Asphalt Materials Performance Laboratory, School of Civil and Construction Engineering

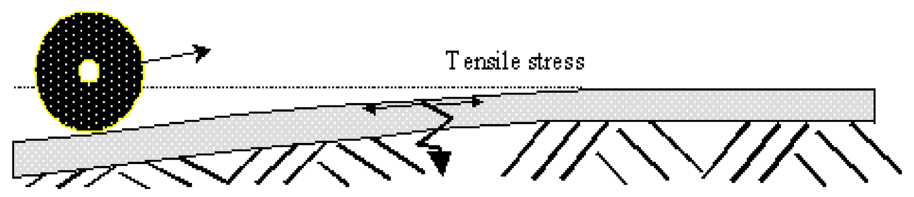
SELECTION OF A DURABLE, SUSTAINABLE AND COST EFFECTIVE ASPHALT MIXTURE FOR PAVEMENTS IN OREGON

Vikas Kumar, Ihsan Obaid, and Alex Sutherland

Oregon State University

Introduction

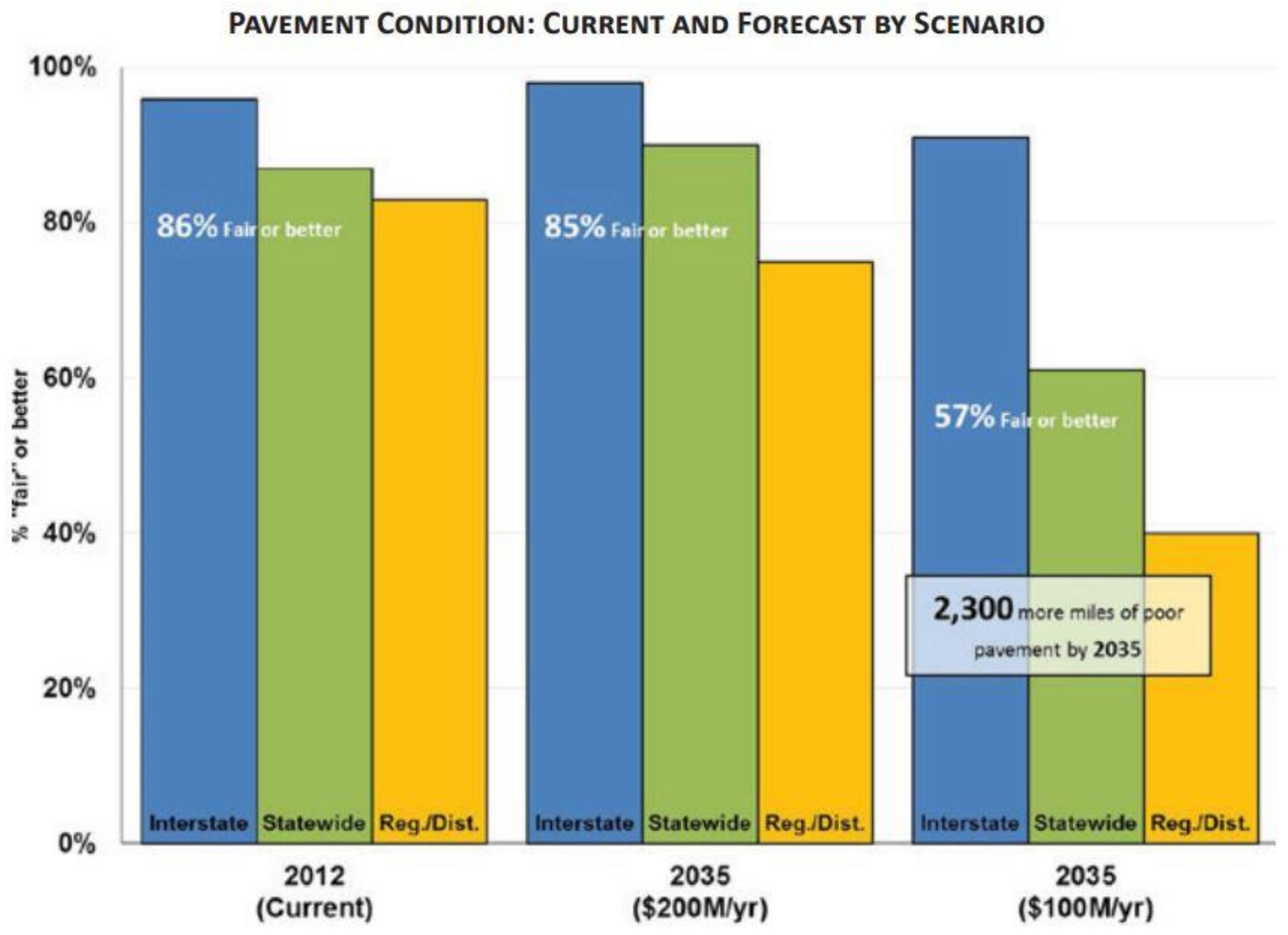
- In Oregon, fatigue cracking is the major distress mode for asphalt concrete pavement structures.



