Implementation Analysis of Reclaimed Materials in Illinois Highway System

IAPA Scholarship Research Paper

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Introduction:

Since the declaration of the Federal-Aid Highway Act in 1956, the formation of the interstate system and the construction of highways in the United States has played an integral role in everyday life. Generally, the primary building materials in highway construction are consisted of aggregate, asphalt, and cement. Nevertheless, the highway systems have now been utilized for many years and a lot of the roads and pavements are in need of maintenance, and with the prolonged research conducted over the last few years, the efficacy and efficiency of various reclaimed materials in Illinois highways and expressways is improving and their implementation is looking more optimal than ever. This study will present the most relevant materials and their implementation feasibility according to their environmental impact and sustainability assessment.

Highway Construction Materials in the Past:

So far, sustainability has not been taken into account as much as it should, as the priority when constructing Illinois highways and pavements has been efficiency and economic value, while recyclability and the overall environmental impact of the utilized materials has been left aside as an afterthought. For instance, commonly used materials such as cement are selected to construct concrete roads due to their high durability under heavy loads, however, it is a material that when formed, produces large amounts of carbon dioxide, which are harmful to the environment. Another example of a material that has been frequently used over the years is asphalt, which is less durable than cement, but it is a popular option due to its low cost and ease of installation. This material, also referred as bitumen, has similar drawbacks in terms of its environmental impact, as it can be a very large source of air pollution, more so during warmer periods of the year, when emissions are found in larger amounts, due to sunlight shining on the asphalt.

Advancements in Research:

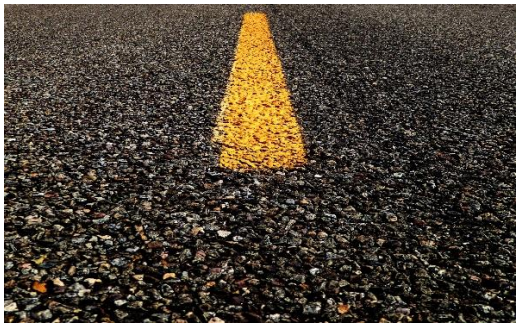
With the rise of technology and the advancement of research throughout the last few decades, as well as with the constant increase of waste being generated and emissions being produced, it seems more and more necessary that highway construction needs to incorporate the utilization of recycled materials and to recycle waste into useful products. A plethora of public and private agencies, along with departments of transportation of a few states and in collaboration with many universities in transportation and pavement engineering have been conducting research studies and carrying out tests in order to find the environmental sustainability of using recycled materials that can deliver sufficient performance levels and last for long periods of time, while having a feasible and affordable installation procedure. What has been found is that not the traditional materials themselves, but more so the waste created from the construction, demolition and renovation which involves mining, digging up land, and processing of the aforementioned materials is what accounts for about half of the overall waste produced in the planet, which is a major concern. Life-cycle assessment (LCA) is a methodology that can be utilized to assess that environmental impact of a material throughout its life cycle. It is a significant tool that was introduced in its full-fledged form in the 1990s and can be applied in this case in order to help with the selection of the best recycled material. The recycled materials that will be analyzed in this research paper will be ones created from waste, such as recycled concrete aggregate that incorporates recycled tyre waste and recycled asphalt pavements made from recycled materials mixed with hot asphalt.

Recycled Concrete Aggregate:

A lot of studies have been done on how we can reinforce concrete aggregate in highways and revamp its environmental impact by integrating it in mixes with recycled materials that can be produced from waste management. The recycled concrete aggregate that is formed as a result and that we will focus on our analysis is the one that incorporates recycled tire waste. Recycled tire waste is any form of repairable, altered waste or scrap tire that has been found to be very useful in creating recycled concrete aggregate by accumulating its crumb rubber components. There are a few different processes that are conducted in order to obtain crumb rubber which is then used in the mix to create recycled concrete aggregate. The processes generally include the removal of tires' steel and fabric contents and reducing the tire waste down to its mesh particles through ambient grinding and cryogenic processing. Ambient grinding can be hugely beneficial into shaping tire waste as a great material option to be mixed with concrete into recycled concrete aggregate. This process involves a sequence of steps of crushing and extracting the steel of the carcass in very warm temperatures and removing the fiber components to be left with the crumb rubber. On the other hand, the cryogenic process takes place in very cold temperatures, by pouring the tires into liquid nitrogen which makes them very brittle in order to be easily broken apart and have the crumb rubber segments accumulated in the process.

Recycled Asphalt Pavement:

Recycled or reclaimed asphalt pavement, also referred to as RAP, is reprocessed pavement that contains reclaimed asphalt mixed with other recycled materials. In its most common form, it can be collected as a byproduct from a few processes such as reconstruction and pavement rehabilitation, and can be used in many different ways, but in terms of highway construction, it can be made use as an aggregate in cold-mix asphalt. The production of RAP occurs when these byproduct fragments are properly crushed, milled, or pulverized in place when necessary, which are then recycled in central processing facilities by using hot and cold in-place recycling processes to mix them with targeted additives to create the desired mixes. The life-cycle benefits of using recycled asphalt pavement, by substituting them for the traditional materials can be quantified and projected through thorough analysis of the results using the life-cycle assessment tool. Recycled asphalt pavement in hot asphalt mix was generally found to be the leading material in terms of supply compared to other recycled material alternatives, such as fly ash, and reclaimed asphalt shingles. The economic benefits that are relevant in our analysis can be quantified by comparing and finding the difference between the average price of virgin versus recycled materials, while the environmental impact changes are evaluated by the amount of CO2 emissions reduced when used compared to the traditional materials used, as well as compared to other recycled materials examined in similar studies.



