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CRITICAL ANALYSIS OF ALTERNATE DESIGN/ALTERNATE BID CONTRACTING FOR HIGHWAY PAVEMENT TYPES

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Abstract: Alternate Design/Alternate Bid (ADAB) allows the pavement-type selection decision to be made as part of the procurement process by permitting contractors to bid their preferred alternative using real-time market pricing for the paving materials. The primary source of information was a survey of US Departments of Transportation which resulted in 40 responses, an 80% response rate. The paper provides a critical analysis of the results of ADAB projects in the US as well as the Canadian province of Ontario. The paper found that many ADAB projects documented an increased number of bidders on a given paving project by allowing both the asphalt and concrete paving industries to compete, as well as a trend of overall bid price reduction for both pavement types. One surprising finding was that when the agency competed asphalt and concrete pavement types on a head-to-head basis without a life cycle cost adjustment factor that concrete won 67% of the time. The paper concludes that head-to-head competition of the two pavement types not only eliminates the industry-based controversy of how to properly compute a rational life cycle adjustment factor but also simplifies the procurement process by allowing current market pricing to determine the pavement type based on hard facts rather than tenuous academic assumptions.

1 INTRODUCTION TO ALTERNATIVE DESIGN/ALTERNATE BID FOR HIGHWAY PAVEMENT TYPES

Owner agencies traditionally perform pavement type years in advance of a highway project by selecting a design alternative in the project planning stages (Gransberg and Scheepbouwer 2010). Agencies often use outlined pavement type selection process and procedures to come to a consensus on the pavement type (Hallin et al. 2011). An alternative approach is to develop design alternatives that are expected to provide similar level of service over an analysis period, solicit bids for both alternatives and select the most favorable bid. This process is called Alternated Design/Alternate Bid (ADAB). The goals of creating an ADAB program are to increase the number of bidders, increase competition and reduce overall agency life cycle cost (LCC). The uncertainty in price escalation over a period of time is not easily accounted for in a life cycle cost analysis performed years in advance of the project letting (Gransberg and Scheepbouwer 2010).

The alternate design-alternate bid process was authorized for use in the United States by the Federal Highway Administration (FHWA) under the Special Experimental Project 14 (SEP-14). Under this program 14 ADAB pilot projects were performed with Missouri being the first in 1996 and they remain the most active ADAB program in the USA (FHWA 2015).

A general survey on ADAB practices was sent out to State Departments of Transportation (DOT) and an 80% response rate was achieved. The goal of the survey was to understand how State Agencies use ADAB in highway projects, how these programs are structured, their role in pavement type selection and which

project factors influence the use of ADAB. The survey responses are presented and several case studies are summarized to compare and contrast the various approaches agencies have to ADAB programs and identify successful practices.

2 AGENCY USE OF ADAB

State highway agency responses to the questionnaire were compiled in 2016. Sixteen states responded they have an ADAB program. Geographically, findings show ADAB is currently being used throughout the United States and there is not a particular geographical region in the US that appears to favor ADAB use; however, the Northeastern region of the US does not appear to have active ADAB programs. Arkansas noted the longest experience with ADAB and Missouri and Florida have the most active programs with over thirty projects per year using the ADAB process. About half of the state agencies using ADAB also use these programs during design build projects in addition to traditional design-bid-build projects. Four states use performance specifications in their ADAB contracts. Figure 1 displays the relative size of ADAB programs by the number of ADAB design-bid-build projects each year.

