The growth of cities and the changing way of life of people are the main reasons for the large volume of waste generated annually, which has different origins. Waste is generated as a result of human activity in the production of products and their subsequent disposal. However, this waste is mostly disposed of in landfills and the high costs associated with the disposal of waste, combined with its inefficiency in some less developed areas and the consumption of space and land, can become a serious obstacle to the management of this waste.

The volume of solid waste generated increases annually, while only a limited amount is recycled and disposed of in landfills, and most of the waste, such as plastic waste (PW), directly or indirectly enters the marine environment.

Plastic waste is one of the solid waste generated in large quantities and poses a serious threat to the sustainability of our planet. Thus, when plastic garbage enters the oceans, it damages the environment, economy and aesthetics. It is estimated that about 300 million metric tons of plastic waste is generated annually. A large amount of plastic waste occurs all over the world due to their widespread use, for example, in the automotive industry, manufacturing, trade and healthcare. A report by the Environmental Protection Agency showed that of the several tons of plastic waste generated annually, only 7% is recycled, about 8% is incinerated, and the remainder is taken to landfills. However, due to the high costs and energy associated with the disposal process, these wastes end up in reservoirs.

In addition, the low biodegradability of plastic imposes huge restrictions on its processing and disposal in the environment. Therefore, it is necessary to find a safe and economical way to manage plastic waste (DHAWAN et al., 2019). Researchers have made various attempts in this area, such as reducing the sources of production of plastic products, reuse and disposal, to reduce the critical amount of such waste generated annually. However, the growth of plastic waste is critically rapid.

Recycling plastic waste will prevent environmental pollution and increase the value of this material, creating opportunities for their use in various fields, for example, in construction. In addition, the possible use of plastic waste in construction will help the construction industry achieve the Sustainable Development Goals. The reuse of plastic waste will result in a significant reduction in energy consumption and carbon emissions, as the amount of recycled and produced new plastic will decrease (KHALID et al., 2018).

The construction industry is a promising sector in which plastic waste can be used profitably for various purposes, mainly because it is the largest industry in the economies of various countries. Plastic waste can be used as a building material in the form of aggregate in cement and asphalt mixes, aggregates, insulation materials, etc. However, despite the huge potential for the use of plastic waste in construction, its use and development is still very limited.
MATERIALS AND METHODS
The paper analyzes various publications and articles on the topic of plastic waste recycling and their use in construction, as well as uses a comparative method and an analytical method of research.

RESULTS
Plastics are used in large quantities because of their useful properties, such as light weight, high impact resistance, the ability to take various forms and resistance to bacteria. However, since plastic is widely used, a certain amount of waste of this material is formed. A significant percentage of the plastics produced are used for one-time (short-term) use, which leads to a subsequent increase in the amount of plastic waste generated annually and improperly disposed of in the environment (TERTYSHNAYA et al. 2016).

As already mentioned, large amounts of plastic not only pose a threat to sustainability due to its high energy consumption and carbon emissions during production, but also pose a huge threat to the environment, as the disposal of plastic waste is associated with significant problems.

Despite government intervention in enacting laws and policies that prohibit the use of plastic bags in certain regions, many countries still lag far behind in this regard. Inadequate handling of plastic waste has led to its disposal in places such as the marine environment. This plastic waste not only got into the water, but was consumed by animals and fish, and then got into human food (KRASILNIKOVA et al., 2017).

Unlike other solid waste generated, the disposal of plastic waste is difficult due to the non-biodegradable properties of most types of plastics and the duration of this process.

Compared to other materials that are used in large quantities, such as paper, ceramics, glass, and aluminum, plastic is recycled much less frequently. Because of the many stages of plastic recycling – production, distribution, use, disposal, and sorting – the entire plastic recycling process is considered complex.

However, plastic waste can be recycled mechanically, chemically, or thermally. However, before recycling plastic waste, it must undergo sorting, which in most cases is performed automatically using technologies such as electrostatics, flotation, fluorescence, infrared radiation and spectroscopy. Mechanical recycling of plastic waste involves the physical decomposition of waste using processes such as shredding. However, mechanical recycling is reported to be somewhat inefficient due to the complex nature of the plastic waste mixtures, and instead most of the plastic waste is incinerated (ERIKSEN; ASTRUP, 2019)

In chemical processing, plastic waste can be separated into monomers or chemically modified, which can then be used instead of the primary raw material in the production of new plastic materials. Thermal processing of plastic waste involves heating plastic waste at elevated temperatures to melt it and then pouring it into a mold to form new products (POTAPOVA, 2018).

