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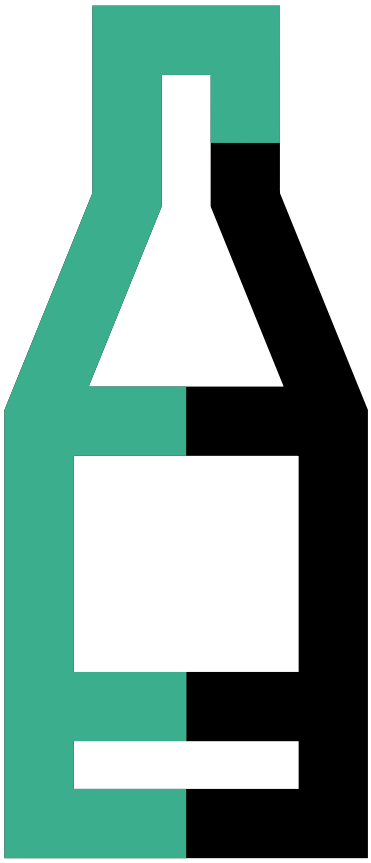

Use of recycled glass in road and rail infrastructure

Introduction

Since the export ban for waste glass in January 2021, the waste industry, the Council of Australian Governments, and local communities have focused on responsible waste management actions to decrease the accumulation of such waste in landfill (Austroads 2022).

At the same time, the depletion of natural resources has been realised and so the replacement by recycled waste materials is being increasingly accepted with the provision that performance specifications are met. In road infrastructure, the use of recycled crushed glass (RCG) as fine aggregate replacement in intermediate and base course asphalt mixes has been permitted in Victoria since 2011, while in 2018 it was found to also be accepted in general concrete pavements (VicRoads 2019). Additionally, the Water Services Association of Australia has developed a specification for the use of RCG sand used for pipe embedment (WSA PS 368:2020).

Lastly, in rail infrastructure, Metro Trains Melbourne has developed a specification (L1-CHE-SPE-313:2019) allowing for the use of RCG as quarried sand replacement for combined service route installed in UPVC and drainage piping (Austroads 2022).

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Material

RCG is a product of manufacturing; construction and demolition (C&D); and consumer mixed glass waste typically processed to pass the 4.75 mm sieve (Trochez, Grenfell & Harrison 2021).

In the consumer market, different types of glass with varying chemical composition, including borosilicate glass, soda-lime glass, and electric glass may be found (Mohajerani et al. 2017), while C&D glass includes shatterproof glass, tinted glass, and insulated glazed glass among others (Shooshtarian et al. 2019).

Care needs to be taken during the sorting of these different types of glass for reuse in road and rail infrastructure as some waste glass, such as laboratory glassware, cathode-ray tubes, and fluorescent and incandescent lights among others, is explicitly excluded for use in certain applications based on specifications (e.g. L1-CHE-SPE-313:2019, WSA PS 368:2020).

In addition, upper limits of various contaminants and the requirement for washing can be restrictive.

Specifications and Applications

As indicated by earlier statements, the incorporation of RCG in road and rail infrastructure has been considered for near a decade and as such, a series of specifications defining its use in road and rail applications have been developed. These are summarised in Table 1.

Table 1: List of specifications encompassing the use of recycled crushed glass in road and rail infrastructure in Victoria and Australia-wide. Source: ARRB (2022)

Specifications	Agency/ Institution	Applications
Vic		
Section 204 Earthworks	VicRoads	Type A, B, and C fill
Section 407 Dense Graded Asphalt	VicRoads	Intermediate and base course layers in dense-graded asphalt
Section 703 General Concrete Paving	VicRoads	Aggregate replacement in shared use paths
Code of Practice RC500.02 Registration of Crushed Rock mixes	VicRoads	Class 2, Class 3, and Class 4
Technical Note TN 107 Use of Recycled Materials in Road Pavements	VicRoads	Granular base and subbase
MTM L1-CHE-SPE-313 Recycled Glass Sand Specification	Metro Trains Melbourne	Replacement for quarried sand as bedding and embedment materials
NIST-2659.1 Specification for Recycled Glass Sand	V/Line	Replacement for quarried sand as bedding and embedment material for CSR and drainage piping
Australia		
ATS 3050 Supply of recycled crushed glass	Austroads	Granular material: ▪ Bedding, haunching, side fill and backfill of pipes and conduits ▪ Bedding and joint filling in block paving ▪ Drainage medium ▪ Embankment fill and earthworks ▪ Landscaping ▪ Partial aggregate replacement for base and subbase Partial aggregate replacement in asphalt Partial fine aggregate replacement in concrete: ▪ General works ▪ Concrete pavement applications

VicRoads has also developed recommendations for upper permissible limits for the incorporation of supplementary materials, including but not limited to RCG. Some are summarised in Table 2.

Table 2: RCG incorporation permissible limits for various applications in Victoria.

Application	Permissible limit	Document reference
Unbound granular pavement	Class 1: max 5%	TN 107
	Class 2: 10%	Code of Practice 500.02, Section 812
	Class 3: 15%	
	Class 4: 50%	
Granular filler for subsurface drainage	100% glass fines	Section 702
General concrete paving	Max 30% glass fines	Section 703

Figure 1 shows two potential applications where RCG has been investigated for use in road infrastructure.

