Forth Replacement Crossing

project update

September 2015

FORTH REPLACEMENT CROSSING

How to build a road deck

As the construction programme reaches the next critical stage where deck sections and stay cables are installed, we take a look at the technical operations involved.

Centre Spread

Connecting to the Queensferry Crossing

Latest news on the construction of the North & South Approach Viaducts and the network of connecting road works.

Centre Spread

Final push for the top

The Queensferry Crossing's 3 towers are nearing their maximum height and are now officially the UK's tallest bridge structures.

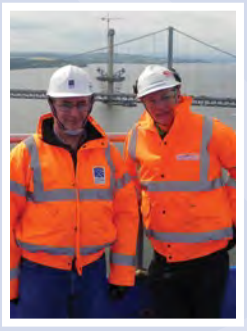
Back Page

TRANSPORT SCOTLAND
CÒMHDHAIL ALBA
An agency of Buidheann le The Scottish Government Riaghaltas na h-Alba

Forth Crossing Bridge Constructors
HOCHTIEF Solutions
American Bridge International
DRAGADOS
Morrison Construction

We have lift-off! Out at the North Tower, the first of 110 deck sections is lifted up from sea-level to road deck height approximately 55 meters (180ft) above the waters of the Forth.

Historic Milestones Achieved



David Climie & Michael Martin admire the unique view from the top of the Forth Bridge

Welcome to the latest edition of the Queensferry Crossing "Project Update". As ever, there is a lot of activity happening out on-site. Elsewhere, you can read about the progress being made across this fantastic, once-in-a-lifetime construction project. Out on the towers and on the emerging road deck, on the two approach viaducts and on the connecting roads north and south of the Forth, we continue to make good progress and remain on schedule to have traffic flowing across the new bridge by the end of 2016.

Recently, we have achieved a number of significant milestones of which the Project Team is proud. In August, the Queensferry Crossing's three towers became the tallest bridge structures in the UK. We still have a little way to go before they 'top out' later this year at 210 metres in height (see back page) but already their height advantage over the towers of the neighbouring Forth Road Bridge is clear for all to see.

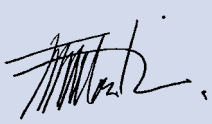
In July, we installed the first four stay cables on either side of the North Tower (see Centre Spread) and at the end of August their counterparts on the South Tower were also installed. These cables are very much the signature feature of the Queensferry Crossing, so it is very exciting to see them beginning to take their place in the bridge's emerging architecture.

Then, at the beginning of September, the first of 110 deck segments was lifted into place at the North Tower (see Front Cover photo and Centre Spread) in a technically challenging operation which represents the leading edge of 21st century civil engineering technology.

Of course, as nobody can fail to have noticed, the weather this summer has been poor. Wind has been a particular feature out on the Forth and one that especially affects our ability to carry out operations at the tower tops and on the deck segments where working at such heights is subject to the most stringent health and safety considerations. Despite the weather, however, excellent progress has been made through careful logistical planning and timetabling, keeping any adverse effects to a minimum. It is a tribute to the skilled and dedicated workforce working across all areas of the Project that they have kept us on track in spite of the persistent winds. Our thanks to all of them.

This summer, we had the opportunity to climb to the top of the North cantilever of the Forth Bridge. It was only ten days after the famous old bridge had deservedly received UNESCO World Heritage Site status and it was an excellent chance to pay tribute to the magnificent structure where the history of bridges in this area all began. The scale and quality of our predecessors' achievement and engineering prowess in the 19th century is breathtaking. As we in the 21st century add a new chapter to the history of bridges in this unique location, everybody working on the Queensferry Crossing remains fully aware of our responsibility to create a structure worthy of taking its place proudly alongside its illustrious neighbours.

David Climie
Transport Scotland
Project Director



Michael Martin
FCBC
Project Director

Meeting FCBC Project Director, Michael Martin, and Chris Hunt, Apprentice Site Engineer

Minister visits site

Keith Brown MSP, Cabinet Secretary for Infrastructure, Investment & Cities, recently welcomed news that the Project is now running with more than 1,200 workers on site, a new peak in direct employment levels.

