

**TECHNICAL GUIDE Building Construction Materials and Civil Engineering**

**Utilization of buton granular asphalt in hot asphalt mixture**

**DEPARTMENT OF PUBLIC WORKS  
DIRECTORATE GENERAL OF BINA MARGA**

## Table of Contents

Table of Contents.....	i
Preface.....	ii
Introduction.....	iii
1 Scope of manual.....	1
2 Normative references.....	1
3 Terms and definition.....	2
4 Equipments.....	3
4.1 Laboratory equipments.....	3
4.2 AMP (Asphalt Mixing Plant).....	4
4.3 Field equipments.....	8
5 The making of job mix formula.....	11
5.1 Preparation of materials.....	11
5.2 Level of buton granular asphalt in mixture.....	11
5.3 Gradation of mixture.....	12
5.4 Planning of mixture.....	12
6 Implementation.....	14
6.1 Preparation of work.....	14
6.2 Production of hot buton asphalt mixture.....	15

Attachment A

Bibliography

## **Preface**

The technical guide on the Utilization of buton granular asphalt in hot asphalt mixture is necessary for all parties involved in the implementation of hot asphalt mixture work that uses buton granular asphalt as additional material.

This technical guide is compiled by the Directorate of Engineering in cooperation with Road and Bridge Research and Development Centre through the Panel Team.

The writing procedure of this book is arranged by following the National Standardization Guideline Number 8 Year 2007 and was discussed in a Discussion Meeting forum in Jakarta which involved related resource persons, experts and institutions.

Should there be any shortcoming or mistake in this guide book, then improvement and completion shall be done in the future.

**Jakarta, August 2008**

**DIRECTOR GENERAL OF BINA MARGA**

**A. Hermanto Dardak**

## **Introduction**

The technical guide on the Utilization of buton granular asphalt in hot asphalt mixture explains important things that need to be paid attention to in the implementation of utilizing buton granular asphalt, beginning from preparation of materials and equipments, making of Job Mix Formula, field implementation and quality control. This technical guide is made with a purpose to give guidance for all Implementers in order for the utilization of buton granular asphalt to be carried out well in accordance with the requirements. The reference used in the making of this technical guide is the specification and full-scale trial experience of buton granular asphalt utilization in year 2006 which was conducted by the Road and Bridge Research and Development Centre of the Department of Public Works.

# **Utilization of Buton Granular Asphalt in Hot Asphalt Mixture**

## **1 Scope of Manual**

This manual covers preparation of materials, equipments, mixing method, and field implementation of utilizing buton granular asphalt in hot asphalt mixture that refers to related standards.

This manual does not cover safety issues that are related to the use of buton granular asphalt. Application of steps and constraints concerning occupational safety and health is the responsibility of the user.

## **2 Normative References**

Below are reference documents related to this manual: SNI 03 1968 1990, Test method for sieve analysis of fine and coarse aggregates SNI 06 2432 1991, Test method for ductility of bituminous materials SNI 06 2433 1991, Test method for flash point and burning point by cleveland open cup SNI 06 2434 1991, Test method for melting point of asphalt and tar SNI 06 2440 1991, Test method for weight loss of oil and asphalt by A method SNI 06 2441 1991, Test method for specific gravity of solid asphalt SNI 06 2456 1991, Test method for penetration of asphalt materials SNI 03 3640 1994, Test method of asphalt content in asphalt mixture by using reflux extractor SNI 06 6721 2002, Viscosity test methods for liquid asphalt and

emulsified asphalt by saybolt device SNI 03 6893-2002, Test method of maximum specific gravity of bituminous paving mixture RSNI M 01 2003, Test method of asphalt mixture by Marshall device

### **3 Terms and Definitions**

The terms and definitions used in this manual are as follows:

#### **3.1**

##### **Buton Asphalt**

Buton asphalt is a mining material located in the Buton Island of Southeast Sulawesi. It contains minerals and asphalt in different levels.

#### **3.2**

##### **Hot Mix Buton Asphalt Mixture**

Asphalt pavement that consists of aggregate, asphalt and Buton Granular Asphalt (BGA) with certain ratio that are mixed together, spread and compacted in hot condition.

#### **3.3**

##### **Buton Granular Asphalt**

Buton asphalt that is obtained from a mechanical processing, with granular size, water level, asphalt level and penetration that are in accordance with the stipulation.

#### **3.4**

##### **Filler Elevator**

Filler elevator is usually placed on the side of AMP and across the position of aggregate elevator. Filler elevator has a function of supplying filler into the filler bin and then the filler is weighed before it enters the mixer.

### **3.5**

#### **Level of Asphalt in Buton**

Asphalt ratio of the weight of asphalt that is contained in buton asphalt to the total weight of buton asphalt (contents of buton asphalt consists of asphalt and mineral), in percentage unit

### **3.6**

#### **Level of Asphalt in Mixture**

ratio of the asphalt weight (level of buton asphalt + level of asphalt pen 60) to the total weight of hot buton asphalt mixture, in percentage unit

### **3.7**

#### **Level of Buton Asphalt in Mixture**

ratio of the buton asphalt weight to the total weight of hot buton asphalt mixture, in percentage unit

## **4 Equipments**

### **4.1 Laboratory Equipments**

Laboratory equipments are in accordance with the Contract Document and must be able to support the tests that are stated in the General Specification/Special Specification.

