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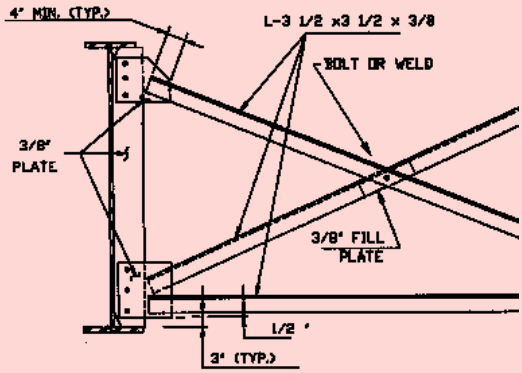

Design Aids For Efficient Short Span Steel Bridges

By Camille Rubeiz, P.E and Dan Snyder

According to a November 1999 survey published by Better Roads, 171,272 of the nation's 589,815 bridges are substandard. Most of the structures are short span bridges and fall within the 20' to 120' span range. While bridge engineers are always concerned with finding the most cost-effective bridge solutions, the time and funding available for comparing alternatives often is limited, particularly for short span bridges.

To address the needs of bridge owners and designers, the American Iron and Steel Institute has developed design aids for short span bridges. The designs and details were developed with input from structural steel fabricators and selected for simplicity, cost effectiveness and fatigue resistance. The aids are available in two forms: a comprehensive set of plans for pre-designed bride superstructures in various roadway widths and beam/girder types and spacing; and computer software to generate customized designs, rating and supporting calculations.

For a specific project, the plans and software can be used to generate both the preliminary design alternatives and the subsequently chosen cost-effective final design. Of course, all final design must be reviewed by a registered Professional Engineer in accordance with state laws.

The Plans

The plans are intended to serve as a guide for state, county and local highway departments for developing cost-effective steel bridge superstructure designs and are particularly valuable for smaller highway departments with limited engineering staff.

An effort has been made to give sufficient information on all plans so they will approach contract drawings as nearly as possible for any given bridge location. However, you should expect that the requirements imposed by site conditions may necessitate modification since the plans have been developed for level roadway grades and right-angle crossings only.

The plans include more than 1,100 designs for non-skewed single or multiple simple span bridges with individual spans ranging from 20' to 120'; span lengths are tabulated in 5' span increments. Seven superstructure options are offered, with widths of 24', 28', 34', 40' and 44'. The 28' and 40' widths each have two optional stringer space configurations. Each of the seven superstructure widths had been allocated a separate section within the plans.

Each of the optional superstructure widths has been designed with both normal weight and lightweight concrete components for the following six beam/girder types:

- non-composite rolled beams without cover plates;
- composite rolled beams without cover plates;
- composite rolled beams with end bolted cover plates;
- composite plate grinders without intermediate web stiffeners;
- composite plate girders with partially stiffened webs (1/16" thinner than web without stiffener).

The design tables include: reactions, maximum moments, deflections and material quantities. The most cost-effective details for cross frames, diaphragms and connections are also included.

The Software

Version 2.0 is currently available—Version 3.0 will be available in Fall 2000.

When parameters such as loading, span, roadway width, beam spacing, slab thickness, ect., are different from the dimensions shown on the plan, the software will permit the user to customize the design to meet specific project requirements.

The software is based on the Strength Design Method (Load Factor Design) of the AASHTO Standard Specifications for Highway Bridges, 16th Edition, 1996, including 1997 and 1998 interim specifications. The software operates under

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Windows 95, 98, 2000 (version 3.0 will include NT)

When developing a design with the software, the bridge designer may refer to the AISI plans detailed above to obtain data that can be used as a starting point for input information, such as diaphragms, cross frames, connections and bearings.

The software performs a line-girder analysis for:

- design or rating of simple span plate gird ers and rolled beam (stringers);
- welded plate girders with unstiffened webs;
- rolled beams with optional welded cover plates;
- composite and non-composite stringers pro ducing up to 25 alternate solutions for each design.

