

Forth Replacement Crossing

project update

May 2014



The only way is up: a view of the Centre Tower and tower crane rising from Beamer Rock in mid-estuary

Reaching for the sky!

The Queensferry Crossing's three main towers are rapidly rising from the waters of the Forth. We take a look at the technical processes underway.

Page 2

Viaducts are vital, too

The Southern Approach Viaduct will soon be out over the water. We explain how it is being constructed and launched out towards the towers.

Page 4

Road Connections

The complex road works to connect the new bridge to the existing trunk road network are moving ahead quickly. Find out more about what is involved.

Page 5



Construction Focus Special Edition

In this special issue of the Queensferry Crossing Project Update, we take a detailed look at the works across the entire construction site. Interest in our activities is increasing as the bridge structures and connecting roads become ever more obvious to local residents and passing motorists.

Construction works are moving ahead strongly on all fronts. All three of the bridge's towers are now well above the level of the foundation caissons (or cofferdam on the Centre Tower) and are heading steadily upwards. We expect the towers to reach deck level during the summer. Later this month, the first steel bridge box sections will arrive on-site from Shanghai. This will trigger the start of production of the reinforced concrete deck which goes on top of these sections at FCBC's precasting sheds in Rosyth Docks. See article on right for information on how we are constructing the towers.



David Climie & Carlo Germani inspecting progress on the Centre Tower

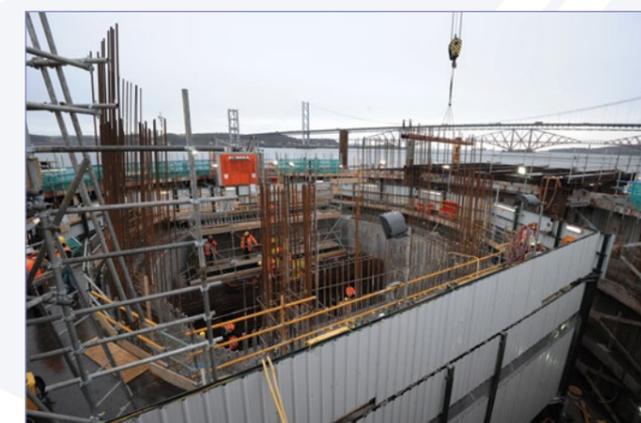
A vital part of our works is the approach viaducts. The Southern Approach Viaduct has recently taken a leap forward with the completion of two of the supporting piers enabling both carriageways of the steel box girder structure to be launched as far as Society Road. Work on the piers supporting the Northern Approach Viaduct is on-going, whilst work on the viaduct itself is on schedule to begin in the autumn. We take a look at the viaducts construction on page 4.

Meanwhile, work on the new connecting roads is progressing well. On the southside, the new Queensferry Junction is rapidly taking shape and, during the summer, we aim to have traffic flowing on the realigned A904 which includes the new roundabout part of the junction. Works on the new stretch of M90 motorway, which will link the bridge to the M90 (formerly M9 Spur), is moving steadily ahead. To the north, good progress is being made with the new road layout at Ferrytoll. The realigned B891 coming out of North Queensferry is due to become operational in the autumn. The new Ferrytoll embankment, destined to be one of the highest motorway embankments in the UK, is now a highly visible feature on the northern approaches to the Forth estuary. More information on the roads construction on page 5.

In summary, major advances are being made right across the project. It is a fantastic job to be involved in and the whole team remains focussed on building a magnificent new bridge of which the whole country will be proud when it opens to traffic in late 2016.

David Climie
Transport Scotland
Project Director

Carlo Germani
FCBC Project
Director



Left: Early morning sunrise and newly produced concrete from FCBC's batching plant being pumped on board one of the barges for transportation to the towers.

Above: A view of the hollow Centre Tower, the jumpform "mould" into which concrete is poured and the steel rods which reinforce each concrete section.

Reaching for the sky!

Hot on the heels of the successful completion of the tower foundations late last year, construction work on the Queensferry Crossing's three huge towers moved into full swing.

What are the main tower features?

Each of the reinforced concrete towers will be more than 200m high (the Centre Tower being the highest at 210m). That is around 57m (or 25%) higher than the towers of the neighbouring Forth Road Bridge and, as such, they will be the highest bridge towers anywhere in the UK. The towers are hollow and have an internal steel access staircase which is being installed simultaneously as tower construction progresses. Lifts will also be provided later in construction. The geometry of the towers reduces with height which means they will taper gracefully like a needle towards the top. Taken together, the towers will eventually contain over 25,000m³ of reinforced concrete containing over 6,000 tonnes of steel reinforcement.

