Address to the NZ Concrete Society, October 2014

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The Concrete Society is a living successful entity and has been so for 50 years.

This is a proud achievement and it is why this 50th birthday is so worthy of celebration.

In fact the Concrete Society's positive contributions both nationally and internationally are remarkable.

I will justify this claim – or seek to do so – and to suggest how they came about.

I believe you can build on and continue these achievements if you learn from them.

At the heart of the Society's success is the commitment of many able Leaders.

So what were their motivations?

What were the achievements?

I believe the early Leaders not all of whom were Presidents were highly motivated because they considered their involvement in the Society as advantageous to their careers. That is to say their involvement helped them strengthen their businesses and in the case of academics helped them improve the quality of their teaching and research programmes

But first we need to understand the business and political settings that prompted the establishment of the Concrete Society

In the 1950s and 1960s there was a massive surge of infrastructure expenditure in transport, roading, public buildings, forestry and hydroelectric power

This was a consequence of the severely limited investment that had been made during the Great Depression and the two world wars.

This infrastructure investment was controlled to a great extent by the NZ Government owned Ministry of Works.

And then what the historian James Belich described as "the process of decolonisation" began. This was in 1965 when Britain turned away from its Empire culminating in Britain joining the EEC in January 1973. And as Britain turned away from the Middle East this contributed to the oil shocks of 1973 and 1979.

The dramatic reduction of access to our traditional British market and the increased cost of oil placed NZ's economy in a precarious position. This eventually necessitated major reforms. But in particular there was a strong and urgent need to minimise imports and thereby save foreign exchange.

So the Concrete industry saw a market advantage that they seized. This was that the use of concrete in general and prestressed concrete in particular meant less imported steel therefore a saving in foreign exchange.

In addition the avoidance of structural steel circumnavigated the strike prone Boilermakers Union thereby giving increased programme certainty. The classic manifestation of this union problem was the BNZ building in Wellington. This structural steel framed building was delayed by strike action in 1973 with construction not restarting until 1981

These twin arguments namely of saving foreign exchange and minimising union disruption were powerful in theory but initially they did not gain traction.

Richard Carr an importer of prestressing components and a charming long term member of the Society has explained why. In those days which may now seem antediluvian you could not import anything without a License.

But licenses were hard to get as they needed foreign exchange. So Government decreed a policy that licenses would be based on what a Company had imported in 1949.

This was of course before prestressed concrete was a possibility so those wanting to import prestressing materials and components had to jump an annual hurdle – and a high one.

Then suddenly and fortuitously a bureaucrat reclassified prestressing components under the category "Nose Rings for Animals".

Dick stated - not without some pride - that for a while his company was by far NZ's largest importer of Animal Nose Rings.

The major reforms that were eventually installed included the floating of the dollar in 1985, the progressive removal of licensing and tariffs, and a major change in the tax regime. Also of significance to the concrete industry was the progressive privatisation of the Ministry of Works which was completed in 1988.

So the early leaders of the Concrete Society lived in interesting times.

Firstly HW (Sandy) Cormack the founding President (1964-5).

He was my dearly loved father. He was the founding chief of Certified Concrete in 1938 and led the establishment of concrete ready mix manufacture and delivery throughout NZ. Later he was an early establisher of precasting factories. He believed strongly that the industry should regulate itself and he did this by successfully setting up a grading system where for example higher strength concretes could only be produced and sold by certified plants.

He saw the Society as an essential means of communicating with all those in the industry because without such communication the growth of the concrete industry would be severely restricted.

In the event the companies he led had strong and profitable business growth. He was highly valued by his shareholders and these businesses remain sound today. His focus was on quality and growth.

A real hurdle for him was the militant Northern Drivers Union who sought to improve the employment conditions of their members by controlling the building industry in the Auckland region by controlling concrete delivery. The Northern Drivers Union was led by Ken Douglas. Ken's career has been justifiably stellar and he has now received our highest honour namely Membership of the NZ Order of Merit. But at that time he was a young firebrand and an acknowledged Marxist. I remember one story about Ken and Sandy's confrontations.

