Sensitivity of Axle Load Spectra in MEPDG for WSDOT

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Washington State Department of Transportation

Outline

- **Background**
- **Research Approach**
  - Traffic Data Preparation
  - Axle Load Spectra Development
  - Sensitivity Analysis
- **Conclusions and Recommendations**

Background

- Traffic loading input for pavement design
  - ESAL
  - Axle load spectra for MEPDG
- Research objectives
  - Develop the axle load spectra
  - Test the sensitivity of the developed axle load spectra
  - Address the need for load spectra in pavement design

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MEPDG Traffic Data

- AADTT, truck speed and annual growth rate
- General traffic inputs
  - Truck-traffic directional distribution factor
  - Lane distribution factors
  - Wheel base configurations
  - Tire characteristics
- Axle load spectra
  - Axle load distribution factors for single, tandem, tridem and quad axle types
  - Truck volume adjustment factors by month, hour and truck class

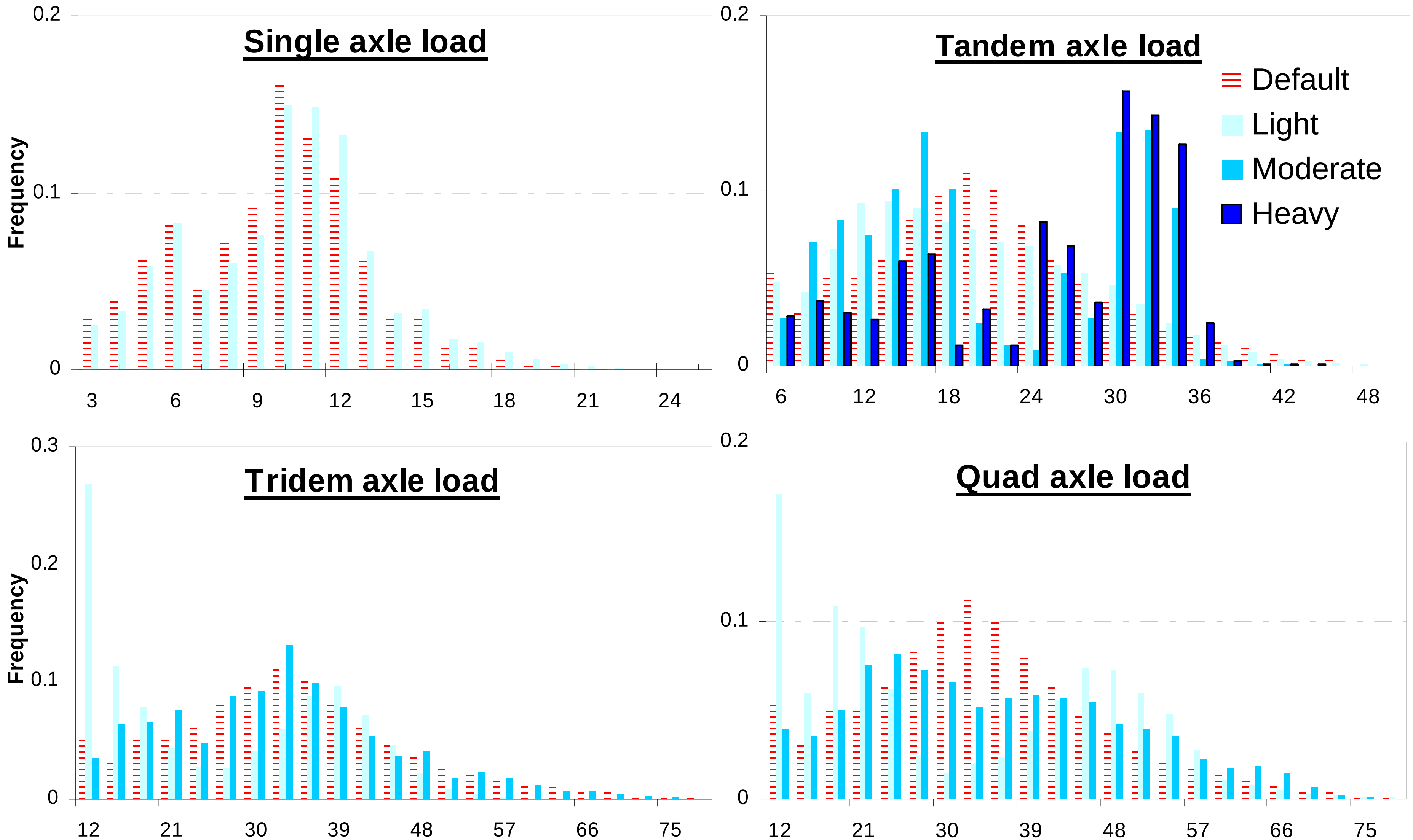
Data Preparation

- Data source
  - WSPMS
  - The WSDOT Pavement Guide
  - WSDOT WIM station data
- Data processing
  - Access
  - TrafLoad
  - MEPDG Utility Program
  - Excel

WSDOT WIM Stations

Site	SR	MP	County	AADT	Truck (%)		
					Single	Double	Train
P03	97	66.3	Wapato	11,000	3	4	1
P05	12	377	Columbia	2,200	10	11	2
P06	14	11.9	Clark	3,500	6	2	1
P07	14	17.7	Clark	6,200	6	4	1
P08	82	48.5	Yakima	24,000	5	9	2
P09	82	121	Wapato	15,000	7	15	2
P10	90	218	Adams	9,900	6	14	2
P13	195	6	Ritzville	4,800	9	7	1
P14	195	22	Whiteman	3,100	9	10	2
P15	195	87.7	Pullman	8,900	7	4	1
P17	221	13.1	Benton	1,800	6	29	9
P30	27	77.3	Spokane	6,100	8	1	0

Axle Load Distribution



(loads in kips)

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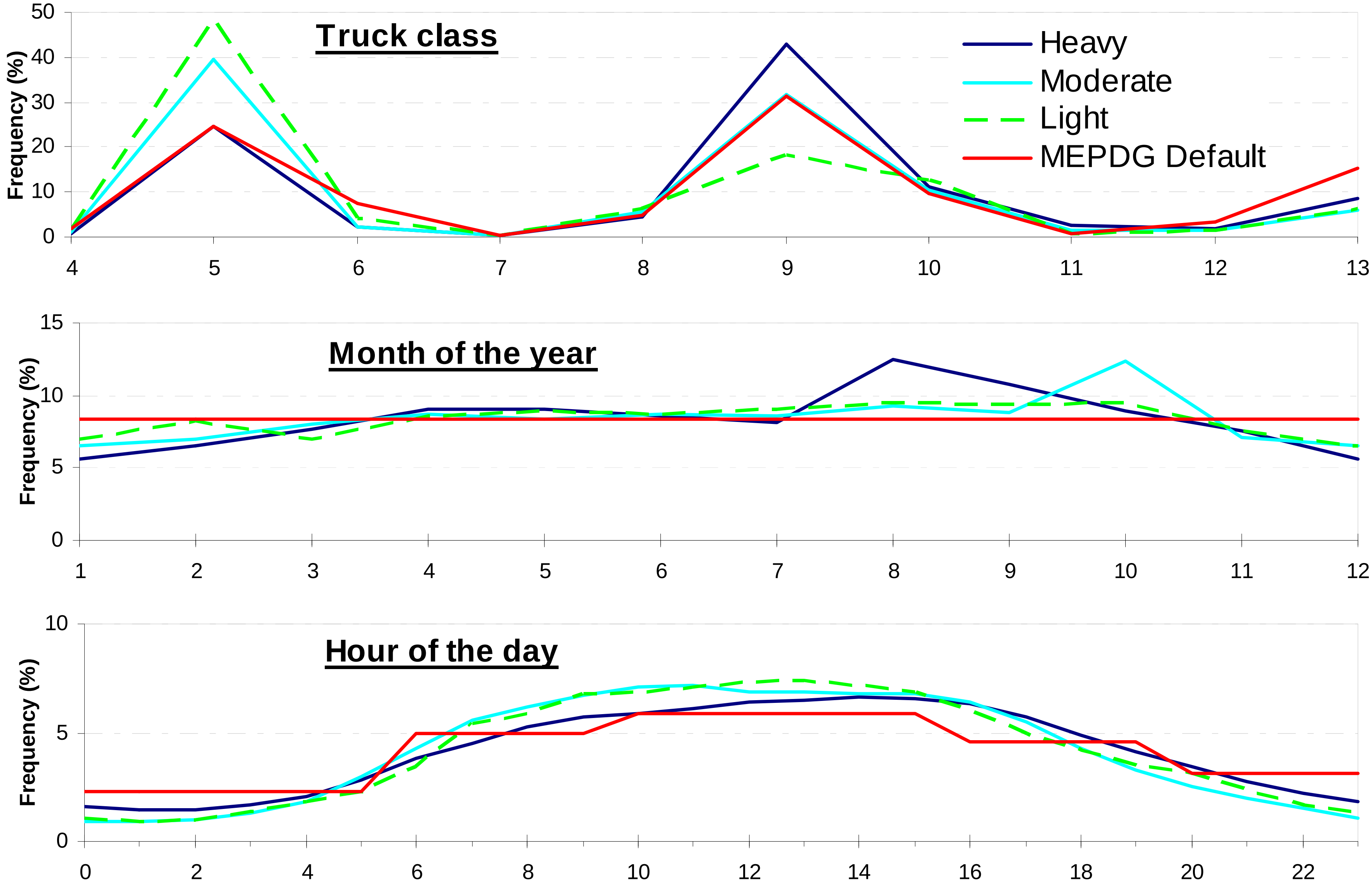
Spectra Development

