

AGENCIES & CONTRACTORS SURVEYS ON **BARRIERS TO REDUCE THE PRODUCTION TEMPERATURES** OF ASPHALT MIXTURES

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SUMMARY

Warm Mix Asphalt (WMA) technologies, introduced in 2002, use additives or foam to produce asphalt at lower temperatures, achieving emission reduction, cost savings, and improved quality. In 2021, WMA represented 41.1% of the asphalt market, but defining it is challenging as only 52.9% of declared WMA mix tonnages had a temperature reduction of at least 10°F. With the industry targeting carbon neutrality by 2050, understanding barriers to WMA at lower temperatures is crucial. This report presents findings from surveys conducted in 2023 involving 81 companies and agencies in 43 US states and two Canadian provinces.

» *Warm Mix Technologies Implementation:* 69% of the 45 responding agencies have adopted WMA technologies. Among these, 67% reported minimum production temperatures below the standard HMA minimum of 285°F, allowing for temperature reduction. However, only 22% set maximum temperature limits at or below standard HMA (285 to 305°F). Agencies can be categorized into four groups based on their WMA approach: (1) Allowing WMA technologies but with production temperatures based solely on binder grade, i.e. limiting WMA use to compaction aid; (2) Having permissive specifications for lower minimum production temperatures without changing the upper limit; (3) Defining specific production temperature ranges with lower minimums and maximums; (4) Considering or having implemented incentives.

» *Factors Inhibiting WMA Utilization at Lower Temperatures:* Agencies perceive low in-place density, moisture-induced performance issues, and a need for guidance as barriers. Contractors perceive specifications, mirroring agencies' concerns, as the main obstacle, with concerns about workability and quality perceptions. Cost and the lack of information and training are also limiting factors.

» *Proposals to Overcome Barriers:* Agencies propose incentives/disincentives, materials moisture control, EPD deployment, certified production temperature recordation technologies, and collaboration with the industry. Contractors suggest education and training, facilitating RAP use with rejuvenators, and incentives for plant operators and paving crews.

1. BACKGROUND

Since being introduced into the US market in 2002, Warm Mix Asphalt (WMA) technology adoption has grown faster than any other new asphalt technology over the past several decades. WMA, which uses technologies such as zeolites, paraffinic waxes, chemical additives, or foamed asphalt to produce asphalt mixtures at lower temperatures, was initially introduced to reduce emissions, lower energy costs, and decrease binder oxidation while maintaining asphalt mixture quality and the ability to achieve compaction in the field. Depending on the technology, this is accomplished to varying degrees by reducing the viscosity of the binder or reducing the internal friction of the asphalt mixture at a given temperature.

Table 1 Demographics of Responses to Contractor Survey

Region	All	South Central	South	Midwest	Mountain States	Mid-Atlantic	West Coast	Northeast	Plain States
Responses	81	19	18	16	9	8	5	3	3
Plants	635	143	153	155	34	80	18	33	19
Urban Plants	42%	47%	56%	50%	44%	38%	100%	33%	67%
Rural Plants	58%	53%	44%	50%	56%	63%	0%	67%	33%

In 2021, according to the latest National Asphalt Pavement Association Industry Survey on Recycled Materials and Warm-Mix Asphalt (IS-138), asphalt produced using WMA technologies represented 41.1% of the total estimated asphalt mixture market. However, defining WMA has become a vexing issue since the use of those technologies at typical HMA temperatures as a compaction aid is now very common. According to the same survey, just 52.9% of declared WMA mix tonnages were produced at temperatures reduced by at least 10°F.

Since the asphalt industry’s efforts toward net zero carbon emissions by 2050 relies on reducing operational carbon emissions, identifying the barriers to using WMA technologies at lower temperatures is critical. This report presents the findings of two surveys conducted in parallel within our industry and agencies, with the objective of identifying the barriers to using WMA technologies at lower temperatures.

