MAINTENANCE

APPLICATIONS OF MICROSURFACING PROCESSES TO PAVEMENT REPAIR WORK

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He joined the Nippon road in 1982. He has been working for the technical laboratory since 1990. He is a chief engineer in the technique laboratory. He is chiefly engaging in the research of the cold mix. Now,he is developing the color microsufacing for the tunnel pavement repair. Date of birth 1958.November.7

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1. INTRODUCTION

Microsurfacing is a thin-layer pavement using bitumens emulsion that was developed in Germany in late 1960s and early 1970s. Since the 1980s, it has been applied in Europe and the U.S. as one of preventive maintenance methods that was considered cost-effective. In recent years, it is also being used in various countries in Asia .

An average thickness of microsurfacing is 5 mm (1 layer) to 15 mm (2 layers). Microsurfacing is a process in which a special operation machine produces a slurry-type cold mixture by mixing modified bitumens emulsion, sands and crushing stones of small size, cement, and water, etc. and then spreads the mixture evenly over the road surface using a spreader box which is attached to the rear part of the machine. The evenly spread mixture starts to harden immediately after being spread and exhibits a level of strength which makes it possible for the road to be served to traffic several hours later.

Microsurfacing is applicable to all methods of preventive maintenance for both asphalt and concrete pavement to highways as well as residential area roads. The applications include improving the properties of roads in operations such as refreshing aged roads, repairing shallow rutting, and restoring skid resistance.

In Japan, most pavement repairs are carried out when the rutting depth reaches about 30 - 40 mm or the cracking ratio reaches about 30 - 40%. Consequently, the applied pavement repair method becomes a large scale one, such as overlay and reconstruction.

While the concept of preventive maintenance is gradually known in Japan, the actual situation is that it has not been established as a maintenance policy and there are few cases of microsurfacing being practically applied as a preventive maintenance method. However, microsurfacing is an energy and resource saving method and it is desirable that its application as a method which contributes to preservation of the global environment is expanded. In this regard, we examined whether microsurfacing should be applied to the repair of pavement which had full-scale damage, rather than simply the repair of pavement at the initial damage stage.

The purpose of this report is to examine the application and cost effectiveness of microsurfacing as a repair method and to investigate its durability and performance when it is applied to damage area conditions exceeding the conditions for which it is normally used.

2. MICROSURFACING MIXTURE PROPERTIES AND CONSTRUCTION METHOD CHARACTERISTICS

2.1 Properties of microsurfacing mixture

ISSA (International Slurry Surfacing Association) type II was used for the microsurfacing mixture. Table 1 shows the properties of the modified bitumens emulsion used. In addition, table 2 shows a comparison between the properties of general hot mix asphalt concrete (dense-graded asphalt mixture) and those of microsurfacing mixture. Table 2 shows that microsurfacing mixture properties is equal to or better than conventional hot mix asphalt concrete.

Table 1:Modified bitumens emulsion properties

Englar degree	6.9
Eieved(1.18mm)	0.0%
Particle charge	(+)
Residual binder	62.4%
Tests on distillation residue	
Solubility in trichloroethylene	99.6%
Penetration(25 ℃) 1/10cm	75
Softening point	54.7 ℃
Ductility (15 ℃)	100+
Toughness(25 ℃)	7.2Nm
Tenacity (25 ℃)	4.7Nm
Settlement (24h)	0.4%

Table 2 Comparison between HMA and microsurfacing properties

	unit	Micro-surfacing	Dense-graded asphalt mixture
Rutting resistance	pass/mm	1500 -2000	1500- 3000
Adhesive strengh between asphalt layers	kNPa	780 -1180	780 -1470
Skid resistance	BPN	70-80	65 ～ 75

2.2 Characteristics of microsurfacing

This construction method has characteristics as follows:

(1) As the pavement thickness is thin, the restriction of its finishing surface height on existing attached structures is small,

(2) Slight rutting repair is possible,

(3) Cracking repair of road surfaces without any structural defects can be performed,

(4) The construction work period can be shortened because large areas can be repaired quickly. This reduces road users delayed cost (3,000 - 5,000 m^2 per day),

(5) Refreshes aged road surfaces and restores their durability,

(6) Restores skid resistance,

(7) Reduces traffic noise generated by coarse road surfaces, and

(8) Microsurfacing contributes to preservation of the global environment because it saves resources and energy, and reduces the emission of carbon dioxide during the construction work.

