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NCHRP Synthesis 499: Alternate Design/ Alternate Bid Process for Pavement-Type Selection. A Synthesis of Highway Practice

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NCHRP
SYNTHESIS 499

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Alternate Design/Alternate Bid Process for Pavement-Type Selection

A Synthesis of Highway Practice

TRB TRANSPORTATION RESEARCH BOARD
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Alternate Design/Alternate Bid Process for Pavement-Type Selection

A Synthesis of Highway Practice

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2017

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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FOREWORD

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Jo Allen Gause
Senior Program Officer
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Research Board

Alternate design/alternate bid (ADAB) is a contracting technique that allows the pavement-type selection decision to be made as part of the procurement process. Contractors are permitted to bid their preferred pavement-type alternative using real-time market pricing for the paving materials. This synthesis documents the state of the practice in ADAB for pavement-type selection by highway agencies.

Information used in this study was gathered through a literature review, a survey of state departments of transportation (DOTs), review of DOT pavement design and procurement documents, and case examples

Douglas D. Gransberg, Ashley Buss, and Ilker Karaca, Iowa State University, Ames, Iowa, and Michael C. Loulakis, Capital Project Strategies, LLC, Reston, Virginia, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

ALTERNATE DESIGN/ALTERNATE BID PROCESS FOR PAVEMENT-TYPE SELECTION

SUMMARY

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. This synthesis 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. ADAB projects also document a general trend of overall bid price reduction for both pavement types. FHWA first authorized ADAB under the provisions of its Special Experimental Project 14 (SEP-14). A total of 14 ADAB pilot projects were completed under the SEP-14 program before ADAB was removed from the experimental program in 2012 and authorized for general usage nationwide.

FHWA Technical Advisory T 5040.39: *Use of Alternate Bidding for Pavement-Type Selection* states that ADAB is conducted by providing two or more equivalent pavement designs and allowing competing construction contractors to determine which pavement design is the most economical based on market conditions at the time of the letting. The FHWA Technical Advisory maintains that ADAB is "a suitable approach for determining pavement type when engineering and economic analysis does not indicate a clear choice between different pavement designs."

The objective of this synthesis is to document the state of the practice in ADAB for pavement-type selection by highway agencies. In doing so, the synthesis offers conclusions about the performance of ADAB, effective practices identified in the study, and suggestions for future research. The primary source of information was a survey of U.S. departments of transportation that resulted in 40 responses, an 80% response rate. Additionally, a comprehensive review of the literature and DOT pavement design and procurement documents was conducted. Finally, case studies were conducted on the ADAB programs in five DOTs and the Ontario Ministry of Transportation to provide an in-depth look at the mechanics of typical ADAB programs.

The synthesis found that implementing ADAB contracts can lead to increased competition and reduced pavement material costs. Most of the DOT survey respondents who did not use ADAB were interested in future implementation to avail themselves of those demonstrated benefits. ADAB has demonstrated its potential to provide a level playing field for both the hot mix asphalt (HMA) and portland cement concrete (PCC) paving industries. Its major benefit is the ability to reduce biases and satisfy local preferences by allowing the marketplace to pick the most economic pavement type based on real-time pricing for both alternatives at bid opening.

The synthesis also identified a number of effective practices by DOTs that have implemented ADAB. One effective practice is to use industry outreach programs during the implementation of ADAB programs to enhance transparency of the process as well as ensure the final procedures are both understood and acceptable. Giving the paving industry

a voice in the development of ADAB procedures enhances the long-term effectiveness of the overall program. Leaders in both the HMA and PCC paving industries have shown support for ADAB procurement.

Last, the synthesis identified needs for future research studies. Research investigating the relationships between material properties, performance, and cost that results in proposed ADAB project material specifications is recommended. Additional research is sought to integrate the mechanistic-empirical pavement design guide into the ADAB process.

