

321.pdf

by

FILE	321.PDF (622.15K)	WORD COUNT	2377
TIME SUBMITTED	25-NOV-2020 05:22PM (UTC+0700)	CHARACTER COUNT	12319
SUBMISSION ID	1456928039		

PAPER • OPEN ACCESS

Prediction of long-term volumetric parameters of asphalt concrete binder course mixture using artificial ageing test

To cite this article: M Tumpu *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **419** 012058

View the [article online](#) for updates and enhancements.



The banner features a background of a globe with a network of lines. On the left, there are three circular logos: the top one is ECS (Electrochemical Society), the middle one is the Electrochemical Society of Korea (ECSK), and the bottom one is The Korean Electrochemical Society. The central text reads: "The best technical content in electrochemistry and solid state science and technology!" Below this, a blue bar contains the text "Available until November 9, 2020." On the right side, the PRIME 2020 logo is displayed, with "PRIME" in large letters, "PACIFIC RIM MEETING" below it, and "ON ELECTROCHEMICAL AND SOLID STATE SCIENCE" in smaller text. Below the logo, the year "2020" is written. At the bottom right, a dark blue box contains the text "REGISTER TO ACCESS CONTENT FOR FREE!" with a right-pointing arrow.

Prediction of long-term volumetric parameters of asphalt concrete binder course mixture using artificial ageing test

M Tumpu¹, M W Tjaronge¹ and A R Djamaluddin¹

¹Departement of Civil Engineering, Faculty of Engineering, Hasanuddin University, Makassar, Indonesia

E-mail: tumpumiswar@gmail.com

Abstract. Ageing of asphalt mixture occurs during the production and construction, and it will continue until the end of the pavement lifetime. Modified Butonic bitumen consists of petroleum bitumen and extracted bitumen from natural asphalt was used as a binding material to produce asphalt concrete binder course (AC-BC). This study purposed to predict the effect of long-term ageing on volumetric parameters of asphalt concrete binder course mixture using an artificial laboratory test. Three different treatments were conducted, the first treatment without the ageing process as the control specimen, the second and third treatments used oven heating as the artificial ageing process for 2 and 4 days 85°C. After ageing process completion, the volumetric parameters were determined by the value of the void in the mixture (VIM), void of mineral aggregates (VMA) and the void filled with asphalt binder (VFB).

1. Introduction

Highways are important transportation infrastructures that influence the economy, society, culture, and defence and security. Highways serve nearly 80-90% population mobility and flow of goods so that the development of road transport infrastructure is a priority. It is reflected by the amount of national budget absorbed for the construction of new road or maintenance of roads [1, 2]. The contractor, as a service provider, influences the quality of road construction and has a potential risk of construction failure in every stage of the project. The contractor failure is always generated from the unskill workers [3]. It is important to use a material that can withstand the negative impact of vehicle emission, climate, weather action, and can be easily used in road construction.

The impact of this activity is an increasing need for both asphalts. The asphalt is imported as many as 600,000 tonnes per annum. It results in reducing the availability of foreign exchange [4, 5, 6, 7, 8]. A lot of discussions was made on a large amount of the national bitumen import looking for another alternative of refined bitumen. The natural rock asphalt in Buton Islands Indonesia is named as Buton rock asphalt (BRA). Buton natural rock asphalt can be refined to separate bitumen from the minerals [9, 10, 11]. In this study, we refer to such bitumen as semi extracted bitumen from Buton rock asphalt is Retona Blend 55 as the binder.

Asphalt concrete is a construction layer consisting of a mixture of asphalt and continuously graded aggregate, mixed, spread, and compacted at a specific temperature. Layers of asphalt concrete consist of a mixture of three types namely Asphalt Concrete-Wearing Course (AC-WC), Asphalt Concrete-Binder Course (AC-BC), and Asphalt Concrete Base (AC-Base) with a maximum aggregate size of 19, 25.4, and 37.5 mm respectively [12].

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

The ageing process influences the characteristic of asphalt mixture compounds corresponding to the service life of the pavement [13, 14, 15, 16]. Figure 1 describes the ageing of bitumen during mixing, subsequently during storage, transportation and application and finally, service.

