

Fig 2.3.10.B

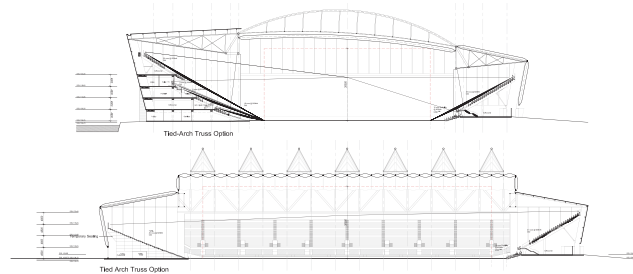


Fig 2.3.10.C

View from the camera position at the top of the lower tier on 15th September at 2:45pm



Fig 2.3.10.E

View from the camera position at the top of the lower tier on 15th September at 2:45pm

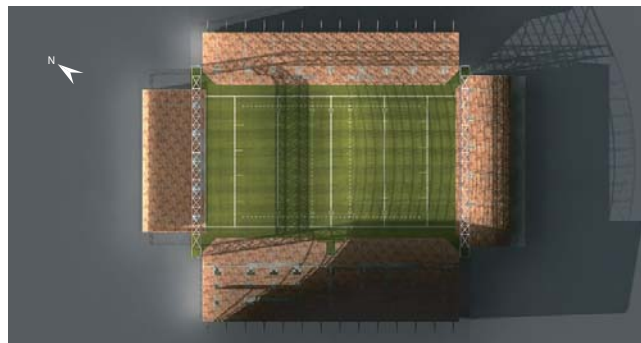


Fig 2.3.10.D

View from the blimp camera positioned over the field of stadium on 15th September at 2:45pm

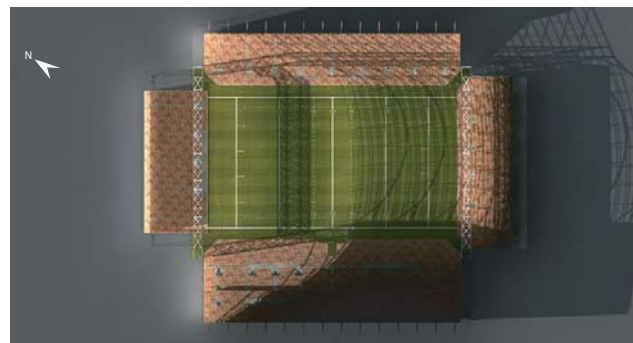


Fig 2.3.10.F

View from the blimp camera positioned over the field of stadium on 15th September at 2:45pm

Because the cables are terminated at the primary East-West trusses there is no change in the direction of pretension force and as such the vertical loads are more manageable.

The pretension forces required for options 1 and 1A are significant, and have consequences for design of the north and south stand structures that are explained in a later section.

Weights of steelwork included in option 1a are as follows.

Lens Trusses	= 15 kg/m ²
Southern stand roof	= 40 kg/m ²
Northern stand roof	= 40 kg/m ²
Eastern stand roof	= 35 kg/m ²
Purlins & roof sheeting to northern & southern stands	= 15 kg/m ²
ETFE cladding and framing allowance	= 5 kg/m ²
Southern 140m truss (9m deep x 5.6 m wide)	= 3.6 Tonnes/m
Northern 140m truss (9m deep x 5.6 m wide)	= 3.5 Tonnes/m
Eastern 90m truss (varying dimensions)	= 1.6 Tonnes/m
Western 90m truss (varying dimensions)	= 1.6 Tonnes/m

Option 2A – Steel Arch Trusses

As an alternative to pretensioned cables, this structural system provides over the playing area trusses with a curved top chord and a pair of flat bottom chords which forms a tied arch in elevation spanning 90 m. In section the trusses are triangular, and they are supported at their ends by the primary East-West longitudinal trusses. The arched truss option features ETFE cladding supported underneath the arches, therefore some structural elements are located externally to the cladding and are thus exposed to the elements. In this arrangement it is envisaged that 2 modules of ETFE cladding panels are located between the bottom chords of the truss and a pair of 5 metre wide modules span between arch trusses.

The key difference between the steel arch truss option and the lens truss options is the lack of pretensioning required. This results in a simpler structural system, and significantly reduces horizontal loads on the supporting north and south stands.

