

NEW ZEALAND CONCRETE SOCIETY

Conference '99

"CREATING IN CONCRETE— ARCHITECTURAL AND ENGINEERING PERSPECTIVE"

WAIRAKEI RESORT HOTEL, TAUPO

15 — 17 OCTOBER 1999

TECHNICAL PAPERS TR 22

NEW ZEALAND CONCRETE SOCIETY

CONCRETE '99
“CREATING IN CONCRETE
– ARCHITECTURAL AND ENGINEERING PERSPECTIVE”

Technical Conference and AGM
Wairakei Resort Hotel, Taupo
15 – 17 October 1999

Conference Programme and Table of Contents

FRIDAY 15 OCTOBER 1999

12 noon	Registrations and Check In	
1.00pm	Welcome and Conference Opening - New Zealand Concrete Society	
1.10pm – 1.45pm	Rob Hamill, Marathon Rowing Champion – “Anything is Possible”	
1.45pm – 3.30pm	Session 1 – “Dreams to Reality” Chairman – Wayne Raymond To provide a forum whereby delegates can gain a better understanding of the architects vision of concrete as a primary building material. <i>Panel Discussion – Architecture in Concrete</i> Architect - Brian Aitken, Executive Director, Peddle Thorp Architects Engineer - John Hare, Director, Holmes Consulting Group Concrete Technologist - Ross Harper, General Manager, Golden Bay Cement Co Ltd Researcher – Pierre Claude Aitcin, Professor/Researcher, Sherbrooke University, Canada	
3.30pm – 4.00pm	Tea/Coffee	
4.00pm – 5.30pm	Session 2 – Case Study; Design and Construction of the Metropolis/Regency Project - Auckland Chairman – Wayne Raymond	
	1. <i>Concrete, Time and Architecture</i> 1 Richard Goldie, Project Architect, Peddle Thorp Aitken Limited	
	2. <i>Metropolis Regency – 40 Storey Apartment Building, A Case Study of Reinforced Concrete High Rise Construction</i> 8 Mark Moore, Project Manager, Holmes Consultancy Group	
	3. <i>Metropolis Regency – A Case Study of Concrete High Rise Construction</i> 17 Rob Lockett, Project Manager, Multiplex Construction (NZ) Limited	
6.00pm	President's Reception	
7.00pm	1999 Concrete Awards Function and Conference Dinner	

SATURDAY 16 OCTOBER 1999

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11.30am – 1.30pm	Session 4 – Specifying Concrete for Architects Chairman – Chris Munn	
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	2. <i>Architectural Concrete Specifications or a Matter of Opinion</i> Duncan Morrison, Stresscrete	46
	3. <i>When An Engineer Needs To Be An Architect!</i> Michael Newby, Michael Newby and Associates	49
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2.00pm	Range of Activities	
7.30pm	Dinner and Entertainment	

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	2. <i>Environmental Aspects of Otira Viaduct Construction</i> Bruce Watson	65
	3. <i>Construction of Otira Viaduct</i> Albert Smith/Peter van den Elzen - McConnell Smith Ltd	72
10.30am – 11.00am	Tea/Coffee	
11.00am – 12.30pm	Session 6 – Concrete Briefs Chairman – Des Bull	
	1. <i>The Main Dock Refurbishment Project, Pago Pago, American Samoa</i> Chris Munn – G K Shaw Limited	73
	2. <i>New Zealand Case Studies for the Use of Steel Fibre Reinforcement in Concrete</i> Jubran Naddaf – Firth Industries Limited	77
	3. <i>Increase of Load Carrying Capacity of Beams by Means of Composite Material Plates</i> J I Restrepo and Y C Wang – University of Canterbury	81
	4. <i>Fire Performance of New Zealand Light Weight Aggregate Concrete</i> Michael Inwood – Macdonald Barnett Partners Ltd	89
	5. <i>The Mana Island Concrete Gannet Colony</i> Len McSaveney – Firth Industries Limited	99
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METROPOLIS REGENCY

A CASE STUDY OF HIGH RISE CONSTRUCTION

Robert Lockett ¹

SUMMARY

The Metropolis Regency Project consists of the design and construction of a high quality forty level serviced apartment/hotel tower within a short time frame.

In order to successfully undertake a project of this magnitude requires the following:

- a) A project team with clear and common objectives.
- b) A project team with the skills, knowledge and experience of high rise construction.
- c) A project team that interacts and has a clear understanding of and respect for each others positions within the project.

As with all projects things can be done better and lessons can be learned for use on future projects.

This paper presents, discusses and evaluates the above issues from the design and construct contractors perspective, an Australian contractor who were undertaking their first project in New Zealand.

INTRODUCTION

Project

The Metropolis Regency Project consists of the development of a forty level serviced apartment/hotel tower in the central business district of Auckland, New Zealand.

The \$160 million development, erected over a 24 month construction duration, is due for completion in December 1999. It consists of two levels of retail and lobby space, five levels of carparking, twenty three levels of residential and serviced apartments, eight levels of penthouses and two levels of plant housed within the tower roof. It also includes the renovation of a four level historical building originally located on the site which now houses the hotel back of house office space, entry lobbies and bar, restaurant and nightclub facilities.

