pISSN 2302-4240
eISSN 2655-2086
Volume 14, Issue 3, September 2025, pp.0711-0717
DOI: http://dx.doi.org/10.32832/astonjadro.v14i3.15719 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

Analysis of Hotmix AC-WC Mixture Using Materials from Lagadar Quarry and Baleendah Quarry for Road Planning Design

Juang Akbardin, Nauval Fajar Alpaqih, Yudi Sekaryadi

Program Studi Teknik Sipil, Universitas Pendidikan Indonesia, Bandung, INDONESIA

E-mail: akbardien@upi.edu

| Submitted: December 22, 2023 | Revised: August 05, 2025 | Accepted: August 13, 2025 |

| Published: September 17, 2025 |

ABSTRACT

The material for the AC-WC hotmix mixture will affect the quality of the AC-WC hotmix itself. In the Bandung City area and its surroundings, materials for the AC-WC hotmix mixture are usually used which are taken from the Lagadar quarry and Baleendah quarry. Therefore, testing is carried out with the aim of comparing the quality of the material from which quarry is better between the two quarries. In addition, testing is needed on the asphalt that will be used because it will also affect the quality of the AC-WC hotmix asphalt produced, and testing is needed on the AC-WC hotmix sample itself by conducting a marshall test. Then the pavement thickness calculation is carried out using the AASTHO 1993 method to determine the thickness of the flexible pavement. Based on the results of the tests that have been carried out on the AC-WC hotmix mixture material taken from the two quarries, the results are quite good, both meet the required specifications. In addition, the test results on the 60/70 pen asphalt used also showed good results because all test results carried out met the specifications according to the existing SNI. The results of the marshall test on the two AC-WC hotmix samples produced showed good results. All marshall parameters for the two samples met the required specifications, but of the two AC-WC hotmix samples, the AC-WC hotmix sample with mixed material from the Baleendah quarry had better marshall parameter values.

Keywords: AC-WC hotmix; AASHTO 1993 method; Marshall testing; asphalt testing.

INTRODUCTION

Roads are all parts of a road, including ancillary structures and equipment intended for public traffic, located on the ground surface, above the ground surface, below the ground surface and/or water surface, and above the water surface, except for railways and cableways [1].

In Indonesia, road construction has developed into two types: rigid pavement and flexible pavement. Flexible pavements have widely used asphalt concrete mixtures because this mixture can produce a waterproof and durable pavement layer and is relatively cheaper than concrete road construction. One such asphalt concrete is Laston Lapis Aus AC-WC, which is the layer that directly comes into contact with vehicle wheels. Asphalt concrete is also commonly referred to as hotmix because the mixing process is carried out at high temperatures.

Aggregate is the main component of hotmix mixtures. There are two types of aggregates used in hotmix mixtures: coarse aggregate and fine aggregate. Coarse aggregate is gravel resulting from the natural disintegration of rock or crushed stone obtained from the stone crushing industry and has a grain size between 4.75 mm (No. 4) and 40 mm (No. 1) 1/2 inches [2]. Fine aggregate is aggregate that passes a minimum of 80% of the No. 4 (4.75 mm) sieve [3]. Fine aggregate that passes the 4.75 mm sieve must consist of natural sand particles or finely crushed stone and other fine particles. Fine aggregate commonly used as a hotmix mixture is natural sand or sand produced by the stone crushing industry.

Hotmix mixture materials taken from different quarries will have different properties and characteristics, which will affect the resulting hotmix. Currently, the hotmix mixture used for hotmix mixtures at several Asphalt Mixing Plants (AMP) in Bandung City, Bandung Regency, and the surrounding areas uses material from the Lagadar Quarry and Baleendah Quarry. However, these two quarries have different properties and characteristics. Therefore, it is necessary to conduct experiments on hotmix mixtures to determine which quarry hotmix material is better, thus optimizing the resulting AC-WC hotmix mixture.

Road Pavement

Road pavement is a layer located between the subgrade and the vehicle wheels, making it in direct contact with the vehicle wheels. Pavement can also be defined as a section of the road hardened with specific construction layers, each with a specific thickness, stiffness, strength, and stability, enabling it to safely and optimally transmit traffic loads to the subgrade. Road pavement technology has developed rapidly since the invention of the wheel around 3500 BC in Mesopotamia and during the Roman Golden Age [4], [5].