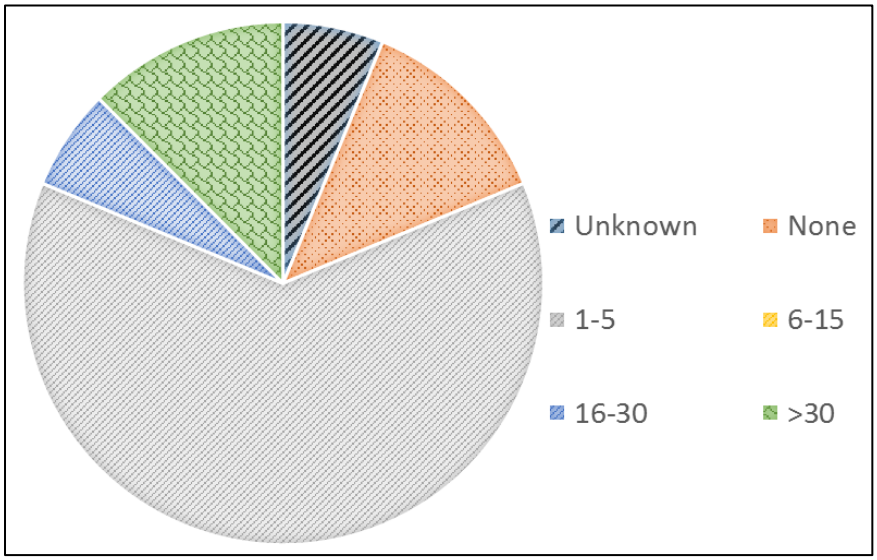


Figure 1. Estimated number of design-bid-build projects bid ADAB each year for States with ADAB programs

The average DOT's roadway network consists of 94% HMA and 6% PCC. The current pavement design methodologies are summarized in Figure 2. Pavement design parameters rely on the ability to anticipate future pavement performance. Several states are currently using performance specifications on ADAB projects. Performance Specifications for ADAB projects is an area that has been identified for future research needs. Efforts for establishing better performance specifications that would apply to ADAB are outlined in a study by De Jarnette et al (2013). This research illustrates the need to link material properties at construction with anticipated pavement performance to establish cost effectiveness of pavement materials based on performance.

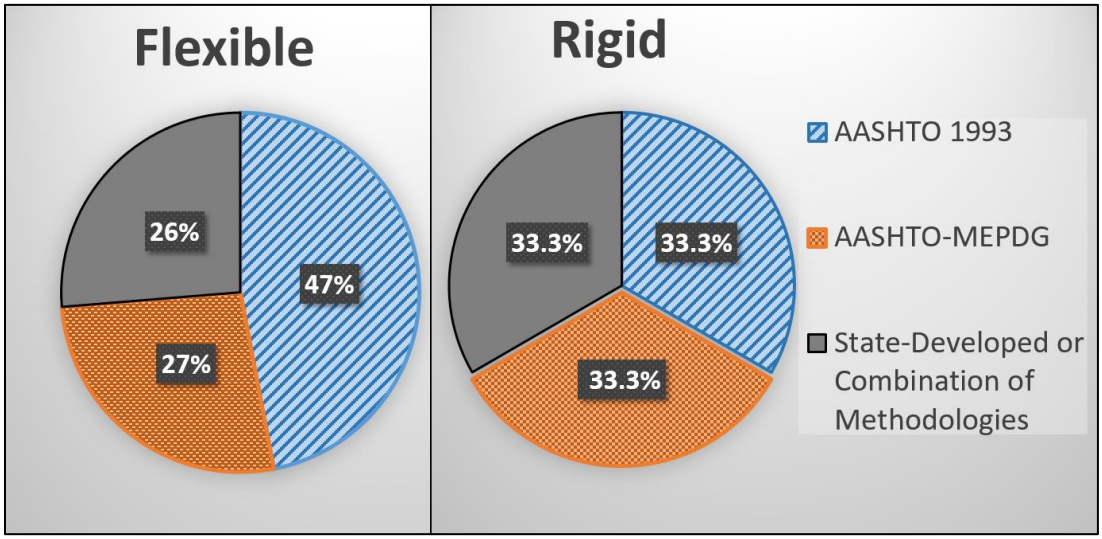


Figure 2. Survey respondent's current pavement design methodologies for flexible and rigid

A life cycle cost analysis (LCCA) is a large component of pavement type selection and a majority of states reported using the life cycle cost when selecting between different pavement alternatives, Figure 3.