The developer who had acquired the site in 1995 had looked at a number of development options before settling on the current proposal. Concept designs, demolition of the existing buildings and piling for the new works were commenced by the developer simultaneously with the sales of the apartments, the sourcing of a hotel operator, the raising of development finance and the conclusion of building contract negotiations. In May 1998 approval was given to the design and construct contractor to proceed with construction of the overall development.

The project organisation chart is depicted in Figure 1.

Project Requirements

The project requirements established for the design and construct team were as follows.

- a) Carry out the design and construction of a high quality building that surpassed its local competition and met the international standards expected of its developer, operator and customers.
- b) Achieve the above by the opening date of December 1999.
- c) Achieve the above within a Fixed Lump Sum Price of \$92.5 million.
- d) Achieve the above within a safe working environment for these responsible for erecting the forty level building.

CONSTRUCTION MANAGEMENT

Staffing

From the beginning of the project the contractor ensured that sufficient full time staff with the appropriate skills and experience were employed on the project. The contractors staff initially consisted of long term personnel from Australia who knew and understood the contractors systems and approach to construction projects and who were also able to bring new or different ideas and technologies to the local market. Those staff were then supplemented by local staff who knew and

¹ Senior Project Manager - *Multiplex Constructions (NZ) Limited*

understood the local market, subcontractors and construction technology.

Emphasis was placed on continuity and support where necessary as well as high morale and team building. The level of seniority, experience, drive and commitment of the site staff is probably higher than that found on most local projects as well as the contractors other projects. This was dictated by the nature of the project and the risks associated with the contractors first project in New Zealand.

Figure 1 depicts the contractors organisational chart for the project.

Subcontractor Selection

The contractors role in the project involves mainly the management and coordination of the design and construction process with the consultants, subcontractors and suppliers undertaking the actual work required for the project.

The contractor therefore placed extreme importance on the correct selection of the appropriate organisations required to carry out the works.

Consultant organisations, who had originally been engaged by the developer, were novated to the contractor once they had established their capabilities to deliver the design service.

Subcontract and supplier selections were made following extensive prequalification, tender and post tender interviews that defined

- Past experience on high rise projects
- Financial capability and stability
- Current capacity/workload
- Ability to meet the project programmes and workloads
- Quality Assurance Procedures and quality of products
- Safety procedures and safety records
- Supervision of project – (quality, programme, employees)
- References of the company and supervisors on past projects
- Design options and alternatives
- Price (least important criteria)

In some instances trade packages were split into a number of individual trade packages to best fit the project and the available resources.

In other instances the contractor was not satisfied that the local consultants, subcontractors or suppliers had the suitable expertise or attitude to work on the project and organisations from

Australia were brought over to New Zealand to undertake the works or part of the works.

Emphasis was placed on openness, honesty, fairness and partnering to ensure the local organisations would be comfortable working with a new foreign contractor, i.e. the contractor focused on putting the handshake back into the business.

Company Procedures, Systems and Controls

The contractors company procedures, systems and controls were implemented and monitored in a disciplined manner and gave the contractor the ability to make decisions quickly and communicated the necessary information to the appropriate senior management within the various organisations. Some of these included:

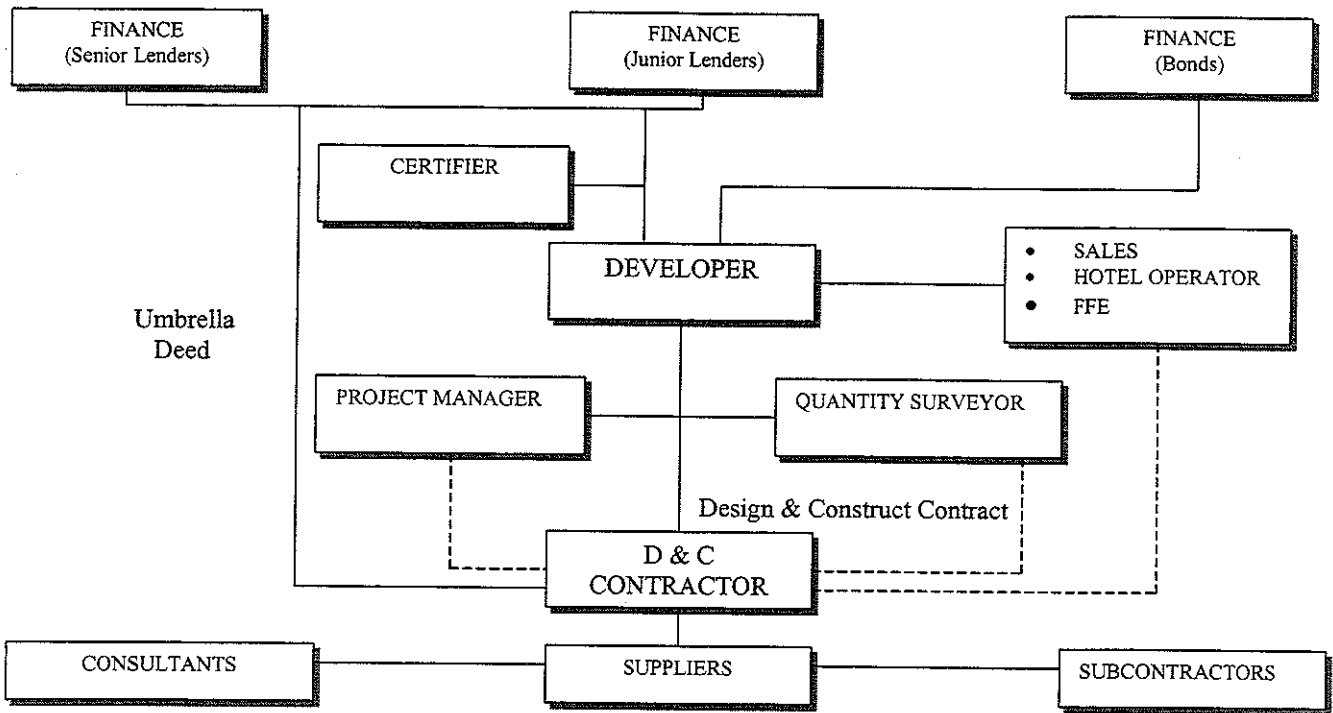
- Programme and Programme Status Reports – Detailed Design, Tendering and Construction Programmes were prepared at the beginning of the project. Regular weekly and monthly status reports were carried out by internal and external staff to ensure that the programmes were being met and corrective action taken where activities were deviating from the programme requirements – Figure 2 depicts a typical programme status report.
- Cost Controls and Reports – Detailed Trade Budgets were prepared at the beginning of the project. Regular weekly and monthly cost planning and reports were carried out to ensure budgets were being met and design changes were being monitored and controlled.
- Regular internal and external quality and safety reports and audits were carried out to ensure that works were being carried out to acceptable quality and safety standards.

