Evaluation of Asphalt Mixture Design Framework for Airfield Pavements in Illinois

64th ILLINOIS BITUMINOUS PAVING CONFERENCE

Uthman Mohamed Ali
Imad L. Al-Qadi
Abdulgafar Sulaiman

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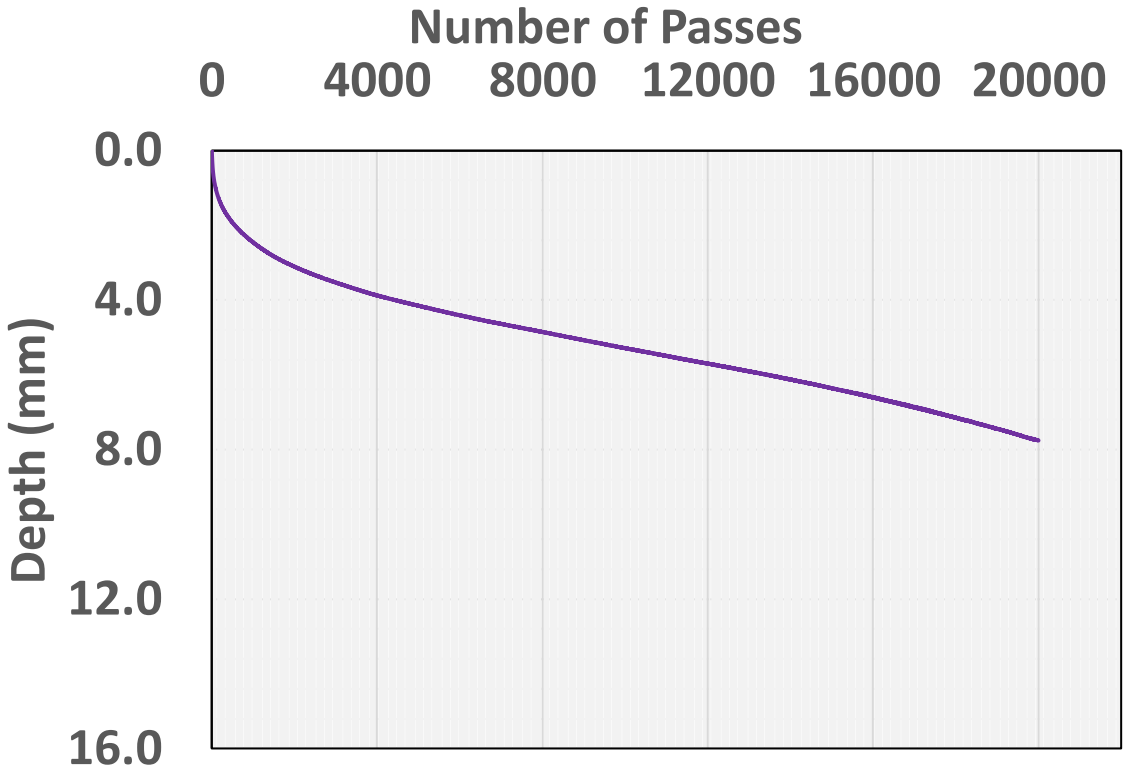
Outline

- Background
- Objectives
- Materials and Experimental Plan
- Test Results and Discussions
- Summary and Conclusions
- Recommendations

Objective and Scope

- **Objective:**
  - To develop a framework that allows extending the use of existing IDOT highway pavement surface and binder HMA to non-primary airfield pavement applications.
- **Scope:**
  - Evaluate existing IDOT-certified HMA for FAA volumetric and performance requirements.

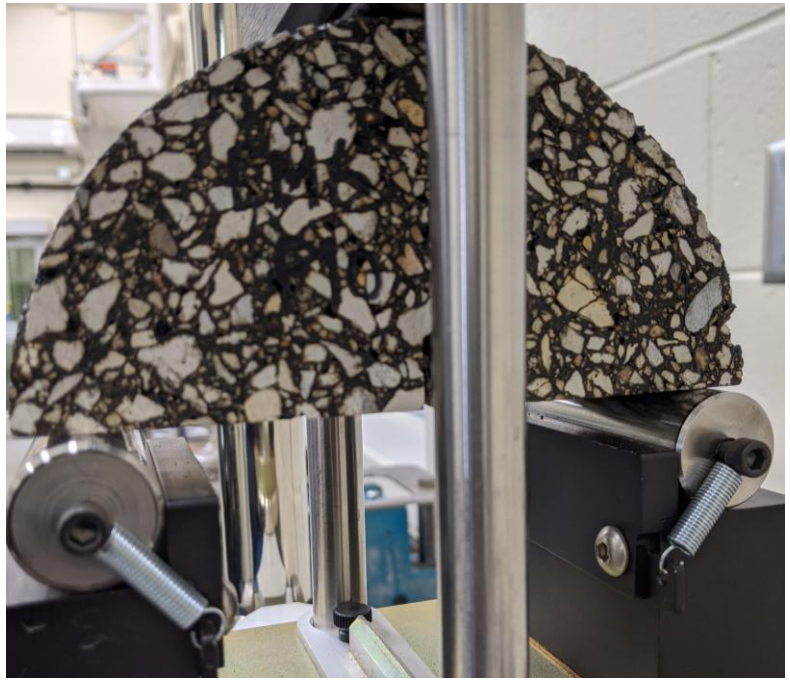
Testing Plan - HWTT

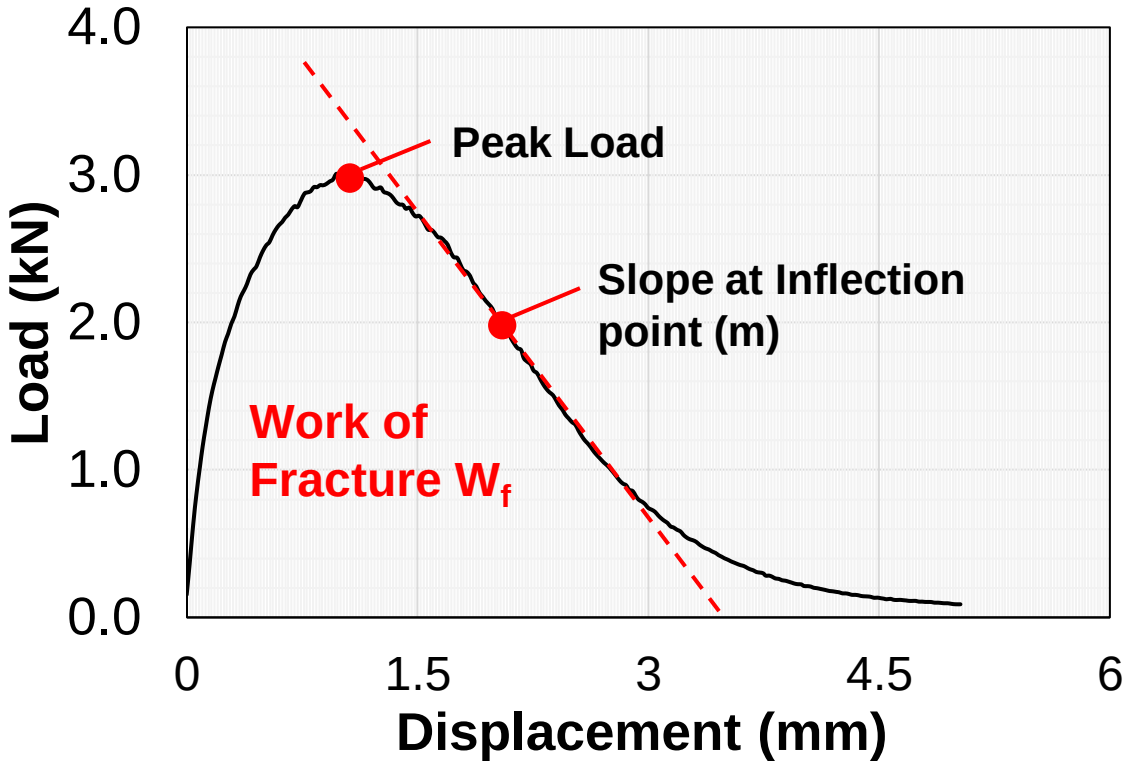


- 52 passes/min @ 50°C
- Rut depth for 12.5 mm (0.5 in)

PG 58-XX or lower	5,000 passes
PG 64-XX	7,500 passes
PG 70-XX	15,000 passes
PG 76-XX	20,000 passes

Testing Plan – I-FIT





- 25°C and 50 mm/min rate
- Fracture Energy $(G_f) = \frac{W_f}{Ligament\ area}$
- Flexibility Index $(FI) = A \times \frac{G_f}{|m|}$ where A = 0.01

Testing Plan - TSR

- Dry subset at 25°C for 2hrs
- Conditioned subset
  - 70-80% saturation
  - 24hrs in 60°C bath & 2hrs @ 25°C
- Split tensile test
  - $\mathbf{TSR} = \frac{\boldsymbol{Conditioned\ tensile\ strength}}{\boldsymbol{Unconditioned\ tensile\ strength}} \boldsymbol{x100\%}$
  - Tensile strength ≥ 60psi (neat binder)
  - TSR ≥ 0.85

Plant Surface Mixes

MIX ID	PH1	PH2^{FG}	PH3	PH4^{FG}	PA1	PA2	PA3	PA4
Design Specification	IDOT Highway	IDOT Highway	IDOT Highway	IDOT Highway	IDOT Airport	IDOT Airport	FAA	FAA
Design Gyrations	50	50	50	70	40	30	50	75
Binder PG	64-22	64-22	64-22	64-22	64-22	64-22	64-22	64-22
NMAS (mm)	9.5	9.5	9.5	9.5	9.5	9.5	12.5	9.5
Friction grade	C	C	C	C	C	D	C	C
Lithology	100% Limestone	100% Limestone	100% Limestone	100% Limestone	100% Limestone	100% Dolomite	100% Limestone	100% Limestone
Binder Content (%)	6.0	6.3	5.9	6.0	6.1	6.4	6.0	6.2
Air Voids (%)	4.0	4.0	4.0	4.0	3.0	2.0	3.5	3.5
VMA (%)	15.5	15.2	15.3	15.9	15.0	14.3	15.9	15.5
Dust/AC ratio	0.83	0.89	0.98	0.9	0.91	1.04	0.87	0.97
RAP (%)	15	15	16	10	0	0	0	0

PH: Plant Highway; **PA:** Plant Airport; **^{FG}:** Fine-graded;

