PAVE 92

APPLICATION OF INTERLOCKING BLOCK PAVEMENTS TO AIRPORTS

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SUMMARY

Pavements in airport aprons are classified into two types; one is for aircraft, and the other is for vehicles. In order to apply interlocking block (ILB) pavements to those apron areas, experimental ILB pavements have been constructed in Tokyo International Airport (TIA). Various kinds of loading tests have been conducted on those pavements and then the test results have been analyzed. The test results are described and discussed herein in detail. Through these two kinds of experience, the principle of ILB pavements has been thought that interlocking blocks have to be placed over stiff base course. This paper deals with the whole process of establishing the interlocking block pavement structure for TIA.

Introduction

Recently, many airports have been being constructed away from urban areas to prevent aircraft-caused problems such as aircraft noise. They are often located on reclaimed land from the sea because of lack of huge flat sites around cities in Japan. Future ground settlements which is suspected to be caused by consolidation of in situ clay layers will affect the pavements constructed on those sites. Interlocking block (ILB) pavements, which can not only follow the settlements but also be repaired easily, are considered as a strong candidate. Moreover, ILB pavements are recognized superior from an aesthetical view point.

Pavements in airport aprons are classified into two types; one is for aircraft, and the other is for vehicles such as fuel trucks. The principle of ILB pavements, however, has been thought as same in these two types; namely, interlocking blocks have to be placed over stiff base course like cement stabilized material layer.

As the first step to apply ILB pavements to airports, especially apron areas, experimental ILB pavements have been constructed in Tokyo International Airport (TIA). This paper describes various kinds of loading tests, which have been conducted on those pavements, and the results.

Experimental ILB Pavement

In order to increase the capacity of Tokyo International Airport (TIA), the expansion project has been being undertaken. In the project, TIA will be expanded by constructing new facilities including apron area on the reclaimed ground from the sea. ILB pavements have been considered as a strong candidate for the apron area as mentioned above. The design principle of ILB pavement for airport may follow that for road pavements. However, structural design procedure of airport ILB pavement has been neither specified, the durability of blocks against heavy aircraft has been nor verified. Furthermore, the procedure of adjusting the surface level using blocks, which is considered most realizable, has never been developed yet. Therefore, the experimental pavements have been constructed, and various kinds of loading tests have been conducted.

Fig.1 shows the experimental pavements. Compared with whole area, ILB pavements have been constructed in small parts. The test site of ILB pavements for vehicle use is 5 m wide and 100 m long and that for aircraft use is 3.75 m wide and 7.5 m long.

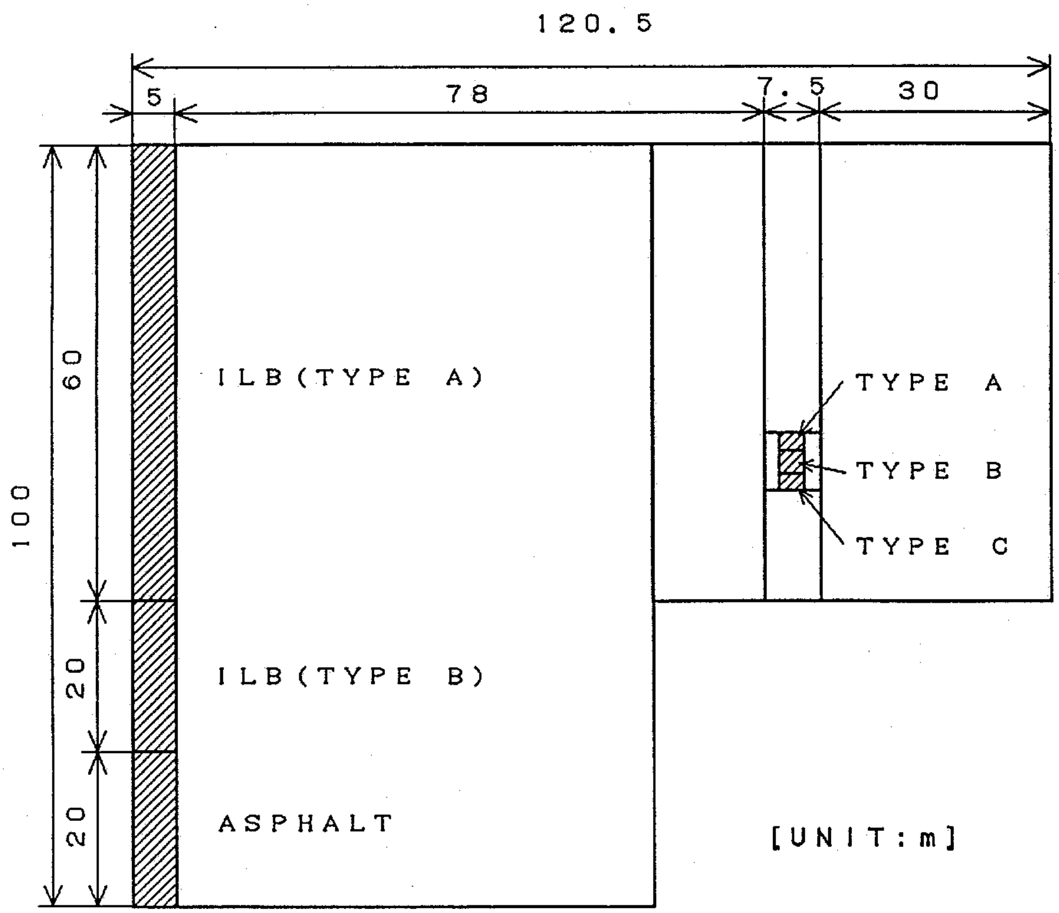

Fig.1 Experimental ILB Pavements

for aircraft use

ILB pavement for aircraft use has been planned to adjust the pavement surface level that is supposed to be lowered due to subsidence of the reclaimed ground. To adjust the surface level precisely, thin blocks are necessary to be adopted (Photo 1). Therefore, aircraft load has to be supported by much stiffer base course like Portland cement concrete layer. An effect of the aircraft load also reaches to a deeper portion of pavement because of its heavier weight compared with automobiles.

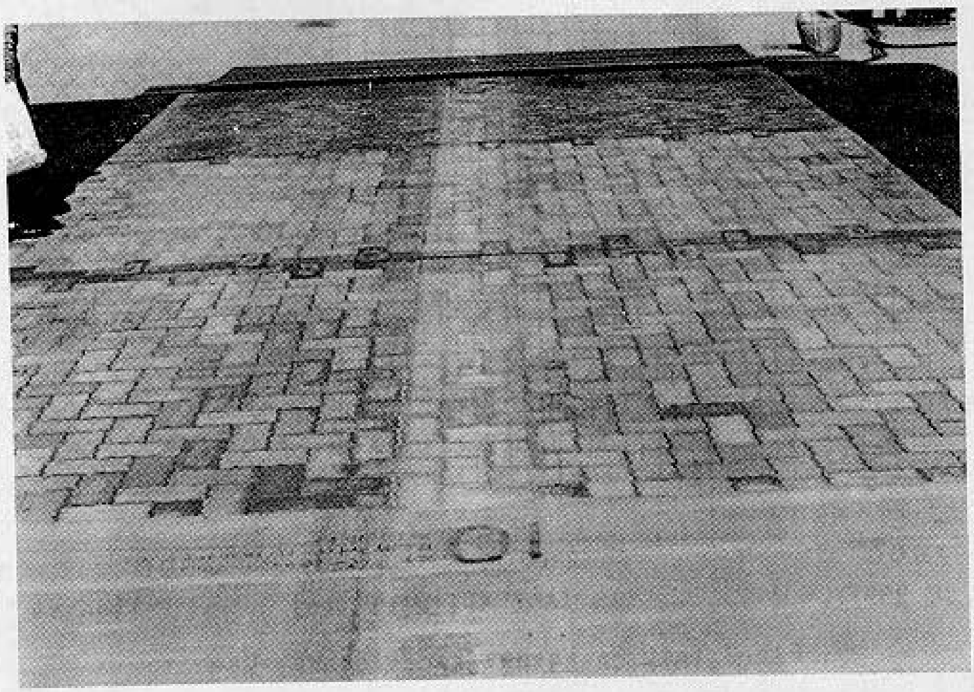

Photo 1 Test Pavements for Aircraft Use

Fig. 2 shows the experimental ILB pavement for aircraft use, which has been divided into three sections. Table 1 summarizes the details. Strengthened blocks with 100 kgf/cm^2 flexural strength have been used in Section B and C although the ordinary blocks having flexural strength of 50 kgf/cm^2 have been used in Section A. Two types of block shapes, namely, rectangle and square have also been examined to determine the suitable shape for heavy duty pavement. As the procedure for placing blocks on concrete layer has not been established, two kinds of construction method of ILB layer have been tried; that is, to place blocks after laying sand on the concrete layer, and to stick blocks on the concrete layer with rubberized latex mortar.

Table 1 Details of Test Pavements

Section	ILB		Intervening Layer
	Shape	Strength	
A	Rectangle	Ordinary	Rubberized Latex Mortar
B	Rectangle	Strengthened	Rubberized Latex Mortar
C	Square	Strengthened	Sand

Durability of three types of ILB pavements has been examined by repetitive loading test using a special cart with landing gear of B-747 aircraft (Photo 2). The deformation caused by the test has been measured and bearing capacity has been evaluated by using FWD.

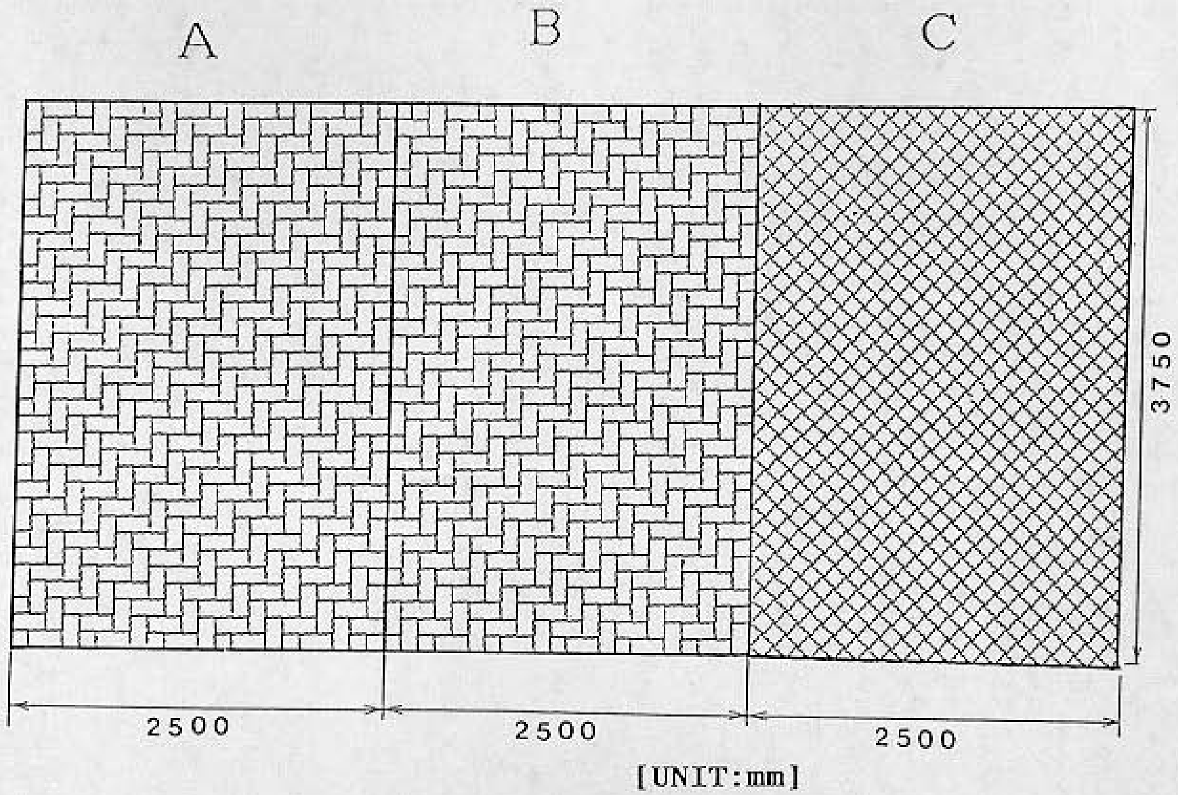

Fig. 2 Test Pavements for Aircraft Use

Photo 2 Loading Cart

for vehicle use

Two types of ILB pavements have been constructed on trial to apply ILB pavement to the apron area for vehicle use (Fig.3). In contrast with the apron area for aircraft use, ILB pavements in this area can be designed with reference to the current airport asphalt pavement design manual in Japan. An equivalency factor (EF) of ILB layer to asphalt concrete layer has been assumed in two ways herein, namely, 1.0 for Section A and 0.5 for Section B. Cement treated material has been utilized as the aforementioned stiff base course. The difference of EF in two sections is reflected on the thickness of the cement treated base course; for the same blocks (10 cm thick) have been used in both sections. 3 cm thick sand layer has been placed in both cases.

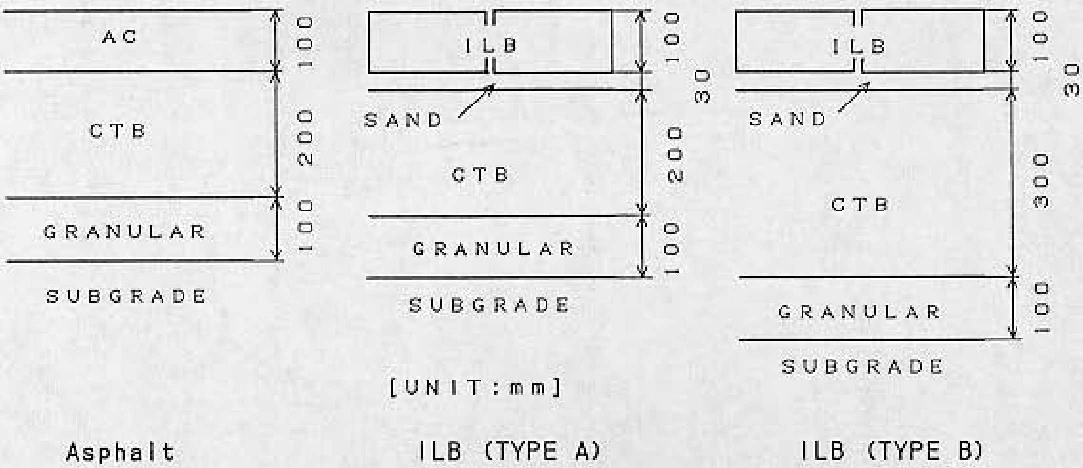

Fig.3 Test Pavements for Vehicle Use

Photo 3 Repetitive Loading Test

In order to evaluate the these ILB pavement, asphalt pavement has also been constructed. Loading tests such as a repeated loading test by a truck with 19 tf axle load have been conducted on these pavements (Photo 3).

Test Results and Discussion

pavements for aircraft use

Table 2 shows the number of broken blocks. After 5,000 repetitive loadings, the percentage of the broken blocks to all is below 10 %. Compared with the adhesion type (Section A and B), the conventional type (Section C) shows a good result. It may not result from the difference in placing methods of blocks; for block shapes are different between A and B, and C. From direct pulling tests of blocks (**Photo 4**), in situ adhesive strength has been found less than 1/10 of the laboratory strength. Once the blocks are peeled from the concrete, they will be easily broken by the load application. Therefore, the adhering procedure may become usable by improving the adhering method together with adopting rectangular shaped blocks. The effect of strengthening the blocks has not been clarified from this study. Its necessity will be investigated further.

Table 2 Number of Broken blocks

Section	No. of Loadings	Broken Blocks	
		Number	Percentage
A	1,000	5	1.3
	2,000	7	1.8
	3,000	10	2.6
	5,000	14	3.7
B	1,000	7	1.9
	2,000	15	4.0
	3,000	18	4.8
	5,000	31	8.3
C	1,000	13	1.6
	2,000	13	1.6
	3,000	13	1.6
	5,000	13	1.6

Needless to say, FWD deflections measured on the test pavements have been affected by their structural condition (Fig.4). Those on the conventional type have been larger than those on the adhesion types. However, the deflections on Section C have not varied with increase of the repetitive loadings. Therefore, all types tried herein have shown the satisfactory durability from a structural view point.

Photo 4 Direct Pulling Test

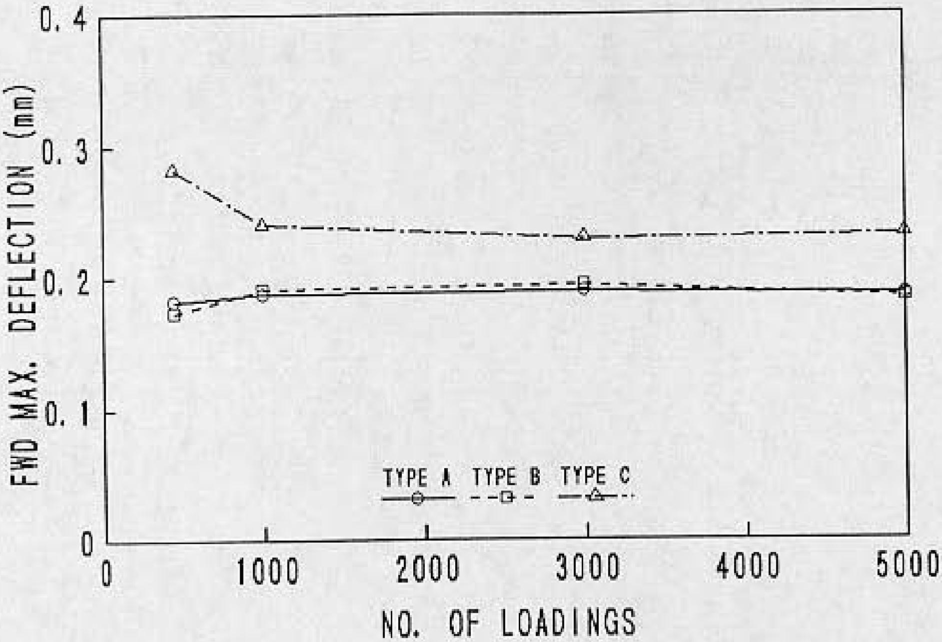

Fig.4 FWD Maximum Deflection

Transversal vertical deformation, faulting between blocks is summarized in Table 3, 4, respectively. Repetitive loadings of aircraft have been supposed to bring about severer permanent deformations especially in Section C. However, the conventional type has shown satisfactory results. This means that the conventional type ILB pavements have a great possibility to be applied to the aircraft used apron area even if very thin blocks are used.

Table 3 Transversal Surface Deformation

Section	No. of Loadings	Deformation (mm)		
		Max.	Min.	Av.
A	2,000 - 3,000 3,000 - 5,000	2 3	-1 -1	0.88 1.28
B	2,000 - 3,000 3,000 - 5,000	1 1	-3 -3	0.65 0.83
C	2,000 - 3,000 3,000 - 5,000	0 1	-2 -2	0.57 0.63

Table 4 Faulting between ILB

Section	No. of Loadings	Faulting (mm)		
		Max.	Min.	Av.
A	2,000 3,000 5,000	2 3 2	0 0 0	0.81 0.77 0.77
B	2,000 3,000 5,000	4 3 4	0 0 0	0.85 0.96 0.92
C	2,000 3,000 5,000	3 3 4	0 0 0	0.88 0.79 0.96

<u>pavements for vehicle use</u>

Fig.5 shows vertical stress in the pavement at Section A. The load spreading effect of the block layer has been considered as same as that of asphalt concrete layer.

Rutting caused by 5,000 repetitive loadings are shown in Fig.6. It is larger in the ILB pavements than in the asphalt pavement. The amount is, however, thought not to cause any problem in view of the airport pavement rehabilitation criteria in Japan.

ILB pavement can be applied to the vehicle used apron area as well as the aircraft used apron area. Considering that the thinner type shows the satisfactory test results, the design procedure of airport asphalt pavement can be used for ILB pavement with an equivalency factor 1.0.

