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Effect of Additive Addition on RAP (Reclaimed Asphalt Pavement) as an Aggregate Substitution Against the Upper Surface Layer of The Road

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ABSTRACT

As development in the field of infrastructure increases, it will require more materials of natural origin. The availability of materials from nature will be reduced and more limited. Meanwhile, the construction of infrastructure continues to run every year for the improvement and comfort of the community. With this, the importation of goods will also increase, especially for bulk asphalt materials, and it is possible that later the stone that becomes one of the main materials for hot asphalt mixture will also bring in from abroad. If waste from peeled asphalt (RAP) can be reused, it will automatically reduce the use of materials from nature and reduce import activities of goods which results in reduced state expenditure. The paper will discuss the reuse of peeled asphalt (milling) on the highway, starting from the benefits of RAP, the advantages of RAP, testing RAP materials and new materials, and how to produce RAP asphalt at the Asphalt Mixing Plant. The composition of the RAP used is 60% with SW1 rejunevile material of 3.8%, the addition of new aggregates of 40%, and the addition of new asphalt of 3.3%. The results of the compaction experiment in the field (trial compaction) which will be used for work reference are initial compaction (tandem roller 2 passing), intermediate compaction (tire roller 16 passing), and final compaction (tandem roller 1 passing), and the resulting density of hot mix beds of 98.36%.

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1. INTRODUCTION

1.1 Background

At first, RAP was only disposed of as waste, but along with the development of technology, with the addition and mixing of asphalt rejuvenation materials and several other technologies, RAP materials can be used as road pavement materials of economic value. This road recycling system is very profitable because it does not damage the environment much. The use of RAP that will be presented here is for the surface layer (ACWC RAP).

The concept of using RAP as a paved mixture began to be documented in 1915 but received less attention, until then there was an oil embargo in the mid-1970s, in the United States. In addition, the use of RAP is getting higher, due to the increasing price of asphalt which is increasingly soaring and the lack of materials that have quality according to requirements.

Meanwhile, in Japan, the use of RAP as a paved mixture has been used since 1970, due to the importance of protecting the environment. Meanwhile, in Indonesia, the use of RAP began in 2006, where recycled materials added with cement were used as a foundation layer.

In 2006, the Center for Roads and Bridges (Pusjatan) initiated an experiment on recycling technology on a full scale with cement added materials, on the Pantura – Palimanan – Jatibarang road. As well as in 2009, a full-scale test of recycling as a surface layer with the use of RAP of 10% on the Pantura road section of West Java was carried out.

Based on the information that the author knows, the use of RAP compositions used by other parties is still around 10% - 30% of the total mixture, which is carried out by PT. KADI Indonesia for a road repair project in the Surya Cipta industrial area in Karawang, this is in line with the proportion of RAP in a practical hot paved mixture according to the Asphalt Institute in 1993 is around (10-35)%, while in this final report the author will present the use of RAP composition of 60% [1].

1.2 Problem Formulation

Based on the description above, the author will provide a formulation of the problem:

a. Is it possible that the use of RAP can be 100% without the addition of new aggregates?
b. Whether all RAP aggregates can be reused?

1.3 Limitations of the Issue

In the preparation of this Final Report, the use of RAP is limited only to the surface layer, while for the use of other types of hot mixes such as RAP as a foundation, namely CTRSB (Cement Treated Recycling Sub Base), CTRB (Cement Treated Recycling Base), CMRFB (Cold Mix with Recycling Foam Bitumen) we will not explain.

1.4 Problems Encountered

A frequent problem in the manufacture of recycling / recycled RAP asphalt is :

a. Availability of rap asphalt raw materials.
b. During the production process, a lot of material is wasted because it has to wait for the temperature to be 145 °c.
c. Frequent scales arise in the doors of RAP asphalt openings in the asphalt mixing plant units.
d. The temperature of the mixture drops faster than that of conventional asphalt mixtures.
e. Supply coarse aggregates and fine aggregates that are not by the design mix formula in the laboratory.
f. Limited AMP that can reprocess (Recycle) RAP.

1.5 How to Solve the Problem

Based on the problems faced above, the way to solve the problem is :

a. The limited availability of RAP raw materials is because many do not know that RAP can be reused, so it is necessary to socialize this matter to all construction actors.
b. For the speed of the engine that runs the RAP conveyor belt should be able to adjust its RPM, for preheating it can be reduced so that the RAP material is not wasted much.
c. Cleaning must be done every time the production is completed, because if the temperature has decreased the crust will harden, making it difficult to centerfire during the next production process.
d. The temperature is relatively faster to fall than conventional asphalt, so it needs to be treated with special treatment.

2. LITERATURE REVIEW

2.1 Definition of the path

According to the Law of the Republic of Indonesia Number 38 of 2004 concerning Roads, the definition of a road is a land transportation infrastructure that includes all parts of the road, including its complementary buildings intended for traffic, which are at ground level, above ground level, below ground and or water level, as well as above water level, except railway roads, lorry roads, and cable roads.

2.2 Rejuneville

Rejuneville additive is a binder for RAP in which it is contained and composed of light aromatic compounds, to replace light aromatic compounds that evaporate or oxidize in RAP. The ability of light aromatic compounds from asphalt emzymetic additives must be able to penetrate the asphalt layer and diffuse on RAP so that it can reconstruct aging asphalt into a new pavement layer material [2]

Additives must have a low viscosity designed for :

a. restores rap properties

b. binding to improve the properties of RAP-containing asphalt mixtures.