Ken had made a procedural mistake in a major industrial dispute. Sandy was delighted because this put him in a stronger negotiating position. He was somewhat surprised when at the outset of a critical meeting attended by a large number Ken said "everyone out - I want to sort out Cormack myself"

Ken was obeyed and when they were alone Ken said to Sandy "I've stuffed up. (He might have used a stronger word) How are you going to save my face?"

They reached agreement on the matter in question and then Ken reconvened the meeting by saying "I've told Cormack this is what we'll accept" and so it was

Many years later I had a lot of contact with Ken and I asked him if the story was true. He smiled and did not reply. He had told me when I first met him how much respect he had for Sandy.

Sandy recognised from the outset that a strong technical base was essential for the Society to flourish. That is why the second President was Bob Norman (President 1966-67)

Here he is and Bob it is a great pleasure to have you present today. Bob is a gifted civil engineer who eventually rose to the top position in the Ministry of Works.

This base of technical excellence was continued by Lyall Holmes (President 1968-9)

He was an academic structural engineer turned consultant and the firm he founded - The Holmes Group - continues his work today. His interest was in the design of buildings and there are many fine examples of his work with the architects Warren and Mahoney,

This strong technical tradition was continued by Professor Bob Park (President 1975-6).

Bob saw the Society as an essential part of his personal quest to educate young engineers to a high standard. The information he gained from his fellow members of the Society enabled him to focus research and teaching on the actual problems the industry was facing. He also used the contacts he had made to raise funds for vital testing and research. He built with his colleagues Tom Paulay and Nigel Priestley a high international reputation for his University and for NZ Engineers.

It is important to remember that prestressed concrete was a new material and gaining its acceptance was difficult from earnest but poorly informed specifying authorities. This was why technical education was so important.

There were also silos that were limiting teamwork. The most important of these was the dominance of the MOW in the Civil Engineering industry. The Ministry had until that time played the dominant role in standard setting, education, design and construction. They did not always welcome the intrusions of outsiders seeking to install a new technology.

The Society played a major role in improving communication. The key player in this was a senior member of MOW Hans Huizing who was not only an active participant in each conference he also formed technical committees that promoted further communication between the Ministry, the Universities and Consultants and Contractors.

An influential and enthusiastic supporter of the Society was Stan Carwardine, who I am delighted to welcome with his wife Anne to this Conference. Stan has told me of his initiation to the world of Prestressing. In 1954 at the age of 20 he was company secretary of a young quarrying and road contracting company. In March 1955 the Thames Valley Electric Power Board called tenders for the supply of 2000 concrete power poles. Stan ever the bold entrepreneur, put in a bid as did Certified Concrete although their bid was for prestressed concrete poles of which neither the Power Board nor Stan had ever heard. In their wisdom the Power Board decided to split the contract between the two which of course made both bids uneconomic

Stan tried to find out what on earth was prestressed concrete. His trail led him to Morley Sutherland (President 1970-1971)

Morley had introduced the Freysinnet prestressing systems to NZ and was then employed by Certified Concrete to lead the development of this new material. Morley advised Stan to make an appointment with Mr Cormack. This led to a Joint Venture and a long term relationship for Stan as Sandy involved him deeply in the business putting to good use his skills as an entrepreneur and as a money man complementing the many talented engineers he had recruited around him

Then there was Rob Irwin (President 1973-4)

Rob founded the firm Contech who celebrated their 50th birthday last year. He was a professional engineer with strong entrepreneurial skills. As agent of the Swiss prestressing components company BBRV he was in competition with Morley and the French company Freyssinet. So Rob and Morley were competitors – fiercely so – but both were enthusiastic contributors to the Society. They were also instrumental in bringing speakers to NZ from Europe who kept NZ in the mainstream of prestressing technology.