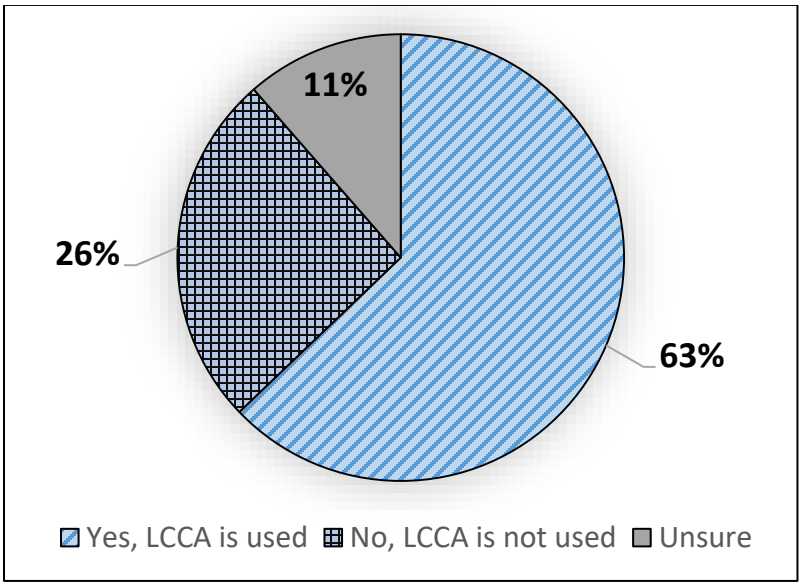


Figure 3. Percentage of Survey Respondents using LCCA when selecting between different pavement alternatives

3 PAVEMENT TYPE SELECTION AND ADAB PROJECT SUITABILITY

Many states have established pavement type selection processes to determine whether a roadway will be concrete or asphalt. The ADAB process provides an avenue for the type selection to be decided during the bidding process. Agencies were asked to select how often

project characteristics become a critical factor when choosing among competing design alternatives. The indexed responses are shown in Figure 4. Most frequently, traffic and percent of trucks will be an influential factor when comparing design alternatives. Other important factors include work zones, traffic control, safety and continuity of adjacent paving lanes. Agencies were also asked which project factors made a project less or more suitable for ADAB. The indexed responses are shown in Figure 5 and ranked by assigning a positive value for factors that make a project more suitable for ADAB, zero if a factor is neutral and factors making a project not suitable for ADAB were assigned a negative weight. The projects with high traffic loads and volumes are generally considered suitable for ADAB. Projects that are perceived as less suitable for ADAB include projects with complex or unsuitable subsoils and projects where continuity of adjacent paving lanes have to be considered.

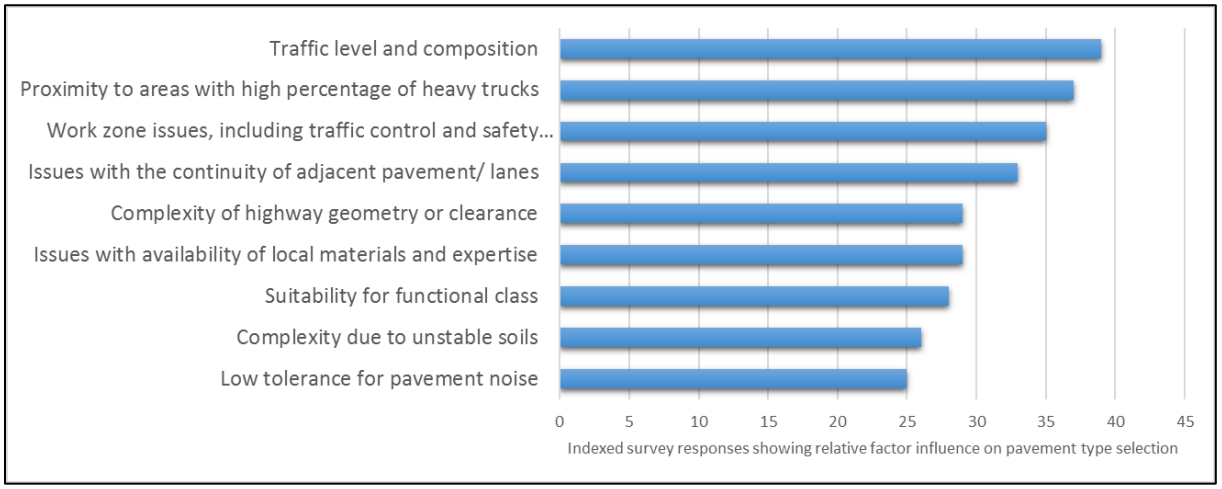


Figure 4. Ranking of project factor considered when choosing between pavement design alternatives based on survey responses

