

Lessons learned from one of New Zealand's most challenging civil engineering projects: rebuilding the earthquake damaged pipes, roads, bridges and retaining walls in the city of Christchurch 2011 - 2016.

# Triumphal Arch and Bridge of Remembrance communication updates

# Story: Bridge of Remembrance and Memorial Arch

Theme: Construction

A series of communication updates provided by SCIRT's Downer Delivery Team to the Christchurch City Council. These updates detailed the progress of the Arch and Bridge restoration.

This document has been provided as an example of a tool that might be useful for other organisations undertaking complex disaster recovery or infrastructure rebuild programmes.

For more information about this document, visit www.scirtlearninglegacy.org.nz









**Fulton Hogan** 





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28/06/2013

# Triumphal Arch and Bridge of Remembrance June Update



The work site around the Triumphal Arch fully has been established and is secure. now Weather conditions in the middle of June have caused some delays but things are back on track and some exciting work has begun.

June has seen some major preliminary works take place on site to prepare the arches for strengthening. Firstly the removal of the two lions. The ornate lions were removed for their protection. They have been removed in the original sections in which they were sculpted, four sections each, one section lifted off at a time. There were no concerns lifting the heads. The stonemason has specially made crates for each lion head which has been labelled, photographed and securely locked away.

The construction teams have created openings, by cutting through the concrete in both the major



and minor arches. The opening of the minor arches were undertaken where the lions were formerly positioned. An internal visual inspection was undertaken, the minor arches were dry and the timber formwork was in a reasonable

condition. This was not the case for the major

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arches, the visual inspection unveiled very wet and rotten timber formwork. During visual inspection of the columns the teams found two, six inch thick, concrete slabs. These concrete slabs have openings to allow access to lower levels. With these findings further investigates will need to be made into the design. The completed video re-strengthening

inspection and surveying of the internal arches will be undertaken by 3 Way Solutions and is scheduled for early July. Detailed dimensions will be provided to the SCIRT designer for confirmation of the internal design strengthening methodology.

### **Bridge of Remembrance**

Bridge works are planned to commence when the stonemasons are finished working on the Arch.

As work on the bridge will be primarily accessed by the river SCIRT contractors Downer have engaged the

services of an ecologist to ensure aquatic life will not be effected.



### Coming up in the next month

Christchurch

- Removal of the of the internal timber formwork.
- Investigations into the concrete shelves in the major arches.
- Stonemasons visiting Tasmania to source additional stone from the original quarry.
- River ecologist to survey river bed and provide feedback on possible trout spawning sites before installation of the temporary river dam.





#### 06/08/2013

# **Triumphal Arch and Bridge of Remembrance July Update**

#### **Triumphal Arch**

July has been a month of internal investigations, and readying the Triumphal Arch for the structural reinforcement.

The team on-site has been busy removing the timber formwork inside the arch which will be replaced with steel casing. We are now 90% of the way through this removal.

To allow access to the inside of the arch the top has been removed and an over hang scaffold has been put in place so that the structure is not damaged while we investigate the internal structure.

The bronze plaques on the arch have been removed and taken away for historic preservation



Image one: original wooden form

When the plaques were being removed, the team found names carved on the underside, believed to be those of the men that constructed the arch.



Image two: where the plaques were removed

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A second survey will take place to investigate further inside the Arch for the purpose of design and forward planning. Scaffolding around the Arch will then be dismantled and work will begin on the Bridge of Remembrance.



#### **Bridge of Remembrance**

This month we have been planning for the work that will be undertaken to repair the Bridge of Remembrance. The Stonemason has visited Tasmania to source the stone specific to quarries of that region. Unfortunately with many quarries now closed down, the search will have to go further a field to look on private land in Tasmania.

Environmental planning has been taking place and a design set out for a guttering that will collect any debris made from the stone cutting while the stone masons remove the damaged stonework on the bridge.

#### Coming up in the next month

Christchurch

- Erection of the scaffolding around the bridge.
- On-going investigations to source the stone for the Bridge of Remembrance
- Stonemason to start taking down the damaged stone work on the bridge.







#### 14/10/2013

# **Triumphal Arch and Bridge of Remembrance October Update**

#### **Triumphal Arch**

Work is progressing well on the Triumphal Arch. Although there has been little visual progress there has been a great deal of investigation work taking place behind the scenes. The investigations have provided new information about the internal structure of both the minor and the major arches.

Investigation work has shown that the internal dimensions vary from the as-built drawings in both the major and minor columns. Concrete 'shelves' have been discovered in the major columns.

