

NEW ZEALAND CONCRETE SOCIETY

# CONCRETE '92

TECHNICAL CONFERENCE AND AGM  
WAIRAKEI HOTEL, TAUPO

Friday 9 to Sunday 11 October 1992



CONFERENCE TECHNICAL PAPERS  
(TR13)

691.32[931] NEW

Principal Sponsor : Cement & Concrete  
Association of NZ  
Co-sponsors : Firth Industries  
Nuplex Industries  
Sansom Contract  
Services  
Works Consultancy  
Services

CEMENT & CONCRETE  
ASSOCIATION



3446

CEMENT & CONCRETE  
ASSOCIATION OF NZ  
LIBRARY

0002968A  
691.32(931) NEW

11 APR 1994

# NEW ZEALAND CONCRETE SOCIETY

## CONCRETE '92

ANNUAL TECHNICAL CONFERENCE, WAIRAKEI, 9-11 OCTOBER

### TECHNICAL PAPERS (TR13)

#### CURRENT CONCRETE RESEARCH

- \* University of Canterbury - R Park, H Tanaka 1
- \* University of Auckland - P G Lowe, R C Fenwick 9
- \* Works Central Laboratories - S A Freitag 12
- \* Cement & Concrete Association of NZ - D P Barnard 15
- \* Seismic assessment and retrofit of concrete structures -  
United States and New Zealand developments - R Park 18

#### KEYNOTE SPEAKER

- \* Concrete advantages: the North American experience  
- J G MacGregor, President, American Concrete Institute 26

#### RETROFITTING

The philosophy of the renewal and retrofitting of urban commercial properties

- \* Architectural viewpoint - G Moller 35
- \* Building owners' and tenants' view - D Keys 38
- \* The contractors' viewpoint - W Chapman 44

Civil Structures

- \* Earthquake resistance evaluation and upgrading of bridges  
- H E Chapman, D K Kirkcaldie 48
- \* The effectiveness of repair techniques on Queens Wharf,  
Lautoka, Fiji - M J Lawson, S W Hobbs 55
- \* Waitakere Dam strengthening - upgrading of a concrete gravity  
dam using post-tensioned ground anchors - J B Gregory, P A Wymer 65

#### QUALITY ASSURANCE AND BUILDING CODES

- \* The Building Act - effects on the concrete industry - D Barnard 73
- \* Developments and harmonisation of concrete design codes - SANZ,  
SA and Eurocodes - R Park 74
- \* The importance of accreditation or "Trust me, I know what  
I'm doing" - J Temple 79

#### CONCRETE BRIEFS

- \* Concrete homes - past, present, future - D Morrison 84
- \* Condition survey of Fairfield Bridge, Hamilton - G H Rowe, L Leach 86
- \* Strengthening of a floor slab using bonded steel plates  
- D V Francis, R A Robinson 94
- \* Controlled low strength concrete - T J Browne 97

