Progress Report

Constructability in the Bridge

Design Process

HR - 320

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by

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Information concerning standard design practices and details for the Iowa Department of Transportation (IDOT) was provided to the research team. This was reviewed in detail so that the researchers would be familiar with the terminology and standard construction details. A comprehensive literature review was completed to gather information concerning constructability concepts applicable to bridges. It was determined that most of the literature deals with constructability as a general topic with only a limited amount of literature with specific concepts for bridge design and construction. Literature was also examined concerning the development of appropriate microcomputer databases. These activities represent completion of Task 1 as identified in the study.

A survey was developed and mailed to 36 contractors and designers to collect preliminary information on constructability considerations for IDOT bridge projects. This survey yielded several interesting ideas related to making construction operations more efficient. These included suggestions relating to reinforcement details, forming details, application of standard specifications, construction sequencing, and acceptable materials and methods of construction. It represented a starting point for developing a more focused inquiry through personal interviews. A copy of the survey used is attached. This represents completion of Task 2 as identified in the study.

Personal interviews were conducted with a limited number of contractors and IDOT personnel. These interviews provided several new concepts which could be useful in the eventual database. Interviews will continue during the coming months with visits to projects under construction. The upcoming interviews will collect data closer to the actual workface.

The researchers have begun investigating potential microcomputer database systems for their features which would be applicable to the concept envisioned. The systems being explored include conventional databases and hypertext applications.

The team will be making numerous visits to bridge projects during the next month to gather more constructability data. Effort will also be devoted to evaluating software options for the initial database development. These two activities will proceed concurrently followed by testing with IDOT personnel.

Constructability Survey Questions

Name: _____ Date: _____

Firm: _____ Position: _____

As you complete the questionnaire, please refer to Figure 1, Survey Configuration. Address each question on how it applies to individual bridge components as well as overall considerations. Please make any comments or suggestions that you may have.

Many of the following questions include one or more examples. At the end of each example, a code is given within parentheses. This code refers to Figure 1. For example, you may notice (B2c) designating: Superstructure - Deck - Steel Grid, Concrete Filled.

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1. How can design details be configured to enable efficient construction? **Example:**

   Rebar spaced in the top mat of steel in a pier cap needs to allow for the proper placement and vibration of concrete. Increase bar size to decrease the total number of bars required or install an additional row of rebar "stacked" vertically thus increasing the total free space between bars. (A8)

2. What can be done in design to address simplicity, flexibility, sequencing, or substitutions? **Examples:**

   On dual or side-by-side bridges, the design should permit sufficient free space (eight inches) between structures allowing the barrier rail to be slipformed. (Currently, a two inch space is detailed.) (B4a and B4c)

   Another suggestion is to build one bridge versus two and construct a single, center median barrier. (C)

3. How is construction productivity improved when design elements are standardized? What details or components could be standardized thus enhancing construction activities? **Examples:**

   Presently, "crash wall" construction utilizes a transition from a round column shape to a flat wall structure. In each individual situation, a different size column, wall, and transition is detailed. Standardizing this shape and detail would facilitate the purchase of reusable formwork. (A7a)

   Concrete column dimensions should be detailed the same from pier-to-pier within a project and for all columns within a pier. This facilitates the use of typical column formwork. (A7a and A7b)

4. Which types of design details require more time and human resources to install? **Examples:**

   Unique connections that minimize structural steel materials should be avoided. Standardize connections (bolt sizes) to facilitate construction. (C)

   Detail welded shop and field bolted connections to increase construction efficiency. (C)

   Secondary structural connections should be specified as welded or bolted at the option of constructor/fabricator. (C and D)

5. What can be done with project specifications to promote construction efficiency? **Examples:**

   Coordinate specification requirements and drawing details. Items should be addressed in only one location in the specifications. (C and D)

   If component installation is to be in accordance with a code, specify particulars of that code which apply. (C and D)

6. When can the use of module/preassembly concepts facilitate fabrication, transportation, and installation of components during construction? **Example:**

   Utilizing precast concrete deck panels as stay-in-place forms for the construction of precast concrete beam bridges saves construction time and improves project safety. (B2b)

7. How can access of personnel, material, and equipment be improved through design? **Example:**

   Provide the contractor with a set of standards illustrating spacing, transitions, shoulders, dividers, and locations of traffic flow and control requirements. The contractor can use these standards to develop a traffic control plan that merges project construction requirements with safety and public user needs. (E and F)

8. What should be considered to provide sufficient construction access and staging areas? **Example:**

   The design of the beams/girders and deck systems should consider how they may be used to facilitate scaffolding during construction. (B1 and B2)

9. What process is necessary in development of the contract plans and specifications to insure completeness? **Example:**

   Construction joints on the contract plans should be clearly labeled as mandatory when required. If not thus marked, the construction joint is at the contractor's option. (C and D)

10. What elements used during construction inspection would facilitate field construction operations? **Examples:**

Soil and/or concrete tests are performed at specified intervals during construction activities. Do testing requirements expedite construction. (D)

The administrative process used for permanent material submittals should be clearly and concisely stated in the project specifications. This should include the individual responsible for review, his/her location, review time required, and documents needed for adequate review. (D)

11. What specific material requirements or specifications could be improved? **Examples:**

Vertical concrete surfaces require a designated time period before form removal. Due to advancements in concrete materials, this time period should be shortened. (D)

Shop versus field painted coatings should be addressed to minimize field work. (C and D)

Engineered coating systems should specify time requirements between coats in view of variable weather conditions. (C and D)

12. The integration of permanent components and embedments could be simplified in what ways? **Example:**

The installation of beam bearing pads and anchor bolts may be simplified by first "blocking out" the anchor bolt holes. After pier cap and beam seat concrete placement, set bearing pad with anchor bolts into blockouts at the required grade. Place high-strength grout around bolts and between the top of beam seat and the bottom of bearing pad. This technique insures that the anchor bolts are installed in the proper location and at the correct grade. (A9)

13. How do fabrication specifications and requirements affect construction activities? **Example:**

Careful attention should be given to fabrication and erection tolerances where tolerance should be permitted in one direction only. Expansion joint blockouts and tolerance may need to be adjusted due to weather conditions at time of installation. (B6, C, and D)

14. How can substructure considerations be improved to promote construction efficiency? **Example:**

Steel pile bent foundations encased in concrete with a mat of rebar on each face are designed with an overall concrete thickness of 18". The proper placement of concrete is difficult within this criteria. Increase the thickness to 24" to facilitate concrete placement. (A7)

15. What needs to be considered in the design of permanent reinforced concrete components to facilitate more efficient forming operations? **Examples:**

Combine blockouts where possible. Mechanical blockouts including piping, telephone, and electrical should be merged in one large blockout. Forming operations will be simplified. (C)

16. How can project safety be enhanced in the design process?
Example:

During staged bridge construction on the middle lanes, provide adequate project space for deceleration and acceleration distance into and out of the work area. Without ample space, access is difficult. The traveling public is endangered with construction traffic making quick stops into the work site and rapid starts out of the work site. (E)

17. What other ideas do you have, improvements that "only if 'they' would have thought of this during design," could improve construction performance?

Any questions?: Please write to the address below or call (515) 294-2045.

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