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# Evaluation of Interface between Bituminous Asphalt Layers

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ABSTRACT:

The interlayer holding of present-day multi-layered asphalt framework assumes a significant job to accomplish long haul execution of an adaptable asphalt. It has been seen that helpless holding between bituminous asphalt layers adds to significant asphalt overlay troubles, for example, untimely exhaustion, top-down breaking, potholes, and surface layer delamination. One of the most widely recognized upsets because of helpless holding between bituminous layers is a slippage disappointment, which for the most part happens where overwhelming vehicles are regularly quickening, decelerating, or turning. To upgrade the holding between layers, a tack coat is showered in the middle of the bituminous asphalt layers. A tack coat is a utilization of a bituminous emulsion or bituminous folio between a current bituminous/solid surface and a recently developed bituminous overlay. Regularly, hot bituminous folios, reduction bitumen or bituminous emulsions are utilized as tack coat materials.This investigation is expected to assess the bond quality at the interface between asphalt layers by performing research facility tests. To do this goal, three unique connections are manufactured for use in Marshall Loading Frame for finding the presentation of tack coat laid at the interface between Bituminous Concrete (BC) and Dense Bituminous Macadam (DBM) layers in the research facility. In this examination, the aftereffects of the examples arranged with 100 mm and 150 mm measurement examples utilizing two sorts of regularly utilized emulsions, in particular CMS-2 and CRS-1 as tack coat at application rates fluctuating at 0.20 kg/m2, 0.25 kg/m2 and 0.30 kg/m2 made at 250C temperature are introduced.It is seen that CRS-1 as tack coat gives higher interface bond quality worth contrasted with CMS-2. Also, independent of the kinds of emulsions utilized as tack coat, the ideal pace of use is seen as 0.25 kg/m2 as suggested in MORT&H's particulars.

**Keywords**: Interlayer, bond strength, shear strength, tack coat, performance

## I.INTRODUCTION

The cutting-edge adaptable asphalt is commonly structured and developed in a few layers for powerful pressure circulation across asphalt layers under the overwhelming traffic loads. The interlayer holding of the multi-layered asphalt framework assumes a significant job to accomplish long haul execution of asphalt. Sufficient bond between the layers must be guaranteed with the goal that numerous layers proceed as a solid structure. To accomplish great bond quality, a tack coat is typically splashed in the middle of the bituminous asphalt layers. Thus, the applied burdens are equitably appropriated in the asphalt framework and in this way, diminish auxiliary harm to the asphalts.

It has been seen that helpless holding between asphalt layers adds to significant asphalt overlay troubles. One of the most widely recognized bothers because of helpless holding between asphalt layers is a slippage disappointment, which as a rule happens where substantial vehicles are frequently quickening, decelerating, or turning. The vehicle load makes dynamic ordinary and distracting worries in the asphalt interfaces from even and vertical burdens. With the vehicle load being moved to each fundamental bituminous layer, the interface between the layers is indispensable to the asphalt's trustworthiness. Slippage disappointment creates when the asphalt layers start to slide on each other for the most part with the top layer isolating from the lower layer. This is brought about by an absence of security and a sufficiently high-level power to make the two layers start to isolate. Other asphalt issues that have been connected to helpless bond quality between asphalt layers incorporate untimely weakness, top-down splitting, potholes, and surface layer delamination.

Normally, hot bituminous binder, cutback bitumen or bituminous emulsions are used as tack coat materials. However, the use of bituminous emulsions as a tack coat material is escalating instead of cutback asphalt or hot bituminous binder because of the following advantages:

1. Bituminous emulsions can be applied at lower application temperatures compared to cutback bitumen or hot bituminousbinder.
2. As bituminous emulsions do not contain harmful volatile chemicals, they are relatively pollutionfree.
3. As bituminous emulsions are water based, they have no flashpoint and are not flammable or explosive. Therefore, they are safer to use as they do not pose health risk to workers. (Patel, 2010)

Bituminous emulsion is a mixture of bituminous binder, water and emulsifying agent. The emulsifying agent could be soap, dust or colloidal clays.Reduction bitumen is additionally fluid bitumen created by adding oil solvents to bituminous cover. Regular oil dissolvable incorporates gas and lamp oil. They are utilized as tack coats since they lessen bitumen thickness for lower temperature use. The utilization of reduction bitumen as a tack coat material has declined quickly throughout the years because of ecological concerns and the wellbeing hazard as the solvents dissipate into climate. Reduction bitumen is isolated into two characterizations Rapid Curing (RC) and Medium Curing (MC) in light of the sort of dissolvable utilized. Quick relieving reduction utilizes gas while medium restoring reduction utilizes lampoil.

