APPENDIX K

REFLECTION CRACKING AMOUNT AND SEVERITY MODEL

TABLE OF CONTENTS

LIST OF FIGURES

REFLECTION CRACKING AMOUNT AND SEVERITY MODEL

The reflection cracking of hot mix asphalt overlays develops with time or number of load repetitions. It is a well known fact that the development of reflection crack amount and severity follows a sigmoidal curve having a finite upper asymptote for three different severity levels, as shown in Figure K-1.

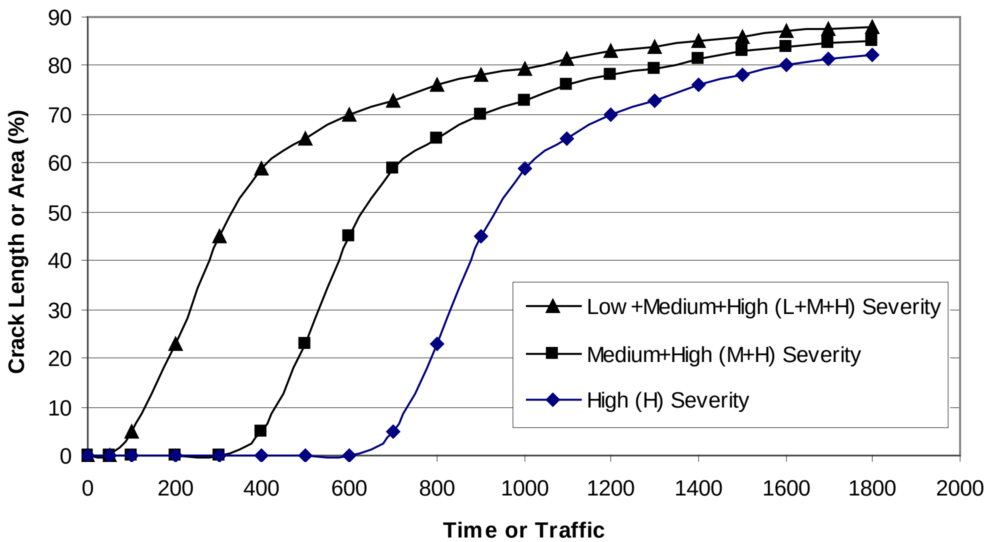

Figure K-1. Typical development of reflection crack by severity levels.

Jayawickrama and Lytton in Reference (12) proposed an s-shaped empirical model to describe the amount and severity development of reflection cracking on asphalt overlay. In the reflection cracking model, it was described that the reflection cracking is developed based on the number of load repetition or time as follows (12):

$$RFAS = 100 \cdot e^{-\left(\frac{\rho}{D_{Total}}\right)^{\beta}} \qquad \text{(K-1)}$$

where

e = the base of natural logarithms (2.71828…)

RFAS = reflection cracking amount and severity, ranging from 0 to 100 percent,

D_{Total} = total damage caused by traffic and thermal loading, and

ρ and β = calibration parameters for each severity level

The parameter ρ is the scale factor on reflection cracking amount and severity. A large ρ number indicates that more time is needed to reach a given level of reflection cracking amount and severity; that is, the parameter ρ describes how wide the rising portion of the curve is. In addition, the parameter ρ is the number of days the reflection cracking requires to reach 36.8 percent (1/e) of the original length of transverse cracks or joints in the underlying pavement. The parameter ρ is the shape factor describing how steep the rising portion of the curve is as shown in Figure K-2.

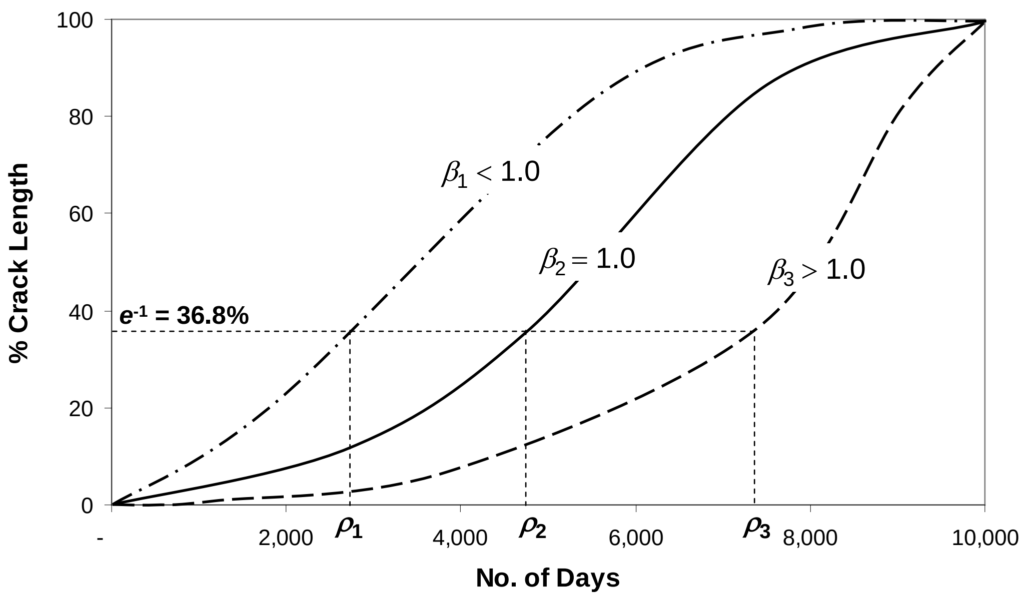

Figure K-2. Parameters in reflection cracking severity model.

Because the reflection cracking severity and amount model has a clear physical boundary condition (0 to 100 percent) and the parameters, ρ and β, have physical meanings, the s-shaped curve chosen to represent the calibration with different field data sets in this study. However, because the database used for calibration consists of the length of observed transverse crack before and after overlay at the date when the survey was performed, the variables of the original reflection cracking model were modified as follows;

$$D(N_i)\,(\%) = e^{-\left(\frac{\rho}{N_i}\right)^{\beta}} \qquad \text{(K-2)}$$

where

$D(N_i)$ = percent of reflection crack length of the maximum crack length at N_i,

i = i^{th} crack observation,

N_i = number of days after overlay, and

The percent of reflection crack length, $D(N_i)$, at each observation was calculated by dividing the observed length of transverse crack after overlay construction by the total length of transverse crack on the existing pavement surface just before overlay construction. The total crack length on an existing surface can be described as the likelihood of maximum reflection cracking length on an overlay surface. The number of days after overlay, N_i, is determined by counting the days for a given set of observations after overlay construction. Based on the field data obtained from the test sections, the parameters, ρ and β, the scale and shape parameters, were calibrated for the different observed severity levels. The three sets of the parameters are calibrated when all three severity levels are available:

- ρ_H and β_H for high severity level,
- ρ_M and β_M for medium and high severity levels, and
- ρ_L and β_L for low, medium, and high severity levels.

The calibration of the reflection cracking models were conducted based on the field data obtained from overlay test sections which have sufficient crack measurements.