THE CASE FOR CONCRETE ROADS

SUMMARY REPORT

concretenz
BUILDING RESILIENCE

2024

Concrete roads compared with asphalt roads over whole-of-life are likely to:

- be more cost-effective to construct and maintain,
- have potentially lower embodied CO_2; and
- present lower procurement risk due to less price volatility.

Two roundabouts linked by 300 metres of road in the Tauranga suburb of Tauriko, recently made use of Roller Compacted Concrete (RCC).

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INTRODUCTION

In late 2023 Concrete NZ commissioned economics consultancy Infometrics to compare the whole-of-life costs of asphalt versus concrete roads, and relative carbon footprints. This update of previous reports on the same topic was completed in April 2024.

As was the case for Infometrics reports on the same topic in 2013, 2018 and 2020, the 2024 report presents a compelling case for the use of concrete in roading.

A message to roading authorities

Roading authorities wishing to reduce the cost of asset construction and operation, embodied carbon in roading assets, and/or reduce the frequency of road maintenance should seriously consider concrete as a roading solution, to better serve communities and all New Zealanders.

Concrete roads are used extensively across Australia, offering a safe and durable pavement in a challenging environment.

CONCRETE ROADS ARE MORE COST EFFECTIVE THAN ASPHALT ROADS

The 2024 report summarises selected international comparisons of concrete and asphalt roading costs. The consensus is that concrete roads are more cost effective than asphalt roads over a life of 40 years, with a wide variety in results.

This variety is owed to factors such as: differing labour and other input costs, the type of asphalt or concrete technology, the discount rate used when calculating costs over whole-of-life, and the differing life span of roads.

Infometrics drew on this data, and available New Zealand data, to run 20,000 computer simulations of roading construction and maintenance costs in New Zealand. The result is a 12% to 23% advantage in costs to concrete over asphalt for the central 90% of the distribution of results. The weighted mean is a 17.5% cost advantage to concrete.

Table 1: Comparison of costs between concrete and asphalt roads over whole-of-life. Note variations between the studies in asphalt and concrete roading typologies, and in service life, and discount rate.

Study	Country	Concrete costs cf asphalt
Adow et al (2011)	Ghana	-52%
GCCA (2022)	India	-48%
Calhoun and Smythe (2018)	US	-29%
Arcadis (2017)	Australia	-25%
Jung et al (2022)	South Korea	-23%
Kumari et al (2022)	India	-20%
ACPA and Cemex (2023)	US	-11%
US Federal Highway Administration (2023)	US, urban road	-10%
Bouteiller and Gustafson (2017)	Canada	-6%
US Federal Highway Administration (2023)	US, rural road	+29%

The United States has seen the increased use of concrete pavements for heavy vehicle routes and intersections/roundabouts where tight low-speed turns are executed.

Discount rates explained

The application of a "discount rate" to a future stream of costs is a way of quantifying the "time value of money". The concept is that $100 today is worth more than $100 earned or spent in one year's time. If the interest rate on putting money in the bank is an annual 5%, then the value today of $100 in a year's time will be $95, and in two years' time, $90.25. The higher the discount rate, the lower future costs become.

By applying a discount rate to costings in tenders for roading contracts, which is a standard procedure, a roading authority places more weight on the upfront costs, and less weight on future maintenance costs. The choice of discount rate artificially favours asphalt relative to concrete over whole of life, because concrete can have higher upfront costs than asphalt, however, much lower downstream maintenance costs.

CONCRETE'S EMBODIED CARBON COMPARED WITH ASPHALT

The relative CO_2 footprints of asphalt and concrete roads are broadly the same, the Infometrics report shows. Concrete has a footprint of 2.2 to 3 kilotonnes of CO_2 per kilometre of road over 30 years, compared with asphalt's 2.1 - 3.1 ktCO_2/km over the same period (refer to table 2 below).

That said, if "carbon uptake" is taken into account, concrete roads may have a lower carbon footprint over whole-of-life. Carbon uptake is a natural process by which exposed surfaces of hardened concrete absorb atmospheric CO_2 over time.