- Based on the potential impacts on pavement performance, three general load spectra were presented.
  - **Light axle load spectra** with light single, tandem, tridem and quad axle load distributions.
  - **Moderate axle load spectra** with the light single axle load distribution, and moderate tandem/tridem/quad axle load distributions.
  - **Heavy axle load spectra** with the light single axle load distribution, heavy tandem axle load distribution, and moderate tridem/quad axle load distributions.

Truck Volume Adjustment Factor



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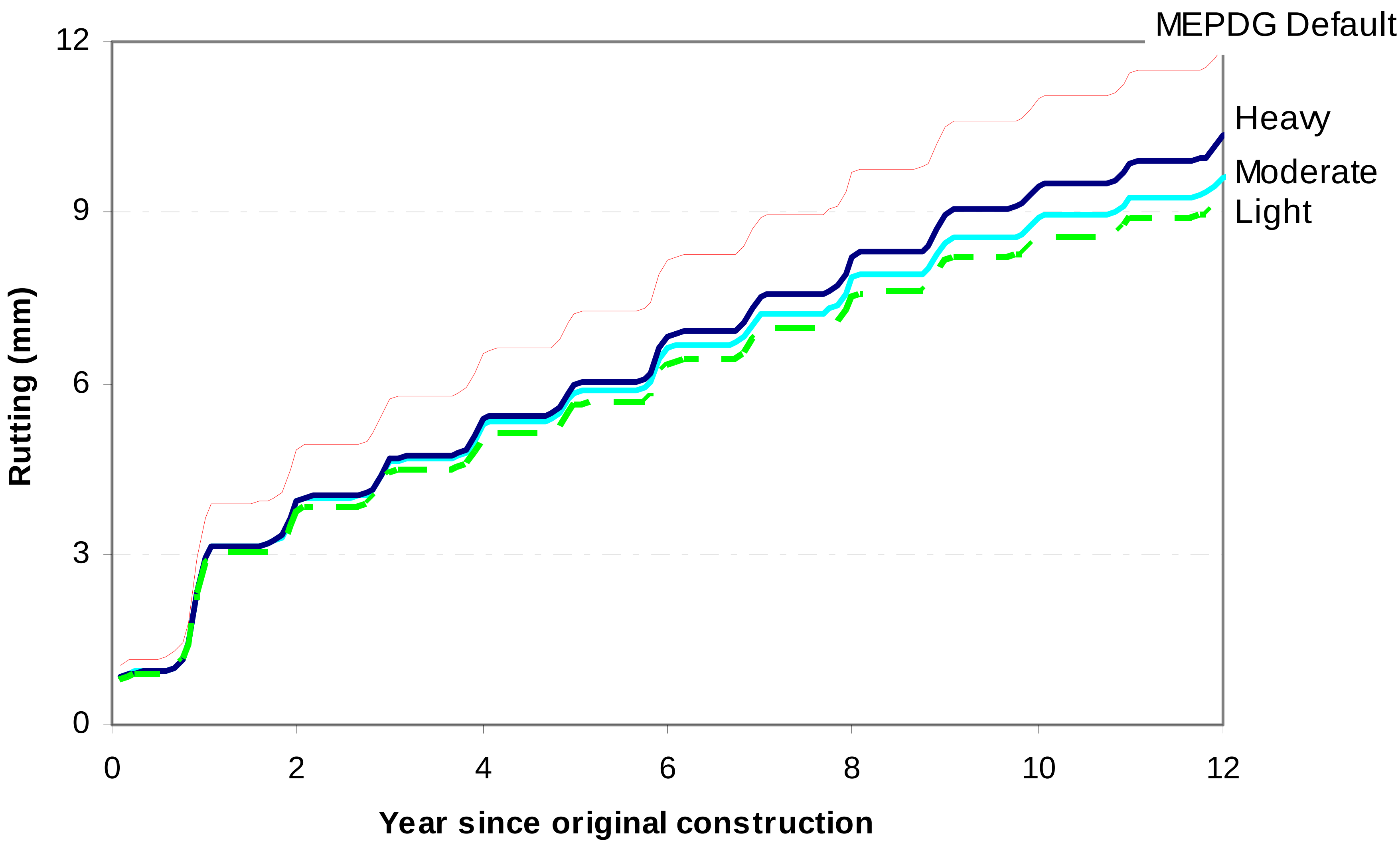
Sensitivity Analysis

