

South Carolina HPMMA Index Models



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1.0 SOUTH CAROLINA HPMA INDEX MODELS

Performance index models are used to relate raw data collected in the field to an easily understood performance indicator. The following performance indexes are used as part of South Carolina Department of Transportation (SCDOT) Highway Pavement Management Application (HPMA):

- Pavement Serviceability Index (PSI) is used represent roughness
- Pavement Distress Index (PDI) is used to represent distress
- Pavement Quality Index (PQI) is used to represent an overall condition index

The HPMA Condition Index Models screen can be accessed through HPMA... Setup... Models...

Model index names, scales and calculations are all user definable. The index models used in SCDOT HPMA are shown in Figure 1.1.

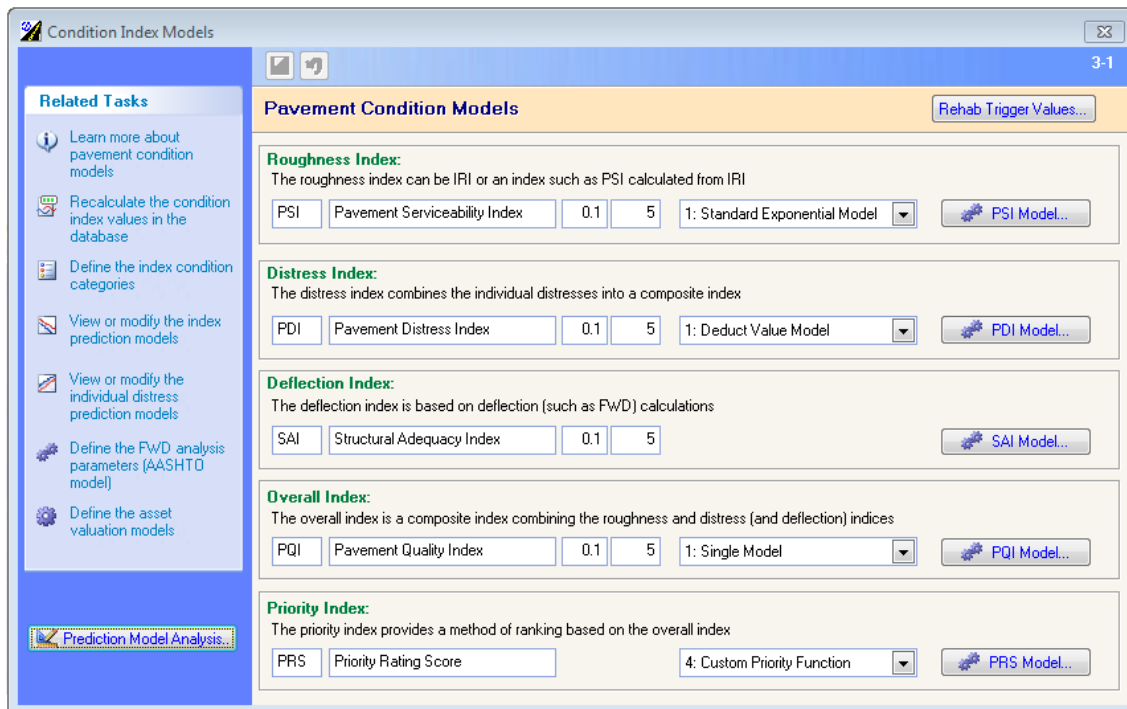


Figure 1.1: SCDOT Pavement Condition Index Models

1.1 PSI MODEL

Roughness is a measure of pavement surface distortion along the roadway. It is used to describe the ride quality of a road and to estimate the ability of the pavement to provide a safe and comfortable ride to its users. Roughness is usually evaluated objectively through field evaluation. Roughness measurement devices typically measure the longitudinal profile of the roadway, which is then used to calculate the International Roughness Index (IRI) using the device's associated software.

While IRI is a standard method for comparing roughness data, it is not always understood by road users and decision-makers in highway agencies due to the fact that it is an open ended scale and its value can change depending on the units used for the analysis. Therefore, IRI is often converted to another normalized performance indicator, which can be easily perceived by road users and decision makers alike.

For SCDOT, the PSI model converts the IRI into a scale common with other indexes. The current model form is the standard exponential model. The current equation is:

$$PSI = 5 * e^{(-0.004 * IRI)}$$

Where, 5 is the index scale, 0.0040 is the local calibration factor, and IRI is the International Roughness Index measured in in/mile.

