Accelerating Plastic Pollution Mitigation through Sustainable Urban Infrastructure Development

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ABSTRACT

Plastic waste plagues both land and aquatic environments. The surface layer refers to the road pavement layer that comes into direct contact with a vehicle's wheel surface. The surface layer distributes wheel load far more evenly than the layer underneath. The surface layer design incorporates top-notch materials that can be used as additives to enhance the quality of the asphalt mixture. This study evaluates the asphalt mixture's durability using Marshall characteristics and Cantabria tests carried out in a lab setting. An ideal asphalt concentration of 5.25% is obtained. Low Density Polyethylene (LDPE) is added to the asphalt mixture at various contents, 0%, 2%, 4%, 6%, and 8%. The study's findings indicate that adding plastic waste to the asphalt mixture can enhance its performance. The two main mitigating actions are probably plastic prohibition laws and public awareness campaigns. To evaluate the possible environmental effects and resources utilized over the course of a plastic product's life span, researchers stress the importance of its life cycle assessment and circularity. Innovations are necessary to minimize, reuse, recycle, recover, and develop environmentally friendly plastic substitutes. By empowering and educating communities and citizens on how to reduce plastic pollution and use alternative plastic solutions, governments must enforce and promote collective action. This research must prioritize addressing plastic waste as a global issue.

Keywords-plastic pollution mitigation; road infrastructure; environmental systems

I. INTRODUCTION

Compared to the past, developing nations are being urbanized at a much faster pace now [1]. The global shortage of urban infrastructure can be attributed to the increased population living in cities and the restricted availability of public finances. Large segments of the populace living in urban areas across emerging nations now lack access to essential urban amenities including asphalt roads, electricity, sewage lines, and piped water [2, 3]. It is critical to comprehend the impacts of urban infrastructure on economic development since the most disadvantaged residents of a city reside in the neighbourhoods with the lowest levels of infrastructure [4]. To retain and improve social advantages, road infrastructure must be properly maintained [5]. To attain maximum value, maintenance must be recognized in decision-making, appropriate funding, and effective management. Since roads are one of the primary assets of a region's or nation's infrastructure, maintaining an effective and valuable road network depends not only on building new roads, but also on properly maintaining the ones that have already been constructed. A badly thought-out maintenance plan could seriously degrade this legacy [6-8]. Because of their resistance to degradation and long-term survival in the environment, plastics—a geological indication of the Anthropocene—have recently been identified as an environmental danger. Plastic litter refers to the careless and unethical disposal of plastic garbage in any ecosystem. Plastic is a fantastic material that propels economic expansion and manufactured modernity. The current lifestyle is shaped by the intricate web of harmful and economic interdependencies that come with using plastic [9-12].

To make plastic useful for a range of applications, scientists worked hard to understand its physicochemical structures and functions during the 20th century. However, careless handling and unethical disposal of plastic add to contamination in the environment. Because of its detrimental effects on the environment and public health, plastic pollution has drawn the attention of governments, the media, scientific communities, and individuals concerned with environmental stewardship [13]. Plastics are useful materials with many advantages for society, such as comfort, hygienic practices, and safety; yet, if they are not utilized and disposed of properly, their single-use nature might outweigh these advantages. Plastic materials have greatly improved roads, pavements, food packaging, medication distribution, waste fuel, and safety from infectious diseases. Plastics end up in the trash because of the wasteful manufacture, improper landfill disposal, and poor recycling management. The extraordinary rate at which plastic garbage is seeping into the environment, including terrestrial and aquatic ecosystems, presents serious obstacles to waste management for expanding populations, especially in emerging nations [14].

The surface layer is the layer of road pavement that has direct touch with a vehicle's wheel surface. The surface layer has a far higher dispersion of wheel loads than the layer beneath it. This reason motivates the use of superior materials that meet higher technical standards in the design of the surface layer [15-17]. Researchers employ an open or uniform gradation for permeability, a gap-graded gradient for flexibility and durability, and a dense gradation for strength and high stability [18]. Following compaction, certain aggregates are combined with asphalt to generate porous asphalt, which has 20% air pores. Overall, porous asphalt has a lower Marshall stability rating than highly graded concrete asphalt. Porous asphalt is an approach that decreases noise pollution while also improving road safety [19]. The purpose of this research is for porous asphalt to be also made to operate as an anti-slip surface, hence reducing traffic accidents. Porous asphalt pavement offers various benefits to both the environment and other road users, including enhanced drainage, increased safety, and reduced noise levels [20]. The fundamental components of the asphalt mixture have a considerable impact on its quality; using additives is one way to improve it. An addition is a component of asphalt concrete that mixes with the other ingredients for its quality to be increased [21]. Plastic has many advantages, but it also has certain downsides, the most notable of which is plastic trash. On the other hand, there are benefits to employing plastic waste for road construction. One of the numerous disadvantages of asphalt mixtures is the possibility of deformation. Heat-induced fractures, moisture-induced degradation, and excessive truck loads all cause irreversible distortion (deformation) to the asphalt mixture [22].

