

# Improvement of Road and Bridge Preservation Supervisors Training Materials for Hot Mixed Asphalt Work in an Effort to Improve Road Pavement Performance

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**Abstract:-** Training for field supervisors has been carried out but the learning material for hot mix asphalt pavement structures is still not effective in efforts to improve pavement performance. The teaching material for hot mix asphalt for the road surface layer is still weak in terms of supervision. This study aims to add teaching materials for hot mix asphalt to the road surface by adding Standard Operating Procedures (SOP), research methods in the laboratory and collecting questionnaires from field supervisor training alumni. The ineffectiveness of teaching materials for hot mix asphalt for the road surface layer is due to the competence of the supervisor training participants who are not careful in terms of the supervisors who should be handled. The results of this study are teaching materials for hot mix asphalt road surface layers, it is necessary to add teaching material at the pre-development stage of material results, material trials, revisions, carry out dissemination and implementation and as learning media that can be used as a tool help knowledge media, digital transformation, skills, and work attitudes for supervisor training participants achieve competency.

**Keywords:-** Aggregate, Hot Mix, Cleaning, Supervisor, Training.

## I. INTRODUCTION

The development of teaching materials is a key training tool to bridge the gap between participants and their training. Training teaching materials are oriented towards competency-based training which are formulated into three books, namely information books, work books and assessment books. The development of training teaching materials consists of four activities. (1) Planning includes the preparation of competency standards that are made and the preparation of related references. (2) Material writing is done by compiling and organizing the substance of training teaching materials. (3) Reviews and trials of teaching materials are carried out to obtain input in efforts to improve teaching materials. (4) Finalization is the final stage of developing teaching materials after revision. Determination of training teaching materials is carried out by the institution responsible for organizing the training. This Technical Guideline is a development and integration with the Competency Standards for State Civil Apparatus Positions in Public Works and Public Housing Engineering according to the Competency Dictionary in the

Roads and Bridges Sector in accordance with Minister of Public Works and Public Housing Regulation Number 7 of 2020 concerning Competency Standards for State Civil Apparatus Positions in the Field of Engineering Work Public and Public Housing, where the competency development program that has been running currently still requires improvement. Competency Development Center, and Implementation Unit. Efforts to produce competent Human Resources for Road and Bridge Sector Apparatus involve the Road and Bridge Competency Development Center with Technical Assessors through coaching activities in the form of classes and/or experimental scenarios or as trainees in internships. How to improve the learning materials for hot mix asphalt in the Road and Bridge Preservation Field Superintendent Training on road surface layer work in an effort to improve road pavement performance?

Add teaching materials for hot mix asphalt layers to the road surface, in this case regarding material cleanliness, material gradation trajectories, material power gradation, and mixed voids through laboratory trials and the development of Standard Operating Procedures. Research conducted by testing in the laboratory and implementing proper and accurate supervision of the available material mixture, and so that there is good interlocking between staple grains, resulting in an even distribution of loads on the aggregate foundation layer, and resistance to rutting and not easy to crack, and bleeding does not occur in hot mix asphalt.

## II. METHODS

The research method was carried out in the materials laboratory at the Java-Bali National Road Implementation Center and distributing questionnaires to field supervisor training alumni, with experiments conducted at the Center's laboratory including material cleanliness, material gradation trajectories, material power gradations, mixed voids which need to be better understood by the participants. supervisors, so that supervisors understand testing in the laboratory. Many factors affect the performance of asphalt mixture (hot mix), starting from the condition of the equipment (mixer, transporter, spreader and compactor), the quality of the material (asphalt and aggregate), as well as the implementation method that must be applied in accordance with the development of Supervision Standard Operating Procedures (SOP). In this study the focus of the discussion is to obtain the

most appropriate proportion of hot mix asphalt so as to produce a mix that is easy to implement in the field with maximum results with the following results:

In this experiment the selected type of hot mix asphalt was AC-WC with oil company asphalt, the crushed stone used was taken from the stockpile of PT. Baitasari with an experiment as a sample test. The experimental steps were carried out in the laboratory for the Java Bali Road Implementation Center in Surabaya and the material properties were tested, including:

1. Asphalt: Softening point, ductility, penetration and adhesion of asphalt to aggregate;
2. Crushed stone aggregate: Sieve analysis, abrasion, specific gravity and absorption of water, flakiness;
3. Define 5 gradation paths in the AC-WC range, namely:
  - a. Appropriate/close to the upper limit;
  - b. According to the middle track;
  - c. Appropriate/close to the lower limit;
  - d. The fine fraction is close to the upper limit, while the coarse fraction is close to the lower limit;
  - e. The fine fraction is near the lower limit, while the coarse fraction is near the upper limit (Ex. Ats);
4. Asphalt covering thickness is set at 10 microns, so that the total bitumen content can be calculated for each track plus the estimated absorption value of the aggregate to the asphalt ( $\pm$  half of the water absorption);
5. Each track is made 4 test objects, with details as follows:
  - a. Two specimens for carrying out the Marshall test under normal conditions, namely at 60°C with 30-minute immersion, the average value is taken, if there is a difference in value of more than 5%, the data is taken from the smallest value;
  - b. One specimen tested at 60°C immersion for 24 hours;
  - c. One specimen is cut to see the interlock model;
  - d. Determination of the selection of property values based on the following order: has the greatest value of stability, high flow, highest density, smallest cavity.

The results of the research found that data analysis found factors of material cleanliness, material gradation trajectory, material power gradation, mixed voids which need to be better understood by supervisors. To improve learning materials for field supervisors. In this study the authors summarized it into 4 (four) material development activities. As for the author's research on the development of improvements/improvements to teaching materials in training activities, they include:

1. Pre-development of material results, namely collecting information about material needs by conducting curriculum studies and formulating a number of clear, specific training objectives in the form of observations and measured in the field;
2. Material trials, namely conducting small group trials and diagnostic tests to measure the participants' background, knowledge and abilities that they already have as a prerequisite for taking field supervisor training materials;
3. Revision, namely carrying out revisions according to suggestions from the field supervisor training trial activities, where it is necessary for related people to review the draft material, which can be done by subject matter experts, learning experts. Material trials are carried out at

training institutions to find out the achievement of training outputs with competency standards (competence units) for improvement/improvement;

4. Carry out the dissemination and implementation of the results of improving the training materials for field supervisors to obtain determination of training materials carried out by the institution responsible for organizing the training in accordance with the established rules.

### III. RESULTS

In research in the materials laboratory and distribution of questionnaires to alumni of supervisor training and field observations, there is a fact that the hot mix asphalt teaching material (core drill) on average shows that grain grouping occurs. Although in practice it uses densely graded JMF, and is carried out with a finisher equipped with an auger (grain uniformity regulator) that works optimally.

With the temporary conclusion that the gradation path does not just enter the gradation envelope (specification range), but must be made in such a way that the filling material between the coarse grain cavities is not excessive, because it hinders the interlock mechanism between the coarse grains or the body of the mixture. In hot mix asphalt work, the aggregate requirement must be clean, but in another section it states that a maximum clay content of 1% of the total portion of fine aggregate is permitted. So what happens in the field is that there is still dust or clay particles which clump around 0.4% of the total mixture. In 1 ton of hot asphalt mix work there are  $\pm$  4 kg of clay dust attached to coarse and medium aggregates.

Clay dust has very strong adhesion, so collectors and dust collectors are unable to separate it. What's more dangerous is that there are lumps of clay in the form of granules and get into the asphalt mixture, then weakening will definitely occur. So that holes occur in a relatively short time, especially during the rainy season. And the data collection technique provides a questionnaire from alumni of road and bridge maintenance supervisor training in 2021. Improving the quality of training participants or human resources (HR) in an organization, it is necessary to develop participants. Development is an effort to improve technical, theoretical abilities, and in accordance with the needs of the job/position through education and training.

#### 1. Road Pavement Structure Design

In the implementation of repairing the pavement structure of hot mix asphalt (hotmix) data is needed for the volume repetition of heavy vehicle loads around the intersection of plots and at the location of slopes as well as excess loads (overload) that cannot be controlled which can seriously damage the surface of flexible road pavements in the form of rutting and bleeding.

From these results, it is necessary to have material handling factors that must be met for hot mix asphalt, including:

- a. *Material cleanliness*: Indeed, all of these are triggers for damage to the hot mix mixture, but according to the author, the main cause of this type of damage is the level of

material cleanliness. Clay is not evenly distributed, but in groups. So that the parts of the group that contain a lot of clay (dust) will be peeled off earlier, while the other parts with low clay content will be peeled off later.

b. *Trajectory gradation:* In well graded, the expected solid grain composition is crushed stone with a diameter equal to or larger than sieve #4 (4.75 mm), which is the body of the mixture, which is more than 50. If the amount of medium grain aggregate (sieve # 8 to # 30) is too high, the mixture is generally difficult to compact. Whereas if the amount of fine grain aggregate is too high (#50, #100 and #200) then the amount of bitumen required is quite high, to obtain an adequate covering thickness.

