UNDER	**THE COMMISSIONS OF INQUIRY ACT 1908**
IN THE MATTER OF	**ROYAL COMMISSION OF INQUIRY INTO BUILDING FAILURE CAUSED BY CANTERBURY EARTHQUAKES** **KOMIHANA A TE KARAUNA HEI TIROTIRO I NGA WHARE I HORO I NGA RUWHENUA O WAITAHA**
AND IN THE MATTER OF	**THE CTV BUILDING COLLAPSE**

STATEMENT OF EVIDENCE OF MICHAEL JOHN BROOKS IN RELATION TO THE CTV BUILDING

DATE OF HEARING: COMMENCING 25 JUNE 2012

STATEMENT OF EVIDENCE OF MICHAEL JOHN BROOKS IN RESPECT OF THE CTV BUILDING

1. My full name is Michael John Brooks of Christchurch. I am retired.

2. I was the Managing Director of Williams Construction (Canterbury) Limited (**Williams**) when the construction of the CTV building at 249 Madras Street **(the CTV building)** commenced in 1986.

Employment Background

3. I joined Williams Construction (Canterbury) Ltd in 1985. Initially as General Manager and became Managing Director in mid 1985.

4. Prior to that appointment I had worked at Industrial Holdings Ltd, a property developer and builder of commercial buildings, as Development Manager.

5. Before that I was employed by the Christchurch City Council as a Senior Town Planner where I assisted with the review of the District Scheme. I hold a Town Planning qualification from the Nottingham College of Art.

Williams Construction

6. In 1985 Williams Construction consisted of about 25 employees. Most were trade qualified and included three foremen. Bill Jones was one of those foremen, having been with the company for many years. At the time I joined the company, Bill had recently completed a housing development for Christ's College and was due to commence a multi-storey office block for the Aged Persons Council.

7. The Construction Supervisor was Geoff Taylor. He was responsible for overall co-ordination of construction progress.

8. Tony Scott joined the company in mid 1985 as quantity surveyor with the title of Development Manager. His responsibilities were financial, such as estimating construction costs, monitoring of labour and material costs and preparation of progress claims. He was not responsible for technical construction issues.

9. My main responsibilities at Williams were personnel management and obtaining further construction contracts. I had no real involvement in the detailed management of the sites, although my general practice was to visit the sites two or three times a week to check how things were going and whether the foreman needed anything.

10. For the following year or so the management structure remained unchanged. However during 1985 to 1986 the company expanded significantly to about 100 employees. Contracts underway at that time included the Copthorne Hotel on Durham Street, the RNZAF Museum, the Aged Persons Council building and some smaller contracts. Other potential contracts were under negotiation. At this point it had become evident that the management structure of the company needed to be strengthened. This was not simply due to increased workload but the complexity of the buildings being constructed by Williams had also increased.

11. I recall a meeting with the then Williams Group Chief Executive Officer, Mr Williams, to discuss various projects and the future growth of the company. Mr Williams impressed upon me the need to strengthen the management structure by employing a structural engineer. I recall well his comment that far too much responsibility was being placed on the foremen.

12. I then took steps to employ someone with construction experience but particularly with a structural engineering background. This led to the appointment of Gerald Shirtcliff as Construction Manager. The creation of this position effectively replaced the Construction Supervisor role. Gerald Shirtcliff's responsibilities were to ensure satisfactory progress of all Williams' contracts. That would have included co-ordination of sub-contractors, liaison with Consultants and the supply of materials and labour to the various sites, including the CTV building site. Mr Shirtcliff was left to his own initiative as to how this was achieved.

13. Gerald Shirtcliff was the Construction Manager of Williams until I left in March or April 1987 and so far as I am aware continued in that role thereafter. I should make it clear that whilst he was later dismissed from the company, after the CTV building was completed, it was not for reasons of technical incompetence. I never had cause or was given cause to doubt his technical knowledge.

The CTV Building

14. I recall a meeting with Mr Neil Blair of the Prime West Corporation **(Prime West)** in the middle of 1986 regarding the development of the site at the corner of Cashel and Madras Streets, which Prime West owned.

15. I first formed an association with Mr Blair when I was employed by Industrial Holdings. In 1984 or 1985 I had arranged the development of a site he owned in Hereford Street, into a six-storey office block.

