



ANNOUNCEMENTS

[HOME](#) / [ARCHIVES](#) / [VOL. 15 NO. 2 \(2021\): EDISI OKTOBER 2021](#) / [Articles](#)

Effect of Incorporating Super Bond Additives on Volumetric and Mechanical Characteristics of Cold Mix Asphalt Concrete using Asbuton

Rosman Hidayatulloh

University of Mataram

I Dewa Made Alit Karyawan

Universitas Mataram

Ervina Ahyudanari

Institut Teknologi Sepuluh Nopember

DOI: <https://doi.org/10.31849/teknik.v15i2.7616>

Keywords: Asbuton, cold mix, volumetric characteristics, mechanical characteristics, super bond additives

ABSTRACT

Asbuton is the natural asphalt of Buton Island, Southeast Sulawesi. Asbuton has substantial reserves with deposits estimated at between 150 to 300 million tons. Asphalt mixture using Asbuton can be done with a cold mix. This mixture requires a rejuvenating agent that serves to soften and rejuvenate the asphalt properties contained in Asbuton. The rejuvenation process that is less than optimal results

in the low quality of the asphalt mixture. Therefore, it is necessary to conduct a study to improve the performance of cold mixtures using Asbuton. In this study, super bond additives were used. This study aims to determine the extent to which the performance of asphalt-concrete mixtures using Asbuton with the addition of super bond additives in the rejuvenating agent is increased. The addition of additives was varied with levels of 0.0%, 0.2%, 0.3%, and 0.4%, so that the impact could be known. The best asphalt concrete mix characteristics were obtained at the addition of 0.4% additives. Where, for volumetric characteristics the values obtained are: Void in the Mix (VIM) 5.08%, Void in Mineral Aggregate (VMA) 19.6% and Void Filled with Bitumen (VFB) 74.0%. While the mechanical characteristics are: Stability 609 kg, Flow 2.7 mm and Marshall Quotient 223 kg/mm. Only the Marshall Quotient value does not meet the minimum requirements, because it is < 250 kg/mm.

DOWNLOADS

Download data is not yet available.

Volume 15, Nomor 2, Oktober 2021

p-ISSN 1858-4217

e-ISSN 2622-710X

JURNAL TEKNIK

Jurnal Teknik

Volume 15

Nomor 2

Hal : 85 - 200

Oktober 2021

p-ISSN 1858-4217

e-ISSN 2622-710X

Pengaruh Kapasitor Terhadap Faktor Daya Motor Induksi Tiga Fasa di PT. Malindo Karya Lestari. (pp.85-93)

Studi Kebutuhan Perencanaan Pemasangan Busbar Proteksi Pada Gardu Induk Dumai PT. PLN (Persero) UPT Pekanbaru. (pp.94-103)

Studi Pengaruh Pemasangan Soft Stater Motor Induksi Tiga Fasa Pada Tisu Machine di PT. Pindo Deli Perawang. (pp.104-112)

Pola Permukiman Desa Rantau Bais Kabupaten Rokan Hilir. (pp.113-119)

Merancang Museum Sejarah Kota Seribu Sungai di Kota Banjarmasin (pp.120-129)

Effect of Incorporating Super Bond Additives on Volumetric and Mechanical Characteristics of Cold Mix Asphalt Concrete using Asbuton. (pp.130-136)

Durabilitas Beton Sekat Kanal Terpapar Air Gambut dan Air Laut. (pp.137-147)

Sifat Fisik dan Korosi Beton Abu Terbang untuk Sekat Kanal pada Lahan Gambut Bagian Hilir. (pp.148-157)

Analisis Tingkat Kerusakan Bangunan Gedung Asrama Atlit Sport Centre Rumbai. (pp.166-173)

Konsep Desain Masjid Berdasarkan Sinergi Kaidah Arsitektural dan Kaidah Islam. (pp.174-184)

Kualitas Paving Block Dengan Menggunakan Limbah Plastik Polypropylene Terhadap Kuat Tekan. (pp.185-190)

Stabilisasi Tanah Gambut Dengan Campuran Karbit Pada Jalan Lintas Sontang – Duri Kecamatan Bonai Darussalam Kabupaten Rokan Hulu. (pp.190-193)

Analisa Linear Bangunan Gedung Terhadap Beban Angin Dengan Pengaku Outrigger. (pp.194-200)



**Volume 15
Nomor 2
Oktober 2021**

ALAMAT REDAKSI :

FAKULTAS TEKNIK UNIVERSITAS LANCANG KUNING PEKANBARU, JL. YOS SUDARSO KM.08 RUMBAI, PEKANBARU

Email: jurnalteknik@unilak.ac.id

PUBLISHED

2021-10-12

ISSUE

[Vol. 15 No. 2 \(2021\): Edisi Oktober 2021](#)

SECTION

Articles

Abstract viewed = 192 times

pdf downloaded = 142 times

ADDITIONAL MENU

Editorial Team

Reviewer

Author Guidelines

Focus and Scope

Publication Ethics

Publication Frequency

Copyright and Licency

Peer Review Process

Open Acces Policy

Publication Fee

Screening Plagiarism

Indexing

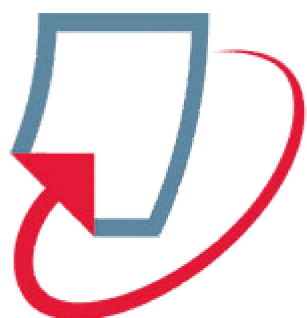
Publisher

Visitor Statistic

Download Template :