The two online questionnaires shown in Appendices A and B were prepared by NAPA’s Committee for Asphalt Research and Technology (CART). Both surveys included questions to identify barriers and practices for lowering production temperatures, as well as increasing the use of Reclaimed Asphalt Pavement (RAP). Only the responses about lowering production temperatures are presented and analyzed here; questions pertaining to RAP are addressed in a separate document.

2. SURVEY DEMOGRAPHICS

The contractor survey was accessible to the industry on NAPA ActionNews for 6 weeks, from mid-March to the last week of May. Demographics presented in Table 1 show that a few regions lack sufficient data to be representative. Fifty-eight percent of the plants

are in rural areas, and 42% in urban areas. Hauling range limiting their market footprint, more plants are needed to cover the large swaths of the rural market.

The Agency survey was circulated through the AASHTO committee on Material and Pavements (COMP) from August to September with 43 US States, Ontario and Quebec participating (Figure 1).

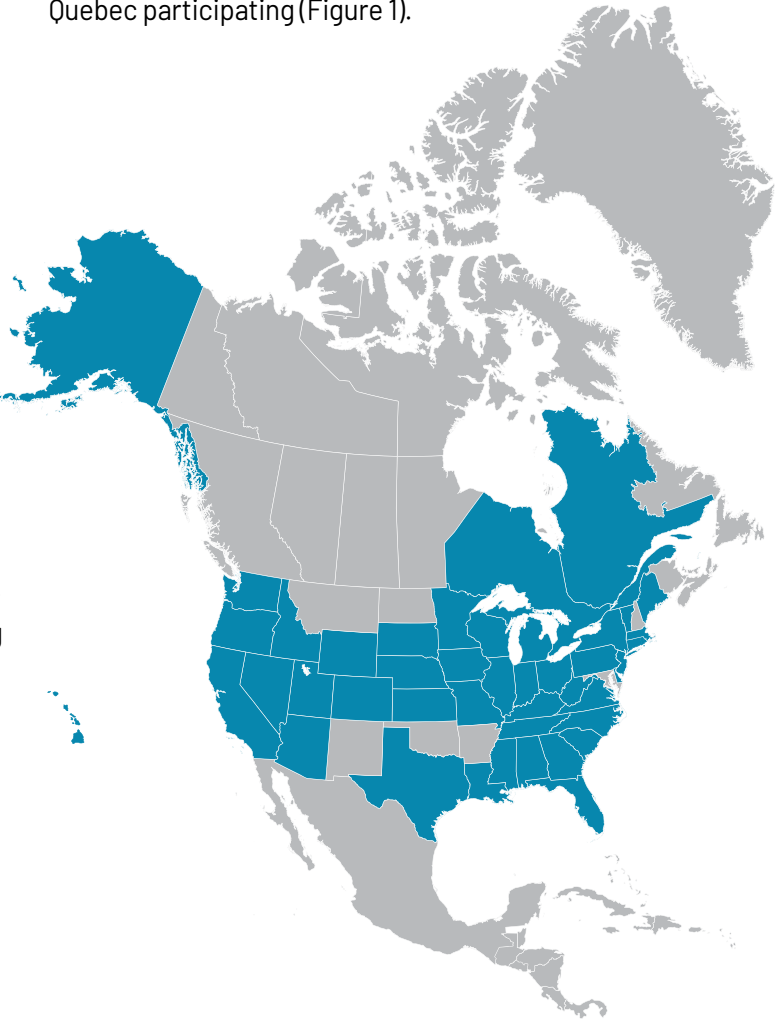


Figure 1 Participating US States and Canadian Provinces.