Top-down cracking

Source: https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/pccp/04122/04.cfm

- Increasing asphalt binder content, using elastomer-modified binders, increasing density and flexibility have been recommended to be viable options to improve longevity of Oregon roadway network (Coleri et al. 2017a, Coleri et al. 2017b).



SOURCE: ODOT (2014)

Key objectives

- ✔ Design three trial asphalt mixtures
- ✔ Evaluate the trial mixes for cracking and rutting performances
- ✔ Determine design binder content range for each mix using the balanced asphalt mix design method developed for Oregon
- ✔ Determine the cost and environmental impact of all three mixtures
- ✔ Recommend the "best" asphalt mixture for the given conditions by considering the cost-effectiveness, sustainability and the long-term performance of the mixes

Strategies of Mix Design

Mix1. Density Effect

Mix with 5% and 7% air voids

30% RAP mixture

Mix2. High RAP content

RAP content increased to 45%

Mix3. Warm-Mix Asphalt (Evotherm)

SOURCE: HTTP://WWW.BITUMIXSOLUTIONS.COM/)

30% RAP mixture

Experimental Plan

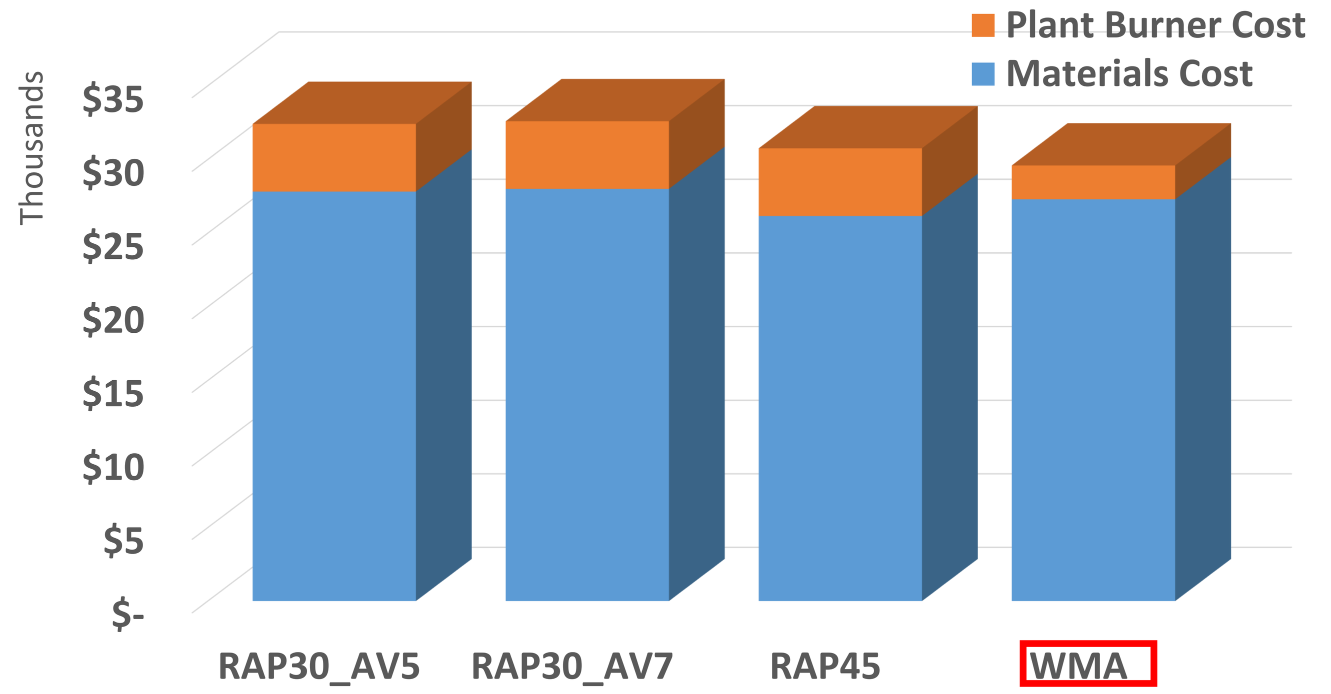
Specimen Type [a]	Mix ID [b]	Test	Temperature (°C)	Asphalt Content (%)	Replicates	Total
LMLC	Mix1_AV5, Mix1_AV7, Mix3	SCB	25.0	OBC [c], - 0.5%, + 0.5%	4	36
		HWTT	50.0		4	36
	Mix2	SCB	25.0	OBC [c], + 0.5%, + 1%	4	12
		HWTT	50.0		4	12