The testing devices that must be available in a field (project) laboratory and are directly related to the daily quality control include;

- a) marshall;
- b) sieve analysis;
- c) extraction;
- d) water level;
- e) laboratory density and field density
- f) Thermometer
- g) Asphalt penetration
- h) Asphalt viscosity

Extraction device used for field laboratory is the Reflux type, with the use of TCE (Trichloro Ethylene) solvent.

**Note 1:**

Testing devices that must be available in a buton asphalt producing laboratory include reflux extraction device, sieve analysis, water level, rotary recovery and penetration.

**4.2 AMP (Asphalt Mixing Plant)**

AMP should be in accordance with General Specification/Special Specification and must be equipped with buton granular asphalt supplier. In hot mix buton asphalt mixture, the buton granular asphalt has the same function as filler in hot asphalt mixture. Thus, the utilization or the filling process of buton granular asphalt in an type Batch AMP is the same as the utilization or the filling process of filler, meaning that there is an



availability of components such as elevator, collecting bin and weigh bin (see Figure 1, Figure 2, and Figure 3).



**Figure 1. The component on the left is an elevator for buton granular asphalt (filler)**



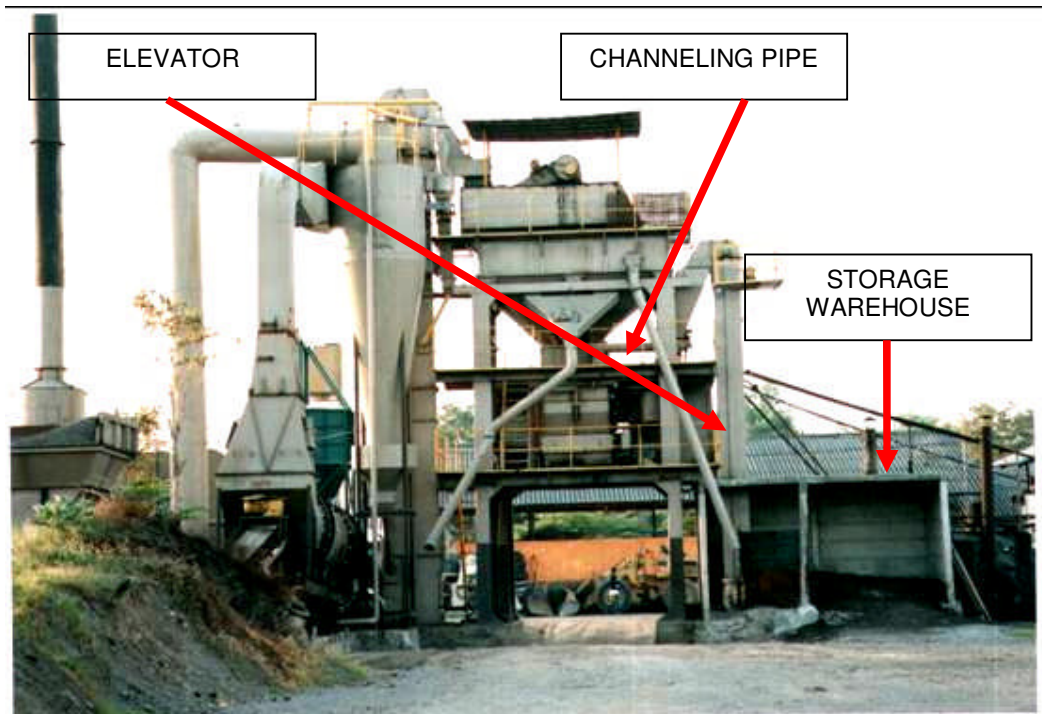
**Figure 2. Channeling pipe of buton granular asphalt, from buton granular asphalt bin into buton granular asphalt weigh bin**



**Figure 3. dial scale of buton granular asphalt (filler)**

In order to make sure that the buton granular asphalt ( $> 4,75$  mm), an assisting device in the form of a  $4,75$  mm sieve must be installed at the mouth of the buton granular asphalt entering funnel.

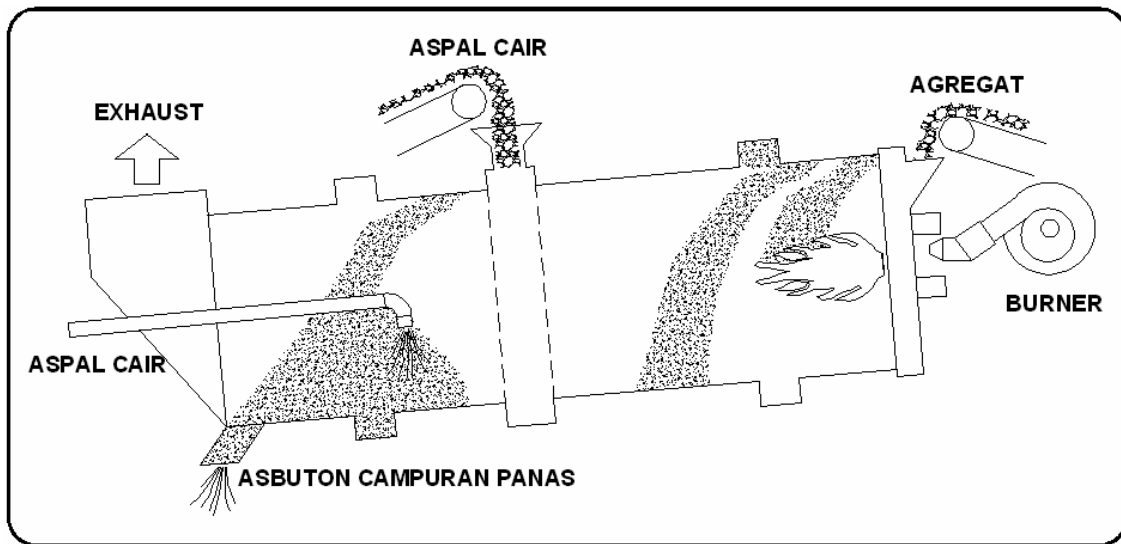
Thread of the buton granular asphalt channel from the collecting bin (see Figure 2 and Figure 4) into the weigh bin must function well, in order for the buton granular asphalt to be able to be weighed smoothly and accurately.



