SCAN TEAM REPORT

NCHRP Project 20-68A, Scan 07-02

Best Practices in Accelerated Construction Techniques

Supported by the

National Cooperative Highway Research Program

The information contained in this report was prepared as part of NCHRP Project 20-68A U.S. Domestic Scan, National Cooperative Highway Research Program.

SPECIAL NOTE: This report **IS NOT** an official publication of the National Cooperative Highway Research Program, Transportation Research Board, National Research Council, or The National Academies.

Acknowledgment

The work described in this document was conducted as part of NCHRP Project 20-68A, the U.S. Domestic Scan program. This program was requested by the American Association of State Highway and Transportation Officials (AASHTO), with funding provided through the National Cooperative Highway Research Program (NCHRP). The NCHRP is supported by annual voluntary contributions from the state departments of transportation. Additional support for selected scans is provided by the U.S. Federal Highway Administration and other agencies.

The purpose of each scan and of Project 20-68A as a whole is to accelerate beneficial innovation by facilitating information sharing and technology exchange among the states and other transportation agencies, and identifying actionable items of common interest. Experience has shown that personal contact with new ideas and their application is a particularly valuable means for such sharing and exchange. A scan entails peer-to-peer discussions between practitioners who have implemented new practices and others who are able to disseminate knowledge of these new practices and their possible benefits to a broad audience of other users. Each scan addresses a single technical topic selected by AASHTO and the NCHRP 20-68A Project Panel. Further information on the NCHRP 20-68A U.S. Domestic Scan program is available at:
http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1570.

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Scan 07-02
Best Practices In Accelerated Construction Techniques

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Abbreviations and Acronyms

A+B	Cost and time
AASHTO	American Association of State Highway and Transportation Officials
ABC	Accelerated bridge construction
ACB	Asphalt concrete base
ADOT	Arizona Department of Transportation
ADT	Average daily traffic
AGC	Associated General Contractors
ALDOT	Alabama Department of Transportation
ASCE	American Society of Civil Engineers
Caltrans	California Department of Transportation
CA4PRS	Construction Analysis for Pavement Rehabilitation Strategies
CAR	Contamination assessment and remediation
CCO	Contract change order
CEI	Construction, engineering, and inspection
CM/GC	Construction Manager General Contractor
CRIP	Cost reduction incentive proposal
DB	Design-build
DBB	Design-bid-build
DOT	Department of Transportation
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
GEC	General engineering consultant
I/D; I/Ds	Incentive/disincentive; incentives/disincentives
IH	Interstate Highway
JV	Joint venture
LCB	Lean concrete base
Mn/DOT	Minnesota Department of Transportation
MOT	Maintenance of traffic
MSE	Mechanically Stabilized Earth
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
PDA	Pile-driving analyzer

PIO	Public Information Officer
PRS	Pavement rehabilitation strategy; performance related specification
PS&E	Plans, specifications, and estimate
RFP	Request for proposals
RO/RI	Roll-out/roll-in
ROW	Right-of-way
SFOBB	San Francisco-Oakland Bay Bridge
SOC	Subcommittee on Construction (AASHTO)
SP	Steel pipe
SPMT	Self-propelled modular transporter
STIP	Statewide Transportation Improvement Program
TCP	Traffic control plan
TIP	Transportation Improvement Plan
TRB	Transportation Research Board
TxDOT	Texas Department of Transportation
UDOT	Utah Department of Transportation
VE	Value Engineering
WSDOT	Washington State Department of Transportation

Executive Summary

A typical highway project, allowing for planning, design, and construction, can take from 10 to 15 years from its inception to completion of construction. This extended duration has very real consequences for the American public. Therefore, transportation agencies are seeking ways to accelerate project delivery. This scan documents case studies that demonstrate how transportation projects can be delivered much more rapidly.

Background

This scan focused on construction operations and management practices to accelerate the delivery of construction projects. Visiting five states from the East to West Coasts, the scan team sought information from DOT staff and contractors on practices that accelerate project construction. The team visited with transportation leaders in:

- Jacksonville and Pensacola, Florida
- Birmingham and Montgomery, Alabama
- Houston, Texas
- Salt Lake City, Utah
- Sacramento and Oakland, California

Transportation agency representatives, contractors, suppliers, and engineering consultants having accelerated project experience shared their viewpoints and knowledge at meetings with the scan team. The team then evaluated these practices for their potential application by other transportation agencies.

Summary Observations

The team found that, for every project examined, the primary factor leading to success was a spirited effort of partnership and collaboration between the DOT and the contractor, together with a supportive design and/or design process. The following summary observations are the principal findings of the study.

Partnering – People

People are the critical element in successfully accelerating a project. Formal partnering is a beginning, but partnering is more than meetings. To accelerate a project, all team members must agree to solve issues at the lowest level and, after contract award, there must be an openness to change as more detailed project information becomes available. During these projects, every team member must exercise tremendous attention to detail and commit to a project-focused, unselfish effort to ensure that there are no interruptions in moving the construction forward. On many projects, the co-location of the DOT and contractor facilitated the partnering atmosphere. Partnering keys include:

- **Align goals to customer goals –** Develop procurement, contract provisions, and construction management methods that better align the goals of the customer, owner, and contractors. Move towards integrated teams that are formed early and focus on customer goals throughout the project development and construction life cycle. The process must begin with disciplined risk assessment and strategic project delivery decisions. These early decisions need to be supported through procurement and construction management techniques that support and motivate the teams to achieve customer goals.
- **Delegate to the lowest level –** Empower the appropriate people to make immediate decisions.
- **Timely decisions –** Have technical expertise at the project site or available at all times.

Design – Material Availability, Fabrication Time, and Logistics

Contractors must be able to procure the necessary project materials expeditiously. Designers must consider the availability of materials and the difficulties of moving and handling items such as bridge girders and precast elements. Logistics issues must be considered when selecting a design approach. Construction speed is achieved when the design allows repetition of activities. Designers should always review the standard specifications for opportunities to remove barriers to acceleration.

Planning Detailed

A detailed execution plan is a critical component of the acceleration effort, and that plan must be updated regularly.

- Include suppliers, fabricators, and equipment suppliers in the planning.
- Develop contingency plans for all possible impediments.
- Schedule concurrent activities to speed the work
- Open multiple fronts to push construction activities with more crews and equipment..
- Require that look-ahead plans be prepared at regular intervals.

Contracting Strategy –Aligned with Requirements

The contracting method needs to be aligned with the project's technical requirements, and the time constraints, type of work, traffic, and project site conditions. Allocate risk to the party best able to exercise control. Set an aggressive schedule with proper incentives, and contractors will respond to the need for acceleration. The contract must clearly define work restrictions (e.g., work hour restrictions, vibration and noise restrictions, and any regulations that will limit work or logistic activities). The use of design-build (DB) contracting will facilitate the introduction of innovation in design and construction.

New Business Model – Serve the Public

Agencies can respond to the market of public desire. Going from accelerated project construction to an accelerated project delivery attitude is possible if an agency thinks in terms of a systematic and holistic delivery approach. The lowest total project delivery cost should drive design and construction and include consideration of societal cost. When an agency involves the community, local governmental entities, and regulatory entities, and establishes project goals aligned with those interests, construction acceleration will reduce the overall cost to the community. "The public can tolerate an awful lot if you tell them ahead of time and how long."

Emergency Projects

Successful delivery of accelerated projects under emergency conditions is highly dependent upon these underlying factors:

- **Contractor** – Find a contractor that has the resources to start immediately. The contractor must have the technical capability together with the ability to mobilize the necessary people and equipment rapidly. The contractor must also have the financial capacity and established trust with suppliers and fabricators so that critical material will move with only a phone call. Communication with the DOT, engineering support, suppliers, and fabricators is critical and sometimes, in the case of emergency projects, the contractor may have to assume responsibility for establishing a communication network.
- **Experts –** Timely decisions are crucial to accelerated project completion. In the case of an emergency project, communication can be difficult and distances can create time lags; therefore, ensure that key

experts are located on the project or are immediately accessible. Decisions are best made on the project site by experts who understand all of the issues.

- **Agreement –** Develop the agreement on site with the parties responsible for execution.
- **Delgate –** Push decision making, including contract award and execution, to the lowest possible level. Empowering project personnel and the designer of record to make project decisions accelerates the work.
- **Design-Build –** Scope for the basic need and allow the contractor to develop solutions. Often design is controlled by available materials that can be drawn to the project site.

Conclusions

Much more up-front planning is required to successfully complete emergency or planned projects that require accelerated construction. Contractors seeking to accelerate their work will have to develop their construction process plans to a much greater level of detail. Additionally, the DOT must research available materials before developing a facility design.

The foundation of accelerating project construction is a design based on resources that can be moved quickly to the project site. As protection against problems that can be caused by project unknowns, the design team should strive for a conservative design. The designer must maintain flexibility in the design approach. There is going to be change and the design must be such that it can easily accommodate adjustments.

Accelerated construction is about minimizing time impacts to the public. When goals are aligned and a partnering atmosphere created, all team members view the accelerated work as an opportunity to demonstrate excellence. As the owner of one company that delivered an accelerated project ahead of schedule stated, “It’s not about making a huge profit. It’s about pride and reputation.” The Chief Engineer for the DOT affirmed that attitude.

CHAPTER 1

Introduction

Background

The planning and implementation of a complex construction project involves bringing together a diverse and dedicated team with complementary skills. Applied in concert, individual skills improve the effectiveness and efficiency of project delivery.

A number of DOTs have considerable experience with accelerated construction strategies. The California Department of Transportation (Caltrans) has had a number of accelerated construction paving projects and is the lead state for a Pavement Technology Consortium effort that includes the Washington State Department of Transportation (WSDOT), the Minnesota Department of Transportation (Mn/DOT), and the Texas Department of Transportation (TxDOT). The consortium has accomplished considerable work with accelerated pavement rehabilitation. The software "Construction Analysis for Pavement Rehabilitation Strategies" (CA4PRS) that was developed as part of this effort estimates how much pavement can be rehabilitated under a variety of traffic closure scenarios (e.g., nights, weekends, and full closures), construction schemes (i.e., concurrent or consecutive activities), and materials choices (e.g., fast-setting cements versus Type II Portland cement).

The Utah Department of Transportation (UDOT) is committed to making accelerated bridge construction the standard in Utah. UDOT envisions that it will be able to quickly assemble project plans and specifications for cost-effective, long-lasting bridges that are built rapidly while minimizing traffic disruption and congestion. Furthermore, these accelerated practices will provide improved work site safety.

Florida, Alabama, and Texas have completed in the last several years major projects that involved many aspects of accelerated construction. These projects served as the proving ground for acceleration approaches and methods. The Florida Department of Transportation (FDOT) replaced the Duval Street Bridge in Jacksonville during the off-season when the stadium to which it provided access was not being used for sports events. This was a project specifically planned for accelerated delivery. When on two occasions a fuel truck collision damaged a bridge at the I-65/I-59 interchange in Birmingham, the Alabama Department of Transportation (ALDOT) dedicated the necessary staff resources to accelerated project delivery under emergency conditions. Caltrans and TxDOT have had similar emergency bridge replacement projects, both in rural and urban settings. FDOT faced a much larger challenge when Hurricane Ivan destroyed the 2.5-mile long I-10 Bridge over the Escambia Bay in Pensacola.

Purpose and Scope

The purpose of this scan was to identify construction operational and management practices that support accelerated project construction and delivery. The scan began with the idea that the team would find agencies using new materials and contractors exploiting equipment innovations to accelerate projects. However, it soon became clear that successful project acceleration is achieved through a partnering atmosphere and selecting the appropriate contracting method that encourages a contractor to expend the planning effort and necessary resources to reduce construction time.

The scan team traveled across the United States to study experiences with accelerated construction both in emergency situations and in planned construction. It investigated construction activities for bridge construction, including the use of prefabricated components and heavy cranes/transporters. In the case of pavement construction, activity sequencing as it impacts highway closure duration and pavement sections was studied. Additionally, the team examined a tool to evaluate construction and traffic control plans.

The team evaluated practices for their potential application by transportation agencies in response to an emergency and as a way to deliver critical projects with minimum disruption to highway users. Over a two-week period, members of the team met with agencies, consulting engineers, contractors, and suppliers having experience in delivering accelerated projects. The scan team and meeting participants shared viewpoints and experiences in mutually beneficial exchanges.

Methodology

This scan employed a two-tier methodology of literature review and on-site interviews with experienced professionals. The literature review and resulting desk scan report provided the team with information for selecting locations meriting site visits. This methodology combined data from previous project reports with information gained through face-to-face interviews with government agencies and individual professionals and experts having first-hand knowledge and experience with accelerated construction practices.

Given the wide variety of scan topics and the relatively short time period for collecting information, this report is not an all-inclusive study of current activities. Rather, it provides information and an analysis of the key factors that lead to successful delivery of projects when time is of critical importance. The scan team has used its professional expertise and experience to derive qualitative judgments concerning acceleration practices.

Figure 1.1 *Accelerated Construction Scan Team*

The scan team was led by three co-chairs: Christopher Schneider (Construction & System Preservation Engineer, FHWA), Thomas Bohuslav (Director of Construction, TxDOT), and Brian A. Blanchard (Chief Engineer, FDOT). They were joined by two other DOT representatives and one member from a Turnpike Authority. The team represented a cross-section of transportation agency professionals. The team was supported by two subject matter experts who prepared the desk scan report and served as recorders during the scan. The team members are shown in Figure 1.1, and their affiliations are listed below. Biographical sketches and complete contact information for the scan team members are provided in Appendix A and Appendix B, respectively.

Front Row, left to right:

- Brian A. Blanchard, P.E. (AASHTO Co-Chair), Chief Engineer, Florida Department of Transportation
- Christopher Schneider (FHWA Co-Chair), Construction & System Preservation Engineer, Federal Highwa Administration
- Narendra Khambhati, P.E. (Coordinator), Senior Vice President, Arora and Associates, P.C.

Back Row, left to right:

- Richard Sheffield, P.E., Assistant Chief Engineer – Operations, Mississippi Department of Transportation

- George Raymond, P.E., Division Engineer, Construction Division, Oklahoma Department of Transportation
- Thomas Bohuslav, P.E. (AASHTO Co-Chair), Director of Construction, Texas Department of Transportation
- Steven D. DeWitt, P.E., Chief Engineer, North Carolina Turnpike Authority
- Cliff J. Schexnayder, Ph.D., P.E. (Subject Matter Expert), Eminent Scholar Emeritus, Arizona State University

Not pictured:

- Stuart Anderson, Ph. D., P.E. (Subject Matter Expert), Zachry Professor in Design and Construction Integration II, Texas A&M University

Subject Matter Experts prepared a "desk scan" to select the most appropriate agencies for the scan team to visit. The object of the desk scan was to maximize the time spent by the team assessing topics of interest. The desk scan was compiled using a three-tier methodology of literature review, expert interviews, and a synthesis of practices. The methodology provided for data collection from government agencies, professional organizations, and experts with personal experience with accelerated construction. This information was assembled by a review of construction literature and through Internet contact with 16 agency and construction executives knowledgeable about accelerated construction practices around the world (Appendix C).

The desk scan identified practices in the areas of:

- Prefabricated components for bridges
- Heavy cranes/transporters for bridges
- Pavement construction
- Supporting products and technologies
- Contractor perspectives

The scan bibliography is provided in Appendix D. The desk scan identified agencies with accelerated construction experience under both emergency conditions and as a planned project delivery method. The scan team used the desk scan document to select host transportation agencies (Appendix E) and to draft a series of amplifying questions to further define the panel's objectives. Appendix F contains the amplifying questions that were sent to the host agencies before the visits.

Although many DOTs could provide meaningful information on accelerated construction, the scan tour's time limitation meant that the scan team had to select the most significant opportunities to gain the maximum amount of information during its site visits. The team's primary targets were agencies with the most intense experience in the widest variety of areas, including accelerated bridge construction under emergency conditions, heavy lifts, and the use of varied approaches to accelerated pavement construction. The team was seeking information about:

- Using different contracting methods for rapid construction
- Using precast components
- Making heavy lifts
- Staffing accelerated projects (because in many cases the contractor works 24 hours a day, 7 days a week)
- Setting the time portion for contracts for which contractors bid time

The delegation visited the southeast U.S. from March 1 through March 7, 2009, then the western U.S. from

March 22 through March 28, 2009. Specifically, the scan team visited:

- Jacksonville and Pensacola, Florida
- Birmingham and Montgomery, Alabama
- Houston, Texas
- Salt Lake City, Utah
- Sacramento and Oakland, California

The visits consisted of a combination of site visits and meetings with highway agency personnel, contractors, fabricators, and design engineers.

CHAPTER 2

Emergency Accelerated Construction

Introduction

When Minnesota's I-35W Bridge across the Mississippi River in Minneapolis collapsed on August 1, 2007, the Minnesota Department of Transportation (Mn/DOT) was faced with the challenge of rapidly replacing a structure that carried more than 140,000 vehicles a day. The urgency of reopening the Interstate Highway (IH) was heightened because the loss of the bridge increased commuter costs significantly and put a severe traffic burden on surrounding roads.

Mn/DOT chose to accelerate the delivery of the I-35W Mississippi River replacement bridge project using the DB procurement method. A casting yard for the precast concrete segments was set up on the closed interstate highway pavement just south of the bridge and the segments were delivered to the bridge construction location by barge. By these efforts, Mn/DOT and its contractor were able to complete the replacement bridge in less than a year (see Figure 2.1).

Many other DOTs have faced similar situations where a river crossing or roadway needed to be reopened with only minimum inconvenience to the traveling public after a sudden event had severely damaged or destroyed the system structure. The scan team, therefore, sought to identify the key factors that led to a DOT's success in delivering an emergency project under emergency conditions. The underlying fundamentals of success that the team identified are listed at the end of each of the individual project sections that follow.

Figure 2.1 *Construction of the I-35W Bridge in Minneapolis*

Replacement of the I-65/I-59 Interchange Bridges, Birmingham, Alabama

On Saturday morning, January 5, 2002, a tanker truck loaded with gasoline crashed into a bridge pier in the northbound lanes of Interstate 65, killing the driver. The fiery crash (see Figure 2.2) virtually destroyed the overhead steel girder bridge carrying the southbound lanes of I-65. This location in the I-65/I-59 interchange handles 240,000 vehicles per day (100,000 on I 65 and 140,000 on I-59/I-20). Temperatures in excess of 2,000 °F caused the bridge girders to sag 8 feet and extensively damaged the columns, caps, and pavement.

Figure 2.2 *Gasoline tanker truck on fire under the bridge*

Project Description (The First Time)

The replacement three-span, 290-ft bridge designed by ALDOT was longer and wider to provide additional future lanes for southbound traffic on the bridge and for northbound traffic moving under the bridge. Design options considered included:

- Replacing Spans 1 and 2 and bent 2 only using plans from the original bridge (i.e., replace in kind, steel girders)
- Replacing the entire bridge with a one-span bridge with steel girders perpendicular to the roadway (eliminating skew)
- Replacing the entire bridge using three-span AASHTO Type IV modified PSC girders

The ALDOT decided to use a precast concrete girder design to replace the bridge because the girders could be fabricated and delivered to the site faster than steel. [1]

[1]"Precast Helps Rebuild Bridge in Record Time," Ascent, Precaset/Prestressed Concrete Institute, Chicaglo, IL., Summer 2002, www.pci.org/view_file.cfm?file=AS-02SU-5.PDF

Project Execution

The main span required 15 140-ft-long girders. The original ALDOT design was for AASHTO Type IV modified girders but that was changed as a result of a value engineering (VE) proposal submitted by the contractor. The contractor's VE proposal specified modified bulb-tee girders (BT-54). These girders were 54 inches in height with an 8-inch web, a 44-inch top flange, and a 28-inch bottom flange. A standard BT-54 has a 6-inch web, a 26 -inch bottom flange, and a 42-inch top flange. The design required an increase in the cross-sectional properties of the standard BT-54 in order to provide the structural capacity needed for the 140-foot span. This modified section also provided better lateral stability during transport and erection of the girders. The two end spans each required eight standard BT-54 girders 70 feet 2 ¾ inches long.

This was a calendar day project, and the contractor received an early completion incentive bonus of $1.3 million as shown in Table 2.1. To complete the project, the contractor drove 160 HP 12 × 53 steel piles, placed approximately 820 cubic yards of substructure concrete, and 825 cubic yards of superstructure concrete. Fourteen hours were lost due to weather. The complete timeline is shown in Table 2.2

	Cost
Second low bid amount	$3,780,654.15
Low bid	$2,096,421.20
Incentive, 52 Days @ $25,000	$1,300,000.00
Total (low bid + incentive)	$3,396,421.20
Net Difference (w/incentive in first and second bidder)	$384,232.95
Square foot bridge cost	$60 without incentives
Square foot bridge cost	$97 with incentives

Table 2.1 *I-65 bridge replacement cost (2002)*

Date	Event	Day	Const. Day
5 Jan. 2002	Saturday morning; tanker accident 5 p.m., demolition work begins, DOT and contractor working together	1	
6 Jan. 2002	Sunday morning; Transportation Director and staff meet and decide to: ❖ Remove the entire bridge ❖ Design a new bridge (design/plans by ALDOT Bridge Bureau) ❖ Select five reputable bridge contractors to bid	2	
7 Jan. 2002	Monday 9 a.m., I-65 NBL opens to traffic; work starts on design for new bridge	3	
8 Jan. 2002	Tuesday, preliminary plans to contractors	4	
10 Jan. 2002	Thursday, demolition completed	7	
12 Jan. 2002	Saturday, p.m., complete plans to contractors	8	
14 Jan. 2002	Monday 1 p.m., pre-bid with five contractors	10	
16 Jan. 2002	Wednesday 10 a.m., bids opened*	12	
18 Jan. 2002	Friday, notice to proceed†	14	
21 Jan. 2002	Monday 12:01 a.m., construction begins	17	1
7 Feb. 2002	Thursday 8 p.m., northbound lanes of I-65 closed to set girder over the travel lanes. All 15 140-ft girders in place before dawn on 8 Feb.	34	18
26 Feb. 2002	Paving and striping completed	53	37
27 Feb. 2002	Opens to traffic (54 days after the accident)	54	38

* By state law, if an emergency occurs, the Director of Transportation has to write a letter to the Finance Director stating that the Department is operating in an emergency. Headquarters in Montgomery decides who gets a contract, but the recommendation is made locally.

† The director awards the contract, but the governor signs all contracts and all supplemental agreements.

Table 2.2 *I-65 bridge replacement timeline (2002)*

Project Description (Déjà Vu: Same Interchange, Different Bridge)

On October 21, 2004, it happened again: a fully loaded tanker truck turned over on a ramp carrying the eastbound lanes of I-20 (see Figure 2.3). The tanker exploded in a ball of flame and again the bridge's overhead steel girders were severely damaged.

ALDOT engineers drew on their earlier experience and quickly chose precast concrete for the project. "We gave only a cursory consideration to steel. It would have taken far too long to replace the bridge with another steel-girder structure. Fabrication, erection, and painting of the bridge would have required two to three months."[2]

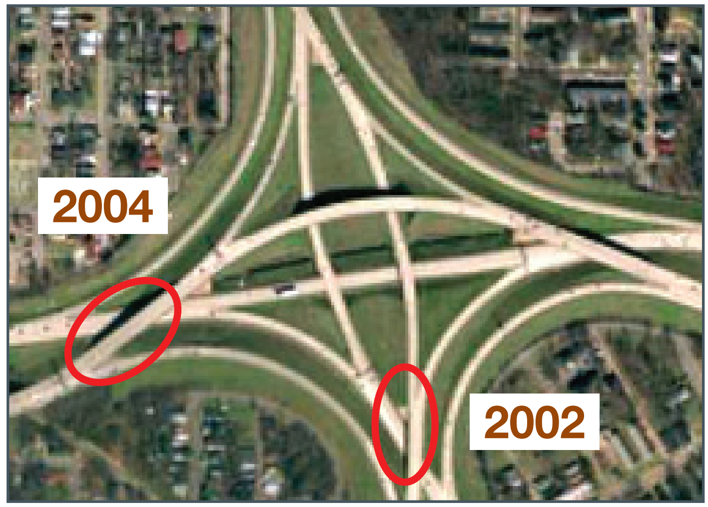

Figure 2.3 *Sites of the 2002 and 2004 accidents*

The second bridge replacement contract included an incentive clause that awarded the contractor $50,000 per day for each day the project was completed prior to December 31, 2004. A disincentive clause was also included at $50,000 for every day later than December 31 (see Table 2.3).

	Cost*
Second low bid amount	$5,535,693
Low bid	$5,450,000
Incentive, 27 Days @ $50,000	$1,350,000
Total (low bid + incentive)	$6,800,000
*Total cost including bridge and road work	

Table 2.3 *I-65 bridge replacement cost* (2004)*

Project Execution

The precast concrete girders specified for this bridge replacement required a special design. Each of the three spans had 12 66-inch bulb tees. The girders had lengths of 87 feet 3 inches, 151 feet 3 inches, and 163 feet 9 inches. That final length, 163 feet 9 inches, was 25 feet longer than any girder ever shipped in the state. The components were specially modified, high-performance concrete (HPC), AASHTO-PCI modified bulb-tee 63 girders, to which 2 inches of width and 3 inches of depth were added for strength and to allow additional prestressing steel. The concrete strength requirement for the girders was 7,500 psi at release and 8,500 psi at 14 days.

[2] "Precast Aids Fast Track Bridge Replacement Again," Ascent, Precast/Prestressed Concrete Institute, Chicago, IL, Spring 2006, www.pci.org/pdf/publications/ascent/2005/Spring/AS-05SP-5.pdf

The engineering manager for the prestressing yard said that, "At 2.9 million pounds, the prestressing was the highest force we ever pulled. We were concerned about the stability of the beams. We especially wanted to make sure that they would withstand shipping and erection." To answer the shipping question, the fabricator conducted transportation tests in the yard prior to shipping the girders the 12 miles to the site. The first girders were delivered and set in place just 16 days after the contract was let; the final girders went into place just three days after that.

The fabricator used special 13-axle vehicles to deliver the beams to the site. The Alabama State Police provided escort service in addition to the usual escorts required for transit of oversize loads. The entire project was completed and the bridge reopened to all traffic on December 4 as shown in Table 2.4. This earned the contractors a $1.35 million incentive. A comparison of the timelines for the two accelerated bridge projects is given in Table 2.5.

Date	Event	Day	Const. Day
21 Oct. 2004	Thursday tanker accident	1	
21 Oct. 2004	Demolition work begins	1	
22 Oct. 2004	Friday morning, started design for new bridge	2	
28 Oct. 2004	Thursday 10 a.m., pre-bid with invited contractors	8	
29 Oct. 2004	Friday 1 p.m., bids opened	9	
29 Oct. 2004	Friday 5:00 p.m., contract award. Completion date December 31, 2004 (62 days) with $50,000/day I/D. Shop drawing approval	9	
30 Oct. 2004	Saturday, construction begins, prestress yard casts first beam	10	1
14 Nov. 2004	Prestress yard casts last beam, Span 3 beams delivered	25	16
16 Nov. 2004	Tuesday, Interstate closed to set girders	27	18
17 Nov. 2004	Span 1 and 2 beams delivered	28	19
3 Dec. 2004	Paving, striping completed 27 days ahead of schedule	44	35
4 Dec. 2004	Opens to traffic	45	

Table 2.4 *I-65 bridge replacement timeline (2004)*

Event	Time 2002	Time 2004
Demolition	6 Days	6 Days
Design and plans	8 Days	6 Days
Advertise and bid	2 Days	1 Days
Construction	37 Days	36 Days
Detour Maintenance	54 days	46 Days

Table 2.5 *I 65 bridge replacement comparison*

Synopsis of Acceleration Efforts

Partnership

The State Bridge Engineer said, "We did things we don't normally do, working closely with each other and spending some weekends working out problems. It was refreshing to be that closely involved in a project." Decisions were made at the project level; requests and approvals were given verbally. The local FHWA provided over-the-shoulder review and on-the-spot approval of the design decisions made by the State Bridge Engineer. Occasionally the contractor was not able to meet specified pile tolerances, so ALDOT had to reevaluate strength based on actual pile locations.

Mutual Trust

ALDOT met with contractors and suppliers the week after the accident to discuss replacement bridge design plans. With the information that came from those meetings, suppliers began preparations for casting the girders.

Fabricator Collaboration

The state also entered into discussions with fabricators about prestressed girder designs well before the letting. While the design was eventually changed, the discussions were invaluable in establishing a project schedule and facilitated timely material availability.

Cooperation

DOT guaranteed one-day turnaround of shop drawings and material certifications. Additionally, the City of Birmingham adjusted the timing of 35 surface-street traffic signals to accommodate the flow of detoured traffic.

Planning

The contractor stated, "We worked on a tight schedule and did a lot of planning." ALDOT noted that the "contractor was very good at scheduling." The contractor scheduled everything in hours from the start of the project and for all suppliers. Furthermore, the contractor took the approach that the job was a cost-and-time project.

Work Multiple Fronts

On the first project, 60 workers plus considerable equipment were working many parts of the project at the same time.

Methods

A separate demolition contract began almost immediately after the incident.

The highway contractor partnered with a vertical construction contractor that had an available labor force.

Precast box culvert sections were used as shoring and footing forms (see Figure 2.4). Precast elements helped to speed construction.

An accelerator was used to obtain high early strength (7,500 psi release strength). As soon as the required strength was achieved, crews moved forward instead having the normal wait for curing. For this project, the fabricator put together a detailed production schedule. Acceleration raised the cost of the girders 1.4 times the normal selling price.

Figure 2.4 *Using precast box culvert as forms*

Many of the old piles were pulled, which made the foundation design simpler.

The state furnished the elastomeric bearings.

Only one ready-mix plant was used, and it was within visual distance of the project.

The contractor worked 24/7 until the very end of the project.

Traffic Management

Local media were a great help in educating the public and keeping it informed about the detour routes the DOT established. Additionally, ALDOT created a Web site to inform the public about detours and progress.

Right-of-Way/Environmental

No additional right-of-way (ROW) had to be purchased, and no environmental permitting was required.

Bonding

By requiring the contractors to bring the required contract bonds to the bid, ALDOT was prepared to award the contract as soon as the bids were evaluated.

Implementation of New Technology

The prestressed girder fabricator had been involved with an ALDOT HPC Showcase event years before that provided experience with 9,000 psi in 24-hour mixes. With that knowledge and ALDOT approval, the fabricator decided to implement this mix design for the project.

Project Delivery

Design-bid-build (DBB) was used for this project because of its limited scope and because the only critical aspect was material availability.

Underlying Fundamentals of Success

Teamwork is always the key element to a successful execution of an accelerated project. Both of these bridge contracts were held by the same two contractors in joint venture (JV). The success of the projects can be traced directly to the fact that both ALDOT and the contractor placed focused teams on the projects. These teams continually displayed mutual understanding and teamwork. Everyone understood the urgency of the projects and the need to open the interstate to traffic.

The design that was produced by ALDOT used materials that the department knew could be procured in the shortest timeframe – precast concrete girders. ALDOT also had the capability to produce a full design in only four and a half days.

Detailed planning and scheduling allowed the contractor to effectively attack the work on multiple fronts. The smaller JV partner (in terms of contractor volume) was a veteran bridge builder with years of experience on DOT projects. This partner, which was familiar with DOT contracting requirements, managed the projects. The other partner was a general contractor with diverse experience building health-care, industrial, office, institutional, retail, educational, and water-treatment facilities. This second contractor had little DOT experience but brought a higher standard of scheduling practice to the team.

Together the two contractors created a schedule that displayed activities by the hour.

Contractor capacity is a crucial component to successfully completing an accelerated project. Contractors must have the ability to draw people and staff the projects as necessary and an equipment fleet that can support the activity demands of working on multiple fronts. In the case of large projects, only a contractor or JV with a large capability in terms of workforce and equipment inventory has the capability to execute an accelerated project. For smaller projects, experience with transportation projects and DOT contracting requirements becomes an important selection factor. However, as these two bridge projects demonstrate, there are many ways to bring critical resources to a challenging project.

A unique aspect of the first bridge replacement contract was the use of a vertical construction contractor to furnish the labor force. Most states would question the ability of a contractor unfamiliar with highway construction to handle such a project, yet the close coordination between the JV contractors made their workforce efforts a success.

Repair and Replacement of the I-580/880 MacArthur Maze, Oakland, California

The MacArthur Maze, commonly referred to as the Maze, is a series of major interchanges east of the San Francisco-Oakland Bay Bridge (SFOBB) that distributes traffic to east-Bay freeways. The Maze connects Oakland, Berkeley, and San Francisco via five major highways. It handles approximately 80,000 vehicles daily.

At 3:41 a.m. on Sunday, April 29, 2007, a tanker truck carrying 8,600 gallons of gasoline overturned on the southbound I-880 connector structure, spilling its cargo and catching on fire. The fire reached temperatures in excess of 1,500 F, which caused the structural steel in the I-580 connector immediately above the burning truck to soften and eventually collapse (see Figure 2.5).

This collapse closed both the southbound I-880 and eastbound I-580 connectors, interrupting SFOBB traffic as shown in Figure 2.6. The portion that collapsed was built in 1955 and underwent a major seismic retrofit after the 1989 Loma Prieta earthquake.

The collapsed 160-foot long portion of I-580 was 51 feet wide and encompassed the steel girders on both sides of the bent as well as the bent cap. The failed spans had six steel girders with a 45 foot-wide concrete deck. The I-880 connector sustained less damage.

Figure 2.5 *MacArthur Maze bridge damage*

Project Description

The governor issued an emergency declaration, and Caltrans began immediate repair and replacement of the interchange. This declaration streamlined public contracting and environmental codes and provided emergency funding to allow repair operations to begin the day of the accident. The emergency declaration also authorized funding to provide free transit services in the Bay Area for Monday, April 30. Statutes that allowed for expedited environmental, public involvement, and contracting procedures are critical to emergency contract success.

A $2 million emergency demolition contract was awarded the day of the accident to demolish the damaged structure. Demolition work began that Sunday afternoon. Additionally, another contractor began shoring up the I-880 roadway early the following morning with temporary supports so demolition could continue.

Figure 2.6 *Location of the I-580/I-880 MacArthur Maze bridge*

Caltrans brought a consulting engineering firm to the site the day following the fire to provide on-site emergency structural engineering services. That firm worked throughout the following days to obtain concrete column core samples for testing and to accurately document the extent of the fire damage to the structural elements. The concrete cores were shipped to laboratories in Cleveland, Ohio; Northbrook, Illinois; and Austin, Texas, for expedited petrographic studies and compressive strength testing. The engineer provided Caltrans a comprehensive report on the affected elements just five days after the fire. Based on the engineer's testing and analyses, Caltrans was able to open the I-880 connector eight days after the fire.

On the afternoon of the accident, Caltrans management rushed to its offices in Oakland and Sacramento and set up a teleconference between the emergency response units to determine the composition of the team needed to handle immediate replacement of the bridge. Communication went out to all staff members who would be working on this emergency project to report to work early Monday morning for a briefing on the project and to start the bridge-type selection process. Caltrans Structural Maintenance engineers began the work by locating the plans for the Maze bridges. As-built plans identified the structural steel in the I-580 connector as ASTM A7. ASTM A7 is a legacy specification, commonly used at that time until it was replaced by ASTM A36 in 1960. The structure consisted of steel stringers with a reinforced concrete deck supported by column bents with steel caps. In 1993 and 2001, Caltrans retrofitted this structure to seismic standards by adding steel column casings and bridge joint restrainer brackets. Well in advance of the letting, Caltrans put significant effort into coordinating with suppliers for prefabricated products.

By viewing the damage on television and by the use of Web cameras together with calls from the engineers at the bridge, the designers began preparing plans for replacement bridges (only the I-580 became necessary). Caltrans' ability to quickly procure the steel was the critical factor governing construction time to complete the two-span I-580 bridge. The design, therefore, conformed to currently available materials that could easily be fabricated immediately.

On the day of the accident, Caltrans officials mobilized a worldwide search to assess steel availability and fabrication capabilities. This information, gathered within two days, became a critical guide for engineers selecting the reconstruction alternatives.

Caltrans design staff members arrived early Monday morning (April 30) for the briefing and began their structure-type selection process. This process helped the Caltrans design engineers in the selection of the correct structure type. By mid-afternoon, the structure type and alternatives were selected and the design begun. The engineers considered precast concrete girders, but decided against this idea because it would require foundation enhancement to support the additional weight. The replacement design, therefore, mirrored the original bridge: 12 steel girders and a 55½ foot bent cap. The cap was placed on the existing steel-jacketed retrofitted columns.

The engineers debated whether to build a precast, prestressed concrete bent cap or to replicate the existing steel box bent cap. A steel bent cap design would have required fracture-critical fabrication, use of certified steel plate, and additional inspection criteria. This likely would have delayed the project due to material procurement difficulties and stringent fabrication requirements. In the end, Caltrans designed both precast concrete and steel bent cap alternatives and left the final decision of the bent cap type to the contractor.

It should be noted that design for the replacement of the adjacent bent caps was started while the inspection was still underway in case the caps were not repairable. Fortunately, the damage to those two bent caps was repairable, but both concrete and steel bent cap replacement alternatives were well underway when this was determined.

Project Execution

Several different contracting methods were considered for the reconstruction contract: force account, force account with incentive, informal bid with incentive, and informal bid with A+B.

Caltrans presented the following decision matrix:

- Force account contracting was ruled out to allow competition between contractors to drive the best possible bid price and early completion date.

- A+B bidding was ruled out since the contract was not estimated to take more than 50 days and, given the short duration contractors had to prepare bids, they would be conservative on bidding the number of days to complete the work and then would not complete the project faster than necessary.
- An incentive-based early completion date was ultimately chosen to allow the contractor to work as fast as possible and as economically as feasible.

Three contract addendums were pre-scheduled:

- Friday, May 4
- Saturday, May 5, at 9 p.m.
- Sunday, May 6, at 6 p.m.

