



## Construction Practices and its Effect on Bond Strength of Pavements

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### ARTICLE INFORMATION

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### ABSTRACT

Extensive study is carried out to ascertain the effects of various construction practices on the bond strength between different layers of the pavement. In this study various construction practices refers to curing time of the pavement, various equipments used during construction of pavement, surface treatment provided. In this study a review is also carried out of the research work carried out by various researchers for estimating the bond strength between the existing old hot mix asphalt (HMA) layer and the new hot mix asphalt (HMA) layer overlaid. Also a review is taken in study regarding various experiments conducted by the researchers on the bond strength of different layers. Normally milling provides a good strength and good bond at the interface between the old layer and new layer overlaid on it. It is also observed that curing time has least effect on the bond strength.

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### 1. Introduction

Any pavement consists of various layers made up of different materials. All layers have different bonds at the interface surface. Till date a very extensive research is carried out regarding performance of the pavement material. But unfortunately very less research is carried out on the performance of adhesion between different layers of the pavement and its effect on the overall performance of the pavement and its life. Due to that very few codes, standards and procedures are existing which specify the quality of interface between different layers of the pavement.

Overall performance of the pavement is extensively depends on the bonding between various layers. Good bonding between various layers of the pavement is highly crucial for achieving the desired results, the higher load carrying capacity and a longer life span of the road pavement. Tack coat is used as adhesion between existing and new asphaltic pavement. Existing literature shows that different types of material is used as a tack coat between two hot mix asphalt (HMA) layers. The most commonly used track court emulsions are SS-1, SS-1h, CSS-1, and CSS-1h. During their study Paul and Scherocman [1], showed that the

slow-setting type of emulsion is most commonly used in various countries.

Optimum use of tack coat is essential because lesser quantity results in poor bonding between layers and excessive quantity results in slippage between layers. Mohammed et al. [2] suggested 0.09 L/ m<sup>2</sup> as optimum residual rate, while Lavin[03] recommended, rate of application of tack coat as 0.2 to 1.0 L/ m<sup>2</sup>. He also suggested 1.0 L/ m<sup>2</sup> for milled pavements. For obtaining the shear strength of the pavements Sholar et al.[04] developed shear testing device. He concluded that the shear strength of the pavement can be slightly improved by increasing the curing time.

Sholar et al. [4] also found that the fine graded mix of HMA has poor shear strength than the coarse graded mix because the surface roughness increases with coarseness and adds the shear strength. But at the same time West et al. [5] proved that the fine graded mix of HMA has higher bond strength than the coarse graded mix at 25°C.

Piotr and Wałach [6] conducted the study for evaluation of strength of bond between concrete layers. The experiments conducted by them showed different modes of interface failure depending on the configuration type of concrete in composite specimens.

## 2. Experimental work

Extensive experimental work is carried out by Laith Tashman et al. [6]. During experimental

work various factors related with construction practices where considered such as;

- surface treatment- milled versus non-milled
- curing time- broken versus unbroken
- approximate target residual rate- 0.00, 0.08, 0.22, and 0.32
- equipment tracking- track of the wheel versus middle of the track

The three quality tests for tack-coat construction quality verification are considered. The three tests considered are FDOT shear test, Torque bond test and UTEP pull-off test.

## 3. Result and analysis

The above mentioned three types of tests were conducted to study the influence of various factors on the bond strength of track coat at the interface between the two layers of the pavements.

### 3.1 FDOT shear tester

In this test the road pavement was divided in two type's milled and non-milled sections and surface condition as unbroken, broken and non-tack. Target residual rates of 0.075, 0.215 and 0.33 L/m<sup>2</sup> were applied to both broken and unbroken sections. For the milled sections it was observed that there is no considerable difference in the mean shear strength for the three curing time slot categories considered. For both surface condition i.e. milled and non-milled surfaces there was negligible difference in broken and unbroken sections. Table 1 shows the observed results.