CHAPTER ONE

INTRODUCTION TO ALTERNATE DESIGN/ALTERNATE BID

INTRODUCTION

> "The pavement-type selection process involves a level of risk for an agency due to the potential variations in material costs and performance. Volatility of pavement materials costs may make it more difficult to select the most cost effective pavement structure for a project."
>
> FHWA Technical Advisory T 5040.39 (2012)

Alternate design/alternate bids (ADAB) is a contracting technique in which the pavement-type selection decision is made as part of the procurement process. This synthesis studied ADAB contracts for pavement reconstruction or pavement replacement. According to FHWA's Technical Advisory T 5040.39 (FHWA 2012), alternate bidding for pavement type can be accomplished by developing two or more equivalent pavement designs and allowing competing construction contractors to determine which pavement design is the most economical to bid based on market conditions at the time of the letting. The FHWA Technical Advisory suggests that ADAB is "a suitable approach for determining pavement type when engineering and economic analysis does not indicate a clear choice between different pavement designs." As currently implemented, ADAB procedures often incorporate a life-cycle cost (LCC)-based bid adjustment factor that attempts to portray the value added by building a longer-lasting, lower-maintenance pavement structure. By delaying the pavement-type selection decision until the day of the project's letting, the risk of material price volatility is mitigated by allowing the head-to-head competition of both hot mix asphalt (HMA) and portland cement concrete (PCC) at their real-time market prices at bid opening (Ahlvers 2010).

One commonly cited ADAB benefit is an increased number of bidders on a given paving project, leading to the reduction in unit prices for both HMA and PCC. Temple et al. (2004) found that ADAB provides a process for the pavement-type selection to be made through the bid process. The paper also documents the increased competition among the paving industries and the cost savings recognized by the administrating agency. The ADAB process documented in this study incorporates the life-cycle cost analysis (LCCA) of pavement alternatives. The ADAB process moves away from selecting the alternative based on lowest initial construction cost and often incorporates LCC and time factors of equivalently designed pavement alternatives. The ongoing interest in implementing ADAB policies has established the need to benchmark the state of the practice in ADAB to chronicle both successes and challenges. By consolidating the knowledge and experience gained to date, the synthesis will serve as a reference for public agencies considering implementation of ADAB processes.

SYNTHESIS OBJECTIVE

The objective of this synthesis is to provide a state-of-the-practice documentation for ADAB for pavement-type selection by transportation agencies. The synthesis compares the ADAB practices being used with those documented in *NCHRP Report 703: Guide for Pavement-Type Selection* and FHWA Technical Advisory T 5040.39. This synthesis also provides a resource for highway agencies interested in ADAB procedures that lead to pavement-type selection on highway projects.

BACKGROUND

ADAB pilot projects were first implemented under FHWA's Special Experimental Project 14 (SEP-14) (FHWA 2015). In 1996, Missouri became the first state to request alternate pavement-type bidding under SEP-14 (FHWA 2015). Since then, 14 ADAB pilot projects have been completed under that program. In 2012, ADAB was removed from the experimental program and authorized by FHWA for general use nationwide. The Missouri Department of Transportation (MoDOT) remains the leader in the number of projects that were let using ADAB by mandating its use on all projects with 7,500 square yards of continuous paving. From 2002 to 2015, MoDOT let 246 ADAB projects worth $2.72 billion. Of those, 169 projects worth about $2.09 bil-

lion went to PCC and the remainder went to HMA. The average number of bidders was 5.7 for ADAB projects versus 4.4 for conventional paving projects, similar to other values reported in the literature (Ahlvers 2010). From 2002 to 2010, the average unit prices for HMA and PCC paving dropped 5.1% and 8.6%, respectively (Ahlvers 2010). The Indiana DOT (INDOT 2011) reported similar results in its SEP-14 ADAB projects, with 4.3 bidders on conventionally bid projects and 6.4 bidders on its ADAB projects—an overall savings of 9.0% in 2010 and 5.7% in 2011.