Morley played an important marketing role with architects and in particular Miles Warren in the development of precast post tensioned frames and Bart Gillespie with lift slab technology.

The first lift slab in the southern hemisphere was a simple beach house designed and built by Sandy Cormack for his family in 1953. It was one storey formed by pretensioned units 8.4 m in length which were post tensioned transversely. The total floor area was a little less than 40 sq m. I remember Sandy telling me about his discussions with the local authority of the time the Chief Engineer of the Waitemata County Council. For God's sake said he "don't submit your design for a permit it will drive my guys around the bend" I checked the design 30 years later and decided I could add another story with safety. Permitting was a separate issue and I will say no more except that I demolished the old building 4 years ago and found the grouted post tensioning cables to be in excellent condition

The links with FIP now FIB were also important and the Society actively engaged with FIP and their working groups especially in precasting. Harry Romanes was a wonderful ambassador in this respect and ensured a close collaboration between the precasting developments in Europe and NZ. Our Society also contributed substantially in the field of seismic resistant design

Annual conferences were essential attendance to those seeking to grow their businesses because of the relevance of the technical information that was being presented along with the opportunity to share real life experiences.

The early years of the Society were largely funded by business. Namely by precasters, prestressing component suppliers and Contractors. In fact the constitution required a minimum number of Councillors from business as opposed to Central and Local Government or Consultants. The contractors who appeared regularly at Conferences were Wilkins and Davies, Fletchers, and Downers. Precast companies were also active. And there were others who as contractors did the hard work to put our ideas into reality. First in my mind here is Rope Construction and their marvellous general manager Bill Parker. Ropes had a very low cost structure. They were not so strong on delivery on time. I remember having some concern that on one bridge project the first task they did on establishing on site was to put down a vegetable garden. As was often the case in those days time was not as important as cost.

The essence of the early days of the Society was the annual Conference.

This was where participants

- Discussed common problems
- Learned what was happening in Europe the birthplace of prestressing
- Learned about current and potential new projects
- Were updated on the latest research
- Initiated informal alliances
- And above all had a lot of fun which was instrumental in breaking down the many silos in the Industry. Bob Norman was always a popular figure as he gathered many or at least all those who fancied their singing ability around the Wairakei piano. There were others who took their beer and whisky to the Wairakei hot pool. They were remarkably friendly occasions and looked forward to by all including partners.

What were the Projects? Who contributed to them?

There are so many.

We have sought to do justice to them in the book of the Society's history which I commend to you. I acknowledge Lawrence Schaffler the chief scribe and Allan Bluett, Jason Ingham and Stan Carwardine's essential input who I think you will agree have done a wonderful job.

Of the very early projects the two that stand out for me are the Benmore Penstocks and the Waitaki River Bridge.

The Waitaki bridge with its 30 metre spans was when it was built in 1956 the world's longest prestressed concrete bridge at 906 metres. It was designed and built by the Ministry of Works and Bob Norman has described it as a deliberate learning experience of this new material. Bob remembers how in 1957 he showed a film of its construction to a World Conference in San Francisco and how the 1200 delegates were flabbergasted by a bunch of kiwis mainly in gumboots and shorts with a couple of cherry picker cranes and a front-end loader throwing up a world beating structure.

Benmore was remarkable because this was the first use of prestressed concrete for penstocks and on a massive scale. There were 6 penstocks each of 5.3 m internal diameter with a head of 95 metres. Design and construction was in the early 1960s.