At 10 a.m. Monday, May 7, Caltrans bid the I-580 bridge replacement. This project was let as an invitation-only bid. Nine proven and experienced bridge contractors who work in the area were invited to bid. Eventually only seven submitted bids (one declined the invitation and another withdrew before the site visit). There was a mandatory pre-bid conference at the project site on Saturday afternoon and a mandatory small business outreach meeting. Over the next day Caltrans provided immediate responses to bidder inquires. The project was advertised with a $200,000 per day incentive/disincentive clause capped at a $5 million maximum. The contract time was set up for 70 calendar days with an internal milestone of 50 calendar days for opening the bridge to traffic. In addition, the contractor would be fined $200,000 for every 10 minutes the short-duration lane closures were not reopened to traffic.

By creating bonus incentives of up to $5 million, nearly 100% of the state's estimated cost for construction of the project, the state clearly conveyed that it placed a high value on project completion speed.[3] The contract set a construction completion deadline of re-opening I-580 on June 29 (53 calendar days). The bids and costs are compared in Table 2.6.

	Cost
Engineers' estimate	$5,140,070
High bid	$6,484,000
Fourth low bid	$2,368,930
Third low bid	$1,444,444
Second low bid	$1,117,777
Low bid	$867,075
Incentive received	$5,000,000
Total anticipated amount	$5,867,075

Table 2.6 *I-580 bridge replacement cost*

[3]Bleharski, Josh, Brian Gross, Erik Hebert, and Leif Kalberg, "A-MAZE-ing Game Theory: How California Turned the MacArthur Maze Collapse into a PR Success," paper for MBA 211, Game Theory, University of California at Berkeley, http://faculty.haas.berkeley.edu/rjmorgan/mba211/2008%20Projects/Mac_Maze_Paper.pdf.

Within hours of the award, at approximately 3:30 p.m., the contractor had crews on site and the concrete beam fabricator was working to produce the 243,750-pound bent cap that would have to be placed before the girders could be installed. The steel fabricator found the 2-inch plate for the bottom flange of the girders in Pennsylvania and the necessary ½-inch and 1-inch plate in Texas. These materials were immediately shipped to the fabricator by truck. Each truck had two drivers so the trip could be made with fewer stops. Early coordination by Caltrans with the fabricators assisted project' materials need planning.

One day after contract award, Caltrans had a senior reviewer at the steel fabricator's shop full time to provide immediate guidance for welding and shop plans. In order for Caltrans to meet the one-day review times, its engineers directly solicited draft copies of all welding submittals. In this way, Caltrans provided the fabricator immediate feedback, often before the official copy was even submitted.

Three days after contract award, Caltrans and contractor representatives conducted a pre-welding meeting on site at the steel fabricator shops in Arizona. The steel from Pennsylvania arrived the same day. Caltrans provided the fabricator with review comments on its Welding Quality Control Plan, to which the fabricator was able to respond immediately. By the end of this meeting, Caltrans officials were satisfied with the fabricator's plan, and fabrication began that evening.

Caltrans maintained a constant presence with Quality Assurance Inspectors on the shop floor. This proved to be critical to the success of steel girder fabrication. Designers were available at all hours and, together with the Materials Engineers, they quickly worked through issues.

> ***"Caltrans came in and put good people in our shop. If there were any problems, we could go to them and get immediate answers. Usually it takes weeks. It was a breath of fresh air to have a government agency come in and perform like that."***
>
> **—President of the steel fabricator firm**

The fabricator worked two 10-hour shifts and loaded the first two girders on trucks seven days into the contract. The plate girders were 42 inches tall, with the longest one measuring 90 feet. They were constructed from A709 Grade 50, a high-strength, low-alloy structural steel. All 12 girders were finished in nine days. They then went to Vallejo, California, to be painted.

The bent cap beam arrived eight days after contract award. The 18-axle truck transporting the beam was not permitted on I-580 over Altamont Pass and had to use rural roads to deliver the bent cap. Two days later the first steel girders were set during a night closure. As soon as a pair of girders was secured, the contractor's workers swarmed the steel, installing the deck formwork and reinforcing steel. Typically, a contractor would have waited for all of the girders to be in place before starting the formwork. This project's contractor was good at coordinating and eliminating waiting time between activity transitions.

The day after the last girder was installed, the deck pour was completed. The slab strength came up to 3,500 psi in 48 hours, but Caltrans delayed the bridge opening by requiring 96 hours of cure time under burlap to keep the deck damp as a measure to prevent cracking. Table 2.7 is a summary timeline of the MacArthur Maze project.

Date	Event	Day	Const. Day
29 Apr. 2007	Sunday, 3:41 a.m.: Tanker accident; demolition work begins Phone calls and e-mails to key Caltrans staff to assemble	1	
30 Apr. 2007	Contractor shores I-880 bridge Caltrans locates steel In Sacramento, design team begins studying feasible designs	2	
1 May 2007	Clean-up and inspection	3	
3 May 2007	I-580 contract advertised; Caltrans uses same design	5	
4 May 2007	Caltrans receives petrographic study report	6	
5 May 2007	Mandatory on-site bid conference for I-580 I-880 deck repaired.	7	
6 May 2007	I-880 girders heat straightened Adjacent bent caps repaired Addendum #3 sent at 9:30 p.m.	8	
7 May 2007	Monday, 5 a.m.: I-880 reopens 10 a.m.: I-580 bridge bid opens. 3:30 p.m.: I-580 bridge bid is awarded; contractor is on site almost immediately	9	0
8 May 2007	First workday	10	1
10 May 2007	Pennsylvania steel arrives at fabricator in Arizona	12	3
11 May 2007	Girder fabrication begins	13	
15 May 2007	Precast bent cap arrives at night	17	8
17 May 2007	I-880 closed from 8 p.m. Thursday to 5 a.m. Friday to set the steel girders	19	10
19 May 2007	I-880 closed from 8 p.m. Saturday to 9 a.m. Sunday to set the last four steel girders	21	12
20 May 2007	Concrete deck is placed from 4 p.m. to 7:30 p.m. Sunday	22	13
24 May 2007	Opens to traffic at 8:40 p.m. Thursday (96 hours after pour)	26	17
25 May 2007	Opens to traffic in time for Memorial Day weekend	27	
26 May 2007	Ceremonial reopening		
21 June 2007	Project accepted		

Table 2.7 *I-580 MacArthur Maze timeline*

Synopsis of Acceleration Efforts

Mutual Trust

The contractor for this project had significant experience with similar types of emergency projects. The firm was the lead contractor in the Santa Monica Freeway reconstruction after the 1994 Northridge earthquake and the Geyserville Highway 128 bridge reconstruction after its collapse in 2006.

Incentive/Disincentive

The collapse of these structures had a significant impact on the entire Bay Area. The loss of the connector was estimated to have a total economic impact to the Bay Area of $6 million a day. Thus, the state viewed the contract in terms of the respective payoffs for the state and the contractor. Every day earlier than June 29 that the freeway opened was effectively worth a $6 million payoff to the state. From the contractor's perspective, without the incentive, its payoff is completely independent of time.

Availability of Materials

Caltrans and the contractor carefully analyzed the availability of steel plate. Caltrans matched the bridge design to the available steel. By working with the fabricator, the contractor expedited delivery of the needed steel ahead of the letting.

Design

Rolled shape sizes were not known to be readily available and would have required several weeks for fabrication; hence, the design team decided to proceed with built-up sections. In addition, to reduce the number of stiffeners required for local buckling checks and to reduce the amount of welding required on built-up girders, the web thickness was increased. The flange plates were kept to only one size to simplify the fabrication. The web depth was adjusted to ensure that the overall depth would not require adjustment of the existing bearings that were to be reused.

Contractor Team Effort

The contractor agreed to share 25% of the profits with the steel fabricator. Similarly, in terms of aligning incentives, the contractor shared a percentage of the project's profits with its employees to provide incentive to work around the clock to beat the incentive deadline.

DOT and Contractor Team Effort

Caltrans had three shifts of field engineers, including a Senior Bridge Engineer and a Senior Transportation Engineer, on site for each shift. Daily video conferences were used between project team members from the project's inception. Caltrans provided rapid shop drawing approval and had people at the fabrication site.

Additionall, in this specific instance, Caltrans allowed an exception to its specification compressive strength requirements (Section 90) to apply to the 96-hour limit instead of a 28-day limit. Caltrans permitted the contractor a couple of mix design options. The one that was chosen essentially eliminated the Caltrans requirement for supplementary cementitious material and added a shrinkage-reducing admixture (SRA) that was not on the list of pre-approved admixtures.

Communication Tools

All contractor submittal reviews were limited to 24 hours. E-mail and electronic transmission of documents were critical to meeting these review times. Pre-reviews of these documents were also helpful, and most reviews were completed prior to submission of the official document. E-mail was extensively used to communicate with the contractor to maintain a trail of what was stated and what had been completed. Mobile broadband cards were provided for all laptops used on the project.

Mobilization Ability

The contractor already had significant resources deployed on a project in close proximity to the MacArthur Maze and could quickly divert resources on an as-needed basis to match requirements on the accelerated project.

Underlying Fundamentals of Success

The official emergency proclamation smoothed the bureaucratic path to success for the accelerated reconstruction. This proclamation allowed the State to grant environmental, public involvement, and building code exemptions.

For the contractor, the value of out-performing the state's expectations on these high-profile projects is enormous, given the obvious benefits of maintaining a strong relationship with Caltrans. In fiscal year 2006 to 2007 alone, Caltrans bid 286 bridge and highway projects totaling more than $2.3 billion. The owner of the company stated, "It's not about making a huge profit, it's about pride and reputation," and the Chief Engineer for Caltrans affirmed that statement.

Caltrans prequalified experienced contractors. Experience builds the confidence and instills skills in an organization that are necessary to successfully complete accelerated contracts. After the 1994 Northridge earthquake flattened a section of the Santa Monica Freeway in Los Angeles, this same contractor rebuilt the highway in 66 days, 74 days ahead of schedule. That work earned the contractor a $15.4 million bonus on a $14.7 million contract. On that project the contractor worked around the clock seven days a week and had some 400 employees in the field.

The I-580 MacArthur Maze project was successfully completed in such a short time duration because of teamwork between Caltrans, the contractor, and the fabricators of the concrete bent cap and steel girders. The teamwork was backed up by a contractor who carefully planned the construction operations and who had the ability to draw together workers and equipment in a timely manner for periods of intensive effort.

The Maze project and the Mojave Bridges project described in the next section were both accomplished using designs prepared by DOT staff engineers. Other successful accelerated projects had designs prepared by consultants. If the critical factors of partnership and consideration of material availability are considered by the designer, it does not seem to matter if the engineering is handled by DOT staff or by consultants

Replacement of the I-40 Bridge, Mojave Desert, California

In early 2006, during routine maintenance bridge inspections, Caltrans discovered severe damage to 12 bridges on I-40, near Essex (see Figure 2.7). Essex is a crossroads some 30 miles west of Needles and 100 miles east of Barstow in the southern end of the Mojave Desert. It was quickly determined that all 12 bridges required immediate replacement.[4]

The potential for a complete Interstate closure of this 130-mile stretch was high if the replacement bridges were not completed quickly. In addition, the effort to build temporary detours would be greatly increased. The cost

[4] *Accelerated Bridge Construction Applications in California- A "Lessons Learned" Report*, August 2008 (Version 1.1), Paul Chung, Raymond W. Wolfe, Tom Ostrom, Susan Hida, editors, Caltrans – Engineering Services, Accelerated Bridge Construction, http://mceer.buffalo.edu/meetings/6nsc/review/ABC_LessonsLearned_v1_1.pdf.

of building temporary detours would exceed $600,000 per bridge location, or $3.6 million in total. This would require additional mitigation for ROW and environmental issues. Understanding the urgency, Caltrans sought solutions to accelerate the work.

The design process was expedited in order to secure approval of the project. A design project like this one normally takes a minimum of two to three years to complete before it is ready for advertisement; this design effort took about two and a half months. Design's ability to deliver plans on schedule was a key to project success. The plan made it possible to replace all 12 bridges, from discovery of the problem to completion, in only 14 months. A project of this magnitude would typically require two to three years to complete. Speed was accomplished, in part, due to the commitment to partnering.

Project Description

This stretch of I-40 carries two lanes in each direction, with 15,000 vehicles daily; more than 40% of the traffic is heavy trucks. The majority of the bridges had lost their girder-to-bent and girder-to-abutment load-carrying capacity, and some had lost their deck-bearing capacity. Although the bridges were immediately shored to carry one lane of traffic in each direction, the unpredictability of weather in this desert region causes it to be prone to flash floods with the potential to damage the structures that were shored. If this occurred, it could lead to the loss of the bridges and result in a full closure of I-40. No practical detour route was available to handle trucks if I-40 were fully closed. Therefore, the DOT's goal was to accelerate the delivery of this project in the most timely and cost-effective manner.

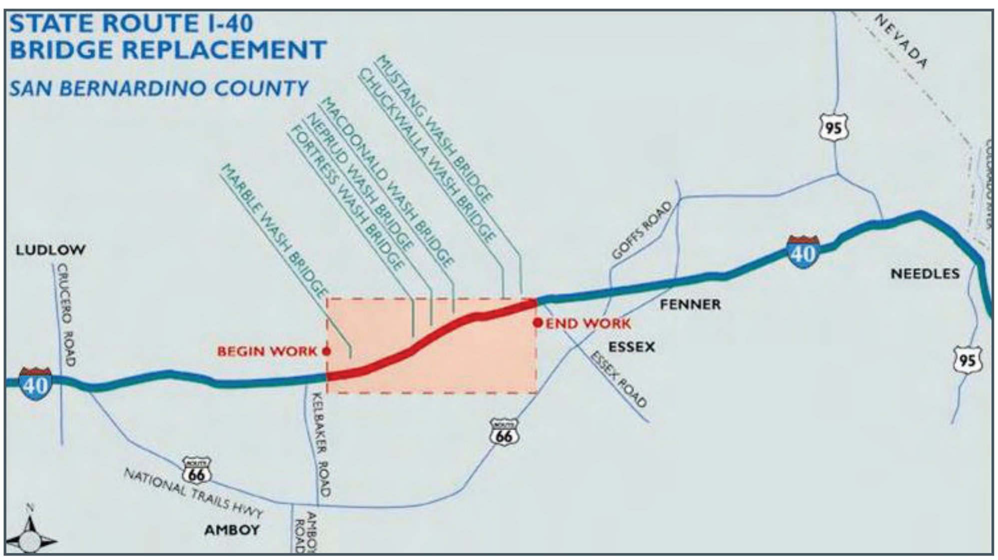

Figure 2.7 *Bridge locations in the Mojave Desert*

To accommodate concurrent construction activities, precast girders were specified for all 12 structures. Additionally, to expedite cast-in-place deck construction, the girders were designed for the additional dead load of stay-in-place deck forms. Precast deck panels were considered, but rejected due to concerns over girder camber and connection details. At several locations both I-and bulb-tee girders were specified to allow the fabricator to fully utilize yard capacity; however, not all structures could be economically designed with both girder options.

Single-span precast girder structures replaced existing two-span structures at locations where hydraulic freeboard could be maintained with deeper sections. This solution eliminated the need to construct the center bent columns and footings and thus saved construction time. However, the longer span exceeded the capacity of standard I-girders, and bulb-tee sections were required.

To mitigate traffic impacts and expedite on-site construction of the Marble Wash westbound bridge, it was decided to precast as much of the structure as possible. The existing two-span, 106-foot-long Marble Wash Bridge was replaced with a single-span structure designed to reduce substructure construction efforts. Furthermore, site geology permitted the use of spread footings, thereby facilitating a precast abutment solution. The advantage of this strategy was that the abutments could be placed and the girders set soon thereafter. This was the first use of precast abutments for road construction in the state of California.

Project Execution

The heavily traveled route demanded accelerated construction to replace the damaged bridges. The first phase project (there were separate contracts for the east and west bridges) rerouted eastbound traffic to the westbound lanes with two detours: one around the bridge at Marble Wash and the second encompassing the remaining five structures. Since the Marble Wash Bridges were separated by nearly 10 miles from the remaining structures, the two-part detour assisted in alleviating traffic congestion by providing an intermediate passing lane within the project limits. Upon completion of the six structures on the eastbound roadbed, traffic was rerouted off the westbound road in a similar manner, and those six damaged structures were then replaced. The second phase of the work was accelerated at the Marble Wash Bridge to reduce the traffic impacts of the second detour. The projects were awarded based on an A+B bid and included an I/D clause. The westbound bridge contract also had an internal incentive for the completion of Marble Wash Bridge in fewer than 40 calendar days. The contract language for the westbound project is shown in Table 2.8

INCENTIVE AND DISINCENTIVE

Attention is directed to details shown on the plans and to the provisions in “Order of Work,” and “Maintaining Traffic” of these special provisions. Incentive payments and disincentive deductions shall conform to the following:

I. If all work is completed for the construction of Marble Wash Bridge prior to **40 calendar days**, the Contractor shall receive an incentive payment of **$25,000 per** day for each and every calendar day prior to the 40 calendar days, to a **maximum dollar amount of $250,000.**

   a) The calendar days for completion of Marble Wash Bridge is defined as the first day on which traffic is switched from WB I 40 around the existing Marble Wash Bridge to the day on which traffic returns to WB I 40 over the newly constructed Marble Wash Bridge.

II. If all work is not completed at Marble Wash Bridge in 40 calendar days, as defined above, a disincentive deduction of $25,000 per calendar day shall be deducted from any monies due or that may become due to the Contractor under this contract for each and every calendar day's delay after the 40 calendar days.

III. If all work is completed and the contract is accepted by the Engineer **prior to the number of working days bid,** the Contractor shall receive an incentive payment of **$45,000 per calendar day** for each and every calendar day prior to the number of working days bid, to **a maximum dollar amount of $2,750,000.**

IV. Partial hours will be counted as one calendar day used by the Contractor for the purpose of calculating incentives and disincentives.

Liquidated damages shall accrue separately and independently of disincentive deductions.

Table 2.8 *I-40 westbound bridge contract I/D language*[5]

Girder fabrication was completed at established off-site yards while concurrent demolition and substructure work commenced in the field. Installation of rock slope protection beneath the structures to protect the abutment footings from scour was the only factor disallowing immediate placement of the girders once the abutments were set.

For the westbound Marble Wash Bridge, the specifications were written to only allow use of its detour when the precast abutments and girders were ready. The detour was then implemented, demolition operations commenced, and the abutment subgrade prepared to receive the precast abutment. Additionally, the specifications limited the duration of the detour at this location, forcing the contractor to shift forces from other operations as necessary to expedite completion of the westbound road crossing the new bridge at Marble Wash.

The precast abutments were fabricated as whole-width pieces in a casting yard in Perris, California, which is approximately 200 miles southwest of Marble Wash. They were 50.14 feet long, 6.53 feet wide, and 5.91 feet high. The heavier of the two weighed approximately 82 tons, requiring transport permits and a larger crane for lifting than might otherwise be found on a similar project of this size. The challenge was to find a large-capacity crane and a hauling truck to accommodate hauling and lifting of these precast abutments. Because of weight limitations, only the abutment's seat and a portion of the footing were precast. The footing shear key, the abutment backwall, and the approach fill-wing walls were cast-in-place components. These latter operations proceeded simultaneously with the cast-in-place concrete deck construction.

A 500-ton crane was used to lift and place the precast abutments (see Figure 2.8). A 360-ton crane could have handled the load considering the crane position relative to the pick and placement of the abutment section, but one was not readily available.

Figure 2.8 *Installation of precast bridge abutment at Marble Wash*

[5]Notice to Contractors and Special Provisions for Construction on State Highway in San Bernardino County from Marble Wash Bridge to Mustang Wash Bridge, District 08, Route 40; December 22, 2006,
www2.dot.ca.gov/hq/esc/oe/project_ads_addenda/08/08-0J1024/pdf/08-0J1024sp.pdf

Traffic detours using median crossovers and one-lane traffic within the work zones were efficient and safe. Implementation of a speed reduction to 45 mph from 70 mph greatly improved safety through work zones and helped minimize the deterioration of the damaged bridges. The use of the Construction Zone Enhanced Enforcement Program (COZEEP) around-the-clock for these projects helped tremendously in controlling traffic conditions. COZEEP is a statewide interagency agreement (contract) between Caltrans and the California Highway Patrol that enables the DOT to hire highway patrol officers and vehicles to patrol project construction zones. Moreover, the utilization of around-the-clock traffic work crews in monitoring and maintaining traffic devices helped significantly in minimizing traffic interruptions.

The contractor for the projects front loaded the projects with staffing and equipment because they were accelerated. Additionally, due to the isolated work locations, the contractor provided housing for its staff and made sure additional equipment was available for unforeseen conditions. The contractor began the project working seven days a week with extended-shift daytime work. This schedule was later changed to six days a week due to employee fatigue.

The detour at the Marble Wash Bridge was removed after only 28 days. The remaining structures on the westbound roadbed were completed soon after, and the road opened to traffic in only three months. The contractor had bid the time portion of the contract at 165 days. Therefore, by completing all bridges and roadwork in 71 days and the Marble Wash Bridge in 28 versus the contract maximum of 40 days, the contractor earned the full $3 million incentive. The contractor's dollar bid amount was $6,645,684 for the six bridges and roadwork, as shown in Table 2.9.

Replace Eastbound Bridges	Cost	Days	A+B
Engineer's estimate	$10,812,345	180	
High bid	$9,657,740	160	$12,297,740
Fourth low bid	$8,163,830	180	$11,153,830
Third low bid	$7,875,734	160	$10,515,734
Second low bid	$6,948,787	180	$9,918,787
Low bid	$6,567,450		$9,537,450
Incentive received	$3,000,000		
Total amount	$9,567,450		
Replace Westbound Bridges	**Cost**	**Days**	**A+B**
Engineer's estimate	$8,747,880	180	
Only bidder	$6,645,680	165	$11,595,684
Incentive received	$3,000,000		
Total amount	$9,645,680		

The same contractor held the previous eastbound contract, which had an engineer's estimate of $10,812,345. For that contract the contractor bid $6,567,450 or $4,244,895 under the engineer's estimate; but for the duration part (B), the contractor bid the full 180 days. The second bidder for that contract also bid the full 180 days.

Synopsis of Acceleration Efforts

Design

The design was completed in three months from the time it was begun until the time the project went to bid. Precast girders were specified for all 12 bridges to accommodate concurrent construction activities. At some sites, single-span precast girders replaced the existing two-span structure. That solution eliminated the need to construct the center bent columns and footings and thus saved construction time. While the contractor thought the precast abutments were a good idea, the comment was made that:

> *The state needs to develop generic abutment details in which adjustments can be made by field staff. The state was asking the contractor/precaster to build a unique product (skews, abutment seat layouts, etc.) with very little guidance. The contractor had to "teach" the precaster how to build this unique product.*

Contractor input during development of the design phase of an accelerated project can provide knowledge about constructability issues that make construction proceed smoother and faster.

Incentive/Disincentive

The incentive provisions of the contract encouraged the contractor to complete the bridges as quickly as possible. The eastbound contract was bid A+B and set a maximum contract time of 180 days with a $50,000 per day incentive capped at $3 million. For the westbound contract, again it was bid A+B and had a 180-day maximum duration. However, the incentive was reduced to $45,000 with a cap of $2,750,000, but there was an internal incentive for the Marble Wash Bridge. This internal incentive was set at $25,000 per day with a cap of $250,000 for completion in fewer than 40 calendar days.

An interesting comment from the contractor about I/D provisions was that:

> *The I/D needs to be a realistic amount. If the I/D amount is too small, we are not interested. If the I/D is too large, our concern is that it encourages contractors to take "unnecessary" risks that are not good for the agency nor the contractor.*

Partnering

Formal partnering was a contract requirement. Through partnering, team players were able to resolve critical issues at the lowest level, such as inspectors and contractor's foremen, who dealt with details at the job site. Communication among all project team members through effective partnering eliminated potential rework and mistakes. The round-the-clock schedule and remote location posed serious obstacles. However, every team member involved exercised tremendous attention to detail and was unselfish with special efforts to ensure that no interruptions would prevent the project from moving forward.

The contractor for the project stated:

> ***Route 40 was the first time we were able to submit ideas to Caltrans for accelerating a project prior to bid opening. We believe that having a mechanism to submit ideas to Caltrans on a regular basis would be good for both Caltrans and the contracting industry.***

Planning

The contractor attributed success to good planning.

Special DOT Support

Electronic submittals were made to the resident engineer rather than to headquarters. This change in procedure reduced review time to five days. A Caltrans biologist did an initial sweep for the desert tortoise and then a temporary tortoise fence was installed. Once the temporary fence was in place, a tortoise monitor was needed only when work was being performed outside the fence area (see Table 2.10).

5-1.20 DESERT TORTOISE PROTECTION

The Contractor shall be informed of the laws, rules, regulations, and conditions regarding the desert tortoise *(Gopherus agassizii)* as specified in these special provisions, and shall conduct all work operations accordingly.

APPLICABLE LAWS

This project is within or near identified desert tortoise range/habitat. The laws applicable to protection of the desert tortoise are the Federal Endangered Species Act of 1973 (16 U.S.C. 1531-1543) 50 CFR Part 402 and 50 CFR Part 17.3, and the California Endangered Species Act, Section 2080 and Section 2081.

PRE-CONSTRUCTION ACTIVITIES

The Contractor shall notify the Engineer at least 10 days prior to any construction activities so that the Department can perform on-site monitoring, if required.

MONITOR/SURVEYOR

The Contractor shall retain, and have available, the services of a qualified or authorized biologist as specified in this special provision for a pre-construction sweep of the project site, on site monitoring, if required, and all tortoise handling that may be required. The Contractor shall submit the name of the biologist to the United States Fish and Wildlife Service, the Department of Fish and Game and the DOT at least 14 days prior to the performance of work activities for approval. The Engineer will forward the request to the Chief of Biological Studies, District 8. Approval of the biologist by the resource agencies and the Department of Transportation is required prior to performing any work.

Table 2.10 *Desert tortoise protection requirement in the I-40 Bridge contracts*

Underlying Fundamentals of Success

Precast elements can successfully accelerate bridge construction. The main challenge is to keep the precast components within a practical weight range for transporting, picking, and placing. A segmented abutment design would reduce or eliminate the need for securing transport permits, lessen the premiums paid for trucking fees, and allow the use of cranes already expected on site for other operations, such as setting girders.

Because the eastbound and westbound traffic were on separate roadbeds, it was possible to redirect traffic off one roadbed at a time to facilitate complete bridge replacement.

There was concern about using precast girders because at the time most fabricators were working at full capacity on other projects, some of which were also very high-profile projects. The DOT met with the industry before finalizing the design to ensure that there was capacity to deliver as needed.

Replacement of the Russian River Bridge, Geyserville, California

The existing steel truss bridge, built in 1932, over the Russian River in Geyserville, Sonoma County, California, was severely damaged during a series of storms in the last two weeks of December 2005. A maintenance crew from Caltrans observed lateral rotation of a mid-channel pier and approximately 8 inches of differential settlement between the upstream and downstream sides. The bridge was closed to traffic on January 1, 2006, causing hardship to the local community because this was the shortest route to the high school on the other side of the river. The bridge closure resulted in a 40-minute detour every school day. Table 2.11 provides a project timeline.

Date	Event
Mid-Dec. 2005	Storms
1 Jan. 2006	Bridge closes; 49-minute detour for school buses
4 Jan. 2006	Governor issues State of Emergency Proclamation
15 Jan. 2006	Caltrans issues $10.5 million emergency contract to repair bridge
3 Feb. 2006	FEMA declares Sonoma County a disaster area
6 Feb. 2006	Emergency contract amended for removal of existing bridge; Caltrans starts designing replacement bridge
Mid-Mar. 2006	Design complete and bid package ready
11 Apr. 2006	New bridge contract awarded: 80 days for construction
12 Apr. 2006	Contractor submits cost reduction incentive proposal (CRIP) to change superstructure
Early May 2006	CRIP approved; construction starts
17 Aug. 2006	Bridge opens, one week before the school year begins
12 Mar. 2007	Contract completed and accepted

Table 2.11 *Russian River bridge replacement timeline*

Project Description

Caltrans studied the options of repairing or replacing the bridge. After site geology and scour mitigation studies were completed, the department decided to replace and reopen the bridge to traffic before the next school year began. The replacement bridge layout was to have the same overall length, profile, and vertical clearance over the channel as the existing bridge. The decision to match the existing layout was made primarily to minimize the time for acquiring ROW and to keep the number of permits to a minimum. Raising the bridge profile and consequently extending the bridge length would have led to legal issues.

Caltrans' engineers started the design during the first week of February 2006; it was a completely in-house design effort. The replacement bridge was designed to carry two 12-foot-wide traffic lanes, 8-foot-wide shoulders on each side, and a 5.3-foot-wide sidewalk for an overall width of 49.15 feet. Overall length of the replacement bridge was 980 feet. Hydraulic considerations required the use of fewer spans for the replacement bridge. Eight 102.5-foot-long spans and two 80-foot-long spans at the ends were used. To provide freeboard clearance for the 100-year-flood design, the superstructure depth was limited to 45 inches, a span-to-depth ratio of 0.037 for the longer spans.

Sensitive environmental issues and regulations limited the construction window to four months, May to the end of August. Additionally, falsework was not allowed in the main channel. These restrictions led to the use of a precast, prestressed concrete bridge as the most suitable alternative. Standard precast, prestressed AASHTO box beams 48 inches wide and 39 inches deep, with a 6-inch-thick, cast-in-place reinforced concrete deck were selected.

The precast box beams were to be supported on cast-in-place drop bent caps using two elastomeric bearing pads at each end of each beam. The drop bent caps would have a constant width of 6 feet and a variable depth with a minimum dimension of 6 feet. Each drop bent cap was to be supported by two cast-in-steel-shell pile shafts. The shafts were chosen based on their high load-bearing capacity, the site conditions, and their hydraulic suitability, and were preferred over cast-in-drilled hole pile shafts because of the potential for a cave-in during drilling.

A few aesthetic measures were considered for the bridge bent caps, beams, and barriers. The bent caps were designed with simulated capitals, rounded noses, and arched soffits to visually reduce their otherwise massive appearance. This effort aided in bringing the bent caps and column shafts into a closer proportional relationship to each other. The smooth vertical face of the precast box beams contributed to the tidy effect of the superstructure exterior, thus complementing the nautical theme of the barriers' surface treatment and context-sensitive handrails.

Other issues that affected the preparation of the bid package included the necessity for ROW agreements with four property owners. These were needed for the relocation of existing overhead power and cable lines and to accommodate a natural gas line that was on the existing bridge. A downstream utility easement was obtained and the overhead lines adjacent to the bridge were relocated. The 4-inch natural gas line was placed under the river in this easement by directional drilling. The utility company contractor bored a 1,000-foot-long, 8-inch-diameter hole that reached a depth of 65 feet below the river.

Under the first emergency contract, a trestle was constructed to provide all-weather access for removing the old bridge and for the future construction contract. The use of a trestle was also dictated by the need to minimize environmental impacts. The contractor was required by the permitting agencies to use isolation casings to minimize sound and vibrations from the driving of the 24-in. trestle pipe piles due to the presence of endangered coho salmon and threatened coastal steelhead trout. Hydroacoustic monitoring was also performed during the pile-driving operation. A pile-driving analyzer (PDA) was used for pile quality control.

An emergency contract was executed for the bridge repair. However, when the decision was made to rebuild the bridge, that contract was amended by a Contract Change Order (CCO). Because Caltrans was looking ahead to bid a second contract to construct a replacement bridge, the CCO stated:

> *Both the Contractor and the Subcontractor shall coordinate all work necessary to complete the bridge removal work within the time of* ***25 calendar days.*** *All costs of overtime hours necessary to complete the demolition work within 25 calendar days from the start date are included in the agreed price of this Contract Change Order. For each day past the allotted 25 calendar days,* ***the Contractor shall receive $32,000 less*** *in total payment for this work. The area between the existing bridge pier 11 and the most easterly abutment shall be completed as the first order of bridge removal work. Any demolition work activities remaining after May 01, 2006, on the east river bank shall be coordinated with the new bridge replacement contractor*

By mid-March, the design package of plans, specifications, and cost estimates was ready for bidding. The contract provided that the state would supply the steel pipe (SP) 1219-mm diameter pipe piles for the bridge. All piles were to be available by June 20. The project was bid A+B as an incentive for the contractor to submit a bid with the least amount of working days (see Table 2.12).

	Cost	Days	A+B
Engineer's estimate*	$20,080,750	134	
High bid	$20,451,130	134	$24,739,130
Fourth low bid	$14,281,739	77	$16,745,739
Third low bid	$13,153,104	100	$16,353,104
Second low bid	$11,373,144	105	$14,733,144
Low bid	$11,823,026	80	$14,383,026
* Contract allowed 80 working days to open the bridge plus an additional 225 days for project acceptance.			

Table 2.12 *Russian River bridge bid summary*

This was actually a three-phase contract:

- Phase 1 – Mobilization, submittal review, and material procurement
- Phase 2 – Completion of the bridge replacement (This was the time or B portion of the bid, which had a 134-working-day maximum.)
- Phase 3 – Completion of all other work

The contract was awarded on April 11, 2006, to build the bridge in 80 days.

Project Execution

The very next day after award, the contractor, along with a consultant and a precast fabricator, submitted a CRIP to use a nonstandard, double-tee, precast, prestressed concrete beam with multiple stages of posttensioning in the field. The proposed nonstandard double-tee beam was twice as wide as the original design (8 feet compared to 4 feet). As a result, half as many girders were required per span. The original design had a total of 120 girders; now only 60 girders were needed. A standard double-tee section is typically suitable for 40- to 65-foot span lengths, but was not an option in Caltrans-approved beam sections for such long spans used for the replacement bridge.

The proposed beam design used two-stage posttensioning to maintain continuity of the superstructure under applied loads. Cast-in-place diaphragms between beams and first-stage posttensioning were used to create continuity under the weight of the 6-inch-thick deck slab. Second-stage posttensioning was applied to carry the superimposed dead and live loads. Because the original superstructure depth was maintained in the contractor's proposed design, no changes were made to the substructure design. Not only was the double-tee section nonstandard, but the two-stage posttensioning was not a standard practice for the precast industry in California.

Caltrans immediately evaluated the proposal and approved the concept, primarily to reduce construction time and increase possible cost savings. Closure of the nearest precasting yard and the difficulty of transporting long girders on the local roads made this CRIP necessary. The contractor's consultant submitted superstructure design plans to Caltrans by the end of April for review and approval.

Caltrans engineers performed independent calculations using time-dependent concrete properties to check stresses in the double-tee beams during pretensioning, erection, first posttensioning, deck casting, and second posttensioning construction stages. The independent check included a review of deflections at various construction stages, long-term camber, and superstructure seismic response.

The Caltrans independent check resulted in modifications to the amount and location of the prestressing in the contractor's design. The additional posttensioning of the 980 foot-long continuous double-tee beam frame produced large longitudinal forces that needed to be transferred to the substructure pile shafts. These large service loads acting on the piles were not part of the original design. Caltrans requested that the superstructure-to-bent-cap connection be modified at the two outer bents to allow for longitudinal movement during posttensioning without transferring any displacement to the pile shafts. Metal plates with a greasy surface were used to allow for superstructure sliding with minimal force transfer to the supporting bent caps. After initial shortening of the superstructure and grouting of the posttensioning ducts, the connection was locked in place.

Caltrans engineers cooperated with the contractor's consultant to review and approve the design and detailing of the proposed double-tee beams in two weeks. The accepted CRIP resulted in a saving of $641,558, shared equally by Caltrans and the contractor.

Construction started in early May with driving the cast-in-steel-shell pile shafts and building the drop bent caps. Pile load testing was conducted at two different bent locations to determine actual in-situ soil resistance. No reduction in driving length was gained from the results of the load tests.

In the meantime, new beam formwork was built and the double-tee beams were fabricated and transported to the site in May and June. Erection of the beams was completed in July. The cast-in-place diaphragms and intermediate diaphragms were cast in early August, followed by the first-stage posttensioning operation. The deck was cast and the second-stage posttensioning took place three days later. Work around the clock resulted in the bridge opening to traffic on August 17, 2006, one week before the school year began, to the delight of the local community.

Synopsis of Acceleration Efforts

Design

The original design sought to address three issues:

- The sensitive environmental condition of the work site
- A construction window limited to four months
- The prohibition against using falsework in the main channel

These requirements led to the design of a precast, prestressed concrete bridge. The contractor took the process one step further and considered the transportation cost of delivering the girders and the impact of girder erection time. The contractor's double-tee design (see Figure 2.9) required 60 girders versus the 120 in the original design. Additionally, the wider double-tees eliminated the deck falsework. Here

Figure 2.9 *Installation of double-tee precast girders*

again, like at the I-40 Mojave Bridges, is the finding that contractor involvement in project design can have a significant benefit in realizing the goal of speedier construction.

Contract

A+B bidding was used to emphasize the importance of construction time. The contract was also structured in phases so that all preparatory work (Phase 1) could be completed before construction and the time portion commenced.

Partnering

Working closely with the all impacted parties (i.e., utilities, property owners, and environmental agencies) and the contractor minimized the project construction time. Caltrans learned that, with effort, its CRIP approval process could be accelerated successfully.

Planning

Caltrans's decision to execute a change order to the original repair contract and have that contractor construct a trestle instead of performing the repair work gave the second contractor immediate access to the site.

Material Supplies

Concern for potential delays because of the non-availability of the steel piles in a timely manner led to the decision for the DOT to furnish the material to the contractor. This is typically considered unwise, as most contractors are adept in securing materials as inexpensively as possible; however, Caltrans eliminated a major project risk by taking this action.

Interagency Agreement

Caltrans drew on its agreement with the Highway Patrol for assistance with transporting the oversize double-tees to the project.

Prior to being faced with an emergency acceleration situation, agencies should have such agreements established with all authorities that could impact the movement of materials or structural elements to a project.

Underlying Fundamentals of Success

What had been a three-minute drive from fire department headquarters on the west side of the Russian River to the east side became a 25-minute detour when the bridge was closed. With the bridge out, the department spent $32,000 a month to staff a station on the east side. The school district spent an additional $10,000 a month on fuel for its buses. Therefore, everyone in the community understood the importance of accelerating construction of the replacement bridge.