Laboratory Surface Mixes

MIX ID	H1	H2	H3	H4*	H5*	A1	A2
Design Specification	IDOT Highway	IDOT Highway	IDOT Highway	IDOT Highway	IDOT Highway	IDOT Airport	IDOT Airport
Gyration	70	70	50	50	50	30	40
Binder PG	64-22	70-22	64-22	64-22	64-22	64-22	64-22
NMAS (mm)	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Friction Grade	C	D	D	D	D	C	C
Lithology	100% Limestone	50% Limestone 50% Gravel	100% Dolomite	50% Traprock 50% Limestone	100% Dolomite	100% Limestone	100% Limestone
Binder Content (%)	6.0	6.2	6.2	6.0	6.1	6.0	6.0
Air Void (%)	3.9	4.0	4.1	4.9	5.1	2.0	2.8
VMA (%)	14.9	15.2	15.2	16.2	15.9	13.3	14.5
Dust/AC ratio	0.85	0.95	0.8	0.99	1.0	0.83	1.1
RAP (%)	15	16	15.5	18	15.5	0	0

H: Highway; **A:** Airport; ***:** Superpave 5;

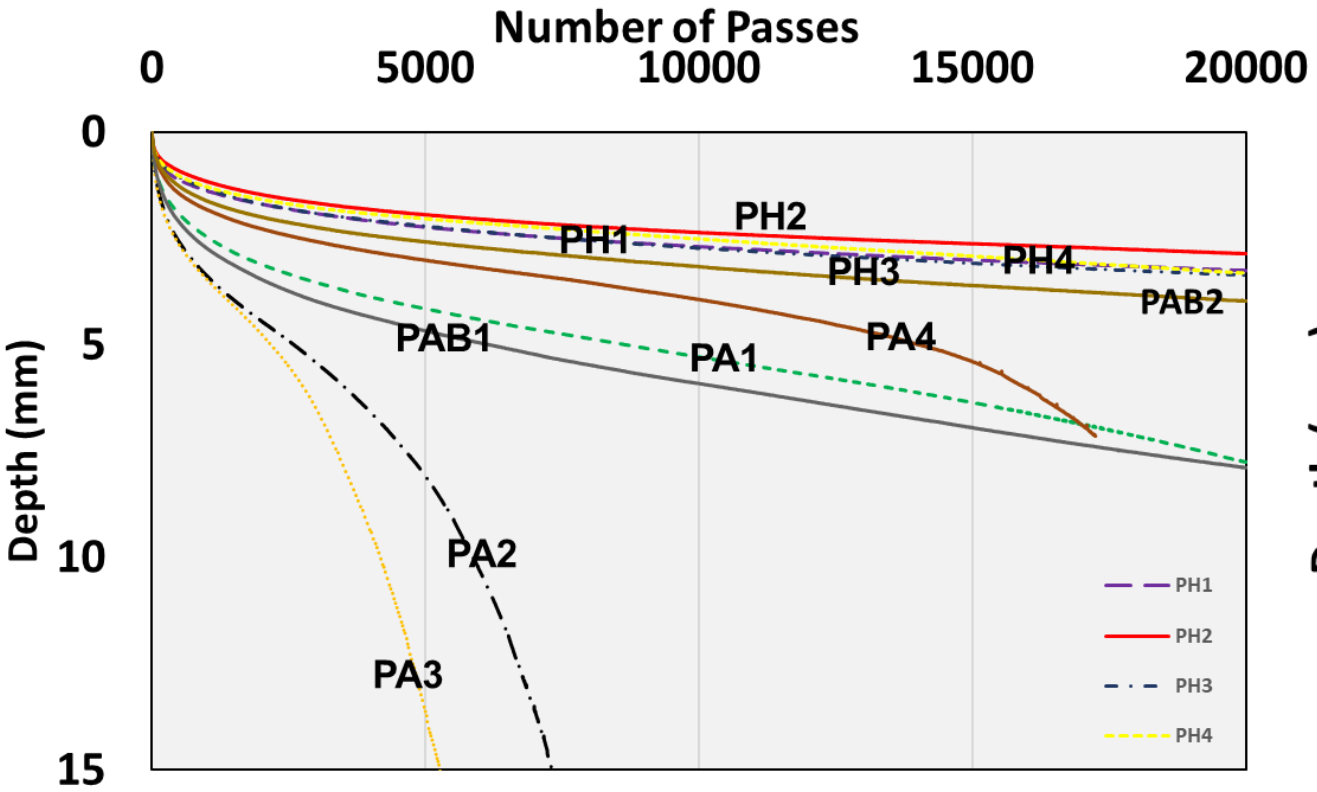
Binder Mixes

MIX ID	AB1	PAB1	PAB2
Design Specification	IDOT Airport	IDOT Airport	FAA
Gyration	30	30	75
Binder PG	64-22	64-22	64-22
NMAS (mm)	19.0	19.0	19.0
Friction Grade	N/A	N/A	N/A
Lithology	50% Limestone 50% Gravel	100% Limestone	100% Limestone
Binder Content (%)	6.0	6.2	5.7
Air Void (%)	3.9	4.0	3.5
VMA (%)	14.9	15.2	14.3
Dust/AC ratio	0.85	0.95	1
RAP (%)	15	16	20

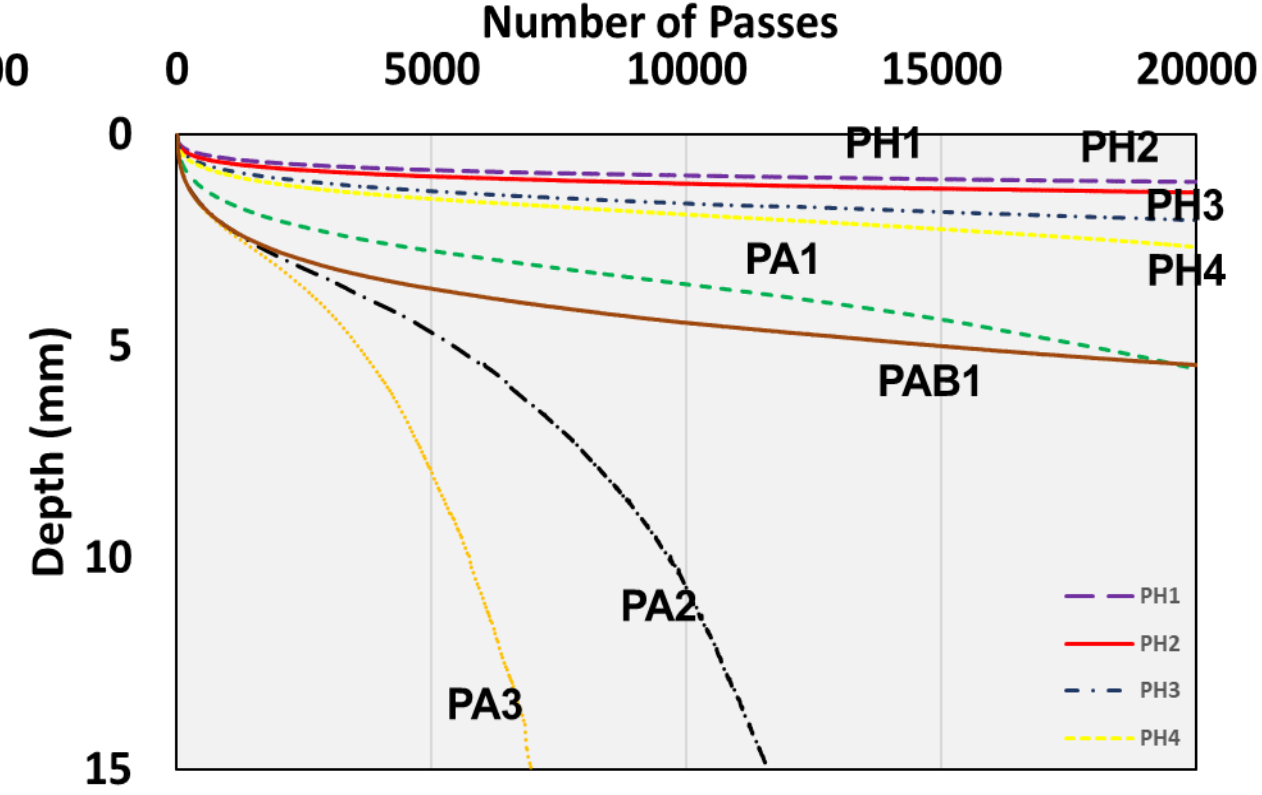
AB: Airport binder; **PAB:** Plant airport binder

Test Results- HWTT (Plant Mixes)

7.0% AV



4.0% AV



PH: Plant highway surface; **PA:** Plant airport surface; **PAB:** Plant airport binder

Test Results- HWTT (Plant mixes)

7.0% AV

Mix	# Passes	Rut depth (mm)	Passes to 12.5 mm
PH1	7,500	2.5	>20,000
PH2	7,500	2.2	>20,000
PH3	7,500	2.5	>20,000
PH4	7,500	2.3	>20,000
PA1	7,500	4.7	>20,000
PA2	**7,500**	**Failed (17.6)**	**6,244**
PA3	**7,500**	**Failed**	**4,768**
PA4	7,500	3.4	>20,000
PAB1	7,500	5.4	>20,000
PAB2	7,500	2.9	>20,000

4.0% AV

Mix	# Passes	Rut depth (mm)	Passes to 12.5 mm
PH1	7,500	0.9	>20,000
PH2	7,500	1.1	>20,000
PH3	7,500	1.5	>20,000
PH4	7,500	1.7	>20,000
PA1	7,500	3.2	>20,000
PA2	**7,500**	**6.7**	**10696**
PA3	**7,500**	**Failed (17.5)**	**6,426**
PAB1	7,500	4.1	>20,000

PH: Plant highway surface; **PA:** Plant airport surface; **PAB:** Plant airport binder

Test Results- HWTT (Lab mixes)