Ideal rejuvenation not only restores the mechanical properties of asphalt, but also corrects the chemical composting of age asphalt. The peremaja material of very light aromatic compounds can increase resistance to cracking at low temperatures and permanent deformation [3]

2.3 Past Research

1. Emrizal in 2009 [4], in a study entitled "Utilization of Concrete Asphalt Recycling Material for Cold Mixed Concrete Asphalt Material Using Emulsion Asphalt", it was found that the characteristics and properties of the material structure of the concrete asphalt unloading material according to the results of the extraction examination have undergone degradation with the asphalt content in RAP is 4.8%. This research utilizes the material of ex-scratching the Yogyakarta-Prambanan Road (BP03). The asphalt emulsion used is of the CSS-1H type. A cold mixture of asphalt concrete with a RAP content of 90% for the extracted dense aggregate gradation mixture (DGEM), and 95% for the dense aggregate gradation mixture (DGEM) without extraction resulted in a Marshall stability value of > 800.
   The difference between the previous research and the research to be carried out is Emrizal (2009), in a study entitled "Utilization of Concrete Asphalt Recycled Material for Cold Mixed Concrete Asphalt Material Using Emulsion Asphalt", it was found that the characteristics and properties of the material structure of the concrete asphalt unloading material according to the results of the extraction examination have undergone degradation with the asphalt content in RAP is 4.8%. This research utilizes the material of ex-scratching the Yogyakarta-Prambanan Road (BP03). The asphalt emulsion used is of the CSS-1H type. A cold mixture of asphalt concrete with a RAP content of 90% for the extracted dense aggregate gradation mixture (DGEM), and 95% for the dense aggregate gradation mixture (DGEM) without extraction resulted in a Marshall stability value of > 800.
   The difference between the previous research and the research to be carried out is :
   a. The RAP material used comes from the stripping of the pavement layer of Jalan Ir. Soekarno, Tabanan.
   b. The asphalt used is in the form of cationic type emulsion asphalt type CMS-2.
   c. The type of cold asphalt mixture used is open gradation mixture.
   d. This research also reviewing the use of RAP in terms of cost.

2. I Wayan Muliawan in 2011 [5], in a study entitled "Analysis of Characteristics and Improvement of Stability of Cold Emulsion Asphalt Mixture (CAED)", it was found that based on the comparison of average values, standard deviations and t values for the category of comparison of curing time lengths, increased CAED stability without addition and the addition of 2% cement from 3 days to 6 days gave the best results. As for the comparison without and the addition of 2% of cement for the same curing time, the best CAED stability is found at a curing time of 12 days.
   The differences with this study are:
   a. The aggregate material used is a mixture of natural aggregates and the results of stripping pavement layers (RAP) from Jalan Ir. Soekarno, Tabanan.
   b. The asphalt used is in the form of cationic type emulsion asphalt type CMS-2.
   c. The type of cold asphalt mixture used is open gradation mixture.
   d. This study also reviewed the use of RAP in terms of cost.

3. Esti Peni Kusmarini in 2012 [6], conducted laboratory research for the analysis of the use of RAP as a mixture of Hot Asphaltic Concrete paved on the Gemekan – Jombang and Pandaan Malang Road Sections using Asphalt Pen 60-70. The result is an optimal composition of adding coarse aggregates by 6%, medium aggregates by 25%, fine aggregates by 48%, cement by 1%, and asphalt pen by 60-70 by 5.2%. The optimal composition of the use of RAP in terms of technical and cost is 20% RAP and 80% new material with a mixed KAO of 5.9%. The savings achieved were 10.6%.
   The differences with this study are: This study analyzes the use of RAP as a surface layer.

3. RESEARCH METHODOLOGY

The method used in this study is the experimental method, which is a method carried out by holding experimental activities to obtain data. The data is processed to get a comparison result with existing conditions. Experimental investigations can be carried out inside or outside the laboratory. This study will be carried out in the laboratory. The initial purpose of this study was to determine the value of asphalt content contained in RAP and other rap aggregate characteristic values.

3.1 Primary Data
Primary data is data that is collected directly through a series of experimental activities carried out by yourself with reference to annual instructions, namely:
1. RAP asphalt extraction inspection
2. Asphalt penetration check+SW1 (TFOT)
3. New asphalt penetration check
4. Asphalt mushy point check + SW1
5. Checking of new asphalt soft points
6. New aggregate sieve analysis
7. RAP filter analysis

3.2 Secondary Data
Secondary data is data obtained indirectly (obtained from other studies) for the same material/type and is still related to the study. In this study, secondary data include:
1. Data on the value of the characteristics of asphalt pavement
2. Aggregated inspection data.
3. From the results obtained from the extraction of RAP with an optimum of 30%, it will then be used for mixing with new aggregates in this study.
4. (OAC) value data (Optimum Asphalt Content) marshall test from previous research and is one research group, namely the final project with the same material.

3.2. Research Methodology Flow chart

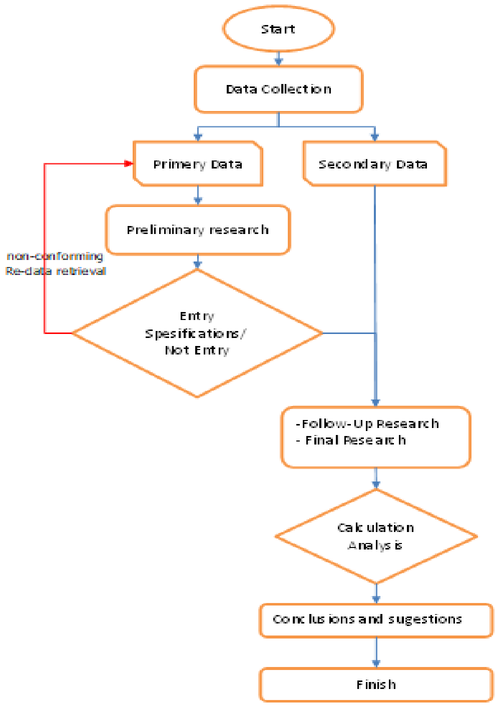

Figure 1. Flowchart Research Methodology

The steps in this research methodology are:
a. Get started
b. Data collection
   a) Primary data
      Extraction testing (Minimum 3.8% asphalt content), if below that then the RAP cannot be recycled
   b) Secondary data
      Further testing is if the resulting RAP asphalt content is at least 3.8%. This follow-up testing includes marshall experiments with variations of peremaja additives, testing the properties of

