BBR CONTECH
SPECIALIST CONTRACTING

Canterbury Earthquakes Royal Commission
P O Box 14053
Christchurch Airport
Christchurch 8544

File Ref: CG2240

Attention: **The Commissioners**
canterbury@royalcommission.govt.nz

2 March 2012

Concerning: **DESIGN OF CONVENTIONAL STRUCTURAL SYSTEMS FOLLOWING THE CANTERBURY EARTHQUAKES**

Dear Sirs,

We refer to the SESOC practice note "Design of Conventional Structural Systems Following the Canterbury Earthquakes" and have some comments that may be relevant for the Royal Commission to consider. These comments are based on structures that performed very well and it does seem relevant to consider these things when designing future structures. The comments below have been communicated directly to SESOC and they have requested that they be copied into the submission that is made to the Royal Commission.

In general, we thought the SESOC document read very well and was comprehensive in its content. However, BBR Contech do have some specific information and experience in some areas of concrete slab construction which we feel should be referenced to provide engineers and building owners a wider view of some very positive developments over the past 10 years.

Over the past 18 months BBR Contech has been working hard in a wide range of remedial activities to play our part in the recovery, repair and rebuild of Canterbury. In conjunction with our many inspections of damaged buildings in the region, we have also been reviewing our post-tensioned floor work to gauge performance under these extreme loading situations. The floor slabs in question have been constructed in a wide range of commercial, retail and industrial warehouse buildings – as well as in some civil structures.

Over the past 10 years, BBR Contech has delivered over 40 post-tensioned slab-on-ground projects in Christchurch ranging in size from 1,000-32,000m^2. These building projects were located throughout the earthquake affected region and they have performed to a very high level. With relatively high compression forces integral to the design and a minimum of joints, post-tensioned slabs have the ability to resist high loadings and to bridge over areas of local weakness. The performance of these slabs has not disappointed in Christchurch with virtually no damage reported. A number of warehouses and storage facilities suffered from collapsed racking and damage to other building elements, however the post-tensioned floors remained intact and provided a solid foundation to effect a rapid clean-up and were ready for service again once racking and stock was replaced.

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The slabs have resisted high ground accelerations and the self-restoring characteristics of the post-tensioning have enabled the floors to mitigate the effects of the ground motions and weak subgrades. Many other buildings with conventionally reinforced floor slabs have suffered significant damage and some of these floors have required complete replacement. Also observed was substantial damage to saw cuts and movement joints in these conventional slabs as a result of lateral displacements and pounding. We have been active in replacing some badly damaged conventionally reinforced slabs – using smaller sized post-tensioned configurations which can be readily placed usually with a complete absence of any joints.

Late in 2011, we set out to inspect all of the buildings that we had installed post-tensioned slabs in. We attach a copy of the schedule of buildings in question. We were not able to inspect every building but we did examine the majority of them and determined that the performance characteristics we were observing were consistent throughout Christchurch. Based on our observations and discussions with building owners and tenants, we discovered that there was virtually no damage in the floors (we found two examples where some very minor damage was noted).

Having now constructed some 1,500,000m^2 of post-tensioned floors in over 200 buildings (throughout NZ), it is very much our contention that this method of construction is the new convention for a wide range of commercial buildings. Based on this assertion, we consider that some additional comments are warranted on this method in relation to "design of conventional systems." The President of SESOC has acknowledged our comments although has not had the opportunity to observe or discuss our findings in detail. We have not sought any endorsement from SESOC and our approach has been to inform them of our recent observations.

We note some specific comments in relation to section 9.4 in the practice note. Slabs-on-grade have not performed badly when they were post-tensioned. In fact they have performed to a very high level and could arguably have exceeded design and performance expectations. With approximately 40 Christchurch buildings to use in our database, we believe are able to make some valid comments. We would contend that the post-tensioning structural system for slabs-on-grade is very much a conventional method and the use of this technique has been a real benefit to building owners and tenants. There was virtually no damage on any of our slabs and most tenants suffered no or little business interruption. We saw one example of a particular building where we are able to compare the performance of a conventionally reinforced and jointed slab with that of a joint-less post-tensioned slab. These floors were in the same building and located immediately adjacent to each other. The conventionally reinforced and jointed slab suffered serious damage. The pounding due to lateral movements destroyed the jointed slab but had negligible effect on the PT slab (a small longitudinal crack extended across the middle of the post-tensioned slab).

We think it is appropriate to comment on this good performance observed in a large number of buildings rather than remain silent on it. We doubt many people have the knowledge like us but we did take some time to do a thorough visual assessment. Some slabs did undergo some minor heave but none suffered any distress. It is an impressive result given some of the floor locations were very badly hit by the earthquakes. If we are genuinely trying to guide designers about ways to design for better performance and more resilience, then this should warrant some specific reference. The industry spends a lot of time commenting on detailing of joints in slabs but not much time on discussing how well the post-tensioning (and joint-less) systems are actually doing. It is very much a

competitive method and in most cases the best and cheapest way of constructing commercial slabs-on-grade. Does this low damage system come at a substantial cost as is written in the SESOC practice note? Or is there some observed performance in this sample of over 40 buildings that suggests PT slabs very much avoided damage with only a minor cost premium – if any premium at all in the buildings in question?

Thank you for the opportunity to present our observations and we would be happy to provide additional detail should the Commissioners or SESOC require this.

