A Sustainability Analysis of Different Types of Asphalts

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Abstract

The present work aimed to analyze ecological asphalts, aiming at their influence on the tripod of sustainability in the social, environmental and economic spheres. The option of using eco-rubber asphalt and EVA as a raw material for paving roads and highways is a bet for a more resistant material that requires less nature degradation and easier maintenance. One of the main reasons for the degradation of flexible pavement is the wear caused by the time of use, as well as the traffic of vehicles carrying excessive loads. This study reports some alternatives to multiply the improvement of reverse logistics of waste tires and EVA (ethyl vinyl acetate) plastics, facing problems related to environmental impacts, which directly affect the Brazilian population. This project is important because it is directly linked to sustainability and the development of the environment, facing renewable and suitable alternatives to be employed, such as ecological asphalts, and their benefits. Among the benefits of ecological asphalt we can mention the contribution to the environment by reducing the amount of waste tires improperly discarded in nature and the durability of ecological asphalt compared to conventional asphalt where it showed greater resistance to climate fatigue. The research used the qualitative method being a study based on bibliographies, analyze and discuss the reuse of solid waste and the mitigation of environmental impacts through asphalt. Ecological asphalt seems to be more expensive than the bituminous asphalt used today, however it is environmentally friendly and its effectiveness, durability and safety are noticeable advantages.

Keywords: Sustainability tripod; paving; environmental impacts.

1. Introduction

In order to solve environmental problems, plastic waste, even though it is a problem, given the amount of material generated, also appear as a source of progress, with technological attributes, where the transformation of this waste recovered from landfills to produce a more asphalt. resistant, with ecological characteristics replacing the CAP (Petroleum Asphalt Cement), being more resistant than the common asphalt.

A sector of great importance in the waste sector is plastics, which occupies 49.7% of total waste in 2017, about 21,153 out of a total of 43,945 tons per day. Plastic obtained 1,737 tons per day recycled out of a total of 13,969, or 12.44%. This figure shows that there was a 15% reduction in the recycling rate compared to 2012 [1].

Thus the solution for waste according to [2] occurs through the National Solid Waste Policy Act [3], which lists environmentally sound disposal: waste disposal that includes reuse, recycling, composting, recovery and energy utilization in paragraph 7, and the orderly distribution of tailings into landfills, observing specific operational standards to avoid damage or risk to public health and safety and to minimize adverse environmental impacts (paragraph 8). In Article 9 of the law there is no generation, reduction, reuse, recycling, treatment and final disposal [4].

Contrary to common sense, the waste recycling production chain, and especially plastics, involves relatively complex cycles and interactions, especially as it integrates activities of a different nature and involves different types of agents (citizens, waste pickers, scrap dealers, the government, processing industries, etc.). Essentially, the cycle of this chain can be described from the emergence of waste through its anthropogenic generation, which is followed by selective disposal, selective collection, sorting and packaging, recycling (which transforms recycled waste into recycled material), industrialization (which transforms the material into a product of social interest), commercialization and consumption (acquisition of the product, putting it to use and generating waste, thus returning to the beginning of the cycle) [5].

Sustainable development has been gaining ground in the various areas of knowledge and practice, raising in institutions and scientific circles, adding sustainability values in their production processes, in order to guarantee goods and services to the present population and to promote the security that future populations also have. the right to use the same resources [6].

Based on the above, reverse logistics within a company has the purpose of managing and operationalizing the return of goods and materials after their sale and / or consumption to the point of origin, presents the main objective of preserving the environment, meeting the principles of sustainability.

The LR procedure is a great chance to expand the systematization of waste streams, disposed goods and products, also contributing to the reduction of the use of natural solutions and other environmental conflicts, ie, the reversibility system focuses on an organizational instrument. which enables reverse chain savings to contribute to enhancing the sustainability of successful chains. However, the management of the Reverse Logistics network is still starting, with a lack of specific and unified methods, which causes companies' lack of interest in improving the management of reverse channels [7].

In practice, taking into account not only the educational process, there are companies, where managers, in making strategic decisions, include from the acquisition of raw materials to final consumption, following the flow and information about products, aiming to reduce costs and promote difference in meeting the demands, adding value to the final product, aiming at constant production and less impact on nature.

Reverse After Sales Logistics is characterized by product returns that for some reason did not please the end customer. Such products are durable, semi-durable or disposable in nature, sold through various distribution channels and returned by the direct distribution chain itself or by the end customer [8].

Given the problems related to environmental impacts that directly affect the characteristics that make up sustainability find alternatives and direct them to the reverse logistics process of large-scale disposable materials, such as waste tires and EVA (ethyl vinyl acetate plastic).) it became essential to reduce the problems generated by these materials.

Addition of Ethylene Polyethylene Terephthalate (PET) in Petroleum Asphalt Cement (CAP) may be an alternative to increase mechanical properties as it is a plastomer, providing increased susceptibility to fatigue and thereby extending pavement life. [9] In order to provide users with comfort and safety, it is of utmost importance to consider the design of the floor, it must be conserved over the project lifetime and must be economically and environmentally viable [10].