Caltrans developed its design considering speed of construction and availability of materials. But when the contractor suggested a modification, the DOT was very open to the suggestion and provided a speedy review that quickly led to an acceptable solution that cut more time out of the critical phase of delivering the bridge to the community.

Repair of the I-5 Tunnel, Los Angeles, California

A 31-vehicle accident shortly before 11 p.m. on Friday, October 12, 2007, resulted in a blazing inferno in an I-5 bridge (tunnel) superstructure (see Figure 2.10) north of Los Angeles. The fire caused significant damage to the 1,000-foot-long tunnel and the closure of I-5. A subcontractor who worked on the rehabilitation project stated, "There were truck tires, batteries, seats ... melted to ash. It was emotional for me to look at it when I saw it the first time. The heat was so intense, concrete had spilled off the walls and concrete on the ground had exploded 6 inches deep."

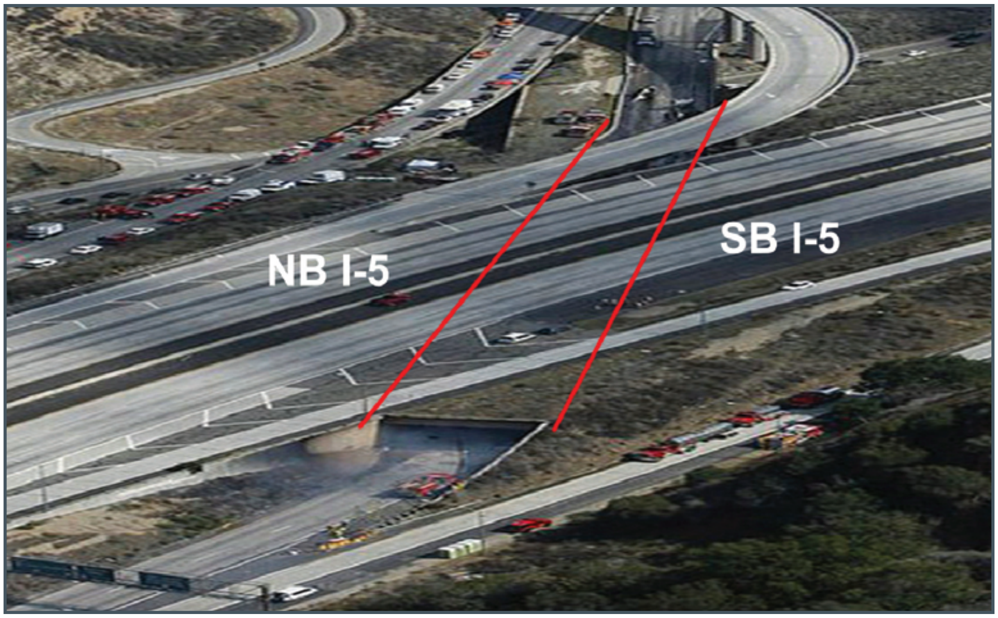

Figure 2.10 *Location of I-5 tunnel, Los Angeles, California*

Project Description

The I-5 tunnel is a truck bypass that runs beneath eight lanes of I-5, the major West Coast interstate linking Mexico to Canada. Caltrans maintenance personnel and emergency response agencies diverted the truck traffic onto the roadway above. The diversion caused heavy traffic congestion at this vital link between the Central Valley and Southern California. Thus, it was obvious that extensive work would be needed to repair the tunnel, and it would have to be accomplished quickly. The governor immediately declared a state of emergency. However, due to debris and potential toxic conditions, Caltrans and the consulting engineer could not enter the tunnel until three days after the accident (October 15). The consulting engineers were from the same firm that supported Caltrans after the I-580 MacArthur Maze fire only five months before.

All agreed that the pavement would have to be completely replaced and the walls repaired; in some places the walls sustained damage a few inches deep. Parts of the ceiling could be retained or repaired; others needed replacement. "A lot of the damage came because as the concrete heated and the fire crews sprayed water in, it caused the concrete to spall." Twenty-four inches of fire-damaged concrete pavement and sub-base material had to be removed.

Caltrans was looking for a maintenance-free surface that could be easily cleaned, would enhance visibility for safety, and would reduce the energy requirements for lighting. Paint was considered, but it has a limited life and degrades over time, particularly when washed with high-pressure water blasting. Concrete made with white cement, however, would be expected to last the entire life of the tunnel and would have the added benefit of enhancing the lighting in the tunnel.

White cement concrete is brighter because it possesses a higher albedo rating. The standard unit of measurement for pavement reflectivity is albedo (ASTM C1549), which is a simple ratio of the amount of light reflected from a material to the amount of light projected on the material. The higher the albedo number, the more light is reflected from the surface. A typical asphalt surface can range from 0.04 to 0.12. Concrete pavements can range from 0.2 to 0.5 or higher. The albedo rating of white cement concrete is 0.7 to 0.8 – it reflects double the light of gray concrete.

Caltrans began the contracting process almost immediately. The engineering evaluation was completed around October 19, and on October 27 Caltrans hosted a bidder walk-through, accepting a handful of bids and solidifying the project strategy. A 33-day contract was awarded on October 29. The work was complicated by the confined quarters and the fact that to stay on schedule a high number of personnel were employed at all times.[6] The repair contract, which was let using an A+B-type contract, was for $11 million and included an I/D clause. The incentive for early completion was capped at $2.9 million; the disincentive was $150,000 plus liquidated damages for each day beyond the stated duration. Table 2.13 shows the I-5 tunnel project timeline.

Date	Event	Day	Const. Day
12 Oct. 2007	Wreck and fire; I 5 NB and SB lanes closed	1	
15 Oct. 2007	Crews inspect damage to tunnel	4	
27 Oct. 2007	Walk through and bid	16	
29 Oct. 2007	33-day contract awarded	18	
30 Oct. 2007	First workday (demolition)	19	1
6 Nov. 2007	Shotcrete completed	26	8
7 Nov. 2007	Girders set	27	9
9 Nov. 2007	Concrete paving	29	11
15 Nov. 2007	Tunnel opens	35	17

Table 2.13 *I-5 tunnel repair timeline*

Project Execution

The work included replacing portions of the fire-damaged bridge superstructure with precast concrete girders (see Figure 2.11, left), repairing portions of the fire-damaged retaining walls and abutment walls, and replacing the fire-damaged pavement (see Figure 2.11, right) with rapid-set concrete. Acceleration techniques used on this project included precast concrete girders and rapid-set concrete for the pavement. There was a full closure of the southbound truck lanes during the work.

[6] Prokopy, Jenni, "White light," *Roads & Bridges,* January 2008, Vol. 46 No. 1, www.roadsbridges.com/White-light-article8881.

Figure 2.11 *Setting girders and paving on the I-5 tunnel project*

Twenty hours of demolition was the first item of work. Demolition involved chipping back the walls and water blasting to remove the damaged concrete. The crews had to chip out the worst areas by hand. The depth of wall concrete removal ranged from 3 to 4 inches (the walls are 18 to 22 inches thick). The first 90 feet of the tunnel (nearest the site of the accident) was entirely rebuilt. While the demolition was proceeding, the mix designs for the paving were finalized.

Shotcrete work to repair the walls followed the demolition and wall preparation. The first layer in the heavily damaged areas was a 4,000-psi ready-mixed concrete designed to replace all the damaged concrete. A specialty bagged, high-strength, noncorrosive material was used to patch areas with deep damage. Following the repair work, the entire tunnel area (27,000 square feet) received a refractory shotcrete lining. This was a specialty mix incorporating white cement for reflectivity and durability. Procuring the necessary raw materials did require a significant effort. The mix included a blend of 50% ground granulated blast furnace slag, 50% white cement, and silica sand. It was not the easiest component to find in Southern California because of its use in stucco buildings. The walls received a troweled finish.

The pavement concrete mix was also unique. In addition to color specifications, Caltrans had stringent strength requirements for the pavement. Typically, the specification is for 550-psi flexural strength in 10 days; for this project, the DOT specified 550 psi in 24 hours. There was also a flexural strength requirement of 650 psi in seven days.

The mix contained Type I white cement plus five admixtures, one mineral and four chemicals. Metakaolin, the mineral admixture, is white and is typically included to improve the durability of concrete. A super-plasticizer was used to provide workability and reduce the water-to-cement ratio. A large quantity of hardening accelerator helped provide high early strength. A shrinkage-reducing admixture limited drying shrinkage, and a hydration stabilizer was used to provide sufficient time for the mix to remain workable.

The original goal was to use high-grade white aggregates from another area of the state, but the team chose local aggregates instead, so the final concrete mix is not pure white. The compromise of using local aggregates that were not pure white still provides good reflectivity. The concrete is extremely light; in fact, it was necessary to paint black stripes on either side of the white stripes to make them stand out (see Figure 2.12).

*Note the black lines flanking the white striping

Figure 2.12 *Finished I-5 tunnel**

The low clearance in the tunnel limited equipment options for handling the concrete. A Texas screed was used to place the first 8-inch lift of lean concrete. Because the concrete was extremely fast-setting, the contractor had 15 to 20 workers finishing the pavement behind the screed, hand-floating it with a rough finish. The final layer of concrete across the four 12-foot lanes was placed with a Whiteman roller screed. The time for finishing was again minimal, so a crew of six followed the roller screed for finishing. A final pass of profile grinding on the surface took an additional 15 hours.

Synopsis of Acceleration Efforts

Contract

A+B bidding was used effectively with an I/D to emphasize the importance of time.

Design

Readily available precast concrete girders were used.

Partnering (Teamwork)

The contractor commended Caltrans, saying that it was a full team player, with staff available 24/7. “Everybody in the whole Caltrans group was really awesome.”

Underlying Fundamentals of Success

Caltrans developed its design considering speed of construction and availability of materials. When it was not possible to obtain the white aggregate, the DOT was open to modifying the requirement so that the highway would be back in service in the shortest time possible.

The I/D provisions of the contract encouraged the contractor to complete the tunnel as quickly as possible.

Repair of the I-10 Bridge over Escambia Bay, Pensacola, Florida

Hurricane Ivan (see Figure 2.13) made landfall at Pensacola, Florida, during the night of September 15/16, 2004, and destroyed the 2.5-mile long I-10 bridges over the shallow Escambia Bay (see Figure 2.14). On September 16, before the actual extent of the damage was known (see Figure 2.15), the Florida Department of Transportation (FDOT) asked four contractors to bid on a 14-day Phase I repair of the westbound bridge and a 90-day Phase II repair of the eastbound bridge.

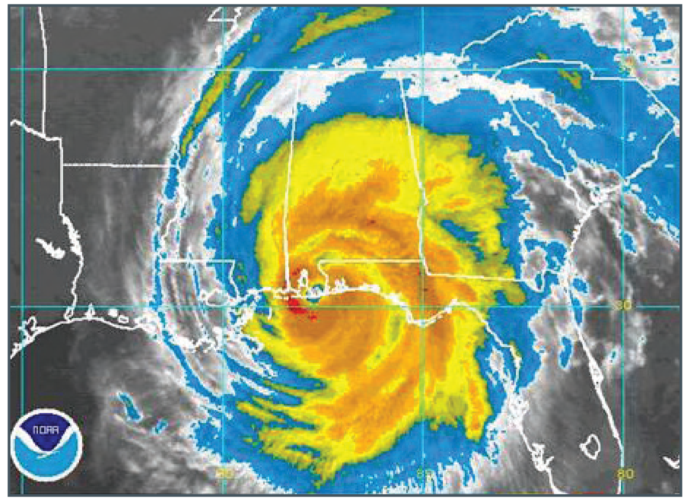

Figure 2.13 *Hurricane Ivan*

Project Description

The contractors had to immediately assemble their teams, including engineers to provide design support. FDOT conducted a project scoping meeting on September 17 and accepted DB proposals that same day (see Table 2.14 for the FDOT timeline). However, as discussions continued, the receding waters revealed substantially more substructure damage than was originally anticipated. The superstructure had moved laterally, at an angle to the bridge, twisting and dragging down piers (see Figure 2.16).

Figure 2.14 *Location of the Escambia Bay Bridge*

Figure 2.15 *Escambia Bay Bridge missing decks after Hurricane Ivan*

Date	Event
15/16 Sept. 2004	Hurricane Ivan makes landfall
17 Sept. 2004	9 a.m.: Pre-proposal meeting in Chipley, Florida 1 p.m.: Question-and-answer meeting 4 p.m.: Price proposals Before midnight: contract signed
19 Sept. 2004	Heavy equipment begins to arrive
22 Sept. 2004	Welding begins on pipe piles
28 Sept. 2004	600-ton crane arrives
4 Oct. 2004	11:30 p.m.: Crane sets last span in position
5 Oct. 2004	6 a.m.: Two-way traffic restored on westbound bridge
20 Nov. 2004	Eastbound bridge opens to traffic
16 Dec. 2004	Contract completed

Table 2.14 *I-10 Escambia Bay Bridge timeline*

Figure 2.16 *I-10 Escambia Bay Bridge's damaged piers after Hurricane Ivan*

FDOT later changed the time duration for repairing the eastbound bridge to 24 days. Additionally, to accelerate the project, FDOT's top management approved a $250,000/day incentive/disincentive with a cap of $3 million for Phase I. The Phase II deadline was set at 90 days with a $50,000/day incentive/disincentive.

The contractors submitted prices on Friday, September 17, at 9:30 p.m. FDOT then conducted negotiations with the selected contractor throughout Friday evening. Discussions centered on approaches to the work and contingencies. At one point everybody had to take a break and go for a walk; however, by midnight, FDOT and the contractor struck a deal, with both parties signing the emergency contract.[7] This was a day and a half after the storm destroyed the bridge.

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[7] Talbot, Jim (2005). "Repairing Florida's Escambia Bay Bridge," *Dixie Contractor*, 21 March.

The first six pages of the Natural Disaster Emergency Contract were typed. After that there were seven pages of hand-written Assumptions and Clarifications to the typed document (Appendix G). There were two phases to the work:

- **Phase I –** The westbound bridge had a contract time of 24 days. The contractor completed this phase in 17 days. The westbound had a total of 229 spans, of these 12 were destroyed and 19 misaligned.
- **Phase II –** The eastbound bridge had a contract time of 90 days and was completed in 63 days. Of its 229 spans, 51 were destroyed and 33 misaligned.

FDOT provided the contractor Acrow bridge components for connecting 58 spans. The Acrow prefabricated steel bridge system is the third generation of improvements to the renowned Bailey bridge[8].

Project Execution

One of the JV contractors mobilized its 600-ton floating crane, which had been scheduled for work with the Louisiana Department of Transportation and Development (LADOTD). LADOTD postponed its contract to help with Florida's recovery efforts. This crane, one of a very limited number in the United States, can pick up a 300-plus-ton load 100 feet away from its center pivot. To expedite the delivery of necessary materials, neighboring states granted permits for oversize widths and loads for piling and other supplies. From a sister company the JV mobilized 40 welders who were then working on offshore platforms. The contractor also identified and purchased 36-inch steel roll beams from a disassembled bridge in Tennessee, secured the mill certifications for the beams from the Tennessee Department of Transportation, and shipped them to the project site for use in the Phase I bridge substructures.

During Phase I everyone worked seven days a week. FDOT, the contractor's engineer, and part of the contractor team all co-located in the engineer's Tallahassee office. To expedite approval of engineering calculations and drawings, FDOT committed to a four-hour turnaround 24/7 until traffic was moving on the completed Phase I Bridge. The contractor, together with its engineer, had to design new pile bents for repairing both the westbound (Phase I) and eastbound (Phase II) bridges as well as a support system for the Acrow Bridge sections.

All designs had to conform to the available materials.

The contractor organized four teams to move the project forward:

1. **Mobilization** team – to put the camp infrastructure in place
2. **Construction mobilization** team – to assemble the necessary equipment
3. **Operations** team – to attack the work (i.e., schedule, work plans, safety, and crews)
4. **Design** team – to accelerate the engineering

[8] "Historical Background of Steel Bridges," *Prefabricated Steel Bridge Systems: Final Report*, (Web Doc) Federal Highway Administration, 12 May 2008, www.fhwa.dot.gov/bridge/prefab/psbsreport03.cfm.

There was no electrical power except what the contractor provided, there were no living facilities for the workforce, and there were no eating establishments remaining in the area. Consequently, the contractor had to provide the work force with living facilities and arrange for food service; it was basically a “camp job.” In the early stages, the contractor used helicopters to bring supplies to the project site.

When construction began, the job was isolated and everyone struggled with communications; however, all parties knew that they had to work together to rapidly open the bridge. A system of runners was established to carry information between the project and the engineering office in Tallahassee. Within a week, a camp of trailers was established on the east approach to the bridge. To address critical needs, the contractor robbed staff and labor from other projects (e.g., welders were brought from Texas to fabricate the piles and bent caps).

Because during Phase I the crews had to work around debris, the design allowed pile location adjustment to avoid the wreckage. Piling material was a critical item at the beginning of the work because the contractor had only located about one-third of the estimated total requirement. The remaining piles had to come from the mills and, therefore, the rolling schedule at the mills soon became critical to the acceleration effort. Outside construction, engineering, and inspection (CEI) professionals did quality assurance on fabrication welding. The state did quality assurance on construction, but to a lesser extent. FDOT used a dynamic PDA for pile testing/acceptance. The DOT did not test the steel, but the contractor submitted certifications. Because this was temporary construction, there was no “buy America” requirement.

The Phase I work involved using good eastbound bridge spans to reconstruct the westbound bridge. Bringing marine equipment from other projects along the Gulf Coast and on the Mississippi River, the contractor used barge-mounted hydraulic platform transporters to lift the eastbound bridge spans off their bents. The barges were then maneuvered so that a ringer crane (see Figure 2.17) could pick and place the slab onto the westbound bridge bents. “On day 17, October 4, the crane set the remaining seven spans into place. The last span was in position at 11:30 p.m., seven days ahead of the bonus/penalty deadline. This qualified the contractor for a $1.75-million bonus. By 6:00 the next morning, one lane of traffic started rolling across the repaired section of the bridge in both directions.”[9]

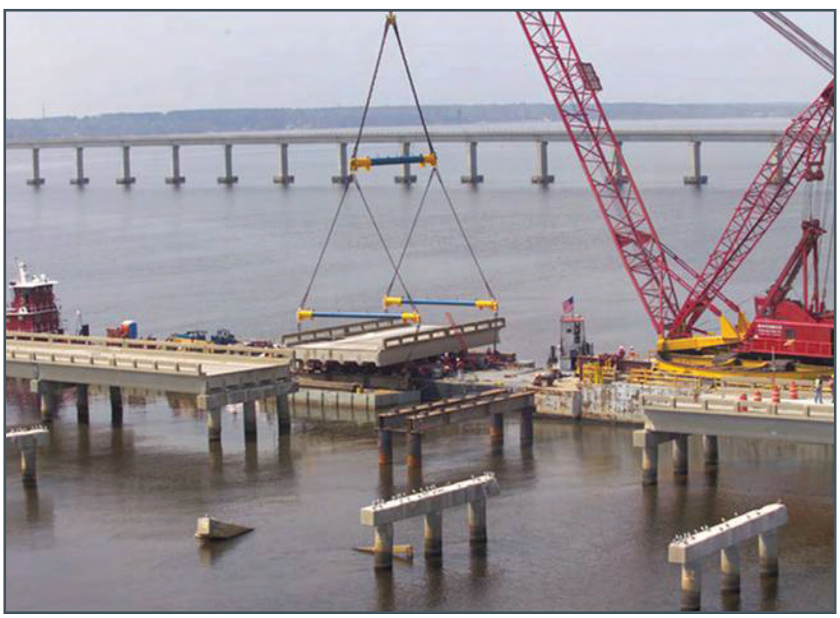

Figure 2.17 *Lifting an Escambia Bay Bridge deck section with a ringer crane*

[9]Talbot, Jim, “Repairing Florida’s Escambia Bay Bridge,” *Dixie Contractor,* 21 March 2005, www.acppubs.com/article/CA511040.html.

Synopsis of Acceleration Efforts

Contract Award and Execution Delegated to Local FDOT Office

This fast-tracked the selection process and contract signing so that the contractor could begin moving people, assembling equipment, and securing materials quickly.

Basic Scope Only

FDOT let the contractors propose and then made a best-value decision. Contractors were given latitude about means and methods for these projects.

Need to Execute a Contract

The contractor would not assume liability for entering the ROW or for beginning to order materials until a contract had been executed.

Mobilization Ability

Only a large contractor in terms of labor, equipment, and financial resources can respond quickly to a project of this magnitude during an emergency.

Right Team

The urgency of the situation and isolation of the site required decision makers to be on site and readily available.

Work Concurrent with Design

The design had to utilize material that could be found and moved quickly to the project site. The work was considered temporary construction. The designers were conservative when considering pile lengths to avoid problems.

Change Is Inevitable

The contractor immediately began an inventory of materials that were available and then communicated this to the designer. The designer was then able to communicate back in terms of flexibility in design based on those materials.

Scope Will Change

As the work progressed, there was better knowledge of the damage situation and the scope was changed accordingly.

Availability of Materials

The contractor had a yard in Texas from which it was possible to draw the necessary materials for the early phase of the work. This existing available supply of material was augmented by the contractor's ability to call on historical relationships with suppliers across the country to obtain other materials. These past relationships had established trust, making it possible to work with only a phone call.

Daily Meeting

The contractor prepared daily look-ahead schedules to ensure that there would be no "gotcha's." Due to hurricane-caused communication outages, daily meetings were the only effective way to communicate. Decisions on whether to salvage or replace existing elements of the damaged bridge were made during the daily meetings.

Underlying Fundamentals of Success

On September 10, 2004, the governor of Florida issued an Executive Order declaring an emergency. This order, which was issued before Hurricane Ivan made landfall, was the instrument that permitted FDOT to use its Natural Disaster Emergency Contracting procedures in response to the damage caused by Ivan.

Issuing the order before the hurricane actually struck allowed the DOT to respond immediately to the challenge of reopening the Escambia Bay Bridge.

In less than 48 hours after the I-10 bridge was severely damaged, a DB contract had been executed. Only 19 days after the hurricane, a temporary bridge was reopened to traffic.

The keys to success in the case of this emergency repair effort were:

- ❖ **Expedited contract execution –** FDOT delegated award to the local office; work was scoped for basic requirements of the needed facility. Obtain an agreement quickly, handwritten if necessary; the formal contract can follow later.
- ❖ **Mobilization –** Marshal people and equipment to the project site as soon as possible. Select a contractor that has the ability to bring people and equipment to an isolated location quickly.
- ❖ **Design team in place to support the project –** Relocate experts to the site and in position to make quick decisions. Develop the design concurrent with the work.
- ❖ **Flexibility based on material availability –** Speed can only be achieved if the DOT is willing to accept available materials for repair.

An important point made by the contractor about how emergency contracts, such as this one, are approached was that its comfort with the DOT affects how it prices the risk of performing the work. It was also noted that large contractors that have the resources to support these projects prefer DB approaches for emergency construction.

Replacement of the Queen Isabella Causeway to South Padre Island, Texas

At 1:59 a.m. on September 15, 2001, a tug pushing four loaded barges heading north veered from the Gulf Intercoastal Water Way channel and collided with bent 32 of the Queen Isabella Causeway. The loss of the bent toppled two 80 foot sections of the bridge. The tug/barge tow came to rest against the causeway, also damaging bent 26. The damage to the adjacent bent foundations resulted in the collapse of span 30 later the same day. As part of this collapse, bent 31 fell over and onto bent 32 (see Figure 2.18). Nine vehicles plunged into the water, resulting in eight deaths. The sequence of events, starting with the collision, is shown in Table 2.15.

Figure 2.18 *Damaged Structure after bent 31 fell on bent 32*

Date	Event
15 Sept. 2001	1:59 a.m.: Tug pushing barge hits bent 32 Tug/barge comes to rest, damaging bent 26 Afternoon: Span 30 collapses Bent 31 falls onto bent 32 due to span 30 collapse Pedestrian ferry operation starts Corpus Christi District requested to provide vehicular ferry Docking facilities contracted via negotiated bid Damage inspection starts Conceptual design starts
16 Sept. 2001	Construction begins on temporary landing for ferry
17 Sept. 2001	First vehicular ferry arrives
21 Sept. 2001	Design completed (plans, specifications, and estimate [PS&E] package ready) Contract awarded for demolition/reconstruction
22 Sept. 2001	Demolition starts and continues throughout construction
7 Oct. 2001	Field construction starts
21 Nov. 2001	Contract completed and accepted
22 Nov. 2001	Bridge reopens (32 days ahead of schedule)

Table 2.15 *Queen Isabella Causeway replacement timeline*

Project Description

The Queen Isabella Causeway is the only vehicular access to South Padre Island. It connects Port Isabel to the Island. The causeway was built in 1974 and is approximately 2.4 miles long. It carries two lanes of divided traffic in each direction. The average daily traffic (ADT) at the time of the accident was 21,000 vehicles.

Night fishermen were the first to arrive at the bridge collapse and were able to save three individuals. Local emergency/rescue agencies also responded quickly, as did the United States Coast Guard, Department of Public Safety (DPS), Texas Parks and Wildlife Department, and TxDOT. The Coast Guard and DPS served as lead agencies since the incident involved both vehicles and vessels. DPS set up a command center at the site.

The first major decision was related to determining if a temporary structure could be constructed quickly to span the collapsed section. Once this approach was ruled out, attention was turned to private boats and vehicular ferries to provide temporary transportation from the island to Port Isabel. TxDOT established and maintained both pedestrian and vehicular ferry operations, and local entities provided parking and staging areas with shuttle transportation.

Pedestrian ferry operations began September 15 (see Table 2.15) with four boats hired via a negotiated bid emergency purchase of services; (see Table 2.15). This contract was for two weeks. Subsequent to this service contract, a low-bid emergency purchase of services resulted in six boats (see Figure 2.19) being hired from three different firms for the duration of construction (see Figure 2.19). Later, in order to increase pedestrian traffic flow, an emergency maintenance contract was executed with another company to provide more vessels to carry an additional 200 to 400 passengers per hour.

Providing vehicle ferry operations was the next hurdle for TxDOT to overcome. TxDOT immediately requested its districts to provide support for a temporary ferry operation. The Corpus Christi District agreed to help locate and construct temporary ferry landings. On September 16, construction with TxDOT forces began on the first temporary landing on the island side. At the same time, the existing Port Isabel Navigation Dock was retrofitted by TxDOT forces to serve as the Port Isabel landing. Ferry operations started September 19 using a TxDOT-owned ferry. A second TxDOT ferry arrived and began operating September 22. Additional ferry capacity was added through an emergency maintenance contract, which brought a commercial vehicular ferry into the operation (see Figure 2.20). Finally, at the request of the local school district, TxDOT approved a separate ferry system to transport schoolchildren.

Figure 2.19 *Temporary pedestrian ferry*

Figure 2.20 *Temporary vehicular ferry*

TxDOT had to acquire an Army Corps of Engineers permit for construction of both temporary ferry landings. TxDOT personnel surveyed and identified protected sea grasses in the area and located the landings to avoid them. Demolition of the damaged structure commenced once the temporary vehicular and pedestrian ferry systems were in place.

Project Execution

With temporary transportation to and from the Island addressed, the next major concern was re-opening of the Gulf Intercoastal Water Way to barge traffic. The adjacent spans and supporting foundations of the steel unit that crossed it were inspected (see Table 2.15). Based on these inspections, barge traffic was allowed to resume with certain restrictions. Barges were only permitted to operate during daylight hours and were not allowed to pass through during adjacent span/bent demolition.

TxDOT district and Bridge Division personnel began damage assessment immediately. The Bridge Division had a diving team perform all underwater inspections. Due to the extent of the piling damage on adjacent bents 30 and 33, it was decided to replace these bents, as well as spans 29 and 33. Bent 26 was damaged by the tug/barge tow and would require only repair. With the damage assessment underway, conceptual design commenced. As shown in Table 2.15, the intent was to complete a PS&E package by September 21, 2001.

Due to the considerable unknowns related to the demolition effort, this emergency work was performed under a force account contract executed with a local contractor on September 21. The contract had an initial limit of $1 million and a termination date of January 31, 2002. An emergency bridge demolition/reconstruction permit was obtained from the ACOE, and demolition started September 22, 2001, with the contractor clearing debris so that remaining vehicles could be removed. The demolition work, which continued throughout construction operations, was only slightly ahead of construction (see Table 2.15). Some debris was too heavy to lift using the contractor's equipment, so explosives were used to break it up into reasonably sized pieces (see Figure 2.21). This effort had to be coordinated with several agencies.

Figure 2.21 *Demolition with blasting*

A turtle survey was required to ensure that the endangered Kemp's Ridley sea turtle was not harmed. This survey was completed prior to and during the blasting.

Once it was determined that a temporary crossing was not feasible, conceptual design began and was performed concurrent with the detailed damage assessment. It was quickly determined that matching the original structure would be the fastest and most economical means of reconstructing the bridge. This decision was based on input from district and division personnel, potential suppliers, and contractors. There were six exceptions:

- Use Type IV beams instead of Type 54 (The fabricator was already set up for this, plus the beams were more stable and did not require diaphragms.)
- Support the water line with hangers from the deck as opposed to concrete diaphragms (to save time)
- Use the original-size bearing pads (1½-inch versus 2½-inch pads)
- Rotate the footings 45 degrees to avoid existing piling
- Add one additional pile to each footing to ensure adequate foundation support and reduce the possibility of time-consuming build-ups
- Cast the footings one foot higher than existing to limit the potential for construction delays due to adverse tide or weather conditions

The Bridge Division provided details for the replacement of spans 29 through 33 and bents 30 through 33. At the same time, the PS&E package was assembled and executed. After the damage had been assessed, the Bridge Division provided design details for the repair of Bent 26. The design included new drilled shaft foundations (concern with pile driving next to damaged column), new footing on top of the existing one, replacement of a section of the tie beam, crack injection, and column encasement. Struts were also designed to help stabilize the column during construction; they were attached to adjacent footing and the new drilled shaft casing.

Bridge reconstruction commenced on October 7, 2001, after a lump sum emergency contract was negotiated and executed on September 21, 2001. The contract duration was set at 87 calendar days. The contract also included a $10,000-per-day incentive and disincentive, capped at $200,000. Three change orders were executed, including an increase in the incentive amount beyond the 20-day maximum to add another seven days at $75,000 per day (cost of ferry and other services exceeded this value). The first change order also added the repair of bent 26 to the contractor's scope of work.

The contractor had the necessary resources in the area to support this short-duration schedule. For example, the contractor was in the marine business and was already hauling sand and gravel and could easily supply marine equipment to the project. TxDOT had considerable experience working with this contractor. The contractor worked an around-the-clock schedule.

Construction was expedited by using high-range water reducers for the substructure concrete. A work plan was developed for their use, and trial batches were used to establish slump versus time graphs and desired dosages of the high-range water reducers. The initial slump was approximately ½ inch with concrete dosed to achieve an 8–inch slump. Final mix/dosage was developed to provide 3,000 psi compressive strength at 16 to 20 hours. This treatment allowed for early removal of the forms to continue with rapid form placement and construction.

Figure 2.22 *New footing construction at bent 30*

Figure 2.23 *Last three spans poured on November 15*

Reconstruction and demolition continued concurrently, with the same contractor being responsible for both efforts. TxDOT worked closely with the contractor through the construction period. Construction was completed in 56 days, 32 days ahead of the fixed duration, and the contractor earned a bonus of $725,000. Parts of the construction process are shown in Figure 2.22 and Figure 2.23. The total cost of the project is summarized in Table 2.16.

Approximate Cost	Cost
Bridge demolition	$1,883,529
Bridge reconstruction	4,766,666
Temporary transportation	4,815,908
Other district (mostly temporary transportation)	3,308,896
Local entity reimbursement (temporary transportation)	1,184,378
Total estimated cost	$15,959,377

Table 2.16 *Queen Isabella causeway bid summary*

The contract allowed 87 calendar days to open the bridge.

Synopsis of Acceleration Efforts

Team Commitment

TxDOT, the fabricator, and the contractor were committed to the project based on a 24/7 schedule.

Design-Build Decisions

Decisions were made based on input from all parties as if the project were DB, although project delivery was DBB.

Timely Decision Making

Problems were addressed immediately because project team members were on call throughout the day over the duration of the project.

Incentives

Monetary incentives motivated the contractor to complete the project early.

Concurrent Construction Sequence

Demolition started as soon as the damage assessment was complete and continued during construction. This overlap reduced the overall construction duration.

Mobilization Ability

The contractor responded quickly to the need and had the necessary resources (i.e., equipment and people) in the area to staff the project and sustain a highly accelerated schedule.

Total Closure

Both pedestrian and vehicular traffic were handled using temporary ferries, eliminating the need for a temporary structure and providing an unobstructed working area.

Accelerated Materials

Use of high-range water reducers in the substructure expedited form removal and allowed construction to continue at an accelerated pace.

Underlying Fundamentals of Success

The decision to use a temporary ferry system to move pedestrians and vehicles to and from the island allowed TxDOT to move forward with demolition of the existing damaged structures in a timely fashion. The use of the same structure design as the existing structure, with some changes, facilitated rapid design. In turn, this allowed TxDOT to contract for construction within weeks of the accident. A team approach with common goals promoted a successful work environment where decisions were made in a timely manner based on input from all the participants in the design and construction process. The contractor was very organized and efficient in planning and executing the work with the needed resources available to accelerate demolition and construction.

Conclusions: Emergency Accelerated Construction

As demonstrated by the projects investigated during this scan, the ability to successfully execute an accelerated project under emergency conditions depends the following:

- Have knowledgeable people (i.e., experts) who can make timely decisions. Have the technical expertise to design quickly. Use partnering to facilitate collaboration and resolve problems at the site.
- Quickly execute a contract or agreement that addresses responsibilities and risks. Obtain a basic agreement and follow up with a formal contract.
- Find a contractor that has the resources to start immediately. The contractor must have financial capacity together with immediate access to the required crews and equipment.
- Offer larger incentives, because emergency work places more risk on the contractor to perform rapidly.
- Ensure that designs consider material availability and logistical limitations.
- Collaborate with suppliers, fabricators, and contractors before the bid.

Recommendations

Departments of Transportation should:

- Establish Emergency Project Delivery Teams (EPDTs) with the necessary subject matter experts to evaluate and work on project design and delivery.
- Include contractor input during the design development phase of an accelerated project; contractors can provide knowledge about constructability issues that can make construction proceed smoother and faster.
- Have a pre-established Incident-Command System (ICS), similar to that used by most emergency responders. An ICS consists of organizational hierarchy and procedures for the management of incident(s) and a mechanism for controlling personnel, facilities, equipment, and communications (see www.osha.gov/SLTC/etools/ics/index.html). The ICS should be interdisciplinary and organizationally flexible to:
    - Meet the needs of incidents of any kind or complexity (i.e., expand or contract)
    - Allow personnel from a variety of agencies to meld rapidly into a common management structure with common terminology
    - Provide logistical and administrative support to operational staff
- Have an established Executive Management Team (EMT) that can be responsible for emergency project delivery decisions. The EMT will decide on when to advertise and award, what procurement mechanisms to use, which contract type to use, and what the delivery schedules will be. The EMT will make decisions based on recommendations by the EPDT and others. EMT decisions need to be clear and must be made within a short time frame so that the scope of work and objective are clearly identified and communicated to the staff.
- Develop and train key staff and engineers in the decision-making skills needed to respond effectively to an emergency-recovery effort.
- Establish flexible, accelerated PS&E processes. Allow predesignated options, yet actively seek contractor/fabricator constructability knowledge.

- Streamline the addendum-request process.
- Consider establishing on-call engineering contracts. In addition, the DOT needs to be able to enter into construction contracts quickly in response to emergency needs[10].
- Develop procedures and criteria for the use of large incentives/disincentives and responsive bid requirements.
- Have the ability to expedite construction administration processes. The shop drawing-review process should be expedited by delivery via e-mail directly to all interested parties. The request-for-information process should also be expedited by e-mailing information directly to all interested parties. Software-development companies are offering Web-based project management software that supports online document collaboration sessions and electronic tracking of file activity; these programs can be used to speed shop drawing-review processes.
- Create a post-event Lessons Learned Team to document lessons learned from the project. The team should consist of subject matter experts in structural analysis, loads, reinforced concrete, prestressed concrete, structural steel, maintenance, geotechnical, materials, construction, and other relevant fields.
- Train personnel on how to share large files electronically. With an increasing amount of information provided electronically, the ability to access this information at the project level, in a timely manner, is critical. Consider adding wireless mobile broadband cards to laptop computers.

Community awareness is a vital part of project success. It is critically important to maintain positive community relations and to keep the media informed. The media will help to disseminate information about detour routes and construction progress. Personal contact is the best way to deal with the community. When disseminating information:

- Identify the work activities and locations
- Identify the work hours
- Explain impacts to progress
- Share the schedule
- Provide a point of contact for obtaining more information

[10]Caltrans (with FHWA agreement), under a Director's Order, can approve new emergency construction contracts. These can be force account contracts (noncompetitively bid projects paying on a time-and-materials basis), emergency limited-bid contracts, informal bid contracts, or emergency equipment rental. These can be initiated verbally within minutes, depending on the urgency. The department keeps an active contractor listing to reference depending on the area and type of work specified in a Director's Order.

CHAPTER 3

Planned Accelerated Construction

To meet community desires and specific externally imposed project duration constraints, transportation agencies must often take steps to accelerate the completion of their projects. By careful planning of preconstruction activities and thoughtful staging of field operations, projects can be accelerated and roadways opened with only minimum inconvenience to the traveling public To induce contractors to speed construction work, many agencies are using I/D-type contracts.

Two common factors that have contributed to the success of planned accelerated projects are partnering and provision for a time period between contract execution and the start of construction. These delayed construction start periods provide time for detailed planning, approval of shop drawings, and procurement of long lead-time materials.

This section of the report uses case studies to present background material about each of the visited projects and to explain how each project was accelerated. Topics discussed include agency acceleration approach, contracting method, and the roles and responsibilities of the primary stakeholders. Each of these topics was probed by open discussions with the DOT or with highway contractors. Key factors that led to each project's success are listed at the end of each case study.

