Waka Kotahi research summary

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A calculator to holistically assess pavement environmental performance

Waka Kotahi wishes to use more recycled materials in pavements and to increasingly reuse existing pavement layers. This can contribute to a low-carbon, circular economy.

Waka Kotahi already allows certain recycled materials and by-products (such as recycled crushed concrete) in road pavements, yet their use is relatively limited. Other studies show several reasons for this, including:

- a lack of policy incentives
- risk-averse clients and contractors
- cost increases relative to virgin materials
- technical uncertainty over their long-term performance.

Calculating environmental trade-offs

Researchers in this study wanted to calculate the trade-offs of using recycled materials (which contribute to a circular economy) against other environmental indicators (such as carbon footprint), particularly when materials are transported over long distances. These calculations can help avoid creating any unintended negative consequences resulting from increasing the use of reused or recycled materials.

The researchers developed an Excel-based 'Pavement Environmental Calculator' to compare different pavement designs over their full life cycle and to provide rules of thumb. The calculator computes the environmental footprint of a full pavement over its life, including all layers of the pavement but excluding supporting infrastructure such as bridges, culverts, kerbs and catchpits.

The calculations are intended to sit alongside existing pavement design cost calculations, allowing users to consider the environmental attributes along with life cycle cost and technical performance. The calculator allows multiple time horizons to be considered (from annual impacts to total impacts over 100 years). Designed to take a holistic view, it calculates the carbon footprint of the pavement along with many other environmental and human health indicators. The calculator considers:

- production of raw materials for pavement (virgin and recycled or reclaimed)
- transport of raw materials to manufacturing plants
- manufacturing of pavement materials
- transport of pavement materials to construction sites
- construction/installation of the pavement
- maintenance, repair, replacement and refurbishment of the pavement within its service life
- energy losses from pavement–vehicle interactions in vehicles travelling on the road
- deconstruction of selected pavement layers at their end of life
- transport of waste to waste-processing sites
- processing of waste for cleanfill or recycling
- recovery of selected pavement layer materials such as asphalt and aggregate.

Initial rules of thumb for environmentally conscious pavement design

The researchers compared exemplar pavements using the calculator and noticed these trends:

- Recycled crushed concrete can be transported at least 30 km further than virgin aggregate and still have an equivalent or lower carbon footprint from 'cradle to site'.
- Reclaimed asphalt pavement can be transported at least 500 km for recycling and have an equivalent carbon footprint to virgin asphalt pavement from 'cradle to site'.
- The relative impacts of raw materials are higher when pavements have shorter design lives.
- Pavement–vehicle interactions can be very significant, and they become more important as the speed and flow rate of vehicles increases.
- Reusing suitable layers of pavement is an effective method of reducing emissions.

Invitation to use and improve the calculator

Waka Kotahi invites industry to:

- use this initial version of the tool in real-world projects
- provide feedback on:
  - its usability
  - the availability of data for use within the tool
  - its functionality.

Waka Kotahi hopes that the user group will share their findings and knowledge. This will improve:

- rules of thumb for environmentally conscious pavement design
- the environmental performance of New Zealand's pavements.

RR 695: Life cycle assessment of pavements: Development of a calculator, Waka Kotahi NZ Transport Agency research report. Available at **www.nzta.govt.nz/resources/research/reports/695**