3. OVERVIEW OF CONSTRUCTION

3.1 Construction site

Microsurfacing was applied on a road in Okayama prefecture located in the southwest area of Japan. Table 3 shows the local climatic conditions. The road surface temperature is 50 - 60°C during summer and there is snowfall on several days and the road is subject to raveling from snow tyre chains in winter.

Table 3 Climatic conditions

Average temperature during year	１４℃
Average temperature in August	２６℃
Average temperature in February	３℃
Precipitation during year	1300mm

In order to verify the application and cost effectiveness of microsurfacing as a repair method, two sections with rutting and cracking, both of which are common damage on asphalt pavement in Japan, were selected for repair work. In addition, a section with rutting was selected as a control section to compare microsurfacing with milling and resurfacing, which is the major preventive repair method in Japan. The details of these sections are as follows:

(1) Site 1: One section with rutting (200 m in length)

(2) Site 2: One section with cracking (110 m in length)

(3) Control site : One section with rutting (100 m in length)

3.2 Existing road pavement surface conditions

Table 4 shows road surface condition before repair.

Table 4 Road surface condition before repair

	Site １	Site ２	Control Site
Rut Depth (mm)	２０～５０	５～１２	１０～３６
Cracking Ratio (%)	１．３	１３．９	０
Roughness (mm)	４．００	１．４１	３．２４
CBR of Subgrade(%)	１８	２２	１６

3.2.1 Site 1

Rutting was found on the whole surface due to mixture flow. Repairs had been carried out once in the past by means of road surface cutting, but the rutting was still found thereafter. The plastic deformation of the mixture was severe, and both edges of the wheel path were protruding 10 - 15 mm more than the design road surface elevation.

3.2.1 Site 2

Cracking was found over the whole area, and it was particularly concentrated in the vicinity of the outer wheel path.

Along with a certain amount of structural defect, it was thought that the cracking was initiated due to deterioration of the mixture because the subgrade CBR using FWD showed no significant difference between cracked and non-cracked sites. The width of the cracking was about 2 - 3 mm.

3.2.3 Control site

The existing pavement conditions were roughly the same as those of site 1.

4. REPAIR METHOD

4.1 Site 1

For the case of using microsurfacing in the repair of the road surface with rutting, it was not suitable to repair the rutting using only microsurfacing because of poor spreadability, cost effectiveness, and delay in the development of the mixture strength. Therefore, the work was performed applying microsurfacing after cutting vaults in both sides of ruts.

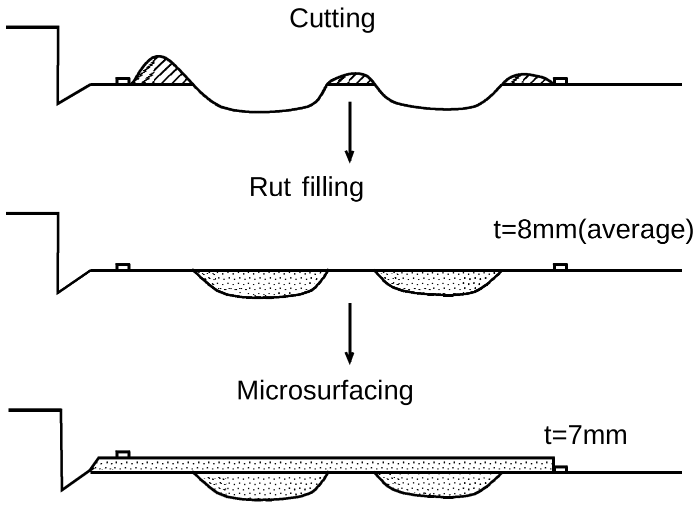


FIgure 1 :Repair method of site 1

After cutting the vaults, ruts were filled using microsurfacing mixture. The road was served to traffic for 2 - 3 days because mixture's consolidation by traffic was expected, then a layer of microsurfacing was spread over the whole area. The rut filling thickness was an average of 8 mm, and the microsurfacing layer was 7 mm (Figure 1).