16. Mr Blair was an experienced and successful property developer and investor with a clear understanding of market conditions. I am quite sure that he would have had definite knowledge of the site's potential prior to purchase, if only to determine its price.

17. The meeting resulted in Williams being invited to submit a design/build proposal to Prime West. I put a proposal to Prime West which was accepted, subject to the final details being worked out.

18. I had a clear view on how the building should look. It was my idea to have the lift shaft at the back of the building. This allowed for maximum rentable space. As I recall it, I set this out on a piece of paper, just a square box with the lift shaft drawn at the back. I ran it by Tony Scott to get an idea of how much it would cost.

19. I then gave my drawing to Alun Wilkie to draw up final plans. He had worked for developers before and understood that the building needed to be as efficient as possible and provide the maximum lettable space. Tony Scott and I then prepared a contract.

20. A contract price of about $2.45 million was agreed with the client. It was a fixed price and did not include any bonus or penalty clause. I recall that a profit of about $200,000 was budgeted for, which was maintained throughout, if not improved upon.

21. The considerations that led to the design of the building and its location are as follows:

(i) District Planning Scheme

22. The site is located in the Commercial 4 zone (C4) Uses permitted as of right include retail and office use.

23. The maximum height of the building was determined by an angle of 68% from the road centre (about 24m).

24. The total permitted net floor space was determined by the plot ratio of 3.5 multiplied by the site area (ie: 3490m^2 net).

25. The number of onsite car parks and layout dimensions were determined by conditions of the zone.

26. The District Scheme imposed strict limitations on access. In this case the site access was limited to the western extremity of the site off Cashel Street by an existing building.

27. Both the height and floor space of the building were less than was allowed under the District Scheme. The final design complied with the District Scheme in all respects.

(ii) Market Conditions

28. The amount of floor space and floor size was ultimately determined by the client based on his own perception of the market. Although I cannot speak for him, it is fair to say that our views were similar.

29. As best as I can recall, demand for office space at that time was mainly in the range of 250-500 square metres. Large floor areas were very difficult to lease. Retail activity in this area had declined dramatically over the previous 10 years, to the extent that it was not profitable to provide ground floor retail space in this building. This partially explains why the building was not located on the corner.

30. The site itself was very much regarded as secondary. It is at the opposite end of town to the central business district's medical, banking and legal services. However it did benefit from good access and off-street parking. Demand was expected to come from tenants with little concern for public profile but with a need for low-cost, basic office space.

(iii) Building Cost and Design

31. The actual location of the building on the site was largely determined by the requirements for access and car parks. There was no compelling need to locate the building on or near the corner.

32. The architect Alun Wilkie, was expected to produce a building with an efficient use of floor space, keeping non-lettable space to a minimum. The floor space may also need to be sub-dividable in the future.

33. The client required a building that was for as low a cost as possible, consistent with achieving its function and having a reasonable experience and reasonable appearance.

34. Economy of cost starts with an efficient and simple architectural design supported by a structure of similar nature. These factors coupled with the skill and experience of the builder led to a profitable project that met the client's criteria in all respects.

35. The final appearance of a building and how it is perceived is usually determined by its location as a building by the river looks more attractive than one in Tuam Street.

36. The structural frames of reinforced concrete buildings, whilst there being many different methods, are fundamentally alike. I have four photographs to illustrate my point **[BUI.MAD249.0423]**. Although it is not clearly shown, each building is similar in floor

space and each one with the lift shaft and services on the side. It is what is attached to the frame and what is included in the interior, such as carpets, marble floors, air conditioning which makes a point of difference. These items can add substantially to a building's cost and therefore rental potential.

37. The CTV building had none of those items when first completed. It is only in those optional extras that economies were made.

38. It was a standard kind of speculative deal but it had a little bit of sharpness to it. By contrast, my previous employer, Industrial Holdings, did a couple of buildings down the road which were of the same design (columns and reinforced concrete floor) but they lacked that little bit of sparkle that the CTV building had.

39. Williams did not work on this building on the basis of a price it had committed itself to, based on sketchy plans from Alun Wilkie and Alan Reay. As multi-storey buildings go it was very straightforward. If you have done a few buildings like this you get to know that 20,000 square feet is about one million dollars, 40,000 square feet is about the same ratio or 5% less and so on.