The cost savings documented in the literature illustrate that ADAB can be implemented in a manner that achieves the stated goals of the program. However, in light of the competitive nature of the paving industry, agencies are faced with the question of how to most effectively implement ADAB procedures in a manner perceived to be fair and transparent to the agency's industry partners. The remainder of this synthesis will be devoted to documenting observed effective practices, case studies, and the synthesis of the ADAB literature.

KEY DEFINITIONS

To ensure that the information contained in the synthesis is fully understood by the reader, a number of key definitions of the technical terms used in the report are essential. These terms are defined here and can be found in a glossary at the end of this report. The definitions are divided into three categories: pavement design terms, procurement terms, and LCCA terms.

Pavement Design Terms

Key pavement design–related terms are defined here.

- Alternate bid: The practice of providing two or more alternate design alternatives and allowing competing contractors to bid using real-time market pricing (FHWA 2012).
- Alternate design: The practice of generating equivalent pavement design alternatives for the purposes of implementing the most economical design (FHWA 2012).
- Design life: The length of time for which a pavement structure is being designed based on structural distresses and traffic loadings (Hallin et al. 2011).
- Equivalent design: Designs that provide similar levels of service over the same performance period, and have similar life-cycle costs (FHWA 2012).
- Rehabilitation: The act of restoring a pavement to a former condition (Hallin et al. 2011).
  - Major rehabilitation "consists of structural enhancements that both extend the service life of an existing pavement and/or improve its load-carrying capability" (AASHTO 2015).
  - Minor rehabilitation is nonstructural enhancements made to the existing pavement sections to eliminate age-related, top-down surface cracking that develops in flexible pavements as a result of environmental exposure (FHWA 2 http://www.fhwa.dot.gov/pavement/preservation/091205.cfm).
- Service life: The period of time from completion of construction until the structural integrity of the pavement is determined to be unacceptable and rehabilitation/replacement is required (Hallin et al. 2011).

Procurement Terms

Key procurement-related terms are defined here.

- Cost plus time (A+B) bidding: Contractors are required to bid a contract amount, which is defined as the sum bid for the contract's work items and the number of days specified by the contractor to complete the work. The "A" portion of the bid is the contract amount and the "B" portion is the number of days. The number of days (B) is multiplied by the road user cost (RUC) to determine the value of the time bid. The sum of the cost and time bids is used only to determine the successful bidder. The contract is awarded to the qualified contractor who bids the lowest combination of cost and time (Anderson and Russell 2001). Other variations also include A+C or A+B+C, where "C" is user costs, LCCs, or costs associated with construction duration (Wimsatt et al. 2009).
- Design-bid-build (DBB): A project delivery method in which the public agency provides the design and solicits bids for the construction of the specified design.
- Design-build (DB): A project delivery method in which the public agency combines procurement for both design and construction services into a single contract and from the same private-sector entity.

LCCA Terms

Key LCCA-related terms are defined here. The definitions come from *NCHRP Report 703: Guide for Pavement-Type Selection* (Hallin et al. 2011).

- Analysis period: "The time period used for comparing pavement-type alternatives. An analysis period may contain several maintenance and rehabilitation (M&R) activities during the life cycle of the pavement being evaluated. The analysis period should not be confused with the pavement design or service life."
- Discount rate: "The time value of money used as the means of comparing the alternative uses for funds by reducing the future expected costs or benefits to present-day terms. Discount rates are used to reduce various costs or benefits to their present value or to uniform annual costs so that the economics of the various alternatives can be compared (approximately equal to interest minus inflation)."
- Life-cycle cost (LCC): "The total cost of ownership of a pavement section computed over the analysis period."
- Life-cycle cost analysis (LCCA): "An economic assessment of an item, area, system, or facility and competing design alternatives considering all significant costs of ownership."
- Remaining service life: "[The] structural life remaining in the pavement at the end of analysis period."
- Residual value: "[The] value of the in-place pavement materials less the cost to remove and process the materials for reuse."
- Salvage value: "The value (positive if a residual economic value is realized and negative if demolition costs are accrued) of competing alternatives at the end of the life cycle or analysis period. [It] typically consists of remaining service life and residual value."