a LMLC = Laboratory mixed, and laboratory compacted;
b Mix1_AV5 – Mix3 = LMLC samples from three trial mixes;
c OBC = Optimum binder content obtained from volumetric mix design.

Performance test results and BMD approach

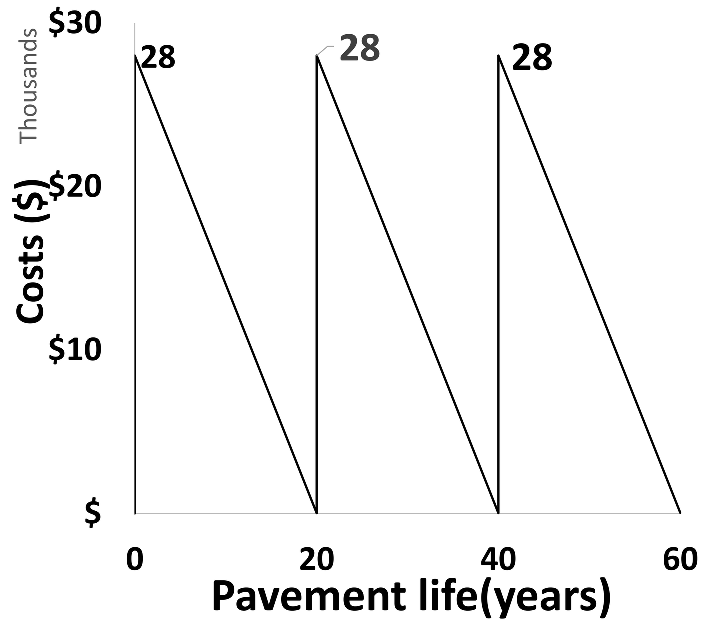
- WMA had highest cracking resistance among all three mix types
- Based on BMD approach developed by Coleri et al (2020), WMA mix was satisfying both cracking and rutting performance requirements at a significantly lower binder content.

