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Experimental study on properties of bituminous concrete mix by using Low Density Polyethylene and Polypropylene

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ABSTRACT:

Roads are crucial in the current situation since they link various towns and rural areas to the major state or federal routes. But building a road comes at a hefty price. In order to lower the overall cost without sacrificing the material's actual characteristics, it is necessary to suggest an alternate material in place of the more traditional ones. India ranks 12th in terms of garbage production and has the second-largest road network after China. As a result, using waste materials to create flexible pavement will turn out to be both economical and environmentally beneficial. The most often utilized materials for flexible pavement construction worldwide are bituminous mixtures. It is made up of mineral aggregate and asphalt or bitumen (used as a binder), which are combined, spread out in layers, and then compacted. When properly designed and implemented, standard bituminous pavements function rather well in most scenarios. However, in other instances, bituminous mixes perform very poorly. This study looks into the possibility of improving the properties of asphalt mixtures using polyethylene, one type of polymer. Determining the ideal kind of polyethylene to use andhow much of it to use is another goal. The aggregate was coated with two different kinds of polyethylene: low density polyethylene (LDPE) and polypropylene (PP).For testing, five weight percentages of polyethylene of each kind and state with the ideal binder concentration were chosen (5, 10, 15, 20 and 25%). The tests involve determining ductility, flash and fire point, penetration, softening point tests and marshall stability test. Determining the proportions of air spaces and air voids of mineral aggregate is necessary for Marshall mix design. According to the findings, PP polyethylene modifier that has been ground offers superior engineering qualities.

Keywords: Keywords are important word in paper Example Weather Prediction, forecast accuracy

Introduction:

According to present scenario, Population is increasing day by day and people are using more plastic polymers, automobiles etc. and due to this pollution is also increasing day by day with waste polymers. There are different challenges coming in day to day life for decomposition of waste polymers. There are need of disposal of these waste materials because if these waste materials will not have decomposed then they will remain same on earth for hundreds of years which can increase environmental pollution. There is a solution of decomposing these material is recycling or reusing the waste materials into useful way. There are new advance researches into new and innovative techniques for utilising waste materials. There are many private companies and highway agencies completed many advance researches and projects for utilising the waste polymers for road construction which are environmentally suitable and by using it performance will also increase.

These studies are done for trying to match safe and economical disposal of waste material or for more cost efficiency in road construction. Bitumen is defined by Indian standard institution that it is black or dark brown in colour. It is crystalline and having adhesive properties. It is mainly coming from crude oil by naturally or by refinery processes. Mainly bitumen is adhesive in nature and mixture of hydrocarbons which are generally found in tar, asphalt etc. Bituminous binders are widely used by paving industry. In general pavements are categorized into 2 groups, i.e. flexible and rigid pavement. Flexible Pavement Flexible pavements are those, which on the whole have low flexural strength and are rather flexible in their structural action under loads. These types of pavement layers reflect the deformation of lower layers on-to the surface of the layer. Rigid Pavement If the surface course of a pavement is of Plain Cement Concrete then it is called as rigid pavement since the total pavement structure can't bend or deflect due to traffic loads.

Objective:

There are several objectives that need to be achieved when completing this project. The objectives are: -

- A comparative study has been made in this investigation between SMA, BC, and DBM mixes with varying binder contents (3.5% - 7%) and polyethylene contents (0.5% - 2.5%).
- The effect of polyethylene and LDPE as admixture on the strength of bituminous mix with filler.
- To assess the different engineering implications and physical characteristics with the addition of waste materials into the binder mixture.

- To study resistance to permanent deformation of mixes with and without polyethylene.
- Utilization of waste material in pavement construction to create sustainable environment, cost effectiveness without compromising with the requisite properties.

Review of Literature:

Verma (2008) studied that plastic increases the melting point of the bitumen and makes the road flexible during winters resulting in its long life. According to author while a normal "highway quality" road lasts four to five years, plastic-bitumen roads can last up to 10 years and it would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes.