7.0% AV

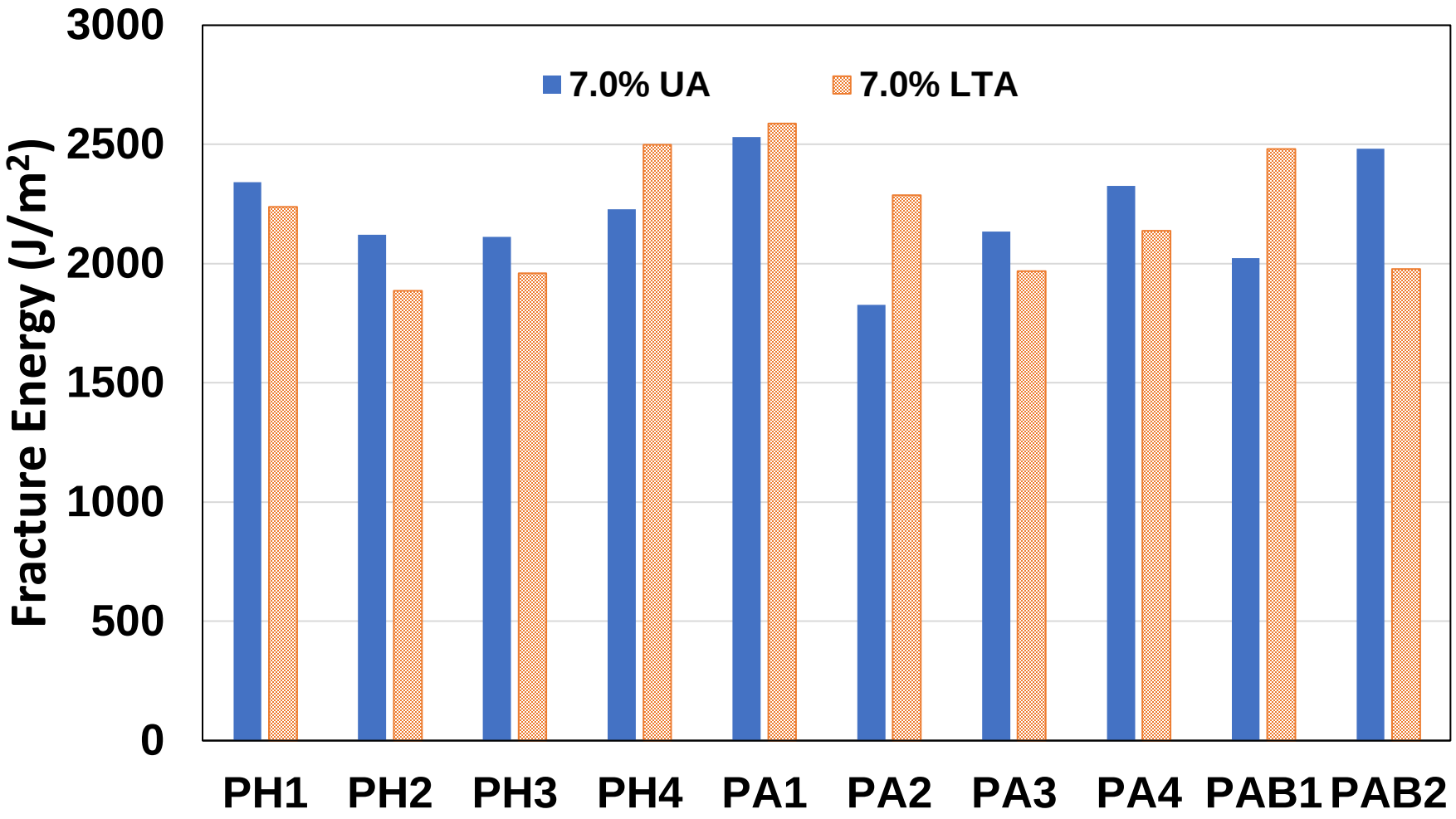
Mix	# Passes	Rut depth (mm)	Passes to 12.5 mm
H1	7,500	6.1	10,920
H2	15,000	4.7	>20,000
H3	7,500	6.4	13,560
H4*	7,500	4.8	15,926
H5*	7,500	5.0	14,492
A1	**7,500**	**Failed (>15)**	**4,608**
A2	**7,500**	**Failed (>15)**	**3,170**
AB1	7,500	5.6	>20,000

4.0% AV

Mix	# Passes	Rut depth (mm)	Passes to 12.5 mm
H1	7,500	1.2	>20,000
H2	15,000	4.0	>20,000
H3	7,500	4.6	13,742
H4*	7,500	3.0	>20,000
H5*	7,500	3.4	15,938
A1	**7,500**	**Failed (>15)**	**6,353**
A2	**7,500**	**Failed (>15)**	**4,894**
AB1	7,500	2.5	>20,000

H: Highway surface; **A:** Airport surface; **AB:** Airport binder;

Test Results- I-FIT (Plant Mixes)



PH: Plant highway surface; P**A:** Plant airport surface; **PAB:** Plant airport binder

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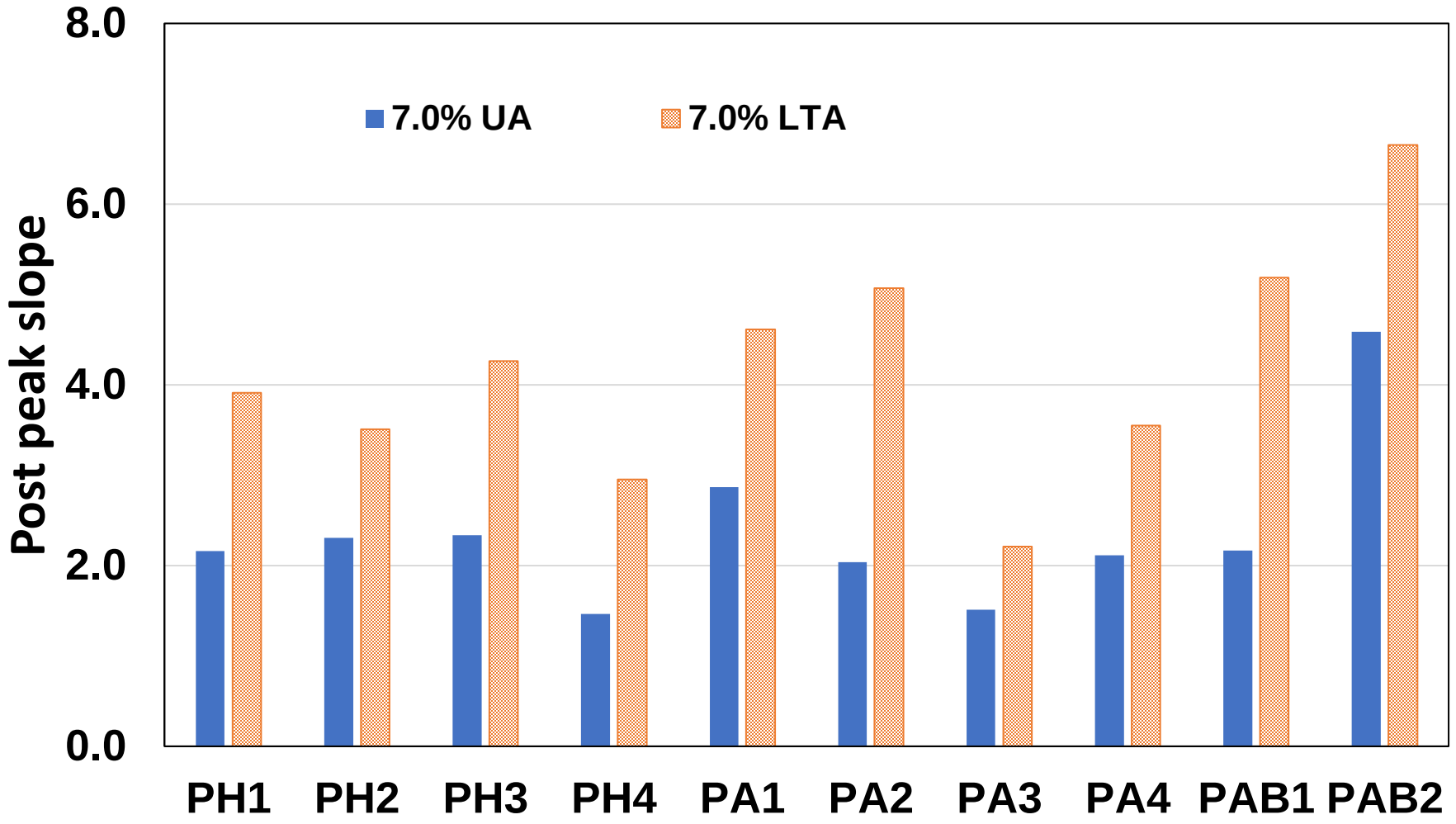

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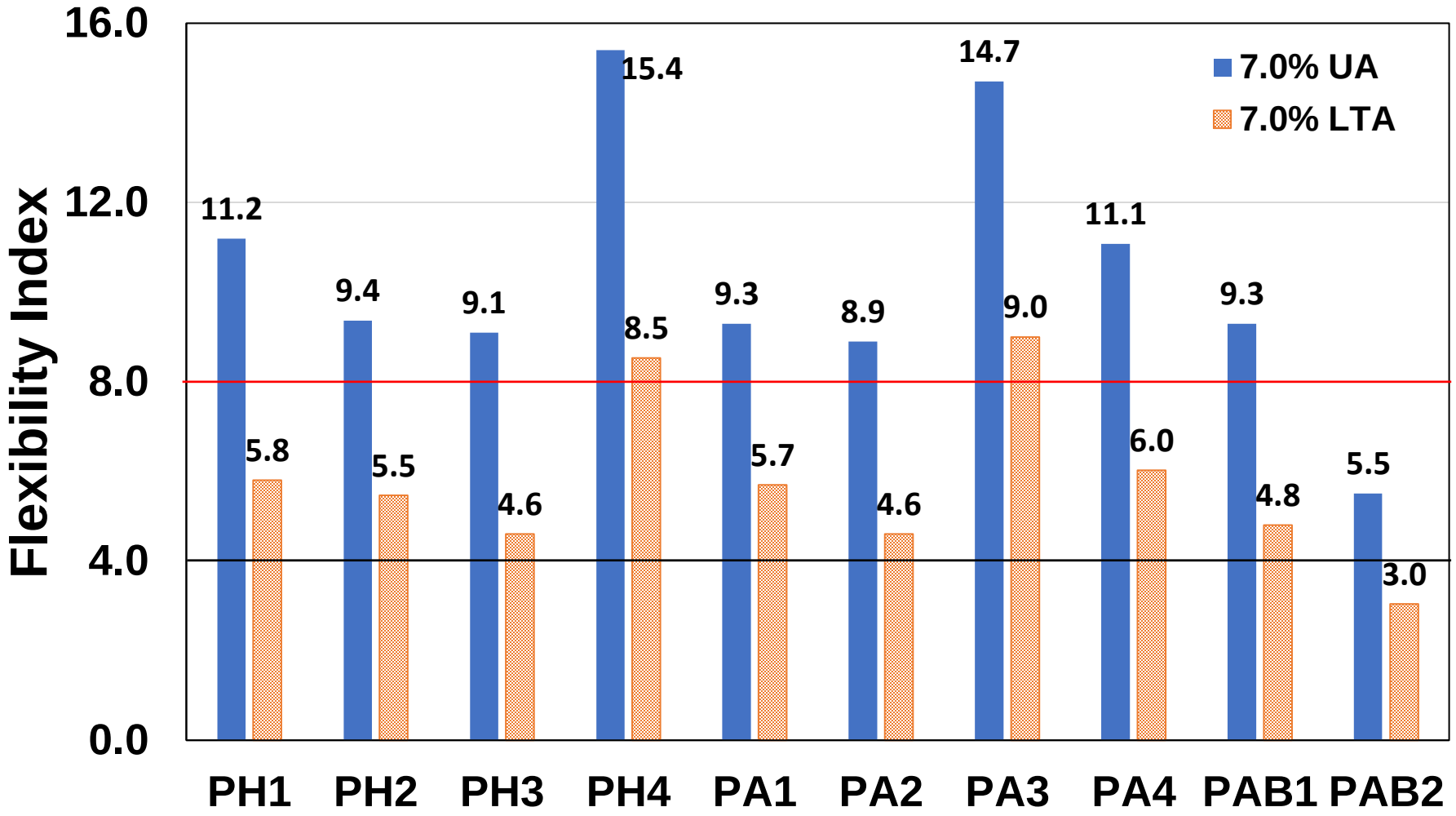

