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Evaluation of the "FiberDowel" Corrosion Proof Dowel Bar System as a Load Transfer Device

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*see supplementary notes

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North Dakota DOT
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14. Supplementary Notes

15. Abstract

Purpose and Need

Corrosion of reinforcing causes distresses in concrete and can lead to premature failure in PCC pavement. An alternative to standard reinforcing steel needs to be looked at to prolong the life of PCC pavement.

Objective

The objective of this study will be to determine if a dowel bar composed of continuous fiberglass filaments and polyester resin will prevent faulting from recurring in jointed concrete pavement as well as serve as a corrosion free device.

Scope

In 1995, the North Dakota Department of Transportation incorporated a test section containing a corrosion proof dowel bar system called "FiberDowel" as a load Transfer Device. Test sections were incorporated into project IM-8-029(007)022.

The "FiberDowel" bars will be evaluated similar to the steel dowel bars and the results of both test sections will be compared. Evaluating items such as monitoring of distresses around the dowel bars and non-destructive deflection testing of load transfer across the doweled joints will be evaluated annually for a period of five-years. The non-destructive deflection testing will be accomplished with the use of a falling weight deflectometer.

Summary

The retrofitting of "FiberDowel" bars as load transfer devices is similar to that of plain steel dowel bars except for the absence of epoxy coating or bond breaking material.

Post construction FWD analysis showed the joints retrofitted with plain steel dowel bars initially exhibited approximately 20% greater load transfer than the corresponding joints retrofitted with "FiberDowel" bars.

FWD analysis taken during the 1997/1998/2001 seasons indicate the joints retrofitted with plain steel dowel bars are performing well and are registering nearly twice the load transfer percentages than the corresponding joints retrofitted with "FiberDowel" bars.

Recommendation

The use of "FiberDowel" bars may prove to be less corrosive over time. However, the loss of load transfer experienced when compared to plain steel dowel bars coupled with significantly higher costs far outweigh any advantages. It is not recommended that "FiberDowel" bars be used as an option on dowel bar retrofit projects.

16. Key Words

Dowel Bars
Load Transfer
Concrete

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NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH DIVISION

Experimental Study MR 96-03

Evaluation of the "FiberDowel" Corrosion Proof Dowel Bar System as a Load Transfer Device

Final Report

Project IM-8-029(007)022

September 2001

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Disclaimer

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Objective

The objective of this study will be to determine if a dowel bar composed of continuous fiberglass filaments and polyester resin will prevent faulting from recurring in jointed concrete pavement as well as serve as a corrosion free device.

Scope

In 1995, the North Dakota Department of Transportation incorporated a test section containing a corrosion proof dowel bar system called "FiberDowel" as a load Transfer Device.

These "FiberDowel" bars are located adjacent to the plain Grade 60 dowel bar test sections. Both of these test sections were incorporated into project IM-8-029(007)022.

The "FiberDowel" bars will be evaluated similar to the steel dowel bars and the results of both test sections will be compared.

Evaluating items such as monitoring of distresses around the dowel bars and non-destructive deflection testing of load transfer across the doweled joints will be evaluated annually. The non-destructive deflection testing will be accomplished with the use of a falling weight deflectometer.

Location

Project IM-8-029(007)022 is located on the I-29 northbound lanes from the Mooreton Interchange to the Christine Interchange. The project length is 22.1 miles. The "FiberDowel" dowel retrofit test sections are located at mile marker 35.

Project History

Construction

Table 1 shows the history of the pavement section near mile marker 35 located between ND 13 and the Colfax Separation, northbound.

Year Constructed	Type of Construction	Depth (in.)	Rdwy Width (ft.)
1974	Grade	-	48
1975	Lime Treated Subgrade	6	48
1975	Plant Mix Bit. Base 85-100	2	41
1975	Plain Jointed P.C.C.	9	27
1975	16 Foot Joints	-	
1975	P.C.C. Shoulders	9	10
1995	Grinding	-	18
1995	Concrete Pavement Repair	-	37
1996	Dowel Bar Retrofit	-	-

Table 1. Project History

Traffic

Traffic estimates for project IM-8-029(007)022, between ND 13 and the Colfax Separation, northbound are shown in table 2. The ESAL'S annual percent growth rate is 2.5%.

YEAR	PASS>CAR	TRUCKS	TOTAL	MAX HR	RIGID ESALS
1997	1,820	420	2,240	280	575
1998	1,950	550	2,500	250	765

Table 2. Traffic Estimates

Design

The design of the "FiberDowel" dowel bar retrofit sections is similar to the original design used for the plain steel dowel bar retrofit sections, except that no bond breaking material is needed.

The patch mix used on this project was a proprietary mix manufactured by FOSROC. This mix was called Patchroc 10-60.

Construction

Installation of the "FiberDowel" dowel bar retrofit sections was performed on 7/16/96. The prime contractor was Highway Services. The installation of the "FiberDowel" bars required no different techniques as compared to the installation of the plain steel dowel bars. Bond breaking materials were needed for the plain steel dowel bars. The "FiberDowel" bars were supplied by RJD Industries, Inc. Twelve samples were supplied of the companies FD1500 bars, 1½ " nominal diameter by 18" long to be used.

Patchroc 10-60 was used as the patch mix material. The material was extended with 40 lbs of Class 43 chips for every 50 pounds of Patchroc 10-60. The material, when placed, registered a slump of approximately 7.5 inches. There were no major difficulties with the installation process.

