THE INFUENCE OF USING LOCAL MATERIALS ON QUALITY OF POROUS ASPHALT IN INDONESIA

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Abstract: Porous asphalt is an innovative road surfacing technology, which allows water to enter into the asphalt mixes beyond its continuous air voids. Porous asphalt designed so that after laying and compacting, they form a surface with a void's more than 20 percent, and used for wearing. The problems that the present porous asphalt pavements hold are a problem that a drainage function falls, the aggregates scattering loss and plastic deformation. The drainage falls caused by clogging, where the voids of a mixture blockade with dust or movement of asphalt mortar. Scattering of aggregates caused by ravelling, plastic deformation related with rutting, caused of the porous asphalt pavements employ around more than 20 percent of air voids. In Indonesia, porous asphalt has not been used as popular technology. Objectives of this research are to study usage of local materials and that relationship with quality of porous asphalt mixes, and to compare porous asphalt mixes quality for numbers of different design methods.

The experiment works was dividing into three phases, for phase one was developed to investigate the properties of aggregates and straight asphalt qualities. The experiment work for phase two was developed to design the porous asphalt mix. In this phase Australian's method and Japan's method was used to define optimum asphalt content. In this phase, has result cantabro loss, asphalt flow down, air void and density values. The experiment work for phase three was developed to investigate the qualities of porous asphalt. In this phase, wheel tracking machine test was used to investigate the dynamic stability of mixes. Result of this research will be valuable for development porous asphalt technology in Indonesia.

Key Words: local material, Japan's method, Australian's method, quality of porous asphalt

1. INTRODUCTION

Porous asphalt is a developing in road surfacing technology; Porous asphalt is an innovative road surfacing technology, which allows water to enter into the asphalt mixes beyond its continuous air voids. Porous asphalt designed so that after laying and compacting, they form a surface with a void's more than 20 percent. They are used in wearing courses and always laid on impervious base course, was promising and effective in enhancing traffic safety. The use of porous asphalt also to reduce noise and glare.

Porous asphalt also namely open-graded asphalt has been use as a wearing surface since the 1950s. Its first major use in Australia was about 1973 and in Japan was about 1987. Both of Australia and Japan have their own methods. In general, the difference of the methods is on gradation composition. This experiment to compare the difference of the quality of porous asphalt mixes was designed by Australian's method and Japan's method. This experiment also to evaluate the quality of porous asphalt mixes Indonesian local materials.

The following scope of work was undertaken are the coarse and fine aggregates from Tanjungan in South Lampung, the grading use specification of Australian and Japan methods, evaluation is performed on mixture at optimum asphalt content by wheel tracking test.

2. LITERATURE REVIEW

2.1 Quality Related Properties

The term "quality related" indicates that the properties used in the mix selection and design process are those which determine it's on road performance. Thus if good test result for a mix are obtained in the laboratory there is confidence that the material will perform satisfactorily on the road. For this reason, standard of porous asphalt mixture in Japan required the dynamic stability value reach 3000 pass/mm or more (Nakanishi, 2002)

The design of porous asphalt mixes has focussed on attaining a grading and binder content that gave a range of air void contents. While the provision of a porous structure is crucial to the quality of this type of mix. Porous asphalt is a mix with a high air void content (in excess of 20 %) provides enhanced skid resistance, reduced noise, reduced surface water spray, improved visibility, and a smooth riding surface.

The problems that the present porous asphalt pavements hold are a problem that a drainage function falls, the aggregates scattering loss and plastic deformation. Permeability to water is one of the characteristic properties of porous asphalt, i.e. drainage function. The drainage falls caused by clogging, where the voids of a mixture blockade with dust or movement of asphalt mortar (Nakanishi, 1995). Scattering of aggregates caused by ravelling. Plastic deformation related with rutting, caused of the porous asphalt pavements employ around more than 20 percent of air voids.

In laboratory, to know the quality related properties usually was tested with water permeability test, cantabro loss test, loss of running off test (drain down test) and wheel tracking machine test. Nakanishi, et al. (1996) also stated that cantabro loss and dynamic stability have relationship with percentage of air void and asphalt viscosity.

2.2 Mix Design Method

Two design method will use are Australian's and Japan's method. Both of the methods use air void content, cantabro loss and loss of running off value to define the optimum asphalt content. The main difference of the methods on defining of target aggregate grading and defining optimum asphalt content.