**Figure 4. storage of buton granular asphalt (not too good),  
elevator and channeling pipe of buton granular asphalt**

At a continuous type of AMP or continuous model drum mix, the supplying of buton granular asphalt is carried out through an opening in a form of a funnel that is located in the middle part of the dryer (see Figure 5), or by channeling from the stock silo of buton granular asphalt to a mixer that is installed outside of the dryer as the second mixer (modification) or after mixer.



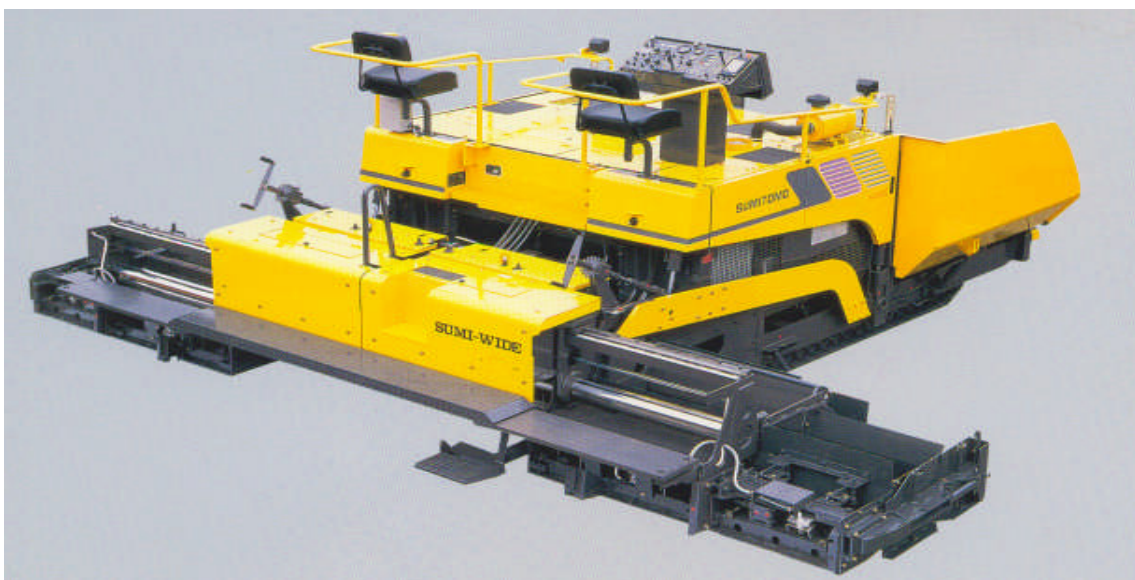


**Figure 5. The supplying of buton granular asphalt in a continuous type of AMP**

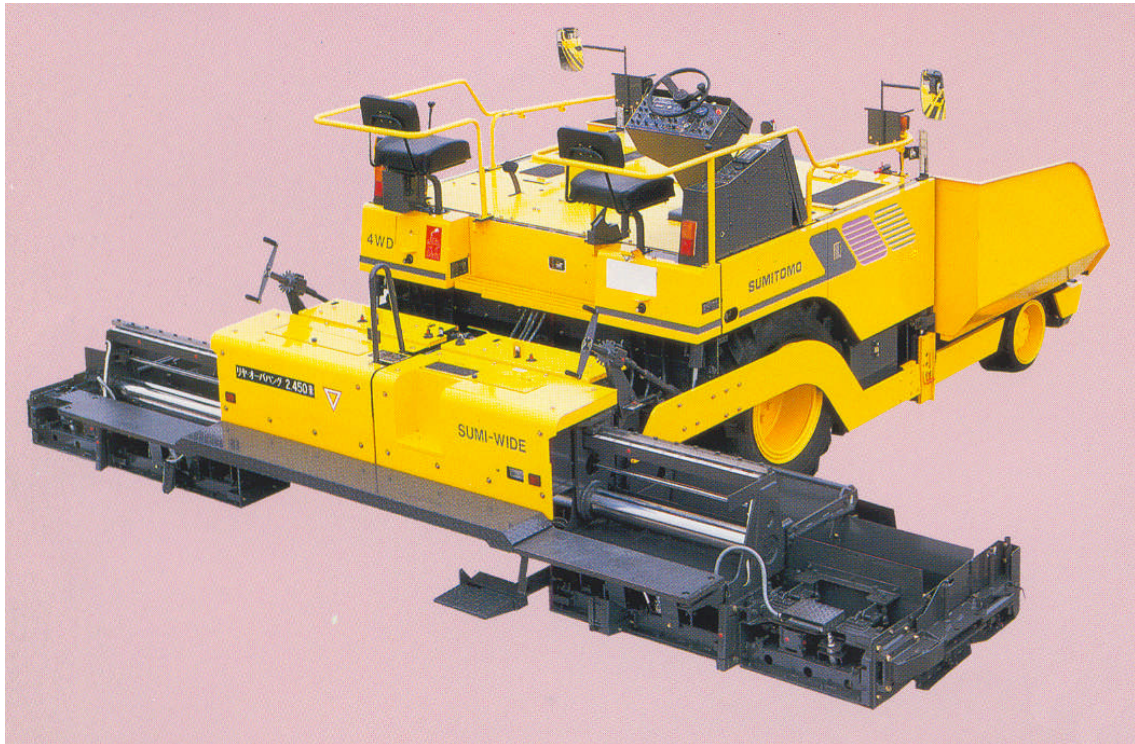
#### **4.3 Field Equipments**

Spreading and compacting equipments must be in accordance with the Contract Document and meet the Standard requirements.

There are 2 (two) types of spreader, the crawler type and the wheel type (see Figure 6 and Figure 7). The type of spreader is selected according to the Contract Document.



**Figure 6. The Crawler Type Spreader**



**Figure 7. The Wheel Type Spreader**

A compactor that is needed in field consists of 1 (one) piece of tandem roller (see Figure 8) for breakdown rolling and finishing rolling, and 1 (one) piece of pneumatic tyre roller/ PTR (see Figure 9) for intermediate rolling. If necessary, the quantity of tyre roller may be added into 2 (two) pieces. Field thermometer must be available in order to know the temperature of the hot buton granular asphalt mixture.



Figure 8. Tandem Roller



Figure 9. Pneumatic Tyre Roller



## **5 Making of Job Mix Formula**

### **5.1 Preparation of Materials**

Materials used consist of aggregate, asphalt pen 60, and buton granular asphalt. Before use, these materials must be tested and meet the General Specification/Special Specification requirements. The buton asphalt that has been approved for dispatch must be stored in bag packaging or other type of packaging that is waterproof and easy for handling when the asphalt is mixed in the pugmill. The Buton Granular Asphalt must be stored in a dry and roofed place to avoid the Buton Granular Asphalt from rain or direct sunlight. The packaging of the Buton Granular Asphalt must be labeled clearly and contain the following information:

- a) factory logo
- b) identification codes, such as type, weight, penetration, bitumen, and maximum diameter of the granular.

