JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

EFFECT OF WASTE BOTTLE IN ASPHALT CONCRETE USING MARSHALL MIX-DESIGN METHOD

1Aaliya Quraishi, 2Kruti B. Jethwa

1PG Scholar, 2Assistant Professor

1,2Department of Civil Engineering, Shri Shankaracharya Technical Campus -SSGI, Bhilai

Abstract *- This works implies that the characteristics of asphalt concrete mix having different proportion of waste plastic bottles. The percentage of waste bottles ranges from 0% , 3 % , 7 % and 10 % to analyze experimentally the Marshall Mix-Design for the making of this asphalt concrete. The test conducted is Density, Stability, Deformation, Voids in Total Mix, Total Air voids, Voids in Mineral Aggregate. The result shows that the case having waste bottle having 7 % are showing better performance as compared to other cases. This mix can be applied in heavy traffic flows.*

Keywords - Asphalt, Natural Sand, Density, Stability, Deformation

1. Introduction

Single use plastic is a type of disposable plastic found in items like water bottles, straws, and cups that are only used once before being discarded. Businesses prefer to produce single-use plastics due to their low cost. As a result of Covid-19-related safety measures, consumers have recently expressed concern about plastic reuse. Because of the pandemic's challenges, trade organisations such as the All-India Plastic Manufacturers Association (AIPMA) have recommended that the government extend the deadline for phasing out single-use plastic products by one year to 2023.

It should be noted that per capita plastic consumption in India is 11 kilogrammes (kg) per year, as opposed to the global average of 28 kg per year. According to data from the Ministry of Environment, Forests, and Climate Change, India generated over 3.4 million tonnes of plastic waste in 2019-20, up from 3.06 million tonnes in 2018-19. The situation worsens when a significant amount of such unrecyclable waste ends up in rivers, oceans, and landfills. The greatest challenge to eliminating single-use plastic in India is the lack of a well-established system for effective segregation, collection, and recycling. Furthermore, despite environmental concerns expressed by various State Pollution Control Boards, India continues to lack a waste recycling policy (SPCBs).

2. Materials Used

The waste plastic used in this research work are collected from Raipur, Chhattisgarh. Each materials have such physical properties which is to be studied to produce bitumen concrete blocks. Other than waste plastic, the rest material is same as provided in the bitumen concrete.

3. Case Trials for the Considered Study

In this study, the specimens were utilized for testing to identify the properties. The design is been carried by Marshall Mix-design in which four basic requirement is evaluated for Stability, Density, Voids in Mineral Aggregate, Voids Filled with Asphalt to obtain optimized Asphalt content from the mix-design.

Table 1 Case Trails for the Study (All Values are in percentage)

Test Specimen Case Id	Coarse Aggregate	Fine Aggregate	Filler (Cement)	Waste Bottle	Bitumen Asphalt
Sample 1	34	55	8	-	3
Sample 2	32	52	8	3	3
Sample 3	30	49	8	7	3
Sample 4	28	46	8	10	3

Fig. 1 Marshall Bitumen-Aggregate Mix

5. Result

5.1 Density

The density of mixture of bitumen with waste foundry sand is previously done by Hakan Koyuncu (2006) in which the percentage of foundry sand were from range five to twenty percentage. The result values according to the test are given in table and graph below in which the densities are calculated as per equation-

$$G_{mb} = \frac{W_{air}}{W_{SSD} - W_{water}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Table 3 Density values of Asphalt Bitumen Mix

Test Specimen Case Id	Bitumen Content (%)	Waste Bottle (%)	Average Density (gm/cm^3)
Sample 1	3	-	**2.38**
Sample 2	3	3	**2.32**
Sample 3	3	7	**2.26**
Sample 4	3	10	**2.21**

5.2 Stability Test

The result values according to the test are given in table and graph below in which the stability is calculated as per equation-

$$G_{mm} = \frac{W_f + W_b + W_{ca} + W_{fa} + W_{fs}}{\frac{W_f}{G_f} + \frac{W_b}{G_b} + \frac{W_{ca}}{G_{ca}} + \frac{W_{fa}}{G_{fa}} + \frac{W_{fs}}{G_{fs}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Table 4 Marshall Stability values of Foundry Sand–Asphalt Bitumen Mixtures

Test Specimen Case Id	Bitumen Content (%)	Waste Bottle (%)	Load (KN)
Sample 1	3	-	**10.61**
Sample 2	3	3	**10.83**
Sample 3	3	7	**11.11**
Sample 4	3	10	**10.26**

5.3 VTM (Voids in total mixture)

The results based on void of total mixture are given below which is calculated as per equation (3)

$$\text{Voids in Total Mix (VTM)} = \left(1 - \frac{G_{mb}}{G_{mm}}\right) X\ 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where G_{mb} = bulk specific gravity of mixture and G_{mm} = maximum specific gravity of mixture