40. We made a decent profit margin on that job, more than most. I used the fact that Williams was very good at concrete to make money. If, for example, the concrete component of a job was $250,000, I used to load as much of that as I could into the early payments to assist with cash flow. I did this on the CTV job.

41. There was no financial pressure on this job and Prime West made progress payments on time which kept Williams ahead in terms of cash flow. I do recall that by the time the CTV building was finished Prime West was in trouble and there was some uncertainty about whether we would be paid right up until the cheque was received.

Alun Wilkie Architects and Alan Reay Consultants

42. I was familiar with Alun Wilkie's work from working with him at Industrial Holdings and Alan Reay was the structural engineer on the Aged Persons Council building which Williams had built.

43. I cannot single out any particular reason why Alun Wilkie and Alan Reay were selected. However both were experienced in dealing with builders and developers and had a particular understanding of developer's requirements – to maximise floor space and use of the building and to employ economical construction techniques.

44. I do not recall speaking to Alan Reay about the CTV building. In my mind David Harding, as an employee of Alan Reay Consultants, was the principal engineer for the

building. I remember speaking to him when the CTV building job was first given to Alan Reay Consultants. I also remember speaking to him two or three times throughout the project, I doubt whether this was about a specific engineering matter, but rather more social contact, checking on the progress of the building.

45. At all times both Consultants undertook their duties to Williams' satisfaction. I have no doubt that had we continued in business, both Consultants would have been employed on other jobs.

Building Permit and the Tapper letter

46. I had no dealings with the Council over the building permit for the CTV building. I have been advised during the course of preparing my evidence that prior to the permit being issued Mr Graeme Tapper, who was at that time a Council engineer, recorded in a letter to Alan Reay a number of concerns he had about the building. I had not been aware of this. I do not recall David Harding or Alan Reay saying anything to me about it at the time. The fact that there was a letter does not of itself ring alarm bells for me, as it would often happen that the Council would question aspects of drawings that they were not sure of and on such matters the Council would go directly to the design engineer.

Union Construction

47. In late 1986 Williams became the subject of a takeover by the Smart Group. This had little impact at first, but a hostile situation developed in early 1987. I learnt that attempts were being made to sell Williams and that the tower crane was up for sale. This did most certainly have an unsettling effect on everyone.

48. When situations like this occur it may manifest itself in the following areas:

    i) Absenteeism – supposed 'sickness'

    ii) Accidents

    iii) Lower productivity – 'work to rule'

    iv) Poor quality workmanship

49. During this period three serious accidents occurred including one at the CTV building. Whether or not these were caused by distraction as a result of the Smart Group takeover I could not say, but nevertheless recognise this as a distinct possibility.

50. I wish to comment on this issue in the context of whether or not it could have impacted detrimentally on work standards at the CTV building.

51. At first the takeover had, if anything, a positive effect, insofar as the Smart Group gave an assurance that Williams would be retained. In addition an issue of shares to the staff was promised.

52. Regarding the issue of standards of workmanship falling, I reject this assertion entirely for the following reasons. Prior to me joining Williams the company had undergone two management changes which to the best of my knowledge had no effect on the work standards. The site staff of Williams were entirely skilled and conscientious tradesmen, well led by experienced foremen, themselves very capable tradesmen in their own right. Work standards and good tradesmanship are second nature to those people and I cannot envisage a situation where they would compromise their principles.

53. There is some indication that the progress of the CTV building slowed down after March 1987. However, based on my experience some months later, I believe this was due to non-payment of suppliers and sub-contractors.

54. I was dismissed from Williams in March 1987. Mr Scott left Williams shortly afterwards whilst Mr Shirtcliff remained employed by Williams.

55. Tony Scott and I established our own construction company, Union Construction Ltd (**Union**) in March 1987 **[BUI.MAD249.0238]**. It consisted of myself as Managing Director, Mr Shirtcliff as Construction Manager and Mr Scott as Development Manager. We each held 10% of the shares (unpaid), the balance of 70% being held by nominees of Angus Construction Ltd (**Angus**). Board membership consisted of myself and two directors of Angus.