How are the towers built?

The towers are built in 4 metre high segments, each called a "lift".

The formwork (or "jumpform") into which the concrete is poured is hydraulically jacked up to the next level once the concrete in each lift has gained sufficient strength to support itself and the jumpform. This takes approximately 36 hours. The high-performance concrete is produced at FCBC's concrete batching plant in the Rosyth Docks and is delivered to the towers by specially designed barges in an operation similar to the record breaking foundation concrete pours last year. One of the most powerful pumps in the world pumps the concrete up to a concrete distributor on top of the jumpform where it is then poured into the mould to make the next lift. A man-hoist (or elevator) on the outside of the tower transports the teams up and down.

What are the biggest challenges in constructing towers such as these?

It is all about logistics: proper planning, clear briefing, experience and the right equipment to get materials and teams where they are needed. Weather, especially wind, always plays an important role in an exposed site such as the Forth Estuary. And the most important ingredient? Teamwork with lots of determination, commitment and skill from the people who make up the construction team. We have great people working on this project with plenty of the right experience. Work never stops. We're at it 24/7 around the clock, battling all weathers throughout the seasons.

Are we in good shape?

We have very strong momentum going into the summer. The teamwork from all involved is second to none in my experience. Every single person involved in the construction – from the towers teams to the surveyors, the workshop teams, the Designers, the concrete batching plant team, the laboratory guys, the marine logistics and

marine control people, the mechanical & electrical specialists, our Health & Safety colleagues, the temporary works people, as well as all our back-up colleagues in such functions as procurement, quantity surveying, accounts, cost control, HR, Community Liaison ... in fact, **everybody** is focussed on one common goal: building world-class towers efficiently and safely to the highest possible quality standards. We are determined that the Queensferry Crossing will become a global benchmark for quality in major infrastructure construction projects. By September, all three towers will be beyond 80 metres high and growing fast at approximately 4 metres every 12 days. It will need a top class Champions League performance but the team is already well on the way to delivering. Everything we do is "top of the range", as I always say!

When will the first sections of deck be installed?

The first deck sections, which are not supported by cables, will be installed in September, hoisted up by a floating crane and positioned around the towers. In the following period, the towers will continue to grow whilst the remaining deck sections, which will be cable supported, are prepared on-land. Cable installation and deck erection will commence in earnest early next year and will kick-off the most spectacular phase of the bridge construction.

Which tower will win the race to the sky?

We often get asked this question! Of course, it is not really a race because safety and quality are our top priorities and our work schedules are clearly scheduled in advance. But the tower teams are highly competitive and, whilst the Centre Tower is currently in front due to a head start, the team there also have some specific construction challenges ahead specific to that tower which the flanking North and South Towers don't have. So the result of the "race" will be a close call. By October, we should see all three towers very close together in height and the race for the top will be on. The sky is the limit! But, of course, it is not really a race at all...



By Meinolf Droste, FCBC Department Head Towers & Deck



Viaducts are the first recognisable bridge elements

A cable stayed bridge, such as the Queensferry Crossing, is that part of the overall structure which is supported by the cables anchored to the towers.

In order to allow traffic to flow over the bridge, we must have viaducts at both ends which join the bridge to the land.

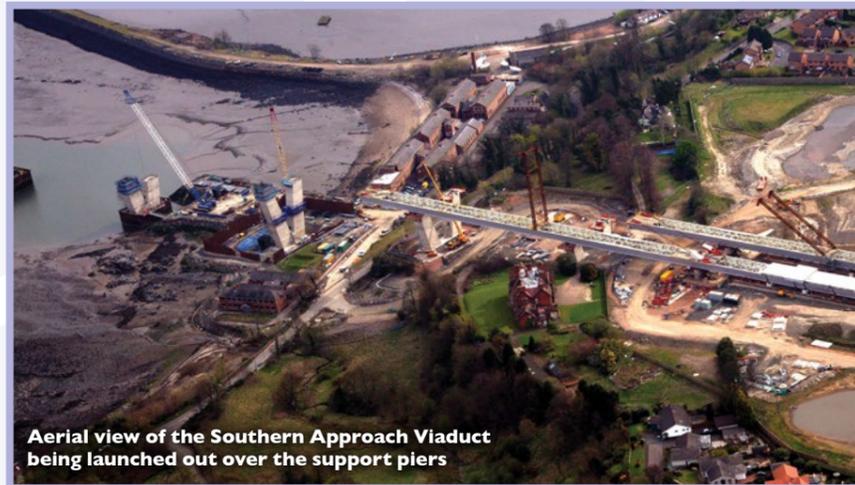
So, the North and South Approach Viaducts (as we call them) are a critical component to the success of the Forth Replacement Crossing project as a whole.

