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Best Practices in Pavement Design for Design-Build Projects

The purpose of this TRS is to serve as a synthesis of pertinent completed research to be used for further study and evaluation by MnDOT. This TRS does not represent the conclusions of either CTC & Associates or MnDOT.

Introduction

In the traditional construction procurement model, generally referred to as design-bid-build, the owner is responsible for the full design of a project before contractors are invited to bid on it. Design-build contracting, on the other hand, shifts responsibility for some of the design to the contractor. The owner specifies its requirements for the project and often performs some portion of the design, but some components are left to bidders to define.

MnDOT uses design-build on certain transportation construction projects within the project delivery guidelines of the Federal Highway Administration. Under its current practices, however, MnDOT specifies the pavement designs to be used. The agency was interested in investigating other states' practices for pavement design in design-build projects to determine if it is feasible to open the pavement design component of its projects to bidders, and if it is, to identify best practices for doing so. As part of this investigation, MnDOT is also interested in using alternate technical concepts in which the agency designs a project for bidding but bidders may submit alternatives that meet or exceed requirements for certain components with agency approval.

We gathered information for this report through an online survey of state departments of transportation to assess their experience with pavement design in design-build projects and through a literature search of published findings. Using those results, we worked with MnDOT to identify five respondents to interview in further detail.

Summary of Findings

Survey of State DOTs

We received 25 responses to an online survey about pavement design practices related to design-build contracts. Many respondents use design-build contracting on highway construction projects, although generally only for a small portion of their contracts. Roughly half of respondents who do use design-build contracts in highway construction leave responsibility for some aspect of pavement design to bidders, although the specific components

vary somewhat, with no clear trend. Each individual component may be left to the contractor to design by most, but not all, states that permit bidders to design pavement.

Alternative technical concepts are permitted by many of the states that use design-build contracts in highway construction, although they generally reported accepting ATCs fairly infrequently. Many states also reported using pavement warranties in their design-build projects, ranging from one to seven years, to ensure quality of the finished project.

Overview of Follow-Up Interviews

Follow-up interviews with respondents from Alaska, Colorado, Florida, Idaho and North Carolina revealed details about a range of design-build approaches. Colorado offers detailed specifications for its process in a design-build manual, while North Carolina's enabling legislation is only two paragraphs long to provide flexibility in the process (although RFPs contain details for each project, and other documents provide procedural guidance).

While most of the survey respondents reported using ATCs fairly infrequently, both Colorado and North Carolina receive large numbers of ATCs that modify projects. Both have well-established procedures to address ATCs confidentially throughout the bidding process.

Many of the interviewed states use pavement warranties in their design-build projects. However, these interviews suggest that in at least some cases, contractors take an active role in identifying and repairing problems with their work to protect their reputations and their prospects for success in future bids.

Literature Search

NCHRP has published guidelines about pavement-type selection, which cover pavement-type selection in an alternate pavement-type bidding scenario (in which the owner designs multiple pavement options that bidders can choose from in making their bids) and in design-build contracts. There are limited published case studies regarding pavement design practices in design-build contracting, however. One that discussed the reconstruction of a section of Interstate 69 in Michigan focuses on the use of alternate pavement bidding. A report on the construction of Virginia Route 288 focuses on the percent within limits specification used to ensure pavement quality in the design-build-warranty project. That report also discussed some issues with pavement design, which had to change as the project progressed because of variations in subgrade conditions throughout the project area.

Survey of State DOTs

We distributed a brief online survey on pavement design practices related to design-build contracts to nearly 50 state DOT representatives. To determine these representatives, we used contact information from a survey list of the 2006 FHWA Design-Build Effectiveness Study. Then we searched department and other websites to confirm these contacts and identify contacts for states not included. We asked all recipients to forward the survey to an appropriate person if they were not responsible for design-build contracts in their state. Minnesota was omitted from the survey as the survey sponsor as well as Alabama because its Legislature has not granted design-build authority for transportation projects. We received 25 responses to the online survey from the following states:

- Alaska
- Arizona
- Colorado
- Connecticut
- Florida
- Georgia
- Idaho
- Illinois
- Indiana
- Maine
- Maryland
- Michigan
- Nebraska
- New Hampshire
- North Carolina
- North Dakota
- Ohio
- Oklahoma
- Pennsylvania
- South Carolina
- Utah
- Vermont
- West Virginia
- Wisconsin
- Wyoming

An additional response came via email from Kansas, explaining that the state was in the procurement phase of its first design-build project and that it was unwilling to comment until the successful bid is announced.

The survey consisted of the following questions:

1. What percentage of your highway construction contracts do you let on a design-build basis? We are not currently investigating design-build-operate-and-maintain contracts, so please omit operate-and-maintain contracts from this percentage and other responses.
   - 0%
   - 1-10%
   - 11-25%
   - 26-50%
   - 51-75%
   - 76-100%

2. What is your minimum project size for design-build contracts?
   - $1 million to $5 million
   - $5 million to $20 million
   - $20 million to $50 million
   - $50 million and above

3. On what basis do you most commonly evaluate design-build bids?
   - Low-bid
   - Best-value

4. On typical design-build contracts, is there any aspect of pavement design that you allow the contractor to complete?

5. For the pavement portion of design-build projects (not design-build-operate-maintain projects), which design parameters does your agency specify and which are left to design-build bidders to propose?
   - Subbase and base thickness
   - Subbase and base material
   - Concrete panel size
   - Concrete reinforcement
   - Drainage—Subsurface
   - Drainage—Surface treatments, daylighting, etc.
   - Pavement type (asphalt, concrete)
   - Pavement mix
   - Pavement thickness

6. Do you allow pavement designs to be modified using alternative technical concepts? If yes, on what pavement elements?

7. How often do you approve pavement design modification ATCs?
   - Always
   - Often
   - Sometimes
   - Seldom
   - Never

8. Do you use any other type of preapproval method for pavement designs prior to the submission of technical proposals? If yes, please explain.

9. If you use warranties for the pavement portion of your design-build projects (not including design-build-operate-maintain projects), how long are they?

10. If you have experience allowing pavement designs to be submitted by the design-build team (not including design-build-operate-maintain projects), please briefly describe the process and reference any manuals or guidance you use.

See **Survey Results** beginning on page 18 for the full text of all survey responses.

Survey findings are summarized in seven topic areas:

- Use of design-build contracts in highway construction
- Minimum project size for design-build contracts
- Low-bid vs. best-value bid evaluation
- Pavement design by design-build bidders
- Alternative technical concepts
- Warranty use
- Process and guidance

Use of Design-Build Contracts in Highway Construction

The majority of respondents have used design-build contracting on highway construction projects. However, most states that do let highway construction projects on a design-build basis do so for only a small portion of these contracts. (Note that we omitted operate-and-maintain contracts from this question, so percentages in the table below do not include design-build-operate-and-maintain contracts.)

State Use of Design-Build Highway Construction Contracts

Design-Build Contracts as a Percentage of Highway Construction Projects	Number of States	States
26-50%	2	North Carolina,* Utah
11-25%	4	Florida, Indiana, Pennsylvania, South Carolina
1-10%	12	Alaska, Arizona, Colorado, Georgia, Idaho, Maine, Maryland, Michigan, New Hampshire, Ohio, Vermont, West Virginia
0% (no design-build program)	7	Connecticut, Illinois, Nebraska, North Dakota, Oklahoma, Wisconsin, Wyoming

*North Carolina DOT based its percentage on total dollar value of contracts rather than number of projects.

Minimum Project Size for Design-Build Contracts

Most respondents with a design-build program have a low minimum project size for design-build to be considered. All except three reported a minimum project size between $1 million and $5 million, the smallest project size category in the survey.

Minimum Design-Build Contract Value		
Minimum Design-Build Project Size	**Number of States**	**States**
$50 million +	1	Arizona
$20 million-$50 million	1	Alaska
$5 million-$20 million	1	Utah
$1 million-$5 million	15	Colorado, Florida, Georgia, Idaho, Indiana, Maine, Maryland, Michigan, New Hampshire, North Carolina, Ohio, Pennsylvania, South Carolina, Vermont, West Virginia

Low-Bid vs. Best-Value Bid Evaluation

Low-bid is the traditional method for bid evaluation: The agency awards the contract for a given project to the bidder that submits the lowest bid. In design-bid-build contracting, this can be fairly straightforward as the agency defines the work to be bid upon.

In design-build contracting, bids may not be comparable on cost alone since bidders have the authority to propose their own designs. While all designs must meet minimum standards, some may exceed them. To take this fact into consideration, some agencies use best-value evaluation in which they consider criteria other than cost in design-build bidding.

Among respondents that have design-build programs for highway construction, the majority use best-value bid evaluation. Several use a hybrid of the two methods, where cost is one of several criteria used in bid evaluation, while others have used both methods.

Low-Bid vs. Best-Value Bid Evaluation		
Evaluation Method	**Number of States**	**States**
Best-Value	11	Alaska, Colorado, Florida, Idaho, Maine, Maryland, New Hampshire, North Carolina, South Carolina, Utah, Vermont
Low-Bid	7	Arizona, Georgia, Indiana, Michigan, Ohio, Pennsylvania, West Virginia

Additional Comments

- Alaska Department of Transportation & Public Facilities generally evaluates bids on a 75% price/25% proposal basis. The low bid usually does not win the contract.
- While Georgia DOT has not used best-value evaluation in the past, it recently was granted legislative authority for best-value evaluation and is modifying its practices to do so.
- Maryland State Highway Administration uses both low-bid and best-value evaluation, depending on the project specifics. But since 2008 most projects have been best-value.
- New Hampshire DOT uses both methods, although best-value is more common.
- South Carolina DOT generally uses best-value evaluation, most often A+B with a quality credit.
- Vermont Agency of Transportation typically evaluates bids on a 60% price/40% technical merit basis. It has also used a 50%/50% split.