In its 6th Assessment Report published in 2021 and 2022, the Inter-governmental Panel on Climate Change (IPCC) formally recognised "recarbonation", or carbon uptake. AR6 writers concluded that carbon uptake can absorb more than 15% of the original CO_2 emissions from cement manufacture over time. That would change the above figures for concrete roads to 1.5 – 2.6 ktCO_2/km.

The British Research Establishment (BRE) has produced mathematical formulae for calculating the rate and amount of carbon uptake in structures. Variables include the shape of the structural element, ambient air temperature, and the strength of the concrete. The relevant standard is EN16757 (Environmental Product Declaration - Product Category Rules for Concrete).

Given their shape – in having a large exposed surface for the volume of concrete poured - concrete roads would be expected to deliver rates of carbon uptake at the higher end of the estimates or projections.

It is important to note that carbon uptake is a permanent CO_2 sink, unlike timber and other sources of biogenic carbon, which eventually release greenhouse gases back into the atmosphere as CO_2 or methane.

Table 2: Comparison of embodied CO_2 over whole of life (30-40 years) between concrete and asphalt roads

Kilotonnes of CO_2 per kilometre of road	Concrete	Asphalt
EuPave data	2.2 – 3.0	2.1 – 3.1
Add carbon uptake (IPCC AR6)	1.5 – 2.6	2.1 – 3.1

The Infrastructure Sustainability Committee's (ISC) rating tool for calculating embodied CO_2 in structures is used by the NZ Transport Agency as a factor in procurement. The latest version of the IS Rating Tool is expected to adequately recognise carbon uptake.

Further reductions in the whole-of-life CO_2 footprint of concrete in roading may be expected as more low-carbon concrete is used in New Zealand. This is illustrated in the table on page 9.

As an overall guide, a full life cycle analysis should be undertaken on a project basis to compare emissions across pavement typologies.

Table 3: The reducing CO_2 footprint of concrete in New Zealand

Type of concrete (35 MPa)	Tonnes of CO_2 per cubic metre of concrete
Baseline concrete (Infrastructure Sustainability Council)	391
Low-carbon concrete (30% lower carbon footprint)	274

CONCRETE HAS LOWER RISK OF PRICE VOLATILITY

Since the closure of the Marsden Point oil refinery, New Zealand must now import all petroleum products, including bitumen, which is a key component of asphalt.

The Covid pandemic demonstrated how shipping costs can fluctuate by an order of magnitude, in response to international factors beyond New Zealand's control. As well, New Zealand's 100% reliance on bitumen imports inevitably raises supply chain risk.

For any roading authority, price volatility of inputs into roading carries with it a cost of managing the related financial risk. In this respect, concrete is significantly superior to asphalt.

