SWA INNOVATION HUB

Research of Current Solutions of Waste Derived and Low Embedded Carbon Sound Walls

Office of Major
Transport Infrastructure
Delivery (OMTID)

Contents

1 Introduction

The content of this report consists of research into existing off-the-shelf solutions for sound walls made from recycled plastic materials alternative to those business as usual products made from 100% concrete materials.

An online environmental scan and supplier outreach exercise was undertaken using the following product criteria:

- manufactured from as close as possible to 100% waste-derived material,
- sufficient flame resistance to withstand bushfires, defined in Australian fire-resistance standards, and
- manufactured from waste-derived material primarily sourced within Western Australia and in particular, the Greater Perth Region.

The following considerations were also explored in addition to the previous criteria;

- embodied CO_2 emissions, including the comparison between the waste-derived solution and the concrete equivalent per m^2 in terms of manufacture and transport,
- the cost of each solution, and
- any variations in aesthetic design.

As a result of the investigation, four sound wall products were identified and are presented in this report. Not all currently supply to Western Australia. The suppliers are:

- AIL Sound Walls,
- Pact Group,
- Kedel Noise Barriers, and
- ModularWalls.

Some manufacturers stated that they require project location and specifications in order to provide cost estimates. As a result, not all products presented in this report quote details of cost per unit.

2 Background

2.1 Sustainability Waste Alliance (SWA)

The Sustainability Waste Alliance (SWA) is a collaboration of key agencies, working together across sectors and industries to achieve more than would otherwise be achieved in isolation. The SWA is focused on driving innovative outcomes via the SWA Innovation Hub.

The SWA was established by the Office of Major Transport Infrastructure Delivery (OMTID) and key stakeholders to deliver on the commitment made to the Department of Water and Environmental Regulations (DWER) to identify additional specific opportunities for using recycled materials in upcoming major infrastructure projects.

An objective of SWA is to identify innovative practices to maximise opportunities for resource management, resource recovery and recycling that will lead to better, value-for-money outcomes for the infrastructure and waste industries in Western Australia. This will lead to:

- introducing best practices in utilising applied road and waste recycling technology,
- engaging with Local Government and industry to apply best practices in resource recovery and recycling of road project waste, and
- supply chain behavioural changes towards a 'Circular Waste Economy.'

2.2 Recycle First & Towards100

The Recycle First approach presents a new way to road and rail construction. It requires us to look at all parts of the engineering value chain very differently because of the starting assumption that everything in a project should be reused or recycled.

Using this "*Towards100*" approach to infrastructure delivery leads to a paradigm shift in thinking. Instead of justifying increasing the amount of recycled content in a project (considering price, availability and quality) we now have a starting point that 100% of materials will be reused or recycled and any departure from this stated objective will have to be justified. It flips everything on its head. It drives innovation and a move towards using more fit for purpose materials. It reveals new opportunities that have the potential of supporting the development of a strong waste recovery industry, regional economic development and the creation of jobs.

TOWARDS100

3 Variations in Manufacturing Approach

Two primary categories of sound wall were considered for their individual benefits when researching sound wall solutions. These include the following:

3.1 Expanded Polystyrene (EPS) products

The manufacturing of sound walls using EPS consists of aligning two panes of fibre-reinforced concrete together and expanding polystyrene foam in the space between the two panels, creating a sound wall. Virgin EPS must be used in the manufacturing process.

The embedded CO_2 of an EPS-based noise wall is reported as being significantly less than alternative solutions made from 100% concrete. The final product is also very light, requiring less heavy-duty lifting equipment than needed when installing concrete sound walls. It has been established that the final product has a high level of acoustic performance as well.

At the end of life of the product, the fibre-reinforced concrete slabs can be separated from the EPS core and the core can be fully recycled. Variants of EPS include EPS flame retardant (EPS-FR), which includes a flame retardant additive mixed with the material during the manufacturing process.

3.2 Polyethylene Terephthalate (PET), High-Density Polyethylene (HDPE) and Poly Vinyl Chloride (PVC) products

PET, HDPE or PVC sound walls typically include solutions that use material partially derived from post-consumer recycled (PCR) material, resulting in the added environmental benefit of consuming waste plastic during the manufacturing process. PCR can be incorporated into sound wall applications in a number of ways. In relation to products sold in Australia, it is most often through a co-extruded process or a rotary moulding process. The final outcome from these processes is a panel that is dense and rigid yet lightweight which contributes to ease of installation.