Communication

Communication between the various stakeholders was seen as critical to the success of the project. The means of communication between the parties took a number of forms.

- Design coordination meetings took place weekly and were chaired and minuted by the contractor's Design Manager.
- Subcontract coordination meetings took place weekly and were chaired and minuted by the contractor's Site Manager.
- Senior Management and Board reports and meetings were prepared and attended fortnightly by the Project Manager.
- Computerised document transmittal and control systems were used to issue, monitor and control the flow of documentation through the project. Approximately;
3000 Design Advices
1500 Requests for Information
2000 Site Instructions

Metropolis Project Organisation Chart



Contractors Organisation Chart

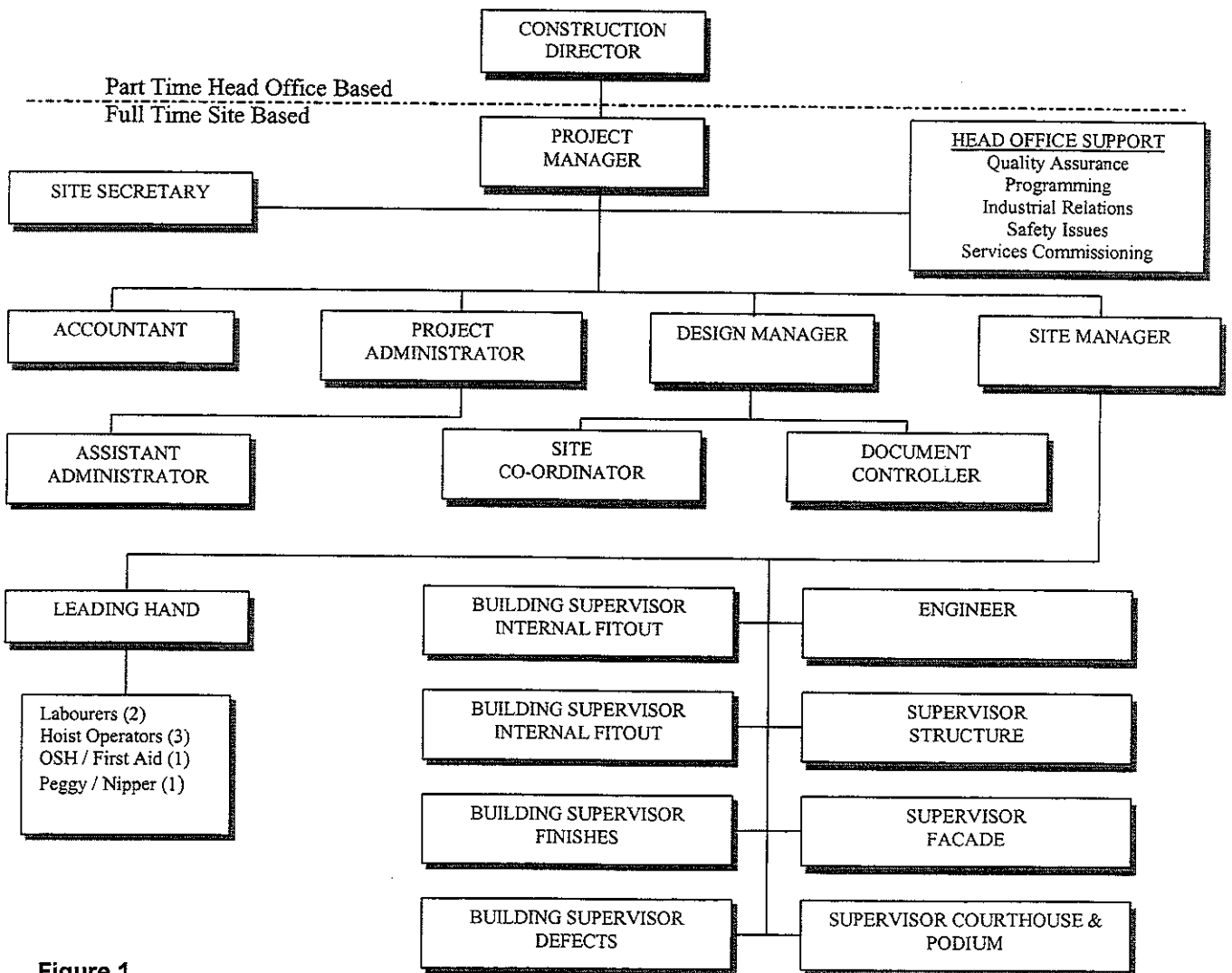


Figure 1

4000 Work Shop Drawings
 10000 Consultant Drawings
 were issued during the project. These documents needed to be circulated between the 12 consultant and development organisations and 70 subcontractors working out of over 10 geographically distant cities around Australia and New Zealand.

The construction management issues highlighted above are fairly basic and common to all types and sizes of construction projects. On this particular project they were given the importance that they deserved and as a result have been key factors in the success of the project to date.

CONSTRUCTION METHODOLOGY AND TECHNOLOGY

Perimeter Safety Screens