RAP aggregates and new aggregates, testing new asphalt until it finds optimum asphalt content and optimum additive level.

c. Final testing
This final test is any testing of optimum asphalt content, which is expected to be standardized into a mix design formula

3.4 The flow of the execution procedure

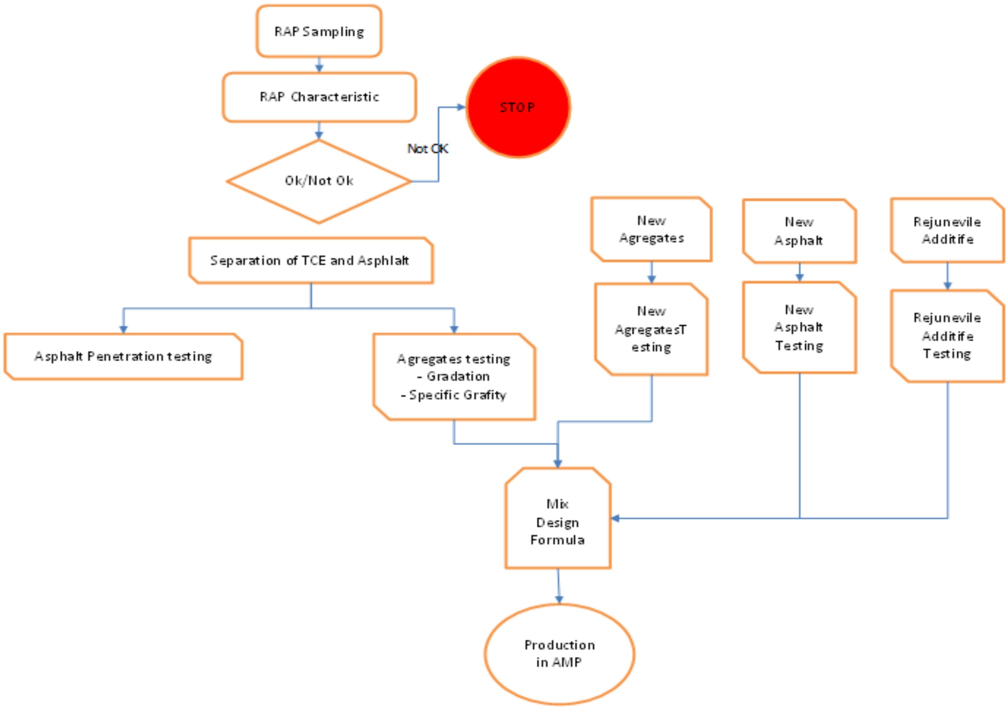

Figure 2. Flowchart of the flow of the execution procedure

3.4.1 Preliminary test
This preliminary test was carried out to determine the characteristics of RAP asphalt taken from the field. These preliminary tests were carried out for rap asphalt and new aggregates.

3.4.2 RAP Testing
An example of RAP asphalt should be taken for a series of tests in the laboratory. The testing will later be used as one of the basics for making a mix formula (DMF) design. The tests for the RAP include:

1. Water content testing

Rap asphalt must be tested for the moisture content contained in it. It is intended to find out how much the dry weight of the RAP asphalt is. Similarly, later to achieve the hourly production target, it can produce how many tons of capacity.

2. Extraction testing

Extraction testing is intended to separate between aggregate and asphalt contained in RAP, thus the level of such RAP asphalt can be known. This is intended to calculate the amount of peremaja additives that will be used and also the addition of new asphalt so that later it becomes a RAP mixture that meets specifications. This extraction test is based on the reference standard SNI 8279:2016: Test Method of Asphalt Content of Hot Asphalt Mixture by Extraction Using Glass Glass Reflux Tube.

3. Penetration Test

Before performing penetration testing, we must separate the TCE liquid from the asphalt result from the extraction. The separation uses a rotary evaporator. The process of separating asphalt and clean with a rotary evaporator is contained in SNI 4797:2015: Procedures for Asphalt Recovery with Rotary Evaporation Device and SNI 2456:2011: Penetration at 25oC, 100 g, 5 seconds, 0.1 mm.

After the separation process is complete, then test the penetration of the asphalt from the extraction. This penetration process is carried out to determine the penetration value of the asphalt contained in the RAP asphalt.

Penetration, which is a number that shows the hardness of asphalt measured from the depth of the penetration needle given a load of 100 grams for 5 seconds at a room temperature of 25°C. The greater the penetration value, the softer the asphalt and vice versa. Specific gravity, that is, a figure that shows the ratio of the weight of asphalt to the weight of water at the same volume at room temperature. The greater the specific gravity value of asphalt, the smaller the mineral content of oil and other particles in the asphalt. The higher the specific gravity value of the asphalt, the better the quality of the asphalt. Minimum asphalt specific gravity of 1.00

Penetration testing aims to determine the penetration of hard or mushy bitumen (solid or semi-solid) by inserting a penetration needle of a certain size, shape, and within a certain time into the bitumen at a certain temperature.

3.4.3. Testing of new materials

3.3.3.1 New Asphalt Testing

Asphalt is an adhesive material (cementitious), black or dark brown in color, with the main element bitumen obtained from petroleum refining residues serving as aggregate binders in roadmaking. Asphalt was chosen for road construction because it has concentrated properties (consistency), resistance to weathering caused by weathering, degree of hardening, and resistance to water.

