Indexing and Abstracting in Following Databases

1. Bowker: A ProQuest Affiliate

2. Crossref

ISBN 9789395118057

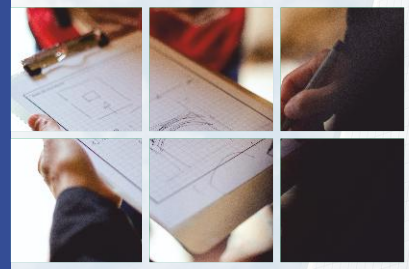
₹ 701 US$ 14

Published by
Integrated Publications,
H. No. 3, Pocket - H34, Sector - 3, Rohini,
Delhi - 110085, India
Toll Free (India): 18001234070
Email: printintegrated@gmail.com

Peer Reviewed & Refereed

VOLUME - 2

Current Advances in Civil Engineering Research



Chief Editor
Dr. N. Sudharsan

Integrated Publications
New Delhi

Current Advances in Civil Engineering Research

Volume - 2

Chief Editor

Dr. N. Sudharsan
Professor, Vidya Jyothi Institute of Technology, Hyderabad, Telangana, India

Integrated Publications
New Delhi

Published By: Integrated Publications

Integrated Publications
H. No. - 3 Pocket - H34, Sector - 3,
Rohini, Delhi-110085, India

Chief Editor: Dr. N. Sudharsan

Publication Year: 2022

Pages: 68

ISBN: 978-93-95118-05-7

Book DOI: https://doi.org/10.22271/int.book.181

Price: ₹ 701/-

Contents

S. No.	Chapters	Page No.
1.	Fractional Substitution of Bitumen by Waste Plastic and Polypropylene in Road Construction *(A. Naga Sai Baba, C.M. Vivek Vardhan, J.S.S.K. Vasa and G. Venkatesh)*	01-13
2.	High Performance Concrete using Silicafume and Superplasticizer *(C. Balakrishna, T. Ramprasanna Kumar Reddy, Somagari Pooja Sri Reddy and L.M. Varun)*	15-25
3.	A Study on Waste Plastics Effectively using in Concrete Blocks *(Shyamala Bhoomesh, V. Naresh, D.V. Tanuja and Vempati Ravindra)*	27-37
4.	Brick Material by Replacing Cement and Sand with Limestone Dust and Wood Saw Dust *(K. Harshada, M. Uday Bhaskar, S. Manasa, G. Naveen Kumar and M. Venkatesh Reddy)*	39-53
5.	Analysis of Newline Nano Engineered Hydrophobic Surfaces *(K. Yugandhara Reddy, K.V.S.G. Murali Krishna and Raja Reddy Duvvuru)*	55-68

Chapter - 1

Fractional Substitution of Bitumen by Waste Plastic and Polypropylene in Road Construction

Authors

A. Naga Sai Baba
Assistant Professor, Department of Civil Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India

C.M. Vivek Vardhan
Professor, Department of Civil Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India

J.S.S.K. Vasa
Assistant Professor, Department of Civil Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India

G. Venkatesh
Assistant Professor, Department of Civil Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India

Chapter - 1

Fractional Substitution of Bitumen by Waste Plastic and Polypropylene in Road Construction

A. Naga Sai Baba, C.M. Vivek Vardhan, J.S.S.K. Vasa and G. Venkatesh

Abstract

In this work some of plastic waste materials which can reuse by various methods and used in road construction. The discussed materials have many advantages over conventional/traditional materials and methods. Now a Days disposal of plastic waste has became a problem of great concern for environmental engineers due its non-biodegradable characteristics and hazard. Bitumen is currently one among the foremost widely used binding materials in road pavement. The explanations thanks to which bitumen is usually used as a binding material are its excellent binding characteristics, waterproofing properties and low cost as compared to other binders Bitumen is currently one among the foremost widely used Binding Material in Road Pavement. This project will conduct a study on recycling plastic waste and blending it with bitumen to get roads in India and compare with the environmental and economic conditions. Some of these Materials are relatively Cheaper compared to other Binders and Materials which provides more strength and Durability as compared to Conventional Road Construction. This Study presents Results of the Waste Plastic and Polypropylene which are used as a Modifier by an amount 2%, 4%, 6%, 8%, 10% by its Weight of Bitumen in making bituminous mixture for pavement applications. When waste plastic is mixed with bitumen it will come up with useful information and creating awareness amongst the learner in the industry regarding waste material and also increases its water Resistivity, Capacity and Stability. Marshal Stability test is taken into account to stimulate with field condition.

