ADVANCING ACCELERATED BRIDGE CONSTRUCTION

Presented at

General Session
AASHTO HSCOBS Meeting

by

Benjamin Tang, FHWA Co-Chair
Mary Lou Ralls, AASHTO Co-Chair
Prefabricated Bridge Elements and Systems Scan Team

June 29, 2005
FOCUS AREAS - REVISIT

✓ Minimized traffic disruption (Congestion)
✓ Improved work zone safety
✓ Minimized environmental impacts
✓ Improved constructibility
✓ Improved product quality
✓ Lower life-cycle costs
FHWA VITAL FEW

- Congestion
- Safety
- Environmental impact
CATEGORIES OF TEAM’S
10 RECOMMENDATIONS

- Movement Systems
- Superstructure Systems
- Deck Systems
- Substructure Systems
OPPORTUNITIES AHEAD

Proposed Programs in Reauthorization

• Innovative Bridge Research and Deployment (IBRD)
• Highways for Life
• Federal Bridge Program ($4 B/Yr.)
Life After Scan - Next Steps

- Disseminate Report (Hot off the press!)
- Implementation Plan (STIP) – Advancing Team’s Recommendations
- Ongoing Technology Transfer Activities
- Compiling Connection Details
- Developing Decision-Making Framework
State Bridge Engineers’ Survey
Prefabricated Bridges to Accelerate Construction
Survey to Sample State Bridge Engineers

Questions:
- Barriers to routinely install PBES in hours or days?
- What would help most to use PBES?

<table>
<thead>
<tr>
<th>Summary: Barriers</th>
<th>Summary: Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lack of education / training / experience (13)</td>
<td>• Education / training / more projects (7)</td>
</tr>
<tr>
<td>• Lack of standards &amp; specifications (13)</td>
<td>• Design &amp; construction standards &amp; specifications (6)</td>
</tr>
<tr>
<td>• Concerns about durability or details (12)</td>
<td>• Additional research/development to address concerns about durability or details (5)</td>
</tr>
<tr>
<td>• Higher cost &amp; limited resources (9)</td>
<td>• Competitive cost &amp; additional funding (6)</td>
</tr>
<tr>
<td>• Lack of perceived need for speed (8)</td>
<td>• Appropriate projects that require speed (4)</td>
</tr>
<tr>
<td>• Construction industry not geared up for prefab (7)</td>
<td>• Fabrication &amp; construction equipment &amp; methods (5)</td>
</tr>
</tbody>
</table>
Prefabricated Bridges to Accelerate Construction
Survey to Sample State Bridge Engineers

Question:
- Barriers to routinely install PBES in hours or days?

Example Responses (lack of education / training / experience):
- Education of DOT and contractors. Training.
- Contractors are reluctant to bid on technologies, methods, or equipment with which they are unfamiliar.
- Engineers do not feel they are knowledgeable on designing projects for rapid construction.
- Exposure to / experience with large prefab systems.
Prefabricated Bridges to Accelerate Construction
Survey to Sample State Bridge Engineers

Question:
- What would help most to use PBES?

Example Responses (education / training / more projects):
- Training for contractors and owner inspectors (shop and field site).
- Projects in the U.S. that demonstrate rapid bridge installation would provide examples and increase interest by State DOTs.
- More knowledge gained through experience.
- Education for design engineers and contractors.
- Information on how and why.
Prefabricated Bridges to Accelerate Construction Survey to Sample State Bridge Engineers

**Question:** Barriers to routinely install PBES in hours or days?

<table>
<thead>
<tr>
<th>Summary: Barriers</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of education / training / experience</td>
<td>13</td>
</tr>
<tr>
<td>Lack of standards &amp; specifications</td>
<td>13</td>
</tr>
<tr>
<td>Concerns about durability or details</td>
<td>12</td>
</tr>
<tr>
<td>Higher cost &amp; limited resources</td>
<td>9</td>
</tr>
<tr>
<td>Lack of perceived need for speed</td>
<td>8</td>
</tr>
<tr>
<td>Construction industry not geared up for prefab</td>
<td>7</td>
</tr>
</tbody>
</table>
Prefabricated Bridges to Accelerate Construction Survey to Sample State Bridge Engineers

**Question:** What would help most to use PBES?

<table>
<thead>
<tr>
<th>Summary: Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education / training / more projects (7)</td>
</tr>
<tr>
<td>Design &amp; construction standards &amp; specifications (6)</td>
</tr>
<tr>
<td>Additional research/development to address concerns about durability or details (5)</td>
</tr>
<tr>
<td>Competitive cost &amp; additional funding (6)</td>
</tr>
<tr>
<td>Appropriate projects that require speed (4)</td>
</tr>
<tr>
<td>Fabrication &amp; construction equipment &amp; methods (5)</td>
</tr>
</tbody>
</table>
Current Activities to Address the Needs

