

END USE DEFINITIONS PROJECT

CRUMB RUBBER

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INTRODUCTION

Did you know that over 370,000 tonnes of scrap tires were recycled in Canada last year? For over two decades, recycling programs across Canada have protected the environment by ensuring end-of-life tires are diverted from our landfills and recycled into various eco-friendly tire-derived products. Crumb rubber is one of the many environmentally responsible products that can be derived from end-of-life tires. Last year alone, Canada recycled 141,732 tonnes of tires into crumb rubber, creating high-value products from waste that might otherwise go into landfills (CATRA, 2021).

HOW CRUMB RUBBER IS MADE

Crumb rubber is the result of grinding whole end-of-life tires from cars and trucks to the desired size. During the process, all steel and fibre is removed from tires, and the remaining rubber is ground into uniform granules.

There are two primary methods for producing crumb rubber: **ambient** and **cryogenic** grinding processes. Ambient grinding is the most common method to produce crumb rubber. Whole scrap tires go through a multi-step process at room temperature where a series of grinding machines create crumb rubber (Fazli & Rodrigue, 2020). On the other hand, cryogenic grinding uses liquid nitrogen to reduce the temperature of scrap tires below - 80° C which makes the material brittle (Fazli & Rodrigue, 2020). Once it is frozen, the tire rubber is crushed as it passes through a hammer mill machine.

A video clip, produced by Eco Green Equipment USA, on how the ambient process produces crumb rubber can be found here: [Ambient Process](#). The video shows how whole end-of-life tires first enter the initial grinding process where the tires are shredded into small pieces. The shredded tires then go through additional processing to achieve the final product, crumb rubber, at the desired particle size.

Ambient and cryogenic processing requires different equipment and technology and produces a slightly different product with each having its advantages and disadvantages. The biggest difference is the shape of the crumb rubber that is created. Crumb rubber made by using the ambient method produces crumb with rugged edges, giving it more surface area that is generally beneficial when making moulded products such as rubber mats (Dondi et al., 2014). A drawback with the ambient method, however, is that a large amount of waste heat is generated which can potentially degrade the product. To prevent this from occurring, the ambient grinding machine's production rate must be

lowered along with intensive cooling (Hoyer et al., 2020). In comparison, the cryogenic method produces smoother and smaller crumbs that are better for use as infill for sports fields (Dondi et al., 2014). Additionally, cryogenic grinding benefits from a higher production rate and lower energy consumption compared to ambient grinding processes (Scrap Tire News, 2021). A disadvantage of the cryogenic method is the cost of liquid nitrogen, which can increase the cost of producing crumb rubber.

Both grinding methods produce crumb rubber for different uses, therefore no one grinding method is preferred for all crumb rubber products. Rather, depending on the end-use of the crumb rubber, experts recommend that the chosen grinding method ensures products are made with the highest quality at the lowest cost (N. Bansal & J. Cassell, personal communication, July 2021).

APPLICATIONS FOR CRUMB RUBBER

Canadian tire recycling programs are dedicated to finding new and better ways to recycle scrap tires into eco-friendly products. As a result of their efforts, Canada has become a global leader in recycling scrap tires into crumb rubber. Crumb rubber has several applications and can be used to make many recycled products such as moulded products, playground surfaces, rubberized asphalt, and synthetic turf applications.

Moulded Products:

Crumb rubber is used as a raw material to make various moulded end-use products for consumers. The crumb rubber is mixed with a binding agent and moulded into products, including floor mats, curb stops, automotive parts, and weightlifting plates. Using recycled crumb rubber in moulded products can help reduce the negative impacts that the extraction and processing of virgin materials would have on the environment.

Playground Surfaces:

For use in playgrounds, crumb rubber is added to a binder mixture that can be poured on to the surface. This gives a surface that is suitably firm and well-cushioned due to the higher compressibility of crumb rubber compared to harder conventional surfaces such as woodchips or pea gravel (PlayPower Canada, 2019). In Canada, rubber playground surfaces are designed to meet the standards set by the Canadian Standards Association to reduce the risk of injury that can result from falls from playground equipment. Another important benefit of poured crumb rubber play surfaces, as evidenced in Figure 1, is that they can be contoured to reduce or eliminate the need for hard corners and steps. This makes playgrounds more accessible, letting children of all abilities play together.