Probably the most critical factor in the success of modern high rise construction is the ability to construct safety at heights and allow each trade to quickly develop and maintain repetitive floor cycles for their work.

These activities were managed by the contractor through the use of perimeter safety screens which are widely used on projects in Australia. This particular system which was purpose developed for the project by the contractor and a Melbourne supplier provides safety screens over five levels as well as providing the perimeter precast beam and balcony support system used for the structure erection.

The screens which are lifted by cranes and fixed to the slabs provide protection for the structure contractor on the working deck plus subsequent trades such as the precast installation subcontractor and the balustrades and window installation subcontractors on the four levels behind the structure. The precast support system enabled the floor cycles to be constructed every seven days and dictated the lifting of the screens every seven days thereby ensuring that the subsequent trades completed a floor every seven days as well in order to carry out their work safely behind the screens.

Figure 3 depicts the perimeter safety screen system used on the project.

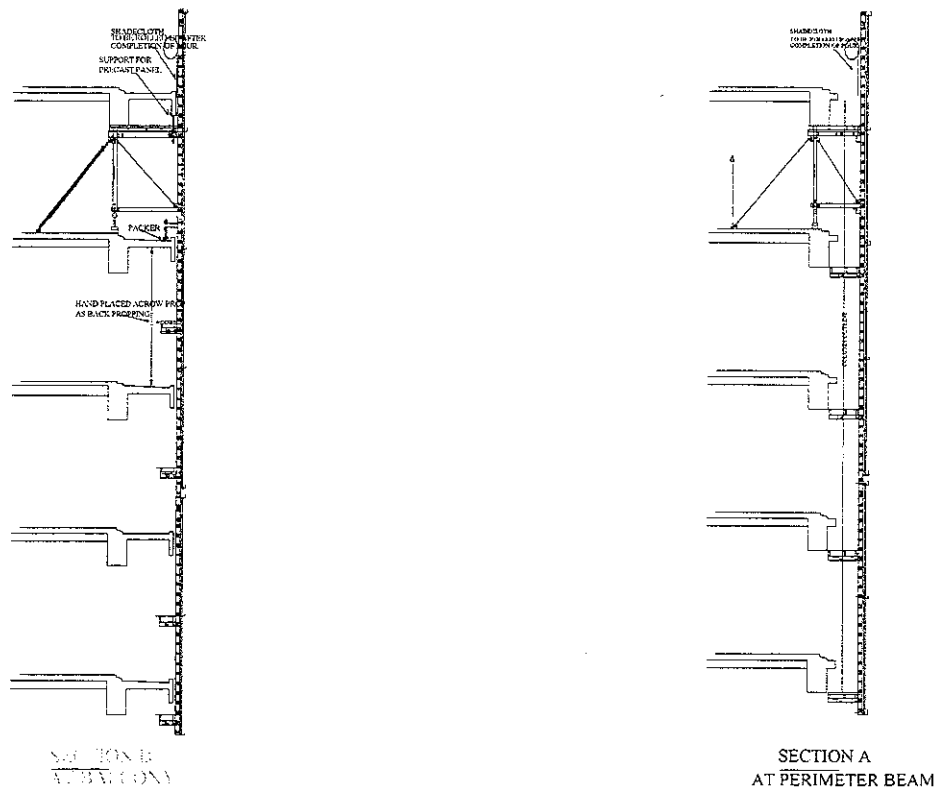


Figure 3

Core Jump Form System

An analysis of the insitu concrete core housing the 4 passenger lifts, 1 goods lift and 2 staircases together with the programme requirements and the critical hook time dictated that a self climbing hydraulic jump form system would be used to construct the insitu core.