Sound walls can be produced with a high percentage of recycled material but typically not 100% because higher rates of PCR material incorporation begin to negatively affect the structural integrity of a sound wall. Many manufacturers require the partial incorporation of virgin plastic to increase UV resistance, to improve panel rigidity, to increase durability, and to extend the product life. During the manufacturing process, manufacturers also tend to mix additives to the PCR material to increase UV resistance or to add colour. At the end of life for these products, the entire panel is typically fully recyclable.

4 Solution 1 – AIL Sound Walls

4.1 Background Information

AIL Sound Walls manufactures their sound wall in Ontario, Canada, and currently works in collaboration with PERMAcast as an Australia-based distributor to supply Australian projects. AIL is also considering working with PERMAcast to establish a local manufacturer for their sound walls in Western Australia. Information on the company and their product can be found at the following weblink https://www.ailsoundwalls.com/.

4.2 Material

The AIL sound walls are manufactured from a rigid Poly Vinyl Chloride (PVC) material using a co-extruded methodology that has a virgin PVC top layer (10% of the product volume) and a recycled PVC matrix/core (90% of the product volume). The top portion exposed to sunlight has to be virgin material to provide UV protection. The top and core layers are fused together in the manufacturing process.

The product has approximately 90% PCR content and the product is 100% recyclable at end of life.

The use of recycled PVC for production is preferable as the waste-derived material cost is generally cheaper. It is estimated that the PVC recycled for the panel's matrix leads to a reduction of CO_2 emissions by 90% per unit of volume compared to using virgin PVC.

PVC is recycled by simply grinding it into pellets or a powder and reusing it in the manufacturing process. The manufacturer advises that it takes relatively little energy to grind the material for reuse. PVC requires relatively low amounts of energy and material to recycle and reuse in comparison to recycling concrete.

4.3 Durability

This sound wall is advertised as meeting the required standards and as exhibiting naturally strong fire resistance. The information supplied suggests that on contact with a flame, the localised area will smoulder and partially melt, but will self-extinguish once the flame is removed, preventing the fire from transferring to other panels.

The AIL sound wall is advertised as being impervious to most weather conditions and requiring no maintenance until necessary replacement from ageing and normal wear. The estimated life is advertised as being between 50 and 75 years. Installation is highly modular, and panels may be replaced with few resources and little effort. The material is also purported to be naturally resistant to graffiti.

4.4 Environmental Impact

Embedded carbon for AIL's products is estimated at between 38 and 40kg of CO_2/m^2. Two product varieties are listed below:

- Tuf Barrier – 20 kg/m^2, 38 kg of CO_2/m^2, and
- Silent Protector – 21 kg/m^2, 40 kg of CO_2/m^2.

Approximate carbon emissions generated by transport are as follows:

- Transport by road freight – 0.10650g CO_2/kg/km.
- Transport by sea freight – 0.01614g CO_2/kg/km.

The industry advertises embedded CO_2 in PVC sound walls to be as little as 10% of that of a concrete equivalent sound wall, which is reported as being around 410kg/m^2.

4.5 Appearance & Features

The manufacturer states that this sound wall can be easily design-integrated with other existing walls, including through changing colour or embedded texture.

The materials used result in a lightweight product allowing for an easier installation that requires less heavy-duty equipment. The final installation is also designed to minimise the land footprint of the wall.

4.6 Installation Examples

We were unable to obtain any case study information on installation examples in Australia. Two examples in the United States are given below.

4.6.1 Arkansas - I-40 Widening

The I-40 was widened to reduce congestion. In tandem, the sound wall was built with the Interstate Freeway widening to protect local neighbourhoods from an increase in traffic noise. The Silent Protector was used to provide absorptive noise reduction. The final installation was 4.5 m high and 400 m long, and the total installation time was reported as taking 3 weeks.

4.6.2 Eulas, Texas - Southgate Design-Build

The site of the sound wall that was built was situated partially over critical utility lines, which would prevent the installation of drilled shaft foundations required by precast sound walls. This required a lightweight solution that functions with a shallow foundation. The product used was the Tuf-Barrier, which provided reflective noise reduction. The final installation varied between 3 and 4 m in height and was 1,200 m long. The installation reportedly took one month to complete.