Recommendation:

Recycled concrete aggregate that incorporates crumb rubber from recycled tire waste, as well as recycled asphalt pavement in hot asphalt mix are both material blends of recycled waste components or byproducts that can be implemented as alternatives to the standard materials in order to reduce carbon dioxide emissions and impact the environment in a positive way. Both mixes have become a considerably easier to create in the last few years due to a rapid increase of material waste in highway construction that results to a supply increase of their components. As a result, they are both great choices to implement in the future of the Illinois highway system, as they have a significantly large reserve that is not utilized optimally and can last for a long time. In both cases, the necessary procedures that take place can be complicated, so it is strongly recommended that they are taken extremely seriously in order to prevent any hazardous accidents from occurring. With the help of the life-cycle assessment tool, we can find how using recycle asphalt pavement in a hot mix and recycled concrete aggregate that incorporates crumb rubber from recycled tire waste compared to other methods is more beneficial due to their vastly greater recyclability levels, proving that they are both great options to use in the Illinois highway system, as long as they are handled appropriately.

Figure 1. OpenLCA Software Homepage

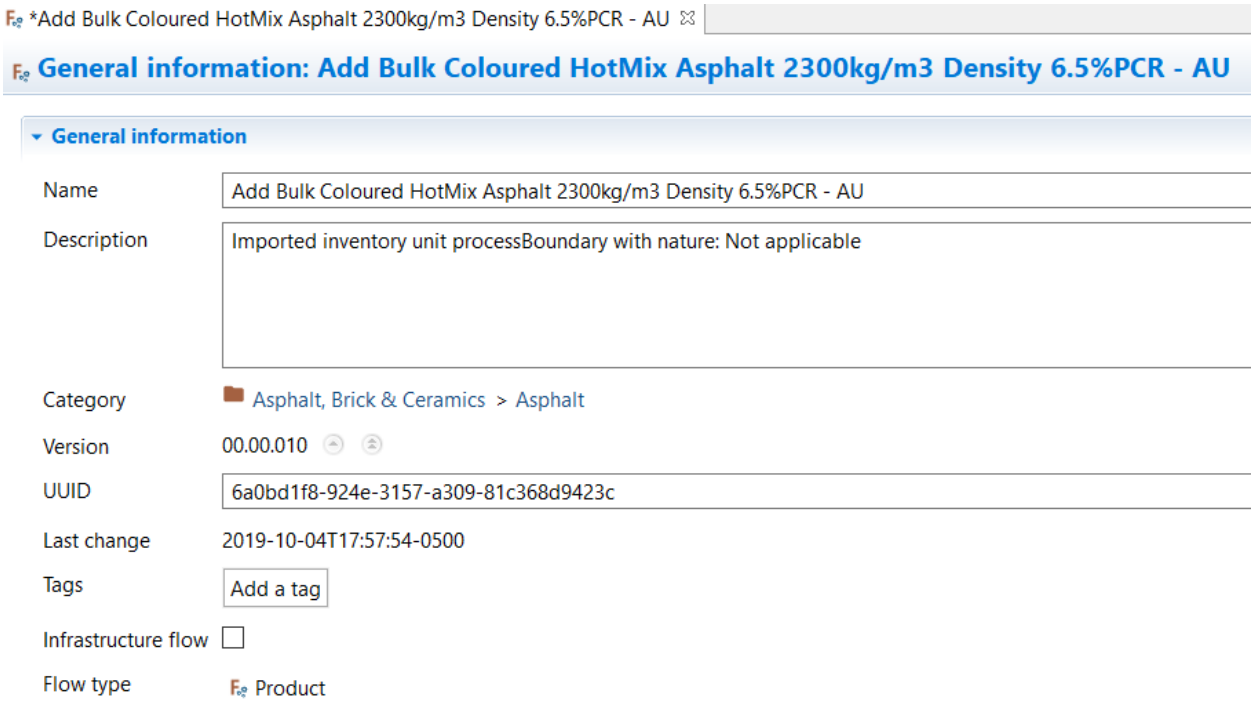


Figure 2. OpenLCA Asphalt Pavement in HMA Option

Conclusion:

This research paper allowed me to delve into a very interesting topic that has been becoming more and more relevant in the last few years. I was able to learn a lot about the feasibility of implementing reclaimed materials and of incorporating a few noteworthy concrete and asphalt mixes in the Illinois highway system, their environmental benefits, and how crucial it is that they are processed in a proper manner. Furthermore, I was able to use the OpenLCA software to conduct a life-cycle assessment analysis of the materials, which helped me gather more information about the life-cycle benefits of the designated recycled materials in highway construction, and which one should be selected according to location and supply. I am grateful to have come across this opportunity to learn about ways to improve the highway system of our state, and I look forward to seeing further advancements in research that can help improve the planet.

References:

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