In this present paper, an ARC-BC mixture made with Retona Blend 55 as the binder. The present experimental investigation focuses on determining the influence of long term over ageing on the volumetric alteration of AC-BC mixtures by conducting Marshall volumetric test. Void in the mix (VIM), void in mineral aggregate (VMA) and void filled bitumen (VFB) were evaluated in AC-BC mixture.

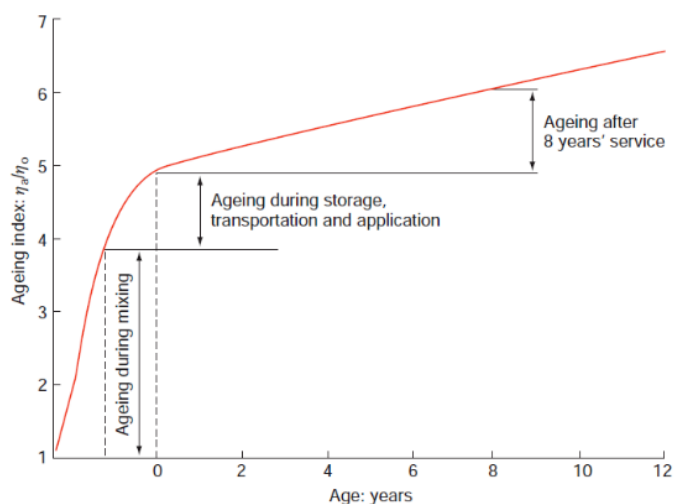


Figure 1. Ageing of bitumen during mixing, subsequently during storage, transportation and application and finally service [16].

2. Materials and Methods

2.1. Aggregates

Two fractions of coarse aggregates derived from crushed river stone were used: one with aggregate diameter 5-10 mm and the other with crushed stone diameter 10-20 mm. River sand and stone dust obtained from the stone crushing process were used as fine aggregate and filler, respectively. These aggregates were from Jeneberang River, Gowa Indonesia. The physical properties of coarse aggregate and fine aggregate are presented in table 1 and table 2.

Table 1. Some properties of coarse aggregate (dimension Ø 20 mm).

Parameter	Value
Bulk density	2.55
SSD density	2.61
Apparent density	2.72
Abrasion (%)	22.64
Particle flat and oval (%)	8.21
Absorption (%)	2.37

Table 2. Some properties of fine aggregate and filler.

9	Parameter	Value
Fine Aggregate		
	Bulk density	2.56
	SSD density	2.61
	Apparent density	2.7
	Absorption (%)	1.89
	Sand equivalent value (%)	83.9
Filler		
	Bulk density	2.55
	SSD density	2.61
	Apparent density	2.71
	Absorption (%)	2.29
	Sand equivalent value (%)	0.66

2.2. Retona Blend 55

Table 3 shows the characteristics of Asbuton modification; Retona Blend 55 used this research.

Table 3. Characteristics of Retona Blend 55.

No.	Kinds of Testing	Testing Result
1	10 Penetration before weight loss (mm)	78.6
2	Softening point (°C)	52
3	Ductility in 25°C, 5cm/minit (cm)	114
4	Flashpoint (°C)	280
5	Specific gravity	1.12
6	Weight loss	0.5
7	Penetration after weight loss (mm)	86

2.3. Combined Aggregate Gradation and Mixtures Design

The combined aggregate gradation is shown in figure 2. The combined aggregate gradation was kept. The mixtures were all prepared in the laboratory. The content of asphalt Retona Blend 55 optimum is 5.80% of the total weight of the mixture. Table 4 shows the mixture by weight 1 AC-BC mixture with 5.80% Retona Blend 55. Retona Blend 55, aggregates and filler were mixed and compacted into the cylindrical mould with a capacity of 1,200 gram and diameter of 101.6 mm. The specimens were compacted with 75 blows each face by using Marshall compactor. Mixing and compaction process was carried out in the laboratory at temperature room 27 C.