### **5.2 Level of Buton Asphalt in Mixture**

For Buton Granular Asphalt with penetration of 0 dmm to 5 dmm, the maximum level of Buton Asphalt in hot asphalt mixture is 3% of the total weight of the mixture. For Buton Granular Asphalt with penetration of 6 dmm to 10 dmm, the maximum level of Buton Asphalt in hot asphalt mixture is 5% of the total weight of the mixture. For Buton Granular Asphalt with penetration of 11 dmm or more, the maximum level of Buton Asphalt in hot asphalt mixture is 7% of the total weight of

the mixture or according to the instruction from the Work Director.

### **5.3 Gradation of Mixture**

Gradation of hot buton asphalt mixture consists of coarse aggregate, fine aggregate, and buton asphalt mineral, and the gradation must meet the determined requirement. Gradation of buton asphalt mineral is obtained from sieve analysis test after the buton asphalt has been extracted.

Selected mixture gradation may be a fine gradation (above the fuller curve) or cuts across the fuller curve, between sieve No. 4 and sieve No. 8.

Mixture gradation may cut across restricted zone as long as all of the determined mixture's physical characteristic requirements have been met.

### **5.4 Planning of Mixture**

- a) Estimation of planned asphalt level can be obtained by the following formula:

$$P_b = 0,035 (\% \text{ CA}) + 0,045 (\% \text{ FA}) + 0,18 (\% \text{ Filler}) + \text{Constant} \dots\dots\dots (1)$$

Explanation:  $P_b$  is estimated asphalt level (level of asphalt + level of buton asphalt bitumen);

CA is coarse aggregate held by sieve No. 8;

FA is fine aggregate allowed through sieve No. 8 and held by sieve No. 200;

Filler is fine aggregate allowed through sieve No. 200;



Constant value ranges from 0,5 to 1,0

- b) Make a test matter with an estimated level of asphalt that is rounded off near 0,5 %, with three levels of asphalt above and two levels of asphalt below this initial estimated level of asphalt that has been rounded off near 5%. The intended level of asphalt is the level of buton asphalt added with the level of oil asphalt (pen 60);
- c) Measure the unit weight of test matter, Marshall stability, melting and stability of residue after submersion. Measure or count the density of test matter at zero air void (Gmm). Measure void in aggregate (VMA), void filled with asphalt (VFB), and void in mixture (VIM). Describe all the results in a graphic;
- d) Make an additional test matter and compact it until it achieves refusal density for three levels of asphalt (the first one is for giving void in mixture in the amount of more than 5%, second one in the amount of 5%, and the third one in the amount of less than 5%). Measure the test matter's unit weight and density;
- e) Describe the required limits in a graphic for every listed parameter, and determine the range of asphalt level that meets all the stipulations.