Hot bituminous covers are acquired from refining of raw petroleum. In contrast to emulsions, bituminous folio particles don't convey any charge. Any evaluation of bituminous folio is acceptable as a tack coat material, although it is generally preferable to use the same grade of bituminous binder used in the HMA for tack coat (CPB 03-1, Tack Coat Guidelines).

### Research Objective

The primary objective of this study is to fabricate a few simple testing devices for the evaluation of the bond strength offered by the tack coats at the interface between bituminous pavement layers in the laboratory scale by performing several laboratory tests with different tack coat application rates. The ideal design will be that the standard setup which produces consistent results comparable to others. A secondary goal of this study is to provide helpful information for the selection of the best type of tack coat materials and optimum application rate.

## II.MATERIALS

This chapter describes the experimental works carried out in this present investigation.

This chapter has been divided into two parts. First part deals with the experiments carried out on the materials (aggregates, bitumen, and emulsions), second part deals with the fabrication of the shear testing devices for evaluation of pavement interface bond strength.

***MaterialsUsed***

***Aggregates***

For preparation of cylindrical samples composed of Dense Bituminous Macadam (DBM) and BituminousConcrete (BC), aggregates were as per grading of Manual for Construction and Supervisions of Bituminous Works of Ministry of Road Transport and Highways (MORT&H, 2001)

***CoarseAggregates***

Coarse aggregates consisted of stone chips collected from a local source, up to 4.75 mm

IS sieve size. Standard tests were conducted to determine their physical properties as summarized

***FineAggregates***

Fine aggregates, consisting of stone crusher dusts were collected from a local crusher with fractions passing 4.75 mm and retained on 0.075 mm IS sieve. Its specific gravity was found to be 2.62.

***Filler***

Portland slag cement (Grade 43) collected from local market passing 0.075 mm IS sieve was used as filler material. Its specific gravity was found to be 3.0.

***Binder***

One conventional commonly used bituminous binder, namely VG 30 bitumen collected from local source was used in this investigation to prepare the samples. Conventional tests were performed to determine the important physical properties of these binders

## III. RESULTS AND DISCUSSION

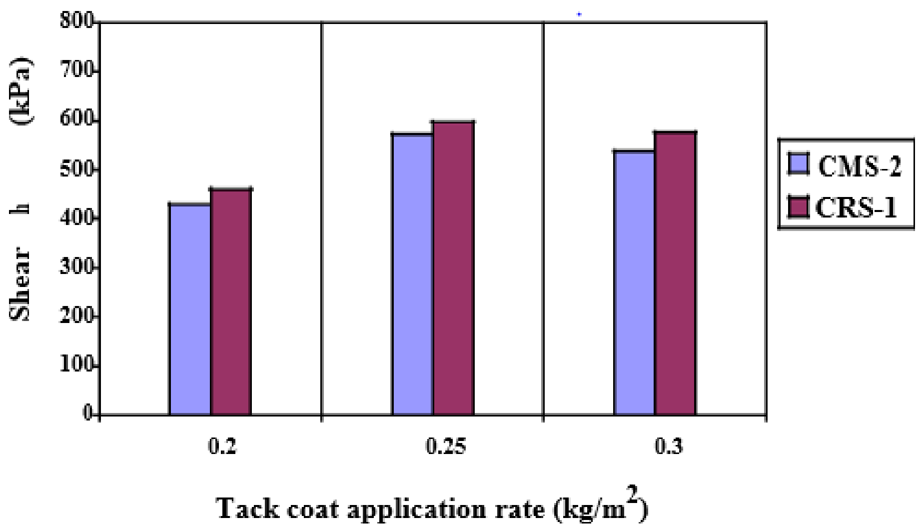
### Shear testing model no. 1

The test was conducted on 100 mm diameter cylindrical specimens with CRS-1 and CMS-2 a stack coats applied at application rate varying at 0.20kg/$m^2$,0.25kg/$m^2$ and 0.30kg/$m^2$ata temperature of 25$^0$C. As seen in table 4.1 and figure 4.1 the specimen with CRS-1 as tack coat exhibited higher shear strength as compared to CMS-2 for all application rates.