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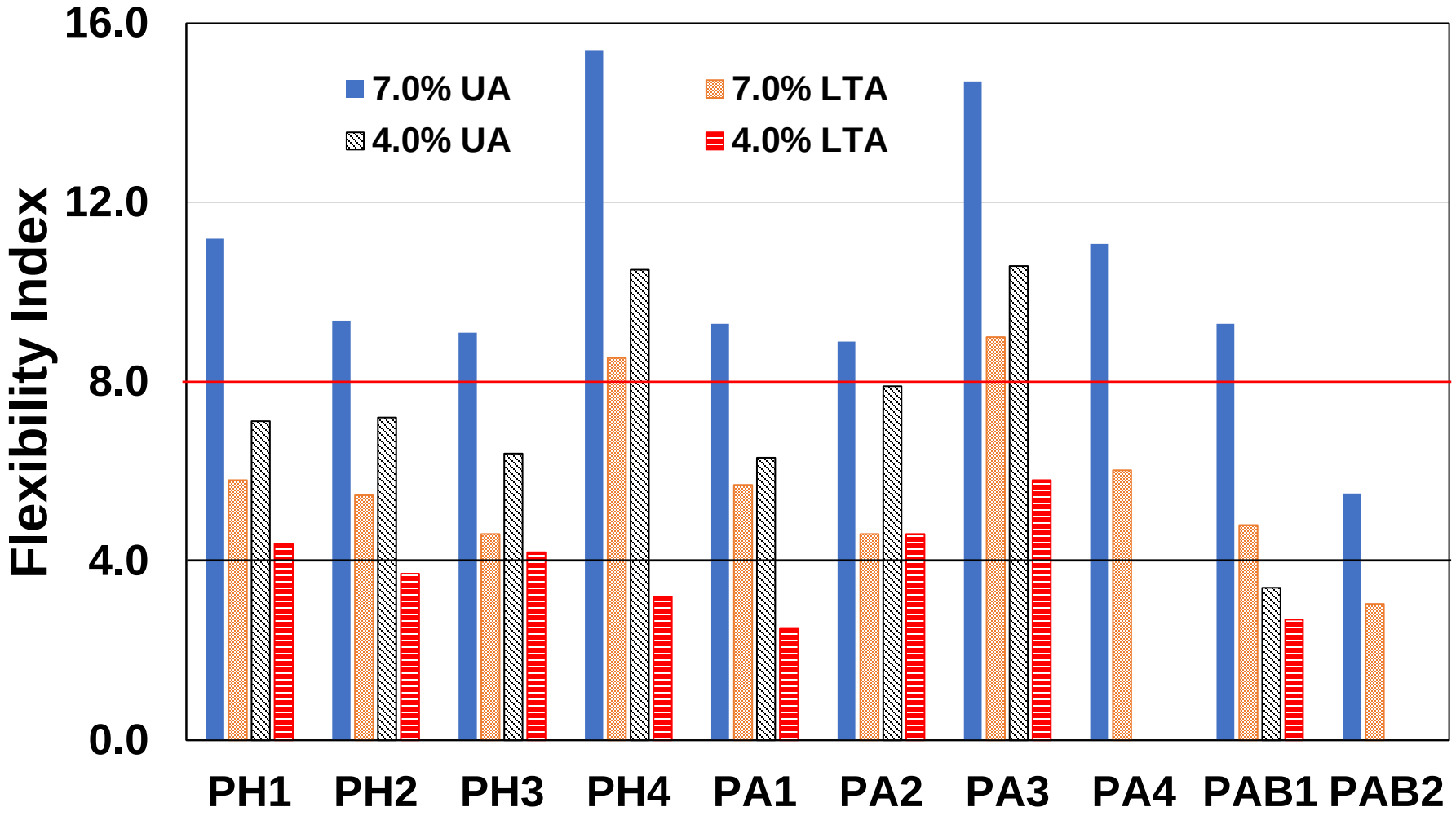
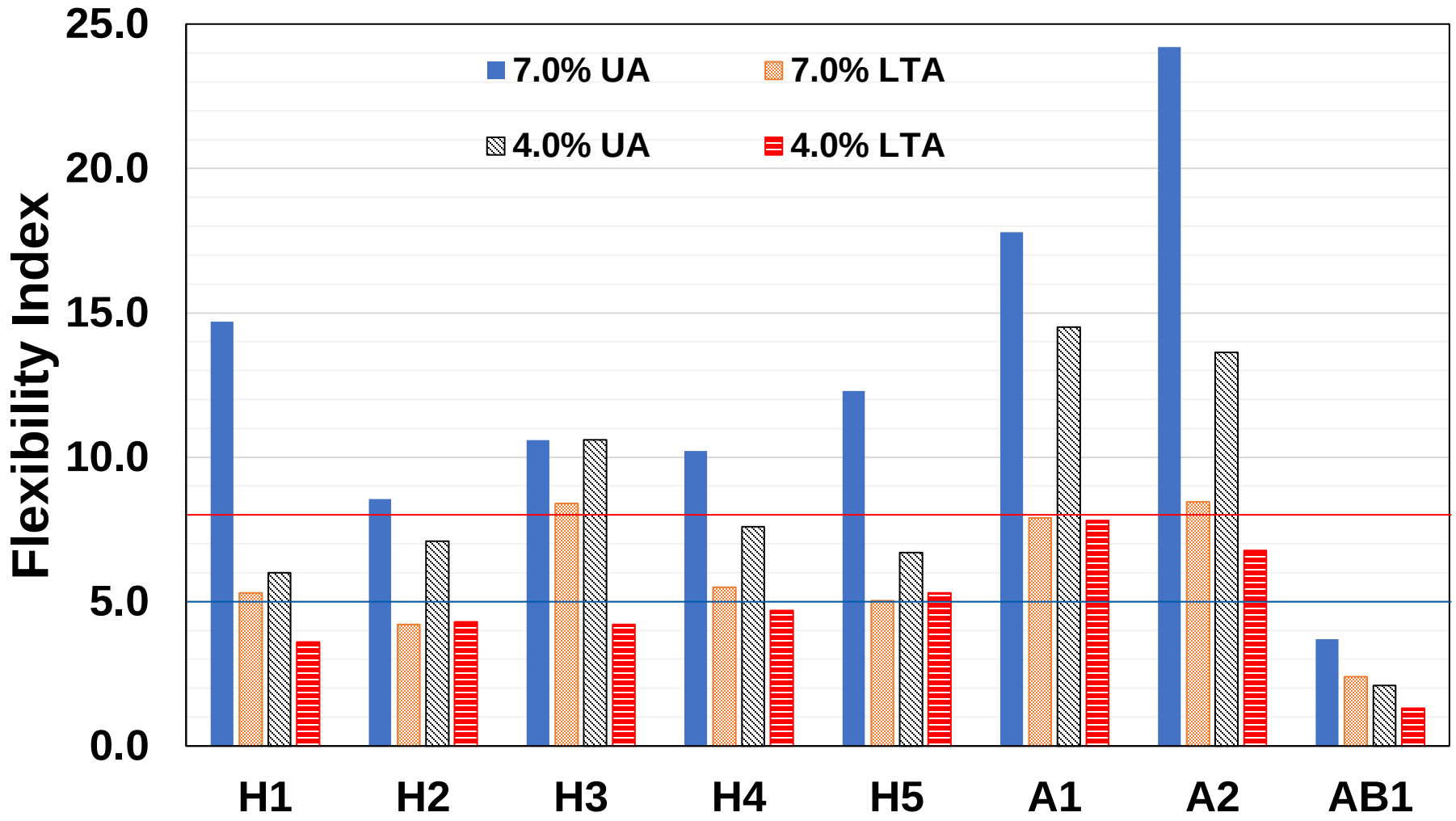
Test Results- I-FIT (Plant Mixes)



