Evaluation of Ontario's Pavement Design Methodology

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Introduction:

Traditionally, pavement has been designed based on experience. Designs moving towards the following design methods and design evaluation:

- ➢AASHTO 93
- ➢Ontario Pavement Analysis of Cost (OPAC)
- ➢Routine (Empirical) Method
- ➢DARWin-ME

Scope and Objective:

Objective is to analyze various typical Ontario Asphalt Pavement Thickness and validate whether the current PMS2 Granular Base Equivalent (GBE) are consistent with those recommended in the Transportation Association of Canada Pavement Asset Design and Management Guide (PADMG) [TAC 2013]

Data Sources:

The data was collected from 1990 to 2010. This data was divided according to the availability to historical and pavement survey data.

Historical Data	Survey Data
Equivalent Total Thickness	Average Annual Daily Traffic (AADT)
Subgrade Type	Equivalent Single Axle Load (ESAL)
Climate Zone	International Roughness Index (IRI)
Pavement Type	Distress Manifestation Index (DMI)
	Pavement Condition Index (PCI)

Methodology:

A total of 870 sections from MTO PMS 2 however, when sections are broken down into treatment cycles (i.e. pavement treatment to next pavement treatment) it results in 17,868 cycles. The 870 sections were classified as shown in Table 1:

Table 1: Categories of Pavement Sections

Influence Factors	Descraption	Number of Sections
Pavement Type	(AC) Asphalt	651
	(PC) Portland cement	6
	(CO) Composite	26
	(ST)Surface Treatment	187
Equivalent Total Thickness	L(Low) (<500 mm)	846
	M(Medium) (≤500-750mm)	19
	H(High) (≤750 mm)	5
ESAL	Class1 (< 500,000)	423
	Class 2 (500,000 - 100,000)	447
Subgrade Type	(SS) sandy silt	645
	(GM) Granular Material	114
	(LC) Lacustrine Clay	93
	(VC) Varved Clay	18

Typical Pavement thickness (mm) used in Ontario, were used to calculate the corresponding thickness and compared. An example of typical thickness are found in Table 2

Table 2: Typical Pavement thickness (mm) used in Ontario

Subgrade Type	Conventional Pavement Structure Course	Traffic Loading (ESAL) (1000)	
		500	1000
Sandy Silts	Asphalt Stabilized	90	130
	Granular subbase Select granular	150	150
	Total	240	430

GBE for Ontario Structural Pavement Design were used to calculate GBE used in Figure 2

Table 3: Granular Layer Equivalencies for Ontario Structural Pavement Design

1mm Asphalt Concrete Equivalent to	Component Layer Material Ratio Actual Thickness = Granular Base Equivalency (GEB)
1.1mm treated base (PC)	1.80 treated base (PC)
3mm treated base (asphalt)	1.50 treated base (AC)
2 mm granular base	1.00 granular base
3 mm granular subbase	0.67 granular subbase
2mm OGDL	1.00 OGDL

➢Multiple regression analysis was carried out to assess performance of the various treatments.

➢To develop models that were statistically valid, some constraints were applied and any category that did not achieve these constraints were removed:

➢A minimum of 30 treatment cycles within each category was required to carry out the analysis.

➢Any section or treatment cycle has a PCI value less than 50.

➢Equivalent total thickness less than 30 mm

$$Average\ Absolute\ Error\ (AAE) = \frac{1}{N}\sum_{i=1}^{N}\left|\frac{Oi - Pi}{Pi}\right|$$

Where: Oi = Observed Value

Pi = Predicted Value

N = Number of Validating points

Results:

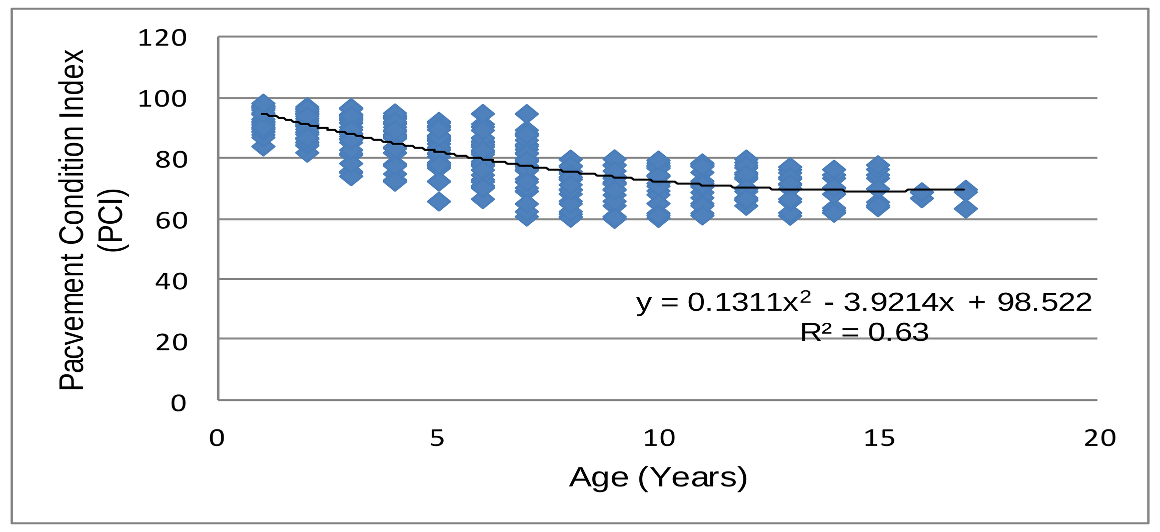

Figure 1: Performance Model for asphalt on silt with 500,000-1,000,000 ESALs.

