

## 1 Introduction

The existing Forth Road Bridge forms a key link in Scotland's transport network. The crossing currently carries some 66,000 vehicles per day which includes over 70 percent of travellers across the three Forth bridges (Kincardine, Forth Road Bridge and Forth Rail Bridge).

In 2007, the Employer – the Scottish Ministers – announced that a Replacement Forth Crossing would be promoted by the Scottish Government. The Forth Replacement Crossing Study undertaken by Transport Scotland included consideration of alternative corridors and structures for the Replacement Forth Crossing and on 19 December 2007, the Scottish Ministers announced that the Replacement Forth Crossing would cross the Firth of Forth immediately upstream of the existing Forth Road Bridge and would be a three-tower cable-stayed bridge, future-proofed to allow provision of multi-modal transport.

The Jacobs-Arup commission is for the management and delivery of the Replacement Forth Crossing Project inclusive of all roads and other infrastructure associated with such a crossing.

This report outlines the development and assessment of a number of concepts for a D2M Option on the Main Crossing. The preparation of this report has been carried out in association with:

- Dissing + Weitling
- Flint & Neill
- Professor Niels Gimsing

### 1.1 Background to D2M Option

The Main Crossing has been developed as far as Scheme Assessment stage based on the brief to provide a replacement crossing with multi-modal corridor and footways in addition to a D2M dual two lane motorway standard carriageway. Conceptual designs were developed in consultation with Transport Scotland which resulted in a number of options being progressed to allow preliminary cost comparisons to be made.

An Options Selection Workshop was held on the 29th July 2008 which resulted in a Three Corridor functional cross section with a Needle Tower being recommended as the preferred option for the cable stayed bridge. Details of this scheme are included in the report "Forth Replacement Crossing, Main Crossing (Bridge), Scheme Assessment Report, Development of Options", February 2009.

However, recent investigations of the suspension cables of the Forth Road Bridge have indicated an improved prognosis for the main cables. This has increased the attractiveness of finding a future use for the Forth Road Bridge. A managed crossing strategy has therefore been developed to consider the most appropriate use of the existing bridge allowing it to continue to provide a link across the Firth of Forth in combination with the new bridge. If this is feasible then it could be possible to reduce the cost of the new bridge by reducing the functional requirements.

This report documents the development of options for a new bridge carrying only a D2M dual two lane motorway standard carriageway. The development has been progressed in two stages. Feasibility studies were initially carried out to investigate the available

options and after an initial sifting exercise a short list of options has been developed in sufficient detail to allow a Scheme Assessment to be made.

### 1.2 Multi-Modal Base Case



The D2M Options will be compared against the preferred option from the original Scheme Assessment illustrated above and also shown in drawings included in Appendix A. This option will be referred to in this report as the Multi-Modal Base Case and the original Scheme Assessment will be referred to as the **Multi-Modal Scheme Assessment**.

### 1.3 Dual 2 Lane Configurations Studied

The general arrangement of the bridge in elevation will remain largely unchanged with 650 m main spans either side of a central tower on Beamer Rock. Tower heights are unchanged and the typical span lengths in the southern approach viaduct will remain at approximately 90 m. The distinctive crossing stay cables which provide stability of the central tower are retained.

The functional cross section requirement is a D2M dual two lane motorway standard carriageway with widened hard shoulders to allow for peak hour usage as a bus lane. The deck has been slightly widened so as not to exclude future conversion to a D3 dual three lane all purpose road.

A central Mono-Tower solution follows naturally from the Needle Tower developed for the original Scheme assessment and both single deck and twin deck options have been developed for this tower type.

However, conventional towers with one leg either side of the deck are also reasonable for the reduced deck width associated with the D2M option and H-Shape, Diamond and A-Frame towers have also been studied.

With stay cable support along the deck edges now a reasonable solution, a composite ladder beam deck becomes worthy of investigation, although aerodynamic stability is a concern. Whilst ladder beam decks have been utilised for cable stay bridge spans up to 605 m, the longest span with wind shielding is believed to be the Second Severn Crossing, which at 456 m is significantly shorter than the 650 m required for the Forth Replacement Crossing.

## 1.4 Development of Scheme Options

An initial sifting exercise was carried out during the D2M Concept Workshop held on 22nd August 2008 to produce a short list of options for scheme development. The feasibility studies and initial sifting exercise are documented in Appendix B of this report.

Subsequent to this workshop, further analysis and investigation has been carried out to develop the concepts into a number of Scheme Options. The options can broadly be considered in terms of:

- **Functional Cross Section** – What the bridge is required to carry and how that will be arranged on the deck in terms of location of traffic lanes, etc.
- **Deck Type** – The construction material and structural arrangement of the cable stayed bridge deck.
- **Tower Form** – The appearance of the towers which will be the major aesthetic and visual impact of the bridge.
- **Approach Bridge Type** – The construction material and structural arrangement of the approach spans to the north and south of the cable stayed bridge.
- **Foundation Type** – The construction form of the foundations.



*Scheme Design Options*