ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

By Using Waste Glass as Secondary Aggregates in Asphalt Mixtures

Ahmed Abbas Jasim

Lecturer in department of Civil Engineering, College of Engineering University of Babylon - Iraq.

Manuscript Info

Manuscript History:

Received: 11 November 2013
Final Accepted: 25 December 2013
Published Online: January 2014

Key words:
Waste Glass , Asphalt Mixtures, Marshall Properties , Aggregate, Portland cement .

Abstract

The use of primary aggregate in the asphalt mixture layers of a road or airfield pavement is seen as a wasteful use of a finite natural resource. The recycled crushed glass can be considered valuable alternative sources of aggregate for asphalt mixture production. The aim of this study is evaluation the effect of using waste glass as secondary aggregates in asphalt mixtures on Marshall Properties. The study work covers firstly using glass as aggregates including two percentages of glass content (50 and 100 %) by weight of each sieve, and six sizes of glass (1/2, 3/8, No.4, No.8, No.50 and No.200). Secondly, using glass as additives including three percentages of glass content (1, 2 and 4 %) by weight of total mix, and two sizes of glass (No.50 and No.200). The engineering properties of the control and glass mixtures (stability, flow, bulk density, and percent of voids in total mix) were evaluated by Marshall Test. The study results indicated that Marshall Stability for glassphalt is higher than of the control mixture by (127 and 174) % when using glass size (No.8 and No.200) respectively as secondary aggregate in asphalt mixture.

1. INTRODUCTION

Asphalt containing glass as an aggregate is called "glassphalt," and has been widely tried as a mean to dispose of surplus waste glass since the 1960's. Glassphalt is basically the same as conventional hot-mix asphalt, except that (5% to 50%) of the aggregate is replaced by crushed glass[1]. The glass must be properly cleaned and crushed, and combined with the natural aggregate, preserving agents, and bitumen in their specified proportions. The glass should contain less than (2%) by weight of metal, plastic, or other miscellaneous debris such as paper and food residue. Acceptable gradations for the glass within the asphalt will be determined by the purpose of the glass aggregate in the mix. For surface course, glass aggregate graded to 3/8-inch and finer is recommended[1]. Glassphalt is used in the structural layers of the pavement below the surfacing layer to prevent the problems that occur when it is used as surfacing asphalt. These include lack of skid resistance and poor bonding of glass cullet to the bitumen in the asphalt mix, which results in stripping and raveling problems[2]

Ordinary glass is rigid and brittle and easy to crush to form satisfactory particles for asphalt concrete applications. Glass is a non-metallic inorganic made by sintering selected raw materials comprising silicate and other minor oxides. The ratio of main oxides SiO2, Na2O, CaO are: 77%, 9.4% and 6.7% respectively[3]. Recycled glass processed from empty soft drink, beer, food, wine, and liquor containers collected at residential curbside, drop boxes, trash barrels, deposit stations, or recycling stations, and is either source-separated or co-mingled with plastics, aluminum cans, ceramics, or colored glass containers[4].

Man-made glass was first made by heating a sand, soda, and lime mixture, which formed a clear liquid that turned into a hard solid when cooled. Glass has been made into containers since about

1500 BC, and glass-making evolved from the Roman times about 50 A.D when transparent glass with various colors was formed into mouth-blown shapes[5].

2. MATERIAL AND TESTING PROCEDURE

The experimental work is limited to the determination of Marshall properties as stability and flow and volumetric properties like bulk specific gravity, max. specific gravity, and air void of the asphalt mixture.

Material used in this work are locally available in south and middle areas of Iraq. The properties are evaluated according to American Association of State Highway and Transportation Officials[6]. standards compared with the State Organization of Road and Bridge[7].specification requirements.

3. ASPHALT CEMENT

In this study, the binder is petroleum asphalt cement brought from Al Durah refinery (60-70). The physical properties of the asphalt cement used are presented in Table (1).

Table (1): Physical Properties and Tests of the Used Asphalt Cement. [8].