Asphalt has visco-elastic properties and depends on the loading time. Asphalt will melt if heated to a certain temperature and freeze again if the temperature drops. The asphalt content consists of 80% carbon, 10% hydrogen, 6% sulfur, and the rest of oxygen and nitrogen, as well as a number of iron, nickel,l and vanadium. Asphalt is made from crude oil, through the distillation process or can be found in natural ingredients as part of natural components found together with other materials.

Here are some definitions and definitions of asphalt from some book sources:
Asphalt is an adhesive material (cementitious), black or dark brown in color, with the main element bitumen. Bitumen is an adhesive substance (cementitious) of black or dark brown color, which can be obtained in nature or as a result of production [7].

Asphalt is a solid or semi-solid form material in black to dark brown, adhesive (cementitious) that will soften and melt when heated. Asphalt is composed mainly of most bitumens, all of which are found in solid or semi-solid form from nature or as the result of petroleum refining, or are a mixture of bituminous materials with petroleum or its derivatives [8]

Asphalt is the most commonly used material for aggregate binding materials, therefore often bitumen is also referred to as asphalt [9].

Asphalt is a material that is black to dark brown in color whereas at room temperature it is solid to semi-solid. If the temperature is high, the asphalt will melt, and when the temperature decreases the asphalt will again become hard (solid) so that the asphalt is a thermoplastic material [10]

3.3.3.2 Testing of new materials

New materials in addition to RAP asphalt must also be tested for characteristics. The new aggregates that are commonly used are:

1) Coarse aggregates

Coarse aggregates are aggregates that are held by sieve no.4. Coarse aggregates for ACWC mixtures are usually divided into 2 i.e. :

1. Coarse aggregate size 10-20 mm (Split)
2. Coarse aggregate size 05-10 mm (Screening)

2) Fine Aggregates

The fine aggregate is the aggregate that escapes the sieve no.4. This fine aggregate is commonly referred to as stone ash which has a size of 00–05 mm. Fine aggregates must have characteristics that match the required specifications. This fine aggregate can be in the form of stone ash or sand. The use of sand must go through the approval of the Board of Directors and supervisory consultants. Some of the tests of the new aggregate are :

1. Rough aggregate gradation testing
   The aggregate gradation is the distribution of the aggregate grain size variation. Aggregate gradations affect the magnitude of the cavity in the mixture and determine the workability (ease of work) as well as the stability of the mixture. The aggregate gradation is determined by means of sieve analysis, where the aggregate sample must go through a set of sieves. The size of the sieve states the size of the

wire network opening and the filter number states the number of wire network openings per inch of the filter. The purpose and purpose of this test are to analyze the aggregate grains that are retained on the sieve, so that finally later it can be known what percentage of the aggregate is for the RAP asphalt mixture. The reference for gradation testing is SNI 03 - 1968 - 1990.

2. Fine aggregate gradation testing
   Fine aggregate gradation testing is almost the same as rough aggregate testing. What distinguishes it is the arrangement of the sieve and the way it is kwarting.The sieve arrangement for fine gradation testing with an aggregate size of 00 – 05 mm is sieve no.4, no.8, no.16, no. 30, no.50, no. 100, and no.200. In addition, usually fine aggregates must also be washed first before being graded.
3. Combined aggregate gradation combinations
   The combined aggregate gradation combination is required to determine the composition of each of the aggregate fractions to be used for a hot asphalt mixture. The combined aggregate gradation for recycled hot paved mixture must meet the requirements according to the table below :

Table 1. Combined gradation specifications

Sieve Size	**Percent of the passed weight against the total aggregate in the mix**				
	LTBA BRAP		AC RAP		
	Smooth gradations	Rough gradations	WC	BC	Base
37,7 mm					100
25,4 mm				100	90-100
19,1 mm			100	90-100	76-90
12,5 mm	100	100	90-100	75-90	60-78
9,5 mm	90-100	90-100	77-90	66-82	52-71
4,75 mm	68-90	51-90	53-69	46-64	35-54
2,36 mm	47-67	32-47	33-53	30-49	23-41
1,18 mm	31-48	18-31	21-40	18-38	13-30
0,6 mm	19-33	10-20	14-30	12-28	10-22
0,3 mm	11-22	6-15	9-22	7-20	6-15
0,15 mm			6-15	5-23	4-10
0,075 mm	2-10	2-10	4-10	4-8	3-7

3) Testing the specific gravity of coarse aggregates

Aggregate-specific gravity testing is carried out to determine one of the characteristics of such aggregates. In this specific gravity test, bulk specific gravity, dry saturated specific gravity, pseudo-specific gravity, and aggregate absorption will be produced. Bert testing of this type should be carried out on coarse aggregates as well as fine aggregates.

1. Bulk-specific gravity is the ratio between the weight of the dry aggregate and the weight of distilled water whose content is equal to the content of the aggregate in a saturated state at a temperature of 25°C.
2. Pseudo-specific gravity is the ratio between the weight of the dry aggregate and the weight of distilled water whose content is equal to the content of the aggregate in a dry state at a temperature of 25°C.
3. Absorption is the ratio of the weight of water that the pore can absorb to the weight of the dry aggregate, expressed in percent.

4) Aggregate Specific Gravity Combination

The specific gravity combination between fine aggregates and coarse aggregates is used to search for bulk specific gravity, saturated dry specific gravity and combined pseudo-specific gravity. The results of the calculation of this combination of specific gravity will later be used for marshall calculations.

