UDC 69

ANALYSIS OF CAED CHARACTERISTICS USING EMULSIFIED ASPHALT AT OPTIMUM RESIDUE ASPHALT LEVEL

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ABSTRACT
In Indonesia, the use and availability of data/documentation on CAED performance is still very little. Therefore, support from the government is expected to support the development program of asphalt emulsion technology as road preservation in Indonesia. This research was conducted in the laboratory of PT. Sunan Muria and the Banyuwangi Public Works Department Laboratory. The method used in this research is an experimental research method. While the factors studied were the composition factors of cold asphalt mixtures, with the aim of knowing the effect of cold emulsified asphalt mixtures on asphalt quality. The research design on asphalt will be made a test object with a mixture ratio of asphalt content of 6%: 6.5%: 7%, where this mixture will use cold emulsified asphalt. Based on the results of the study, it was concluded that (1) From the results of 3 tests with variations in asphalt content, it turned out that all of them were included, depending on the aggregate to be used in the mixture. The Optimum Residual Asphalt Level (KARO) of cold emulsion asphalt mixture with a variation of 6.0% is with an average stability value of 1053.07 kg (spec > 800 kg), Flow value 4.15 (min. 3), laboratory density of 2,301 and when tested for asphalt content (reflux) with a value of 5.91% which means it is still within the specified tolerance. (2) Optimum Residual Asphalt Level (KARO) of cold emulsified asphalt mixture with a variation of 6.5% is with an average stability value of 1216.67 kg (spec >800 kg), Flow value of 4.06 (min. spec. 3), laboratory density of 2.304 and level testing. asphalt (reflux) with a value of 6.51% then it is still according to the specifications that have been determined. (3) Optimum Residual Asphalt Level (KARO) of cold emulsified asphalt mixture with a variation of 7% is with an average stability value of 1258.01 kg (spec > 800 kg), Flow value 4.40 (spec min. 3), laboratory density of 2,306 and level testing asphalt (reflux) with a value of 6.93%. The advantage of using Asphalt Emulsion Mixture is that it can make the mixture as needed and is more suitable for patching potholes because the mixture can be done on site.

KEY WORDS
Asphalt emulsion, cold emulsion asphalt mix (CAED).

Road construction planning requires adhesive materials, namely cement and asphalt. Asphalt is a residue from the natural or artificial distillation process (refining) of crude oil. In addition to hot mix asphalt, cold mix asphalt is also known. Cold Emulsion Asphalt Mixture (CAED) consists of liquid asphalt and certain graded aggregates that can be mixed and obtained at room temperature without the need for heating. The types of cold asphalt mixtures commonly used for road construction are: Cold Lay Macadams, Cold Emulsion Asphalt Mixture (CAED), and Cutback Asphalt Mixture.

Asphalt or bitumen is a viscous liquid which is a hydrocarbon compound containing a small amount of sulfur, oxygen, and chlorine. Asphalt as a binder in flexible pavement has viscoelastic properties. Asphalt is solid at room temperature and liquid when heated. Asphalt is a very complex material and chemically has not been well characterized. The main content of asphalt is saturated and unsaturated carbon compounds, aliphatic and aromatic which has up to 150 carbon atoms per molecule.

The type of flexible pavement used in Indonesia generally uses a mixture of hot asphalt. Starting around the 1990s, for road works in Indonesia, another type of asphalt was used, namely emulsified asphalt. Emulsified asphalt has a low viscosity level, so it does not need to be heated and does not cause pollution, saving costs and time. CAED also has several disadvantages, namely: it takes a long time to increase strength, is less strong at early age and has high porosity, which is caused by reduced workability during compaction. In Indonesia, the use and availability of data/documentation on CAED performance is still very little.

Therefore, it is hoped that the government will support the development program of asphalt emulsion technology as road preservation in Indonesia. So this research is expected to increase understanding and knowledge in more detail of the characteristics of CAED in Indonesia based on previous studies, namely characteristic analysis research and increasing stability of cold emulsion asphalt mixtures.

LITERATURE REVIEW

CAED is a ready-to-use asphalt mixture that is made with advanced technology and has been tested for excellence in Indonesia and other Asian countries. With a quality equivalent to hotmix asphalt mix, CAED is very practical for patching and repairing potholes.

In determining the cold asphalt mixture, KARO is needed. KARO was determined by optimizing two parameters, namely bath stability and dry aggregate density. Other parameters such as: porosity, water absorption and film thickness are evaluated according to specifications, where the KARO value of these parameters must meet the requirements.