Respective weights for the Option 2A are

☒ Arch trusses	= 46 kg/m ²
☒ Southern stand roof	= 40 kg/m ²
☒ Northern stand roof	= 42 kg/m ²

Eastern stand roof	= 42 kg/m ²
Purlins & roof sheeting to northern & southern stands	= 15 kg/m ²
ETFE cladding and framing allowance	= 12 kg/m ²
Southern 140m truss (12m deep x 7.5m wide)	= 3.6 Tonnes/m
Northern 140m truss (10m deep x 6.0m wide)	= 3.5 Tonnes/m
Eastern 90m truss (varying dimensions)	= 1.5 Tonnes/m
Western 90m truss (varying dimensions)	= 1.5 Tonnes/m

East and West Ends of Enclosure

For these areas, a truss spanning 90m at each end of the roof over the playing area is required for each option. Along with forming the edge of the roof over the pitch, these trusses provide horizontal support to wall and / or large door opening framing that has a number of possible shapes, including column sections and cable systems.

The preferred roof option has not yet been confirmed by the CST, given both options can be optimised further during the preliminary design phase.



Fig. 2.3.11.A
Artificial lighting rig in operation at Wembley stadium



Fig. 2.3.11.B
Artificial wear application machine.



Figure 2.3.11.C
ETFE test rig



Figure 2.3.11.D
Measurement of surface traction (grip)

2.3.11 Turf

Summary

Since the MP+F report, we have made significant progress in understanding how turfgrass will grow under an ETFE roof. An ETFE test rig has been constructed and a comprehensive turf testing trial is underway. This trial is focusing specifically on the transmission of photosynthetically active light through the ETFE and on the wear tolerance and recovery of turfgrass as it is exposed to an increasing duration of acclimatisation under the test rig. Already it is clear that the management of turfgrass grown under an ETFE roof will be a very specialised business. Results from the trial will be used by the design team along with the results of computational fluid dynamics to optimise the turfgrass growing environment within the stadium.

Turf and ETFE

A desktop study of turf growth within stadia and the potential of growth under an ETFE roof was undertaken for the masterplan and feasibility report, with the following conclusions:

“To date no natural grass playing surface has been grown under a fully covered stadium. Recent retractable roofed stadia have had significant issues in relation to growing and maintaining a natural grass playing surface. These concerns have led to the development of a number of retractable pitch solutions as well as retractable roofs. A palletised turf system is used at Reliant Stadium, Houston and Millennium Stadium in Cardiff and a roll system is used at Telstra Dome, Melbourne to facilitate the removal of the field of play to a more conducive growing environment. More recently technology has been developed to allow the whole field of play to be moved under the stands to grow outside covered stadia such as University of Phoenix Stadium in the USA and Veltins Arena in Germany.

Recent material advances have seen the large scale commercial availability of materials such as ETFE. This material has successfully been used for over 25 years in the construction of agricultural green houses in Northern Europe and has recently been used in a number of high profile buildings and stadia such as the immensely successful Eden Project in Cornwall, UK and the Allianz Arena in Germany. The Eden Project saw the use of ETFE in a series of bio domes that were developed to house varying examples of the earth's biosphere with their accompanying plant species. Our research to date, backed up by Vector Foiltec, the leading manufacturer and supplier of ETFE has indicated that the use of the material at Eden Project has been successful and that the enclosed plant species are healthy and sustainable.”

The continued research into the material maintains that transparent ETFE is the preferred material for the proposed fixed roof, as it allows the majority of UV spectrum through to allow the potential for optimum turf growth. However it should be noted that there is no other similar roof in existence over a professional quality sports field.

As noted earlier the design proposes that the roof falls from South to North as the Northern stand is lower than the Southern stand to allow for greater light ingress for the playing surface. The new enclosed stadium design,

along with the data on ETFE was analysed by the NZSTI (New Zealand Sports Turf Institute) and their preliminary findings are set out in their letter which can be found appended to this report. In summary they appeared satisfied that, based on the information provided to them, it will be feasible to establish and maintain a temperate / cool season grass sward of suitable standard within the stadium. It must, however, be understood that these were preliminary comments and that further assessment by an organisation such as NZSTI or another turf specialist firm was required. Sports Surface Design and Management have subsequently been commissioned to carry out this research.