Just as with the bridge structure itself, foundations are vital to the construction of the viaducts. On this project, there are three types of viaduct foundation. First of all, in the deepest of the viaduct foundations, there is a cylindrical caisson sunk to the seabed (just as we did with the North and South Tower caissons previously reported on in the Project Update). This is the foundation for pier S1, the largest of the viaduct support piers on the south side. Then we have more traditional cofferdam foundations, constructed from sheetpiles to create a box which sits in the seabed above the bedrock. The box is partially filled with mass concrete on top of which the reinforced concrete pier is built. Lastly, on dry land we perform a straightforward open excavation in which we construct the base and pier.

Work on the foundations and pier construction has gone well, allowing us to begin work on the South Approach Viaduct steel superstructure on schedule. (Work on the – much shorter – North Approach Viaduct superstructure is scheduled to start in early 2015.) In February this year, we began the “launch” of the steel sections for the north and southbound carriageways of the South Approach Viaduct. These were fabricated in Darlington by Cleveland Bridge, with finishing welding work and preparation



The Southern Approach Viaduct looms over Society Road



Aerial view of the Southern Approach Viaduct being launched out over the support piers

for installation carried out on-site. They will have a remarkable total weight of 7000 tonnes. Local people have recently seen the giant steel structures emerging over Society Road. These steel sections will carry the road deck out to the new bridge, but the actual process to lay the road deck does not begin until the viaduct launches are complete. This is scheduled for early 2015.

The launch process involves welding steel sections together on land before using powerful hydraulic strand jacks to pull them out over the piers. Cables attached to king posts rising at right angles to the steel sections lift the front edges of the structures to counteract the effect of gravity and ensure that they are at the correct height to meet the lateral guides positioned on the top of each pier. These guides make sure that the viaduct steel sections are in exactly the right alignment as they head out towards the bridge. We believe this may be the first time this launch system has been used in the UK.

Our aim for the rest of 2014 is to carry out one new launch per month on average, so people will soon see the South Approach Viaduct making its way out over the water. In total, there will be 12 launches. It is an exciting phase as the viaduct superstructures represent the first horizontal elements of the project – in

other words, the first time the public have seen something that is recognisably a bridge in the making.

The main challenges involved in the construction of the viaducts are the same as with other parts of the Queensferry Crossing project – ie. weather, especially wind! Logistically, we are working in a confined space which makes the delivery of the steel sections and their preparation for launch a tricky operation. But we have succeeded without any problems so far thanks to careful planning and the skills of the team. Working at height is another consideration. The launch procedure has the benefit that all steel sections are assembled in a launching bay behind the abutment at ground level, so works at height are minimised in comparison to other erection techniques. The alignment of each new section as it is welded on to the section in front of it is critical, so great care is taken to get it 100% right before each launch. During each launch operation, a sophisticated monitoring system is used to control all movements and positioning. It would be too late to make adjustments once the superstructure is fixed into place on top of the piers!

By Juan Jose Consuegra Perez, FCBC Approach Viaducts Manager

Making Connections

In April, “New Civil Engineer”, one of the country’s most respected civil engineering journals, published a feature article looking at the construction of the new roads, north and south of the Forth, which will connect the Queensferry Crossing to the existing trunk road network.

NCE articles such as this are a credit to all involved in the project: FCBC (comprising HOCHTIEF Solutions, Dragados, American Bridge International and Morrison Construction), the Design Joint Venture (Ramboll, Grontmij and Leonhardt Andra & Partners) and the client, Transport Scotland, and their advisers, Jacobs and ARUP). Here, we publish excerpts from the article (with thanks to NCE).

New road links from the bridge site to the existing motorway network are fast becoming reality on both banks of the estuary. As innovative in design and construction as the new bridge itself, this 6.4km of new and upgraded motorway link road contributed significantly to the project’s keen £790M tender bid three years ago from winning contractor, Forth Crossing Bridge Constructors (FCBC).