II. RESEARCH SIGNIFICANCE

Under the category of urban infrastructure, road infrastructure is the subject of this study. The goal of this research is to add plastic trash of LDPE type to porous asphalt mixtures. Reducing the quantity of plastic trash in society is the aim of using plastic waste to porous asphalt mixtures, which is a result of the population growth rate. The purpose of this study is to investigate the utilization of plastic waste in porous asphalt mixtures, with an emphasis placed on Cantabria testing. This research is intended to enhance road infrastructure, increasing its capacity and performance as well as contributing to the development of the urban infrastructure.

III. PLASTIC WASTE MANAGEMENT: ENVIRONMENTAL SYTEMS IMPACT

Plastic is a broad category of soft, synthetic or semi-synthetic organic materials that may form into solid objects in a variety of shapes. High molecular mass organic polymers make up most plastics although they can also incorporate other materials. Many of them are partly natural, but most are synthetic, mainly generated from petrochemicals. Plastic constitutes 10% of the household garbage, most of which is disposed of in landfills. Nevertheless, 60%–80% of the trash discovered on beaches and in the ocean is made of plastic. Researchers found 2.3 billion pieces, totalling 30.500 kg, on beaches in Southern California in less than 72 hours. The majority consisted of foams, such as polystyrene (71%) with entire products (1%), pre-production pellets (10%), and various pieces (14%). The 81% of all plastics, including complete objects (1%), had a size range from 1 mm to 4.75 mm [23, 24]. Plastic will find more uses in the future, while developing and emerging nations will continue to use it more. Increased plastic garbage will add to the already-existing backlog of plastic waste if proper waste management is not implemented. The amount of time it takes for plastic to break down is unknown; it could take thousands or even hundreds of years. The growing usage and production of plastic in developing and emerging nations raises special concerns, according to EU studies, because the sophistication of their waste management infrastructure might not keep up with the expanding amounts of plastic garbage. The release of chemicals from plastic debris or its transportation, as well as the decomposition of plastic into secondary microplastics, may be impacted by temperature and environmental changes. When bigger plastic materials degrade, secondary microplastics are produced [25]. Plastic trash is an international issue with some geographical variations. Two things that contribute to air pollution are the burning of plastic garbage in open fields and air warming. This also holds true for plastic debris that ends up in marine environments, as it can cause chemical leakage and water pollution. Plastic has qualities that make it valuable, and because of its affordability, low weight, and durability, its disposal becomes difficult. Given tghat it is so durable, plastic frequently ends up back in the environment. India is not an exception to the fact that plastic is now everywhere. Burning Municipal Solid Waste (MSW), which has a 10-12% plastic content, is a common way to release dioxins, furans, mercury, and polychlorinated biphenyls, among other harmful chemicals, into the atmosphere. Only a few investigations on the effects of such poisonous gasses have been carried out in India. Fossil fuels and landfills together account for around 20% of the greenhouse gas emissions. Rubbish dumps are currently filling landfills to capacity, while burning rubbish in combination with plastic bags creates health hazards. These are issues that must be immediately addressed.