Rebuild of the I-15 Devore Corridor, Devore, California

In 2004, as part of its Long-Life Pavement Rehabilitation Strategies (LLPRS)[11] program, Caltrans used an innovative approach to rebuild a heavily traveled section of I-15 in the city of Devore (see Figure 3.1). The Devore corridor carries approximately 110,000 ADT, about 10% of which is heavy trucks. In contrast to typical urban freeways in California, which have lower traffic volumes on weekends and higher traffic volumes during weekday peak rush-hour periods, the Devore corridor has both high weekday commuter peaks and high leisure traffic volumes on weekends. The two highest peak traffic volumes are northbound on Friday afternoon and southbound on Sunday afternoon, when leisure travelers in the Los Angeles area are going to and returning from Las Vegas.

During this project, a 2.8-mile stretch of badly damaged concrete lanes was rebuilt in only two single, continuous closures (also called extended closures) totaling 210 hours, using counter-flow traffic (i.e., flowing in the opposite direction to the main traffic flow) and 24-hour-per-day construction operations. Traditional nighttime-only closures would have required 10 months of work, as estimated on the preconstruction schedule. Instead, the rebuilding took 19 days, with each extended closure for one roadbed lasting 9.5 days.

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[11]CA4PRS *Implementation Project for Long-life Pavement*, California Department of Transportation, State of California, www.dot.ca.gov/newtech/roadway/llprs/index.htm

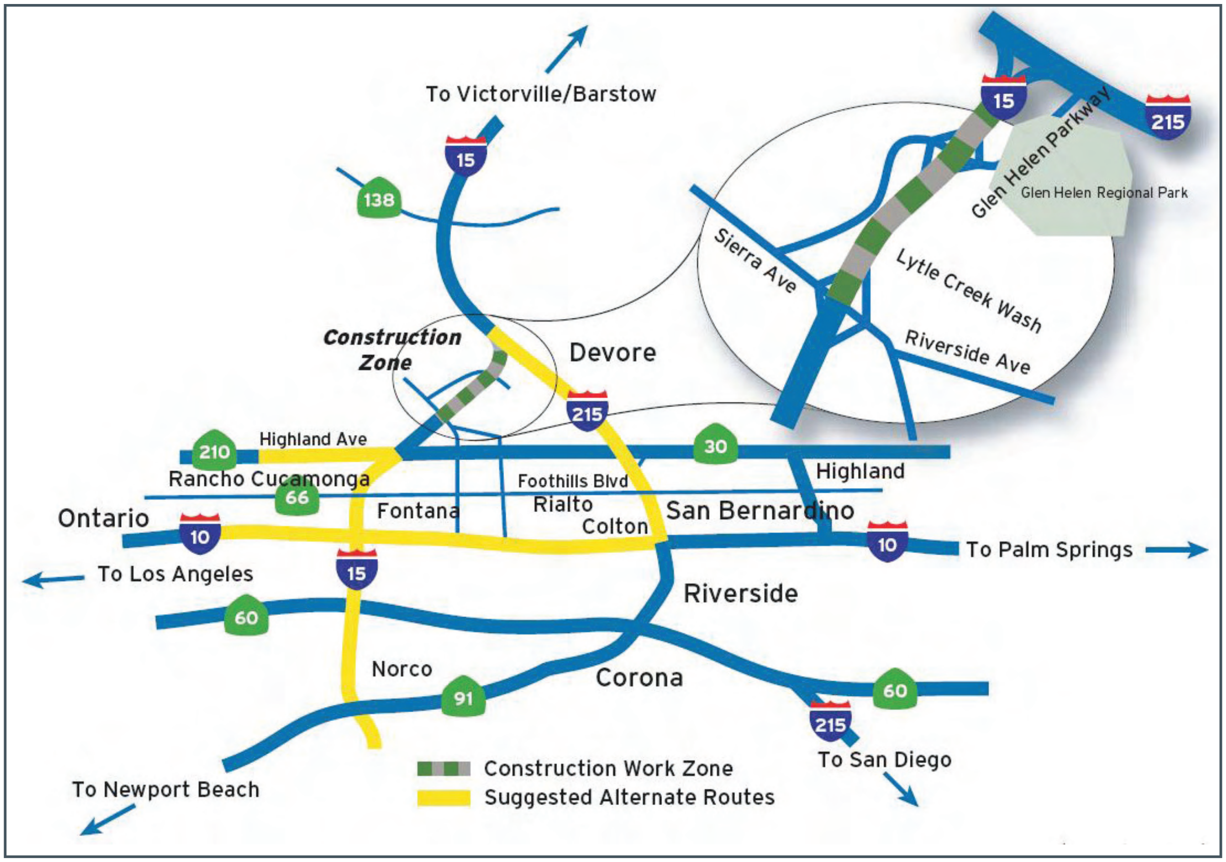

Figure 3.1 *Location map of the I-15 project at Devore*

Project Description

The preconstruction analysis sought the most economical reconstruction closure scenario while integrating the competing concerns of construction schedule, traffic impact, and agency cost. Four closure scenarios were compared: 72-hour weekday, 55-hour weekend, one-roadbed continuous (24/7), and 10-hour nighttime. The analysis concluded that the continuous/extended closure scenario would be the most economical. Compared with traditional 10-hour nighttime closures, the preconstruction analysis indicated that the extended closure scenario (two single-roadbed continuous closures) would need about 80% less total closure time, resulting in about 30% less road-user cost due to traffic delay, and about 25% less agency cost for construction and traffic control.

This analysis was performed using Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS). CA4PRS identified the costs associated with road-user traffic delay to determine appropriate incentives and disincentives for the construction contract.

Initially, Caltrans moved ahead with the project assuming the use of 72-hour weekday closures due to major concerns about traffic delay on weekends for Las Vegas-bound leisure traffic. However, at public hearings Caltrans met with strong opposition from weekday commuters to the 72-hour weekday closures. The weekday commuters felt that their time delay was of greater value than that of leisure traffic. Although the contract was awarded based on the 72-hour weekday closures, Caltrans adjusted the reconstruction plan to one-roadbed continuous closures just one month before the first extended closure was set to begin.

For this type of work in California, the Devore Project was the first to implement an automated information system in the work zones. Prior to construction, it was decided to have a 24-hour command center. The system provided motorists with real-time information on travel and detour routes. The information was posted on permanent and temporary changeable message signs placed at strategic locations where roadway users could make decisions about travel routes. As part of an interactive public outreach program, the information was also posted on a traffic road map accessible on the project Web site.

By structuring the work as continuous, Caltrans was able to specify rapid-strength concrete with a 12-hour curing time rather than fast-setting hydraulic cement concrete (FSHCC) with a 4-hour curing time. The 8-hour time advantage of FSHCC is offset by these factors:

- Higher concrete slump and material stickiness
- The need for more delivery trucks and a smaller paving machine
- The restriction to single-lane paving at one time
- The typically rougher finished surface, which frequently requires diamond grinding after curing

In addition, FSHCC is about twice as expensive as Type III PCC in California.

Another measure to speed the work was the substitution of a 6-inch new asphalt concrete base (ACB) instead of the usual 6-inch lean concrete base (LCB). According to a study at the Pavement Research Center, University of California, Davis-University of California, Berkeley, the two types of bases perform almost equally well.[12] LCB requires a 12-hour curing time before PCC slab paving. LCB also requires placement of a bond-breaker to minimize friction between the base and slab. The bond-breaker increases the risk of early-age cracking and the placement process would slow paving production. The ACB scenario, additionally, permitted parallel production of the base and slabs, with each operation utilizing its own resources, while the LCB needs to use the PCC plant and a paver.

A widened 14-foot-wide lane, rather than the usual 12-foot-wide lane, tied the new concrete shoulder to the outermost truck lane. However, high project bids in the first round of bidding resulted in altering the rehabilitation scope. The initial scope included reconstruction of two lanes (the outermost and adjacent), but the revised project included reconstruction of only the outermost lane and targeted partial (about 10%) slab replacement on the adjacent lane.

Project Execution

The I-15 northbound roadbed was closed for reconstruction first, and northbound traffic was switched to the southbound side via median crossovers at the ends of the work zone. The two directions of traffic shared the southbound lanes as counterflow traffic separated by a Quickchange Movable Barrier system. The same process was repeated for reconstruction of the southbound roadbed. The use of the moveable barriers, at a cost of $1.5 million, helped balance traffic impacts on commuters and weekend travelers by providing dynamic lane configuration. Twice-daily operations required only 30 minutes to move the barrier (see Figure 3.2) and convert one additional lane temporarily from the rehabilitated asphalt concrete shoulder to accommodate peak directional commuter traffic.

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[12] Venkata Kannekanti and John Harvey, "Sensitivity Analysis of 2002 Design Guide Rigid Pavement Distress Prediction Models," Pavement Research Center, University of California, Davis-University of California, Berkeley, June 2005, p. 23.

The work combined conventional construction materials and operations with state-of-the-practice technologies to expedite construction and minimize traffic impacts. The contract required that the contractor have contingency plans for items identified by previous LLPRS case studies as risks that could impact progress. One of these was the possibility of encountering poor subgrade during demolition and excavation. It was agreed that FSHCC could be used, either to achieve more production at the end of the closure, to make up for any unforeseen delay, or as a temporary paving material in case of an emergency. Project features that contributed to traffic control included the following:

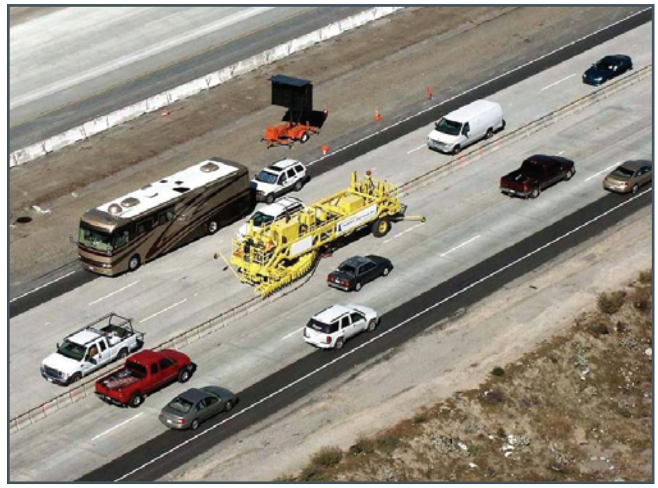

Figure 3.2 *Moving the I-15 median barrier*

- A **project command center** facilitated DOT coordination between disciplines (e.g., construction, design, traffic, and public affairs) and with other agencies. The command center also enabled remote monitoring of traffic and construction on closed circuit TV.
- Caltrans **shared information** and received constructive feedback from the local community through the High Desert Commute Advisory Committee.
- Caltrans allocated $65,000 to establish free **commuter bus service** to promote ridesharing. Fourteen buses were added to existing lines serving commuters traveling from the High Desert to the south, increasing overall usage by 40%.
- The Freeway Service Patrol **tow-truck service** removed 1,243 disabled vehicles from the work zones at a cost of about $100,000.
- The Construction Zone Enhanced Enforcement Program **improved traffic control** and enforcement in the construction work zones. The California Highway Patrol issued 1,034 traffic citations during the construction period.
- Contractor **production rates** exhibited a significant learning curve. The majority of the reconstruction operations during the southbound reconstruction (later in the project) were 28% more rapid for slab removal and 22% more rapid for paving than those of the northbound reconstruction (earlier in the project). The continuous lane reconstruction on the outer truck lane had twice the productivity of the random slab replacement operation on the inner truck lane.

Synopsis of Acceleration Efforts

Planning

Caltrans made a dedicated effort to analyzing the impacts of different road closure scenarios. The scenarios supported best alternative decisions in terms of construction speed and cost – both cost of construction and cost to the public. Caltrans also retained the contractual authority to open the freeway prior to the end of closure due to emergencies (e.g., severe weather, fires, vehicle accidents, or construction-related problems that would compromise the quality of the finished product). Under such circumstances, the contractor was required to use FSHCC, hot-mix asphalt, or cold-mix AC as temporary paving materials to be eventually replaced with specified materials.

Contract

The contract had two I/D provisions to encourage the contractor to complete the closures on time. One was to minimize the duration of each roadway closure (a closure incentive bonus of $300,000) and the second was to minimize the total closure days of the entire main reconstruction work. The latter incentive was set at $75,000 per day for each day less than 19.

Public Outreach

Prior to construction, large employers and affected business (i.e., airports and postal and package service companies) were informed about the project through project fliers, public meetings, and intensive media outreach. Project planners hoped that the dynamic effort to raise public awareness would prompt a 20% reduction in peak-hour traffic demand; the effort was successful.

Surveys on the project Web site showed dramatic changes in public perception of the "Rapid Rehab" approach of the extended closures from initial reluctance and objection to positive support.

Design

The design specified rapid-strength concrete with a 12-hour curing time rather than FSHCC with a 4-hour curing time and substituted a 6 inch new ACB for the usual 6 inch LCB.

Partnering (Teamwork)

Caltrans used formal partnering on this project.

Underlying Fundamentals of Success

The advantages of using this method of accelerated construction were:

- Shorter period of disruption for the traveling public
- Greater life expectancy for the new pavement than could have been obtained using nighttime closures
- Improved safety for motorists and workers
- Significantly reduced construction costs (by about $6 million)

Caltrans credits the success of the project to two factors: its public involvement and outreach campaigns and project planning: "Our massive public outreach campaign and available data are what made this project a success." In the five months preceding the extended closures and while the closures lasted, the project Web site received nearly 100,000 hits and played an important role as an interactive tool to gain input from the public. Community Web surveys indicated that most (72%) of the people who used the site considered the project information it provided useful to their trip planning[13]. Planning by Caltrans as to how the project work should be scheduled was the second key to the success of accelerating this paving project.

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[13]Lee, Eul-Bum, David K. Thomas, "Accelerated reconstruction of I-15 Devore corridor," Public Roads, Vol. 70, No. 4, Jan.-Feb. 2007, www.tfhrc.gov/pubrds/07jan/05.htm.

Yerba Buena Island Bay Bridge, San Francisco, California

Viaduct Roll-In

The Yerba Buena Island (YBI) Viaduct carries I-80 traffic across the island and links the East Spans of the SFOBB with the YBI Tunnel. A 348-foot portion of the YBI Viaduct needed to be replaced (or significantly retrofitted and modified) to accommodate a detour structure required to allow traffic to bypass construction on YBI during the replacement of the East Spans of the SFOBB. The replacement structure was also needed to replace a section of the YBI Viaduct considered seismically deficient.

Numerous advance-planning studies for both retrofit and replacement of this section of the YBI Viaduct were completed. All required significant traffic delays (lane closures and short-term bridge closures for approximately 8 hours) for at least nine to 12 months to complete the project. Construction was risky due to the close proximity of live traffic and tight schedules for closures. These all were deemed too risky and disruptive to implement.

The last advance planning study looked at building a new structure next to the existing structure and then quickly demolishing the old structure and moving in the new structure. This **Demo-Out-Move-In** strategy required at least three full days of bridge closure. It was felt that the public would be more accepting of a three-day closure than months of traffic delays. The other major advantage of this strategy was that construction would take place away from live traffic, reducing risks both to the traveling public and to the construction timeline schedule.

Project Description

The project goal for the viaduct replacement was to limit the bridge closure to three days. Traffic Operations estimated that the economic impact was best minimized with the three-day shutdown compared to the conventional staged partial detours that would take more than a year. Labor Day weekend 2007 was selected as the target timeframe for roll-in as the bridge had the least traffic demand over the Labor Day weekend and thus the closure would inflict the least economic impact.

The selected design was a cast-in-place/posttensioned box girder with transverse girders and large edge beams spanning column supports. The edge beams sit on bearing pads placed on top of the columns and are tied to the support columns with structural steel pins. This enabled the superstructure to be placed onto the support columns with minimum complexity.

The construction sequence was developed with input from the construction contractor and the bridge-moving contractor. It was decided to move the bridge with skid shoes that run on oiled steel tracks. The bridge section was pushed with hydraulic rams. The bridge had to be designed to withstand the moving loads. The basic construction sequence was as follows:

- Prepare a level staging area adjacent to the existing structure for construction of the new superstructure. In this case, two large soil nail walls were needed to provide the level staging area for the roll-in operation.
- Build the new support columns on the side of the existing viaduct.
- Build the new superstructure, including temporary support columns, in the staging area.
- Place the moving equipment, including the skid shoe rails and rail foundations.
- Close the SFOBB to traffic for up to three days.
- Demolish the existing structure.
- Move in the new structure.

- Set the new structure down on the support columns and place the column pins.
- Place the closure pour between the new and existing viaduct.
- Open the SFOBB to traffic.

Project Execution

The staging area required level ground for the skid shoes to perform adequately. New temporary concrete columns were built in the staging area that mimicked the location of the new columns. This was required to minimize differential settlement at support locations during construction. This proved to be expensive, since the temporary columns were almost as expensive as the permanent columns.

The cast-in-place/posttensioned box girder was built on falsework and then posttensioned. The falsework was then removed, and the moving equipment was installed between the temporary columns.

A test lift was performed; this proved to be an essential step because the bridge-moving contractor underestimated the weight of the structure. Corrections were made to the setup to facilitate a smooth lift once the actual move commenced.

The SFOBB was closed to traffic at 8 p.m. Friday. Since there was no room to roll out the existing superstructure span, the contractor chose to demolish the 6,500-ton structure on site within two days. The existing floor beams (75.5 feet long each) were saw cut and hauled across the east span of the SFOBB to a dumpsite in Oakland. The substructure was demolished using demolition hammers as depicted in Figure 3.3.

Lifting and moving the new span into place required slightly less than three hours (see Figure 3.4). The clearance between the new and existing structure was 3 inches on each end. The superstructure was set on its new columns, and the column pins were installed. The column pins were dropped through prefabricated holes in the edge beam into prefabricated holes in the columns. The successful installation of the column pins was a testament to the tight tolerances the contractor was able to achieve during construction and moving.

Traffic was placed back on the Bay Bridge at 6 p.m. Monday, 11 hours ahead of the scheduled 5 a.m. Tuesday opening. A video of the demolition and roll-in operation can be found at www.mtc.ca.gov/news/info/bay_bridge_9-07.htm.

Figure 3.3 *Demolition of the old YBI viaduct*

Synopsis of Acceleration Efforts

Design

The design team worked closely with the contractor and the heavy-lift contractor in developing the construction sequence.

New Technology

Although the innovative roll-out/roll-in (RO/RI) equipment had never been used on a Caltrans project, Caltrans was willing to pursue a risky operation for which there was no in-house experience and which, if it was not successful, would impact reopening the bridge to traffic.

Figure 3.4 *Roll-in of the new YBI viaduct*

Contract

This was a project fraught with risk and unknowns. Caltrans does not have authority to do Design-Build but was seeking a way to obtain more contractor involvement in the design of this challenging work. Therefore, the original contract was performance based; however, as the number of issues began to mount, Caltrans took complete control of the design and the construction work was completed by force account.

Partnering

The partnering process between Caltrans and the contractor was expanded to include the designer, subcontractors, and fabricators. This collaboration was instrumental to the project's success.

Risk Planning

Caltrans has a six-step process that constantly monitors existing risks and seeks to anticipate potential risks. The steps are:

1. **Management planning –** Determine and ensure that the methods used are suitable to ultimately mitigate risks.
2. **Identification –** Identify the risks using a mix of standard risks and project-specific potential risks.
3. **Qualitative analysis –** Rank risks based on how likely they are to occur, as well as their impact on project goals, including whether the risk will make the project exceed the budget or finish behind schedule and, if so, by what amount.
4. **Quantitative analysis –** Estimate the probability that a project will be on time and on budget, based on the qualitative analysis.
5. **Response planning –** Consider, using team structures, various strategies to mitigate risk, including altering the project's scope, schedule, or budget, or mitigation by taking early steps to reduce the threat, impact, or possibility of a risk.
6. **Monitoring and control –** Assign a risk owner to monitor and manage each risk.

More information can be found on the Bay Bridge Web site at http://baybridgeinfo.org/risk-mgt.

The test lift of the span, which demonstrated problems, allowed time to adjust the jacking arrangement and led to successful roll-in of the span.

Public Outreach

Caltrans began an extensive notification campaign six months before the closure, spending nearly $1 million on Web sites, flyers, radio ads, and pre-movie commercials to warn Bay Area, Central Valley, and Southern California residents of the closure. The DOT also subsidized mass transit, paying for BART to offer limited overnight service and for the ferry systems to operate additional boats.

Underlying Fundamentals of Success

Risk management has proven to be an invaluable asset in dealing with the inherent risks in a project as massive and complex in scope and scale as the Bay Bridge, of which the YBI Viaduct Roll-In is just one component. The SFOBB East Spans Project schedules are all centered around and driven by the Self-Anchored Suspension (SAS) Bridge. To keep the entire project moving forward, the YBI Viaduct span had to be completed expeditiously to fit into the time available for the subsequent YBI Transition Structure, which in turn has to match to the SAS schedule. (The contracts can be viewed at http://baybridge360.org/.)

The Caltrans risk-management process is a methodical approach of planning for, identifying, analyzing, responding to, and monitoring project risks. The process helped project leaders respond to design challenges (i.e., a structure capable of resisting the loads imposed by the moving process). Contract risk-transfer elements maintained a focus on acceleration (e.g., responsibility for bridge closure duration). Risk management was the impetus for the test lift as a strategy to mitigate risk.

Detour and Transition Structures

The YBI Detour contract is for constructing a temporary detour from the YBI tunnel to the existing East Span of the Bay Bridge as shown in Figure 3.5. This detour will be used to maintain traffic on the existing East Span of the Bay Bridge while the YBI Transition Structure contract completes the tie-in from the new SAS Bridge to the existing YBI tunnel. The YBI Transition Structure will transition the SAS span's side-by-side road decks to the upper and lower decks of the YBI tunnel. Part of the transition work is included in the YBI Detour contract.

The first in a series of phases to build the temporary 900-foot-long YBI Detour, as well as the YBI Transition Structure, took place during the 2007 Labor Day weekend (the YBI Viaduct roll-in described in the previous section). That seismically upgraded section of roadway will serve as a connection to both the YBI Transition Structure and the YBI Detour. The plan for constructing the span that will connect the detour to the existing bridge is to roll out the span that currently connects the bridge to the viaduct and roll in the detour-connecting span. To accomplish this, everything must be ready by Labor Day weekend 2009.

* The YBI viaduct is the lighter roadway in the lower left part of this figure.

Figure 3.5 *Aerial view of the YBI detour (right*)*

Contract Description

A YBI Detour contract to construct a temporary detour structure for the planned SAS Bridge was awarded in early 2004. Re-advertisement of the SAS superstructure contract in 2005 changed the detour's timeline. The required suspension of the work and design risk issues caused Caltrans to significantly change the YBI Detour contract.

Originally, the YBI Detour work was bid as an A+B contract. Given the initial scope of the contract, the selected B factor was significant: $100,000 per day. It was based on the estimated costs of potential owner and user damages not only associated with the contract, but also to the corridor as a whole (as the contract was corridor-critical at the time of letting). Contract liquidated damages were set at $100,000 per day under the same basis. The contract was crafted as a performance-based contract in which design parameters were stated and the contractor was to develop a design complying with those parameters. Additionally, the contractor's design had to be approved by Caltrans engineers (something close to DB). Caltrans could not let a pure DB contract because at the time of this work state statutes prohibit the use of that contracting method on highway projects. Ultimately, two-thirds of the detour contract was taken back by Caltrans and the design was completed by the state.

The contract also included other innovations to expedite corridor completion:

- A "Working Drawing Campus" provided for co-location of working multidisciplinary cross-functional teams to facilitate expedited completion of design/construction working drawings
- The specifications required that the bidder submit its preliminary design with the bid package
- The specifications provided for bidder compensation (stipend)
- All prospective bidders had to be prequalified

The critical factor driving the original contract was schedule. At the time that the contract was issued, it was thought that the detour needed to be constructed as soon as possible to reduce the time needed to achieve seismic safety for the bridge. No I/D contract provisions were associated with interim contract milestones or contract completion in the original contract. The contract, which has now been modified by CCOs, has incentive provisions to expedite completion of the tie-in. Some of these CCOs provided only incentives, while others provided incentives and disincentives. In addition, CCOs to compensate the contractor for working additional shifts and providing additional resources were authorized. Caps on the CCO incentive and disincentive amounts were provided. While the work related to some of these CCOs is still ongoing, the incentive CCOs appear to have been extremely effective in expediting critical contract milestones.

Work is just starting: falsework erection for the span that will be slid into place to tie the detour to the existing bridge.

Figure 3.6 *YBI detour construction*

Design, fabrication, and construction sequencing and scheduling are all now tightly integrated, accelerating the construction approach for a bridge closure and the RO/RI of the detour span (see Figure 3.6) over Labor Day weekend 2009.

Project Execution

The contract provides for VE and CRIPs. As the contract progressed, many workshops were jointly conducted with the contractor (including subcontractors and fabricators), designers, and DOT personnel. These meeting provided for an open exchange of design and constructability ideas. Many of these concepts were adopted in the ultimate design and construction.

Caltrans established the work schedule for this project in conjunction with the occupants of YBI, the U.S. Coast Guard, the City and County of San Francisco, and the contractor with the goal of allowing the contractor maximum flexibility to achieve delivery of the project. The Coast Guard station can be seen in Figure 3.5 under and immediately to the right of the detour work. In essence, the overall East Bay Bridge program schedule and permit conditions drove the project work schedule.

Caltrans was developing the design as the work progressed, and that process was the other factor guiding the scheduling of work. Specifically, the plans were released sequentially: foundations, substructure, and superstructure. Even these were broken down into many subpackages (e.g., material procurement prior to final design completion). Each set could be considered mini-PS&E packages. When a construction package was implemented, the contractor was given as much flexibility as possible to phase the work.

In March 2007, the YBI Detour contract was modified to better integrate the detour work into the total bridge project schedule and to reduce overall project risks. This CCO advanced the YBI Transition Structures foundation work into the YBI Detour contract. YBI Detour viaduct structural sections were fabricated in Korea, and the first shipment of the viaduct steel was received at the Port of San Francisco in September 2007.

The detour bridges were being constructed without impacting bridge traffic. However, for the RO/RI operation, a very specific traffic management plan is being developed that is far above normal Caltrans practices.

The program management team met with the contractor in 2009, and it was decided that the final determination on the feasibility of a Labor Day 2009 RO/RI of the east tie-in segment can be made once the skid bents loading details, final shop drawings, and bearings are approved.

Synopsis of Acceleration Efforts

Risk

Caltrans and the contractor took numerous actions to reduce project risk. A second fabricator was brought on board to remove the truss fabrication from the schedule's critical path, thereby mitigating schedule risk. Caltrans secured the permits for a crane trestle on the YBI shoreline, which allows flexibility in construction going forward and reduces schedule risk during the critical weeks before the traffic switch. (This crane trestle can be seen in the foreground of Figure 3.6) Caltrans moved some of the YBI Transition Structure advance work into the YBI Detour contract.

Partnering

As the contract progressed, the partnering arrangement between Caltrans and the contractor was expanded to include the designer, subcontractors, and fabricators. This collaboration has been instrumental to the project's success.

Design/Construction Overlap

Once Caltrans took over the design process, individual design packages were released to the contractor as they were prepared. This approach allowed design and construction to proceed concurrently.

Underlying Fundamentals of Success

Matching the availability of the detour to the SAS construction schedule was the primary project situation that drove the accelerated construction process. Given the situation (i.e., changes in the schedule for the SAS Bridge), the Caltrans/constructor team did an excellent job in finding solutions to a multitude of problems and overcoming many challenges. Planning has been the key to success; however, both the DOT and the contractor concede that they would have welcomed the opportunity and time to plan more extensively.

The project and the 2007 roll-in clearly demonstrate the importance of partnering. A partnering atmosphere that includes all members of the project team has been a repeated theme found in all accelerated construction projects. The partnering obviously must include the DOT and the contractor, but with an accelerated project it must be expanded to include the designer, subcontractors, and fabricators. Total collaboration by all parties is instrumental to project success.

The planning process that determined and considered public expectations was begun six months prior to the first full bridge closure of Labor Day 2007. These same expectations are currently being analyzed relative to the detour RO/RI. Public outreach will again be critical to successfully completing the detour connection to the existing Bay Bridge. The RO/RI operation has not yet been performed, and that is the element of the project that will define success.

Replacement of the Duval Street Bridge, Jacksonville, Florida

The Florida Department of Transportation (FDOT) replaced the Duval Street Bridge in Jacksonville during a seven-month period in 1999. This was a fairly small project that was performed over a decade ago; however, the lessons learned have helped both the DOT and the contractor improve their approaches to accelerated construction. The compressed schedule was dictated by the need to provide access to a major sports stadium before the start of the following season. The replacement bridge contract specified 120 calendar days for construction and had an incentive of $15,000 per day for each day of early completion. Liquidated damages were $1,924 per calendar day beyond the allowed time.

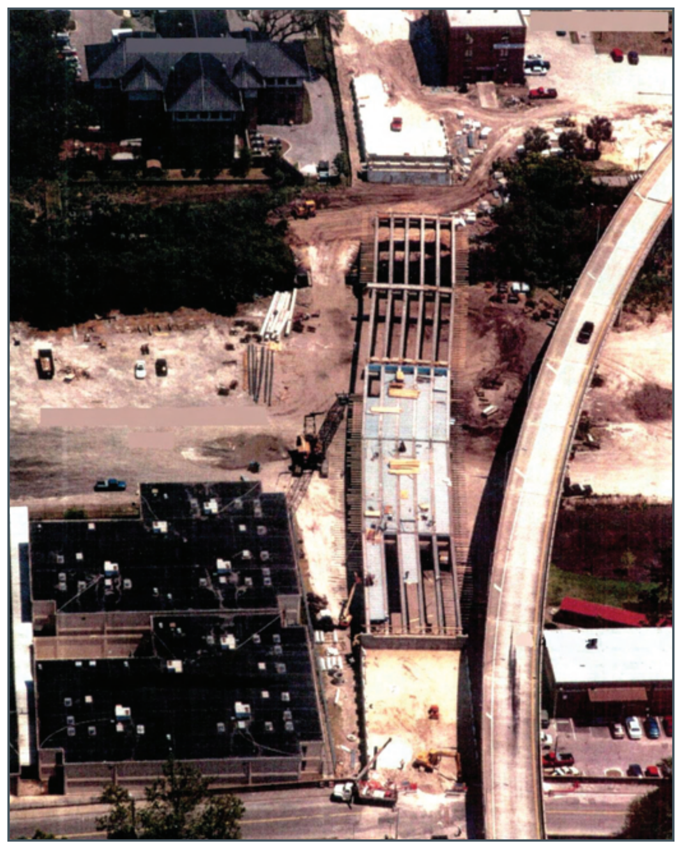

Figure 3.7 *Duval Street Bridge during construction*

Project Description

The new bridge is 528 feet long and has two 12-foot lanes with 8-foot shoulders (see Figure 3.7). It has six spans constructed on concrete pilings and bent caps, with a deck supported by AASHTO Type IV beams. The project also involved 450 linear feet of mechanically stabilized earth walls and the construction of sidewalks and barrier walls. The contractor completed the project in 70 days, 50 days ahead of schedule, and earned an incentive of $750,000. The success of this project encouraged FDOT to expand the use of incentive contracts.

Project Execution

Some project challenges that were overcome by the project team included the time constraints of construction, the project's close proximity to neighboring facilities (a home for battered women and children, a homeless shelter, and an historic building), and remediation of contaminated soil on the project site.

Factors that contributed to the project's success were:

- Extensive preplanning by the contractor ensured that once the work started in the field it could proceed smoothly. The scan team found that for many of the accelerated projects studied, preplanning was a critical key to success.
- Partnering: "Nobody wanted to be labeled as an impediment to completion."
- The use of a demand services contract to handle site remediation (what FDOT calls a "push-button" contract). FDOT was able to use a separate Contamination Assessment Remediation (CAR) contractor with the necessary skills and workforce to support the construction contractor. Realizing it was a contaminated site, FDOT placed all remediation work with its CAR contractor. This included pipework that required excavation into possibly contaminated material and preparing the pile-driving locations for the construction contractor. The CAR contractor worked under a separate work-order type contract.
- A six-month delayed start/procurement period between contract execution and start of construction allowed the entire shop drawing process, the pile casting, and AASHTO beam casting to be completed. The project was bid in June, but construction did not start on the site until the following January.
- FDOT eliminated the usual test pile and specified the pile lengths in the contract documents. They then used a Pile Driving Analyzer (PDA), which is a dynamic load testing and pile driving monitoring system, to assess the capacity of piles as they were driven.
- The contractor formed and poured precast caps on site.
- The road was completely closed to traffic.
- The contractor shared the performance incentive bonus with his subcontractors.

Synopsis of Acceleration Efforts

Up-Front Planning

One distinct difference was the level of detail in the contractor's schedule. They admitted going to a much greater level of detail in planning for the project due to the schedule constraints and overall contracting risk. Because of this experience, the contractor now plans all projects in greater detail.

Partnering

Formal partnering meetings were held for this project; normally, partnering is conducted at the contractor's option. Everyone agreed to check their egos for the project's duration. All participants were willing to work together and openly discuss innovative ideas. Decisions and commitments were made and upheld.

Delayed Construction Start

FDOT provided six months between contract award and the beginning of construction at the site. Floating the construction start date was an important factor in the project's success, and it worked in everyone's favor. The procurement period allowed review and approval of all shop drawings, production of all piles, production of all Mechanically Stabilized Earth (MSE) wall panels, and production of all beams. It also allowed the contractor to elect to use the precast cap option and cast them on site, just outside of the ROW. The materials payment concept can help make it economically feasible for the contractor and/or keep prices down. The “payment of material on hand” procedure to deal with the procurement period was a lesson learned on this project, and FDOT has incorporated it on subsequent projects.

Elimination of the Test Pile Program

The DOT allowed procurement of all project piles and avoided any time delay between the test piles being driven, receipt of pile lengths from geotech, and casting of production piles. The time savings offset the cost of purchasing longer piles.

Contractor Innovation

The contractor used precast pile caps, which allowed setting of caps as soon as the piles were driven. Precast caps were an alternate and were slightly more expensive. They weighed 150,000 lbs each. The four precast caps saved three to four days per bent. The contractor was able to do this because FDOT allowed direct contact between the contractor and the Engineer of Record.

Work Schedule Considered Project Neighbors

The contractor chose to work 7 am to 7 pm, with no night work. There was no night work due to social concerns, such as the proximity of the women’s/children’s shelter. The City ordinance did not permit work between 10 p.m. to 7 a.m. The contractor worked every weekend except Easter and Independence Day.

The new MSE wall was constructed less than 3 feet from the historical building’s foundation. Because of the close proximity of this structure, the contractor hired an independent laboratory to make a preconstruction video and perform crack surveys. Once the existing features and damages were documented, the laboratory monitored vibrations during pile driving and placement of the backfill behind the MSE walls. The use of pre-augered holes for the piles and premium soil for backfilling behind the MSE walls kept vibrations from exceeding the maximum threshold.

DOT Remediation Contract in Place

The project site was contaminated by arsenic, lead, polychlorinated biphenyls, and chromium. FDOT had a Contamination Assessment Remediation (CAR) contractor on-call to support the bridge contractor’s construction work. This remediation process was an important factor in the project’s success. The remediation contractor demolished the old bridge, removed contaminated soil, and placed drainage structures in contaminated soils.

The original plan was for the remediation contractor to excavate the entire width of the pile bent, a 10 foot × 10 foot section, for pile-driving activities. The bridge contractor suggested test probing to determine the extent of obstructions. This resulted in handling and disposing of less contaminated material, saving both money ($400,000 of CAR cost) and time. This was captured in a supplemental agreement.

Decision Making at the Lowest Level

FDOT and the contractor had a successful partnering process and placed a great deal of attention on planning construction phases/sequencing of work. “Nothing works without total commitment from all team members.”

Total Road Closure

Road closure was not an issue because there were nearby alternate routes; however, work needed to be completed before the start of the National Football League’s season.

Underlying Fundamentals of Success

Both FDOT and the contractor pointed to the partnering process, which everyone bought into, as the key to accelerating this project. Issues were resolved in a timely manner and all parties had a sense of urgency. Project partnering created an atmosphere where options could be freely discussed, and FDOT was open to the contractor's ideas. There was a sense of partnership and acceptance of innovation for the purpose of delivering a quality bridge in a limited time period.

The contractor admitted that for this accelerated project much more time was spent planning the work up front and believes that this effort was critical to achieving project success. In fact, once the contractor came to realize the benefit of such in-depth up-front planning, the process has become almost standard for all of its projects. Transportation agencies should seek ways to encourage contractors to put more effort into up-front planning.

Essential to accelerating the project, and the prime contractor's ability to deliver the bridge within the desired time period, was the in-place remediation contract. By having a separate and independent CAR contractor, FDOT handled pre-identified contaminated work items. This consequently relieved the prime contractor of a major unknown in executing the work. Additionally, the DOT's ability to call on the CAR contractor to deal with contamination that had not been previously identified was also very important.

Improvements to the SR 9A/I-295 Corridor, Jacksonville, Florida

FDOT is in the process of upgrading SR 9A around the east side of Jacksonville to interstate standards. When the improvements are completed, SR 9A will become part of the I-295 loop around the city. FDOT used contractor incentives, consultant incentives, and DB to accelerate several of the projects in this corridor improvement effort.

Project Description

One of the largest of the SR 9A corridor projects was the $110 million SR 9A/I-295/I-95 interchange south of Jacksonville (see Figure 3.8). The project involved multiple bridges and more than 33 lane miles of concrete paving. Because Super Bowl XXXIX was scheduled to be played in Jacksonville on February 2, 2005, FDOT wanted to accelerate the project and have it open some two weeks before the game.

Figure 3.8 *SR 9A/I-295/I-95 interchange south of Jacksonville*

Project Execution

Because of the high daily vehicle traffic (95,000 ADT) in the work zone area and the multiple traffic phases that were required to accommodate the work, the contractor was required to diamond grind the entire final surface.

An interesting aspect of the project that raised its overall quality was FDOT's decision to use Performance Related Specifications (PRSs) on the US 1/SR 9A portion of the project – the first time FDOT used a PRS. PRS provides rational methods for contract price adjustments based on the difference between the as-designed and the as-constructed life cycle cost of the pavements. From the contractor's perspective, the extra attention to the details up front enabled the paving to be completed months ahead of schedule to a standard above the specification.

