PG Binder Grade Selection for Airfield Pavements

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Advanced Asphalt Technologies, LLC

"Engineering Services for the Asphalt Industry"

Project Objective

- Develop technical guidance for PG binder grade selection for civilian & military airfields
- Consider tire pressure, channelization, load repetitions, pavement temperature, speed, depth in pavement, non-traffic areas, reliability, grade bumping, modified binders…

In a Nutshell…

Base PG grade: LTPPBind 3.1

<u>Technical Note</u>

- ***Revision of existing specification***
- ***Equivalent highways ESALs***
- ***EHEs from departures, tire pressure***
- ***Table for speed adjustments***

Final Report on NCAT/AAPTP website

<u>PMAs</u>

- ***Elastic recovery***
- ***Required in some cases***
- ***Encouraged for others***

Selecting PG Binder Grades for Airfield Pavements: Current Practice

Current Practice: PG Grades for Airfields

- P-401: Surface courses
- P-403: Base and leveling courses
- FAA Advisory Circular 150/5370-10A
- No grades higher than XX-22
- No grades higher than 76-XX
- Grade bumping in some cases according to tire pressure/aircraft weight

Grade Bumping for Tire Pressure/Stacking

- Bump only when stacking is anticipated
- Top 5 inches of pavement only
- Tire pressure 100 to 200 psi
  - Bump 1 grade
- Tire pressure > 200 psi
  - Bump 2 grades

Grade Bumping for Aircraft Gross Weight

Gross Weight, lb	Runway	Taxiway/Apron
< 12,500	---	---
12,500 to 60,000	---	1
60,000 to 100,000	---	1
> 100,000	1	2

Northwest Mountain Region PG Grade Selection

- Use local PG grade for 98% reliability, >10 million ESALS
- Bump one grade for GAW > 60,000 lb
- Bump two grades for GAW> 100,000 lb
- Table of PG grades
- Toughness/tenacity requirements for polymer-modified binders

Concern with Polymer-Modified Binders

- PMAs exhibit many desirable characteristics for use in airfield pavements
- In Europe, use of PMAs in airfield surface course mixtures is common
- Little or no research on use of PMAs in airfield pavements in US
- Questionnaire to collect information

Proposed Method

Low-Temperature Grading

- Airfields more open than highways
- Small airfields see little traffic
- Durability a problem
- Availability of alternative low-temperature grades probably limited
- Use same grade as for highway pavements

Intermediate-Temperature Grading

- Current fatigue requirement is empirical and controversial
- But, no rational basis yet available for improving it
- Durability is a concern—***FOD***
- Avoid unnecessary bumping, especially on small airfields

High-Temperature Grading

- Must consider many factors
- Increased tire pressure—to 300+ psi
- Much greater traffic wander
- Aircraft speed/stacking
- Impact, braking, turning
- Runway vs. taxiway/apron
- Mix composition & compaction

Equivalent highway ESALs

- Tire pressure
- Pass to coverage ratio (PCR)
- Mixture composition
- Lab and field compaction
- Reliability
- Design life
- Growth in traffic

Equivalent Highway ESALs

$$EHEs = \sum_{i=1}^{m} \left[\left(TP_i\right) \left(\frac{PDR_i}{PCR_i}\right) \left(N_i\right) \right] \left(COMP\right) \times$$

$$\left(LC\right) \left(FC\right) \left(REL\right) \left(Y\right) \left(1 + \frac{R}{100}\right)^{0.5Y}$$

Base Grade Selection

- ~~LTPPBind 2.1 + rutting resistivity model~~
  - ~~Existing software—but not widely used~~
  - ~~Flexible~~
  - ~~Complex~~
- ✓ LTPPBind 3.1 + MEDG models for calculation of EHEs and adjustments
  - New software
  - Consistent with MEDG *if not modified*
- *Neither system is widely used by DOTs*

Tire Pressure Adjustment

- Critical issue is relationship between stress/pressure and rutting damage
- MEDG predicts damage proportional to $(\text{tire pressure})^{2.09}$
- Analysis of flow number test data supports MEDG model—round stress exponent to 2.0

Aircraft Wander: Pass-to-Coverage Ratio

- Aircraft wander significantly greater than highway traffic
- Differences in landing gear arrangement also affects damage accumulation
- Both factors considered in pass-to-coverage ratio (PCR)
- The higher the PCR, the less damage done per pass

