.

The Road User Charges system is not cheap to administer being based on a moderately costly piece of hardware which can be damaged. There is the time-consuming process of recording, filling out forms, queuing at the Post Office to purchase licences, claiming rebates, etc. It is a burden on the transport operator and a chore for the Government. Given all this, plus the pre-payment aspect of buying a licence before the time of travel, and the worry about competitive disadvantage in the face of widespread evasion, the road transport industry sought a review of the system. The Government agreed and in 1982 established a Working Party made up of representatives from the relevant Government departments and the N.Z. Road Transport Association.

2.3 Fixed and Variable Costs

The most fundamental issue was the distinction between fixed and variable costs. Variable costs are those that vary when the amount of traffic varies. Fixed costs make up the residue, and are not altered by a change in traffic volume.

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(1) Pavement wear is in proportion to the number of EDA-km of travel over the road surface, one EDA (or "equivalent design axle") being 8.2 tonnes on a twin-tyred single-axle, or 14.5 tonnes on a tandem, or 19.8 tonnes on a tridem. Axles at greater or lesser loads than the reference load can be converted to EDAs using the fourth-power rule e.g. 8.3t on a tandem is equivalent to $(8.2/14.5)^4 = 0.10$ EDA

Some costs are wholly fixed, some are wholly variable and others are a mixture. Examples of costs with variable components are general maintenance and pavement rehabilitation. Bridge costs are mainly fixed because, once built, costs are almost unrelated to traffic use.

2.4 The Charges Should Recover Only Variable Costs

The road tranport industry argued that if the benefit to be gained from travel exceeds the variable cost of making the trip then it is in the interest of the nation for that trip to take place; in other words, provided a trip can afford to pay its share of variable roading costs the trip is in the national interest and should be made. But if the charge for road use is higher than the variable cost (i.e. recovers fixed costs as well) there will be some trips that cannot afford the higher price and will therefore no longer be made; this is a loss to the nation as the trips forgone would have been in the national interest. The road transport industry therefore contended that the charges for road use should recover only the variable costs of road use. In the language of economists, the industry was calling for "marginal cost pricing".

Marginal cost pricing is not new. It is a standard approach to pricing of economic resources to ensure they are used to best effect. Applied to roads the approach should take into account that building strength into pavements is subject to economies of scale; that is, the more strength (i.e. life) we build into a pavement the cheaper that extra strength (i.e. life) becomes. With an inch more basecourse pavements would have double the life (in terms of EDAs they can carry before they deform) and 2 x 2 = 4 times the life with only two inches more basecourse. The cost that varies with changes in EDA-loadings on the road is the cost of the last inch or so of basecourse. This is the variable part of the cost of pavement life. The remaining cost is effectively fixed, i.e. it will not vary with varying traffic load.

2.5 Meeting Fixed Costs

If Road User Charges covered only variable costs, fixed costs would need to be met in some other way. This might be through a fixed annual licence fee. The

industry considered the Government should fund the heavy vehicles' share of fixed costs by returning to roading the general revenue taxes paid by heavy road transport. For the 1984/85 year, the Working Party assessed these to be (in pre-devaluation terms):

Customs duties on new vehicles	21.5
Sales tax on - tyres	7.4
- new vehicles	14.1
- spare parts	14.1
- truck and trailer bodies	3.0
Registration fees	3.9
	$64.0 million p.a.

(source: Reference 1)

2.6 Fully Implemented Road User Charges

In the end, the Government decided against this approach and resolved to "fully implement" Road User charges as from February 1985. (The price freeze had prevented Road User Charges being increased to their planned levels even though sales tax on new vehicles had been progressively reduced from 40% to 10% to partly offset the higher charges.) The charges were set so as to recover both fixed and variable components of National Roads Board expenditures.

Supporting the Government's decision was that Local Authorities also contribute to roading from their revenue. Road User Charges (together with the equivalent charge on light vehicles levied through petrol tax) would cover the total expenditure of the National Roads Board. But half the road works undertaken by Local Authorities are not funded by Board subsidies. If, as advocated by the road transport industry, Road User Charges covered the variable costs of roading, all Local Authority roading expenditure would need to be counted. Instead, the "fully implemented" charges included only half of Local Authority expenditure but compensated by including the fixed as well as the variable costs.