56. Mr Scott joined Union shortly after it was formed but Mr Shirtcliff stayed at Williams and came over to Union later in the year. Some months later all of the employees of Union were former employees of Williams. At some point Bill Jones joined Union in the same capacity. I am unable to recall approximate dates.

57. From April 1987 I had no further contact with Williams until September or October of 1987. I received a call from Stephen Smart, the Chief Executive Officer of the Smart Group asking me to go back to Williams, as he was unhappy with the state of the company. I agreed to do so.

58. At this point the CTV building was nearing completion. Although I cannot recall its exact state at that time, I am fairly certain that the structural frame, columns, floors, beams and shear walls had been completed.

59. On returning to Williams, it was apparent that the company was in a parlous state, almost out of work, behind in payments to creditors' and had been issued with a Council stop work notice on one job. I also discovered that the two persons appointed to manage the Company were clearly out of their depth.

60. It was agreed with the Smart Group that Williams would be closed down and that the existing contracts including the CTV building contract would be assigned to Union. Union would purchase the plant and equipment of Williams. Many of the Williams employees also joined Union at this point.

61. The CTV building was completed by Bill Jones and Union carpenters.

62. During this period, Union also built a multi-storey office building in Victoria St, a multi-storey car park in Lichfield Street, the foundations for a 12 storey building in Oxford Terrace and completed internal alterations to the former Winder Gardens in Madras Street.

63. A management dispute arose at Union Construction in late 1987 or early 1988. However this was sometime after the completion of the CTV building.

64. In early 1988 Union became insolvent and closed down in late 1988.

1990 Holmes Consulting Group Report

65. After Union closed I took up a position in real estate with H G Livingstone Ltd. By this time the CTV building was owned by the Bank of New Zealand as mortgagees in possession because Prime West had gone into receivership. The building was offered for lease or sale and H G Livingstone was the agent.

66. As a result of my employment I learned that the former Canterbury Regional Council had considered purchasing the CTV building but had declined to do so. Malcolm Douglass, the former Chief Executive of the Canterbury Regional Council, was a former colleague of mine so I phoned him. He told me that Holmes Consulting Group had identified a design fault with the building. I remember reference to the connections between the floors and shear wall.

67. I remember being shocked when he told me about the report. I knew Malcolm as a pedantic person who would have taken the report very seriously. I never saw the report or any other related documents.

68. I had no further involvement of any kind with the building. To the best of my knowledge I was the only employee of H G Livingstone to have dealt with the property. The policy of H G Livingstone at the time would have precluded the company from dealing with the property unless full disclosure of all relevant facts could be made to potential tenants and investors.

Roles and Responsibilities of the Foremen on Williams' contracts

69. I have read the report prepared by Dr Clark Hyland and Ashley Smith for the Department of Building and Housing on the collapse of the CTV building and wish to make the some comments on matters discussed in that report. However, I would first like to make some comments on the roles and responsibilities of a foreman on a project like the CTV building.

70. Most foremen of that era, indeed Mr Jones would be a classic example, are fundamentally carpenters by trade, formally or informally trained to the level of building light timber framed structures up to three storeys in height. Over years of experience many pick up other skills and a wealth of knowledge of construction. They are characterised by a 'can do' attitude, daunted by very little.

71. In my experience few, if any, foremen of that era would have the benefit of a written employment contract with appropriate conditions and terms of reference. Indeed this was the case at Williams.

72. A typical scenario of Williams being a successful tenderer would be a call to the appropriate foreman "*to pick up the drawings and let me know what you need*". That would just about be the sum total of management instructions.

73. The type of contract that the job is has I believe, a great deal of influence on the responsibilities that may be imposed on the foreman. I use the term impose deliberately. With the benefit of hindsight I realise that so often management expected more from the foremen than they were initially trained for, or for that matter paid for.

74. An example is the RNZAF Museum at Wigram. In all ways this was a traditional type of contract with an architect and engineer appointed by and reporting to the client. This contract was won by tender and I well recall the drawings and specifications which were of a high standard. In that case the client also employed a Clerk of Works.

75. The Clerk of Works carried out frequent inspections (almost daily) to a level of detail greater than normally carried out by the architect and engineer. In addition there would have been a formal meeting and recording regime. This was a very typical construction management system of the Ministry of Works Division.

