A New Era for Short-Span Bridges

BY ATOROD AZIZINAMINI, PH.D.

Steel provides a simple and economical solution.

ALMOST 45% OF THE BRIDGES in U.S. bridge inventory are less than 60 ft in length. Most are simple spans located on county roads. Many of these short-span bridges are either structurally deficient or functionally obsolete and need to be replaced. It is essential to develop alternatives that are economical, can be constructed using light construction equipment and have long service life with minimal maintenance.

A new solution, referred to as the Folded Plate Bridge System, offers an economical and exciting solution for many of the nation's bridges with maximum span lengths up to 60 ft. The system consists of a series of standard shapes that are built by bending flat plates into inverted tub sections using a break press (see Fig. 1) and has many advantages for both steel fabricators and bridge owners. The maximum span length for this system is currently limited to about 60 ft, reflecting the longest press breaks that are available in the industry.

Folded plate girders suitable for different span lengths differ only by their cross-sectional dimensions. More specifically, varying the width of the top and bottom flanges and the depth of the web while keeping the plate thicknesses to either ⅜ in. or ½ in. can accommodate span length requirements. The different top and bottom flange widths and web depth can easily be accommodated by changing the bend locations, so fabricators can build folded girders very quickly while only stocking two plate thicknesses. That is important because delivery of steel bridge girders in a timely manner is an important issue for the bridge owners.

The shape of the cross section for the Folded Plate Bridge System has several key advantages in its design and construction:

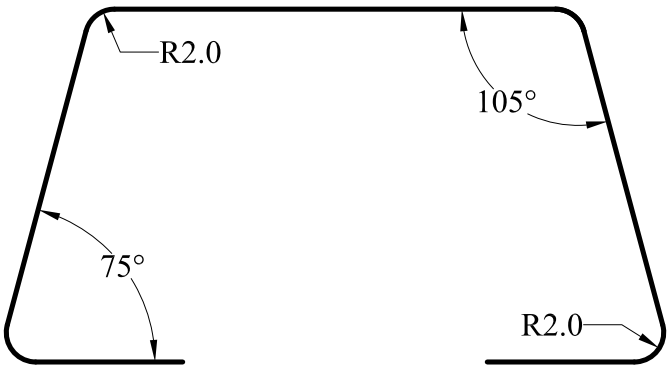

Fig. 1 Typical cross section for the Folded Plate Bridge System. Dimensions vary based on span length.

- The inverted tub shape produces a very stable bridge girder configuration that does not require internal or external cross frames for either local or global stability. A single cross frame could cost as much as $1,000, so eliminating cross frames helps reduce cost. It also eliminates a major factor responsible for fatigue and fracture observed in old steel bridges. Further, the Folded Plate Bridge System is very user friendly during the construction phase. For example, the formwork for casting concrete can be accomplished using conventional equipment and practices.
- The top flange of the Folded Plate Bridge System is wide enough (about 25 in. to 35 in.) to serve as a work platform. That itself can reduce many construction hazards associated with workers walking on girders during construction.
- Box or tub girder bridges are very efficient bridge systems but usually are used only for longer span bridges (longer than about 300 ft). That is in part because of the inspection issue. Longer span lengths result in tub sections that are deep enough to allow internal inspection. However, for short-span bridges (less than 60 ft) the depth of the box needed is so small that it prohibits crawling inside the box for inspection. This is one of the reasons for not using box girder bridges for short-span bridges. The cross section of the Folded Plate Bridge System, however, is open on the bottom side, making inspection very easy.

Fabrication and Construction

One of the advantages of the Folded Plate Bridge System is its promise for rapid delivery. The concept uses only two plate thicknesses—⅜ in. and ½ in.—and bending the plate to specified shapes is

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Photos provided by Atorod Azizinamini.

Fig. 2 Conventional forming materials and methods can be used to form the concrete deck on the folded plate girder.