4.6.3 British Columbia, Canada – Evergreen Line Rapid Transit Project

The AIL sound barrier was used on a project in British Columbia to reduce rail noise for properties adjacent to the Evergreen Line. The wall was built 4 m tall and 169 m long. It took 2 to 3 weeks to install around storm interruptions. A key objective of this project was to limit the amount of vegetation clearing and to protect existing mature trees. With the use of smaller footings and a flexible lightweight design, it was possible to install these walls around some mature trees and hug very close to others in the straight sections of the installation (as shown in the images).

4.7 Procurement

The AIL sound wall unit cost rate in Australia is $(redacted)/m^2 based on the cost supplied to the BRE Project in Perth that AIL is intending to supply through PERMAcast. Through communication with PERMAcast's representative Razmus Sorensen, we were advised that AIL is keen to establish a local manufacturing plant for this product in Western Australia using recycled plastic materials. Razmus' contact information is provided below.

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Email: RSorensen@permacast.com.au

Phone: +61 484 348 032

5 Solution 2 – Pact Group Noise Reduction Wall

5.1 Background Information

Pact Group manufactures a Rationally Moulded Plastic (RMP) based sound wall in Carrum Downs, Victoria sold through the supplier of the product, AusGroup Alliance. Pact Group has confirmed that establishing local manufacturing in Perth using plastics sourced in Australia would be possible. Information on the products were found from the following weblinks:

https://www.ausg.com.au/services/noise-walls/

https://pactgroup.com/products-services/reuse/infrastructure-solutions/noise-wall/

5.2 Material

The Pact RMP sound walls are made from HDPE containing 75% to 80% PCR plastic. Of the PCR material, half is derived from milk bottles and half from general soft plastics, which Pact advertises as being a difficult plastic to repurpose. The remaining 20 to 25% of the HDPE material comprises virgin plastic to ensure the mechanical properties are suitable for long term performance. End-of-life panels are reported as being 100% recyclable.

5.3 Durability

The Pact sound wall is advertised as being able to endure the harsh Australian climate.

The manufacturer has stated that independent testing to European Standard EN 1794-2 RMP resulted in reaction to fire classification: 2. This European standard specifies methods and criteria for assessing the general safety and environmental performance of road traffic noise reducing devices under typical roadside conditions in Europe.

The Pact RMP is reported as being not easily ignited and requiring a significant fire event and ongoing exposure to cause it to burn. Tests have purportedly been conducted that included applying ignitable liquids to the Pact RMP and then applying a flame, resulting in the liquid burning out and barely any recognizable damage occurring to the Pact RMP panels. If a Pact panel does catch fire and burn it will allegedly propagate upwards but due to the relatively low melting temperatures the panels are described as likely to melt away thereby limiting the exposure to adjacent panels restricting the fire from moving down the barrier alignment and providing time for appropriate fire control mechanisms to come into effect.

The sound wall is advertised as requiring little to no maintenance until the end of its expected service life of 40 years when the panels require replacement. The plastic is promoted as being tough and able to withstand physical impacts during installation. In the event panels are damaged, minor impacts can be repaired through plastic welding. Otherwise, the modular system allows for the substitution of damaged panels with new panels requiring minimal effort.