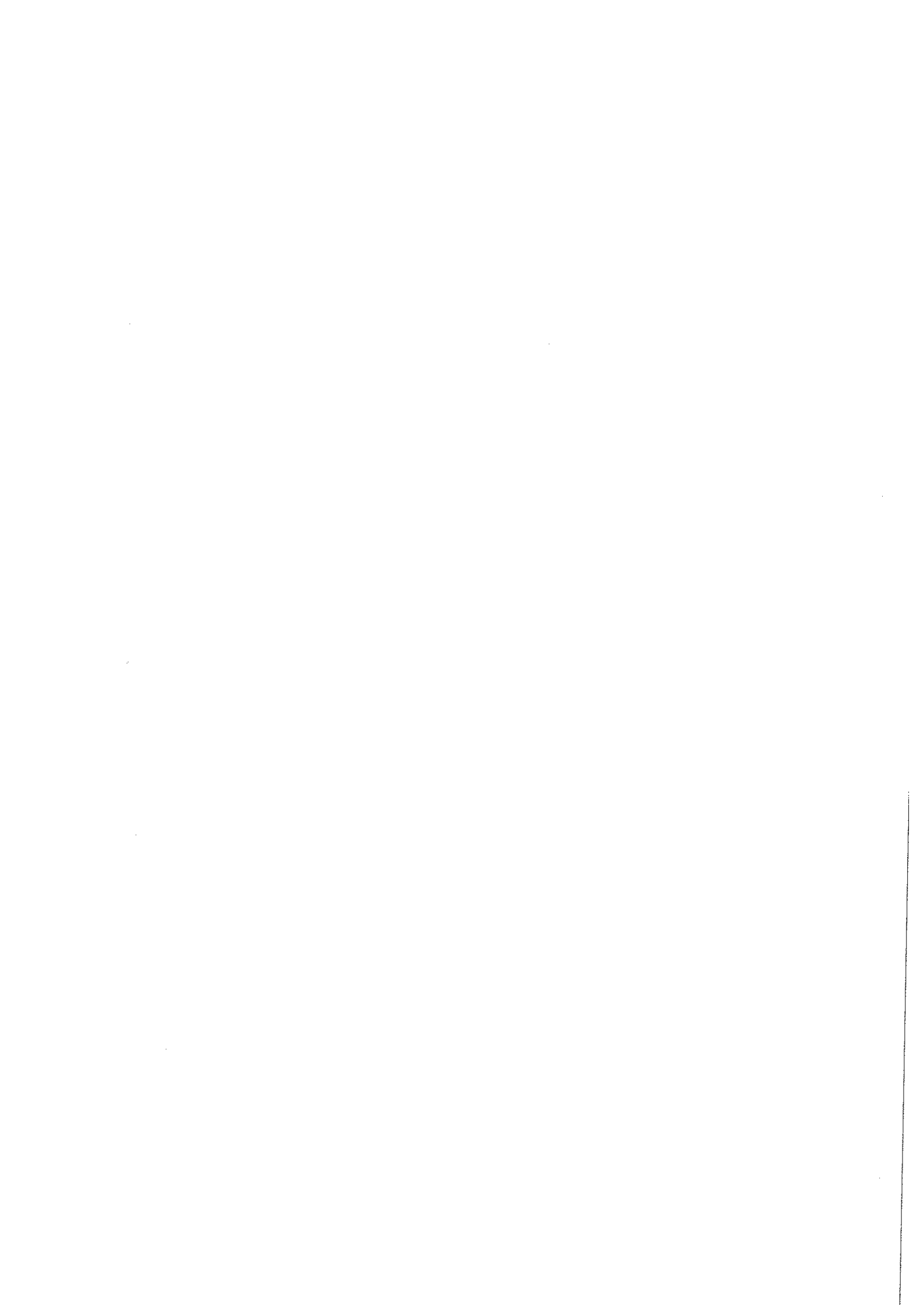
Further copies of this volume, designated NZCS Technical Report (TR) 13, price \$40 + GST, are available from:

The New Zealand Concrete Society  
P O Box 17-268  
Wellington  
New Zealand

Phone/Fax (04) 476-6866







## CONDITION SURVEY OF FAIRFIELD BRIDGE, HAMILTON

by : Dr G.H. Rowe\* and Mr L. Leach\*\*

### INTRODUCTION

Construction of the Fairfield Bridge (Fig. 1) across the Waikato River was undertaken by Roose Shipping Company Ltd, Hamilton and completed in 1937. The bridge is 139 m long, consists of three main spans and two approach spans, and is constructed of reinforced concrete. Leach (1991) described the structure as: "The three main spans are supported by bowstring arches with major structural elements relying on reinforcing steel acting in direct tension. Bearings are provided which allow the arches to rotate and translate along the bridge in response to the applied loads (traffic, thermal, shrinkage, creep). Pedestrian access is provided on both sides of the carriageway by footpaths cantilevered off the arch tie beams. The sub-structure comprises abutments founded on reinforced concrete piles and piers founded on wooden piles."

Henshall (1948) also described the design and construction of the Fairfield Bridge and identified it as the fourth large reinforced concrete bowstring bridge in New Zealand at that time.

The first remedial work undertaken (Allardice, 1956) involved strengthening of the abutment at the Hamilton end (western end) to prevent the continuation of settlement which had caused cracking in the approach span beams. In addition, the pier caps and beams of the approach spans were extended and strengthened to correct discrepancies in the placement of the reinforcing steel.

In 1981 the DSIR was commissioned by Hamilton City Council to investigate the cause of cracking in the arches and end blocks. St John (1981) concluded that cracking in the end blocks and lower arches of the eastern arches was caused by alkali aggregate reaction (AAR).

In August 1990 the New Zealand Historic Places Trust (the Trust) classified this structure as "B" under the Historic Places Act 1980. This category is for structures which the Trust considers merit permanent preservation because of their very great historical significance or architectural quality. An implication of this classification is that

the bridge will probably have to be retained and, when no longer serviceable, a replacement bridge would have to be built at a different location.

The Trust also finds particular architectural quality in the form of the bowstring arches and the pierced concrete balustrades.

Because of this classification it was considered important that remedial works and an ongoing maintenance programme be implemented to maximise the serviceable life of the bridge.

In January 1991 Hamilton City Council Design Services visually inspected the bridge as access allowed. The amount of primary reinforcement corrosion observed gave cause for concern, particularly as the corrosion identification was the result of spalling concrete.

A more detailed investigation to determine the condition of the bridge reinforcement was considered necessary to allow complete evaluation of the condition of the structure. This work is most appropriately carried out using non-destructive testing methods which allow identification of areas of concrete where the reinforcement is at risk but where the symptoms are not yet visible.