The concrete shelves provide no structural purpose and can be safely removed. Changes are required to the internal steel column design.

A modified design is required for the minor arches. On-going discussions with Southern Cross Engineering, the Designer and Downer are progressing. When the redesign is finalised a large scale timber box template will be created and lowered into the columns. Once this test is complete and design approved, Dower will be in a position to order the steel.



Early testing with a smaller timber box

Removing the scaffolding from the Triumphal Arch

The scaffolding that was in place for the initial investigation works has been deconstructed. The tiles and coal tar around the base of the arch is now being removed in preparation for piling and foundation work.

#### **On-going work**

Remove tiles around the base of the Triumphal Arch.

Remove several layers of coal tar beneath the tiles.

Sub-Contractor, Piletech is preparing a screw pile design for submission to SCIRT designers.









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#### **Bridge of Remembrance**

The Tasmania quarry that supplied the original stone closed a number of years ago. The Stonemason has found an alternative stone sourced from the same area in Tasmania. The stone has been analysed and has identical characteristics to the original stone. The alternative stone has been approved by CCC Heritage Advisor, Jenny May, and CCC Asset Owner, Maria Adamski.



Capping stone removed from the north parapet



Capping stones have been removed off the parapets to access lower stones that need to be realigned. There are a small

A stonemason imploding a damaged stone.

number of stones situated at the base of the parapets that are damaged. These are surrounded by many undamaged stones. The stone masons are carefully removing the damaged stone using a method called imploding. Imploding is where the stone is collapsed inwardly enabling the undamaged stone to remain intact.

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Now that the CCC Heritage Advisor has agreed on the mortar mix the teams are progressing with relaying stone on the north parapet.

Spalled stone, splintered pieces from the surface of the stone, will be fixed back in place. Stone with natural spalling will be left as this is part of the bridges history.

#### Coming up in the next month

- Work continues on replacing stone that has been removed.
- To strengthen the parapets 1.2m stainless steel pins are to be drilled and installed through several layers of stone. The caps will then be put back in place.
- Damaged stone around the Northwest abutment will be removed.

#### Environmental

Bidim cloth is being used on scaffolding overhanging the river to catch debris and filter any run-off from the stone cutting.

A second system installed in the river below is a floating boom and silt curtain. This system will catch any debris that escapes the Bidim cloth.

#### **Community Engagement**

Downer wanted to involve the community in creating a larger scale model and met with the principal and technology teachers from Christ's College. Downer proposed a model competition. Students from three Year 10 classes will compete against one another to create a large-scale model.

The model must demonstrate the technical repairs to the Triumphal Arch. The three classes will focus on this project during terms three and four. The models will be judged by SCIRT

and the winning



Example of a model

displayed at the Triumphal Arch site later in the year.

The Communications team are in the process of arranging site visits for students from local schools such as St Michael's School.

model will be

Options are being considered for a Bridge Open Day.









#### 07/11/2013

# **Triumphal Arch and Bridge of Remembrance November Update**

#### **Triumphal Arch**

As work continues on the Triumphal Arch the Downer crew are learning more about the original construction of the structure and surrounding area. This has resulted in a number of unexpected findings.

A hydro excavation contractor is working with the engineers to investigate the proposed pile sites. In the south east pile position a number of services have been exposed including four high voltage cables. Discussions are in progress with Orion to have these cables redirected before the piles are installed.

Surveying of the void inside the minor arches continues as they are different to the original plans. Confirmation of the dimensions at the base of the void is required by the designer. From these dimensions the steel columns will be fabricated that will be inserted inside the minor arches.



Layers of coal tar and sand under the tiles

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Hydro excavation site



Four high voltage cables alongside other services in the excavation hole

Lifting the coal tar from around the base of the Arch continues. The Downer crew have been surprised to find four separate layers of coal tar which is being removed in preparation for the installation of the piles. Uncovered beneath these layers of coal tar and sand is the original kerbstone that was in place when cars drove under the arches.





#### **Bridge of Remembrance**

Work is progressing on the bridge.

- On the south parapet all the stainless steel pins have been installed. Now this is completed the capping stones can be replaced.
- All the capping stones on the north parapet have been replaced.
- There is a large crack on the northwest abutment of the Bridge that can be seen from Remembrance Park. Half of the stone around this crack has been removed. Once all the stone has been removed we will investigate the extent of damage to the concrete interior of the abutment. Cracks found in the concrete will then be repaired. Stone that is in good condition and stone that is repairable will then be re-laid.

