

Road surface noise and vibration: good practice paving techniques

CASE STUDY

Issue 01 October 2014



PAPAKURA INTERCHANGE UPGRADE

Papakura Interchange is located on State Highway 1 approximately 35km south of central Auckland. A \$35 million upgrade of the interchange was undertaken in 2012/13 to improve safety and access to the Southern Motorway from Papakura to the east and the Hingaia Peninsula to the west. This early contractor involvement contract was undertaken by HEB Construction with consultants AECOM, and Beca was the principal's advisor.

A number of complaints were received regarding vibration during construction of the widened and lengthened southbound on/off-ramp as part of the upgrade. As well as adapting some aspects of the construction methodology to address the complaints, the project team also reviewed the road-traffic vibration assessment and took measures to further minimise potential operational effects. This case study describes these issues and illustrates the good practice measures that can be undertaken to minimise road-traffic vibration.

As part of the outline plan for the works, an assessment was carried out to determine the existing levels of road-traffic vibration. Vibration measurements were made at various distances from the existing southbound off-ramp and future vibration levels at all of the properties were predicted for the proposed alignment. The assessment concluded that if the new road surface was free from defects and seal joints, road-traffic vibration levels would be within the Transport Agency target of Class D (see 'vibration effects') at the nearest houses and would therefore be acceptable.

Two reasons were identified for the construction vibration from the southbound ramp to be above the human disturbance threshold of 1mm/s:

- The close proximity of inhabited residential dwellings to the road construction works (minimum 6m).
- Favourable ground conditions for vibration propagation, likely to be predominantly due to a layer of soft peat between 5 and 6m below the surface.

Vibration effects

Vibration from road-traffic seldom causes building damage, but can sometimes be felt by people and might cause annoyance in buildings immediately adjacent to roads (within approximately 10m). Rattling of building components, such as windows, is more commonly caused from heavy vehicle sound travelling through the air, rather than from vibration travelling through the ground.

In terms of vibration perception, the levels at which humans perceive vibration is significantly below levels that will cause damage to houses and structures.

The key aspects of a road surface that can cause vibration are the megatexture; defects; and other surface features. These factors are reflected in NAASRA counts (*Guide to state highway road surface noise*) which are measured using a dedicated test vehicle.

The Transport Agency uses NS 8176 for the assessment of road-traffic vibration (see *Technical Memorandum 3*). Categories of vibration are assigned with Class A having the lowest levels and Class D the highest. The target for houses by new roads is Class C or better, and for houses by existing roads, further investigation would be undertaken if levels exceed Class D.

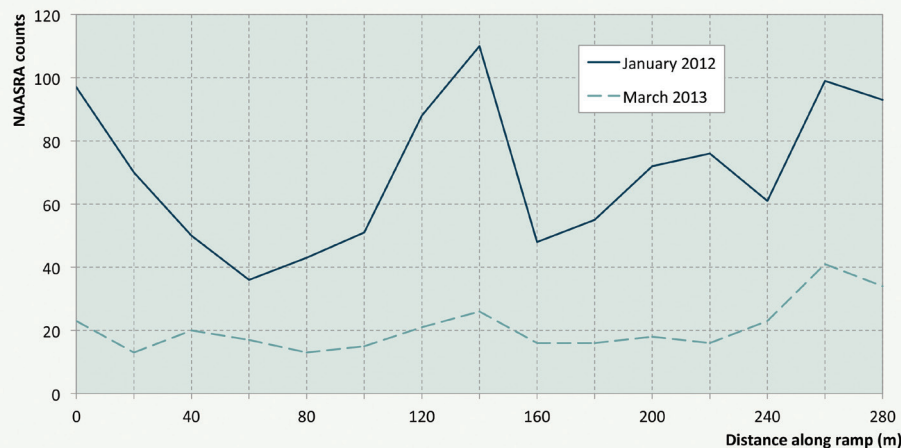
RAMP SURFACING

To minimise potential vibration effects, the project team sought to achieve a smooth surface finish free of joints and defects. Specifically, when laying the surface, the following good practice methods were adopted:

- A single surfacing run of the complete ramp to avoid joints in the road surface.
- The use of a 'shuttle buggy' to supply the surfacing material to the paving machine via a conveyor, thus avoiding impacts that can occur between the paver and a supply truck which can affect the surface texture.
- Particular attention was paid to the interfaces between the existing and new surfaces at either end of the ramp, to maintain a smooth transition between the two.

The roughness of the completed road surface was measured in terms of NAASRA counts and counts between 13 and 41 were achieved on the new ramp, indicating a good surface texture.

For comparison, Auckland Motorways Alliance specifies a NAASRA count of 40 (average) and 50 (maximum) for new asphalt surfaces. The average NAASRA count across the Auckland Motorway network is 38.



NAASRA measurements

Post-construction

Following completion of the project, the vibration levels were measured at one location and predictions undertaken for each of the neighbouring properties, with assumed vibration transfer functions between the ground and the internal floor vibration. All properties were Class C or better, with the majority being in Class A or B. This compares favourably with the pre-construction predicted vibration levels based on vibration measurements from the original ramp, where the majority of the properties were Class C and the three closest properties to the road were Class D.

Lessons Learnt

- Good practice laying of asphaltic mix surfaces to minimise road-traffic vibration should include:
 - Avoiding surface joints near houses.
 - The use of a 'shuttle buggy' to supply the material to the paving machine.
 - Achieving smooth transitions between existing and new surfaces.
- The project team responded positively to construction vibration issues that arose by modifying construction activities and equipment. The project was awarded a 'GEM' Award for Innovation in Customer Care by the Transport Agency.



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