Generally, the optimum asphalt level plan approaches the median of the asphalt level range that fulfills all the required parameters. That optimum asphalt level value is generally

around the top point of stability value or minimum point of VMA value.

The range of asphalt level for asphalt mixture that meets all the planning criteria must approach (or bigger than) 0,6%. This range of asphalt level is intended for accommodating the real fluctuation in the asphalt mixture production.

In order to obtain Job Mix Formula, it is necessary to conduct a mixing test at the AMP and a density test at the field based on the Job Mix Formula that is obtained in the laboratory. The proportion of this measurement must be determined by looking for gradation using wet method from a sample taken from the hot bin.

The suggested Marshall stability value ranges from 1000 kg (the minimum in specification) to 1400 kg. If a stability value of more than 1400 kg is obtained, then the level of buton asphalt in the mixture is best reduced.

## **6 Implementation**

### **6.1 Preparation of Work**

- a) Preparation of field condition, all damages including unevenness, have been fixed;
- b) All devices, assisting devices, and operators are ready and operable.
- c) Weather condition is possible.
- d) The Director has stated in writing that the implementation work is allowed to begin.

## **6.2 Production of Hot Buton Asphalt Mixture**

- a) Preparation of hard asphalt; Asphalt must be heated at a temperature between 140°C to 160°C inside a tank that has been designed in a certain way to avoid local heating and able to continually channel asphalt to a mixer at an even temperature at all times. Every day, before the start of the mixing process, there should be at least 30.000 liters of hot asphalt ready to be channeled into the mixer.
- b) Preparation of aggregates;
  - 1) Every aggregate fraction must be channeled into the asphalt mixer installation through a separated cold bin supplier (see Figure 10 and Figure 11). A pre-mixing of aggregate from various types or from different sources is not allowed. Aggregate for asphalt mixture must be dried by heating in the dryer before put into mixer (see Figure 12 and Figure 13). The fire flame in the drying and heating process must be set accurately to avoid a formation of guard membrane on the aggregate.



**Figure 10. Each Aggregate fraction inside its own bin (cold bin)**



**Figure 11. Preparation of loading Aggregate into the Cold Bin  
by using a wheel loader**



Figure 12. Aggregate being dried by heating in the dryer

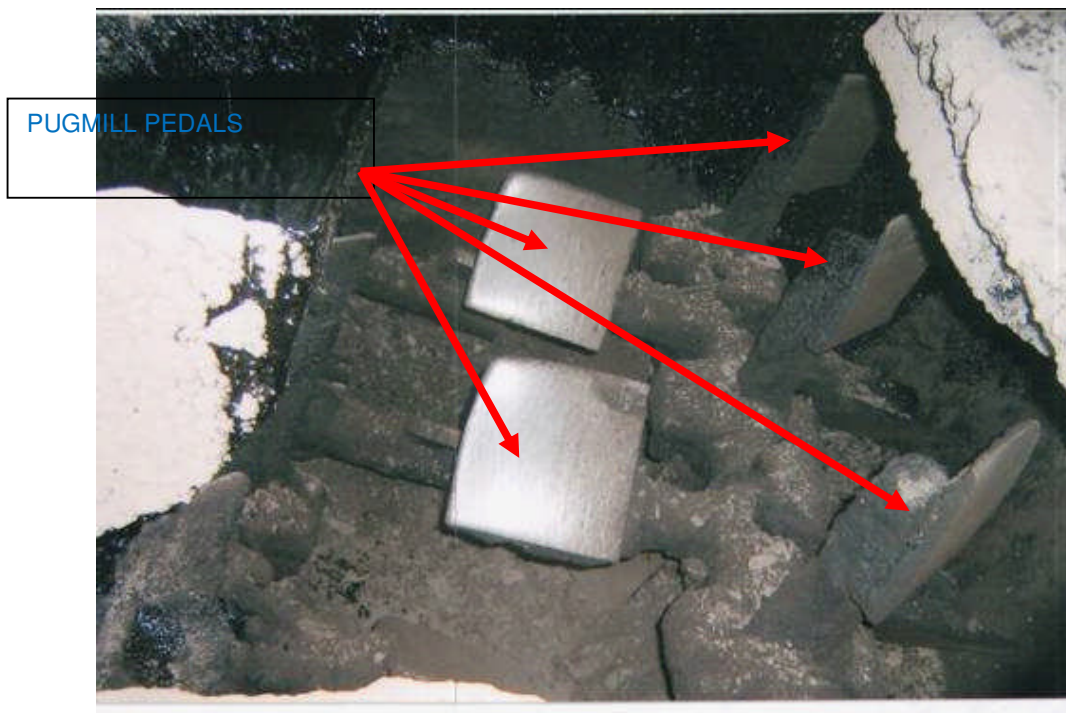


Figure 13. Pedals in a mixer (pugmill)