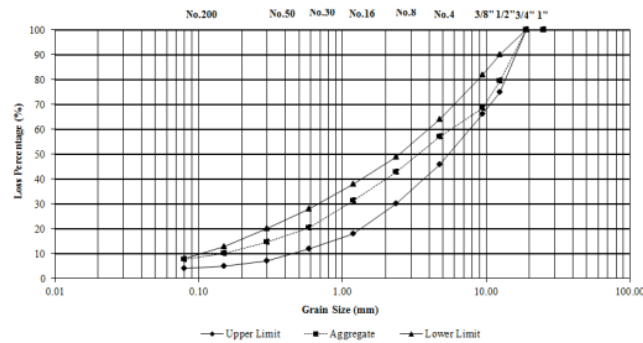


Figure 2. Combined aggregates gradation.

Table 4. Asphalt mixture with 5.80% Retona Blend 55.

Retona Blend 55 (gram)	69.600
Coarse aggregate (gram)	
• Crushed stone 1-2 cm	218.750
• Crushed stone 0.5-1 cm	405.000
Fine aggregate (gram)	506.250
The total weight (gram)	1200

4. Long Term Oven Aging (LTOA)

Long term oven ageing (LTOA) process was performed by subjecting the prepared asphalt concrete binder course mixture, using Retona Blend 55 as the binder. The prepared porous asphalt samples were subjected in an oven at 85°C for 2 and 4 days to perform long term oven ageing [14].

2.5. Volumetric Test of AC-BC Mixture

The Marshall volumetric test was conducted on AC-BC mixture specimens according to SNI 06-2489-1991 [17]. Figure 2 shows the volumetric properties of the asphalt mixture.

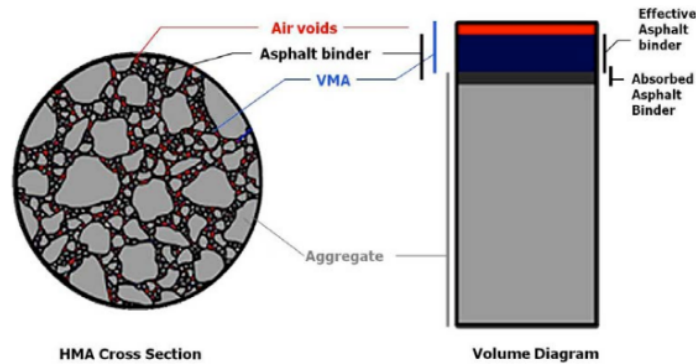


Figure 3. Volumetric properties.

3. Results and Discussion

Volumetric in asphalt mixtures, especially VIM, has a great effect on strength and durability, so it is very important to measure each asphalt mixture. Table 5 shows the results of the asphalt mixture volumetric test consisting of VIM, VMA and VFB values on all variations of good specimens without undergoing ageing processes and specimens undergoing laboratory ageing for two days and four days at 7°C.

It can be seen in table 5 that the VIM value is increasing while the VMA and VFB values are decreasing along with the increase in the ageing process in the laboratory. There was an increase in the average value of VIM test specimens from the ageing process to the specimens that underwent a laboratory ageing process for 2 and 4 days, which were 6.62% and 55.61%, respectively. Based on the Bina Marga requirements, 2010 in Indonesia, the VIM value requirements are 3% - 5% so that the ageing process for four days does not meet the required specifications.

While the decrease in VMA values that occurred was 16.49% and 26.18%, respectively, and VFB values were 9.88% and 30.23% respectively. Therefore, the VMA and VFB values for all variations of test objects meet the specifications required by the general Bina Marga requirement, 2010 in Indonesia.

Table 5. Volumetric value of asphalt mixture affects the ageing process.

No.	Laboratory aging process (oven 85°C)	Test specimen treatment	VIM (%)	VMA (%)	VFB (%)
1	0 day		3,02	22,13	90,91
2			3,94	21,54	86,37
3			3,46	17,77	80,40
\bar{x}			3,47	20,48	85,89
1	Two days	√ Volumetrik	5,02	16,54	69,66
2			4,71	16,78	71,95
3			1,38	19,43	92,88
\bar{x}			3,70	17,58	78,16
1	Four days		5,54	16,13	65,67
2			7,08	14,90	52,49
3			3,59	17,67	79,69
\bar{x}			5,40	16,23	65,95
	Spesification		3 - 5	> 15	> 65

The increase in VIM value that occurs in the test object is caused by the influence of ageing in the laboratory. This effect causes evaporation of the liquid part of the asphalt due to hardening so that the asphalt becomes brittle and loses its adhesion. This adhesive loss causes cavities in a large mixture. Therefore it affects flexibility and adhesion of asphalt and can cause the road to be easily damaged when receiving traffic [13,15,16].