Auxiliary Tools



turnitin®

Open Journal System





p-ISSN : 1858-4217



e-ISSN : 2622-710X

[View My Stats](#)

INFORMATION

[For Readers](#)

[For Authors](#)

[For Librarians](#)

[Print ISSN : 1858-4217](#)

[Online ISSN : 2622-710X](#)

[Jurnal Teknik Visitor History](#)

[DOI : 10.31849/2622-710X](#)





(p)ISSN :

1858 4219

(e)ISSN :



9 772622 710124

Jurnal Teknik: is licensed under a [Creative Commons Attribution International](#)

Editorial Office of Jurnal Teknik Universitas Lancang Kuning

Jl. Yos Sudarso KM.8, Umban Sari, Rumbai, Kota Pekanbaru, Riau
28266





ANNOUNCEMENTS

[HOME](#) / [ARCHIVES](#) / Vol. 15 No. 2 (2021): Edisi Oktober 2021

Vol. 15 No. 2 (2021): Edisi Oktober 2021



Volume 15, No. 2 Tahun 2021

DOI: <https://doi.org/10.31849/teknik.v15i2>

PUBLISHED: 2021-10-01

FULL ISSUE

- SAMPUL, DAFTAR ISI DAN EDITORIAL

ARTICLES

Pengaruh Kapasitor Terhadap Faktor Daya Motor Induksi Tiga Phasa di PT. Malindo Karya Lestari

Rio Alfredo Sinaga, Hamzah Eteruddin, Abrar Tanjung

85-93

 PDF

 DOI : <https://doi.org/10.31849/teknik.v13i1.2360>

 Abstract views: 505 ,  PDF downloads: 1211

Studi Kebutuhan Perencanaan Pemasangan Busbar Proteksi Pada Gardu Induk Dumai PT. PLN (Persero) UPT Pekanbaru

Joulelin Yonatan Siallagan, Abrar Tanjung, Arlenny Arlenny

94-103

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.6623>

 Abstract views: 319 ,  PDF downloads: 1674

Studi Pengaruh Pemasangan Soft Stater Motor Induksi Tiga Fasa Pada Tisu Machine di PT. Pindo Deli Perawang

Hendri Naldi, Elvira Zondra, Hazra Yuwendius

104-112

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.6169>

 Abstract views: 326 ,  PDF downloads: 698

Pola Permukiman Desa Rantau Bais Kabupaten Rokan Hilir

Repi Repi, Wati Masrul

113-119

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.6851>

 Abstract views: 469 ,  PDF downloads: 513

Merancang Museum Sejarah Kota Seribu Sungai di Kota Banjarmasin

Noor Hamidah, Ilham Akbar

120-129

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.7462>

 Abstract views: 230 ,  PDF downloads: 219

Effect of Incorporating Super Bond Additives on Volumetric and Mechanical Characteristics of Cold Mix Asphalt Concrete using Asbuton

Rosman Hidayatulloh, I Dewa Made Alit Karyawan, Ervina Ahyudanari

130-136

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.7616>

 Abstract views: 192 ,  pdf downloads: 142

Durabilitas Beton Sekat Kanal Terpapar Air Gambut dan Air Laut

Rita Yulismawati, monita olivia, Edy Saputra

137-147

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.7081>

 Abstract views: 276 ,  pdf downloads: 302


Sifat Fisik dan Korosi Beton Abu Terbang untuk Sekat Kanal pada Lahan Gambut Bagian Hilir

Andi Darmawan, Monita Olivia, Sigit Sutikno

148-157

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.7198>

 Abstract views: 271 ,  pdf downloads: 351

Analisis Tingkat Kerusakan Bangunan Gedung Asrama Atlit Sport Centre Rumbai

Wahyudi, Fadrizal Lubis, Widya Apriani

166-173

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.7428>

 Abstract views: 666 ,  pdf downloads: 782

Konsep Desain Masjid Berdasarkan Sinergi Kaidah Arsitektural dan Kaidah Islam

Titin Sundari, Agus Basri Saptono, Hendri Silva

174-184

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.6939>

 Abstract views: 144 ,  PDF downloads: 1632

KUALITAS PAVING BLOCK DENGAN MENGGUNAKAN LIMBAH PLASTIK POLYPROPYLENE TERHADAP KUAT TEKAN

Erdin Khalid Zulfi Erdin, Zainuri, Fitridawati Soehardi

185-190

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.7435>

 Abstract views: 367 ,  pdf downloads: 2134

STABILISASI TANAH GAMBUT DENGAN CAMPURAN KARBIT PADA JALAN LINTAS SONTANG – DURI KECAMATAN BONAI DARUSSALAM KABUPATEN ROKAN HULU