Property	AASHTO Designation	Test Result	SCRB/R9 Specifications
Penetration (25 C0, 100 gm, 5 sec), (0.1 mm)	T49	65	(60 – 70)
Kinematic Viscosity at 135 C0, (cst).	T201	340	
Ductility (25 C0, 5 cm/min), (cm)	T51	110	> 100
Flash Point (Cleveland open cup), (C0)	T48	245	232>

4. AGGREGATE AND MINERAL FILLER

Crushed coarse aggregate is brought from Al Nib'aee quarry. Intermediate gradations were selected for aggregate with maximum size of 12.5 mm and aggregate grading according to[7]. specification requirements.

In this study, Portland cement used and brought from lime factory in Karbala government.

In this study, The window glass used as waste glass and Los Angeles apparatus used to achieve the required sizes.

5. PROPERTIES OF ASPHALT CONCRETE MIXTURES:

The properties of asphalt concrete mixture used in testing of Marshall Test are presented as follow:

Asphalt cement type and grade: (60-70) from AL Durah refinery,Asphalt Content: 5 %.,Aggregate maximum mineral size: 12.5mm (1/2").,Mixing and compaction temperature: 160 C° and 120 C°.,Filler type: Cement.,Type of Secondary Aggregate: Waste Glass.,Percentage of Secondary Aggregate: (50 and 100) % for each size (1/2 in, 3/8 in, No.4, No.8, No.50 and No.200).,Percentage of Additives Aggregate: (1, 2 and 3) for size (No.200) and 2% for size (No.50).

Marshall Stability and flow tests are performed on each specimen. The maximum load resistance and the corresponding flow value are recorded. Three specimens for each combination are prepared and the average results are reported. The bulk specific gravity density and theoretical (maximum) specific gravity of void less mixture are determined at the laboratory. The percent of air void is then calculated.[8,9,10].

6. RESULTS OF EXPERMENTAL WORK:

6.1 Effect of Waste Glass Size on Marshall Properties

It is demonstrated that the glass size is the essential contributor to properties of asphalt mixture. The results of Marshall Stability, flow and air voids for control and glassphalt mixtures shown in Figures (1, 2 and 3) respectively, it is evidenced that the glass size had significant influence on Marshall properties. Marshall stability increasing for all glass sizes expect No.50 as shown in Fig.1. Whereas, Marshall flow decreasing for all glass sizes expect No.50 as given in Fig.2. The glass size higher than (9mm) is broken during compaction and test of mixture, thus Marshall stability lower than control mixture. [11].

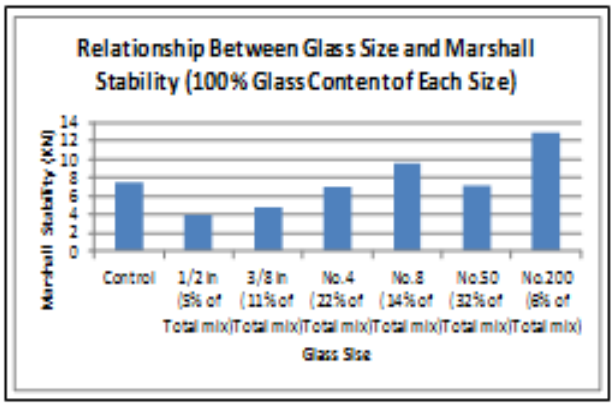


Figure (1): Effect of Waste Glass Size on Marshall Stability.

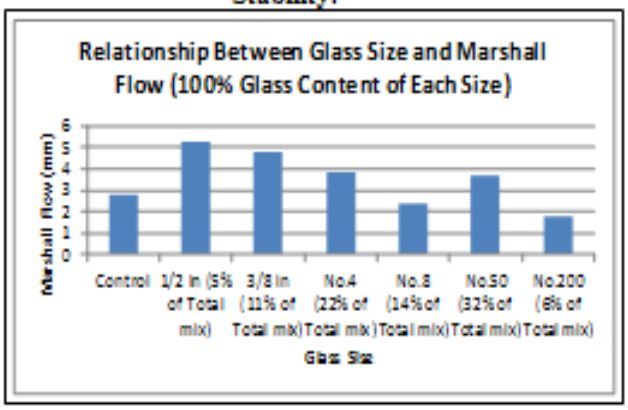


Figure (2): Effect of Waste Glass Size on Marshall Flow.