Now half complete, this £109 million package of largely raised motorway both sides of the bridge boasts half a dozen different ground treatment techniques, plus considerable brownie points for sustainable construction, as the contractor swapped the client’s suggested piled viaduct designs for a single, record height embankment.

To create the initial 300m of elevated motorway, sweeping off the bridge’s

northern end, the client had proposed a multi-span piled viaduct. Instead, FCBC designed a much shorter 100m viaduct, carrying the approach motorway over a local road and dedicated bus lane, with the remainder one impressive 200m long embankment, up to 25m high.

Reducing construction costs for this section by some £30 million has, though, given FCBC engineers a considerable technical challenge.

“This initial length of road is routed across a complex mix of hard, soft, weak and reclaimed ground with local contamination – hence the initial piled viaduct design,” explains FCBC head of network connections Ross Glendinning. “By opting for one large embankment we must first treat the ground beneath with a wide variety of strengthening techniques.”

The route crosses reclaimed riverside, now a marsh created with material excavated a century ago to form a nearby dockyard. It then sweeps over an old quarry loosely infilled with boulders and a landfill site containing domestic waste.

Ground treatment for the new Ferrytoll embankment ranges from the relatively conventional dig and replace, surcharging, sand and band drains, to more complex



“By opting for one large embankment we must first treat the ground beneath with a wide variety of strengthening techniques”

ROSS GLENDINNING

trench mixing and controlled modulus columns (CMC). These last two techniques have been needed mainly in the weak reclaimed riverside area lying beneath an adjacent smaller second embankment that carries the realigned B981 and the new bus lane. These columns leave soft ground undisturbed and are much more economic than the alternative precast piling often earmarked for particularly weak areas.

Ground strengthening is now complete and about two thirds of the main 160m wide embankment laid over the top. Towering up to 25m, it is claimed to be one of the UK’s highest man-made embankments and is being formed conventionally in maximum 800mm layers.

Fill for both embankments is sourced locally.

A 20m high dolerite hill lies to the north near the motorway trace and could have been left alone, but FCBC opted to remove it to provide a valuable 120,000m³ of fill for the main embankment. The remaining 380,000m³ of fill is also won from near the bridge site. This material is recycled from a vast stockpile of spent oil shale, the discarded by-product of the area’s once booming shale oil industry sited near the estuary’s southern shoreline.

“The contractor has developed a varied geotechnical design which is working well and has saved us all time and money,” says Transport Scotland’s roads and infrastructure manager, Steven Brown.



An aerial view showing the new Queensferry Junction under construction and the route of the new stretch of the M90 to the south of South Queensferry

“Use in the embankment of non-primary aggregates won locally has offered a good sustainable solution.”

South of the bridge, the main challenge constructing the 3km link road to the existing motorway network centres on minimising disturbance to the town of South Queensferry. The closest section passes just 50m from housing and the road profile has been designed specifically to economically balance cut and fill. This allows a semi urban stretch to be formed within a sound-muffling 8m deep cutting topped with acoustic barriers.

Noise, dust and vibration are closely monitored round the clock at both road sites in common with most major construction schemes. But the Queensferry Crossing project faces strict restraints – not just contractual but legally binding through the project’s parliamentary Act.

Any construction activity likely to generate even minor disturbance has to be approved up to 72 days in advance by a 20 strong external liaison group, formed of key stakeholders, national environmental bodies and local councils.

To this committee Glendinning must submit for approval a detailed Plan for Control of Noise and Vibration (PCNV) before hopefully receiving an Issue for Construction (IFC).

“Our environmental approval process is modelled on a hybrid bill similar to the one used to oversee the Channel Tunnel project, forcing me to plan detailed construction activities up to six months in advance,” says Glendinning. “For major events, we have to provide around 20 bespoke documents, triggering a significant administration exercise.”



The Ferrytoll embankment takes shape with the Forth Road Bridge north tower in background

Environmental Monitoring – Monitor Hosts & Good Causes

FCBC carries out all construction activity under a contractual requirement to monitor its environmental performance. Since the beginning of the Forth Replacement Crossing project, a number of our neighbours have selflessly volunteered to host, on their properties, the technical monitoring instruments involved.

Liam Soden, FCBC’s Environmental Manager, explains: “Equipment to measure potential pollutants is strategically placed so that FCBC can accurately measure, record and report on our performance in controlling the levels of dust, noise and vibration throughout the construction period. We are extremely grateful to local residents who host these instruments in their gardens, and/or provide the power source to operate them.”