Amsal Manogu Sianturi Amsal, Virgo Trisep Haris, Lusi Dwi Putri

190-193

 PDF

 DOI : <https://doi.org/10.31849/teknik.v15i2.7433>

 Abstract views: 324 ,  pdf downloads: 502

ANALISA LINEAR BANGUNAN GEDUNG TERHADAP BEBAN ANGIN DENGAN PENGAKU OUTRIGGER

resti nur arini, Fadli Kurnia, Dwi Ariyani

194-200

 **PDF**

 DOI : <https://doi.org/10.31849/teknik.v15i2.8301>

 Abstract views: 268 ,  pdf downloads: 245

ADDITIONAL MENU

Editorial Team

Reviewer

Author Guidelines

Focus and Scope

Publication Ethics

Publication Frecuency

Copyright and Licency

Peer Review Process

Open Acces Policy

Publication Fee

Screening Plagiarism

Indexing

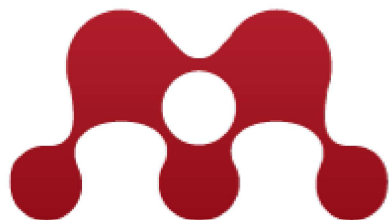
Publisher

Visitor Statistic

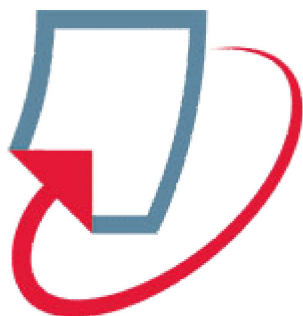
Download Template :



Auxiliary Tools



MENDELEY



turnitin®

Open Journal System





p-ISSN : 1858-4217



e-ISSN : 2622-710X

[View My Stats](#)

INFORMATION

[For Readers](#)

[For Authors](#)

[For Librarians](#)

[Print ISSN : 1858-4217](#)

[Online ISSN : 2622-710X](#)

[Jurnal Teknik Visitor History](#)

[DOI : 10.31849/2622-710X](#)





(p)ISSN :

1858 4219

(e)ISSN :



9 772622 710124

Jurnal Teknik: is licensed under a [Creative Commons Attribution International](#)

Editorial Office of Jurnal Teknik Universitas Lancang Kuning

Jl. Yos Sudarso KM.8, Umban Sari, Rumbai, Kota Pekanbaru, Riau
28266





HOME / Editorial Team

Editorial Team

Editorial Board

Editorial Team

Editor in Chief



Name : [Dr. David Setiawan, ST., MT](#)
 Affiliation : [Universitas Lancang Kuning](#)
 email : dsetia@unilak.ac.id
 Sinta ID ... : [5973810](#)
 Google Scholar ID: [xcST5b4AAAAJ](#)
 Scopus ID : [57193501172](#)
 Riau, Indonesia

EDITORIAL BOARD :



1.

Name : [Widya Apriani, S.T., M.T.](#)
 Affiliation : [Universitas Lancang Kuning](#)
 Email : widya@unilak.ac.id
 Sinta ID : [202872](#)
 Google Scholar ID : [ZidvEHwAAAAJ](#)
 Scopus ID : [57200091463](#)
 Riau, Indonesia



2.

Name : [Boby Samra, ST., MT.](#)
 Affiliation : [Universitas Lancang Kuning](#)
 Email : boby@unilak.ac.id
 Sinta ID : [6004073](#)
 Google Scholar ID: [2w8CwdgAAAAJ](#)
 Scopus ID : [57200085272](#)
 Riau, Indonesia



Name : [Indra Wijaya, S.Pd., M.Pd.T](#)
 Affiliation : [Universitas Putra Indonesia YPTK Padang](#)
 Email : indrawijaya25@gmail.com
 Sinta ID : [6003242](#)
 Google Scholar ID : [VQraobAAAAAJ](#)
 Scopus ID : -
 Sumatera Barat, Indonesia

3.



Name : [Dr. Rizky Ema Wulansari, S.Pd., M.Pd.T](#)
 Affiliation : [Universitas Negeri Padang](#)
 Email : sariema15@gmail.com
 Sinta ID : [6758305](#)
 Google Scholar ID : [uC37RXcAAAAJ](#)
 Scopus ID : [57193502350](#)
 Sumatera Barat, Indonesia

4.



Name : [Mhd Arief Hasan, S.Kom, M.Kom](#)
 Affiliation : [Universitas Lancang Kuning](#)
 email : m.arief@unilak.ac.id
 Sinta ID : [202879](#)
 Google Scholar ID: [xfXdBiAAAAAJ](#)
 Scopus ID : [57203022634](#)
 Riau, Indonesia

5.



Name : [Isra Mouludi, S.Kom, M.Kom](#)
 Affiliation : [Akademi Teknologi Industri Padang](#)
 Email : isra.mouludi@gmail.com
 Sinta ID : [6028512](#)
 Google Scholar ID: [B1qZGTcAAAAJ](#)
 Scopus ID : [57200211249](#)
 Sumatera Barat, Indonesia

6.

Editorial Address :

Fakultas Teknik, Universitas Lancang Kuning
 Jl. Yos Sudarso km.8, Umban Sari, Rumbai, Kota Pekanbaru, Riau 28266
 Office: (0761) 53581 | Phone: 085271220118
 Email: jurnalteknik@unilak.ac.id

ADDITIONAL MENU

Editorial Team

Reviewer

Author Guidelines

Focus and Scope

Publication Ethics

Publication Frequency

Copyright and Licency

Peer Review Process

Open Access Policy

Publication Fee

Screening Plagiarism

Indexing

Publisher

Visitor Statistic

Download Template :



Auxiliary Tools



Open Journal System



p-ISSN : 1858-4217



e-ISSN : 2622-710X



[View My Stats](#)

INFORMATION

[For Readers](#)

[For Authors](#)

[For Librarians](#)

[Print ISSN : 1858-4217](#)

[Online ISSN : 2622-710X](#)

[Jurnal Teknik](#)

[Visitor History](#)

[DOI : 10.31849/2622-710X](#)



(p)ISSN :



(e)ISSN :