4.2 Site 2

Pavement with cracking at site2 was repaired by pouring filling agent into the cracks that had occurred on the exisiting pavement surface, and then two layers of microsurfacing were

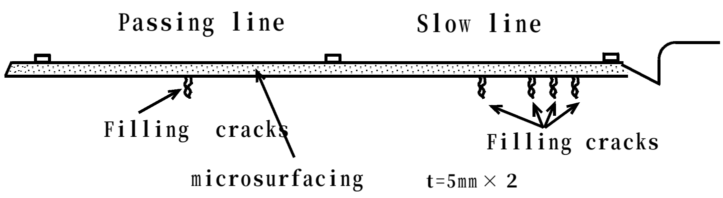


FIgure 2 : Repair method of site 2

applied over the whole area. Each layer was 5 mm thick, giving a total thickness of 10 mm (Figure 2).

4.3 Control site

After cutting the existing pavement surface an average depth of 50 mm, it was resurfaced with 50 mm thick hot mix asphalt concrete (Figure 3).

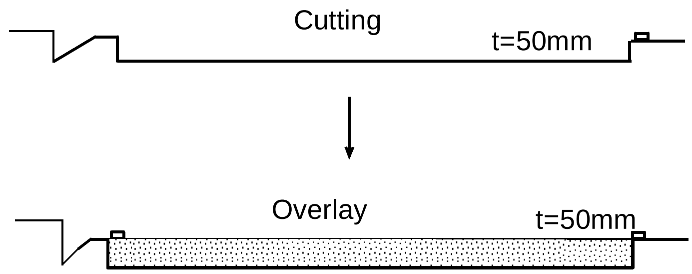


Figure 3: Repair method of control site

4.4 Execution procedure

The main repair methods discussed here are as follows:

(1) Vaults area cutting work

The vaults area cutting was performed using a cutting machine. At this time, longitudinal unevenness repairs were also performed using the cutting machine.

(2) Rut filling work

First, the microsurfacing mixture was spread uniformly on the area with rutting to an average thickness of 8 mm (max. 20 mm). Then it was compacted using a tire pneumatic roller.