REPORT APPROACH

The approach used to complete the synthesis relied on independent sources of information. The first was a comprehensive review of both the national and international literature. An effort was made to seek not only the most current information but also historical information so that the change, if any, over time in ADAB practices could be mapped and related to the current state of the practice. The second source of information came from the general survey responses of U.S. state highway agencies. The survey questions were based on the output of the literature review. The ADAB procedures and pavement-type selection documents written by agencies constituted the third source of information. Important points where only one source of information furnished substantive findings on ADAB programs were used to identify gaps in the body of knowledge that showed potential for future research. Similarities found between two or more sources of information were used to develop conclusions about ADAB and identify candidate ADAB practices for the list of effective practices. The following three primary review instruments were used:

1. Comprehensive literature review
2. Survey of U.S. state transportation agencies
3. Case study analysis of select U.S. and Canadian ADAB programs.

CASE STUDY METHODOLOGY

The primary objective of this chapter is to supplement the knowledge framework created through the literature reviews and agency surveys with a series of practical examples using in-depth case studies. Case studies provide a critical source of information in the synthesis by demonstrating effective practices observed in the study inside a specific DOT's context. The analysis was conducted using the following three sources:

1. Analysis of ADAB projects of different sizes, different states, and different levels of success as identified in the literature review and agency surveys;
2. Interviews of public transportation agency personnel, contractors, and consultants with ADAB experience; and
3. Published reports of ADAB case study projects from the highway and airport sectors.

The primary input to the case studies was gathered through structured interviews with agency personnel, contractors, and consultants. The structured interview outlines were developed using the method prescribed by the U.S. Government Accountability Office (GAO 1991). The GAO method states that structured interviews can be used where "information must be obtained from program participants or members of a comparison group … or when essentially the same information must be obtained from numerous people for a multiple case-study evaluation" (GAO 1991). Both conditions apply to this synthesis, making the tool appropriate for the purpose.

The process involved developing a questionnaire that was made available to each interviewee before the interview and then collecting responses in the same order using the same questions for each interviewee. The information was gathered by both face-to-face and telephone interviews. In the GAO method, ample time is allotted to ensure that the interviewee understands each question and that the data collector understands the answer. Additionally, interviewees are allowed to digress as desired, which permits the data collectors to capture additional information that was not included in the questionnaire. The output is used to present the agencies' perspective on various points analyzed in the subsequent tasks.

The case studies were collected using Yin's methodology, following Yin's three principles in the process of case study data collection:

1. Use of multiple sources,
2. Creation of a database, and
3. Maintaining a chain of evidence (Yin 2008).

The case study findings were coupled with information collected in the survey and literature review to validate any conclusion drawn from the case studies. The case studies attempted to identify both the challenges of implementing effective practices as well as the strategies that were used to meet these challenges. Inclusion of cases from individual ADAB projects and published reports also took into consideration project attributes, agency function, and geographic locale to ensure a comprehensive collection of case studies.

Literature Review

The literature review provided a wide-ranging look at the subject of ADAB. Special attention was paid to national and international experience as it may apply to state-level projects. The literature review was used to prepare the survey of state DOTs to better document agency ADAB experience. The case studies were also primarily identified in the literature and information found was used as the basis for follow-up phone interviews.

Survey of Public Highway Agencies

In addition to the content analysis, a survey was issued to state DOTs in the United States (see Appendix A for details). The general survey on ADAB practices provided responses from 40 U.S. state DOT agencies, an 80% response rate. The respondents are shown in Figure 1. One point of confusion was the survey wording of the question regarding ADAB use. A number of DOTs have used ADAB and will use it in the future given an appropriate opportunity, but they are not currently using or have not recently used ADAB, which generated a "no" answer. Those states were placed in a separate category to indicate their past use of ADAB according to available literature. For example, literature about the Louisiana ADAB program was documented in the literature (Temple et al. 2004), but the survey response shows a "no" answer. No information from nonresponding states was added to the synthesis survey discussion.