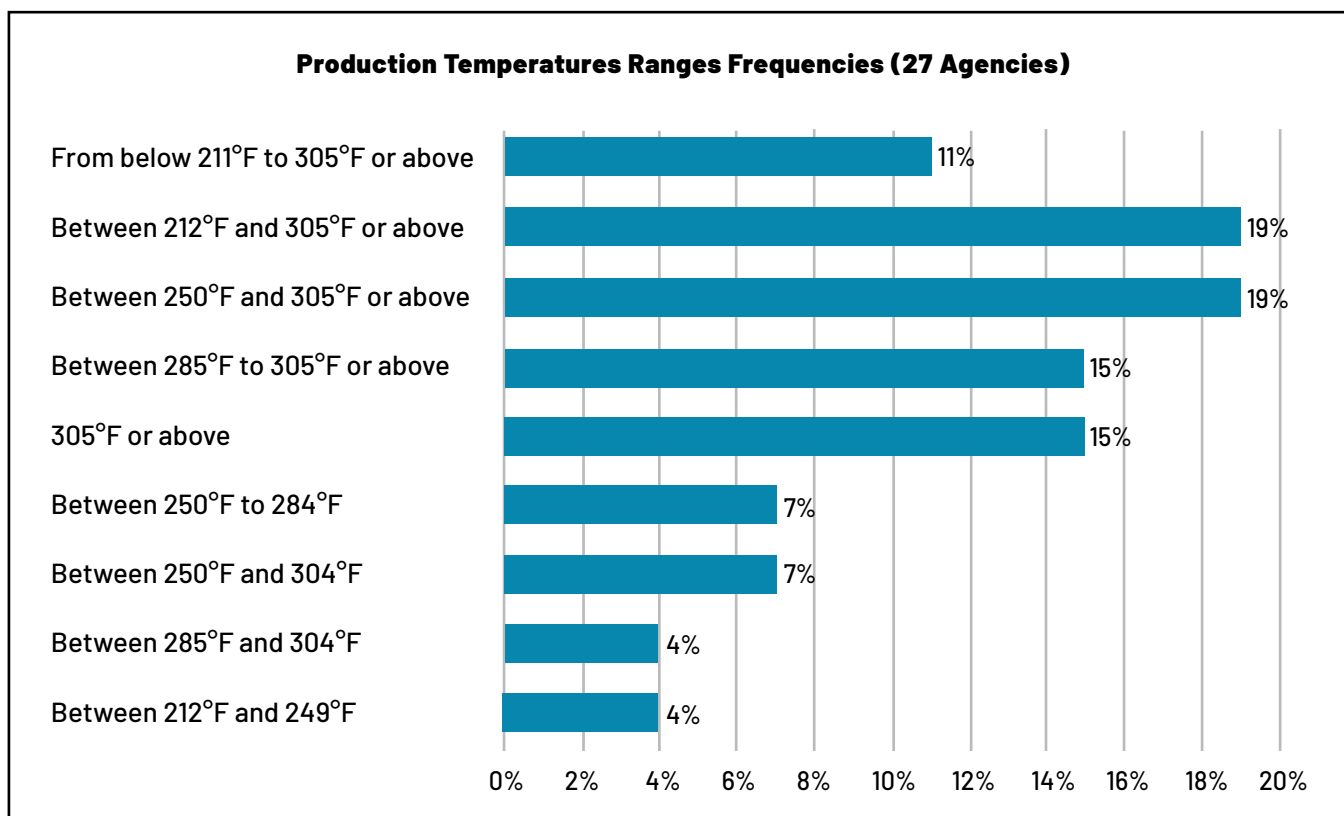


Figure 2 Specification Production Temperature Range Frequencies (27 Agencies)

3. WARM MIX TECHNOLOGIES USE REVIEW.

Sixty-nine percent of the 45 responding agencies declared to have implemented technologies or specifications allowing lower production temperature. This is consistent with the distribution of the production temperatures ranges specified by 27 of these agencies shown in Figure 2.

Notably, 67% of these agencies reported minimum production temperatures below the standard HMA minima of 285°F, with some even below 250°F. This trend suggests broad acceptance of lower production temperatures, likely influenced by the adoption of WMA technologies.

Notably, only 19% of agencies specified minimum production temperatures above the standard HMA minimum of 285°F. This figure does not exclude the use of WMA technologies and may represent states where they are used for compaction aid only.

A lesser proportion of agencies — but still sizable at 22% — have established maximum temperature limits at or below standard HMA (285 to 305°F), indicating the specification of WMA technologies to reduce production temperatures.