IV. PLASTIC POLLUTION, WASTE MANAGEMENT, AND SUSTAINABLE DEVELOPMENT GOALS

Following the Millennium Development Goals, the United Nations introduced the Sustainable Development Goals (SDGs) in September 2015, and many countries have extensively adopted them to achieve sustainability. The SDGs aim to address the most pressing multifaceted socio-economic, environmental, and planetary concerns by means of collective action. Only SDG 14: Life Below Water, especially objective 14.1.b, out of the 169 aims, explicitly addresses plastic pollution. It focuses on having lowered marine (micro) plastic debris burdens, notably from land activities, by 2025. The target 14.1.b serves as an indicator for this goal [26]. SDG indicators show the difficulties that every nation faces in pursuing the characteristics and actions of plastics in the environment, including the management and monitoring of microplastic (MP) pollution, at national, subnational, or supranational levels. As a result, the connections between waste management, plastic pollution, and all the SDGs are covered in the subsections that follow. People have already been negatively experiencing the effects of climate change. Plastic burning, open burning, and incineration produce pollutants and waste management, endangering the health of people as well as the environment and the adjacent plants. To prevent chemical exposure from plastic, appropriate policies must be developed, and research in this area should be encouraged. The urgent requirement is to take a sustainable step toward a cleaner and healthier environment of the future. This would raise public awareness of the seriousness of the issue and promote the use of less hazardous technology for human health, especially in poor countries [27]. Therefore, cumulative environmental exposures that could be harmful to human health need to be considered by the scientific community. If the right conditions are met, pyrolysis, an alternate approach to combustion and incineration, can produce varying amounts of potentially beneficial byproducts along with less hazardous compounds. Recycling increases sustainability by reducing the strain on the resources and making better use of the byproducts. Studies and recycling program implementation will make a big difference in the issue. Although pyrolysis systems have been initiated and seem to be the best option, there is a lack of scientific data, unit design, and follow-up investigations [28].

V. MATERIALS AND METHODS

A. Physical Properties of Aggregate

The coarse aggregate from a stone company in Bili-bili, Parangloe subdistrict, Gowa Regency, which has already passed through the 1/2" and 3/4" sieves, is retained in the 3/8" sieve used in this study. Testing results are compiled in Table I. Fine aggregate was employed in this research on sieves No. 8 (2.36 mm) and No. 200 (0.075 mm). Aggregate from a stone company in Bili-bili, Parangloe subdistrict, Gowa Regency, was used in this investigation. The summary findings of the fine aggregate tests are depicted in Table II, which also demonstrates the physical characteristics of the fine aggregate utilized in this investigation. The properties of both coarse and fine aggregates and filler employed in this study show that the material fits the standards for road materials and the Indonesian National Standard. As a result, the most essential aggregate parameter is specific gravity.

TABLE I. PHYSICAL PROPERTIES OF COARSE AGGREGATE

No.	Properties	Results	Interval
1	Water absorption (%)	2.88	Max. 3.00
2	Bulk specific gravity	2.70	
3	Saturated surface dry specific gravity	2.78	
4	Apparent specific gravity	2.93	
5	Abrasion (%)	20.20	Max. 40
6	Flatness index (%)	23.90	Max. 25

TABLE II. PHYSICAL PROPERTIES OF FINE AGGREGATE

No.	Properties	Results	Interval
1	Water absorption (%)	2.65	Max. 3.00
2	Bulk specific gravity	2.64	
3	Saturated surface dry specific gravity	2.71	
4	Apparent specific gravity	2.84	
5	Sludge content (%)	49.60	Max. 50

B. Physical Properties of Petroleum Bitumen Grade 60/70

To comprehend the performance of the used asphalt as a binding material, this study looks at its physical characteristics. Table III presents the test findings for the petroleum asphalt with 60/70 penetration that was employed in this study. The petroleum asphalt used complies with the requirements for a road material.

TABLE III. PHYSICAL PROPERTIES OF PETROLEUM BITUMEN

No.	Properties	Results	Interval
1	Penetration before losing weight	62.10	60-70
2	Soft point (°C)	50.50	Min. 48
3	Ductility (25°C 5 cm/minute)	140.00	Min. 100
4	Flash point (°C)	304.22	Min. 232
5	Specific gravity	1.035	Min. 1.0
6	Penetration Index after weight loss	76.48	Min. 54