Offers of service were invited from firms known to be able to competently carry out a detailed condition survey and recommend suitable remedial options to extend the serviceable life of the bridge. WORKS Central Laboratories were successful in their offer.

The Fairfield Bridge is Hamilton City's most northern bridge and currently carries up to 25,000 vehicles per day.

### PART I CONDITION SURVEY BY WORKS

Central Laboratories undertook the condition survey over a period of 12 days with the intention of identifying the extent, severity and causes of concrete deterioration so that the Hamilton City Council could use the most appropriate techniques to repair and maintain the bridge.

\* Section Head, Concrete Section, Central Laboratories, Works Consultancy Services Ltd (WORKS)

\*\* Civil Engineer, Design Services Section, Hamilton City Council

The bridge was suffering from corroding reinforcing steel and alkali aggregate reaction (AAR). It was suspected that cracks caused by either of these defects might be letting water into the concrete, initiating or accelerating reinforcement corrosion and AAR.

1. SITE TESTS

As a condition of the contract with Hamilton City Council, all damage induced by the on-site sampling and measuring processes had to be made good. However, the measurements that were taken involved minimal or no damage to the concrete.

Specifically the on-site work included:

- (a) A complete visual survey which recorded the extent, severity and distribution of construction and durability related defects. This allowed factors contributing to deterioration to be identified.
- (b) The measurement of the depth of concrete covering reinforcing steel. When related to the chloride ion concentration and carbonation results, these readings indicate the amount of steel in each member within the zones affected by chloride ions and carbonation.
- (c) Depth of carbonation: "Carbonation" is a natural reaction which lowers the alkalinity of the concrete to a level at which the steel is no longer protected from corrosion. Concrete is always carbonated near the surface, generally the more permeable the concrete the more deeply it may be carbonated. If concrete surrounding the steel is carbonated the risk of corrosion is increased.
- (d) Chloride ion concentration: Chloride ions can induce corrosion even in non-carbonated concrete. The presence of absence of chlorides will determine how damage by corroding steel can best be repaired. Comparing chloride ion concentrations at different depths from the surface will indicate whether the chloride is from an external source (windborne salt) or was introduced in admixtures or aggregate when the concrete was mixed. It will also indicate the chloride levels adjacent to reinforcing steel.
- (e) Corrosion potential: Using an appropriate reference electrode (a silver/silver chloride half cell), this technique gives an indication of the potential for steel to corrode in areas where there may be little or no deterioration evident. Locations where corrosion is likely are identified with a map of isopotentials.
- (f) Concrete resistivity: This technique gives an indication of

the likely rate of corrosion at regions of high corrosion potential identified in (d). The higher the resistivity of the concrete, the slower the rate of corrosion. It is also a parameter useful when considering the cathodic protection option for rehabilitation.

- (g) Internal moisture content: Such measurements enable more accurate and informed interpretation of data from corrosion potential and resistivity measurements, and greatly assists in selecting appropriate remedial measures.

A total of 30 sites were selected at which these tests were undertaken. The sites were chosen so that each of the principal structural elements were examined. Aspect and exposure were used as selection criteria where several examples of the same element were inspected.

Sites on each of the main structural elements above and below deck were examined. Cherry pickers, specially constructed platforms, and Works Civil Construction's Palfinger "Snooper" inspection platform unit, which reaches under the deck from road level, were used to gain access to different parts of the bridge. All work above deck had to be carried out during restricted periods of road closure and in fine weather.

Core samples were taken from the piers of the bridge to check for 'softening' of the concrete from soft water attack and to measure its compressive strength.

2. RESULTS

Generally the cover to the reinforcement was generous with minimum cover ranging between 11 mm and 92 mm. Chloride ion concentrations were low (<0.05% w/w, Cl<sup>-</sup>/concrete), maximum carbonation depth for all elements above deck level was 8 mm and was 31 mm below deck level. Such a difference in carbonation depths suggested a corresponding difference in moisture content above and below deck level. Indeed moisture contents above deck level were >4% by mass and below were <4% by mass.

All resistivity results were high, but particularly so below deck level in keeping with the low moisture contents and high carbonation depths. A correlation existed between resistivity and the occurrence of alkali aggregate cracking. Where cracking occurred, the resistivities are 30-80% lower. In addition, local resistivity anomalies existed due to drainage effects. Where water ran across surfaces beneath the deck, resistivities were lower.

Corrosion potential measurements identified three features on the end blocks and lower arches which were more susceptible to corrosion:

- (a) at the construction joints between end blocks and arches;

- (b) at diagonal cracking which started at the springline;
- (c) in areas affected by AAR cracking.

Elsewhere corrosion potentials were high in areas of honeycombing, at flow lines, at epoxy patch repairs, and adjacent to cracks and drainage ports.