➢ Education / Training through 2005
  ➢ July 17-20 – TRB 6th Intern’l. Bridge Engineering Conference, Boston, MA
  ➢ Sept. 8 – MnDOT/FHWA Precast Slab System Workshop, Vadnais Heights
  ➢ Sept. 12-13 – New York City Bridge Conference
  ➢ Sept. 26-28 – Western Bridge Engineers Conference, Portland, OR
  ➢ Oct. 16-19 – 2005 PCI National Bridge Conference, Palm Springs, CA
  ➢ Nov. 29-Dec. 2 – 2005 World Steel Bridge Symposium, Orlando, FL
  ➢ Dec. 14-16 – FHWA Accelerated Bridge Construction Conf., San Diego, CA

➢ Projects / Details, Standards, and Specifications
  ➢ Online resources on prefabricated bridges
    http://www.fhwa.dot.gov/bridge/prefab
    ➢ Projects – details, contacts, standards, specifications
    ➢ Research
    ➢ Publications

➢ Technical Advancements, e.g., on durability issues
  ➢ NCHRP and other research projects on connections and other details
  ➢ Available innovative construction equipment
Badhoevedorp, Netherlands

April 2004
Prefabriicated Bridges
International Scan

Superstructure Roll-In:
390-ft Length,
3300 M Tons,
2 Hours to Move,
1 Weekend Road Closure
Wells Street Bridge
Chicago – 2002

Third Avenue Bridge
New York – 2004
Framework for Effective Decision-Making
Prefabricated Bridges to Accelerate Construction
Survey to Sample State Bridge Engineers

Questions:
- Barriers to routinely install PBES in hours or days?
- What would help most to use PBES?

<table>
<thead>
<tr>
<th>Summary: Barriers</th>
<th>Summary: Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of education / training / experience (13)</td>
<td>Education / training / more projects (7)</td>
</tr>
<tr>
<td>Lack of standards &amp; specifications (13)</td>
<td>Design &amp; construction standards &amp; specifications (6)</td>
</tr>
<tr>
<td>Concerns about durability or details (12)</td>
<td>Additional research/development to address concerns about durability or details (5)</td>
</tr>
<tr>
<td>Higher cost &amp; limited resources (9)</td>
<td>Competitive cost &amp; additional funding (6)</td>
</tr>
<tr>
<td>Lack of perceived need for speed (8)</td>
<td>Appropriate projects that require speed (4)</td>
</tr>
<tr>
<td>Construction industry not geared up for prefab (7)</td>
<td>Fabrication &amp; construction equipment &amp; methods (5)</td>
</tr>
</tbody>
</table>
Framework for Prefabricated Bridge Elements and Systems (PBES) Decision-Making Framework

FHWA Team

- Benjamin Tang
- Vasant Mistry
- Gary Jakovich
- Helene Bowman
- Eric Gabler
- Byron Lord
Framework for PBES
Decision-Making – Format

- Introduction
- Flowchart
  - Decision-Making at a Glance
- Matrix
  - Decision-Making Questions
- Decision-Making Considerations
  - Questions with Discussion and References
PBES are better

- Due to improved quality control off-site and off-the-critical-path fabrication

PBES are faster

PBES are safer

PBES have lower initial costs

- Due to significantly reduced traffic control, risks, environmental impacts, user delay costs
Framework for PBES Decision-Making – Specific Project Considerations

✓ Better
✓ Faster
✓ Safer

? Lower initial costs for this specific project?

? Long lasting for this specific project, i.e., effective connection details?
Framework for PBES Decision-Making

Users

- Decision makers for bridge type
- Implementers
  - Designers
  - Project Managers
IMPACTS
Traffic / Commerce / Safety / Costs / Emergency / Constructibility

Diagram:
- Multiple Identical Spans?
- Emergency Replacement?
- Back-Ups Expected during Construction, or Excessive Detours?
- Over Railroad or Navigation Channel, or Evacuation Route?
- High ADT and/or ADTT?
Start here

- Multiple Identical Spans?
  - Yes
  - No

- Emergency Replacement?
  - Yes
  - No

- Back-Ups Expected during Construction, or Excessive Detours?
  - Yes
  - No

- Over Railroad or Navigation Channel, or Evacuation Route?
  - Yes
  - No

- High ADT and/or ADIT?
  - Yes
  - No

Compare Construction Costs between Conventional Bridge and Prefabricated Bridge

Construction Costs Less for Prefabrication, or Above Constraints Control?