Following tenders and discussions with the preferred supplier it was decided to use a Lubeca jump form system from Melbourne, Australia.

The Lubeca jump form system is a fully clad and enclosed formwork system that utilises hydraulic jacks (and not cranes) to lift itself from lower concrete pours quickly and safely. It also contains trailing decks that enable trades such as Lift Installers to install lift rails up the core as the jump form system moves up the structure thereby enabling the contractor to obtain early use of the lifts.

Figure 4 depicts the core jump form system used on the project.

Lubeca Jump Form

1. Dropper Columns
2. Grid Work
3. Hydraulic Rams
4. Jacking Beams
5. Shear Key Beams
6. Shear Key Pockets
7. Shutters (internal & external)
8. Top Deck

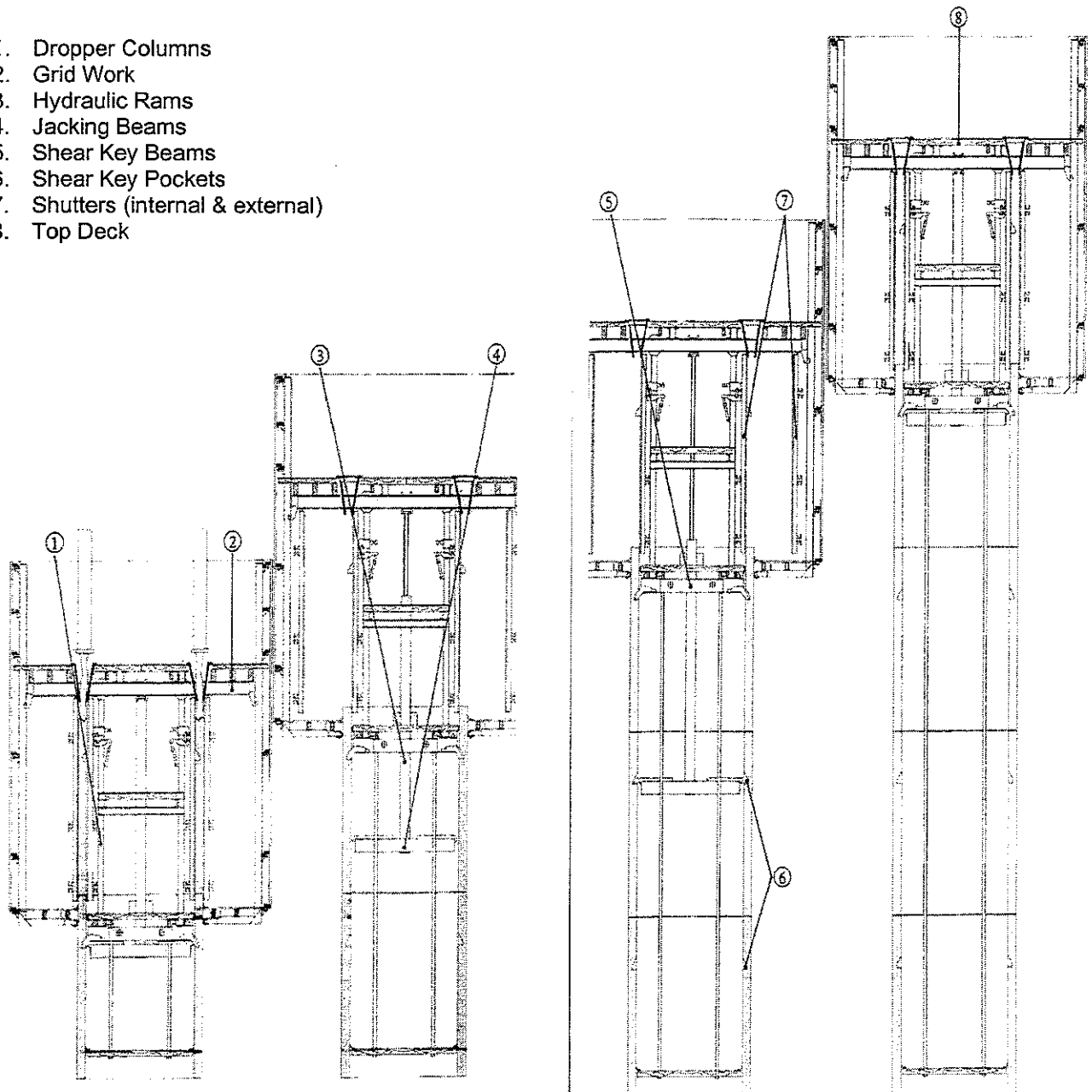


Figure 4

Craneage

A detailed analysis of the concept designs, craneage and hook time required for the construction indicated that two tower cranes were required for the project. Following tenders and discussions with the preferred suppliers on the cranes available locally it was decided to source two new Favelle M380D tower cranes from Sydney, Australia.

