STATE OF FLORIDA

An Evaluation of Asphalt Treated Permeable Base

Research Report
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ABSTRACT

Recent research and pavement evaluations in California regarding the effectiveness of asphalt treated permeable base (ATPB) in concrete pavement structures have resulted in the discontinued use of ATPB in California. The California findings revealed that moisture damage was occurring in the ATPB layer. In light of this information, the Florida Department of Transportation (Department) investigated the condition of the ATPB layer for three projects and, for comparison, investigated the condition of one cement treated permeable base. The Department investigation focused on a visual evaluation of cores obtained from each project. Results of the investigation were mixed with some cores showing no moisture damage and others showing severe moisture damage. In some cases, both of these distresses were evident within the same project. There were several confounding effects that diminish the ability to make firm conclusions regarding the effectiveness of ATPB: traffic loads, pavement age, aggregate type and pavement structure were different between the projects examined.

INTRODUCTION

The Florida Department of Transportation's (Department) current practice for the design of concrete pavements is to use an asphalt treated permeable base (ATPB) layer as a drainage layer in order to drain water that seeps through joints and cracks in the concrete pavement. Water that is allowed to seep through concrete pavements and is not drained will typically result in a weakened substructure and subsequently a premature pavement failure. Typically, the ATPB layer is placed over a dense graded asphalt layer and directly under the concrete layer. As water seeps through joints and cracks in the concrete pavement, it reaches the ATPB layer and, due to the cross slope of the road, the water travels horizontally through the ATPB layer to edge drains located at the outer edge of the pavement. The underlying dense graded asphalt layer prevents water from seeping into the subgrade. Since the main function of ATPB is to drain water, it is imperative that the ATPB mixture be resistant to moisture damage and that the edge drains work properly.

ATPB mixtures are typically constructed four to five inches thick and are composed of a single coarse aggregate (#57 or #67 stone) and two to three percent asphalt binder by weight of the mixture. The low asphalt binder content is to assure adequate, long term permeability for the ATPB. However, the low asphalt binder content adversely affects the mixture's resistance to moisture damage because there is minimal asphalt binder to bind the aggregates together.

Recent evaluations of concrete pavements in California have found severe moisture damage in the ATPB layer resulting in the discontinued use of ATPB in California. In light of this information, the Department decided to investigate the condition of the ATPB layer in several concrete pavement structures located throughout the state. For comparison, one project containing cement treated permeable base (CTPB) was also investigated. The investigation focused on the visual examination of cores obtained from each project and specifically, whether any moisture damage had occurred within the ATPB layer.

Following is a summary of the investigation for each project.

I-10 WEIGH STATION - JACKSON COUNTY

Construction

This project was constructed in 1999/2000 and consists of the following pavement structure from top to bottom: nine inches of Portland Cement Concrete (PCC) pavement, 4.5 inches of ATPB consisting of Alabama limestone aggregate, 1.25 inches of dense graded SP-9.5 Superpave mix, 12 inches of Type B stabilized subgrade, and embankment.

Core Locations

A total of seven cores were obtained from various locations within this project (see Figure 1). All of the cores were obtained at joints in the concrete pavement, which represents the worst case scenario for moisture intrusion and potential damage to the ATPB layer.

Figure 1 – Core Locations for I-10 Weigh Station - Jackson County

Visual Observations

Four of the seven cores exhibited moisture damage, though the magnitude of the damage varied among the four cores. Figure 2 shows a core that exhibits moisture damage and Figure 3 shows a core that does not exhibit moisture damage. In one area of the pavement, water filled the core holes to within two inches of the pavement surface after the cores and coring water were removed. The cores removed from this area exhibited severe moisture damage. It is likely that the drainage system had been non-functional for an extended period of time and the ATPB layer was continuously saturated, resulting in the observed moisture damage.

Another area of the pavement adjacent to the truck scales resulted in cores that displayed a moderate amount of moisture damage. It should be noted that the pavement in this area was cracked and it is not known whether the damaged pavement was a result of the moisture damage in the ATPB or whether the moisture damage in the ATPB was due to excessive moisture intrusion through the cracked pavement.

None of the other cores exhibited moisture damage.

Figure 2 – Core Exhibiting Moisture Damage; I-10 Weigh Station - Jackson County

Figure 3 – Core Exhibiting No Distress; I-10 Weigh Station - Jackson County

I-95 REST AREA - MARTIN COUNTY

Construction

This project was constructed in 2005/2006 and consists of the following pavement structure from top to bottom: ten inches of PCC pavement, four inches of ATPB consisting of southeast Florida limestone aggregate, four inches of dense graded asphalt, stabilized subgrade, and embankment. Some areas that were cored did not have the four inch layer of dense graded asphalt and the ATPB was placed directly on the subgrade.

Core Locations

A total of six cores were obtained from various locations within this project (see Figure 4). All of the cores were obtained at joints in the concrete pavement, which represents the worst case scenario for moisture intrusion and potential damage to the ATPB layer. Due to the high volume of truck traffic at this rest area, the cores were obtained near the edges of the parking area and not in the travel lanes.

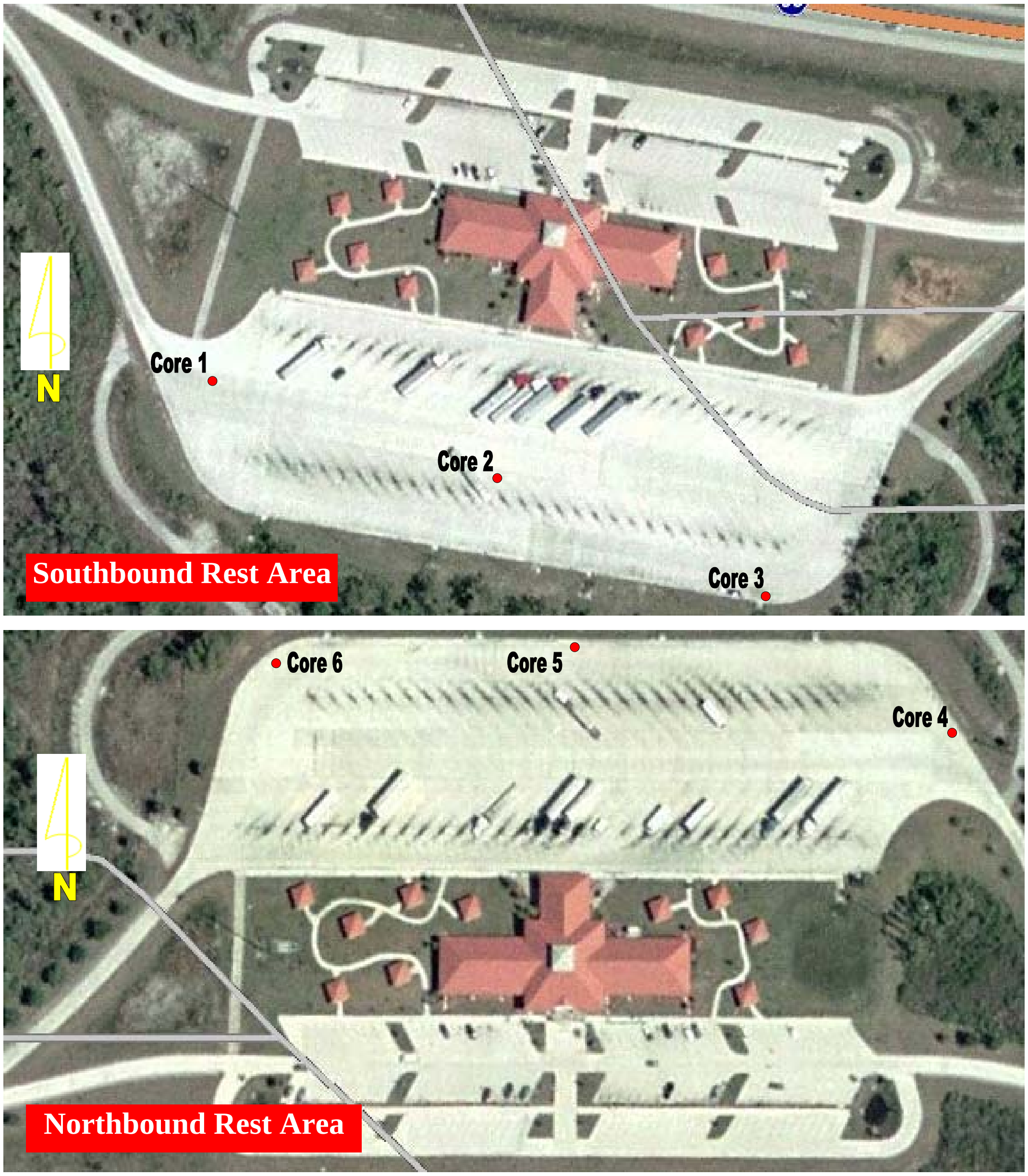

Figure 4 – Core Locations for I-95 Rest Area - Martin County

Visual Observations

None of the cores revealed any signs of damage in the ATPB layer (see Figure 5). The edge drains appeared to be working correctly, as there was no standing water in the core holes. It should be noted that this pavement has only been in service for approximately two years and the cores were obtained in lesser-trafficked areas, which could explain the lack of observed distress in the ATPB.

Figure 5 – Core Exhibiting No Distress; I-95 Rest Area - Martin County

SR-60 AND NORTH 22ND STREET - HILLSBOROUGH COUNTY

Construction

This project was constructed in 1997 and consists of the following pavement structure from top to bottom: twelve to fourteen inches of PCC pavement, five inches of ATPB, five inches of dense graded asphalt, stabilized subgrade, and embankment. For three of the four areas cored, the aggregate type used in the ATPB was Florida limestone. For the fourth area, the aggregate type used was Nova Scotia granite. It is uncertain why there was a difference in the aggregate type used for the ATPB.

Core Locations

A total of four cores were obtained from various locations within this project (see Figure 6). All of the cores were obtained at joints in the concrete pavement, which represents the worst case scenario for moisture intrusion and potential damage to the ATPB layer.

Visual Observations