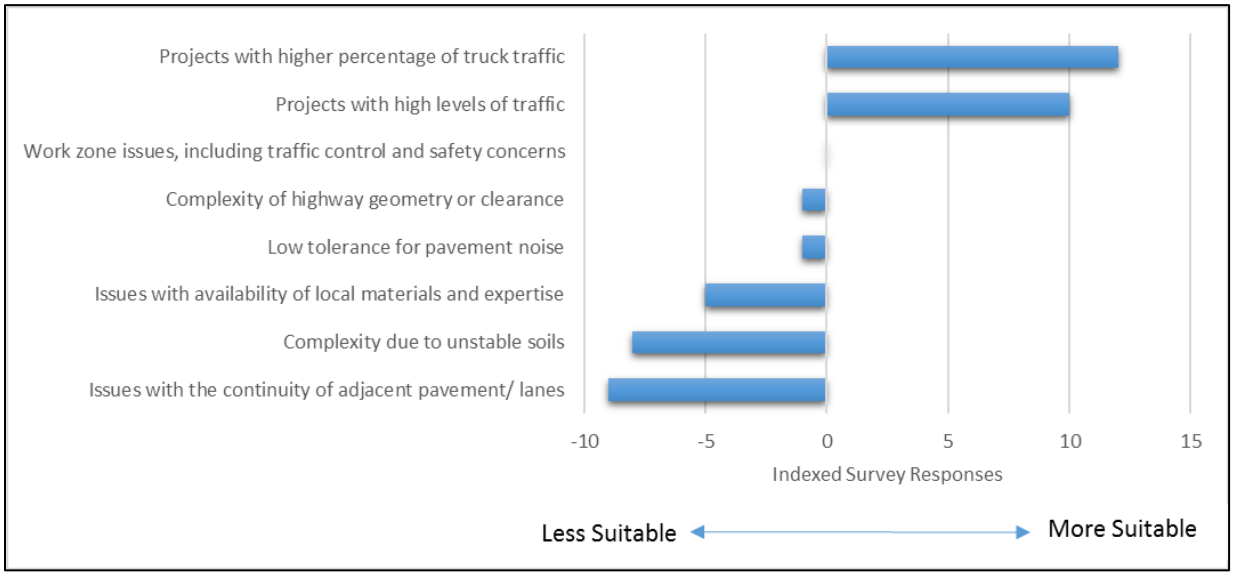


Figure 5. Project factors that make a project more or less suitable for ADAB based on survey responses

The responses show that traffic loads and volume are major factors when choosing between alternatives; however, these same factors can be accounted for during the design process allowing suitable ADAB alternatives to be developed. Highway projects with higher traffic and truck volumes are more likely to have higher pavement material and placement costs. ADAB procedures provide a way for the different materials and placement costs to be competitively bid. It is anticipated that the projects where pavement costs are the main driver of the project are most likely the projects that will benefit the most from ADAB implementation.

4 BENEFITS FOR ADAB

The responses of the State Agencies using ADAB were analyzed for the leading benefits of ADAB programs and agency thoughts about the program. The responses were given a numerical value with agreement given a positive number, maximum of two, and disagreement given a negative value, minimum of -2. First, agencies using ADAB show confidence that the ADAB projects are providing comparable design alternatives. Next, the major benefit is that ADAB does increase project competition and that it provides some cost savings to the agency. Agencies using ADAB perceive that ADAB programs do not improve the overall pavement performance or result in accelerated project completion.