#### **Armistice Day**

The Returned Services Association, RSA, are holding the 2013 Armistice Day Service at the foot of the Sergeant Henry Nicholas VC MM statue in Remembrance Park beside the Bridge of Remembrance. Downer have been in communication with the RSA. In respect to those New Zealanders who gave their lives for us in World War I and all subsequent conflicts across the Globe we will be attending the service at 11.00am on Monday 11 November 2013.

#### **Community Engagement**

Downer is organising a Bridge Open Day in the Central City. This will be on Saturday 30 November 2013 between 10am and midday. There will be Downer engineers, environmental and communications staff available at the Bridge of Remembrance and the Colombo Street Bridge to inform the public of the work we have completed to date and what is yet to be done. These two bridges are in walking distance of each other along the banks of the Avon River. We expect that many

of the public will come and participate in the Open Day either on foot or on bicycles and afterwards enjoy lunch in the Central City.



Northwest abutment



Close up view of crack



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#### 17/12/2013

# **Triumphal Arch and Bridge of Remembrance December Update**

#### **Triumphal Arch**

Downer has continued exploring the location of services around the proposed pile positions using hydro-excavation.

Pile testing was deferred until Orion's four high voltage power cables were relocated away from where the new piles are to be inserted. These cables have now been re-laid further away from the Triumphal Arch foundations towards the east entrance of the Bridge.

The pile load testing is now planned to be undertaken in February 2014.



Jointing the four high voltage cables

#### **Bridge of Remembrance**

There has been plenty of activity on the Bridge of Remembrance repairing stone that has minor cracks and spalling (splintered stone). Along with this minor work the bridge parapets have now been completed. The majority of the scaffolding for the parapets has been removed. Only a small amount remains in place to give access to the abutments.

The scaffolding system to access the parapets has been recognised by SCIRT as a value innovation. Due to the working area required by the stone masons and the desire to

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1—The crack in the lighting column after being injected.2- A close up view of the crack injection method.

not disrupt the Avon River bed by installing scaffold foundations Downer invested time to design a creative solution. The outcome was a hanging scaffold with counterweights which also allowed access for the crew to work on both the parapet and arch at the same time.

The stone around the crack on the northwest abutment has been completely removed. The cracks in the concrete that sit behind the stone can now be repaired by the crack injection method. Work on the large crack on the southwest abutment is due to start in the New year.

The stone on the northeast lighting column has been repaired using crack injection. It was planned to deconstruct this stone but when investigated the damage was found to be less severe.

#### Holiday shut down

Over the holiday break the site will be secured with minimal scaffolding left in place. The Downer crew will return on Monday 13 January 2014.





### **Community Engagement**

#### **Armistice Day**

The Downer team stopped work on the Bridge of Remembrance site at 10.50am on 11 November 2013 to join the Christchurch Memorial and Returned Services Association (RSA) and NZ Veterans to remember the sacrifices by our NZ Defense Forces for Armistice Day.

Downer Communication Team member, Roslyn Service and Site Foreman, Paul Williams laid a wreath at the base of the Sgt Henry Nicholas VC MM statue to honour the NZ soldiers that gave their lives to protect our country.

#### **CTV news story**

Downer Project Manager Tim Mason was interviewed by CTV at the Bridge of Remembrance site. Tim explained the work Downer has done to date and the systems that will be installed to future proof the Triumphal Arch from further seismic events. This news story was aired on CTV prior to the 2013 Armistice Day celebrations.

### **Open Day at the Bridge of Remembrance**

On Saturday 30 November 2013 Downer welcomed over 200 people to the Open Day on the western end of the Bridge of Remembrance. Downer engineers, environmental and communications staff were joined by two Christ's College year 10 students. All involved were kept busy talking with the interested public about the work being done on the bridge and arch. On display Downer had three interactive models of the Triumphal Arch that have been created by the Christ's College students. These models along with the other ten will be judged in the New Year against the competition criteria.

### HAPPY HOLIDAYS FROM THE DOWNER TEAM



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Paul Williams laying the Downer wreath



Public getting a close view of the Triumphal Arch



One of the interactive models created by students from Christ's College





21/03/2014

# **Triumphal Arch and Bridge of Remembrance March Update**

### **Triumphal Arch**

Work resumed in January with test piling and ground investigation work following on from the high voltage power cables being relocated away from the arch at the end of last year.

Installing the new piles up to 24 metres deep is one of the critical paths to strengthen the arch.

