Issues Paper

Use of Expanded Polystyrene in Construction

Commissioned by Auckland Council

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Acknowledgements

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Executive Summary

This report outlines how Expanded Polystyrene (EPS) is currently used in construction, as well as the challenges, impacts and alternatives.

Consideration of the benefits and disadvantages EPS presents, there are also a number of other considerations such as:

- improved education
- management of the product
- greater responsibility and consideration for the environment and future generations
- impacts at both start and end of life
- alternatives

The use of petrochemical products provides us with many convivences we enjoy today, but as its non-biodegradable, it persists as litter in the environment.

Advantages:

Thermal Insulation: EPS has excellent thermal insulation properties and can contribute to energy savings by reducing the need for heating or cooling systems.

Moisture Resistance: EPS has a closed-cell structure, which makes it resistant to moisture absorption reducing the risk of mould or rot.

Lightweight, durable, provides sound insulation, and easy to install.

Versatility: EPS is available in various forms, including rigid boards, moulded shapes, and custom-cut panels. This versatility allows for its application in different building areas, such as walls, roofs, and foundations. It can be shaped and customised to fit specific design requirements.

Cost-Effective: EPS insulation is often considered cost-effective compared to other insulation materials. Its relatively lower material and installation costs and energy-saving properties can provide long-term savings for building owners.

Disadvantages:

The lack of proper handling of EPS on-site presents a significant environmental risk. Poor onsite handling could be minimised through better awareness and education, mandatory containment methods when hand cutting on-site and hot wire cutting to seal EPS preventing beads from entering the environment.

Petrochemical products are considered finite resources and unsustainable.

End of life handling. Current methods of use include rib raft (EPS reinforced with rebar anda concrete top layer). During demolition or deconstruction, beads can be released into the environment, and currently there are no viable methods to separate EPS from concrete or the like, rendering both materials fit for landfill only.

What is Expanded Polystyrene?

EPS stands for Expanded Polystyrene. It is a lightweight, rigid, and insulating plastic foam commonly used in various applications due to its versatile properties. EPS is produced from polystyrene, a thermoplastic polymer made from styrene monomer. The production process involves expanding small polystyrene beads by applying heat and pressure, resulting in the formation of a foam material with closed-cell structure and low density.

EPS has both beneficial and adverse characteristics, including:

- Lightweight: EPS is a lightweight material, making it easy to transport and handle.
- Thermal insulation: Its closed-cell structure provides excellent thermal insulation properties, making it commonly used in building and construction applications.
- Cushioning and shock absorption: EPS is often used as protective packaging material for fragile items due to its ability to absorb shocks and impacts.
- Buoyancy: EPS floats on water, which is why it is used in various marine applications like floating docks and buoys.
- Cost-effective: EPS is relatively inexpensive to produce, making it a cost-effective material for various applications.

While EPS has practical uses, it also poses environmental challenges, especially when it becomes waste. Due to its non-biodegradable nature, improper disposal of EPS can lead to pollution and harm to marine life when it enters the oceans.

- This has led to increased scrutiny of EPS use and calls for better waste management and recycling practices to mitigate its environmental impact. Some countries have already taken measures to ban or restrict the use of EPS in certain applications to address these concerns.
- The lack of proper handling of EPS on-site presents a significant environmental risk. Poor onsite handling and end of life demolition appear to be where EPS snow or beads are released the frequently.
- Alternatives and/or through better awareness and education EG: mandatory containment methods when forming on-site, such as hot wire cutting to seal EPS preventing beads, minimise the material from entering the environment.
- Petrochemical products are considered finite resources, unsustainable and despite the use of fire retardants, can pose a potential fire risk at very high temperatures.
- End of life handling. Current methods of use include rib raft (EPS reinforced with rebar with concrete top layer). During demolition or deconstruction, beads can be released into the environment, and currently there are no viable methods to separate EPS from concrete, rendering both materials fit for landfill only and unable to be recycled.

Overview of EPS Types

EPS is a lightweight, rigid, closed-cell plastic foam material. It is made from styrene monomer which is heated and then injected with steam to create small, uniform foam beads. These beads are then moulded into various shapes and sizes for use in a wide range of applications, including packaging, insulation, and construction.

There are several variants of EPS available in the market. Some of the most common ones are:

- **Flame Retardant EPS**: This variant of EPS contains additives that make it more resistant to fir but contain additional chemicals cited to be toxic.