Jurnal Teknik: is licensed under a [Creative Commons Attribution International](#)

Editorial Office of Jurnal Teknik Universitas Lancang Kuning

Effect of Incorporating Super Bond Additives on Volumetric and Mechanical Characteristics of Cold Mix Asphalt Concrete using Asbuton

Rosman Hidayatulloh¹, I Dewa Made Alit Karyawan¹, Ervina Ahyudanari²

¹Department of Civil Engineering, Faculty of Engineering, University of Mataram, Mataram, Indonesia

rosmanhidayatulloh@gmail.com

dewaalit@unram.ac.id

²Department of Civil Engineering, Faculty of Civil, Planning, and Geo-Engineering,
Sepuluh Nopember Institute of Technology, Surabaya, Indonesia

ervina@ce.its.ac.id

ABSTRACT

Asbuton is the natural asphalt of Buton Island, Southeast Sulawesi. Asbuton has substantial reserves with deposits estimated at between 150 to 300 million tons. Asphalt mixture using Asbuton can be done with a cold mix. This mixture requires a rejuvenating agent that serves to soften and rejuvenate the asphalt properties contained in Asbuton. The rejuvenation process that is less than optimal results in the low quality of the asphalt mixture. Therefore, it is necessary to conduct a study to improve the performance of cold mixtures using Asbuton. In this study, super bond additives were used. This study aims to determine the extent to which the performance of asphalt-concrete mixtures using Asbuton with the addition of super bond additives in the rejuvenating agent is increased. The addition of additives was varied with levels of 0.0%, 0.2%, 0.3%, and 0.4%, so that the impact could be known. The best asphalt concrete mix characteristics were obtained at the addition of 0.4% additives. Where, for volumetric characteristics the values obtained are: Void in the Mix (VIM) 5.08%, Void in Mineral Aggregate (VMA) 19.6% and Void Filled with Bitumen (VFB) 74.0%. While the mechanical characteristics are: Stability 609 kg, Flow 2.7 mm and Marshall Quotient 223 kg/mm. Only the Marshall Quotient value does not meet the minimum requirements, because it is < 250 kg/mm.

Keywords: Asbuton, cold mix, volumetric characteristics, mechanical characteristics, super bond additives

I. INTRODUCTION

One source of Indonesia's natural wealth that is quite potential is natural asphalt, which is found on the Indonesian island of Buton. So this asphalt rock is known as Asbuton (Buton asphalt). It is estimated that at least about 670 million tonnes are deposited in limestone formations and bitumen residues of ancient petroleum. The bitumen in the rock is between 15% and 35% of the total rock weight. If extracted, it is predicted that there will be around 160 million tons of pure bitumen. These reserves can guarantee the supply of bitumen for Indonesia for at least 100 years [1]. However, its existence has not been proportional to the percentage of its use, because the implementation of road pavement works in Indonesia is still dominated by petroleum asphalt which tends to be more expensive than Asbuton. The low stability value compared to mixtures that use petroleum asphalt is one of the reasons [2]. The weakness of Asbuton as natural asphalt is that the asphalt content is hard and not homogeneous. Asphalt that is not soft

causes the bond is not optimal. Inhomogeneous asphalt content affects the homogeneity of the asphalt mixture. The bitumen present in the granular asbuton is very difficult to separate from the minerals, so it cannot wrap and bind between the aggregates [3]. Seeing these conditions, pure asphalt must be separated from Asbuton minerals so that asphalt can be used widely and economically and can replace the country's dependence on imports [1].

Research and implementation of mixed using Asbuton to get good quality has been done for a long time in Indonesia. Until the 1987's, Lasbutag and Latasbum were known for mixing asphalt with conventional grain asphalt. The properties of asphalt contained in Asbuton are softened and rejuvenated by using rejuvenating agents such as bunker oil or flux oil. However, this is very difficult to achieve, because the fluffier in the form of bunker oil cannot remove the bitumen and then keep it soft. It takes 254 days for the fuel oil type refining agent to reach the bitumen asbuton in the granules, and as a consequence, a good asphalt mixture is not achieved [3].

Asbuton can also be treated with hot, warm or cold mixed systems. Energy consumption for mixing in a warm or cold way is smaller than the hot method which is usually done in asphalt concrete mixes (asphalt concrete). The use of cold mixed Asbuton can reduce production costs because aggregates and binders can be mixed, stored and compacted without energy consumption. Because it is made without heating, it is considered a green pavement, and is friendly to the environment [4]. Compared to Hot Mix Asphalt (HMA), especially at its low energy requirements, Cold Mix Asphalt (CMA) offers many environmental and economic advantages. However, generally less superior in performance [5].

The addition of 0.3% Wetfix-BE additive to improve the performance of the cold asphalt mixture with Asbuton was able to speed up the asphalt setting time. This can be seen from the time required for the asphalt softening process in Asbuton where as long as needed, 3x24 hours, but in this research, optimal results were obtained for materials with Marshall characteristics according to the 2010 Bina Marga Specification, without curing [6].

With a large number of reserves, Asbuton has the potential to be developed as an asphalt mixture for road pavements, especially in Indonesia. The use of Asbuton as an asphalt mixture needs to be increased to meet the needs of road construction programs in Indonesia. This utilization must be accompanied by efforts to improve performance through research. In this regard, a study was conducted on the use of Asbuton as a cold asphalt mixture by adding super bond additives. The research objective was to obtain volumetric

and mechanical values of cold asphalt mixture using Asbuton with the addition of super bond additives. So that recommendations can be given whether the composition of the mixture and the addition of additives meet the requirements. Or provide recommendations both in terms of mixture composition or the percentage of addition of super bond additives, so that they meet the requirements as road pavement materials.