Following the initial analysis of shadows from the surrounding structure on the field of play it is apparent that certain management controls may also be required, such as relocatable areas of turf, turf reinforcement and the use of artificial lighting sources, a situation that is no different from what is typically required at other modern stadia (refer Fig 2.3.11a). It may be possible that areas off the field of play may need to be artificial due to shade and a turf maintenance regime. These shadow studies are informing the design such that the consultant team is now looking at enveloping the East, West and North facades in ETFE to allow more sunlight access to the sports surface.

Fig 2.3.11a – Artificial lighting rig in operation at Wembley stadium

When considering the health of the grass, it is important to remember the performance of the envelope needs to be considered from a holistic point of view. There is not one growth element, for example UV exposure, which once satisfied will guarantee the growth of the grass. Further input and design development is still required on all growth factors, being humidity, heat and ventilation to name a few.

The turf will also need a significant level of ventilation across the sward (advised by SSDM), and this is being assessed via computational fluid dynamics (CFD), which will further inform the design as to the percentage of open or operable screens and louvres. The ventilation for the sward will be assessed hand in glove with the ventilation for the spectators, providing a robust natural ventilation strategy for the bowl and sports surface.

(A report on the material ETFE by Vector Foiltec, as well as the consultants preliminary assessment is appended to this report).

The ETFE envelope material is currently being assessed by SSDM (Sports Surface Design and Management) regarding robust turf growth at present in a temporary test rig, which as been constructed in Dunedin, adjacent to Carisbrook. The background to the test rig trial and SSDM's involvement in this research is set out below.

Figures 2.3.11.B, 2.3.11.C, 2.3.11.D: Images of ETFE Turf growth Test rig.

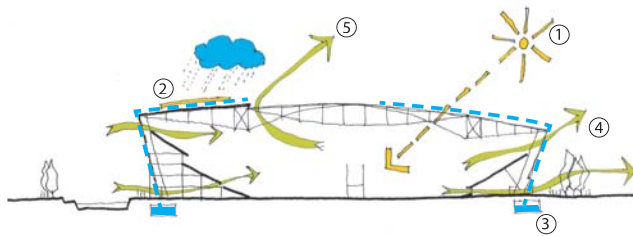


Figure 2.3.12.1. ESD Schematic

- 1 solar radiation
- 2 solar panels / photovoltaics
- 3 rainwater storage tanks
- 4 cross ventilation
- 5 heat loss / stack effect

2.3.12 Environmental Sustainable Design

The overarching ESD objective is to ensure that the design, construction and operation are future proof and sustainable within the appropriate budgets. Therefore the approach taken in the first instance needs to be strategic and involve all stakeholders, design team and operators. The following is a list of possible initiatives that can be investigated at the next stage with a strategic and inclusive approach in mind.

Possible ESD Initiatives.

- Rainwater harvesting and potentially grey water for irrigation and toilet flushing.
- Bio-filtration of storm water from the plaza through permeable paving, car parking through vegetated swales, landscaped areas through interconnecting tree pits. Note this will need to be considered against possible onsite soil contamination.
- Solar hot water heating.
- Photo-voltaic cells on the south stand roof or integrated within the ETFE foils.
- Low energy lighting external and internal. Reduce light spill.
- Increased insulation to occupied conditioned spaces.
- Cooling via utilization of Leith River and or sea as a heat sink
- Recycling of onsite demolition materials and fixtures and fittings from the existing Carisbrook stadium if possible.
- Use REBRI guidelines to establish waste management and recycling plans for construction and operation.
- The orientation and design to take advantage of natural light wherever possible.
- Natural ventilation at concourse levels and back of house areas where possible.
- Selection of mechanical and electrical systems to conserve energy.
- Use of materials with low embodied energy and low emissions where possible.
- Natural cooling of stadium bowl by stack effect and ventilation at low and high levels. To be developed through CFD modeling.
- Sourcing aggregates from local quarry where appropriate.
- Public transportation initiatives and traffic management planning to reduce car usage and onsite parking during event days.

Green Certification

In order to ensure that all aspects of environmentally sustainable design are properly considered in the new stadium development the design team will undertake internal assessment based on the 'LEEDS', BREEAM and NZ Green Star environmentally sustainable design accreditation systems.