Pavement Design by Design-Build Bidders

Ten states—roughly half of the survey respondents that use design-build contracts for highway construction—permit bidders to perform some aspect of pavement design: Alaska, Arizona, Colorado, Florida, Idaho, Maine, Maryland, New Hampshire, North Carolina and Utah. Note that North Carolina DOT doesn't permit bidders to design specific elements. Instead, it designs asphalt or concrete pavements, or both, but permits ATCs that modify those designs.

Seven additional states—Georgia, Indiana, Michigan, Ohio, Pennsylvania, South Carolina and Vermont—have design-build programs but don't allow contractors to perform any aspect of pavement design in typical design-build contracts. West Virginia DOT does permit contractors to submit design modifications, subject to agency approval.

The survey also asked respondents to indicate whether states permitted bidders to design any of the following elements:

- Subbase and base thickness
- Subbase and base material
- Concrete panel size
- Concrete reinforcement
- Drainage—subsurface
- Drainage—surface treatments
- Pavement type
- Pavement mix
- Pavement thickness

Drainage (both subsurface and surface treatments) and pavement mix are the parameters most commonly left to bidders. The tables below provide more details about contractors' involvement in pavement design.

Contractor Allowed to Complete Pavement Design Aspects?

Response	Number of States	States
Yes	10	Alaska, Arizona, Colorado, Florida, Idaho, Maine, Maryland, New Hampshire, North Carolina,* Utah
No	7	Georgia, Indiana, Michigan, Ohio, Pennsylvania, South Carolina, Vermont
No response	1	West Virginia**

*Bidders not permitted to design specific elements. Instead, North Carolina designs asphalt or concrete pavements, or both, but permits ATCs that modify those designs.

**Design modifications subject to agency approval.

Pavement Design Aspects Left to Contractors		
Aspect	**Number of States That Leave to Contractor**	**States**
Subbase and base thickness	6	Alaska, Arizona, Idaho, Maine, Maryland, Utah
Subbase and base material	6	Arizona, Florida, Idaho, Maine, Maryland, New Hampshire
Concrete panel size	5	Arizona, Idaho, Maine, Maryland, New Hampshire
Concrete reinforcement	6	Arizona, Idaho, Maine, Maryland, New Hampshire, Utah
Drainage—subsurface	8	Alaska, Arizona, Florida, Idaho, Maine, Maryland, New Hampshire, Utah
Drainage—surface treatments, daylighting, etc.	8	Alaska, Arizona, Florida, Idaho, Maine, Maryland, New Hampshire, Utah
Pavement type (asphalt, concrete)	5	Arizona, Colorado, Idaho, Maine, Maryland
Pavement mix	8	Alaska, Arizona, Colorado, Florida, Idaho, Maine, Maryland, Utah
Pavement thickness	6	Arizona, Colorado, Florida, Idaho, Maine, Maryland

Pavement Design Aspects Left to Contractors by State		
State	**Aspects**	**Notes**
Alaska	Subbase and base thickness, drainage—subsurface, drainage—surface treatments, pavement mix	
Arizona	Subbase and base thickness, subbase and base material, concrete panel size, concrete reinforcement, drainage—subsurface, drainage—surface treatments, pavement type, pavement mix, pavement thickness	Typically lists minimum requirements. Any designs are submitted to Arizona DOT for ultimate approval.
Colorado	Pavement type, pavement mix, pavement thickness	Depends on the life cycle cost analysis.
Florida	Subbase and base material, drainage—subsurface, drainage—surface treatments, pavement mix, pavement thickness	
Idaho	Subbase and base thickness, subbase and base material, concrete panel size, concrete reinforcement, drainage—subsurface, drainage—surface treatments, pavement type, pavement mix, pavement thickness	Project-specific; Idaho Transportation Department is flexible, but will restrict certain aspects of pavement design if it cannot or will not accept design options.
Maine	Subbase and base thickness, subbase and base material, concrete panel size, concrete reinforcement, drainage—subsurface, drainage—surface treatments, pavement type, pavement mix, pavement thickness	Bidders must follow 1993 Guide for Design of Pavement Structures (AASHTO), the MaineDOT Highway Design Guide and the 2002 MaineDOT Standard Specifications. RFP provides initial and terminal serviceability, reliability level, overall standard deviation and subgrade resilient modulus.

Maryland	Subbase and base thickness, subbase and base material, concrete panel size, concrete reinforcement, drainage—subsurface, drainage—surface treatments, pavement type, pavement mix, pavement thickness	Bidders may design all project elements. However, the agency also has prescribed sections with the ability to change materials or prescribed sections. Drainage features are typically designed by bidders.
New Hampshire	Subbase and base material, concrete panel size, concrete reinforcement, drainage—subsurface, drainage—surface treatments	
North Carolina	None	Typically provides an asphalt pavement design, a concrete pavement design or both, depending on the project. ATCs can modify these designs but must meet minimum thicknesses. Bidder designs pavement needed for temporary traffic control (subject to North Carolina DOT review and approval).
Utah	Subbase and base thickness, concrete reinforcement, drainage—subsurface, drainage—surface treatments, pavement mix	Only a few best-value design-build projects completed where bidder provided pavement design. Project-specific; the agency provides minimum requirements, parameters and the range of values for those parameters based on a Utah DOT pavement design guide. Bidders aren't given free [rein] to provide any pavement type with a performance requirement (20- to 30-year design life). Utah DOT has allowed additive bids for asphalt and concrete, or set the project dollar amount and allows them to bid asphalt or concrete, with a predetermined added value for concrete.

Alternative Technical Concepts

The majority of respondents that use design-build contracts in highway construction—12 of 17—permit ATCs in some, if not all, design components. The table below identifies the states that permit ATCs and design elements that are allowed.

Alternative Technical Concepts	
States Permitting ATCs	**Design Elements Where ATCs are Permitted**
Alaska	All
Colorado	Pavement type
Florida	All, unless a project-specific need is restricted in the RFP
Idaho	[No response]
Maine	All
Maryland	Subbase material, pavement type, pavement mix and pavement material. Changes to pavement thickness are not permitted.
New Hampshire	[No response]
North Carolina	All
Ohio	Pavement thickness, based on expected traffic
South Carolina	Base and subbase
Vermont	All, with agency approval
West Virginia	All, with agency approval

Arizona, Georgia, Indiana, Michigan, Pennsylvania and Utah do not use ATCs. However, Georgia noted that it considered ATCs related to surface course, subgrade treatments and specifications on one major design-build-finance project. The state pavement engineer was responsible for final acceptance of these ATCs. Utah has occasionally accepted alternative subgrades identified in advance by design-build teams.

While the majority of respondents do permit ATCs, accepting ATCs is relatively uncommon. As shown in the table below, only two states reported accepting ATCs often.

Frequency of ATC Acceptance		
Frequency	**Number of States**	**States**
Often	2	Florida, Idaho
Sometimes	5	Alaska, Colorado, North Carolina, Ohio, South Carolina
Seldom	6	Arizona, Georgia, Maryland, New Hampshire, Utah, West Virginia
Never	5	Indiana, Maine, Michigan, Pennsylvania, Vermont

Additional Comments

- While Maine allows ATCs, it has not received any for pavement design.
- In Maryland, ATCs are typically related to reducing pavement thickness, which is not allowed in the RFP. (ATCs are not typically submitted if the bidder is responsible for complete pavement design.) The agency has approved ATCs for pavement mixes or materials on prescribed sections.
- According to state statute, Michigan DOT must provide pavement design.
- New Hampshire considers changes to wearing surface in bridge decks (concrete versus pavement).
- In Ohio, decisions regarding ATC acceptance are frequently left to individual regions of the state.
- South Carolina would not consider changes to pavement type (from concrete to asphalt or asphalt to concrete).
- While Vermont permits ATCs, to date the agency has only gone through the process for one project, and no ATC for pavement design was submitted.
- West Virginia accepted an ATC to an Interstate 81 widening project, allowing a reduction in shoulder thickness.

Only two respondents reported using any other type of preapproval method for pavement designs before technical proposals are submitted. Colorado reported using life cycle cost analysis. Idaho's conceptual design team runs multiple scenarios before the RFP to develop a range of options.

Warranty Use

Many of the survey respondents reported using warranties in design-build projects, ranging from one to seven years. Only Arizona, Georgia, Indiana, Maryland, Utah and Vermont reported no warranty usage. The following table summarizes state warranty use.

State Warranty Use in Design-Build Highway Contracts		
State	**Warranty Length**	**Notes**
Alaska	2 years	
Colorado	1-2 years	Warranties are permitted, but not usually used.
Florida	3 years (asphalt), 5 years (concrete)	Design-build firms may propose and provide longer warranties using existing parameters.
Idaho	None	The agency is currently developing a pavement warranty program for design-build contracts.
Maine	5 years	
Michigan	5 years	
New Hampshire	None	Quality assurance is accomplished through design acceptance and independent field checks.
North Carolina	12 months minimum	Design-build teams can earn extra points in bid evaluations by extending the warranty. The state is often offered five-year warranties, and occasional offers are up to 10 years.
Ohio	7 years	
Pennsylvania	5 years (special warranty provision)	The warranty provision can be used on overlay projects for the wearing and binder courses.
South Carolina	3 years	
West Virginia	3 years	

Process and Guidance

Eleven survey respondents described their process for allowing design-build teams to submit pavement designs. Several cited state manuals or AASHTO's 1993 Guide for Design of Pavement Structures. Only one response (Arizona) cited mechanistic-empirical design as guidance.