Based on the binding material, road pavement structures can be divided into two types: flexible pavement and rigid pavement.

Flexible pavement is a type of pavement that uses asphalt as a binding material. This layer structure is designed to transmit traffic loads to the subgrade.

Asphalt Concrete Layer (Laston AC-WC)

Asphalt concrete-wearing course (AC-WC) is a flexible pavement layer that comes into direct contact with vehicle wheels. Therefore, it is designed to withstand weather and shear forces, and to provide waterproofing for the underlying layers.

The primary materials used in an asphalt mixture are actually only two types: aggregate and asphalt. However, asphalt and aggregate can be used in various ways, depending on the method and intended purpose of the pavement.

Marshall Testing

Marshall testing is a test used to evaluate the strength and stability of asphalt concrete mixtures. The Marshall testing procedure follows [7]-[8]. Testing using the Marshall method and equipment was first introduced by Bruce Marshall of the Mississippi State Highway Department in 1948 and subsequently developed by the U.S. Corps of Engineers [9].

The Marshall test is a method for examining and determining the stability of an aggregate and asphalt mixture. Flow is defined as the change or strain of a mixture from unloaded to loaded, resulting in flow, expressed in kilograms [10].

This method is the most widely used and standardized. Three important parameters are used in the Marshall test: Marshall stability, Marshall flow, and the ratio between the two (Marshall stability and Marshall flow), known as the Marshall quotient (MQ).

The Marshall test aims to determine the performance characteristics of an asphalt concrete mixture, including stability, strength, and deformation. The test results are used to ensure that the asphalt concrete mixture meets established technical requirements and standards.

The characteristics of an asphalt concrete mixture can be determined by examining the Marshall properties, which are indicated by the following parameters:

1. Stability
2. Flow
3. Marshall Quotient (MQ)
4. VIM (Void in the Mix)
5. VMA (Void in Mineral Aggregate)
6. VFA (Void Filled with Asphalt)
7. Density

AASHTO 1993 Method

ASTONJADRO

pISSN 2302-4240
eISSN 2655-2086

Volume 14, Issue 3, September 2025, pp.0711-0717
DOI: http://dx.doi.org/10.32832/astonjadro.v14i3.15719 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

Method [11] originates from America and is one of the most frequently used methods for designing road pavement thickness. Furthermore, this method has been widely used worldwide for planning and has been adopted as a planning standard in various countries [12]. Essentially, Method [11] is a planning method based on empirical methods [13], [14].

Evaluation of flexible road damage relative to its design life is performed by comparing the existing condition of the pavement with established performance standards. Damage such as cracks, potholes, deformation, and surface damage are important indicators in assessing road durability. If damage appears earlier than the design life, it indicates that the pavement has experienced decreased performance due to excessive traffic loads, poor material quality, or construction errors. Conversely, if the road remains functional until it approaches its design life, the design and maintenance are considered successful. This evaluation forms the basis for rehabilitation and service life extension strategies [20], [21].

Handling of flexible road damage is based on the severity and type of damage. For hairline or surface cracks, routine maintenance such as sealing or thin overlays can be applied. If deformation occurs, local patching or resurfacing is the solution to restore structural stability. For severe damage such as potholes and subsidence, partial reconstruction with material replacement is required. Furthermore, implementing road management based on design life is crucial for planning periodic maintenance before damage spreads. With a combination of preventive, corrective, and rehabilitative maintenance, the road's service life can be optimally extended according to planned targets [23], [24].

RESEARCH METHODS

This study employed a quantitative descriptive research methodology. The aim was to describe the test results, which were then presented in words as they were.

The samples used in this study were materials taken from the Lagadar and Baleendah quarries. Furthermore, the samples were randomly selected.

RESULTS AND DISCUSSION

Material Testing

The materials taken from both quarries underwent several tests, including specific gravity and water absorption, sand equivalent, silt and clay agglomerate content, abrasion testing with a Los Angeles machine, and aggregate flatness and flatness testing. Based on the test results, the materials from both quarries all met the required specifications based on the technical specifications [15] for flexible pavement or hot mix asphalt. However, the material from the Baleendah quarry had better properties and characteristics than the material from the Baleendah quarry.

Asphalt Testing

Asphalt testing included penetration, viscosity, softening point, flash point, ductility, specific gravity, solubility, weight loss after TFOT, penetration after TFOT, and ductility after TFOT. These testing requirements comply with the 2018 Binamarga General Specifications, Revision 2, Division 6, regarding hot asphalt mixes.