Meeting members of the team during a site visit in August, Mr Brown said: "It's great credit to the hard work and dedication of the men and women working on the Queensferry Crossing to see the progress made since my last visit. Everywhere you look, there are major operations underway or already complete."

Visiting the Queensferry Crossing or live nearby?

Become a part of the Project's legacy with a quick click of your camera or smartphone.

Take a photo of yourself, family and/or friends with the bridge works in the background and you can become part of "Frame the Bridge"! Upload your photograph to help build the fantastic online "People's Bridge" mosaic. Your photos will also form a key part of the celebrations when the bridge opens. It couldn't be easier.

Find out more at www.framethebridge.co.uk

FRAME THE BRIDGE


Chris Hunt with the award-winning pupils

FCBC helps Inverkeithing High achieve success

School teams from across Fife and Falkirk attended Fife College in May to compete in their regional Go4SET programme. Go4SET is a national initiative designed to promote STEM subjects (Science, Technology, Engineering and Maths) to 2nd year pupils. The Inverkeithing High School pupils were tasked with coming up with a creative idea for an 'Eco Hotel' and were awarded 'Best Overall Project' on the day. They improved their design and model for the final competition in Edinburgh and were commended for their team-working ability.

Chris Hunt, FCBC Apprentice Site Engineer, was asked to get involved to help the Inverkeithing team. According to Chris: "This was a fantastic opportunity to work with ambitious and enthusiastic youngsters and a chance to promote the civil engineering profession to 2nd year pupils about to make their course choices."

FRC CONTACT & EDUCATION CENTRE

EVENTS & ACTIVITIES

Over 20,000 people have visited the Forth Replacement Crossing Contact & Education Centre since it opened in April 2013 and it continues to host a range of events and activities:

PROJECT EXHIBITION
Open every Saturday 1000 – 1600 hours (March – October). Members of the public can explore exhibition panels about the FRC Project, view detailed bridge models, meet members of the Project team to learn more about the construction of the new Queensferry Crossing and enjoy spectacular views of the Forth.

PROJECT PRESENTATIONS
Presentations take place on the last Friday of every month at 1000 & 1300 hours (March – October). These include an in-depth look at the construction of the Queensferry Crossing and its connecting roads. The team also takes group bookings from universities, colleges, professional and community organisations interested in visiting for a presentation.

SCHOOLS PROGRAMME – FREE EDUCATIONAL VISITS
Our trained and knowledgeable staff lead a range of visits in the exhibition area which provides an excellent learning environment. Pupils participate in interactive and inspiring educational activities related to bridge construction, science, technology, engineering and maths.

To find out more about what's on offer at the Contact & Education Centre, or to book a visit for your group, contact us via:
Email: frcenquiries@transportscotland.gsi.gov.uk Tel: 0800 078 6910

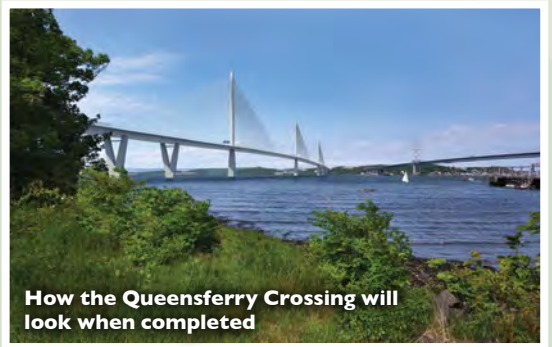
Considerate Constructors – Gold Award No 3

FCBC and the Queensferry Crossing construction project won a Gold Award at this year's Considerate Constructors Awards Scheme for the third year in a row – a fantastic achievement. The Considerate Constructors Scheme is designed to help constructors continually improve standards and the image of the construction industry.