76. By way of contrast, the CTV building was a design/build contract a package deal. The most obvious difference between a design/build contract and a tendered job in terms of management is that that the architect and engineer were employed by and reported to, the builder. In this case the client did not employ anyone, such as a clerk of works, in a contract supervisory capacity.

77. Despite the added bureaucracy of a Clerk of Works, I feel sure that it not only gave a level of added comfort to the client, but also to those directly involved on the construction, especially the foreman.

78. To the best of my knowledge, much of Mr Jones' experience was previously on work of the likes of Ministry of Works contracts. The CTV building may have been his first experience with a Design Build contract.

79. With regard to the specific responsibilities of the foreman, I make the following comments:

    a. He is mainly responsible for carrying out the work that falls within his trade. For example, had we elected to make our own columns and beams with timber framework, then clearly it would have been his responsibility to ensure the work was to the appropriate trade standard.

    b. A large percentage of work undertaken on a construction site is by sub-contractors or sub-trades. These people or organisations are appointed by management and are expected to perform to their own standards of trade. This would include the electrician, plumber, steel placer, floor placer, and lift installer.

    c. The foreman's role where these activities are concerned is that of facilitator. This means to ensure that the 'job' is ready or prepared for a particular trade and where reasonably necessary provide assistance by way of labour and materials.

    d. The fact that the foreman has an in-depth knowledge of those trades does not under any circumstances make him responsible for their activities. His responsibility is limited to the extent of reporting to management on their performance or otherwise.

e. I would like to clarify the issue of concrete testing at this point. The Hyland report has identified this matter as being of some concern. The Specification does of course make it clear as to responsibility **[BUI.MAD249.0199.4]**. However, even if the Specification were silent on this subject, my clear view is that concrete testing is outside the foreman's terms of reference.

Construction Deficiencies identified by Dr Clark Hyland and Ashley Smith

(i) Asymmetrical design

80. Designs of this nature are quite commonplace and I am at a loss to understand how this could be seen as a fault.

81. Locating the service core on the side not only produces the maximum amount of net leasable space, but also offers more flexibility for office layout. Locating the service core centrally was not an option. The north and west walls were fire hour rated walls and had to be of solid construction without windows. A central service core would therefore result in office space without any natural light which was not acceptable.

(ii) Building out of 'plumb'

82. The report refers to a survey carried out that established that the North Core was 90 – 100mm out of 'plumb' (90-100mm). Whilst that is not surprising under the circumstances, the conclusion that it was built like that most certainly is. If that was the case, the lift installer would have experienced great difficulty in installing the lift.

(iii) Cobbling' of concrete

83. It is a general trade standard to ensure that the surface of existing hard concrete be suitably roughened, or cobbled, where it is to join new concrete. This is to aid adhesion and is normally carried out manually with a hammer and chisel.

84. However, in the case of shell beams, this is not necessary for the following reasons:

i) The inside of the beam is already roughened by the manufacturer during the moulding process.

ii) The bottom edge of the face has reinforcing protruding thus avoiding the need for cobbling.

iii) The side edges are not done because of the fragile nature of the beam. Chipping with a hammer would most likely cause cracking and break off the edges.

iv) The top edges also do not require 'cobbling' because the metal Hi-Bond floor is laid over it.

85. I refer to a copy of typical manufacturer's specification for shell beams which I have provided with my statement **[BUI.MAD249.0423A]**.

(iv) 'Bending of steel'

86. Reference is made to the bending of H24 steel bars back into the concrete on the site.

87. Steel of this size can only be bent manually with great strength and mechanical assistance. An H24mm bar is 6metres in length. Approximately 4metres of that would first need to be firmly fixed. A pipe of suitable length would then need to be applied to the free end and upward force applied. The resulting 'bend' would be a 'kink' rather than a smooth even curve.

88. The suggestion that such an action was undertaken on scaffolding 3 metres of the ground in wet concrete is in my view, utter nonsense.

89. Those H24 bars were formed in a semi-circular pattern to a pre-determined radius, on a machine under factory conditions and subsequently delivered to the site. Every beam that connects to a shear wall contains, or should contain one pair.

90. Consideration of the above has led me to a certain conclusion that I believe to be fundamental to the cause of the collapse.