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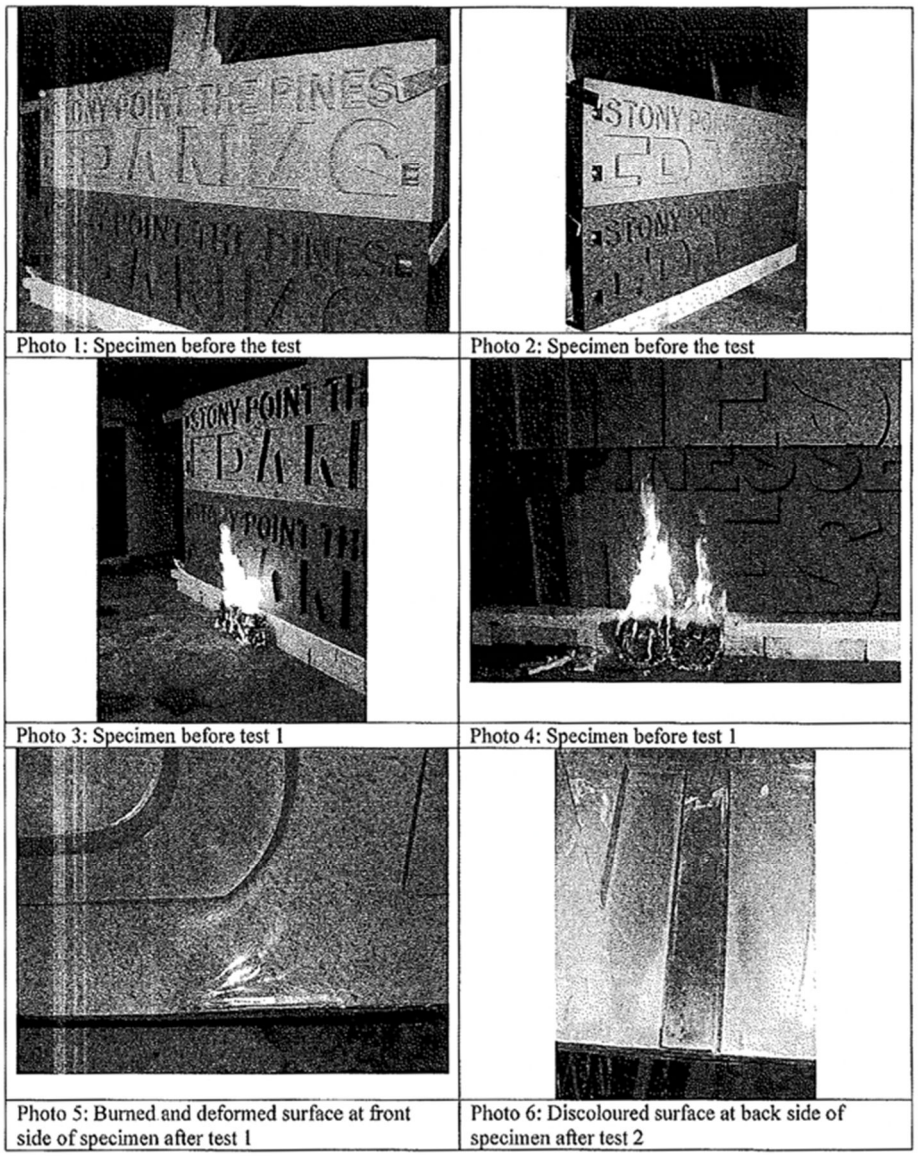


Photo 1: Specimen before the test | Photo 2: Specimen before the test

Photo 3: Specimen before test 1 | Photo 4: Specimen before test 1

Photo 5: Burned and deformed surface at front side of specimen after test 1 | Photo 6: Discoloured surface at back side of specimen after test 2

5.4 Environmental Impact

AusGroup reports these Pact RMP sound walls as having 300 kg of embedded CO_2 per element (defined by AusGroup as being a 3 m x 1 m unit). This is promoted as being approximately 60% of a concrete equivalent, when compared to around 492 kg per concrete element of the same dimensions.

AusGroup has advised that these sound wall panels weigh between 65 and 70 kg per element while the concrete equivalent is estimated to weigh between 1,100 and 1,200 kg. The reduction in weight is promoted as contributing to fewer CO_2 emissions during transportation.

5.5 Appearances and Features

The Pact sound wall product is advertised as able to incorporate any custom design involving texture and colour to achieve visual integration with surroundings or to serve as an art exhibit. AusGroup charges an additional cost for the fabrication of Pact custom moulds for sound walls. After the completion of a project, the mould can be kept for the event that replacement panels need to be made. As an economic alternative, one of Pact's template moulds or a design from a previous job can be used to manufacture panels.