C. Marshall Characteristics

Deploying the Marshall test apparatus, this research evaluates several Marshall parameters to ascertain the melt, flow, and stability values. The Marshall SNI 06-2481-1991 test rules should be examined to obtain the stability and flow characteristics. The porous asphalt mixture is supplemented with LDPE plastic waste and the oil asphalt concentration is varied using asphalt briquettes as the test material in the laboratory. The Marshall test apparatus utilized in this study, was specifically conducted for the purpose of determining the mixture's flexibility and stability, or flow value. The maximum load before the destruction of the test object is referred to as Marshall Stability; the amount of deformation before destruction is referred to as Marshall yield (flow); and the question posed by the Marshall Quotient is the ratio between stability and flow. To ascertain the properties of hot asphalt mixtures and to acquire stability and flow, the dial should be immediately read. Authors in [29] examined asphalt mixtures following the Marshal method. The values of asphalt mixture density, Void in Mineral Aggregate (VMA), Void in Mix (VIM), Marshall quotient, stability, and flow were obtained in addition to these other parameters. The Marshall approach was deployed for the asphalt mixture design while the elastic modulus of asphalt concrete mixtures was examined. Authors in [30] claimed that compacted cylindrical specimens manufactured from Superpave or a Marshall compaction equipment can be used to evaluate the permanent deformation characteristics of asphalt mixes, regardless of the aggregate type and asphalt mixture design method adopted. In the meantime, the crack characteristics were assessed by authors in [27] using the Marshall approach in asphalt mixture design.

D. Cantabrian Test

Combinations of stone aggregates make up porous asphalt mixtures, just like dense or traditional asphalt mixtures do. Mineral filler and asphalt cement should be added as needed. Such mixtures' main feature is that they have a sizable enough vacuum. The content's particle size distribution enables the water product created from raindrops falling on the road to swiftly escape. Even when there is heavy and protracted rain, infiltration can move laterally in the direction of the porous and sub-porous materials, keeping them from staying on the worn course's surface [7]. To put it another way, a structure that allows water to flow through is created and is made of multiple layers of construction materials. Their only function is to drain water to the edges so that it does not build up in the pavement's bottom layers. To avoid water seeping into the lower levels or building up in the files, they must be constructed on fully impermeable asphalt bases with superior planimetric, geometric, and porosity criteria. One of the most frequent issues when it rains is the tire's lack of adhesion or even contact with the road, which reduces visibility for drivers. Sometimes the failure of the cross-slope to completely remove the water-thin coating on the surface leads to hydroplaning. This situation could become dangerous if the driver is driving quickly, which would make it more likely for a car to flip because of a lack of surface grip [31]. To sum up, the primary purpose of porous asphalt mixtures' original design was to improve rain circulation and avoid hydroplaning or aquaplaning. It has, however, been proven to offer a few other noteworthy security advantages, such as eliminating splash and spray effects, which improves visibility. But the life of road surfaces made of porous asphalt mixtures is short, mostly because the spaces are clogged [32]. The Los Angeles machine's Cantabria test measured the pavement's resistance to abrasion without the need of steel balls. This abrasion is indicated by the difference between the sample's initial weight before entering the machine and its weight after 300 spins. The sample's resistance to abrasion using the Los Angeles machine is described by the Cantabria test value.

VI. RESULTS AND DISCUSSION

A. Aggregate Combination Analysis

As this research previously noted, the production of a porous asphalt mixture requires a unique combination of standard particle size distribution, which implies a sizable percentage of voids. Because of this, internal friction rather than cohesiveness is the basis for the mixture's durability. Due to this cohesiveness deficit, the combination is quite vulnerable to some types of traffic, especially tangential traffic, which can cause disintegration. To achieve a combination of high porosity and high disintegration resistance, a thorough mixture design must be carried out, involving meticulous component selection, trial and error, and proportioning. The Road Engineering Association of Malaysia's (REAM) open gradation criteria are used in this study to determine mix gradation and mix design. Table IV displays the combined aggregate design that is built and received in this investigation. Since this research is within the REAM specification period, it is intended to get an ideal blend. To ascertain the composition of the aggregate, a sieve is utilized and the aggregate is weighed according to the size of the sieve. Unlike the by-portion method, this approach does not classify the aggregates based on the aggregate fraction (coarse aggregate, fine aggregate, and filler). The proportions of each filter size employed in this investigation are rather determined by weighing.