Ewen Macdonell, FCBC’s Community Liaison Officer, recently hosted a light lunch at the Contact & Education Centre to thank the “Monitor Hosts” for their support. They were also given a presentation on the progress of the Queensferry Crossing as well as a site tour.

We have 16 “Monitor Hosts” who, as part of this initiative, are asked each year of the project to nominate a good cause to receive a donation of up to £500 from FCBC. This is the third year that the scheme has been in place and a large variety of causes are benefitting.



Considerate Constructors Gold Award

In March, the FRC Project received a second successive Gold Award from the Considerate Constructors Scheme. The objective of this national scheme is to promote the highest possible standards within the construction industry via continuous improvement.

Carlo Germani, FCBC’s Project Director, commented: “To win successive Gold Awards is testament to the effectiveness of our ongoing quest for improvement in everything we do.”

Many initiatives have caught the eye of the Considerate Constructors Scheme, including the Monitor Host Good Cause Initiative (see above) and last year’s Forth Road Bridge Veterans Day to name but two, but the scheme doesn’t let us rest on our laurels. We need to strive to do better in many different areas..... and so the quest goes on!

CEC Update

The FRC exhibition at the Contact & Education Centre (CEC) attracted 2,400 visitors over a series of Open Days held between April and November 2013 and, due to the positive feedback received, we are now open every Saturday from 10am – 4pm until 25 October 2014.

The Project Outreach & Education programme is going from strength to strength as the project progresses, with over 2,000 school pupils having visited the CEC since the beginning of the 2013/14 academic year and over 2,500 people attending one of our pre-booked talks or presentations.



Pupils from Alloa Academy visit the CEC in March 2014



The best seat in the house!

Destined to become the highest in the UK, three large yellow cranes are now an increasingly visible and rapidly growing feature of the Queensferry Crossing construction site out on the Forth. We talk to **Andrew Hume**, FCBC Crane Controller, to find out more about what these tower cranes are for and how they operate.

Q First of all tell, tell us something about the cranes themselves.

A The cranes are made of modular structural steel components connected using high tensile steel bolts. They will rise to a staggering total height of 235 metres (770 feet) above the water when the three bridge towers are nearing completion. At that point, they will weigh about 450 tonnes. The maximum lift capacity of the cranes is 40 tonnes. They are independent structures adjacent to the towers themselves, being based on separate foundations pile-driven into the seabed. This makes them by far the largest single element of the project’s temporary works (*Ed note: see October 2013 Project Update for more details of the all-important temporary works*).

Q How do the cranes increase in height?

A The process is ingenious and, for the uninitiated, rather surprising. At the top of the crane just below the cab and jib (the long horizontal “arm” at the top of the crane), there is a separate hydraulically operated external climbing frame. This pushes the jib upwards 6 metres allowing each new 5.8 metre section of crane, which has been hoisted up from the water level barge by the crane itself, to be inserted on to the main “mast”, or tower, of the crane. Once fixed in place – a two hour operation – the jib is then lowered to rest on the newly lengthened mast. Each new section of crane weighs 6.4 tonnes. It’s clever stuff!

Q How is the crane stabilised?

A Well, apart from the sizeable foundations at the bottom, a series of steel “ties” will be fixed at regular intervals from each crane mast to the concrete bridge tower. There will be six ties in total. The crane is designed to flex, or twist, with the wind and under the weight of whatever it is carrying at the time, but it is clearly essential – especially at the extreme heights we are talking about – that the crane is securely attached to the permanent bridge structure.

Q And what function do the cranes perform?

A The cranes are used to lift into place materials used in the construction of the bridge’s towers. This includes steel reinforcement bars (known as “rebar”) which reinforce the concrete in each new section of tower, and the concrete distributors which ensure an even spread of concrete during concrete pours. The cranes also lift into place each new section of the steel internal tower stairway and elevator structure. They do not lift the concrete used in the tower construction; this is pumped up to height by powerful pumps at the bottom of the tower structure. Above road level, the cranes will lift and place into the towers the large steel anchor boxes which anchor the bridge’s cables to the towers.

Q The scale of the cranes is enormous. Are they safe?