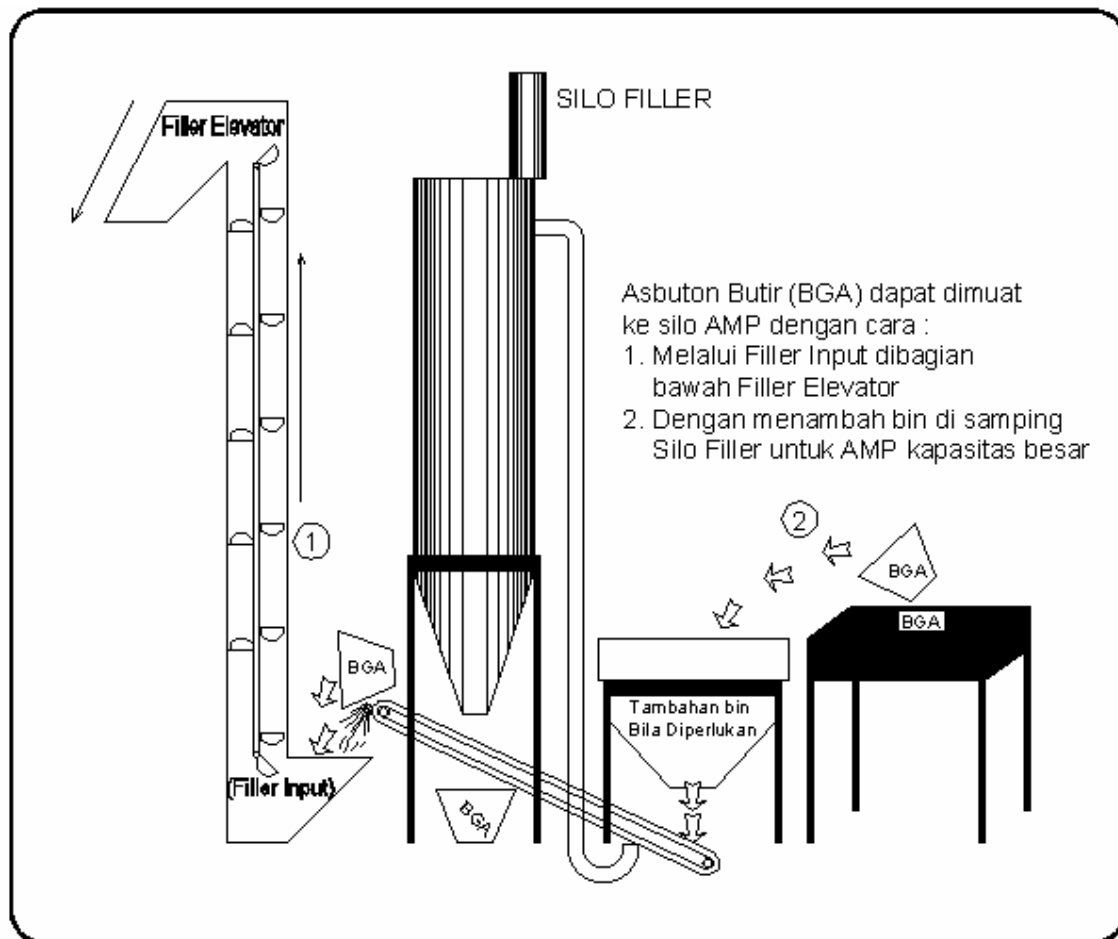
2) Aggregate that is to be mixed with asphalt must be dry with a temperature in the required range for hot asphalt, but not exceeding 15°C above the asphalt temperature on the viscosity of the mixing.

c) Preparation of buton granular asphalt;

The prepared buton granular asphalt must be in a dry condition and must be stored in a place that is protected from weather and water, and also it has to have the same quality or is of 1 (one) type, or of a same type that is in accordance with what has been approved by the Work Director and meets the determined requirements. The buton granular asphalt must be available and ready to be channeled into the mixer in the minimum amount for 1 day production.

The buton granular asphalt that has been contained in the buton granular asphalt collecting bin is channeled through a threaded channel pipe (see Figure 2 and Figure 4) into the weigh bin to be weighed according to the formula determined in the requirement.

Diagram showing the entering of buton granular asphalt into the collecting bin or the buton granular asphalt bin (Figure 2) can be seen on Figure 14.