Table 1: FDOT shear tester observations

Factor	Degree of freedom	Sum of squares	Mean square	Ratio of mean square	P value
Surface condition	1	271,439	271,439	501.30	0.000
-Curing time	4	020,937	005,546	008.97	0.000
-Residual rate	8	019,849	002,490	004.51	0.000
Tracking	1	001,576	001,576	002.95	0.079

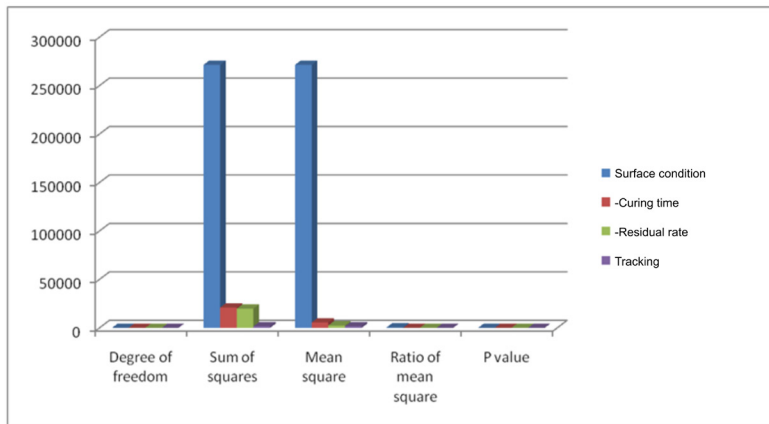


Figure 1: FDOT shear tester observations

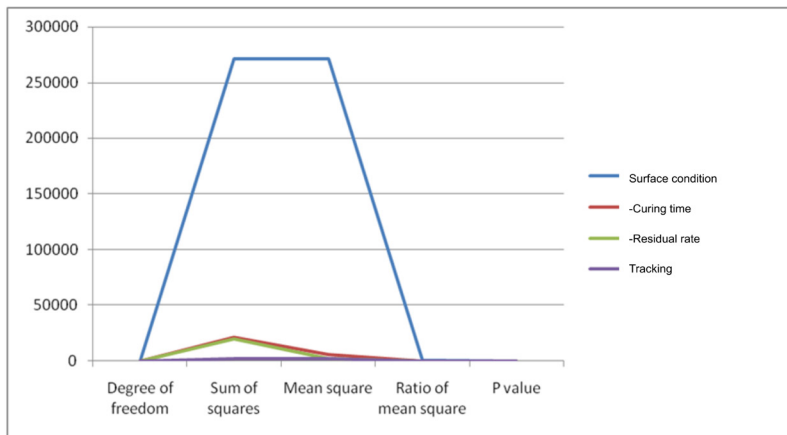


Figure 2: FDOT shear tester observations

From Fig. 1 it may be observed that during FDOT Shear test, the surface condition do not affect the residual rate as well as tracking. From Fig. 2 it is seen that the residual rate varies along with curing time. Also it can be observed that the tracking is having negligible effect over shear strength.

### 3.2 Torque bond test

The torque bond test was performed ac-

ording to 'British Board of Agreement standards', according to which the required torque 300 N m capacities. Milled and non-milled sections were tested for torque bond. The cores that could withstand the 300 N m torque are considered as right cores, while the cores that could not withstand the torque of 300 N m were considered as left cores. Table 2 show the observed results.

Table 2: Torque bond test observations (1)

Factor	Coefficient	Standard error	Z	P value
Surface condition (milled & non-milled)	-425.027	81.340	-4.85	0.0000
Curing time (no tack & broken)	-278.136	91.789	-2.18	0.0025
Curing time (unbroken & no tack)	318.765	94.335	3.76	0.0012
Curing time (unbroken & broken)	042.896	54.763	0.69	0.4295
Tracking	-047.083	50.016	-0.89	0.3483
Residual rate	425.832	1,186.42	0.29	0.7325

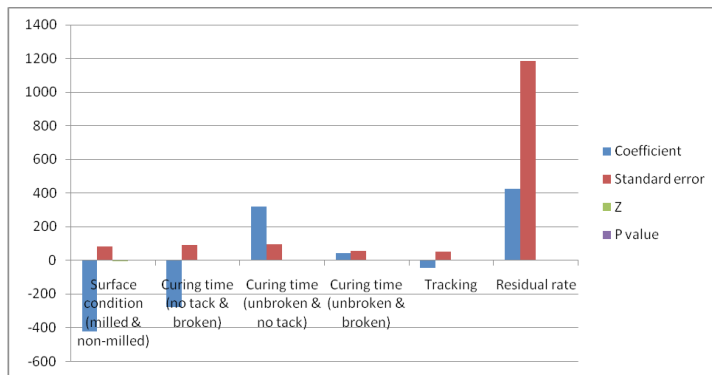


Figure 3: Torque bond test observations (2)

From Fig. 3 it may be observed that in Torque bond test, the surface condition has negative effect on coefficient. Curing time also adversely

affects with surface condition. From Fig. 4 it is seen that the standard error is relatively constant for all factors except residual rate.