Soft water attack of the piers had taken place to a depth of 14 mm below the existing surface. Dissolution of concrete by soft water had probably removed up to about 10 mm of concrete from the worst affected areas of the piers, but was proceeding very slowly due to the presence of river contaminants, the presence of manmade structures upstream, and the growth of weed on the textured surface of the concrete.

### 3. DISCUSSION

The principal concerns Hamilton City Council had about the bridge were the presence of alkali aggregate reactivity and the corrosion of reinforcement.

#### 3.1 Alkali Aggregate Reaction

The reactive aggregate component in the concrete was identified by St John (1981) as glassy volcanic components of the sand. The survey found that deterioration due to AAR was restricted to above deck elements, and the most severe cracking was concentrated in two arches. The northern faces of these end blocks showed the greatest deterioration as a result of increased temperature and a more pronounced wetting and drying cycle. The extent of the cracking was similar to that recorded in a previous investigation (St John, 1981) and movement across cracks since 1981 had been negligible ( $\leq 0.3$  mm), even in an area that was particularly rich in gel and that was extensively cracked internally. The presence of significant confining reinforcing steel in the arch structure may have restricted the development of cracking due to AAR and minimised deformation.

#### 3.2 Reinforcement Corrosion

If the depth of carbonation exceeds the depth of cover over reinforcing steel, the steel is no longer protected by the normally high pH of cement paste, and corrosion may proceed provided there is sufficient water and oxygen present in the concrete. Carbonation depths were generally less than average cover depths over the whole structure, but there was a distinct difference between elements above and below deck. The average rate of carbonation on elements above deck indicates carbonation was unlikely to become a factor initiating corrosion within the foreseeable life of the bridge. Carbonation rates on elements below deck were significantly higher and can be related to the low moisture content of the concrete which promotes gaseous diffusion. Carbonation depths on the abutments exceeded the average cover depths, but widespread corrosion due to carbonation

was considered unlikely to occur on these or any other elements below deck provided the moisture content, and therefore water available for corrosion, remains low.

The measured depth of cover concrete generally exceeded the specified cover and may be regarded as adequate for durability purposes using current standard specifications. There were a few instances where a significant proportion of measured cover depths were less than specified, and lack of cover was a contributing factor to corrosion in these areas. However, in most of these cases the depth of cover concrete was not the principal cause of corrosion. Invariably the quality of the cover concrete was poor and/or drainage details were inadequate.

The moisture content of the concrete had a significant influence on both AAR and reinforcement corrosion as neither reaction can proceed without water. The significantly higher moisture contents in elements above deck had not contributed to reinforcement corrosion in sound concrete since the majority of reinforcing steel remained passivated due to low carbonation rates and low chloride ion contents. High carbonation rates are matched by low moisture contents below deck, so widespread carbonation-induced corrosion was not evident.

The resistivity results were clearly influenced by the moisture content of the concrete, and indicated that the "probable corrosion rate" over the majority of the bridge was low. The resistivities measured above deck were significantly lower than below deck and the lowest results were measured on the end blocks affected by AAR cracking, confirming the increased access of water to these elements.

Lack of effective concrete cover and inadequate drainage details were the principal cause of reinforcement corrosion on the Fairfield Bridge. The quality of cover concrete had been compromised by both workmanship and concrete mix design. Compaction of the concrete was inadequate in some areas, particularly where the reinforcing steel is dense or the configuration of the formwork complicated. The poorly compacted concrete was concentrated near the arch/end block construction joint, where the top and bottom surfaces of the arch are steeply inclined.

Quality of cover concrete had been compromised by the presence of poorly executed construction joints and cracking which, in association with poor drainage details, had resulted in reinforcement corrosion.

The ingress of atmospheric CO<sub>2</sub> and/or chloride ions was not a principal factor in the corrosion of reinforcement on the bridge. Invariably reinforcement corrosion could be related to features which have compromised the effective concrete cover. Where the quality of cover concrete was good, the reinforcing steel was in excellent condition. The corrosion potential survey confirmed these findings. Where corrosion risk was high,

details such as honeycombing, cracking (including AAR cracking), construction joints and related drainage problems were usually present. The concrete in areas showing low corrosion risk was usually free from defects. In general, the occurrence of reinforcement corrosion and the likelihood of increased corrosion risk could be related to visible defects. Remedial measures such as restoration of effective concrete cover and improvements in drainage details could therefore be undertaken with the knowledge that reinforcement corrosion would be unlikely to occur beyond these areas.

3.3 Remedial Options

The remedial recommendations presented were required to address the main defects discussed in Sections 3.1 and 3.2 above, and were further required to:

- (a) prevent the ingress of water while allowing the concrete to dry; and
- (b) repair areas of damage that had already occurred.