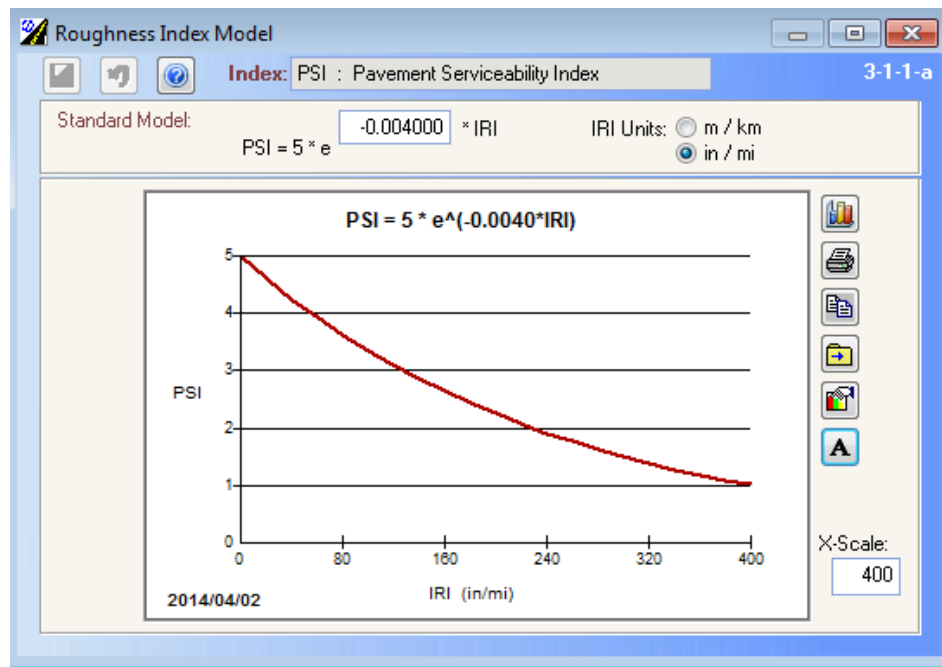


Figure 1.2: SCDOT HPMA PSI Model

1.2 PDI MODEL

The PDI model converts the individual distress measurements into a composite distress index on a scale common with other indexes.

The PDI of a pavement is assessed by identifying and rating the type, severity, and extent of surface distresses. The distresses used in the SCDOT HPMA are shown in Table 1.1. Most surface distresses for SCDOT are collected in three severity levels (low, moderate, and high), with the exception of rutting, which is measured solely based on extent (no severity level).

Table 1.1: SCDOT HPMA Distresses by Pavement Type

Bituminous (BIT) & Bituminous on Concrete (BOC)	
<ul style="list-style-type: none"> • Fatigue Cracking (FatC) • Longitudinal Cracking (LngC) • Patching (Ptch) • Raveling/Weathering (Ravl) 	<ul style="list-style-type: none"> • Rutting (RutD) • Transverse Cracking (TrnC) • <i>Transverse Crack Length (TrCL)</i>
Concrete (Jointed)	
<ul style="list-style-type: none"> • Faulting (Falt) • <i>Fault Height (Ftht)</i> • Longitudinal Cracking (LngC) • Patching (Ptch) • Water Pumping (Pump) 	<ul style="list-style-type: none"> • Punchouts (PchO) • Surface Deterioration (SrfD) • Spalling (Spal) • Transverse Cracking (TrnC) • <i>Transverse Cracking Length(TrCL)</i>
Concrete (Continuous)	
<ul style="list-style-type: none"> • Faulting (Falt) • Longitudinal Cracking (LngC) • Patching (Ptch) • Water Pumping (Pump) • Punchouts (PchO) 	<ul style="list-style-type: none"> • Surface Deterioration (SrfD) • Spalling (Spal) • Transverse Cracking (TrnC) • Transverse Crack Length (TrCL)

Derived distress; a distress that is not measured in the field, but calculated based on other distresses.

The various distresses are combined using a deduct value model. The deduct value model used for SCDOT HPMA is a modified version of the PCI Method (ASTM D 6433 Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys), which calculates a deduct value (DV) based on the type of distress and its severity and extent. The model coefficients have been modified from the ASTM standard and customized to best suit the needs of SCDOT.

The PDI incorporates the severity and density ratings for each distress and converts the data into a single distress score. The PDI starts at 5 and is then reduced by DV for each type, severity and extent of distress.

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The deduct value for a severity/extent is:

$$DV = 10^{(a+b \times \log_{10}(PDA))}$$

Where:

- DV is the deduct value for the distress / severity
- PDA = percent distressed area (or other stored extent value)
- a, b = model coefficients

Figure 1.3, Figure 1.4, and Figure 1.5 show the current individual a and b coefficients for calculating the severity / extent DVs for asphalt pavements, jointed concrete pavements, and continuous reinforced pavements, respectively.