Table 1 summarizes the demographic makeup of the state DOT survey respondents that reported using ADAB. The table shows the experience each state has with ADAB projects, the predominant pavement type in each state network, contracting provisions, and any protests or litigation regarding ADAB decisions. Findings show that 11 of 16 DOTs have a formal process for selecting ADAB projects, and 10 of those 11 have made it an integral part of their standard pavement-type selection process. The average DOT has used ADAB for approximately 8 years and has completed an average of 24 ADAB projects and a median of five ADAB projects. The average DOT's road network consists of 94% HMA and 6% PCC. The road networks of the DOTs that do not use ADAB are nearly the same, with a distribution of 93% HMA and 7% PCC.

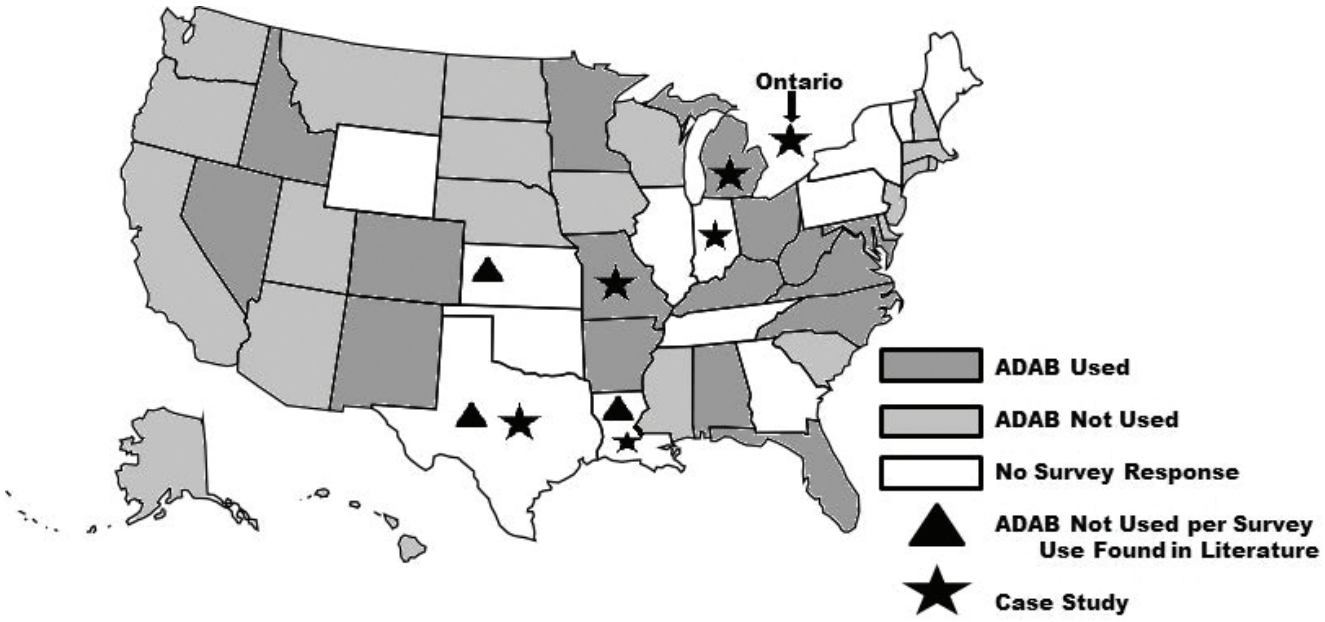

FIGURE 1 Survey response summary.