Results of the shear strength of 100 mm diameter specimens using Sheartesting model no. 1 at $25^{0}$C

| Tack Coat Type | Application rate (kg/m$^2$) | Load (kN) | Shear Strength (kPa) | Average Shear Strength (kPa) |
|---|---|---|---|---|
| CMS-2 | 0.20 | 3.228 | 411.001 | 429.590 |
| CMS-2 | 0.20 | 3.374 | 429.590 | |
| CMS-2 | 0.20 | 3.52 | 448.179 | |
| CMS-2 | 0.25 | 4.397 | 559.842 | 572.277 |
| CMS-2 | 0.25 | 4.397 | 559.842 | |
| CMS-2 | 0.25 | 4.690 | 597.148 | |
| CMS-2 | 0.30 | 4.032 | 513.369 | 538.155 |
| CMS-2 | 0.30 | 4.251 | 541.253 | |
| CMS-2 | 0.30 | 4.397 | 559.842 | |
| CRS-1 | 0.20 | 3.812 | 485.358 | 460.615 |
| CRS-1 | 0.20 | 3.667 | 466.896 | |
| CRS-1 | 0.20 | 3.374 | 429.590 | |
| CRS-1 | 0.25 | 4.543 | 578.431 | 597.106 |
| CRS-1 | 0.25 | 4.69 | 597.148 | |
| CRS-1 | 0.25 | 4.836 | 615.737 | |
| CRS-1 | 0.30 | 4.543 | 578.431 | 575.376 |
| CRS-1 | 0.30 | 4.397 | 559.842 | |
| CRS-1 | 0.30 | 4.617 | 587.853 | |

The optimum rate of application was found to be 0.25 kg/m$^2$ for both CMS-2 and CRS-1 as tack coat.



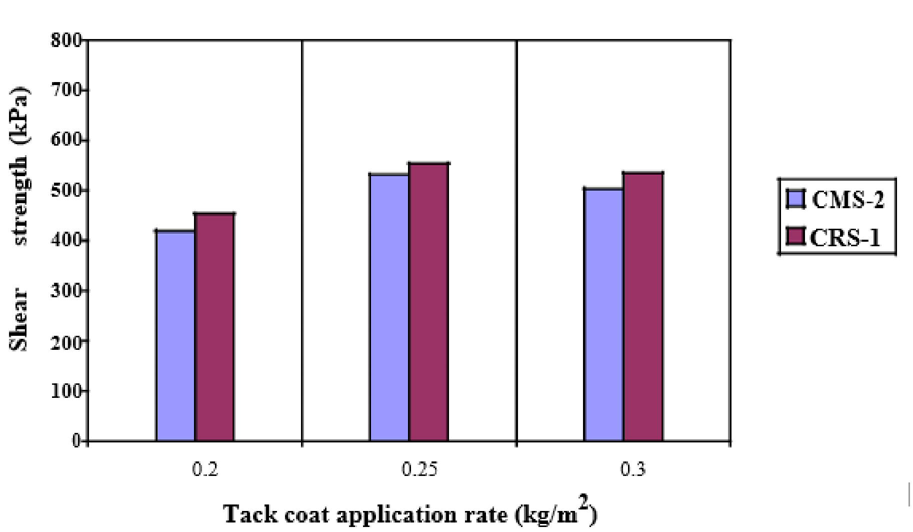
**Shear testing model no. 2**

The test was conducted on 150 mm diameter cylindrical specimens with CRS-1 and CMS-2 as tack coats applied at application rate varying at 0.20 $kg/m^2$, 0.25 $kg/m^2$ and 0.30 $kg/m^2$ at a temperature of $25^0$C. As seen in table 4.2 and figure 4.2 the specimen with CRS-1 as tack coat exhibited slightly higher shear strength than CMS-2 for all tack coat application rates.