Aircraft Speed

- Enormous variation in aircraft speed
- Assume fast speed on central part of runways
- Taxiways and runway ends 10 mph
- Stacking varies: little or none, some, frequent
- Speed/grade adjustment based on MEDG model

Effects of Mix Composition and Construction

- HMA for highways and airfields differ significantly in composition
- Degree of compaction for airfield pavements generally higher than for highway pavements
- Both of these differences will affect rut resistance and must be considered
- Use resistivity-rutting model

For Eight Different Airport Runways…

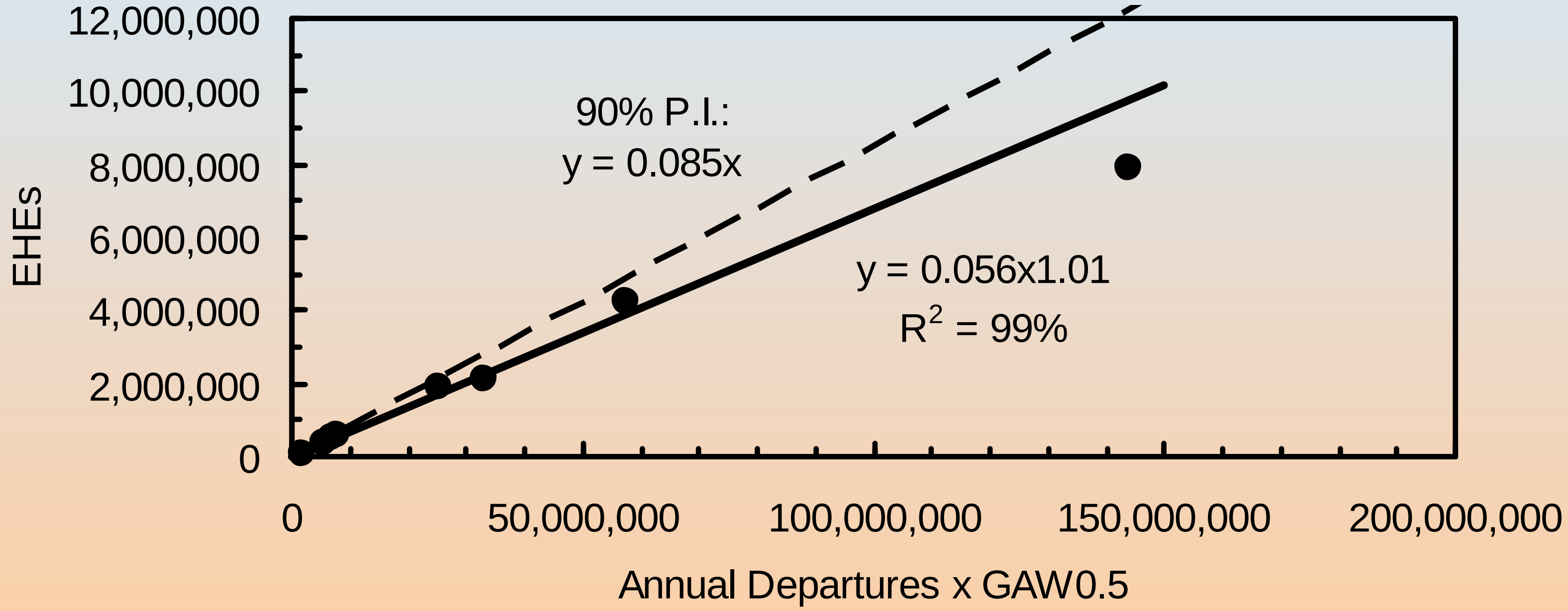
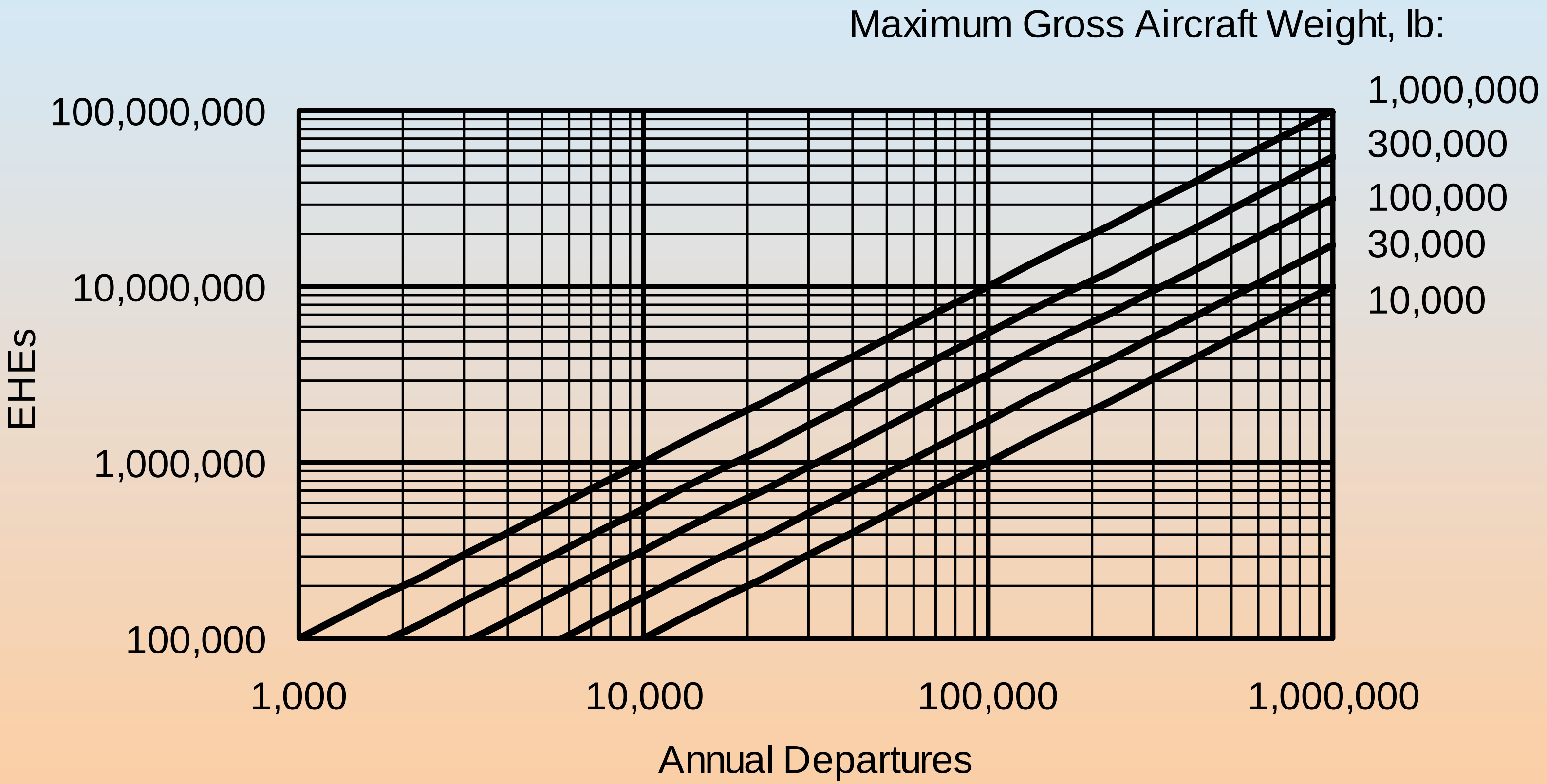


