

# Innovative Drainage Pavement System

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## Innovative Drainage Pavement System

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### 1. Introduction

Porous asphalt mixtures used for porous asphalt pavement (PA) contain air voids in a percentage of around 20 in Japan. Rainwater permeates the surface course through these air voids and is removed from the road surface. This prevents the hydroplaning phenomenon, poor road marking visibility due to vehicle headlights and occurrence of splash or spray by vehicles during wet conditions, and improves the highway safety in the rain.

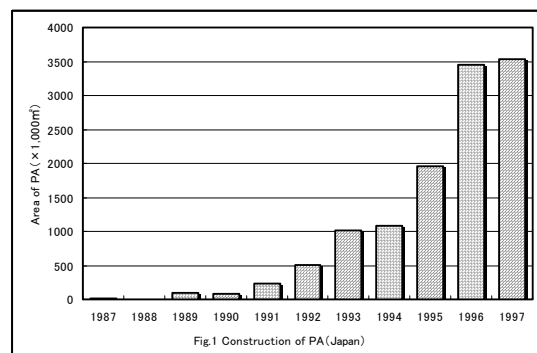
However, there is a limit to the amount of rainwater that the porous surface course (permeable layer) can hold, and it takes a certain time before the rainwater once held flows out. As a result, if the amount of rainfall is large or where the cross slope is small, after the rainwater permeates the permeable layer, a surplus will occur on the road surface in the form of flooding. At and around an inflection point (the portion on an S-shaped curve where the cross slope is small or zero) in particular, flooding debases the running safety of vehicles, and this has become a problem.

Thus, the authors devised an innovative drainage pavement system as a draining measure at a place where the cross slope on the pavement surface is small. By giving a cross slope to the bottom surface of the permeable layer, this pavement has the function of improving the lateral draining performance and shortening the water retention time.

This report summarizes the concept, features and rainfall simulation test results of the innovative drainage pavement system.

### 2. Construction achievements of porous asphalt pavement in Japan

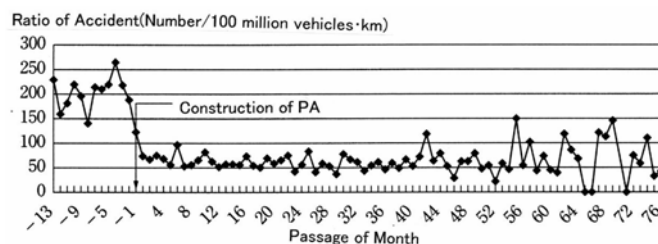
The construction achievements of porous asphalt pavement has shown a rapid growth in recent years (Fig.1)<sup>1)</sup>. On expressways, a substantial reduction of the accident rate has been ascertained (Fig.2)<sup>2)</sup>.



### 3. Features of innovative drainage pavement system

The following may be cited as the features of the innovative drainage pavement system:

(1) Because the permeable layer has a



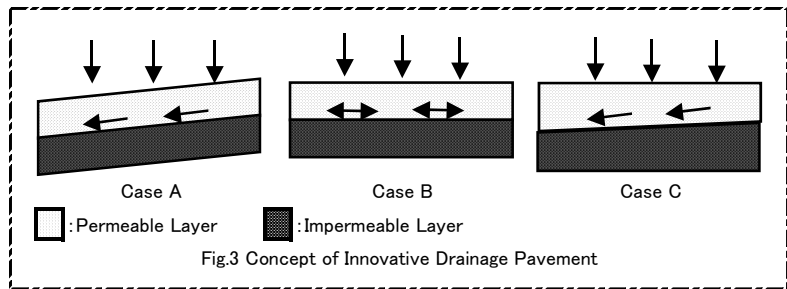
large volume, the amount of water that the layer can hold is large, even if there is a large amount of rainfall.

(2) Because the impermeable layer has a cross slope, the retention time of the rainwater in the permeable layer is short. Therefore, the time of the impermeable layer's being under the effect of rainwater is

also short, and the influence on the durability of the impermeable layer is small.

A schematic of the innovative drainage pavement system is shown in Fig. 3. With an ordinary porous asphalt pavement, rainwater will be swiftly drained to the road shoulder if a cross slope is secured at the pavement surface (Case A). However, at an inflection point or other portions where an adequate cross slope cannot be secured, rainwater is likely to stagnate and cause flooding (Case B). On the other hand, with the innovative drainage pavement system (Case C), a cross slope is provided at the surface of the impermeable layer, and this slope can swiftly drain rainwater to the road shoulder and reduced the occurrence of flooding.

By applying the innovative drainage pavement system, it is considered that rainwater will not stagnate even at a place where the cross slope is small, and so a comfortable road surface can be secured for the driver in the same way as at ordinary places.



#### 4. Experimental construction of road surface for rainfall simulation test

##### 4.1 Plan of experimental construction

The plan of experimental construction and the rainfall simulation test layout are shown in Fig. 4.

##### 4.2 Construction procedure

The construction procedure of the experimental construction is as follows:

(1) Construct the pavement to the surface course in the same way as in ordinary pavement construction work.

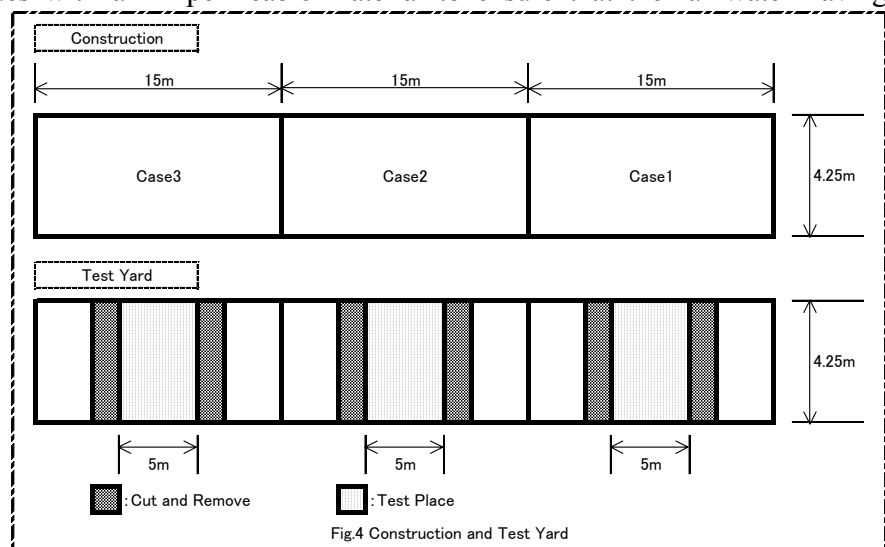
(2) Cut the outside portion on both side of the test place and remove that portion shown in Fig.4.

(3) Of the 4 sides of the test place to be subjected to the

simulation test, seal 3 sides with an impermeable material to ensure that the rainwater having permeated the permeable layer will be drained only from one side.

##### 4.3 Types of drained pavement system tested

The view of various pavement cross section tested is shown in Fig. 5. Case 1 is the section generally applied to



expressways in Japan except cross slope. In this rainfall simulation test, the cross slope of the pavement was taken to be 0% at any layer.

Case 2 is the section typically applied to expressways in Japan at the portion around an inflection point. The amount of rainwater that can be held is made larger by increasing the permeable layer thickness. As with Case 1, the cross slope on the pavement surface was taken to be 0%.

Case 3 is the section of the innovative drainage pavement under discussion now. The cross slope at the pavement surface is 0%, while a cross slope of 2% is given at the surface of the impermeable layer.

## 5. Rainfall simulation test

### 5.1 Water spray machine

A photograph of the water spray machine used for the test is shown in Fig. 6. One machine is equipped with 20 nozzles, which can slide right and left to sprinkle water uniformly over the road surface under test. Because the water spraying pressure can be kept constant, the test can be carried out continuously at a uniform sprinkling rate.

### 5.2 Method of rainfall simulation test

#### (1) Rainfall intensity

The test was performed at 3 levels of rainfall intensity, i.e., at 7, 8 and 10 mm/h. For information only, the situation of rainfall at Tokyo are shown in Table 1<sup>3)</sup>.

In Japan, if the rainfall intensity exceeds 5 mm/h, that is perceived to be a fairly heavy rain, and

there are few cases of rainfall intensity exceeding 10 mm/h. The rainfall intensities above were decided from these and other reasons.

#### (2) Measurement items

The items measured at the test are as follows:

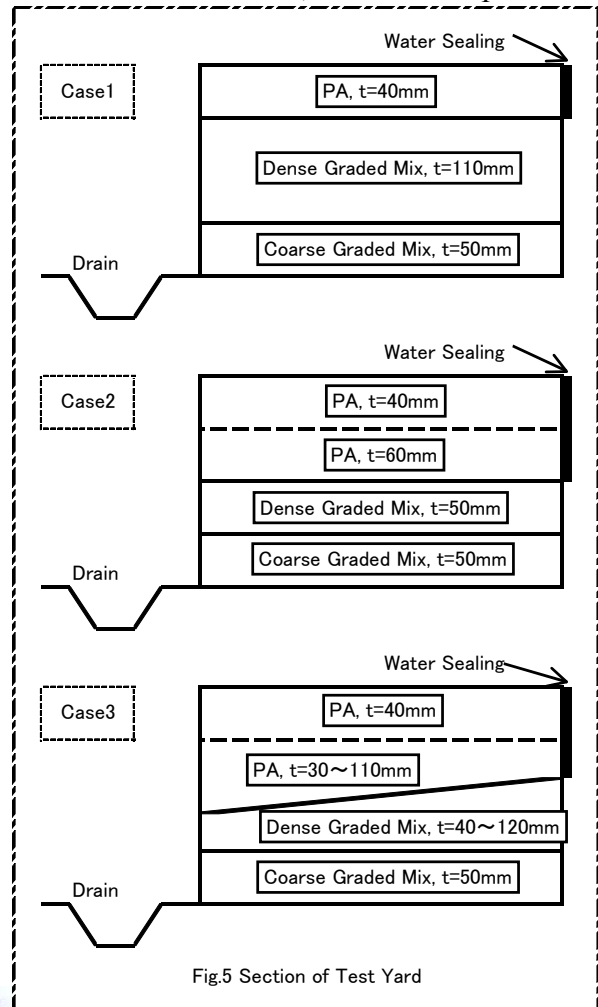


Fig.5 Section of Test Yard



Fig.6 Water Spray Machine

Table.1 Situation of Rainfall (Tokyo,2002)