Marshall Testing

The Marshall test results represent the properties of the asphalt mix itself, obtained after all requirements related to materials, asphalt, planned asphalt content, and optimum asphalt content have been obtained. The following is a Marshall summary of the AC-WC design mix formula using mix materials taken from both quarries and Pen 60/70 asphalt.

The test results showed that the Marshall parameters of the AC-WC hot mix using mix materials taken from both quarries all met the required specifications based on the technical specifications [15]-[17].

Pavement Thickness Calculation Using the AASTHO 1993 Method

Based on the 2017 road pavement design manual, the flexible asphalt layer used has a design life of 20 years. The directional distribution factor (DD) was set at 0.5 and the lane distribution factor (DL) at 0.8. Then, the traffic growth factor was 4.8% for arterial roads in Java based on the 2017 road pavement design manual [18], [19].

Example of calculating the equivalence factor on a single axis.

Formula:

$$E = [\frac{Beban\ Grup\ Gandar}{Beban\ Gandar}]^4 \quad (1)$$

So: Example calculation on 1.2L truck

$$E = [\frac{8.3\ x\ 34\%}{5.4}]^4$$
$$= 0.07458$$
$$E = [\frac{8.3\ x\ 66\%}{8.16}]^4$$
$$= 0.2031$$
$$E = 0.07458 + 0.2031 = 2.777$$

So, to calculate traffic on the design lane (W18) you can use the equation below:

$$W18 = (ESAL)o\ x\ DD\ x\ DL$$

where:

W18 = Traffic on the planned lane
ESALo = Total ESAL/day in both directions
DD = Directional distribution factor
DL = Lane distribution factor
This can be calculated as follows:

$W18_{peryears}$ = (ESAL) ox DD x DL x 365
= 8494 x 0.5 x 0.8 x 365
= 992.115.34

Calculate cumulative traffic over the design life (Wt)

$$Wt = W18_{peryears}\ X\ \frac{(1+0.01\ i)^{UR}-1}{0.01\ i}$$
$$= 992.115.34\ X\ 20.09$$
$$= 19.933.049$$
$$= 19.9\ X\ 10^6\ ESAL$$

The CBR value for the subgrade is 6%, resulting in a resilient modulus (MR) of 900 psi. The serviceability value is 2. Since the road is an arterial road, the reliability (R) value is 75%, resulting in a ZR value of -0.674.

Based on the 2013 flexible pavement thickness planning guidelines, the So value is 0.4 and the drainage coefficient (m) is 1.075. Based on the 2013 Flexible Pavement Thickness Planning Guidelines, the a1 value is 0.4 due to the use of a wearing course, the a1 value is 0.4, the a2 value is 0.135 due to the use of a class A aggregate base layer, and the a3 value is 0.125 due to the use of a class B aggregate base layer.

pISSN 2302-4240
eISSN 2655-2086
Volume 14, Issue 3, September 2025, pp.0711-0717
DOI: http://dx.doi.org/10.32832/astonjadro.v14i3.15719 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

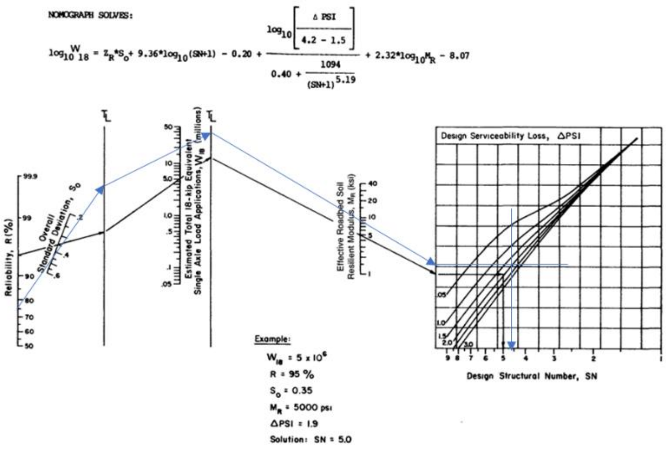

Figure 1. SN Nomogram Value Graph

Based on the graph above, the SN value is 4.6. Because the subgrade MR value is >3000, the pavement thickness is based on the minimum value required in the 2013 Flexible Pavement Thickness Planning Guidelines, as follows:

Table 1. Minimum Pavement Layer Thickness

No	Material Type	Thickness (inchi)	Minimum (cm)
1	Surface Layer		
	Modified Laston		
	- Modified Wear Layer	1,6	4,0
	- Modified Interlayer	2,4	6,0
	Laston		
	- Wear Layer	1,6	4,0
	- Interlayer	2,4	6,0
	Lataston		
	- Wear Layer	1,2	3,0
2	Foundation Layer		
	Modified concrete foundation layer	2,9	7,5
	Concrete foundation layer	2,9	7,5
	Concrete foundation layer	1,4	3,6
	Concrete foundation layer	2,5	6,5
	Class A aggregate	4,0	10,0
	CTB (Cement Treated Base)	6,0	15,0
	CTRB (Cement Treated Recycling Base)	6,0	15,0
	CMRFB (Cement Mix Recycling Foam Bitumen)	6,0	15,0
	CTSB (Cement Treated Subbase)	6,0	15,0
	CTRSB (Cement Treated Recycling Subbase)	6,0	15,0
	Milled concrete (BPG/RCC)	6,0	15,0
	Lean-Mix Concrete (LC)	6,0	15,0
	Cement Soil	6,0	15,0
	Lime Soil	6,0	15,0
3	Subbase layer		
	Class B aggregate	6,0	15,0
	Class C aggregate	6,0	15,0
	Telford Construction	6,0	15,0
	Selected material	6,0	15,0

So we can do the calculation to find the value of D3 with the following steps:

$$SN = a1.D1 + a2D2m2 + a3D3m3$$

$$D3 = \frac{SN-(a1D1+a2D2m2)}{(a3m3)}$$

$$D3 = \frac{4.6-((0.4x4)+(0.135x4x1.075)}{(0.125x1.075)}$$

D3 = 18.01 Inch
= 45.73 Cm

From the calculation results above, the thickness of the pavement for each layer is as follows:

Surface Course = 4 Inch
= 10 Cm
Base Course = 4 Inch
= 10 Cm
Sub Base Course = 18.01 Inch
= 45.73 Cm

Table 2. Thickness of pavement layers

No	Laston	Surface layer
1	Wear-Layer Concrete (AC-WC)	Surface Course AC-BC = 6 cm AC-WC = 4 cm
2	Intermediate-Layer Concrete (AC-BC)	Base Course = 10 cm With a CBR value of 90%
3	Class A Aggregate	Sub-Base Course = 45.73 cm With a CBR value of 60%

CONCLUSION

Based on the test results on the materials from the two quarries, both showed good results because both had results that were in accordance with those required based on the existing SNI and the technical specifications of Bina Marga Year 2018 Revision 2 Division 6. The test results on the 60/70 pen asphalt used also showed good results because all the test results carried out on the 60/70 pen asphalt had results that were in accordance with the specifications required for 60/70 pen asphalt as a mixture of AC-WC hotmix for flexible pavement design. Based on the analysis results, it shows that the AC-WC hotmix mixture using mixed materials from the two quarries has characteristics of marshall parameter values that meet the specifications required for flexible pavement. However, the AC-WC hotmix with a mixture of materials taken from the Baleendah quarry has better marshall parameter value characteristics compared to the AC-WC hotmix with a mixture of materials taken from the Lagadar quarry. Based on the results of the analysis of the AC-WC hotmix with mixed materials taken from the two quarries, it shows that the AC-WC hotmix produced meets the specifications for flexible pavement thickness design, because it has a marshall stability value above 800 kg. Based on the results of the calculation of flexible pavement thickness using the AASTHO 1993 method, the thickness for the surface course layer is 4 inches, for the base course layer is 4 inches with a CBR value of 90%, and for the sub base course is 18.01 inches with a CBR value of 60%.

REFERENCES

[1] Undang-Undang Republik Indonesia Nomor 22 Tahun 2009 Tentang Lalu Lintas Dan Angkutan Jalan

[2] SNI 1969: 2008

[3] SNI 03-6819-2002

[4] Sukirman, Silvia; 2010 “Perencanaan Tebal Struktur Perkerasan Lentur” Penerbit Nova Bandung

pISSN 2302-4240
eISSN 2655-2086
Volume 14, Issue 3, September 2025, pp.0711-0717
DOI: http://dx.doi.org/10.32832/astonjadro.v14i3.15719 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

[5] Sukirman, Silvia; 2003 “Beton Aspal Campuran Panas”Penerbit Granit, Bandung

[6] Syafaruddin, A. S., & Azwansyah, H. Perkerasan Campuran Aspal Ac-Wc Terhadap Sifat Penuaan Aspal. *JeLAST: Jurnal PWK, Laut, Sipil, Tambang*, *5*(2).