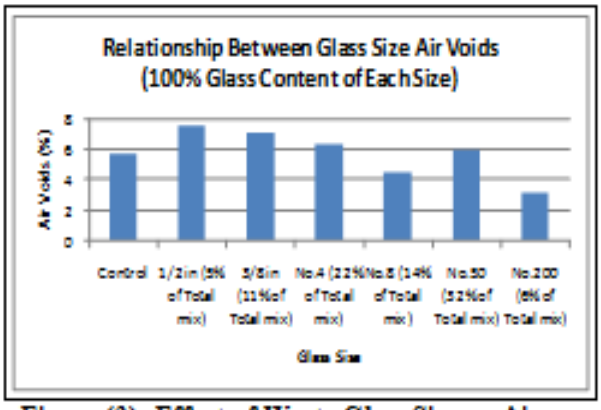


Figure (3): Effect of Waste Glass Size on Air Voids.

6.2. Effect of Waste Glass Content on Marshall Properties

Adding a glass with variable content had significant influence on Marshall properties. The results of Marshall stability, flow and air voids for control and glassphalt mixtures shown in Figures (4,5, 6,7,8 and 9). It is indicated that the increase of glass content for all size (expect No.8 and No.200) decreasing the Marshall stability. While Marshall flow increase with increasing the glass content for all size (expect No.8 and No.200).

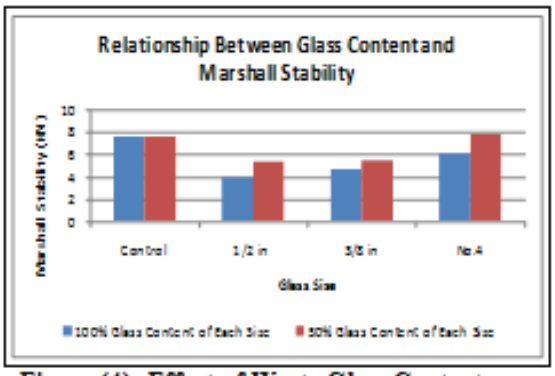


Figure (4): Effect of Waste Glass Content on Marshall Stability.

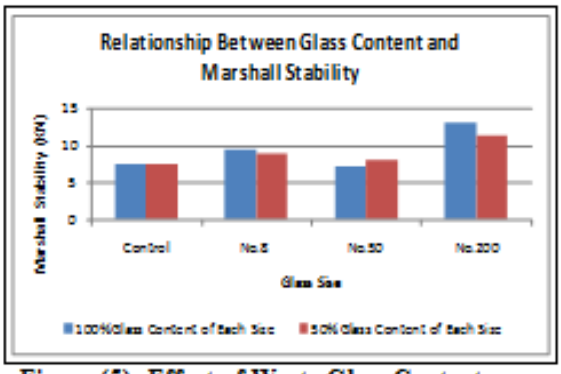
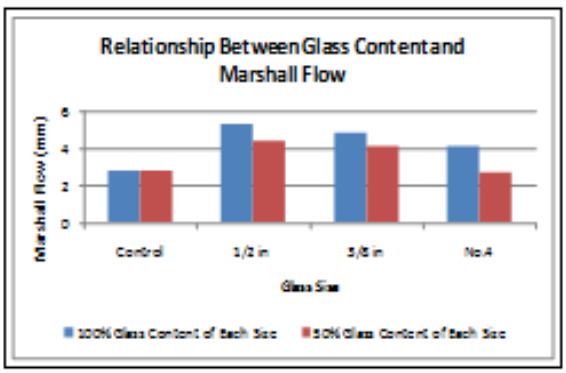


Figure (5): Effect of Waste Glass Content on Marshall Stability.



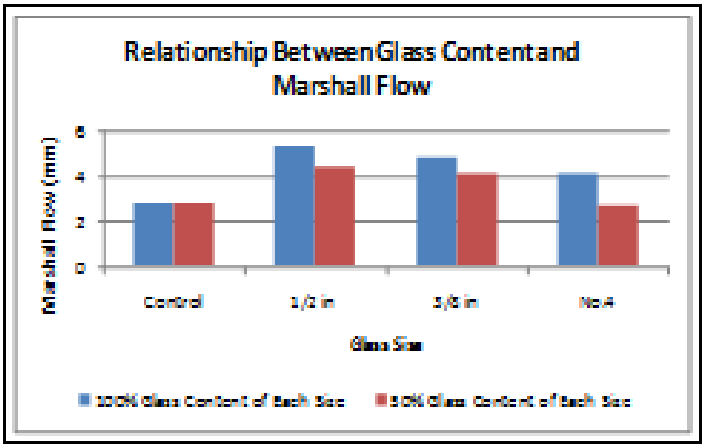


Figure (6): Effect of Waste Glass Content on Marshall Flow.