Synopsis of Acceleration Efforts

No Excuse Bonus

The contract documents for the SR 9A/I-295/I-95 project included a $3 million No Excuse Bonus for an opening milestone of January 15, 2005. The guidance for a No Excuse Bonus can be found in Section 1.2 of the FDOT Construction Project Administration Manual.[14] The No Excuse was later revised to February 20 because of hurricane impacts.

7. No Excuse Bonus

No Excuse Bonuses should be used only on projects that have the highest levels of impact on abutting businesses and the traveling public. A designation Level of Community Awareness 4[15] is a prerequisite. The No Excuse Bonus concept can be used to achieve particular milestones or for total project completion by a certain contract day or a specified date. The Scheduling Engineer must provide a maximum number of days and set the bonus date based on calendar date or an actual contract day.

Contractors will sometimes strive to earn a No Excuse Bonus; however, problems can arise if, after making the commitment, the contractor falls short because of uncontrollable events.

Liquidated Savings

This contract also had a provision for Liquidated Savings at $7,500 per day up to a maximum of $2 million for a total incentive of $5 million.

[14] Construction Project Administration Manual, Section 1.2, "Contract Duration and Alternative Contracting Techniques," revised September 14, 2007, www.dot.state.fl.us/construction/Manuals/cpam/New%20Clean%20Chapters/Chapter1s2.pdf.

[15] Level 4 requires that the project is interstate highway work.

> **10. Liquidated Savings**
>
> **The contractor will be rewarded for each calendar day the contract is completed and accepted prior to the expiration of the allowable contract time. The daily amount of liquidated savings should be equal to the liquidated damages**

The contractor earned an incentive of $217,500 (29 days @ $7,500 per day).

Creating a Team

With several projects in one corridor, FDOT saw an opportunity to encourage CEI consultants to embrace construction acceleration. It therefore built incentives into the CEI contracts. This approach was a response to the perception that the CEI team could interfere with the contractor achieving the maximum incentive offered in the contract because the CEI has no incentive to finish early because it may have no other work.

The consultant CEI advertisement read:

> *The Department has set a target of $10 million for the services identified above, excluding those projects identified as optional. If a fee at or below that amount is negotiated with the selected consultant and the Department considers the performance of the consultant to be satisfactory, the consultant will be offered a supplemental amendment for the optional projects contingent upon satisfactory negotiation of a fee for those services.*

While FDOT was pleased with the results, it is not clear that there was any benefit from this to the acceleration effort.

Design-Build

To accelerate two other projects in the corridor, FDOT used the DB contracting method. Both projects were successful. In the case of one of the projects (a new alignment), FDOT handled the ROW agreements and had all the permits in hand for the contractor.

Incentive/Disincentive

The final project, a challenging interchange bid at $84.8 million, was let using the usual DBB process. However, FDOT entered into a $3,300-per-day incentive agreement after contract award.

Underlying Fundamentals of Success

FDOT has worked hard to take a planned approach for accelerating many of its projects and has experimented with numerous methods for reducing construction time. A key comment that was often repeated when assessing the success of these efforts to reduce time was that decision makers must be accessible.

In the case of the SR 9A corridor work, which was within the Jacksonville municipal limits, there were issues with noise caused by night work. Though FDOT does not have to abide by the City's regulations, it has sought by contract language to make contractors aware of the noise ordinance and hold them in conformance. Contract language used to inform contractors of the Jacksonville Noise Ordinance include

FDOT Standard Specifications: Section 7, Article 7-1 **Laws to be Observed**, Sub-article 7-1.1, "The contractor is required to become familiar with and comply with all Federal, State, county and city laws, by-laws, ordinances and regulations that control the actions or operation of those engaged or employed in the work or that affect materials used."

FDOT Standard Specifications: Section 8, Article 8-4 **Limitations of Operations,** Sub-article 8-4.1, "Night Work," "The contractor is required to comply with all applicable regulations governing noise abatement."

Plan Sheet M-13 **Pile Driving,** Note 1 stated, "All pile driving activities are subject to the Noise Ordinance of the City of Jacksonville."

Addendum 2, which was written in Response to Requests for Information from the Mandatory Pre-Bid Meeting, included the following: "Regarding noise restrictions, refer to Sheet M-13. For additional information regarding the Jacksonville Noise Ordinance, please contact XXXX with the Duval County Air and Water Quality Office at (904) xxx-xxxx.

Even with these notices about noise limitations imposed on project work hours, there were complaints that FDOT hindered the contractor's efforts to secure the offered bonuses. In the case of projects that have I/D clauses or offer a lump sum bonus, the bid documents and contract should explicitly state the work-hour limitations. Reference to rules or regulations that seem clear can cause misunderstandings and arguments when they impact the contractor's ability to achieve a bonus.

Furthermore, it was clear from contractor comments that they do not like "No Excuse" lump sum bonus situations. This contracting approach should only be used when there is a real reason for acceleration, such as an emergency situation. There was also discussion of A+B bidding as a way of accelerating a project. It was voiced by some that the success of A+B is subject to the general contracting climate. If there is plenty of work, contractors will tend to put their resources elsewhere and not be receptive to the added risk of an A+B contract. Conversely, when there is a lack of work, A+B is a viable method for accelerating a project.

Replacement of the I-10 Bridges Over Escambia Bay, Pensacola, Florida

FDOT replaced the I-10 twin bridges over Escambia Bay, which, after Hurricane Ivan, had been repaired to immediately restore the flow of traffic under restricted conditions. The new three-lane bridges were built south of the existing bridges at the very limit of the State's ROW. This alignment was chosen because the engineers were trying to minimize the impact of pile driving operations on the damaged bridges. They did have to obtain a temporary easement on the south side of the ROW from the Florida Department of Environmental Protection.

Project Description

The award amount was $242 million and the final contract was $255 million. Each bridge has three 12-foot travel lanes and 10-foot inside and outside shoulders. They have a minimum clearance over water of 25 feet, while the clearance of the original bridges damaged in Hurricane Ivan had a clearance of less than 12 feet. Over the navigation channel, the spans reach 65 feet above the water, 10 feet higher than the original bridges; this was dictated by the Coast Guard. The project began in April 2005 and was substantially complete by autumn 2007. The eastbound bridge opened in December 2006 and the westbound bridge in December 2007. Although both bridges were opened, construction work continued until April 2008 on items such as lighting and demolition of the old bridges.

FDOT utilized its existing DB process, but the contract for building a replacement bridge across Escambia Bay also had an A+B component. A $10 million lump sum bonus was offered as the incentive to open the Phase I eastbound bridge by December 29, 2006. The eastbound bridge actually opened on December 19, 2006.

The FDOT proposal guidance stated:

1. Maintain or improve, to the maximum extent possible, the quality of existing traffic operations, both in terms of flow rate and safety, throughout the duration of the project.
2. Minimize the number of different Traffic Control Plan (TCP) phases, that is, the number of different diversions and detours for a given traffic movement.
3. Accomplish Contract Work Item #1, that is, completion of bridge structure(s) and placement of four lanes of traffic on the completed bridge structure(s) by December 15, 2007.
4. Accomplish completion of bridge structure(s).
5. Demolish existing bridge structures (including fender system and dolphins [16]).
6. Maintain reasonable direct access to adjacent properties at all times.

Proposals were evaluated by the formula:

$$\text{Proposal rating} = \frac{\text{Price + Time}}{\text{Technical Score}}$$

The engineer for the winning DB team stated, "We only had about three weeks to put the proposal together. In that time, we took the whole bridge to 30% design, with certain elements at 60 to 90%. The design had to be at a level the JV was comfortable with." [17] FDOT's bid analysis is provided in Table 3.1; Table 3.2 is a summary of the major project quantities.

	Team A	Team B	Team C
Technical score	137.5	136.2	126.6
Bid price	$242 million	$360 million	$317 million
Contract days	862	932	905
Final ranking	1	2	3

Table 3.1 *DB bids for replacing the I-10 Escambia Bay bridges*

[16] Timber fender systems serve as navigation aids to vessel traffic by delineating the shipping channel beneath bridges. They are designed to survive a multitude of bumps and scrapes from vessels and to absorb kinetic energy while redirecting an errant vessel. Timber dolphins serve to protect the bridge substructures that are not designed to resist the impact of vessels. ("3.14 Fender Systems," *Structures Design Guidelines,* Florida Department of Transportation, January 2009, http://www.dot.state.fl.us/structures/manlib.shtm#archivedpublications

[17] Buckley, Bruce, "Replacement of Florida's Escambia Bay bridges on a fast track," Constructor, (publication of McGraw-Hill Construction), September-October 2006, http://constructor.construction.com/features/build/archives/2006-09escambiaBridges.asp.

Item	Size/Type	Quantity	
Concrete piles	24-in.	5	
	36-in.	1,274	
Precast pile caps		133	
Cast-in-place pile caps		934	Cy
Girders	Bulb-tee 78-in.	986	
	Type-II	63	
	Posttensioned	30	
Concrete		71,881	Cy
Steel reinforcement		20,263,683	Lbs

Table 3.2 *Summary of quantities for the I -10 Escambia Bay bridges*

The success of the FDOT's timeline (see Table 3.3) for constructing a replacement bridge depended on the expeditious settlement of the NEPA process. Information gathered through the NEPA process was included in the request for proposals (RFP). Concurrent activities allowed for the timely delivery of both the NEPA documents and the contract documents. The project was advertised while in the midst of the NEPA process. Prospective DB firms were not only allowed, but encouraged, to attend all NEPA coordination and public meetings[18].

Date	Event
15/16 Sep. 2004	Hurricane Ivan makes landfall
5 Oct. 2004	NEPA process begins
21 Dec. 2004	Project advertised for letters of interest
10 Jan. 2005	Shortlist of DB firms
3 Feb. 2005	Public information workshop
10 Feb. 2005	VE study completed
11 Feb. 2005	NEPA completed
16 Feb. 2005	RFP approved by FHWA and issued
20 Apr. 2005	DB contract executed

Table 3.3 *I-10 Escambia Bay bridges contract award timeline*

[18] *Transportation Invest In Our Future*, Accelerating Project Delivery, American Association of State Highway and Transportation Officials, August 2007, www.transportation1.org/tif7report/tif7.pdf.

Project Execution

It was clear from the geotechnical data gathered when the original bridges were constructed, from the railroad bridge further north, and from six borings completed during the proposal phase that the site soil conditions were variable. Only after the first test piles were driven and an additional 60 borings were made during construction did the engineers come to appreciate the high variability of the soil deposition in the bay. The unpredictability even from pile to pile forced the contractor to use longer piles; most are 145 feet long, but the longest one measured 170 feet and weighed 80 tons.

Additionally, the contractor had to deal with three major storms and take protective measures for every named storm. For a major storm, it took five days to demobilize the sizeable fleet of barges and 21 large-capacity cranes that were on site. Most were moved to protected locations upriver. During the project the contractor had to demobilize six times because of storms, four times in 2005 and twice in 2006.

Hurricane Katrina in August 2005 did little damage at the site; however, it did disrupt the flow of materials. Precast concrete elements were coming from two yards, one in Tampa, Florida, and another in Pass Christian, Mississippi. The Tampa plant was not severely impacted, but the one at Pass Christian was destroyed.

Synopsis of Acceleration Efforts

Partnering

Management should ensure that the parties on the project can make decisions in a timely manner and have an appreciation for the realities of building a major project. The project team members have to be willing to make changes that are necessary to adhere to the schedule and deliver a quality project. It may even be necessary to change people.

Design Flexibility via Design-Build Process

The DB team elected to use 36-inch-square precast piles, a first for an FDOT project. The larger piles created several advantages. Only five piles were needed for each substructure unit; standard 30-inch piles would have required seven or more per unit and a pier structure having more cast-in-place concrete. There is efficiency in the total number of pieces for a given span with piles, precast beams, and caps each weighing roughly the same. Therefore, the same equipment could pick everything. Other construction issues were:

- Pile size was also based on pile hammer availability (ensuring that it would not take extraordinary equipment).
- Precast element size was limited by the lifting capacity of the equipment at both the precast yards and placement point on the project.
- Florida does not allow precast deck panels, so they were not proposed.

Multiple Precasters

Precast was a significant element in the design decision. The bridge was not built linearly. The contractor started with three fronts and later opened two additional fronts. Multiple precasters were needed to maintain the supply of components and to reduce project risk.

Risk Mitigation

The contractor had multiple back-up strategies besides using two precasters. It elected to use a local off-site batch plant and also looked at alternative state-approved suppliers.

Subcontracts

The prime contractor wrote incentives and disincentives into some supplier and subcontractor contracts.

Incentive/Disincentive

There was much discussion about lump sum in lieu of daily I/D. FDOT could adjust a disincentive date but not a No Excuse incentive unless it was a force majeure issue. Contractors preferred a daily I/D rate and had an aversion to lump sum incentives, because there was too much risk that they could not control.

Quality

The contractor was committed to quality and did not want to be delayed by the need for rework; therefore, the QC manager was empowered to stop a work activity. (This is a comment from the contractor.)

Underlying Fundamentals of Success

Partnership is critical to successfully complete an accelerated construction project. Issues will always arise and the team must be committed to finding satisfactory solutions in a timely manner. The contractor developed the Traffic Control Plan (TCP) based on a planned sequence of work activity. However, due to storms, 90 workdays were lost. A change was then suggested to "Get it open." This was an alternate means of opening the bridges to traffic by widening the approach pavement. FDOT agreed to this alternate process and agreed to pay some of the additional cost.

Safety is only achieved if there is commitment by everyone. At the peak of construction there were 350 craft employees going out on boats to their work sites and having to climb stair towers.

Repetition was the key to the accelerated schedule. The execution plan was thoughtfully worked out so that pile driving, forming, and beam placement reached a production rate of 39 feet of bridge per day. The contractor had constructed other accelerated construction projects, and those previous experiences jumpstarted this project's learning curve.

Design cannot require special or one-of-a-kind equipment.

Contract language must address force majeure exceptions to No Excuse. Contracts need to have clear language addressing catastrophic events and how they will be handled in terms of contract time, I/D time, and the lump sum bonus date, whether the event is a hurricane, war, permits, or other occurrence outside the control of both the DOT and the contractor. The force majeure language must spell out consideration for direct and indirect effects both on and off the project. The contract language needs to specifically address:

- Additional time
- Price escalation
- Overhead for additional time
- Acceleration cost to return to the baseline schedule
- Subcontractor actions, such as abandoning the contract or inability to perform because of uncontrollable events.
- Supplier actions, such as abandoning the purchase orders or inability to perform because of uncontrollable events
- Force majeure events and definition of what constitutes a force majeure event

- Duration of the impact
- Impact to time for milestones and completion
- Acceleration to meet deadlines

❖ Whether direct on-the-project or off-the-project impacts are eligible for consideration

Reconstruction of Interstate 10, Houston, Texas

Originally constructed in the 1960s, the 23-mile stretch of Interstate Highway (IH) 10 (a.k.a., the Katy Freeway) from its intersection with IH 610 west to the City of Katy was badly congested 11 hours per day with ADTs in the range of 280,000 vehicles per day. The pavement on sections of the Katy Freeway was 30 and 40 years old. Flooding of the mainline interstate roadway and frontage roads was a continuous problem during heavy rainfall. Maintenance costs had reached nearly $8 million a year. The Texas Department of Transportation (TxDOT), therefore, embarked upon a $2.8 billion Katy Freeway Reconstruction Program.

The planning process for the reconstruction program began with a Major Investment Study in 1995. This study focused on the entire IH 10 Katy Freeway Corridor. It involved assessing mobility needs and the environmental and community effects of many alternative solutions. Inputs were received from the public and local agencies. A locally preferred alternative was selected and the ultimate design was based on recommendations from all affected stakeholders. Design work commenced in 2000 with an Environmental Impact Statement that reflected the social, economic, and environmental impacts of reconstruction. The FHWA issued a Record of Decision in January 2002. TxDOT began the reconstruction of the IH 10 in late 2003 and reached completion early in 2009.

Project Description

The limits of the Katy Freeway Program started at the Harris/Fort Bend County line (City of Katy) approximately 20 miles from Houston and the IH 610/IH 10 interchange (see Figure 3.9). The existing configuration included dual three-lane mainlines, dual two-lane frontage roads, and one reversible high-occupancy vehicle lane. The proposed configuration included dual four-lane mainlines, dual three-lane frontage roads, and two managed toll lanes. In addition, two freeway-to-freeway interchanges were reconstructed and 27 grade-separated intersections were built. The estimated cost of the project is $2.64 billion (based on final bid prices), with about two-thirds of this cost for construction and one-fourth for ROW acquisition and utility relocation. The remaining budget cost covered design, program management, and construction management.

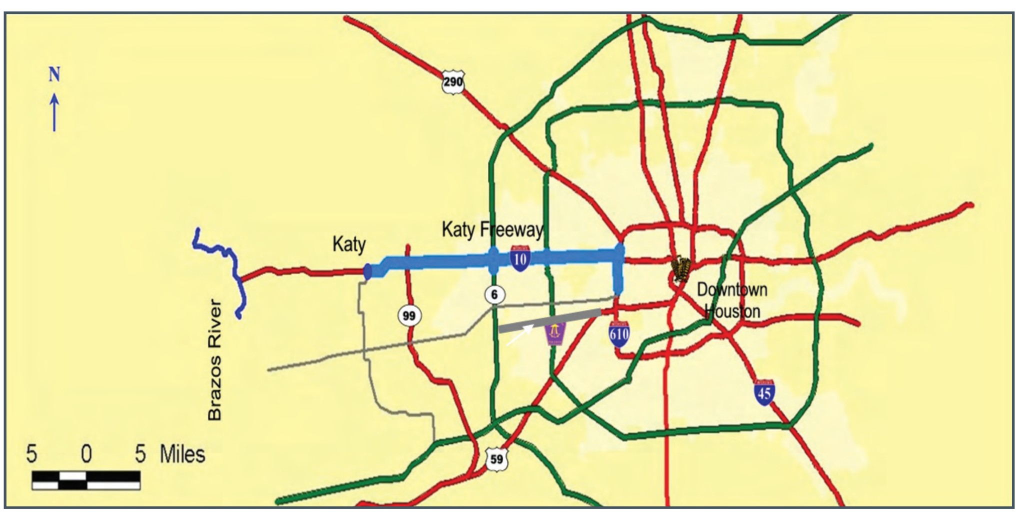

Figure 3.9 *Katy freeway program location*

The Katy Freeway Program was one of the largest highway construction projects in the state's history and included nine major construction contracts. It was also the first project in the nation to construct toll lanes on an existing interstate highway. TxDOT hired a general engineering consultant (GEC) to provide oversight guidance to the 10 section design consultants contracted by the Houston District of TxDOT to perform final design. The section design consultants also provided support services during construction, including shop drawing reviews and responses to requests for information. The GEC also hired subconsultants to provide various services for executing and managing the project as directed by the district.

Project Execution

Detailed design for the Katy Freeway Program started in 2001, with ROW acquisition and utility relocation starting in mid-2002. Detailed design, ROW acquisition, and utility relocation were performed concurrently after mid-2002. Construction started in 2003 (see Figure 3.10).

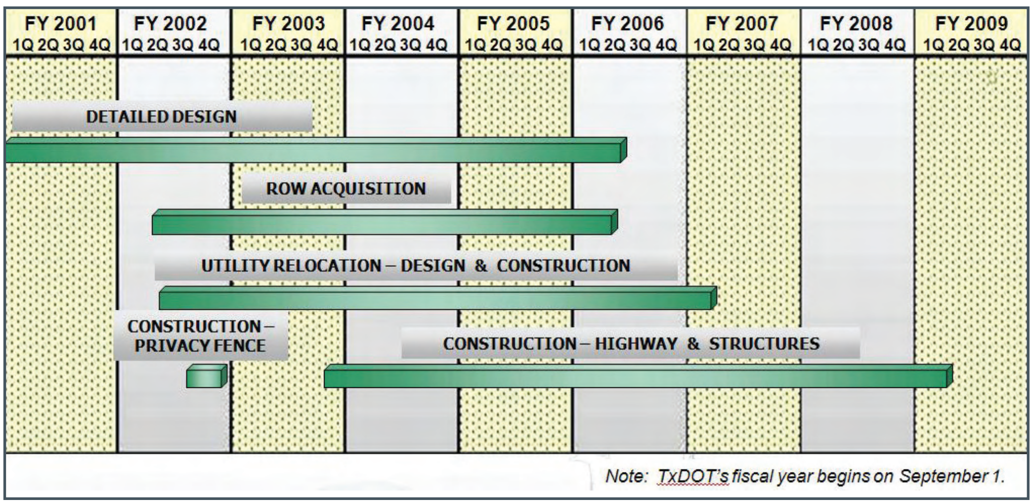

Figure 3.10 *Katy freeway program location*

The project delivery approach for the Katy Freeway Program was considered DBB, as all construction work was bid competitively after completion of design for a portion of the project. The construction effort was split into nine major packages. Two contractors were awarded the construction of the nine contracts; one contractor was awarded six and the other contractor was awarded three (see Figure 3.11).

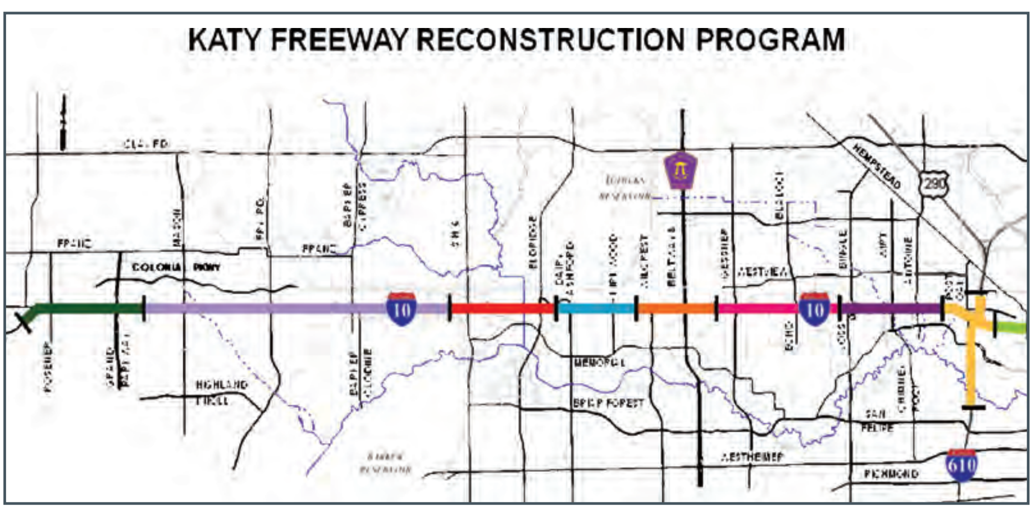

Figure 3.11 *I-10's nine construction packages*

The decision to use an accelerated construction approach began in the detailed design phase. During this phase, TxDOT and the GEC closely coordinated their efforts and worked with construction personnel. These two teams combined efforts to reduce construction time by using past experiences and known variables to estimate anticipated time schedules. The design team carefully scrutinized every design element and asked, “How can we reduce the expected construction time?” Every bid item was evaluated from a constructability perspective. Strategic milestones were defined, and project incentives/disincentives were tied to each milestone. In addition, lane rental fees were used to maximize the efficiency of lane closures.

The design team, relying on TxDOT’s relationship with the Associated General Contractors of America, worked closely with contractors to obtain constructability reviews. TxDOT modified its use of constructability reviews to incorporate these reviews at various design milestones (e.g., 60%, 90%, etc.). This approach was a departure from the normal practice of performing constructability reviews at the end of design, just prior to construction letting. Contractor input on estimated construction durations and other contract timelines was provided as part of these reviews.

TxDOT also worked closely with major suppliers and manufacturers to help expedite material availability. This interface resulted in an overview of key construction elements. Specifically, the focus of this effort was on plans and specifications and anticipated requirements for quantities of materials, especially materials requiring longer lead times for delivery.

Figure 3.12 *Utility relocation*

TxDOT typically does not start construction until ROW is acquired and utilities are relocated; however, this approach would not work for the Katy Freeway Program due to the decision to accelerate construction. A modified ROW plan was prepared to integrate simultaneous acquisition of ROW and the timing of utility relocations with selected construction activities. ROW acquisition required the purchase of 442 parcels and more than 910 relocations. In addition, more than 35 different utility companies were involved in relocations based on more than 130 utility agreements. The ROW team acquired over 223 parcels in 18 months, a significant contribution to the project’s acceleration. At the same time, the GEC coordinated utility relocations. The size of this effort was substantial and cost an estimated $311 million. For example, 24 miles of various pipe sizes were relocated (see Figure 3.12).

The nine construction contracts were bid and awarded over two years. The first contracts were awarded for work at each end of the total project limits, including the IH 10 and IH 610 interchange at the east end of the project. Major roadway construction started at the west end of the project, near Katy, Texas. The construction packages were generally awarded moving from west to east (see Figure 3.11). The traffic requirements during construction focused on maintaining the existing number of main lanes and frontage lanes, maintaining local access across the corridor, and keeping the existing high-occupancy vehicle lanes operating. Generally, construction was performed from the inside out. In other words, main line construction was completed first, while ROW acquisitions and utility relocations were completed near frontage roads (see Figure 3.13). Once mainline construction was completed, construction on the frontage roads commenced (see Figure 3.14).

Synopsis of Acceleration Efforts

Implementation of Fast-Track Project Schedule

The decision to use an accelerated construction approach was made early in the detailed design phase. Project management, in consultation with and approved by district management, developed an initial traffic control plan based on the amount of ROW available and the scope of work to be performed. With input from construction and local contractor personnel, a detailed Critical Path Method schedule was prepared based on the project's proposed traffic control plan. The schedule also included early purchase of rights-of-way and relocation of critical utilities, both planned as concurrent activities. The work included addressing traffic control coordination between each of the nine projects.

Figure 3.13 *Mainline I-10 construction*

Figure 3.14 *Frontage road construction*

Significant Early Construction Input

Several contractors provided feedback and suggestions involving constructability issues (e.g., equipment placement, material staging, etc.) and quantity reviews. Some suggestions were incorporated into the plans. Many of the contractor suggestions involved expanding the work zone and the traffic control plan restrictions, unaware that the TCP was developed with the schedule of ROW acquisition.

Aggressive Work Schedule

The work schedule was 24/7, including nights, weekends, and holidays, with a project duration of four to five years. The contracts had three float (or noncharge) days per month that the contractor was required to take. Because the contractor did not want to disrupt momentum, it was difficult to get the contractor to agree to the use of or need for these float days.

Incentive/Disincentive Structure Motivated Contractors

Incentives and disincentives (I/Ds) were used throughout the corridor in various amounts and times, depending on the work and its complexity (i.e., major interchange, metro section with and without structures, or rural section). I/Ds were tied to hard milestones as follows:

- **Project milestones** usually would involve finishing and operational acceptance of a major part of the project (e.g., opening the westbound main lanes or frontage roads).
- **Interim milestones** would involve finishing a section and/or a particular task to facilitate and improve commuters' time (e.g., opening a direct connector or a ramp heavily used for commercial developments).

- **Project completion milestones** used in some of the projects with a final completion date (i.e., hard date) with No Excuse clauses.

In addition to I/Ds, lane rental fees were used to encourage constrained timeframes for major closures. Approximately $50.9 million was paid for meeting milestone incentives. Early completion incentives paid amounted to $7.5 million. Lane rental fee assessments resulted in another $3.7 million in credits for the contractors.

Continuous Use of Partnering

Partnering was a big part of the success of the Katy Freeway construction contracts. Weekly partnering meetings were attended by all the players (e.g., contractors, contractor superintendent/engineer, utility companies, section designers, inspectors, project managers, area engineer, assistant area engineer, ROW staff, public information officers [PIOs], schedulers, and many others). Networks were formed from the first day and contacts were made. A point was made to understand each participant's role, responsibilities, and issues. Timely solutions to problems were the result of this close interaction. These meetings were formally held every week, one separate meeting for each construction project.

Partnering meetings were also held informally as needed when critical issues arose. These meetings were successful in putting peer pressure on entities involved in critical utility relocation efforts. Each party was challenged to keep the project on schedule.

Management of Multiple Construction Contracts

The construction plan included nine different contracts. The district, with the assistance of the GEC, managed the interface between contractors. During construction, the GEC contract and other design contracts were extended to support construction. Their charter was to review shop drawings, utility relocations, and construction schedules. The GEC also reviewed change orders. This approach improved the time needed to make decisions when problems arose. TxDOT stated that during the design phase, the GEC was a key in coordinating the multiple consultants in phasing construction and project tie-ins. During the construction phase, the GEC supplemented TxDOT forces, because TxDOT simply did not have the staff to cover the multiple projects that were being constructed simultaneously.

Public Awareness Campaign

A public information office was established when construction started. Multiple forms of communication were used to keep the public informed of construction progress (see www.katyfreeway.org/). PIOs attended early traffic control workshops and schedule development meetings as well as partnering meetings after construction started. As a result, the PIOs were well-versed project spokespersons who were able to really understand and explain key milestones (i.e., closures, traffic changes, and phases) and emphasize successes.

Underlying Fundamentals of Success

TxDOT made the decision to accelerate construction early in project development. This decision helped maintain a constant focus on finding ways to support the accelerated construction effort during detailed design, ROW acquisition, and utility relocations. In this way, the construction schedule provided the framework for the program to take only six years; typically, a program of this scope would take from 10 to 12 years.

With construction acceleration the focus, collaboration was the word of the day before and during the construction phase. The design team worked closely with the construction team to carefully evaluate every design element, with a focus on acceleration. Because the project schedule required concurrent work for all major activities, new strategies to coordinate ROW acquisition and utility relocations with construction work were needed. A ROW team focused on rapid acquisition of a large number of properties through a single service provider. TxDOT and the GEC worked closely with utility companies to ensure timely relocation of priority utilities. Partnering meetings during construction included all participants, including the GEC, local government agencies, and utility companies.

The construction staging and traffic control plan were based on the least conflicts. The construction approach started at the west end of the corridor at Katy and work proceeded inbound toward IH 610. Construction was inside/out, with the main lines constructed first while ROW was acquired around the frontage roads and utilities were relocated. Further, the plan to synchronize improvements at major interchanges helped facilitate construction and add capacity early. The traffic control plan was so effective that the public often cited that, "traffic flows better during construction than it did prior to construction."

The use of incentive structures placed the emphasis on meeting key milestone dates during construction. This required dedicated staff and on-site decision makers to ensure that issues could be resolved in the field or quickly elevated to the appropriate decision maker within TxDOT. The contractor provided communication devices and satellite offices to enhance field operations and coordination.

Consistent communication with the public was a key to success. Aggressive and proactive interface with the media helped make the media a true communication partner. Media pictures allowed TxDOT to tell its own story. The media expanded the audience reach for advanced notifications and explanations of scheduling and scope of work. Information was disseminated on weekend and long-term closures. When new roadways were opened and major contractor milestones were achieved, celebrations were held with the help of the media. Finally, special events and outreach campaigns were held to celebrate key program accomplishments.

Conclusions: Planned Accelerated Construction

As demonstrated by the projects investigated during this scan, the ability to successfully execute an accelerated project depends on the following:

- Partnering is a component of accelerated construction that was mentioned on every project visited. The partnering arrangement between the DOT and the contractor is often expanded to include the designer, subcontractors, and fabricators.
- Public involvement and outreach campaigns are critically important to achieving modified traffic densities during construction operations. Even a slight reduction provides better site access during construction operations.
- Total collaboration by all parties is instrumental to project success. Close coordination between the design team and the contractor can smooth the way for faster construction.
- Force account contracting should be considered when a project is fraught with risk and unknowns because of the proposed acceleration.
- Delayed start/procurement periods between contract execution and start of construction have proven to be effective in reducing traffic impact time because they allow for completion of the shop drawing process and fabrication of long-lead-time items.
- Repetition was the key to an accelerated schedule.

Recommendations

Departments of Transportation should:

- ❖ Mandate partnering for all accelerated projects; in many cases, partnering must include, in addition to the DOT and the contractor, the designer, subcontractors, and fabricators.
- ❖ Evaluate the benefits of a delayed construction start date or procurement period that allows time to review and approve all shop drawings and production of fabricated items. This may require that payment-of-material-on-hand procedures be clearly defined.
- ❖ Seek ways to encourage contractors to put more effort into upfront planning.
- ❖ Have clear language in contracts that addresses catastrophic events and how they are to be handled in terms of contract time, I/D time, and the lump sum bonus date, whether the event is a natural disaster, war, permits, or other occurrence outside the control of the DOT and the contractor.
- ❖ Make the decision to accelerate construction early in project development. That decision will focus the project team on finding ways to support the accelerated construction effort, including detailed design, the acquisition of ROW, and utility relocations.
- ❖ Encourage contractors to work multiple fronts.
- ❖ Develop procedures and criteria for the use of incentives/disincentives.
- ❖ Use No Excuse lump sum bonus schemes only when there is a real reason, such as an emergency situation.

Community awareness is usually easier to achieve for an emergency project where the facility need is readily apparent. However, with a planned project, the public does not always understand or appreciate the need to accelerate a project and disrupt their normal use of a facility. It is, consequently, very important to create a bond of trust that will eliminate potential problems before they become issues that disrupt the acceleration effort. To be successful, community awareness efforts must be championed by top management, be integrated into the project development process, and continue during the construction phase.

CHAPTER 4

Program Approach to Acceleration

Introduction

The accelerated construction activities of most state highway agencies have focused on delivery of an emergency project or a selected project where a planned acceleration process is viewed as beneficial to the public interest. However, in some agencies, the acceleration approach is being institutionalized at the program level. The Utah Department of Transportation (UDOT) is aggressively implementing a program-level effort to accelerate bridge design and construction. The DOT has instituted an Accelerated Bridge Construction (ABC) program. This chapter provides a summary of the UDOT program-level approach to accelerated construction.

UDOT's organizational structure is decentralized, which is a factor in how business is conducted. There are four regions with a total of 15,500 lane miles of roadway, of which, 4,175 lane miles are interstate. The program typically has more than 150 projects, and the volume of construction in the past has been around $300 million per year. However, the current program budget is $1.9 billion, and it will grow even larger with projects added through the American Recovery and Reinvestment Act of 2009. As of early 2009, UDOT has 205 projects at $2.2 billion.

A key component of the program is the UDOT innovative contracting experience. UDOT has completed 14 DB projects, has 16 under contract, and another four in the procurement stage. In addition to DB, UDOT has pioneered the Construction Manager/General Contractor (CM/GC) approach (similar to Construction Manager at Risk; see NCHRP Synthesis Topic 40-2 for more information on this delivery approach). UDOT has completed eight projects using this delivery approach, has seven under contract, and has one in the procurement stage. Eight of these projects are under the FHWA Special Experimental Projects-14 initiative. Eight others are funded solely by the state.

UDOT also uses I/Ds, A+B bidding, and lane rental contracting approaches to accelerate construction. UDOT just approved a policy that balances user costs with construction by A+B bidding on all projects.

The DOT has an excellent working relationship with the Associated General Contractors of Utah that focuses on partnering and DB boilerplate development. The partnering process is used on all UDOT projects, and partnering sessions are both facilitated and non-facilitated. A 12-hour commitment to partnering training is a requirement for all UDOT staff and contractor project managers and superintendents. Partnering metrics indicate that claims have been reduced from 10 in 2003 to one or two in 2009.

Philosophy

UDOT Executive Director John Njord commented in January 2008:

> *"It is no longer acceptable in Utah to take months and in some cases years to build our structures. Finding ways to accelerate that process has become paramount and essential for the Utah Department of Transportation to be successful. Reducing bridge construction time from months to days and sometimes hours is critical to that success."*

This quote emphasizes the focus on acceleration and implies a need for broad program support for accelerated construction. UDOT accelerates all projects in its program for the following reasons:

- ❖ Reducing turnaround times
- ❖ Lessening impact of projects
- ❖ Improving trust held by UDOT
- ❖ Responding to the market of public desire

UDOT is reducing project development and construction time while maintaining quality, safety, and price. It is lessening the impact of its projects on the traveling public and reducing the impact of road-user costs on the economy. The DOT is improving the level of trust the legislature and public have in UDOT, and the results are tangible. From 1996 to 2007, UDOT's budgets have expanded to unprecedented levels, a direct result of its ability to deliver the program quickly, efficiently, and consistently. UDOT delivers on its promises. It uses public surveys to determine the public's attitudes toward project delivery (e.g., more pain in terms of traffic disruption is acceptable as long as construction time is shorter). The focus is on the "get in, get out, and stay out" mentality. The public does not complain nearly as much when it is told what is being accomplished.

In addition to focusing on acceleration in relation to time, UDOT is concerned about cost. However, because accelerating construction is often perceived to increase cost, UDOT is implementing a new paradigm of moving from lowest construction cost to lowest total project cost. UDOT looks for ways to accelerate construction throughout the entire project development process. Initial decisions are made during concept development and are generally based on user impacts, but also include items such as risk, delivery schedule, industry resources, and cumulative construction impacts. The decision to accelerate may affect the budget, so it is critical that this decision is made before the funding is pursued.

Focus Areas

UDOT has evolved into a mode of operation that constantly seeks to accelerate project delivery. Initially, like nearly every other DOT, UDOT was punitive in its efforts to accelerate project delivery, focusing on liquidated damages. It then moved to incentivizing contracts to complete work quicker, using DB, A+B, and lane rental. Under these delivery and contracting schemes, time became a biddable quantity. Construction firms could then compete for contracts using time as a commodity. UDOT is now transitioning into a collaborative phase, where the contractor's expertise is utilized in developing project approaches. Collaboration is critical to understanding and nurturing the technical tools that UDOT will rely on in the future to continue accelerating projects. Figure 4.1 shows several of the innovations UDOT is using to reduce project delivery time. A key area is ABC, which was considered the next step in accelerating construction at the program level.