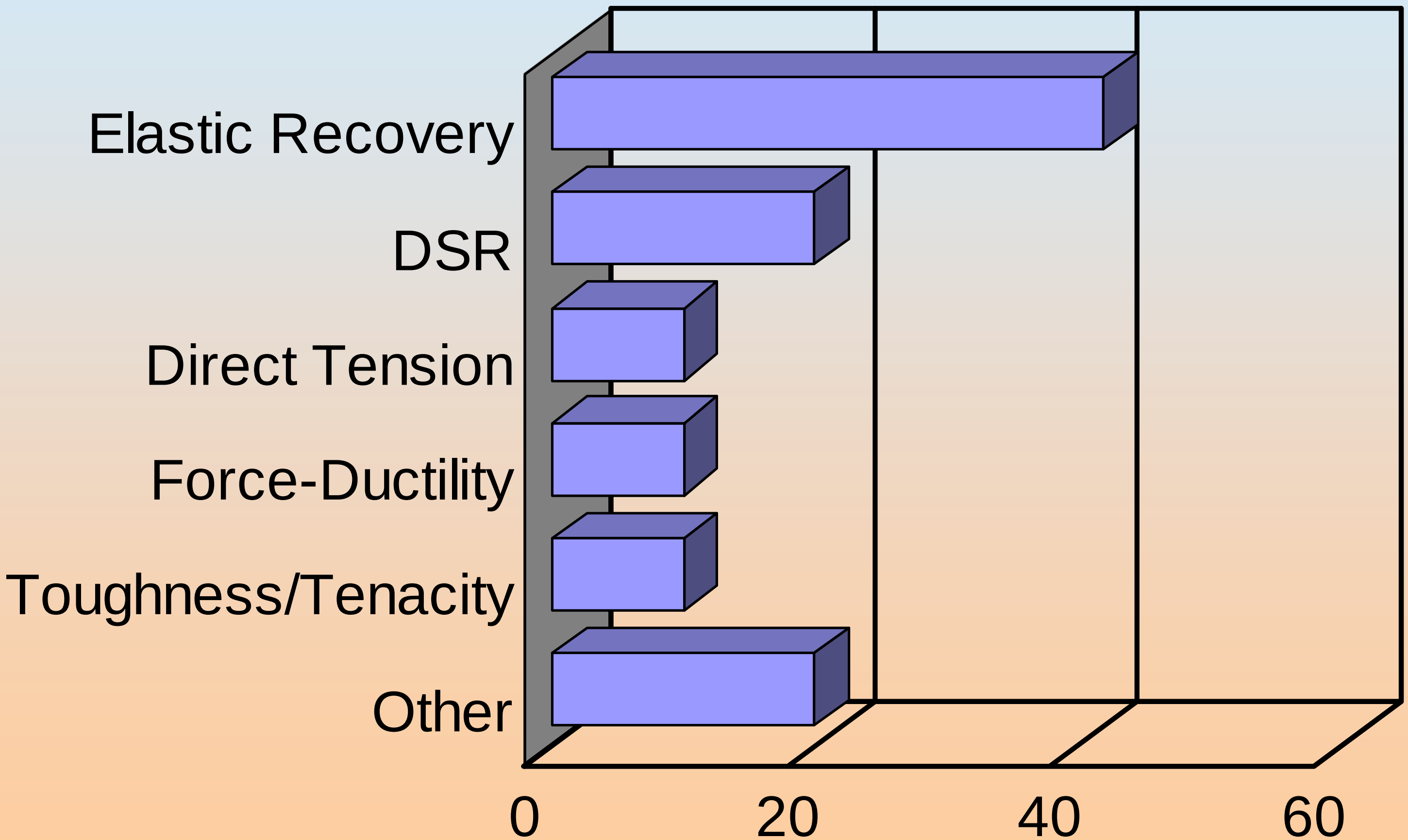
Chart for EHEs



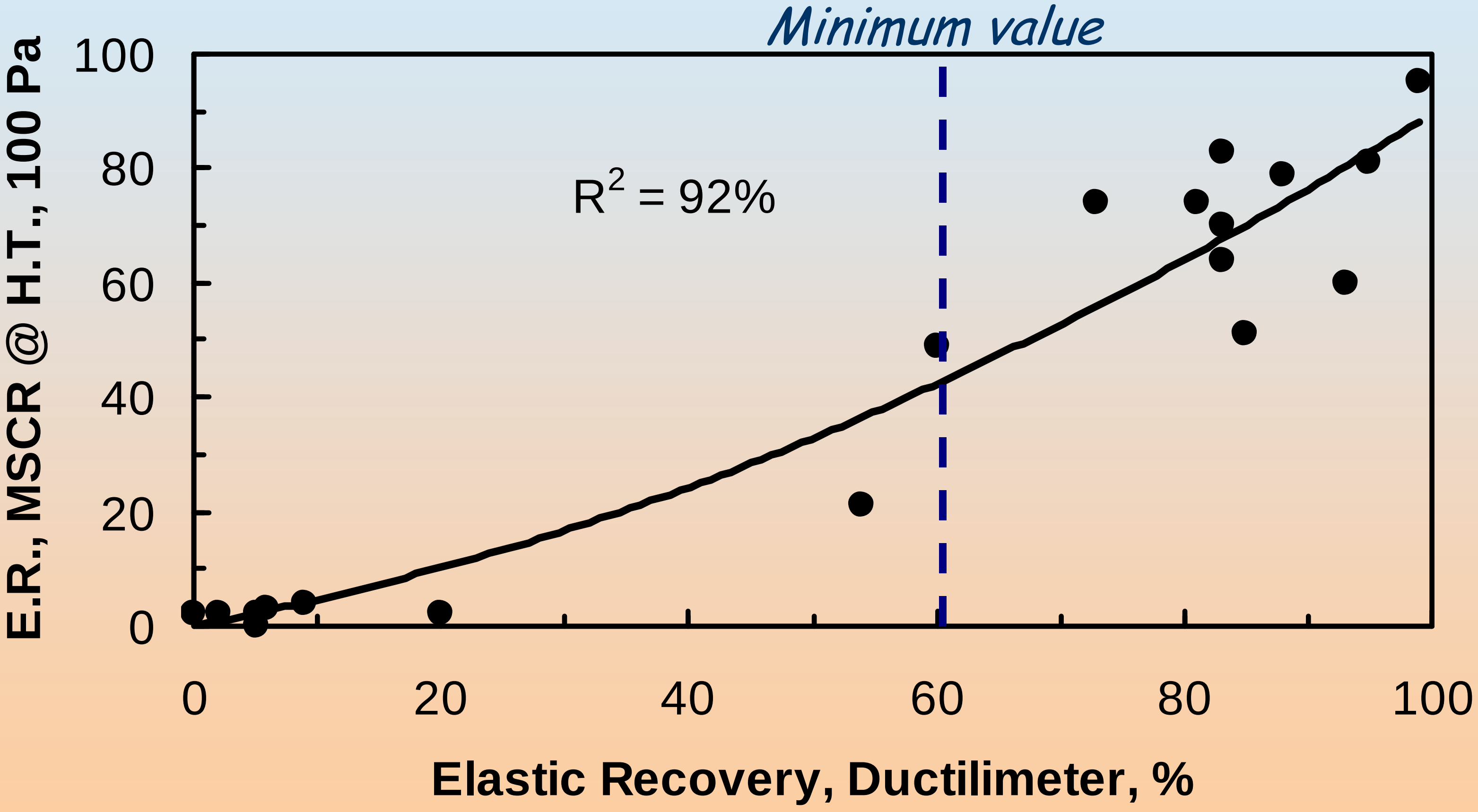
Polymer Modified Asphalts

- Many DOTs now use PG plus to address modified asphalts
- Many polymer modified asphalts exhibit performance beyond grade level
- Adjust PG grade for polymer modified asphalts meeting requirement
- Main test will be elastic recovery

Tests for Modified Binders: Superpave "Plus"



Elastic Recovery as a Temporary Surrogate for MSCR



Use of PMAs

Design Traffic Level *EHEs*	Aircraft Stacking	Polymer Modified Binder Use in HMA
< 10 million	None	No
	Some	Suggested
	Frequent	Required
≥ 10 million	None	Suggested
	Some	Required
	Frequent	Required

Note: PMAs should be specified in HMA for airfield pavements that have exhibited a history of excessive rutting unrelated to improper construction, regardless of the specific loading conditions.

PG Grades used by State Highway Departments

- Not practical for refiners to produce large numbers of PG grades
- Large number of PG grades in given region would be confusing