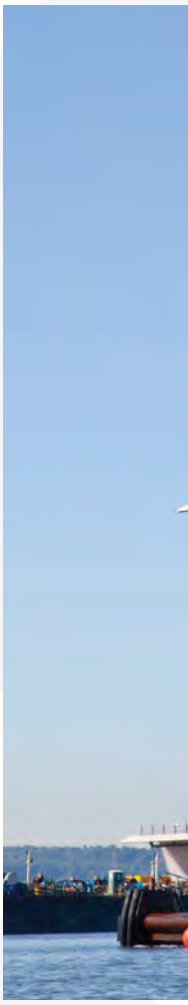
Pictured is the FCBC team (Andy O'Kane, Ross Glendinning, Pedro Jadraque and Don Fraser) attending the Awards ceremony at the Balmoral Hotel in Edinburgh.

Flying the flag for the Queensferry Crossing

As part of FCBC's mentoring programme with the University of Strathclyde, a group of international civil engineering students recently visited the Queensferry Crossing. The group included a number of post-graduate students from 18 countries: Brazil, Bulgaria, Czech-Republic, Finland, France, Hungary, India, Malaysia, Netherlands, Nigeria, Oman, Pakistan, Poland, Saudi Arabia, Spain, Sweden, Syria and Thailand.


How the Queensferry Crossing will look when completed

Looking up from sea-level at dusk, the sheer scale of this construction project is obvious



Road deck construction explained

This autumn marks the start of one of the most technically challenging periods in the construction of the Queensferry Crossing - the operations to lift the bridge's deck segments into place and install the all-important stay cables. Here, **Carson T. Carney, FCBC Cable Stayed Bridge Technical Manager**, explains the complex processes necessary to ensure all 110 deck segments are installed successfully.

Over the past two to three years, looking out across the Forth, local residents and members of the public have been able to see key elements of the new Queensferry Crossing growing in front of their eyes, week-by-week, month-by-month. The three main towers, for example, reaching ever higher into the sky and now significantly higher than the towers of the neighbouring Forth Road Bridge. Or the Approach Viaduct South being steadily launched out over the water.

What hasn't been so obvious is the ongoing work to the deck which will ultimately carry many thousands of vehicles across the bridge every day. This is about to change as we enter the next phase of building this amazing bridge: installing the individual deck segments and the stay cables which will hold them up. By filling the gaps between the three towers and connecting to the viaducts, these segments will, for the first time, actually begin to make a ***bridge*** out of the structure we are building.

As previously reported in the Project Update (***see November 2014 issue***), the first four deck segments on each tower have already been installed. These are connected directly to the towers supported by temporary 'falsework' trestles beneath. At the North Tower, the initial deck segments have recently been lifted off the falsework and tilted to give them the required geometry to fit the graceful arc which the final, completed road deck will form. This tilting – we call it "rotation" – was achieved through the recently installed first stay cables taking the weight of the deck for the first time in late August, a significant milestone for the Project.

Starting from early September, all subsequent deck segments will start to be lifted into place with their reinforced concrete decks already in place having been cast and fitted in FCBC's on-shore fabrication yard in Rosyth Docks. This lifting process will last throughout a good part of 2016.

Here is a brief, "nutshell" description of the processes we will have to complete 110 times between now and the completion of the bridge deck:

Step 1: Each deck segment, weighing 750 tonnes on average, is transported out from the dockside fabrication yard on one of two huge barges positioned by tugs. On arrival at the tower site, the barge is anchored – to within a tight 200mm tolerance - beneath the blue erection traveller cranes positioned up at deck level, one either side

Halfway through the first deck lift operation

of each tower. These erection travellers will lift the deck segment up to deck height (approx. 55 metres) in a delicate operation which lasts about two hours in which wind, sea and tide conditions will all play a critical part. Each deck segment is then rotated by a few degrees in order to match the final geometry of the completed bridge deck and a series of interlocking plates are joined together to hold the structures in place.

Steps 2 & 3: Once the segment has been correctly positioned, it has to be fixed permanently in place. This is achieved by a huge amount of welding around the steel box structure and internal beams within it. This is a time-consuming operation but a critical one as a perfect top weld is vital to allow the reinforced concrete "stitch" to be poured on top of the structure. This stitch, along with the welds, permanently secures the segment to its neighbour. These operations are constantly monitored by non-destructive test inspections to ensure perfect positioning is achieved after which permanent bolts complete the steel connections.