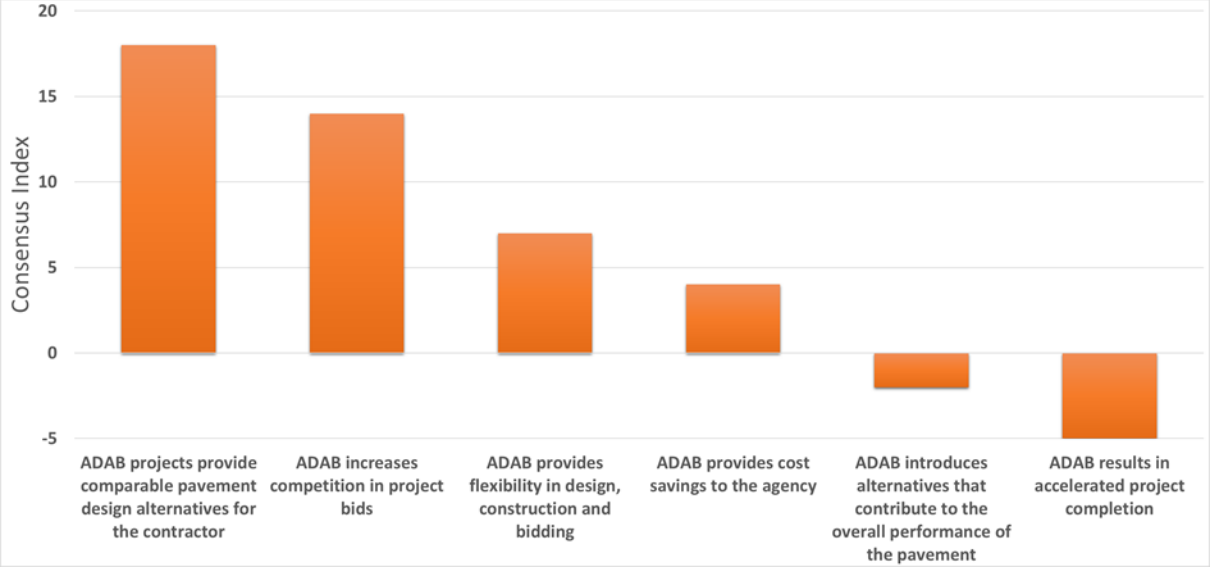


Figure 6. Indexed survey responses on ADAB program attributes and benefits

The agencies currently not using ADAB processes selected the cost savings and increased competition as for their interest in future use of ADAB. Agencies that are not interested in using ADAB in the future most often responded this is due to insufficient experience with the process.

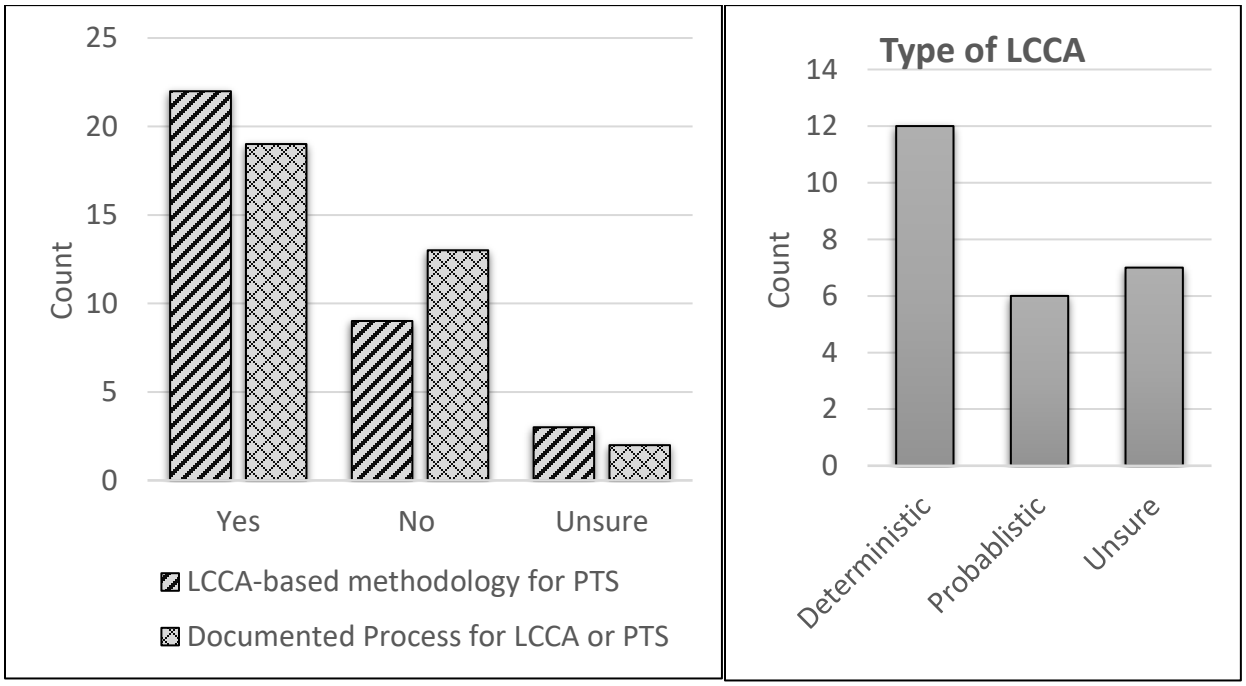
5 CHALLENGES OF ADAB AND EFFECTIVE STRATEGIES FOR IMPLEMENTATION

Many of the states that implemented ADAB mention the importance of having all parties on the same page as the ADAB process was implemented.