In Australian's method targeted aggregate grading was stated in 2 (two) type, i.e. Type I for ESA (Equivalent Standard Axles) < 5 x 10^6 and Type II for ESA > 5 x 10^6, which both of them was divided by nominal mix size of aggregate, i.e. 10 mm, 14 mm, and 20 mm. Asphalt content provisional then define by mean of asphalt content which meet with specification below:

Table 1. Summary of Design Limits

Design Criteria	Type II	Type I
Cantabro loss-Unconditioned (%)	< 20	< 25
Cantabro loss-Conditioned (%)	< 30	< 35
Air Void Content (%)	20 – 25	> 20
Loss of Running Off (%)	< 0,3	-

source: Alderon, A., et al (1997)

Optimum asphalt content then defined by adding asphalt content provisional with loss of running off value.

In Japan's method target aggregate grading and optimum asphalt content was defined from target air void content, which was generated from trial error samples using 3 (three) proportion of coarse aggregate, i.e. 80%, 85%, and 90 %, also some provisional asphalt content combinations.

3. RESEARCH METHOD

The experiment works was divided into 3 (three) phases, for first phase was developed to investigate the properties of aggregates and asphalt qualities. The experiment work for second phase was developed to design the porous asphalt mix. In this phase Australian's method and Japan's method was used to define optimum asphalt content. In this phase, has result cantabro-loss, asphalt flow down, air void and density values. The experiment work for the last phase was developed to investigate the qualities of porous asphalt at optimum asphalt contents. In this phase, wheel tracking machine test was used to investigate the dynamic stability of mixes.

Table 2. Shows aggregate grading was used in this experiment. Marshall Specimens were prepared at asphalt content range 4 %, 4, 5 %, 5 %, 5, 5 % and 6 %. In Japan's method there 3 (three) modifications on proportion of coarse aggregate, i.e. 80 %, 85 %, and 90 %; also on proportion of mineral filler, i.e. 4 %.

Table 2. Aggregate Grading Used For Experiment (Percent passing)

Sieve Aperture (mm)	**Nominal Mix Size 14 mm**
19,0	100
13,2	95
9,5	50
6,7	27
4,75	11
2,36	9
1,18	8
0,6	6,5
0,3	5,5
0,15	4,5
0,075	3,5

source: Alderon, A., et al (1997)

For Australian's method, optimum asphalt content then define by cantabro loss value and air void then adding by loss of running of value. For Japan method's, optimum asphalt content was defined by cantabro loss value and loss of running off value and air voids target to get optimum asphalt content and percentage of coarse aggregate.

4. DATA AND ANALYSIS

Table 3. Shows properties of straight asphalt were used in the experiment. It shows that type of asphalt is straight asphalt penetration 60/70. In general, asphalt binder qualities comply with the requirement and recommended to apply for practical purpose.

Table 3. Properties of Asphalt

Properties asphalt	**Value**
Penetration (1/10 mm) 25^{o}C	64
Softening Point (^{o}C)	55
Ductility (cm)	> 140
Specific Gravity (gr/cm^{3})	1,034

Table 4. Shows properties of aggregates were used to the experiment. It shows that material comply with the request in specification and recommended to apply for practical purpose too.

Table 4. Properties of Aggregates

Properties	**Value**
Coarse Aggregate	
Bulk Specific Gravity (gr/cm^3)	2,72
Saturated Specific Gravity (gr/cm^3)	2,67
Apparent Specific Gravity (gr/cm^3)	2,82
Absorption (%)	0,82 %
LA Test (%)	14,4 %
Fine Aggregate	
Bulk Specific Gravity (gr/cm^3)	2,68
Saturated Specific Gravity (gr/cm^3)	2,65
Apparent Specific Gravity (gr/cm^3)	2,68
Absorption (%)	1,28

Figure 1. Shows relation between cantabro loss and asphalt content. It illustrates that increasing in asphalt content, make decreasing in cantabro loss. It also shows that cantabro loss from Australian's method rank between cantabro loss Japan's method 85% coarse aggregate content and 90% coarse aggregate content. It explains that Australian's method content more than 85 % of coarse aggregate content.

By adding asphalt content, it will increase aggregate surface area covered by asphalt film. This condition strengthening binding force between aggregates, therefore Cantabro loss value decrease. Cantabro loss value also affected by percentage of coarse aggregate. Higher the percentage higher cantabro loss value. Explanation of this condition is by increasing in percentage of coarse aggregate have an effect on decreasing in interlocking between aggregates.