Designers can define live load of any types: HS-Type truck or up tp 15 axle loads and spaces; AASHTO's deflection and constructability criteria; AASHTO's Case I, II or III Roadway Classification for fatigue; strength and type of concrete for composite design; grade of steel beyond the Gr. 50 used in the plans; roadway width; girder spacing; distribution factors for moment; shear and deflections; effective width and impact factor. Default selections are accepted if desired.

Additional features to the software include:

- Metric units
- Alternate live load deflection criteria
- Rating for any steel grade
- Non-compact design for Grade 70 and 100 steel (version 3.0 will also include HPS-70W)
- Alternative fatigue load
- Multiple lane reduction factors
- Self weight calibrations

The software also provides printouts of back-up calculations to support the design.

In the design mode, the software iterates between a range of minimum and maximum cross sections specified by the designer to find a minimum weight solution. In the load rating mode, the designer will input the exact cross-section properties based on an existing or predetermined design. The software provides inventory and operating ratings in accordance with AASHTO's "Manual for Condition Evaluation of Bridges."

The combined plans & software package costs $195. To order, call 800/277-3850. Also available as a free 30 day trial at www.steel.org/infrastructure. (If you purchase version 2.0, version 3.0 will be sent to you free of charge)

SUGGESTIONS FOR MAXIMIZING ECONOMY

Several steps may be taken to reduce the cost of a short span bridge project.

- Remember that least weight does not necessarily equal least cost. Cost is a function of both material weight and fabrication time. More material and less fabrication could be less costly than less material and more fabrication. Designers are encouraged to contact their local fabricators for assistance in making the most economical design (for a list of AISC member fabricators, check out AISC's homepage at http://AISC.org) Also, if more than one option could be less costly, put out bid plans with both options and let the marketplace select the least-cost scheme. Preferences for section type and details vary among fabricators depending on their equipment, experience and shipping considerations. Again, discuss your options with the selected fabricator.
- When possible, use uncoated weathering steel (Gr. 50W), which has proven to be eddective in virtually all highway environments.
- Strong consideration should be given to the design of jointless integral bridges. Schematic details for this type of design are included in the AISI plans & software package. These details have been used successfully in many states and have avoided the problems and costs associated with deck joints, especially in areas where deicing chemicals are used.
- Alternate systems for diaphragms or cross frames, including channels and bent plates for shallow sections and cross frames consisting of angles for deeper sections, should be allowed as options. Bent plates provide adequate stiffness and are easy to fabricate for shallow beams.
- If there are no depth restrictions, wider stringer spacing will always generate a more cost-effective design. Cost savings result form the reduced number of main members to fabricate, transport and erect, and from the reduced number of secondary elements, such as shear connectors, cross frames, stiffeners and bearings. To eliminate redundancy concerns, a minimum of three stringers is suggested.
- For plate girders, designs may be generated that have butt-welded flange splices to minimize material requirements. However, flange splices are costly. The fabricator should be given the option to continue the heavier plate to eliminate the splice, without submitting justification.
- Plans should be prepared for both stiffened and partially stiffened plate girders. Unstiffened webs require more material but less fabrication. Only the bids can tell you which is the least cost alternate.
- For rolled beams, the most economical design

will often depend on the steel fabricator's preferences. Again, to achieve the most economical design, consult with your fabricator.

- The non-composite design requires heavier beams than a composite design. In some locations, the added cost to shear connectors for the composite spans may offset the savings in beam weight, especially in the very short span segment.
- If lightweight concrete can not be ruled out initially, then for every normal weight option there should be a corresponding lightweight option.

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The mission of The National Steel Bridge Alliance (NSBA), which was formed in 1995, is to enhance the art and science of the design and construction of steel bridges. Its activities include organizing meetings, conferences and national symposia, conducting the Prize Bridge Awards competition, supporting research, developing design aids, and providing assistance to bridge owners and designers. The NSBA membership includes representatives from all aspects of the steel bridge industry.