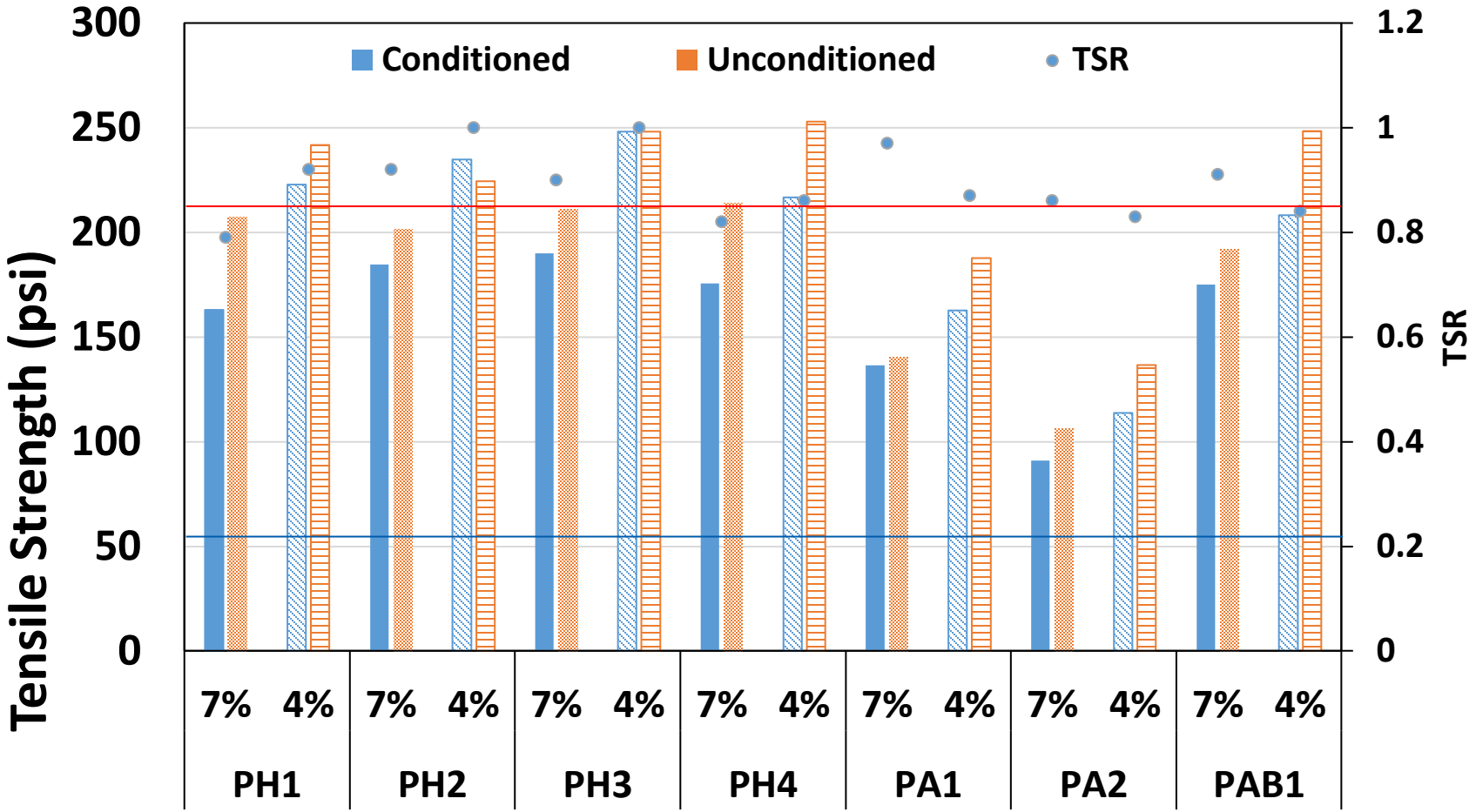
PH: Plant highway surface; P**A:** Plant airport surface; **PAB:** Plant airport binder

Test Results- I-FIT (Lab Mixes)



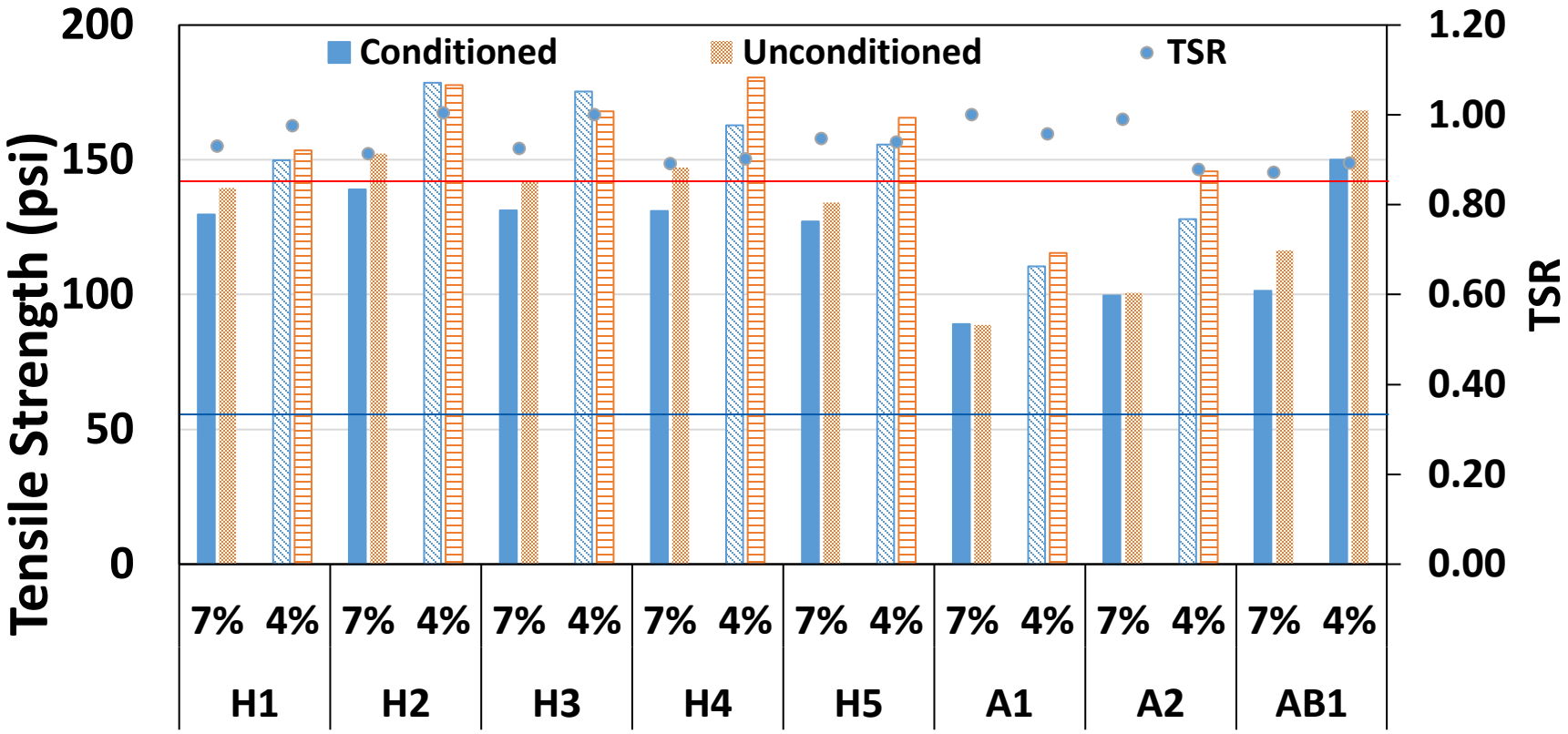
H: Highway surface; **A:** Airport surface; **AB:** Airport binder;

Test Results - TSR (Plant Mixes)



PH: Plant Highway PA: Plant airport

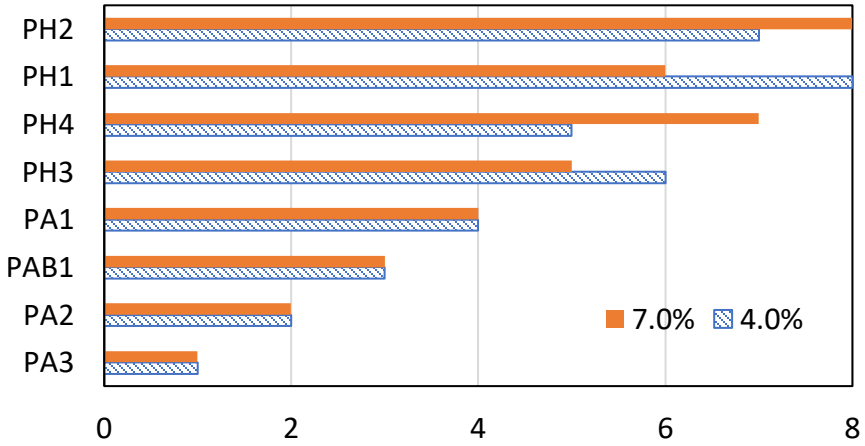
Test Results - TSR (Lab Mixes)



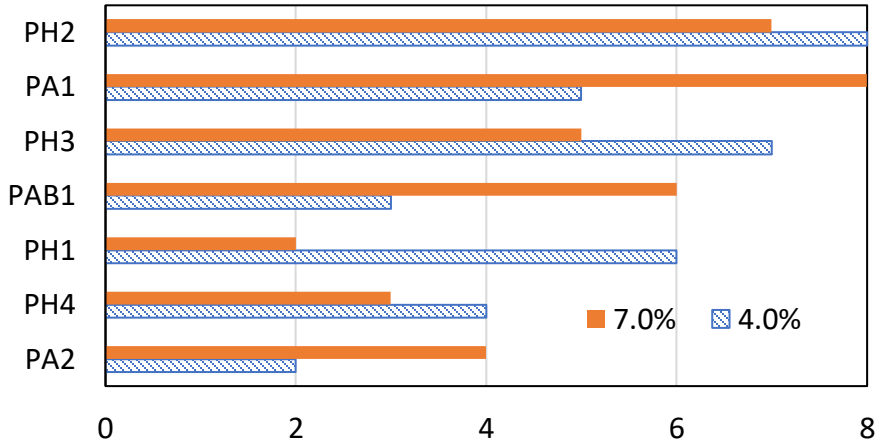
H: Highway surface; **A:** Airport surface; **AB:** Airport binder

Performance Ranking (Plant Mixes)