CAED, if directly spread and compacted, is still relatively wobbly and its stability tends to be low, because the residual content of CAED is still around 60% and water content is 40% of the total weight of emulsified asphalt. The evaporation process is required to increase the stability of the mixture up to 2 months after spreading depending on the local weather. The addition of cement to the mixture aims to increase stability, the addition of cement is expected to bind water in the mixture so as to accelerate the process of binding aggregates with residues.

Aggregate is a hard and rigid material used as a mixture consisting of various grains or fractions. The aggregate amount of the pavement mix is generally 90% - 95% by weight, or 75% - 85% by volume. Aggregate properties should be checked as they are determinants of mix performance.

Emulsified asphalt is liquid asphalt which is more liquid than liquid asphalt in general and has the property of being able to penetrate fine pores in rock that ordinary liquid asphalt cannot pass. Emulsified asphalt consists of fine asphalt particles in water which are given an electric charge, so that the asphalt particles do not stick together and remain at the same distance.

Initially the free emulsifier in an emulsion system is absorbed onto the aggregate surface, then another emulsifier is followed according to the aggregate surface area (amount of aggregate). This causes the stability of asphalt grains to decrease and eventually coalesce. This is followed by the evaporation of the liquid, resulting in the aggregated bitumen particles adhering to the aggregate surface. Factors that affect the incorporation of emulsified bitumen grains include:

- Absorption of emulsifying agent onto aggregate surface. This mechanism occurs due to the opposite electric charge on the emulsifying material and the aggregate surface which can result in unstable asphalt granules in the emulsion which then combine with each other;
- Movement of asphalt granules towards the aggregate surface. In this case the asphalt granules are surrounded by the emulsifying material, moving towards the aggregate surface which has an opposite electrical charge. The concentration of asphalt grains on the aggregate surface causes coalescence and then covers the aggregate surface;
- Changes in Ph. Some types of aggregates such as limestone, limestone filler, or cement can neutralize the acid in the cationic emulsified asphalt and increase the pH value. This can result in unstable emulsion resulting in the incorporation of asphalt granules;
- Evaporation of water. With the evaporation of water, asphalt grains become

concentrated, resulting in coalescence of asphalt grains. Evaporation may be the main grain-aggregating mechanism for very slowly reacting emulsified asphalt types.

Asphalt emulsion is produced in a special installation using a colloid mill as the main tool. The hard asphalt is heated and then broken down in a colloid mill through the movement of the rotor and stator, until the asphalt grain size becomes 2-5 microns. Then simultaneously into the colloid mill flowed water that has been mixed with emulsifier (emulsifier), acid solution to adjust the pH, and the necessary additives. The emulsifying solution provides the same electrical charge on the surface of the emulsified asphalt granules so that the emulsified asphalt granules do not combine because of the mutual repulsion forces. This gives the asphalt emulsion stability.

For the storage of emulsified asphalt for a long period of time, the emulsified asphalt stored in the drum should be turned over occasionally to re-homogenize the emulsified asphalt grains or it can also be done by stirring. Asphalt emulsion in storage can be said to be stable if there is no indication of precipitation. Precipitation occurs because emulsified asphalt has a slightly greater density than water.

Due to gravity, asphalt particles, especially those with a larger size, tend to be pulled down. The slow setting type of emulsion can remain stable for a period of 3-6 months, if there is no evaporation of water, no electrolyte contamination, and the emulsifying agent does not change/decrease in stability. The stability of the asphalt emulsion is still satisfactory if the sedimentation that occurs can still be homogenized again with stirring.

The use of emulsified asphalt for various needs in road pavement construction is usually adjusted to the type. Cold mix asphalt is intended for road sections that serve moderate traffic, namely for planned traffic < 1 million ESA or LHR < 1000 vehicles and the maximum number of trucks is 5%, such as district roads.