II. METHODS AND MATERIAL

Materials

The materials used to make asphalt concrete mix test specimens are: (1) Asbuton; (2) Aggregate; (3) Rejuvenating agents; and (4) super bond additives. Super bond works by increasing adhesion and bonding and reducing the negative effects of water and moisture resulting in a very sticky surface.

Properties of Asbuton

Asbuton contains asphalt (bitumen) and minerals. Based on the asphalt content, Asbuton can be divided into several types. In this study, Asbuton type B 5/20 was used. Asphalt content contained in Asbuton B 5/20, is known by testing the centrifugal method of extraction using premium as a decomposer. Asphalt content in Asbuton B 5/20 is 19.83% (see Table 1), the rest is fine minerals that will be mixed in the asphalt mixture. This shows that the asphalt content in Asbuton B 5/20 is close to 20% according to the label on the package.

TABLE 1
ASBUTON EXTRACTION TEST[6]

No	Weight		Value	Unit
a	The weight of the cup + asphalt mixture		879.3	gram
b	The weight of the cup + material elements after extraction		739.3	gram
c	Weight of the cup		173.2	gram
d	Weight before extraction	(a - c)	706.1	gram
e	Weight after extraction	(b - c)	566.1	gram
f	Filter paper weight + material element		16.7	gram
g	Filter paper weight		14.8	gram
h	Additional material on filter paper	(f - g)	1.9	gram
i	Cup weight + filler		144.2	gram
j	cup weight		140.0	gram
k	Weight of filler on the cup	(i - j)	4.2	gram
l	The total weight of the material elements	(e + h + k)	572.2	gram
m	Weight of asphalt in mix	(d - l)	140.0	gram
n	Percentage of asphalt in the mix	$(m \div d \times 100)$	19.83	%

TABLE 2
AGGREGATE PROPERTY TEST RESULTS[6]

Test type	Testing standard	Test result	Specification
Los Angeles abrasion	SNI 2417:2008	19.10%	Maximum 40%
Clay lump	CA 3/4"	0.20%	Maximum 1%
	CA 3/8"	0.23%	Maximum 1%
	FA	0.23%	Maximum 1%
	CA 3/4"	3.86%	Maximum 10%
Soundness test	CA 3/8"	4.29%	Maximum 10%
	FA	4.22%	Maximum 10%
Aggregate adhesiveness to bitumen	SNI 2439:2008	98.75%	Minimum 95%
Aggregate flatness index	ASTM D 4791-10	2.80%	Maximum 5%

TABEL 3
PROPERTIES TEST RESULTS OF ASPHALT PENETRATION 60/70[6]

No	Type of Test	Results	Requirement	Unit
1	Penetration	62.4	60-70	mm
2	Softening Point	51.5	≥ 48	°c
3	Ductility	140	≥ 100	mm
4	Flash point	308	≥ 232	°c
5	Specific gravity	1.04	≥ 1.0	-
6	Losing weight	0.0484	≤ 0.8	% of weight
7	Penetration after losing weight	55.2	≥ 54	mm
8	Ductility after losing weight	130	≥ 100	mm

Aggregate Properties

The aggregates used are: coarse aggregate, medium aggregate and fine aggregate with a maximum grain size of 3/4 inch, 1/2 inch and No. 4. Aggregate in this mixture is the main component of cold asphalt mixture, which is 70-75% based on the percentage weight. Aggregate properties obtained through tests include: Los Angeles abrasion, clay lump, Soundness test, aggregate attachment to asphalt, index and aggregate flatness. The results of the aggregate test can be seen in Table 2. While the results of the combined gradation analysis are shown in Figure 1

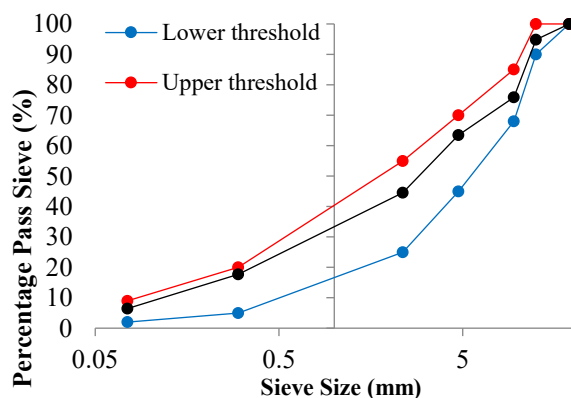


Figure 1: Combined gradation and specification limits

Figure 1 shows the gradation of the combined aggregate consisting of coarse aggregate, medium aggregate, and fine aggregate and the specification limits. These limits indicate the maximum and minimum sizes. No limits are exceeded so that the combined aggregate is eligible for use in asphalt mixtures.

Rejuvenating properties

The rejuvenating agent is a mixture of asphalt, kerosene, and bunker oil. Kerosene is a colorless and flammable hydrocarbon liquid resulting from the fractional distillation of petroleum at temperatures of 150°C and 275°C (carbon chain C12 to C15). The rejuvenating agent is made by heating (diluting) the 60/70 penetration bitumen first. After the asphalt melts, it is then mixed with kerosene and bunker oil. The composition of each ingredient for the rejuvenating agent is 63% asphalt 60/70 penetration, 22% kerosene, and 15% bunker oil. The asphalt used is 60/70 penetration oil asphalt. Table 3 is the result of testing asphalt properties including: penetration, penetration after weight loss, softening point, flash point, ductility specific gravity, and ductility after losing weight.