- Arizona DOT typically lists minimum requirements, and designs are submitted to the agency for final approval. As mentioned, the agency follows AASHTO 1993 or ME design.
- Colorado DOT provided the following guidance from its Design Build Manual (beginning on page 25):

  Pavement Design
  Pavement design data should consist of condition reports, existing sub-grade information, or supplemental as-built plans. End result designs, or performance provisions, should be developed based on "life-cycle-cost" and future traffic forecasts. Temporary or detour pavements should be based on existing traffic data and existing or proposed sub-grade conditions. The risks of maintenance of temporary and detour pavements should be placed completely on the Design-Build Contractor. All shoulders for final configuration alignments should be designed with the same criteria as the final end-result condition to provide safety and maximum potential for future use.

  To select a preferred pavement alternative, a Life Cycle Cost Analysis (LCCA) will be performed pursuant to the requirements of the CDOT Pavement Design Manual. When the LCCA(s) for the alternate sections are greater than *%, the Region will specify the most cost-effective alternative as the required pavement section.

When the LCCA(s) for the alternate sections is within *%, for all types of D-B project delivery methods, the Region may elect to allow alternate pavement sections on the project, or the Region will select the pavement type pursuant to the Pavement Type Selection Committee procedures in the CDOT Pavement Design Manual.

When the Region allows alternative pavement type bidding:

- For low-bid Modified Design Build Project, the bids will be adjusted by the factor specified in the Contract. The adjustment factor will be calculated pursuant to the most recent version of the Alternative Pavement Type Bidding Specification currently used for Design-Bid-Build projects. Selection of the lowest bidder will be based on the lowest adjusted bid.

- For Design-Build (D-B) and Streamlined Design-Build (SDB) projects, no cost adjustment factors will be applied to the proposals. The Design-Build Team will be required to construct the section(s) specified by the Region and described in the RFP, unless an ATC is accepted which modifies the approved section. Criteria for Best Value assessment will be determined by CDOT. The Region will determine best value assessment criteria based on project goals, risks, and Region priorities. Long-term maintenance, rehabilitation, user costs and maximizing scope are examples of acceptable Best Value criteria.

*= 10% for projects with less than $30 million in pavement materials; 15% for projects with greater than $30 million in pavement materials.

The CDOT LCCA should be included in the RFP package for information only.

- Florida DOT uses agency-approved design manuals.
- In Georgia, the design-build specification refers bidders to its Design Policies documents posted on the Georgia DOT website at http://www.dot.ga.gov/doingbusiness/PoliciesManuals/roads/Pages/DesignPolicies.aspx.
- Idaho uses the ATC process if the bidder deviates from the manuals or guidance.
- Maine refers bidders to the AASHTO 1993 Guide for Pavement Structures; Chapter 13, Flexible Pavement Design, in the MaineDOT Highway Design Guide; and the 2002 MaineDOT Standard Specifications. The agency evaluates and scores the design based on how well the bidder meets RFP requirements.
- In Maryland, the bidder must complete a pavement investigation, pavement analysis and design based on the RFP's geotechnical and pavement performance specifications, which define the performance requirements, criteria, guidelines and submittals required for both geotechnical and pavement elements. Guidelines include SHA's Pavement Design Guide, AASHTO 1993 Guide for Design of Pavement Structures, SHA Standards, SHA Specifications, and various AASHTO and ASTM requirements.
- New Hampshire DOT provides pavement design criteria through its design-build specifications.
- Pennsylvania DOT uses alternate pavement type bidding that requires bidders to determine a C factor, which accounts for future maintenance and user delay costs. The C factor is added to the construction cost so that the low bid is based on life cycle costs. More information about the C factor is available in Pennsylvania DOT's Pavement Policy Manual, Publication 242.
- Utah DOT directs bidders to information on its Pavement Management Web page.
- West Virginia refers bidders to the Division of Highways Design Directives; Standard Specifications, Roads and Bridges; and AASHTO guidance.

Overview of Follow-Up Interviews

After conducting the survey, we followed up with five respondents in Alaska, Colorado, Florida, Idaho and North Carolina to gather more details about their state's experiences with design-build in pavement projects. These interviews focused on five areas: how the design-build process is specified; general lessons learned, best practices and things to avoid regarding specific design elements; the use of ATCs in design-build projects; issues with the warranty process and the frequency with which they are enforced; and any other protests or challenges related to design-build work. These interviews revealed a number of useful insights.

Specification of the Design-Build Process

Interviewees were mixed as far as how their design-build process is specified. Colorado, for example, summarizes the state's enabling legislation in its thorough Design-Build Manual. This manual describes both administrative issues, such as the considerations used in selecting design-build contracting and the process of defining the project scope, and task activities related to project design. About two years ago, the state revised the manual to specifically address pavement design. The pavement design manual mandates an LCCA to determine the preferred pavement type. The agency will only consider alternatives if the LCCA for alternative sections are within 10 percent (15 percent on the largest projects) of the preferred type.

At the other extreme, North Carolina's enabling legislation is only about two paragraphs long, and according to Rodger Rochelle, state alternative delivery engineer, the state likes it that way. RFP documents provide the specifications for individual design-build projects. The state does offer a policy document that spells out what RFPs should contain and the two-step bid selection process, and submittal guidelines that define what bids must include, how many copies need to be submitted and who must receive them, and prerequisites for each item.

Alaska provides specifications for the design-build process primarily on a project-by-project basis through the project document. That document covers procurement and selection details, construction specifications and design guidelines. Alaska's design-build program is fairly new, however, and Steve Saboundjian, state pavement engineer, said that the project-by-project approach may evolve into universally applied guidelines as the state gains design-build experience.

Warranties

As the survey revealed, warranties are a fairly common feature among design-build transportation projects. The interviews suggested that a design-build team's interest in protecting its reputation may be more important in ensuring quality than the warranty provisions.

North Carolina requires a 12-month warranty on all projects, whether let on a design-build basis or not, and design-build projects receive extra credit for a longer warranty. Those warranties rarely need to be enforced, however. In one instance, a warranty was enforced because the contractor notified North Carolina of a problem with the project it had built and that it planned to fix the problem at its own expense.

Colorado uses warranties only on specific items of a project rather than a general warranty that covers the whole project. Nabil Haddad, innovative contracting manager, said that when warranties have been enforced, the contractors did not put up much resistance. "The Colorado contracting community is small, and they wanted to protect their name," he said.

Colorado prefers a quality assurance program to general warranties. Its contracts also have retainage provisions that delay full payment until all aspects of the project are completed. Vegetation can take a year or more to grow after construction, so issues that arise in that time will need to be addressed before payment will be made.

ATCs and Communication

Most of the interviewees noted the importance of close communication between the DOT and design-build teams during the bidding process, holding regular and confidential one-on-one meetings with the bidders to address issues as they come up, particularly related to ATCs. Colorado and North Carolina both receive large numbers of ATCs—an average of 50 per project in North Carolina and more than 100 on some projects in Colorado.

North Carolina described its ATC approval processes in detail. It offers bidders a preliminary process where they can provide a brief description of their concept to gauge its potential and avoid wasting the effort on an ATC that has no chance of being approved. The formal approval process requires a fully developed concept and review by the North Carolina Design Build Group and other relevant offices.

Rochelle said that the state's responses to ATCs can be viewed as contractual documents. When the state rejects an ATC, it revises the RFP to clarify that the concept is not permitted so other bidders do not submit a final bid that includes it. ATCs that are accepted, on the other hand, are proprietary and kept confidential, with one exception: If multiple bidders submit essentially the same ATC, the state reserves the right to consider it no longer a unique idea and incorporate it in the design.

In Florida, Alternative Contracting & Contract Administration Specialist Alan Autry said the agency learns from the ATCs it receives. Successful ATCs frequently become part of the design in similar projects that follow them.

Project Selection

Idaho and Florida both noted the importance of project selection in the success of the design-build process. Idaho's Innovative Contracting Unit has seven evaluation criteria to determine whether a project should be procured on a design-build, design-bid-build or construction manager/general contractor basis: complexity and innovation, delivery schedule, level of design, risk, agency factors, market factors and third-party coordination.

In Florida, Autry said that pavement projects tend to be appropriate for design-build when they are relatively complex, particularly when there's a well written RFP but room for innovation in the design itself.

Detailed Follow-Up Interviews

Alaska

Contact: Steve Saboundjian, State Pavement Engineer, Alaska Department of Transportation & Public Facilities, steve.saboundjian@alaska.gov, 907-269-6214.

Alaska's design-build program for highways is relatively young and includes about four projects so far, all in the Central region (which includes Anchorage). Specifications for the design-build process are primarily provided through the project document, which includes sections focusing on procurement and selection details, construction specifications (and any deviations require DOT approval) and design guidelines (which includes reference manuals, code books and specific revisions and additions from various support groups on specific elements). Saboundjian said that these project-by-project guidelines may evolve into general policies and guidelines applicable to all projects as the state gains experience in design-build.