Step 4: Whilst the reinforced concrete stitch is being poured, the stay cables have to be prepared. The stay cables are one of the signature features of the Queensferry Crossing. They consist of a varying number of strands (up to 109 for the largest cables) which are threaded through an external, white pipe (essentially a covering or sleeve). Each strand is made up of seven high tensile, galvanised steel wires, 5.2 millimetres in diameter. Six of the wires, coated in wax, are wound in a helix pattern round a central king wire which is straight. The strands are each contained in a high density polyethylene (HDPE) coating. Think of it this way: 7 wires = 1 strand. A bundle of strands up to 109 strands = 1 stay cable. The external white pipe is welded to the correct length and a single strand is threaded through. The pipe is then lifted into position using the enormous, yellow Tower Crane.

Steps 5 & 6: The remaining strands are then threaded through the pipe using a winch and shuttle system which brings the strands through the pipe one at a time. Each strand is cut to length and wedged into a steel anchor plate at either end. The final result is one of the strongest steel cables in the world, capable of supporting the Queensferry Crossing road deck for many decades to come. By the end of Step 6, the stay cables – two per deck segment – have been fully assembled and tested but the weight of the deck segment is still primarily being carried by the blue erection traveller cranes. The stay cables are now tensioned up to final tension at which point the weight of the deck segment is transferred from the erection traveller crane to the stay cables.

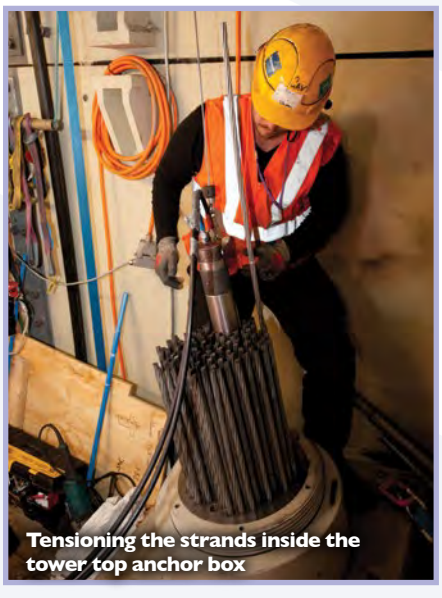
Looking to the North Tower from the Central Tower

The moment of lift-off

Step 7: The hydraulically powered, 250 tonne erection traveller can now move forward (typically 16.2 metres) on rails to the leading edge of the newly installed deck segment ready to lift the next segment making its way out from the land – and the above cycle is repeated.

On completion of all 110 deck segment installations, the stay cables will be finely adjusted to achieve the "global geometry" required by the design of the new bridge. Taking into consideration the massive weights and loads involved, the dramatic heights at which we will be working and the variable weather and sea conditions which Mother Nature will doubtless throw at us in this exposed, maritime location, the operations to install the road deck represent leading edge civil engineering at its most raw and exciting - and we cannot wait to get on with it!

Looking up, the steel strands enter the external pipe forming a stay-cable



Tensioning the strands inside the tower top anchor box

Approach Viaducts and Piers: progress update

A lot has been happening out on the north and south Approach Viaducts since the last issue of the Project Update. We catch up with **Juan Jose Consuegra Perez, FCBC Approach Viaducts Manager**, for a summary of the current state of play.

June saw the completion of Pier S3 on the southside which then triggered the operation to launch the Approach Viaduct South into its final position. This was successfully completed in July, the culmination of an operation which started in late 2013. At 543 metres in length and over 7,000 tonnes total weight, this operation was a major civil engineering project in its own right. Work is now underway on installing internal scaffolding, shuttering and steel reinforcement along the entire length of the east and west carriageway steel viaduct box girders. This will allow the FCBC team to start pouring the reinforced concrete deck which will carry the roadway and, eventually, the traffic to and from the main cable stayed section of the Queensferry Crossing itself. This work will be carried out in a total of seven phases, the first six being completed next Spring while the final phase will take place in autumn 2016 when the main cable stayed deck sections finally reach as far as the viaduct.