Keywords: Waste plastic, aggregate, bitumen, polypropylene.

1. Introduction

The amount of waste plastics and polypropylene are produce in day today life. The most threat to the environment is that the disposal of waste

plastic. During a highway, the potholes and corrugation is that the most problem. Disposal of this waste plastic is that the challenging problem altogether over the world. They either get mixed with municipal solid waste or disposed over acreage. Various attempts are made for the recycling and reuse of waste plastic like polythene covers, plastic bags, plastic bottles, etc., the rapid increase in high traffic intensity additionally to significant alteration in daily and seasonal temperature, demand qualitatively best road characteristic. Especially in under developing countries where proper maintenance of road networks is difficult due to lack of funds, heavy control while laying and effective machinery. These polymers besides being costly aren't easily available that's why many research are performed for modification of bitumen by using waste polymers. The polymers used for modification of bitumen for paving purposes are generally styrene-butadiene styrene, copolymer styrene-butadiene, rubber latex, ethylene vinyl acetate, copolymer PVC, polypropylene etc. The use of waste plastic improves the abrasion & slip resistance of asphalt pavements. In India, because of hot and really humid climate, plastic pavements of greatest advantage. In order absorb the smoke from the vehicles; titanium di-oxide are often used. It also enhances the mechanical properties of the plastic, leading to higher strength and high resistance.

Objectives

1) To increase the durability of Pavement.
2) To increase the flow value.
3) To reduce the worth of the materials (bitumen).
4) It are getting to be economical since waste like plastic is used.
5) It reduce soil Fertility, biodegradable condition.
6) To use the waste plastic as useful binding material.

2. Materials used

Plastic

Plastic may be a material consisting of any of a good range of synthetic or semi-synthetic organics that are malleable and may be moulded into solid objects of diverse shapes. Plastics are generally organic polymers of high molecular mass, but they often contain other substances. They're usually synthetic, most ordinarily derived from petrochemicals, but many are partially natural. Plasticity is that the general property of all materials that are ready to irreversibly deform without breaking, but this happens to such a degree with this class of mouldable polymers that their name is a stress on this ability.

Low density poly ethylene (LDPE)

Low-density polyethylene (LDPE) may be a thermoplastic made up of the monomer ethylene. It had been the primary grade of polyethylene, produced in 1933 by Imperial Chemical Industries (ICI) using a high process via radical polymerization. Its manufacture employs an equivalent method today. The EPA evaluate 3.3.7% of LDPE (recycling number 4) is recycled. Despite competition from more modern polymers, LDPE continues to be a crucial plastic grade. In 2013 the worldwide LDPE market extend to a volume of about US$33 billion.

Fine aggregates

Fine aggregate (Sand) may be a present granular material composed of finely divided rock and mineral particles. It's describe by size, being finer than gravel and coarser than silt. Sand also can ask a textural class of soil or soil type; i.e., a soil containing quite 85% sand-sized particles (by mass).

Coarse aggregates

Construction aggregate (coarse aggregate), or just "aggregate", may be a broad category of coarse particulate material utilized in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates.

Bituminous material

Bituminous materials are one among the oldest and most generally used construction materials. While their components are obtained from finite resources, these materials have long been referred to as sustainable products thanks to their capacity to increase their serviceable lives through reclaim, reuse and/or the recycling processes. This part presents holistic aspects on the sustainability of bituminous materials, including their sources, processes, productions, standards, designs, good practices, and preservative maintenance.

3. Experimental investigation

Tests on aggregates

1) Aggregate Impact Value Test
2) Los Angles Abrasion Test
3) Aggregate Crushing Test
4) Specific Gravity And Water Absorption Test

Tests on bituminious materials

1) Penitration Test on Bituminious Material
2) Ductility Test on Bituminous Material
3) Softening Point Test
4) Flash and Fire Point Test
5) Marshall Stability Test on Bitumen

4. Marshall stability test on bitumen

This Test is used to regulate the Marshall Stability of Bituminous Mixture of ASTM D 6927. This test is that the Marshall Stability is the Resistance to Plastic Flow of Cylindrical Specimens of a Bituminous Mixtures loaded on the Lateral Surface. It is the Loading Capacity of the mix at 60 deg centigrade and measured in kg.

The Total Weight of the mixed Specimen should be 1200gr.

