

## Applied Research on Optimum Dosage of Flexible Waterproof Material for Bridge Deck

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**Abstract.** The dosage of bridge deck waterproof material can influence not only the road performance but also the construction cost of waterproof layer. The bond strength, shear strength and pull strength of different bridge deck waterproof material dosage are tested to determine the optimum amount. The method of dosage control during construction is proposed. And the test road is paved according to the research result. The test results of test road can meet the requirements.

### Introduction

The waterproof layer of bridge deck is set to bond the bridge deck and asphalt concrete pavement together and prevent water from infiltrating into bridge structure [1]. Its performance has a direct influence on the life of bridge deck pavement. When water infiltrates through the waterproof layer into bridge deck, the bond strength between the pavement and bridge deck will decline even to delaminate from each other. Therefore, the waterproof layer can improve the usage quality and durability.

The bridge deck waterproof material are divided into two major kinds, they are flexible waterproof material and rigid waterproof material [2]. The flexible waterproof material has the advantages of adaption to the deformation, convenient construction and low cost. For these reasons, it becomes the preferred waterproof material for concrete bridge deck. The study of this article mainly focuses on this kind of widely used waterproof material.

The road performance indexes of bridge deck waterproof are bond strength, shear strength and pull strength [3,4]. The main purpose of this study is to reveal the relationship between the road performance of waterproof layer and the dosage of waterproof material and to determine the optimum dosage of waterproof material. With the help of research project, comprehensive technology study of flexible waterproof layer in highway bridge deck, the common used flexible waterproof materials are sifted. And two kinds of material with stable performances are selected for test study. The selected materials are labeled as 1# material and 2# material [5].

### Laboratory Test

**Bond strength tests of different waterproof material dosage.** The model shaped “8” is made in the same way of cement mortar strength specimen as shown in Fig.1. 1# and 2# material are painted on the sections of the specimen. Each section is painted three times. The dosages of the specimens are 0.2, 0.4, 0.6, 0.8, 1.0 and 1.2 kg/m<sup>2</sup>. And the specimen should be kept 40±2°C in the oven for 4~6 hours after each paint. After the last paint, put the specimens in the oven until they become sticky (about 15mins). Take out the specimens and put them together and put them on the glazed brick for 1 hour. Then dry it in the oven of 40°C for 24 hours and leave it in room temperature for 6 days.

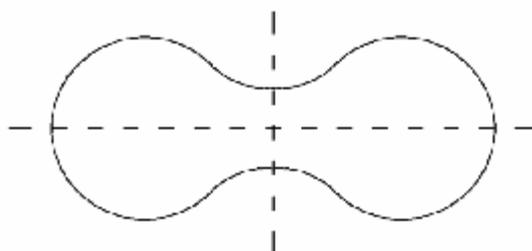


Fig.1 Sketch of model shaped "8"

Put the prepared specimens in the oven of 25°C for 6 hours. The specimens are tested at the pulling speed of 10mm/min. The bond strength is the arithmetic mean value of four specimens in one group. The bond strength of 1# and 2# waterproof material are shown in Fig.2 and Fig.3.

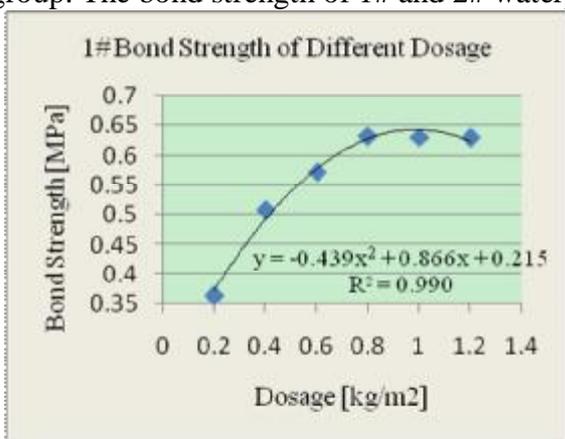


Fig.2 1# bond strength of different dosage

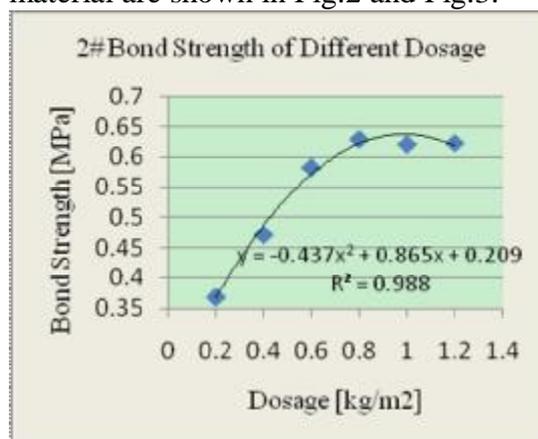


Fig.3 2# bond strength of different dosage

**Shear Strength Test of Different Waterproof Material Dosage.** The cement concrete and asphalt concrete test blocks are made in the mould of rutting plate. They are cut into blocks with the size of 50mm×50mm×30mm after maintenance. The sections of both cement and asphalt concrete blocks are painted with the waterproof material in the same way, and the dosages are 0.4, 0.6, 0.8, 1.0, 1.2, 1.4 kg/m<sup>2</sup>. The maintenance condition is the same with the previous test. The model of shear strength is shown in Fig.4.