- •Fast deterioration
- •Shorter service life , Therefore:

ccompression between actual GEB used in construction based on PMS2 data and the recommended GBE by the PADMG

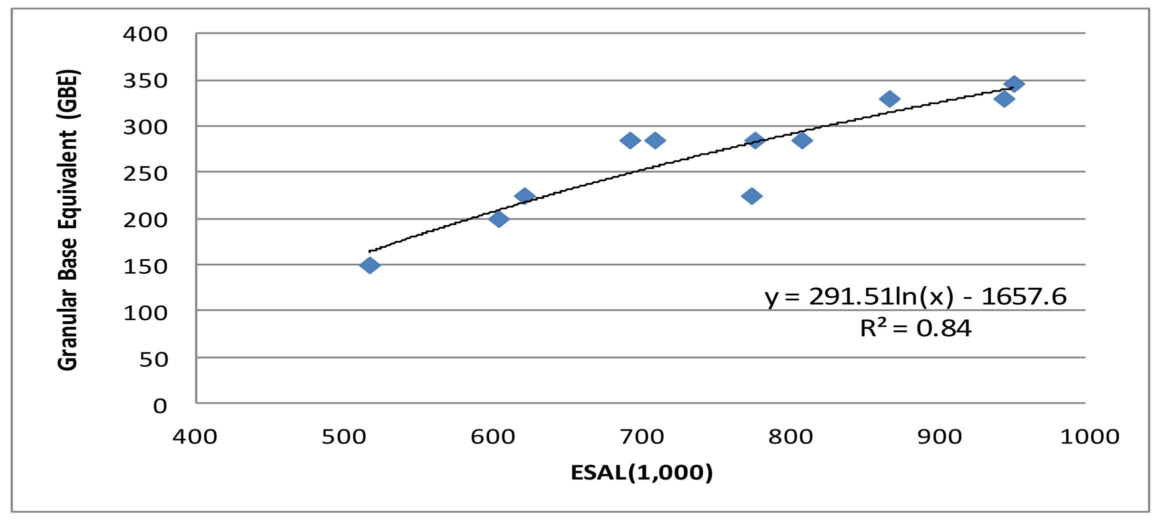

Figure 2: Model prediction between GBE vs. ESAL

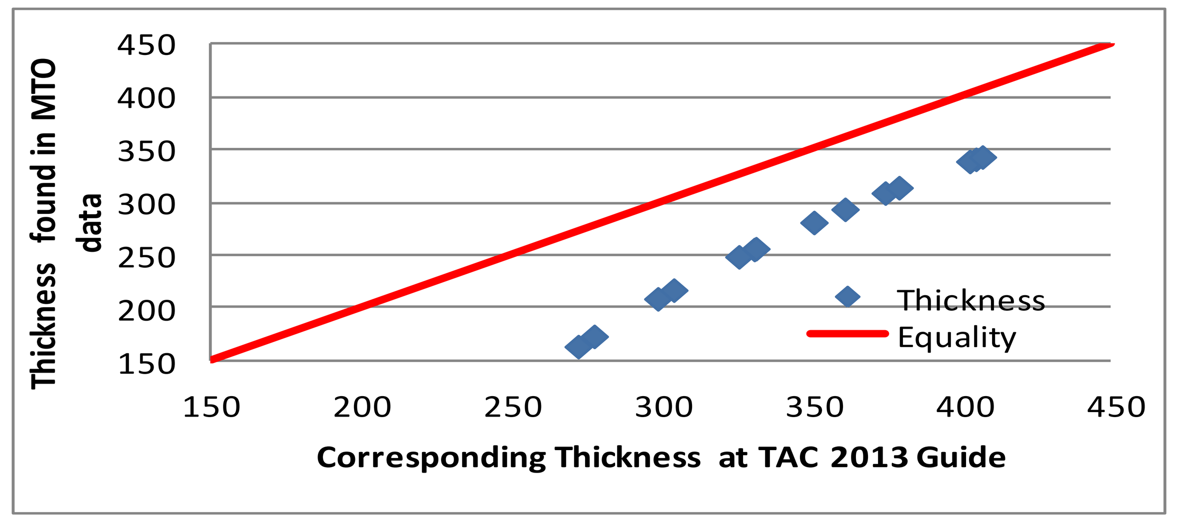

Figure 3: Thickness used in MTO Data vs. Recommended Thickness by TAC

Figure 3 presents Models for GBE. As the ESAL increase the thickness also increases.

Statistical Analysis:

t –test has used to examine the means of the thicknesses used in the MTO data and the recommended by PADMG. The following hypothesis has been followed:

H0:µ1-µ2=0 H1:µ1-µ2>0

Where:
µ1= thicknesses recommended by PADMG
µ2= thicknesses out of MTO data

Table 3 shows the results from the t-test

	Thickness	
	MTO	TAC
Mean	270.68	346.49
Variance	3537.73	2039.96
t Stat	-19.54	15
P(T<=t) one-tail	7.36E-12	
t Critical one-tail	1.76	

p-value is less than α (0.05) that leads to reject the null hypothesis which means that the result is statistically significant deference between the two means.

Conclusions:

➢Study showed the climatic zone is an important influence factor in pavement design, as the climatic zone was absent in the procedure followed in the PADMG for estimating typical pavement thicknesses based on the traffic loading

➢Using adequate GBE will lead to longer service life for the pavement

➢The recommended GBE guidelines in PADMG for low ESAL categories and thin pavements should be followed

Acknowledgement:

The authors gratefully acknowledge the support of the Ministry of Transportation of Ontario (MTO)
Special appreciation is also extended to Li Ningyuan, and Becca Lane from the MTO.

Ontario