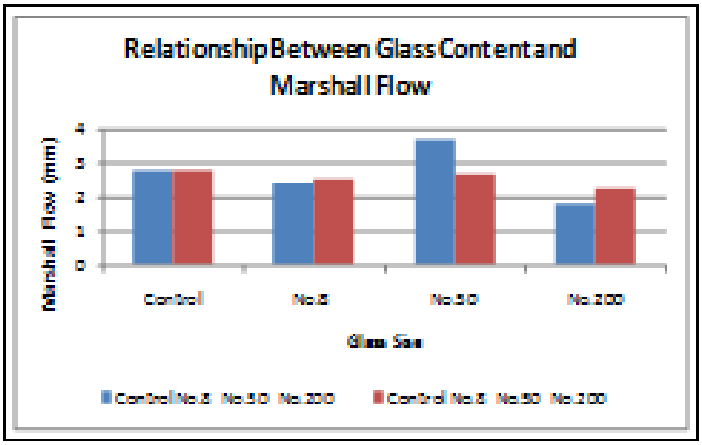


Figure (7): Effect of Waste Glass Content on Marshall Flow.

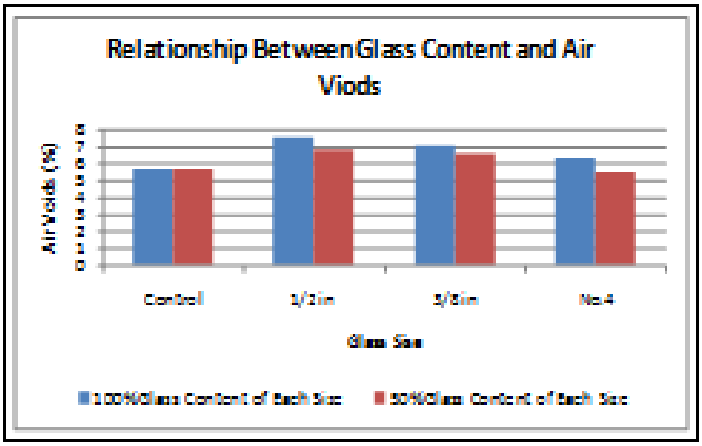


Figure (8): Effect of Waste Glass Content on Air Voids.

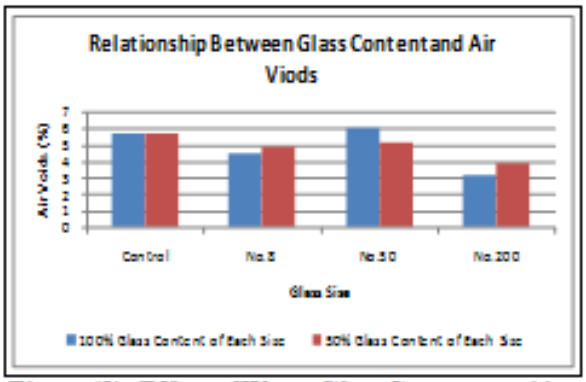


Figure (9): Effect of Waste Glass Content on Air Voids.

6.3 Effect of Waste Glass Size on Marshall Properties

The use of waste glass as additives in asphalt mixture was investigated in this study, two sizes of glass (No.50 and No.200) as additives. The results of Marshall stability, flow and air voids for control and glassphalt mixtures shown in Figures (10,11 and 12). It is noticed that with the decreasing of glass size, Marshall stability increases while Marshall flow decreases.