Patch repairs were recommended and consisted briefly of filling cracks, excavating honeycombed areas, removing epoxy patches, increasing cover to certain elements, e.g. hangers, epoxy injecting some cracks in kerbs and piers, removing areas of construction debris and laitance in the soffits of beams and transoms, repairing spalls associated with reinforcement corrosion, reprofiling footpaths and the carriageway to provide adequate falls to drains, improve the drainage from both the footpath and carriageway, replacement of the concrete handrails, replacement of specific deck joints, and the erection of screens to prevent pigeons roosting beneath abutments and on pier caps.

4. CONCLUSIONS

The two main conclusions from the condition survey report (Bruce and Rowe, 1991) were:

- (a) "Defects due to concrete mix, handling and placing methods, and in construction and design detail particularly as they relate to drainage, are the principal causes of deterioration with time. Generous concrete cover to most reinforcing steel and geographic location has meant that harmful natural agencies and natural processes - chloride ion ingress, carbonation and soft water attack, have had little effect on the serviceability of the structure."
- (b) "Spalling and cracking due to local reinforcement corrosion and alkali aggregate reaction, the latter possibly now in abeyance, are the predominant manifestations of deterioration. Such deterioration may be repaired with relative ease and considerable confidence given the sound nature of the bulk of the structure indicated by this condition survey."

PART II REPAIR PLANNING BY HAMILTON CITY COUNCIL

The Works Consultancy report has enabled a comprehensive restoration and strengthening project to be put into place. When the work is completed the City will have an attractive bridge of a past era which will give many years of effective service.

This has replaced the previous approach of ad hoc patch and repair due to the considerable doubt as to the future of the bridge because of the discovered presence of alkali aggregate by the DSIR in 1981 (St John, 1981). There can be no doubt that the in-depth report of Works Consultancy has proved of great worth.

The following discussion briefly covers the approach that Council will take to upgrade the bridge, and some of the related aspects in conjunction with the rehabilitation works.

1. REHABILITATION STAGING

During the 1980's the future of this bridge was in doubt. Therefore it was pleasing to receive the report from WORKS with findings clearly indicating that the remaining life in the structure may be extended by carrying out appropriate remedial works. The bridge will generally be improved in accordance with WORKS' recommendations which include the following.

Stage 1

- Cleaning of superstructure, excluding deck soffit.
- Removal of honeycombed concrete.
- Cleaning and protection of exposed reinforcing.
- Build up over areas of low cover.
- Epoxy injection of small cracks and cementitious filling of larger cracks.
- Any required superstructure strengthening.
- Carriageway and footpath drainage taking water clear of the bridge elements without compromising reinforcement covers.
- Sealing coats and profile over both the carriageway and footpath compatible with both drainage requirements and joint geometry.
- Cementitious overcoat and acrylic topcoat to the superstructure.

Stage 2

- Cleaning of superstructure soffit and substructure.
- Removal, repair, patching and coating the concrete similar to stage 1.

Advantage will be taken during rehabilitation to carry out additional works to minimise further disruptions to the public in the future. Some of these works are as follows.

During stage 1:

- Replacement of those bridge joints that are significantly through their useful life.
- Upgrade the carriageway to the eastern bridge approach.
- Upgrade the bridge lighting, taking consideration of both the bridge form and lighting standards.

During stage 2:

- Recondition the bridge bearings.
- Improve the seismic response of the bridge.

2. WORK PROGRAMMING

The first stage of the physical works are programmed to commence early in 1993. This timing avoids affecting the higher volumes of traffic over the Christmas period, provides good daylight hours and drying weather, and encompasses the lower traffic volumes of the year.

The works were deferred from the 1992 early summer to accommodate the rehabilitation of another major Hamilton bridge, the Victoria Bridge, which in brief was strengthened, redecked and repainted.

The second stage of the works will be carried out at a later date which:

- (a) allows time for the water stored in "reservoirs" within parts of the structure to seep away prior to overcoating the lower elements; and
- (b) spreads the financial commitment.

3. TRANSIT NEW ZEALAND SUBSIDY

The bridge rehabilitation work will be subsidised by Transit New Zealand, with the work eligible in terms of the Transit New Zealand Act 1989. Part of the terms of eligibility require the awarding of the physical works by a competitive pricing procedure. The rehabilitation work will be let to tender with evaluation of competing tenders carried out in accordance with Transit New Zealand's requirements for competitive pricing procedures.

4. NZ HISTORIC PLACES TRUST

As discussed in the first part of this submission, the New Zealand Historic Places Trust (the Trust) has classified the Fairfield Bridge as "B". This category is for buildings the Trust considers merit permanent preservation because of their very great historical significance or architectural quality.

During the design of the rehabilitation works, consultations with the Trust will ensure the final form of the bridge is to the satisfaction

of all parties. In particular, there will be reference to the bridge lighting, colour of the bridge coating, and details of any replacement balustrades.