c. *Power gradation:* Power gradation is a gradation path that is arranged based on the maximum grain size. The number of percent passing on each sieve is determined by the maximum grain size. The formula for the power gradation path for each aggregate arrangement based on the maximum grain size according to NAPA 1996 is as follows:

$$P = 100 (d/D)^{0.45}$$

Where:

- P = Percentage passed the filter
- d = The grain size sought
- D = Maximum sieve grain size

Table 1. Power Gradation Trajectory According to Maximum Grain Size

FILTER		MAXIMUM SIEVE GRAIN SIZE					
SIZ E	(m m)	37.5 0	19.1 0	19.1 0	12.5 0	9.50	4.75
1 ½	37.5	100.00	100.00	100.00	100.00	100.00	100.00
1	25	83.32	100.00	100.00	100.00	100.00	100.00
¾	19.1	73.82	88.59	100.00	100.00	100.00	100.00
½	12.5	61.00	73.20	82.63	100.00	100.00	100.00
3/8	9.5	53.91	64.70	73.03	88.38	100.00	100.00
# 4	4.75	39.46	47.36	53.46	64.70	73.20	100.00
# 8	2.3	28.81	34.57	39.03	47.23	53.44	73.00
# 16	1.1	21.09	25.31	28.57	34.57	39.12	53.44
# 30	0.6	15.55	18.67	21.07	25.50	28.85	39.41
# 50	0.3	11.39	13.67	15.43	18.67	21.12	28.85
# 100	0.1	8.34	10.00	11.29	13.67	15.46	21.12
# 200	0.075	6.10	7.32	8.27	10.00	11.32	15.46

d. *Cavity value limitation*

There are 3 (three) types of cavities in the asphalt mixture, namely:  
 Voids in mineral aggregates (VMA);  
 Asphalt filled voids (VFA);

Cavity in mix (VIM)

e. *Void in mineral aggregate (VMA)*

Cavities in mineral aggregates are cavities that exist or occur between two or more aggregate grains that interact with each other (interlocking).

In the 1996 NAPA book Hot mix asphalt materials mixture design and construction, it is stated that the VMA value is closely related to the maximum grain size, the smaller the maximum aggregate grain used, the greater the minimum VMA value limit.

In calculating the VMA value, it is formulated as follows:

$$VMA = 100(V_v + V_{eff}) / V_T$$

Where:

- V<sub>v</sub> = The volume of air voids in the mixture
- V<sub>eff</sub> = Effective asphalt volume
- V<sub>T</sub> = The total volume of the mixture

If the shape of the aggregate is flat and oval, the VMA will be even greater, but the VMA that occurs is not a result of aggregate interlocking space, but a contribution from the relatively large aggregate surface area. This is not proportional, so the mixture will be unstable. For example, if the upper specification limit is used, the VMA value will be large due to the contribution of the aggregate surface area.

Meanwhile, if the lower limit is used, the VMA value will be very small so that the mixture will be brittle. Therefore, the subject matter of this paper will describe the various advantages and disadvantages of trajectory gradation and its effect on the toughness of asphalt mixtures.

f. *Void in total Mix (VTM):* The cavity in the mixture is the space provided for the material expansion process due to high temperature changes. Using a high maximum grain size requires extra effort to control, especially in the mixing process in AMP, transportation and spreading, so that a uniform mixture is obtained at all times.

In calculating the value of VTM is formulated as follows:

$$VTM = 100(V_v) / V_T$$

Where:

- V<sub>v</sub> = The volume of air void in the mixture
- V<sub>T</sub> = The total volume of the mixture

Or with the following formula:

$$VTM = 100 \{ 1 - (G_{mb}/G_{mm}) \}$$

Where:

- G<sub>mb</sub> = Apparent specific gravity of solid mixture
- G<sub>mm</sub> = The theoretical maximum specific gravity of the mixture.

g. *Cavity filled with asphalt (void filled with asphalt, VFA)*

Cavity filled with asphalt is the total volume of effective asphalt content covering the entire surface of the aggregate. The minimum asphalt blanket thickness is 8 microns, with a maximum limit of 11 microns.

Asphalt less than 8 microns thick covering will experience rapid aging due to the oxidation process, while more than 11 microns stability will be disturbed, compaction is difficult due to decreased interlocking.

In addition to the above, the gradation trajectory can also affect the surface area of the aggregate, which in turn also affects the total surface area of the aggregate.