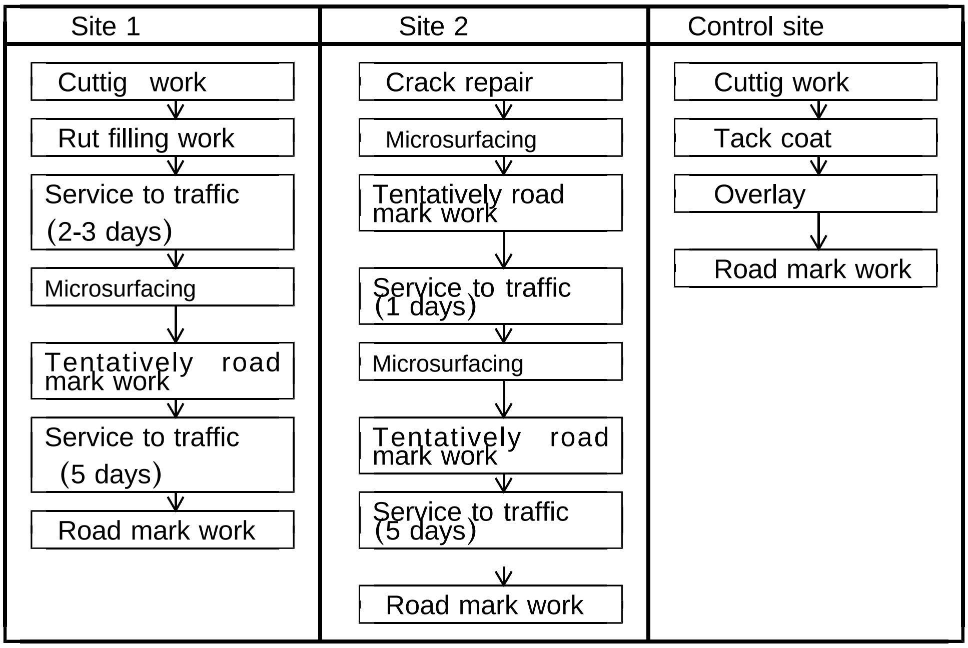
(3) Microsurfacing laying

The microsurfacing mixture was spread uniformly over the whole area, and then after hardening, it was compacted using a tire pneumatic roller. The layer thickness for site 1 was 7 mm ,while it was 2 layers of 5 mm thickness each, giving a total thickness of 10 mm for site 2. Thickness adjustment was executed by means of the thickness of the screed rubber at the rear of the spreader box and the viscosity of the mixture.

(4) Asphalt laying work

A tack coating (emulsifed rubberrized asphalt)was sprayed over the cut road surface at the rate of 0.4 • /m^2. Then, the hot mix asphalt concrete was paved uniformly to the specified thickness using an asphalt finisher, and compacted using a tire pneumatic roller and road roller to obtain sufficient density.

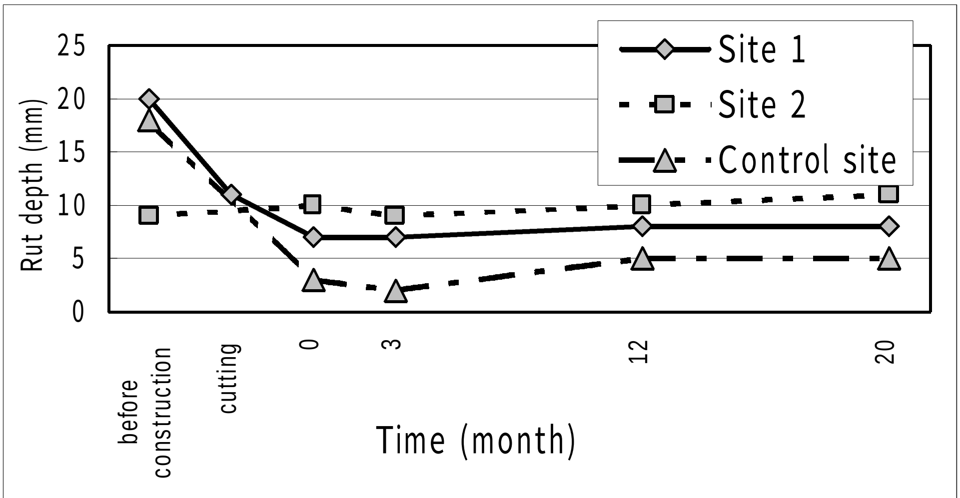
Figure 4: Execution methods



5. PAVEMENT CONDITION SURVEY RESULTS

5.1 Rutting depth

The rutting depth measurement results are shown in Figure 5.



Fgure 5:Rutting depth

The rutting depth of the existing pavement in site 1 was an average of 20 mm, and after cutting the surface's vaults the rutting depth was 11 mm. Then, after the rut filling and microsurfacing layer work, the rutting depth became 7 mm. Therefore, the rutting was improved by 9 mm as a result of the road surface cutting, and by 4 mm as a result of microsurfacing.

Also, after construction, the increase in the rutting depth of the sites which used microsurfacing after they were served to public traffic was 1 - 2 mm, while that of the control site was 3 mm. Therefore, the plastic flow resistance of 5 cm of resurfacing and of microsurfacing are, in the current situation, about the same.

In the case of deep rutting repair, because there is a limit to the layer thickness when using microsurfacing and the consolidation amount is large, deep rutting can not be repaired completely. However, it is clear that rutting repair is possible by microsurfacing after surface cutting work. The progression of rutting after service to traffic, even though it is after only one summer, indicates that it is equivalent to the milling and resurfacing method. In the experiment, it was found that the road surface flow resistance improved by applying 10 mm of microsurfacing on conventional hot mix asphalt.