Before the 18 screw piles are installed the following stages are undertaken:-

- 1. Review of geotechnical investigations reports outlining the layers and properties of the ground. This
  - informs us on the suitability to install the test piles.
- 2. A test pile is then installed in the ground adjacent to where final piles will be placed. This step is to test that the pile design is correct.
- Once the engineers are satisfied that the design is correct, construction of the permanent piles will commence.



The first test pile being installed.

Design considerations for stage 2 are:-

- The screw pile is the best type of pile to install.
- The ground conditions are suitable for the piles to penetrate through the various layers.
- The pile is load tested to ensure the designed behaviour is achieved and will therefore support the arch.



Ground conditions encountered at test pile location.



To gain more specific ground information in the immediate area of the pile locations, two additional boreholes have been undertaken.

Downer is working with the specialist screw pile contractor and are reviewing the new information to develop options to move forward.

### **Bridge of Remembrance**



Grease nipple sealed into the concrete crack. The grout is injected through this nipple.

Work is progressing on the west abutment. The stone has been removed to expose cracks in the concrete. The cracks have been cleaned out and sealed in preparation for being injected with grout. Α number of grease nipples are inserted into the concrete inject the to grout specifically into the crack cavities.



Crack is exposed in the concrete layer below the stone.

Crack is sealed in preparation for grout injection.

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# **Community Engagement**

### **Triumphal Arch Model Competition**

Downer and Christ's College have collaborated to produce a number of large models of the Triumphal Arch. The criteria for the year 10 technology students was to build functional models that demonstrate the earthquake proofing mechanisms that Downer will install. The models were judged in February 2014 by a panel of judges from Christchurch City Council, Christ's College and SCIRT. The winning team of four boys produced an exceptional product. The first placed team will be taken on a tour of a number of SCIRT sites around the Central City.

Teacher Tony Holland said the model-making project gave the boys a strong focus for the end of 2013 and they had all risen to the occasion. Technology was a popular choice at the school for many boys thinking of engineering or architecture careers, although the winning team all agreed they were open-minded about their futures at this point.

CTV filmed the event and an item was included on the Friday night CTV News.

The top three teams have agreed to their models going on display at the Bridge of Remembrance and around the city.



Judges discussing the merits of each of the seven models.



Peter Routledge, SCIRT designer, and Emma Parkinson, Downer Project Engineer examining the sliding joint system on a model.



The winning team, from left to right Ben Smith, Sam McGuire, Logan Findlay and Hunter McKenzie. In the background are the two runner up teams.

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Rebuilding earthquake damaged roads, water, wastewater and storm water pipes.

# **Triumphal Arch and Bridge of Remembrance October Update**

Chris Gareze, who previously worked on the Heathcote Bridge, has joined the project as Project Engineer.

### **Triumphal Arch**

Work has ramped up on the Triumphal Arch over the last month.

March Construction is contracted to test and install the piles. A new pile design using mini bored piles has been accepted. These piles are smaller in diameter which are advantageous to working this site with on а vulnerable structure. The advantages are that:

the drilling process will cause less disruption and vibration.

The plant used is smaller and lighter which is better suited for the Bridge structure.

The bore piles can penetrate through the hard layer of the ground that was experienced with the screw piles.

We will be installing 32 mini bored piles to a depth of 25 to 30 meters deep.

We have now installed one test pile. After 28 days we will test this



Chris Gareze on the right with site foreman Trevor Watling



Piles being installed



An installed pile still to be cut to finished level.

pile with a tension pull out test. This is to prove that the pile can perform as designed. We have also successfully

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installed four permanent piles.

Downer used a 3D laser scanner to create a computer 3D model of the Arch. This tool has given the Engineers many advantages:

1. The internal dimensions of the arch are needed to design the strengthening components, steel boxes and channels. These dimensions are irregular. The

3D laser scanner has given us these dimensions in a safer method than putting a person inside the structure to do measurements.

2. Inserting the steel boxes and channels inside each of the columns in the Arch will be a very complicated

3D model of steel box and rocking collars

process. The Engineers are now able to check the feasibility of their planned method which will involve carefully inserting each piece and rotating it into position before inserting the next piece.

3. When the steel boxes are being inserted they need to

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be lined up with the base plate. The 3D model allows the Engineers to plan how this will be done.

In preparation for the base plates to be positioned the Stone masons are removing the exterior stone to create access at the base of each column. This will give the engineers access to manage the precise placement of the baseplate, the steel boxes and the channels.



Stone mason cutting into the inner concrete layer.

03/10/2014







### **Bridge of Remembrance**

The work on the Bridge almost completed is except for the northeast wing wall. One of the design strategies to prevent damage and cracking in the event of a seismic event is to cut stone creating the а space between the



Example of the cut between the bridge balustrade and the arch.

bridge balustrade and the arch column. The northeast wing wall will be repaired at the same time as this piece of work.