A Yes, they are! We closely follow the manufacturer’s operating instructions and HSE regulations and guidance (LOLER 1998 and BS7121). The cranes are inspected daily before use and a weekly inspection is also carried out. The cranes are serviced every 8 weeks and undergo a thorough examination every 6 months which is necessary to maintain

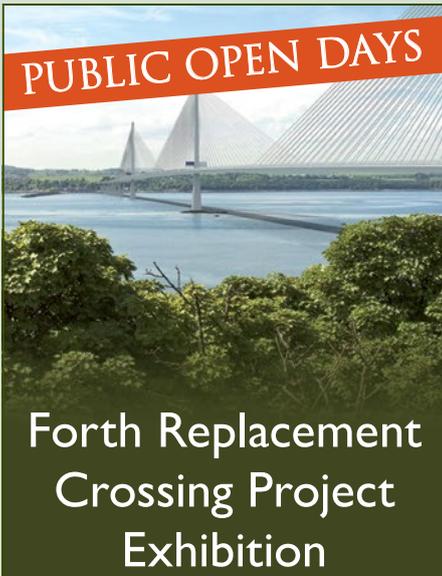
the operating certificates issued by the Health & Safety Executive without which we are not allowed to work. In addition, we liaise very closely with our colleagues in the Marine Office who receive hourly wind forecasts from the Met Office (*Ed note: see February 2014 issue for information the close liaison between FCBC and the Met Office*). The maximum wind speed we are allowed to work is 38mph – about Force 7. An anemometer gauge fixed to the top of the crane feeds constant wind speed data to the crane operator sitting in the cab.

Q How does the crane operator get to his cab?

A At the moment, with the cranes at only 25% of their eventual height, the operator climbs up the steps contained within the structure of the crane’s mast. It certainly keeps you fit! Later on, as the bridge towers reach ever higher, there will be an elevator attached to the outside of the towers to take the construction teams up to the top. The operator will then cross a gantry between the tower and the crane from where steps will take him further up to the cab. It’s a similar process, really, to astronauts making their way to the control capsules at the top of rockets prior to launch.



New sections of tower crane being prepared for installation as the crane rises ever higher



Forth Replacement Crossing Project Exhibition

OPEN SATURDAYS 10AM – 4PM

The new Queensferry Crossing is steadily rising from the waters of the Forth. The Project is reaching an exciting stage of construction with the towers visible from the FRC Contact & Education Centre.

In response to demand, the FRC Exhibition is now open every Saturday, 10am – 4pm until 25th October 2014 for anyone interested in finding out more about the largest transport infrastructure project in a generation.

We welcome visitors of all ages to visit this free exhibition to learn about the project, view the exhibition boards and 3D models and take in a presentation and ask questions about the project. The centre provides spectacular panoramic views including the existing Forth Bridge and Forth Road Bridge as well as the chance to assess the construction progress on the Queensferry Crossing. Staff will be on hand to answer your questions and explain more about the work being undertaken.

You can find us at: FRC Contact and Education Centre, Ferry Muir Gait, South Queensferry, EH30 9SF. (See map below)

SCHOOLS UPDATE

Camdean Primary School, Rosyth – Science Week

Staff from FCBC (engineers, surveyors, planners, environmental and health & safety advisors) took part in Camdean Primary School's Science Week in March. This involved an initial address to the school assemblies on the Friday to set the scene, followed by a number of staff members spending two periods each in different classes the following week. The cumulative effect was that 26 separate classes received a talk from an FCBC staff member. Carrie Parkyn, Camdean's Depute Headteacher, was delighted: "FCBC's talks completely captivated the children and will hopefully help to inspire the next generation of engineers! It was fantastic to have so many people from different fields of science and engineering and it really helped the children to understand the variety of different jobs and their role in such a big project. All of the speakers engaged really well with the children and I hope they enjoyed the experience as much as the children!"

Bridges to Schools

Local primary school pupils enjoyed building their own cable stayed bridge at the FRC Contact & Education Centre at the end of April. "Bridges to Schools" week has become a popular annual event for FCBC, organised in conjunction with the Institution of Civil Engineers. The event is intended to give primary school children an insight into the challenges of civil engineering while having some fun along the way.



Budding bridge engineers prepare to walk across the bridge they have just constructed

Almost 300 pupils from seven local schools attended the event over the course of the week. Dressed in hard hats and high visibility vests, they participated in the construction of a 12 metre long model of a cable-stayed bridge, supervised by volunteer civil engineering staff from the Queensferry Crossing project. The pupils were then able to walk across the bridge (some asked their teachers to test it first!) before deconstructing it. The whole construction and dismantling process takes little more than an hour.

In addition to learning about the new Queensferry Crossing itself, the focus was on health and safety, teamwork and civil engineering in general.



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**

Log on to the project website at

www.forthreplacementcrossing.info

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