Both cranes were equipped with 55m booms, had a maximum capacity of 32 tonnes or 5.4 tonnes at 55m and a high speed winch system that enabled them to lift loads at speeds up to 210m/minute.

One crane was configured as an external climber with the other being configured as an internal climber, climbing itself up the internal lift shaft using a pocket climbing system.

Figure 5 & 6 depicts the crane analysis and layout done initially for the project.

Concrete Pumps

To assist with the craneage hook time it was decided to pump the concrete as opposed to using skips or buckets. The special concrete mix designs and high powered concrete pumps required to pump the concrete to heights of over 100m were supplied by local suppliers and subcontractors.

A pump was located adjacent to the old Courthouse building at ground level with booms placed on the core to pour the lift core walls and on the slabs to pour the columns and concrete slab topping.

Pump boom support grills were fabricated from steelwork and spanned between beams so that backpropping of slabs was not required and early installation of services behind the slabs could take place.

Hoists / Lifts

Another key component in high rise construction is the ability to move men and materials up and down the building quickly. To do this the contractor sourced internal and external hoists from Melbourne, Australia.

An internal Alimak was placed within the core so that the men could access the jump form system. An external twin Alimak Scando Super 32/40C hoist was utilised on the outside of the building with each car having a capacity of 3200kg and a speed of 1.5m/s.

The lift core was erected at a rate of a pour every 3/4 days and was pushed out ahead of the structure. The Lift Motor Room was then constructed on the top of the core and fitted out and the lifts made operational. This then enabled the passenger lifts as well as the hoists to move men and material up and down the building while the lower levels were still being constructed.

Scaffold / Swing Stages

The architectural finishes to the Courthouse and tower façade dictated the use of fixed scaffolding and swing stages.

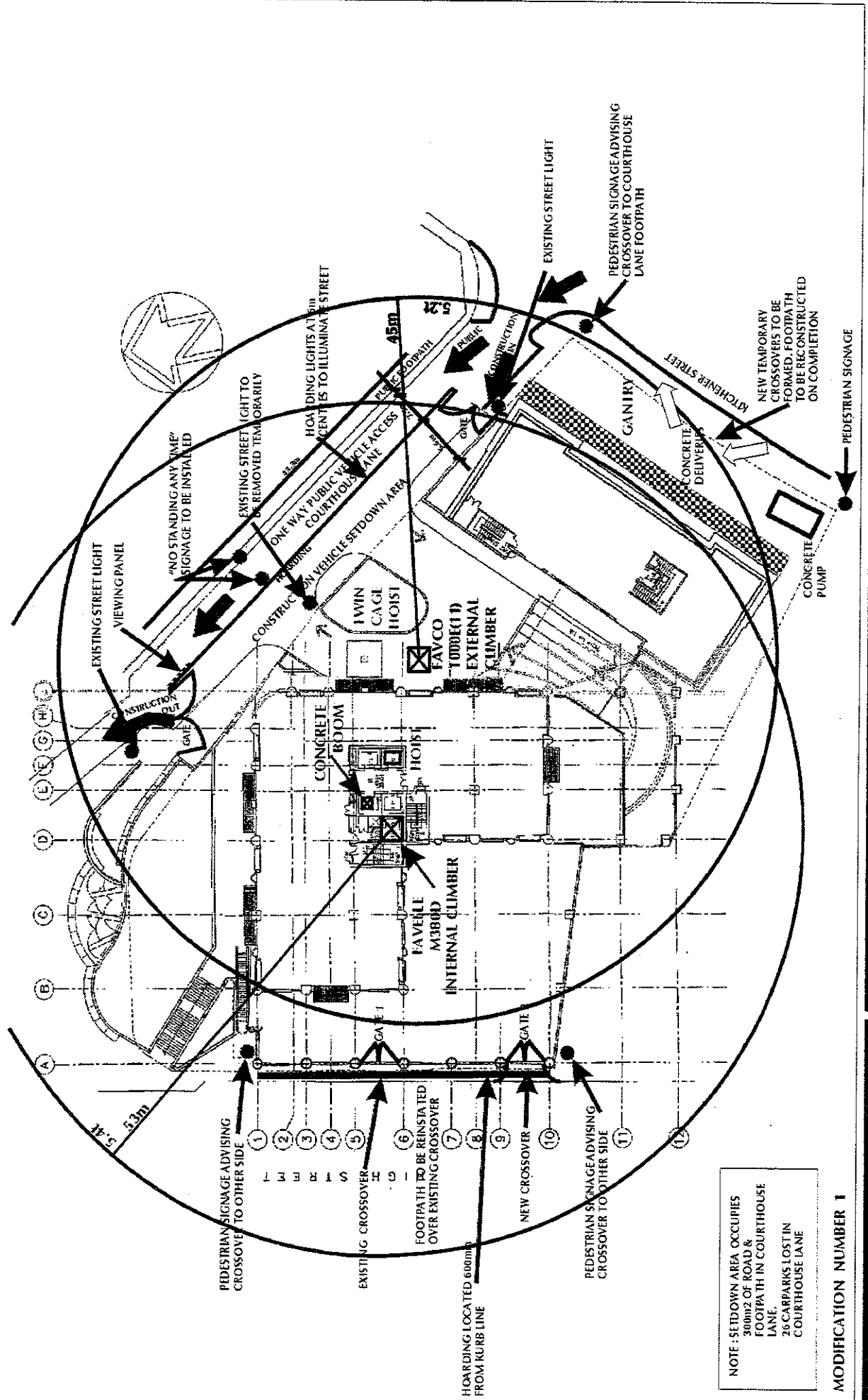
Fixed scaffolds were erected to the perimeter of the podium facades over 9 levels to fix the limestone panels and aluminium louvres to the unistrut framework and concrete frame. Fixed scaffolds were also used on the roof over four levels where the structure steps in to fix the precast and glazing to the structural frame as well as carry out the caulking and painting of the precast façade.