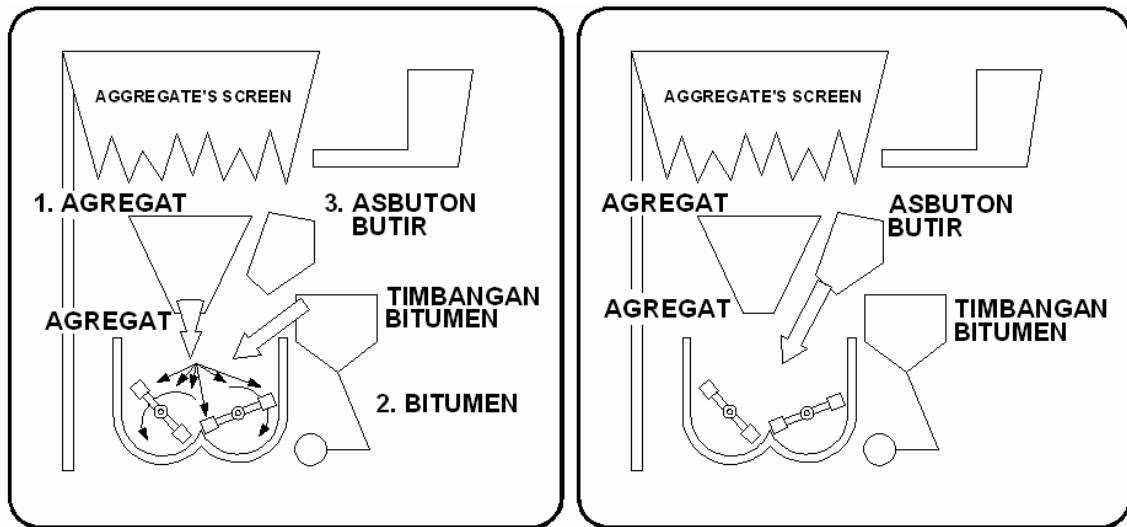
**Gambar 14. The Entering of Buton Granular Asphalt (BGA)**

d) Mixing

- 1) If a batch system mixer installation is used, all of the dry aggregate must first be mixed, then an accurate amount of asphalt is added into the aggregate and is mixed for 5 -10 minutes more or less. For the last step, the buton granular asphalt is put into the mixture and is stirred for a shortest possible time. The packaging of the buton granular asphalt is not put into the AMP. In general, it takes around 45 seconds in the total time for mixing to produce a homogenous mixture

and to ensure all of the aggregate granular is evenly covered with asphalt;

The order of the entering of aggregate, buton granular asphalt and asphalt can be seen on Figure 15.



Note: order of entering (1) aggregate, (2) asphalt (bitumen), (3) buton granular asphalt Figure 15. Order of mixing at a weigh type of AMP (batch)

- 2) Other than by using a batch system mixer installation, mixing can also be done by using a continuous system mixer installation with several modifications;
  - 3) When taken out from the mixer, the temperature of the hot buton asphalt mixture must be in the absolute range as explained in Table 1.
- e) Transporting;
- 1) The hot buton asphalt mixture must be received in the field to be spread at a certain mixture temperature in



order to meet the requirement of absolute asphalt viscosity as shown in Table 1;

- 2) For every truck that has been loaded, the tank of the truck must be covered by tarpaulin in order to keep the mixture temperature from decreasing too fast.

f) Spreading;

- 1) A moment before the spreading, the surface on where the spreading will be carried out must be cleaned from loose and unwanted materials by using power broom and if necessary, by a manually assisted compressor;
- 2) The tack coat or the prime coat must be applied according to the specification;
- 3) Before starting the spreading, screed and asphalt finisher must be clean, slippery and heated. The asphalt mixture must be spread and leveled according to the required inclination, elevation, and shape of the transverse section;
- 4) The pre-compactor machine (vibratory roller) on the screed of finisher must be operated during the spreading and formation;
- 5) Container of the finisher must not be emptied, but the temperature of the hot asphalt mixture residue must be maintained at a level that is not less than the required temperature or the viscosity as shown in Table 1;
- 6) Finisher must be operated with a speed that does not cause cracks, tears, or other forms of unevenness on the surface;

- 7) If there is a segregation, tear or rutting on the surface, then the finisher must be stopped and is not be allowed to be re-operated until the cause has been found and fixed;
- 8) Locations of segregation, tear or rutting can be fixed by spreading a fine material made from buton granular asphalt mixture and re-leveled before compaction, but this should be best avoided. Spreading of coarse granular onto a spread surface is not allowed;
- 9) It should be given attention that the mixture does not gather and cool down on the wall of the mixture container, the finisher or other places.

**Table 1. Range of Temperature**

No.	Implementation Procedure□	Bitumen Viscosity (PaS)	Estimated Temperature *□
1	Mixing of Marshall test materials	0,2	160 + 5□
2	Compaction of Marshall test matter	0,4	150 + 5□
3	Maximum mixing temperature at AMP	unnecessary	170□
4	Mixing, range of target temperature	0,2 – 0,5	170 - 145□
5	Pouring asphalt mixture from mixer into truck	0,5 – 1,0	170 - 140□
6	Supplying into finisher	0,5 – 1,0	155 – 135
7	Breakdown rolling (tandem)	1 – 2	145 - 125□
8	Intermediate rolling (pneumatic tyre)	2 – 20	125 - 100
9	Finishing rolling (tandem)	-	> 95
* : the above temperature estimation is based on 7% addition of buton granular asphalt			

f) Compaction;

- 1) As soon as the mixture is spread and leveled, the surface must be examined and every imperfection must be

fixed. The temperature measuring of the mixture that is spread in loose condition must be monitored and the compaction must be started at the asphalt temperature range as shown in Table 1;