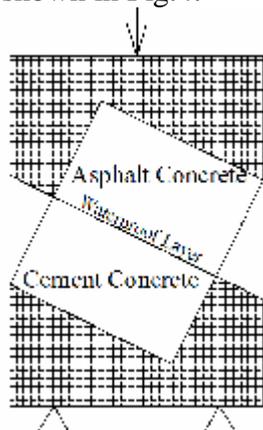


Fig.4 Model of shear strength test

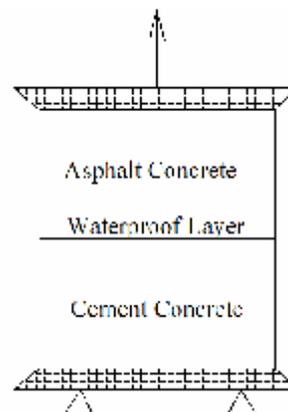


Fig.7 Model of pull strength test

Put the prepared specimens in the oven of 25°C for 6 hours. The specimens are tested at the speed of 10mm/min on shear strength tester. The shear strength is the arithmetic mean value of four specimens in one group. The shear strength of 1# and 2# waterproof material are shown in Fig.5 and Fig.6.

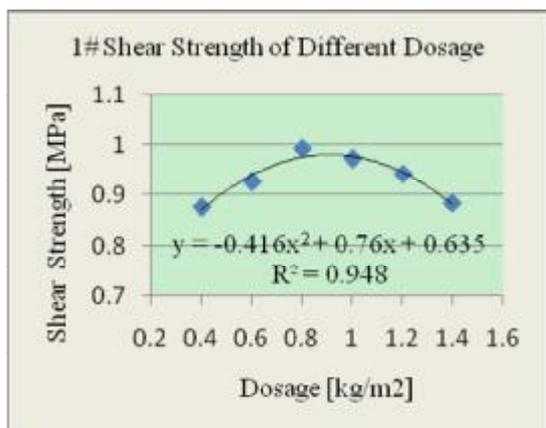


Fig.5 1# shear strength of different dosage

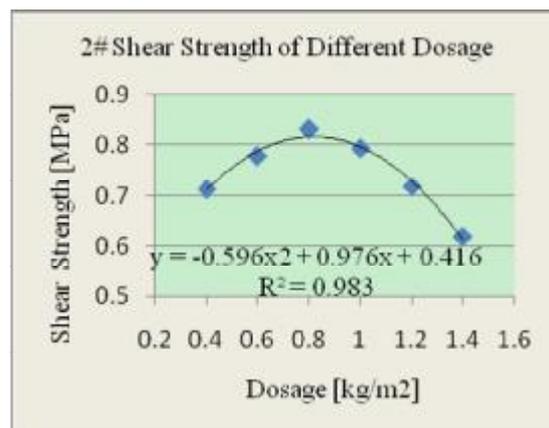


Fig.6 2# shear strength of different dosage

**Pull Strength Test of Different Waterproof Material Dosage.** The pull strength test is done to see the cohesiveness between bridge deck and concrete pavement. The specimens are made in the way of shear strength test. AB adhesive or epoxy resin is used to put the specimens together with the indenters. Model of pull strength test is shown in Fig.7.

The pull strength of different dosages measured on pull strength tester is shown in Fig.8 and Fig.9.