5.2 Roughness

The roughness measurement results are shown in Figure 6.

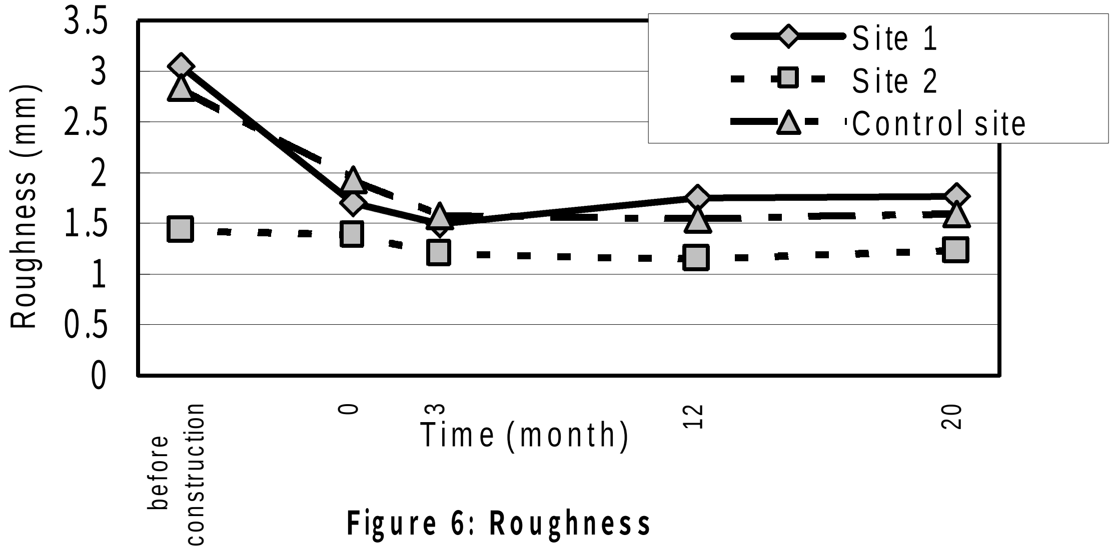


Figure 6: Roughness

Figure 6 shows that the roughness of site 1 was improved after repairs by cutting. Also, the improvement on the control site with surface milling and resurfacing work was almost same as for site 1. The roughness improvement could not be recognized, because only 10 mm of microsurfacing was applied on site 2, and the shape of the existing pavement surface was not changed.

5.3 Skid resistance

Figure 7 shows that the results of the skid resistance measurement using the British Pendulum Tester. In addition, the results of measuring the level of road surface texture using MTM (TRRL specification) are shown in Figure 8.

The skid resistance value of surface immediately after the microsurfacing layer applied was 72 BPN. The skid resistance value after 20 months was 68 BPN, indicating a tendency to decrease gradually. The dense-graded asphalt mixture of the control site shows a similar tendency, however the tendency to decrease is larger than the skid resistance value decreasing to 61 BPN.