A challenge of ADAB is the perception that one of the alternatives is not provided with a “level playing field”. Two states responding to the survey selected there had been a protest history in ADAB contracts. Three other states answered “unsure” to this question. The FHWA SP-14 reports show that best practices recommend ensuring alternatives are relatively similar. One example is that differences in earth work requirements for the different alternatives should not drive the cost of the final winning bid (Gisi 2009, Mikesell, 2012). Missouri credits the success of their program to involving industry early during the implementation of the ADAB program so that challenges the program faces can be overcome at an early stage. The survey showed that while industry support is important, even more respondents noted that agency support and leadership were a factor for ADAB success.

6 ADAB PROGRAM COMPARISONS AND ANALYSIS

The survey aimed to better understand the processes and procedures that states are using for their ADAB programs. A majority of the respondents using ADAB programs had defined process, specifications and policies in place, as shown in Figure 7. Life cycle cost analysis is often incorporated into pavement type selection and responses show that deterministic methods are the most common, Figure 7(b). One important policy is a threshold set by the agency that defines two pavement alternatives as being essentially equal. A typical threshold is 10% difference between life cycle cost of the alternatives. A recent study showed that an agency could theoretically select the volume of projects being alternatively bid by adjusting the threshold value (Karaca et al. 2017).



(a) (b)

Figure 7. (a) Number of respondents having a documented process for LCCA, pavement type selection (PTS) and (b) LCCA-based methodology for PTS.

7 SUMMARY OF CASE STUDIES AND PROGRAM COMPARISONS

Past research has shown that LCCA is sensitive to the analysis inputs so multiple ADAB programs and case studies were compared to determine if a general consensus of successful ADAB practices can be inferred. Case studies included the following factors (Gransberg et al. 2017):

- Analyzing Life cycle cost bid adjustment factors
- Use of a construction time factor, user cost or lane rental
- Missouri's requirement of ADAB protocol on all projects greater than 7,500 square yards of continuous area (Roark 2011).
- Using data-driven framework in LCCA and ADAB procedures

Life cycle cost analysis parameters will have an influence on the final decisions. The survey results were compared to determine if a general consensus of how to implement future maintenance and rehabilitation costs into the ADAB program were analyzed. Indiana was active in the SEP-14 ADAB program and their LCCA approach accounted for crack sealing and joint sealing in pavement alternatives as part of future maintenance and rehabilitation costs. In the Indiana case study, PCC won over HMA without the life cycle cost adjustment factor in 67% of the cases; however, this is likely due to the market conditions at the time of the letting. Missouri also reported that the bid adjustment factor is responsible for selecting the winning bid in only a small percentage of projects. The dynamic nature of the economy and material prices provides ADAB programs with the opportunity to select the lowest bid based on real-time conditions and increase competition due to more than one alternative. Similar to Indiana, the Ontario Ministry of Transportation (MTO) also considers the future maintenance and rehabilitation for both PCC and HMA. These costs are added to each bid at the time of the letting. The MTO publishes the LCCA protocol in the solicitation documents. The unique aspect of MTO's approach is that it uses the actual construction bid costs in calculating the adjustment factors for each bid during the competitive bid process. Using the actual costs at the time of construction reduces the assumptions of the LCCA analysis because actual project costs are being used in the analysis.

Another important factor is the bid adjustment factor. The recently published ADAB synthesis outlines the variety of ways the bid adjustment factor can be calculated based on the life cycle cost analysis (Gransberg et al. 2017). Some agencies incentivize faster construction with the use of user costs and/or lane rental factors. The questionnaire asked how these costs are accounted for and the majority of states responding noted that user costs/time value is not considered in the adjustment factor. For agencies who consider a user costs /time costs/lane rental, these costs are kept separate from the agency costs. The allows for the agency to program according to agency costs (Hall 2007).