A number of monitors have been installed to safe guard both structures from any damaged caused from the repairs. These are:

> Vibration sensors are placed at strategic points that are linked to a computer. NZTA



has set limits specific <sup>A crack monitor on the minor arch</sup> to work on heritage

structures. A daily report is produced. Warnings are also given on the computer as well as an alarm in the event of any excessive vibrations.

Tell tails have been placed on all visible cracks. These are to monitor any changes in the cracks due to the ongoing work.

A total station survey is done twice daily. This monitors the overall position of the arch to assess if there is any settlement of the arch during the piling process.

# **Community Engagement**

### **Business Day**

Neighbouring businesses in close proximity of the Bridge of Remembrance were invited to visit the site in August. The original day in July was postponed due to a sleet and wind weather forecast.

Even though the day was overcast and cool we were pleased to have over 50 people attend the three sessions that were offered, catering for staff to fit a visit in with their work schedule. Information included samples of stone, environmental systems, models built by Christ's College of the Arch and posters as well as having Engineers and Stone masons on hand to answer questions.



Downer staff with a visitor at the Business Day

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#### 17/12/2014

Ref: 10465

# Triumphal Arch and Bridge of Remembrance December Update

# **Triumphal Arch**

There has been good progress with the work on the Triumphal Arch. We have installed all 32 piles to a depth of 25 meters. These foundation piles have been cut down to their final height.



Saw cutting the debonding cut into the major column. In front are three installed piles cut to their final height

The area around the base of each column has been excavated to a depth of two meters. Over 200 cubic meters of material has been taken out of this area. A concrete floor was then laid to create a work area. This excavation has created the space to continue the work on the foundations.

This work includes -

• Inserting reinforcing bars into each column. 132 holes are being bored into the four columns at a depth of 850mm. These bars tie together with the piles as part of the foundation.



Excavating around the base of the Arch

- Cutting around the circumference of each column with a 300mm cut to create the rocking collar. This will "debond" each column and enable it to rock if there is a seismic event. This has been completed on the two major columns.
- Access hatches have been cut in each column. This enables a construction worker to be on the floor inside the column. The floor is being lowered to assist with the rocking collar system.



3D modelling of the pile cap and rocking collar

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# **Triumphal Arch continued**

- When one of the crew is inside a column he wears a safety harness attached to a winch that sits on top of the arch. This is a safety system designed to lift the person out in the event that he cannot access the hatch.
- A test plate has been trialled inside a column. The placement of this plate is critical as it will line up the steel box when it is inserted.



Above - Manning the winch at the top of the arch while one of the crew are inside the column Below - the test plate inside a column



Scaffold has been set up which allows work to be done at three levels simultaneously. While crew are working at height, a stone mason is removing stone at ground level and work is continuing in the excavated space below ground.



Scaffold erected around the Triumphal Arch

To work on the north column the area around the base has had to become dry. A dewatering set up has been in place that pumps the water away from the column base into a sediment tank on the Bridge. The water is then discharged onto the south riverbank. It is filtered through bidim cloth, which removes any further sediment and softens the flow of the water when it re-enters the river.



The dewatered site on the north side of the Arch

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# **Bridge of Remembrance**

Stone masons have started to remove stone on the north-east wingwall. This will create a movement space between the Arch and the Bridge. This stone is being securely stored on site.

There are some cracks on the north-east abutment that are yet to be repaired. When this is done all the Bridge work will be completed.

The final surface of the Bridge will be completed by the Christchurch City Council.

# Work in 2015

- Cores will be drilled in the columns where the rocking collar bars will be inserted
- The main pile cap will be reinforced with 30 ton of steel and 80 cubic meters on concrete.
- The steel boxes will then be installed in each of the four columns.
- Installing the post tensioning system in the arches.

# Community Engagement Kids Zone

A Kids Zone has been set up on the grassy area outside the fences on the southern side of the work site. St Michael's School visited the site to learn more from Sam SCIRT and the information bubbles.



Trevor Watling, Site Foreman, with students from St Michael's School. Back Row (L to R): Hamish O'Connor, Camille Perelini, Joshua Thornley, Lauren Matthews;

Front Row (L to R): Annabelle Caldwell, Emma Bennett, Sophie O'Connor.



Hamish O'Connor stands in front of Sam SCIRT



Two information bubbles in the Kids Zone

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Rebuilding earthquake damaged roads, water, wastewater and storm water pipes.