The comparison between production temperatures reported by contractors and the specified categories set by agencies, as illustrated in Figure 3, evidences the similarity of distribution. Both parties favor higher temperatures, with contractors' production temperatures skewing toward the hotter side.

While the IS-138 survey data is based on estimated tonnages produced at temperature reduction ranges that don't directly match the specified categories above, Table 2 confirms a significant finding — about half of asphalt mix production (47%) employing Warm Mix Technologies is carried out at standard HMA temperatures, serving as a compaction aid.

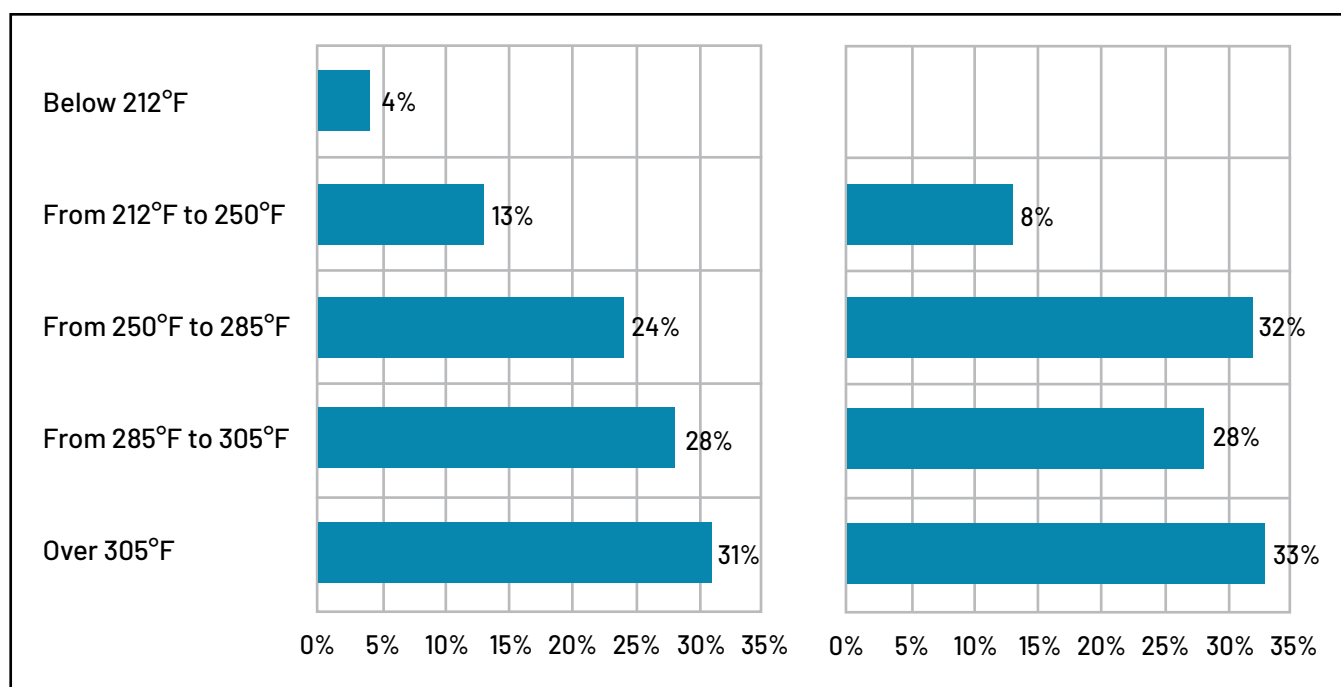


Figure 3 Agency and Contractor Production Temperature Frequencies

Table 2 Temperature Reduction Percentages from RAP/RAS/WMA Survey (NAPA IS-138)

Temperature Reduction Categories	None	10° - 30°F	31° - 50°F	> 51°F
Of mixes using WMA technologies	47.1%	44.2%	7.4%	1.3%
Of Total Asphalt Production	58.9%	34.4%	5.7%	1.0%

4. WMA IMPLEMENTATION IN SPECIFICATIONS AND OTHER MEASURES TO REDUCE PRODUCTION TEMPERATURES.

In this section, responses to questions 4, 6, and 7 of the agency survey are consolidated. These responses cover the incorporation of WMA technologies in specifications and any measures, including incentives, undertaken to promote the reduction of production temperatures. The results are presented in Figures 4 and 5.