Marshal test procedure

- Specimens are heated to 60 ± 1 °C in a water bath for 30 - 40 minutes or in an oven for minimum of 2 hours.
- The specimens are separated from the water bath or oven and place in lower segment of the breaking head. The upper portion of the breaking head of the specimen is placed in position and the complete assembly is placed in position on the testing machine.
- The flow meter is placed over one of the post and is adjust to read zero.
- Load is applied at a rate of 50 mm per minute until the maximum load reading is secured.
- The maximum load reading in Newton is noticed. At the same immediately the flow as recorded on the flow meter in units of mm was also noted.

Marshall mix design

Properties of mix

The properties that are of interest involve the theoretical specific gravity Gt, the bulk specific gravity of the mix Gm, percent air voids Vv, percent volume of bitumen Vb, percent void is mixed aggregate VMA and percent voids filled with bitumen VFB. To make out these calculation a phase diagram is given.

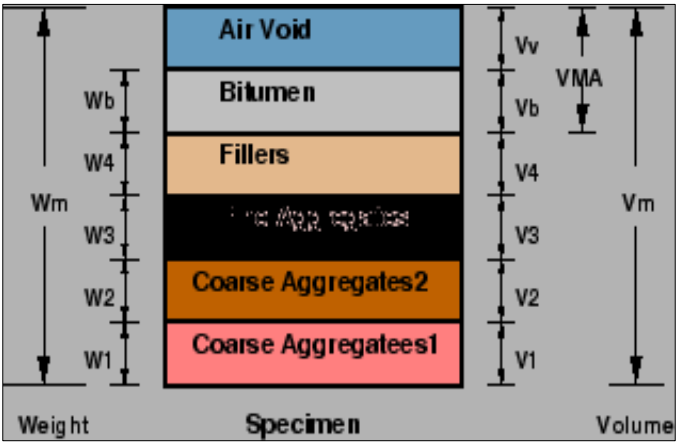


Fig: Phase Diagram of a Bitumenios mix

$$G_t = \frac{W_1 + W_2 + W_3 + W_b}{\frac{W_1}{G_1} + \frac{W_2}{G_2} + \frac{W_3}{G_3} + \frac{W_b}{G_b}} \quad (1)$$

Bulk specific gravity of mix [G_m]

The bulk specific gravity or the actual specific gravity of the mix G_m is the specific gravity considering air voids and it is found out by

$$G_m = \frac{W_m}{W_m - W_w} \quad (2)$$

Air voids percent V_v:

Air voids V_v is the percent of air voids by volume in the specimen and it is given by

$$V_v = \frac{(G_t - G_m)100}{G_t} \quad (3)$$

Percent volume of bitumen V_b

The volume of bitumen V_b is the percent of volume of bitumen to the total volume and it is given by

$$V_b = \frac{\frac{W_b}{G_b}}{\frac{W_1+W_2+W_3+W_b}{G_m}} \quad (4)$$

Voids in mineral aggregate VMA

Voids in mineral aggregate VMA is the volume of voids in the aggregates, and it is the sum of air voids and volume of bitumen, and is calculated from

$$VMA = V_v + V_b \tag{5}$$

Voids filled with bitumen VFB

Voids filled with bitumen VFB is the voids in the mineral aggregate frame work filled with the bitumen, andit is calculated as:

$$VFB = \frac{V_b \times 100}{VMA} \tag{6}$$

Determine marshall stability and flow

Marshall stability of a test specimen is the maximum load essential to produce failure when the specimen is preheated to a prescribed temperature placed in a special test head and the load is put in at a constant strain (5 cm per minute). While the stability test is in advance dial gauge is used to measure the vertical deformation of the specimen. The deformation at the failure point intimate in units of 0.25 mm is called the Marshall flow value of the specimen.

5. Discussion

Tests on aggregates

1) Aggregate impact value test

For determination of the aggregate impact value of coarse aggregate, which passes through 12.5 mm, IS sieve and retained on 10 mm IS sieve.

Discussion

Aggregates are worn for wearing course, the impact value shouldn't be exceed 30 percent. For bituminous macadam the utmost permissible value is 35 percent. For Water bound macadam base courses the utmost permissible value defined by IRC is 40 percent.

2) Los angles abrasion test

Abrasion test is fetch out to test the hardness property of aggregates and to decide whether they are suitable for different pavement construction works. Los Angeles abrasion test is a favour (preferred) one for carrying out the hardness property and has been standardized in India (IS: 2386 part-IV).