TABLE IV. AGGREGATE COMBINATION

No. Sieve			**3/4"**	**1/2"**	**3/8"**	**no. 4**	**no. 8**	**no. 200**
Coarse aggregate	Used	% Passing	100	84.67	55.67	0	0	0
	83%	% Retained	83	70.27	46.20	0	0	0
Fine aggregate	Used	% Passing	100	100	100	100	75	13.5
	7%	% Retained	7	7	7	7	5.25	0.95
Stone dust	Used	% Passing	100	100	100	100	60.5	16
	10%	% Retained	10	10	10	10	6.05	1.6
Combined aggregate			100	87.27	63.2	17	11.3	2.55
Specification			100	85 - 100	55 - 75	10 - 25	10 - 25	2 - 4

B. Marshall Characteristics

The results of the Marshall parameter test on hollow asphalt mixture test specimens with the addition of 0%, 2%, 4%, 6%, and 8% of LDPE plastic waste include stability, VIM, VMA, Void Filled with Bitumen (VFB), melt (flow), and Marshall Quotient (MQ). Table V demonstrates that the Marshall properties are produced by porous asphalt mixtures, which incorporate LDPE plastic waste as an extra ingredient. The stability characteristics show that at 0%, 2%, 4%, 6%, and 8% LDPE plastic waste levels, the values are 403 kg, 454.67 kg, 444.33 kg, 465 kg, and 413.25 kg, respectively. In porous asphalt mixtures containing and excluding LDPE plastic waste, the improvements in stability values are 12.82%, 10.25%, 15.38%, and 2.54%, in that order. The test findings indicate that the stability value increases until it reaches an optimal value in proportion to the increase in the LDPE plastic waste content. The combination has the highest stability value when the LDPE plastic waste content is at the ideal asphalt content; when the LDPE plastic waste content is above the optimum asphalt content, the stability value likewise gradually drops. One important metric in the response study of road pavement systems is the Poisson ratio. The principal parameter in the viscoelastic, elasto-visco-plastic, and elastic studies of asphalt mixes is the Poisson's ratio. The stiffness of the asphalt mixture is intimately related to its flow values and stability. Every variant of porous asphalt mixture yields flow values between 2 mm and 4 mm. It is evident that the measurements of the porous asphalt mixture are 2.10 mm, 2.18 mm, 2.25 mm, 2.2 mm, and 2.2 mm, respectively, with and without LDPE plastic waste. The usage of high quantities of LDPE plastic waste combining petroleum bitumen with the voids in the mixture can cause the plastic melt (flow) value to rise.

The MQ value is influenced by both flow and stability. Porous asphalt mixtures with and without LDPE plastic waste generated MQ values of 191.73 kg/mm, 208.07 kg/mm, 198.42 kg/mm, 211.61 kg/mm, and 189.28 kg/mm, in that order. A porous asphalt mixture with LDPE plastic waste added as an extra ingredient has a low MQ value because of its high flow, thickly covered, easily changing particles, and low stability. When the mixture is loaded, these elements eventually lessen the binding force between the aggregates. Higher flow values will arise from a combination with less stability due to decreased bonding between the particles. In specifi, the porous asphalt mixtures' void properties are indicated by the VIM, VMA, and VFB values. The combinations with and without LDPE plastic waste are 19.28%, 18.24%, 19.42%, 18.90%, and 18.05%, respectively, according to the VIM value characteristics. In the meantime, the VFB values were 34.47%, 36.06%, 35.08%, and 36.92%, and the corresponding VMA values for the combination with and without LDPE plastic waste were 29.41%, 28.50%, 29.53%, 29.07%, and 28.14%, respectively. Low Marshall properties are seen in asphalt mixtures, especially in porous ones, and particularly in cavities with high flow values. Because of this, the combination becomes more rigid, mainly in test specimens that contain a lot of plastic debris. Everyone used the Marshall test (ASTM D6927). The resilience of the asphalt concrete to plastic deformation was investigated. This test examined the stability, flow rates, and volumetric factors. It also measured the attributes of asphalt concrete specimens, such as the percentage of Air Voids (%AV), %VMA, and %VFA. To determine these volumetric parameters, researchers measured the bulk specific gravity in accordance with ASTM D2726, and the theoretical maximum specific gravity was calculated using ASTM D2041. As mentioned before, excessive tensile stress results from low bitumen, asphalt, and oil penetration. This can also be explained by observing that asphalt mixtures including plastic waste have a higher VIM value than asphalt mixtures without the plastic waste component. The combination is denser and stiffer when the VIM value is big, as supported by the Marshall characteristic MQ value. When the asphalt mixture has a high MQ value, it is brittle, stiffer, and eventually leads to the specimen cracking easily. Furthermore, asphalt hardens and becomes more rigid because of combinations that contain plastic waste, which affects the asphalt's performance.

