New thin surfacing in Japan

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ABSTRACT:

We have developed a new surface treatment method to enable pavement maintenance at lower cost than the conventional maintenance methods. In the method thin hot mix asphalt is spread at 15mm thickness and compacted with rollers. Asphalt finisher with emulsion spray device spreads heated asphalt mixture and sprays emulsion at the same time.

Construction time becomes short because of simultaneous emulsion spraying, which eliminates prior emulsion spraying and curing process. And making pavement thickness at 15mm in average cuts the material cost into half. The heated asphalt mixture has proper voids to release emulsion resolution steam. Maximum grain size of aggregation is 5mm for easy construction of thin layer. Furthermore because of no emulsion spraying in preceding process, dump truck tires are free from emulsion, which results in keeping surrounding roads clean during the construction.

This paper describes outline of this method, characteristics of heated asphalt mixture for this method and a case example. The case example shows that this method is applied to aged residential road in the quiet neighborhood, which is more than 20 years old and has many pavement faulting due to manholes and filling restorations of underground water pipe. Serviceability evaluation of the pavement before and after construction, and the follow-up result after mending are also reported.

KEY WORDS Thin surfacing , The self priming asphalt paver (The asphalt finisher with emulsion spray device) , Low cost

1. INTRODUCTION

The balance of Japanese long term national and local government debt has been the highest ratio among the economically advanced nations. In order to reduce this debt, government expenditure is reviewed and downheld, and investment for social capital is decreasing year after year. On the other hand rapid aging of road stock, one of such social capital, is a serious concern in Japan.

Under this situation, an early countermeasure before large scale repair can reduce not only life cycle maintenance cost of road stock but enables to prolong the road life. However this type of procedure has been implemented as a preventive maintenance in the pavement field, it will be more important hereafter.

This paper reports a thin layer overlay method (hereinafter this method) using asphalt mixture, which has better endurance and appearance than conventional maintenance method and is more economical than conventional repair method

2. CONVENTIONAL ROAD MENDING

Conventional road mending is generally divided into two categories; maintenance method and repair method.

Table-1 Conventional road mending

<table>
<tr><th>Methos</th><th>Construction</th><th>Endurance</th><th>Function</th><th>Cost</th><th>Mending area (appearance)</th></tr>
<tr><td rowspan="4">Maintenance Method</td><td>Patching</td><td rowspan="4">Not enoough</td><td rowspan="3">Not enoough</td><td rowspan="4">Low</td><td rowspan="3">Partial</td></tr>
<tr><td>Filling</td></tr>
<tr><td>Partial replacemet</td></tr>
<tr><td>Surface treatment</td><td>Satis factory</td><td rowspan="4">Flat</td></tr>
<tr><td rowspan="3">Repair Method</td><td>Overlay</td><td rowspan="3">Good</td><td rowspan="3">Good</td><td rowspan="3">High</td></tr>
<tr><td>Milling overlay</td></tr>
<tr><td>Replacemet</td></tr>
</table>

Maintenance methods do not mend pavement permanently but fix the road damage temporarily for usage. Patching, filling, partial replacing and surface treatment are examples of these.

Since the repair is partial and limited to surface treatment, it has no improvement in appearance and flatness, the road function and performance are not restored.

On the other hand, repair methods mend the pavement from a long time view point, which are overlay, milling overlay, replacing method and etc. Repair methods restore various characteristics including flatness, endurance and they improve appearance. But all these methods are expensive.

Therefore we developed the thin layer overlay method using asphalt mixture, which is not only as economical as conventional surface treatment but also as endurable as overlay method.

3. OUTLINE OF THIS METHOD

3.1 Outline of This Method

In this method, as showwn in figure-1, asphalt mixture of maximum grain size 5mm is spread out at approximately 15mm average depth by a finisher equipped with emulsion spray device and compacted by rollers.

Asphalt emulsion resolves after spreading and compaction. In order to remain no steam in the process, asphalt mixture has continuous voids to release it.

Since this method is an overlay type thin layer pavement, construction thickness is not uniform, but having 10mm at minimum and 15mm at average as the standard thickness.

This can eliminate drying and curing time after prior tack coat spraying that is necessary for

conventional overlay, it cuts the construction time significantly and 15mm average construction thickness enables cost reduction.

Folowing table -2 shows construction outlines of this method and conventional method.