METHODS OF RESEARCH

This research was conducted in the laboratory of PT. Sunan Muria and the Banyuwangi Public Works Department Laboratory. The research time is planned for 3 months starting from the preparation period until the testing period for the compressive strength of concrete bricks, namely in October-December 2019. The method used in this study is an experimental research method. While the factors studied were the composition factors of cold asphalt mixtures, with the aim of knowing the effect of cold emulsified asphalt mixtures on asphalt quality. The research design on asphalt will be made a test object with a mixture ratio of asphalt content of 6%: 6.5%: 7%, where this mixture will use cold emulsified asphalt. Based on the research design, the number of samples can be determined by testing the compressive strength, specific gravity, and asphalt content of each 2 test objects. Penelitian ini secara garis besar dibagi dalam dua tahapan, yaitu:

This research is broadly divided into two stages, namely:

(1) Stages of material research (new aggregates, and asphalt emulsion) with the following steps:
- Prepare materials which include, new aggregates, and new emulsified asphalt;
- Extracting so that the asphalt and aggregate are separated so that the asphalt content contained in the mixture is known;
- To test the gradation and physical properties of the extracted aggregate;
- Perform specific gravity testing;
- To test the gradation and physical properties of the new aggregate;
- Test the marshal compressive strength on the test object.

(2) Research stages of cold emulsified asphalt mixture with the ultimate goal of knowing the optimal composition of the mixture, cold emulsified asphalt, and new aggregate with the following steps:
- Re-grading the gradation of aggregates by adding new aggregates with a certain amount and size to fill the gradation envelope;
- To calculate the additional amount of cold emulsified asphalt used in the mixture;

- Marshall Test;
- Results and conclusions. The series of research activities are briefly presented in the form of a flow chart and carried out at the AMP Testing Laboratory of PT. Sunan Muria – Jember.

RESULTS AND DISCUSSION

In carrying out this aggregate test, the function is to find the gradation in the aggregate, to carry out this aggregate test the material used comes from AMP PT. Sunan Muria Jember. A series of experiments were carried out to determine, among others, the specific gravity, the strength of the aggregate, and the most important thing was to know the aggregate gradation to determine the percentage of each aggregate fraction used for layer mixtures. To see and understand more clearly the results of aggregate testing in this study can be seen as follows: Based on SNI 03-1968-1990 this examination is intended to determine the division of grains (gradation) of aggregate using the American Society for Testing and Materials (ASTM) standards and to determine the composition of the aggregate mixture that meets the specified specifications.

Table 1 – Combine Grading Agregate

Sieve	Ca 10 – 20		Ca 10 – 15		Ma 5 - 10		Fa 0 - 5		*Filler*		Total
size	0%		15%		38%		47%		0%		
2 "	100	0	100	15	100	38	100	47	100	0	100
1½"	100	0	100	15	100	38	100	47	100	0	100
1 "	100	0	100	15	100	38	100	47	100	0	100
3/4"	97.7	0	100	15	100	38	100	47	100	0	100
1/2"	32.2	0	58.3	8.7	100	38	100	47	100	0	93.7
3/8"	8.4	0	19.4	2.9	99	37.8	100	47	100	0	87.7
# 4.	2.8	0	0.4	0.1	35	13.3	100	47	100	0	60.4
# 8.			0	0	11	4.1	88	41.3	100	0	45.5
# 16.			0	0	8.5	3.2	54	25.6	100	0	28.8
# 30.			0	0	6.8	2.6	36	16.9	100	0	19.5
# 50.			0	0	5.7	2.2	23	10.7	100	0	12.9
# 100.			0	0	3.9	1.5	12	5.7	100	0	7.2
# 200.			0	0	2.3	0.9	9.1	4.3	99	0	5.1

Source: Test Results, 2019.

From the table above, the proportion of aggregates of size 0-5 = 47%, aggregates of size 5-10 = 38%, aggregates of size 10-15 = 15%. After getting the results from the calculation table above, the mix design results graph has appeared. In order to make it easier to read and understand the results can be seen in the graph the calculation results above are as follows:

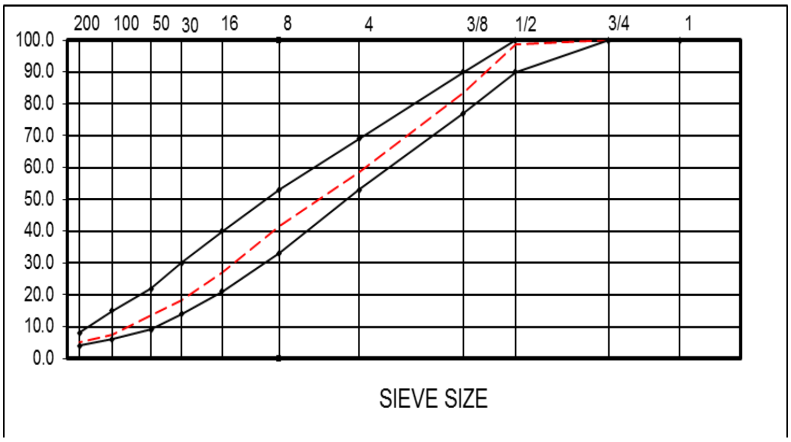

Figure 1 – Grafity Combined Grading

The results of the graph above show that the proportion of the aggregate mixture has met the requirements and is included in the envelope as stated in table 1 above.