The high growth of the vehicle fleet causes traffic congestion that demands more from the pavement not only by volume but also by reduced speed, to avoid early pavement defects, we seek to improve mechanical behavior through research for new refinement materials [9].

[9] also mentions that the use of reused polymers is a common measure and that the addition of PET in asphalt mixture is promising because it is an inert material, resistant and with good chemical stability. To give alternative use to PET should deepen the knowledge about its mechanical behavior in asphalt mixtures.

The most common and currently used coating is Hot Machined Bituminous Concrete (CBUQ), being a material composed of the mixture of sand, stone dust, gravel and petroleum asphalt cement better known as CAP. The CBUQ is defined by DNIT 031/2006-ES [10] Flexible Pavements - Asphalt Concrete - Service Specification as “a hot, spread, compact and hot mix, with specific characteristics, being manufactured in an appropriate plant and made up of graded aggregate and filler (filer) and asphalt cement ”.

PAC is a material used mainly in paving activities, as it has the function of aggregating the components of the mixture, being highly binder, viscous and impermeable. Impermeability is an important factor against the action of water on structures due to weather conditions. “PAC is a heat-sensitive material resulting from the distillation of specific types of oil in which light fractions (gasoline, diesel and kerosene) are removed in refining” [10].

Another model is classified as cold asphalt or cold machined asphalt mixtures, also called cold premix (PMF), are composed of coarse, fine and filler aggregates. PMF (cold premix) is usually used as a coating or intermediate layer of roads with low traffic volume. This type of mixture can be classified into dense and open mixtures [11].

Cold Premix (PMF) - It is a mixture performed at room temperature in a suitable plant, composed of coarse aggregate, filler and cold-pressed asphalt emulsion. The aggregate can be durable, crushed stone or pebble, free of clods and harmful substances. The fine aggregate can be sand, rock dust or a mixture of both [10].

When the PMF is opened, its void content can reach 20%, resulting in a very draining material. This feature

refers to the need for special care with the mixture: the bottom layer of the PMF must be tightly sealed (or even closed) to prevent water from descending to underlying layers, and the PMF must extend to the edge of the shoulder to lateral drainage of water occurs.

The material of the open mixtures will have resistance basically provided by the compaction effort, given the internal friction between the aggregates; The binder promotes minimal cohesion between the grains. They are especially suitable as base or leveling layers for an existing floor [11].

Conventional pavement, due to the composition of its layers generates high cost, for this reason there is a need to look for new alternatives in the market that present a better cost-benefit, asphalt rubber presents in its composition unusable tires where this material can be used. recycled and prepared; being incorporated into asphalt binders that are used in the paving process [12].

After collecting a tire, it is taken to its final destination, which can be basically two, the reuse as an energy source or the reuse of materials that make up the tire in other products. In these two main forms of reuse, there are several subtypes that represent the final destination of solid tire waste, including rubber asphalt.

Studies related to the incorporation of EVA into the asphalt binder indicate increased viscosity and improvement in the performance of bituminous material, due in part to the solubilization capacity of EVA in saturated asphalt fractions. On the other hand, accelerated aging tests have shown that the presence of EVA reduces the oxidative decomposition process of asphalt [13].

Therefore, the purpose of the study is to make a brief analysis comparing the different types of asphalt, given their

2. Materials and Methods

For the development of this study, the applied qualitative methodology [14], aimed to analyze and discuss the reuse of solid and plastic waste and the mitigation of environmental impacts through asphalt.

Bibliographic researches were conducted to support [14] the problem approached, and further clarification on the viability of the asphalting process and its norms, in order to compare the type of asphalt composition used in the state of Amazonas and ecological asphalt, as an alternative to contribute to the preservation of the environment, also emphasizing its durability and composition in order to reduce the impacts caused by the region's climate and other variables.

Given the above, it was reported the raw material that make up the ecological asphalts, derived from solid waste and post-consumer liability to be applied, aiming at the improvement of the lanes, as well as the mitigation of damages related to the economic, social and environmental.

The asphalts and the processes aiming at their improvement and the durability in the traffic roads of the cities of Brazil were compared. Since over the century studies have been conducted on the mixture of asphalt composition, associated with new technologies to discover its applicability.

Four types of asphalt, rubber asphalt, EVA asphalt, CBUQ asphalt and cold asphalt, were presented in order to present the best quality asphalt, a condition of adaptability for its use in the city of Manaus, AM.

3. Results and Discussion

From the information it was determined that the addition of tire rubber dust and plastic waste to the asphalt

binder becomes a highly sustainable improvement thanks to environmental and economic advantages. This is because ecological asphalt increases the durability of the pavement and uses recycling as an alternative to reduce environmental degradation.