Whether this was a reasonable trade-off depends on what proportion of roading cost is indeed variable, and what is fixed. On this the Working Party could not

agree. The industry representatives believed that the "fully implemented" charges covered much more than just those costs that were variable. There was evidence pointing towards possible reductions of up to one-third in the levels of Road User Charges if only the variable costs were covered. But it depended upon the rules adopted for deciding which costs were variable and which were not.

2.7 Fourth Power Rule and Pavement Wear

The fourth-power rule was another issue raised in the Working Party. An effect of this rule is to ascribe virtually zero road wear to private cars, leaving Road User Charges vehicles to pay for over 99% of pavement wear.

There is no single "correct" power rule that relates axle loads to pavement wear, but worldwide the power of 4 is regarded as a middle-of-the-road figure. Rigid pavements (e.g. concrete) are associated with higher powers and flexible pavements (such as New Zealand's) are associated with lower powers. It was argued by the industry that since a power of 4 is accepted as an average in the Northern Hemisphere, where concrete roads and other rigid pavements are commonplace, a lower power should be used as the rule for New Zealand.

But even if New Zealand adopted a third-power rule it would do little to spread responsibility for pavement wear over light vehicles. Heavy vehicles would still pay for virtually all pavement wear. The only noticeable change would be in the relative levels of Road User Charges as between the heavier and lighter vehicles paying Road User Charges. Heavier axles would pay less and lighter axles would pay more.

An even more fundamental point is whether the fourth(or any other) power rule applies to pavement cost. There is no doubt that some such rule applies to pavement wear. But as noted earlier, building more life into a pavement so that it can cope with more wear is not costly; double the wear can be accommodated for the cost of only an inch more basecourse. This cost effect happens to cancel out the effect of the power rule relating axle weight to pavement wear. As explained by Dr Max Lay, Executive Director of the Australian Road Research

Board. (Reference 2):

> "It is important to note... that the cost of new construction to cater for the increased wheel loads will be approximately (in proportion to the increase in wheel loading) and is not predicted by the more severe fourth-power law."

New construction and pavement rehabilitation are not the only costs that Road User Charges allocate according to the fourth-power rule. There may still be merit in spreading some costs that way. But the conclusion that only variable costs should be covered by the charges, and the conclusion that an important component of roading cost is not fourth-power related after all, raised the question whether the Road User Charges system is worth the effort.

2.8 An Alternative to Road User Charges

Arguing in favour of replacing Road User Charges by a combination of fuel tax, tyre tax and annual licence fee, the road transport industry pointed out the comparative limitations of the Road User Charges system.

Roading costs vary greatly from road to road but a hubodometer-based system cannot take such variations into account. The final report of the Road User Charges Working Party detailed a range of costs. In relation to average numbers of vehicles per day, annual road maintenance costs vary from $29 per vehicle-km in Wairoa County to 40c per vehicle-km for the Auckland Southern Motorway.

Fuel and tyre taxes would go some way toward reflecting cost differences between roads since there is more tyre wear and more fuel is used, per vehicle-km, on high-cost roads. Moreover, taxes on fuel and tyres would raise revenue for roading in a way that reflected the actual load on the vehicle at the time of travel, not just a nominated maximum weight.

2.9 The Average Load Factor Problem

Under a system where vehicle weight must be nominated in advance, as is the case with Road User Charges, the weight nominated becomes the heaviest weight expected. Actual weight at the time of travel varies greatly, up to this maximum.

Pavement wear depends upon the actual weight, not the nominated weight. Two identical vehicles may be licensed to carry the same weight, but if one is on rural cartage, with generally low load factors, whereas the other is on line-haul depot-to-depot freight haulage at or near 100% load factor, the road wear they cause can differ greatly; one causes three or four times the road wear of the other.

The need for Road User Charges to assume a specific load factor is often referred to as the "55% average load factor problem". It has been a contentious issue for those who know they are not achieving that high an average load factor. But "55% average load factor" is a misleading way of saying that Road User Charges are based on the assumption that half a vehicle's travel is at licensed weight, and the other half is at a weight which results in 10% of the road wear when the vehicle is at full licensed weight. Thus, the average road wear caused by a vehicle is assumed to be 55% of the wear when the vehicle is full licensed weight. It is inaccurately referred to as a "load factor" when in reality there is a weighting introduced into the calculation which reflects road wear. This weighting destroys any meaningful use of the 55% figure in relation to payload.

