Developing Permanent Deformation Model for Hot Mix Asphalt

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Introduction

- Various Failures in Flexible Pavements,
- Why Rutting is the One Selected for this Study?
- Rutting Classification,
- Gap,
- Laboratory Experiments &
- Design Approach.

Introduction

Longitudinal

Transverse

Potholes

Raveling

Introduction

Rutting-1.1,

Fatigue cracking-1.8, and

Thermal cracking-2.2

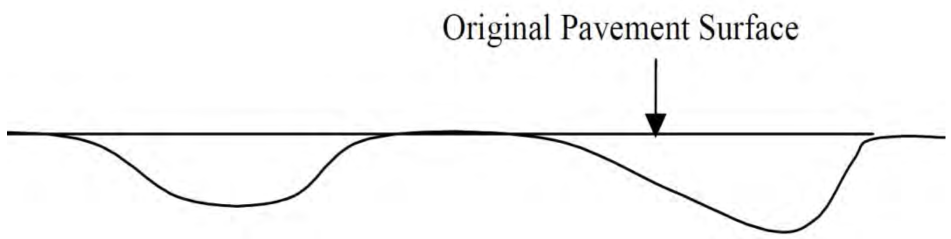
Background

Rutting Definition;

Rutting in Flexible Pavement

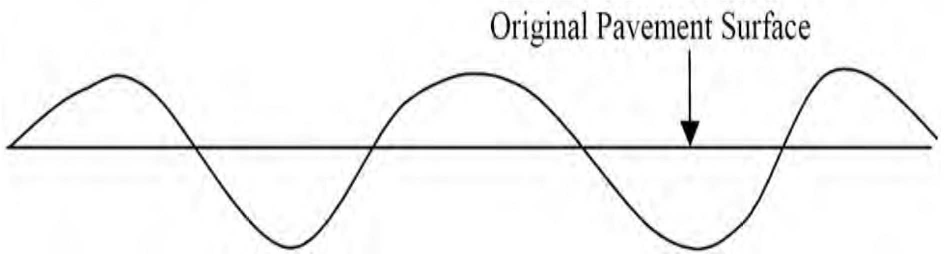
Background

One dimensional densification or vertical compression;



- *Excessive Air Voids*
- *Lack of Compaction*

Lateral flow or plastic movement;

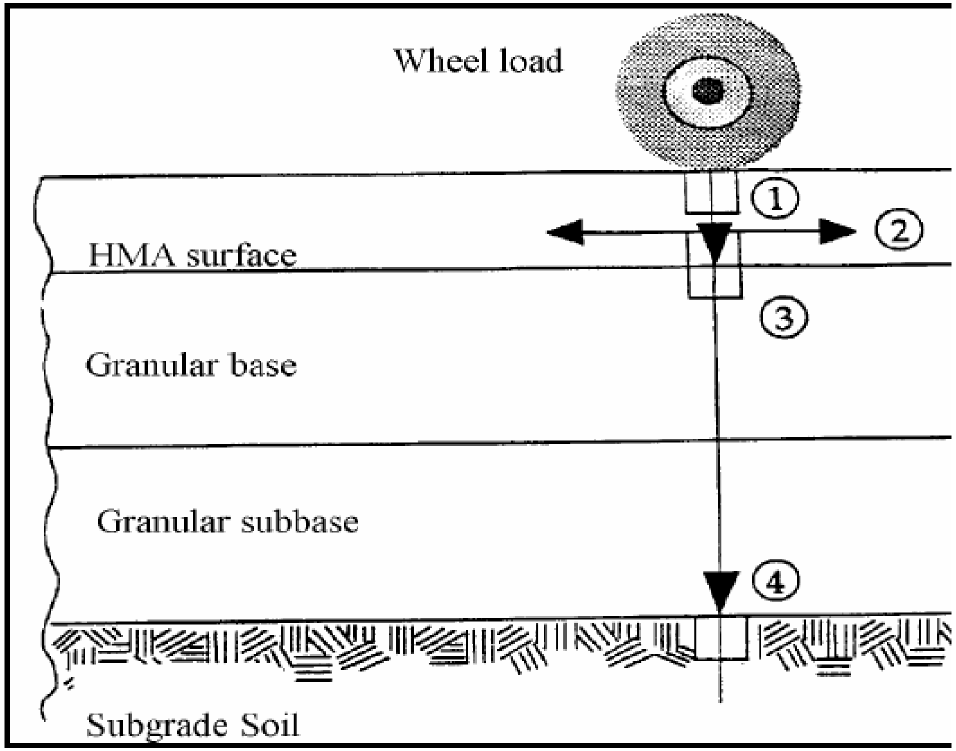


- *Primary Type*
- *Purely Shear*
- *Low Air Voids*
- *Asphalt Layer*

Mechanical deformation.