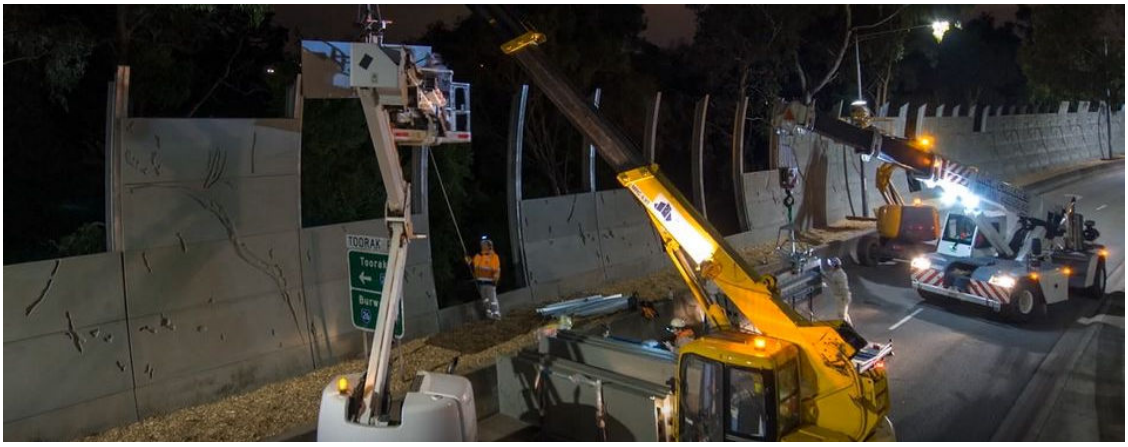
The natural material colour of the plastic wall is a light transparent green that can be mixed with dye to achieve any desired colour before casting. The manufacturing process means each panel can only have one colour, but many panels in one installation can have different colours.

5.6 Installation Examples

A number of different installation examples in Australia and Europe were identified and are presented below.

5.6.1 Victoria - Monash Freeway

The Monash Fwy Pact RMP sound wall installed in Victoria had a pre-existing sound wall made from cast concrete panels that had begun to fail structurally. The manufacturer was able to create a custom Pact RMP wall to replicate the old wall's exact design. The concrete panels were then easily substituted with the Pact RMP copies, reusing the original steel framework for installation.



5.6.2 Netherlands – Groningen

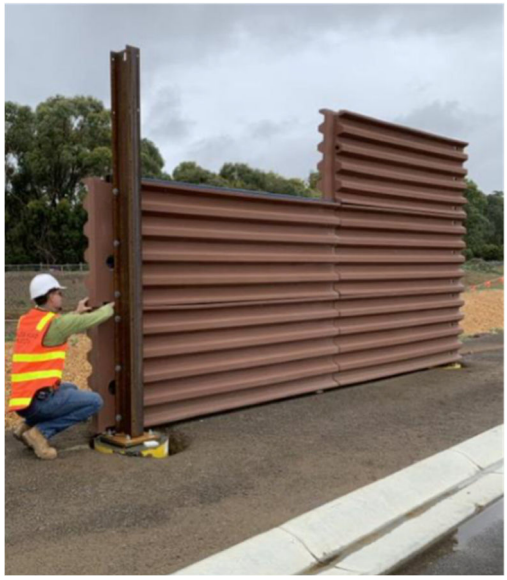
The Groningen Pact RMP sound wall installation in the Netherlands in 2016 required a design that integrated with the surrounding environment. Multiple designs and samples were

created to ensure satisfaction with the final product before full-scale manufacturing was initiated.

5.6.3 Victoria – Peninsula Link Freeway

The Peninsula link installation in 2012 is one of the more unique designs of this product. The sound wall consists of panels with varying textures, colours and patterns, including embedded text. This wall is an example of the capacity of the manufacturer/supplier to accommodate design variation between projects.

5.6.4 Victoria – Mordialloc Freeway



The Mordialloc Fwy sound wall project was a government-supported project that is advertised as having enabled the consumption of 570 tonnes of previously un-useable waste plastic to produce the Mordialloc sound walls, spanning approximately 32,000 m^2.

5.7 Procurement

For each project, AusGroup separates their expenditure into three quotable services:

- the construction of a custom mould (if needed),
- the manufacture of panels, and
- transportation from the factory to the installation site.

Estimates of service costs are given below. These were provided by AusGroup representatives based on past projects, noting that the overall project scope can affect the cost per m^2 of the sound wall, i.e., it depends on dimensions, design, and site conditions.

A contract requiring a custom design requires the fabrication of a mould, costing around $(redacted). The production mould can be stored for later reuse in the event that replacement panels are needed. This cost may be excluded if the contract reuses a pre-existing mould.

Each panel will cost between $(redacted) to $(redacted)/$m^2$. If manufacturer transportation and installation are also required, the cost would increase to approximately $(redacted) to $(redacted)/$m^2$. This includes the supply of footings, posts and panels, as well as professional installation.