The 32 agencies that responded can be divided in four groups:

➤ The first group permits the use of WMA technologies but implements no specific measures, keeping the production temperature range unchanged. Production temperature is solely based on binder grade. In those states, WMA technologies can exclusively be used as a compaction aid to achieve field density requirements.

➤ The second, larger group adopts permissive specifications, allowing lower minimum production temperatures with WMA technologies, while keeping maximum limits unchanged. Contractors have flexibility in using WMAs for temperature reduction or compaction aid based on project specifics and varying conditions.

➤ The third group defines specific production temperature ranges with lower minimums (215°F to 220°F) and maximums (275°F to 300°F) when WMA technologies are used. In some cases, the maximum temperature is defined as a reduction from HMA production temperature, ranging from minus 30°F to minus 40°F. Some mandate WMA technology use with maximum production temperatures for cold weather paving or for special mixes.

➤ The fourth group includes a few agencies that initially encouraged lower production temperatures by allowing higher RAP content and waiving the

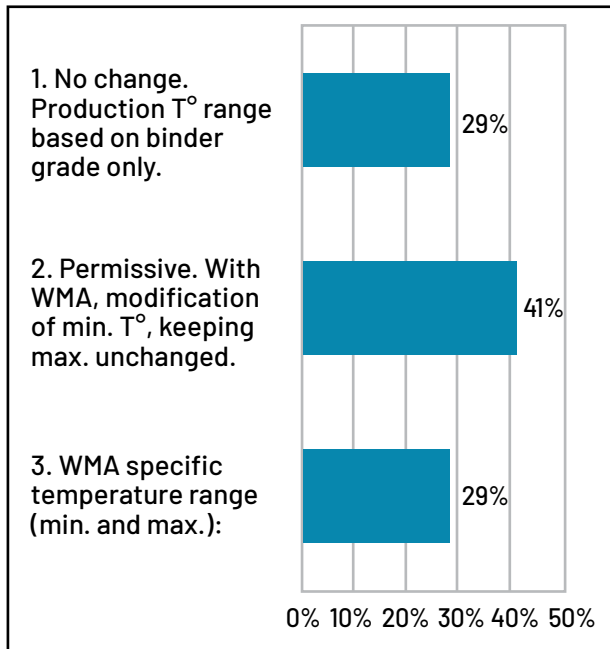


Figure 4 Impacts of Specifications

need for softer binders when using WMA produced below 275°F. These provisions were later withdrawn due to performance issues. Some agencies are now considering monetary incentives to balance low-density penalties and encourage contractors to reduce production temperatures.