Swing stages were used on the perimeter of the tower from levels 9 to 38 for external caulking and painting of the precast facade. This was done in two stages with needles and swing stages being used on level 21 to carry out the work from level 20 down to level 9 while construction was taking place above on the upper levels. Once the structure reached the top of the tower to level 38 needles and swing stages were used for painting from level 38 down to level 20.

Loading Platforms

Moving large quantities of materials onto floors by crane is made easier through the use of loading platforms. Retractable loading platforms from Sydney, Australia were sourced that move up the building with the structure and screens. Retractable platforms have added benefits over fixed platforms in that platforms can be placed directly above each other thereby requiring less modification to screens and allowing more of the building to be closed in.

Loading platforms also dictate the use by subcontractors of palletisation and A frames for the stacking of materials. This improves hook time and also provides for the ease of movement on the floors in the horizontal direction which help to keep the floors less congested. Loading Platforms also assist with the use of large rubbish bins and rubbish removal and enable the floors to be kept clean and tidy.



NOTE: SETDOWN AREA OCCUPIES 300mm² OF ROAD & FOOTPATH IN COURTHOUSE LANE. 26 CARPARKS LOST IN COURTHOUSE LANE

MODIFICATION NUMBER 1

MULTIPLEX
 Project: AN.H. 10000000 LP
 Date: 22.02.99
 Drawing No: METRO1A3.GDR

**METROPOLIS APARTMENTS
 AUCKLAND, NEW ZEALAND**

SITE LAYOUT

Figure 6

Survey

The contractor elected to retain control of the site survey. A local surveyor was appointed full time to carry out this work on site.

Their role was to control the verticality of the core and perimeter columns as well as establish major grids on the floors and levels on the core and perimeter columns. This was done on every level. They also played a role in the checks required by the engineers over the duration of the project on the long term movement of the structure.

Other Construction Issues

Other construction issues carefully considered and managed by the contractor included;

- Waterproofing - Waterproofing of penetrations on every level using plywood and waterproofing membrane to ensure that water would not penetrate more than two levels below the working deck.
- Amenities - The provision of adequate amenities for employees on site at varying levels to ensure downtime was minimised.
- Radio Control - Provision of radios to the contractors staff and main subcontractors supervisors to ensure improved communication on site.
- Rubbish Bins & Refuse Removal - The provision by the contractor of sufficient wheelie bins, crane bins and large rubbish bins on the site and sufficient crane time to ensure rubbish was moved from the site daily.
- Power, Lights & Water - Sufficient task lighting, distribution boards and water points were placed on every level to ensure that all subcontractors had sufficient access to temporary services.
- Traffic - Proper signage, gates, hoardings and daily planning ensured optimum use of traffic, loading and hoisting facilities.
- Safety - The contractor provided sufficient safety rails, lift guards and carpenters to ensure that the site was continually in a safe situation.

Figure 6 depicts the site layout with some of the services provided by the contractor. Appendix 1 provides a brief summary of how the tower was constructed.

Again, as with the construction management issues, the construction methodology and technologies needed to be carefully planned and properly managed for the construction process to be successful.

CONSULTANT / CONTRACTOR INTERACTION

Floor Slab Systems

Because the structural concept designs were well developed by the stage that the contractor was appointed and because the local subcontractors appeared better equipped to handle precast technology as opposed to post tensioned flat slabs it was decided to retain the precast floor slab systems and not move to a post tensioned flat slab system.

Some modifications were made by the contractor to the structural floor slabs where unispan or flat precast slabs were substituted for double T's over the shorter spans. This resulted in cost savings, reduced the floor programme cycle times and improved the flexibility for services installations.

Axial Shortening

Movement of the high rise structure over the short and long term was anticipated by the structural engineers. These deflections were discussed and debated between the consultants and the contractor who then made every possible provision to minimise the effects or problems associated with these deflections. These included:

- Adjusting the levels of the core and the perimeter columns to allow for the differential settlement between the two.
- Survey controls and monitoring of the structure over the duration of the construction at varying levels with adjustments made to the structure to pick up movements detected.
- Building precambers into the structure to allow for deflections.
- Introducing wall and ceiling joints into the finishes to allow for differential movement of the floors and walls without cracks developing in the plasterwork.
- Leaving gaps and spaces above kitchens and wardrobes to allow for movement in the ceilings.
- Introducing floor joints into floor finishes to cater for the expected movement.