Moghaddam and Karim (2012) reported that the utilization of waste material in asphalt pavement would be beneficial in order to find an alternative solution to increase service life of asphalt pavement and reduce environmental pollution as well. Form their study it is concluded that Polyethylene Terephthalate (PET) reinforced mixtures possess higher stability value, flow, fatigue life in comparison with the mixtures without PET.

Wegan and Nielsen (2001) studied microstructure of polymer modified binders in bituminous mixtures by preparing thin sections of the specimen and analysing that thin section by Infrared Fourier Transform Spectrometer. When thin sections were illuminated with the UV light, the polymer phase emits yellow light, fine and coarse aggregates often appear green, the bitumen phase is black and air voids or cracks appear with a yellow-green colour.

Herndon (2009) investigated moisture susceptibility of asphalt mixture using phosphonylated recycled polythene. They indicated that there is a significant reduction in moisture susceptibility with the addition of recycled un modified polyethylene to asphalt concrete mixtures in both the Wet Process and the Dry Process. Jain et al.

(2011) studied mitigation of rutting in bituminous roads by use of waste polymeric packaging materials and concluded that rutting of bituminous mix can be reduced to 3.6 mm from a value of 16.2 mm after application of 20,000 cycles, by adding optimum quantity of polyethylene in bituminous mix for road construction, ultimately improves pavement performance, besides alleviating disposal problems of WPPM for clean and safe environment.

Methodology

Different findings and methodologies are gathered from the research work of other researchers and to be incorporated in this project. First and foremost, various journals and technical papers were read through the get the general understanding on the project. It is also needed to identify the objective of this project and to come up with a proven method to run the experiment later.

A typical thesis methodology for bitumen modification with polyethylene (PE) and Low Density Polyethylene (LDPE) involves preparing modified bitumen samples, testing their properties, and analyzing the results. This includes selecting appropriate bitumen and plastic types, determining mixing ratios and temperatures, and conducting standardized tests like penetration, softening point, ductility, and viscosity. The methodology also involves comparing the properties of modified bitumen with unmodified bitumen and analyzing the results to determine the suitability of LDPE as a bitumen modifier.

Stage 1: - Physical properties of aggregates and VG30 Grade bitumen are to be determined.

Stage 2: - Mixing and compaction temperatures shall be maintained as per code by developing viscosity temperature relationships between bitumen, plastic, aggregates and filler.

Stage 3: - Optimum dosage of Bitumen, plastic and filler shall be determined from the test results of maximum stability and air voids from marshal test results for different percentage.

Stage 4: - Marshall mix design shall be carried out on Plastic bituminous mix specifications prepared using IRC code and VG30 bitumen are to be determined. Optimum bitumen content will be determined as per the procedure laid in IRC standards.

Stage 5: - Analysis of the results and discussion on the experimental investigations is discussed

Stage 6: - Conclusions and scope for future scope of this work is summarized.

Material used

Aggregate: - Granular mineral particles make up aggregates; the ideal aggregate should be robust, resilient, long-lasting and able to crush into large particles with few flaky ones. The aggregate must be strong enough to support and transfer the applied loads in addition to meeting gradation standards.

Bitumen:- Bitumen refers to a group of naturally occurring, solid or semi-solid hydrocarbons. It is commonly found in crude oil and is also known as asphalt or tar. Bitumen is used for various purposes, including road construction, roofing, waterproofing, and in some industrial processes. It is known for its adhesives and waterproofing properties, making it a valuable material in construction and infrastructure projects

LDPE:- LDPE (low density polyethylene) is a soft, flexible, lightweight plastic material. LDPE is noted for its low temperature flexibility, toughness, and corrosion resistance. It is not suited for applications where stiffness, high temperature resistance and structural strength are required. It is often used for orthotics and prosthetics. LDPE has good chemical and impact resistance and is easy to fabricate and form. Flexible, translucent/waxy, weatherproof , good low temperature toughness (to -60'C), easy to process by most methods, low cost, good chemical resistance.