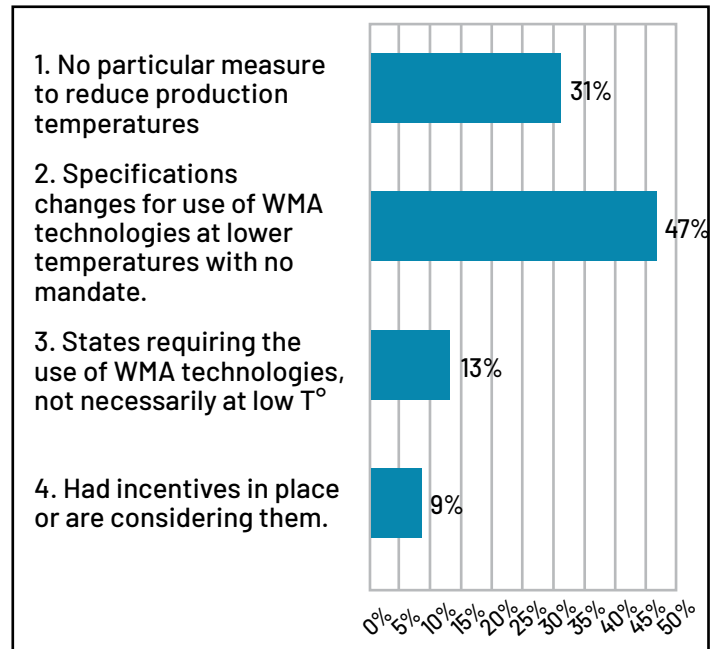


Figure 5 Agency Actions to Reduce Production Temperature

5. FACTORS THAT INHIBIT WARM MIX UTILIZATION AT LOWER PRODUCTION TEMPERATURES.

Agencies' perspective:

Figure 6 provides insight into what agencies feel are the barriers to producing asphalt mixtures at lower temperatures.

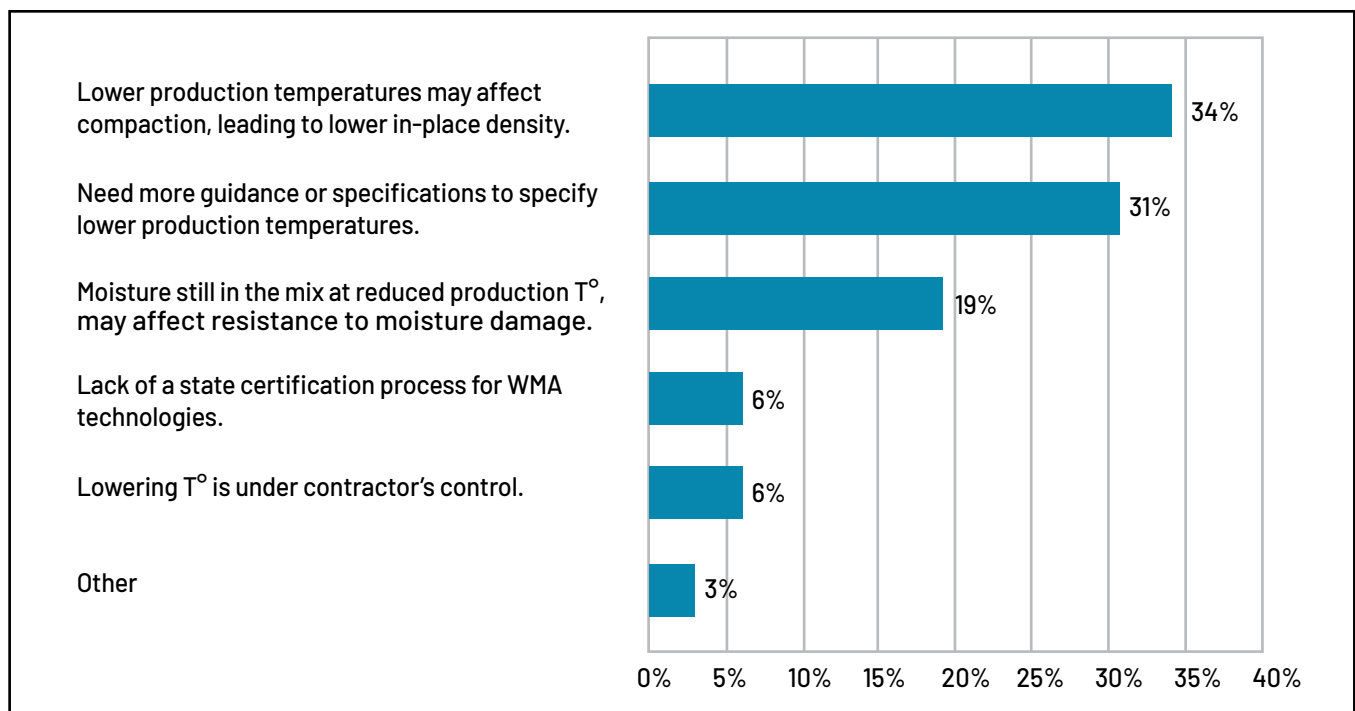


Figure 6 Agencies perceived barriers to produce asphalt mixtures at lower temperatures.