Two of the four cores, one with ATPB containing Florida limestone aggregate and one with ATPB containing Nova Scotia granite aggregate, showed no indications of moisture damage. However, the other two cores, which contained ATPB with Florida limestone aggregate, showed severe moisture damage (see Figures 7 and 8). When the cores were removed from the core bit, the ATPB mixture completely fell apart. A significant portion of the large aggregate particles from the ATPB were not coated with asphalt binder. However, an attempt was made to pry some of the ATPB aggregate particles loose from within the core hole utilizing a screwdriver, but the particles were bound together tightly. Most likely this was due to the upper and lower confining forces acting on the ATPB in the pavement structure.

Figure 6 – Core Locations for SR-60 and North 22nd Street - Hillsborough County

Figure 7 – Core Exhibiting Moisture Damage; SR-60 and North 22nd Street - Hillsborough County

Figure 8 – Uncoated Aggregate from ATPB Layer; SR-60 and North 22nd Street - Hillsborough County

MARION STREET - HILLSBOROUGH COUNTY

Construction

This project was constructed in 1988 and consists of the following pavement structure from top to bottom: ten inches of Portland Cement Concrete (PCC) pavement, eight to ten inches of cement treated permeable base (CTPB) consisting of Florida limestone aggregate, stabilized subgrade, and embankment.

Core Locations

A total of four cores were obtained from various locations within this project (see Figure 9). All of the cores were obtained at joints in the concrete pavement, which represents the worst case scenario for moisture intrusion and potential damage to the CTPB layer.

Visual Observations

There were no signs of deterioration within the CTPB at any of the core locations. However, the composition and porosity of the CTPB varied widely among the cores (see Figure 10). Regarding composition, the aggregate size varied widely between core locations. Some cores had very large aggregate (one inch top size) while other cores had much smaller aggregate (half inch top size). Additionally, the cement and fines content varied widely. With respect to porosity, some of the cores appeared to be nearly impermeable. This is due to the smaller aggregate size and high cement and fines content. Other cores appeared to be more open graded and permeable. Also, it was observed that the concrete joint had propagated through the CTPB, as a crack, in all of the cores.