*Figure 1. Playground surface made from crumb rubber in Vancouver, British Columbia.
Source: Suttle Recreation Development*

A video clip on how crumb rubber playground surfaces are installed can be found here: [Rubber Crumb Playground Installation](#)

Rubber Modified Asphalt:

Rubber modified asphalt (RMA) is an alternative to traditional road pavement material. It is produced by mixing crumb rubber with a conventional asphalt material. Incorporating crumb rubber into asphalt not only helps keep tires out of landfills but also helps reduce project costs that would be incurred by strictly using natural resources. This replacement of natural resources with a material that would otherwise be waste allows RMA to be recognized as a sustainable product. An additional benefit of RMA is that it is more efficient in sound absorption than conventional asphalt roads that tend to reflect considerable noise into neighbouring communities (CalRecycle, 2020). The addition of crumb rubber can also improve the durability and safety of roads making them more resistant than conventional asphalt to cracking, rutting, and skidding. (CalRecycle, 2020).



*Figure 2. Rubber modified asphalt road.
Source: Liberty Tire Recycling*

Crumb Rubber as Infill for Synthetic Turf Sports Fields:

Synthetic turf fields were first introduced in the 1960s in the United States and since then have become a popular choice in many countries, including Canada. As shown in Figure 3, crumb rubber is combined with sand and used as a filler to help support the artificial blades of grass, giving the field a more natural texture (Environmental Protection Agency, 2019).

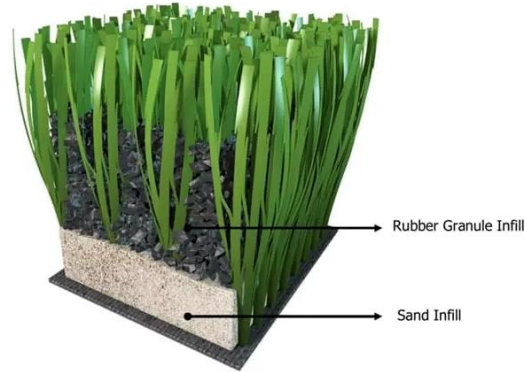


Figure 3. Cross section image of synthetic turf field.
Source: Rubber Mulch Products USA

The use of rubber crumb materials for turf fields can provide several benefits over natural grass. Natural grass requires maintenance that can be costly, making it difficult for many municipalities to keep their fields in a playable and safe condition. The fact that synthetic turf maintenance requires no watering, mowing, or treatment with fertilizers or pesticides can help conserve resources and reduce costs (Synthetic Turf Council, 2021). Synthetic turf can offer a place for continuous play throughout the year, in all weather conditions.

THE ECONOMICS OF PROCESSING AND USING CRUMB RUBBER

Tires continue to drive our economy even when they are off the roads. Millions of end-of-life tires have been diverted from Canadian landfills back into our economy as a raw material for new products, creating a more circular economy (CATRA, 2020). The tire recycling industry has invested significantly into the research and development of crumb rubber, which has been vital to increasing its economic viability. Here are a few economic benefits of recycling end-of-life tires into crumb rubber:

- Whether crumb rubber only is used, or blended with other non-recycled materials, (e.g. virgin rubber, wood, gravel, sand, etc.), the cost of crumb rubber compared to conventional materials often brings down the overall cost of the project or the product. Note that all-in costs such as energy and transportation must be considered.
- Roads that are built with RMA can improve the durability of roads as they are more crack and rut resistant than conventional asphalt. This improved durability can reduce long-term pavement maintenance costs.

- As infill for synthetic turf, crumb rubber is an essential part of a turf ‘system’ that allows year-round activity on safe surfaces (an increase in value), while reducing maintenance costs and resources.
- The crumb rubber industry supports Canadian manufacturing and creates jobs

HEALTH AND SAFETY

Since the introduction of synthetic turf, there have been public concerns that the chemicals in surfaces made from recycled tires may be hazardous to human health. In response, there have been more than 100 scientific studies to date, including multiple peer-reviewed academic research and government reports from the United States Environmental Protection Agency (EPA) and European Chemical Agency (Environmental Protection Agency, 2019 & European Union, 2021).