91. It is a fundamental precept to reinforced concrete construction that the steel reinforcing forms a continuous 'flow' without gaps, breaks or other form of interruption. In simple terms the foundation steel must connect to the column steel and in turn to the beam steel and shear wall and so on. Any interruption to that flow must inevitably undermine the integrity of the structure.

92. This is precisely what has occurred in the CTV building and furthermore has occurred at the point where the beam connects to the shear wall.

93. The pair of H24 rods are located in the beam such that each semicircular end protrudes into the shear wall just beyond the line of vertical reinforcing rods. A horizontal H24 rod should then have been inserted through the semi-circular ends and tied in place, prior to the concrete pour. The insertion of this item would have provided continuity to the steel connections and would have gone someway towards frustrating any forceful attempt to collapse the structure, if not to prevent it. I have prepared my own diagram to illustrate this **[BUI.MAD249.0423B]**.

94. This in my opinion is a major contributory reason for the collapse of the building.

Signed: _____
Michael John Brooks

Dated: 31 May 2012.

A

B

C

Cambridge Tce. Buildings

NB. [A = Aged Persons Council]

D

Former Oxford Clinic, under demolition. 25.3.12.

NEW ZEALAND | COMPANIES OFFICE

Certificate of Incorporation

UNION CONSTRUCTION LIMITED

341325

This is to certify that UNION CONSTRUCTION LIMITED was incorporated under the Companies Act 1955 as a Private Company (Shares) on the 17th day of March 1987 and was removed from the register on the 3rd day of March 1993.

Registrar of Companies
5th day of March 2012

Neville Harris

REGISTRAR OF COMPANIES NEW ZEALAND

The validation code for this Certificate of Incorporation is: INC75049898
For further details relating to this company check www.companies.govt.nz
Certificate generated 05 March 2012 10:41 AM NZDT

2. CONCRETE & REINFORCING STEELWORK.

2.1 GENERAL

Refer to the General and Special Conditions of Contract Clauses which shall apply to all work in this section of the Specification.

2.2 SCOPE

This section of the specification includes the supply, forming and casting of all cast-in-place, plain and reinforced concrete including all items necessary to complete the work indicated on the drawings and not specifically described elsewhere in this Specification. This section of the Specification includes the supply, erection, reinforcing and casting of the components of the approved proprietary floor system specified in Clause 2.16 of this Specification.

This section of the Specification includes the erection of all precast concrete. The PRECAST CONCRETE section includes manufacture of precast concrete units as detailed and delivery to the site if necessary.

2.3 MATERIALS AND WORKMANSHIP

The Contractor shall comply with all requirements of NZS 3109:1980 except where specified otherwise herein or instructed otherwise by the Engineer. A copy of this standard shall be kept on the site and relevant parts read with the following clauses of the Specification.

2.4 CONCRETE

Site concrete and concrete required to make good excavations shall be 10 MPa at 28 days or better. All other conrete shall be SPECIAL ro HIGH GRADE, from an approved ready-mix plant, and as defined in NZS 3109: Clause 6.2 and of the following strengths:-

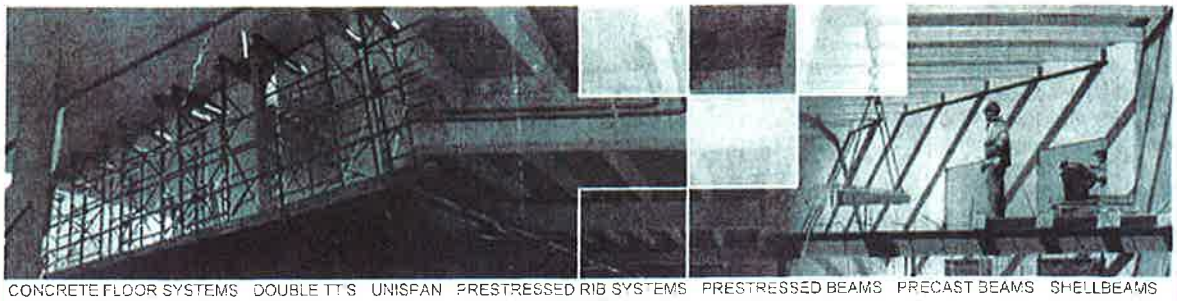
Foundation beams and pads	20 MPa
Columns at Level 1	35 MPa
Columns at Level 2	30 MPa
Columns at Level 3	25 MPa
All other structural concrete including floors and walls	25 MPa

The maximum aggregate size shall be 19mm.