[7] SNI 06-2489-1991

[8] ASTM D 1559-76

[9] Bancin, E. D. L., Lubis, K., & Mahda, N. (2021). Pengaruh Penggunaan Tanah Merah Sebagai Filler Pada Campuran Aspal Ac-Bc Terhadap Nilai *Marshall*. *Journal Of Civil Engineering Building and Transportation*, *5*(1), 17-25.

[10] Junaedi, D. R. (2020). Pengaruh Penggunaan Pasir Kuarsa Sebagai Bahan Pengganti Agregat Halus Untuk Perkerasan Laston Ac-Bc. *Jurnal Student Teknik Sipil*, *2*(2), 109-117.

[11] AASHTO 1993

[12] Irianto, I., & Warayaan, J. R. (2019). Perencanaan Tebal Perkerasan Lentur Dengan Metode Aashto 1993 Dan Mdp Jalan 2013 Pada Ruas Jalan Pirime-Balingga Kabupaten Lanny Jaya (Sta 0+ 000 S/D Sta 7+ 500). Jurnal Portal Sipil, 8(2), 83-95.

[13] Farida, I., & Hakim, G. N. (2021). Ketebalan Perkerasan Lentur Dengan Metode Aashto 1993 Dan Manual Perkerasan Jalan 2017. Jurnal Teknik Sipil Cendekia (Jtsc), 2(1), 59-68.

[14] Direktorat Jenderal Bina Marga. (2018). Spesifikasi Umum Untuk Pekerjaan Konstruksi Jalan Dan Jembatan (Revisi 2). Kementerian Pekerjaan Umum Dan Perumahan Rakyat.

[15] Manual Desain Perkerasan Jalan Tahun 2017 No. 02/M/BM/2017 Kementerian Pekerjaan Umum dan Perumahan Rakyat Direktorat Jenderal Bina Marga

[16] Pedoman Perencanaan Tebal Perkerasan Lentur (PT T-01-2002-B)

[17] Surat Edaran Menteri Pekerjaan Umum No. 12/SE/M/2013 Tentang Pedoman Perencanaan Tebal Perkerasan Lentur.

[18] Tahir, A. (2009). Karakteristik Campuran Beton Aspal (AC-WC) dengan menggunakan variasi kadar filler abu terbang batu bara. *SMARTek*, *7*(4).

[19] Tarigan, G. (2019, May). Pengaruh Penggunaan Agregat Alam Pada Campuran Aspal Beton Terhadap *Marshall* Properties. In *Seminar Nasional Teknik (SEMNASTEK) UISU* (Vol. 2, No. 1, pp. 170-173).

[20] Hari Shofia, M., Susanto Haryadi, E., & Syaiful, S. (2021). ANALISIS KONDISI INTERFACE ANTARA WEARING COURSE DAN BINDER COURSE DENGAN MENGGUNAKAN PROGRAM CIRCLY 5.0. ASTONJADRO, 1(2), 14–28. https://doi.org/10.32832/astonjadro.v1i2.787

[21] Akbardin, J., & Sukma Permadi, G. (2014). KAJIAN PENGGUNAAN FILLER KAPUR PADA AC-WC HALUS SPESIFIKASI JALAN BINA MARGA 2010. ASTONJADRO, 3(2), 43–51. https://doi.org/10.32832/astonjadro.v3i2.814

[22] Triyanto, T., Syaiful, S., & Rulhendri, R. (2020). EVALUASI TINGKAT KERUSAKAN JALAN PADA LAPIS PERMUKAAN RUAS JALAN TEGAR BERIMAN KABUPATEN BOGOR. ASTONJADRO, 8(2), 70–79. https://doi.org/10.32832/astonjadro.v8i2.2628

[23] Susanto Hariyadi, E., & Rulhendri, R. (2020). PENGARUH JENIS PEMBEBANAN DALAM ANALISIS STRUKTUR PERKERASAN LENTUR TERHADAP KINERJA PERKERASAN. ASTONJADRO, 2(2), 49–57. https://doi.org/10.32832/astonjadro.v2i2.798