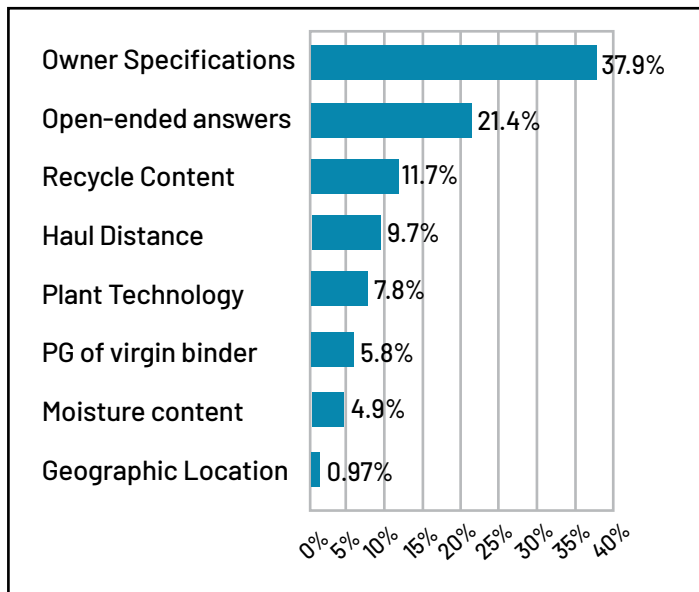


Figure 7 Factors that inhibit warm mix production.

- The primary concern for agencies is low in-place density, particularly with long haul distances. Additionally, moisture-induced performance issues resulting from incomplete drying of aggregates, and the potential presence of residual moisture, is another major concern.
- The request for more guidance in selecting production temperatures is tied to these concerns about in-place density and moisture damage.
- To address the perceived lack of a State Certification process, the AASHTO Product Evaluation & Audit Solutions program (PEAS) is suggested as a potential solution.
- Agencies with permissive specifications observe that contractors often prefer using WMA technologies as a compaction aid.

Contractors' perspective:

Contractors have a slightly different perspective as seen in Figures 7 and 8. The contractors view specifications as the main barrier to reducing production temperatures. This may seem inconsistent with the Agencies' survey findings above. However, a little less than half of these Agencies have "permissive" specifications that give the contractors the option to

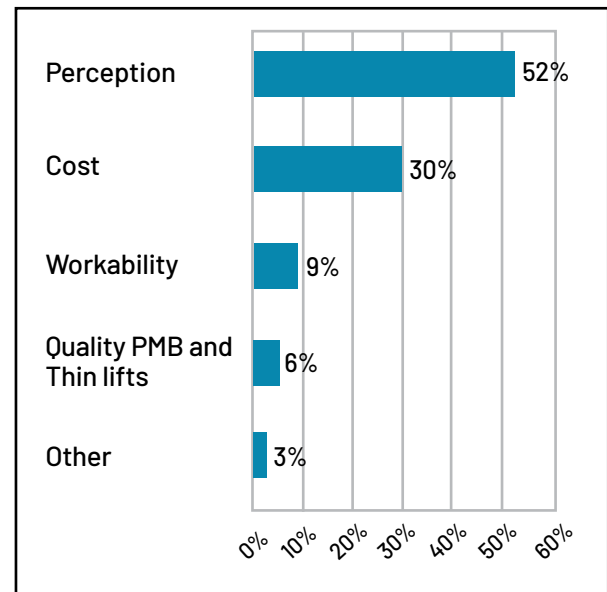


Figure 8 Open-ended answers

- Contractors' open-ended answers ranked the leading limiting factor as what could be summarized under "perception," i.e., the perceived construction workability and quality issues by both customers and paving crews, largely attributed to a lack of information and training.
- Another limiting factor mentioned is cost. WMA additives are only used when specified or in special situations (long hauls, cold weather, etc.) because their cost cannot be offset by the induced energy savings.