Since the growth of urbanization and population growth is inevitable, the development of the construction industry is inevitable. Accordingly, the use of plastic waste for various construction needs is one of the most effective ways to recycle and use plastic waste.

DISCUSSION
The construction industry is the foundation of every nation and contributes greatly to its economy. Therefore, the possible use of waste will increase the sustainability of construction processes and methods. The sustainable use of plastic waste in construction also provides economic benefits. Innovative sustainable use of plastic waste in construction will significantly reduce the amount of plastic waste dumped into the marine environment and offer alternative materials to meet the needs of the construction industry. However, in order to be used for construction purposes, the plastic must meet both the mechanical characteristics and the durability characteristics for the intended application. For example, plastic waste bags that are not biodegradable have been recycled to produce floor and wall tiles with lower flammability and increased tensile strength. It has been shown that plastic bags, which usually contribute to
soil and water pollution, can be turned into light and very durable products (IBRAGIMOV et al., 2018).

Individual authors have studied the fresh properties of self-compacting concrete, which includes plastic waste as a fine-grained aggregate. The researchers concluded that adding plastic to the self-compacting concrete in an amount of 12.5% by weight of fine-grained aggregate improved its fresh properties, such as throughput and filling capacity.

Other authors have studied the characteristics of plastic waste in fiber-reinforced concrete beams. PET waste was added to the concrete in order to increase the compressive strength, splitting tensile strength, breaking energy, and bending strength of the beam. The study showed that the addition of plastic fibers to the concrete did not significantly affect the failure mode, but improved the mechanical behavior of the beams in terms of the load on the first crack and strength (HASHEM; RAZEK, 2019).

The possibility of adding different materials in the mixing process of cement composites opened the way for the inclusion of different materials. Several types of waste have been incorporated into the cement composite as a binder and aggregate. The researchers determined that the slag can be used exclusively as a binder in geopolymer mixtures. Similarly, waste such as fly ash, recycled concrete, microsilica, rice husk ash, etc., can be used as pozzolans and fillers in cement composites.

Mechanically recycled plastic waste can be incorporated into cement composites as fillers and fillers because of their hardness and stability. When plastic waste is used in such applications, its chemical composition does not matter much, since fillers and aggregates are not expected to change the hydration process. The use of plastic waste as a filler in cement composites creates opportunities to reduce the environmental burden resulting from the extraction of natural aggregates.

In addition, the lightweight of plastic waste makes it a viable component for the production of a lightweight cementing composite, which is advantageous for various structural applications due to its reduced self-weight. However, since plastic waste has been labeled as impurities in cement mixes, highlighting their ability to weaken the strength of concrete, it has been suggested that plastics should not be used in non-structural concrete. Plastic waste during grinding can also be incorporated into cement composites in the form of fibers, however, compared to its use as a filler, the resulting properties of the resulting composite are different. For example, it was found that the use of plastic waste as fiber reduces the settling of the cement mixture, while an increase in precipitation was observed when used as a filler.

Similarly, an increase in the air content in the cement composite was observed when using plastic waste as fiber at doses higher than 0.3%. This increase in the air content during the introduction of plastic waste fibers into cement composites can be explained by the possible appearance of voids in the matrix, another reason is the influence of the residual surfactant on the surface (HAMEED; AHMED, 2019). In terms of mechanical properties, the use of plastic waste as a fiber in cement composites does not adversely affect the compressive strength. The slight impact of the plastic waste fiber may be a result of its impact strength and hardness, which eliminates the harmful effects of the voids included in the matrix. In contrast, the use of plastic waste as a filler has led to a decrease in the compressive strength of concrete mixes, which further decreases with an increase in the content of plastic waste. This decrease in compressive strength can be attributed to the lack of adhesion between the plastic waste and the cement paste. Similarly, the use of plastic waste as a filler in cement composites leads to a decrease in the tensile and flexural strength when splitting.

Taking into account the permeability of cement composites containing plastic waste, it was found that the permeability of composites increases with the introduction of plastic waste as a fiber. On the other hand, the abrasive abrasion resistance of the composite was improved by including plastic waste as a fiber (MURTHI et al, 2018). Similarly, the use of recycled plastic as fibers in cement composites has been found to control plastic shrinkage. In addition, a significant improvement in the thermal properties of cement-based materials can be achieved by adding recycled plastics. The ability of plastic waste to improve the thermal properties of the cement-based material can be explained by the low thermal conductivity of plastic waste.
In addition to the previously mentioned use of plastic waste in the binder composite, several studies have examined the use of this waste as a binder for the production of polymer concrete with improved properties. For this purpose, polyethylene terephthalate (PET) was used, which is mainly used as a packaging material.