- *Least Common Type*
- *Unbound Layers*

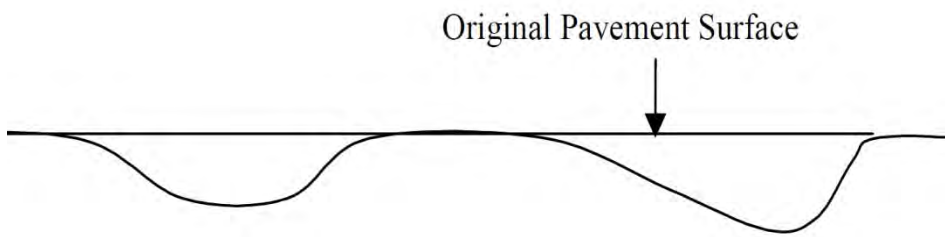
Background



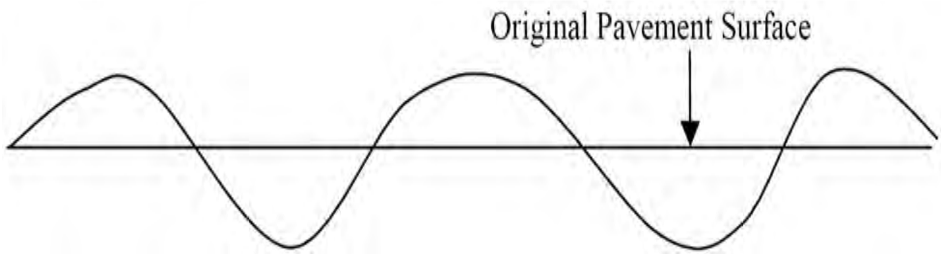
Critical stresses transmitted in flexible pavement (Druta,2006)

Background

One dimensional densification or vertical compression;



Lateral flow or plastic movement;



Mechanical deformation.

1. Least Common Type
2. Severity Level; low to moderate

New Design Procedure

Strategic Highway Research Program (SHRP)

↓

Superpave, short for ***Su***perior ***Per***forming Asphalt ***Pave***ments

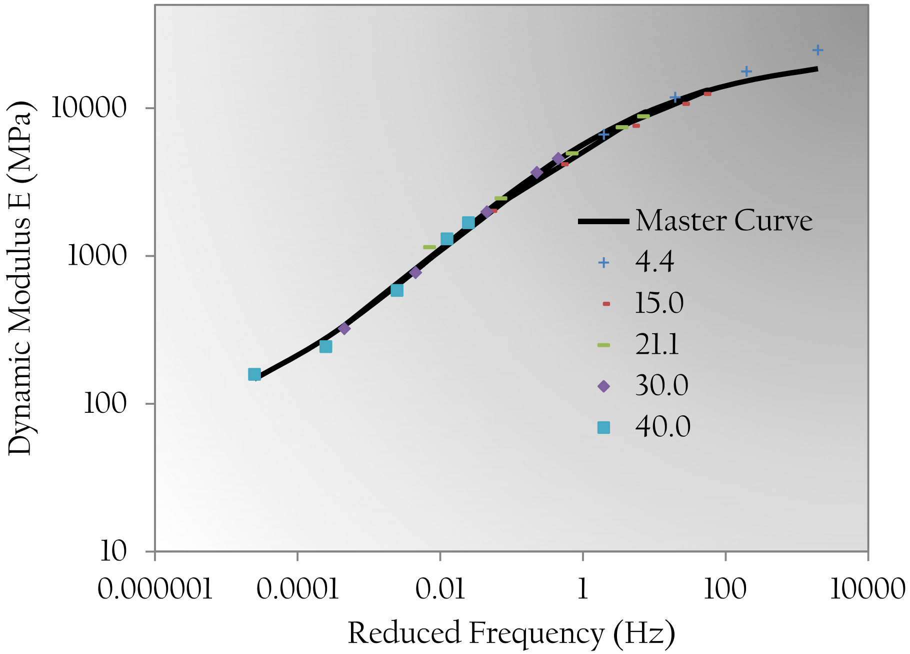
New Design Procedure

Dynamic Modulus, E^*, determined by the uniaxial and triaxial compression test;