The purpose of this study is to determine the asphalt content that has been calculated in the previous mixture by after making the test object whether it is in accordance with the specifications that have been determined according to SKBI-24.26.1987, namely the allowable asphalt content ranging from 4% to 7%. Asphalt content is a percentage of the weight of the sediment and the weight of the mixed sample is made by pounding the test object that has been tested with the marshal test. There are 2 methods for testing asphalt content, namely reflux and centrifuge, but lately most use reflux devices because they are considered more accurate, therefore in this study the testers used reflux devices which are located and available at the Banyuwangi Public Works Laboratory with the test object. as many as 3 kinds, namely variations in asphalt content of 6.0%, 6.5%, and 7.0%.

This test intends to determine the calculation of the aggregate gradation after the mixture, whether it still meets the specified requirements. This test uses a mixture of used aggregate from asphalt content or reflux testing. By securing the used aggregate from the extract test which is still wrapped in filter paper and ensuring that there is no addition or subtraction of aggregate material or other objects. For testing the gradation of this extract, it is necessary to have one test object for each variation of asphalt content and must be a material that is in accordance with the previous asphalt content test.

Table 2 – Gradation Extract Test

Filter Number	1/2"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
	12.5	9.5	4.76	2.36	1.18	0.6	0.3	0.15	0.08
Retained material weight (gr)	35.0	70.4	187.5	274.6	357.5	412.8	451.7	482.7	508.7
Retained material (%)	6.52	13.11	34.92	51.15	66.59	76.89	84.13	89.91	94.75
Material passes (%)	93.5	86.9	65.1	48.9	33.4	23.1	15.9	10.1	5.3
Specification	100	90	69	53	40	30	22	15	9

Source: Test Results, 2019.

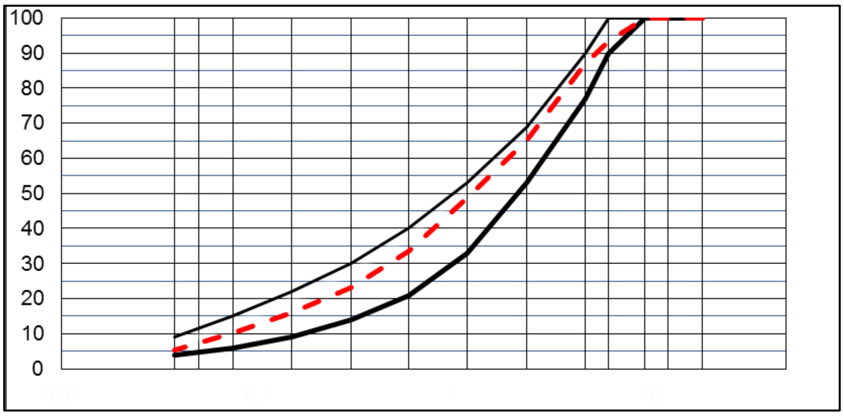

Figure 2 – Gradation Extract Graph

Based on the graphs and tables above are the results of the extract gradation test using the necessary sieve, it can be stated that the aggregate still meets the specified requirements.

Table 3 – Gradation Extract Test

Filter Number	1/2"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
	12.5	9.5	4.76	2.36	1.18	0.6	0.3	0.15	0.08
Retained material weight (gr)	38.4	72.5	200.3	294.0	377.3	437.2	471.9	502.9	556.2
Retained material (%)	6.60	12.46	34.42	50.52	64.84	75.13	81.10	86.42	95.58
Material passes (%)	93.4	87.5	65.5	49.4	35.16	24.87	18.9	13.5	4.4
Specification	100	90	69	53	40	30	22	15	9

Source: Test Results, 2019.

