Best practices in the use of Steel Box Girders for medium and long span Bridges in UK and Europe.

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Summary

Steel box girders were common in UK for long span bridges up to the late 1960s until a few collapses of Box Girders at various parts of the world in the early seventies. The detailed investigation of these collapses by an investigating committee from the UK Department of Transport led to the development of IDWR / Merrison's rules. It was mandatory to check all existing and new Box Girder bridges complied with those rules to avoid any further failure.
These collapses followed by implementation of Merrison's rule and the increase in fabrication cost led to a decline in the popularity of Steel Box Girder in the last few decades, while the introduction of T& I machines for fabrication made plate Girders hugely popular enabling of 100m spans. Other forms of bridges took precedence for longer spans. However steel box girders are gradually regaining popularity since T&I machine can also be used for fabrication (with imitations up to 70□ inclined web with horizontal plane).
In this particular paper efforts have been made to highlight the best practices in the past and present in the effective use of steel box girder not only in the UK & Europe but also in the rest of the world.

Keywords: Steel Box Girder (SBG), Open top Box Girder, Merrison, T & I machines, cross-fall, super-elevation, Distortion, Warping, Eurocode

1. Introduction

Box girders tend to be used for long span bridges, where flange plate sizes of equivalent plate girders becomes excessive or where torsion, curvature or aerodynamic considerations demand torsional rigidity.

Before the events preceding the Merrison inquiry into the basis of design and method of erection of steel box girder bridges (in the 1970s), they were commonly used in the UK over a wide range of span lengths on highway bridges.

Following the introduction of BS 5400-3 in the early 1980s, and with the advent of modern plate girder fabrication methods, the use of box girders has become much less frequent. Trends in Highway Bridge design in the past few decades show decreasing use of steel box girders, particularly for shorter spans.

2. General overview

For long span highway bridges, the choice of bridge type will depend primarily on economics. A few of the notable long span steel box girders in the UK, Europe and rest of the world are tabulated below.

Bridge	Friarton	Cleddau	Foyle	Neckartalbrücke-1	Rio-Niteroi	Shibanpo
Location	UK	UK	UK	Germany	Brazil	China
Opened	1974	1975	1984	1978	1974	2012
Main span	174	213	233	263	300	330
Longest Steel Box Girder bridge in UK						
Longest Steel Box Girder bridge in Europe						
Longest Steel Box Girder bridge in World						
Longest Box Girder bridge in World whose central 108m is made up of Steel Box girder						

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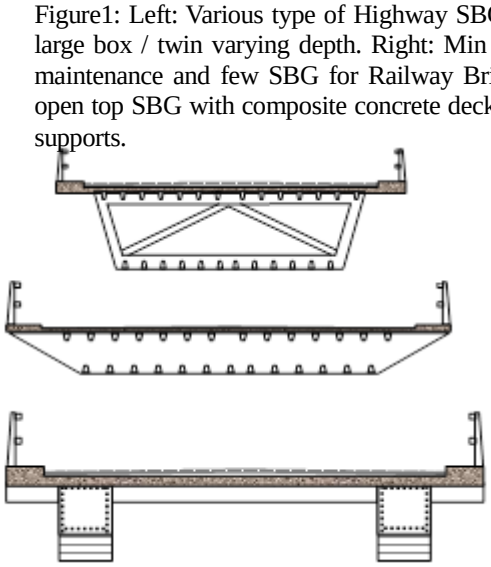
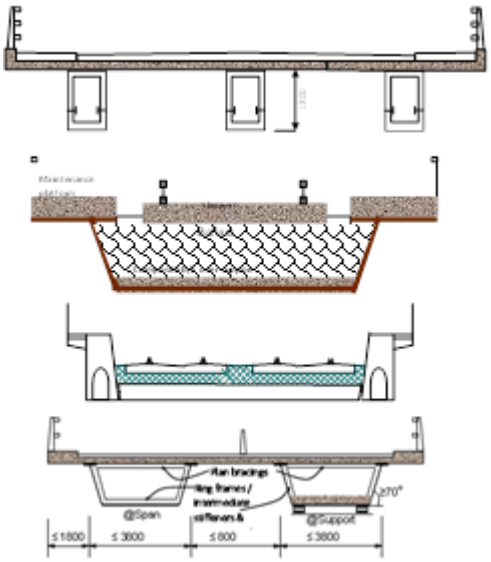
Though the popularity of Steel Box girder has decreased over the past few decades due to a variety of reasons such as fabrication allowing plate girder bridges to be longer and steel box girders becoming expensive, led to steel boxes being used as part of other landmark bridges. Recent use of thicker plate and T&I machine for fabrication (with limitations to web inclination of 70 °) has brought the box girder back into constructor's consideration.

3. Deck cross section used for Highway, Railway and Footway Bridges

The following figures show some of the good practices followed in the UK and Europe.

Figure1: Left: Various type of Highway SBG bridge deck (single large box / twin varying depth. Right: Min 1.8m deep boxes for maintenance and few SBG for Railway Bridges and the bottom open top SBG with composite concrete deck top and bottom over supports.





4. Design, detailing, construction and Maintenance of Box girders

Some of the best practices in design of box girders are briefly mentioned. For example careful detailing of articulation for decks curved in plan is particularly essential especially when accidental loading situation could cause catastrophic failure. Consideration of distortional and shear lag effect in the design is equally important. Health & Safety aspects of construction are not only a good practice in the UK designers but are mandatory. The consideration of maintenance aspects in the design such as use of weathering steel, keeping access to appropriate places for future inspection is equally important and also considered as the best practice.

In cold condition condensation of water inside can be detrimental and may need maintenance earlier than expected, but the good practice is to ensure provision of internal drainage and dehumidification of inside the box.

Use of protective treatment to inside and outside surfaces are also another best form of practice.

5. Services & Aesthetics

Carrying services in box girder is another reason for using them in bridge construction especially when they are large and need to be hidden. Examples are the Olympic Bridges in the UK which were required to be aesthetically pleasing like Hoover Dam Bypass Bridge in United States.

6. Discussion and Conclusion:

It is evident that Steel Box girders on their own may have lost their popularity over the decades but not their existence. Engineers still use them for long span bridges, wherever appropriate. To make the land mark structures the steel boxes may have changed their role from deck to arch / pylon / tower or they remained as bridge deck with additional intermediate cable supports for much bigger single spans and are also used for intermediate spans.

Reference:

1 Steel Bridge Group (2006). *Design Guidancenote on Best Practice in Steel Bridge Constructions* (SCI Publication 185) (4th ed.). Ascot: Steel Construction Institute.