ATCs are permitted, and Saboundjian said that the DOT is in regular contact with the design-build team to address issues early on as they arise. There are several design constraints in Alaska within which contractors must work, however. The state only uses hot-mix asphalt, with elevated base and subbase and a defined foundation.

The design-build projects in the state have experienced minimal warranty-related issues. One project, a design-build-operate contract for two years, had no issues during the two years of operations. Warranty issues with the other three projects were limited to landscaping.

One particular challenge faced by Alaska is the fact that there is limited design-build experience among contractors in the state. The private sector doesn't currently have the consulting abilities to match the construction abilities of the contractors. Saboundjian added that he expects this kind of experience to be developed as design-build is used more in the state.

Colorado
Contact: Nabil Haddad, Innovative Contracting Manager, Colorado Department of Transportation, nabil.haddad@state.co.us, 303-757-9104.

Colorado DOT has a thorough design-build manual that summarizes the state's legislation enabling design-build. Pages 25-26 describe policies related to pavement design in particular. Haddad said that this level of detail has served the state well and would recommend a similar approach to other states.

When the manual was developed in 2006, it did not contain guidance for choosing pavement type. The state has powerful lobbies for both concrete and asphalt, so this lack of guidance had proven problematic in some situations. About two years ago, Colorado DOT added new guidelines on specifying pavement type. For all design-build projects involving pavement, Colorado will perform an LCCA for both concrete and asphalt. If the total cost difference is more than 10 percent, Colorado will strictly specify either concrete or asphalt. If the cost difference is less than 10 percent, Colorado will consider a bidder's alternate proposal.

Colorado uses similar procedures for pavement thickness, although that has not been as serious an issue. ATCs related to pavement thickness are evaluated by CDOT's materials branch.

Colorado receives a wide variety of ATCs on its design-build projects, including pavement thickness, traffic control phasing issues, environmental issues and bridge structural considerations. Haddad said that some projects can have more than 100 ATCs. The odds of acceptance are pretty high—about 30 to 50 percent. "We get some great ideas, but others we have to reject. That's why we see a lot of value in this process," Haddad said.

ATCs are handled confidentially, since they often include proprietary information that bidders would not want shared with their competitors. Colorado's Innovative Contracting Branch has one-on-one meetings with the shortlisted design-build teams to either approve or reject each ATC, or refer it to specialty units at Colorado DOT for elements such as bridges that require further investigation.

While Colorado does use warranties on specific items of a project like landscaping or culverts, it does not use general warranties for whole projects. Haddad said that Colorado prefers a robust quality assurance program to warranties. Contracts also have retainage provisions, so contractors do not receive full payment until the project is completed. Since vegetation can take a year or more to grow after construction, design-build teams are still on the hook for the quality of their work for that time.

In any event, Haddad said that reputation is a stronger motivation for design-build teams than warranties or contract provisions. In some projects, slabs have settled one or two years after the project, and the contractors fixed the problems without much prodding from Colorado. "The Colorado contracting community is small, and they wanted to protect their name," Haddad said. "They know if something fails on their project, we'll ding them on future contracts." He added that because the firms made the repairs without complication, they have been considered and chosen for other projects.

Colorado has not experienced any protests, challenges or litigation in more than 20 design-build projects. "We've been very successful as far as partnering with the industry," Haddad said. Colorado DOT has dispute resolution procedures that have been used, but it allows disputes to be resolved early and at low levels rather than getting elevated.

Florida
Contact: Alan Autry, Alternative Contracting & Contract Administration Specialist, Florida Department of Transportation, alan.autry@dot.state.fl.us, 850-414-4195.

Florida has not conducted any in-depth study of its design-build program since the late 1980s. It was originally granted limited statutory authority to do a small number of projects at the time. Those projects were reviewed, and then Florida DOT received full statutory authority for design-build in 1996, based in part on the results of that review. Florida is currently planning another study of design-build projects undertaken since then to identify best practices, but they do not currently exist in a formal document.

However, Autry said that Florida DOT does learn from its experiences. An FAQ document is available on the DOT's design-build website, and more informally, best practices get rolled into the project management process. ATCs are frequently used, and Florida endeavors to learn from them as well. The state will incorporate ATCs that turn out to be suitable in the RFP for similar projects.

Autry did identify several factors that contribute to design-build success. "Project selection is really important," he said. "As you pick jobs and implement the design-build method, you may learn that in projects like a simple milling and resurfacing, the juice is not worth the squeeze." Design-build for pavement work tends to work well for relatively complex projects, particularly when there's a well-written RFP but there's room for innovation in the design.

The RFP is another critical component, and one which needs to strike a balance. "We want to allow design-build firms to innovate and push boundaries, but still comply with our standards," Autry said. The RFP should be flexible enough to accept and encourage innovation.

Autry highlighted a third area: procurement methods. Until about three years ago, the state took a traditional approach, in which Florida DOT received letters of interest and selected the firms from which it would invite proposals. Today, the state receives letters of interest and grades them, but it lets the firms know the grades they received and decide for themselves whether they wish to continue participating in the procurement process for that project.

Autry said that the state has not seen any recurring trend in the ATCs that it receives from project to project, although there may be recurring trends from firm to firm. There is extensive communication: The state holds one-on-one meetings with contractors where they can give feedback and have a dialogue about the ATCs they propose.

Challenges to the design-build process generally come from the firms that don't win contracts, and they are related to the procurement and selection method rather than design.

State statutes govern Florida's use of design-build. Statute 337.11.7 covers the majority of design-build contracts. The Innovative Contracting Statute, 337.025, also impacts some smaller projects. Rules and other guidance documents, including sample RFPs and ads, are available on the state construction office website's design-build webpage.

Idaho
Contact: Amy Schroeder, Innovative Contracting Management, Idaho Transportation Department, amy.schroeder@itd.idaho.gov, 208-334-8772.

Idaho's design-build program is relatively new. The state has seven evaluation criteria to determine whether a project should be procured on a design-build, design-bid-build or construction manager/general contractor basis: complexity and innovation, delivery schedule, level of design, risk, agency factors, market factors and third-party

coordination. So far, one paving and widening project and one bridge project have been let on a design-build basis.

Specifications for design-build projects are defined more in individual RFPs than in an overarching design-build manual. "The state's stance on design-build is to allow as much flexibility as possible to the design-build team," Schroeder said. "As long as they are meeting our requirements, it's up to the design-build team to develop the pavement section."

Design-build teams do need to follow departmental manuals and AASHTO design requirements for bridges. The state does have an ATC process, however. On the paving and widening project, most of the ATCs were related to pavement type, whether a full reconstruction was needed or if cement recycled asphalt base stabilization could be used and similar issues.

Idaho requires warranties only on seal coats and pavement markings. The agency is interested in implementing warranty requirements for design-build, but it is still working on that.

There have been no protests so far related to the state's design-build projects, one of which has been completed and one of which is in the RFP phase.

North Carolina
Contact: Rodger Rochelle, State Alternative Delivery Engineer, North Carolina Department of Transportation, rdrochelle@ncdot.gov, 919-707-6601.

North Carolina's enabling legislation for design-build is notably short—about 2 paragraphs long. "That gives us the flexibility to use design-build on any project that we deem is in the best interests of the public," Rochelle said. Certain legislators do need to be informed when design-build is used on a project greater than $50 million, but they do not have any power to approve or disapprove.

Specifications for individual design-build projects are primarily provided through RFP documents, which also reference documents like standard design manuals, standard specifications and instructional documents to aid in the preparation of components like roadway plans or signal timing plans. A 17-page policy document spells out precisely what RFPs will contain and describes the two-step process for bid selection for both best-value and low-bid processes. The agency also provides submittal guidelines, which define the number of copies required for each bid and who they go to, as well as prerequisites for various submittals. "Before we had that document, we could get a final design submittal for an item, but we couldn't review it until we had a different one approved," Rochelle said. As a result, it saves a lot of reworking for design-build teams: They may work ahead of the process if they choose, but the guidelines clearly define checkpoints for them to meet.

North Carolina has a dedicated staff for design-build. Rochelle said that makes the process fairly seamless because the same person who is writing the RFP manages the solicitation and selection process.

While the smallest projects (typically those under $15 million to $20 million) will forgo alternative technical concepts, larger projects receive an average of 50 ATCs, which Rochelle said cover all aspects of a project rather than any specific component. The ATCs received include both truly innovative ideas that change the intended design and ideas that bidders suspect is permitted under the RFP but want confirmation in writing to reduce the number of bidding contingencies.

North Carolina has two types of ATC approval processes: preliminary and formal. The preliminary process allows bidders to avoid putting a lot of effort into something that clearly won't be approved. In it, the contractor provides a short (1- to 2-page) description of its concept. The agency will either reject the ATC outright or tell the bidder to proceed to a formal approval process. The formal ATC approval process involves a fully developed concept that gets reviewed by the Design Build Group and other relevant offices.

"Our responses to ATCs are, in effect, contractual documents," Rochelle said. "We not only think about how the contractor we're writing to will respond, but also how their competitors will respond when this correspondence becomes available after the award." If a bidder submits an ATC for a specific design component that the agency decides not to allow, it generally revises the RFP to clarify what isn't permitted so other bidders (who may have interpreted the RFP as permitting that design component) don't submit a final bid that includes it.