Yes

No
PBES CONSTRUCTION COSTS LESS, or ABOVE CONSTRAINTS CONTROL ???

Compare Construction Costs between Conventional Bridge and Prefabricated Bridge

Construction Costs Less for Prefabrication, or Above Constraints Control ?

Yes

No
ENVIRONMENTAL or OTHER SITE CONSTRAINTS CONTROL

Consider Conventional Construction

- Do Environmental or Other Site Constraints Justify Prefabrication?
  - Yes: Consider Prefabrication
  - No: Return to Consider Conventional Construction
Start here

- Multiple Identical Spans?
  - Yes: Consider Conventional Construction
  - No: Emergency Replacement?
    - Yes: Back-Ups Expected during Construction, or Excessive Detours?
      - Yes: Over Railroad or Navigation Channel, or Evacuation Route?
        - Yes: High ADT and/or ADTT?
          - Yes: Consider Prefabrication
          - No: Consider Conventional Construction
        - No: Consider Prefabrication
      - No: Construction Costs Less for Prefabrication, or Above Constraints Control?
        - Yes: Consider Prefabrication
        - No: Consider Prefabrication
    - No: Consider Prefabrication

- Consider Construction Costs between Conventional Bridge and Prefabricated Bridge

- Consider Prefabrication
<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>Maybe</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the bridge have high average daily traffic (ADT) and/or average daily truck traffic (ADTT), or is it over an existing high-traffic-volume highway?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the bridge over a railroad or navigable waterway, or is it on an emergency evacuation route?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Will traffic be subject to back-ups when using the bridge during construction, or be subject to excessive detours during construction of the bridge?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Must traffic flow be maintained on the bridge during construction?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can the bridge be closed during off-peak traffic periods, e.g., nights and weekends?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the bridge have multiple identical spans?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can the bridge be grouped with other bridges for economy of scale?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Will roadway construction activities away from the bridge be completed quickly enough to make rapid installation of a prefabricated bridge a cost-effective solution?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can adequate time be allocated from project award to site installation to allow for prefabrication of components to occur concurrently with site preparation?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do worker safety concerns at the site limit conventional methods, e.g., adjacent power lines?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the site in an environmentally sensitive area requiring minimum disruption (e.g., wetlands, air quality, noise)?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the bridge location subject to construction time restrictions due to adverse impact on local businesses?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there natural or endangered species at the bridge site that necessitate short construction time windows or suspension of work for a significant time period, e.g., fish passage or peregrine falcon nesting?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If the bridge is on or eligible for the National Register of Historic Places; is prefabrication feasible for replacement/rehabilitation per the Memorandum of Agreement?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Totals:
### Questions to Determine Whether a Prefabricated Bridge Should Be Considered for This Project

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>Maybe</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>High traffic volume?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over railroad or navigable waterway, or evacuation route?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmentally sensitive (wetlands, air quality, noise)?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adverse impact on commerce?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Decision-Making Matrix

✓ One or two factors may warrant use of PBES

✓ Alternatively, user may assign weights to factors

✓ In any case, a majority of “Yes” responses indicates PBES offers advantages

⇒ A more detailed evaluation
Considerations in Selecting a Prefabricated Bridge as the Construction Method of Choice

Costs related to the Maintenance of Traffic

Traffic management and user delay-related costs associated with bridge construction activities will significantly influence the selection of the most cost-effective bridge technology. Close cooperation with the agency’s traffic analysis experts is critical to development of the traffic information described below.

- What are the agency costs per day for implementing the traffic control plan, e.g., costs for traffic control devices, flagging, maintenance of devices, lighting, temporary roadways, and maintenance of detours?

    Agencies implement traffic control plans for safety and to lessen the disruptive impacts of bridge replacement on highway users; these costs can significantly add to the cost of the replacement. Because prefabricated bridges can be installed in hours or days compared to weeks or months for conventional bridges, the prefabricated bridge can greatly reduce these traffic control costs.

    Guidance on cost estimating of traffic control plans is available from some States, such as California ("Traffic Management Plan Effectiveness Study," California Department of Transportation Traffic Operations Division, 1993). For conventionally built bridges, such costs can range from 5% to more than 30% of construction costs, although they are typically less than 10%. Values above 10% appear to occur in the case of smaller projects, where the set-up costs of the traffic control plans may be high relative to the overall project costs. Cost savings from the reduced duration of the traffic control plan can be estimated based on the reduced number of days of traffic control cost times the average daily cost of such measures for comparable bridge projects.