# Triumphal Arch and Bridge of Remembrance March Update

# **Triumphal Arch**

Work is progressing well around the Triumphal Arch above and below ground. The large excavated area around the arch structure has created the space, below ground level, where the rocking collars and steel reinforcing is being installed.

The rocking collars are a system that will allow each column to move independently if there is a seismic event. Each column has been "debonded'. Debonding is when a 300mm deep cut is made around the base of the column. Black polythene is inserted to provide a smooth rocking surface. 48 cores have been drilled into the four columns and rocking collar bars have then been inserted into these cored holes. These bars are designed to reinforce each column in the event of seismic induced rocking.

Steel reinforcing is being placed into each column to construct the main pile cap. These bars are another piece of the foundation and tie the original columns into the newly inserted piles. As work progresses more steel reinforcing will be laid down followed by the concrete pour to complete the foundation.

On the north side of the arch the column extends down beside the river. The temporary piling platform that was installed to build the low level pile cap around this column has now been removed. This work placed us close to the river bank. We installed systems to keep sediment out of the river and protect the river bank. Managing environmental impacts is a high priority for all SCIRT work.



Above - installing the rocking collar Below—epoxying the rocking collar bars into the drilled cores





Work on the north pile cap beside the Avon river. The yellow silt boom and the concrete blocks protect the river from silt run off

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16/03/2015



# **Triumphal Arch continued**

The scaffold that has reappeared around the arch is to create a platform for the stone masons and to provide access to the top of the structure.

The stone masons are removing the remaining stone to allow room for the insertion of the steel boxes (see below), channels and the insertion of the post tensioning rods.

Two steel clamps have been installed around the major columns. These are situated above the minor arch level and will reinforce the stone where additional cracking has been found in the concrete layer behind the stone. These clamps will also give additional temporary strengthening to the columns while other work is being carried out inside the major columns. These clamps have been designed to spread the load and protect the arch.

With the top of the arch accessible the first steel box has now been lifted into place in the south minor column. The rocking collar bars were then inserted through the bottom of the steel box. This ties together the steel boxes and the rocking collars.

The major columns are different and will have two steel channels lifted in first. Then the steel box will be inserted. These will all be located on the steel plate at the bottom of the column. This work is to be done in the next month.



Lowering the first steel box inside the south minor arch

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Right -Scaffold erected to the top of the Triumphal Arch.



A steel clamp fitted around the major column



Working inside one of the columns, in a confined space, roughing the concrete surface to make sure the new concrete will bond.

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# Bridge of Remembrance

Repairs the north abutment on the Bridge continues. Stone has been removed and the cracks in the concrete have been repaired by injecting them with grout. The original stone is laid back exactly where it originally was placed and any cracked stone is replaced with new stone sourced from Tasmania.

Work has also started on the north abutment to minimize damage from the arch if there is a seismic event. A space is being created between the arch column and the bridge abutment. This new seismic gap will be 100mm wide to allow the arch to move in the event of an earthquake and not affect the bridge structure.

### Upcoming Work for March and April

- The concrete pour of the foundation
- Installing the remaining steel channels and boxes
- Completing the rocking collars

# **Community Engagement** "Adopt A Bridge"

St Michael's School have "adopted" the Bridge of Remembrance.

St Michael's School is a close neighbour to the work site being situated across Lichfield Street. By adopting the bridge the students will have opportunities to follow the completion of this project with research, talks from the engineers and visits to the site.

In February the entire school spent an afternoon learning about the significance of the Bridge of Remembrance and the Triumphal Arch and about the work that SCIRT are doing. The students from years one to eight were split into two groups. While one group learnt about the historical significance of the structure and why SCIRT is doing these repairs the second group were visiting the site. Fraser Sherson, site engineer, talked with the students about the work he is doing to repair and strengthen the structures, the PPE (personal protective equipment) he wears and what work is still to be done.



Above - Fraser Sherson and Callum Pilcher from Downer talk to students from St Michael's School. Insert - Phoenix Newman, Sophie O'Connor and Jada Thomson use a model to understand the systems that are being installed on the Triumphal Arch.

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# **Triumphal Arch and Bridge of Remembrance April Update**

# **Triumphal Arch**

Work is progressing well around the Triumphal Arch above and below ground. The large excavated area around the arch structure created the space where the rocking collars and steel reinforcing have been installed. The concrete is now poured completing the foundations.

The steel boxes have been inserted in the two major columns and the south minor column. This was a technically difficult process but due to the detailed surveying of the column interior the insertion of the steel boxes went smoothly.

