Effect of Interface Bonds on Pavement Performance

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Introduction

Abstract

As per the five-year provincial roads plan (2017 edition), the Department of Transportation and Works of Government of Newfoundland and Labrador shifted its focus from the construction of new roads to the maintenance and rehabilitation of existing highways. With more than 270 km of road planned to be rehabilitated/upgraded in the province by 2022, appropriate strategies are needed to maintain and rehabilitate the roads. Many past studies reported that the life of overlays depends on the interface condition between the existing pavement and overlay. In addition to this, the overlay fails mainly due to lack of proper maintenance for existing pavement before constructing the overlay. In this paper, Finite Element-based software program (ABAQUS) was employed to evaluate the interlayer damages between the existing pavement and overlay. Various interface conditions are modelled for evaluating the performance of the overlay. The results obtained from the analysis could help in selecting appropriate maintenance strategies for developing a sustainable overlay construction specification

Objectives

- Classification of bonding between Asphalt and concrete surface
- Interface bond strength and Interface condition
- Fatigue life of Asphalt surface overlay

Delamination of Asphalt Overlay:

The causes of delamination are as follows: 1) Inadequate tack coating, 2) Seepage of water through the surface layer, 3) A loose asphalt mixture and 4) less adhesive force between the layers.

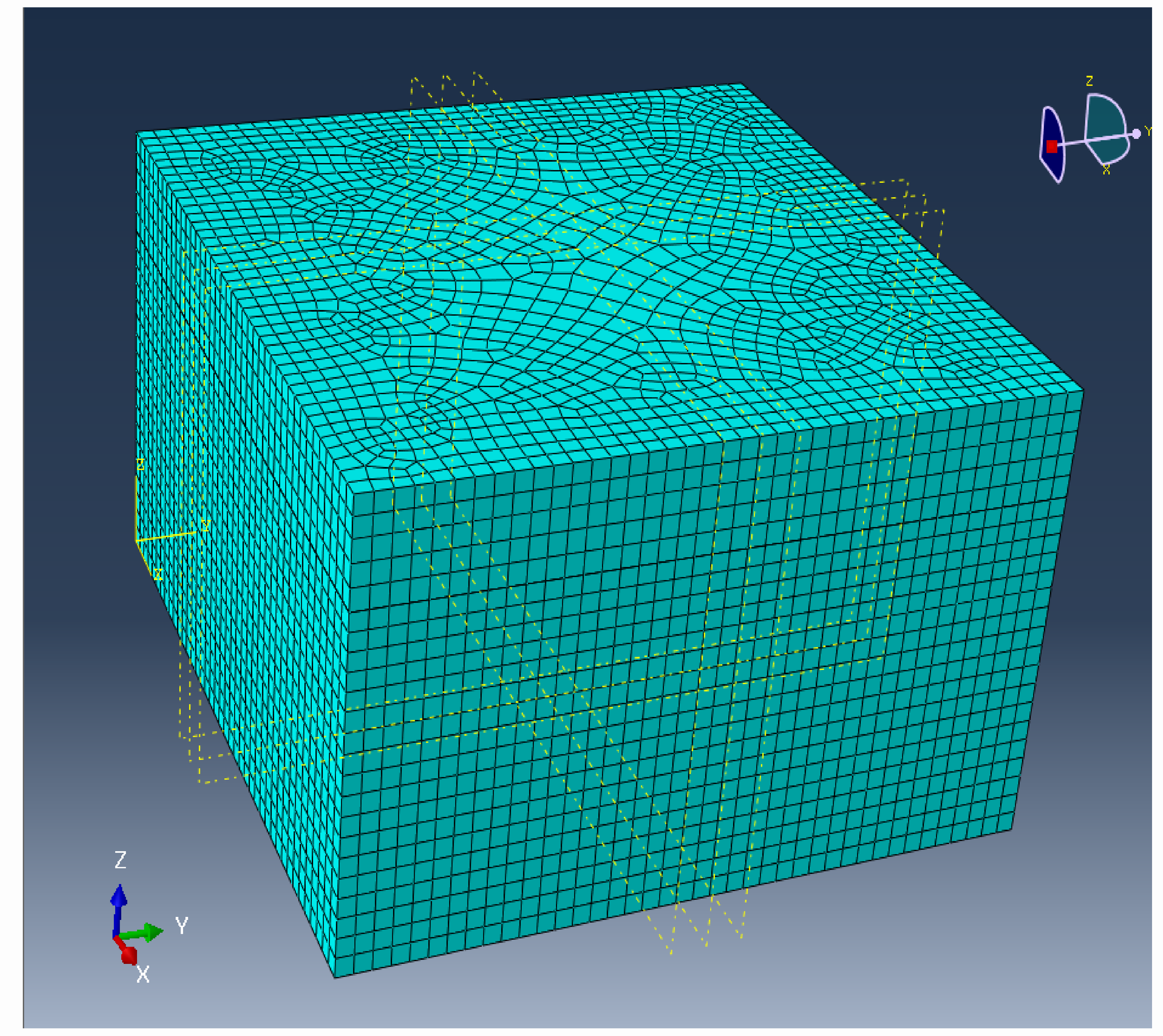
Literature

Test methods for evaluating the interface bond strength

Test Method	Variables Evaluated	Developed by	Author
Direct shear test	Penetration grade bitumen	Uzan et. Al.	Uzan et al. [10]
	Stress absorbing interlayers	Delft University of Technology	Heerkens et al. [11]
Swiss Standard SN 671 961	LPDS tester	Swiss Federal Laboratories for Materials Testing and Research	Roffe et al. [12]
Superpave Shear Tester	Various tack coat types, application rates and different temperature conditions	Mohammad et al.	Mohammad et al. [13]
Torsion test	Various tack coat types	In the UK	Roffe et al. [12]
Leutner test	Various bonding conditions	University of Nottingham	Collep et al.[18]
Simple direct shear device	Emulsion tack coat material	Florida Department of Transportation (FDOT)	Sholar et al.[14]
Ancona Shear Testing Research and Analysis (ASTRA)	Effects of temperature and surface	In Italy	Santagata et al. [15]–[17]
ATACKER™ device	Tensile mode or in torsion.	Instrotek, Inc	Instrotek, Inc (ATACKER™ InstroTek, Inc 2005)
Direct Shear Test	Various interface conditions	Illinois Center for Transportation	Leng et al. [20]

