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Kent Messenger Millennium bridge, Maidstone, UK

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Summary

The Kent Messenger Millennium Bridge at Maidstone, UK is the world's first 'cranked' stress ribbon, and the winner of a 2002 Royal Institute of British Architects Award. The deck of this bridge consists of two concrete catenaries that were designed with a *dogleg* alignment with the angle between them at 25 degrees. The overall length of the bridge is 101.50 m, the length of the clear main river span 49.5 m, and the side span 37.5 m.

Fig. 1 General view of the completed bridge

Maidstone Borough Council and the UK Millennium Commission financed the project. It was also part sponsored by the Kent Messenger Group. It was one of only two UK Millennium bridges not subject to a design competition (both at Maidstone, by the author). It appears also to be the only UK concrete Millennium Bridge. The project was commenced in 1998 and completed in 2001. The lead consultant was the author; the bridge engineer Strasky Husty and Partners and the checking engineer Flint & Neill Partnership. The author designed also other stress ribbons of varying types, including an arch supported proposal for the Kelvin Link Bridge in Glasgow (with Techniker), and two competition winning designs : the Carlisle Hadrian's Millennium Bridge (with Atelier One), and the Portsmouth pedestrian / cycle bridge (with Buro Happold).

Keywords: stress ribbon, purpose, innovation, elegance, tension, expression, restraint, flamenco, lead consultant, millennium bridges

1. Introduction

The structural principle of a stress ribbon is a modern construction method that utilises tensile strength of contemporary materials in an economic manner. A post-tensioned deck is made from individual planks, usually pre-cast concrete, resting on sets of cables. Such bridges are very slender, light and relatively easy to erect. Using little material they have minimal environmental impact, and are relatively

cheap to maintain as they do not need bearings and expansion joints. Nonetheless, they create substantial horizontal forces, which need to be anchored at abutments, and thus a stress ribbon's cost is directly related to the load transfer characteristics of the ground. Most of the twenty or so stress ribbons in existence are in the Czech Republic, Japan, Germany and the USA. Professor Rene Walther built the world's first stress ribbon bridge in Switzerland. Some, like the 127-meter bridge across Sacramento river in California, are single span, others, like the 261-meter bridge at Nymburk, have intermediate props. However, all of them are straight in plan with the exception of a star-like Japanese example, which has three equal fully balanced spans meeting in one point without an intermediate support.

Although deceptively simple in appearance stress ribbons are specialist structures. A *cranked* stress ribbon brings another level of complexity to its engineering. The change of direction in the bridge deck creates a new set of forces, which could be quite large and which depend on the angle at which the deck spans meet. When the two spans are of different lengths, as at Maidstone, the asymmetric loading on the support pier creates a still more difficult static condition. The deck-prop-pile cap connections have to accommodate varying thermal and live load conditions for the two spans. An issue, is also the allowable gradient for ramps. A stress ribbon deck follows a catenary curve, i.e. it becomes increasingly steeper towards the abutments. The longer the span the steeper the ends. Reduction of the sag, up to a point only, can be achieved through the increase of tensile forces – but this increases the cost. Spans of around 70m are just on the verge of 1/20 maximum gradient and reasonable economy, subject to ground conditions.

Aesthetically the issue with stress ribbons is that they are maybe just too simple in appearance. Their great drama of forces is so well contained that barely any of it is visible to the untrained eye. The cranked ribbon idea expresses these tensions and forces, and brings restrained expression to the bridge form. Like a skilled flamenco dancer the bridge keeps it fiery tension well under control.

Fig. 2 View along shorter span