Yours sincerely

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Post-tensioned slabs - Track Record and Experience Matrix

Elevated/Suspended PT slabs

Project	Location	Date	Size	Head Contractor	PT Design	PT Install
Fonterra Darfield Drystore	Christchurch	2012	12,500	Calder Stewart	BBR Contech	BBR Contech
Fonterra Darfield Loadout Apron	Christchurch	2012	4,200	Calder Stewart	BBR Contech	BBR Contech
Kathmandu Warehouse	Christchurch	2012	5,000	Arrow International	BBR Contech	BBR Contech
St Martins New World	Christchurch	2012	2,500	Fletchers	BBR Contech	BBR Contech
Coleridge St	Christchurch	2011	1,250	TBA	BBR Contech	BBR Contech
Fonterra Darfield Packing Room	Christchurch	2011	2,000	Ebert	BBR Contech	BBR Contech
Synlait Dunsandel	Christchurch	2011	10,000	Ebert	BBR Contech	BBR Contech
Air NZ Christchurch Dist Centre	Christchurch	2010	1,500	Calder Stewart	BBR Contech	BBR Contech
The Warehouse Rolleston Square	Rolleston	2010	2,000	Hanham & Philp	BBR Contech	BBR Contech
PGG Wrightson	Christchurch	2009	10,000	HRS Construction	BBR Contech	BBR Contech
Fonterra Edendale Drystore Ext	Edendale	2009	6,500	Calder Stewart	BBR Contech	BBR Contech
Fonterra Edendale Packing Store	Edendale	2009	1,500	Ebert	BBR Contech	BBR Contech
Westland Milk Products Apron	Rolleston	2009	6,000	Calder Stewart	BBR Contech	BBR Contech
Westland Milk Products Store	Rolleston	2009	17,000	Calder Stewart	BBR Contech	BBR Contech
Glassworks - F&P / NZ Safety	Christchurch	2008	5,000	Armitage Williams	BBR Contech	BBR Contech
Winstone Wallboards	Christchurch	2007	5,000	Fletcher	BBR Contech	BBR Contech
Synlait Drystore	Dunsandel	2007	3,500	Ebert	BBR Contech	BBR Contech
Mitre 10	Ferrymead	2007	5,000	Calder Stewart	BBR Contech	BBR Contech
Bunnings	Marshlands	2007	9,000	Calder Stewart	BBR Contech	BBR Contech
The Warehouse Ashburton	Ashburton	2006	4,500	Bradford Construction	BBR Contech	BBR Contech
Foodstuffs Hornby Warehouse	Christchurch	2006	11,000	Armitage Williams	Evans Douglas	BBR Contech
NZ Post	Christchurch	2006	7,000	Leighs Construction	BBR Contech	BBR Contech
Packaging House	Christchurch	2006	1,500	Hanham Philp	BBR Contech	BBR Contech
Mico Plumbing	Christchurch	2005	1,500	Naylor Love	BBR Contech	BBR Contech
The Warehouse Blenheim Rd	Christchurch	2005	8,500	Naylor Love	BBR Contech	BBR Contech
Coca Cola	Christchurch	2004	6,000	Arrow International	BBR Contech	BBR Contech
Crane Distribution	Christchurch	2004	3,000	Naylor Love	BBR Contech	BBR Contech
Paperlinx	Christchurch	2004	3,200	Calder Stewart	BBR Contech	BBR Contech
Placemakers Riccarton	Christchurch	2004	7,000	Naylor Love	BBR Contech	BBR Contech
Boise	Christchurch	2003	5,500	Hawkins Construction Ltd	BBR Contech	BBR Contech
Foodstuffs Hornby Freezer	Christchurch	2003	2,000	Foodstuffs	BBR Contech	BBR Contech
Integrated Hydraulics	Christchurch	2003	1,000	Naylor Love	BBR Contech	BBR Contech
Mitre 10 - Hornby Extension	Christchurch	2003	2,500	Allied Concrete	BBR Contech	BBR Contech
The Warehouse - Northlands	Christchurch	2003	6,500	Naylor Love	BBR Contech	BBR Contech
The Warehouse Distrb Centre	Christchurch	2002	32,000	Naylor Love	BBR Contech	BBR Contech
Edendale	Edendale	2002	7,000	Calder Stewart	BBR Contech	BBR Contech
Avon Picture Mouldings	Christchurch	2001	1,000	Hawkins Construction	BBR Contech	BBR Contech
Independent Fisheries Freezer	Christchurch	2001	2,500	Long International	BBR Contech	BBR Contech
The Warehouse at Hornby	Christchurch	2001	1,500	Naylor Love	BBR Contech	BBR Contech
The Warehouse at Eastgate	Christchurch	2000	8,000	Naylor Love	BBR Contech	BBR Contech
Woolworths Distribution Centre	Christchurch	2000	1,000	CBD Construction Ltd	BBR Contech	BBR Contech
The Warehouse Rangiora	Rangiora	2000	3,500	Naylor Love	BBR Contech	BBR Contech
Bromley Digestors	Christchurch	1999	4,500	Daniel Smith Industries	Beca/City Solns	BBR Contech
Foodstuffs	Christchurch	1999	5,500	Hawkins	BBR Contech	BBR Contech
	Total	**44**	**246,650**	m^2		
	Minimum		**1,000**	m^2		
	Maximum		**32,000**	m^2		
	Average		**5,606**	m^2		