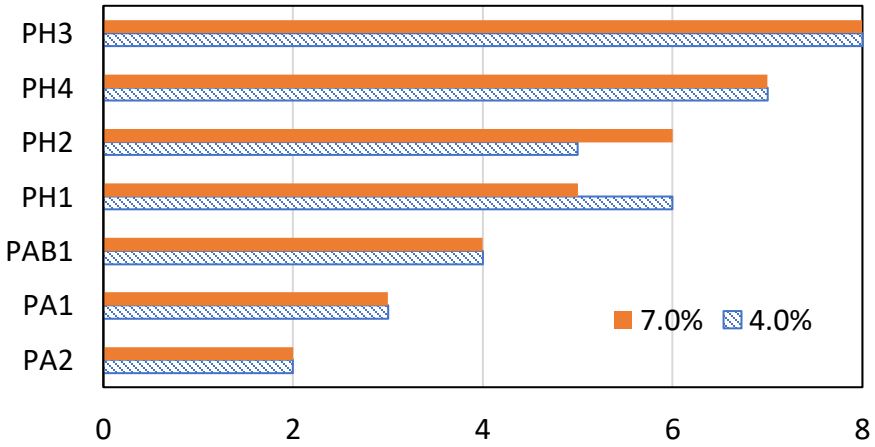
HWTT



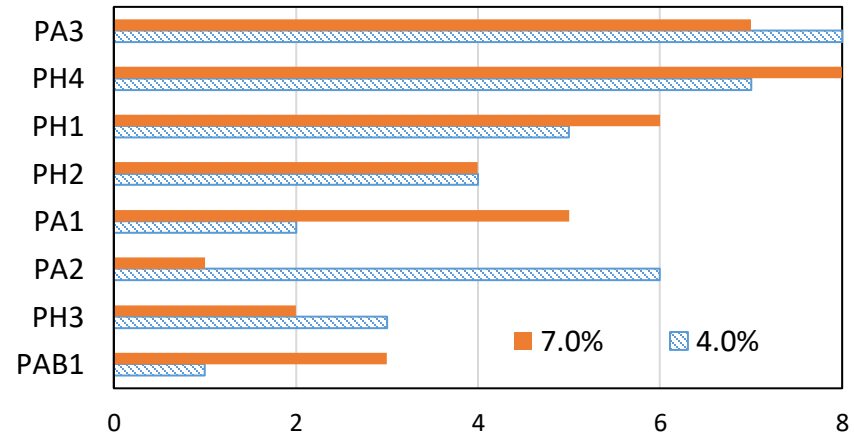
Tensile Strength Ratio



Indirect Tensile Strength

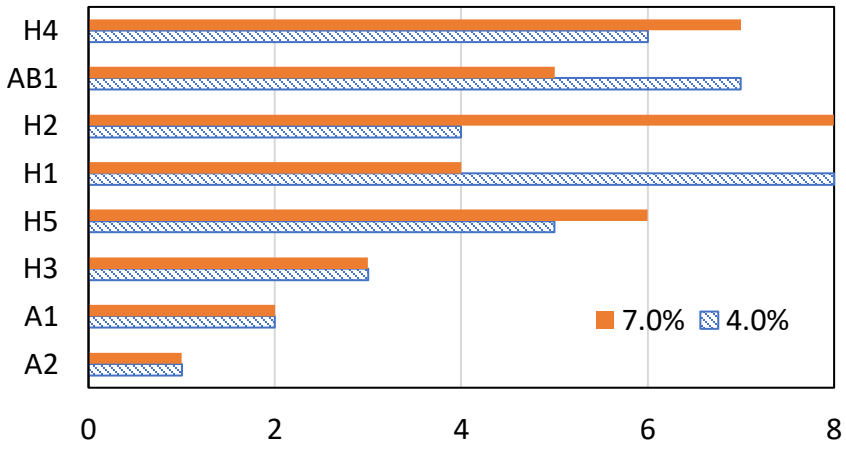


I-FIT

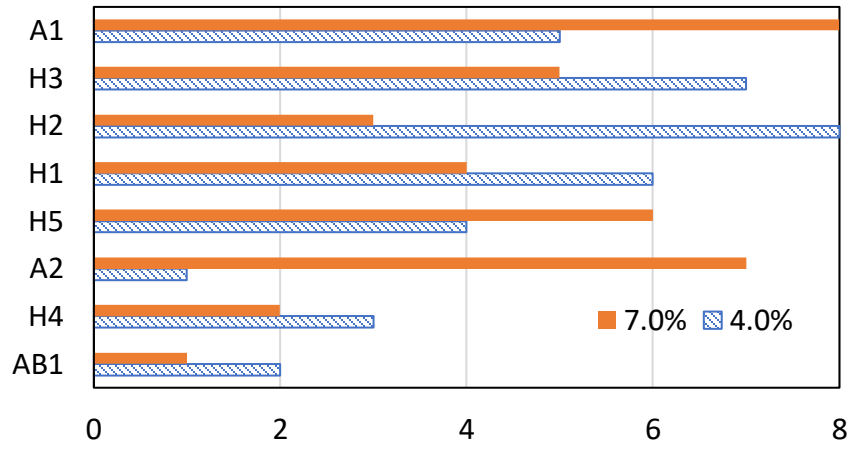


Performance Ranking (Lab Mixes)

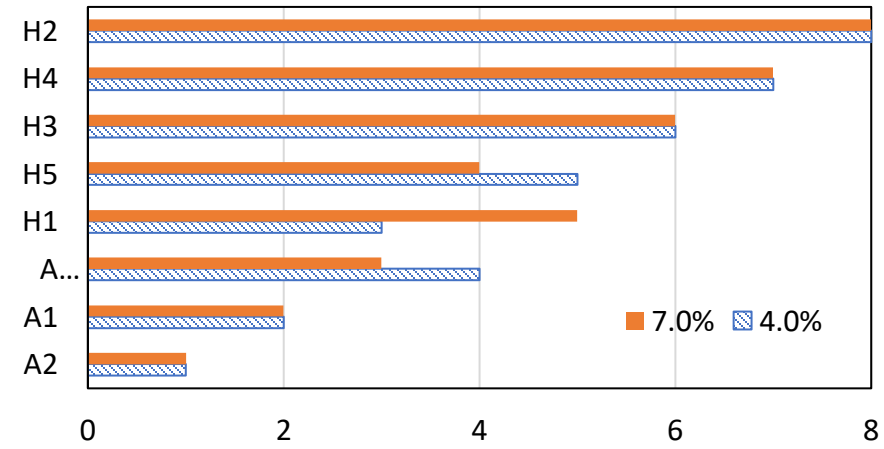
HWTT



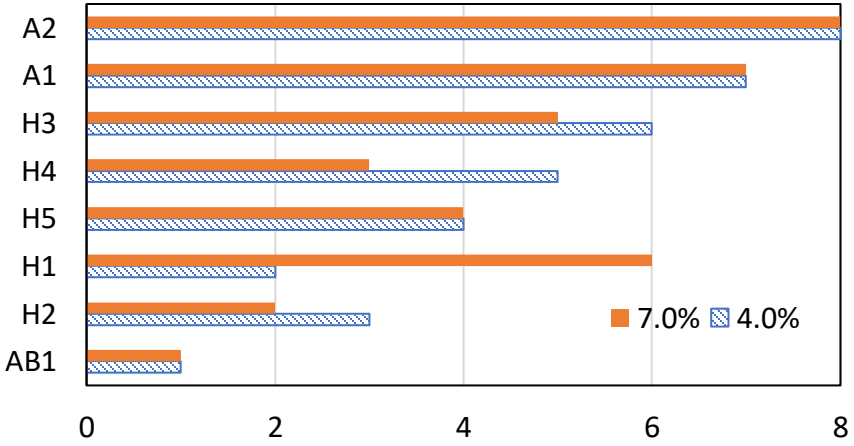
Tensile Strength Ratio



Indirect Tensile Strength

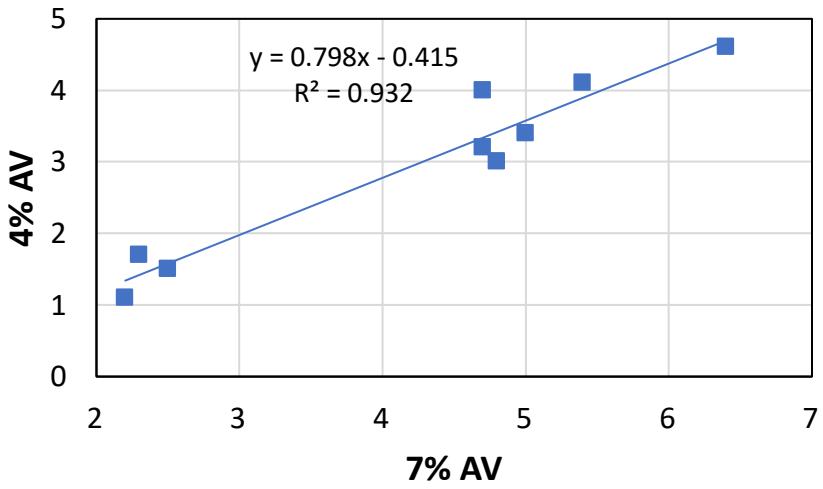


I-FIT

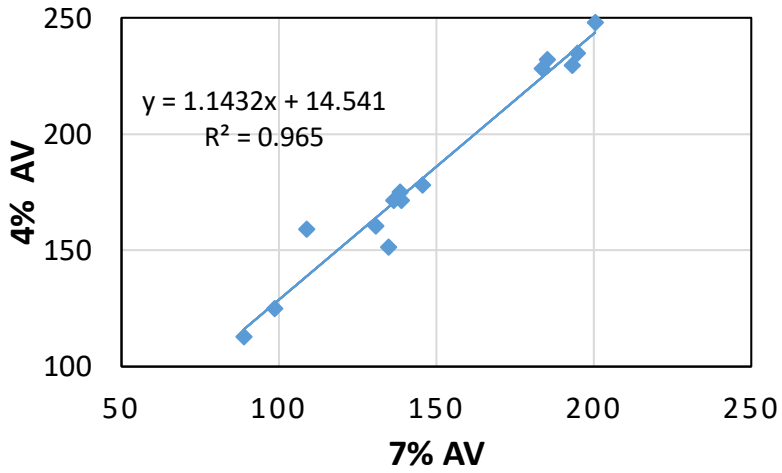


Impact of Air Voids

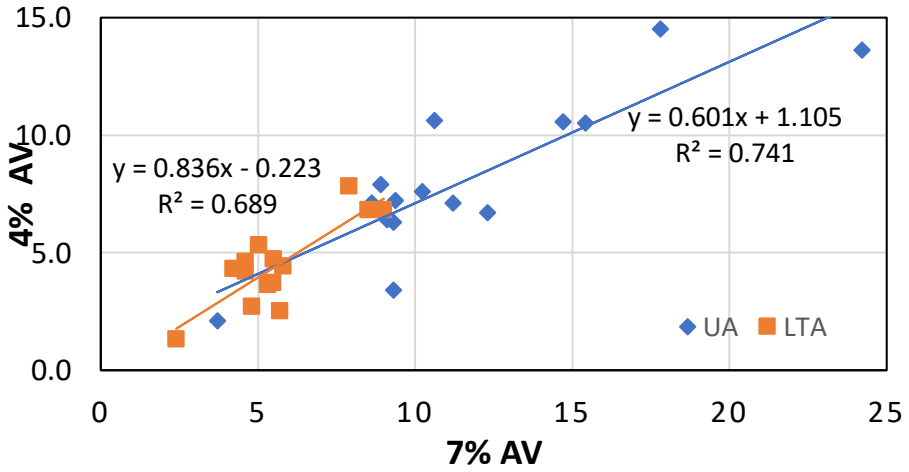
HWTT (mm)