Information was provided by the following product representatives:

Name: Andrew Rhodes; Email: Andrew@ausg.com.au Phone: +61 434 075 353	Name: Mar Poyo Guerrero; Email: Mar.PoyoGuerrero@pactgroup.com Phone: +61 417 376 935

6 Solution 3 – Kedel Noise Barriers

6.1 Background Information

Kedel Noise Barriers manufactures its sound walls in Burnley, England. Kedel representatives have stated they cannot supply a project based in Australia right now as they do not currently export internationally beyond the UK and Europe. Their product may serve as a useful reference point for a sound wall that is based on a 100% waste-derived product.

The Kedel website is as follows: https://www.kedel.co.uk/noise-barriers.html

6.2 Material

The Kedel sound walls are made from HDPE plastic sourced from food industry packaging, including film, soft plastics and hard plastics. The plastics consist of polyethylene, polystyrene, and polypropylene. The substances are heat-treated to eliminate any organic material before consumption. The final manufacturing material weighs 0.75 g/cm^3, or 10.35 Kg/m^2 of sound wall panel.

The final sound wall is made entirely from treated PCR plastic, resulting in a product that is 100% waste derived. At the end of the panel's life, the material is reported as being 100% recyclable.

6.3 Durability

The estimated lifespan of the Kedel sound walls is advertised as being 50 years. The panels are reported as being rot, graffiti and weather-resistant, including demonstrating resistance to UV radiation.

The panels are advertised as fire-resistant to flammability class ISO 13501-1.

The panels are also advertised as exhibiting chemical resistance to white spirit, lighter fluids, bleach, and hot oil. The panels are maintenance-free until an essential replacement is required.

6.4 Carbon Emissions

Kedel does not provide any explicit value for embedded CO_2, but advertises their manufacturing process as saving on the following per tonne of Kedel Barrier (by an undefined ratio):

- 1.66 tonnes of CO_2,
- 262 Litres of oil,
- 98 million KJ of energy, and
- 23 m^3 of landfill space.

6.5 Appearance & Features

The Kedel sound walls are advertised as being a generalised solution tailored for maximum efficiency. This results in a limited variety in design with only 4 colour options available as displayed above and an unchangeable thickness of 138 mm.

There are 6 available options for dimensions;

- depth is configurable between 28 mm, 32 mm and 38 mm, and
- length is configurable between 3000 mm and 3600 mm.

The sound walls feature a modular design comprising many small planks assembled into panels for a quick and easy installation. The planks stack on top of each other vertically between metal pillars secured to the ground. The pillars are hot tip galvanised to prevent corrosion and to enhance weather resistance.

6.6 Installation Examples

All installation examples are in Europe.

6.6.1 Estonia – Kose Aruvalla

Kedel supplied the 2 km sound wall installation along the Kose-Aruvalla section of the Tallinn Tartu Highway in Estonia to protect local neighbourhoods from highway noise. The project was advertised as repurposing 218 tonnes of PCR plastic through the manufacturing of the sound walls.

6.7 Procurement

The Kedel panels are advertised as 'made to order' and take between 3 and 5 weeks to manufacture from the date of purchase. The approximate cost is £(redacted)/m^2. This excludes transport, installation, etc. Kedel does not currently provide international shipments of this product outside the UK and Europe.

7 Solution 4 – EnduroMax

7.1 Background Information

ModularWalls manufactures a variety of sound walls with the EnduroMax advertised as incorporating the most environmentally conscious design. The EnduroMax is not a sound wall that is manufactured from PCR material but is advertised as having a high level of recyclability at the product's end of life and a very low embedded carbon footprint. ModularWalls' combined head office and manufacturing plant are based in Kurnel, NSW. Further office branches exist in Wacol, South Brisbane and Thomastown. Information was found via the following weblinks:

