DJIM Dalhousie Journal of Interdisciplinary Management

Volume 9 – Spring 2013
djim.management.dal.ca
doi:10.5931/djim.v9i1.3356

Canadian Waste Tire Practices and Their Potential in Sustainable Construction

Abstract: This paper is an analysis of two Canadian provincial waste tire management programs and demonstrates the potential for using repurposed tires in sustainable construction. In an effort to mitigate the environmental hazards and landfill challenges waste tire piles present, Canadian provinces have responded in various ways to repurposing tires for different uses. While the tire reprocessing programs of Nova Scotia and British Columbia produce a wide variety of recycled-material products - mainly Tire Derived Aggregate and crumb rubber, they both depend on secondary industrial processes to break down the existing tire structure into its bare components. To capitalize on the initial energy inputs that exist in tire fabrication and avoid further reliance on energy-intensive industrial reprocessing, waste tire use in sustainable construction is proposed as a viable policy addition to further sustainable resource management in Canada. The pioneering architecture firm, *Earthship Biotecture*, is examined to highlight the potential that exists in reprocessing tires as structural building blocks in rammed earth tire homes.

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Introduction

In the context of waste management, there are certain irreplaceable products in mainstream use that cause unique problems for our society. It is widely known that in the hierarchy of waste management, the outright prevention of a specific product's use is the ideal option for managing its waste; however, products we rely on must be managed much more closely so that they continue to serve their societal function, but can be disposed of in a sustainable manner. The management of rubber tires has been a popular topic of discussion and policy as of late. They present a unique challenge in terms of being extremely wasteful, but also holding great potential for repurposing. Since we still depend on ground transportation, and technology does not have an answer on how we can abolish the use of rubber tires, policies and processes have been put in place provincially to mitigate the waste of this product. Using a coast-to-coast examination of recycling programs in both Nova Scotia (NS) and British Columbia (BC), we can highlight how two coastal provinces tackle the challenge of waste tire management. After reviewing where both provinces direct their efforts, we will explore how their existing processes could be more sustainable and what other options exist in furthering the sustainability of repurposed waste tires.

Tire recycling in Canada began in response to a crisis in 1990 that caught national attention. On February 12th, 1990, 12.6 million tires caught fire in Haggerville, Ontario (Scrap Tire Recycling Canada, 2006). The seventeen-day uncontrollable fire forced the evacuation of 1,700 people as a result of the immense toxic fumes emitted from the blaze, and caused massive contamination of nearby water wells (Scrap Tire Recycling Canada, 2006). Besides posing significant threats for toxic fires, tire piles also promote the spread of disease as they act as ideal breeding grounds for mosquitoes and vermin. Since waste tires were taking up considerable space all over the country, provinces went in to action to address this space-consuming and hazardous waste product in landfills.

Current Practices

The Resource Recovery Fund Board Inc. (RRFB) in Nova Scotia is a not-for-profit organization that operates provincially. It promotes and facilitates waste diversion, recycling, industrial stewardship, and many other environmentally-centered programs. The RRFB is closely linked with the province's Solid Waste Management policy, and operates in all seven provincial regions of Nova Scotia (RRFB, 2012). The Used Tire Program is one of the nine industrial stewardship practices operated by the RRFB. It began in 1997 and has been gaining importance ever since (AIA Canada, 2004). The increased emphasis on waste mitigation programs comes from the *Environmental Goals and Prosperity Act* of 2007, where Nova Scotia's Legislature set the target of only 300 kilograms of waste, per person per year, by 2015. Compared to the estimated 401 kg/person/year that was calculated for 2010, this is an ambitious goal (Environmental Goals and Prosperity Act, 2007).

The Used Tire Management program operates by requiring distributors and retailers of on-road passenger tires within the province to have a stewardship agreement with an RRFB administrator. Within the stewardship program, distributers agree to collect an environmental fee for every tire they sell within the province (RRFB, 2012). The fees per tire range from $3.00 to $9.00 based on rim size, and the fees enable the RRFB to support the costs involved with the collecting and processing of the tires (RRFB, 2012).