Meanwhile, construction of two further piers on the south shore is progressing well. Pier S1 is scheduled for completion by the end of the year. Its V-shaped legs are now emerging above its foundation caisson sunk into the seabed. Next door, the foundations of Pier S2 are now complete and work has started on the pedestal structure from which its V-shaped legs will rise.

Laying the steel reinforcement prior to concrete deck pour

Aerial view of the 3 famous bridges

Aerial view of Approach Viaduct South

Turning to the piers on the north side, Pier N1 will be complete in early September while Pier N2 was successfully completed some months ago. On the Approach Viaduct North structure itself, welding has been completed on the twin east and west carriageway sections and is nearing completion on the single box section which, during 2016, will join with the bridge deck segments coming from the North Tower.

The next major milestone will be reached during this autumn when the entire 5,600 tonne structure is launched out over the two piers in a single operation. This is a very different operation from the phased launch of the longer Approach Viaduct South but no less complex in that it will involve "pivoting" the structure as it moves along so that the trailing edge is lowered by approximately two metres to create the right profile to allow the structure to pass over Pier N1 and be at the correct angle to meet the main crossing deck segments suspended from the North Tower.

So, it's 'full steam ahead' with the all-important viaducts!

Steelwork assembly on Approach Viaduct North

Aerial view of Approach Viaduct North under construction

The roads to success

The Queensferry Crossing would be nothing but a very prominent civil engineering 'white elephant' if it were to remain unconnected to the existing trunk roads network on either side of the Forth. That's where the work of FCBC's Network Connections team comes in. According to **Ross Glendinning, FCBC's Network Connections Manager**, activity is progressing well on all fronts. Here's a brief update.

Turning to the south side first, the newly constructed B800 bridge over the A90 was fully opened to traffic in both directions on schedule in late July. The old bridge will be demolished in the autumn. This will involve temporary closures to the A90 route in late October which will be well publicised in advance through the usual media channels and on the Project website. Standing on the new bridge looking west gives passers-by a dramatic view of the new stretch of M90 being constructed towards the new Queensferry Gyratory and the Queensferry Crossing. Mainline earthworks and drainage installation are nearing completion and road construction works are progressing well with the placement of sub-base (a mixture of spent oil shale and cement) which will create the foundation for the main road surface.

Nearby, the team has recently completed the installation and commissioning of three Advance Works ITS (Intelligent Transport System) gantry signs over what was previously known as the M9 Spur, now the M90.

The Queensferry Gyratory is essentially complete with any remaining carriageway restrictions being kept in place while the adjoining slip roads on and off the M90 are under construction.

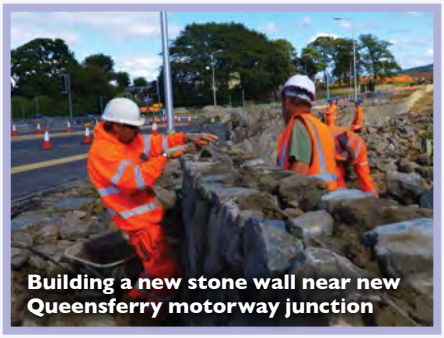
Nearer the Queensferry Crossing itself, following the final launch into position of the Approach Viaduct South, the second phase of construction at the south abutment is now underway. This will see the completion of the abutment structure so that it ties in seamlessly with the new motorway sweeping round to the Queensferry Crossing from the south. Similar operations will be carried out at the north abutment following the launch of the Approach Viaduct North later this year.

Staying on the north side, the lifting into place of the 18 steel beams to form the new Ferrytoll Viaduct was successfully completed in March. Currently, we are installing the reinforced concrete deck on which the final road surface will sit.

Just north of the Viaduct, work is progressing well on the main structures which will form the new, re-located Ferrytoll Gyratory. This autumn, northbound travellers on the motorway will find themselves diverted over two recently completed gyratory bridges and a temporary bailey bridge. On nearby Castlandhill Road, work to create a new earth retaining wall and embankment is complete. This supports the new M90 northbound merge slip road which opened to traffic in mid-August.