TABLE 1
SURVEY RESPONSE DEMOGRAPHICS FOR STATES USING ADAB

State	Defined ADAB processes	Defined ADAB process, specifications, and policies	ADAB experience (years)	ADAB integral part of the pavement-type selection	% concrete lane miles	% asphalt lane miles	No. of DBB—ADAB projects	No. of DB—ADAB projects	No. of DBOM—ADAB projects	No. of P3 and ADAB projects	Total ADAB projects	Performance specifications for ADAB contracts	Other ADAB special contract provisions	ADAB protest or litigation
AL	No	No	4	No	5%	95%	2	0	0	0	2	Yes	—	No
AR	No	No	25	No	3%	97%	30	0	0	0	30	—	—	?
CO	Yes	Yes	7	Yes	5%	95%	5	0	1	0	6	—	Yes	No
FL	Yes	Yes	10	No	3%	97%	?	—	—	—	—	—	—	No
ID	Yes	No	7	No	—	—	?	—	—	—	—	—	—	No
KY	Yes	Yes	10	Yes	1%	99%	5	0	0	0	5	—	Yes	No
MD	Yes	Yes	2	Yes	1%	99%	—	6	—	—	6	Yes	—	No
MI	Yes	Yes	15	Yes	—	—	20	2	0	0	22	Yes	Yes	No
MN	Yes	Yes	8	Yes	10%	90%	12	3	—	—	15	—	Yes	No
MO	Yes	Yes	12	Yes	15%	85%	200	—	—	—	200	Yes	—	No
NV	No	No	2	No	4%	96%	1	0	0	0	1	—	—	No
NM	Yes	Yes	1	Yes	5%	95%	1	0	0	0	1	—	—	?
NC	No	No	1.5	?	10%	90%	0	5	0	0	5	—	—	No
OH	Yes	Yes	6	Yes	5%	95%	25	8	0	1	34	—	—	Yes
VA	Yes	Yes	5	Yes	15%	85%	5	0	0	0	5	—	—	?
WV	Yes	Yes	9	Yes	—	—	1	—	—	—	1	—	—	No

Note: P3 = public–private partnership; — = no response; ? = unsure.

Case Study Practical Examples

Case practical examples were developed from five state DOTs and the Ontario Ministry of Transportation (MTO) in Canada. The state DOTs were Indiana, Louisiana, Michigan, Missouri, and Texas. The first four U.S. state case studies demonstrate different approaches to the ADAB process including specific outcomes for actual ADAB projects. The Texas case provides a programmatic view of the topic and reviews a decision tool developed to determine which projects are good candidates for ADAB. Ontario's MTO provides an international perspective and the use of stochastic modeling in the LCCA.

PROTOCOL TO DEVELOP CONCLUSIONS, EFFECTIVE PRACTICES, AND SUGGESTIONS FOR FUTURE RESEARCH

The major factor in developing a conclusion was the intersection of trends found in two or more review instruments. In this synthesis, the instruments used included the survey, literature and specification content review, and ADAB case studies. Similar findings identified in two or more of the review instruments provided justification to develop a conclusion. Additionally, greater authority was ascribed to information developed from the general survey of highway agencies. The literature review and specification content analysis were considered to be supporting lines of information. The case studies were then used to

validate the conclusion as appropriate because they were examples of how highway agencies in the United States and Canada have actually implemented ADAB. Effective practices were identified when a given practice was reported to be successful in the literature, and the same practice was also reported to be in use satisfactorily by agencies other than the one found in the literature, either from the survey or from case studies.

Suggestions for future research were developed based on the effective practices that were described in the literature and confirmed as effective by one of the review instruments but generally not widely used. Gaps in the body of knowledge found in this study were also used to define the areas where more research would be valuable.

ORGANIZATION OF THE REPORT

This synthesis report contains seven chapters covering the following topics:

- Chapter one: Introduction to Alternate Design/Alternate Bid
- Chapter two: Alternate Design/Alternate Bid Design Aspects
- Chapter three: Alternate Design/Alternate Bid Life-Cycle Cost Analysis
- Chapter four: Department of Transportation Alternate Design/Alternate Bid Procurement Policies, Procedures, and Programs
- Chapter five: Alternate Design/Alternate Bid Contract Administration Procedures
- Chapter six: Alternate Design/Alternate Bid Case Studies
- Chapter seven: Conclusions