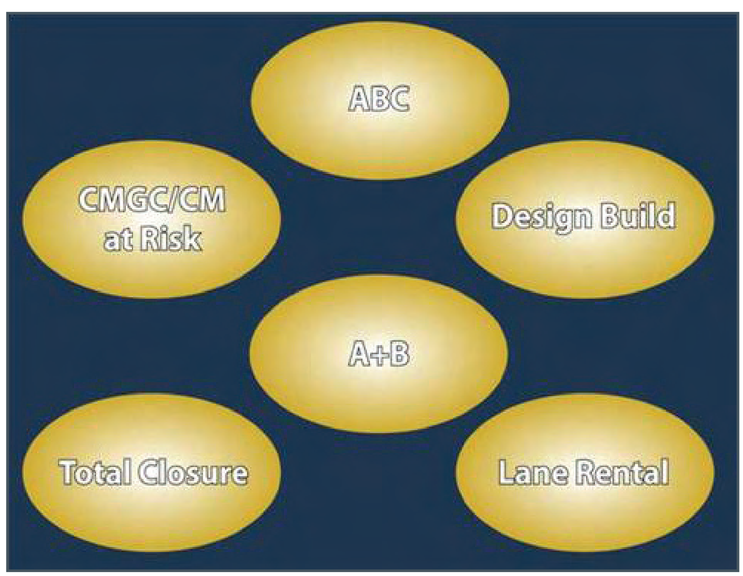

Figure 4.1 *Innovations to reduce project delivery times*

Enabling Accelerated Project Completion

Three areas that have enabled project- and program-level acceleration include innovative contracting, partnering, and changing the agency culture.

Innovative Contracting

UDOT has been involved in innovative contracting for some time, and it is an important tool to facilitating ABC at both a project and program level. Accelerated construction approaches are developed through various means at the program level. CM/GC was pioneered at the central office level. To use CM/GC, UDOT and the FHWA negotiated a Memorandum of Understanding. The CM/GC process draws on the experience of the contractor, designer, and owner. The contractor and designer work together during design to identify and minimize future construction risks.

DB was adopted and refined for use in Utah using a similar process. Specific technologies and practices associated with accelerated construction approaches are identified by the various divisions and regions within UDOT, researched, adopted for use, and applied in real-world situations. Specific approaches to accelerate projects are determined at the project level by project management teams, taking into account maintenance of traffic, input from the contracting community and public involvement, constructability, and maintainability. All levels of the project team provide input into the project approach, from the designer to UDOT senior staff and outside stakeholders.

The initial implementation of any Accelerated Project Completion technique requires an iterative process between design and construction. That is a major reason why new techniques are implemented using innovative delivery methods like CM/GC and DB. These processes allow collaboration between design and construction that is virtually impossible using the DBB environment.

UDOT also uses other contracting methods, such as A+B, lane rental, and I/Ds. UDOT uses some form of I/D on the majority of its projects. I/D clauses are viewed as an important tool for motivating the contractor to help UDOT solve complex issues on projects. UDOT has standard I/D clauses built in to certain standard specifications, including a pavement smoothness bonus and material quality; most additional I/D clauses relate to schedule. UDOT has also used I/Ds for public involvement, traffic control, and utilities.

Partnering

Partnering is mandated by contract on all projects. Partnering is accomplished either formally or informally. Formal partnering is performed with the assistance of a partnering facilitator who has been through the UDOT partnering training program. Informal partnering is facilitated by the Resident Engineer and the contractor superintendent. Both types of partnering involve the project team members evaluating the state of their efforts at least monthly using on-line reporting tools.

Partnering is a process used to resolve problems as quickly as possible and at the lowest possible level. Partnering also reduces claims, because the project team is committed to working together to resolve project issues rather than becoming entrenched and allowing issues to become personal.

UDOT has two phases of partnering training for UDOT construction personnel, the contractor's superintendents, and consultants working on projects. These personnel are required to take both phases of the training. They must either have taken the training or be registered to take the next available training to work on UDOT projects. All other personnel are encouraged to attend.

Contractor and UDOT construction personnel are required to participate formally by contract as previously stated. To help resolve issues as they arise, each project team works together to determine which constituents or stakeholders should participate. This list is large and may include public involvement liaisons, local government staff, subcontractors, utility companies and their contractors, and designers.

Partnering has an overall effect of reduced claims, lower overall cost, happier personnel, improved communication, and quicker resolution of project issues. This last benefit is important to project acceleration. Figure 4.2 shows the number of claims UDOT has experienced in recent years. In 2005, UDOT started requiring partnering on every project. Figure 4.2 shows that partnering has been a very beneficial tool in reducing the number of claims. UDOT's construction program has grown by approximately 600% over the course of the years listed in Figure 4.2, while effectively reducing the number of claims.

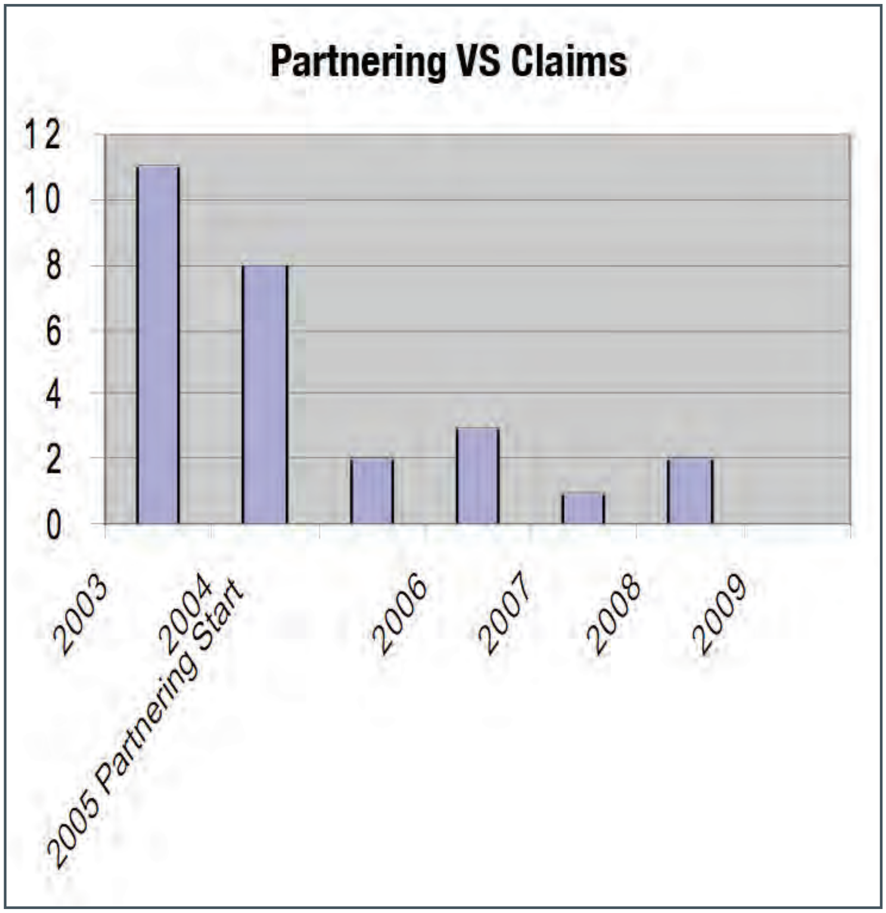

Figure 4.2 *Partnering implementation and claims reduction*

Partnering is vital on all accelerated construction contracts because of the speed with which decisions are made and issues must be resolved. The contractor and agency personnel must work together as a true team. Significant costs will occur due to the time constraints in the contract if issues are not resolved quickly. The CM/GC process is in some ways a very formal contractual partnering arrangement.

Cultural Change

With any opportunity for improvement comes a need to address the impact the improvement will have on the people who work within the agency. Recognizing that, with improvement, change will occur not just for the sake of change, but also to address real needs. Moreover, recognizing that improvement is healthy and accelerating projects is beneficial, UDOT has implemented this change from the top down. This effort has been ongoing for some time, involving agency personnel at all levels in the project acceleration process. UDOT staff has, for the most part, bought into the concept of project acceleration as a way of doing business. In cases where new technologies are involved, a critical mass of supporters has emerged to aid in the acceptance of these new technologies as a way of achieving acceleration.

Change was driven by necessity. UDOT, like many other DOTs, has experienced shrinking staff headcount, increasing workloads, and a more demanding legislature and public. Momentum has developed for project acceleration, and expectations have increased for further improvements in reducing project delivery time while lessening the impact of construction on the public.

Change is sustained through strong and consistent support from the highest levels of UDOT management. The reason for change was clear: improvements were required in project delivery time. Change also influenced UDOT's organizational structure. UDOT established a research group that has assisted in the identification and implementation of new technologies and the tracking of improvements. Thus, performance measures were developed so that improvements are visible to end users of facilities. UDOT staff members share in the success of the program and are recognized for their role in this success.

Accelerated Bridge Construction

ABC focuses on innovative methods to decrease bridge construction time. Typically, under ABC, bridge elements are built off site or outside of the area of traffic. Once the elements or a complete section of a bridge is finished, it is transported to the site and rapidly installed. A number of components comprise an ABC program and are shown in Figure 4.3.

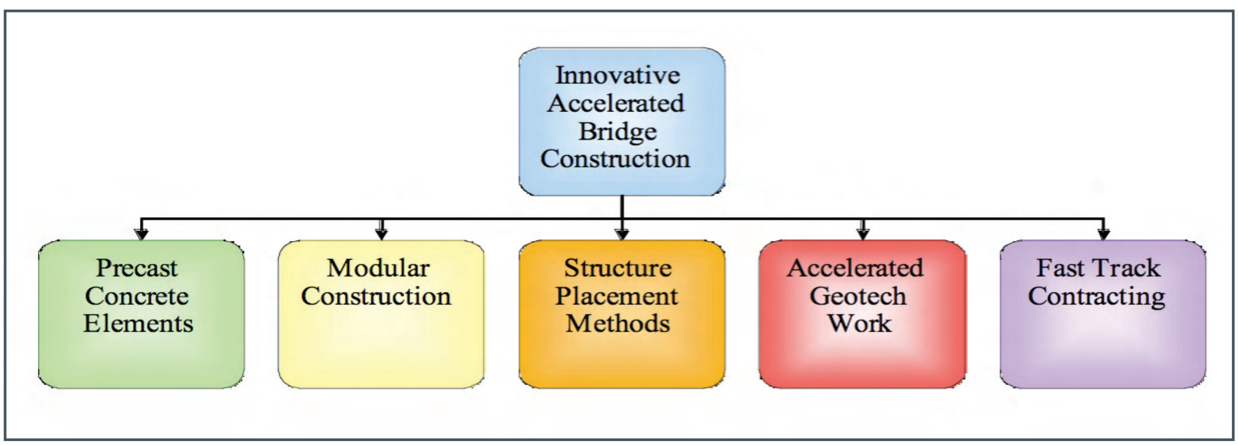

Figure 4.3 *ABC components*

UDOT's ABC program started with typical precast elements, including girders, culverts, and noise and retaining walls. The program has now advanced to include a number of additional items, including precast deck panels, precast piers, heavy-lift bridge sections, specialty materials, and standards. UDOT has 17 projects, including 80 bridges, completed or under construction utilizing ABC. Some of these projects are listed in Table 4.1.

UDOT is developing standards for the different ABC applications. Phase I is focusing on Self-Propelled Modular Transporters (SPMTs) and precast deck panels, while Phase II is concerned with standards for substructures, bulb-tee girders, seismic details, and approach slabs.

Method	Projects	Bridges
Self-Propelled Modular Transporters (SPMTs)	4	13
Half-thickness precast deck panels	2	47
Prefabricated bridges (Lego bridges)	0	2
Full-depth precast deck panels	8	11
Precast voided slabs	1	2
Segmental bridges	1	1
Heavy-lift cranes	1	1

Table 4.1 *ABC project methods*

To facilitate implementation of ABC, UDOT developed a decision process chart (see Figure 4.4).

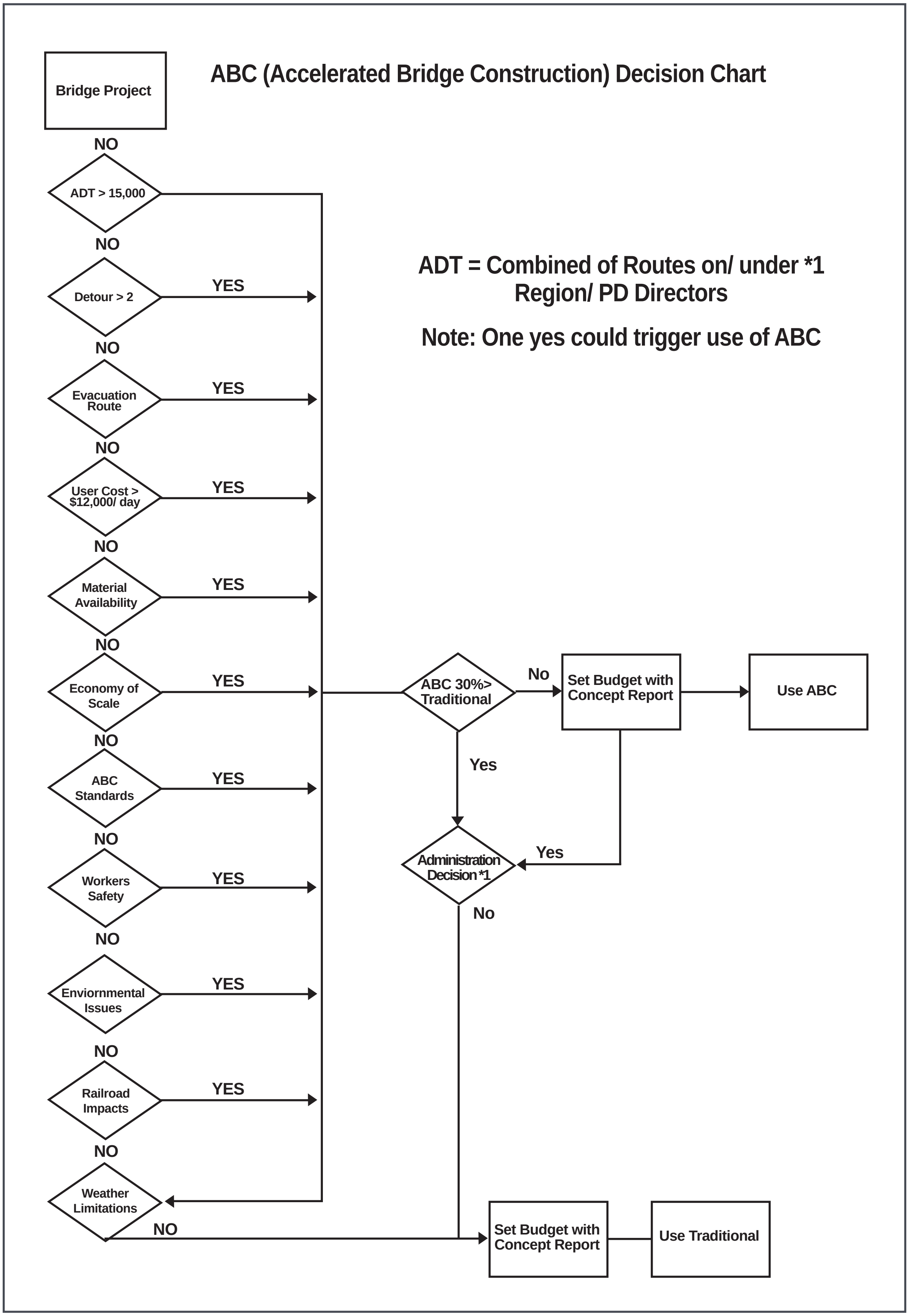

Figure 4.4 *ABC decision chart*

The intent of the decision chart is to achieve the following objectives:

- Realize the difference between rural and urban locations
- Eliminate personal preferences
- Minimize user impact, crash, traffic, and many other expensive studies
- Allow for increased use of new technology through reasonable price protection
- Provide a straightforward flowchart
- Establish definitive questions
- Have flexibility for future adjustments

There are 11 decision criteria that require yes or no answers. The outcome is the decision to use ABC or the traditional method of bridge construction. The advantage of such a chart is that it standardizes the decision-making process across the DOT. In this way, consistent decisions can be made throughout the program to determine which bridges should be designed and constructed following the ABC process.

Projects in two areas illustrate the implementation of the ABC process. First, precast deck panels were used on the I-84 – US 89 to SR 167 Weber Road project. This project had three structures, the longest being 586 feet. Two bridges have steel girders (432 and 586 feet long), and one has prestressed concrete girders (187 feet long). The scope of the project was to replace the deck with precast deck panels (see Figure 4.5). Panel fit was an issue of concern because of reverse curves. Further, a railroad and the Weber River underneath the structures limited access and increased the project's complexity.

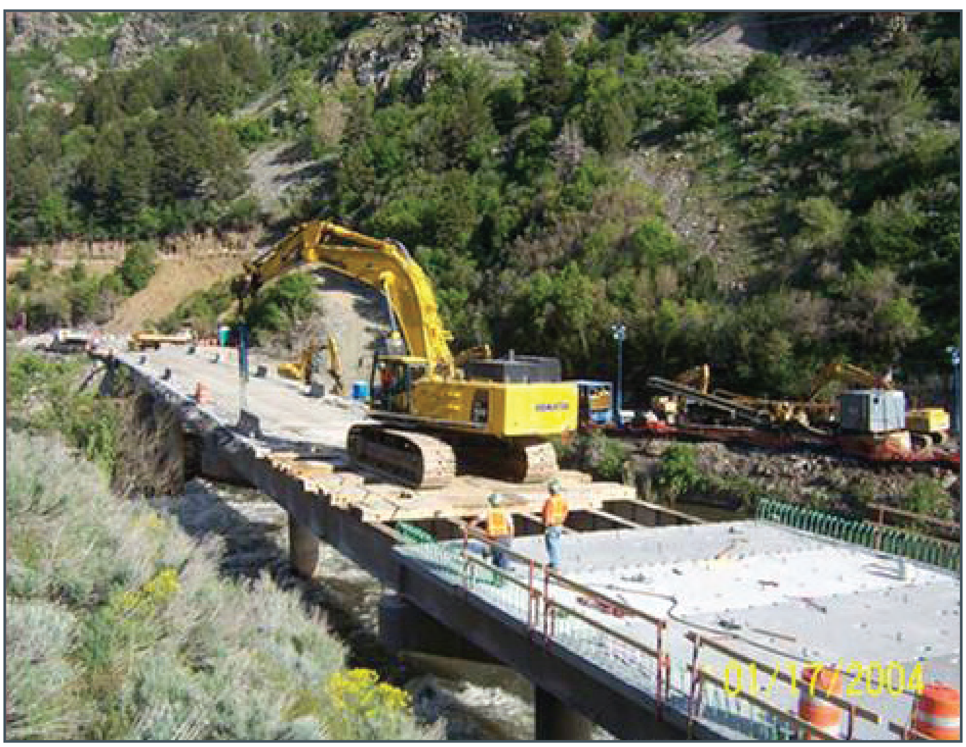

Figure 4.5 *Weber Canyon precast deck panel project panel installation*

During the design phase, UDOT used national experts and held pre-bid meetings with contractors. This approach helped identify project-related risks, such as the construction challenges regarding the alignment of the panels, forming and pouring the parapets, and installing the approach slab (see Figure 4.6 and Figure 4.7).

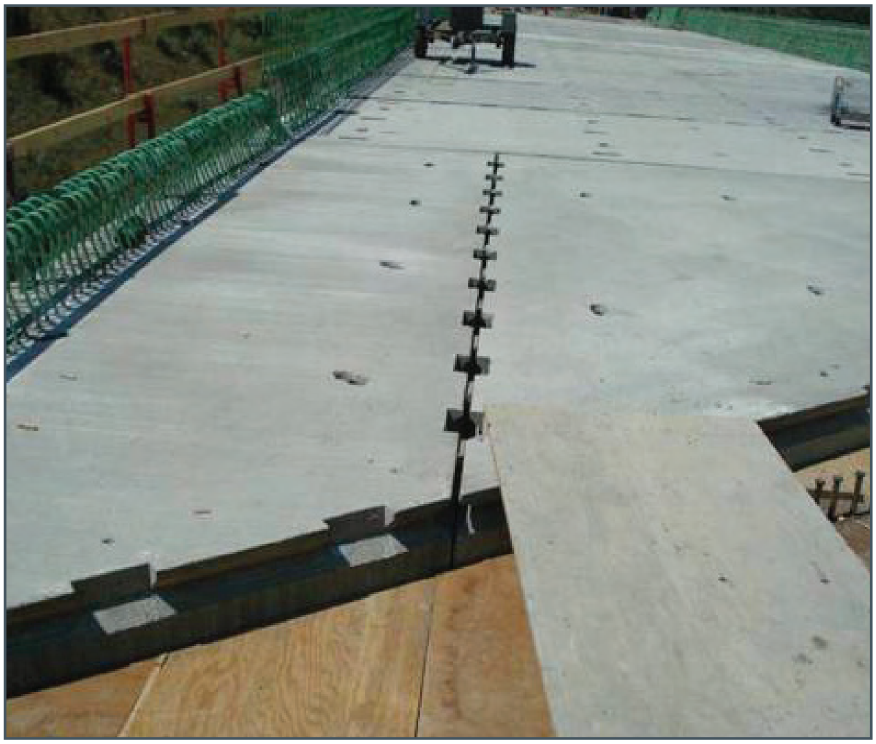

Figure 4.6 *Weber Canyon precast deck panel project*

Figure 4.7 *Weber Canyon precast deck panel project parapet*

The US 89 to SP 167 Weber Canyon Precast Deck Panel Project was considered successful. Some of the lessons learned included standardizing panel size and shape (to enhance the efficiency of truck transportation), standardizing blockout size and shape, and using a 14-day cure time.

UDOT is tracking unit costs for this work. Since 2007, precast bridge deck unit cost has shown a decrease as depicted in Figure 4.8. All costs per square foot include the price to install deck panels, such as lifting into place and placing nonshrink grout and shear stud blockouts. The costs per square foot were found by taking the volumetric fraction of the total precast deck panel cost (the cost that was strictly deck panels, parapets, and closure pours) and dividing that cost by the deck area.

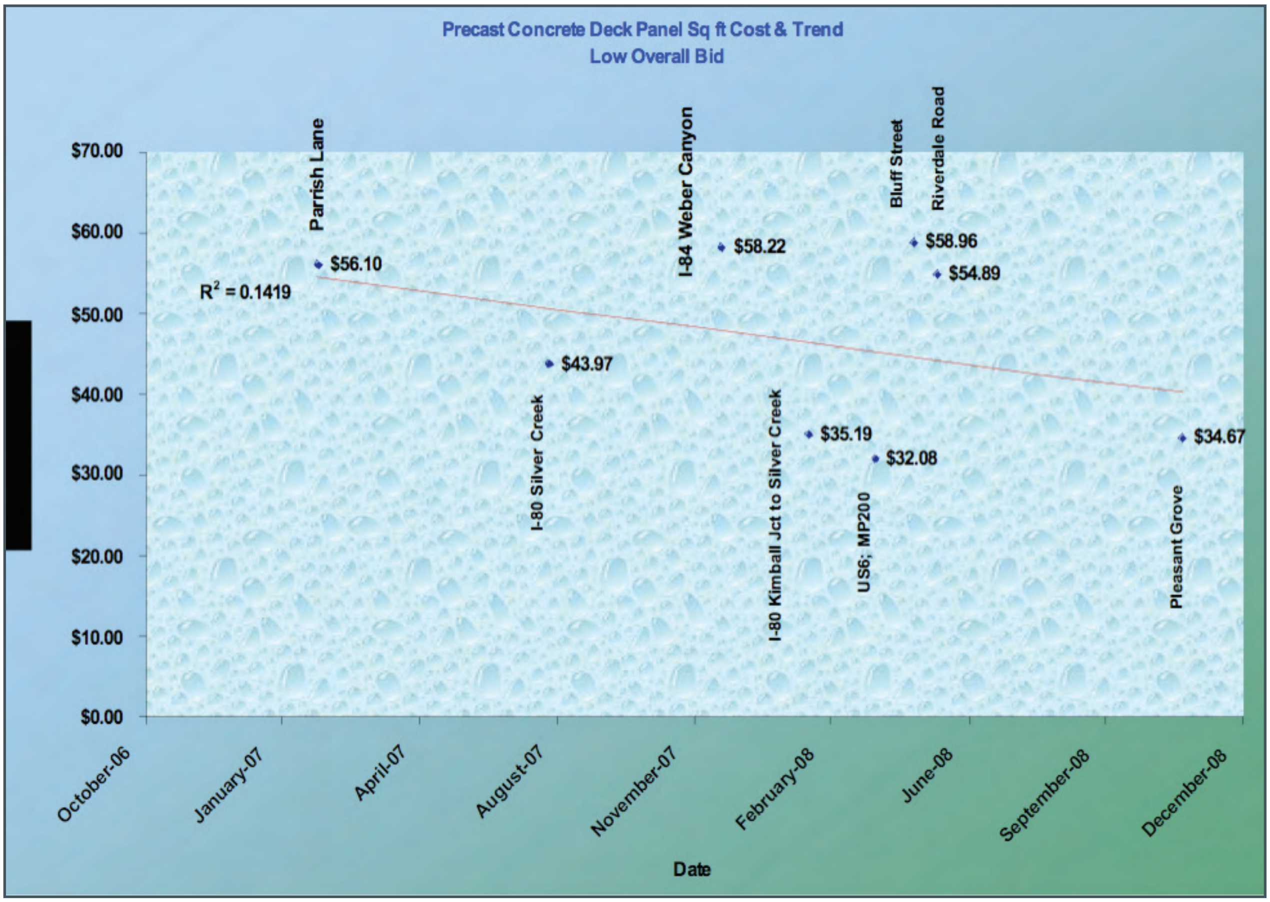

Figure 4.8 *Unit costs of precast bridge deck panels over time*

A second method used within the UDOT ABC program is the SPMT system. SPMTs have multiple axle lines of independently steered bogies. Each bogey has a 360-degree turning capacity. The lifting capacity is 25,000 pounds per axle. A pilot use of this system was the I-215 at 4500 South project. The bridge superstructure crossing I-215 was replaced in one weekend. The existing bridge superstructure had two spans. These bridge spans were removed and carried from the 4500 South location on an SPMT to a demolition area near the staging location for erecting the new bridge superstructure but on the other side of the 4500 southbound off ramp. The new single-span bridge structure was fabricated in the staging area between I-215 and the southbound off ramp at 4500 South (see Figure 4.9). The new bridge was moved into place with the SPMT, once the existing bridge was removed and relocated to the demolition area (see Figure 4.10). The SPMT contractor was Mammoet.

Figure 4.9 *Staging area for new superstructure*

Figure 4.10 *Moving existing superstructure to demolition area*

For more than 15 years, Mammoet personnel have pioneered the development and use of hydraulic skidding systems in North America. There are numerous constraints to cope with before determining the optimal solution when moving large and/or heavy objects. These constraints are assessed by an in-depth engineering effort. Stability of the load during movement is critical. To ensure this, extra support may be necessary. The initial and end configurations of the load have to be considered, and structural integrity has to be checked. In addition, a detailed time schedule should be developed to plan the operation within specified requirements.

The success of the I-215 project has led to the use of the SPMT on 12 more projects in 2008. One project is the I-80 State to 1300 East project. Seven bridge superstructures were built in a staging area (or a bridge farm, as described by the contractor) at 1300 East (see Figure 4.11). The dimensions of these structures varied up to 75 ft by 175 feet. The weight varied to as much as 3.0 million pounds. The maximum travel path was 1.5 miles. The success of this project with respect to reducing the number of days to install the superstructures with the SPMT system is conveyed in Figure 4.12. In the first installation attempt at Highland, the transporter experienced web crippling in a carrier beam. After making corrections, the first bridge structure was then installed.

Figure 4.11 *Bridge farm for the seven superstructures*

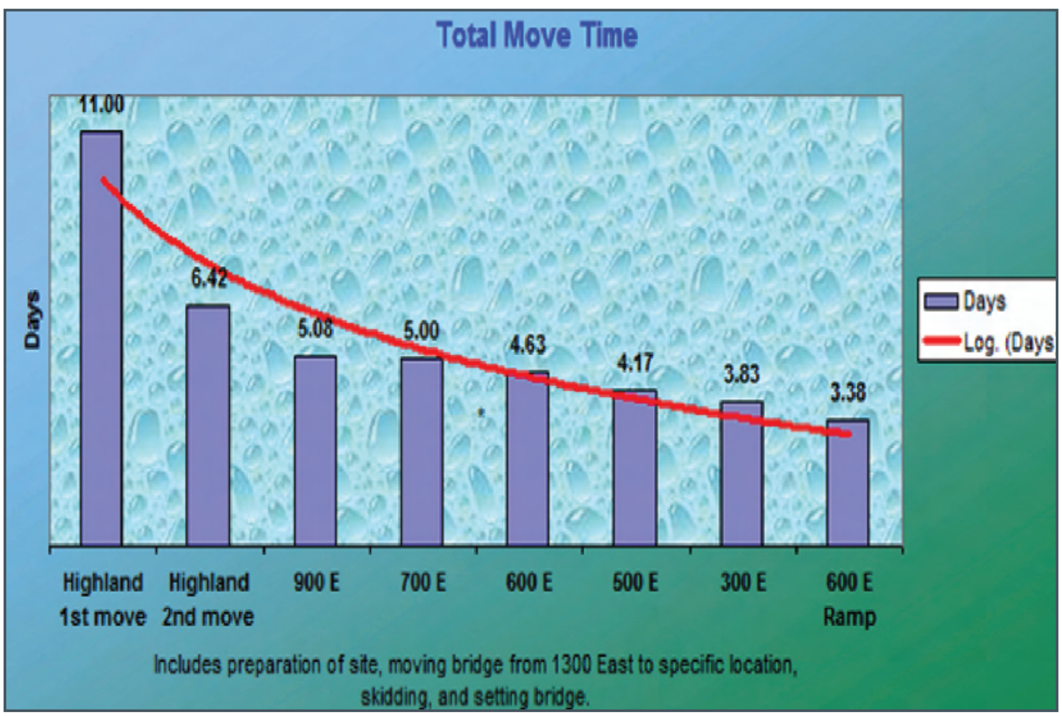

Figure 4.12 *Time to move and set the bridge superstructures*

The general value added by using SPMTs is illustrated in Figure 4.13, which shows the costs per bridge span moved. This figure clearly identifies the increasing value-added trend.

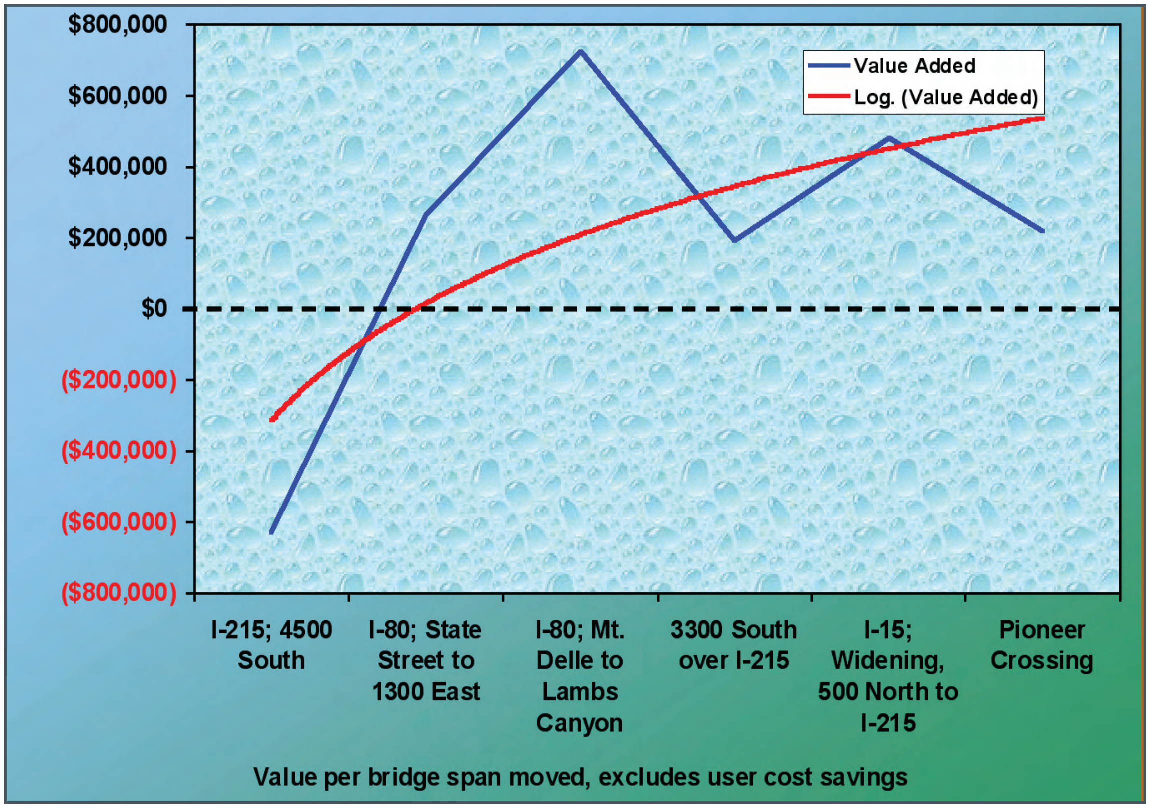

Figure 4.13 *Value added by using SPMT*

Value added has increased as contractors and UDOT have become more familiar with the SPMT process and construction methods. The two projects with the lowest value added were 4500 South, which was the first project of its kind in the state, and 3300 South, which was also a difficult move. Increased value was realized on the I-80 projects due to economy of scale (11 total bridges moved on both projects). The increased value depends on these factors:

- The difficulty of the move
- Savings in traffic control and maintenance of traffic (MOT)
- Increased quality and safety for the workers and the traveling public because the superstructure is built in a controlled environment separated from the road
- Future maintenance savings due to increased quality
- The ability to build multiple bridges in one location.

Contractor's Perspective of Accelerated Construction

Contractors provided their perspective on accelerated construction in general and specifically on accelerated construction as it relates to the program that UDOT is pursuing. This perspective is organized around general program issues, contracting strategies, planning and scheduling, and construction practices.

General Issues

During preconstruction phases, contractors have had, on occasion, an opportunity to provide input to UDOT on accelerated construction projects prior to delivery. This usually only occurs when solicited by UDOT and generally takes the form of providing comments or constructive criticism of an alternative already selected by UDOT. As an example, a recent scan tour invited contractors to observe the I-15 Payson, I-80 2300 East, and I-80 Echo Interchanges and to provide constructive criticism of concepts already chosen by UDOT, such as the precast deck panels on the Payson project and the use of SPMTs on the I-80 2300 East bridges and Echo bridges.

Contractors focus on many issues during the preconstruction phases of accelerated construction projects. Typically, they analyze schedule, MOT, lane rental, and construction sequence to determine the best and lowest price for the project. This price is often a combination of price, number of days (in an A+B format), and possibly lane rental. The winning bid may not actually be the lowest cost nor the best finished product, but the lowest combination of price, schedule, and user costs as established by the project parameters and the delivery and contracting approach.

The mandated accelerated construction practices can shift emphasis from traditional low-bid strategies wherein all contractors focus on achieving a low bid cost, to a nontraditional evaluation wherein the goal is to select the combination of MOT, schedule, price, and phasing to best meet the specified project criteria. UDOT recognizes that in the early stages of ABC strategy evaluation, there are trade-offs between quality and speed; with time and continued innovation, the gap between quality and speed will narrow.

An important aspect of time-sensitive projects is for contractors to assess contingency strategies to overcome potential delays due to unexpected events. Contingency strategies for accelerated construction projects differ from project to project. Some accelerated construction projects use very specialized equipment, such as SPMTs, where no replacement equipment is available, only replacement parts. The contractor can anticipate what parts might be needed, but it is a best-guess scenario. A contractor can arrange for a back-up crane on deck panel replacement projects, but the size and type of the required crane typically requires at least a full day to truck the crane to the project site and set it up. The choice then becomes one of having a spare crane on the project or making contingency MOT plans.

One of the biggest challenges with accelerated construction projects is that the timeframe for bridge or deck panel replacement continues to shrink as UDOT imposes tighter schedules based on past successes. The lesson here is that if this continues to happen, UDOT may experience a catastrophic failure one day that will dramatically reduce public support for accelerated construction and will require so much backup equipment for future projects that these projects will become unaffordable. Therefore, it is important the DOT and contractors properly evaluate risk in a partnered atmosphere.

Contracting Strategies

Contractors prefer DB contracts with fair A+B I/Ds that do not tie their hands with design and encourage early completion by rewarding ingenuity. Traditional DBB usually encumbers contractor efforts to think outside the box by establishing design parameters that may or may not be applicable.

Lane rental usually has only a punitive aspect to it. As such, lane rental does not find much favor with contractors, although it may be necessary as a contract element; when implemented correctly, it should provide an incentive. UDOT often uses lane rental, A+B, or both to arrive at an accelerated solution when the same result can be obtained by making it a contract requirement to either complete the project in a specified number of days or with a stated accelerated technique. Contractors' hands are tied when they attempt to arrive at the goal of an accelerated project by oblique penalties or time constraints. This may be the result when an acceleration strategy is not well thought out by a DOT.

Some contractors expressed a preference for DB for accelerated construction projects over CM/GC and DBB because the project path for CM/GC is usually already plotted by the time the contractor comes on board. However, this condition has been somewhat corrected by beginning the selection process earlier. CM/GC allows UDOT to start the selection process before any design is completed. UDOT can start before it knows everything about the project and involve the contractor in the design decision process. UDOT begins the CM/GC process earlier and selects a contractor more quickly than it does when it uses DB. DB averages 250 days for contractor selection, while selection using CM/GC can take only 70 days.

Traditional delivery imposes even tighter restrictions, and in the accelerated construction projects, the specifications are often too restrictive or even not applicable because UDOT may not have the same expertise the construction community has in establishing the design. The I-80 CM/GC project had the designer work for the contractor. The contractor is better able to influence the project schedule and include innovations in the final product.

Some quality problems are inherent with these acceleration construction practices, such as:

- Moving bridges with SPMTs can cause some deck cracking, especially when the decks are not designed to be lifted at the quarter points.
- Precast deck panels can have some issues with the connections and camber strips.