Discussion

An utmost value of 40 percent is authorized for WBM base course in Indian conditions. For bituminous concrete, a utmost value of 35 percent is specified.

3) Aggregate crushing test

One of the model in which pavement material can fail is by squash (crushing) under compressive stress. A test is systematize by IS: 2386 part-IV and used to determine the crushing strength of aggregates. The aggregate squash (crushing) value gives a relative measure of resistance to crushing under gradually applied crushing load.

Discussion

A value less than 10 signifies an exceptionally strong aggregate while above 35 would normally be considered as weak aggregates.

4) Specific gravity and water absorption test

The specific gravity and water absorption of aggregates are considerable properties that are required for the design of concrete and bituminous mixes. The specific gravity of a solid is in the ratio of its mass to that of an equal volume of distilled water at a identified (specified) temperature.

Discussion

The specific gravity of aggregates usually worn in road construction ranges from about 2.5 to 2.9. Water absorption values ranges from 0.1 to about 2.0 percent for aggregates commonly worn in road surfacing.

Tests on bitumen

1) Penitration test on bituminious material

It measures the hardness or softness of bitumen by estimate the depth in tenths of a millimeter to which a standard loaded needle will penetrate vertically in 5 seconds. BIS had standardized the equipment and test procedure.

Discussion

When the modifiers are mixed with Bitumen the penetration values Persist Decreasing compared with Conventional. Due to Decreasing of Values, its Signified that the penetrated values for Modifiers indicates that there will be a improvement in the Temperature Liability Resistant Characteristics in road Constructions.

It may be noted that penetration value is largely determine by any inaccuracy with regards to pouring temperature, size of the needle, weight placed on the needle and the test temperature.

In hot climates, a lower penetration grade is (Favoured) preferred.

2) Ductility test on bituminous material

Ductility is the property of bitumen that permits it to go through great deformation or elongation. Ductility is describe as the distance in cm, to which a standard sample or briquette of the material will be elongated without breaking.

Discussion

As, we know that the Ductility value should not be less than 50cm as per Standards and References Given by IS. But, the modifiers in the bituminous materials percentage Values are variously decreasing in Both Waste Plastic and LDPE (Polypropylene) in the Ductility Test. So, as the Ductility Values Decreases with increasing in modifiers Percentages it should not be used in Road Constructions, but it can be used as a Filler Materials in Less Percentage for filling and Healing both of Cracks and Joints.

The ductility value gets pretentious by factors such as pouring temperature, test temperature, rate of pulling etc.

A minimum ductility value of 75 cm has been specified by the BIS.

3) Softening point test

Softening point indicates the temperature at which the bitumen attains a particular degree of softening under the specified condition of test.

Discussion

As, the modifiers Percentages Increases in the Addition of Bituminous material, the Softening point Values also Increasing Parallelly, by this Result we can Suggest that the modifiers with bitumen can be mixed with lower Percentage which can be used for Road Constructions.

In generally, higher softening point indicates lower temperature susceptibility and is preferred in hot climates.

4) Flash and fire point test

Flash and Fire point test is to manage on bitumen to know the safe mixing and application temperature values of particular bitumen grade.

Discussion

As, Modifiers Percentages in the Bitumen increases the Temperature Values for Flash Point and Fire Pont also Increasing Rapidly. So, Modifiers can be used in the Road Constructions, Where the Temperature Increases Rapidly.

5) Marshall stability test on bitumen

Marshal test is extensively used in procedure test programs for the paving jobs. The stability of the mix is reported as a maximum (utmost) load carried by a compacted specimen at a standard test temperature of 600 °C. The flow is measured as the distortion in units of 0.25 mm between no load and maximum load carried by the specimen during throughout stability test (flow value can also be measured by deformation units of 0.1 mm). This test aims to get the optimum binder content for the aggregate mix type and traffic intensity. This test will helps us to draw Marshall Stability vs. % bitumen.

Discussion

As the additive content increases in the Bitumen the Stability Rate also Increases initially and when it reaches the Maximum Value the percent starts Decreasing. The addition of LDPE (polypropylene) raises the Stability value of control mix and the Percentage increases for Waste Plastics.

By, this it was stated that the Specific Gravity of Additive mixture is less than 1 which is less than that of Bitumen. Hence, it is stated that the penetration between Particles and inflate (Strengthen) the interlock of Aggregates, which increases the Stability and Decreases the flow value.