- **High Impact EPS**: This variant of EPS has improved impact resistance and is used in applications where the material may be subject to impact or shock.
- **Low-Density EPS**: This variant of EPS has lower density than standard EPS, making it more suitable for applications where weight is a concern.
- **Shape Moulded EPS**: This variant of EPS is moulded into specific shapes, such as cups, plates, and other food containers.
- **Recycled EPS**: This variant of EPS is made from recycled EPS and is used in applications where sustainability is a concern.

How EPS is used in Construction

EPS is a lightweight and versatile material that is used in many building products. Some building materials that contain EPS include:

- **Insulation:** EPS is commonly used as insulation material in products such as RibRaft foundations, insulated panels (SUP), insulated concrete forms (ICFs), and spray foam insulation.
- **Roofing**: EPS is used in roofing products such as insulation board, roofing tiles, and metal roofing systems.
- **Masonry:** EPS is used as a lightweight aggregate in concrete blocks and as a core material in composite masonry panels.
- **Packaging:** EPS is used as packaging material for many building products, such as doors, windows, and panels.
- **Decorative elements:** EPS is used to create architectural mouldings, columns, and other decorative elements.
- **Geotechnical applications:** EPS is used as geofoam in soil stabilization and lightweight fill applications, such as embankments and retaining walls.
- **Facades:** This is a decorative facade made of concrete but containing EPS beads to help make this product lighter. EPS beads escape during cutting and handling.
- **Landscaping:** EPS is becoming more commonly use in landscape applications. This can be used to save on topsoil, reduce weight on embankments, hillslopes and bulk out retaining walls. When this polystyrene eventually gets unearthed, it will be contaminated with organic material, rendering it unrecyclable and fit for landfill only due to current recycling methods, and over time potentially leach toxins into the environment.

Figure 1 Examples of the use of EPS in stone facades and EPS beads having escaped into the environment during cutting.

Recyclability of EPS

Although EPS is recyclable, in New Zealand it is typically required to be clean and free of other contaminants (EG packaging). Once combined with other materials such as concrete, the process can be somewhat challenging due to the bonding between the two materials.

When EPS is used as insulation in concrete construction, it is typically embedded within the concrete structure, making its removal for recycling more complicated than standard mechanical separation methods.

Overseas, one common technique for EPS separation from concrete is through mechanical means, such as crushing or grinding the concrete to break it down into smaller pieces. This process can help release the embedded foam from the concrete matrix. However, it may not be 100% efficient, and some EPS particles may remain attached to the concrete.

Another approach involves using specialised equipment, such as hot water or steam, to melt or dissolve the EPS foam from the concrete. The melted EPS can then be separated from the concrete, and the concrete can be reused or recycled separately.

In recent years, researchers and waste management companies have been exploring various methods to improve the efficiency of EPS separation from concrete to increase recycling rates and reduce waste.

It's important to note that the feasibility and effectiveness of EPS separation from concrete depend on the specific construction and recycling processes used. Additionally, the costs and energy requirements associated with recycling EPS from concrete need to be considered to determine the overall environmental benefits. As recycling technologies continue to advance, the potential for separating and recycling EPS from concrete may become more viable.

Figure 2 EPS slabs with rebar framing for load bearing and rigidity with concrete poured over bonding the materials.

Delivery, Storage and Recover to Site

EPS blocks can be damaged during delivery and transit which can release what is commonly referred to as EPS “snow” or “beads” (similar to what is typically found in bean bags) and enter the environment directly or via stormwater systems.

Significant weather events, such as heavy rainfall, gusty Westerly winds combined with the high flotation attributes of EPS, may also contribute to EPS snow more easily blowing off site and entering fresh and saltwater environments directly or via stormwater networks.

As per one of New Zealand’s largest manufacturer of EPS in construction, Expol, it is recommended EPS should be stored covered and in a dry and ventilated area to maintain its insulation properties. However, construction sites often have limited space or facilities for this, leading to damage, degradation, and release of EPS ‘snow/beads’ into the environment.

Figure 3 Improperly contained EPS on-site allows beads or snow to escape.

Handling of Waste EPS

Handling EPS waste can present several difficulties for construction companies.

- **Size**: EPS scraps can be small and lightweight, making them challenging to handle and transport. It can be challenging to pick up and move small pieces of EPS on construction sites, especially if they are spread out over a large area.
- **Static electricity**: EPS can generate static electricity, which can make it challenging to control or move. The static electricity can cause the EPS scraps to cling to surfaces or to each other, making it difficult to remove or transport them.
- **Dust**: Cutting or handling EPS can generate dust. Workers must use appropriate protective equipment, such as masks and gloves, to protect themselves from the dust.
- **Disposal:** Disposing of EPS scraps can be challenging, especially if they are not recyclable. EPS takes up a lot of space in landfills, and it can take hundreds of years to decompose.