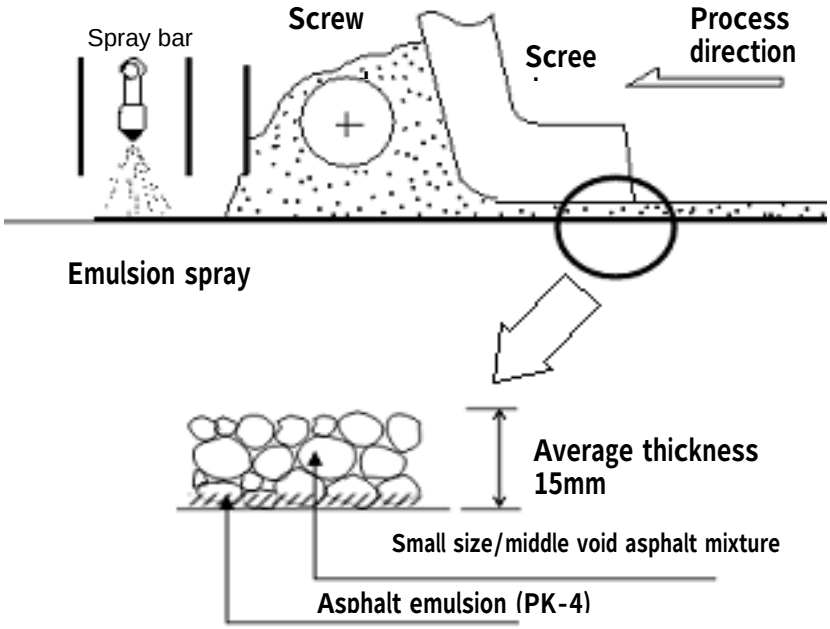

Figure-1 Outline of this method

Table-2 Construction outline of this method and conventional method

Item		Surface treatment	This method	Conventional thin layer overlay
Construction outline	Average thickness	Approx.5～10mm	15㎜	≧30㎜
	Max. grain	5㎜	5㎜	13㎜
	Tack coat scattering method	No need	Immediately before the mixture is placed and spread	Prior scatter/ dry & curing
	Spreading machime	Special spreader	Safe paver Asphalt finisher with emulsion spray device	General asphalt finisher
	Roller	No need	Road roller	Road roller
			Tire roller	Tire roller

3.2 Specification and characteristics of the mixture

(1) Endurance

The same degree of endurance as conventional overlay asphalt mixture.

Endurance evaluation index are "Martial stability," "residual stability," "dynamic stability" ai "Cantabro loss rate."

(2) Study of void rate which prevents blistering

This method applies asphalt finisher with emulsion spray device to increase construction efficiency, which sprays emulsion just before asphalt mixture spreading. Therefore blistering is the

main concern in a usage of conventional dense grade asphalt mixture that has less voids. Open graded asphalt mixture does not have such a concern, but it has a problem in endurance. Development of asphalt without blistering occurrence and with suitable strength is required. Our study confirmed that 7% void degree gives the pavement almost no blistering.

Experiment below found the suitable void rate that prevents blistering. Consulting previous documents 1), blistering simulation had been done by sending compressed air of almost saturated steam pressure to center boundary face of concrete base and test mixture, shown in figure 2. Figure 3 shows the relation between test mixture void rate and swelling height.

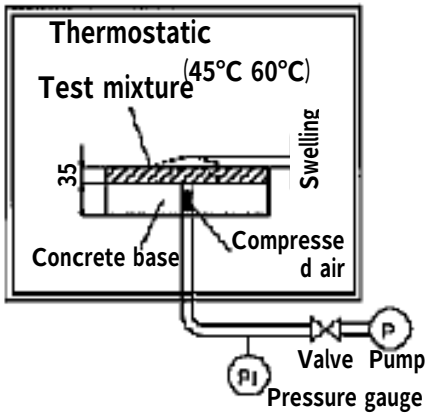

Figure-2 Testing outline

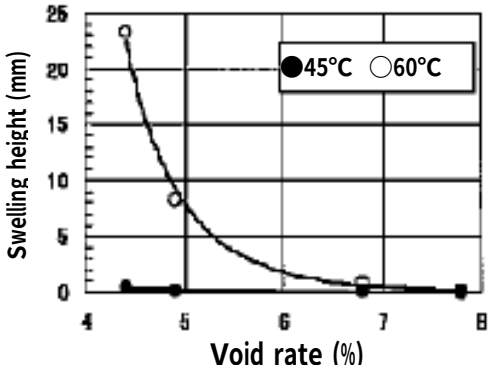

Figure-3 Relationship between blistering and void rate

(3) Specification and characteristics

Table-4 shows specification and characteristics of the asphalt that is used in this method. 7% void asphalt has equivalent characteristics to dense grade asphalt mixture (13).

Table-3 Specification and characteristics of the mixture

Items		Asphalt mixture of this method		Dense grade asphalt mixture(13)	
		Typical spec.	Company standard	Typical spec.	Standard
Mixture grading	13.2mm (%)	100	100	100	95～100
	4.75	95.7	90～100	62.5	55～70
	2.36	45.8	30～50	42.5	35～50
	0.075	6.9	4～8	6.0	4～8
Asphalt amount (%		6.3	5～7	6.0	5～7
Mixture characteristic (N=50)	Density(g/cm3)	2.275	-	2.350	-
	Void (%)	7.0	≧7.0	4.5	3～7
	Stability (KN)	7.4	≧4.9	8.3	≧4.9
	Flow value (1/100cm)	35	-	25	20～40
	Residual stability (48ｈ%)	82.9	-	92.5	≧75
	Cantabro loss rate (%)	5.9	-	4.0	-
	Dynamic stability (times/mm)	730	-	1000	-

4. CASE EXAMPLE

This is a case example that this method is applied to an aged residential road in a quiet neighborhood, which is more than 20 years old and the road has many pavement faultings due to manholes and filling restorations of underground water pipe. And the surface characteristics and the follow-up results after mending are also reported.