In the next projects I have selected a few in which I was personally involved with the aim of giving additional insight into the key issues involved in each

These are the Bluff Smelter pot lines. A world first in that a precast concrete solution was adopted. The corbels on these columns were required to support heavy gantry cranes. In this period difficulties had been encountered with corbels on a bridge in Auckland. George Beca was the driving force behind the selection of concrete which was designed and detailed in his office in Auckland. The problem was that the draftsman detailing the corbels had his drawing board just where George passed twice a day to get his coffee. Every time he passed he reiterated the need to reinforce the corbels well. So often that it took an inordinate time for the draftsman to complete the drawing. Many months later I went to Invercargill for discussions with the precaster. I remember him well Ray Nieuwenheuse. He said "Gavin the reinforcing in these corbels is very well detailed there are no clashes it is just that we can't physically assemble it." Some alleviation of reinforcing was indeed possible and this was duly approved

The South Rangitikei bridge was we believe the world's first base isolated structure. Designed in 1973 each pier sits on an elastomeric bearing and under large earthquake induced accelerations each leg is designed to lift off or "step" thereby mobilising steel torsion bars to dissipate energy as they lift up and come down. This concept meant that the maximum compression load in each pier had an upper bound. As buckling of these very slender piers was a key design consideration this was an important and welcome benefit. It was remarkably easy to construct. During construction the pier bases were seated on sand jacks and prestressed on to the piles. When the superstructure was complete this prestressing was detensioned, the sand allowed to run out of the jacks and the piers settled down onto their elastomeric bearings.

The North Rangitikei and Kawhatau Bridges with their 110 m cantilever constructed centre spans were unusually long for a railway bridge where deflection both long term and immediate needs care. I happened to be making an inspection of them shortly after their opening when I saw a heavily loaded ballast train approaching. Feeling an acute sense of responsibility I rushed to the centre of the span inside the box girder and looked carefully at the lower flange as the train passed overhead. No cracking, no perceptible deflection but the noise was horrific.

The Aircraft Hangar at Christchurch. The 122 m clear span of the lintel beam supporting this hangar was built in prestressed concrete Nigel Priestley described this project as “a bridge masquerading as a building”. We compared this concrete alternative with more traditional steel alternatives. John Hollings recommended to his client that the concrete solution should be adopted primarily because of its superior performance in fire. This was because the hangar was designed for servicing 7 aircraft concurrently. A key design case was that of fire protection. Namely that the hangar should not collapse on the others should one aircraft be on fire. The value of the aircraft were of course considerably greater than the cost of the hangar. Concrete was somewhat more costly than the steel alternatives and its construction was more complex because of the need to add counterweights to permit progressive stressing. When of course the roof was in place the counterweights were removed.

These last two projects were of unusual complexity so we arranged an external peer review of our design. This was led very efficiently by Nigel Priestley. I recommend this approach to you. For example the main columns in the Hangar are very highly loaded and have to sustain significant rotations under the design earthquake accelerations. They are highly loaded firstly because of the prestressed ties that help take the cantilever bending moments and secondly because in lateral earthquake induced accelerations the vertical loads are transferred from the outer to the inner column.

The University of Canterbury was at that time studying the ductility capability of heavily load columns so their research and input was highly valued and appreciated.

The Eden Park Boxes. In 1987 a rundown Eden Park was desperately in need of funds This unusual and complex structure had to be constructed over the top of an existing stand which had to remain operational without interruption to rugby and cricket. Their completion provided the owner with a return well in excess of the interest rates which were then 21% p.a. It is of course a single degree of freedom structure which is inherently undesirable. Nevertheless we sought to make the structure ductile even in the overturning mode. When we analysed it for vibration induced loads that might be produced by a vigorous crowd in the boxes at a pop concert we found that indeed it could be excited producing vertical deflections of considerable amplitude. However these deflections could be very large - even as much as a metre - without distressing the structure. So we judged that the crowd behaviour that was the forcing mechanism would quickly cease if in fact resonance did occur.