1. Sludge content testing
   Sludge is a lump or layer that covers the surface of the aggregate and escapes sieve No. 200. The content of sludge content on the surface of the aggregate buiran will affect the bond strength of the asphalt and aggregate so that it will reduce the strength and resistance of the paved mixture (hotmix). The sludge and fine dust resulting from the breakdown of the stone are particles measuring between 0.002 mm to 0.006 mm (2 to 6 microns). Sludge content testing is divided into 2, namely, fine aggregate sludge content testing and coarse aggregate sludge content testing.
2. Sand equivalent testing
   Sand equivalent testing is a method of testing fine aggregates or sand passed by sieve number 4 (4.76 mm), using a sand equivalent test tool and a specific working solution; 2) sand equivalent

value is the ratio between the scale of sand readings to the scale of sludge readings on sand equivalent test equipment expressed in percent

3. Testing of Coarse Aggregate Sludge Levels
   Sludge content testing is not only carried out on fine aggregates but on coarse aggregates as well. The purpose of this test is what percentage of particles pass the 200 sieves in coarse aggregates.

5) Bitumen Adhesion Test on Aggregates

This experiment was carried out to determine the attachment of bitumen to a particular rock. The adhesion of asphalt to the aggregate, which is a figure that shows the percentage of the surface area of the silicate rock aggregate that is still covered by the asphalt after the agergat is soaked for 24 hours. High asphalt adhesion can be interpreted as the asphalt has a high ability to attach aggregates so that it is better used as pavement binding material. A good asphalt stickiness value of at least 85%.

6) Abrasion Testing Coarse aggregates

Abrasion is the ability of the aggregate to withstand the friction it receives until the aggregate is destroyed. Resistance to abrasion is often used as an indicator of quality in the field. The low resistance of coarse aggregates to abrasion leads to the destruction of aggregates, thereby increasing the percentage of fine aggregates. To calculate the abrasion value can use the Formula:

$$\frac{W1-W2}{W1} x100\ \%$$

W1= the amount of weight of the test object
W2= weight of sieve test object no.12, after abrasion (gr)

a. Alignment Index Testing
   In natural rocks and crushing plants, there are aggregate fractions that have various forms. British Standard Institution, BSI, (1975) divides aggregate forms into six categories, namely, round (rounded) irregular (irregular), angular (angular), flat (flaky), oblong (elongated), and flat and oblong (flaky and elongated).
   Round, irregular, and angular categories for specific purposes are grouped into one category, that is, uniform dimensions (equidimensional or cubical). An aggregate said to be flattened, oblong and oblong, or uniformly dimensional is determined based on the ratio between the shortest, longest, and average diameters. To illustrate, for a beam-shaped aggregate, the shortest diameter is its thickness, the longest diameter is its length, and the average diameter is its width. BSI determines that if the ratio between the average diameter and the longest diameter is less than 0.55 then the shape of the aggregate is oblong, while if the ratio between the shortest diameter and the average diameter is less than 0.60 then the aggregate shape is flat.
   The purpose of this experiment is to quantitatively assess the distribution of aggregates in the form of flaky (flattened) and elongated (oblong) expressed by the Alignment Index and the Oblong Index.

3.3.4 Job Mix Design

Mixed design planning includes aggregate gradation planning and RAP, determination of asphalt and measurement of the composition of each fraction of both aggregate, RAP, asphalt, and emphatic material. The gradation used is the Indonesian Standard (SNI). The ASTM procedure [8] on the manufacture of test objects can be divided into several stages, namely:

1. Phase I
   It is a preparatory stage for preparing the materials and tools to be used. Determining the percentage of each fraction to facilitate mixing and carry out weighing cumulatively to obtain a more precise proportion of the mixture.
2. Phase II
   Determine the weight of 60/70 penetration asphalt, SW1 weight, aggregate weight, and RAP weight to be mixed based on variations in asphalt content. The percentage is determined based on the total weight of the mixture, which is 1200 grams.
3. Phase III
   A mixture of aggregate and RAP that has been weighed, poured into a pan and then heated on a heater until it reaches a temperature of ± 135°C.
4. Phase IV
   A mixture of new aggregates and preheated RAP is weighed for the calculation of the addition of new asphalt, and subsequently new asphalt is added.
5. Phase IV

After the new asphalt is added, it is immediately reheated while stirring so that the mixture is evenly distributed / homogeneous. It must be observed the temperature at the time of mixing until it reaches a temperature of ± 145°C

6. Phase VI

Additive asphaltene peremaja material (SW1) is added while stirring for a few seconds until the correct homogeneous mixture.

7. Stage VII

The mixture is compacted with a compactor by 75 collisions for each of its sides. Furthermore, the test object is cooled at room temperature, then it is removed from the mold with the help of a hydraulic jack and left again at room temperature until the test object cools.

3.4. Stages of Research

As scientific research, this research must be carried out in a clear and orderly systematics and order so as to obtain results that can be accounted for. Therefore, the implementation of the research is divided into several stages, namely:

a) Phase I

Called the preparatory stage. This stage aims to prepare all the needs of materials and equipment needed in research, so that it can run smoothly.

b) Phase II

So called the stage of examination of materials. At this stage work is carried out as follows:

a. Examination of gradations and characteristics on new aggregates
b. Examination of gradations and characteristics on RAP.
c. Inspection of specific gravity of new aggregates and RAP aggregates (after extraction)
d. GMM testing for variations in asphalt content

c) Phase III

It is called the stage of making test objects based on the results of optimum asphalt content. At this stage work is carried out as follows:

a. Determination of the mix design of rap content in the air conditioner.
b. Manufacture of planned test objects.
c. GMM Testing for Optimum Asphalt content

d) Phase IV

After getting the optimum asphalt content results, at this stage, 3 marshall test objects were made for 30 minutes of soaking and 3 pieces for soaking for 24 hours. In addition, a PRD test object was also made.