Cost Calculation

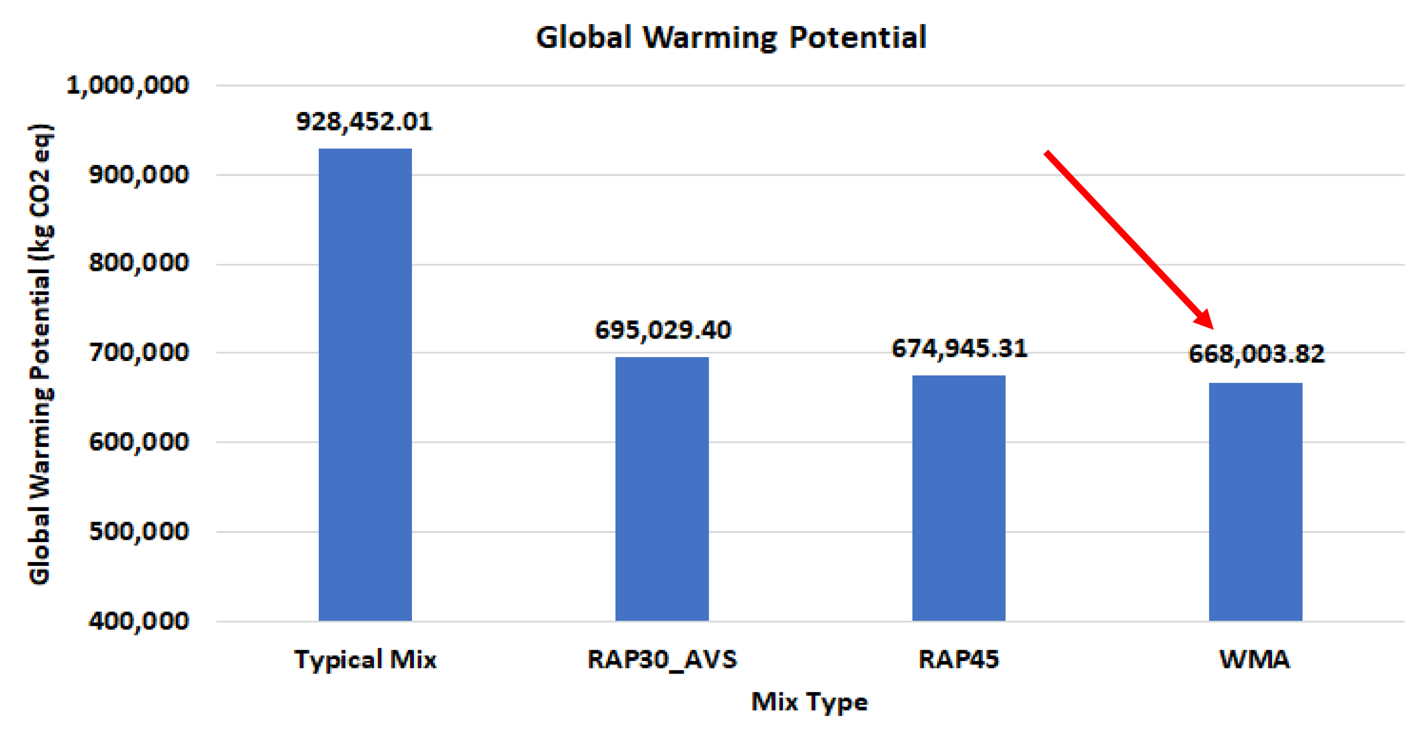


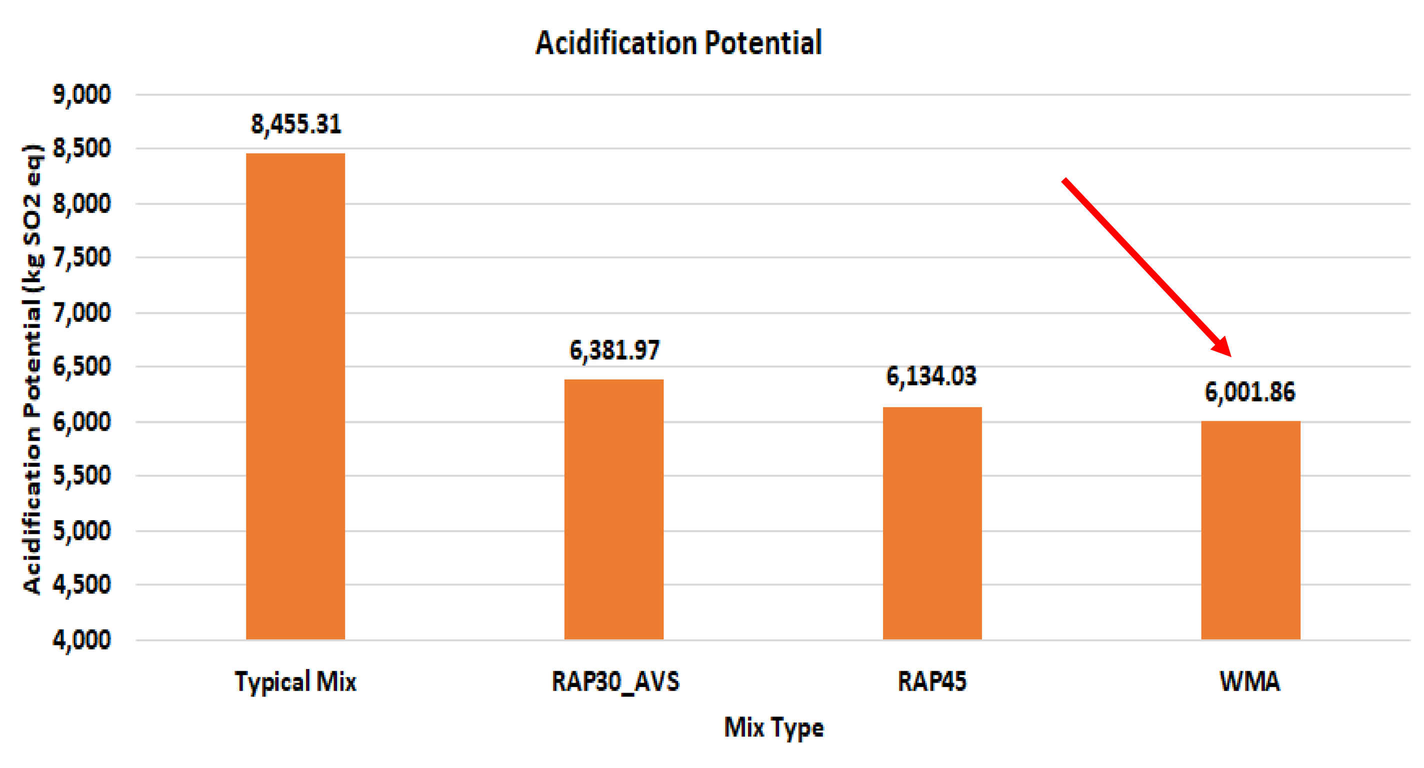
Life Cycle Cost Analysis

Mix ID	Initial cost ($)	NPV ($)
Mix1_AV5	32,416	53,962
Mix1_AV7	32,599	54,267
High RAP Mix	30,761	51,207
WMA	29,597	49,269



Life Cycle Assessment (Pavement LCA)





Major Conclusions

- *Mix3 (WMA) has cracking resistances significantly higher than all other mixtures;*
- *It is possible that Mix 3 with warm-mix additives can have better "compactibility";*
- *The most cost-effective mix is the warm mix asphalt (Mix 3) considering the reduced production temperature;*
- *Mix 3 (warm-mix) is also the most environmentally friendly mix with lower expected GWP, EP, and AP values for a 60 year analysis period*

The mixture with warm-mix additives (Mix 3) is selected as the best asphalt mixture with lowest cost and lowest environmental impact.

References

1. Coleri, E., S. Haddadi, S. Sreedhar, S. Lewis, Y. Zhang, and B. Wruck. 2017a. Binder-grade bumping and high binder content to improve performance of RAP-RAS mixtures. Final Rep. No. SPR 797. Salem, OR: Oregon Dept. of Transportation.
2. Coleri, E., S. Sreedhar, S. Haddadi, B. Wruck, and M. Haynes. 2017b. Adjusting asphalt mixes for increased durability and implementation of a performance tester to evaluate fatigue cracking of asphalt concrete. Final Rep. No. SPR 785. Salem, OR: Oregon Dept. of Transportation.
3. Coleri, E., S. Sreedhar, and I. Obaid. 2020. Development of a balanced mix design method in Oregon. Final Rep. No. SPR 801. Salem, OR: Oregon Dept. of Transportation
4. Rough Roads Ahead: The Cost of Poor Highway Conditions to Oregon's Economy, 2014

ACKNOWLEDGMENTS

- Dr. Erdem Coleri, Assistant Professor, School of Civil and Construction Engineering, Oregon State University
- Oregon Department of Transportation
- CRH Americas
- Albina Asphalt