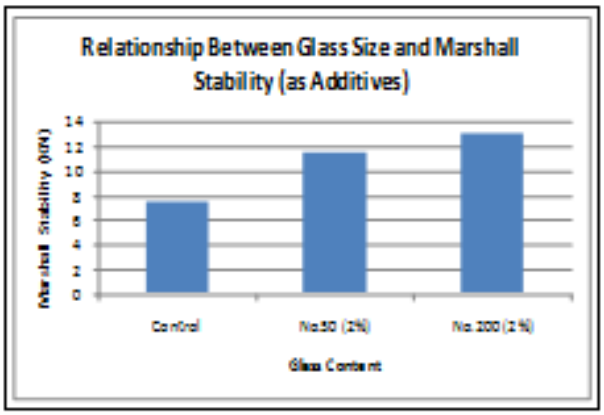


Figure (10): Effect of Waste Glass Size on Marshall Stability.

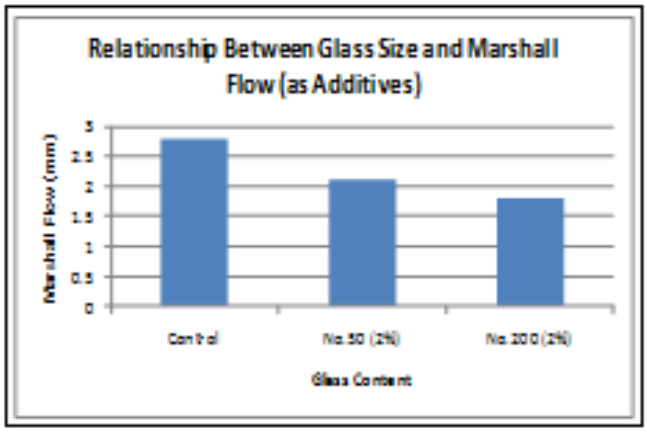


Figure (11): Effect of Waste Glass Size on Marshall Flow.

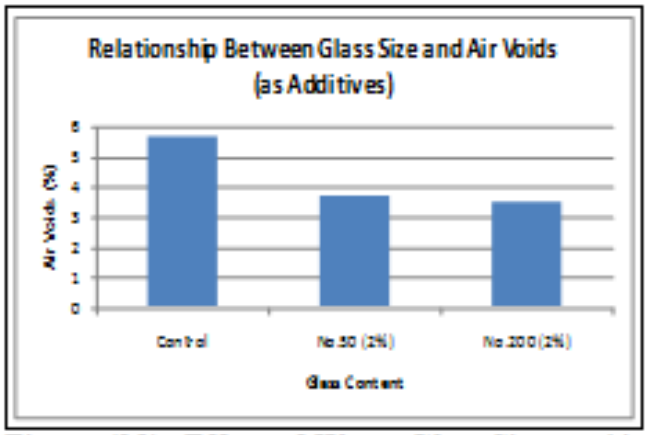


Figure (12): Effect of Waste Glass Size on Air Voids.

6.4 Effect of Waste Glass Content on Marshall Properties

Three percentages of glass content (1,2 and 4 %) as additives were studied. The optimum content of glass size No.200 was 2% as shown in Figure (13,14 and 15) consecutively.

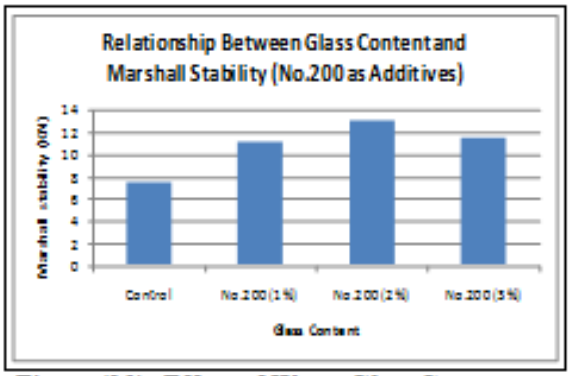


Figure (13): Effect of Waste Glass Content on Marshall Stability.

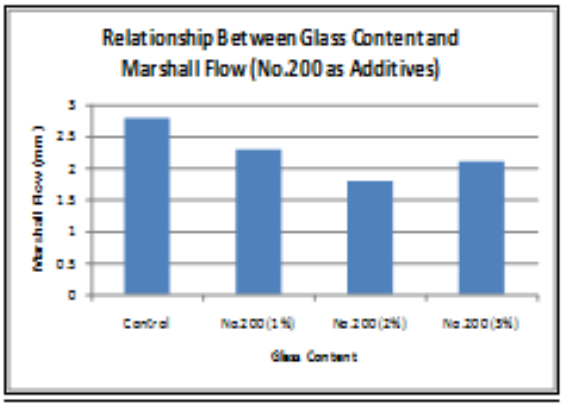


Figure (14): Effect of Waste Glass Content on Marshall Flow.