Plastic waste is converted into a binder in a process called “transesterification”. The transesterification process uses dibasic acid and glycols to convert PW to unsaturated polyester resin. After the resin is formed, it can be mixed with aggregates to produce concrete or mortar. The polymer concrete obtained as a result of the above-mentioned process has increased mechanical and strength properties. The increased durability can be explained by the high resistance of plastic waste to aggressive acidic or alkaline environments.

The innovative use of plastic has been investigated when adding it to the production of reinforcing construction plaster. It was reported that when using 1-2% plastic fibers and 5-10% glass powder in the preparation of the paste, the bending strength and brittleness of the reinforcing gypsum beams were improved (HAMA; HILAL, 2019). It has also been found that the use of plastic waste as a substitute for aggregate in the construction of the base and base for road surfaces improves the shear, stiffness and load-bearing capacity of the road surface.

The possibility of using plastic waste pellets together with demolition waste as mixtures for road construction was also investigated. Their study showed that the inclusion of plastic waste reduces the stiffness, load-bearing capacity and modulus of elasticity of the mixtures, but acceptable characteristics were still achieved. The deterioration in the properties of the mixtures was attributed to the physical properties of the PW (i.e., their smooth surface).

Similar to the use of plastic waste as a filler in cement composites, it can also be incorporated into asphalt mixes. The use of PW as a filler in asphalt has been found to improve the slip and crack resistance of the road surface. In particular, the characteristics of asphalt mixtures modified with plastic waste have been improved in terms of rigidity and resistance to rutting. However, it was concluded that the optimal amount of plastic waste that can be added to asphalt mixes without any negative impact on their viscosity is no more than 5%. In addition, the level of traffic noise on sidewalks made of asphalt mixtures, including recycled plastic waste, is significantly reduced.

The lower level of transport noise associated with asphalt mixtures containing plastic waste can be explained by the plastic behavior of the matrix in combination with high energy absorption. Having several types of waste obtained from different types of plastic (SALIM et al., 2019), Another perspective of the use of plastic waste in construction is the use of it as fillers. This method is one of the most effective and simple, since the chemical properties of plastic waste are not taken into account here.

Some authors suggest using plastic waste as a substitute for wood. So, the material obtained in the process of processing plastics can be used as wood (it can be sawn, nailed, etc.). In addition to the fact that such products are similar to wood, they are also more durable in terms of their resistance to weather, biological and salt water. However, the high cost associated with recycling this type of plastic, combined with its bulkiness, limits its use. However, these types of plastic waste are suitable for railway sleepers, fences, boat piers, benches, etc. This type of recycled finished product is called “plastic lumber”.

Plastic waste can also be combined with wood to produce an eco-friendly door panel. These eco-friendly door panels can be produced by combining plastic waste in the form of pellets or powder with cellulose fiber or wood flour to form a thermoformed wood-plastic matrix that can be used for door panels. Insulation materials are the most important components of buildings. However, the economic and sustainability challenges associated with traditional insulation materials have necessitated the use of alternative materials as insulation materials. One possible more environmentally friendly alternative materials that can be used is recycled plastic. In particular, plastic waste sent to the production of expanded polystyrene can be used as an insulating material in the construction process. However, the low density of styrofoam combined with its fire safety limits the ability to process and transport recycled materials (Arulrajah et al., 2017).
Plastic waste can also be used to produce building materials for walls. To do this, the recycled plastic is placed in thermal molds and pressed into blocks. It should be mentioned that these types of walls cannot be used as load-bearing structures but are suitable for wall structures such as partitions.