There are numerous advantages with increased pavement life compared to conventional asphalt; delaying the appearance of cracks in the highways and sealing existing cracks (Table 1).

Table 1: Comparison between the different types of Ecological Asphalt

TYPES OF ASPHALT	CBUQ (Standard asphalt)	EVE (ethyl vinyl acetate)	ECOLOGICAL ASPHALT (Rubber Asphalt)	COLD ASPHALT (cold premixed-PMF)
FEATURES	1. Composed of ground aggregate (sand); coarse aggregate (gravel) and the binder (Asphalt Oil Cap).	1. Demonstrates better rheological properties or equivalent to conventional asphalt.	1. Accumulate successful experiences (Private companies that run Brazilian highways).	1. Consisting of large aggregates, fines and filler
	2. Obtained in fractional distillation of oil.	2. Increased viscosity and improved degree of performance of bituminous material.	2. Use by grinding 0.30 mm until powdered.	2. Mix at room temperature with petroleum asphalt emulsion.
	3. Mixing aggregates with the hot binder in an asphalt plant.	3. Studies related to the incorporation of EVA into the asphalt binder.		3. PMF is normally used for the preservation and maintenance of deteriorated coatings.
	4. Transported by truck to your application site.	4. Indicates solubilization (dissolution) of EVA in saturated asphalt fractions.		4. classified into mixtures according to their aggregate grading and the volume of voids in the mixture;
	5. Occurs the deterioration of the environment affecting the hydrological cycle and relief forms.			5. Material used in temporary or emergency maintenance services

Source: Own authorship (2019).

Modified asphalt is one that, when additive, has improved physical and chemical characteristics, so that its service performance is superior to conventional asphalt. These additives are basically polymeric elastomer and / or plastomer type materials [15].

A study by technicians from the National Department of Roads (DNER) and the Brazilian Transport Planning Company (Geipot) show that a degraded road represents a 58% increase in fuel consumption, a 38% increase in vehicle maintenance expenses, 50% in the accident rate and up to 100% in time spent traveling [16] [17].

Thus, understanding the asphalts powders and cons among them, showing the benefits of the asphalt, can generate numerous benefits, while their characteristics and applications (Table 2).

Table 2: Advantages and disadvantages of ecological asphalts (Rubber and EVA).

TYPES OF ASPHALT	EVE (ethyl vinyl acetate)	ECOLOGICAL ASPHALT (Rubber Asphalt)
BENEFITS	1.High degree of softness and hardness;	1. Increased pavement life or durability (Decreased aging and oxidation of asphalt binder);
	2. Longer pavement durability up to 40% longer than usual;	2. High elasticity due to high swelling index
	3. Decrease of waste recklessly discarded on the planet;	3. Reduced risk of deformation;
	4. Greater grip, which helps to prevent accidents;	4. Reduced risk of early fatigue cracking due to increased tensile strength provided by improved elastic recovery of modified asphalt;
	5. Influence on maintenance reduction of vehicles hit by bumpy roads.	5. Contribution to the environment by reducing the amount of waste tires improperly disposed of in nature;
DISADVANTAGES	1. More expensive than conventional Asphalts	1. Boiler with higher heating capacity, as this type of asphalt requires temperatures above 170 degrees Celsius
	2. Lower efficiency in tropical climates	2. Requires more powerful pumps than usual
	3. Higher energy consumption in its applicability	3. Odor emitting more polluting gases and harmful to human health;
	4. Reduction time for CBUQ transport, spreading and compression.	4. High temperature machining;
		5. Stocking that requires constant recirculation of Rubber Asphalt

Source: Own authorship (2019).

Asphalt pavements should provide comfort and ideal conditions of trafficability and the appearance of pathologies generates disturbances and shortens their life span. Pathologies are caused by several factors, design error, bad weather, lack of maintenance, among others [17].

Moreover, knowing that these processes occur in favor of the community, reducing the use of natural resources and the cost of the product, as well as the use of different materials in the asphalt composition, based on new materials, this can directly infer about sustainability, showing that The use of reverse logistics is extremely important as an environmental mitigation measure.

4. Conclusions

With the proper comparative study of conventional asphalt and ecological asphalt, the great parameter to obtain the efficiency of the roadway is the durability, achieved through these new technologies that use the residues that could be deposited in landfills, presenting benefits. through the adequacy of waste treatment, its regular disposal in the environment, which can become a mitigation process, minimizing social, economic and environmental impacts.

Rubber asphalt stands out for its reverse logistics, its major challenge would be the reuse of material already disposed of in the environment, which may cause visual, soil and water impact, as well as being an indicator of disease proliferation.

The applicability of unusable tires on the roadway has numerous characteristics that demonstrate efficiency, highlighting their ability to withstand the action of weathering.

In addition to reusing a material / product, previously considered environmental passive, the pavement made by waste tires and also by plastic, has the highest durability and safety in all its extension, where its asphalt feature provides better driving comfort.

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