Flow Number, F_N, determined from the repeated load test; and

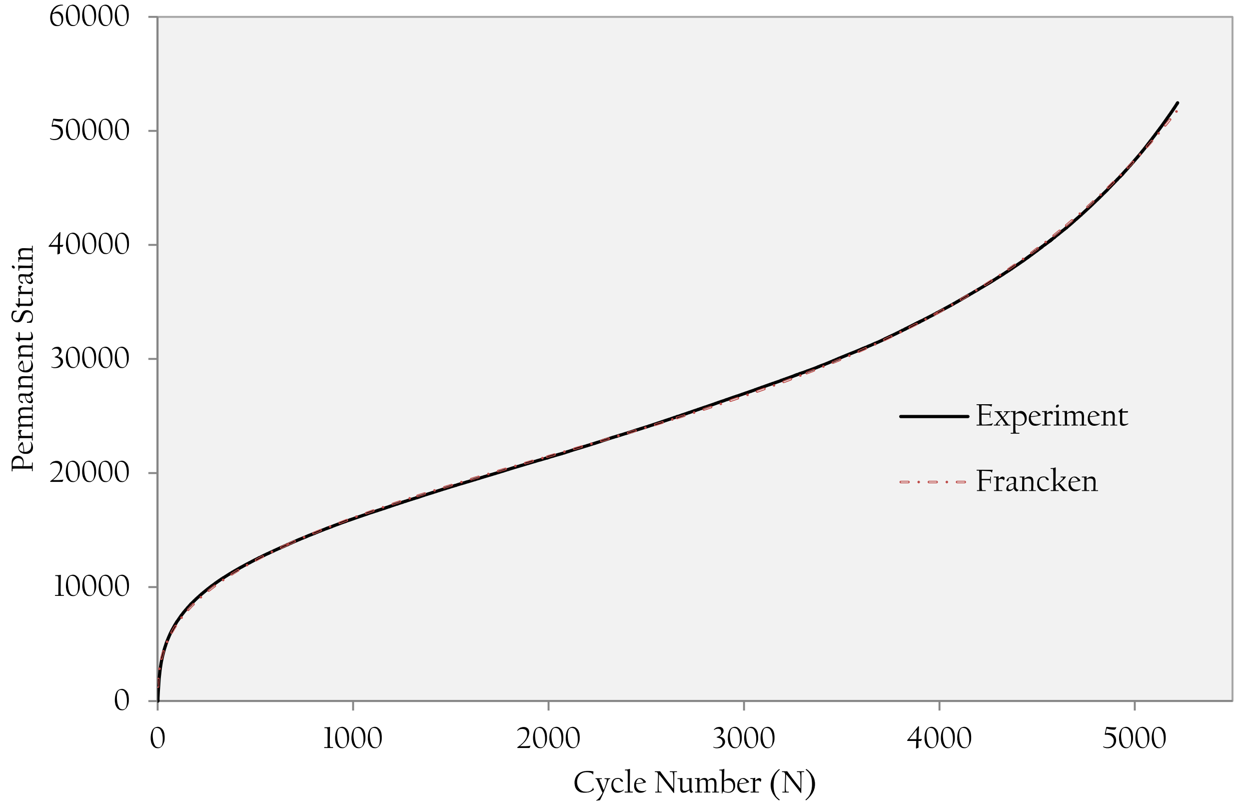
Flow Time, F_T, determined from the static creep test.