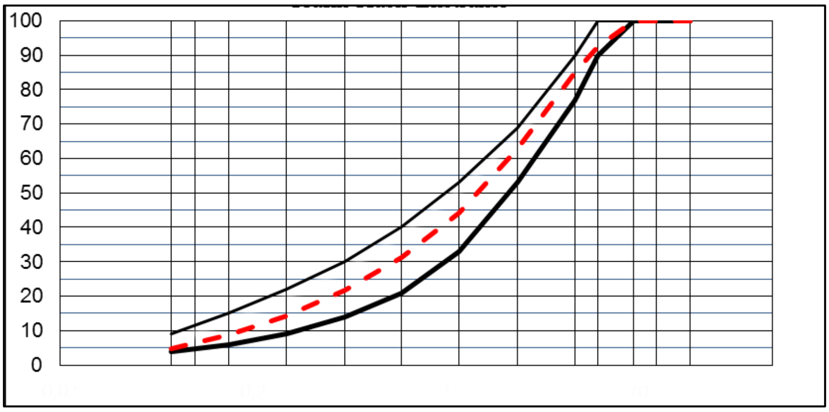

Figure 3 – Gradation Extract Graph

Based on the graphs and tables above are the results of the extract gradation test using the required sieve, it can be stated that the aggregate still meets the specified requirements.

Table 4 – Gradation Extract Test

Filter Number	1/2"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
	12.5	9.5	4.76	2.36	1.18	0.6	0.3	0.15	0.08
Retained material weight (gr)	37.7	69.1	199.2	290.8	339.5	377.2	402.4	419.4	432.1
Retained material (%)	8.20	15.04	43.35	63.29	73.88	82.09	87.57	91.27	94.04
Material passes (%)	91.8	84.9	56.6	36.7	26.1	17.9	12.4	8.73	5.96
Specification	100	90	69	53	40	30	22	15	9

Source: Test Results, 2019.

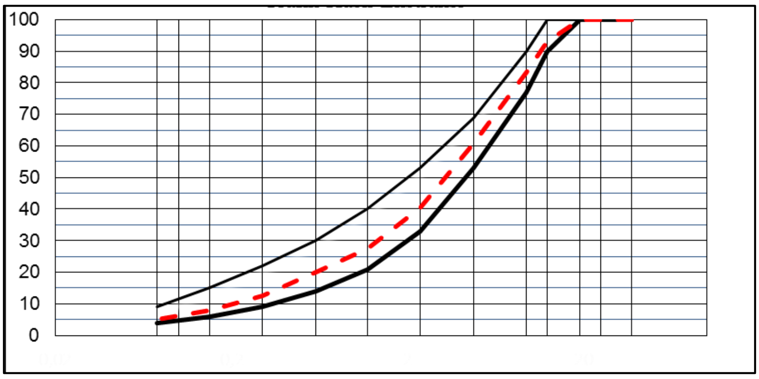

Figure 4 – Gradation Extract Graph

Based on the graphs and tables above are the results of the extract gradation test using the necessary sieve, it can be stated that the aggregate still meets the specified requirements.

CONCLUSION

From the tests and calculations that have been carried out, several things can be obtained that can be used as a basis or benchmark as a cold emulsion asphalt mixture of Css-1h type for actual application or implementation on possible road locations for this type of Css-1h coating. And the results obtained are as follows: (1) From the results of 3 tests with variations in asphalt content, it turns out that all of them are included, depending on the aggregate to be used in the mixture. The Optimum Residual Asphalt Content (KARO) of cold emulsion asphalt mixture with a variation of 6.0% is with an average stability value of 1053.07 kg (spec > 800 kg), Flow value 4.15 (min. 3), laboratory density of 2,301 and when tested for asphalt content (reflux) with a value of 5.91% which means it is still within the specified tolerance. (2) Optimum Residual Asphalt Content (KARO) of cold emulsified asphalt mixture with a variation of 6.5% is with an average stability value of 1216.67 kg (spec >800 kg), Flow value of 4.06 (min. spec. 3), laboratory density of 2.304 and level testing. asphalt (reflux) with a value of 6.51% then it is still according to the specifications that have been determined. (3) Optimum Residual Asphalt Content (KARO) of cold emulsified asphalt mixture with a variation of 7% is with an average stability value of 1258.01 kg (spec > 800 kg), Flow value 4.40 (spec min. 3), laboratory density of 2,306 and level testing. asphalt (reflux) with a value of 6.93%. (4) On the graph of the extract gradation test results in each variation of asphalt content, everything is still in accordance with the specified ampoules or specifications. (5) The advantage of using Asphalt Emulsion Mixture is that it can make the mixture as needed and is more suitable for patching potholes because the mixture can be done on site.

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