e) Stage V

It is called the stage of data analysis. At this stage the data obtained from the test results are analyzed to obtain a conclusion on the relationship between the variables studied in the study.

f) Phase VII

So-called the stage of drawing conclusions. At this stage, the analyzed data are made a conclusion that relates to the purpose of the study. From the planning stages above, a flow chart of the stages of the research methodology can be made.

g) Phase VIII

Trialmix preparation and production in AMP: Mixing experiments at the Asphalt Mixing Plant must be carried out to find out whether the formula mix design that has been made by the laboratory is in accordance with the amp's own production results. At the time of the trial mix should be taken an example of the resulting mixture and hotbin aggregate. The tests carried out are as follows:

a. Marshall testing, for a 30-minute marinade
b. Marshall testing, for 24-hour marinade
c. Marshall testing, to find out the stability of the rest
d. Maximum Specific Gravity Testing (GMM)
e. Gradation testing / sieve analysis for hotbin

h) Phase IX

The next stage is the experimentation at the project site (trial compaction). In this compaction trial, 3 types of compaction experiments were carried out, namely:

a. Early compaction
b. Intermediate compaction
c. Final compaction (finishing)

Things to note in this compaction trial are the temperature of the hotmix mixture. The temperature should correspond to the table below:

Table 2. Hotmix spreading temperature

Stages of mixing and compaction	Mixing and Compaction Temperature (oc)
Mixing Marshall test objects	160±2
Compaction of Marshall test objects	145±2
Mixing the target temperature range	150-160
Asphalt mixture bending from mixing device to dump truck	145-155
Supply to the spreader	140-155
Initial compaction	130-150
Compaction between	105-135
Final compaction	>90