The agency also reserves the right to revise the RFP if more than one bidder submits essentially the same ATC. While ATCs are often innovative and proprietary, if multiple bidders submit essentially the same ATC then North Carolina reserves the right to say it's not a unique idea. "We lay it out in the design to ensure that we are responding to all contractors the same way," Rochelle said.

The ATCs have provided a mechanism for North Carolina to incorporate ideas from around the country, Rochelle said. In one instance, design group members provided what they said was the only possible solution for a given intersection. The ATCs received changed the intersection design and provided savings of $35 million. "We didn't know that kind of intersection existed in the U.S., but we ultimately became the second or third state to implement it," Rochelle said.

Design-build work does require a lot of coordination between the agency and the design-build teams. "On our design-build projects we turn all right of way acquisition, utility relocation and permitting efforts over to the design-build team," Rochelle said. That makes it efficient for the agency, but the design-build team sometimes runs into problems. The agency stays involved to partner with the design-build teams and help them through those processes.

The state requires a 12-month warranty for all projects, whether let on a design-build basis or not. Design-build projects receive extra credit for a longer warranty. Bidders commonly offer five-year warranties, and the state has received bids of up to 10 years.

Rochelle said that these warranties are rarely enforced. "I can think of one instance where that occurred, and that time the contractor came to us when one of their designers noticed the problem after the facility was built and told us they were going to fix it at their own expense," he said. "I think it was a good business decision for them. It gave them more credibility on future bids."

There have been no formal protests related to the procurement process. While North Carolina uses a best-value scoring mechanism for choosing winning bids, it didn't have any impact on the first 25 to 30 design-build projects because the highest score also had the lowest bid. To minimize the possibility of any issues the first time the winning bid was not the low bid, Rochelle made a presentation to the Board of Transportation to explain the best value scoring and why the lowest bid was not selected.

The state has also implemented an express design-build program, which it uses on projects with little or no room for innovation. The express program bundles small bridge projects together into 40 to 50 contracts. The state provides estimated spans and other specifications for these bridges for bidders to base their bids on. If the final specifications are different from those estimates, the payment is adjusted accordingly. The program has been successful at getting bridges built quickly, Rochelle said. "We've also brought a lot of contractors and designers into design-build that weren't otherwise willing to take the risk."

Survey Results

The full text of each survey response is provided below. For reference, we have included an abbreviated version of each question before the response. The full question text begins on page 3 of this report. Note that if the response to question 1 was 0%, respondents were directed to skip the remaining questions.

Alaska

Contact: Steve Saboundjian, State Pavement Engineer, Alaska Department of Transportation & Public Facilities, steve.saboundjian@alaska.gov, 907-269-6214.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $20 million to $50 million.
3. **Design-build evaluation basis:** Best-value. Usually 75% Price, 25% Proposal. Usually low bid does not get project.
4. **Are pavement design aspects left to design-build contractors?** Yes.
5. **If so, which?** Subbase and base thickness, drainage—subsurface, drainage—surface treatments, pavement mix.
6. **Permissibility of Alternative Technical Concepts:** Yes; all elements.
7. **ATC approval frequency:** Sometimes.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** 2 years.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** [No response.]

Arizona

Contact: Ali Zareh, Senior Pavement Design Engineer, Arizona Department of Transportation, azareh@azdot.gov, 602-712-8082.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $50 million and above.
3. **Design-build evaluation basis:** Low-bid.
4. **Are pavement design aspects left to design-build contractors?** Yes.
5. **If so, which?** Subbase and base thickness, subbase and base material, concrete panel size, concrete reinforcement, drainage—subsurface, drainage—surface treatments, pavement type, pavement mix, pavement thickness. Typically, minimum requirements are listed by the Department and any designs are submitted to the Department for ultimate approval.
6. **Permissibility of Alternative Technical Concepts:** No.
7. **ATC approval frequency:** Seldom.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** [No response.]
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** Typically, minimum requirements are listed by the Department and any designs are submitted to the Department for ultimate approval. We follow AASHTO 1993 or [mechanistic-empirical] design.

Colorado

Contact: Nabil Haddad, Innovative Contracting Manager, Colorado Department of Transportation, nabil.haddad@state.co.us, 303-757-9104.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Best-value.
4. **Are pavement design aspects left to design-build contractors?** Yes.
5. **If so, which?** Pavement type, pavement mix, pavement thickness. Depends on the LCCA.

6. **Permissibility of Alternative Technical Concepts:** Yes; pavement type.
7. **ATC approval frequency:** Sometimes.
8. **Preapproval methods for pavement designs:** Yes; LCCA.
9. **Length of warranties:** 1-2 years. But we usually do not use them.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** From our Design-Build Manual:

    Pavement Design
    Pavement design data should consist of condition reports, existing sub-grade information, or supplemental as-built plans. End result designs, or performance provisions, should be developed based on "life-cycle-cost" and future traffic forecasts. Temporary or detour pavements should be based on existing traffic data and existing or proposed sub-grade conditions. The risks of maintenance of temporary and detour pavements should be placed completely on the Design-Build Contractor. All shoulders for final configuration alignments should be designed with the same criteria as the final end-result condition to provide safety and maximum potential for future use.

    To select a preferred pavement alternative, a Life Cycle Cost Analysis (LCCA) will be performed pursuant to the requirements of the CDOT Pavement Design Manual.

    When the LCCA(s) for the alternate sections are greater than * %, the Region will specify the most cost-effective alternative as the required pavement section. When the LCCA(s) for the alternate sections is within * %, for all types of D-B project delivery methods, the Region may elect to allow alternate pavement sections on the project, or the Region will select the pavement type pursuant to the Pavement Type Selection Committee procedures in the CDOT Pavement Design Manual.

    When the Region allows alternative pavement type bidding:
    - For low-bid Modified Design Build Project, the bids will be adjusted by the factor specified in the Contract. The adjustment factor will be calculated pursuant to the most recent version of the Alternative Pavement Type Bidding Specification currently used for Design-Bid-Build projects. Selection of the lowest bidder will be based on the lowest adjusted bid.

    - For Design-Build (D-B) and Streamlined Design-Build (SDB) projects, no cost adjustment factors will be applied to the proposals. The Design-Build Team will be required to construct the section(s) specified by the Region and described in the RFP, unless an ATC is accepted which modifies the approved section. Criteria for Best Value assessment will be determined by CDOT. The Region will determine best value assessment criteria based on project goals, risks, and Region priorities. Long term maintenance, rehabilitation, user costs and maximizing scope are examples of acceptable Best Value criteria.

    *= 10% for projects with less than $30 million in pavement materials; 15% for projects with greater than $30 million in pavement materials

    The CDOT LCCA should be included in the RFP package for information only.

Connecticut

Contact: Andrew Cardinali, Project Engineer, Connecticut Department of Transportation, andrew.cardinali@ct.gov, 860-594-3315.

1. **Percentage of highway construction contracts on design-build basis:** 0%.

Florida

Contact: Alan Autry, Alternative Contracting & Contract Administration Specialist, Florida Department of Transportation, alan.autry@dot.state.fl.us, 850-414-4195.

1. **Percentage of highway construction contracts on design-build basis:** 11-25%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Best-value.
4. **Are pavement design aspects left to design-build contractors?** Yes.
5. **If so, which?** Subbase and base material, drainage—subsurface, drainage—surface treatments, pavement mix, pavement thickness.
6. **Permissibility of Alternative Technical Concepts:** Yes. Typically wide open unless a project specific need is restricted in the RFP.
7. **ATC approval frequency:** Often. As often as possible.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** Yes. 3 years for asphalt. 5 years for concrete pavement. DB Firms may propose and provide longer periods using existing parameters.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** FDOT approved design manuals.

Georgia

Contact: Darryl VanMeter, State Innovative Program Delivery Engineer, Georgia Department of Transportation, dvanmeter@dot.ga.gov, 404-631-1703.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Low-bid. We have recently been granted legislative authority to award by means of Best Value. Our practices are being modified to reflect this.
4. **Are pavement design aspects left to design-build contractors?** No.
5. **If so, which?** None.
6. **Permissibility of Alternative Technical Concepts:** No. We did consider ATCs on a Design Build Finance project (a Major project) related to surface course, subgrade treatments, and specifications (such as another state's spec), however, final acceptance of the pavement related ATC went through the State Pavement Engineer.
7. **ATC approval frequency:** Seldom.
8. **Preapproval methods for pavement designs:** No. ATC would be the only process.
9. **Length of warranties:** N/A.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** The Design Build Spec refers proposer to the Design Policies documents, which are located at this website: http://www.dot.ga.gov/doingbusiness/PoliciesManuals/roads/Pages/DesignPolicies.aspx.

Idaho

Contact: Amy Schroeder, Innovative Contracting Management, Idaho Transportation Department, amy.schroeder@itd.idaho.gov, 208-334-8772.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Best-value.
4. **Are pavement design aspects left to design-build contractors?** Yes.
5. **If so, which?** Subbase and base thickness, subbase and base material, concrete panel size, concrete reinforcement, drainage—subsurface, drainage—surface treatments, pavement type, pavement mix,

pavement thickness. Project-specific. We allow as much flexibility as possible, but will restrict certain aspects of pavement design if the Department cannot or will not accept those options.
6. **Permissibility of Alternative Technical Concepts:** Yes.
7. **ATC approval frequency:** Often.
8. **Preapproval methods for pavement designs:** Yes; no preapproval method available to Proposers, but the conceptual design will run multiple scenarios in order to develop a range of options prior to the RFP.
9. **Length of warranties:** Not yet using pavement warranties in DB, but working on developing that.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** Through the ATC process if the Proposer deviates from the manuals/guidance.