nth	Jan.	Fev.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Max Rainfall (mm/h)	20.0	3.0	10.0	6.0	9.5	11.5	18.0	30.5	24.0	25.0	4.0	6.0
Over 10mm (day)	2	0	3	2	4	5	3	3	5	6	1	3

- Time to the occurrence of flooding
- Drainage rate per unit hour of rainwater having permeated the PA

### 5.3 Results of rainfall simulation test

The occurrence or absence of flooding and the time to the occurrence are shown in Table 2. Case 1 (ordinary pavement section) and Case 2 (section currently employed as a measure at an inflection point) have no cross slope on the road surface, and flooding occurred in both Cases 1 and 2 at any rainfall intensity. The time to the occurrence of flooding is shorter for a higher rainfall intensity. On the other hand, no occurrence of flooding was seen in Case 3 (innovative drainage pavement) at any rainfall intensity.

Next, the rainwater drainage rate at rainfall intensity of 10 mm/h is plotted with time in Fig.7.

While the amounts of water sprinkled on the various road surfaces are the same, the amount of drained water is largest in Case 3, indicating swift drainage.

### 6. Conclusion

The rainfall simulation test confirmed that the innovative drainage pavement system is effective as a rainwater drainage measure at the portion around an inflection point and found the possibility of its contributing to improving the running safety in the rain.

As of October 2004, two actual construction projects are under way on the expressway, and the authors will plan to monitor their properties after they are placed in service(see Fig.8).

### References

- 1) A survey by a corporation “Japan Road Constructors Association” in 1998
- 2) “Revised Review of Low Noise Pavement” by the Construction Research Institute (a foundation), 2001
- 3) <http://www.data.kishou.go.jp/>

Table.2 Result of Rainfall Simulation Test

Test No.	Rainfall (mm/h)	Case1	Case2	Case3
1	7.0	● (15min)	● (40min)	○
2	8.0	● (15min)	● (30min)	○
3	10.0	● (10min)	● (25min)	○

○ : non flooding    ● : flooding

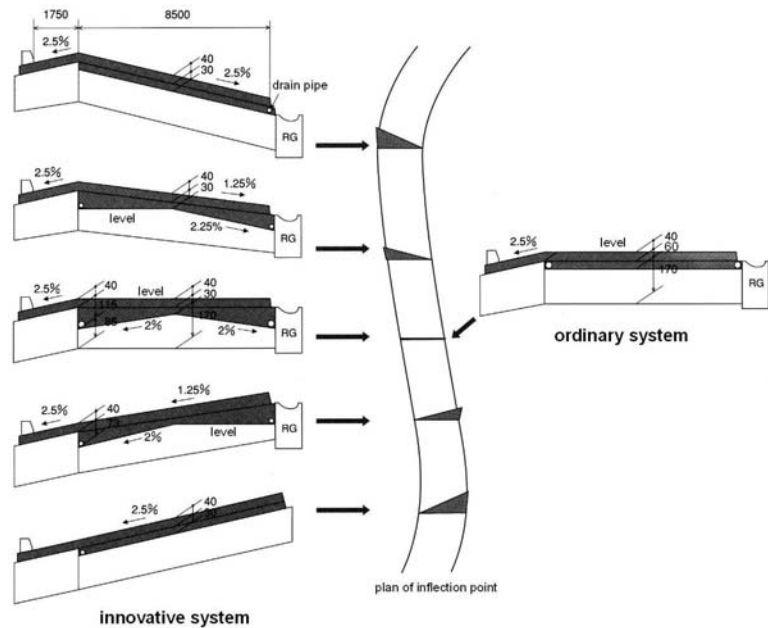
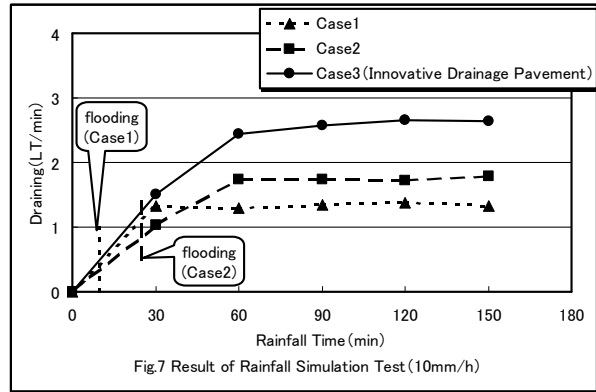


Fig.8 Innovative Drainage Pavement System