These various systems provide a basis for considering and evaluating potential environmental initiatives during the design, construction, commissioning and operation of the proposed stadium. This would form a

live document that will be referred to during the course of the project.

Due to the specific nature of the project we recommend that the client establish appropriate budgets within the project plan to allow for specific environmentally sustainable initiatives including formal verification to an appropriate rating system.

Life Cycle Costing

The design of the stadium will take consideration of a lowest life cycle cost (LCC) approach for all major approach for all major elements, such as choices of services equipment, sports lighting equipment, finishes, façade materials, and other applicable elements.

The following LCC evaluations may be considered during the design stages of the project:

- Type of floor finish (e.g. carpet, tile, sheet vinyl, rubber)
- Type of ceiling finish (e.g. metal pan, plasterboard, mineral fibre)
- Type of sanitary fixtures (stainless steel versus vitreous china)
- Painted surface (on-going maintenance and re-painting needs)
- Gutters and downpipes (e.g. metal, copper, plastic)
- Service elements (e.g. natural lighting, passive ventilation, air conditioning plant)
- Vertical Transportation (e.g. lifts, escalators)
- Seats

Facility Life Expectation

The new stadium shall, with reasonable maintenance, be capable of having an operating life of at least fifty years. The Asset Management Plan, O&M manuals and standards will outline how the operating life of 50 years will be achieved.



Fig. 2.3.13.A



Fig. 2.3.13.B



Fig. 2.3.13.C

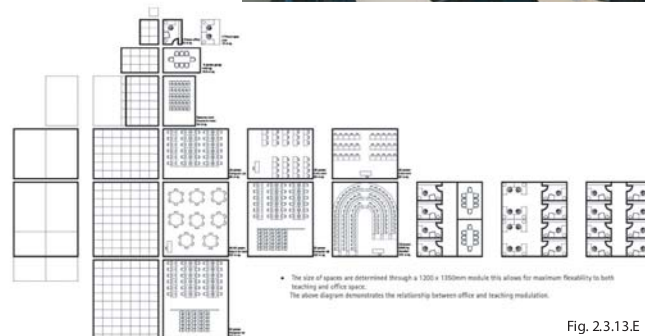


Fig. 2.3.13.E

2.3.13 University Integration

A key component of the new stadium development Master Plan is to provide an integrated precinct that is utilised not only during events but day to day. Being located right next to the University of Otago as it stretches along Union Street, the Awatea Street site provides a unique opportunity to integrate the precinct of the new stadium development with facilities for the University of Otago.

This provides two key benefits to the development as a whole:

- The precinct becomes inhabited throughout the week becoming a vibrant part of the city.
- It allows the University to extend its growing requirements and create a focal node at the eastern end of the campus to complement the centre of the Campus towards the West.

Discussion with the University of Otago during the Master Plan and Feasibility Stage explored a number of University activities that can be located within the Stadium precinct. These included general academic space, university student support activity spaces and the possibility of space for Unipol, a recreational gymnasium used by students and members of the public.

The two facilities shown within the Master Plan are for a University Building of approximately 7,000m² and space for Unipol Services of approximately 6,400m². While no further discussions specifically relating to design have taken place with Unipol or the University since the Master Plan and Feasibility Stage, the University has expressed a strong preference that, subject to Unipol being interested in locating to the site, it should be located on the western side of the stadium within the university precinct zone. The Master Plan proposes that Unipol be located adjacent to the University Building and fronting the Plaza directly behind the Western Stand. The Western Stand will house temporary seating erected for large events leaving a large flexi-space available for other activities throughout most of the year. This creates an opportunity for Unipol to integrate with the stadium locating some of the required facilities within the flexi-space. Alternatively Unipol could be a separate self contained building leaving the flexi-space free for other sporting events, commercial activities, exhibitions, and the like. The Unipol Building designated in the Master Plan is a generic gymnasium / physical activities block. This is proposed to be 2 levels possibly with some mezzanine type structures with large span spaces on the upper level and smaller span spaces at ground level - the exact brief will be discussed during the later stages. Ground level spaces such as a café, shop, fitness clinic and the like will integrate with and positively activate the Plaza edge. This edge will be further enlivened by visual connections that will be established through a transparent facade along the western face of the upper level spaces - gyms, dance space and the like.

