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3 December 2013

Attention: Andrew McKillop

Dear Andrew

50 MAX HPMV - Pavement Impacts

Further to our recent meeting and subsequent discussions, we have carried out calculations to demonstrate the effect of the introduction of 50MAX HPMV's (previously referred to as Lower Bound HPMV's) on typical rural roads in the Waikato and Bay of Plenty (BOP).

1 Background

The April 2013 Opus report entitled "Lower Bound HPMV's, Analysis of Pavement Impacts" was reviewed. We consider this report accurately concludes that "the overall risk of increased pavement deterioration as a result of LB HPMV's is assessed to be low".

The current mix of heavy commercial vehicles (HCV's) is wide ranging and to assess the impact of the 50MAX HPMV's as they begin to replace existing HCV's is problematic. The approach taken in the Opus report has been to try and assess the current HCV mix and the associated Equivalent Standard Axles to move the existing quantity of freight on NZ State Highways. They have then attempted to model the impact of moving freight carried using 50MAX HPMV's as replacements for existing HCV's. This has required significant effort but results in rather broad outcomes.

We have assessed a simplified approach, assuming a specific type of HCV that is likely to be replaced by a specific pro-forma 50MAX HPMV shown in the Opus report. We have then set up the specified HCV and pro-forma 50MAX HPMV in the CIRCLY elastic analysis program, and compared the calculated damage to the subgrade to carry the same amount of freight using either vehicle.

2 Example Vehicles used in the Analysis

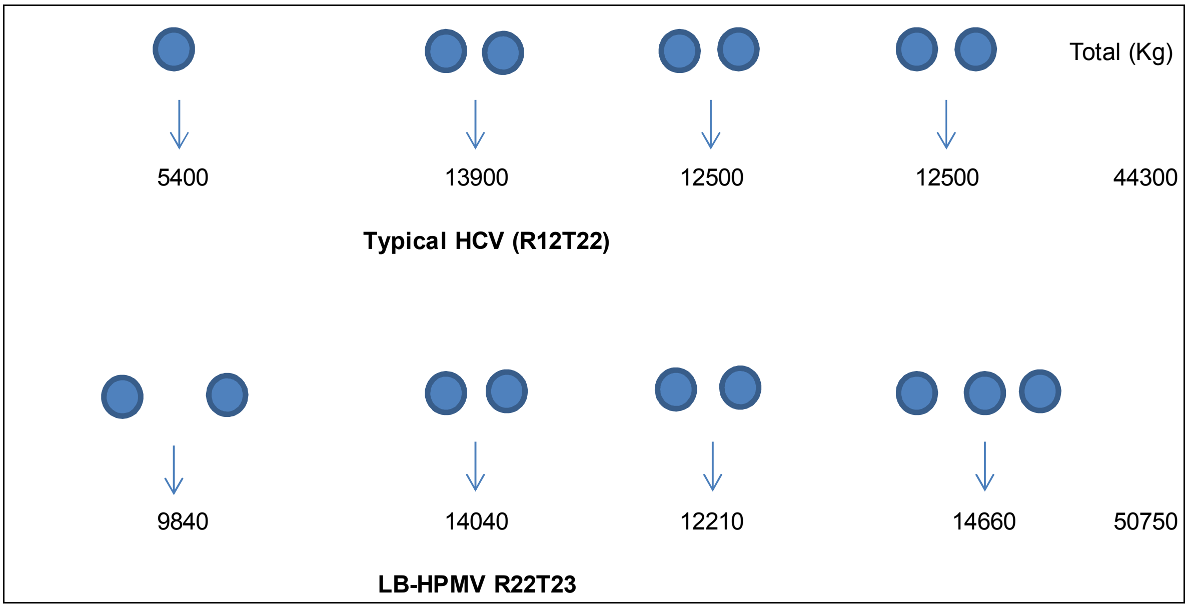
- Typical HCV Configuration

This vehicle was assumed to be a rigid truck and trailer (R12T22) that is likely to be replaced ultimately with the 50MAX HPMV configuration. The axles assumed and weights per axle are shown in Figure 1. The tare weight of this truck is assumed to be 17 tonne, with a payload of 27.3 tonne. This vehicle is considered to be a relatively common vehicle in current usage.

- Typical 50MAX HPMV Configuration

The 50MAX HPMV used in the analysis is a pro-forma vehicle detailed in the Opus report. This vehicle is assumed to be a rigid truck and trailer (R22T23) and is shown in Figure 1. The tare weigh of this truck has been adopted from the Opus report as 18.93 tonne, with a payload of 31.82 tonne. This vehicle is considered to be a commonly used 50MAX HPMV.