4. Conclusions

- Good adhesion between bitumen and aggregate particle arose from a good cohesion between bitumen of BRA and petroleum bitumen as droplet phase in the Asbuton modification, Retona Blend 55.
- Before and after the LTOA process completion, the VIM, VMA and VFB obtained from Marshall volumetric test showed that the AC-BC mixture using Retona Blend 55 as the binder could affect the VIM value. In contrast, there was no significant change in the values of VMA and VFB as the results of the ageing process.

References

- [1] Bustan B, Samang L, Ali N, Ramli M I 2016 Risk Level Assesment on Road Construction's Contractors Using Cultural Proffesionalism Based Approach *International Journal of Civil Engineering and Technology (IJCIET)* **10**(1) 199-210
- [2] Sugiyanto G, Harmawan A, Mulyono B 2015 The Characteristics of Asphalt Concrete Binder Course (AC-BC) Mixture with Bottom Ash as Aggregate Substitute *Civil Engineering Dimension* **17**(1) 29-37
- [3] Aly S H, Ramli M I 2016 A Development of MARNI 12.2 Model: A Calculation Tool of Vehicular Emmision for Heterogeneous Traffic Conditions *Journal of Engineering and Applied Sciences* **11**(1) 43-50
- [4] Suryana A, Tobing S M 2003 Inventory on solid bitumen sediment using 'outcrop drilling' in Southern Buton region, Buton Regency, Province Southeast Sulawesi *Colloquium on Results Activities of Mineral Resources Inventory—DIM, the TA*
- [5] Mahyuddin A, Tjaronge M W, Ali N, Ramli M I 2017 Experimental analysis on stability and indirect tensile strength in asphalt emulsion mixture containing Buton granular asphalt *Int. J. Appl. Eng. Res* **12** 3162-3169

- [6] Israil, Tjaronge M W, Ali N, Djameluddin R 2016 Extraction of Bitumen Asbuton as Asphalt Emulsion in Cold Asphalt Mix AC-WC *International Journal of Applied Engineering Research II*(22) 10898-10906
- [7] Gaus A, Tjaronge M W, Ali N, Djameluddin R 2015 Compressive strength of asphalt concrete binder course (AC-BC) mixture using buton granular asphalt (BGA) *Procedia Engineering* **125** 657-662
- [8] Budiamin B, Tjaronge M W, Aly S H, Djameluddin R 2016 Marshall Characteristics of Hotmix Cold Laid Containing Buton Granular Asphalt (BGA) with Modifier Oil Base and Modifier Water Base *International Journal of Engineering and Science Applications* **2**(1) 47-52
- [9] Affandi F 2009) Properties of Bitumenous Mixes Using Indonesian Natural Rock Asphalt *Journal 13th REAA Conference, Maroko*
- [10] Zamhari K A, Hermadi M, Mohamed H A 2014 Comparing the Performance of Granular and Extracted Binder from Buton Rock Asphalt *Int. J. Pavement Res. Technol* **7**(1)
- [11] Chaeruddin F., Tjaronge M W, Ramli M, Patanduk J 2014 Experimental Study on Permeable Asphalt Pavement Used Domato Stone (Quartzite Dolomite) as Course Aggregate for Surface Layer of Road Pavement *Advanced Materials Research* **935** 255-258
- [12] Ministry of Public Works 2006 *Campuran Beraspal Panas* (Jakarta: Ministry of Public Works)
- [13] Nishijima K, Higashi S, Ikeuchi M 2009 Development of re-paved Porous Asphalt Pavement Method for Reconstructing Existing Dense Graded Asphalt Pavement into Porous Asphalt Pavement Using The in-place Surface Recycling Method” *Proceeding of 13th Conference of the Road Engineering Association of Asia and Australasia (REAAA)* pp.5-14
- [14] Klierer J E, Bell C A, Sosnovske D A 1995 Investigation of the relationship between field performance and laboratory aging properties of asphalt mixtures *Engineering Properties of Asphalt Mixtures and the Relationship to their Performance*
- [15] Rizal M, Tjaronge M W, Ali N, Bahar T 2016 Influence of Laboratory Short Term Aging on Tensile Strength of Porous Asphalt Mixture Containing Buton Granular Asphalt *International Journal of Advanced in Mechanical and Civil Engineering (IJAMCE)* **3**(3) 22-25
- [16] Airey G D 2009 *Bitumen properties and test methods In ICE manual of Construction Materials : Volume I : Fundamentals and theory; Concrete; Asphalts in road construction; Masonry* (Scotland : Thomas Telford Ltd) pp. 263-272
- [17] Indonesia National Standard 1991 *Standard Test Method of Asphalt Mix with Marshall Test SNI 06-2489-1991* (Jakarta: Indonesia National Standard)