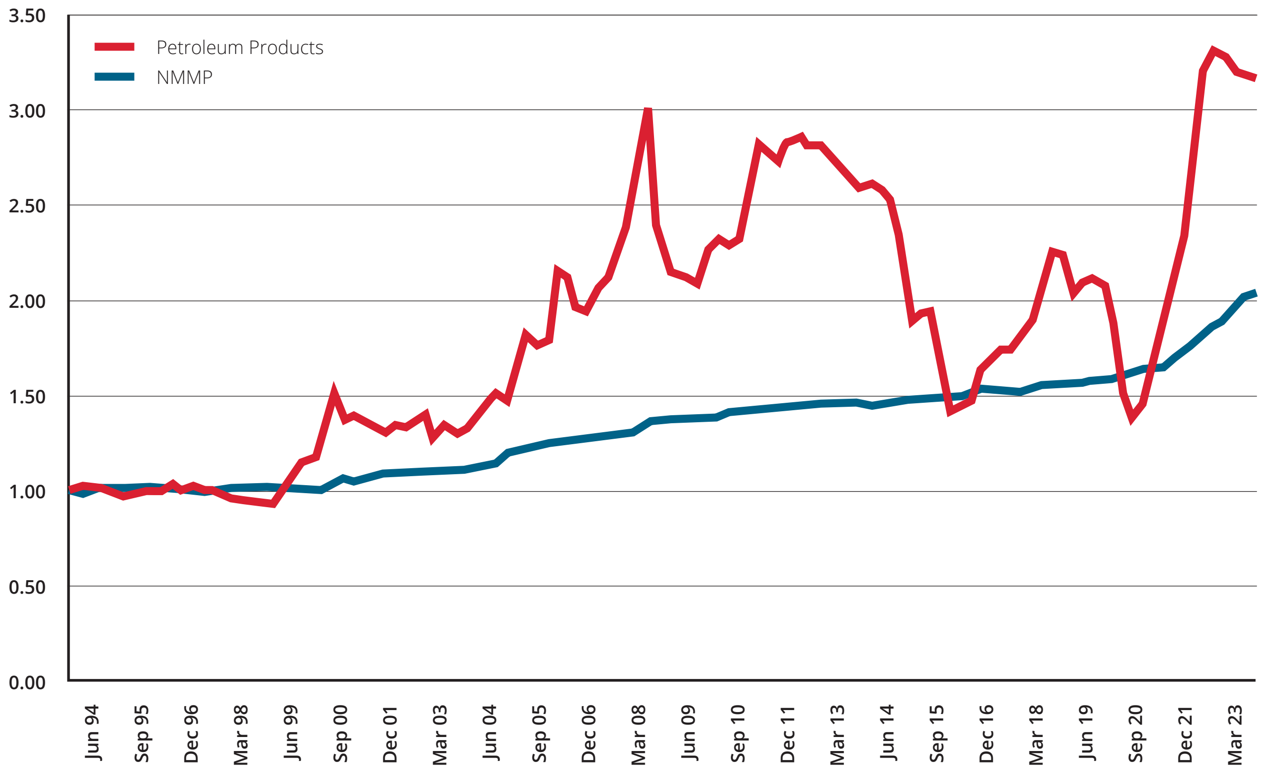


Figure 1. Output Producer Price Indices (PPI) for two industries, Petroleum Products vs. Non-Metallic Mineral Products (NMMP).

ADDITIONAL BENEFITS OF CONCRETE ROADING

Better fuel efficiency

Concrete pavements are rigid, meaning that vehicles travelling on them experience less "rolling resistance". This is the friction that occurs between an asphalt road surface and vehicle tyres as a result of the road surface depressing slightly under the weight of the vehicle as it passes.

The effect is obviously more pronounced for heavy trucks, and it can be significant. Over long haulage distances, the fuel savings become noticeable.

Research by the Massachusetts Institute of Technology (MIT) in 2020 showed the lower rolling resistance of concrete roads compared with asphalt-surfaced roads would save on about 0.5 percent of total transport related CO_2 emissions in the USA over 50 years.

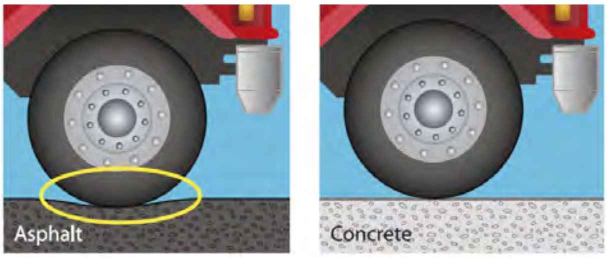


Figure 2. Exaggerated depiction of a truck tyre deflecting an asphalt road (left) but not a concrete road (right). Image: ACPA.