. *Results of the shear strength of 150 mm diameter specimens using Sheartesting model no. 2 at $25^0C$*

| Tack Coat Type | Application rate ($kg/m^2$) | Load (kN) | Shear Strength (kPa) | Average Shear Strength (kPa) |
|---|---|---|---|---|
| CMS-2 | 0.20 | 7.417 | 419.715 | 419.583 |
| CMS-2 | 0.20 | 7.117 | 402.739 | |
| CMS-2 | 0.20 | 7.710 | 436.296 | |
| CMS-2 | 0.25 | 9.193 | 520.216 | 531.421 |
| CMS-2 | 0.25 | 9.490 | 537.023 | |
| CMS-2 | 0.25 | 9.490 | 537.023 | |
| CMS-2 | 0.30 | 9.193 | 520.216 | 503.428 |
| CMS-2 | 0.30 | 8.896 | 503.409 | |
| CMS-2 | 0.30 | 8.600 | 486.659 | |
| CRS-1 | 0.20 | 8.007 | 453.102 | 453.084 |
| CRS-1 | 0.20 | 7.710 | 436.296 | |
| CRS-1 | 0.20 | 8.303 | 469.853 | |
| CRS-1 | 0.25 | 9.490 | 537.023 | 553.735 |
| CRS-1 | 0.25 | 10.080 | 570.410 | |
| CRS-1 | 0.25 | 9.786 | 553.773 | |
| CRS-1 | 0.30 | 9.638 | 545.398 | 535.193 |
| CRS-1 | 0.30 | 9.341 | 528.591 | |
| CRS-1 | 0.30 | 9.394 | 531.590 | |

The optimum rate of application was found to be 0.25 $kg/m^2$ for both CMS-2 and CRS-1 as tack coat.




**Plot of Shear Strength v/s Tack Coat application rates for 150 mm diameter specimens using Shear testing model no. 2.**

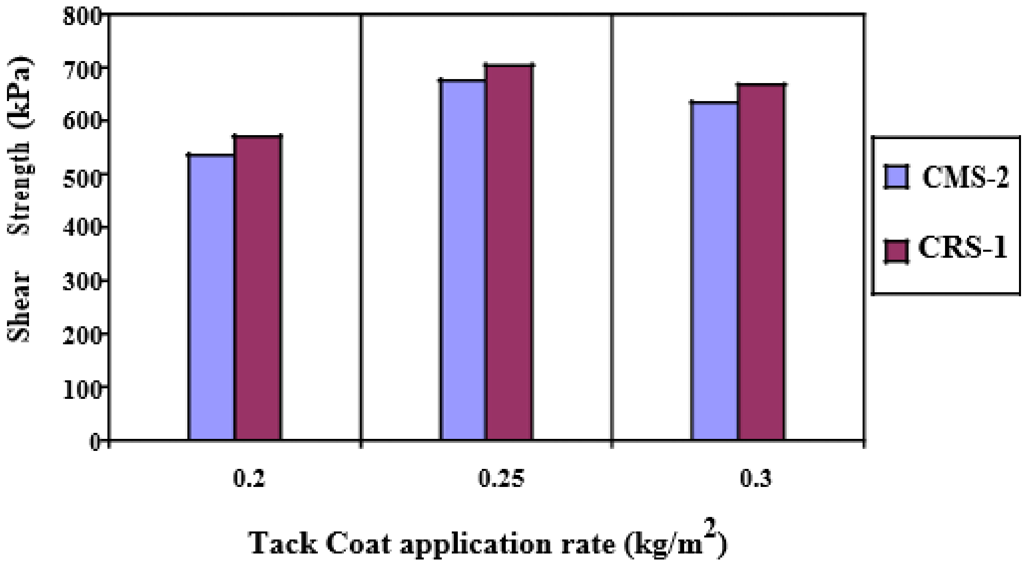
**Shear testing model no. 3**

The test was conducted on 150 mm diameter cylindrical specimens with CRS-1 and CMS-2 as tack coats applied at application rate varying at 0.20 kg/$m^2$, 0.25 kg/$m^2$ and 0.30 kg/$m^2$ at a temperature of $25^0$C. As seen in table 4.3 and figure 4.3 the specimen with CRS-1 as tack coat exhibited slightly higher shear strength than CMS-2 at an application rate.