- What are the delay-related user costs per day?

    The quicker installation of prefabricated bridges will also reduce the costs to highway users associated with traffic queues and detours during the bridge installation. Users incur costs during installation due to increased vehicle miles traveled (using detours) and increased vehicle hours of delay (caused by queues that form in front of work zones or in over-capacity detours).

    The FHWA’s QuickZone 2.0 (see http://www.fhwa.dot.gov/tri/trad/tsys/quickzon.htm) or various traffic simulation models (see next paragraph on FHWA’s Traffic Analysis Toolbox) can be used to measure the degree to which expediting the construction will lower vehicle miles and hours of travel. Published monetary values (see U.S. DOT’s “Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis” (February 11, 2003) http://ostpxweb.dot.gov/policy/DTO/TravTime/TravTime.pdf) can then be attached to these performance units to estimate the savings to the highway user. (QuickZone will automatically assign values to delay.)

    Numerous other traffic analysis products are available to capture the effects of work zones and bridge closures on traveler delay costs. In July
Considerations in Selecting PBES

✓ Category, e.g., Costs-MOT
  ✓ Introductory Comments
    ✓ Question
      ✓ Discussion
    ✓ Question
      ✓ Discussion
    ✓ Question
      ✓ Discussion
Considerations in Selecting PBES – Categories

✓ Costs related to the Maintenance of Traffic

✓ Costs related to the Contractor’s Operations

✓ Costs related to the Owner Agency’s Operations

✓ Costs related to Service Life
Considerations in Selecting PBES – Categories, cont’d.

- Environmental Issues
- Availability of Prefabrication
- Site Conditions
- Design Considerations
- Available Online Resources
Considerations:

**Costs related to Maintenance of Traffic (MOT)**

- Traffic management and user delay-related costs will significantly influence selection of most cost-effective bridge technology.

- Close cooperation with agency’s traffic analysis experts is critical to development of traffic information described below.
Considerations:

Costs related to MOT, cont’d.

✓ Daily agency costs for traffic control plan (e.g., devices and their maintenance, flagging, lighting, detours and their maintenance)?

➤ Costs typically less than 10% of construction cost with range from 5% to more than 30%; greater than 10% for smaller projects with high set-up costs relative to overall project costs
### Available Resources

<table>
<thead>
<tr>
<th>Description</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Information:</td>
<td><a href="http://www.fhwa.dot.gov/bridge/prefab/">http://www.fhwa.dot.gov/bridge/prefab/</a></td>
</tr>
<tr>
<td>Projects constructed to date:</td>
<td><a href="http://www.fhwa.dot.gov/bridge/prefab/projects.htm">http://www.fhwa.dot.gov/bridge/prefab/projects.htm</a></td>
</tr>
<tr>
<td>Research:</td>
<td><a href="http://www.fhwa.dot.gov/bridge/prefab/research.htm">http://www.fhwa.dot.gov/bridge/prefab/research.htm</a></td>
</tr>
<tr>
<td>Calendar of upcoming events:</td>
<td><a href="http://www.fhwa.dot.gov/bridge/prefab/calendar.htm">http://www.fhwa.dot.gov/bridge/prefab/calendar.htm</a></td>
</tr>
</tbody>
</table>
Review and Feedback from State Bridge Engineers and Others

- Mal will email framework next week:
- Is it helpful?
- How can it be more effective for you?
  - Content?
  - Format?
- Return comments to MLR by end of July
You’ve heard it said …

“IF YOU WANT IT FAST
IT WON’T BE GOOD
IT WON’T BE CHEAP
IF YOU WANT IT GOOD
IT WON’T BE CHEAP
IT WON’T BE FAST
IF YOU WANT IT CHEAP
IT WON’T BE FAST
IT WON’T BE GOOD

PICK ONE”
However, for bridges ...

*If you want it fast*
- It won't be good
- It won't be cheap

*If you want it good*
- It won't be cheap
- It won't be fast

*If you want it lower cost*
- It won't be fast
- It won't be good

**Pick Prefabrication**

Subject to evaluation using Decision-Making Framework
THE FUTURE IS HERE!

- MnDOT/FHWA Precast Slab System Workshop, Vadnais Heights, MN – September 8, 2005
  www.dot.state.mn.us/bridge

- 2005 FHWA Prefab Workshop, San Diego, CA – December 14-16, 2005
  www.acceleratedbridge.com

- Prefabricated Bridges Resource Websites
  http://www.fhwa.dot.gov/bridge/prefab
  http://www.international.fhwa.dot.gov