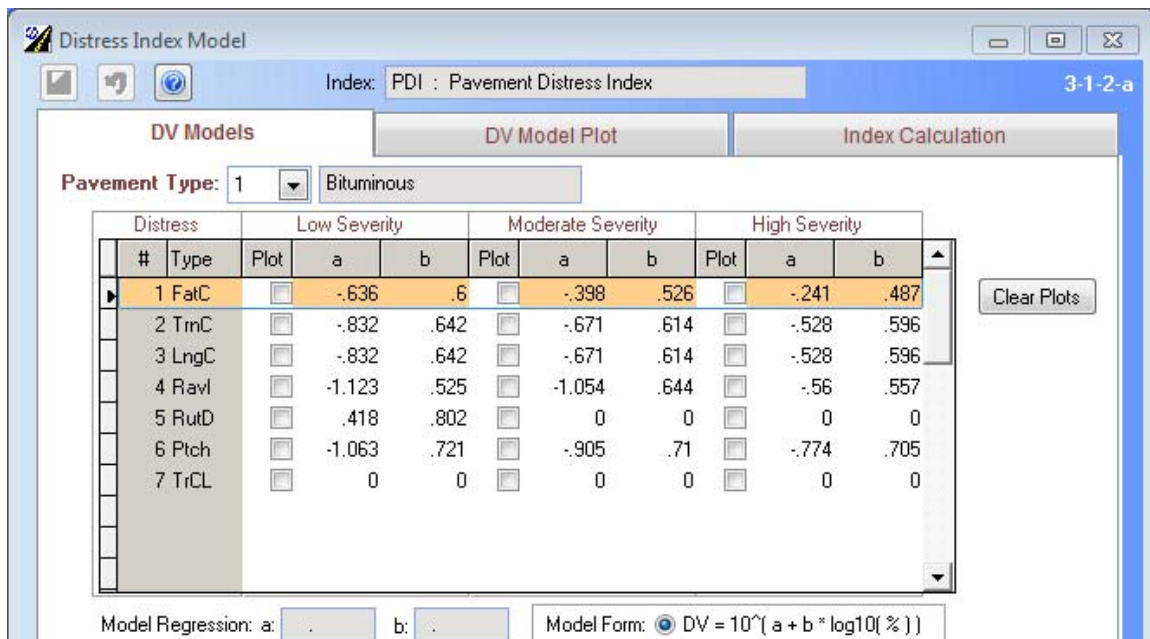


Figure 1.3: SCDOT HPMA DV Model Coefficients for Asphalt Pavements

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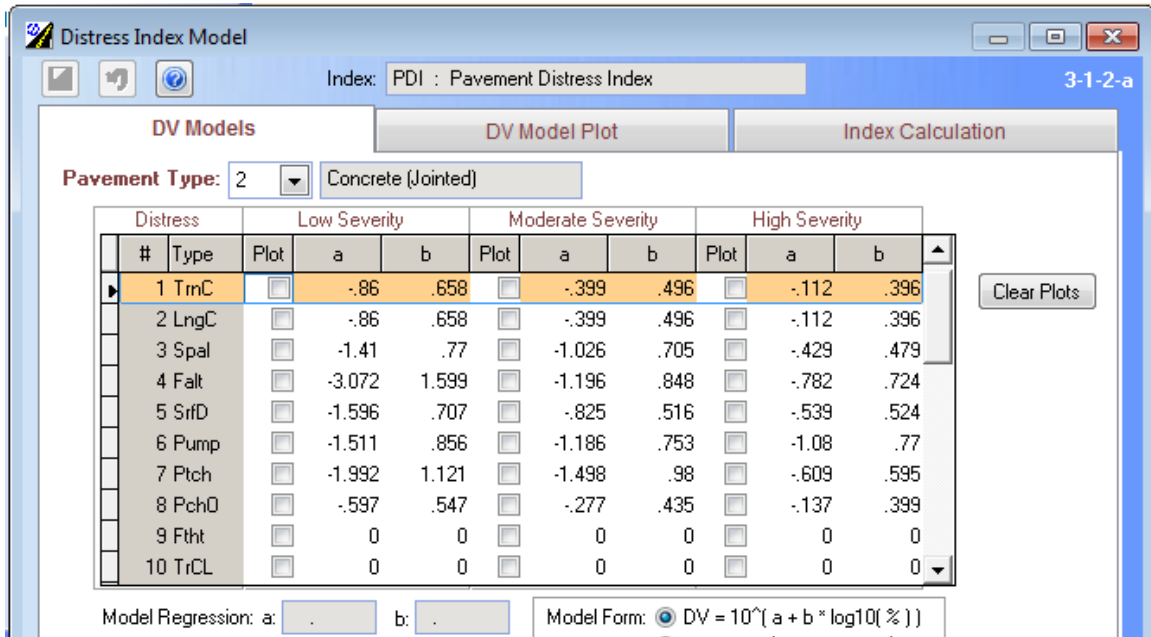