**Results of the shear strength of 150 mm diameter specimens using Shear testingmodel no. 3 at $25^0$C**

| Tack Coat Type | Application rate (kg/$m^2$) | Load (kN) | Shear Strength (kPa) | Average Shear Strength (kPa) |
|---|---|---|---|---|
| CMS-2 | 0.20 | 9.193 | 520.216 | 537.004 |
| CMS-2 | 0.20 | 9.786 | 553.773 | |
| CMS-2 | 0.20 | 9.490 | 537.023 | |
| CMS-2 | 0.25 | 11.560 | 654.161 | 676.607 |
| CMS-2 | 0.25 | 12.450 | 704.524 | |
| CMS-2 | 0.25 | 11.860 | 671.137 | |
| CMS-2 | 0.30 | 11.414 | 645.899 | 634.732 |
| CMS-2 | 0.30 | 10.970 | 620.774 | |
| CMS-2 | 0.30 | 11.266 | 637.524 | |
| CRS-1 | 0.20 | 9.786 | 553.773 | 570.523 |
| CRS-1 | 0.20 | 10.082 | 570.523 | |
| CRS-1 | 0.20 | 10.378 | 587.273 | |
| CRS-1 | 0.25 | 12.450 | 704.524 | 704.430 |
| CRS-1 | 0.25 | 12.150 | 687.548 | |
| CRS-1 | 0.25 | 12.745 | 721.218 | |
| CRS-1 | 0.30 | 11.710 | 662.649 | 668.195 |
| CRS-1 | 0.30 | 11.857 | 670.967 | |
| CRS-1 | 0.30 | 11.857 | 670.967 | |

The optimum rate of application was found to be 0.25 kg/m$^2$ for both CMS-2 and CRS-1 as tack coat.




**Plot of Shear Strength v/s Tack Coat application rates for 150 mm diameter specimens using Shear testing model no. 3.**

**Comparison of Shear Strength v/s Application rates for the three models.**

Analyzing the results graphically as shown in figure 4.4, it can be concluded that specimen with CRS-1 as tack coat exhibited higher shear strength values compared to CMS-2 as tack coat at all application rates varying at 0.20 kg/m$^2$, 0.25 kg/m$^2$ and 0.30 kg/m$^2$ for all three types of shear testing devices. Also, the optimum application rate was found to be 0.25 kg/m$^2$ for the all three models.

## IV. CONCLUSION AND DISCUSSION

A research center investigation was led to assess the bond quality between the Bituminous Concrete (BC) and Dense Bituminous Macadam (DBM) layers with tack coat showered at the interface. For this reason three straightforward shear testing models were created and tries were led utilizing the equivalent in a Marshall Stability Apparatus. For shear testing model no 1, research facility tests were directed on 100 mm distance across tube shaped examples at a temperature of 25$^0$ C by applying a shear power of steady distortion pace of 50.8 mm/min.

While the shear testing model no. 2 and 3 were manufactured to assess the bond quality of 150 mm distance across tube shaped examples. The examples were set up in research facility by applying CMS-2 and CRS-1 as tack coat at interface at application rates fluctuating at 0.20 kg/m$^2$, 0.25 kg/m2 and 0.30 kg/m$^2$.

Coming up next are explicit perceptions drawn from the test outcomes.

- The test results closed the application pace of 0.25 kg/m2 as the ideal one for all the tackcoats.
- Generally, CRS-1 as tack coat gave the most noteworthy shear quality at all application rates, 0.20 kg/m2, 0.25 kg/m2 and 0.30 kg/m2 when contrastedwith CMS-2.
- The shear quality qualities acquired from shear testing model no. 3 were higher than those acquired from model no.1 and 2 for a wide range of tack coat at all application rates. This may be because of erraticism as the shear load was applied close to the interface along these lines; the shear quality qualities got were lower than those acquired from model no. 3 where a concentric shear load wasapplied.
- Considering all models together, normal shear quality qualities were seenas 462.059,
- 593.435 and 558.772 kPa utilizing CMS-2 as tack coat at application paces of 0.20 kg/m2, 0.25 kg/m2 and 0.30 kg/m2 individually while utilizing CRS-1 as tack coat at application paces of 0.20 kg/m2, 0.25 kg/m2 and 0.30 kg/m2 the normal shear quality qualities acquired were 494.740, 618.424 and 592.921 kPa separately.

## FUTURE RESEARCH RECOMMENDATIONS

The following recommendations are provided as a part of future work based on the observations drawn from this study.

- It is recommended to compare the results obtained from the laboratory specimens with the results obtained from field core specimens. This will assist in getting a correlation between the laboratory test results and the fieldobservations.
- Further research is recommended to examine the variation of interface bondstrength at varying tack coat material types, temperatures and normalpressure.
- Theoretical models are to be developed to validate the experimental results anddecide the best model to beadopted.

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