In calculating the VFA value, it is formulated as follows:

$$VFA = 100 V_{eff} / (V_v + V_{eff})$$

Whare:

$V_v$  = The volume of air voids in the mixture

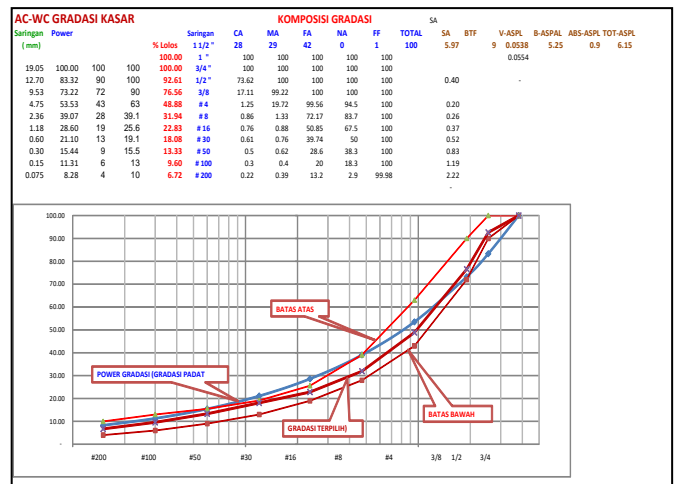
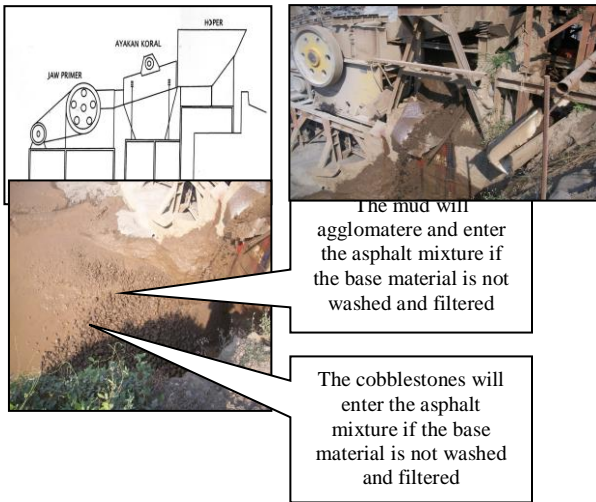
$V_{eff}$  = Effective asphalt volume, or

$$VFA = 100 \{ (VMA - VTM) / VMA \}$$

- h. Source of aggregate material supply. In the 2010-2011 specifications it is stated that the maximum clay content is 1 (one)%. This provision is actually detrimental, if in 1 ton of hot mix there are 9 (nine) kg of mud/clay, of which 9 kg means 0.9% less than 1%. However, it should be noted that the clay content of 9 kg in 1 ton of hot mix will greatly damage the mixture, because the dust from the mud/clay will not come off when it is attached to the aggregate, even if it is sucked up by a dust collector. This dust comes off just washed. Therefore, if this dust is in the hot mix, ± 0.3% additional asphalt is needed. This rarely gets the attention of the executors, so that failures often occur. The washing of the mechanical system must be carried out as illustrated in Figure 2. The crushed stone mixed with clay, gravel and silt must be sieved with a size of 2-3 inches. AMP that does not have a stone crusher, must provide processed washing of dirty crushed stone, with a size of 5 x 4 x 2 (length, width and depth).

directly from the sun. Therefore, the AC-WC surface layer must be strong and durable.

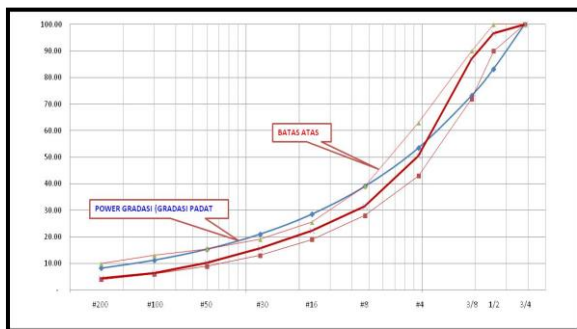
The capacity of the stone crusher at AMP is insufficient for production, so material must be imported from other sources, so the mud or silt content of the material needs to be controlled. The mud content value is added to the #200 passing sieve percentage to calculate the amount of additional asphalt that must be added so that the effective asphalt content for the coating thickness against the aggregate surface area is still fulfilled. If the dust content is 1%, then the amount of additional asphalt is ± 0.3%. There fore the grains below it should not be larger in number than the larger grains because it will interfere with the interlocking process. The shape of the track must be concave on the fine grain fraction, while on the coarse fraction it must be convex, with the turning point occurring between sieve #4 and 3/8.