% **12**
SIMILARITY INDEX

%
INTERNET SOURCES

% **12**
PUBLICATIONS

%
STUDENT PAPERS

PRIMARY SOURCES

- 1** Gaus, Abdul, Tjaronge M.W., Nur Ali, and Rudy Djamaluddin. "Compressive Strength of Asphalt Concrete Binder Course (AC-BC) Mixture Using Buton Granular Asphalt (BGA)", *Procedia Engineering*, 2015. %**3**
Publication
- 2** Gunawan Tarigan, Muhammad Husni Malik Hasibuan, Marwan Lubis, Darlina Tanjung et al. "Effects of Aggregate Abrasion Values to Marshall Properties of Asphalt Concrete AC-WC", *International Journal of Engineering & Technology*, 2018 %**2**
Publication
- 3** K. Aamodt, N. Abel, U. Abeysekara, A. Abrahantes Quintana et al. "Two-pion Bose-Einstein correlations in collisions at ", *Physical Review D*, 2010 %**2**
Publication
- 4** Justas Bražiūnas, Henrikas Sivilevičius, Romualdas Virbickas. "DEPENDENCES OF SMA MIXTURE AND ITS BITUMINOUS %**1**

BINDER PROPERTIES ON BITUMEN BATCHING SYSTEM, MIXING TIME AND TEMPERATURE ON ASPHALT MIXING PLANT", Journal of Civil Engineering and Management, 2013

Publication

5

Adelia Dwidarma Nataadmadja, Oki Setyandito, Fiona Maida Basrian, Michael Grashinton Kurniawardhani. "The study of the usage of coral and limestone aggregates as asphaltic layer on coastal structures", MATEC Web of Conferences, 2017

Publication

% 1

6

Xiaowen Zhao, Kezhen Yan, Shu Yang, Hanyu Peng. "Laboratory Research on the Properties of Warm Amorphous Poly Alpha Olefin-Modified Asphalt Mixture Using Sasobit and Deurex", Journal of Materials in Civil Engineering, 2018

Publication

% 1

7

Yafei Li, Jing Chen, Jin Yan, Meng Guo. "Influence of Buton Rock Asphalt on the Physical and Mechanical Properties of Asphalt Binder and Asphalt Mixture", Advances in Materials Science and Engineering, 2018

Publication

<% 1

8

RILEM Bookseries, 2016.

Publication

<% 1

9 Hendry Anjar Purwanto, Ananto Nugroho, Ririt Aprilin S. "Study of Volcanic-Ash-Impregnated-Bacteria Filler to the Compressive Strength of Concrete", MATEC Web of Conferences, 2017
Publication <% 1

10 "7th RILEM International Conference on Cracking in Pavements", Springer Science and Business Media LLC, 2012
Publication <% 1

11 Tayfur, S.. "Investigation of rutting performance of asphalt mixtures containing polymer modifiers", Construction and Building Materials, 200702
Publication <% 1

EXCLUDE QUOTES ON
EXCLUDE ON
BIBLIOGRAPHY

EXCLUDE MATCHES < 5
WORDS