It has also been found that concrete containing plastic waste as a partial replacement for sand in fine-grained components provides good impact resistance. The impact resistance of concrete increased by 39% when using 20% plastic components, and with this mixture, a stronger and more energy-absorbing concrete was obtained, which performed well under shock loads (MOSCOW STATE UNIVERSITY OF THE FOREST, 2011) Although there are numerous environmental and economic benefits associated with the use of plastic waste for construction purposes, there are still some restrictions that prevent its large-scale use. This should include:

- different composition: unlike building materials such as steel, plastic waste consists of different grades and types of plastic, which can lead to non-isotropic characteristics when used for construction purposes. In addition, the complex composition of some types of plastics makes conventional recycling methods unsuitable for its reuse, which leads to the need to dispose of such plastics;
- low density: although the use of low density materials is an advantage in some designs, the low density of plastic waste makes it unsuitable for applications where high viscosity and modulus of elasticity are expected. It also increases transportation costs, since plastic waste is quite voluminous;
- limited understanding of the characteristics of recycled plastic, especially long-term, limits the use of plastic waste for various construction works;
- economic constraints: recycling some types of plastic requires advanced technologies that are currently expensive, which limits the ability to recycle these types of materials;
- currently, there is no standard supporting the use of plastic waste for construction purposes (MUSTAFA et al., 2019)

CONCLUSIONS

Plastics play an important role in our society, and the waste generated by the use of these plastics is unavoidable. Therefore, in order to properly manage this plastic waste while improving the sustainability of the environment, using it for a variety of construction applications is a viable option. The use of plastic waste in construction will solve both the problem of solid waste management and deplete the stocks of raw materials used for construction purposes. In addition, the use of such waste for various construction needs supports the trend of sustainable development of the closed-cycle economy.

The use of plastic waste in construction creates opportunities for using this waste in the long term compared to short-term ones, such as recycling into new products that turn into waste in a short period of time. The possible use of plastic waste as a binder, aggregates and fibers makes it a viable replacement for all components in cement composites with an acceptable negative effect on the characteristics of the resulting composite.
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Prospects for the use of used plastic products in the construction industry

Perspectivas para o uso de produtos plásticos usados na indústria da construção
Perspectivas de uso de productos plásticos usados en la industria de la construcción

Resumo
Os resíduos gerados pelo uso de produtos plásticos de uso único tornam-se extremamente perigosos para o meio ambiente devido à sua grande quantidade gerada, o que causa sérios danos ao meio ambiente e aos seus habitantes. A principal vítima dessa ameaça é o ambiente marinho. Os resíduos plásticos gerados em terra acabam em corpos d’água, onde causam efeitos nocivos, como inundações e envenenamento de animais no ecossistema marinho. Plásticos no ambiente marinho que entram no corpo de peixes também são prejudiciais à saúde humana se esses peixes forem comidos, pois isso pode causar câncer em humanos. Para encontrar uma maneira eficaz de gerenciar esses resíduos e melhorar a sustentabilidade do meio ambiente, diferentes abordagens para a reciclagem de resíduos plásticos em novos produtos estão sendo exploradas. Em particular, o uso de resíduos plásticos na construção melhorará significativamente a sustentabilidade do meio ambiente, bem como servirá como fonte confiável de materiais para fins de construção.


Abstract
The waste generated by the use of single-use plastic products becomes extremely dangerous to the environment due to their large amount generated, which causes serious harm to both the environment and its inhabitants. The main victim of this threat is the marine environment. Plastic waste generated on land ends up in water bodies, where it causes harmful effects such as flooding and poisoning of animals in the marine ecosystem. Plastics in the marine environment that enter the body of fish are also harmful to human health if such fish are eaten, as this can cause cancer in humans. To find an effective way to manage this waste and improve the sustainability of the environment, different approaches to recycling plastic waste into new products are being explored. In particular, the use of plastic waste in construction will significantly improve the sustainability of the environment, as well as serve as a reliable source of materials for construction purposes.

Keywords: Construction. Plastic waste. Building materials. Recycling.

Resumen
Los residuos generados por el uso de productos plásticos de un solo uso se vuelven extremadamente peligrosos para el medio ambiente debido a su gran cantidad generada, lo que causa graves daños tanto al medio ambiente como a sus habitantes. La principal víctima de esta amenaza es el medio marino. Los residuos plásticos generados en tierra terminan en cuerpos de agua, donde causa efectos nocivos como inundaciones e intoxicaciones de animales en el ecosistema marino. Los plásticos en el medio marino que entran en el cuerpo de los peces también son perjudiciales para la salud humana si se comen tales peces, ya que esto puede causar cáncer en los seres humanos. Para encontrar una manera eficaz de gestionar estos residuos y mejorar la sostenibilidad del medio ambiente, se están explorando diferentes enfoques para reciclar residuos plásticos en nuevos productos. En particular, el uso de residuos plásticos en la construcción mejorará significativamente la sostenibilidad del medio ambiente, así como servirá como una fuente fiable de materiales con fines de construcción.