Figure 4 EPS snow/bead contamination after hand-sawing on-site and general litter blocking drains at the Flatbush residential development in South Auckland (photo courtesy of Auckland Council Environmental services)

Impacts on Freshwater Ecology

The lifecycle of polystyrene yields toxicity at each stage and the volume of EPS in our freshwater systems is growing. Consequently, this material has already been phased out by other jurisdictions, mostly in the food and beverage industry.

It's a lightweight material that is easily picked up by winds and is scattered from construction sites, commercial waste skips and rubbish bins, into adjacent fields, residential areas, overland waterways and marine environments.

This is particularly prevalent in the Auckland region in the event of westerly and south westerly winds due to high velocity gusts. Once present in the waterways and marine environment, it breaks down into very small particles, making recovery of the material virtually impossible.

The following images are typical scenes in Auckland urban streams – polystyrene debris clusters accumulating in back eddies. By the time the material lodges in lowland streams it creates a mix of polystyrene and other plastics amid other organic detritus.

Because it has photo-degraded into is constituent beads and is well mixed, there is little that can be done from this point forward to intercept and separate the material.

Figure 5 Puhinui Stream, South Auckland (photo courtesty of Auckland Council Environmental Service)

The lowland stream reaches are a temporary staging point as the material eventually gets carried offshore. A portion lodges on coastline, the rest can be assumed to reach the Pacific once it has broken free of coastal waters.

Tetra Traps are effective in capturing larger and semi submerged debris, however, are not effective when dealing with micro plastics and substances such as EPS 'snow'. At this stage it is unsure how this can be tackled aside from limiting, banning or restricting the use of EPS in other industries.

Education

For some time, manufacturers have provided guidance about their product and education around better handling of EPS and more recently third-party training providers have been offering courses on waste minimisation that feature handling of EPS.

Following are a few examples.

- **Site Safe: Environmental Site Management** This two hour fully online course has been developed in partnership with Auckland Council and is designed to improve environmental practices that are happening on small residential building sites.
- **Sime Group: Resource Sorter - Construction** A new initiative from Sime Group and supported by Naylor Love, now offers a micro-credential qualification in Waste Hierarchy, Sorting Waste, Construction Waste and Team Engagement. The aim is to achieve zero construction waste to landfill by 2040.
- **Expol:** Resources include on-site flyers, provision of products to reduce contamination including APPS to book collections and provide guidance on handling, educational videos)

Auckland EPS Waste Collection Services

Take-back schemes provide programmes and systems that encourage or mandate the return or disposal of certain products, materials, or waste in a responsible and sustainable way.

Such schemes are designed to reduce the environmental impact of certain products, either by promoting their recycling, reusing or recovering certain components, or by ensuring their safe disposal.

1		Clean and dry - No contamination, no water. If too contaminated it will be sent to landfill and a fee charged.	Abilities Group	Base fee of $25/m3 (+GST)	Glenfield, Auckland	(09) 444 0611
2		Clean and dry	Waste Management	Cost for collection bin and collection	North Shore & Papakura, Auckland	0800 10 10 10
3	Expanded polystyrene (EPS)	Clean and dry	EPS Foam (NZ) Ltd	Own customers: free of charge for collection of own product External customers: $80-100+GST per trailer	Papakura, Auckland	(09) 299 6902
4		Clean and dry	JJ International	$50/m3	Rodney, Auckland	(09) 427 8964
5		Clean and dry (own product only). Expol supplies their own bag for Expol EPS cutoffs. Please use Expol app to arrange pickups	Expol	None	Onehunga, Auckland	(09) 634 3449

Figure 6 Sample of providers that take EPS from cites

Following are additional EPS collection or recycling options.

- **Green Gorilla**: Green Gorilla is a New Zealand-based waste management company that offers EPS collection and recycling services in Auckland.
- **Auckland Foam Recycling**: Auckland Foam Recycling is a company that specializes in EPS recycling and provides collection services in Auckland.
- **Simply EPS**: Simply EPS is a New Zealand-based company that collects and recycles EPS, including in Auckland.
- **Mitre 10 stores** provide collection points for consumer EPS on behalf of Expol.
- **Auckland Council**: Auckland Council accepts EPS at the Waitakere Transfer Station and many Community Recycling Centres.