As of 2009, the RRFB began diverting waste tires towards the production of Tire Derived Aggregate (TDA). Under contract with the RRFB, Halifax C and D Recycling opened the province's first and only tire recycling facility in Nova Scotia. This recycling facility processes an estimated 1.2 million tires a year into TDA (Halifax C & D Recycling, 2012). In 2012, the RRFB boasted a 90.9% recovery rate of tires, compared to the 89.8% in 2011, resulting in 1.18 million tires being diverted from landfills (RRFB, 2012). Tire Derived Aggregate has various uses as a product. Its engineering uses include lightweight and conventional fill, retaining wall backfill, insulation, and french drains, as well as aggregate used in road construction (Humphrey, 2011). One of the largest uses of TDA in Atlantic Canada saw the processing of 1.6 million tires for landslide stabilization in St. Stephen, New Brunswick in 2008 (Humphrey, 2009).

Tire Derived Aggregate clearly has some very viable applications in an engineering context because it not only reuses a formerly wasted material, but also saves on traditional materials by replacing them with TDA. In a drainage blanket cost comparison of gravel and TDA done by Alberta Recycling, it was found that TDA can cost six times less for similar drainage blanket systems when transportation and production costs are subsidized (Alberta Recycling, 2013). It is estimated that developing and instituting a functional TDA plant costs upwards of $2.5 million for machinery and operation costs, plus the overhead and maintenance of the systems involved (Gray, 2009). While this is a relatively small cost considering the value in waste reduction it creates, as well as the value of the repurposed product, it does have some drawbacks.

There is limited knowledge related to the effects that TDA leaching into ecosystems may have on groundwater. While studies have shown that TDA is unlikely to raise levels of groundwater substance concentrations above normal levels, and leaching substances from TDA are unlikely to migrate away from their installation, the unknown long-term effects could limit the widespread use of TDA (Humphrey & Sweet, 2006). Considering that the costs and effort put into refining TDA in Nova Scotia are fairly substantial, exploring other potential programs and products would seem like a viable inquiry.

The Tire Stewardship BC program could be considered one of the largest tire recycling programs in Canada. It began in 1991, some 6 years before Nova Scotia's tire recycling program began, and as of 2001, boasted a 96% capture rate (AIA Canada, 2004). Tire Stewardship BC (TSBC), like Nova Scotia's RRFB, has a distributor stewardship program in which distributors charge an "eco-fee" for every tire sold, ranging from $5-$35 dollars per tire (TSBC, 2012). The eco-fee is more expensive in BC than it is in NS, but this could be attributed to their vastly more developed product range for waste tires. In an advanced refining process, 80% of diverted BC tires are reprocessed in to crumb rubber. This crumb rubber is used for several purposes, ranging from athletic tracks and synthetic turf fields, non-slip pavers, walkways and playgrounds, flooring in recreational facilities, to flooring and mats for agricultural and industrial use. The other 20% of scrap tires are used as a fuel supplement in the cement and pulp and paper industries (TSBC, 2012). The diversity of products derived from scrap tire products in the BC framework could be viable because of their larger population and therefore larger tire volume; however, with more products comes more costs. Not only are the initial tire fees higher, the increased processing needed to remove the metal components from rubber requires more work than simply breaking up used tired as done with TDA (TSBC, 2012). The increased processing cost of crumb rubber on the front end does produce potential for higher quality tire-derived products, but the input energy costs should be considered when evaluating how much this process actually mitigates environmental impact.