- Related MEPDG pavement distresses
  - Longitudinal cracking
  - Alligator cracking
  - Rutting
  - IRI
- Three major assumptions
  - The load spectra for each axle type do not change.
  - The truck volume distributions do not change.
  - The axle numbers per truck class do not change.

Typical WSDOT Design Parameters

Design Parameters	Input Values
Surface Thickness *(inch)*	4.2, 5, 8, 12
Binder Type	PG 58-22, PG 64-28, PG 58-34
Base Type	asphalt treated, granular
Base Thickness *(inch)*	4.2, 6, 8, 12
AADTT (on design lane)	100, 1000, 2000
Annual Growth Rate	2%, 4%, 6%
Soil Type	A-4, A-5, A-7-5, A-7-6
Subgrade Modulus *(psi)*	7500, 12500, 15000, 17500
Climate	Camas, Spokan, Pullman, Seattle, Stempad pass

Rutting



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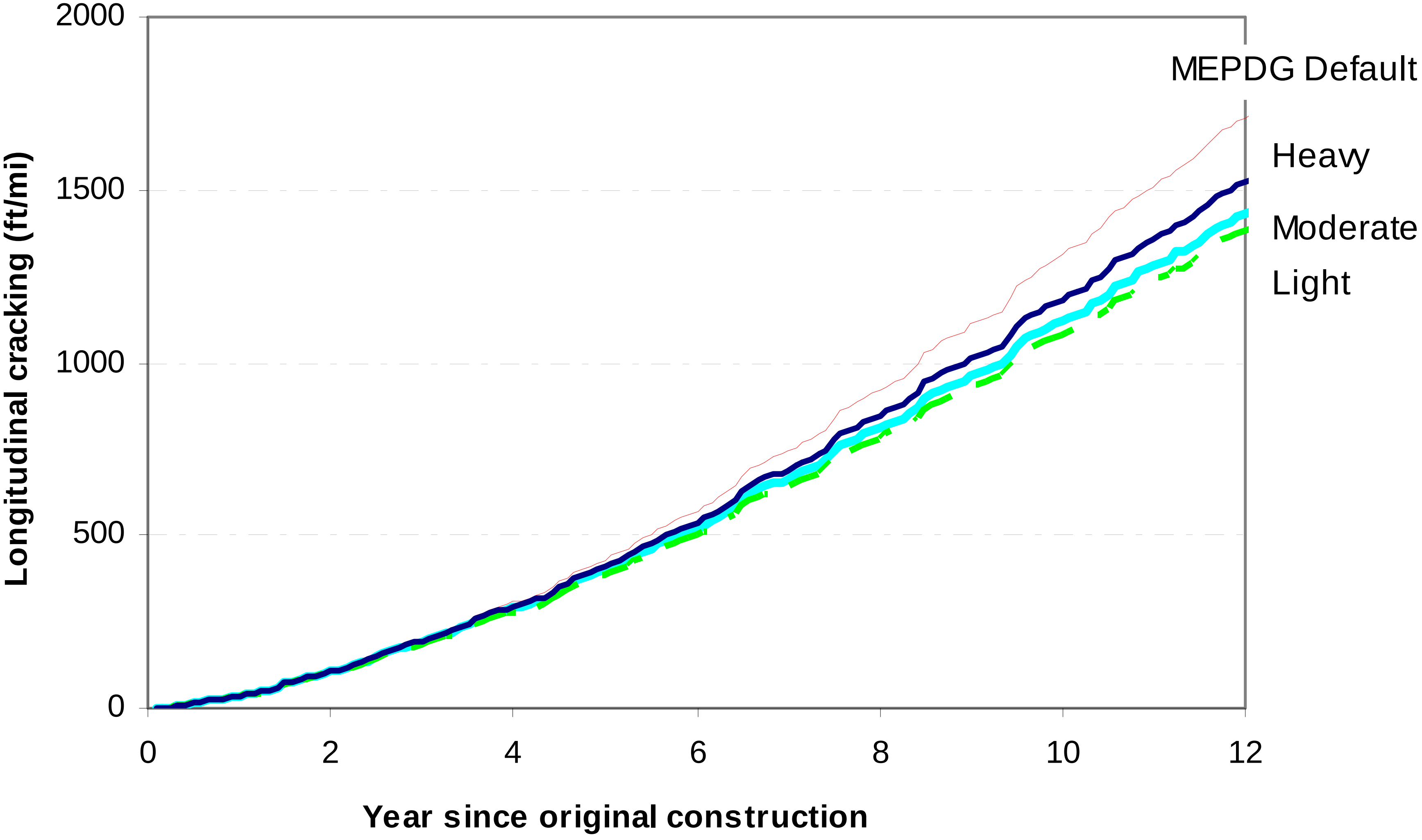
Longitudinal Cracking



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Alligator Cracking

Sensitivity Analysis

- The three developed axle load spectra have similar effects on MEPDG outputs.
  - Negligible differences on the estimated alligator cracking, longitudinal cracking and IRI.
  - Less than 2.5 mm differences of the estimated rutting.
  - No impact on transverse cracking estimation.
- The default MEPDG models predict less distresses than the actual roads.
- MEPDG outputs were more sensitive to AADTT and annual growth rate than the developed load spectra.

Special Investigations

- For roads with anticipated change of traffic loads in future, the total number of axle repetitions by axle type over the entire design life should be determined.
- For design of high-volume roads used by heavy vehicles, site-specific inputs are preferable.
- In determining the impact of heavy-loading vehicles on pavements, specific axle loads and configurations should be provided.

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Conclusions

- The typical load spectra required by MEPDG were developed for WSDOT.
- Sensitivity analysis was conducted.
  - MEPDG is only moderately sensitive to the developed axle load spectra for typical WSDOT pavement designs.
  - One group of axle load spectra can present the axle load characteristics in MEPDG.
  - WSDOT needs to calibrate the MEPDG before use.
- The developed axle load spectra were used in calibration of the MEPDG flexible portion for WSDOT.

Recommendations

- The state or region specific loading patterns will result in better designs than the MEPDG defaults.
- It is recommended to create traffic characteristics with reasonable certainty for agencies having limited truck load information.
- Calibration efforts can improve the accuracy of MEPDG estimations.