- 2) The compaction of the buton granular mixture must consists of the following three operational stages: breakdown rolling, intermediate rolling and finishing rolling;
- 3) Breakdown rolling must be carried out using a tandem roller and is operated with the wheel drive located near the finisher;
- 4) To prevent unwanted temperature decrease, breakdown rolling must be conducted as close as possible to the finisher (breakdown rolling must be conducted when the spreading has reached 20 meters at the maximum);
- 5) The first rolling of the breakdown rolling must be carried out on a transverse joint;
- 6) Compaction must start from the longitudinal joint and then from the outer edge. Next, the compaction is done in parallel with the road axis in sequence toward the direction of the road axis, except for superelevation on road bends, where it should start from the lower place and moving toward the higher place. The sequenced crossings must overlap, at least as much as half the width of the tandem roller wheel and these crossings

must not end at a point of less than one meter from the previous crossing;

- 7) When rolling a longitudinal joint, the roller for the breakdown rolling must first tread on the lane that has been compacted before, with the position of the roller wheel at 15 cm maximum above the wheel of the roller of longitudinal joint edge that has not yet been compacted. Compaction with sequenced crossing must be continued by moving the position of the roller little by little, passing by the joint, until a neatly compacted joint is achieved.
- 8) The speed of the roller must not exceed 4 km/hour for tandem roller and 10 km/hour for pneumatic tyre roller and must always be maintained in order to avoid the hot mixture from moving. Crossings, speed and direction of the compaction are not allowed to be changed unexpectedly or in a way that causes the asphalt mixture to be shoved;
- 9) All types of compaction operations must be carried out continually to obtain an even compaction when the asphalt mixture is still in an easy condition to work on, so all traces of wheels and unevenness can be eliminated;
- 10) The roller wheels must continually be made wet to prevent the sticking of mixture onto the roller wheels, however, excessive use of water is not allowed. A small amount of detergent solution may be used to avoid the sticking of mixture;

- 11) Heavy equipments or rollers are not allowed to be placed on the surface that has just been worked on, until the whole surface is cold;
- 12) Every petroleum product that is spilled or scattered from a vehicle or an equipment that is used on the pavement being carried out, may be a reason for a demolition and improvement;
- 13) The surface that has been compacted must be smooth in accordance with the transverse slope and inclination that meet the required tolerance. If there is a discharge or a damage on a mixture that has been compacted, or the mixture is mixed with dirt, or if there is a damage in any form, the mixture must be demolished and replaced with a new mixture and a compaction must be done as soon as possible in order to make it similar to the surrounding surface. Certain places of buton granular mixture that shows excess or lack of asphalt material that is spread in breadth of 0,1 m<sup>2</sup> or more, must be improved. All local bumps, joint bumps, cavities caused by subsidence, and segregation of porous surface must be fixed.
- 14) When the surface is being compacted and finished, the edge of pavement must be cut neatly. Every excess material must be cut upright after the finishing rolling, and then thrown away.
- 15) Joint.

- a) Both longitudinal or transverse joint on the sequenced layer must be arranged in such a way that the joint on one layer is not in line with another layer. Longitudinal joint must be arranged in such a way in order to place the joint on the top layer on lane separator or traffic lane separator. The transverse joint must be straight and spread in a step-by-step manner with a minimum distance movement of 25 cm;
- b) The mixture must not be spread beside a solid asphalt layer unless the edge is upright. A binding layer must be put a moment before the mixture is spread beside the solid asphalt layer.

16) Quality control;

- 1) Test for flatness of pavement surface;

The pavement surface must be examined by using a 3 meter straight ruler or a 3 meter wheeled straight ruler, the examination is done upright and in parallel with the road axis. The test for examining flatness must be carried out soon after the breakdown rolling, deviations must be fixed by throwing away or adding material as necessary.

- 2) Test for density

Test for the density of mixture is conducted at a maximum range of 200 meters on as many as 6 core samples and the obtained density must meet the determined stipulation.

3) Test of mixture;

(a) Frequency of test;

Frequency of tests is carried out in accordance with the stipulation in the specification.

(b) Test sampling;

Test sampling is carried out at the asphalt mixer installation (AMP), however it can be carried out at a spreading location if there is an excessive segregation during the transporting and spreading of the asphalt mixture.

(c) The following tests must be conducted on every production day:

(1) Sieve analysis (wet method), at least on two samples of aggregate from each hot bin;

(2) The temperature of mixture when taking sample at the asphalt mixer installation (AMP) as well as at the spreading location, conducted at every batch;

(3) The complete daily Marshall density of all examined test matters;

(4) The density of the compaction result in the field and the relative percentage of field density that is compared against the density of the Work mixture for every core test matter;

- (5) Measurement of the Marshall stability, melting, and quotient must be conducted on at least two test matters;
- (6) The examination of the level of buton granular asphalt must be carried out by a reflux method on the test sample that is represented with an amount if no less than 1 (one) kilogram. The solvent used is TCE (Trichloroethylene) and the time length of the reflux must not be less than 24 hours or until the solvent is relatively clean;
- (7) Void in the mixture at the refusal density
- (8) The level of asphalt absorbed by the aggregate is measured based on the maximum specific gravity of asphalt pavement mixture according to the SNI 03 6893-2002;
- (9) Data of test result must include the location of test sampling.



## Attachment A

### (informative)

#### List of Names and Institutions

##### a) Initiators

Directorate of Engineering, Directorate General of Bina Marga and Road and Bridge Research and Development Centre, Research and Development Agency, Department of Public Works.

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Ir. Suhartono Irawan□	Resource Person

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### **Bibliography**

General Specification and Special Specification, Field of Road and Bridge, Department of Public Works.