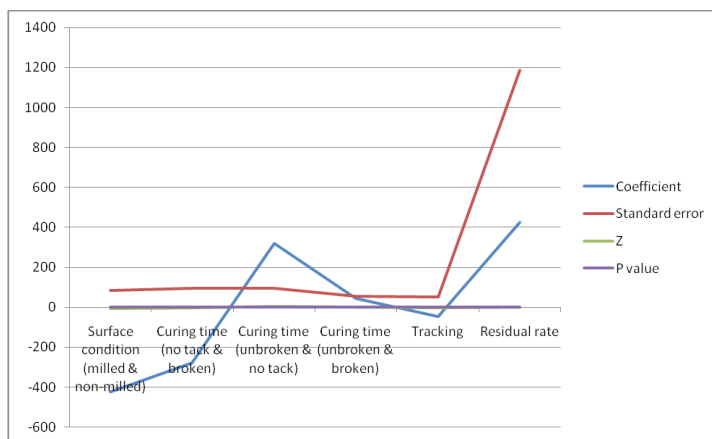


Figure 4: Torque bond test observations (3)

### 3.3 Pull off test

In this test the road is divided in to two separate parts as milled and non-milled section. Thus surface condition is considered as main governing factor. Further the surface condition is classified into different residual rates. Testing time is also a factor that affects the results. During the experiments it was observed that the base contact plate has better adhesion with the non-milled

section than the milled section. This results in higher tensile strength for non-milled section as compared to milled section.

Also it is interesting to note that the pull off strength inversely varies with the time. As time increases the pull of strength reduces. This effect was observed over entire length of the road. Table 3 show the observed results.

Table 3: Pull off test observations

Factor	Degree of freedom	Sum of squares	Mean square	Ratio of mean square	P value
Surface condition	1	3.8568	3.8568	16.04	0.009
-Residual rate	3	0.6325	0.1786	00.82	0.653
Testing time	1	0.8297	0.7995	03.96	0.111

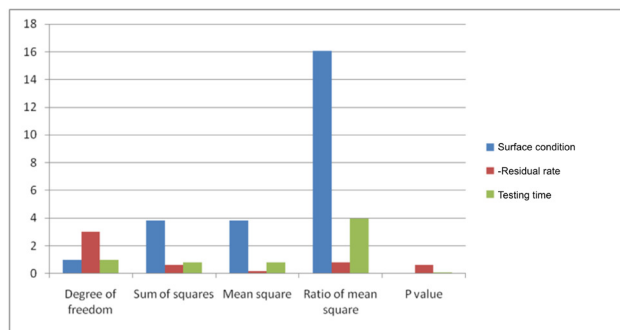


Figure 5: Pull off test observations (1)

From Fig. 5 it may be observed that in Pull Off test, the surface condition do not have

considerable effect. From Fig. 6 it is seen that the residual rate does not vary considerably.

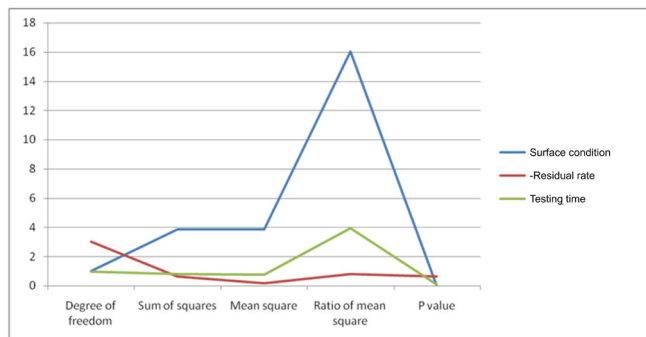


Figure 6: Pull off test observations (2)

#### 4. Conclusion

The study and review of experimental work presented in this research paper is for the three tests which has different mechanisms. The experiments conducted for FDOT shear tester and tabulated in Table 1, shows that, except tracking factor all other factors are statistically significant. It is also observed that for milled as well as for non-milled sections, increase in residual rate does not improve the shear strength.

The results presented in Table 2, shows that, there is large difference in torque strength between milled and non-milled section. Milled section offers higher torque resistance than the non-milled section. Also it was observed that for non-milled section a significant difference exists for the torque resistance in no tack, broken and unbroken specimens.

The results of Pull-off test presented in Table 3, clearly indicates that the non-milled sections have higher pull-off strength than that of the milled section. Overall it is observed that the milled section provides considerably higher bond strength at the interface of existing and new pavement surface. The tack coat does not affect the bond strength of milled section. But for non-milled section the tack coat significantly affects the bond strength of the pavement.

#### 5. Acknowledgement

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