Illinois

Contact: Roger Driskell, Acting Director of Innovative Project Delivery, Illinois Department of Transportation, roger.driskell@illinois.gov, 217-342-8201.

1. **Percentage of highway construction contracts on design-build basis:** 0%.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** We currently do not have D-B authority. We are however beginning a P3 in which we are currently reviewing and making decisions on these items. However, since this is our first project and we have not made final decisions I am unable to respond. But, I am very interested in the responses as we are moving toward D-B.

Indiana

Contact: Mark Miller, Director of Construction Management, Indiana Department of Transportation, mrmiller@indot.in.gov, 317-232-5456.

1. **Percentage of highway construction contracts on design-build basis:** 11-25%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Low-bid.
4. **Are pavement design aspects left to design-build contractors?** No.
5. **If so, which?** None.
6. **Permissibility of Alternative Technical Concepts:** No.
7. **ATC approval frequency:** Never.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** [No response.]
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** [No response.]

Maine

Contact: George Macdougall, Contracts and Specifications Engineer, Maine Department of Transportation, george.macdougall@maine.gov, 207-624-3410.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Best-value.
4. **Are pavement design aspects left to design-build contractors?** Yes.
5. **If so, which?** Subbase and base thickness, subbase and base material, concrete panel size, concrete reinforcement, drainage—subsurface, drainage—surface treatments, pavement type, pavement mix, pavement thickness. Design Build bidders must follow 1993 Guide for Design of Pavement Structures (AASHTO), the MaineDOT Highway Design Guide and the 2002 MaineDOT Standard Specifications. Initial and Terminal Serviceability, Reliability level, overall standard deviation & subgrade resilient modulus are given in the RFP.
6. **Permissibility of Alternative Technical Concepts:** Yes; all elements.
7. **ATC approval frequency:** Never. We do allow but have not received any for Pavement Design.
8. **Preapproval methods for pavement designs:** No.

9. **Length of warranties:** 5 years.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** AASHTO 1993 Guide for Pavement Structures, MaineDOT Highway Design Guide (Ch 13 - Pavement Des), 2002 MaineDOT Standard Specifications. Design is evaluated and scored based on the design build bidder meeting the requirements of the RFP.

Maryland

Contact: Jeffrey Folden, Assistant Division Chief, Innovative Contracting Division, Maryland State Highway Administration, jfolden1@sha.state.md.us, 410-545-8814.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Best-value**.** While MSHA uses both Low-bid and Best-Value depending on the project specifics, the majority of projects since 2008 have been Best-Value. Pre-2008, the majority were Low-bid.
4. **Are pavement design aspects left to design-build contractors?** Yes.
5. **If so, which?** Subbase and base thickness, subbase and base material, concrete panel size, concrete reinforcement, drainage—subsurface, drainage—surface treatments, pavement type, pavement mix, pavement thickness. The MSHA has allowed the Design-Builder to design all elements listed on projects. We, however, have also prescribed sections with the ability to change materials or prescribed sections. Drainage features such as underdrains, etc., are typically designed by the Design-Builder on all projects.
6. **Permissibility of Alternative Technical Concepts:** Yes. On projects where we did not allow the DB Team to design, we have allowed changes to the pavement type, mixes, and materials, but not thicknesses. For example, on a recent project, the MSHA prescribed [an] HMA and Concrete section and the Design-Builder was allowed to choose. They could also submit ATCs to change subbase material or pavement mix, but no changes were allowed to the thickness of either section.
7. **ATC approval frequency:** Seldom. ATCs typically would be related to reducing thickness and those changes are not allowable per the RFP. When the pavement design is 100% on the Design-Builder, ATCs are not typically submitted. We have approved ATCs for mixes or materials on prescribed sections.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** Not applicable.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** The Design-Builder must complete a pavement investigation, pavement analysis and design based on the Geotechnical and Pavement Performance Specifications included in the RFP. These sections define the performance requirements, criteria, guidelines and submittals required for both geotechnical and pavement elements. Guidelines include SHA's Pavement Design Guide, AASHTO 1993 Guide for Design of Pavement Structures, SHA Standards, SHA Specifications, and various AASHTO and ASTM requirements.

Michigan

Contact: Chris Youngs, Innovative Contracting Manager, Michigan Department of Transportation, youngsc1@michigan.gov, 517-373-0031.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Low-bid.
4. **Are pavement design aspects left to design-build contractors?** No.
5. **If so, which?** None.
6. **Permissibility of Alternative Technical Concepts:** No.
7. **ATC approval frequency:** Never; State statute requires MDOT to provide pavement design.
8. **Preapproval methods for pavement designs:** [No response.]
9. **Length of warranties:** 5 years.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** [No response.]

Nebraska

Contact: Kendall Stege, Nebraska Department of Roads, kendall.stege@nebraska.gov, 402-479-4528.

1. **Percentage of highway construction contracts on design-build basis:** 0%.

New Hampshire

Contact: Keith Cota, Chief Project Manager, New Hampshire Department of Transportation, kcota@dot.state.nh.us, 603-271-1615.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** The most used method is Best-value. We have done one D-B using low-bid.
4. **Are pavement design aspects left to design-build contractors?** Yes.
5. **If so, which?** Subbase and base material, concrete panel size, concrete reinforcement, drainage—subsurface, drainage—surface treatments.
6. **Permissibility of Alternative Technical Concepts:** Yes.
7. **ATC approval frequency:** Seldom. Consideration for change in wearing surface is discussed for bridge decks (concrete versus pavement).
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** No warranties are included in our D-B projects for pavement. We have acceptance of design and complete independent field checks in the field for quality assurance.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** NHDOT provides the pavement design criteria through our D-B specifications.

North Carolina

Contact: Rodger Rochelle, State Alternative Delivery Engineer, North Carolina Department of Transportation, rdrochelle@ncdot.gov, 919-707-6601.

1. **Percentage of highway construction contracts on design-build basis:** 26-50%. This response is based on dollar volume, not total percentage of the number of projects let.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Best-value.
4. **Are pavement design aspects left to design-build contractors?** Yes.
5. **If so, which?** None. We typically provide an asphalt pavement design, a concrete pavement design, or both depending on the project. The ATCs are permitted to modify these designs although we do have a minimum thickness that even ATCs have to satisfy. Note that any pavement needed for temporary traffic control is designed by the design-builder subject to our review and approval.
6. **Permissibility of Alternative Technical Concepts:** Yes. Any and all.
7. **ATC approval frequency:** Sometimes.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** 12 months is minimum. Then they can get extra points in the evaluation for extending the warranty. We commonly are offered 5 year warranties this way and on occasion will be offered up to ten years.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** [No response.]

North Dakota

Contact: Justin Ramsey, Technical Services Section Leader, North Dakota Department of Transportation, jramsey@nd.gov, 701-261-8293.

1. **Percentage of highway construction contracts on design-build basis:** 0%.

Ohio

Contact: Eric Kahlig, Division of Construction Management, Ohio Department of Transportation, eric.kahlig@dot.state.oh.us, 614-387-2406.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Low-bid.
4. **Are pavement design aspects left to design-build contractors?** No.
5. **If so, which?** None.
6. **Permissibility of Alternative Technical Concepts:** Yes. Have allowed some ATC to redesign thickness based off of individual expected traffic versus standard pavement thickness.
7. **ATC approval frequency:** Sometimes**.** Somewhat left up to the individual regions.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** 7 years.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** [No response.]

Oklahoma

Contact: George Raymond, Construction Engineer, Oklahoma Department of Transportation, graymond@odot.org, 405-521-2561.

1. **Percentage of highway construction contracts on design-build basis:** 0%.

Pennsylvania

Contact: Kelly Barber, Civil Engineer Consultant, Pennsylvania Department of Transportation, keluckenbi@pa.gov, 717-787-5810.

1. **Percentage of highway construction contracts on design-build basis:** 11-25%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Low-bid.
4. **Are pavement design aspects left to design-build contractors?** No.
5. **If so, which?** None.
6. **Permissibility of Alternative Technical Concepts:** No. We currently do not use ATCs with our design build projects.
7. **ATC approval frequency:** Never.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** We currently have a 5 year warranty special provision, which can be used on overlay projects for the wearing and binder courses.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** The Dept. currently uses Alternate Pavement Type Bidding with a c factor. For more information on the c factor, please see Publication 242.

South Carolina

Contact: Claude Ipock, Design-Build Engineer, Construction, South Carolina Department of Transportation, ipockcr@scdot.org, 803-737-4202.

1. **Percentage of highway construction contracts on design-build basis:** 11-25%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Best-value; most often A+B with a quality credit.
4. **Are pavement design aspects left to design-build contractors?** No.
5. **If so, which?** None.
6. **Permissibility of Alternative Technical Concepts:** Yes; bases & subbase.

7. **ATC approval frequency:** Sometimes. We would not allow the pavement type to change, i.e., from concrete to asphalt or vice versa.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** 3 years is the standard requirement for SCODT DB contracts.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** [No response.]

Utah

Contact: Michelle Page, State Construction Engineer, Utah Department of Transportation, michellepage@utah.gov, 801-965-4513.