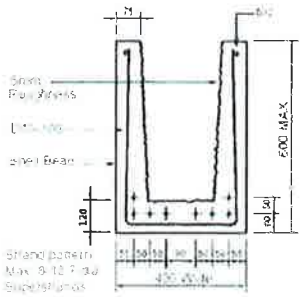
2.5 CONCRETE TESTS

The ready-mix supplier shall make control tests in accordance with NZS 3104, and shall pay the costs of such tests. Tests shall be made either at the ready-mix plant or at the site, except that if the Engineer specifically calls for tests at the site as a result of any dissatisfaction with the plant testing procedure, these shall be done by the ready-mix supplier.

FORMSTRESS PRECAST LTD



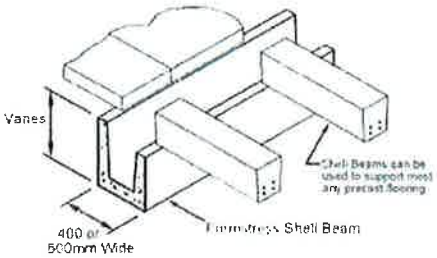
Product Range - SHELL BEAMS



Solutions that speed up construction times have always been in demand and the Formstress Shell Beam helps in this area by reducing the amount of on-site formwork and minimising the amount of beam reinforcing required.

QUICK FIND:

- Specifications
- Construction
- General Notes



MOMENT CAPACITY TABLE

Ultimate Moment Capacity Table - (400 wide Shell Beams with 6-12.7 dia. Superstrands)

Flooring System		Shell Beam Depth (mm)				
		200	300	400	500	600
150 Ribs	O/A Depth (mm)	450	550	650	750	850
+ 75 topping	Ult. Moment (KNm)	302	396	490	585	679
75 Flat Slabs	O/A Depth (mm)	350	450	550	650	750
+ 75 Topping	Ult. Moment (KNm)	207	302	396	490	585

Ultimate Moment Capacity Table - (600 wide Shell Beams with 8-12.7 dia. Superstrands)

Flooring System		Shell Beam Wall Depth (mm)				
		200	300	400	500	600
150 Ribs	O/A Depth (mm)	450	550	650	750	850
+ 75 topping	Ult. Moment (KNm)	411	537	663	789	915
75 Flat Slabs	O/A Depth (mm)	350	450	550	650	750
+ 75 Topping	Ult. Moment (KNm)	286	411	537	663	789

PRODUCT SPECIFICATIONS

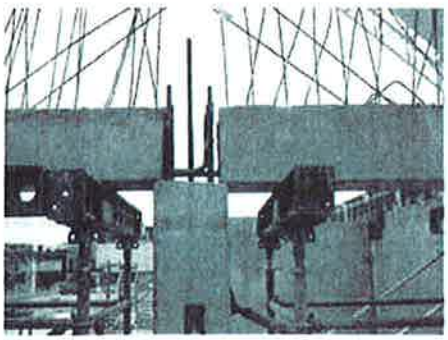
Precast Shell beams are either 400 or 600mm wide with wall heights up to 600mm tall.

All Formstress Shell Beams are cast from 45 MPa (at 28 days) concrete.

When specifying precast shell beams, your project structural engineer should provide the number of strands, diameter required and the stress or alternately the ultimate midspan moment capacity required for the beam length.

Engineers should note that the Shell Beam contains a small cage of reinforcing. This steel is for construction and handling purposes only and should not be considered in the main beam design, including shear calculations.

Refer to NZS 3109:1997 Table 5.1 for precast construction tolerances.



INSTALLATION & CONSTRUCTION

All Precast Shell Beams need to be fully supported (shore loaded) during the construction process. Builders should install the props to the required levels prior to placing the beams. This should be achieved to within ±3mm. The propping system (designed by others) must be adequate to carry all construction loads.

Drilling holes through or cutting precast Shell Beams should only be undertaken with the written approval of a Formstress engineer.