Picture 2 Sketch of basic material washing machine by mechanical means

aggregate material were produced as shown in the following table:

Table 2. Proposed changes to specifications on the limits of coarse fractions



Picture 1. An example of a gradation path formed to minimize segregation and reduce filler material

- i. Trajectory gradation; In this paper, the specification used is the AC-WC specification, because AC-WC is a pavement surface layer that receives vehicle loads directly, and also receives heat

Size	Specivation 2010	Change
3/4 "	0	10
1/2 "	90	97
3/8	72	85
# 4	43	54
# 8	28	36
# 16	19	0
# 30	13	25
# 50	9	6
# 100	6	19
# 200	4	1

## 2. Material Improvement in Superintendent Training

In an effort to improve work performance on the hot mix asphalt road surface layer, it is necessary to improve teaching materials that are in accordance with real conditions when carrying out supervision in the field in accordance with the expected standard operating procedures.

From the results obtained in the improvement/perfection of the material in the activity, among others are:

- a. Pre-development of material results, namely collecting information about material needs by conducting curriculum studies and formulating a number of clear, specific training objectives in the form of observations and measured in the field;
- b. Material trials, namely conducting small group trials and diagnostic tests to measure the participants' background, knowledge and abilities that they already have as a prerequisite for taking field supervisor training materials;
- c. Revision, namely carrying out revisions according to suggestions from the field supervisor training trial activities, where it is necessary for the relevant person to review the draft material which can be carried out by material experts in the field of study, learning experts. Material trials are carried out at training institutions to find out the achievement of training outputs with competency standards (competence units) for improvement/improvement;
- d. Carry out the dissemination and implementation of the results of improving the field supervisor training materials to obtain the determination of training materials carried out by the institution responsible for organizing the training in accordance with the established rules.

## IV. DISCUSSION

1. From the results of this study, it is necessary to make improvements starting from the pre-development of the material, testing the material, revising, disseminating and implementing training activities. The use of dirty crushed stone material is no longer permitted in the hot mix asphalt mixing process, because the dust originating from the mud will not come off even if it is vibrated when it is filtered, unless washing is carried out. Therefore, the Development of Standard Operating Procedures (SOP) was made for supervision of material cleanliness through a mechanical washing system for split stones before entering the hopper stone crusher.
2. Repair of hot mix asphalt material (hot mix) is one of the learning materials that can be used as a learning transformation of knowledge, skills, and work attitudes for trainees to achieve competency.

As for the research, the authors improve the refinement of material in activities including:

- a. Pre-development of material results, namely collecting information about material needs by conducting curriculum studies and formulating a number of clear, specific training objectives in the form of observations and measured in the field;
- b. Material trials, namely carrying out small group trials and diagnostic tests to measure the participants' background, knowledge and abilities that they already have as prerequisites for taking field supervisor training materials;

- c. Revision, namely carrying out revisions according to suggestions from the field supervisor training trial activities, where it is necessary for a related person to review the draft material which can be carried out by material experts in the field of study, learning experts. Material trials are carried out at training institutions to find out the achievement of training outputs with competency standards (competence units) for improvement/improvement;
- d. Carry out the dissemination and implementation of the results of the improvement of training materials for field supervisors to obtain determination of training materials carried out by the institution responsible for organizing the training in accordance with the established rules.

## V. CONCLUSION

1. In the future, in terms of research, it is possible to make additional Standard Operating Procedures (SOP) for supervision and understanding of laboratory testing of raw materials on the cleanliness of mechanically washing aggregates of crushed stone before entering the stone-breaking machine hopper, which should be a prerequisite for stone-breaking machine business owners. or AMP and batching plant, in order to obtain clean crushed stone, including:
  - a) The silt content in fine aggregate should not be allowed, so that a maximum amount of silt content of 1% must be removed;
  - b) It is permissible to use natural sand, so the equivalent sand value should be above 90%;
  - c) The specifications for the coarse grain fraction are adjusted to the grains that enter the filter according to the desired requirements from the trial results.
2. The addition of Hot Mix Asphalt material to the Road and Bridge Preservation Field Superintendent Training strictly refers to the Competency Standards and the results in the laboratory for material specification guidelines that have been produced. In the results of the analysis of the training needs of field supervisors according to standards, so that a link and match learning system occurs. With the addition of hot mix asphalt material to the supervision training, it is hoped that the quality of the training results at the PUPR Human Resource Development Agency will increase.

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