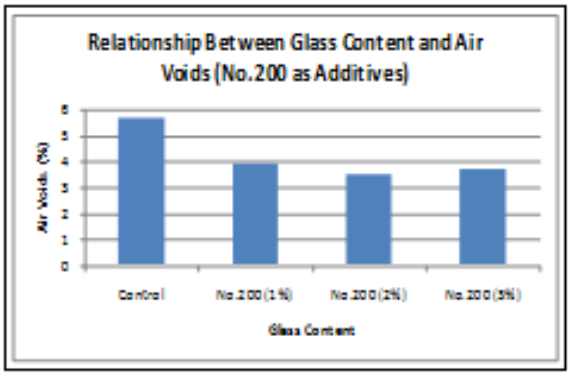


Figure (15): Effect of Waste Glass Content on Air Voids.

CONCLUSION

Within the limitations of materials and testing program adopted in this work, the followings are concluded:

1. Using waste glass size (1/2in, 3/8in, No.4, and No.50) as secondary aggregate in asphalt mixture decrease Marshall stability.

2. Using waste glass (No.8) as secondary aggregate in asphalt mixture increase Marshall stability by more than 127%.
3. Using waste glass (No.200) as secondary aggregate in asphalt mixture increase Marshall stability by more than 174%.
4. The Marshall stability of asphalt mixture increased by 166% after adding 2% of waste glass (No.200) as additive.

7. Recommendations For Future Works

1. Evaluate the long term performance of projects using waste glass as a construction Material.
2. Evaluation of glassphalt to resist the permanent deformation and cracking.
3. Evaluation of glassphalt to water stability.

REFERENCES

[1] Clean Washington Center, CWC, 2005 "Best practices in glass recycling

[2] Greg Arnold, Sabine Werkmeister, and David Alabaster, 2008, "The effect of adding recycled glass on the performance of basecourse aggregate", NZ Transport Agency Research, Report 351.

[3] Shaopeng Wu, Wenfeng Yang ,and Yongjie Xue, 2008, "Preparation and Properties of Glass-asphalt Concrete", Key Laboratory for Silicate Materials Science and Engineering of Ministry of Education, Wuhan University of Technology, China.

[4] Landris T. Lee , 2007, "Recycled Glass and Dredged Materials", ERDC TN-DOER-T8.

[5] Glass Packaging Institute, 2005, Washington, DC.

[6] American Association of State Highway and Transportation Officials (AASHTO), 2005, "Standard Specifications for Transportation Materials and Methods of Sampling and Testing", Washington, DC.

[7] State Organization of Road and Bridge, (SORB/R9), 2003, "Hot Mix Asphalt Properties".

[8] American Association of State Highway and Transportation Officials, AASHTO T48, 2004, "Standard Method of Test for Flash and Fire Points by Cleveland Open Cup".

[9] American Association of State Highway and Transportation Officials, AASHTO T49, 2003, "Standard Method of Test for Penetration of Bituminous Materials".

[10] American Association of State Highway and Transportation Officials, AASHTO T51, 2004, "Standard Method of Test for Ductility of Bituminous Materials".

[11] American Association of State Highway and Transportation Officials, AASHTO T201, 2004, "Standard Method of Test for Kinematic Viscosity of Bituminous Materials".

[12] Airey G. D., Collop A. C. and Thom N. H., 2004, "Mechanical Performance of Asphalt Mixtures Incorporating Slag and Glass Secondary Aggregates", Proceedings of the 8th Conference on Asphalt Pavements for Southern Africa, Sun City, South Africa.

[13] A A Jasim, S. Mutliack, and A . A Mohammed., 2013, " Investigating the Effects of Using Crumb Rubber in Hot Mix Asphalt Surface on Skid Resistance Properties ", International Journal of Advanced Research (2013), Volume 1, Issue 7, 423-430

****