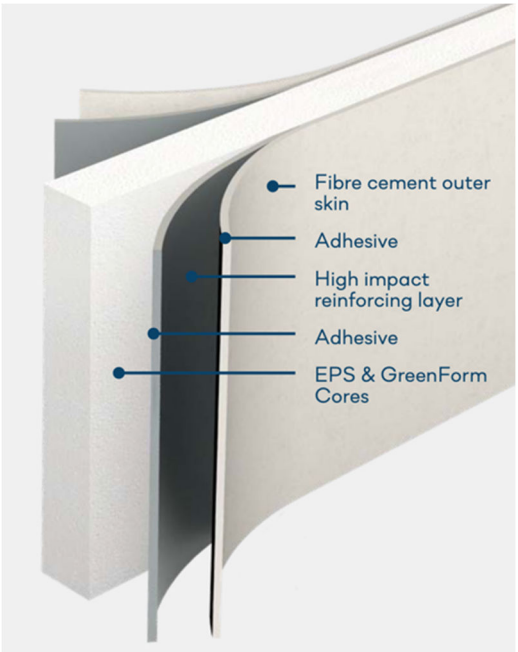
https://modularwalls.com.au/

https://modularwalls.com.au/commercial/noise-walls-acoustic-fences/

https://modularwalls.com.au/resources/order-processing-and-shipping/

7.2 Material

The EnduroMax sound wall is a composite product that is made up of a core and two outer layers on each side of the panel.



The outside layer consists of a 4.5 mm thick fibrous cement layer on the outside and a 1.5 mm thick perforated steel layer on the core-facing side. The outer layers sandwich an EPS-Flame-Retardant (EPS-FR) core that can vary in thickness depending on the required wind resistance.

All of the materials included in the production of this wall are virgin. Modular Walls advertises the Enduromax as being 100% recyclable at the end of the product's life after the layers are separated.

7.3 Durability

The EnduroMax is fire retardant only, advertised as having a bushfire attack level (BAL) of 40. The EPS-FR core is tested to self-extinguish in the event of catching fire, however, the outer composite layer made from fibre cement and steel will combust after 4 to 5 hours of constant exposure to a flame.

Under normal operating conditions, the EnduroMax is advertised as being able to resist high temperatures, salty air, cyclonic winds, and other extreme weather conditions associated with isolated road, rail, and civil infrastructure settings. In projects where wind strength must be considered, the EPS core can be thickened to provide additional structural rigidity to suit the installation site's wind load in accordance with the Standard for Wind Loads AS4066.

The sound wall is also tested by the Queensland Department of Transport to satisfy the WA 904 Specification for sound walls and is advertised to resist high-level impacts including withstanding flying debris and minor vehicle collisions. It is also advertised as resistant to graffiti, rot, warping, cracking, and corrosion. The total lifespan of the EnduroMax is advertised as being 50+ years.

7.4 Environmental Impact

ModularWalls advertises the total embodied CO_2 of EnduroMax as being 15 kg/m^2, which is less than 30% of the advertised concrete equivalent being around 55 kg/m^2.

The reduction in CO_2 is contributed by the sound wall's comparatively lower total weight for transportation, being 30.5 kg/m^2 compared to approximately 400 kg/m^2 for concrete alternatives, i.e., as a result of it being less than 8% of the equivalent concrete panel weight.

ModularWalls' product representative expressed that while the EnduroMax is made from primarily virgin material, all of the layers can be separated at the end of the sound wall's life to be 100% recycled.

7.5 Appearances & Features

The EnduroMax is available in 2.4, 3.0 and 4.2 m lengths, and in heights of 6, 9, and 12 m and above. Larger and smaller dimensions are available on request after a quotation from ModularWalls. The thickness of the wall can also be varied from a minimum of 75 mm to a maximum of 150 mm. Thickness is usually changed to enhance wind resistance if an installation site is subject to high winds or cyclones. The weight of the core is 15.5 kg/m^3, or approximately 0.2 kg/m^2 of sound wall depending on the core thickness.

While exhibiting equal durability to concrete panels, the EnduroMax is advertised as being a cost-effective alternative that is easier to install due to its lightness compared to concrete. This results in less heavy-duty lifting equipment and time required to complete installation, repairs or replacements.

ModularWalls recommends the EnduroMax wall be painted with a minimum of 2 coats of exterior grade paint within 30 days of installation to improve weather resistance, and to refinish the paint periodically in accordance with the paint manufacturer's recommendations. ModularWalls provide an additional service to paint the sound walls following the manufacturing process before dispatching the walls to the installation site. The EnduroMax comes with a 10-year warranty.

7.6 Installation Examples

The installation examples provided were all on the east coast of Australia.