Construction Issues

The construction methodology and technologies utilised by the contractor imposed temporary loads onto the structure that were often greater than the final in service design loads. They also imposed specific design restrictions and impositions on to the designers who constantly needed to review, check and possibly modify their designs to cater for the construction requirements.

Examples of these included:

- Engineering checks on computations and modification to reinforcing to cater for crane ties, jump forms, hoist ties, pump supports, preloading etc.
- Amendments to details to cater for jump forms and screens such as vertical walls with steel angles bolted on afterwards as opposed to insitu concrete corbel support.
- Modifying the lift motor room to allow for the early construction of the LMR and the use of the lifts early during the construction stage.
- Provision of precast details that utilised and accommodated the screen fixing supports.

Column Shapes

The concept designs developed by the architects allowed for a large number of column shapes and configurations. In order to reduce costs and improve programming time these were rationalised to mainly two shapes where column form use could be optimised. Similar exercises were also carried out on the roof clip on precast panels.

Balcony Shapes

The architectural and engineering concept designs allowed for square, flat balconies to both the large and small balconies. This was what was priced by the contractor. The developer and architects felt that a deep rounded balcony with steps below the balcony would improve the architectural façade of the building.

The precast moulds were revised by the subcontractors to incorporate the design change and a stepped fibreglass mould was introduced beneath the large balconies which was installed from behind the screens after the balconies were erected. No additional time constraints or costs were incurred to make this significant design change.

Precast Side Panels

During the construction contract negotiation stage several cost saving design alternatives were put forward by the contractor and were accepted by

the developer in order to meet his budget. The architects were not party to these decisions and once construction was started believed that some of the alternatives would be detrimental to the aesthetic appearance of the building.

The contractor revisited some of these alternatives and through replanning, redesign and repricing was able to revert back to the original architectural designs without any time or cost implications.

One such example was the replacement of all the windows spanning between the columns by two precast side panels and a smaller window spanning between the two side panels. The problem of hook time and installing the panels with the safety screens in place was overcome through the preloading of the side panels on to the floors prior to the slabs being poured and the use of a purpose built modified forklift to install the panels from the floor.

Some of the examples of interaction between the consultants and contractor highlighted above may seem basic or common to all types of projects but too often this interaction is ignored or not carried through properly. Through an understanding of and respect for each others positions on the project a win win situation was often achieved on the project.

LESSONS LEARNED

With three months due to completion the project is anticipated to be a success. It will be completed approximately two months ahead of programme. It is within the budgets established for the design and construction. There are no major quality problems on the project and it is arguably one of the most significant projects built in New Zealand recently. There have been no serious accidents to date with very little lost time due to injuries. There have been no insolvencies, contractual disputes or problems with payments to any party involved in the project.

The key factors contributing to the projects success has been identified as follows:

- A project team with clear and common objectives.
- A project team with the skills, knowledge and experience of high rise construction.
- A project team that interacts and has a clear understanding of and respect for each others positions.

As with most projects there is always room for improvement and lessons can be learned from this

project that can be taken to future projects. Some of the mistakes identified and improvements that could be made are as follows:

Flexibility

While flexibility is necessary it is possible to be too flexible. This flexibility can lead to frustration and demotivation particularly when issues are revisited too many times and not resolved once and for all quickly. Individuals should be encouraged to be flexible but once a decision is made to stick with it and make it work.

Communication

While communication on the project was good it can always be improved on. The quicker quality information is disseminated between the parties the quicker and easier it is to reach solutions to problems.

Inexperience of High Rise Construction

There simply have not been enough high rise projects recently in New Zealand for consultants to gain the required expertise and experience.

Proactive Resolution of Problems

At times various parties were reactive (possibly due to their inexperience with high rise construction). Individuals should be encouraged to tackle and resolve the hard or difficult problems immediately as on projects of this nature if resolutions are delayed they can quickly become a lot more difficult as one does not have the time to resolve them adequately.

Dogmatic Approach to Problem Solving

At times people appeared to be too dogmatic (inflexible or narrow minded – again put down to inexperience). Individuals should be encouraged to open their minds to new ideas and technologies and not reject them simply because they have no knowledge of or have not experienced them previously.

Overestimating Self Importance

While this did not play a big part on this project with the senior members of the project team there were times when some of the more junior members allowed their own self importance to interfere with their work. Individuals should be encouraged to work in an environment where the project is bigger than the individuals and to understand and respect each others positions.

Ability To See The Big Picture

At times senior members of the project team did not have the ability to view the bigger picture or the long term implications of their decisions. People became entrenched in their positions and were not prepared to consider the other parties position or the impact of their position on the project. Individuals should be encouraged to reach or achieve a win win situation at most times and to understand the impact their decisions have on the project as a whole.

Time/Cost/Quality/Safety Objectives

The well known objectives or trade-offs of time, cost, quality and safety were always apparent on this project. At times various parties believed that they were not achieving the project objectives or what they wanted out of the project. People should be encouraged to be realistic, to compromise and to try and achieve all the project objectives not just their own. In addition there should always be enough time, money and integrity in a project to achieve the expected outcomes for all the parties to the project.