Prior to construction, the test sections were analyzed with the falling weight deflectometer (FWD) on 06/24/96 to determine a percentage of load transfer with no dowel bars present.

After construction was completed, the same joints were tested on 07/23/96 to determine the percentage of load transfer after the dowel bars were installed. The first five joints north of mile marker 35 were tested which included the two joints containing the "FiberDowel" dowel bars and three joints containing the plain dowel bars for comparison purposes. The results of the FWD analysis for load transfer before and after construction is shown in table 3 on the following page.

STATION	TYPE OF DOWEL BAR	PERCENTAGE OF LOAD TRANSFER (%)	
		BEFORE INSTALLATION (6-24-1996)	AFTER INSTALLATION (7-23-1996)
35.0007	Steel	28	100
35.0024	Fiber	30	72
35.0042	Steel	26	89
35.0058	Fiber	26	67
35.0072	Steel	26	85

Table 3. Results from FWD analysis

From the data presented the plain steel dowel bars are exhibiting an average of approximately 20% greater load transfer per joint shortly after construction.

Evaluation

Materials and Research visited the test site on 9/12/01. Photo 1 depicts a view of a typical dowel bar slot where fiber dowels were installed. Notice also in photo 1 the distresses present near the joints. It is believed that the

Photo 1. A view of a typical test joint where "Fiberdowel" bars were installed.

distresses present were caused by a possible core board failure.

Photo 2 depicts a view of a typical dowel bar slot where steel dowels were installed. Some raveling and spalling were noted. Again distresses were present near the joint which could be related to a possible core board failure.

Photo 2. A view of a typical test joint where Steel bars were installed.

Visibly, there appeared to be no difference between the steel and fiber dowel bar sections.

Table 4 tabulates 1997,1998 and 2001 FWD analysis which shows load transfer percentages for the “FiberDowel” slots vs. the joints where steel dowel bars are used.

STATION	TYPE OF DOWEL BAR	PERCENTAGE OF LOAD TRANSFER (%)			
		AFTER INSTALLATION	1997	1998	2001
35.0007	Steel	100	96	98	98
35.0024	Fiber	72	50	49	42
35.0042	Steel	89	95	95	96
35.0058	Fiber	67	59	44	49
35.0072	Steel	85	96	96	97

Table 4. Load Transfer Data

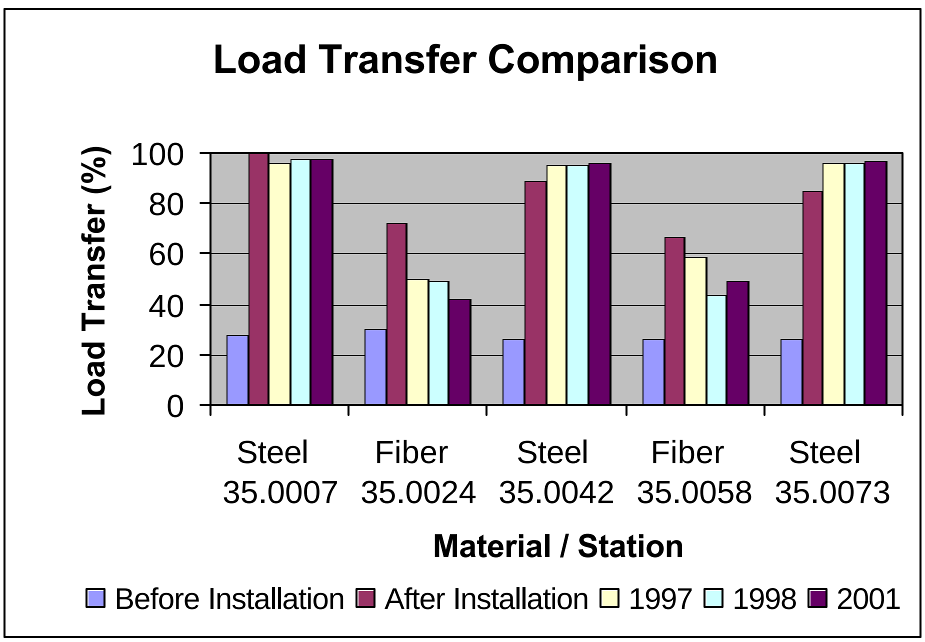

Chart 1. Load Transfer Comparison

FWD analysis shown in Table 4 on the previous page indicates the slots containing "FiberDowel" bars are registering significantly less load transfer percentages when compared to the slots containing regular steel bars. It appears that after the initial drop in load transfer percentages shown in1997 that the joints containing the "FiberDowel" bars have leveled off. Chart 1 illustrates the load transfer comparison by material.

Cost

2001 price quotes for 1½ " X 18" "FiberDowel" bars are approximately $6.00 per bar. 2001 price quotes for 1½ " X 18" plain steel dowel bars are approximately $2.69 per bar. These costs do not reflect shipping or installation costs.

Summary

The retrofitting of "FiberDowel" bars as load transfer devices is similar to that of plain steel dowel bars except for the absence of epoxy coating or bond breaking material.

Post construction FWD analysis showed the joints retrofitted with plain steel dowel bars initially exhibited approximately 20% greater load transfer than the corresponding joints retrofitted with "FiberDowel" bars.

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The use of "FiberDowel" bars may prove to be less corrosive over time. However, the loss of load transfer experienced when compared to plain steel dowel bars coupled with significantly higher costs far outweigh any advantages. It is not recommended that "FiberDowel" bars be used as an option on dowel bar retrofit projects.