Research Design

Asphalt-concrete mixture used as a specimen with the following proportions: (1) coarse aggregate (CA) <math><3/4''</math> = 22.5%; (2) coarse aggregate (CA) <math><3/8''</math> = 9.0%; (3) fine aggregate (FA) <math><#4</math> = 43.5%; (4) Asbuton = 25.0%; (5) rejuvenating agen = 4.5%. Additives are added with variations of 0.0%, 0.2%, 0.3%, and 0.4% to the asphalt. For each variation, 3 specimens were made, so that the total number of specimens made was

TABLE 4
SPECIMEN VARIATION

Additive Content (%)	Specimen Code	Number of Specimen
0.0	0.0% - 1	1
	0.0% - 2	1
	0.0% - 3	1
0.2	0.2% - 1	1
	0.2% - 2	1
	0.2% - 3	1
0.3	0.3% - 1	1
	0.3% - 2	1
	0.3% - 3	1
0.4	0.4% - 1	1
	0.4% - 2	1
	0.4% - 3	1
Total Specimen		12

Based on the percentage of asphalt in Asbuton and asphalt in the modifier, the asphalt content in the mixture is as shown in Table 5.

Specimen manufacture and testing

Making the specimen begins by weighing the asphalt-concrete mixture material according to the design composition. The mixing and compaction process was carried out without heating, at room temperature. Figure 2 is a specimen of the asphalt mixture that has been compacted and is ready to be tested.



Figure 2: Specimens of compaction of asphalt-concrete mixture

Testing using Marshall method [7] and [8] to obtain volumetric and mechanical characteristics. Volumetric characteristics include: Void in the Mix (VIM), Void in Mineral Aggregate (VMA), Void Filled with Bitumen (VFB), obtained by weighing the specimen, see Figure 3(a). While the mechanical characteristics, namely stability, flow and Marshall Quotient (MQ) were obtained by testing with Marshall test equipment, see Figure 3(b).

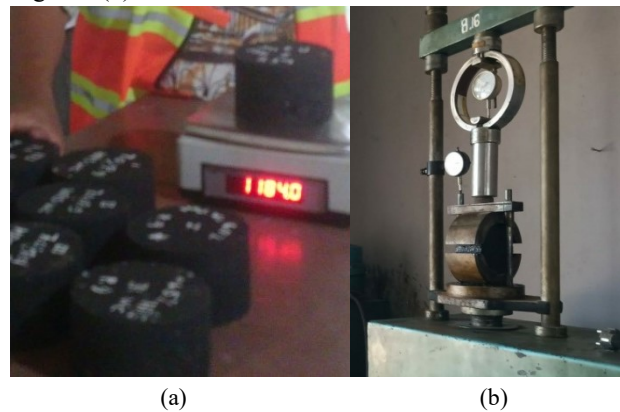


Figure 3: Specimen testing: volumetric (a) and mechanical (b)

TABLE 5

ASPHALT PROCENTAGE CALCULATION

Mixed asphalt content without rejuvenating agen				
Proportion (%)		Asphalt Content (%)		Total in mixture (%)
Asbuton	Rejuvenating agen	Asbuton	Rejuvenating agen	
25.00	0	4.96	0	4.96
Mixed asphalt content with rejuvenating agen				
Proportion (%)		Asphalt Content (%)		Total in mixture (%)
Asbuton	Rejuvenating agen	Asbuton	Rejuvenating agen	
23.88	4.50	4.73	2.84	7.57

III. RESULTS AND DISCUSSION

Volumetric Characteristics

Volumetric is closely related to voids and density. Density-void analysis was used to determine unit weight, VIM, VMA and VFB [9]. Figure 4, shows the results of the density test (unit weight) of cold asphalt mixture specimens with Asbuton based on variations in the addition of additives. The density of the mixture increases with the addition of super bond additives. This means that the addition of a super bond can reduce the cavity so that the weight of the specimen increases.

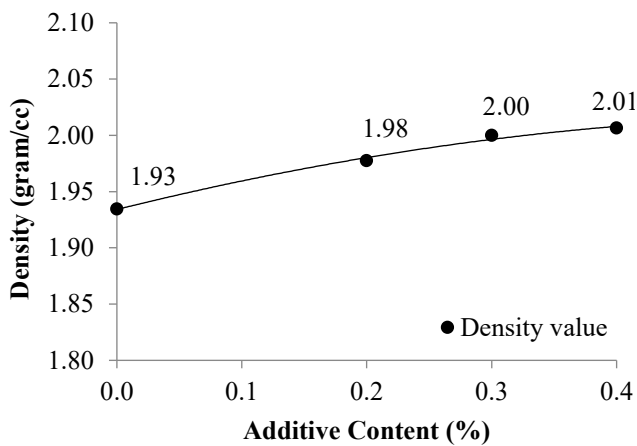


Figure 4: The relationship between additive addition and the density of the mixture

Figures 5 - 7 are the test results in the form of VIM, VMA and VFB. The volumetric characteristics of cold asphalt mixture specimens with Asbuton indicate that the addition of additives has a different effect on each volumetric characteristic.