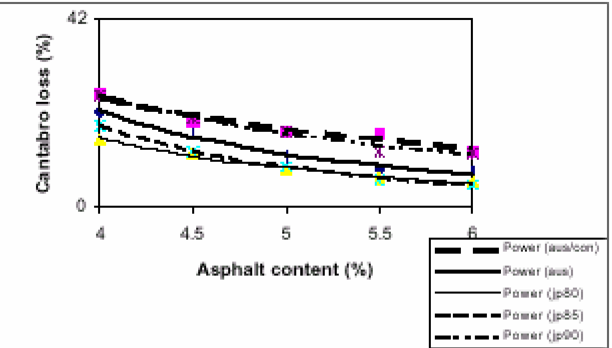

Figure 1. Asphalt content vs Cantabro loss

Figure 2. Shows relation between air void and asphalt content. It shows that increasing in asphalt content, make decreasing in air void. By adding asphalt content have an effect to the volume of void space was filled with asphalt binder. Higher volume of void was filled with asphalt binder, lower percentage of air void content.

It also shows that air void from Australian's method higher than air void Japan's method 85% coarse aggregate content. It can explain that higher coarse aggregate content have an effect to volume of void space in compacted asphalt mixes. Surface contact area of aggregates affected by their size. Bigger number size of aggregate will make surface contact area of aggregates lowest and it causes bigger in volume of void space. Furthermore, increasing in air void make decreasing in deformation resistance.

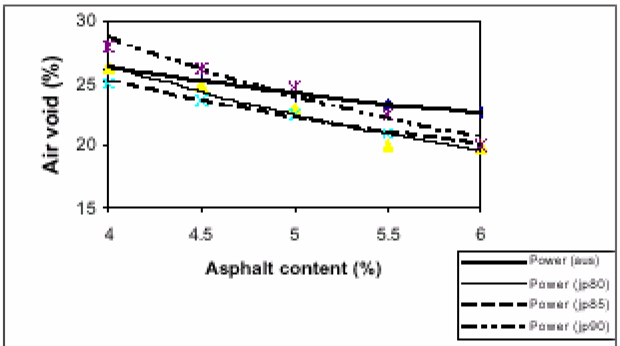

Figure 2. Asphalt content vs Air void

Figure 3. Shows relation between loss of running off versus asphalt content. It illustrates that increasing in asphalt content, make increasing in loss of running off. This condition explains that melting possibility of asphalt binder will increase as increasing in temperature and asphalt-binder content. It also shows that loss of running off Australian's method most lowly.

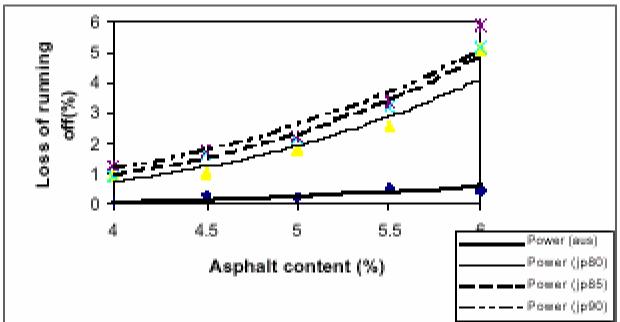

Figure 3. Asphalt content vs Loss of running off

From the three figures above, then used to define porous asphalt mix design. Table 5. Shows the result of mix design using Australian's and Japan's method, also dynamic stability was resulted from wheel tracking machine test.

Table 5. Mix Design of Porous Asphalt and Dynamic Stability

	Mix Design	
	Australian's method	**Japan's method**
Asphalt content (%)	5,30	5,19
Air Void (%)	22,0	22,0
Dynamic stability (pass/mm)	2068,9	2135,59

Based on Table 5, which result of preliminary experiment, it can be seen that the Japan's method has lower optimum asphalt content compare to the Australian's method. it also indicate that dynamic stability resulted from the Japan's method is higher than the Australian method. However, more experiments are needed in order to get better interpretations as well as mean and standard deviation values of dynamic stability.

5. CONCLUSIONS

Findings of the experiment are:

1. Cantabro loss will be decrease with increasing in asphalt content, and decreasing in proportion of coarse aggregate in mix.
2. Air void will be increase with decreasing in asphalt content, and increasing in proportion of coarse aggregate in mix.

3. Loss of running off will be increase with increasing in asphalt content, and increasing in proportion of coarse aggregate in mix.
4. The Japan's method resulted lower optimum asphalt content and higher dynamic stability compare to the Australian's method, although it is required more evidence.

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