4.1 Construction outline

Picture-1 shows road condition before construction.

Surface was aging and bumpy due to water pipe restoration, and also had sinkages and cracks. Flatness was too large to measure.

Since the road has a few big vehicle passage, this method was applied to the road to improve endurance considering cost performance and short construction time.

Picture-1 Existing road condition before construction

4.2 Construction procedure

Table - 4 shows a battery of machines used for construction

Asphalt finisher with emulsion spray device spread asphalt mixture on the existing road, and two 4t combined rollers and a 15t tire roller compacted it. (Picture-2～Picture-4)

Table-4 Battery of machines used for construction

Item	Machines	Number
Placing & spreading	Asphalt finisher with emulsion spray device	1
Initial rolling compaction	Conbined roller 4 t	2
Secondary rolling compaction	Tire roller 15 t	1
Edge rolling compaction	Plate compacter	2

Picture-2 Emulsion spraying and

Picture-3 Spreading and rolling

Picture -4 Rolling

Picture-5 and Picture-6 show road and finished pavement surface after construction.

Picture-5 Road after construction

Picture-6 Finished surface after construction

4.3 Function of the surface

Flatness, skid resistance (BPN・coefficient of dynamic friction), surface texture depth, cracking incidence rate and visual appearance check were done as a follow-up study of this method just after the construction and 1 year later being in-service

Table-5 Road function

Item	Immediately after construction	1 year later	Refference
Flatness (σ)	2.3	2.6	3m Profile meter
Skid resistance			
ＢＰＮ (BPN)	55	70	Pendulum skid resistsnce tester ASTM E 303
Coefficient of dynamic (RSN)	0.41	0.74	DF(Dynamic friction)tester ASTM E 1911-98
Surface texture depth (mm)	0.33	0.32	Sand patch-test method
Crack rate (%)	—	0.6	According to pavement test method handbook

Note 1) Flatness σ：Standard deviation of wave hight
2) Cracke rate：(Cracked pavement area)/(All pavement area)
Ref. 1) Crack rate of existing road: 35% (Before construction)

No change in flatness and surface texture depth after the construction.

Skid resistance was small initially, but it rose up to enough level at present. This may be caused by the removal of oil and asphalt film.

Approximately 2 years passed now after construction. It may be early to evaluate the function (performance), but the road has alomost no reflection cracking and maintains good appearance

5. FUTURE SUBJECTS AND COUNTERMEASURES

An area facing parking lot had a aggregate fly apart from frequent tire steering for garage parking at an early stage after construction. （See Picture-7）

Straight asphalt aggregate might not have enough gripping force for tire steering stress. But further aggregation fly away or other occurrence has not been found and it settled down after half a year later.

The thinkable reasons of this are below.

① Spread thin layer asphalt cooled down rapidly. This might give insufficient compacting density to the asphalt mixture.

② Since construction was done in small residential area, standard large machineries were not able to operate. Only small size rolling machines were allowed to use.

Picture-7　Macro photography of road surface

As a immediate countermeasure, the binder was changed to polymer modified asphaltⅡ. No aggregation flied away in result.

Based on these, future subjects are below.

① To improve aggregation grip by using polymer modified asphaltⅡ binder.

② Countermeasures to secure the density

- Countermeasure against cooling down in winter construction
- Compaction density improvement in construction at small limited area.

6. SUMMARY

This paper introduced thin layer pavement with asphalt mixture as a low cost road mending method. Features and things to keep in mind for application of this method are below summarized.

【Feature】

- A mending method in between maintenance and repair, which is as economical as conventional surface treatment and as endurable as overlay.
- Further material cost reduction due to thinner layer than conventional general thin layer pavement.
  Therefore application to existing structure is easy and economical.
- General materials and machines are usable.
- Possible to refurbish aged surface into the surface with suitable texture and skid
- Short road blocking time by tack coating process and curing time cutting down, bcause emulsion is sprayed simultaneously with asphalt mixture construction.

【Things to keep in mind】

- Polymer modified asphaltⅡ should be used to the area having frequent tire steering like a garage parking.
- Construction should avoid the coldest winter season, because thin layer asphalt mixture cools down rapidly after spreading.

7. CONCULUSION

This method is an economical and durable thin layer pavement, which is applicable to local government control roads with a few traffic and roads in residential area. And fundamental road characteristic restoration by this method improves safety of road users. This method can provide a certain level of service to local communities and road users with a small construction investment.

In shrinking budget for public works including maintenance expenditure in Japanese aging and fewer child society, it is important to utilize existing social capital effectively and maintain its function. We are planning a further development to hand down our safe and secure social capital to the next generation.

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