The new B981/Ferrytoll Road/King Malcolm Drive junction will be completed in September. The patience of drivers during this phase of the works is much appreciated. Nearby, works on St Margaret's Marsh to improve irrigation and to promote the propagation of the marsh into the reed bed area are nearing completion with the installation of three sluice gates in the sea wall, refurbishment of five sluice gates in the reed bed area and the installation of connecting drainage throughout this Site of Special Scientific Interest (SSSI).

On the north side, looking south down the M90...



Building a new stone wall near new Queensferry motorway junction

Aerial view of new southern approach road under construction south of South Queensferry

Southern motorway approach to new bridge takes shape

Standing on newly poured concrete deck at North Tower

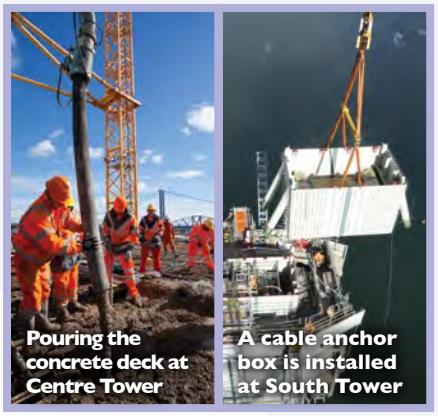
Towers: final push now on towards completion

Christian Niemietz, FCBC's Senior Engineer North Tower, is delighted with the progress being made with the construction of the Queensferry Crossing's three enormous reinforced concrete towers.

"I do not believe things could have gone any better," says Niemietz. "Of course, we have had challenges to overcome – you don't expect anything else on a project of this scale – but all the concrete pours completed so far have been carried out very successfully and we are on target to top out all three towers on schedule this autumn. We are very proud of what is being achieved."

In the past three months, several further concrete pours (each 4 metres high) have been successfully completed and 32 steel cable anchor boxes have been inserted inside the towers. To date, 50 pours have been completed on the North Tower, 47 and 46 on the South and Centre Towers respectively involving over 22,000 cubic metres of concrete in the towers and an additional 15,000 cubic metres for the foundations. The initial four deck sections at the North and South Towers have been concreted successfully, allowing cabling works to progress. This performance is a tribute to teamwork, says Niemietz, citing the FCBC joiners, jump teams, steel fixers, crane crews, scaffolders, the concrete batching team, temporary works team, surveyors and laboratory technicians whose joint skills have been vital to the efficient way the works have been carried out.

Looking down, down, down from one of the Tower Cranes



Pouring the concrete deck at Centre Tower

A cable anchor box is installed at South Tower

Choppy waters: a barge brings concrete to the South Tower

Progress has been steady despite the poor summer weather. Wind is a particular challenge when working at such heights and prolonged windy conditions since early June have been a particular feature this year. "Frankly, if you can cope with a Scottish summer like this one, you can cope with a Scottish winter!" says Niemietz.

So, what remains to be done? Well, each tower will eventually consist of 54 pours, so the next few weeks will see the remaining pours completed. Then a 6m x 4m precast concrete slab, complete with entry hatch and parapet walls, will be fitted across the top of each hollow tower structure, thus marking the completion of the tower construction programme. Down at road deck level, the operation is now underway to insert tensioned steel strands inside the already poured reinforced concrete deck slabs in an operation (called post-tensioning) which increases the strength of the final road deck, making it fit to carry the traffic load in the decades ahead.

According to Christian Niemietz: "Finishing these fantastic towers will be an amazing achievement and we are looking forward to a wee celebration to mark the event!"

Contacting the FRC team

There are a number of ways you can contact us to ask questions, provide comments, make a complaint or find out more about the Forth Replacement Crossing project:

Call the dedicated 24 hour Project Hotline **0800 078 6910**

Email the team **enquiries@forthreplacementcrossing.info**

Look for us online:

- www.forthreplacementcrossing.info
- www.queensferrycrossing.co.uk
- @FRC_Queensferry
- Or go to the Queensferry Crossing YouTube channel

Or drop into the **Contact & Education Centre**
Adjacent Forth Road Bridge Administration Office,
South Queensferry, Edinburgh EH30 9SF

Opening times
Mon-Thu: 0900-1700, Fri: 0900-1600, Sat: 1000-1600