7.6.1 Alfords Point Road

Twenty years ago, Alfords Point Road was fitted with a concrete sound wall that failed structurally. ModularWalls was approached to supply a replacement wall that fitted the design requirements specified by urban designers. Site access was made difficult by the freeway and barrier's presence providing little operating space. It was therefore required to close a lane and undergo the installation during night time. Due to the assembly process, the installation reportedly took significantly less time resulting in the total duration of the lane closure being shorter than expected.

7.6.2 Cooroy / Bruce Highway

Bruce Hwy is the largest carrier of traffic in Queensland. As a result, the adjacent town of Cooroy is heavily impacted by road noise resulting in the necessity of a sound wall installation. The site also presented additional civil infrastructure requirements and required consideration of the sloped terrain.

A combination of GuardianWall and EnduroMax was used for the project, and the wall's height varied from 1.1 m to 3.4m to tailor to the varying highway exposure at different points along the freeway. The wall's natural lightness aided installation, which compensated for the sloped landscape on which the site was based.

7.6.3 Captain Cook Drive

The project required facilitating communication and cooperation between residents and public services, as well as navigating critical utility lines and sewerage mains which involved further communication with Sydney Water and Jemena Gas.

Design consultations spanned over 2 years to ensure the final product was satisfactory to all parties. The final solution was a composite sound wall 3.6 m high. The first 2.4 m was made from EnduroMax, and the remaining 1.2 m was made from acrylic for transparency to allow light through to the residential side of the wall.

7.7 Procurement

ModularWalls does not provide unit rates or indicative cost estimations for any of their products. Cost is advertised as varying depending on project specifications, scope and transport distance, and is calculated on the request for quotation.

ModularWalls provide a table of waiting times for the completion of orders depending on their nature. Standard orders are advertised to be processed in 5 business days, while custom orders are processed in 10 business days. Delivery to sites in the Perth Greater Area is estimated to take up to 10 business days, while subject to conditions of transportation. ModularWalls' manufacturing facility has a production capacity of 2,000 m^2/day.

Information was provided by ModularWalls' representative Paul Oden, whose contact details are as follows:

Email: Poden@modularwalls.com.au;

Web: commercial@modularwalls.com.au;

Phone: +61 417 985 950.

8 Solution 4 – Table for Comparative Product Specifications

A comparison of the four products that were reviewed is given in the table below:

SPECIFICATIONS (AS or ISO Standards where necessary)	MANUFACTURER			
	AIL Sound Walls (supplied via PERMAcast)	**Pact Group (supplied via AusGroup)**	**Kedel Noise Barriers**	**ModularWalls**
PCR Material (%)	90% PVC	75-80% HDPE	100% HDPE	0%
Fire Resistance Standard	*Not Provided*	AS 1530.3, Class 2, EN1794-2	ISO 13501-1 E	BAL-40
Sound Resistance Standard	AS/NZS ISO 717-1, AS ISO 354, AS1191-2002	*Not Provided*	ISO 1793-2-B3	ISO 717-1
Impact & Damage Resistance Standard	ASTM F3459 ASTM D4226	*Not Provided*	*Not Provided*	AS4066 / WA Spec 904
Weight	21 Kg/m^2	23 Kg/m^2	10.35 Kg/m^2	~0.2 Kg/m^2
Embedded CO_2	40 Kg/m^2	100 Kg/m^2	*Not Provided*	15 Kg/m^2
Transportation CO_2 (Road)	0.11 Kg/m^2	0.12 Kg/m^2 *	*Not Provided*	0.01 Kg/m^2 *
Transportation CO_2 (Sea)	0.02 Kg/m^2	0.02 Kg/m^2 *	*Not Provided*	0.002 Kg/m^2 *
Product Lifespan	~50-75 years	~40 years	~50 years	~50 years
Contacts	Razmus Sorensen; RSorensen@permacast.com.au +61 484 348 032	Andrew Rhodes; Andrew@ausg.com.au +61 434 075 353 Mar PoyoGuerrero; Mar.PoyoGuerrero@pactgroup.com +61 417 376 935	Sales; Sales@kedel.co.uk +44 1282 861 325	Paul Oden; POden@modularwalls.com.au commercial@modularwalls.com.au +61 417 985 950

NOTE: Transportation emissions provided for Pact Group/AusGroup and ModularWalls' products were estimated based on a proportion of the figure provided by AIL sound Walls. They are indicative only.

SWA

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