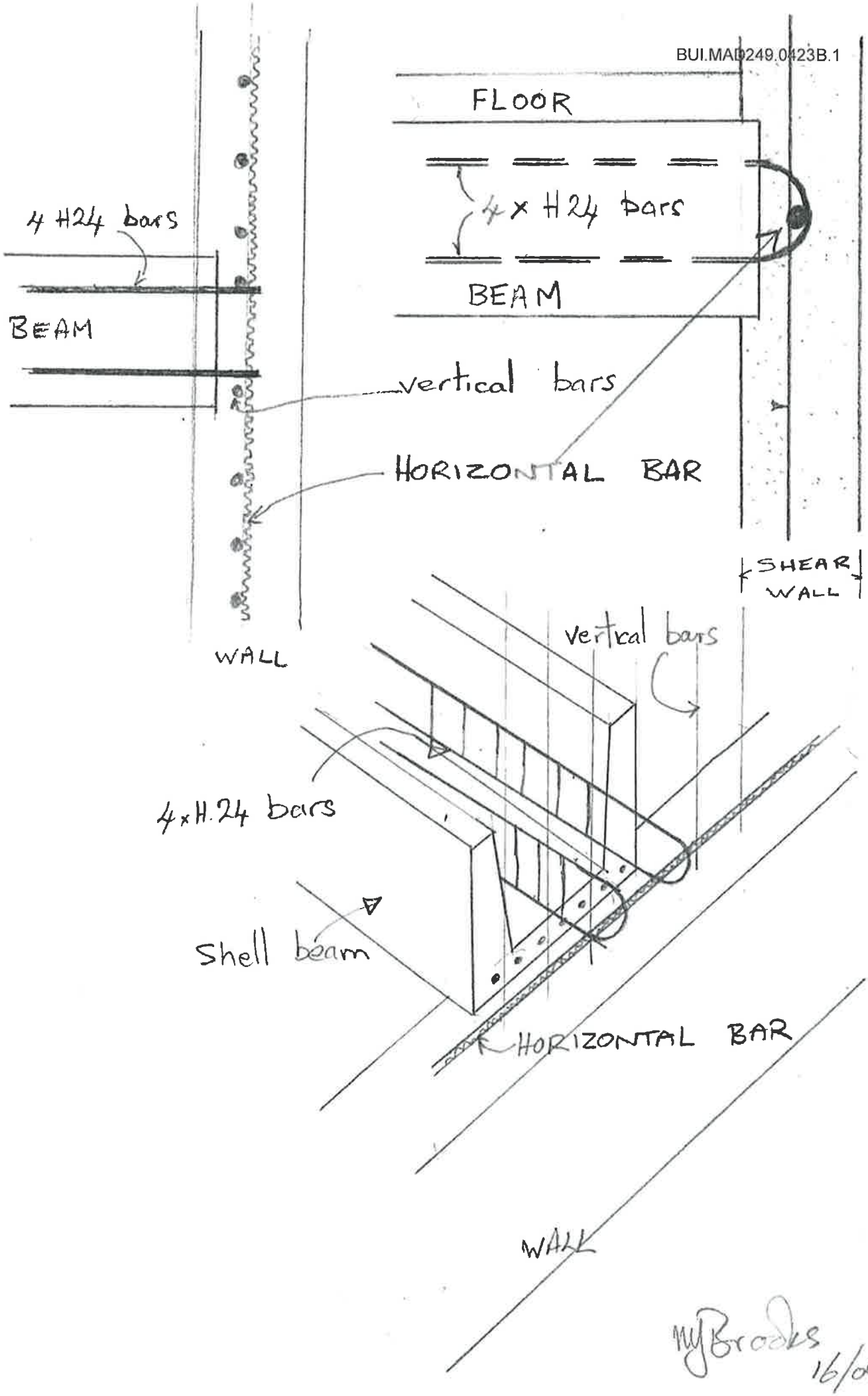
GENERAL NOTES

Contact Formstress Precast about any specialist needs you may have.

Before manufacture can commence the contractor shall sign off the precast shop drawings certifying that the shop drawings are dimensionally and structurally correct.

All Formstress precast units are provided with lifting eyes. Chains and strops must be of the correct length and not more than 30 degrees of vertical.

For temporary storage of precast Shell Beams provide bearers each end on level ground. Formstress do not recommend the stacking of shell beams.



MJ Brooks 16/05/12