### WW100 Celebrations

Downer have attached a number of posters on the site fence provided by WW100. These posters are photos of WWI scenes both at Lyttelton and at Gallipoli, see photos below.

On Monday April 20th 2015 the Mayor, Lianne Dalziel, and Pete Dawson, RSA, will be present when the "Anzac Poppy" is installed on the scaffold at the top of the Triumphal Arch.

Rannerdale war veterans and residents are visiting the Bridge of Remembrance to lay a wreath on Friday 24 April.



A group of unidentified Australian and New Zealand soldiers in a front line trench on the Gallipoli Peninsula.



Above—the RSA "Poppy" installed on the Triumphal Arch Below—WW100 posters on the site fence



# **Anzac Day**

Anzac Day celebrations are being held in Latimer Square as in previous years.

Downer will have an area cleared on the Bridge of Remembrance for Anzac weekend. People who wish to visit the bridge and lay a wreath can access this site up the steps off Cambridge Terrace on the west side of the bridge.

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# Triumphal Arch and Bridge of Remembrance June/July Update

# **Triumphal Arch**

The foundations, the structural steel work and most of the post tensioning systems are completed. When the hexagonal concrete reinforced perimeter walls that surround the exterior of the rocking collars are completed we will fill in the last metre to level the ground around the base of the Arch. The perimeter walls will complete the rocking collar design ensuring all four columns rock in the same plane in the event of seismic movement.



Reinforced steel surrounds the rocking collars to build the perimeter walls.

We are now working on the many pieces that make up and support the sliding joints in the top of each of the arches.

We have completed installing the post tensioning system in both minor arches. Post tensioning is a system of inserting and anchoring 12.5mm steel strands across the top section of each arch. These strands will hold each arch in place after the sliding joint cuts are completed, like a rubber band. The post tensioning strands replace the structural tension that is lost when the sliding joint cuts are done.

The first step in this process is to insert PVC ducts in the existing cavity at the top of each arch. Post tensioning anchors are then installed at each end of the duct. A 40MPa fibre reinforced concrete mix is poured in to fill

the cavity and around the ducts. Finally five post tensioning strands are inserted into each duct. They are anchored at each end and then pulled, tensioned, at a specified force through one anchor.



Exterior stone has been removed to allow access to the internal cavity. The ducts have been positioned for the post tensioning strands to be inserted. Freshly poured concrete now fills the cavity.

All the structural steel has been inserted into the cavities. Each of the four columns have a steel box inserted inside the column cavity. These columns have then been filled with concrete in stages to minimise the hydrostatic pressure on the structure. When the concrete from one pour has set the hydrostatic pressure is reduced to zero. Another pour is then able to be carried out without stressing the structure. The minor columns, 6m high, had two pours or stages to completely fill it.

When the columns are completely filled with concrete the concrete and the steel boxes take the weight of the structure. The existing stone work of the arch then becomes a cladding or façade, like a jacket.





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# **Triumphal Arch continued**

On top of the major arch the final 8.2 ton steel beam has been inserted. The post tensioning system will be inserted inside this beam in the same process as we have done in both minor arches.

The sliding joints are made up of large steel plates that will slide on each other and allow the structure to move in a controlled manner. Each joint is made up of six pieces, three pieces on each side being outer, middle and outer. The two inner pieces for each joint have been installed through the opening in the top of each arch.

We have had a number of stonemasons busily working on the arch removing stone. This is to enable us to do the next phase which is installing the sliding joints. This stone is stored on site and will be returned to it's place on the structure when the work is completed.



Right:

The 8.2 ton steel beam being lifted into the top of the arch.



#### Top Left:

The top of the steel box inserted into the column of the minor arch before the concrete has been poured inside the cavity.

Top Bottom:

The top of the cavity now filled with concrete.



### **Bridge of Remembrance**

All work on the Bridge of Remembrance is completed and this project has now been handed over to Christchurch City Council

# Upcoming Work for July to September

- Post tensioning to be installed in the major arch
- Concrete poured to fill the major arch and the columns
- Removing stone to allow the sliding joint cut. This includes removing the cross at the top of the major arch and the coat of arms at the top of each minor arch.
- Inserting the steel plates on each side of the inner steel to complete the sliding joints
- Replace the removed stone

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- Install the lions and repair them in place on top of each minor arch.
- When SCIRT have complete this work Christchurch City Council will do the final stage - the paving work on the bridge.

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### **Community Engagement**

The Downer crew at the site had a busy few days leading up to Anzac Day. Downer had consulted with the RSA and it had been confirmed that the RSA did not intend to hold a ceremony at the Bridge of Remembrance site. Aware that this structure has great significance to the people of Christchurch Downer moved the fencing to create a space for public to visit the Triumphal Arch, to leave poppies as a sign of respect and to view some of the WW100 posters that were placed on the fences.

Christchurch Mayor Lianne Dalziel and Mark Solomon, Kaiwhakahaere of Te Runanga o Ngai Tahu were present when Downer placed the large poppy on the top of the Arch.

Downer also hosted residents from Rannerdale War Veterans home at the bridge on Friday 24th May. This was a wonderful occasion for them and many laid a poppy on the Bridge in respect of their fellow men and women. Downer also visited Rannerdale Home and gave a presentation to residents who were unable to make the trip earlier in the day to the Bridge of Remembrance. This included the historical significance and the work that is being done to repair this iconic structure.

Opawa School had an organized school trip into the Centre of Christchurch and the Bridge of Remembrance was on their tour. They brought with them poppies they had made and hung these around the WWI posters on the fences.

Below: Opawa School students placing their poppies around the WWI photos on the Bridge of Remembrance.





Below: Christchurch Mayor Lianne Dalziel with Mark Solomon Kaiwhakahaere of Te Rūnanga o Ngāi Tahu and Ros Service from Downer when the poppy was installed in top of the arch.





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# **Triumphal Arch and Bridge of Remembrance September Update**

# **Triumphal Arch**

The SCIRT earthquake repairs on the Triumphal Arch are close to completion.

The scaffolding has been taken down in two stages. Initially it was reduced to the minor arch level to give better access for work in this area. Now the scaffold has been completely removed revealing the completed arch.



The Triumphal Arch standing proud with scaffold removed. Final earthworks are being completed at the base.

The post tensioning work is now complete in the minor and major arches. The internal cavities of these arches are now filled with concrete. In total there were 30 concrete pours with a total of 220.5m3 of concrete.



A concrete truck on site with the pump putting concrete into the northern minor arch.

The arch is now a rigid structure with the stone work as a façade. The mechanisms that have been installed i.e. sliding joints and rocking collars, will allow this rigid structure to move in a controlled manner if there is another seismic event.

The sliding joints in all three arches are now installed. Each joint is made up of steel plates that will slide on each other in a controlled manner.

Right - One of the sliding joints installed in the arch. The two steel plates are surrounded by concrete. The stone is then replaced to complete the installation.



All the stone that was removed to either be repaired or to allow access for the installation of the mechanisms has been placed back on the arch.

The symbols that sit in the middle of each arch have been put back in place. Each of these symbols has been cut through the middle to line up with the sliding joint inside the arch. This will allow the structure to move without damaging the symbols in a seismic event.

The British coat of arms.

Above - before being cut for the sliding joint.

Below - with the cut in the middle which will allow movement.

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# The lions return







People will have noticed that the lions are again sitting on top of the minor arches.

When work started in June 2013 the lions were removed and carefully placed in storage.

The lions were originally carved in six pieces. Some of the earthquake included damage cracking along these joins as well as spalling or chipping of the stone. The tail ends. that are attached to the main arch structure, shattered.

The return of the lions was a slow process as each piece was carefully put in place to ensure they were not damaged.

The stone masons then repaired the lions on site. They have carved some new pieces as well doing as small repairs to the cracks. Stainless steel pins have been inserted into the lions to shear prevent movement,

movement from forces along the base of each lion. This is added protection if there is another seismic event.



Left -

The head of the southern lion being carefully lifted into place.

#### Below -

The south lion ready for repairs. The rear end is missing waiting for a new piece to be carved.



The completed northern lion proudly sitting on the arch.



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# **Triumphal Arch continued**

All the attachments and symbolism has been returned to the arch. The bronze lanterns have been hot waxed as part of their annual maintenance and installed along with the flags.



Above - a bronze lantern being hot waxed.

Below - the bronze lanterns and flags back on the arch.



Views from the scaffold taken under the major arch.

Above looking east over Re-start mall.

Below looking west down Cashel Street towards the Botanic Gardens.

Work to be done - The final pieces are now being put in place on the arch

The soil is being backfilled to ground level around the arch

On the north side of the bridge the environmental controls will be taken out of the river and the riverbank reinstated.

### **Upcoming Work**

SCIRT/Downer have completed the strengthening work on the Triumphal Arch and Bridge of Remembrance. Further work on the bridge surface, steps and approach ramps is required and will be completed as part of the Avon River Precinct project work by CERA.









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