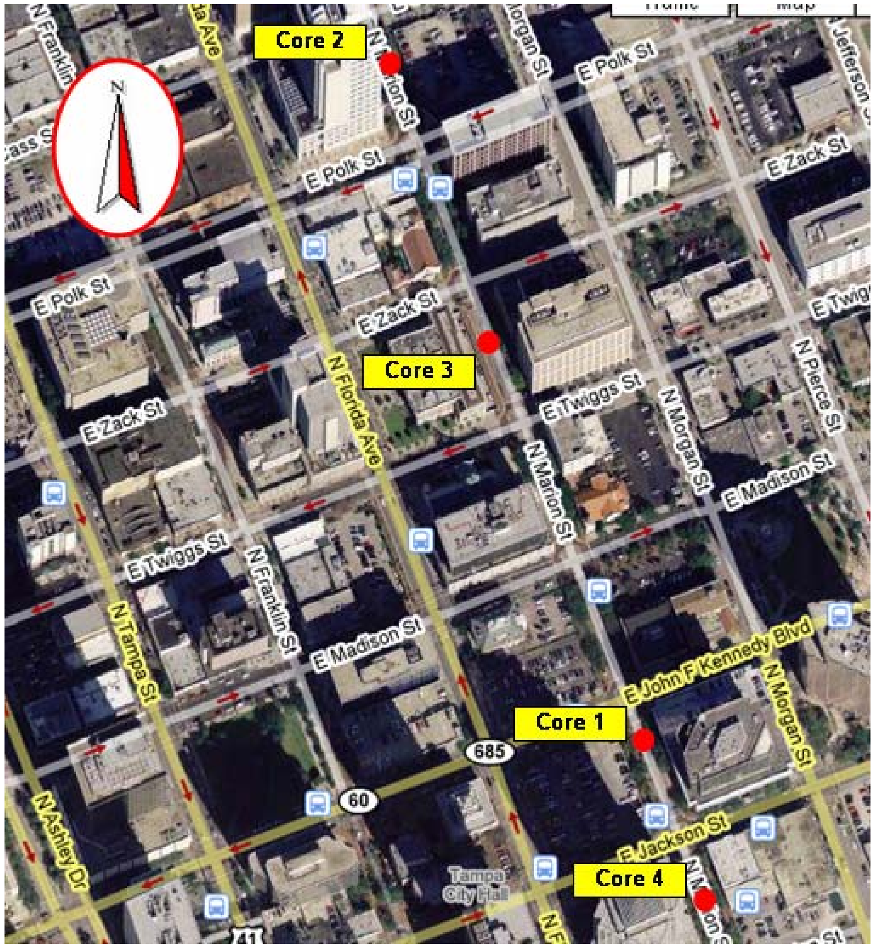

Figure 9 – Core Locations for Marion Street - Hillsborough County

Figure 10 – Variation in CTPB Composition; Marion Street - Hillsborough County

CONCLUSIONS

The following conclusions were observed from the investigation of the three projects with ATPB and one project with CTPB:

1. The visual condition of the ATPB layer varied widely among the three projects investigated. For some projects, the condition of the ATPB within the same project varied widely.

2. Moisture damage was observed in two of the ATPB mixtures; one consisting of Florida limestone aggregate and one consisting of Alabama limestone aggregate.

3. One project with a non-functional drainage system showed severe moisture damage in the ATPB layer.

4. A portion of one project was constructed with the ATPB placed directly on the subgrade, which is not the recommended practice for construction of ATPB. ATPB should be placed over a dense graded asphalt layer.

5. There was a wide variation in the pavement age, applied traffic, construction details and aggregate types among the projects investigated.

6. The one project investigated with CTPB revealed inconsistent aggregate gradation, cement content and fines content within the CTPB layer. Some cores appeared to be very impermeable. All of the cores showed that the construction joint in the PCC layer had propagated through the CTPB layer.

RECOMMENDATIONS

Due to the limited number of projects investigated and the variation among those projects, the following general recommendations can be made:

1. The asphalt binder content of the ATPB mixture should be established at the high end of the design range (2.0 to 3.0% by weight of the mixture). It is recommended to use a design asphalt binder content of 3.0% for non-absorptive granite aggregates and 3.5% for absorptive limestone mixtures. This will ensure that there is adequate asphalt to bind the aggregates together.

2. ATPB needs to be constructed over an impermeable dense graded asphalt layer. This will provide proper support for the ATPB and prevent water from penetrating into the subgrade.

3. The edge drain system must function properly and be maintained to prevent water from saturating the ATPB layer.

4. Following the above recommendations will result in a functioning ATPB layer; however, there is some evidence that an ATPB layer is not needed at all. Some states place the PCC layer directly over an impermeable dense graded asphalt mixture and experience good performance.

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