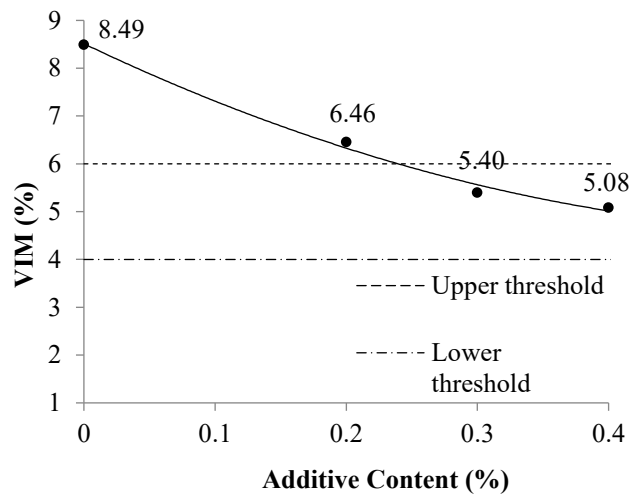


Figure 5: Relationship of additive addition with VIM

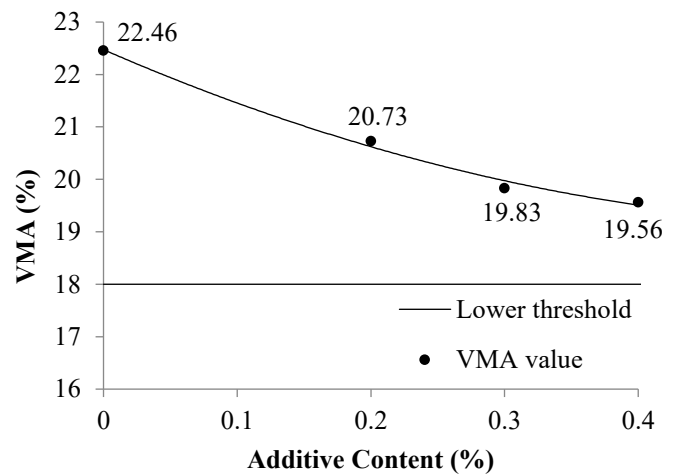


Figure 6: Relationship between additives and VMA

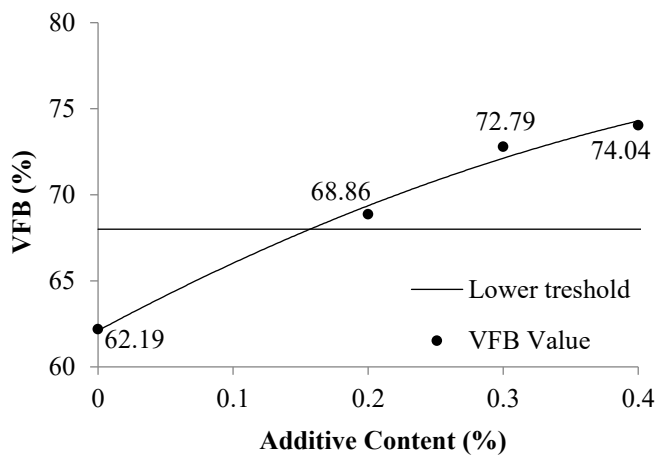


Figure 7: Relationship between additives and VFB

The addition of additives showed an effect on the size of the void mixture. The higher the percentage of additive addition, the smaller the value of VMA and VIM (Figure 5-6). The decrease in the VIM value was caused by an additive reaction that was able to soften the asphalt in Asbuton so that it filled the voids between aggregates (VMA) and enveloped the aggregates. This also causes the VFB value to increase with the addition of additives (Figure 7). Based on the applicable standards in Indonesia [10], the addition of 0.3-0.4% additives meets the volumetric requirements of the mixture. As for the addition of < 0.3% additive, the requirements for VIM and VFB are not met.

Mechanical Characteristics

The Marshall mechanical characteristics measured were the stability and flow of the specimen. Stability is the value of the load at which the specimen fails or has undergone deformation. Flow is the amount of deformation to maximum stability when the sample reaches the limit of collapse [11]. Meanwhile, to determine the stiffness of the asphalt mixture can be known from the value of Marshall Quotient (MQ), namely the ratio of stability to flow. If the specimen loading results have low stability and high flow values, the mixture will tend to deform. On the other hand, if the specimen has high stability and low flow values, the mixture will tend to become brittle and crack when loaded. Figure 8-10 shows the results of stability, flow and MQ testing.