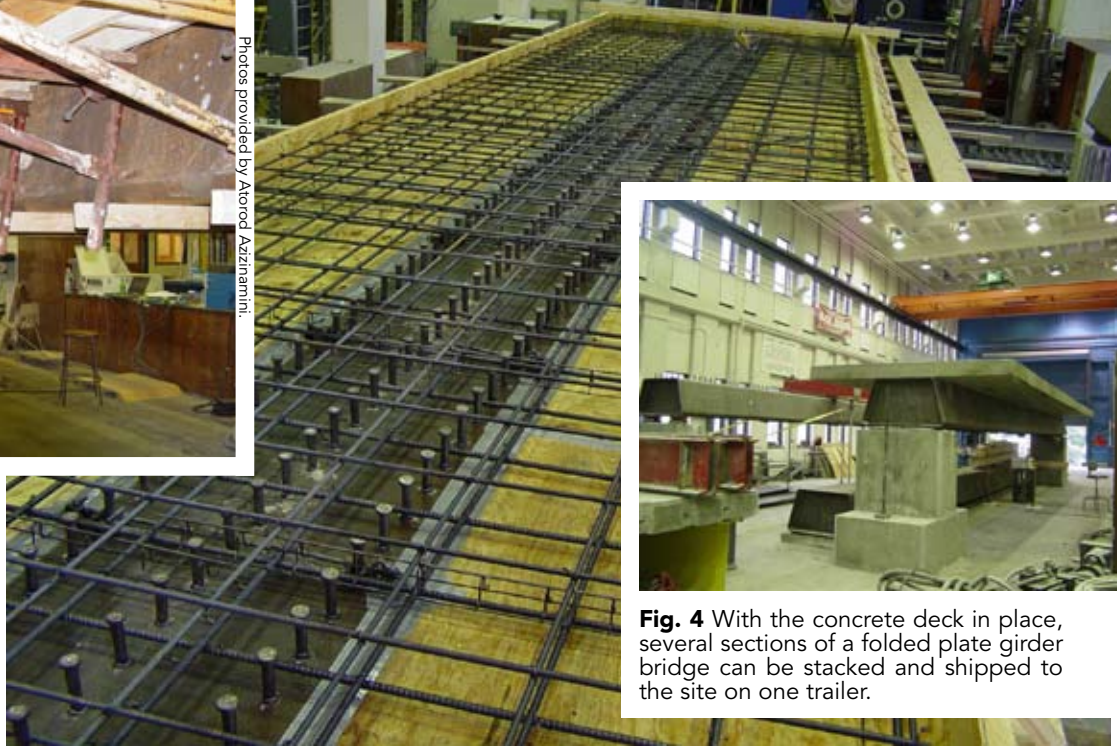

Fig. 4 With the concrete deck in place, several sections of a folded plate girder bridge can be stacked and shipped to the site on one trailer.

Fig. 3 A folded plate girder with deck forms and reinforcing steel in place. Note the studs on the girder and the sizable work platform it provides.

not time consuming. These attributes combined allow rapid fabrication and delivery. For example, many U.S. electrical utility pole manufacturers have the capability of building one folded plate girder in less than a minute.

Recently, the trend within the bridge construction industry has been toward reducing construction activities on the bridge site and eliminating the interruption to traffic. The Folded Plate Bridge System can be constructed using conventional construction techniques as well as using principles of Accelerated Bridge Construction. In the case of conventional construction procedures, readily available construction equipment could be used to build the formwork for casting the concrete deck (see Fig. 2 and Fig. 3).

An alternate and perhaps better approach when using the Folded Plate Girder system to construct short-span bridges is to use prefabricated elements. The tributary width of concrete deck for each folded plate girder could be cast on the girder prior to shipping to the site. In this scenario each prefabricated bridge element would be in the form of a folded plate with a precast top deck (see Fig. 4).

A typical two-lane county type bridge will require three such folded girder sections placed side by side and connected longitudinally. A number of approaches can be used to connect pre-decked girders in the longitudinal direction. A 40-ft.-long folded plate girder with precast deck will weigh about 24,000 lb, allowing use of a relatively lightweight crane on the construction site.

The development of the folded plate bridge system is a result of research at the University of Nebraska-Lincoln. Ongoing research and development work is nearing completion and the new bridge system will be available for field application by December 2009. MSC