Beginning in 2016, the EPA launched a two-part research project in partnership with the Center for Disease Control. The project represents the largest and most robust study of synthetic turf fields and tire crumb rubber to date in the United States. Published in 2019, part one of the above study had similar findings to other studies – including those from Europe - that found that, while many chemicals are present in the recycled tire crumb rubber, human exposure during activity on the field is limited (Environmental Protection Agency, 2019). Part two of the study will attempt to collect additional data to further understand this potential human exposure to chemicals found in crumb rubber (Environmental Protection Agency, 2019).

Additionally, a 2018 peer-reviewed paper published a study on the risk of exposure to chemicals found in recycled rubber (Peterson et al., 2018). The researcher found that all estimated exposure risk to chemicals fell within EPA guidelines and that cancer levels for synthetic turf field users were comparable to or lower than those associated with natural soil fields.

NOTABLE PROJECTS USING CRUMB RUBBER

In 2020, approximately 38 percent of the tires collected in Canada were recycled into crumb rubber, in large part due to support from recycling agencies across Canada that provide grants and research & development funding to encourage the use of locally created tire rubber products in local projects (CATRA, 2021). Manitoba, Ontario, British Columbia, Alberta, and Saskatchewan all have community-focused grant programs that have funded numerous crumb rubber projects, including playground surfaces, infill for synthetic turf fields, and RMA.

In 2018, Emterra Tire Recycling supplied recycled crumb rubber to help the Canadian Tire Jumpstart Charities build Charlestown, PEI’s first accessible playground. The crumb rubber was used to build the rubberized playground surface to provide inclusive play for children of all abilities.

Crumb rubber projects are also found all over the United States, from school playgrounds to highways. Crumb rubber was first used as an additive in asphalt pavement in Phoenix, Arizona in the 1960s and has since continued to advance throughout the United States, notably in California, Arizona, and Texas (U.S Department of Transportation, 2014).

Many countries in Europe recognize crumb rubber as a valuable product that supports a circular economy. For example, the government of the United Kingdom funded its first asphalt technology that will incorporate crumb rubber into asphalt roads (Highways Magazine, 2019). This trial is the first step to reduce the number of tires entering landfills in the United Kingdom.

Tyre Stewardship Australia is funding a research project that will look at the performance of several trial roads that use RMA throughout Australia. This evidence-based research is Australia's first project that is testing crumb rubber made from passenger tires in asphalt, with the aim to better understand the application and performance of crumb rubber in RMA. For more information on the research project visit: Tyre Stewardship Australia

ADVANCES IN CRUMB RUBBER

Several advances in crumb rubber over recent years, including improved equipment and new technology, have increased the quality of crumbs and broadened the range of crumb characteristics, thus opening the opportunity for new uses. For example, scientists and engineers from the United States and Australia have developed a form of concrete that incorporates fine crumb rubber with the intent to use it in concrete buildings, dams, and bridges. By strengthening concrete with crumb rubber, scientists and engineers have developed a sustainable product that they believe outperforms traditional concrete (RMIT University, 2021).

Producing high volumes of crumb rubber without sacrificing quality has been a challenge for the industry. However, modern equipment has made producing crumb rubber more efficient. For example, Eco Green Equipment, a tire recycling equipment manufacturer, has developed a new ambient grinding technology that allows their machine to increase production rates of crumb rubber while reducing power consumption (Recycling Product News, 2020).

CONCLUSION

Processing end-of-life tires is a critical aspect of today's waste management. The tire industry has made great strides in ensuring end-of-life tires in Canada are recycled responsibly into products such as crumb rubber.

As a result of ongoing investment in research and development, there is optimism that crumb rubber will continue to be a part of our everyday lives, from playground surfaces and sports fields to roads and highways - helping improve the future of the environment and the future of the economy.

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