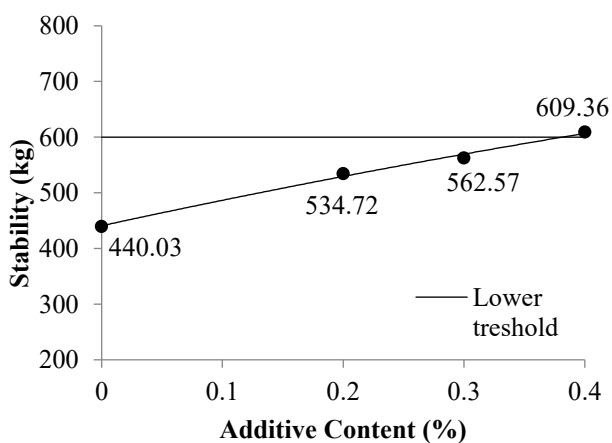


Figure 8: Relationship between additives and stability

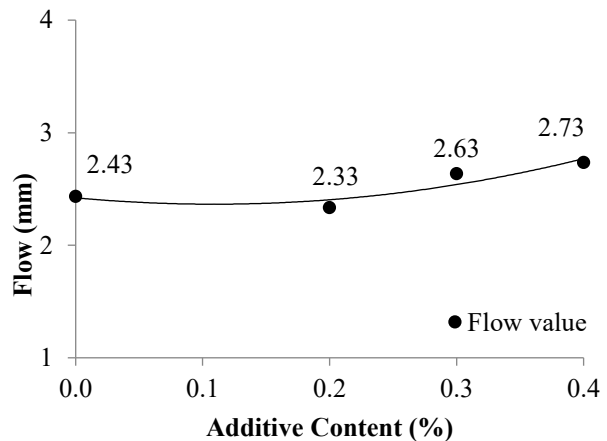


Figure 9: Relationship between additive addition and flow

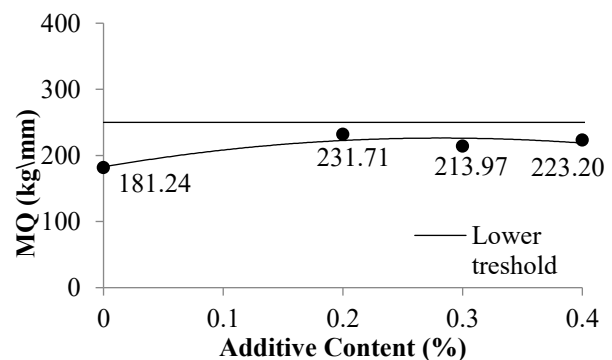


Figure 10: Relationship between additive addition and MQ. The stability test results show that the increase in the amount of additive addition results in an increase in the stability value. However, the addition of additives < 0.4 has not reached the minimum requirements. The addition of additives has an effect on increasing flow, but overall it does not meet the requirements. When viewed from the test results curve, the higher the percentage of additive addition, the performance of the asphalt mixture will increase. So that further research can be done by optimizing the addition of super bond additives to meet all requirements, including MQ which is still < 250 kg/mm.

IV. CONCLUSION

The addition of super bond additives affects the volumetric and mechanical characteristics of the asphalt concrete mixture using Asbuton. Addition of additives with the highest percentage (0.4%) showed the best results. However, not all of the parameters meet the requirements. The value of Void in the Mix (VIM) 5.08%, Void in Mineral Aggregate (VMA) 19.6% and Void Filled with Bitumen (VFB) 74.0%, as volumetric characteristics. While the Stability is 609 kg, Flow 2.7 mm and Marshall Quotient 223 kg/mm, for its mechanical characteristics.

V. REFERENCES

- [1] M. Halimi, I. B. Mochtar, and A. Altway, "A Breakthrough In Asphalt Technology - Cheaper Bitumen Extracted From 'Asbuton', The Rock Asphalt Of Buton Island, Indonesia," *Int. J. Educ. Res.*, vol. 2, no. 8, pp. 347–358, 2014.
- [2] S. Gusty, Erniati, and Yosis, "The effect of using asbuton with used waste diesel oil on the stability of the porous asphalt mix with hot mix cold laid method," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1088, no. 1, p. 012095, 2021, doi: 10.1088/1757-899x/1088/1/012095.
- [3] F. Affandi, "Karakteristik Bitumen Asbuton Butir Untuk Campuran Beraspal Panas," *J. Jalan-Jembatan*, vol. 25, no. 3, pp. 350–368, 2008.
- [4] S. I. Sarsam and Z. A. Samor, "Evaluation of Cold Mix Asphalt Concrete Properties," *J. Civ. Eng. Inter Discip.*, vol. 1, no. 1, pp. 34–40, 2020, doi: 10.47890/jceid/2020/sisarsam/12045784.
- [5] A. K. Arshad, E. Shaffie, F. Ismail, and S. Alam, "Performance Evaluation of Dense," no. October, 2018.
- [6] I. G. Mardawa, E. Ahyudanari, and S. Murtiadi, "Karakteristik Marshall pada Campuran Aspal Dingin dengan Asbuton Akibat Dari Penggunaan Aditif Wetfix-BE," *J. Sains Teknol. Lingkungan.*, vol. 6, no. 1, p. 50, 2020, doi: 10.29303/jstl.v6i1.149.
- [7] Puslitbang Teknologi Prasaranan Jalan Bandung Departemen Pemukiman dan Pengembangan Wilayah, *Metode Pengujian Campuran Beraspal Panas dengan Alat Marshall*. 2003.
- [8] Bina Marga, *Metode Pengujian Campuran Aspal dengan Alat Marshall (SNI 06-2489-1991)*, no. 1. 1991.
- [9] M. M. E. Zumrawi and S. A. Sheikh Edrees, "Comparison of Marshall and Superpave Asphalt Design Methods for Sudan Pavement Mixes," *Int. J. Sci. Tech. Adv.*, vol. 2, no. 1, pp. 29–35, 2016.
- [10] Kementerian PUPR; Ditjen Bina Marga, *Spesifikasi Umum Bina Marga 2018 untuk Pekerjaan Jalan dan Jembatan (General Specifications of Bina Marga 2018 for Road Works and Bridges)*. 2018.
- [11] N. N. Hayati, E. Faculty, S. Sulistyono, and Y. Pratidina, "Marshall Mixed Characteristics Ac-Bc Using Buton Granular Asphalt (Bga) 15 / 20 As Material Composition of Fine Aggregate," no. June 2016, pp. 1–10, 2012.