Modeling

Finite element model of pavement: AC overlay over existing PCC pavement



Properties of the pavement system

Layer Details	Density (ρ) (kg/m³)	Elastic Modulus (N/mm²)	Poisson's Ratio (μ)	Thickness (mm)
AC Overlay	2250	2500	0.35	60
Existing PCC layer	2400	15000	0.15	200
Sub Base	1900	400	0.35	200
Sub Grade	1800	40	0.35	infinite

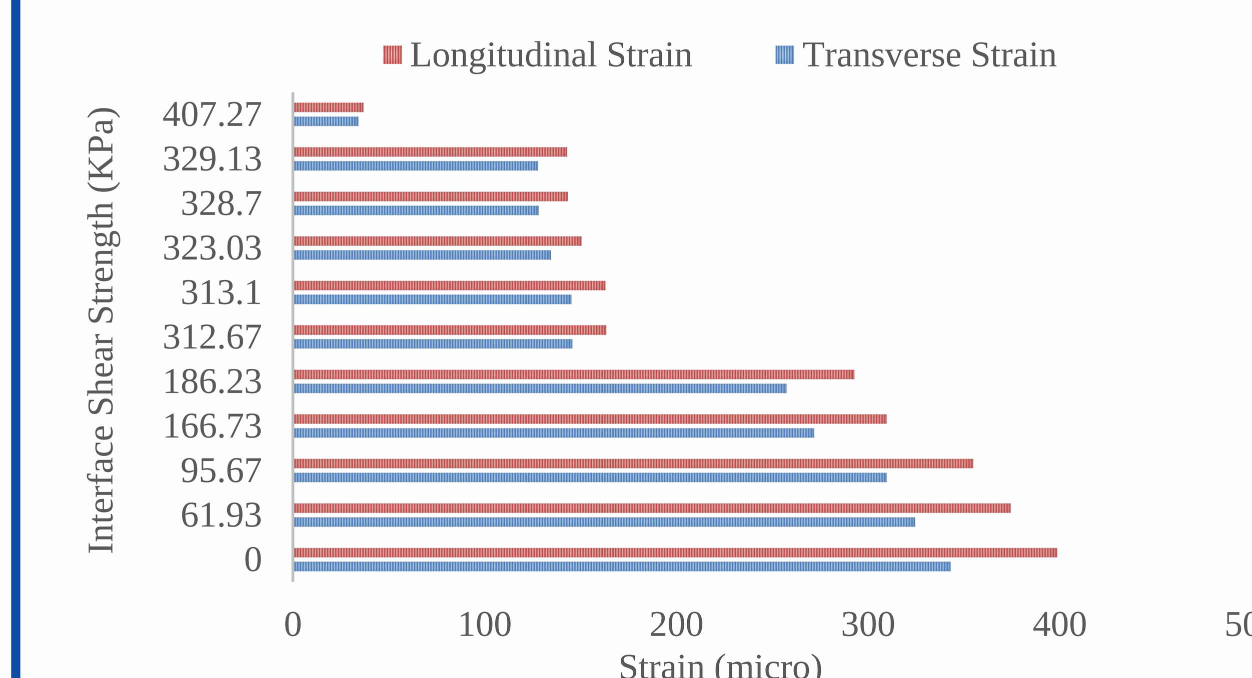
Interface types considered

Interface Type	Tack Coat Application Rate (gal/yd²)	Interface Shear Strength (KPa)
Frictionless	0	0
Smooth	0	61.93
Smooth	0.02	95.67
Longitudinal Tining	0.02	166.73
Transverse Tining	0.02	186.23
Transverse Tining	0.09	312.67
Longitudinal Tining	0.09	313.1
Smooth	0.09	323.03
Longitudinal Tining	0.05	328.7
Transverse Tining	0.05	329.13
Smooth	0.05	407.27

Results

Effect of Interface Shear Strength on Strain

Interface Type	Tack Coat Application Rate (gal/yd²)	Interface Shear Strength (KPa)	Longitudinal Strain (ϵ_x) (x10⁶)	Transverse Strain (ϵ_y)(x10⁶)
Frictionless	0	0	343.1	398.71
Smooth	0	61.93	324.6	374.43
Smooth	0.02	95.67	309.8	354.98
Longitudinal Tining	0.02	166.73	272	309.83
Transverse Tining	0.02	186.23	257.61	292.98
Transverse Tining	0.09	312.67	145.89	163.58
Longitudinal Tining	0.09	313.1	145.43	163.06
Smooth	0.09	323.03	134.67	150.77
Longitudinal Tining	0.05	328.7	128.4	143.62
Transverse Tining	0.05	329.13	127.92	143.08
Smooth	0.05	407.27	34.25	36.89



Conclusions

- When there is an increase in interface bond strength between the AC overlay and existing PCC pavement, the strains at the bottom of the AC overlay are reduced, which corresponds to the high fatigue life of the pavement.
- The combination of tining and a tack coat performs well when the application rate of tack coat is less; but at the optimum application of the tack coat, a smooth interface can provide better bonding than a tined interface.
- An overlay without any interface bonding will lead to the premature cracking of pavement.