Tensile Strength (psi)



I-FIT



Summary

	Lab Mixes		Plant Mixes	
Mix Type	**Highway**	**Airport**	**Highway**	**Airport**
Rut depths (mm)	4.8 – 6.1	5.6 – > 15	2.2 – 2.5	4.7 – 17.6
Tensile Strength (psi)	130 – 179	89 – 115	163 – 214	90 – 140
TSR	0.91 – 0.93	0.88 – 0.99	0.9 – 0.92*	0.86 – 0.97
Fracture Energy J/m^2	2194 – 2739	1808–2102	1887 – 2498	1827 – 2286
Unaged FI	8.6 – 14.2	17.8 – 24.2	9.1 – 15.4	8.9 – 14.7
Aged FI	4.2 – 8.4	7.9 – 8.5	4.6 – 8.5	4.6 – 9.0

*Two plant mixes had TSR values of 0.8 and 0.82

Summary

- **Use of highway surface mixes in airport applications (compared to airport mixes)**
  - Less rutting potential and higher split tensile strength
  - Similar TSR and fracture energies
  - Highway mixes had good FI values
  - Superpave5 mixes – H4* and H5*
    - Can achieve high field density >95%
    - Had less rutting and cracking potential

Conclusions

- **Adoption of highway mixes in nonprimary airports is viable and have the following advantages:**
  - Environmental benefits through the use of RAP
  - Technical advantages
    - Proficiency
    - Expertise
  - Economic gains
    - Available and readily produced materials
    - More eligible contractors

Recommendations

- Review of compaction data to ascertain the feasibility of achieving high densities for nonprimary airport applications.
- Possible modification of thresholds to meet airport needs.
- Using SMA with local aggregates for nonprimary airport applications may be evaluated for future use.

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THANK YOU

Any Questions?

Presenter: Uthman M. Ali
Email: uthmanm2@illinois.edu

Illinois Center for Transportation

Test Results- HWTT (Lab Mixes)

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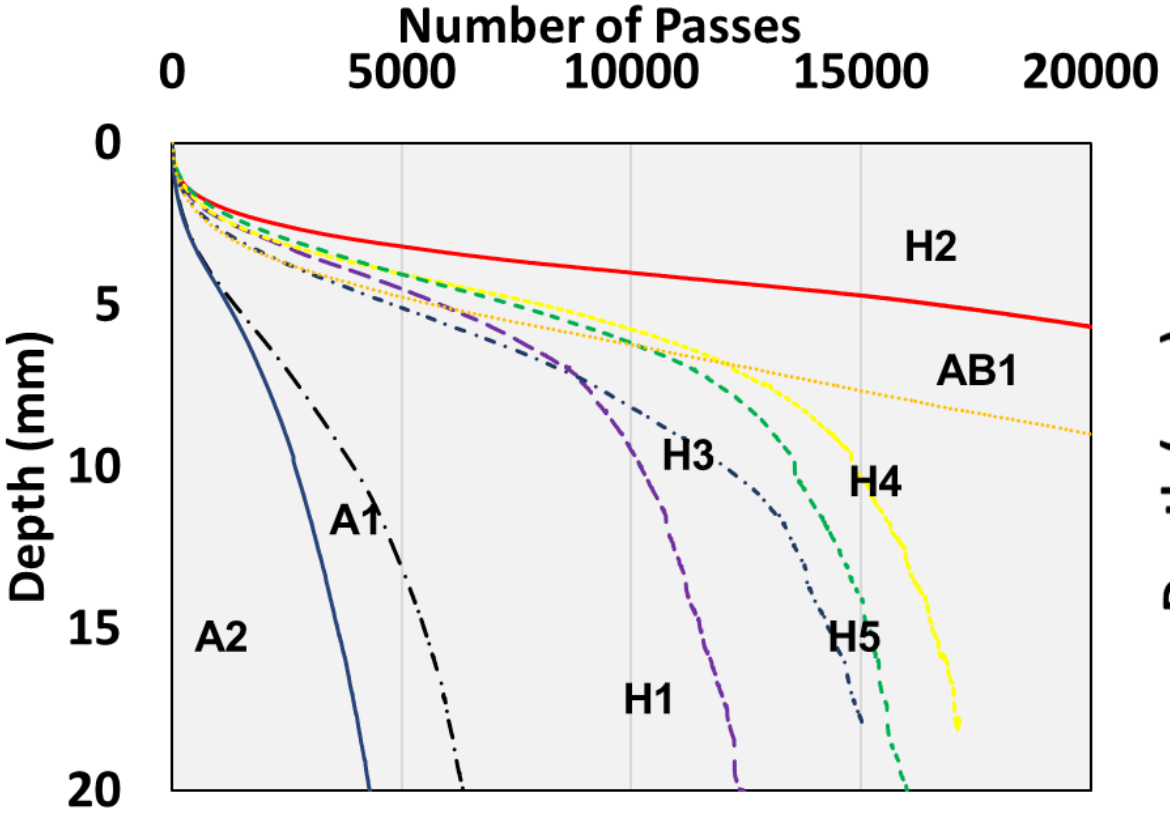
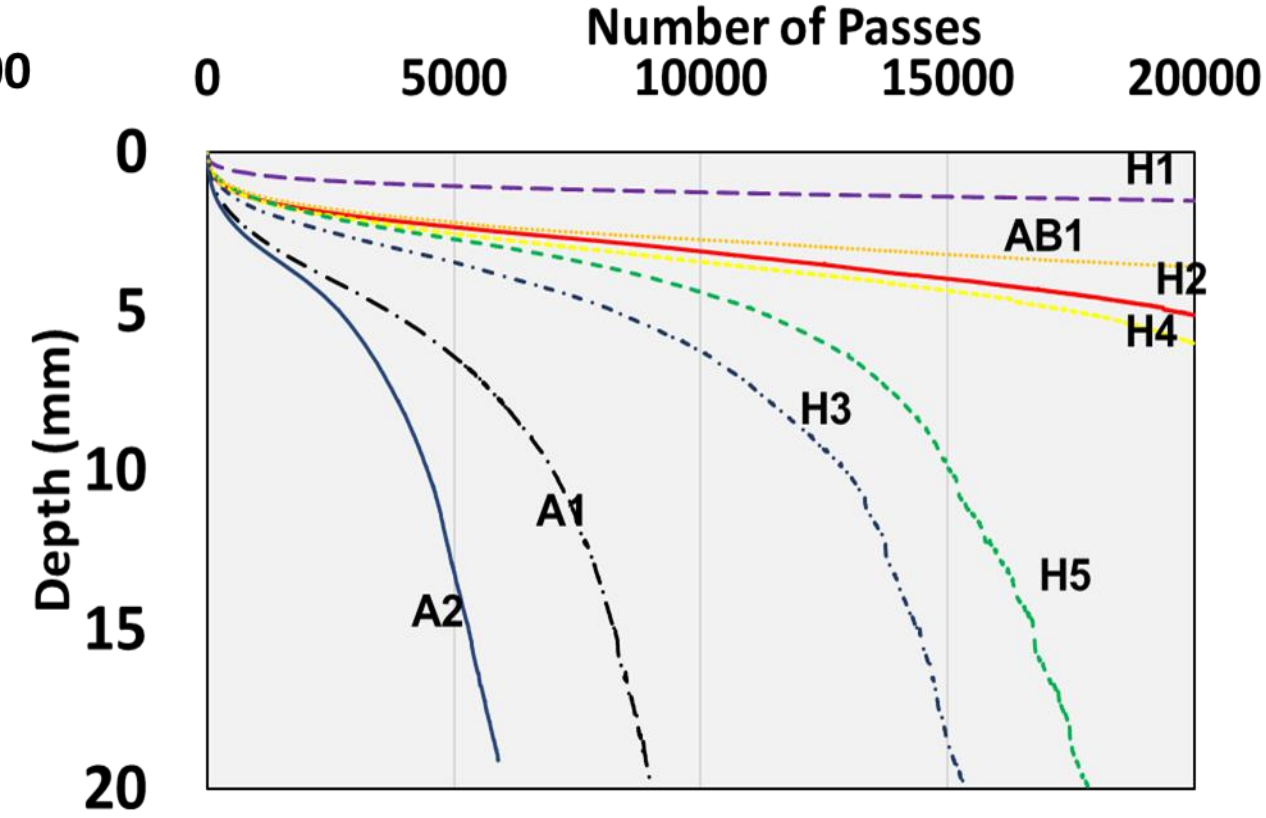
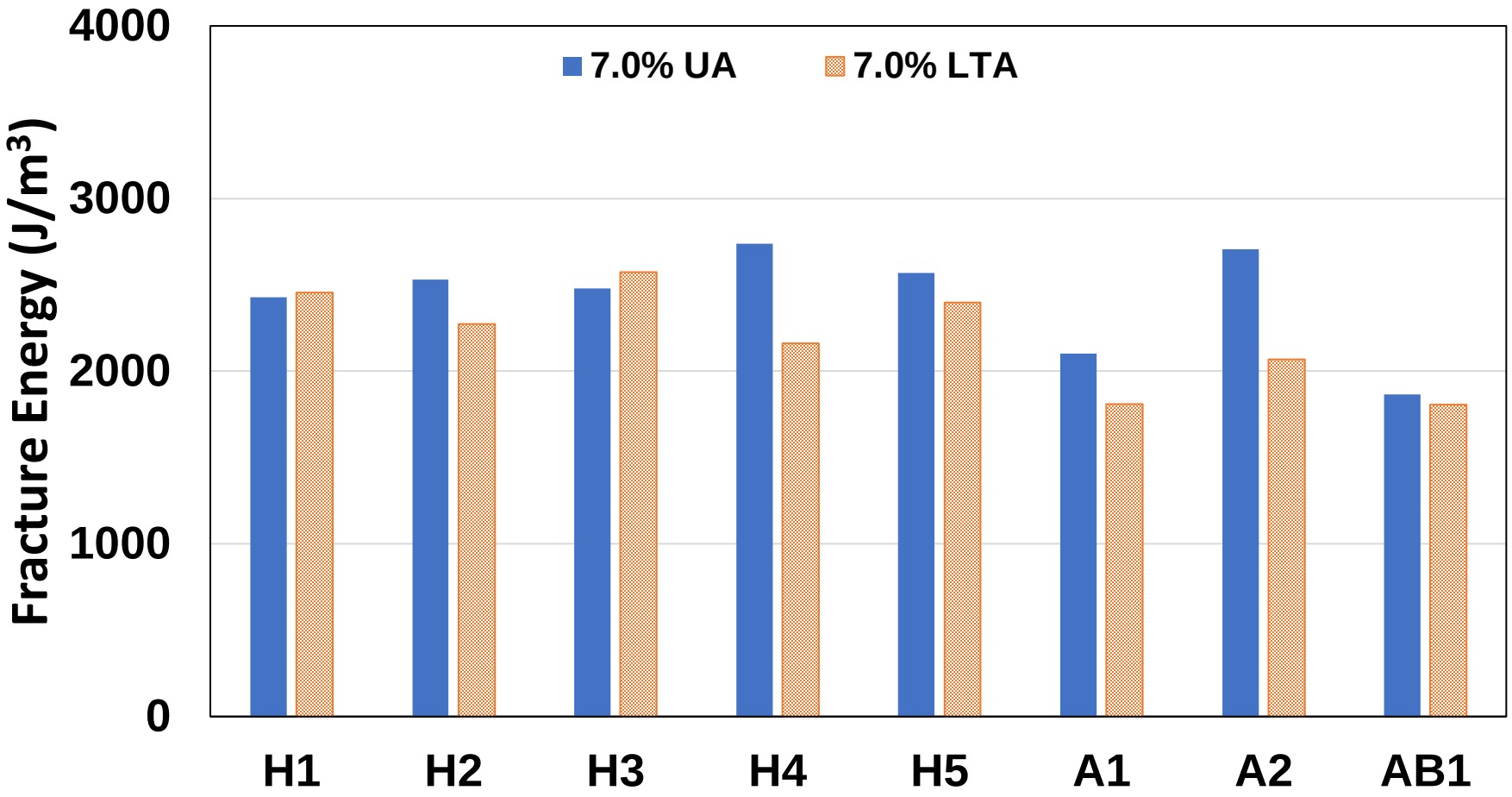