The University Building designated in the Master Plan is a generic academic/administration block. Various options exist for the use of this space and will require further review by the University. Notwithstanding this, there is a clearly identified need by the University of Otago for a building of approximately 7,000m².

The building mass is provided over four levels and flanks the south western side of the main plaza. If required, additional effective area could be provided by increasing the number of floors; however urban design issues such as shading effect would need to be further considered.

By flanking the main Plaza at the western end of the site, this building becomes a gateway landmark for the University of Otago at the East end of its campus. In providing a major node in this location, the development will have the tendency to reinforce the sense of inclusion within the campus of the smaller buildings along Union Street and the Leith

The University space is zoned in terms of flexible space and circulation space. The flexible space is configured on a 9x10 m module and will be suitable for teaching space, office space, tutorial space and the like. Utilising this building module will ensure good access to natural light and ventilation along the exterior of the building

Entry to the University building can be directly off the Plaza and be available 24/7 year round. The plaza is an important outdoor space for the University. It is intended that this space be a 'hub of activity' during the University week. A café located beside the entry foyer in the ground floor of the University building will open onto the plaza. Mounded grassed areas in front will help break down the scale of the plaza and provide areas for students to relax or congregate between lectures.

Key differences between the Master Plan and Feasibility Stage and the Concept Design Stage as they relate to the integration of the University Facilities with the Stadium:

- Under the MP + F Design the preferred option was to locate the Unipol recreational facilities at the western end of the stadium beside the plaza. An option was also included in the MP + F Design that allowed the Unipol facilities to be located on the eastern side of the stadium, utilizing the Flex Space for some of the facilities. This option has been deleted from the Concept Design.
- Under the MP + F Design the University facilities wrap around on three sides to enclose the western stand over three levels. A further level directly above the university and running the full width of the west stand houses plant. Integrated structural elements support both the upper floors of the university and the seating tiers. This configuration has been deleted from the Concept Design.
- The Concept Design shows all the University facilities (academic, support and recreational) located at the western end of the stadium with the exception of the western wall of the west stand which could be a shared internal wall running the full width of the west stand.
- Under the Concept Design the north and south walls to the western stand enclosure plus the north wall to the eastern stand enclosure will be clad in ETFE down to a height of 3500mm above level 1. The zone between Level 1 and + 3500mm will remain open.

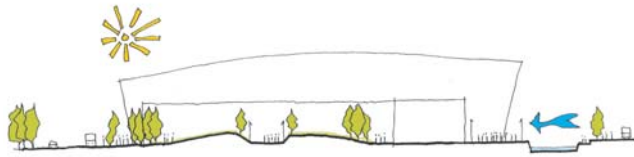


Figure 2.3.14.A



Figure 2.3.14.B



Figure 2.3.14.C



Figure 2.3.14.D



Figure 2.3.14.E



Figure 2.3.14.F



Figure 2.3.14.G

2.3.14 Landscape

Landscape Design Objectives

The new stadium development precinct will be landscaped as an integral part of the development, enhancing the precinct and improving the amenity for Dunedin City and the University of Otago. It is proposed that the landscaping address connections beyond the limitations of the site boundary with the University and Stadium acting as a promoter for intensification and redevelopment of the northeastern part of Dunedin City. Key objectives of the landscape design include the following:

- Provide a link between the City and the New Stadium Complex
- Identify and enhance the relationship between the University and the New Stadium
- Provide a human scale to the stadium precinct
- Define the external spaces around the stadium and university and guide its users
- Creatively interpret the quite different external spatial requirements of the stadium and the university into a single design.

Design Approach

Connection with the city is reinforced by structured street tree planting continuing around the perimeter of the precinct. This will reinforce the existing streetscape patterns along Anzac Avenue, Union Street East and the beginning of Ravensborne Road along its northern side.

The mixture of University and Stadium activities creates the need for a plaza in front of the main buildings that can accommodate the different needs of both user groups. The plaza needs to be large enough to accommodate large crowds but it also needs to work at a smaller scale to be used as an amenity space by the University. Connection to the university campus will be enhanced by paving Anzac avenue between the Water of Leith and Ravensborne Road.

It is anticipated that this plaza area will orientate towards the northwest establishing a physical connection with Logan Park. This space can provide relaxation spaces with outlook to Logan Park as well as back towards the rest of the University and City. As part of the landscaping strategy it is envisaged that local artists be included in the design of artworks for the plaza and any art works to be placed in it.