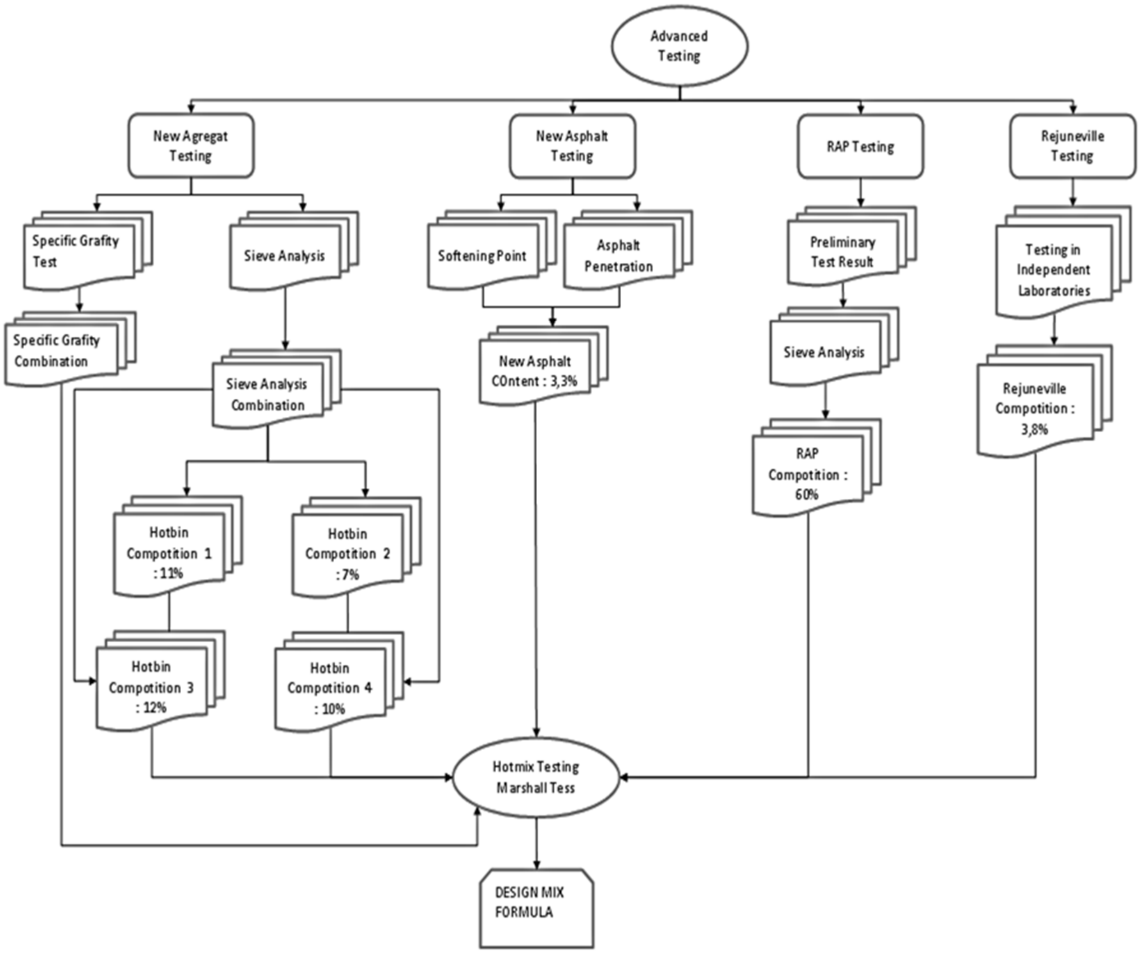

Figure 3. Flowchart ACWC RAP60 hotmix manufacturing

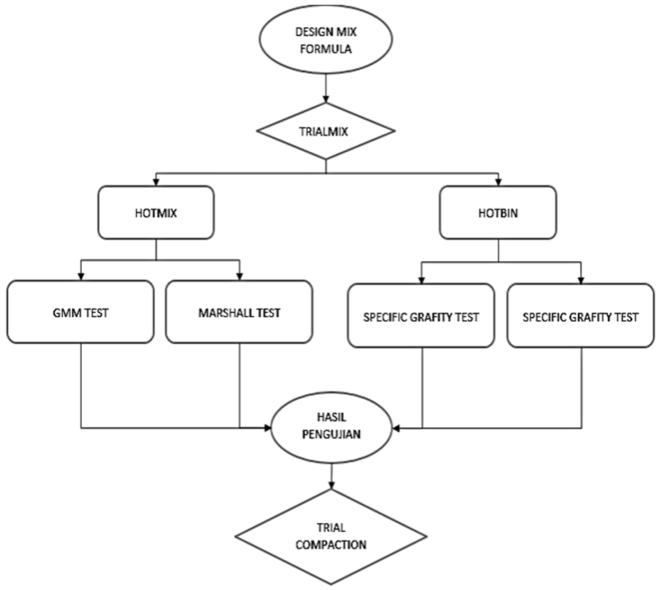

Figure 4. Flowchart Trialmix in AMP

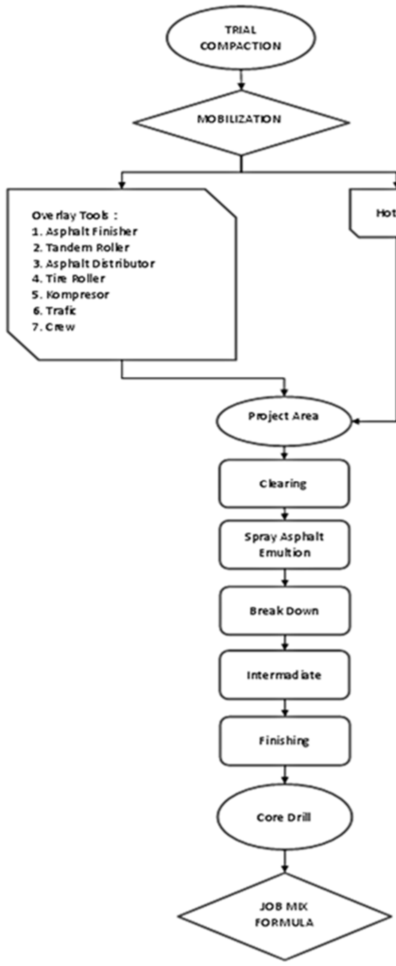

Figure 5. Flowchart Trial Compaction

4. Calculation Analysis

4.1. EXTRACTION TEST

Table 3. Extraction test

Mix Type : ACWCRAP Date : Jan 27,2022				Done by : Ahmad. M Checked by : Tibi.S				
No	Description		Unit	I		II		Average
1.	Weight Sample	Before	Gram	730,0		700,0		
		After	Gram	698,1		669,6		
2.	Weight filter paper	Before	Gram	3,1	3,2	3,2	3,1	
		After	Gram	4,7	4,8	4,7	4,8	
3.	Weight Filler	4-3	Gram	1,6	1,6	1,5	1,7	
4.	Total weight aggregates	2+5	Gram	701,3		672,8		
5.	Weight Asphalt	1-7	Gram	28,7		27,2		
6.	Asphalt Content	(8/1)x100%	Gram	3,93		3,89		**3,91**

4.2. MARSHALL RAP TESTING 100%

Table 4. Marshall + Additive variation

SNI: 06-2489-1991

Project : Trial *ACWC*Rap60 di tol Cipali Km.109 — Done by : Ahmad.M
Date : Jan 28,2022 — Checked by : Tibi.S
Proving Ring Calibration : 31,2477 lbs x 0,4536 = **14,17 kg** — **Bj. *Bulk Agregates* : 2,563**

No	Add	Asphalt content	Weight in air	Weight in water	Weight ssd	Vol	Density	Gmm	AV	VMA	VFB	Stabilitas				MQ
												Dial	Koreksi	Konversi	Flow	
	%	%	Gram	Gram	Gram		Gr/cc	Gr/cc	%	%	%			Kg	mm	Kg/mm
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q
1	1,0	3,91	1197,0	678,6	1202,7	524,1	2,284					84	1190,3	1142,7	2,7	
2	1,0	3,91	1194,2	667,0	1202,3	535,3	2,231					95	1346,2	1292,3	1,9	
3	1,0	3,91	1201,4	674,6	1208,4	533,8	2,251					101	1431,2	1373,9	3,7	
Average							**2,255**							**1269,6**	**2,77**	**458,9**
1	2,0	3,91	1192,4	680,3	1202,4	522,1	2,284					81	1147,8	1147,8	1,7	
2	2,0	3,91	1200,6	689,9	1206,2	516,3	2,325					79	1119,4	1119,4	1,7	
3	2,0	3,91	1197,8	672,0	1203,5	531,5	2,254					78	1105,3	1061,1	1,6	
Average							**2,288**							**1109,4**	**1,67**	**665,6**
1	3,0	3,91	1195,6	678,2	1207,3	529,1	2,260					71	1006,1	965,8	2,6	
2	3,0	3,91	1199,5	680,0	1208,4	528,4	2,270					80	1133,6	1088,3	2,8	
3	3,0	3,91	1195,2	666,8	1201,1	534,3	2,237					85	1204,5	1156,3	2,3	
Average							**2,256**							**1070,1**	**2,57**	**416,9**
1	4,0	3,91	1198,2	682,0	1206,8	524,8	2,283					72	1020,2	979,4	2,2	
2	4,0	3,91	1198,4	679,1	1206,5	527,4	2,272					83	1176,1	1129,1	2,0	
3	4,0	3,91	1200,6	672,3	1206,6	534,3	2,247					84	1190,3	1142,7	1,9	
Average							**2,267**							**1183,7**	**2,03**	**533,0**
1	5,0	3,91	1189,2	666,5	1194,9	528,4	2,251					71	1006,1	965,8	2,1	
2	5,0	3,91	1188,5	664,3	1192,6	528,3	2,250					72	1020,2	979,4	2,1	
3	5,0	3,91	1187,8	647,6	1194,2	546,6	2,173					76	1076,9	1033,8	2,3	
Average							**2,224**							**993,03**	**2,17**	**458**