EPS Take-Back from Site

Some EPS pod suppliers operate collection systems for EPS waste from building sites. The process typically works by the supplier providing large bags for off cuts to be contained in and protected from environmental factors such as wind, rain, waste and other site contaminants until collection can be arranged. Some EPS suppliers in Auckland do not provide this service so any wastage from their customers will either end up in a skip as landfill or in the environment.

Excess EPS should be returned and recycled from a building site back to the provider i.e., EXPOL. This can be contained for collection in bags provided by the supplier or in fadge sacks and covered to prevent EPS escaping prior to collection.

As an industry example, Expol provides good containment, collection and education services for builders, however there is a need for the teams on site to be up to speed with on site handling and the wrap around services suppliers such as Expol provide in order to minimise the risk to the environment due to this, poor containment, delays or missed collections.

Figure 7 Expol take-back scheme https://www.expol.co.nz/expol-recycling-process/

Methods of Onsite Cutting and Forming

Typically, standard size slabs are used to fit the foundation framework, however there is a requirement to hand cut to allow for pipes and non-standard areas.

According to an Auckland-based builder of 20 years, approximately 30% of EPS will require custom shaping, typically hand sawing, usually resulting in the EPS bead escape. These beads are very difficult to contain, blowing around sites and enter the environment easily.

Hot wire cutters are available for forming larger slabs requiring linear edges. The cost for a hot wire cutter from Expol is $1300 approx. These are not available to hire at present. Hot wire pen sets for non-linear/rounded shapes to allow for pipes and rounded form work are $500 approx. Both are effective in re sealing the EPS.

Currently the use of these tools is limited, and hand sawing is considered the main method.

End of Life

Demolition of existing structures that contain concrete combined with EPS results in both materials going to landfill. According to ClevaCo, at current landfill costs an average 160m² concrete slab containing polystyrene weighs approximately 64 tonnes at a cost of $37,873 to dispose of.

Alternatives to EPS in Construction

There are several alternatives that can be used in the construction industry.

Floor Slabs

The CLEVA POD is a completely recyclable foundation, significantly reducing construction waste to landfill, which can fully recover, recycle and reuse the concrete, steel and plastic pods at the end of its life creating a “Circular Foundation”.

The CLEVA POD is a “like-for-like” replacement, for the traditional Poly Pods within the AS 2870:2011, Residential slabs and footings.

Figure 8 ClevaPod system enabling the separation of reusable plastics from concrete at end of life.

Firth Rib Raft X-Pod: The X-Pod system is similar to the Clevapod system above but uses smaller pods making them an alternative option in some applications.

Insulation

Rockwool insulation has several benefits when used as a construction material:

Thermal Insulation: Rockwool has excellent thermal insulation properties, which can help reduce energy consumption and lower heating and cooling costs.

Rockwool is made from natural and renewable materials and can be recycled at the end of its useful life. It is also free from harmful substances like CFCs, HCFCs, and formaldehyde.

Cellulose Insulation: Cellulose insulation is made from recycled paper and treated with non-toxic chemicals to make it fire-resistant. It is an alternative to EPS insulation and can provide excellent thermal and sound insulation properties.

Aerogel Insulation: Aerogel insulation is a highly effective insulation material made from silica aerogel. It is an eco-friendly alternative to EPS insulation and can provide excellent thermal insulation properties while being lightweight and durable.

Natural Fibre Insulation: Natural fibre insulation is made from materials such as hemp, flax, and cotton, and is a renewable and sustainable insulation option. It can provide good thermal and sound insulation properties and is also biodegradable and compostable.

Phasing out of Single Use Plastics in New Zealand

At a government level, the use of single use plastics in the food and beverage industries are being phased out or banned (2023 - *Ministry for the Environment: Phase Out of Single Use Plastic* & 2023 *Ministry for the Environment: Phase Out of Single Use Plastic*).

Recycling of EPS in construction is only possible when not bonded with other materials. EG clean, uncontaminated excess, fit for collection and reused such as Expol's programme – see above.

The current method for forming foundations in new builds (and over the past 30 years in New Zealand and Australia) use EPS slabs reinforced with rebar and concrete poured over the top to provide a solid foundation.

However, once EPS bonds with concrete, it renders both materials fit for landfill only, meaning the EPS component can only be used once.

Further investigation could be considered into the carbon emissions that transporting this heavy EPS and concrete based material may present.