Tensile stress is the capacity of a material to withstand the tensile force brought on by the load that happens, whereas the modulus of elasticity, also known as Young's modulus, is a measurement of how a material or structure will be harmed and deformed if put under strain. In this study, the strain occurs when the stress reaches 50% of the peak stress, and the elastic modulus value sought is when the stress reaches 50% of the peak stress. By causing it to solidify and clump together, LDPE plastic waste also increases the hardness and stiffness of asphalt. Additionally, the asphalt and plastic waste mixture's thermo-viscoelastic characteristics are altered. The raise in viscosity, drop in binder penetration, and raise in the asphalt softening point are indicative of changes in the thermo-viscoelastic characteristics. The study's findings also demonstrate that mixing duration and binder source have an impact on how much the asphalt mixture performs. For instance, adding plastic waste to aggregate raises the viscosity and hardness of the binder, decreasing penetration and raising the softening point. The capacity of a material to absorb energy during plastic deformation is referred to as toughness. This energy is measured in static tensile strength testing as the area under the stress-strain curve until the test object splits. The maximum amount of energy that a unit volume of material can absorb before breaking is known as the toughness modulus, and this is the characteristic that matters. According to the Marshall characteristic and Cantabro tests, the percentage of plastic waste created was 2%. This study recommends using this percentage for putting porous asphalt made from LDPE plastic waste to roads with low to moderate Low to High traffic Road (LHR) values. Previous research demonstrated similar conditions when authors in [34] produced a plastic percentage value of 2% utilizing PET plastic in the AC-WC mixture. Nous advocate applying the findings to highways with high LHR.

TABLE V. MARSHALL TEST CHARACTERISTICS

No.	Plastic waste (%)	Marshall characteristics					
		Stability (kg)	**Flow (mm)**	**MQ (kg/mm)**	**VIM (%)**	**VMA (%)**	**VFB (%)**
1	0	403.00	2.10	191.73	19.28	29.41	34.47
2	2	454.67	2.18	208.07	18.24	28.50	36.06
3	4	444.33	2.25	198.42	19.42	29.53	34.26
4	6	465.00	2.20	211.61	18.90	29.07	35.08
5	8	413.25	2.20	189.28	18.05	28.14	36.92
Specification		350-800	2-4	Min. 200	18-25	Min. 16	70-80

C. Cantabrian Test

The results of the Cantabria test for the REAM grading meet the necessary requirements, with a maximum weight loss of 20%. These have the smallest weight loss value, with an average weight loss from 0% to 12.23%. The test findings are following the REAM (2008) guidelines, which state that a porous asphalt mixture should not lose more than 20% of its total weight. This guarantees that the REAM grade meets the specified requirements.

VII. CONCLUSION

This study investigates the potential application of porous asphalt mixtures, which use LDPE plastic as plastic asphalt, on low- to moderate-traffic roadways as a component of urban infrastructure. The proportion of LDPE plastic trash that emerged from this study can be used as a recommendation. The study's findings lead to the following conclusions:

1. The Marshall characteristic values with the addition of waste LDPE plastic as a material. It is thus anticipated that the Marshall characteristic value will be impacted by LDPE plastic trash. Using LDPE plastic trash as a supplemental material, practitioners can support road implementers and provide recommendations for field application by utilizing the Marshall value.
2. To provide Marshall test results that match the Marshall features, LDPE plastic trash was added to the test objects, except for holes filled with bitumen (VFB) and Marshall Quotient (MQ).
3. Every Cantabria test result fulfilled the necessary requirements, which included a weight loss cap of 20%. The least amount of weight was lost when 2% LDPE was added.
4. The findings of this study can help build a country's infrastructure using waste materials, oil, asphalt, and particularly LDPE plastic waste. This, in turn, should lead to more ecologically friendly development being implemented.

This study established Marshall characteristics and grain release values for porous asphalt mixtures, which can be utilized as a part of today's sustainable urban infrastructure. To alleviate the consequences of flooding, urban infrastructures can use a mixture of porous asphalt. However, because of its high porosity value, porous asphalt is only suitable for low-traffic roads. The purpose of this research is to support the development of environmentally friendly urban infrastructure. The proportion of LDPE plastic trash utilized in this paper can be used as a recommendation or novelty derived from this study.

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