Some of these issues can be mitigated with lessons learned through design and others will always require a compromise. Allowing the projects to be a pure DB without having to adhere to certain parameters that are sacred cows within UDOT will allow greater flexibility in solving some of these problems; however, this will require a change of culture in the DOT.

Planning and Scheduling

On the I-80 State to 1300 East project, the contractor was allowed to make changes to the MOT plan, improving the original sequencing. These modifications reduced costs and addressed scope changes, including the following:

Phase I.	Original sequencing included temporary widening of the median. The eastbound shoulder was permanently widened to accommodate a 3/2 altering direction traffic configuration.
Phase I	Original sequencing included temporary widening of all structures from 300 East to 900 East. Traffic requirements were met with only minor modifications to the 600 East Structure.
Phase I	Original sequencing included construction of two crossovers. Due to the scope change of adding the State Street structures, the planned west crossover was deleted and moved to an area further west, where the median was concrete and a temporary crossover was not required.
Phase II	Original sequencing included construction of superstructures on mainline I-80 adjacent to the existing bridges. The contractor's plan included the bridge farm (see Figure 4.11). All bridges were constructed in the same location, reducing costs, impacts to the public, and ROW takes.

Construction Practices

Two issues that would help improve construction practices both relate to more time. More time for designers, ROW requisitions, and plan review by the contractors before officially starting construction would alleviate delays to the aggressively scheduled construction activities. More lead time for utilities is also a concern. The various infrastructure owners expressed opposition to being pressured into decisions and strict time constraints. UDOT pays penalties, overtime, and premium cost for labor associated with utility relocations under these circumstances.

There are limits to the tightening of project windows. Time must be scheduled for unforeseen incidents. Past successes do not dictate future constraints.

The contractor for the I-80, 3300 South, and 4500 South projects made these projects a priority and had a large pool of equipment and manpower enlisted as contingency. The contractor has also developed good relationships with other contractors and suppliers for backup resources in case of an emergency. Any contractor undertaking an accelerated construction project has to have this type of backup or contingency planning to be successful.

One strategy that was used on the SPMT project was a pre-move risk identification meeting where UDOT, contractors, suppliers, and design team members participated in a "what if" brainstorming session to identify potential risks and hazards; contingency plans were developed accordingly. This strategy helped team members unify to identify and manage potential risks.

One example of an emergency encountered was a design flaw in the transport beams that needed to be immediately replaced with a new set of beams. One of the suppliers worked around the clock until the new critical component of the bridge moving process had been delivered. The contractor's crews then worked 20-hour days for 6 weeks to maintain the schedule.

Program Acceleration: The Future

UDOT has a vision for the future of project and program acceleration. This vision encompasses six areas:

- Continue to implement ABC programmatically
- Instrument bridges to aid in for future economical design
- Expand and improve the use of innovative contracting methods
- Continue to collect supporting data
- Expand into other accelerated construction methods
- Implement and promote practical design

As UDOT continues to implement ABC programmatically, an effort will be made to expand the use of the ABC decision flowchart (see Figure 4.4) and improve this decision process. Development of accelerated standards will continue. The training program will be expanded to include project managers as well as consultants and contractors in the principles, concepts, and practices related to acceleration. UDOT will continue to learn from other states and share its experiences in this area.

UDOT plans to instrument more bridges during moves to ensure that they perform as designed in terms of staying within elastic limits. This monitoring will aid in improving future designs by reducing deflection/cracking and should support preparation of more economical designs. The ultimate goal is to improve long-term performance.

Current alternative contracting methods need to be refined and improved, such as CM/GC and DB. Other contracting methods will continue to be explored, including, but not limited to, alliance, performance, task-order contracting, pooled DB, and public-private partnerships.

An aggressive measurement program is required to determine how UDOT is performing against the various initiatives supporting project and program acceleration. Some key areas for measurement include the cost impact due to economy of scale, SPMT costs, total project costs, public perception, time savings to construct, and the impact of acceleration on safety, quality, and durability. Performance measures will be established.

In the area of construction methods, UDOT intends to explore precast, prefabricated concrete pavements; geotechnical methods; and standardization and uniformity of appurtenances to achieve greater acceleration. In addition, innovation in lifting, transporting, and manufacturing equipment and innovative materials such as carbon fibers and plastics will be explored.

UDOT is evaluating the practical design concept used by the Missouri DOT. Work related to practical design will incorporate the following tenets:

- ❖ Expand on previous work, such as VE and context sensitivity, by formalizing and integrating these processes with other processes
- ❖ Practice real engineering; in other words, know when to deviate
- ❖ Avoid using a cookie cutter approach
- ❖ Implement common sense
- ❖ Think of what you want to achieve and not what you have always been doing
- ❖ Meet the goals of the project and do not compromise safety
- ❖ Do not design for more than you need
- ❖ Make economical decisions

Emergency Construction

UDOT has established an emergency on-call and response program. This program was started as a response to substantial problems responding to emergency issues, especially in the bridge area. Since 1999, more than 50 bridges were identified as needing some repair due to collision damage. Insurance recovery of funds due to damages was considered poor at best. Insurance money that was collected ended up in the UDOT general fund and was not specifically programmed to fix bridges. Communications between regions, planners, bridge engineers, and others were poor at best. UDOT had no process in place to respond to emergencies in an effective manner. Hiring contractors required UDOT to track the traditional process of planning, design, and advertising for construction – this process took years.

UDOT embarked on a new process to fix the response problem, initiating a Contractor-On-Call pool and process to select contractors quickly when emergency situations arise. UDOT had to obtain special procurement approval to select contractors from the pool during emergencies. Commission approval was not required for projects less than $500,000. To ensure rapid response time, simplified plan packages were created to reduce waste. Contractors would submit proposed cost, approach to the work, details, and schedules similar to a DB project. UDOT created a bridge collision fund to ensure that funds were immediately available for the work. UDOT replenishes this fund with insurance recovery money. Further, UDOT created a communications hub with a Traffic Operations Center and an emergency rating system to determine the severity of the emergency. Training was also introduced to reinforce the process.

The contractor on-call pool is determined by an RFP that is advertised every two years. This allows contractors to become part of the on-call emergency pool; however, listing in the pool is not a guarantee of work. Project RFPs are prepared as needed. Actual selection for immediate emergencies (e.g., for shoring, closures, and demolition) is based on availability, location, and contractor technical expertise, with verbal approval from senior leadership. Selection for repairs uses proposals that consider cost, technical expertise, approach to work, and schedule.

The procurement approach for emergency projects was streamlined in relation to typical project procurement, which requires plans, advertisement, and selection based on low bid. Further, typical project procurement requires projects and funding to be approved through the annual STIP process. UDOT obtained approval from state procurement to use existing rules that allow UDOT senior leaders authority to immediately award work for emergencies up to $500,000. Projects over $500,000 must also obtain Commission approval. Finally, projects using federal funds must have FHWA approval or the appropriate agency's approval.

Funding processes were also changed. A Bridge Emergency Recovery Fund was established to serve as a clearinghouse to distribute and collect money for emergencies. State funds are used to allow for greater flexibility. Emergency funding is immediately available. Insurance recovery money goes back to reimburse the account. Shortfalls are addressed in each year's STIP process.

UDOT does not follow traditional processes for preparing plans, specifications, and estimates. Instead, it prepares a project Concept Report and RFP to convey scope, schedule, budget, and schedule constraints. Contractors submit proposals similar to DB that define cost, related experience, approach to work, and schedule. Contractors are selected by a team using a predetermined scoring method and are recommended for approval to senior leadership. Detail sheets are used in place of CADD drawings where possible. Standard specifications are used in place of special provisions as much as possible.

Communication is extremely important in initiating and sustaining the emergency response approach. UDOT created an emergency on-call list for distribution. Use of this list was tied to the severity of the event as depicted in a graph to aid in prioritizing response (see Figure 4.14). UDOT created a Ready-to-Go bridge information package in both hard copy format and electronic formation the UDOT Web site. UDOT also created a bridge emergency rating system that identifies four levels of severity to quickly communicate severity of the damage to a structure or roadway after an event. The Traffic Operations Center becomes the communication hub during bridge emergencies.

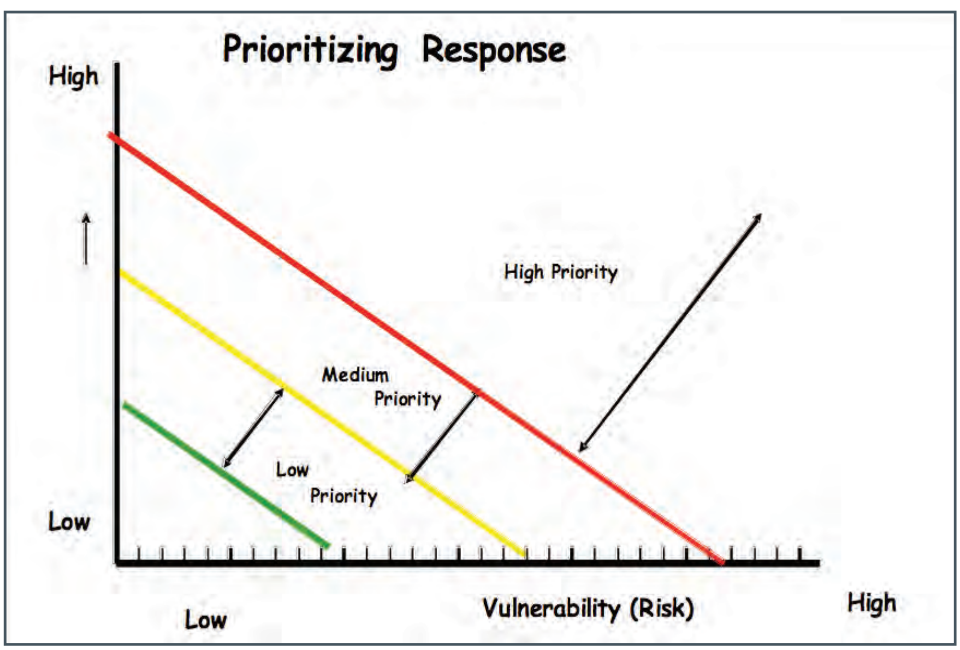

Figure 4.14 *Priority response graphic*

Two project successes under the emergency response program include the I-70 Floy Interchange and the 75-Year Flood in January 2007. The first emergency project resulted from a beam collision under the I-70 Floy Interchange where a drilling rig damaged a girder (see Figure 4.15). The region notified the Traffic Operations Center, which sent out the notice to the on-call list of contractors. Bridge inspectors were on site within hours. Within two days, a contractor was selected and removed the damaged girder (see Figure 4.16). The RFP was sent out to select a contractor to replace the girder within 30 days.

Figure 4.15 *I-70 Floy interchange damaged girder*

The second emergency project was the 75-Year Flood in January 2007 (see Figure 4.17). In anticipation of severe weather, National Weather Service information was linked to the Traffic Operations Center and the Structures Division to monitor changing weather patterns. Bridge inspectors were sent to the area as a precaution before the flood. Bridge inventories and scour-critical bridges were identified using an inspection database. UDOT created a triage system for inspection and updates of flooded bridges. Those bridges that were washed out were closed. UDOT used the contractor pool to replace several bridges within three to six months.

Figure 4.16 *Damaged girder removed*

The emergency contractor on-call process is working very well. The backlog of collision-damaged bridges has been eliminated. The response time to emergency situations has been reduced from months to hours. The response process has been expanded to cover structural issues such as deck blowouts and natural disasters. Lessons Learned reviews are completed after every event to identify what worked and what did not. Finally, funds for insurance claims are going directly to the problem.

Figure 4.17 *75-year-flood damage*

Keys to Successful Program Implementation

UDOT has a successful program to accelerate project delivery. Some keys to its success include:

- Gaining upper level management support – without this type of support the goals and objectives of program acceleration will not be achieved.
- Having enabling processes in place – UDOT had developed mature processes related to alternative project delivery, contracting, and partnering.
- Recognizing that implementing new processes requires cultural changes within the organization – a need is recognized and efforts are made to enlist the support of UDOT staff.
- Being willing to try new technologies – UDOT has aggressively implemented some new technologies in the area of bridge design and construction and has the patience to wait for the benefits of new technologies to outweigh the costs.
- Engaging industry in improvement processes – hearing the voice of industry through input, discussion, and collaboration is critical.
- Measuring performance is critical – UDOT is tracking the results from project and program acceleration and can point to successes.
- Learning from the past – changes to improve the acceleration process have been made based on past experiences.
- Maintaining a vision for the future – UDOT is constantly looking for new and better ways to accelerate project and program delivery.

UDOT has embarked on an ambitious program of project acceleration while focusing on lowest project cost. While UDOT has been successful thus far, it continues to look forward to find ways to further reduce delivery times while minimizing the impact on road users.

CHAPTER 5

Observations Recommendations, and Implementation

Introduction

The scope of this scan was to identify construction operational and management practices that lead to successful accelerated construction and project delivery. The scan purposely focused on actual construction operations and management practices, together with contractual and incentive approaches that serve to encourage contractors to accelerate a project. The scan team evaluated practices in construction acceleration for their potential application by transportation agencies in response to an emergency and as a way to deliver these emergency projects with minimum disruption to highway users. Many DOTs have experience with accelerated projects in response to an emergency situation. For these types of projects, the entire delivery process, including design, is compressed. General project/program construction acceleration approaches were the second type of acceleration reviewed by the scan team. In this area, acceleration was a planned approach selected intentionally by the DOT. In this case, accelerated construction was both project-specific and program-focused.

The scan team studied eight emergency and seven planned accelerated projects. The DOTs visited included Florida, Alabama, Texas, Utah, and California. Many of the accelerated projects involved bridge construction, although several projects were primarily pavement construction-type work. Accelerated construction durations were as short as one month for the I-580 MacArthur Maze and as long as five years for the multiphase rebuilding of I 10 in Houston. Further, a program perspective on ABC was the focus of one DOT interviewed. Several bridge projects were presented by this DOT to illustrate a program approach to acceleration and the overall success of its program.

Observations

Transportation communities are quite similar in terms of the political, financial, and resource challenges that they face. However, some agencies are better at leveraging alternative contracting approaches and technical innovations. For every project examined, the primary element leading to success was a spirited partnership and collaboration between the DOT and contractor, together with a design supportive of accelerated construction. The following summary observations provide the fundamental findings of this study. These observations provide a context for the recommendations and implementation strategies that follow.

Partnering – *People*

People are the critical element in successfully accelerating a project. Formal partnering is a beginning, but partnering is more than meetings. To accelerate a project, all team members must be committed to resolving issues at the lowest level. There is also a need for openness to change after contract award, when more information becomes available. Every team member must exercise tremendous attention to detail and commit to an unselfish effort to ensure that there are no interruptions in moving the project forward. On many projects, the co-location of DOT and contractor personnel facilitated the partnering atmosphere, as suggested by one participant, "You can't go fast if you're not co-located."

Partnering keys include:

- **Align goals –** acceleration has a construction cost; establish incentives sufficient to cover increased cost plus risk
- **Delegate to the lowest level –** empower people to make immediate decisions
- **Make timely decisions –** have technical expertise on site or available at all times

Design – *Material Availability and Logistics*

A contractor must be able to procure the necessary project material in an expeditious manner. Designers must consider the availability of materials and the difficulties of moving and handling items such as bridge girders and precast elements. Logistics issues must be considered when selecting a design approach. Construction speed is achieved when the design allows repetition of activities. Designers should always review the standard specifications for opportunities to remove barriers to acceleration.

Planning – *Detailed*

A detailed execution plan is a critical component of the acceleration effort, and the plan must be updated regularly. Planning must include material suppliers and fabricators and construction equipment suppliers. Additionally, there must be contingency plans for all possible impediments. Speed is achieved by working concurrent activities. Plan to open multiple fronts to push construction activities with more crews and equipment. Prepare look-ahead plans at regular intervals.

Contracting Strategy – *Aligned with Requirements*

The contracting method needs to be aligned with the technical requirements of the project, including time, type of work, traffic, and project site conditions. Risks should be allocated to the party best able to manage those risks. Set an aggressive schedule with sufficient incentives and contractors will respond to the need for acceleration. The contract must clearly define work restrictions – schedule restrictions, vibration and noise restrictions, and any regulations that will limit work or logistics activities. The use of DB contracting will facilitate the introduction of innovation in design and construction. Further, the use of a new delivery approach, CM/GC, allows the agency to obtain critical constructability input from the contractor during the design phase. This approach fosters a cooperative relationship and can also promote innovation.

New Business Model – *Serve the Public*

Agencies should respond to the market of public desire. Going from accelerated construction to an accelerated project delivery attitude is possible if an agency thinks in terms of a systematic and holistic delivery approach. The lowest total project delivery cost should drive design and construction and include consideration of societal cost. When an agency involves the community and local and regulatory entities and achieves alignment with them regarding the project goals, construction acceleration will reduce the overall cost to the community. The "public can tolerate an awful lot if you tell them ahead of time and how long."

Recommendations

The recommendations for accelerating construction specifically and project delivery in general are based upon the findings from studying various project and program activities covered during the scan. While there are some common themes that lead to successful acceleration, approaches to acceleration do differ based on whether the acceleration is in response to an emergency situation or whether it is a planned project delivery approach. Further, institutionalizing project acceleration can be accomplished at the program level. Recommendations are provided for each category of acceleration.

Emergency Projects

Some projects are accelerated due to unforeseen events. Typically, these events are related to an accident, natural disaster, or failure of a structure. These emergency projects are always accelerated to the highest possible degree. Any recommendations for emergency project acceleration would include processes related to the study observations, such as the use of partnering, detailed planning, contracting strategies, and material use. Several more specific recommendations for projects under emergency acceleration include:

- The agency should find contractors that have the resources to start immediately. The contractor must have the technical capability together with the ability to rapidly mobilize the necessary people and equipment, including backup machines. The contractor must also have the financial capacity and established trust with suppliers and fabricators so that critical material will move with only a phone call.
- In the case of an emergency project, communication can be difficult and distances can create time lags; therefore, ensure that the needed expertise is available on the project. Decisions are best made on the project site. On-site decisions are crucial to achieve accelerated project completion.
- Push decision making to the lowest possible level, including award and execution of the contract. If necessary, develop the agreement (contract) on site with the parties responsible for execution of the work. The ability of the local offices and their designers to make project decisions accelerates the work.
- Get a contract or agreement in place so the contractor(s) can go to work.
- The scope should be developed for the basic project need and then allow the contractor to develop solutions. Often design is controlled by available materials that can be drawn to the project site. Finally, there will be changes (scope growth) and the design must be able to easily accommodate the resulting adjustments.

Planned Project Acceleration

Many projects are delivered based on accelerating either construction only or both design and construction in order to minimize the impact of construction on road users, businesses, and the local community. Sometimes specific events may drive a project toward acceleration. These project requirements lead to planned acceleration for selected projects.

Certainly any recommendations would include processes related to the study observations, such as the use of partnering, detailed planning, and contracting strategies. Several more specific recommendations for planned acceleration include:

- The decision to accelerate construction should be made early in project development. That decision will focus the project team on finding ways to support the accelerated construction effort through detailed design and approaches to the acquisition of ROW and utility relocations.
- Partnering should be mandated for all accelerated projects and should include all project team members. In addition to DOT staff, the designer, contractor, subcontractor, and material supplier/fabricator personnel should participate. Depending on the project's complexity, local government agencies and utility companies should be involved. The partnering process should be implemented consistent with the characteristics of the project. For example, on projects where design and especially construction lasts a year or multiple years, partnering should be a continuous process.
- The benefits of delaying the construction start date or "Delayed Start/Procurement Period" should be carefully evaluated. This would allow the project team time to review and approve all shop drawings and facilitate the production of long-lead fabricated items. During this period the agency should seek ways to

encourage contractors to place more effort in upfront planning. The contractors may have to work multiple fronts and extended workweeks (e.g., 24/7) to meet specified completion dates.

- Procedures and criteria for the use of incentives/disincentives should be developed. I/D contract provisions must motivate the contractor to accelerate the work. When using the I/D contracting approach, the agency must have decision makers at the site and delegate decision making to the lowest staff level. A sufficient incentive should be added to shorten project delivery time significantly.

Program Project Acceleration

Some agencies are focusing on program-level approaches to accelerating project delivery. The program approach tends to be comprehensive and in many DOTs is related to bridge construction. Key recommendations related to developing a successful program for accelerating projects include:

- The agency needs a champion of project acceleration who has the support of upper level management. The focus at this level within the agency should be on setting the vision, goals, and objectives of project acceleration at the program level. Policies and procedures should be developed to implement the vision, goals, and objectives. The vision should constantly promote looking for new and better ways to accelerate projects and, therefore, program delivery.
- The agency should have enabling processes in place that are mature and can support project acceleration. There are three critical enabling process areas:
    - **Partnering –** a process that is standard across the agency. Partnering can be formal (where facilitation is used) or informal. All project participants should be involved in the partnering process, and that process should be used for every project.
    - **Alternative project delivery and contracting methods –** the agency should have a toolbox of project delivery approaches and contract methods that have been proven to successfully support acceleration. The agency should recognize that these approaches and methods have to fit the requirements and conditions of the project.
    - **Cultural change –** the agency must recognize and plan for changes as new policies and procedures are implemented to support project acceleration.
- The agency should be willing to try new technologies. For example, there are new technologies in the area of bridge design and construction to accelerate projects. While new technologies are costly when first implemented, the cost associated with the technology should decrease over time. Project durations should also decrease over time.
- The agency should consider total project costs, including capital investment, road user costs, and societal costs when implementing an accelerated program of projects. The cost and time impacts of acceleration should be covered in budgets when projects are programmed early in the project development cycle.
- The construction industry must be engaged when improvement processes are institutionalized at the program level. Hearing the voice of industry through input, discussion, and collaboration is critical.
- Performance measurement is another critical component of acceleration activities. Tracking the results gained from both project and program acceleration should point to successes but also identify areas where there are opportunities for further improvement.
- The agency should learn from the past. Tracking lessons learned will aid in making changes based on past experiences to improve the acceleration process.

Implementation

The communication of successful processes and methods used to accelerate construction of the projects studied will aid agencies faced with the need to rapidly replace vital infrastructure in an emergency situation or as a planned approach with minimum impact to the public. The scan team firmly believes widespread distribution of the scan findings can best be achieved through a series of presentations targeted for transportation industry audiences. Therefore, the team has formulated a schedule of technical presentations at AASHTO, FHWA, and Transportation Research Board meetings and other conferences. In support of these presentations, the team would like to encourage the publication of both a flyer and technical data report that summarizes the findings and recommendations of the scan report. The scan team formulated the implementation activities shown in Table 5.1.

Activity	When
Summary Report (50 page maximum)	August 2009
Flyer (based on the executive summary)	August 2009
Articles in *Focus* and *Public Roads*	To be determined
Activity	**When**
AASHTO Subcommittee on Construction (SOC)	4 Aug. 2009 Chicago, IL
Southeastern Association of State Highway and Transportation Officials (SASHTO)	28 Aug.-2 Sept. 2009 Biloxi, MS
American Road & Transportation Builders Association	6–9 Oct. 2009 Charleston, SC
AASHTO Standing Committee on Highways (SCOH)	22–27 Oct. 2009 Palm Desert, CA
Transportation Research Board, Annual Meeting	10–14 Jan. 2010 Washington, DC
Associated General Contractors (AGC) of America, Highway & Transportation Div.	Spring 2010

Figure 5.1 *Accelerated construction implementation activities*

The team also encourages the Research Steering Committee of SOC to continue the effort of collecting case study information on accelerated construction projects from its membership.

Conclusions

The scan team members strongly recommend that the innovative ideas described in this report be considered and evaluated for use. The true value of this information will only be realized when these recommendations are shared, evaluated, and, as appropriate, put into place.

Accelerated construction requires much more upfront planning. The DOT must research available materials and the marketplace before developing a project design. Contractors seeking to accelerate their work must develop their plans to a much greater level of detail due to schedule constraints and overall contracting risk.

The foundation of accelerating project construction is a design based on materials that can be moved quickly to the project site. In the case of emergency projects, a conservative design is suggested as protection against problems that can be caused by project unknowns, and finally, the designer must maintain flexibility in the design approach.

Accelerated construction is about minimizing time impacts to the public and the impact on overall cost. When goals are aligned and a partnering atmosphere is created, all team members view the accelerated work as an opportunity to demonstrate excellence. The owner of one company that delivered an accelerated project ahead of schedule stated, “It’s not about making a huge profit. It’s about pride and reputation.” The Chief Engineer for the DOT affirmed that opinion.

APPENDIX A

Scan Team Biographical Information

Brian Blanchard (AASHTO Co-Chair) is the Chief Engineer of the Florida Department of Transportation (FDOT). He has more than 26 years' experience in structural design, roadway design, and construction management. Blanchard is the former FDOT Director of Construction, the former State Roadway Design Engineer; prior to that, he was the District Design Engineer for the panhandle of Florida. He is a graduate of Louisiana State University and is a licensed professional engineer in Florida and Louisiana. Blanchard is a member of the AASHTO Standing Committee on Highways and Subcommittee on Construction

Thomas Bohuslav (AASHTO Co-Chair) is the director of the Construction Division of the Texas Department of Transportation (TxDOT). He is responsible for developing and issuing statewide policy and procedures for all construction contracting, including accelerated construction. Additionally, he ensures that all materials used in construction and maintenance of TxDOT highways are uniformly tested for quality. Bohuslav also oversees TxDOT's responsibilities for pavement management and design. He has been with TxDOT for more than 28 years. He earned his Bachelor of Science degree in Civil Engineering from Texas Tech University in 1982 and became a licensed professional engineer in Texas in 1988. He serves as the Vice Chair of the AASHTO Subcommittee on Construction. He was a member of the 2004 International Construction Management Scan.

Christopher J. Schneider (FHWA Co-Chair) serves as Construction & Systems Preservation Engineer in the Office of Asset Management for the Federal Highway Administration (FHWA) in Washington, DC. He is responsible for program areas involved with improving construction quality and management. Schneider's program areas include Performance Contracting and Specifications, Innovations and New Technologies, and the Accelerated Construction Technology Transfer (ACTT) program. Schneider previously worked with the FHWA's Eastern Federal Lands Highway Division (EFLHD) for 18 years. Prior to serving as the FLH Road Inventory Program Coordinator, he spent 10 years in the EFLHD Construction office having served as Project Engineer, Construction Quality Assurance Engineer, and Construction Operations Engineer. A graduate of Mississippi State University with a Bachelor of Science degree in Civil Engineering, Schneider began his career with FHWA in 1987. He serves as a panel member for current NCHRP Project 20-73, "Accelerating Transportation Project and Program Delivery: Conception to Completion."

Stuart D. Anderson (Co-Subject Matter Expert) is a Professor in the Zachry Department of Civil Engineering at Texas A&M University. He is also a Program Manager of Construction for the Texas Transportation Institute (TTI) in the Constructed Facilities Division of TTI. Anderson's research includes work in the area of accelerated construction and specifically studying processes to aid in acceleration both overall project delivery as well as construction delivery. He was the Principal Investigator on a FHWA research project on "Traffic Management Studies for High Volume Roadways." Previously, Anderson was the Principal Investigator on NCHRP Project 10-50A "Guidelines for Selecting Strategies for Rehabilitating Rigid Pavements Subjected to High-Traffic Volumes" and NCHRP Project 10-49, "Improved Contracting Methods for Highway Construction Projects." He holds a Bachelor of Science degree from the University of Washington in Building Construction, a Master of Science degree from the University of Illinois at Urbana in Civil Engineering with emphasis on Construction and Geotechnical Engineering, and a PhD degree from the University of Texas at Austin in Civil Engineering with emphasis on Construction Engineering and Project Management. He is a licensed professional engineer. Anderson is the Chair of Transportation Research Board (TRB) Construction Management Committee, a member of the TRB Project Delivery Methods Committee, a member of the American Society of Civil Engineers (ASCE) Construction Institute, and a member of the Project Management Institute.

Clifford J. Schexnayder (Co-Subject Matter Expert) is an Eminent Scholar Emeritus at the Del E. Webb School of Construction at Arizona State University. During his career, Schexnayder has worked as a professional engineer on major construction projects across the United States and dedicated himself to teaching construction courses at universities around the world. He has 15 years of construction contractor experience as a field engineer, estimator, and corporate chief engineer. In the Army Reserve, his last assignment was in the Office of the Chief of Engineers, Washington, DC, as Executive Director, Directorate of Military Programs. He retired from the Army in March 1998 with the rank of Colonel. He holds a Ph.D. in Construction Engineering and Management from Purdue University and is a licensed professional engineer. He served on the Executive Committee of the ASCE Construction Division (1986–1992) and as Chairman of the TRB Construction Section (1997–2003). Since May 2006, Schexnayder has served on the Renewal Technical Coordinating Committee for the Strategic Highway Safety Program (SHRP 2). He is author of the Army Field Manual Earthmoving Operations, FM 5-434, and the McGraw-Hill textbooks *Construction Planning, Equipment & Methods and Construction Management Fundamentals.*

Steven DeWitt is the Chief Engineer for the North Carolina Turnpike Authority (NCTA). He is responsible for all engineering activities relating to the planning, design and construction of NCTA's toll road projects. He is also the lead on North Carolina's first Public Private Partnership procurement for transportation infrastructure. DeWitt previously served as North Carolina Department of Transportation's (NCDOT) Director of Construction. DeWitt's 22-year career with NCDOT included a variety of positions in construction management, contract procurement and other related activates. He was the lead in creating the North Carolina Department of Transportation's Design-Build program with a focus on accelerating project delivery. DeWitt is a graduate of the University of North Carolina at Charlotte with a Bachelor of Science degree in Civil Engineering and is a licensed professional engineer in North Carolina. DeWitt served as Chairman of the TRB Construction Section, serves as Chairman of the TRB Project Delivery Committee, and is a member of the TRB Construction Management Committee (and Past Chairman). He served for over 13 years as a member of the AASHTO Subcommittee on Construction. He serves as Co-Chairman of the FHWA/AASHTO Expert Technical Group on Construction Management. DeWitt was a co-chair of the 2004 International Scan on Construction Management Practices.

George T. Raymond is the State Construction Engineer for the Oklahoma Department of Transportation (ODOT) and has served in that capacity for eight years. He is a 23-year veteran of ODOT and has spent his entire career in highway construction, including six years as a Resident Engineer. In 2002, he contributed to the successful reconstruction of I 40 at the Arkansas River, which was closed for 65 days after a barge knocked down a third of the bridge. Raymond received a Bachelor of Science degree in Civil Engineering from the University of Oklahoma and is a licensed professional engineer. He is a member of the AASHTO Subcommittee on Construction (SOC) for the past 10 years and is currently the Chair of the SOC's Computer & Technology Technical Section.

Richard H. Sheffield is the Assistant Chief Engineer – Operations for the Mississippi Department of Transportation, with oversight responsibilities of Contract Administration, Materials, and Research Divisions. Sheffield was appointed to the position in October 2005, right after Hurricane Katrina demolished the Mississippi Gulf Coast. In the past three years, he has been heavily involved in development of two major fast–tracked design-build bridge projects on the Gulf Coast, in addition to tracking all Local Public Agency Emergency Repair projects for compliance with federal regulations (from design through construction and project closeout). He is also involved with leading the team that is developing all the contracts and specifications for Mississippi's first public-private partnership (P3) project, to be awarded in early 2009. Sheffield spent the first 15 years of his career as a geotechnical engineer and the next nine years as a materials engineer, specializing in hot mix asphalt design and construction and soil stabilization techniques. Sheffield received a Bachelor of Science degree from Mississippi State University in 1981. He is a licensed professional engineer.

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APPENDIX D

Bibliography

Anderson, S. D., J. J. Schwartz, and D.G. Zollinger (1998). "A Process Approach to Fast-Track Urban Intersection Reconstruction," TRB 77th Annual Meeting, Transportation Research Board, National Research Council, Washington, DC, January.

Anderson, S.D., de las Casas, R. Daniels, G., "Michigan Department of Transportation: US 23 Unbonded Overlay Project," *Research Report*, Task 1, Traffic Management Studies for High Volume Roadways, Federal Highway Administration and Texas Transportation Institute, Cooperative Agreement No. DTFH61-03-H-00101, December 2003.

Anderson, S.D., R. de las Casas, and G. Daniels, "Michigan Department of Transportation: I-496 Concrete Reconstruction Project" *Research Report*, Task 1, Traffic Management Studies for High Volume Roadways, Federal Highway Administration and Texas Transportation Institute, Cooperative Agreement No. DTFH61-03-H-00101, December 2003.

Anderson, Stuart D. and Gerald L. Ullman (2000). *Reducing and Mitigating Impacts of Lane Occupancy During Construction and Maintenance*, NCHRP Synthesis 293, National Cooperative Highway Research Program Project 20-5 FY 1998 (Topic 30-12), Transportation Research, National Research Council.

This synthesis discusses prefabricated facility components as an approach that can be used to reduce lane occupancy. Prefabricated bridge components, such as beams and deck panels, are used to accelerate reconstruction of bridges and interchanges. In addition, temporary bridges are frequently used to allow for the complete closure of traffic in one direction over an existing bridge while it is being repaired or replaced.

Badie, Sameh S. and Maher K. Tadros (2008). *Full-Depth Precast Concrete Bridge Deck Panel Systems*, Report 584, National Cooperative Highway Research Program Project 12-65, Transportation Research, National Research Council.
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_584.pdf

Full-depth precast panel systems with no overlays or longitudinal posttensioning are attractive for two reasons. First, eliminating overlays helps get the bridge opened to traffic faster, especially on a deck replacement project, because cast-in-place concrete is needed only at the joints between the prefabricated panels. Rapid-set concrete mixes, which do not require skilled concrete placement and finishing workers, can be used for those joints. Second, eliminating field posttensioning shortens the construction schedule, lowers the cost of the deck, and simplifies the process of partial deck placement and replacement.

Bridging Multiple Communities, New Hampshire's I-93 Improvement Project (2006). ACTT Workshop, February; www.rebuildingi93.com/content/initiatives/actt/

NHDOT hosted the I-93 Improvements ACTT workshop in February 2006, structuring it to 1) evaluate innovative means of contracting and financing; 2) identify and expedite critical path tasks such as right-of-way (ROW) and utility relocations; 3) evaluate traffic control; 4) maintain safety; and 5) adhere to environmental commitments.

Carson, J. C. Chabannes, and S. Anderson, "City of Austin: Lamar Boulevard Utilities and Reconstruction Project," *Research Report*, Task 1, Traffic Management Studies for High Volume Roadways, Federal Highway Administration and Texas Transportation Institute, Cooperative Agreement No. DTFH61-03-H-00101, March 2005.

Chabannes, C., S. Anderson, S. Jangle, J. Hudson, and J. Carson. "Georgia Department of Transportation I-85 Pavement Reconstruction Project Case Study," *Research Report*, Task 1, Traffic Management Studies for High Volume Roadways, Federal Highway Administration and Texas Transportation Institute, Cooperative Agreement No. DTFH61-03-H-00101, March 2006.

Chabannes, C., S. Anderson, J. Carson, and J. Hudson, "California Department of Transportation I-15 Devore Pavement Rehabilitation Project Case Study," *Research Report*, Task 1, Traffic Management Studies for High Volume Roadways, Federal Highway Administration and Texas Transportation Institute, Cooperative Agreement No. DTFH61-03-H-00101, September 2005.

Cho, Aileen (2007). "Utah Embraces Accelerated Construction Method," ENR, Oct. 31; enr.construction.com/news/transportation/archives/071031a.asp

Using multi-axle, remote-controlled transporters, Utah crews removed two 1.7-million-pound main spans of an Interstate 215 overpass and replaced them with a 3-million-pound single span over a single weekend closure – a job that typically would take at least four months.

CTC & Associates LLC (2004). "Accelerated Construction Techniques," Transportation Synthesis Report Wisconsin Department of Transportation, Oct. 22; http://on.dot.wi.gov/wisdotresearch/database/tsrs/tsracceleratedconstruction.pdf

A few articles from transportation publications that describe efforts in several states.

Dunstom, P.S. and F.L. Mannering (1998). "Evaluation of Full Weekend Closure Strategy for Highway Reconstruction Projects: I-405 Tukwila to Factoria," Report WA-RD 454.1, Washington State Department of Transportation, Olympia, December.

The Washington State Department of Transportation (WSDOT) closed a single direction of I 405 over an entire weekend for constructing the overlay on a 5.5-mile section. Work was performed over two weekends. Data were collected from field measurements, records, and surveys to assess construction quality, construction costs, and user impacts.

Embracing Innovation: The I-84 Corridor Improvements Project (2007). Idaho ACTT Workshop, February; www.fhwa.dot.gov/construction/accelerated/wsid07.pdf

The focus of the I-84 Corridor Improvements Project is to minimize construction time and costs for the reconstruction

Ferragut, Ted (2003). Accelerated Highway Construction Workshop Series Summary, Transportation Research E-Circular, Number E-C059, December; http://onlinepubs.trb.org/Onlinepubs/circulars/ec059.pdf

Summarizes three workshops held in Washington, DC; Indianapolis, Indiana; and Pittsburgh, Pennsylvania, in 2000–2002. The objective of this workshop series was to provide a forum for the exchange of new ideas and developments in the field of accelerated construction.

Gambatese John Anthony, James Pocock, and Phillip Dunston (2007). *Constructability Concepts and Practice,* American Society of Civil Engineers, 149 pages: http://books.google.com/books?id=yLIOdJF_wEAC

It covers timely constructability topics such as state-of-practice, impacts, tools and resources, accelerated construction, and education and training.

Goodrum, Paul M., Yinggang Wang, Chris N. Jones, Philippe C. Fenouil, Donn E. Hancher (2005). *Innovative Rapid Construction/Reconstruction Method*s, Research Report KTC-05-14/SPR-283-04-1F, Kentucky Transportation Cabinet. www.e-archives.ky.gov/Pubs/transportation/tc_rpt/ktc_05_14_spr_283_04_1f.pdf

The report examines past projects that used innovative rapid construction methods.