From the survey results, 60% of respondents using ADAB include user costs in their LCCA methodology. The individual project conditions will likely govern weather user costs are appropriate in the ADAB program. Hall et al. (2003) recommends it may be undesirable to consider all user costs because large impact on the outcome and the agency should program the funding according to agency costs.

ADAB program size can be decided by the agency. One example of a specification that makes Missouri's program the largest ADAB in the United States is the requirement of ADAB for all highway projects greater than 7,500 continuous square yards of surface area for pavement.

Missouri credits the success of their program to early industry involvement and transparency in the process.

Texas Transportation Institute funded a study that developed a framework for Texas' ADAB program called the "Alternate Pavement Design Analysis Tool". The framework is programmed to filter projects that have conditions not generally favorable to ADAB, such as a pavement widening project. The methodology uses current performance and price databases to run in the analysis. This approach helps build a network-specific decision making tool for determining the suitability of a project for ADAB procedures.

Table 1. Life cycle cost analysis Bid Adjustment Factor Summary (Gransberg et al. 2017)

Name	**Formula**	**Highway agencies**
A + C Bidding; C applied to HMA only	HMA Bid = HMA Contract Bid Amount + NPW of future HMA Rehab PCC Bid = PCCP Contract Bid Amount	KS, MT, OK,
A + C Bidding; C applied to both	HMA Bid = HMA Contract Bid Amount + NPW of future HMA Rehab PCC Bid = PCC Contract Bid Amount + NPW of future PCC Rehab	IN
A + B + C Bidding	HMA Bid = HMA Contract Bid Amount + Value of Time + NPW of future HMA Rehab PCC Bid = PCC Contract Bid Amount + Value of Time + NPW of future PCC Rehab	KY; LA
A + C + lane rental	HMA EUAC = [HMA Contract Bid Amount + Lane Rental + Future HMA Maint costs] (capital recovery factor at OMB discount rate for 26 years) PCC EUAC = PCC Contract Bid Amount + Lane Rental + Future PCC Maint costs] (capital recovery factor at OMB discount rate for 26 years)	MI
Adjustment Factor	Adjustment Factor = NPW Future Asphalt Rehab - PW Future Concrete Rehab Low bidder = lower of (PCC bid price) vs. (HMA bid price + adjustment factor) (Assuming asphalt has higher NPW M&R costs)	MO
LCC Advantage	Low bidder = lower of (PCC bid price + NPW Future Concrete M&R) vs. (HMA bid price + NPW Future HMA M&R)	ON
A – D (Alternative Differential) Bidding	Adjustment Factor = Fixed Value set by DOT for each project Low bidder = lower of (PCC bid price- adjustment factor) vs. HMA bid price (Assuming asphalt has higher NPW M&R costs)	IA
No adjustment	Low bidder = lower of PCC bid price vs. HMA bid price	AL,AR, FL, NC, OH, WV

8 SUMMARY AND CONCLUSIONS

The survey results show that ADAB programs and processes are diverse with active programs located throughout the United States. Most ADAB programs average 1-5 projects per year for

traditional design-bid-build projects. The ADAB programs were successful in increasing competition and saving the agencies money. The survey responses showed the primary benefit is increasing competition leading to cost savings and the agencies show confidence that the design alternatives are comparable. High traffic and truck volumes were found to be significant factors that agencies consider when comparing alternatives; however, projects with the higher traffic and truck volumes are alo likely to be projects that would benefit from ADAB programs. Agency responses show confidence in the ADAB program to solicit bids for comparable alternatives.

The bid adjustment factor for ADAB has been implemented in a number of different ways. Most commonly, the bid adjustment factor accounts for the difference between future maintenance and rehabilitation costs between two alternatives. In many cases, it was found that the bid adjustment fact did often not influence the final winning bid. The MTO's practice of using actual construction bid data as an input into the life cycle cost analysis to determine the winning bid reduces the uncertainty in costs used in calculating the bid adjustment factor. The ADAB study performed in Texas provided a data-driven methodology for agencies to follow to build their ADAB program.

Agencies using ADAB are seeing reduced costs and more competition on projects. Trends from the survey and literature show that pavement management systems, pavement design methodologies, performance testing and current market prices can all work together to provide a successful ADAB framework for agencies. The replacement of life cycle cost analysis assumptions with actual pavement performance and cost information will continue to improve the effectiveness of ADAB programs.

9 References

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