National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

Redesign & Updates of the Perpetual Pavement Design Software: PerRoad Version 4.3

RESEARCH SYNOPSIS 17-06

Background

Perpetual or long-life asphalt pavements are designed to perform longer than 50 years, requiring only periodic mill and inlay of the top layer to maintain an excellent riding surface. Many perpetual pavements have been built over the years. In 2001, the Asphalt Pavement Alliance instituted the Perpetual Pavement Award program to recognize the long life of a flexible pavement structure.

Perpetual pavement structural design relies on controlling the bending strain at the bottom of the asphalt concrete (AC) to prevent bottom-up fatigue cracking and vertical compressive strain deeper in the structure to prevent rutting of non-AC layers. The computer program, PerRoad, enables designers to consider these critical locations in the pavement cross-section and choose appropriate thicknesses and materials to achieve a perpetual pavement. PerRoad Version 1.0 was first released in 2003, and the last major update was completed in 2010 with the release of Version 3.5. These early versions relied on controlling bottom-up cracking and rutting through single threshold response values that had the potential to produce overly conservative designs. These earlier versions of PerRoad were also only capable of conducting perpetual design, while some design situations call for either conventional mechanistic-empirical (M-E) design or comparing between perpetual and conventional M-E.

New criteria recommended in recent research at the National Center for Asphalt Technology have shown to produce more optimal perpetual pavement cross-sections consistent with those found in the Perpetual Pavements Award winners (*1*) and those at the NCAT Test Track (*2*). The new criteria focus on controlling the tensile strain distribution at the bottom of the AC and a single compressive strain percentile at the top of subgrade to mitigate non-AC rutting.

Given these needs and new developments, PerRoad was redesigned to implement the new criteria and enable designers to execute conventional mechanistic-empirical pavement designs within PerRoad to compare against perpetual designs when making pavement type decisions during the design phase.

Objectives

The PerRoad software was updated to achieve the following specific objectives:

- Accommodate strain distribution criteria for fatigue cracking.
- Accommodate single strain percentile criteria for rutting.
- Implement conventional, non-perpetual, mechanistic-empirical design.

PerRoad Version 4.3

The newest release of the software, PerRoad Version 4.3 (Figure 1), fully implements the new design criteria through redesigned interfaces within the input and output program windows. These new features allow the designer to select default strain distributions based on previous studies (*1, 2*) or enter a laboratory-determined fatigue endurance limit that the program will use to compute a control strain distribution.

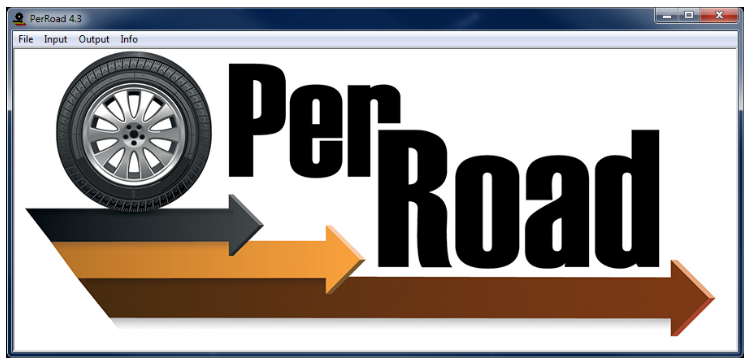

Figure 1. PerRoad 4.3 Main Window.

Figure 2 illustrates the new strain distribution input interface. The program's output window has been modified to accommodate the new design criteria. The output table in Figure 3 informs the designer of whether the criteria have been met in a simple Pass/Fail format. For example, 95% of the strains need to be less than 257 microstrain in tension (-257). For this pavement design, the response model indicates that 99% are less than 257

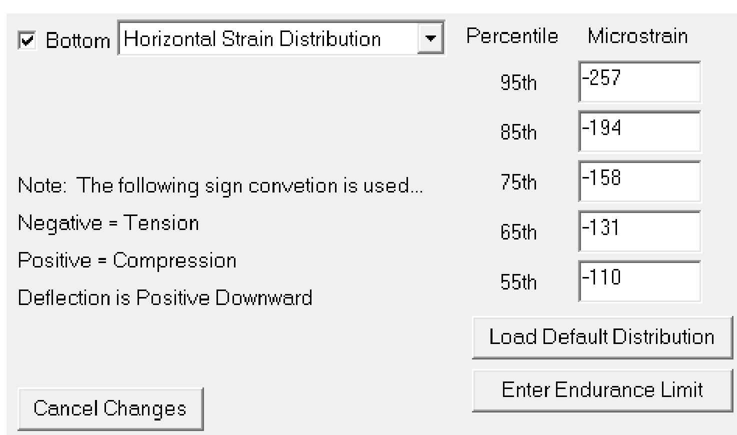

Figure 2. Strain Distribution Design Criteria.