EPS Waste in the Marine Environment

Studies indicate that EPS waste has significant negative impacts on fresh water and marine ecosystems (*Marine litter: EPS foam marine debris as a source of brominated flame retardants & Effects of Expanded Polystyrene (EPS) Marine Litter on the Feeding Activity of the Sandy Goby*):

These references highlight the dangers posed by EPS, and other plastic waste to marine life, ecosystems, and the overall health of the oceans. They emphasise the need for effective waste management practices and global efforts to reduce plastic pollution to protect marine biodiversity and ecosystems.

The amount of waste EPS in the oceans is difficult to estimate accurately because it can break down into small particles, making it difficult to track. However, it is known that EPS is one of the most common types of plastic waste found in oceans and beaches worldwide (Unesco - https://oceanliteracy.unesco.org/plastic-pollution-ocean/)

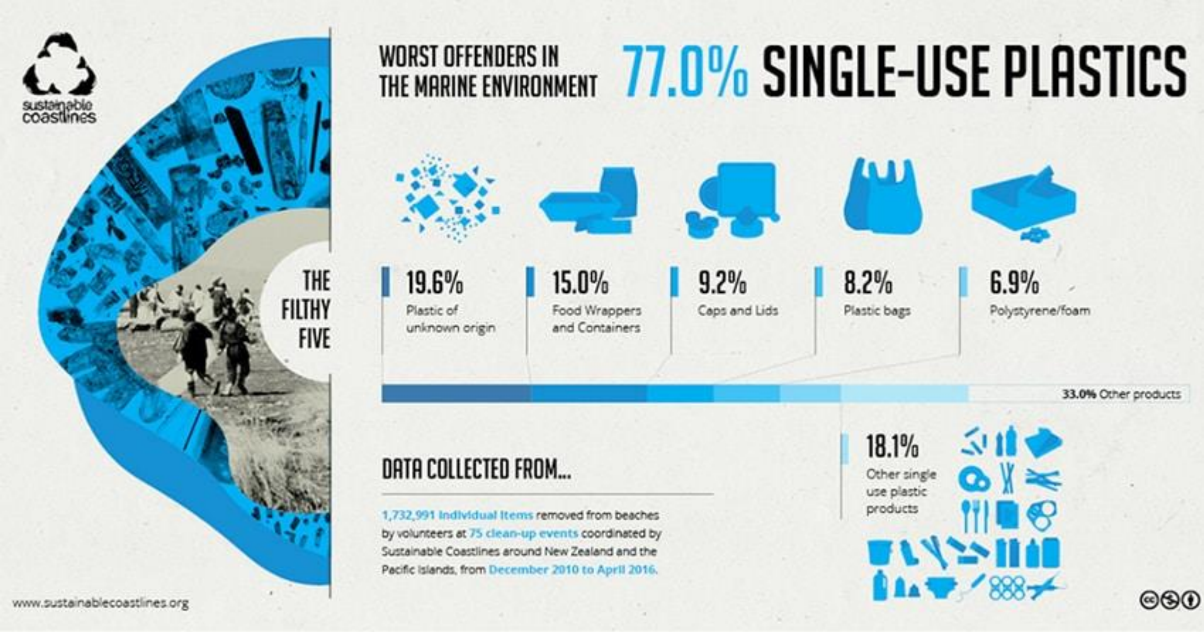

Figure 9 Most prevalent ocean plastics.,https://greenbusinesshq.com/plastic-waste-top-concern-for-new-zealanders/

Conclusion

The recommendation for Auckland Council is to consider viable and sustainable alternatives and further investigate the benefits vs disadvantages across start and end of life, longevity in the environment, management of handling on-site and the opportunity to spearhead greater awareness around the use of EPS in construction.

Stewardship of Council buildings should be considered as Councils generally continue to own their buildings and structures as opposed to developers which tends to culminate in the handover of consequences to local Councils and future owners.

Better handling at start of life appears to have viable solutions such as hot wire cutting, however at end of life, despite the shift towards deconstruction over demolition, contaminated EPS simply becomes landfill currently in New Zealand.

Within New Zealand (and on average globally), construction waste represents approximately 50% of all waste to landfill.

As technology progresses there may be solutions in the future for end-of-life management, but currently there doesn't appear to be viable options once combined with concrete or other materials.

The food and beverage industry has led the way in global bans using EPS, identifying the importance of long-lasting environmental impacts versus the immediate convenience of using this product.

The global construction sector is significantly lagging in this respect, with little to no governance or bans.

As New Zealand's largest Council, Auckland Council is able to help raise awareness of alternatives, improve current handling of EPS during transportation and on site and consider how to manage this material at end of life for future generations.

Support and leadership for the construction industry through funding for startup initiatives, product development and education should be considered.