



SUSTAINABLE CONCRETE PAVEMENTS

REDUCED ENVIRONMENTAL IMPACT OF CONCRETE PAVEMENTS

CONCRETE PAVEMENTS

- > Utilise recycled materials
- > Reduced eco footprint
 - > Low noise
 - > Save fuel
 - > Save energy
 - > Resilient
- > Lower heat island
- > Absorb carbon
- > Fully recyclable

KEY FINDINGS

- > Concrete pavements are 12% and 30% lower in environmental impact at 40 and 70 years
- > Concrete pavement rolling resistance reduces fuel consumption by 3% to 17%
- > Concrete pavements are 100% recyclable

KEY OUTCOMES

Concrete pavements typically utilise 20% or more recycled materials, demonstrate lower environmental impact, exhibit low noise, reduce fuel use (and CO₂), reduce lighting costs, reduce heat islands, absorb half of the CO₂ generated in cement production, and increase corridor resilience.

CONCRETE PAVEMENT AND ITS REDUCED ENVIRONMENTAL IMPACT

Concrete road pavements reduce environmental impact when compared with asphalt pavements. This Pavement Note summarises the latest findings which compare sustainability aspects of key heavy-duty pavement options. It provides agencies and decision makers with information to assist in meeting sustainability targets.



USE OF RECYCLED MATERIALS

Aside from cement, concrete pavements typically comprise 20%^{8 10} or more recycled content, frequently replacing manufactured or virgin materials^{14 16 17 18} with:

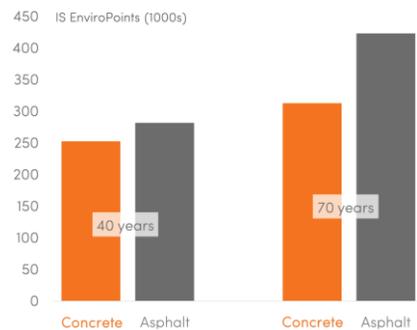
- Recycled concrete aggregate
- Steel/iron slag aggregates
- Coal combustion products (ash)
- Amorphous silica
- Slag (GGBFS)
- Glass (crushed and ground)
- Recycled water
- Lignin by-products



LOWER ENVIRONMENTAL FOOTPRINT

Whilst it is true that CO₂ emissions from cement production are higher than other binders used in construction materials, a more objective assessment of environmental impact considers the broader environmental implications of energy use (eg, global warming, photochemical smog, acidification, eutrophication and resource depletion).

A comparison of concrete and asphalt pavements at design and extended periods of service showed that concrete pavements are 12% and 30% lower impact at 40 years and 70 years respectively³.



ENVIRONMENTAL IMPACT 40 AND 70 YEARS



LOWER HEAT ISLAND

Albedo is the measure of solar energy reflected by a surface²¹. The lighter colour of concrete pavements (compared with asphalt) absorbs less heat energy, lowering the 'heat island' impact in urban areas^{9 13 21 24}. This reduced Albedo Effect minimises summer afternoon temperatures in some cities by an average of 2.8 °C^{11 27}.



CO₂ ABSORPTION

Approximately 43% of the CO₂ released in the manufacture of cement since 1930 has subsequently been absorbed by the concrete it produced¹⁵ in that period.

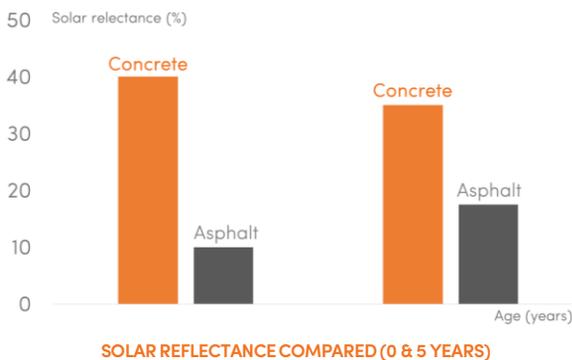
SUSTAINABLE CONCRETE PAVEMENTS

THE REDUCED ENVIRONMENTAL IMPACT OF CONCRETE PAVEMENTS



ENERGY SAVING

The light colour of concrete pavement surfaces better reflects lighting which improves visibility for road users²⁴. A concrete surface is 1.8 times more luminous than an asphalt surface and with a more uniform distribution^{9,19}. Improved light reflectance of a concrete pavement in tunnels typically reduces lighting energy demands by 30%^{5,20}.