6. PROPOSALS TO OVERCOME BARRIERS IN REDUCING PRODUCTION TEMPERATURES.

While there are currently barriers for implementing temperature reductions at asphalt plants, the survey also focuses on finding solutions to overcoming those barriers. These solutions are summarized in Table 3.

Table 3

Agencies' proposals	Contractors' Proposals
<p>1. Incentives / Disincentives: Paying incentives to encourage lower production temperatures or enforcing maximum temperature mandates with penalties, subject to field compaction being achieved, excluding long-distance haul or late season paving projects.</p> <p>2. Materials moisture control: Stipulating proper stockpiles management and cover placement to control aggregate and RAP moisture to save energy and facilitate production temperatures reduction.</p> <p>3. EPDs deployment will incentivize lower production temperatures.</p> <p>4. Certified production temperature recordation technologies</p> <p>5. Partner with the industry to prioritize temperature reduction.</p> <p>6. More studies evaluating WMA technologies' effectiveness.</p>	<p>1. Education and training: to tackle the WMA mixes "perception" issue, educate customers and our production teams about WMA technology, addressing quality and constructability concerns.</p> <p>2. Facilitating RAP use with WMA: Elevated materials moisture levels and high RAP percentages impede lowering production temperatures so as to activate the RAP binder. Plants' efficiency should be improved, and use of rejuvenators should be developed.</p> <p>3. Incentives: Plant operators and paving crews should be rewarded for using WMA.</p>

APPENDIX A

AGENCIES SURVEY QUESTIONNAIRE

Barriers to adopting Technology and Specifications to Lower Asphalt Mix Production Temperatures

Has your agency implemented technologies or specifications to lower production temperatures on paving projects? Yes / No

If Yes to Question 2, "what are the production temperature ranges in your state specifications?" (Please check all that apply):

- ☐ 305°F or above
- ☐ Between 285°F and 304°F
- ☐ Between 250°F and 284°F
- ☐ Between 212°F and 249°F
- ☐ 211°F or below

How were production temperatures established in your state? Also, does your agency provide guidance or specification for producers to set asphalt production temperatures (for example, based on virgin binder PG grade, amount of RAP in the mix, and WMA technologies used)? - Open Response

Please provide a web link to your specifications for lowering production temperature or email it to engineering@asphaltpavement.org.

Is your agency incentivizing contractors to reduce production temperatures?

No

Yes (Please specify the alternate bidding method)

What are other Innovations/best management practices that your agency has employed to reduce production temperatures in your state/jurisdiction effectively? (Please specify)

If No to Question 2, "Why does your agency not specify lower production temperatures?" (Please check all that apply)

- ☐ Lower production temperatures may affect compaction, leading to lower in-place density.
- ☐ Moisture may still be in the mix at reduced production temperatures, affecting its resistance to moisture damage.
- ☐ There needs to be more guidance or specifications to specify lower production temperatures.
- ☐ There is a lack of a state certification process for WMA technologies.
- ☐ For performance issues with production temperature reductions? If so, what are they? Please provide additional information below.

List some ideas to overcome the barriers agencies face in reducing the production temperatures, such as providing an incentive to lower production temperatures or changing to current specifications.

APPENDIX B

CONTRACTORS' SURVEY QUESTIONNAIRE

There are technologies and equipment available that allow the production of asphalt mixtures below the industry's historical "Hot Mix Production" (HMA) temperature range, which the industry refers to as "Warm Mix Production" (WMA). This survey attempts to identify factors that inhibit embracing WMA techniques in day-to-day mix production.

What are the factors that inhibit warm mix production and utilization? (check all that apply)

- ☐ Performance Grade of Virgin Binder
- ☐ Recycle Content
- ☐ Moisture Content
- ☐ Haul Distance
- ☐ Owner Agency Specifications
- ☐ Plant Technology
- ☐ Geographic Location
- ☐ Other (please specify)

What is the lowest temperature you can produce asphalt mixtures with WMA technology that are still workable and high quality?

What temperature do you typically produce asphalt mixtures at your facilities?

Please provide any additional input you feel is valuable regarding the barriers covered in the survey:
