

Submission for the  
NEW ZEALAND CONCRETE SOCIETY  
**CONCRETE AWARDS 2007**



**WAIANAKARUA NORTH BRIDGE**







Submitted by: Dave Charters  
OPUS INTERNATIONAL CONSULTANTS





2007

## ENTRY FORM

The judging panel will select the appropriate categories for all entries.

The Monte Craven Architectural Building Award

The Infrastructure Award

The Residential Award

The Landscaping Award

The Technology Award

## Section A

PROPER NAME building, structure or scheme: WAIANAKARUA NORTH BRIDGE

LOCATION: CENTRAL OTAGO

TYPE OF PROJECT: (eg. bridge, building, research work, design tool) BRIDGE

DATE OF COMPLETION: DECEMBER 2005

NAME & ADDRESS of organisation submitting entry\* OPUS INTERNATIONAL CONSULTANTS  
P.O. BOX 12343, WGTN.

Contact Person: RICHARD SILCOCK Phone: 04-4717047 Fax: 04-4733017

## Section B

OWNER (and client, if different)\*

Owner: TRANSIT NEW ZEALAND

Address: REGIONAL OFFICE. P.O. BOX 5241  
DUNEDIN Phone: 03 478527 Fax:

Client:

Address:

Phone: Fax:

ARCHITECT (name of partner/principal involved with entry project)\*

Firm/organisation:

Address: N/A

Phone: Fax:

CONSULTING ENGINEER (name of partner/principal involved with entry project) \*

Firm/organisation: OPUS INTERNATIONAL CONSULTANTS.

Address: PRIV. BAG. 1913  
DUNEDIN Phone: 03-4715300 Fax: 03 474 8995

CONTRACTOR (name of director/principal involved with entry project) \*

Firm/organisation: WORKS INFRASTRUCTURE.

Address: DUNEDIN

Phone: 03 4885790 Fax:

OTHER FIRMS (i.e. sub-contractors involved with concrete work in entry project) \*

1.Name:

Address: N/A

Phone: Fax:

2.Name:

Address:

Phone: Fax:

3.Name:

Address: N/A

Phone: Fax:

4.Name:

Address:

Phone: Fax:

THE AWARD RECIPIENT Name: DAVE CHARTERS

THIS ENTRY FORM MUST BE ACCOMPANIED BY THE WRITTEN APPROVAL OF THE OWNER (SEE ELIGIBILITY SECTION (iii)) AND ALL CONTRIBUTING PARTIES MUST AGREE AND NOMINATE WHICH OF THEM WILL RECEIVE THE TROPHY; 'THE AWARD RECIPIENT'.

\* COLLECTIVELY ARE CONTRIBUTING PARTIES.

NB: ALL MATERIAL SUBMITTED IN CONNECTION WITH ENTRIES BECOMES THE PROPERTY OF THE NZ CONCRETE SOCIETY.

This form should be completed in block letters or typewritten and returned together with the Statement for Judging and the appropriate entry fee no later than 13 July 2007 to the:

**New Zealand Concrete Society,**  
**PO Box 12, Beachlands, Auckland.**  
**60 Craig Road, Maraetai, Auckland.**  
**Email: concrete@bluepacificevents.com**

Please include one complete unbound copy for photocopying purposes.

Closing Date for Entries: Friday 13 July 2007



Our Ref: SH/13/1/8/226

12 July 2007

Opus International Consultants  
Private Bag 1913  
DUNEDIN

Attention - Dave Charters

Dear Dave,

### **S.H.1 WAIANAKARUA NORTH BRIDGE WIDENING**

Transit wishes to record its appreciation of the efforts made in bringing this phase of the larger realignment contract to completion.

The efforts made by both designers and contractors on this high profile and highly visible bridge in completing the work to the high standard achieved has received much deserved praise.

There were a number of very specific aspects, quite different to those found routinely which were most noteworthy and were recognised at the official Opening Ceremony in April 2005.

These unique features revolved around the modifying of a Category 1 Historic Places structure so that it would provide the necessary level of service, yet retain its historic significance, appearance and overall appeal.

The bridge was over 130 years old, and is very attractive, interesting and unusual in that it comprises of twin skew arches of vermiculated tapered stones, and is one of the few remaining stone arch bridges in New Zealand.

The challenges in pursuing the proposal were immense, with staff from Transit and designers Opus International Consultants, having been involved for many years discussing, cajoling and eventually convincing all the involved parties of the benefits.

Finally the desire to ensure that the bridge was retained, strengthened and utilised overcame other aspects and a design which minimised any appearance alterations, met Historic Places Trust requirements, as well as Transit's needs was arrived at.

This design of alterations to a structure of which there were no plans, was accomplished with technical and professional expertise, and Transit congratulates the designers for their considerable efforts.



In converting this design into the finished product the contractor Works Infrastructure also was presented with further interesting demands, which were met and overcome. Not least of these was ensuring that no structural damage occurred to the old structure as part of it was removed, and of course rebuilding the parapets to match the original appearance.

Transit thanks Opus International Consultants, for detailed investigation, design and contract management, and Works Infrastructure for construction of this work, to the high standard expected and achieved, is pleased to have been the client organisation on this work, and is pleased to provide agreement to this submission proceeding.

Yours sincerely

A handwritten signature in dark ink, appearing to read 'Don Lyon', with a stylized flourish extending to the right.

Don Lyon  
Project Manager



## TRANSIT NEW ZEALAND STATEMENT:

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*"Transit New Zealand wishes to record its appreciation of the efforts made in bringing this phase of the Waianakarua North Bridge realignment contract to completion.*

*The efforts made by both designers and contractors on this high profile and highly visible bridge in completing the work to the high standard achieved, has received much deserved praise.*

*The design of alterations to a bridge structure, of which there were no plans, was accomplished with technical and professional expertise, and Transit congratulates the Opus designers for their considerable efforts."*



# THE PROJECT

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The Waianakarua North Bridge no longer met modern traffic requirements due to its poor horizontal alignment and narrow width. A pronounced 'hump' represented an increased traffic risk due to reduced sight distances. In addition, longitudinal cracking in the arch barrel was evidence of significant structural stress.

Opus was commissioned to widen the original 6.6 metre bridge by a further two metres and ease its vertical curve consistent with Transit policies in terms of highway safety.

## Project Complexities

The design solution addressed a number of issues and complexities:

- Historic Places Trust Category 1 protection – the bridge upgrade had to remain visually faithful to the original design. In this respect, the parapets had to be carefully dismantled and rebuilt using the original blocks, suitably modified to accommodate reinforcement to provide adequate levels of side protection.
- The absence of the original plans meant that the design process essentially had to remain flexible and responsive to changing structural factors.
- Effective repair of the distinct longitudinal cracking (an inherent weakness of arch construction) was essential to ensure the long-term service of this structure. Work involved delicate balanced excavation of the fill material between the top of the arch barrel and the road surface.
- The deck widening required the Oamaru stone parapet to be dismantled and rebuilt with upgraded side protection.
- A reinforced concrete deck would have resulted in heavy localised loads on the spandrel walls (a traditional arch bridge transfers loads to the arch via the fill material above the arch). Opus designers initial design addressed this issue with a soft joint at the head of the spandrel walls to avoid exposure to excessive localised loads on the voussoirs. To further distribute the load and offer a defined point of support, the design also included a traffic lane cantilevered from a sleeper wall embedded in the fill.
- The narrow road corridor did not permit the use of the bridge during the works; necessitating a Bailey Bridge. (Ref. Figure 1) to carry traffic during the construction phase.



# THE PROJECT

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## Requirement for a New Design

Upon excavation of the fill, the Opus designers were faced with the surprise discovery of extraordinarily long blocks of Oamaru stone in the spandrel walls. (Ref. Figure 2) This meant that the initial design had to be abandoned because the sleeper wall support point would have generated an intolerably long cantilever which in turn would have adversely affected the sight distance by impacting on the vertical alignment.

Opus designers had to develop an alternative design that would address the existing constraints i.e. time, budget, historic protection, aesthetics, structural issues and construction practicalities.

Correcting the significant vertical curve was a key safety outcome. Achieving this without changing the appearance of the bridge was only possible by constructing a deck at the level of the historic roadway and filling at the approaches. (Ref. Figure 3)

The location of the deck and associated cantilever was defined by the vertical curve of the parapet and string course at deck level. (Ref. Figure 4)

Requirements for visual continuity over the vertical alignment, however, clashed with structural requirements for the thickness of the concrete deck.

## Innovative Design Solution

Opus designers solved this structural dilemma by using a thinner slab depth with more longitudinal reinforcement and shear stirrups. (Ref. Figure 5)

With the slab resting on the spandrel wall, the problem of localised loading was overcome with:

- a fully specified engineered fill (good quality infill topped with AP40:M4) for predictable high performance under load and minimal settlement
- careful compaction above the arch barrel
- meticulously specified compaction methodology



## THE PROJECT

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The longitudinal cracks – a result of lateral earth pressures – were effectively repaired with a reinforced concrete solution:

- a reinforced concrete saddle was constructed over the exposed arch to absorb tensile forces
- the saddle was keyed into the arch barrel with reinforcing bars resin anchored into the arch (Ref. Fig 6 & 7)
- the spandrel walls were lined with reinforced concrete, keyed into the spandrel walls, thereby transferring any lateral forces to the saddle.

### Authentic Finish

The stone parapet was reinforced and stressed before it was rebuilt with a high degree of historic authenticity and the same level of craftsmanship as the original bridge structure. The top course of the parapet wall is a concrete bond beam faced with stone cut from the original top course of the parapet wall. (Ref. Fig 8)

### Outcomes

Opus' novel solution achieved the following outcomes:

- Vital improvement in road safety by addressing a well known traffic 'black spot'
- Ensured that this important historic asset remains a fully functioning structure on State Highway 1
- Protects an important part of the national heritage for future generations
- Exposed features represent a high level of workmanship with authentic detailing
- Successful management of a number of stakeholders, including the NZ Historic Places Trust
- Completion on time and within budget.



## PHOTOGRAPHS

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Figure 1. A Bailey Bridge with temporary approaches was constructed adjacent to the Waianakarua River Bridge



Figure 2. Exceptionally long slabs of Oamaru stone are seen protruding from the spandrel walls inside the excavated bridge.



## PHOTOGRAPHS



Figure 3. The bridge structure with the engineered fill in place. The parapet walls are in the process of being dismantled.



Figure 4. The decorative string course blocks are being repositioned on the cantilever formwork after being cut down to serve as permanent formwork for the deck.



## PHOTOGRAPHS



Figure 5. Using a thinner slab depth than ideal required more longitudinal reinforcement than an optimally proportioned slab and also shear stirrups.



Figure 6. The saddle slabs under construction and formwork in place for the internal concrete spandrel walls.



## PHOTOGRAPHS

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Figure 7. The exposed bridge barrel following excavation of the fill.



Figure 8. The completed widened bridge with strengthened parapet walls and new capping stones to replicate the originals which were removed during the 1960s.