PP:- Polypropylene is a polymer whose monomer is propylene (an organic hydrocarbon with the chemical formula C3H6). The chemical formula of polypropylene is (C3H6)n. This polymer is also known as polypropylene and is often denoted by the abbreviation 'PP'. Generally, polypropylene is produced via a chain-growth polymerization reaction involving propylene. This polymer is known to be a thermoplastic polymer, i.e. it softens upon heating and can, therefore, be remoulded. It can also be noted that polypropylene is non-polar and has a partially crystalline structure.

Experimental analysis

The following tests were conducted in order to determine the physical properties of aggregates.

- Specific gravity
- Water absorption
- Aggregate impact test
- Los- angeles abrasion test

The following tests were conducted in order to determine the properties of modified bitumen.

- Ductility test

- Flash and fire point
- Penetration test
- Softening point test
- Marshall Test

Result and Discussion

- **Aggregate test result as per IS Code**

Test of aggregate sample	Result
Specific gravity	2.65
Water absorption	3.31%
Impact value test	10.29%
Los angeles abraison test	18.24%

- **Bitumen test result as per IS Code**

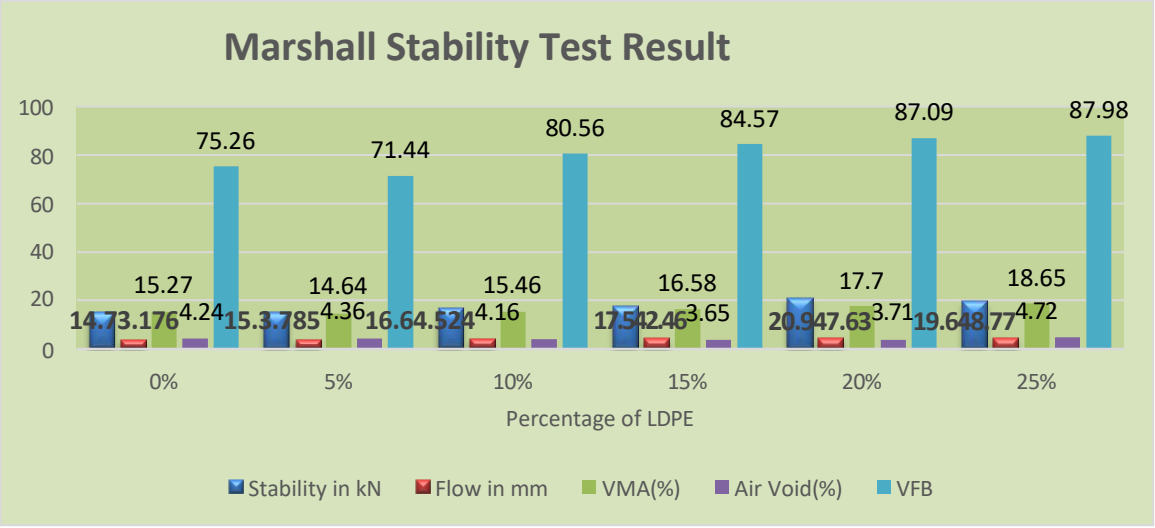
Test of bitumen sample	Result
Penetration test	66.33 mm
Softening point test	47°c
Ductility test	93.33mm
Flash and fire point test	245° and 270°
Specific gravity test	1.14