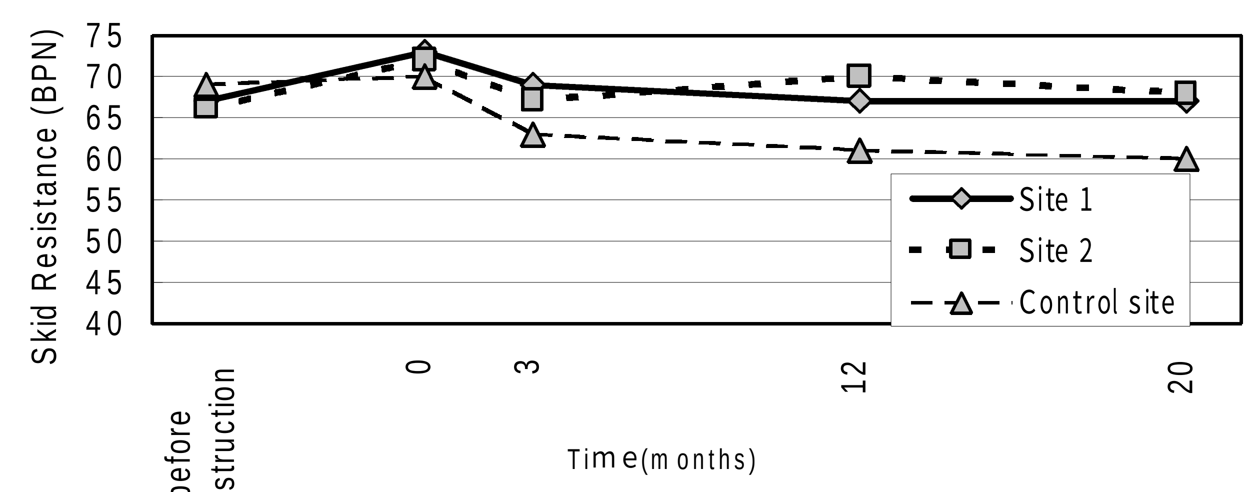


Figure 7: Skid Resistance

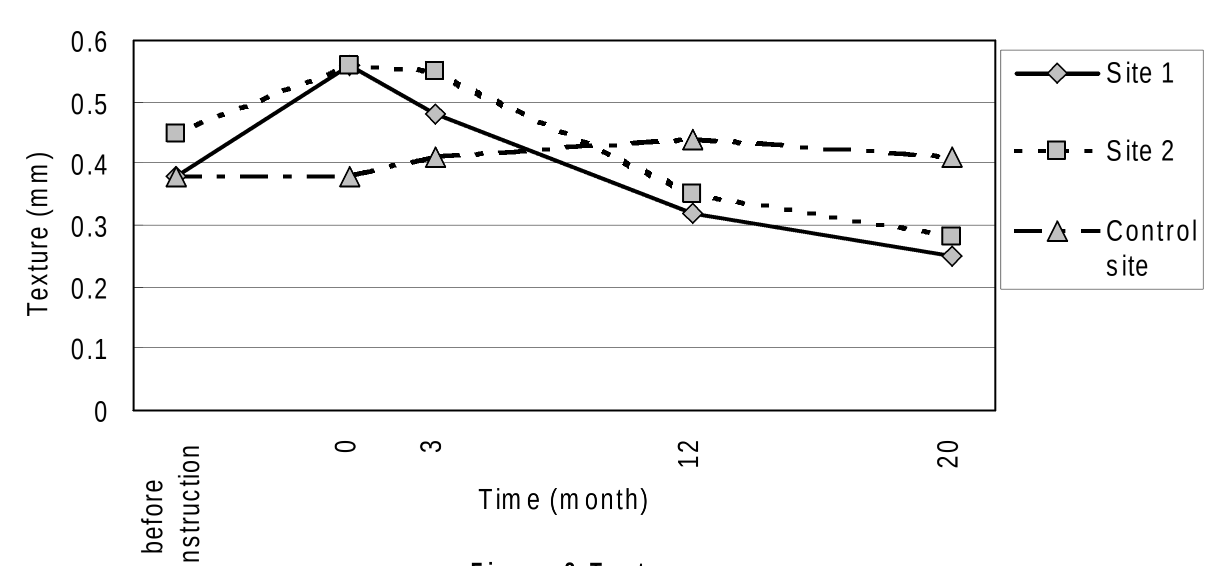


Figure 8:Texture

The degree of road surface texture was a high value immediately after the microsurfacing, however, this value dropped dramatically with time. The surface texture using the dense-graded asphalt mixture had the reverse trend after ten months, the surface texture levels were reversed, with the value for the dense-graded asphalt mixture showed larger value. It is thought that consolidation accompanying service makes the texture of microsurfacing layer macroscopically smooth, on the other hand, the fine part of the dense-graded asphalt mixture was scattered by the passing traffic resulting in a coarse surface.