Figure 1.4: SCDOT HPMA DV Model Coefficients for Jointed Concrete Pavements

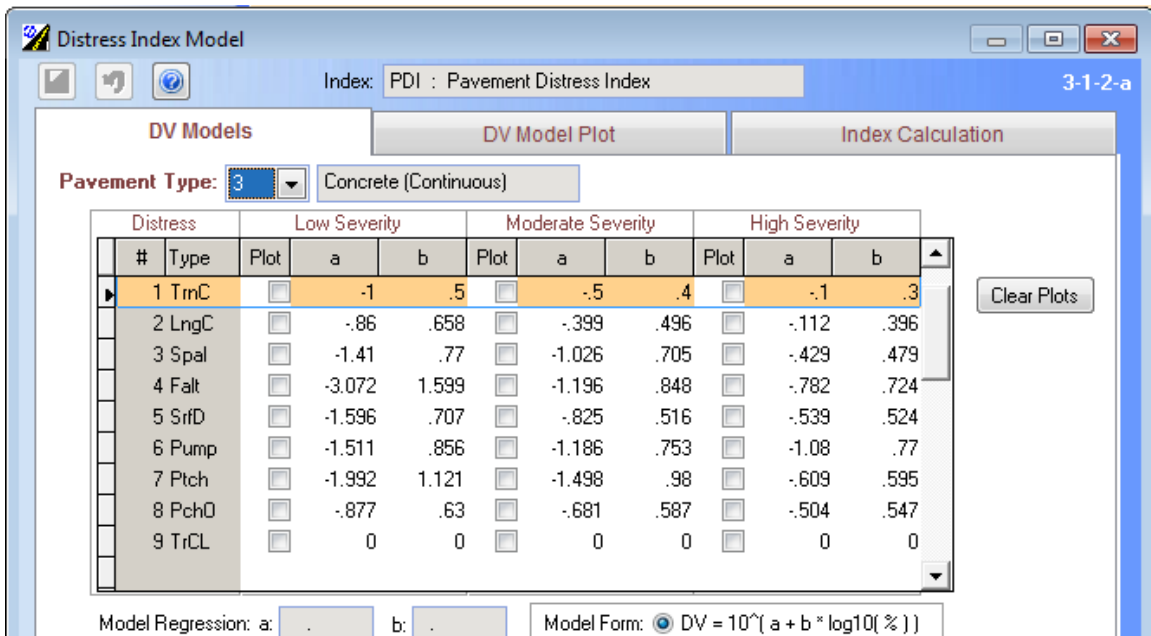


Figure 1.5: SCDOT HPMA DV Model Coefficients for Continuous Reinforced Concrete Pavements

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The Total Deduct Value (TDV) is the sum of the individual DVs.

$$TDV = \sum_i DV_i$$

The Equivalent Distress (ED) is calculated for each distress / severity as the ratio of each DV to the highest observed DV.

$$ED = \frac{DV_i}{DV_{\max}}$$

The Number of Equivalent Distresses (NED) is the sum of the individual distress / severity EDs.

$$NED = \sum \frac{DV_i}{DV_{\max}} = \frac{TDV}{DV_{\max}}$$

The Adjusted Deduct Value (ADV) is calculated from the Total Deduct Value (TDV) using the ADV-TDV model.

$$ADV = 10^{(0.0014 - 0.3958 * \text{Log}_{10}(\text{NED}) + 0.9565 * \text{Log}_{10}(\text{TDV}))}$$

The ADV-TDV model is shown in Figure 1.6 below.