The important point to note is this: no matter what "payload" assumption is made, the charges remain unchanged. The fourth-power rule ensures that Road User Charges vehicles are allocated all pavement wear costs, irrespective of whether it is assumed they travel at licensed weight for half the time, a quarter of the time, or all the time. And having allocated all pavement wear costs to Road User Charges vehicles as a group, the sharing of these costs across individual vehicles is not affected in the slightest by the assumed loading, because the same assumption is applied to every vehicle.

A case has been made for applying concessional charges to vehicles achieving lower than average load factors. For specialist vehicles on dedicated work, such as milk tankers, such an arrangement would be workable. The dairy industry has argued strongly for concessions on the grounds that a milk tanker travels empty on its outward journey and is full for only the final leg of its return

journey. Of course, if milk tankers were made a special case so too could jinkers. Jinkers could be charged a higher rate since they are piggy backed for return journeys.

3. VEHICLE WEIGHT AND DIMENSION LIMITS

Early in 1984 the N.Z. Road Transport Association presented a submission to the Government asking for a revision of the maximum vehicle weight and dimension limits. Since then a sub-committee of the National Roads Board has been evaluating the request and will report to the Board in due course.

3.1 Gross Vehicle Weight

The industry requested an increase in gross combination weight from 39 to 44 tonnes with no change in allowable axle loads. On its own, such an increase would have little visible manifestation to the general public as most vehicle combinations would remain the same size. Initially there may be some slowing in the rates of climb on long grades, but in the longer term there would be an improvement as old vehicles were replaced by more powerful ones. Higher allowable weights would reduce the total number of heavy vehicles on the road, particularly those on long distance haulage, logging work,etc. The freight to be moved would remain the same but the number of trips required to move it would be less. This should benefit road congestion and road safety.

There would be some increase in fuel and tyre cost per vehicle-kilometre as a result of higher loads, but the cost increase would be proportionately less than the increase in payload. Per tonne moved, fuel and tyre costs would decrease. Capital costs would reduce because fewer vehicles would be needed, and other costs would reduce also. For the carriage of indivisible loads, such as containers, higher gross weights, may lead to very large savings. Exports of kiwifruit and pumpkin, for example, annually run to thousands of containers which under present limits must be hauled singly. At 44 tonnes gross weight two boxes can be carried, with large savings in cost.

The total savings industry wide cannot readily be estimated since we do not have detailed knowledge of freight movements by road. From the Road User Charges statistics it is possible to match the vehicle-kilometres of travel by trucks and trailers of different licensed weights and thereby estimate the potential annual travel by vehicle combinations licensed for 39 tonnes. This is not so subjective an exercise as might at first be thought. It results in the conclusion that combinations licensed for 39 tonnes account for about 20% of the 240 million kilometres travelled by vehicles paying Road User Charges.

The 1980 Armitage enquiry (Reference 3) in Great Britain estimate a reduction of 13% in the number of lorries if the limit on gross vehicle weight were raised from 32.5 tonnes to 40 tonnes or more. A 1983 report by the Swedish Transport Research Commission concluded that changed weight regulations (primarily an increase of 4 tonnes in gross weight) would result in 15% fewer vehicles in the heaviest weight class. Even though Sweden already permits the longest, widest and heaviest vehicles in Europe, the report concluded that Sweden's interests would be well served by increasing maximum gross vehicle weight from 56 to 60 tonnes, and increasing tandem axle weights from 16 to 18 tonnes.

3.2 Overall Length

An increase in overall length from 19 to 21 metres has also been requested by the road transport industry. Without a major limiting factor (such as is bridge strength, in the case of 44 tonnes) the length proposal is more difficult to assess. There is no doubt that commodities that "cube out", and cannot make full use of the allowable gross weight, would benefit from the larger volume that could be carried on a longer vehicle. But on the other hand, at 19 metres New Zealand already ranks amongst the leading nations, and surveys conducted last year by the Ministry of Transport showed that even now 10% of truck and trailer combinations on the road exceed 19 metres and 10% of A-trains (semitrailer and full trailer) exceed 20 metres.