4.3. MARSHALL TESTING

Table 5. Optimum Asphalt Content Marshall + Additive

SNI : 06-2489-1991

Project : Trial *ACWC Rap 60* di tol Cipali Km.109 — Done by : Ahmad.M
Date : February7,2022 — Checked by : Tibi.S
Proving ring calibration : 31,2477 lbs x 0,4536 = **14,17 kg** — **Bj. *Bulk Agregates* : 2,563**

No		Asphalt content	W. in air	W. in water	W. SSD	Vol	*Density*	*Gmm*	*Air Voids*	*VMA*	*VFB*	Stability				MQ
												Dial	Conver sion	Conver sion	Flow	
		%	Gram	Gram	Gram		Gr/cc	Gr/cc	%	%	%			Kg	mm	Kg/mm
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q
Marshall soaking for 30 minutes, temperature 60 oc																
1		5,6	1190,8	671,4	1190,8	523,5	2,275					93	1318	1265	3,5	
2		5,6	1193,6	672,4	1193,6	525,4	2,272					88	1247	1197	3,1	
3		5,6	1192,8	672,1	1192,8	524,8	2,273					91	1290	1238	3,3	
Average							**2,273**	**2,371**	**4,13**	**16,28**	**74,63**			**1233**	**3,3**	**374**

Marshall soaking for 24 hours, temperature 60oc																
1		5,6	1191,1	670,5	1195,4	524,9	2,269					81	1148	1102		
2		5,6	1193,5	672,3	1197,4	525,1	2,273					84	1191	1143		
3		5,6	1194,4	672,9	1198,6	525,7	2,272					83	1176	1129		
Average							**2,271**							**1125**		
Residual marshall stability after soaking for 24 hours, the temperature of 60 oc is = (1125 / 1233) x 100% **= 91.24 %**																

Table 6. Aggregate Gradation Combination (COLD BIN)

Size Sieve		**Prosen Pass (%) Cold bin Material**				**Composition**				**Combina tion Results**	**Spec.**	
Inch	**mm**	**Abu Batu 00–05 mm**	**Screening 05-10 mm**	**Split 10-18 mm**	**RAP**	**1**	**2**	**3**	***RAP***		**Min.**	**Max.**
						19%	**8%**	**13%**	**60%**	**100%**		
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**
3/4	19,1	100,00	100,00	100,00	100,00	19,00	8,00	13,00	60,00	100,00	100	100
1/2	12,7	100,00	100,00	75,52	96,33	19,00	8,00	9,82	57,80	96,42	90	100
3/8	9,52	100,00	84,33	36,21	85,44	19,00	6,75	4,71	51,26	81,72	77	90
4	4,76	93,67	33,56	18,52	66,37	17,80	2,68	2,41	39,82	62,71	53	69
8	2,38	77,52	6,32	3,14	45,18	14,73	0,51	0,41	27,11	42,75	33	53
16	1,19	52,44	2,07	1,02	30,58	9,96	0,17	0,13	18,35	28,61	21	40
30	0,595	34,41	1,74	0,97	21,07	6,54	0,14	0,13	12,64	19,45	14	30
50	0,297	23,21	1,59	0,92	14,27	4,41	0,13	0,12	8,56	13,22	9	22
100	0,149	16,52	1,35	0,87	10,25	3,14	0,11	0,11	6,15	9,51	6	15
200	0,074	10,32	0,95	0,74	6,85	1,96	0,08	0,10	4,11	6,24	4	10

Table 7. Aggregate Gradation Combination (HOTBIN) + RAP60

Size Sieve		**Prosen Pass (%) Hot Bin Material**					**Composition**					**Combina tion Results**	**Specifications**	
Inch	**mm**	***Hot Bin 4***	***Hot Bin 3***	***Hot Bin 2***	***Hot Bin 1***	***RAP***	**4**	**3**	**2**	**1**	***RAP60***	**G+H+I+ J+K**	**Min.**	**Max.**
							10%	**12%**	**7%**	**11%**	**60%**	**100%**		
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**
3/4	19,1	100,00	100,00	100,00	100,00	100,00	10,00	12,00	7,00	11,00	60,00	**100,00**	100	100
1/2	12,7	78,36	100,00	100,00	100,00	96,33	7,84	12,00	7,00	11,00	57,80	**95,63**	90	100
3/8	9,52	11,42	90,12	100,00	100,00	85,44	1,14	10,81	7,00	11,00	51,26	**81,22**	77	90
4	4,76	1,13	14,11	83,24	100,00	66,37	0,11	1,69	5,83	11,00	39,82	**58,46**	53	69
8	2,38	0,61	2,85	10,05	95,14	45,18	0,06	0,34	0,70	10,47	27,11	**38,68**	33	53
16	1,19	0,47	1,88	5,66	57,12	30,58	0,05	0,23	0,40	6,28	18,35	**25,31**	21	40
30	0,595	0,44	1,71	4,27	37,21	21,07	0,05	0,21	0,30	4,09	12,64	**17,29**	14	30
50	0,297	0,44	0,78	3,56	26,33	14,27	0,04	0,09	0,25	2,90	8,56	**11,85**	9	22
100	0,149	0,38	0,53	1,11	20,14	10,25	0,04	0,06	0,08	2,22	6,15	**8,54**	6	15
200	0,074	0,26	0,44	0,62	11,82	6,85	0,03	0,05	0,04	1,30	4,11	**5,53**	4	10

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