1. **Percentage of highway construction contracts on design-build basis:** 26-50%.
2. **Minimum design-build contract size:** $5 million to $20 million.
3. **Design-build evaluation basis:** Best-value.
4. **Are pavement design aspects left to design-build contractors?** Yes.
5. **If so, which?** Subbase and base thickness, concrete reinforcement, drainage—subsurface, drainage—surface treatments, pavement mix. We have done a handful of best value design build projects where the DB was allowed to provide the pavement design. As a general rule, we tell them what the minimum requirements are and provide a list of parameters and the range of values that can be used in designing to those parameters. This is done by taking a UDOT pavement design guide, and making it project specific. We have not given the DB teams free reign to provide any type of pavement that meets a performance requirement (20-30 year design life). We have done additive bids for asphalt and concrete, or set the project dollar amount and allow them to bid asphalt or concrete, with a predetermined "added value" for concrete. Hope this helps!
6. **Permissibility of Alternative Technical Concepts:** Generally, no, but on occasion if good subgrade is identified in advance by the DB we have allowed for it to remain in place.
7. **ATC approval frequency:** Seldom, based on explanation to 6 above.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** [No response.]
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** UDOT Pavement Management Information: http://www.udot.utah.gov/main/f?p=100:pg:::1:T,V:120.

Vermont

Contact: Todd Sumner, Project Manager, Structures Section, Vermont Agency of Transportation, todd.sumner@state.vt.us, 802-828-0161.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Best-value. VTrans typically uses 60% price/40% technical merit, although we have used 50%/50%.
4. **Are pavement design aspects left to design-build contractors?** No.
5. **If so, which?** None.
6. **Permissibility of Alternative Technical Concepts:** Yes. A DB Team can always propose a change, but VTrans would need to review and approve.
7. **ATC approval frequency:** Never. VTrans has only gone through an ATC process once and no ATC for pavement design was submitted.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** Do not use.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** Not Applicable.

West Virginia

Contact: James Colby, Contract Administration Division, West Virginia Department of Transportation, james.m.colby@wv.gov, 304-558-9667.

1. **Percentage of highway construction contracts on design-build basis:** 1-10%.
2. **Minimum design-build contract size:** $1 million to $5 million.
3. **Design-build evaluation basis:** Low-bid. We have not yet utilized a best-value procurement.
4. **Are pavement design aspects left to design-build contractors?** [No response.]
5. **If so, which?** We allow the Contractor to submit design modifications which are subject to Agency approval.
6. **Permissibility of Alternative Technical Concepts:** Yes. Again, any contractor proposed design changes are subject to Agency approval prior to implementation.
7. **ATC approval frequency:** Seldom. We allowed a reduction in shoulder thickness on an interstate (I-81) widening project.
8. **Preapproval methods for pavement designs:** No.
9. **Length of warranties:** Generally three years.
10. **Process, manuals and guidance for design-build team-submitted pavement designs:** DOH Design Directives/Standard Specifications/AASHTO Guidance.

Wisconsin

Contact: Donald Miller, Wisconsin Department of Transportation, donald.miller@dot.wi.gov, 608-264-6677.

1. **Percentage of highway construction contracts on design-build basis:** 0%.

Wyoming

Contact: Ken Spear, Contracts & Estimates Engineer, Wyoming Department of Transportation, ken.spear@wyo.gov, 307-777-4150.

1. **Percentage of highway construction contracts on design-build basis:** 0%.

Literature Review

Design-build is a very broad topic, and as a result there is an extensive body of research on design-build in the literature. However, the available literature on pavement design in design-build transportation projects is significantly more limited.

NCHRP Report 703: Guide for Pavement-Type Selection, J.P. Hallin, S. Sadasivam, J. Mallela, D.K. Hein, M.I. Darter and H.L. Von Quintus, 2011.
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_703.pdf
Chapter 6 of this report presents information about alternate pavement-type bidding, and Chapter 7 provides details about contractor-based pavement selection (including design-build contracts, design-build-operate-maintain contracts and performance warranties).

Chapter 6 proposes a selection process for pavement type under an alternate pavement-type bidding system. The steps in this process follow:

1. **Identify potential pavement-type alternatives.** This step is a broad assessment of potentially feasible alternatives, based on the state's (or specific region's) experiences, for further consideration.
2. **Identify feasible pavement-type alternatives.** This step narrows the pavement-type possibilities based on the engineering and noneconomic specifics of the project.
3. **Establish suitability criteria of alternate bidding projects.** This step confirms the viability of alternate bidding for the specific project. While the report suggests agencies should develop their own criteria for making this determination, it notes that alternate bidding is suitable when there is no clear preference

among pavement types, when commodity prices at the time of contract letting are uncertain and may not reflect historical costs, when cost items affected by the alternate bid are likely to influence the determination of the low bidder or when an agency does not have historical price data for some of the feasible alternatives.

4. **Develop pavement life-cycle strategies.** This step involves determining the initial pavement structure and likely maintenance and rehabilitation activities during a selected analysis period. Realistic assessment of M&R activities is necessary for the agency to determine the life cycle cost analysis adjustment factor.
5. **Develop guidelines for conducting LCCA.** This step establishes a framework for the LCCA and develops consensus among stakeholders for it.
6. **Develop criteria for establishing equivalency of design alternatives.** These criteria will ensure that different pavement alternatives perform equally and provide the same level of service over the same performance period, with similar life cycle costs. Life cycle costs generally serve as the basis for determining this equivalency.
7. **Establish criteria for determining bid adjustment factor.** Bid adjustments are used to account for differences in costs in the long term for varying pavement alternatives. Agencies may incorporate only direct costs of M&R activities to determine bid adjustments or M&R costs plus user delay costs. This step establishes how the adjustment factor will be calculated and establishes consensus among stakeholders for that method.
8. **Use comparable project specifications.** Comparable project specifications ensure that there is no bias in favor of one alternative over another. Factors to be considered include specifying material quantities that balance material quantity risk, avoiding adjustment factors for commodity prices and identifying potential bias in quality-based incentives and disincentives.
9. **Involve industry in developing and reviewing the proposed process.** This step offers industry stakeholders the opportunity to review and raise any concerns about the proposed process before it is finalized.
10. **Implement the alternate bidding procedure.** The report recommends that agencies periodically review and evaluate the process to guide its use in future projects.

Chapter 7 describes three milestones in a contractor-based pavement-type selection process: advertising for bids, in which the agency communicates its requirements to potential contractors; bid submission, in which contractors propose pavement designs (including pavement type) that meet those requirements; and bid evaluation, in which the agency accepts or rejects proposals based upon its requirements. Table 10 (page 31 of the report) describes how responsibilities are broken down for various types of contracts. In a design-build project, many roles are shared between agency and contractor.

Several criteria can be used in evaluating contractor pavement-type proposals, including cost feasibility, M&R schedule, structural design, innovation, quality management, construction time and traffic impacts, and constructability.

The size of the pavement component of a project should be considered in deciding whether alternate pavement-type bidding should be used. As the report notes:

> When the pavement portion is a relatively small part of the project, scoring on the pavement design will not be a determining factor in the award of the project. In such cases, and where a low bid award is mandated by law, the agency should consider specifying the acceptable pavement designs in the RFP. (page 35)

In design-build projects, agencies still define the contractor's role in pavement-type selection. In an agency-specified model, the agency specifies pavement type and either the final or minimum thickness of each layer, while permitting the contractor to make necessary design adjustments. In an agency-preferred model, the agency

specifies the preferred pavement types and those that are not permitted. An agency-permitted model allows the contractor to select pavement type and perform structural design, while detailing how design inputs and outputs were determined.

Design-build contracting changes many of the traditional roles of agencies and contractors, which has also shifted how risk is allocated. Agency risks typically associated with design-build contracts include reduced performance, cost overruns, increased unplanned intervention, time delays and indirect effects such as public dissatisfaction or increased work zone accidents. The report recommends that initial costs, supplementary costs, work zone costs and noneconomic factors be included in risk analysis for design-build contracts.

Contract provisions that define contractor obligations can help to control these risks. As the report notes:

> … an agency may use performance criteria to leverage risks associated with the "pavement" component of a proposed facility. The agency then specifies performance threshold values and scheduled monitoring to ensure a desired level of service.
>
> Whenever the measured performance fails to meet the requirements, the contractor is obligated to undertake repair and rehabilitation work, and failure to maintain the threshold performance may result in disincentives. On design-build projects, where the contractor has no responsibility for operation or maintenance, it is appropriate for the agency to reduce its risk by stipulating the pavement alternative(s) suitable for use or by specifying the selection criteria for the contractor to follow. In these cases the agency should clearly indicate the procedure and inputs to be used in the pavement design. (page 32)

However, the overuse of contract provisions may lead to higher bid prices. As a result, they should be robust enough to meet agency needs but achievable enough to attract reasonable bid prices.

Special Experimental Project (SEP-14): Alternative Pavement Bidding, Christian Youngs and Benjamin Krom, Federal Highway Administration, July 10, 2009.
http://www.fhwa.dot.gov/programadmin/contracts/sep14mieval2009.cfm
One notable case study in this report was the reconstruction of a section of I-69 in St. Clair County, Michigan. This project, which was awarded in 2008 and substantially completed by September 2009, was Michigan's second to use alternate pavement bidding under SEP-14 after the 2001 construction of M-6, a limited access freeway near Grand Rapids.