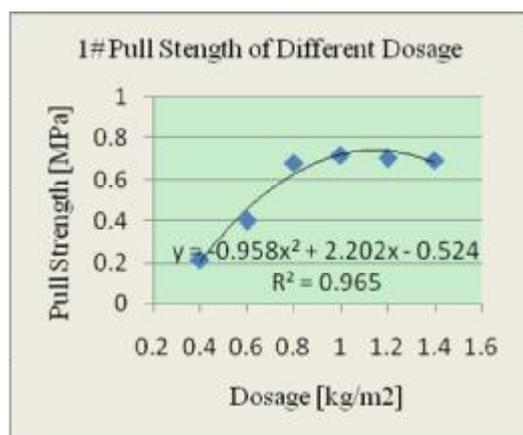


Fig.8 1# pull strength of different dosage

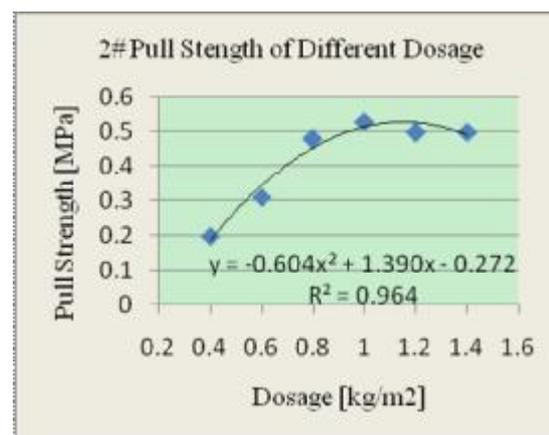


Fig.9 2# pull strength of different dosage

## Discussion of Test Results

Based on the laboratory tests, the following observation and conclusion can be made:

1. The bond strength curves with different dosages of 1# material and 2# material are basically similar. The curve is a hump shape. The bond strength increases with the increase of dosage of waterproof material until the dosage reaches up to 0.8 kg/m<sup>2</sup>. The bond strength decreases when the dosage is higher than 0.8 kg/m<sup>2</sup>. The peak bond strength occurs when the dosage is 0.8 kg/m<sup>2</sup>.

2. The shear strength curves with different dosages are also basically similar. The shear strength increases with the increase of dosage of waterproof material until the dosage reaches up to 0.8 kg/m<sup>2</sup>. The shear strength decreases when the dosage is higher than 0.8 kg/m<sup>2</sup>. And the shear strength reaches the top with the dosage of 0.8 kg/m<sup>2</sup>.

3. The pull strength curves with different dosages are also basically similar. The curve is also a hump shape. And the pull strength increases with the increase of dosage. But the pull strength decreases when the dosage is higher than 1.0 kg/m<sup>2</sup>. The maximum pull strength appears with the dosage of 1.0 kg/m<sup>2</sup>.

The pull strength is more sensitive to the dosage of material compared with the bond and shear strength. According to the test results and taking the impact of bridge deck roughness, the optimum dosage of waterproof material is 1.0 kg/m<sup>2</sup>.

### Dosage Control in Construction

There are two methods to achieve the optimum dosage of the waterproof material.

Before construction, the amount of waterproof material should be determined. Measure the area of the bridge deck. The waterproof material is packed in barrels. And the weight of a barrel is fixed. So we can control the number of barrels needed for construction to achieve the goal.

How can we test the actual amount sprayed to the road? First, weigh the container  $W_1$ , the size of it is 300mm×300mm×40mm, as shown in Fig.10. After the material is sprayed evenly to the bridge deck and the container, the container and the material in it is weighed  $W_2$ . The dosage of the material sprayed can be calculated using Eq.1.

$$q = \frac{(w_2 - w_1) / 10^3}{300 \times 300 \times 10^6} \tag{Eq.1}$$

If the dosage isn't the optimum amount, the amount sprayed or the spray method should be adjusted.



Fig.10 Field test of dosage

### Test Road Survey

The 2# waterproof material is sprayed by special equipment to the test road. The target dosage is 1.0 kg/m<sup>2</sup>. The measured material dosage is 1.1kg/m<sup>2</sup>. After 5 days of maintenance, the pull strength and shear strength are tested. The test results are shown in Table 1, Table 2 and Table 3.

Table 1 Results of 2# pull test

Specimen Number	Temperature[°C]	Tensile area [mm <sup>2</sup> ]	Failure Load [KN]	Pull Strength [MPa]	Average [MPa]
A	18	1963.50	0.81	0.41	0.39
B			0.73	0.37	
C			0.79	0.40	

Table 2 Results of 2# core drilling test of pull strength

Specimen Number	Temperature[°C]	Tensile area [mm <sup>2</sup> ]	Failure Load [KN]	Pull Strength [MPa]	Average [MPa]
A	18	7620.13	3.33	0.44	0.42
B			2.75	0.36	
C			3.44	0.45	

Table 3 Results of 2# field shear test

Specimen Number	Temperature[°C]	Tensile area [mm <sup>2</sup> ]	Failure Load [KN]	Pull Strength [MPa]	Average [MPa]
A	18	21700	10.52	0.48	0.40
B		21000	6.82	0.32	

From the test road survey, the waterproof layer constructed with the optimum dosage can meet the requirements of “Highway Engineering Evaluate Standard by Quality Inspection” [6].

## **Conclusion**

The bond, shear and pull strength of the bridge deck flexible waterproof material increase first and then decrease with the dosage. During the construction, the dosage of waterproof material should be  $1.0\pm 0.1$  kg/m<sup>2</sup>. It can affect the road performance of waterproof layer when the dosage is higher or lower compared with the amount.

## **References**

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