RESILIENCE

If subject to extreme climatic events, concrete roads are much less susceptible to breakdown arising from internal pore-pressures (during flooding) and deformation (during extreme heat) due to their superior strength and durability. Improved resilience leads to improved availability during extreme weather events^{4,24}.



FUEL SAVINGS

Increased rigidity decreases rolling resistance and reduces fuel consumption by 3% to 17%. In the USA for example, potential annual fuel savings could be 670 million litres, leading to an annual CO₂ reduction of 620 000 tonnes^{1,2,24,27}.



LOW NOISE

Concrete roads can be textured to meet stringent noise requirements using treatments such as longitudinal fining, exposed aggregate, diamond grinding and grooving^{7,9} which reduce the acoustic impact on community and fauna. Concrete pavements can match asphalt surfacing noise performance at low and high speed²⁵. Refer also to ASCP Pavement Note 003.



100% RECYCLING

Whilst concrete pavements can frequently be reused as the foundation for future pavements, in situations in which they are demolished they can be fully and beneficially repurposed in several ways^{4,6,26} such as recycled concrete aggregate, granular subbase in flexible pavements, rubblised to form bases, manufactured sand and selected (or verge) material blends. Concrete recycling contributes to a circular economy by the reduction of natural aggregate usage and haulage, the elimination of excavation, landfill reduction and conservation of land¹².

CONCLUSIONS

Concrete pavements typically comprise 20% or more recycled materials, demonstrate a lower environmental impact over long lives, exhibit low noise, reduce fuel consumption (and CO₂), reduce lighting costs, reduce heat island impacts, absorb half of the CO₂ generated in cement production, and increase corridor resilience during extreme weather events.

REFERENCES

1. Akbarian, M., Gregory, J., Ulm, F., Greene, S., 2013, 'Where the Rubber Meets the Road', Massachusetts Institute of Technology, Cambridge
2. Ardekani, S. A., Sumitsawan, P., 2010, 'Effects of Pavement Type on Fuel Consumption and Emissions ...', RMC Research & Education Foundation, MD
3. Moss, J., Liang, N., 2019, 'Concrete Pavements at 40 Years, Retirement or Just a Mid-life Crisis', Concrete 2019 8-11 September, Sydney
4. Johnson, S., Faiz, A., Visser, A., 2019, 'Concrete Pavements for Climate Resilient Low-Volume Roads ...', World Bank, Washington, DC
5. Melvin Pomerantz, M., Akbari, H., Harvey, J., 2000, 'Cooler Reflective Pavements Give Benefits ...', ACEEE 2000 Summer Study on Energy Efficiency in buildings
6. Brand, A., Roesler, J., Salas, A., 2016, 'Replacement of Coarse and Fine Aggregate in Concrete Pavement Mixtures ...', 11th ICCP, San Antonio, Texas
7. Rasmussen, R., Wiegand, P., Fick, G., Harrington, D., 2012, 'How to Reduce Tire-Pavement Noise: Better Practices for Constructing ...', NCPTC, Iowa State University
8. Verian, K.P., Whiting, N., Olek, J., Jain, J., Snyder, M., 2013, 'Using Recycled Concrete as Aggregate in Concrete Pavements to Reduce ...', JTRP, FHWA/IN/JTRP-2013/18, Indiana
9. Iowa State University, 2012, 'Sustainable concrete pavements: A manual of practice', Iowa State University, Iowa
10. Heidrich, C., 2003, 'Ash Utilisation- An Australian Perspective', Ash Development Association of Australia Inc, New South Wales

+ Complete list of references