Application for funding assistance from the Trust will be made where the Trust's requests have a financial impact on the project.

5. STRUCTURAL ANALYSIS

The main superstructure spans will be structurally modelled using "S-Frame", a structural analysis program which has the capability to analyse three dimensional systems. The computer idealisation of the bridge main spans is shown in Fig. 1. A detailed analysis of the stresses induced in the structure based on the design loadings from Transit New Zealand's Bridge Manual will be carried out.

In October 1973 the bridge was checked by hand analysis for HN-HO-72 loading using many simplifying assumptions. The conclusion from that analysis was that the bridge could carry an overload provided the overload was supervised and the lines of the wheels placed to reduce the moments in the transoms.

If the analysis using S-Frame suggests there are bridge elements that cannot accommodate the HN-HO-72 loading, one of two options will be taken:

- (a) if practical, the bridge strengthened to accommodate the required design loadings; or
- (b) overloads prohibited from using the bridge and/or the bridge posted with a notice showing its allowable load.

Having copies of the original drawings and specification and the condition survey information allows a realistic assessment of the strengths of the bridge elements.

6. REINFORCED CONCRETE BALUSTRADES

Pedestrian footpaths are cantilevered off the arch bowstrings on both sides of the carriageway. The outer footpath balustrades are of cast in situ construction comprising columns and rails filled with latticework panels (Fig. 2). Panel thickness varies up to a maximum of 100 mm with 9.5 mm diameter plain reinforcement central through the latticework.

The majority of panels are showing signs of distress, with cracking and spalling concrete evident throughout most panels. This distress is clearly caused by corroding reinforcement which has often been placed to covers less than that recommended by NZS 3101 "Code of Practice for the Design of Concrete Structures". Repair of these panels is not realistic.

The Trust recognises particular architectural quality in the form of the balustrades, and has requested

## FAIRFIELD BRIDGE

that the design of any replacement balustrades should not be altered from the original unless there is no other way of ensuring the long life of newly made panels.

The balustrade condition is not critical to the load carrying capability of the bridge, and they still afford appropriate safety to pedestrians. The decision on whether to permanently upgrade these balustrades will be made after negotiations with the Trust regarding funding from them.

### 7. PERIOD LIGHTING

The original lighting on the Fairfield Bridge consisted of eight Holophane pedestal type light fittings on cast iron lamp posts placed along the balustrades at the pier lines. This lighting provided for footpath illumination only.

During the 1960's extension posts were added to the lamp posts and alternative light fittings installed. At some stage lighting was cantilevered off the top of the arches to provide lighting to the carriageway of the bridge.

Because of the historic nature of the bridge, consideration will be given to upgrading the lighting in a similar style to that on the bridge when it was opened, and also to as near as possible meet the requirements of NZS 6701 "Code of Practice for Road Lighting". Care will be taken to minimise the visual impact on the lines of the arches and hangers. Liaison meetings will be held with the Trust.

### 8. BRIDGE CLOSURE

To enable many of the rehabilitation works to be carried out, the Fairfield Bridge will be closed to vehicular traffic for a period of time. As part of the contract, the contractor will be required to install and maintain appropriately placed signs advising traffic of alternative routes. The layout and position of these signs will be decided by Hamilton City Council.

Buses and taxis will have to take alternative routes, and these and other essential services will be advised of the closure by Council.

The contractor will also be required to provide safe passage across the river for pedestrians and cyclists at all times during the works. Generally (if not at all times) the bridge itself should be able to be used for this purpose. Irrespective of this, the contractor will be responsible for ensuring this access is provided by one means or another.

### 9. BRIDGE CLOSURE PUBLICITY CAMPAIGN

As this bridge is a vital traffic link across the Waikato River, the objective of the publicity campaign will be to inform as many residents of Hamilton as practicable of the temporary closure.

Advertisements will be placed in the local newspapers immediately prior to the closure, with radio advertising being used to remind people of the closure.

The use of a letterbox drop to all Hamilton households (Fig. 3) will also be strongly considered. The use of these "flyers" has been found to have a high impact which, despite objections to "junk mail", are nearly always read. This approach was used when the Fairfield Bridge was temporarily closed in June 1991 to enable the condition survey to be efficiently and effectively carried out. The flyers used had a bright yellow background and were visually stimulating.

The local power authority also employs this method to advertise power shutdowns and have found the approach very successful.

In conjunction with the advertisements, press releases will be provided for the media. Those released for the 1991 condition survey were broadcast and published readily by the radio and newspapers due no doubt to the high public interest in the closure of this traffic link.

### REFERENCES

Allardice (1956): "Fairfield Bridge Over the Waikato River, Report on Examinations of the Structure for the Waikato County Council", 7 November 1956.