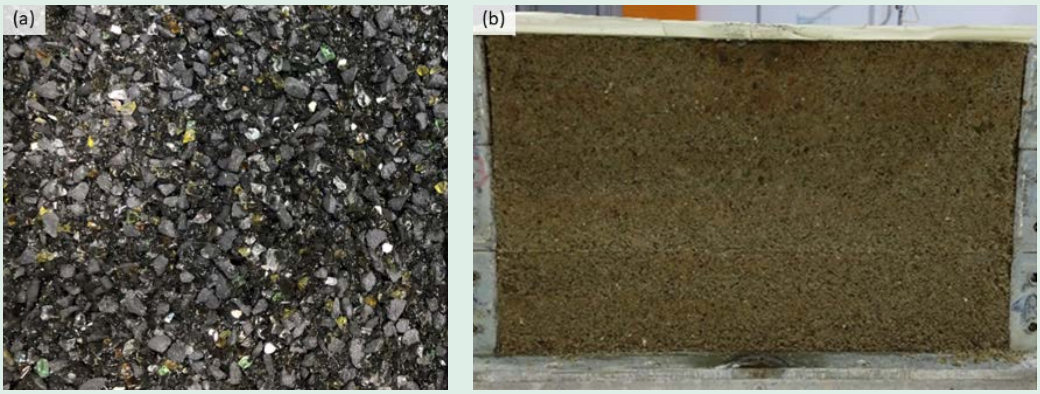
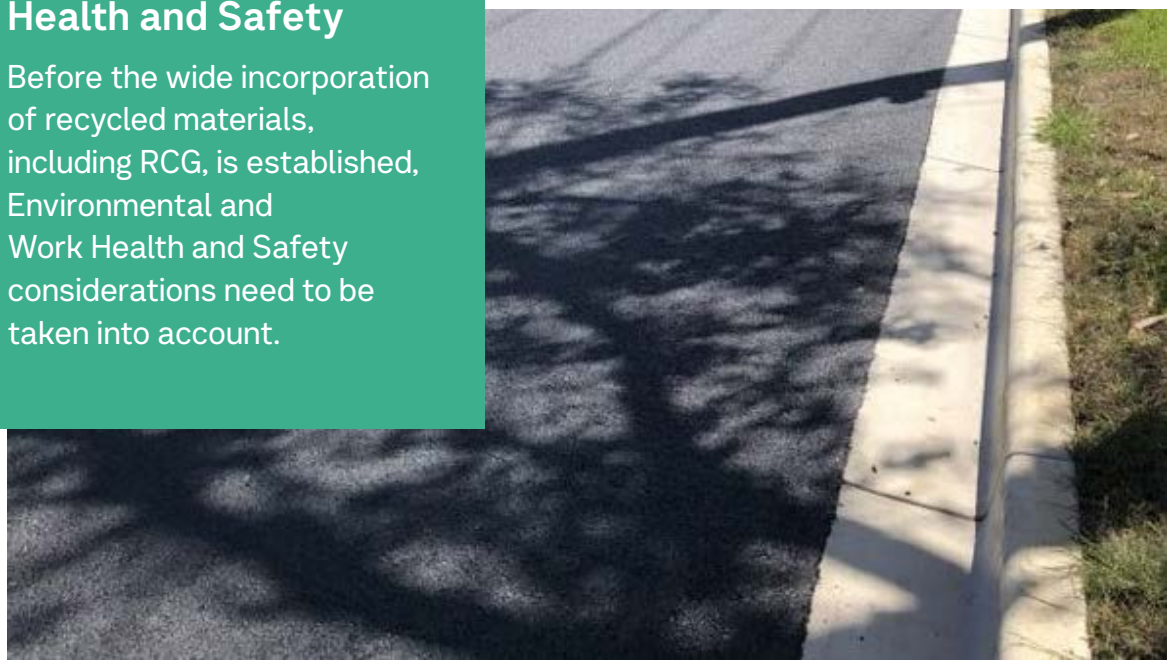


Figure 1: (a) RCG in high friction asphalt wearing surface and (b) 60 wt.% crushed concrete and 40 wt.% RCG as granular materials for subgrade applications. Source: ARRB.

Health and Safety

Before the wide incorporation of recycled materials, including RCG, is established, Environmental and Work Health and Safety considerations need to be taken into account.



Abrasion and handling

Reports of abrasions caused by the handling of glass have been made, but these may be addressed by ensuring that the glass particles are not larger than 5 mm and personal protective equipment (PPE), such as gloves, is used during handling (Austroads 2022).

Winder (2011) showed potential problems of abrasion with particles greater than 5mm, which can include elongated and angular-shaped particles. RCG crushed to smaller sizes are rounder in shape and present lower risk of injury.

Therefore, as long as the supply is processed in a way that produces cubic/rounded particles, handling should not be considered a high abrasion hazard.

Silicosis

The perceived risk from the inhalation of airborne silica has been considered. The risk of silicosis developing in the lungs is associated with crystalline silica, when small enough to be inhaled and get lodged in the lungs.

RCG is comprised of amorphous silica and so may be considered safer than natural sand. Nevertheless, the use of PPE, such as face coverings, is advisable. This is also an effective measure against the inhalation of dust, which might cause skin, ear and eye irritation (Winder 2011).

Chemical composition and leachate potential

The characteristics of RCG are consistent with those expected for natural materials or clean fill, including gravel and sand commonly used in road applications.

Imteaz, Ali & Arulrajah (2012) reported specific contaminants collected from leachate from samples of waste glass used as aggregate in pavement subbases.

The results concluded that most of the tests revealed that contamination levels for the RCG were within the EPA Victoria Guidelines specified for manual handling. RCG was deemed to have passed as a safe and viable material for use in road and pavement construction and does not pose a high risk to the surrounding environment.

Odour

Odour can be of concern for recycled glass products, and can be mitigated through processing the glass as well as via WHS responses, such as PPE. The use of PPE and the training of workers should be encouraged for the handling of any aggregate material (Austroads 2022).

It is important that RCG is sourced by suppliers carrying Environmental Standard ISO 14001 certification and ISO 9001 Quality Management credentials. This would ensure that glass has been processed to the right size, is free of significant odour and is suitable for use.

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