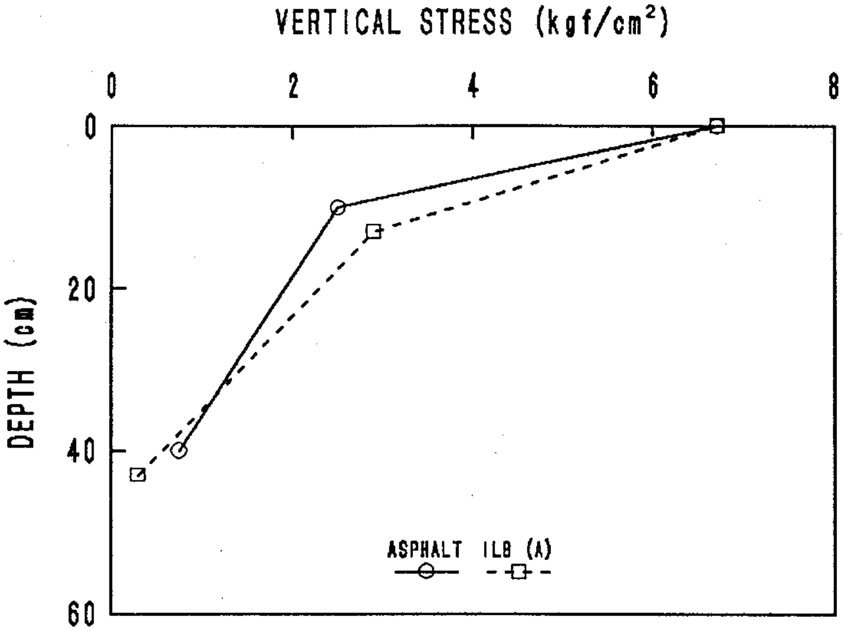

Fig.5 Vertical stress

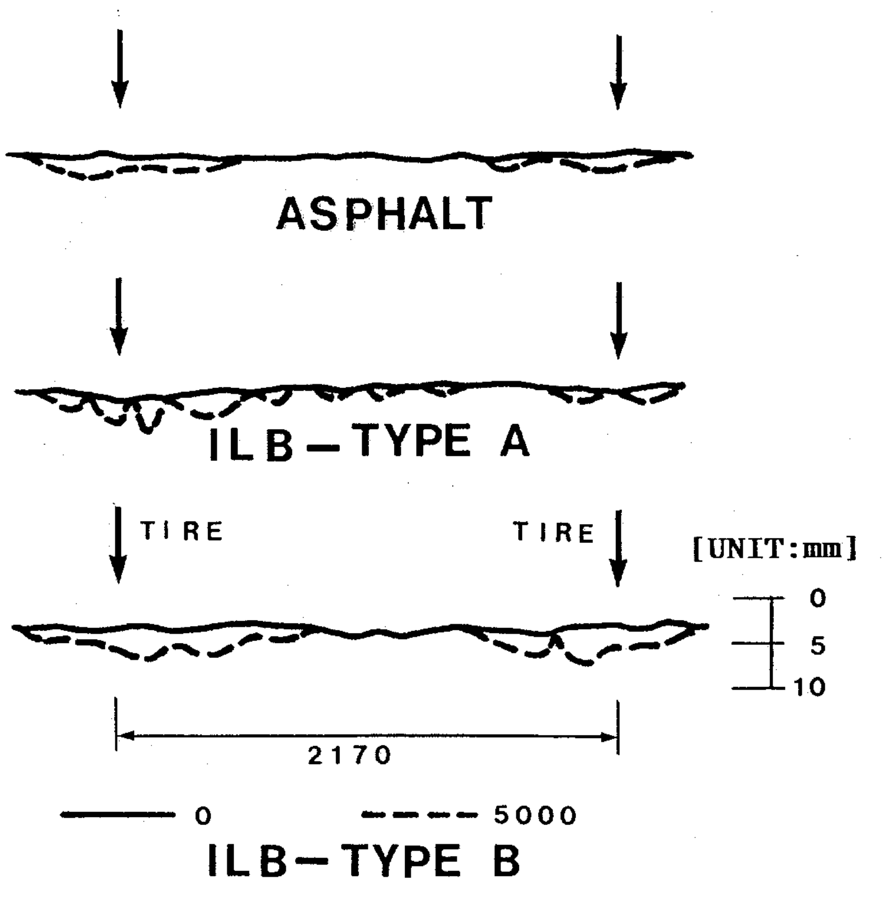

Fig.6 Transversal Deformation

Conclusion

To adjust the level of the settled pavement, the validity of ILB pavement has been clarified. Through these two kinds of experience, the design procedure applicable to Tokyo International Airport has been decided.

For the apron area where aircraft use, thin blocks will be used together with the underlying concrete slabs. As the construction procedure, the conventional one which places sand layer over the concrete slabs can be adopted. The block adhering technique may also be applied after some engineering points are made clear. Both the shape and the strength of block suitable for aircraft using area have not been determined in this study.

The blocks should be placed on stiff stabilized layer like cement treated base course with sand bed in ILB pavements for vehicle use. Design procedure of asphalt pavement can be adopted by considering that ILB layer has structural effect as well as asphalt layer.