Bruce, S.M. and Rowe, G.H. (1991): "Condition Survey of Fairfield Bridge, Hamilton", Central Laboratories Report 91-24303, Works Consultancy Services Ltd, Lower Hutt, 103 p.

Henshall, F.P. (1948): "The Fairfield Bridge, Hamilton", New Zealand Engineering, 10 April 1948.

Leach, L. (1991): "Fairfield Bridge, Inspection and Recommendations", Design Services Section, Hamilton City Council, January 1991.

St John, D.A. (1981): "Fairfield Bridge, Hamilton", Hamilton City Council Reference 250/2/11, DSIR Letter Report, Reference BB 360, CD 25/554.

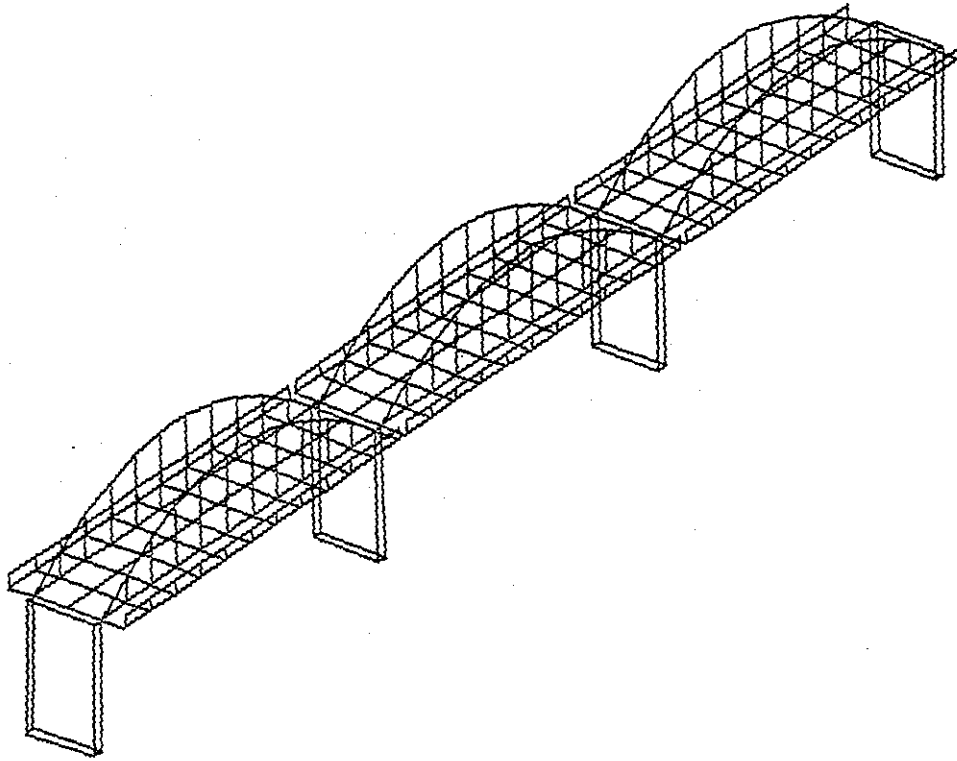


Fig. 1: Computer Generated Diagram of the Fairfield Bridge.  
The approach spans at each end of the bridge are not shown