The microsurfacing layer still showed a large value in the skid resistance even though the degree of road surface texture had decreased after 20 months. This trend has not changed, even at the current time when the microsurfacing layer's road surface texture is finer than that of the dense-graded asphalt mixture. This can be attributed to the effective functioning of the microsurfacing layer's microtexture.

5.4 Cracking

The results of the cracking measurement using the Sketch Rule are shown in Figure 9.

Cracking reflected underlying cracks of existing pavement was found at the early stage in site 1 and site 2. For site 2, the cracking ratio after 20 months was 5.7%. The number of reflective cracks during the approximately 2 years was 1/3 of the existing pavement cracks, then it was found the microsurfacing had less crack initiation effect. While it is necessary to observe the future cracking progress continuously, a pavement life prolongation effect and a life cycle cost reduction effect can be expected.

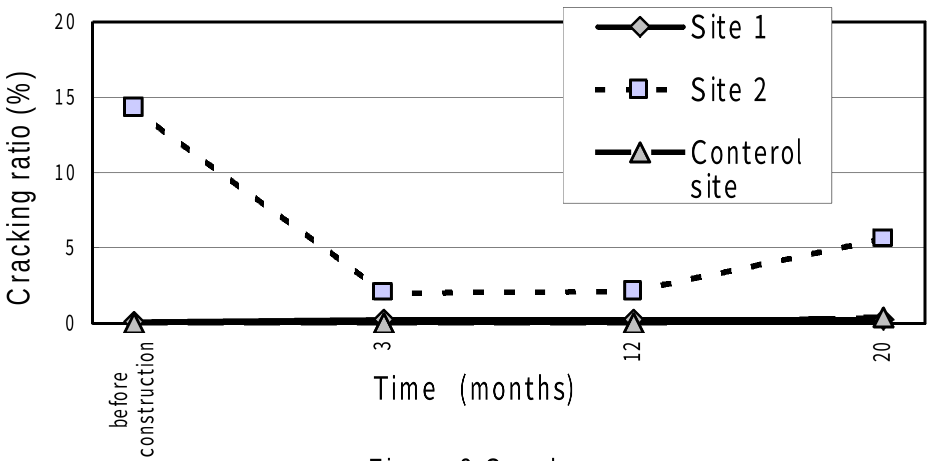


Figure 9:Crack

6. EXAMINATION OF COST EFFECTIVENESS

Table 5 shows that the result of a comparison of each site's cost effectiveness and environmental impact in relation to the construction work.

The difference between the sites in respect of construction cost is relatively small. This is why the construction area of each site was small. And consequently, the cost effectiveness of microsurfacing, which can execute a large amount of construction in one day, was reduced.

In the case of site 1, because smaller amount of cutting than control site was executed, the amount of cutting waste was small and the impact on the environment was minor.

Because the thickness of microsurfacing was 10 mm and it was thinner than HMA used at control site, it is possible to reduce the amount of carbon dioxide, a global warming gas, which was generated. Similar amount of energy consumption reductions were also achieved. Consequently, if the environmental impact is economically evaluated, microsurfacing will be one of the economical methods.

Table 5 : Cost effectiveness (%)

	Site 1	Site 2	Control site
Construction cost	95	70	100
Amount of RAP	10	0	100
Amount of CO_2	45	35	100
Energy consumption	45	35	100

7. SUMMARY

The results of the microsurfacing application discussed here are given below.

- By combining the surface cutting and microsurfacing, rutting repair is possible.

- For flow resistance, durability equivalent to that of hot mix asphalt concrete can be expected.

- High levels of skid resistance can be maintained over a long period.

- A cracked surface life prolongation effect can be expected, however, further up-graging of the microsurfacing mixture performance is required.

8. CONCLUSION

Microsurfacing is one of the excellent preventive maintenance methdologies all over the world. However, its application to severely damaged pavement had been considered difficult.

In this study, microsurfacing was adopted as conventional maintenance and repair construction and verified its application and cost effectiveness.

Microsurfacing is applicable in Japan. As future applications of microsurfacing will be applied on similar surface conditions discussed in this study, above summaries will be useful. We hope that cold paving technologies like microsurfacing will be widely used in Japan.