New Design Procedure



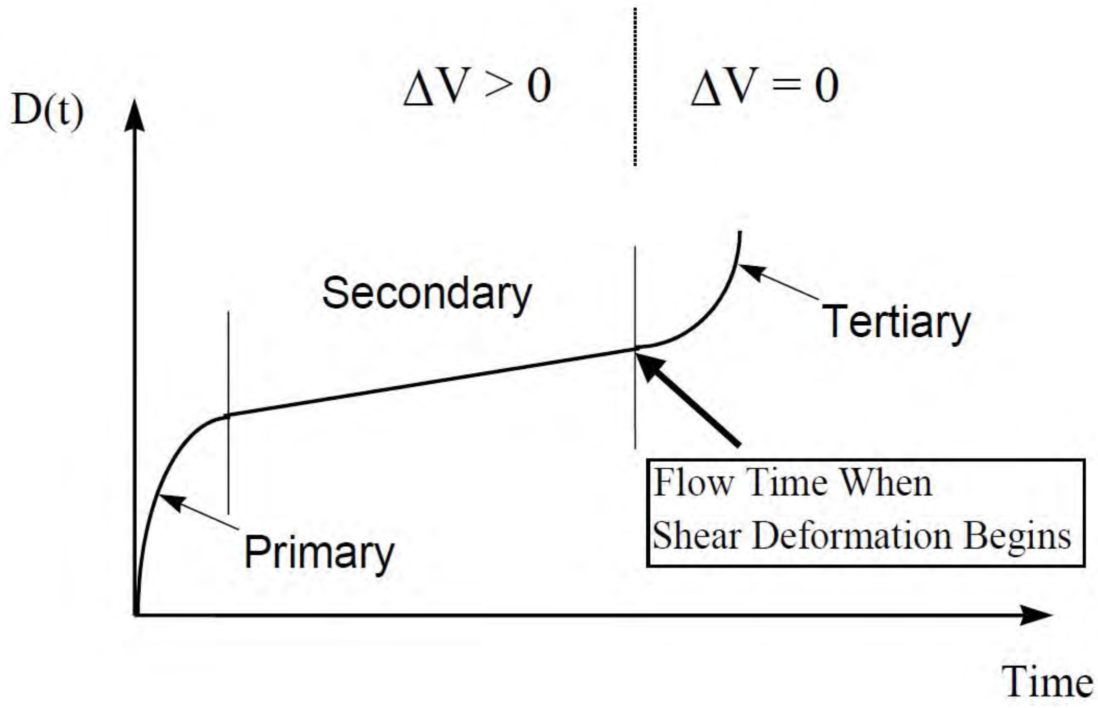
Dynamic Modulus Master Curve

New Design Procedure



Repeated Creep Test

New Design Procedure



Specifying tertiary point (Witczak,2005).

Modeling

Rutting Prediction Methodology and Models:

1) *The Empirical Modeling,*

2) *Mechanistic-Empirical Models,*

→ *Simple Performance Test ,*

(These, we will look at)

3) *Advanced Constitutive Model :*
Linear Viscoelasticy (LVE)

Experimental Stage

Dynamic & resilient modulus variables

Binder 60/70				Binder 80/100			
AC 14		AC 20		AC 14		AC 20	
V_a = 4.0%	V_a = 7.0%	V_a = 4.0%	V_a = 7.0%	V_a = 4.0%	V_a = 7.0%	V_a = 4.0%	V_a = 7.0%

Experimental Stage

Repeated and static load creep test variables

Binder 60/70, 80/100															
AC 14, AC 20															
V_a = 4.0%								V_a = 7.0%							
Temp.1 = 40ºC				Temp.2 = 60 ºC				Temp.1 = 40 ºC				Temp.2 = 60 ºC			
$(\sigma_d)_1$ = 600kPa		$(\sigma_d)_2$ = 690kPa		$(\sigma_d)_1$ = 600kPa		$(\sigma_d)_2$ = 690kPa		$(\sigma_d)_1$ = 600kPa		$(\sigma_d)_2$ = 690kPa		$(\sigma_d)_1$ = 600kPa		$(\sigma_d)_2$ = 690kPa	
$(\sigma_3)_1$ = 0 kPa	$(\sigma_3)_2$ = 275 kPa	$(\sigma_3)_1$ = 0 kPa	$(\sigma_3)_2$ = 275 kPa	$(\sigma_3)_1$ = 0 kPa	$(\sigma_3)_2$ = 275 kPa	$(\sigma_3)_1$ = 0 kPa	$(\sigma_3)_2$ = 275 kPa	(σ_{31}) = 0 kPa	$(\sigma_3)_2$ = 275 kPa	$(\sigma_3)_1$ = 0 kPa	$(\sigma_3)_2$ = 275 kPa	$(\sigma_3)_1$ = 0 kPa	$(\sigma_3)_2$ = 275 kPa	$(\sigma_3)_1$ = 0 kPa	$(\sigma_3)_2$ = 275 kPa

Aim and Objectives

For designing purpose;

1) Based on mechanistic-empirical modeling: RD = $a\ (F_{Nr})^{b}$

2) Deduce from viscoelastic theory:

Generalized Burgers Model;

$$\varepsilon = \frac{\sigma}{E_0}\left(1 + \frac{t}{T_0}\right) + \sum_{i=1}^{n} \frac{\sigma}{E_i}\left[1 - \exp(-\frac{t}{T_i})\right] \textit{ or,}$$

Generalized Maxwell Model;

$$E(t) = \sum_{i=1}^{m} E_i e^{-t/\tau_i}$$

Thanks