3.3 Forward Lengths

Limits are placed on the forward lengths of large vehicles in order that the widths of their swept paths are compatible with the streets they must negotiate. When a rigid truck turns it does so such that a line drawn through its rear axle points at the centre of the circle of the turn. The front of the vehicle projects out in front 'sweeping' a path that is wider than the path tracked by the rear wheels. The 'forward length' is the distance from the rear axle to the front of the vehicle. For trailers, the forward length is the distance from the rear axle to the king pin (in the case of a semi-trailer) or front axle (in the case of a full trailer).

To a first approximation, as a vehicle turns the amount of widening of its path is proportional to the square of its forward length, or the sum of the squares of the forward lengths in the case of a truck and trailer. The present limits have been framed with this relationship in mind. The maximum forward length of a trailer depends on the forward length of the towing vehicle.

Current Limits on Forward Lengths

Towing Vehicle (metres)	Trailer (metres)
7.4 - 8.3	nil
6.8 - 7.4	up to 4.7
6.2 - 6.8	up to 5.5
5.5 - 6.2	up to 6.2
4.7 - 5.5	up to 6.8
4.7 or less	up to 7.4

These limits envisage no more than two vehicles in combination, whereas nowadays it is common to see 'A-trains' (tractor and semi-trailer and trailer) whilst 'B-trains' (tractor and semi-trailer and semi-trailer) are becoming common. Although these rigs are built according to the regulations they have wider swept paths than two-vehicle combination.

B-trains have been operating since 1978 without problem and their swept paths

can be adopted as a standard. There is no logical reason why two-vehicle combinations should not be allowed longer forward lengths provided their resulting swept paths are no wider than those of B-trains. This is of particular significance to semi-trailer combinations. To maximise the trailer length (i.e. to achieve 7.4 metres forward length) the tractor unit currently must be shortened to 4.7 metres forward length, and for no useful purpose. Shortening a tractor from, say, 5.5 to 4.7 metres only slightly reduces the width of the swept path. But there is no point in reducing its swept path when all the three-vehicle combinations on the road have much wider swept paths. Indeed there is every point in not shortening the tractor since shortening is expensive, tampers with manufacturers' specifications, and makes rigs more difficult for the driver to control due to pig-jumping, jack-knifing, sledging, snaking ...

Longer forward lengths have safety benefits in that there is less amplification of steering movements (snaking) at the rear of the combination. Subject to the proviso that semi-trailers are not permitted wider swept paths than those of B-trains, the permitted trailer forward length should be increased. For a 5.5 metre tractor the trailer could be 8.5 metres. An increase of 1.1 metres on the permitted length of semi-trailers should greatly reduce the need for self-steering rear axles for most line haul operations. Self-steering rear axles perform as if a fixed axle were positioned further forward, thus shortening the forward length. The turntables and extra articulation points of self-steering axles detract from vehicle stability through loss of rigidity and increased deck height raising the centre of gravity of the load. And there is reduced sense of roll transmitted to the tractor unit so the driver is less able to 'feel' what is happening behind. Self-steering gear is heavy and its removal increases the payload capacity of the vehicle.

3.4 Weights on Axle Group

If longer, simpler semi-trailers were permitted to carry heavier payloads then semi-trailer combinations would become more popular for long distance haulage. In Australia they are an industry standard. For this to happen in New Zealand we would need to do more than just change the gross weight limit from 39 to 44 tonnes over a spread (first to last axle) of 16.0 metres. the limits of 38 tonnes over 14.4 metres and 37 tonnes over 13.0 metres would need to be altered too.

What is more, before six axle semi-trailers could load to around 39 tonnes a minimum spread would need to be prescribed for 19 tonnes (5.4 tonnes on a steering axle plus 14.5 tonnes on tandem drivers plus 19.0 tonnes on a triaxle bogie sums to 38.9 tonnes gross). At present the regulations jump from 17.5 tonnes over 2.4 metres to 21.5 tonnes over 3.6 metres; and 3.6 metres is too long for a fixed triaxle.

Although the road transport industry did not request increases in permitted weight other than over a 16 metre spread (i.e. the gross vehicle weight) it is clear that changes need to be made to the weight limits defined for lesser spreads of axle groups if the full benefits of higher allowable gross weights are to be realised.

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