Table 5 Air Voids for 3 % Bitumen-Concrete Mixes

Test Specimen Case Id	Bitumen Content (%)	Waste Bottle (%)	VTA (%)
Sample 1	3	-	7.23
Sample 2	3	3	7.86
Sample 3	3	7	8.23
Sample 4	3	10	8.47

5.4 VMA (Voids in Mineral Aggregate)

The results based on mineral aggregate are given in table and graph below which is calculated as per equation (4) -

Voids in Mineral Aggregate (VMA) = $(1 - \frac{G_{mb}\ X\ (1-P_b)}{G_{sb}})\ X\ 100$………………………..(4)

Where Pb = asphalt binder content of mixture

Table 5 Mineral Aggregate Voids for 3 % Bitumen-Concrete Mixes

Test Specimen Case Id	Bitumen Content (%)	Waste Bottle (%)	VMA (%)
Sample 1	3	-	14.23
Sample 2	3	3	14.89
Sample 3	3	7	15.56
Sample 4	3	10	15.87

5.5 VFA (Voids Filled with Asphalt)

The results based on filled asphalt are given in table and graph below which is calculated as per equation (5)

Voids Filled with Asphalt (VFA) = $(1 - \frac{VTM}{VMA})\ X\ 100$ …………………………..(5)

Table 5 Voids in Asphalt for 3 % Bitumen-Concrete Mixes

Test Specimen Case Id	Bitumen Content (%)	Waste Bottle (%)	VFA (%)
Sample 1	3	-	70
Sample 2	3	3	75
Sample 3	3	7	77
Sample 4	3	10	81

6 Conclusions

The stability value indicates that the maximum Marshall stability obtained for the mixture having 11.11 KN for the mixture with 7 % waste bottle content. The stability first increases with increase in bitumen content reach the extreme point then reduces.

REFERENCES

1) Akbulut, H. and Gurer, C., 2007. Use of aggregates produced from marble quarry waste in asphalt pavements. Building and Environment, 42 (5), 1921–1930.
2) Aramide, F. O, Aribo, S, and Folorunso, D. O (2011), Optimizing the Molding Properties of Recycled Ilaro Silica Sand, Leonardo Journal of Sciences, vol 19, pp. 93- 102.
3) Siddique, R., and Sandhu, R. K (2013). Properties of Self Compacting Concrete Incorporating Waste Foundry Sand. Leonardo Journal of Sciences, ISSN-1583-0233 , PP 105-124.
4) Joni, H. H., & Zghair, H. H. Effect of adding used-foundry sand on hot asphalt mixtures performance. *Eng. &Tech. Journal*, *34*(6), (2016).
5) National Cooperative Highway Research Program, "Recycled Materials and Byproducts in Highway", Washington, D.C., 2013.
6) Federal Highway Administration," Foundry Sand Facts for Civil Engineers", Federal Highway Administration (FHWA), Report.
7) Goh, Boon Hoe, Pushan Sunnasee, Kok Hon Chin, Byung Gyoo Kang, and Sien Ti Kok. "Utilisation of Rice Husk Ash in Asphaltic Concrete Pavement." In Advanced Materials Research, vol. 1030, pp. 961-964. Trans Tech Publications Ltd, 2014.
8) Shuaibu, A. A., A. I. Mohammed, U. Hassan, B. H. S. Amartey, S. A. Wada, A. Mohammed, and A. M. Rimi. "An Experimental Study on the Performance of Bituminous Concrete Mixtures with Silica Sand as Filler Replacement." *Arid Zone Journal of Engineering, Technology and Environment* 17, no. 4 (2021): 453-468.
9) Shuaibu, A. A., H. S. Otuoze, H. A. Ahmed, and M. I. Umar. "Effect of Waste Foundry Sand as Partial Replacement of Fine Aggregate in Bituminous Concrete Mixture." *Nigerian Journal of Engineering* 28, no. 2 (2021): 73-73.
10) Alves, B. S.Q, Dungan, R. S. C, Raquel L. P. G, Rosa de Carvalho P, Catia R. S (2014), Metals in waste foundry sands and an evaluation of their leaching and transport to groundwater Water, Air, and Soil Pollution vol 225(5), pp 1-11 DOI – http://10.1007/s11270-014-1963-4 .
11) Yazoghli-Marzouk, O. Vulcano-greullet, N. Cantegrit, L. Friteyre, L. Jullien, A. (2014), Recyclingfoundry sand in road construction–field assessment, Construction and Building Materials, vol. 61, pp 69-78, https://doi.org/10.1016/j.conbuildmat.2014.02.055 .
12) Javed, S. & Lowell, C.W. (1994) Uses of Waste Foundry Sand in Civil Engineering. Uses of Waste Foundry Sand in Highway Construction; Final Report, pp. 109–113. Geotest Engineering, Inc., Houston, Texas, USA