- Most states work with a limited “slate” of PG grades
- Spec includes list of available grades

Final Grade Adjustments

Aircraft Stacking	Typical Speed *Mph*		Design Traffic *EHEs*	Grade Adjustment ℃	
	Runway Centers	**Taxiways/ Runway Ends**		**Non-Modified Binders**	**Polymer Modified Binders***
None	≥ 45	15 to < 45	< 300,000	0	
Little or none	≥ 45	15 to < 45	300,000 to < 3 million	+7	*Not Required* +4
			3 million to < 10 million	+7	*Suggested* +4
			≥ 10 million	---	*Required* +4
Occasional	---	5 to < 15	< 10 million	+14	*Suggested* +11
			≥ 10 million	---	*Required* +11
Frequent	---	< 5	Any	---	*Required* +17

Evaluation of Proposed Method

Facility	Runway	Predicted Grade	Actual Grade
Rantoul, IL	18-36	PG 58-28	PG 58-28
Memphis, TN	9-27	PG 76-22M	PG 76-22M
Louisville KY	6-24	PG 64-22	PG 64-22
Lexington, KY	6-24	PG 64-22	PG 64-22
Houston, TX	12R-30L	PG 76-16M	PG 76-16M
Niagra Falls, NY	10L-28R	PG 64-22	PG 64-22
JFK, NY	13R-31L	PG 82-22M	PG 82-22M

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