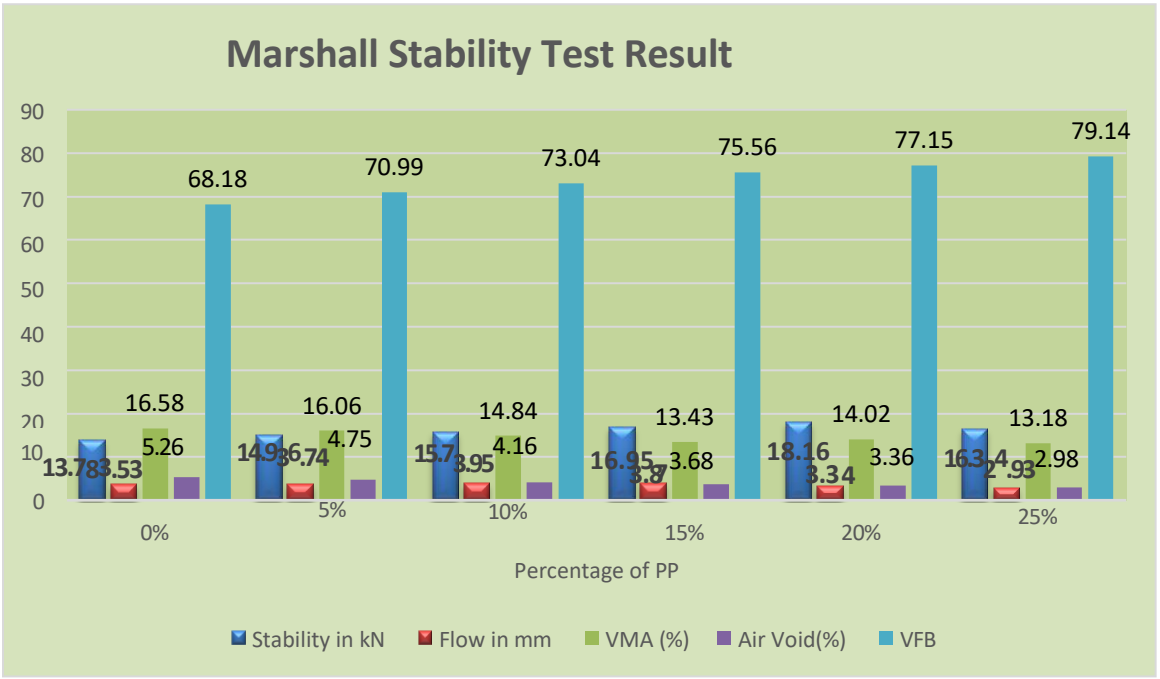
- **Marshall test result**

% of LDPE added with respect to the weight of bitumen mix sample.	Stability in kN	Flow in mm	VMA (%)	Air Void(%)	VFB
0%	14.72KN	3.76mm	15.27	4.24	75.26
5%	15.34KN	3.82mm	14.64	4.36	71.44

10%	16.67KN	4.25mm	15.46	4.16	80.56
15%	17.53KN	4.40mm	16.58	3.65	84.57
20%	20.98KN	4.61mm	17.73	3.71	87.09
25%	19.66KN	4.74mm	18.65	4.72	87.98

% of PP added with respect to the weight of bitumen mix sample.	Stability in kN	Flow in mm	VMA (%)	Air Void(%)	VFB
0%	13.78KN	3.53mm	16.58	5.26	68.18
5%	14.93KN	3.74mm	16.06	4.75	70.99
10%	15.76KN	3.95mm	14.84	4.16	73.04
15%	16.95KN	3.87mm	13.43	3.68	75.56
20%	18.16KN	3.34mm	14.02	3.36	77.15
25%	16.34KN	2.93mm	13.18	2.98	79.14





Conclusion

1. Using Marshall Method of mix design, the optimum bitumen content (OBC) and optimum LDPE and polypropylene content have been determined for different types of mixes. It has been observed that addition of20% of LDPE and polypropylene for BC mixes results in optimum Marshall Properties.
2. Using the same Marshall specimens prepared at their by using both stone dust as filler and it is observed that the retained stability increases with addition of LDPE and polypropylene in the mixes, and BC with 20% results in highest retained.
3. In this study, testing of bitumen with waste LDPE and polypropylene has been used and the result shows that, utilizing of waste LDPE is lowering the penetration value but when we are increasing the waste content in bitumen then penetration value is also increasing and giving best results in 20% replacement.
4. In softening point test result, the result shows that the increasing of LDPE and polypropylene in bitumen is increasing the softening point of modified bitumen.
5. In ductility test result the result shows, decrease in value of ductility but values are more than 50cm so can be used for road construction.
6. FlashandfirepointvaluesarealsoincreasingwiththeincreaseinpercentageofLDPEandpolypropylene.
7. Considering these factors, we can assure that we can obtain a more stable and durable mix for the pavements by polymer modifications. This small investigation not onlyutilizes beneficially, the waste non-degradable plastics but also provides us an improved pavement with better strength and longer life period.

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