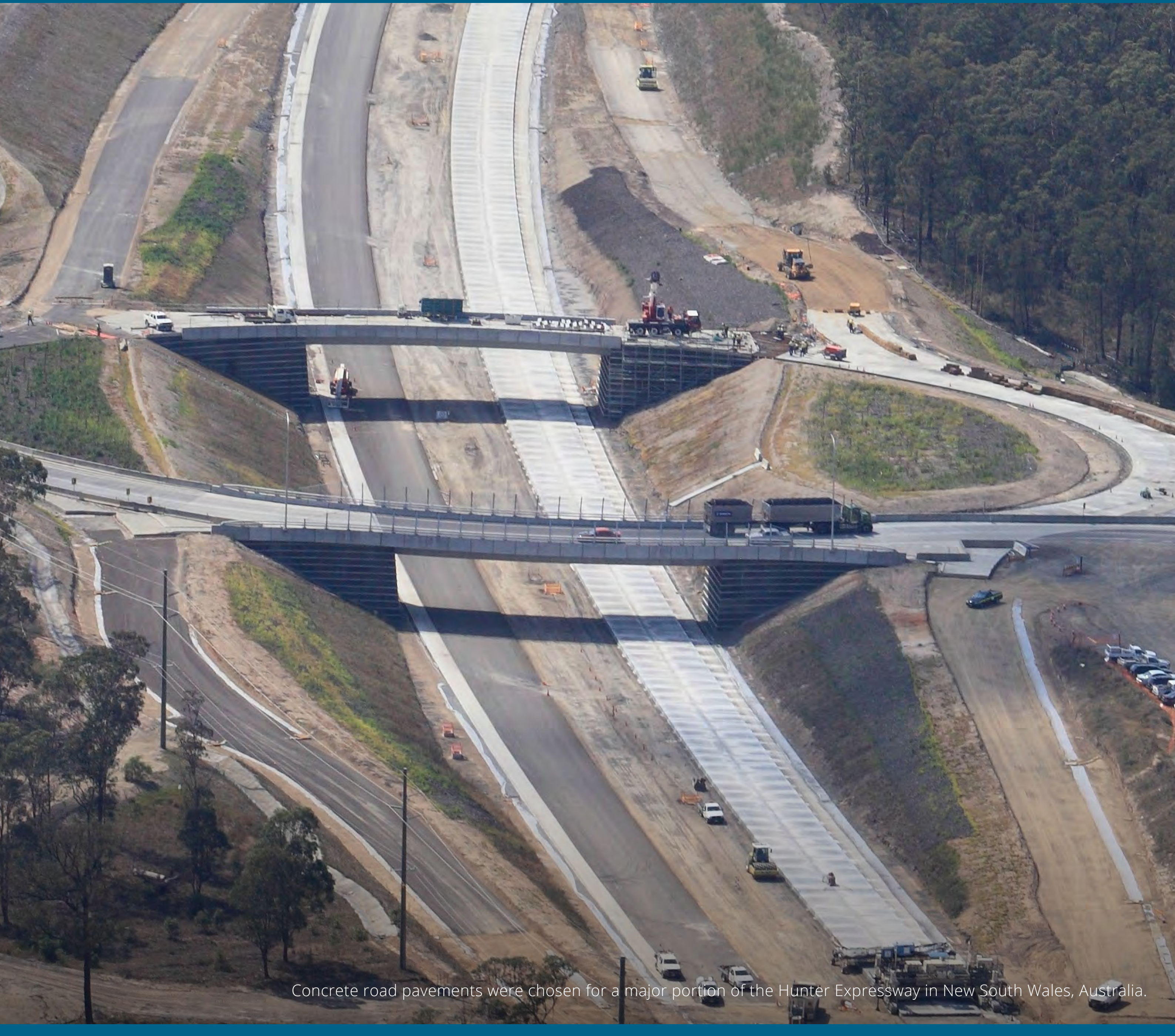
Reducing the greenhouse gas effect

Concrete roads tend to be lighter in colour than asphalt roads early on in the life of the road, and the difference becomes less pronounced as asphalt surfaces age, and lighten in colour. The lighter the colour, the higher the reflectivity of solar radiation, known as the "albedo effect".

The stronger the albedo effect, the stronger the contribution of a concrete road to reducing the greenhouse gas effect. While small compared with the embodied carbon of roading construction, the effect nonetheless benefits global climate.

CONCLUDING REMARKS

This report takes a positive view of the future of concrete roading in New Zealand. The whole-of-life economics, and other benefits present a compelling case for this durable, low-maintenance solution. While concrete will not suit every roading purpose, it certainly deserves more consideration than has occurred to date in New Zealand.



Concrete road pavements were chosen for a major portion of the Hunter Expressway in New South Wales, Australia.

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