Figure 1 – Loaded Axle Configurations for Example Trucks



3 Pavement Configurations Assumed in Analysis

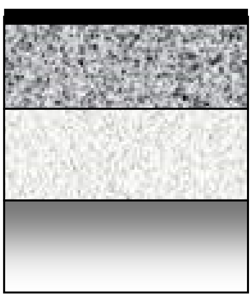
Three pavement scenarios have been considered as follows:

3.1 Pavement Scenario 1 - Moderately trafficked rural Waikato road

It was assumed that the amount of freight to be moved over the life of the pavement in one direction is 500,000 tonnes. Using the payloads from the two example vehicles the number of trips required by the 50 MAX HPMV is 15,713 whereas the standard HCV requires 18,315 trips.

The pavement configuration assumed is shown in Figure 2.

Figure 2 – Pavement Configuration Used in Scenario 1

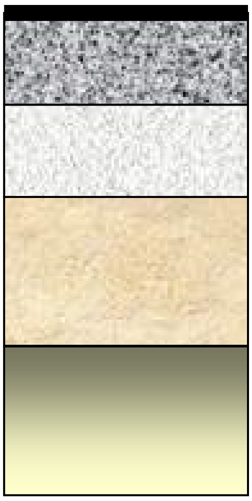


3.2 Pavement Scenario 2 - Low trafficked rural Waikato road

It was assumed that the amount of freight to be moved over the life of the pavement in one direction is 50,000 tonnes. Using the payloads from the two example vehicles the number of trips required by the 50MAX HPMV is 1,571 whereas the standard HCV requires 1,832 trips.

It was assumed that the pavement was constructed on a soft peat subgrade with a CBR of 1.5% - 2.0% and a subgrade improvement layer of sand or soft rock has been placed to give an effective subgrade CBR of 3%. The pavement configuration assumed is shown in Figure 3.

Figure 3 – Pavement Configuration Used in Scenario 2



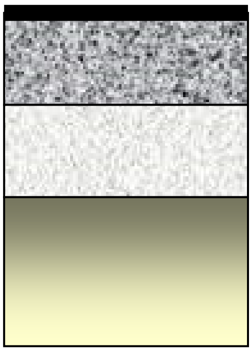
3.3 Pavement Scenario 3 - Low trafficked rural Bay of Plenty road

It was assumed that the amount of freight to be moved over the life of the pavement in one direction is 50,000 tonnes. Using the payloads from the two example vehicles the number of trips required by the 50MAX HPMV is 1,571 whereas the standard HCV requires 1,832 trips.

The Bay of Plenty (BOP) pumice pavements require an in depth soil mechanics discussion to fully understand how these work. However, we can use a simple approach and assume that a good quality appropriately compacted, pumice sand acts more like a poor quality aggregate when used as sub-base layer. The assumption is that the pumice sand sub-base will have an elastic response and not a plastic response which occurs in a fine grained soil such as yellow ash or clay. If the pumice is treated as a compressible select subgrade material, these types of pavement cannot work in theory.

The pavement configuration assumed for a low trafficked rural BOP road pavement constructed with pumice is shown in Figure 4.

Figure 4 – Pavement Configuration Used in Scenario 3



4 CIRCLY Analysis

CIRCLY calculates the subgrade strain under each axle group and the allowable number of load repetitions for the calculated strain values based on the AUSTROADS Pavement Design Guide criteria. The specified number of load repetitions in the analysis period is compared with the allowable load repetitions and reported as a critical damage factor (CDF) which is calculated as Specified Load Repetitions / Allowable Load Repetitions, (i.e. low CDF = less damage)

The results of the analysis are shown in Table 1.

Table 1 - Results of CIRCLY Analysis

Pavement Scenario	Truck	Freight (t)	Pay Load (t)	Trips	CDF
1	HCV (R12T22)	500,000	27.3	18,315	0.9
1	50MAX HPMV (R22T23)	500,000	31.82	15,713	0.8
2	HCV (R12T22)	50,000	27.3	1,832	3.3
2	50MAX HPMV (R22T23)	50,000	31.82	1,571	2.9
3	HCV (R12T22)	50,000	27.3	1,832	0.6
3	50MAX HPMV (R22T23)	50,000	31.82	1,571	0.6

5 Conclusion

Using the specified truck types and pavement configurations assumed in the analysis the 50MAX HPMV incurs no greater damage to the pavement in terms of rut generation. The wheel loads for both vehicles analysed are so similar the shear stress in the basecourse layer will be almost identical. Therefore, there should be no increase in basecourse shear failures because of the use of the 50MAX HPMV.

The use of longer vehicles and triple axles will increase the surface stress on tight curves and at intersections and may increase scuffing damage to the surface.

The analysis reported in this memo could be expanded to include different vehicle types and more pavement configurations; however, the outcome is unlikely to change significantly.

Please do not hesitate to contact me if you have any questions.

Yours sincerely

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on behalf of

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