4.0% AV



H: Highway surface; **A:** Airport surface; **AB:** Airport binder;

Test Results- I-FIT (Lab Mixes)



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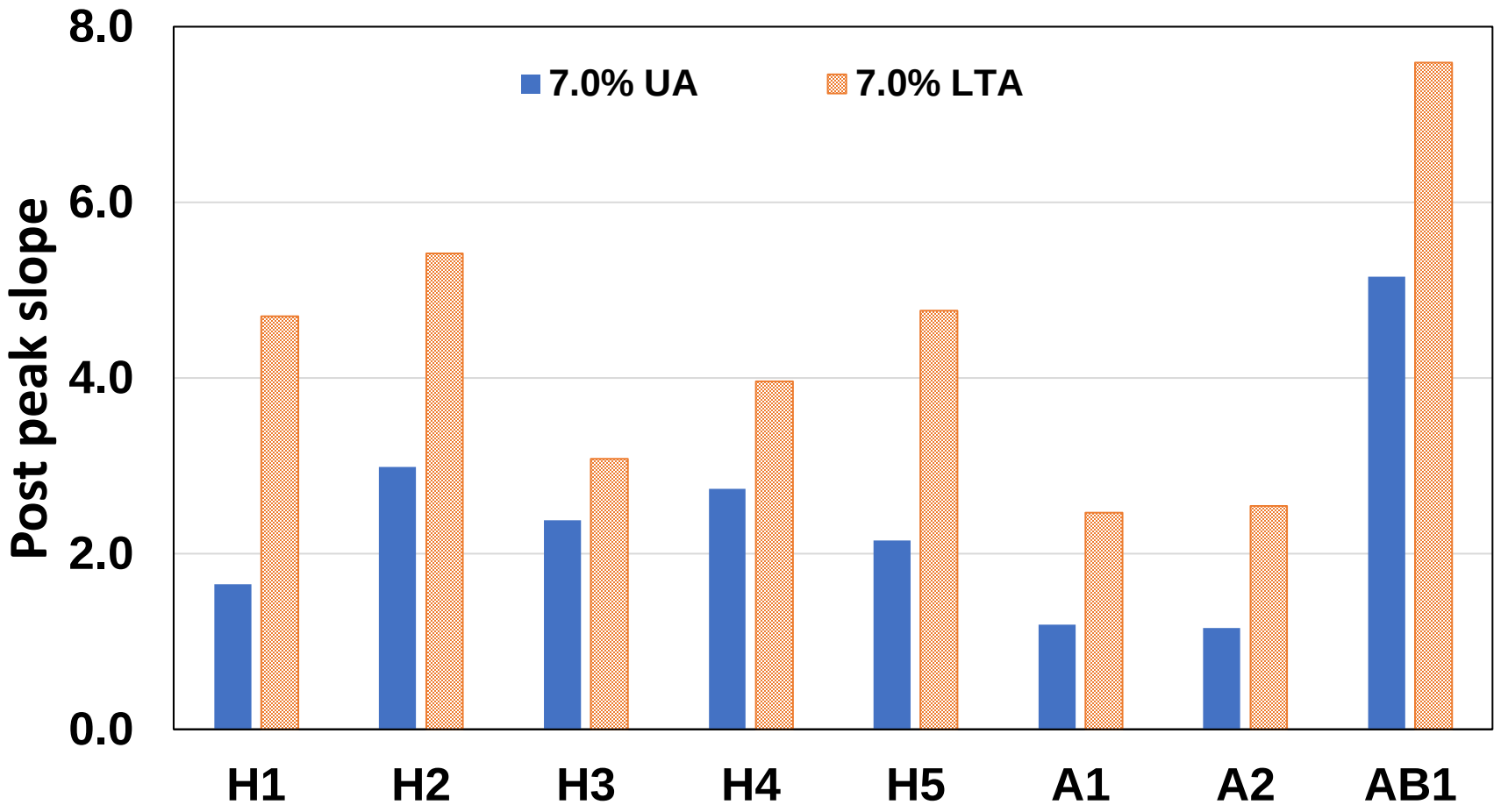

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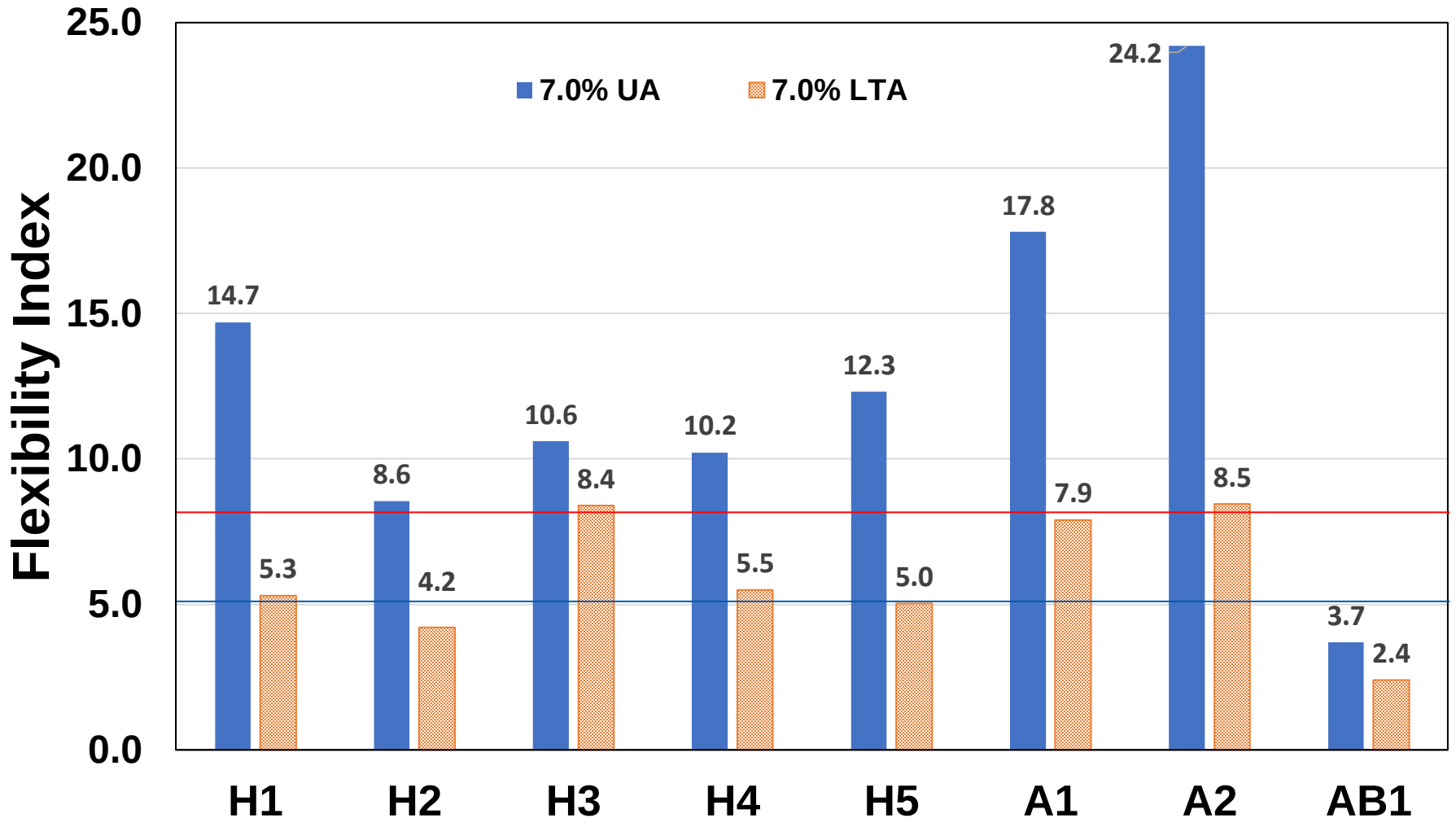

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Project Timeline

	Project Milestones	2021		2022				2023			% Completed
		8-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-8	
1	Literature Review **Completed**										100
2	Specification Comparison **Completed**										100
3	Material Acquisition **Phase 1 Completed** **Phase 2 Completed**										100
4	Mix Design and Testing **Completed**										100
5	Final Report **In progress**										90