Ibbs, C. W. and Hojung Lee (2007). “Productivity aspects of urban freeway rehabilitation with accelerated construction” *Journal of Construction Engineering and Management*, ASCE. 133 (10), pp. 798-806; http://repositories.cdlib.org/cgi/viewcontent.cgi?article=6913&context=postprints

The paper presents the fast-track rehabilitation approaches and the as-built production rates of major rehabilitation operations monitored at the three experimental projects in California.

Innovative Technology for Accelerated Construction of Bridge and Embankment Foundations in Europe (2003). FHWA-PL-03-014, September;
http://international.fhwa.dot.gov/bridgeemb/BridgeEmbankment.pdf

Report of June 2002 European scan (Belgium, Germany, Italy, the Netherlands, Sweden, and the United Kingdom) to identify and evaluate innovative European technologies in accelerated construction of bridge and embankment foundations.

Jackson, D., “Rapid Repair Techniques Save Time,” *Roads and Bridges,* Vol. 36, No. 10, 1998, p.14.

Virginia DOT used a very early strength (VES) latex-modified Portland cement concrete overlay for a bridge repair. The VES overlay is as durable as a conventional overlay but uses a concrete mix that is designed to cure very quickly, allowing the bridge deck to be opened to traffic only 8 hours after construction begins.

Klaiber, F. Wayne, Terry J. Wipe, and Francesco M. Russo (2004). *Cost-Effective Practices for Off-System and Local Interest Bridges* NCHRP Synthesis 327, National Cooperative Highway Research Program Project 20-5 FY 2000 (Topic 32-08), Transportation Research, National Research Council.

Numerous options for off-system bridge replacements including pre-engineered bridges are presented. Bridge design aids, design software, and numerous Web sites, which can be used to expedite the replacement engineering process, are referenced.

Lee, E. B., J. R. Roesler, J. T. Harvey, and C. W. Ibbs (2002). “Case Study of Urban Concrete Pavement Reconstruction on Interstate 10.” *Journal of Construction Engineering and Management,* ASCE, Vol. 128, No. 1, pp. 49-56.

A case study of a Caltrans concrete rehabilitation demonstration project near Los Angeles on Interstate-10, where 20 lane-kilometers was successfully rebuilt using fast-setting hydraulic cement concrete with one weekend closure for 2.8 lane-kilometers and repeated 7- and 10-hour nighttime closures for the remaining distance.

Lee, E. B. and C. W. Ibbs (2005), “Computer Simulation Model: Construction Analysis for Pavement Rehabilitation Strategies”, *Journal of Construction Engineering and Management, ASCE*, Vol. 131, No. 4, 2005, pp. 449-458.

This paper presents the simulation model, Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS), which estimates the maximum amount of highway rehabilitation/reconstruction during various closure time frames. The model balances project constraints such as scheduling interfaces, pavement materials and design, contractor logistics and resources, and traffic operations.

Lee, E. B., H Lee, and J T. Harvey (2006). “Fast-track urban freeway rehabilitation with 55-h weekend closures: I-710 long beach case study,” *Journal of Construction Engineering and Management*, ASCE. 132 (5), pp. 465-472.
http://repositories.cdlib.org/cgi/viewcontent.cgi?article=6914&context=postprints

This case study documents the accelerated rehabilitation process, assesses traffic impacts, and compares collected productivity data on a Caltrans asphalt concrete demonstration project. The project was a 4.4 kilometer stretch of Interstate-710 (I-710) in Long Beach. It was rehabilitated during eight repeated 55-hour extended weekend closures using around-the-clock construction operations and counterflow traffic.

Lee, E.B. and D. K. Thomas (2007), “State-of-Practice Technologies on Accelerated Urban Highway Rehabilitation: I-15 California Experience.” *Journal of Construction Engineering and Management*, ASCE, Vo. 133, No. 2, pp. 105-113.

A case of the fast-track approach applied to a heavily trafficked urban freeway reconstruction project in Southern California. A 4.5-kilometer stretch of I 15 was rebuilt from the gravel base up. The operations, estimated to take 10 months using traditional nighttime closures, were completed in two 9-day continuous closures with round-the-clock (about 210 hours for each direction) operations.

"NYC Commuter Bridge Replaced in Five Months" (1998). *Civil Engineering*, ASCE, Vol. 68, No. 4, April, pp. 12-13.

The New York State Thruway Authority replaced an 80 foot-long (24-meter), 120 foot-wide (37-meter), six-lane bridge in 5 months, beating its own one-year estimate. The fast-track project was necessary because more than 5,000 vehicles an hour cross the bridge during the rush-hour commute to and from New York City. The bridge had been damaged in a gasoline tanker truck explosion. The key to performing the work quickly was the prefabricated superstructure and decking.

"On the Fast Track" (2008). *Better Roads,* August, Vol. 78, No. 8, pp.56-57.

Ralls, Mary Lou and Benjamin M. Tang (2003). "Laying the groundwork for fast bridge construction: prefabricated elements and systems accelerate construction of bridges to hours or days instead of months or years," *Public Roads*, Nov.-Dec.;
http://findarticles.com/p/articles/mi_m3724/is_3_67/ai_113646109

Overview presented at the National Prefabricated Bridge Elements and Systems Conference of successful projects.

Rathbone, D. B. (2000). "Moveable Barriers for High-Traffic Work: Safety on the Highway." *Public Works Magazine*, Vol. 131, No. 2, February, pp. 28-30.

Restrepo, Jose I. *Development of Precast Bent Cap Systems for Seismic Regions,* National Cooperative Highway Research Program, Project NCHRP 12-74 [Active], Transportation Research, National Research Council. Research in Progress
http://rip.trb.org/browse/dproject.asp?n=10572

The accelerated construction benefits of precast bent cap systems support the philosophy of "get in, get out, and stay out." Successful use of precast bent caps relies on proper design, constructability, and performance of the connections.

Saag, J.B. (1999). *Project Development Methodologies for Reconstruction of Urban Freeways and Expressways,* NCHRP Synthesis of Highway Practice 273, Transportation Research Board, National Research Council, Washington, DC.

Methods for effectively managing traffic during the reconstruction process and traffic control procedures in the work zone are discussed. Public participation and public information dissemination related to traffic changes are vitally important to the effective completion of a reconstruction project. Other aspects, such as the design process, including the use of three-dimensional and four-dimensional visualization, pavement renewal procedures, environmental impact mitigation and enhancement activities that are considered in the process, are addressed.

Scheck, Tom (2007). *Other states' experiences inform debate over bridge rebuild timeline*, Minnesota Public Radio, August 15;
http://minnesota.publicradio.org/display/web/2007/08/15/transport/

A Minnesota Department of Transportation public meeting on the new I-35W bridge design and state lawmakers weighing in on the design at a joint legislative. A large part of the hearing focuses on the timeline of the rebuild.

Schexnayder, C., G. Ullman, and S. A. Anderson, "Construction Scenarios for Precast Concrete Pavement Project," *Research Report*, Task 1, Traffic Management Studies for High Volume Roadways, Research Report, Federal Highway Administration and Texas Transportation Institute, Cooperative Agreement No. DTFH61-03-H-00101, May 2006.

Secmen, S., J. Schwartz, S. Anderson, and D. Zollinger (1996). *Accelerated Construction Methodology for Concrete Pavements at Urban Intersections,* Research Report 1454-1F, FHWA-TxDOT, November 1996.

Seiler, Wayne, Thomas Gambino, Soheil Nazarian, Frank Hayes, and Quintin Watkins (2006). "Design and Acceptance Testing During Reconstruction of Terminal Apron Taxi Lanes at Hartsfield Jackson Atlanta International Airport" *Pavement Rehabilitation Techniques,* ASCE Conf. Proc., Volume 191 / Issue 40838 /

The paper describes a project that included the reconstruction of three taxi lanes within the terminal aprons at Hartsfield Jackson Atlanta International Airport. The results from laboratory testing for flexural strength, as required by the FAA, were compared to additional nondestructive seismic and maturity meter tests to determine when the gates could be opened to traffic.

Tadros, H.K. and M.C. Baishya (1998). *Rapid Replacement of Bridge Decks*, NCHRP Report 40, Transportation Research Board, National Research Council, Washington, DC.

The report evaluates existing rapid bridge deck replacement methods to develop better procedures and new superstructure designs for future rapid deck replacement. It provides a comprehensive description of the research, including the details of a continuous precast prestressed stay-in-place concrete system and girder-to-deck connections that would substantially reduce bridge deck construction and replacement time.

Tikalsky, Paul, David Tepke, and Stephen Camisa (2003). *Maturity Method Demonstration*, Final Report SPR 304-181, FHWA-OR-DF-04-01, Federal Highway Administration Washington, DC.

The concrete maturity method is a quality control/quality assurance tool that can be used to assist contractors and transportation officials in producing cost-efficient, durable concrete structures. This report documents the findings of an investigation performed for the Oregon Department of Transportation to demonstrate the use and benefits of the maturity method. The maturity method was shown to be an easily implemented QC/QA tool that can be used to estimate strength development, speed construction operations, and document contractor mistakes.

Utah Department of Transportation Accelerated Bridge Construction Standards Workshop (2008). Workshop Report, January,
www.dot.state.ut.us/main/uconowner.gf?n=1967773121506743774

Recommendations by workshop participants included using prefabricated components for the entire bridge, using complete bridge move-ins, standardizing a model for quantifying user costs, improving public relations and public involvement, and various recommendations related to developing standards.

Vecchio, Rick Del and Diana Walsh (2007). "I-80 Link to I-880 to Reopen Today," *San Francisco Chronicle*, May 7, 2007, *page A - 1*;
http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2007/05/07/MNGNEPMD7M1.DTL

The I-880 MacArthur Maze freeway connectors were damaged when a tanker full of gasoline exploded in flames. Caltrans reopen the bridge well ahead of the date officials had predicted.

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APPENDIX F

Amplifying Questions

Questionnaire for Departments of Transportation: Planned Accelerated Construction Projects

These amplifying questions establish a reference framework for activities that should be performed to capture the required information during the scan. The scan will focus on actual construction operations and management practices used to accelerate construction. This protocol seeks to ensure that all supporting project information is collected, interviews do not digress excessively, and visits to the construction sites are productive. Two separate areas of acceleration are studied in this scan. The first area is general project/program construction acceleration approaches. In this area, acceleration is a planned approach selected intentionally by the Department of Transportation (DOT). The second area of acceleration is related to emergency projects. This type of accelerated project is usually in response to an emergency situation. Two separate sets of questions are proposed, one for Department of Transportations and one for contractors.

General Program Level Issues

- At what point in the project development process is the decision made to use an accelerated construction approach?
- Why is accelerated construction implemented on projects?
- Who are involved in developing the accelerated construction approach and why (construction contractor, in-house construction, traffic management, safety and environmental, maintenance and operations, project management, design)?
- What issues and topics are addressed and analyzed during development of the accelerated construction approach (traffic management, traffic within construction zone, phasing and construction sequencing)?
- Are accelerated construction approaches successful? If so, why and if not please provide reasons why they are not successful.

Contracting Administration

Pre-Construction Questions

- What project delivery and contracting strategies were implemented to enable acceleration for the project (traditional, A+B, lane rental, design-build, other)? What other project delivery and contracting strategies were considered to accelerate the project? Why were these other delivery and contract strategies not used?
- What were the critical issues addressed during the contracting strategy selection process? How did the DOT view their relative importance (schedule, deadlines, cost, traffic, cash flow)?
- Were Incentives/Disincentives (I/D) clauses used? Why?
- What was the I/D structure?

  - Was the incentive capped?
  - How was the cap value established?
  - Was there a limit in the amount of disincentives?
  - How was the disincentive amount established?
- What were the results regarding the use of I/Ds? Did the contractor receive the incentive? If the contractor did receive an incentive; what was the percentage of the incentive amount compared to the maximum amount?
- What processes were allow in the contract for contractor suggestions (e.g., Value Engineering clauses, Alternative Technical Concepts, etc.)?
- Did the contractor provide any feedback and/or suggestions? Where these suggestions incorporated? Why or why not?
- What were the estimated savings due to the suggestions?
- Was formal Partnering included in the project?
- Who were included in the partnering program?
- What were the expected benefits from partnering in the project? Where these benefits fulfilled? Why or why not?

Planning and Scheduling

Pre-Construction Questions

- Was there an established work schedule dictated by the DOT for the project, work times, etc (continuous day work, night work, weekends)?
  - What was the process for selecting this work schedule (traffic, deadlines)? Did issues external to construction (e.g. governmental regulations, public concerns) drive the work schedule?
  - Where there innovative approaches to addressing environmental, social, or other constraints, such as temperature specifications for paving, noise limitations restricting work hours, etc?
- Did your DOT provide flexibility with the DOT's standard specifications?
- Did the DOT specify a phasing sequence for the project? If yes, was the contractor allowed to modify the plan?
- What factors affected the phasing sequence decision process (traffic restrictions, material availability, human resources, etc)?

Construction Practices – Cost, Time, Quality

The Plan: Pre-Construction Questions

- What were the primary construction methods and techniques selected for the project? Why were they selected? What other methods were contemplated and why were they discarded?
- What is the cost of the accelerated project compared to the estimated cost of a project following a normal construction process?

- What practices were followed to ensure that good quality was achieved?
- Because the project followed an accelerated construction process were innovative testing processes used?
- What other accelerated processes could have been used and why were they discarded?
- Did the traffic management plan have flexibility so that it supported the accelerated construction methods?
- What guided the selection of the pavement or bridge type (time restrictions, available area, strength, temperature, etc)? What were the results expected from the use of this pavement or bridge type?

What Did Happen: Post-Construction Questions

- How did the accelerated construction methods and techniques affect traffic passing through the work zone?
- Should the DOT have specified different accelerated construction methods and techniques (including selection or a different design) for the project? Which and why? What would have been the expected results?
- What were the main problems encountered during the accelerated construction process? What were the impacts resulting from these problems (time and cost impacts, traffic delays, affected areas)?
- What were the primary project situations (limited work zone, availability of a staging area, etc.) that facilitated the construction process? Were these situations understood before the project was bid? If they were planned, how was the information transmitted to the bidders and did the contractor use the situation as expected?
- What were the processes for corrective actions to mitigate the impacts of problems that occurred during construction?
- Could the problems have been foreseen? If so, how?
- Could the design have been changed to better support accelerated construction? If so, are there different design principles that should guide a DOTs approach to accelerated construction?

Traffic Control and Management

Pre-Construction Questions:

- At what phase in the planning process were public expectations determined and considered in the design of the traffic management plan to support the accelerated construction strategy?
- How were traffic management strategies selected to address the traveling public’s needs during the accelerated construction project?
- Were analytical techniques used to evaluate traffic management strategies for the accelerated construction project? Was a simulation model used to determine impacts on motorists of alternative traffic management strategies?
- Post-Construction Questions:
- Did the traffic management strategies selected achieve their objectives in support of accelerated construction? Any data to confirm your conclusion?
- What other traffic management strategies might have been considered to support the accelerated construction?

Questionnaire for Departments of Transportation: Emergency Construction Projects

General Issues

Pre-Letting Questions

- Who were involved in developing the emergency construction approach and why (construction contractor, in-house construction, traffic management, safety and environmental, maintenance and operations, project management, design)?
- What issues and topics were addressed and analyzed during development of the emergency construction approach (traffic management, traffic within construction zone, phasing and construction sequencing)?
- Was the emergency construction approach successful? If so, why and if not please provide examples where you were not successful.

Contracting Administration

Pre-Construction Questions

- What project delivery and contracting strategies were implemented to enable emergency construction for this project (traditional, A+B, lane rental, design-build, other)? What other project delivery and contracting strategies were considered for the emergency project? Why they were not used?
- What were the critical issues addressed during the selection process of the contracting strategy?
- Were Incentives/Disincentives (I/D) clauses used?
- What was the I/D structure?
    - Was the incentive capped?
    - How was the cap value established?
    - Was there a limit in the amount of disincentives?
    - How was the disincentive amount established?
- What were the results regarding the use of I/Ds? If the contractor did receive an incentive; what was the percentage of the incentive amount compared to the maximum amount?
- What processes were allow in the contract for contractor suggestions (e.g. Value Engineering clauses, Alternate Technical Concept, etc.)?
- Did the contractor provide any feedback and/or suggestions? Where these suggestions incorporated? Why or why not?
- What were the estimated savings due to the suggestions?

Planning and Scheduling

Pre-Construction Questions

- Was there an established work schedule dictated by the DOT for the project, work times, etc (continuous day work, night work, weekends)? What affected the selection process for selecting this work schedule (traffic, deadlines)? Where there innovative approaches to addressing environmental, social, or other constraints, such as temperature specifications for paving, noise limitations restricting work hours, etc?

- ❖ Did your agency provide flexibility with the agency's standard specifications?
- ❖ Did you specify a phasing sequence plan for the project? If yes, was the contractor allowed to modify the plan?
- ❖ What factors affected the phasing sequence decision process (traffic restrictions, material availability, human resources, etc)?

Construction Practices – Cost, Time, Quality

The Plan: Pre-Construction Questions

- ❖ What practices did you follow to ensure you achieved good quality?
- ❖ Were innovative testing processes used to support the emergency construction process?
- ❖ Did the traffic management plan have flexibility so that it supported the accelerated construction methods?
- ❖ What were the primary construction methods and techniques selected for this project? Why were they selected? What other methods were contemplated and why were they discarded?

What Did Happen: Post-Construction Questions

- ❖ How did the accelerated construction methods and techniques affect traffic passing through the work zone for the emergency project?
- ❖ Should the DOT have specified different construction methods and techniques (including selection or a different design) for the emergency project? Which and why? What would have been the expected results?
- ❖ What were the main problems encountered during the emergency construction process? What were the impacts resulting from these problems (time and cost impacts, traffic delays, affected areas)?
- ❖ What were the primary project situations (limited work zone, availability of a staging area, etc.) that facilitated the construction process? Were these situations understood before the project was bid? If they were planned, how was the information transmitted to the bidders and did the contractor use the situation as expected?
- ❖ What was the process for taking corrective actions to mitigate the impact of the problems encountered during construction?
- ❖ Could these problems have been avoided? If so, how?
- ❖ Could the design have been changed to better support accelerated construction? If so, what changes could have been made in the design?

Traffic Control and Management

Pre-Construction Questions

- ❖ How were traffic management strategies selected to address the traveling public's needs during the emergency construction project?
- ❖ Were analytical techniques used to evaluate traffic management strategies for the emergency construction project? Was a simulation model used to determine impacts on motorists of alternative traffic management strategies?

Post-Construction Questions

- Did the traffic management strategies selected achieve their objectives in support of emergency construction? Any data to confirm this?
- What other traffic management strategies might have been considered to support emergency construction?

Questionnaire for Contractors: Planned Accelerated Construction Projects

These amplifying questions establish a reference framework for activities that should be performed to capture the required information during the scan. The scan will focus on actual construction operations and management practices used to accelerate construction. This protocol seeks to ensure that all supporting project information is collected, interviews do not digress excessively. Two separate areas of acceleration are studied in this scan. The first area is general project/program construction acceleration approaches. In this area, acceleration is a planned approach selected intentionally by the Department of Transportation (DOT). The second area of acceleration is related to emergency projects. This type of accelerated project is usually in response to an emergency situation.

General Program Level Issues

- Does the contracting industry (individual companies or through organizations such as the AGC) typically provide input into the pre-construction phases for accelerated construction projects? If so, do contractors submit ideas for accelerating construction or do contractors only provide comments on DOT proposals regarding construction acceleration approaches?
- What issues and topics do contractors address and analyze when involved in the pre-construction phases of accelerated projects (e.g., traffic management, construction zone traffic, phasing and construction sequencing)?
- What are the principal back-up and emergency strategies that contractors consider for accelerated construction projects (e.g., additional key equipment, back-up concrete plant, back-up energy supply unit, back-up extra work schedules, DOT organization prepared to make decisions 24-7.)? Under what circumstances are back-up and emergency strategies typically implemented?

Contracting Strategies

- What project delivery/contracting approaches (traditional, A+B, lane rental, design-build) do contractors prefer for these types of projects. Can you provide definitive reasons for contractor preferences?
- If an incentive/disincentive (I/D) clause is used in an accelerated construction project contract, what I/D amounts are considered appropriate for motivating the contractor to accelerated construction? What should DOTs consider when setting I/D amounts?
- How do project delivery/contracting approaches impact the contractor's project schedule and plan? Resource utilization approach? Material staging design?
- Do contractors have quality problems due to the project delivery/contracting approach used to accelerate construction? Explain. Could these problems be mitigated using a different project delivery/contracting approach to accelerate construction? Which ones?
- For projects your company has experience with, would a different project delivery/contracting approach have been better suited for the project and why?

Planning and Scheduling

Pre-Construction Questions

- Considering your experiences, did the agency provide the contractor a suggested sequence of construction for the accelerated construction project? What was your assessment of the suggested sequence of construction?
- What critical constraints and restriction are contemplated when your company develops its schedule and plan for an accelerated construction project (traffic volumes, staging areas, haul routes and access areas)?
- What affected your phasing sequence decision process for planning accelerated construction (e.g., time, material handling, and allowance for work flexibility)?
- Was your accelerated construction plan based on the DOT suggested sequence of construction? If not, what were the main differences?

Post-Construction Questions

- What work schedule did you employ for the accelerated construction projects (continuous day work, night work, and weekends)? Are your schedules different from the ones proposed by the agency? If so, why and how?
- Was the DOT phasing sequence for the accelerated construction project respected? If not, why?
- What project phasing flexibility could have been allowed by the DOT to improve the construction acceleration effort? What issues would have to be addressed to prepare such an accelerated construction plan prior to the start of construction?

Construction Practices

Pre-Construction Questions

- What are the primary factors affecting the planned production rates to support accelerated construction (e.g., phasing, traffic, day-work schedule, methods, equipment, work zone, staging areas)? How are these factors influenced by DOT specifications? If so, what are the impacts on planned production rates?
- With respect to following, what type of innovations are most important to contractors for accelerating a project:
    - Material storage location
    - Material access to site (including plants for concrete and asphalt)
    - Materials placed
    - Construction methods and techniques
    - Technology approaches
    - Construction equipment to support the accelerated construction effort
    - Processes (planning, scheduling control, production rate estimation, etc)
- From your experience do the agencies specify the methods and techniques to be followed in their accelerated projects? Is the contractor allowed to participate in the decision making process regarding the selection of methods and techniques?

- To what extend does project design affect the selection of methods and techniques to support accelerated construction? Is the contractor typically allowed to propose alternate designs?
- What were the principal back-up and emergency strategies that contractors considered for accelerated construction projects (e.g., additional key equipment, back-up concrete plant, back-up energy supply unit, back-up extra work schedules)? Under what circumstances are these back-up and emergency strategies implemented on your projects?

Post-Construction Questions

- Have your accelerated construction projects been successful? Why? What were the main contributing factors to success (e.g., planning, innovative methods, equipment, contract flexibility, etc)?
- What are the types of constructibility related problems typically encountered during an accelerated construction project?
- What methods and techniques do contractors employ to gain efficiency during accelerated construction?
- What are the main problems encountered while accelerating construction? What are the impacts resulting from these problems (e.g., time and cost impacts, traffic delays, affected areas)?
- What are the corrective actions taken to mitigate the impacts of these problems?
- Could these problems have been avoided? If so, how?
- From your experience, would you as a contractor now use different methods and techniques for the accelerated construction projects? Which ones and why would a contractor use them?

Questionnaire for Contractors: Emergency Construction Projects

Contracting Strategies

- What project delivery/contracting approaches would the contractors preferred for an **emergency**-accelerated project when there is less than a week to submit a price?
- If an incentive/disincentive (I/D) clause was used for the **emergency** construction project, was the amount of the I/D appropriate to motivate the contractor to accelerated construction?
- Will the contracting approach for an **emergency**-accelerated project cause quality problems? If so can the problems be mitigated by using a different project delivery/contracting approach?

Planning and Scheduling

- Considering your experiences should the agency provide the contractor a suggested sequence of construction for a **emergency**-accelerated construction project?
- What critical constraints and restriction are contemplated when developing the schedule and plan for an **emergency**-accelerated construction project (traffic volumes, staging areas, haul routes and access areas)?
- For **emergency**-accelerated construction projects that you have executed was your plan based on the DOT suggested sequence of construction? If not, what were the main differences and would the DOT work with you to modify their plan? Do you believe this issue sequence control is important to success?
- What drives your decisions about the work schedule for an **emergency**-accelerated project (continuous day

work, night work, or weekends)? Is the limited time frame for accomplishing the work the main or only factor driving the scheduled work hours?

- What critical issues need to be addressed with the DOT prior to the start of construction?

- What critical issues with subcontractors and/or suppliers must a prime contractor address prior to the start of an **emergency**-accelerated construction project?

Construction Practices

- What are the principal back-up and **emergency** strategies that contractors consider for emergency-accelerated construction projects (e.g., additional key equipment, back-up concrete plant, back-up energy supply unit, back-up extra work schedules)? Under what circumstances are back-up and emergency strategies typically implemented?

- What were the primary factors affecting an emergency-accelerated project's production rates (e.g., phasing, traffic, day-work schedule, methods, equipment, time for testing and quality control, work zone, staging areas)?

- Do the standard DOT specifications cause problems and/or delay the work?

- For the agencies you have worked with was the contractor allowed to participate in the decision making process regarding the selection of methods and techniques?

- For the projects with which you have experience:

    - What were the main contributing factors to success (e.g., planning, innovative methods, equipment, contract flexibility, etc)?

    - What methods and techniques did you employ to gain efficiency during construction?

- What are the critical problems that hinder delivering an **emergency**-accelerated project on schedule?

    - What corrective actions can be taken to mitigate the impacts of these problems?

    - Could these problems have been avoided? If so, how?

APPENDIX G

I-10 Escambia Bay Bridge Natural Disaster Emergency Contract

Four typed pages for the Natural Disaster Emergency Contract executed on the night of 17 September, two days after Hurricane Ivan, are shown here. Following these pages are nine pages of hand-written Assumptions and Clarifications that were attached to the typed pages. The standard FDOT contract boilerplate was fixed to those critical contract components.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

375-040-61
PROCUREMENT
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NATURAL DISASTER EMERGENCY CONTRACT

This contract can only be used during a Governor's Declared Emergency and after the Executive Order and Mission Statement has been issued waiving procurement contracting requirements.

CONTRACT #: H3-140 FIN PROJ #: 41747415201

This agreement is entered into in accordance with the Executive Order # 04-206 by the Governor, dated September 10, 20 04, and amendments thereto, Re: Hurricane Ivan (Name of event) and its' aftermath.

BY THIS AGREEMENT, made and entered into this 17 day of September, 20 04, the STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION, an agency of the State of Florida, hereinafter called "Department" and ~~Gilbert Southern Corp.~~ GM Constructors, a Joint Venture of Omaha, NE duly authorized to conduct business in the State of Florida, hereinafter called "Contractor", hereby agree as follows:

1. SERVICES AND PERFORMANCE

In connection with I-10 Escambia Bay Bridge Repair Design Build Project, the Department does hereby retain the Contractor to furnish certain services, information, and items as described in Exhibit A, attached hereto and made a part hereof.

2. TERM

The Contractor shall begin work on or before September 18, 20 04, and shall complete all work required by this agreement on or before December 18, 20 04.

3. COMPENSATION *(choose one)*

☐ Cost Plus ____ %. (Maximum Limiting Amount $ ____________)

☐ Cost Plus (Fixed Fee) ____ (Maximum Limiting Amount $ ____________)

☑ Unit Prices as described in Scope of Services, Exhibit A. (Maximum Limiting Amount $ 26,481,000.00)

☐ Lump Sum in the amount of $ ____________ (Choose one method below)

☐ Entire amount upon completion
☐ Incrementally as detailed in Exhibit ____
☐ Percentage of completion.

Cost, used in the selection above, is defined as Direct Salaries without payroll burden, Direct Materials, Direct Subcontracts, and other Direct Expenses.

Invoices for fees or other compensation for services or expenses will be certified by the Contractor and shall be submitted in detail sufficient for a proper preaudit and postaudit thereof.

Invoices for travel expenses shall be submitted and paid in accordance with Section 112.061, Florida Statutes.

Records of costs incurred under terms of this agreement shall be maintained and made available upon request to the Department. The Contractor shall permit the Department to perform or have performed, an audit of the records of the Contractor and any or all subcontractors to support the compensation paid the Contractor. The audit may be performed as soon as practical after completion and acceptance of the contracted services. The Department shall have the right to deduct from any payment due to the Contractor an amount sufficient to satisfy any amount due and owing the Department by the Contractor under this agreement. Final payment to the Contractor shall be adjusted for audit results. If after completion of the project it is determined that the Department is due a refund of amounts previously paid the Contractor, the Contractor will refund said amount to the Department within 30 days of notification.

4. COMPLIANCE WITH LAWS

The Contractor shall allow public access to all documents, papers, letters, or other material subject to the provisions of Chapter 119, Florida Statutes, and made or received by the Contractor in conjunction with this agreement. Failure by the Contractor to grant such public access shall be grounds for immediate unilateral cancellation of this agreement by the Department.

5. TERMINATION AND DEFAULT

This agreement may be canceled by the Department in whole or in part at any time the interest of the Department requires such termination.

If this agreement is terminated before performance is completed, the Contractor shall be paid only for that work satisfactorily performed for which costs can be substantiated.

6. ASSIGNMENT AND SUBCONTRACTORS

The Contractor shall not sublet, assign, or transfer any work under this agreement without the prior consent of the Department.

7. INDEMNITY

The Contractor shall indemnify and hold harmless the Department, its officers and employees from liabilities, damages, losses, and costs, including, but not limited to, reasonable attorney's fees, to the extent caused by negligence, recklessness, or intentional wrongful misconduct of the Contractor and persons employed or utilized by the Contractor in performance of this agreement.

It is specifically agreed between the parties executing this agreement that it is not intended by any of the provisions of any part of the agreement to create in the public or any member thereof, a third party beneficiary hereunder, or to authorize anyone not a party to this agreement to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of this agreement.

8. ANTI-COLLUSION

The Contractor represents to the Department that no person or persons, firm, or corporation, other than the Contractor, has an interest in this agreement as a principal, and that this agreement is entered into by the Contractor without collusion with any person, firm, or corporation.

9. FUNDING REQUIREMENTS (check if applicable and attach form FHWA-1273 "Required Contract Provisions, Federal-Aid Construction Contracts".) The most recent version of the form can be obtained at http://www.fhwa.dot.gov////programadmin/contracts/1273.htm

☐ The services provided under this agreement involve funding from the Federal Highway Administration (FHWA), and the provisions indicated on form FHWA-1273 (attached) apply.

10 MISCELLANEOUS

Invoices are to be mailed to: Eric Benson - Milton Operations Center - Ph: (850)981-3000

at this address: 6025 Old Bagdad Highway
Milton, FL 32583

375-040-61
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This agreement embodies the whole agreement of the parties.

Attachments: Exhibit A (Scope) Exhibit B (Lobbying Prohibition)

Added Attachments: Echibit "C" Details of Fees Standard Specifications for Design Build Projects - Div. I

Supplemental Specifications – Contractor Clarifications Revised as per DOT Response to Contractor Clarifications (Audio Tape)

incorporated and made a part hereof.

CONTRACTOR

BY:

(Name)

SCOTT L CASSELS F. KEITH JACOBSE

(Title)

STATE OF FLORIDA
FLORIDA DEPARTMENT OF TRANSPORTATION

BY:

(Name)

Director of Transportation Operations

(Title)

Contractor Address:

~~Gilbert Southern Corp.~~ GM CONSTRUCTORS, A JOINT VENTURE

3555 Farnam Street

Omaha, NE 68131

Telephone Number:

(402) 342-2052

Fax #

FEID # ~~[illegible]~~ 20-1646900

EXHIBIT B

LOBBYING PROHIBITION

The undersigned certifies, to the best of his or her knowledge and belief, that:

(a) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence either directly or indirectly an officer or employee of any state or federal agency, a member of the Florida Legislature, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-L. "Disclosure Form to Report Lobbying", in accordance with its instructions.

(c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representative of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any persons who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

BY: ______________________
Signature (Contractor)

SCOTT L CASSELS F. Keith Hudson
Typed or Printed Name and Title

Hand-Written Assumptions and Clarifications

SCOTT CASSELS
GILBERT SOUTHERN

KEITH JACOBSON
MASSMAN CONSTRUCTION

9/17/04 ASSUMPTIONS + CLARIFICATIONS

To Gilbert Southern Corp and Massman Construction's Proposal of Sept 17, 2004

(A) x (deleted)

(B) No special quality and inspection services are included; all inspection services are provided by others.

(C) No anchoring system is provided in resetting or realigning

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any slab.

(D) As explained our system assumes long'l sawcutting + handling all Phase I slabs in thirds

(E) We have assumed there is sufficient water in all areas necessary to be accessed by water

(F) No environmental restrictions are included.

(G) We have assumed we can moor mat'l barges to the existing fender system

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(H) No exterior barrier replacement is included

(I) We have assumed we can drill holes thru the deck for rigging purposes and that the span can be hoisted from places other than just the ends.

(J) No repairs to any span is included (spalls, chips, cracks, barrier, etc)

(K) See Revised (K)
~~As discussed we are not removing any wreckage in Phase I or II. All scour related issues are the responsibility of the owner.~~

(L) Any and all acrow bridge materials are assumed to be delivered by the owner. ~~Acrow design/site services are to be provided by the owner.~~ C ~~[illegible]~~

(M) All extra work is considered to be off the critical path and not impactive to schedule.

(N) No electrical work or any utility or any communication systems are included.

~~(O) Our price is based on the bid form quantities times the unit price as provided by the owner and~~ FC

(O) Our price is the result of using

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owner bid quantities, as provided in the last Sept 17 bidsheet, times the unit prices we developed Friday afternoon, Sept 17, after a series of meetings with the owner.

(P) We expect and clearly understand that the owner will expedite all approvals (4 hours max), and work with the contractor in a fair + equitable manner due to the accelerated nature of the estimating, pricing and scope of this work.

(Q) We have approximated the approach work based on a visual examination of the site conditions as of Sept 17. Further

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deterioration of shoreline or roadway is not our responsibility. No extraordinary erosion control measures have been included.

(R) We understand that Phase I is to be completed (as in "open the bridge to traffic") in 24 days; liquidated damages of $250,000/day will apply after that. Incentive bonus for opening the bridge to traffic also equals $250,000/day up to a max. of 14 days

(S) ~~We understand that the 24 day schedule is developed by the owner on the basis of his quantities~~

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presented to us on Sept 17 late in the afternoon. Significant variation in quantities which increase the time of performance will extend the incentive/disincentive completion date for the purposes of calculating the incentive payment.

Revised (K)

Gilbert/Masman will remove submerged deck slabs from the river bottom and transport slabs to shore for ~~to~~ demolition and disposal for the unit price of $ [redacted] 51,000 per slab. This price assumes that each slab is reasonably accessable for divers to attach rigging and that the slab can be readily raised and transfered to a material barge. This price does not include any excavation, jetting, air lifting, rebar cutting, underwater demolition, or other method to ~~loos~~ uncover, loosen or assist in slab removal. ~~These items~~

All of these extra means, and methods and equipment ~~which might be~~ necessary to ~~facilitate~~ facilitate the slab removal will be performed ~~at at~~ on a force account basis. including time, delays if ~~the slab removal~~ applicable. ~~unit price~~

Gilbert/Massman will remove and dispose of damaged pile bents for the unit price of 25,000.00 per bent. Removals will be ~~from Riser bott~~ down to river bottom.

It is understood and agreed that submerged slabs under Phase I Construction will remain in place as is.

Lump Sum Price Broken into Cost Categories for Phase I

Request for Proposal
<Project Name>

ATTACHMENT "A"

DESIGN-BUILD BID BLANK

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

BID PRICE PROPOSAL

The DESIGN BUILD FIRM is required to break the total firm lump sum price down into the categories shown below and submit in a sealed envelope to Carolyn Watson, Professional Services Administrator, 1074 Hwy. 90, Chipley, Florida, 32428.

Phase I

Item Description	Units	Unit Price	Total
I. Design Services	LS	588,000.00	588,000.00
II. Bridge Construction			
1. Construction Mobilization	LS	2,000,000.00	2,000,000.00
2. Beam Slab Relocation (Eastbound to Westbound)	12 EA	55,000.00	660,000.00
3. Beam Slab Realignment	20 EA	54,000.00	1,080,000.00
4. Substructure – Replace Bent	1 EA	615,000.00	615,000.00
5. Substructure – Major Repair for structural integrity	6 EA	325,000.00	1,950,000.00
6. Removal and Disposal	LS	SEE BELOW IN	PHASE II
III. Roadway Construction	LS	1,100,000.00	1,100,000.00
PHASE I PRICE		7,993,000.00	

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PHASE II

Item Description	Units	Unit Price	Total
I. Design Services	LS	300,000.00	300,000.00
II. Bridge Construction			
1. Beam Slab Relocation (Eastbound)	29 EA	50,000.00	1,450,000.00
2. Beam Slab Realignment	56 EA	20,000.00	1,120,000.00
3. Substructure – Replace Bent	8 EA	615,000.00	4,920,000.00
4. Substructure – Major Repair for structural integrity	10 EA	325,000.00	3,250,000.00
5. Acrow Bridge Span Placement	7080 FT	600.00	4,248,000.00
6. Removal and Disposal	LS	SEE BELOW	
III. Roadway Construction	LS	200,000.00	200,000.00
PHASE II PRICE			15,488,000.00
TOTAL LUMP SUM PRICE			23,481,000.00

SEE ATTACHED ASSUMPTIONS AND CLARIFICATIONS DATED 9/17/04

Phase I shall be completed by 10/11/2004. Incentive-Disincentive $250,000/day for 14 days maximum
Phase II shall be completed by 12/16/2004

DESIGN BUILD FIRM

SIGNATURE:
PRINTED NAME: [illegible] F. Keith Jacobsen
TITLE: [illegible] [illegible]

ALLOWANCE FOR REMOVAL AND DISPOSAL OF WRECKAGE
FOR ITEMS PHASE I II.6 AND PHASE II II.6
$3,000,000.00 NOT INCLUDED IN

PHASE I PRICE
PHASE II PRICE
OR
TOTAL LUMP SUM PRICE