The I-69 project reconstructed 6 miles of the freeway, rehabilitated five bridges, repaired a rest area and installed a weigh-in-motion station. It was a design-build-finance project that used alternate pavement bidding. This went against MDOT's usual process, which is to select a pavement option early in the design based on an LCCA. MDOT hoped that alternate pavement bidding would improve the bids it received. From the Web page:

> The SEP-14 work plan permits MDOT to develop concrete and hot mix asphalt (HMA) pavement cross-sections for a project that is structurally equivalent. HMA and concrete paving contractors are then allowed the opportunity to competitively bid on the project. This process is expected to increase competition, which may result in more favorable bids for MDOT.

MDOT developed concrete and HMA designs using its standard procedures, which in turn use the 1993 AASHTO Guide for Design of Pavement Structures. Bidders were not permitted to propose changes to these pavement designs.

To compare concrete and HMA bids, MDOT converted contractor bids to an Equivalent Uniform Annual Cost. The EUAC incorporated:

- **Initial construction costs**, as provided by the contractor in its bid
- **Future maintenance costs**, which were estimated by MDOT based on historical data
- **User delay costs**, which contractors provided based on the hourly rate MDOT charged for lane restrictions

Communication with the paving industry was valuable for the success of this project. From the Web page:

> Throughout this project MDOT has reinforced the concept that early coordination with industry is critical when introducing new methods of contract procurement. There were several industry meetings regarding the DBF concept, as well as the alternate pavement component, prior to advertising the project.

These coordination efforts included:

- A letter to the Michigan Concrete Pavement Association, the Asphalt Paving Association of Michigan and the Michigan Infrastructure and Transportation Associates that detailed how MDOT had developed the EUAC conversion equation, how it would be used in the I-69 project and how user delay costs would be determined on a lane rental basis.
- A meeting with MCPA, APAM and MITA about the alternate paving methodology. At this meeting, APAM did raise a concern about MDOT's use of a 26-year evaluation period in its LCCA, arguing that a longer period would allow it to more accurately assess pavement maintenance costs. All three organizations, however, concurred that the project should proceed under MDOT's current LCCA process.
- A post-award meeting with MCPA, APAM and MITA to discuss the project. At this meeting, the associations agreed that the evaluation methods were clear, and no issues apart from APAM's previously raised LCCA evaluation period were raised.

Final bids came in under the engineer's estimate. However, only concrete contractors submitted bids for the project. MDOT believed the earthworks needed to build the project with an HMA pavement may have made HMA cost-prohibitive. It also noted that the financial component of the project may have limited the number of potential bidders. At the post-award meeting, Michigan's pavement contracting associations did not offer any reasons that only concrete contractors submitted bids.

Because only one type of pavement was represented in the submitted bids, MDOT could not evaluate the effect of the alternate bidding component. However, MDOT believes that the alternate pavement bidding did not add any significant costs. From the Web page:

> Additional internal costs to develop the alternate pavement bidding component were minimal because the project utilized design build procurement. The procedures used on I-69 to determine the pavement sections are also performed on typical projects with pavement costs over $1,000,000. Therefore, the costs to develop the alternate pavement component would be similar to the costs needed to determine the final pavement on a traditional project.

I-69 Reconstruction Opens to Traffic: Design/Build/Finance Concept a Success, Rob Morosi, Michigan Department of Transportation, September 1, 2009.
http://www.michigan.gov/mdot/0,1607,7-151--221092--,00.html
In this press release, MDOT declared the I-69 reconstruction project in St. Clair County, Michigan, a success. According to Larry Young, manager of MDOT's Port Huron Transportation Service Center, "Using the design/build/finance concept allowed us to reconstruct the freeway well ahead of our intended 2012 timeline."

"Percent Within Limits Experience on a Design-Build Project: Virginia Route 288," James Schmidt, Darío Perdomo and Travis Cable, *Transportation Research Circular*, Number E-C105, TRB 84th Annual Meeting, September 2006.
http://onlinepubs.trb.org/onlinepubs/circulars/ec105.pdf
In 2000, the Virginia Department of Transportation awarded a $236 million design-build-warranty contract for construction of a 17.5-mile section of Route 288 near Richmond. The segment includes 28 bridges and 10 interchanges, and was completed in November 2004. While the contract was not let with an alternate pavement-type component, alternative designs were developed as construction progressed due to inconsistent ground conditions throughout the project area. The contract also used a percent within limits (PWL) specification approach to ensure quality rather than a traditional accept-reject specification system.

Alternative Designs
As the project progressed, it became apparent that not all areas of the project had the same subgrade conditions. The predominant soil was weak saturated clay dominant soils with California bearing ratio values below 5. Some areas, however, had better soils. Alternate pavement sections were designed for these sections.

Two changes to specifications were made based on initial test strips. One change was related to the higher-than-expected variability in base lift density, due largely to the incorporation of recycled asphalt pavement. Performance testing determined that the specification limits could be changed from ±2 percentage points to 3+ or -2 percentage points. Surface lift target density was also reduced from 95 percent to 94 percent after the new value was determined to improve overall quality.

Quality Issues in Construction
A quality assurance control inspection manual detailed quality assurance, inspection, materials testing, the acceptance process, incentives and disincentives, payment calculations and system implementation. The project combined process control (gradation and asphalt content) and performance-related specifications (density, thickness and smoothness) to ensure quality. All specifications required testing frequencies based on quantity rather than time: 1,200 metric tonnes for test strips; 2,400 metric tonnes for normal production; and 3,600 metric tonnes for establishing uniform production (defined as two consecutive lots that meet uniform specification compliance, verification and validation comparisons).

In general, a quality index measure determined acceptance of work, PWL and pay factors. For any lot, if the total PWL for all individual sample results was 60 percent or higher, the lot was accepted as is; if the PWL was below 60 percent, the lot was rejected and removed. All data, whether it passed the PWL requirement or not, was retained and used in pay factor calculations. Potential project incentives and disincentives ranged from a $750,000 incentive to a $2,250,000 disincentive, with 10 percent of the total to be used exclusively for smoothness. The authors of this paper asserted that the incentive/disincentive structure contributed to ensuring construction quality.

All quality testing data was maintained in a custom software package called Quality Builder. The Web-based system provided charts, graphs, summary information and real-time PWL calculations for each lot.

Training was a critical factor in meeting PWL density specifications. From the paper:

> Training the QC staff to recognize, react, and mitigate variability at all opportunities became an important factor in achieving density. Overall, training was a key determining factor in attaining quality throughout the construction of the project as changes and discoveries took place. Higher demands of PWL specifications and successful training resulted in active QC staff coordination and leadership in the overall operations of both plant and field operations (page 172).

As the project progressed, many different factors affected quality, including mix designs, material selection, equipment, site coordination and field conditions. That showed up clearly in the project's first year: Early batches

reproduced laboratory-verified mix designs, but as winter and colder temperatures approached, meeting density and asphalt content levels became difficult as the second binder lift was placed.

During the winter shutdown, the performance properties of out-of-specification materials could be assessed, and additional mechanical characterization of local project materials and mixes could be conducted. The pavement designer and warranty engineer analyzed the placed material and developed a strategy to meet design requirements.

In the second and third year, record precipitation and tornadoes hindered pavement layer compaction. To counter those conditions, the contractor adjusted production rates at the HMA plant to accommodate wet aggregates and moisture impacts, proof-rolled soils and aggregate base layers to ensure stability, and added extra equipment and crews from other regions to expedite completion.

Related Resources

Chapter 4, Design-Build, David O. Cox, Keith R. Molenaar, James J. Ernzen, Gregory Henk, Tanya C. Matthews, Nancy Smith, Ronald C. Williams, Frank Gee, Jeffrey Kolb, Len Sanderson, Gary C. Whited, John W. Wight and Gerald Yakowenko, *Contract Administration: Technology and Practice in Europe*, 2002 (updated December 5, 2013).
http://international.fhwa.dot.gov/contractadmin/04.cfm
From the abstract: In June 2001 a team comprising Federal, State, contracting, legal, and academic representatives traveled to Portugal, the Netherlands, France, and England to investigate and document alternative contract administration procedures for possible implementation in the United States. The scan team discovered that European highway agencies appear to be better exploiting the efficiencies and resources that the private sector offers, through the use of innovative financing, alternative contracting techniques, design-build, concessions, performance contracting, and active asset management. European agencies have created contracts that focus on the users, while seeking to allocate risk appropriately and establish an atmosphere of trust in the implementation of procedures. The United States can directly and immediately employ many European procedures to help cope with its most urgent transportation needs. The report discusses these European techniques in terms of procurement, contract types, and payment mechanisms.

Design-Build Project Delivery Market Share and Market Size Report, Tim Duggan and Darshan Patel, Design-Build Institute of America, May 2013.
http://www.dbia.org/resource-center/Documents/rsmeansreport_2013rev.pdf
From the overview: The purpose of this study is to determine the usage rates and calculate market size of Design-Build Project Delivery Method in Non-Residential construction market. Usage rates and market size were calculated for projects bid between 2005 and 2012. The primary delivery methods analyzed included Design-Build, CM-at-Risk and Design-Bid-Build. Market segmentation analyses delineated usage rates and market size by US Census Regions and the nine Reed Construction Data primary building types / market verticals and projects above or below $10 million. Results are given in both total project values and numbers of individual projects. Metrics calculated for 1,296 market segments (9 census regions x 9 market verticals and 2 size classes and 8 years = 1,296 market segments). Such detailed data-driven information enables differential analysis at the micro-market level, powering strategic competitive advantage in the building Project Delivery Methods.