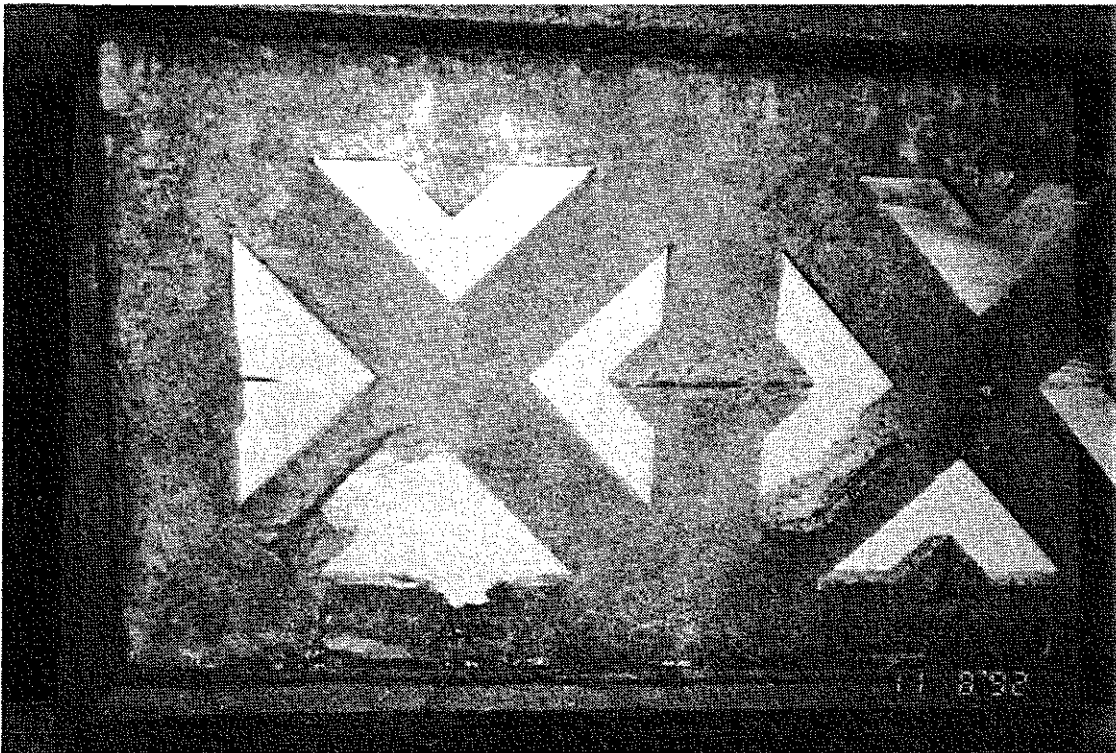


Fig. 2: Handrail Infill Panel Detail

# FAIRFIELD BRIDGE CLOSURE

The Fairfield Bridge will be **CLOSED** for vital survey work.

**Dates:** Monday 17th June - Friday 28th June 1991.

**Times:** 9:15 a.m. - 4.30 p.m. weekdays  
7.30 a.m. - 5.30 p.m. weekends

**Traffic will be diverted to the Whitiora Bridge.  
Pedestrian and bicycle access will not be affected.**

**For Further Information:**  
Public Relations Office,  
Hamilton City Council,  
Tel: 386-644

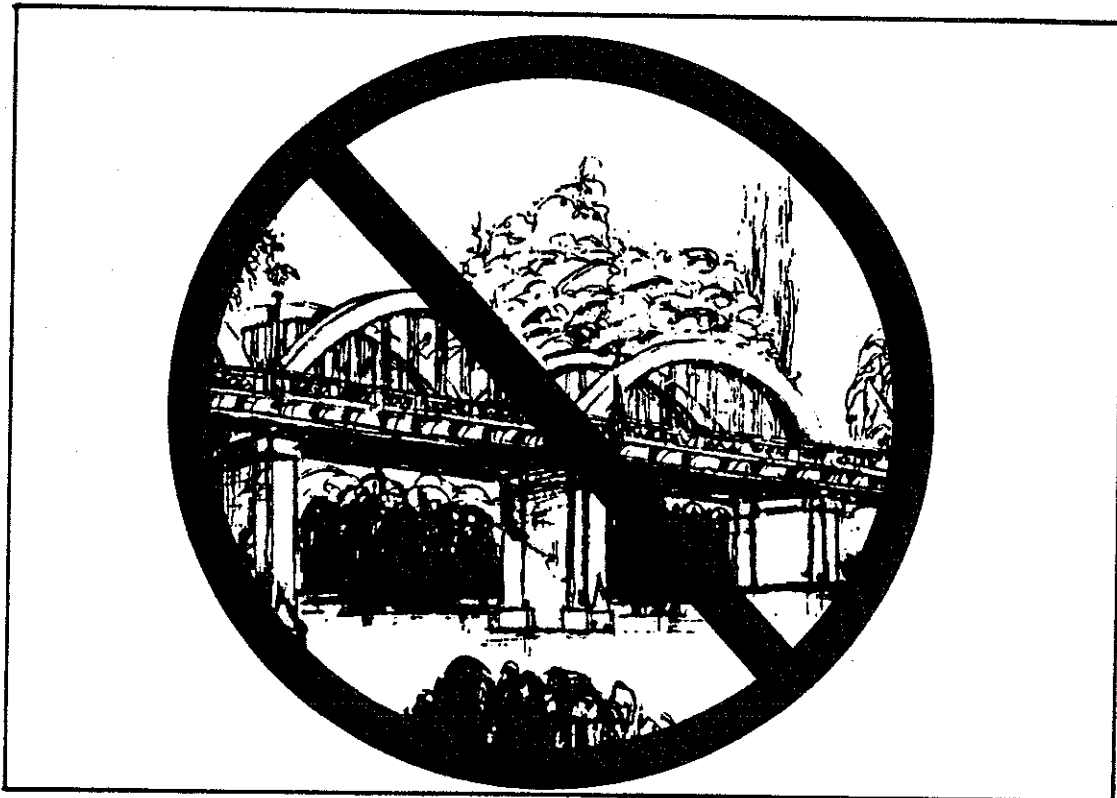


Fig. 3: Household Mail Drop Brochure