Future Potential

The efforts of Canadian provincial organizations are commendable and extremely effective in diverting tire waste from landfills to practical use products; however, there is still room for further refinement of how we process waste tires. Most provincial programs currently depend on the dismantling of the tire structure to get at its raw components instead of utilizing the already created tire structure for other purposes (Canadian Association of Tire Recycling Agencies [CATRA], 2012). The product potential gained from the raw material recycling is very beneficial, although the process in itself is very wasteful on two counts. On one count, the energy inputs used in the production of a tire for its initial purpose in transportation are significantly lowered in value when a tire is ground up as TDA or crumb rubber. On a second count, to reuse the raw materials salvaged from this practice, tires must undergo further industrial processing to create a completely new product. This indicates that the life cycle assessment of a tire sees a large energy and resource consumption at two levels: the initial production of the tire, and the dismantling of its initial structure into components for reuse (Kromer, Kreipe, Reichenbach, & Stark, 1999). In this context, investigating alternatives to extend the value of initial energy inputs in repurposed tires by maintaining the actual structure of the tire seems extremely logical.

One such alternative exists with the use of waste tires as building blocks. Rammed earth homes are by no means a new concept; however, their durability often comes into question as the effects of seasonal weather pose a potentially limiting factor for homes that use rammed earth construction (Ghayad, Reddy, Morel & Bui, 2008). Where waste tires play an interesting role in this scenario is through the use of rammed earth building techniques inside of the tire structure to turn waste tires into rubber and steel building blocks. The tires offer not only a buffer from the elements, but also provide very flexible structural qualities. In reports from *Earthship Biotecture* out of Taos, New Mexico, USA, rammed earth tire homes were reported to withstand earthquakes scoring 7 on the Richter Scale with no serious damage (Earthship Biotecture, 2012b). In addition, the use of rammed earth tires in home building provides “the most economical and environmentally appropriate way to achieve both thermal mass and structure in an actively thermal dynamic building” (Earthship Biotecture, 2012a, para. 4).

When analyzing the impact on home energy consumption using rammed earth tires in Earthship Biotecture construction techniques, it was found that the latest “Global Model Earthship” has an annual heating and cooling load of just over 500 kWh (Freney, 2012). Compared to a rammed earth home that consumes just over 3,000 kWh annually for heating and cooling (Freney, 2012), and the average Atlantic Canadian home consumes roughly 18,750 kWh (Natural Resources Canada, 2009), significant home energy savings could be claimed utilizing Earthship Biotecture construction methods and materials. These energy savings are a result of the “thermal battery” charging and discharging that takes place with south-facing, bermed-dwelling methods utilized in Earthship construction. As reflected in a recent study of Earthship homes introduced in the United Kingdom, thermal charging and discharging of earth-rammed thermal mass (rammed earth tires) moderates extreme external temperatures (Miller, 2009).

In studies assessing the potential off-gassing of rammed earth tires in homes, it was found that tires used in house construction encased with stucco, thermal barriers, and concrete, contribute little-to-no off-gassing. Tires do pose an off-gassing threat in waste piles, especially through photo-degradation (Earthship Biotecture, 2012a). It could be considered that the incorporation of tires in home construction not only extends the value of initial energy inputs in tire production adds to structural flexibility and thermal dynamic activity of homes, but also eliminates the off-gassing potential of repurposed tire materials as they are taken out of the harmful elements and contained. The climactic resilience and energy-saving potential of this building style not only presents huge potential for affordable, eco-friendly home building in the developed world, but also for the developing world. The use of whole-tire retaining walls is also an emerging concept; however, the use of rammed earth tires as retaining walls from an engineering perspective has been largely unexplored and underused. It is generally agreed upon that the recycled material design and construction methods used in Earthships could make significant contributions towards future sustainability, if more widely adopted (Grindley & Hutchinson, 1996).

As a result of the societal dependence on tires, we have created a fabricated “renewable” resource for our planet to utilize. While Nova Scotia and British Columbia provide two examples of how repurposed tires are being incorporated back into material cycles, the provinces have by no means exhausted tire recycling potential. Efforts now need to focus on mitigating the energy inputs into repurposing tires and capitalizing on the energy already invested in their production. As such, construction appears to be a viable avenue into which waste tires could be incorporated. Provincial action behind waste tire management demonstrates that programs around sustainable resource management continue to evolve. This evolution will inevitably allow for the development of further research opportunities by professionals and students alike. The continued efforts of both sectors will, in the end, be necessary for us to refine our industrial processes such as these to sustainable levels.

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