If we Increases the Additive Content beyond more than that it starts decreasing where the Stability Value Decreases i.e., parallelly interlocking between particles also decreases which is offered by bitumen binder and the remaining coated aggregate particle space will be occupied by the bitumen Content.

By testing the result it was concluded that Compared with Polypropylene additive mixture, waste Plastic Stability is more, Which indicates that Waste plastic maintains higher Resistances Compared with LDPE (Polypropylene).

Conclusion

As plastic is being a versatile material and a friend to common man in useful way become a problem to the ambient environment after its use. Today in India only, nearly 10 MILLION TONNES of plastic is used and

hoped to reach 20 million tonnes by 2025. Being non-biodegradable. Waste plastic is the biggest issues in solid waste management. So, we have tried to replace bitumen in bituminous concrete.

As, Polypropylene is a thermoplastic polymer used in wide variety of applications it's help in replacing in bitumen with plastic.

As a Civil Engineers, we have came with an idea to utilize this waste plastic and polypropylene in bitumen to prepare bituminous concrete that will solve two problems

- Solid waste management issue
- Bituminous road problems

We have tried to replace bitumen in bituminous concrete that is usually used nowadays for Asphalting of Roads, by plastic and LDPE (Polypropylene). It will increases the melting point of the bitumen. In this process waste plastic and polypropylene which is evolved from (LDPE) is coated over the aggregates. By result it was concluded that compared with conventional bitumen mixture the stability has been increased by adding of waste plastic and LDPE (Polypropylene). But, in the flow test the conventional bitumen flow value is more compared with waste plastic and polypropylene. In Marshall Quotient also the values are increased with respect to the control Mixture of waste plastic and LDPE (PP).

By adding additive mixtures specific gravity range is in limits as like normal bitumen and it is found that it is slightly higher with waste plastics additive. As the density in the waste plastic and polypropylene is much less than that of aggregates it will penetrate easily into the aggregates, due to this there will be a proper interlocking between the particles which forms a perfect bonding over it.

As, we filled the properties with additive mixtures there will be less voids compared with conventional bitumen. This innovative technology not only strengthened the road construction but also increases the road life as well as help to improve the environment and also solves the solid waste management.

References

1. Sandhya K, Sanjay Kumar L, Rajkumar KN, Sandhya R, Sukuma S. Partial Replacement of Bitumen by using Waste Plastic in Bitumen Concrete Roads.
2. Payal Dubey, Nakul Gupta. Ph.D. Research Scholar From Civil

Engineering Dept, GLA University, Utilization of Low-Density Plastic Waste in Construction of Flexible Pavement with a Partial Replacement of Bitumen.

3. Aakash Bariya, Aakash Ved, Ganesh Chouhan, Lalit Yadav, Naveen Nayak, Rahul Surage *et al*. Scholar, Dept. of Civil Engineering, From Malwa Institute of Technology, Indore, M.P., India "Partial Replacement of Bitumen with Plastic Waste in Hot Mix, 2018.
4. Chandrasekaran M, Aadhil Bathusha SJ, Kanagarajan R, Karthikesh R, Kavin K. Assistant Professor, Department of Civil Engineering, Excel Engineering College, Komarapalayam, Tamil Nadu, India: Experimental Study on the Behavior of Flexible Pavements with Partial Replacement of Bitumen with Plastic Waste, 2017.
5. Gandhiraj J, Karthikeyan V, Rajasekar K, Rajesh Kumar N, Santhosh Kumar S, Sathya *et al*. Experimental Investigation on Road Pavement with Partial Replacement of Plastic Wastes as Bitumen, 2018.
6. Sathish U, Sandeep AV, Shyam Kumar K, Hari Gopal V, Hari Krishna K, Asha Jyothi J *et al*. B.Tech Civil Engineering Students, Sanketika Vidya Parishad Engineering College, Visakhapatnam. Partial Replacement of Bitumen with Waste Plastic in Flexible Pavements, 2020.
7. Surya B, Prakash R, Ranjithkumar S, Saravanan SM, Sivaraja M. UG Scholar, 4HoD/Civil, Principal, N.S.N. College of Engineering and Technology, Karur, Tamilnadu. An Experimental Investigation on Flexible Pavement with Partial Replacement of Bitumen by using Waste Plastic Biomedical Wastes and Bags, 2018.
8. Rahi DC, Chandhak R, Amit Vishwakarma. Department of Civil Engineering Jabalpur Engineering College. Utilization of Liquid Plastic Waste in Bitumen for the Road Construction.