The Auckland Harbour Bridge Movable Barriers. This ground breaking solution was initiated by Ernst Sansom (President 1992/3) when he heard the politician Richard Prebble say in an evening news bulletin after yet another horrific head on crash that a median safety barrier was totally impossible. Ernst who with his wife Ailsa is with us today, responded to this challenge. He established that there were 3 parties working on this problem. An Australian who had passed on his ideas to a Frenchman and then to an American who was working on the concept in California. This united nations team led by Ernst developed a solution that could cope with the grades and curves of the AHB. The solution was kept highly confidential until there was sufficient confidence that it would work. With strong support from the then Works Consultancy the barrier was installed in November 1990 and has given excellent service ever since. Other installations have since been successful in the USA based very much on the NZ experience

Sky Tower. There are many aspects of interest about this structure. One unusual aspect is the support columns. Prestressing techniques enabled the support of the tower to be provided by 8 cylindrical legs. The alternative would have been to have constructed a tapered wall however these legs were a much better urban design solution as they opened up what would otherwise have been a very congested area at the base of the tower

Otira Gorge Bridge Such a difficult site.

Why? I remember well my first inspection of the site. I walked down to the river it looked no more than a stream. But as I approached the roar of the river through the massive boulders kept me from getting too close even though it would have been possible to jump across the boulders.

This site has:

- High seismicity being only a few kilometres from the main southern fault
- It had to be founded in avalanche debris as base rock could not be reached
- Fast glowing underground running and in places artesian water made piling difficult and scour during construction yet another concern
- The rock debris was particularly hard (unconfined compression testing up to 250Mpa) and so difficult to drill through
- The site is In an avalanche zone and the bridge had to be protected from the large boulders that fall from the 700m high slope above the bridge foundations.
- A site of climatic extremes
- The bridge had to be curved and was unusually steep.

Is there a more difficult bridge site than this?

My involvement in many of these projects was as a designer. I have always felt that it is the Contractor that has the much harder job namely that of realising the designer's intent in what can like Otira be very demanding situations. So I applaud those of you who are contractors.

In our book we have dedicated a chapter to lessons that were hard learned. Many of these relate to the problems uncovered by the Canterbury earthquakes concerning the use of precast concrete

I would however like to refer to two other examples.

I remember Rob Irwin saying to me many years ago that prestressing is often done by 2 people in overalls coming unobtrusively onto a site with a harmless looking little hydraulic jack. And that many do not realise the enormity of the forces and therefore the load redistribution they can cause.

The first example is the collapse of the Ramp A in 1975. The prestressing design called for stage stressing at the three quarter point of the cast insitu span. This redistributed load from the end of the 55 metre span that had been cast onto the falsework below. Adding to the problem was the foundation conditions were such that some of the falsework was located on firm clay and the rest on soft rock. This lead to further redistribution of load and eventually progressive collapse.

Even innocent looking grouting equipment can cause collapse. I refer to a precast reservoir in New Plymouth about 1988. The joints between the units were formed using dry pack. My hypothesis for the failure was that the dry pack was placed more firmly on the outside than the inside. This work has to be done up a ladder and is difficult to supervise. This meant that on stressing (and such reservoirs are highly stressed) internal vertical cracks developed connecting the ducts through which the horizontal prestressing cables were placed. These cracks could not be perceived as they were totally internal. When the cables were subsequently grouted the grout flowed into these cracks eventually imploding what had become an internal skin. In this case massive internal pressures were caused by the grout pump so the cracked wall acted like a giant flat jack. This spectacular failure happened during grouting.

On inspection we found that many parts of the internal skin that had not been grouted were “drummy” to lesser or greater degrees. So the Local Authority engineer arranged for a piano tuner to test the whole reservoir and indeed he found that most of the wall had developed these cracks and it had effectively delaminated around its full circumference. The reservoir structure was demolished and rebuilt with cast in situ joints.

The Canterbury earthquakes have demanded a revisiting of almost all aspects of concrete design.

They also revealed that the standard of our earthquake engineering was not consistently at the level to which we aspire.

The dissemination of best practice solutions and innovation has never been more needed. The lessons learned are so wide reaching that New Zealand’s concrete researchers and innovators could once again be the pathfinders.

So there is much work still to be done.

But success will depend on whether you can emulate the determination of the remarkable people I have described so briefly.

I put it to you that you will succeed only if you continue to ensure that participation in the Society is an essential requirement for career development.