Layer	Location	Criteria	Units	Target Value	Target Percentile	Actual Percentile	Pass/Fail?
1	Bottom	Tensile Strain	micr...	-257.	95	99.	Pass
				-194.	85	98.	Pass
				-158.	75	92.	Pass
				-131.	65	82.	Pass
				-110.	55	69.	Pass
3	Top	Vertical Strain	micr...	200.	50.	76.	Pass

Figure 3. Output Table with New Design Criteria.

microstrain, so it passes. If the pavement fails to meet the criteria or is overly conservative, then the structure can be adjusted accordingly.

Conventional M-E design was added as a new design feature to the program. This allows designers to directly compare between perpetual and conventional pavement designs. Figure 4 shows an example where the pavement becomes perpetual at 12.5 inches regardless of the traffic volume (axles/day). The M-E curve shows how the conventional design requires increasing pavement thickness with increasing traffic volume, with no upper limit. After about 400 axle groups/day, the conventional M-E design is thicker than required for this set of conditions. At less than 400 axle groups/day, the designer could evaluate the additional thickness (and cost) required to achieve perpetual status and how best to proceed.

In addition to the input and output updates in PerRoad 4.3, the software was also enhanced to provide an Excel© output formatted ready-to-print. These reports may be used when developing a pavement design project and document all inputs and outputs developed in the design process. Figure 5 illustrates the performance summary page output into Excel©.

Software Download

PerRoad Version 4.3 can be downloaded free of charge at: http://www.asphaltroads.org/perpetual-pavement/about-perpetual-pavements/

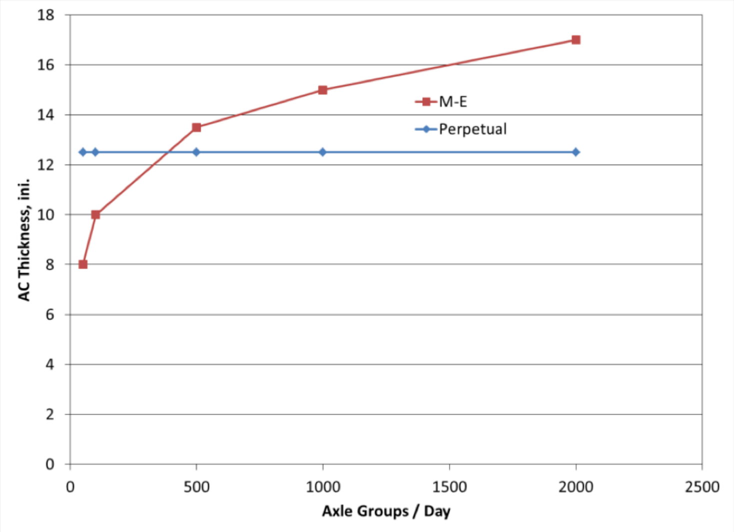

Figure 4. Conventional M-E versus Perpetual Design.

References

1. Castro, A. J., N. Tran, M. M. Robbins, D. H. Timm, and C. Wagner. Further Evaluation of Limiting Strain Criteria for Perpetual Asphalt Pavement Design. In Transportation Research Record: Journal of the Transportation Research Board, No. 2640, Transportation Research Board of the National Academies, Washington, D.C., in press, 2017.
2. Tran. N., M. M. Robbins, D. H. Timm, J. R. Willis, and C. Rodezno. Refined Limiting Strain Criteria and Approximate Ranges of Maximum Thicknesses for Designing Long-Life Asphalt Pavements. NCAT Report No. 15-05, National Center for Asphalt Technology at Auburn University, Auburn, Ala., 2015.

Perpetual Pavement Design Results: Percentile Responses

Layer	Location	Criteria	Target	Units	Target %tile	Actual %tile	Pass/Fail?
1	Bottom	Tensile Strain	-257	microstrain	95	99	Pass
			-194	microstrain	85	98	Pass
			-158	microstrain	75	92	Pass
			-131	microstrain	65	82	Pass
			-110	microstrain	55	69	Pass
3	Top	Vertical Strain	200	microstrain	50	76	Pass

Figure 5. Formatted Excel Output – Performance Summary.

Authors: Dr. David Timm, P.E.; Dr. Nam Tran, P.E.; Dr. Carolina Rodezno

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