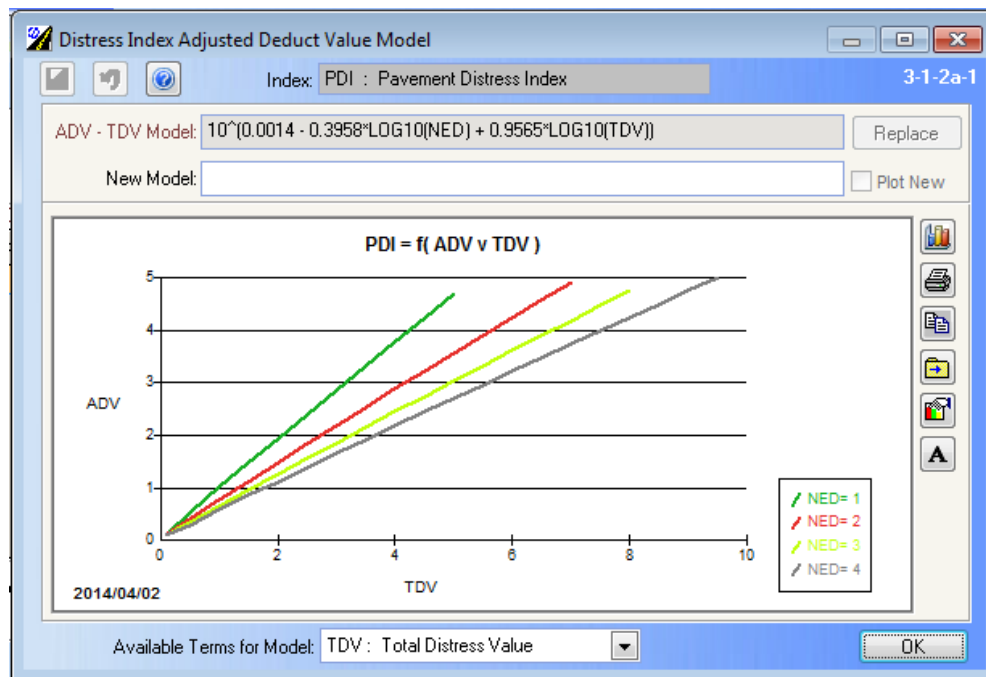


Figure 1.6: SCDOT HPMA ADV-TDV Model

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The resulting PDI is then the index scale, 5, minus the ADV.

$$PDI = 5 - ADV$$

1.3 PQI MODEL

The PQI is used to provide a single overall assessment of pavement quality. The PQI model combines the PSI and PDI into a composite overall index on a common scale.

The current model is based on a weighted geometric average:

$$PQI = PDI^{0.76} * PSI^{0.20}$$

The relationship between PQI and PDI for various PSI values is shown in Figure 1.7.

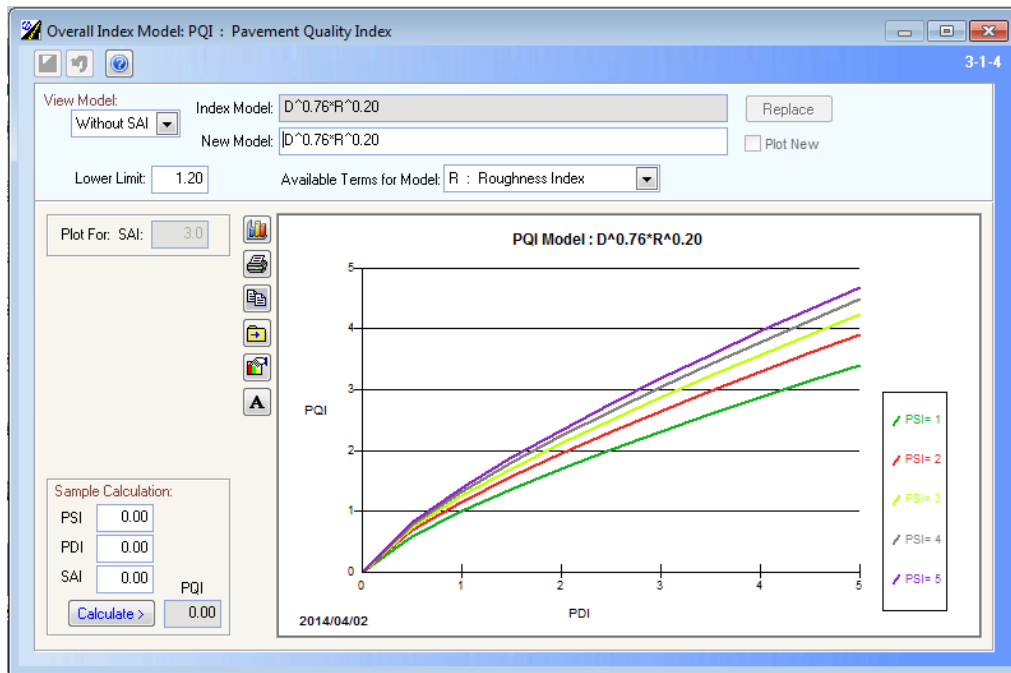


Figure 1.7: SCDOT HPMA Model