The landscape will be designed in such a way that it breaks the large scale of the buildings and becomes user friendly for pedestrians. Objects, such as street furniture help articulate exterior places and create an opportunity for people to engage and react with these spaces. The use of street and feature lighting is envisaged to ensure safety of users, as means of orientation, and to assist in the creation of a civic space.

The predominance of the motor car is significantly reduced by the re-

alignment of SH 88 and by the placement of the main car park away from the Plaza. Trees are used to lessen the impact of a large facility with its surrounding environment and tie the site wide landscaping into the existing street network.

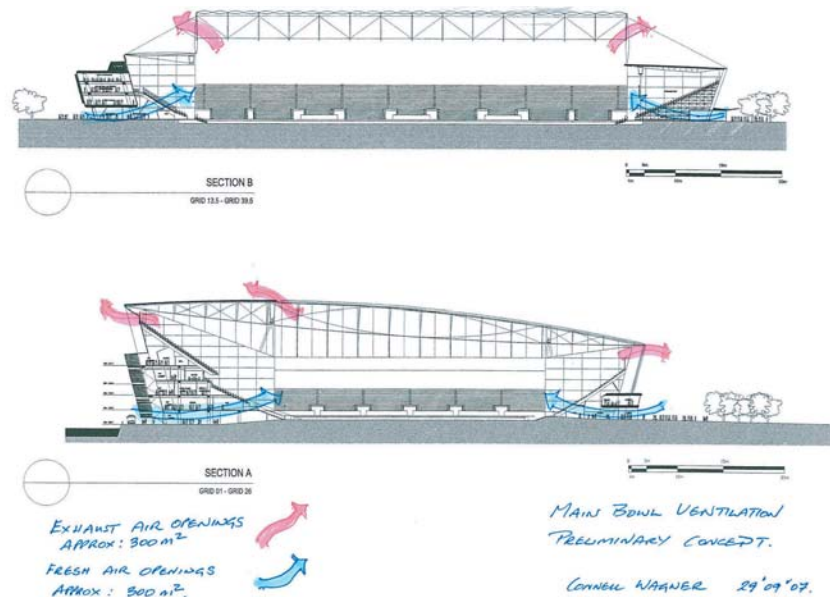


Fig. 2.3.15.A
Bowl Ventilation Schematic

2.3.15 Building Services

Ventilation effectiveness

A fully enclosed stadium creates a number of unique challenges, and in particular ensuring that the microenvironment within the main bowl is suitable to maintain pitch health and that occupant comfort is not compromised.

At this stage it is envisaged that the fully enclosed stadium will be ventilated using a combination of low-level and high-level louvres. The high-level louvres may be able to be replaced by weather-protected overhangs within the roof.

Computational Fluid Dynamics (CFD) modelling will be used to verify the natural ventilation strategy proposed. This powerful simulation software has been used to verify pitch growth on such projects as the MCG, Wembley and Telstra Dome. The data derived from the ETFE trial test rig, will be used to verify the computer model.

The CFD model will predict air velocity; temperature and humidity throughout the stadium and in particular at pitch level. Modelling will be carried out for key wind directions at average and peak wind speeds and for occupied and unoccupied modes.

The same CFD model can also be used to model how the ventilation operates to remove smoke during a fire and model occupant comfort levels within the stadium.

The other essential ingredient for plant growth is the availability of useful light. The levels of photo-synthetically active radiation (PAR) can be modelled using ECOTECT, an advanced environmental modelling platform. Detailed pitch ground temperature, shading analysis, external shading analysis and internal day-lighting levels can also be calculated using the same ECOTECT model.

Mechanical Services

Overview

The selection of the mechanical systems is influenced by the final operating criteria for the Stadium.

If the Stadium is used only for the major sporting events (ie once a month) then the annual operating hours will be minimal. Operating costs will have less significance and the plant will therefore be selected to achieve the requirements of the brief with the lowest capital investment. If however the operation of the Stadium is increased by the inclusion of other commercial activities and the University use becomes more significant then systems selected on their whole of life operation would be more appropriate.

The attached table (Refer Fig.2.3.15.B and Drawings MSK 01 to MSK 05 in Section 5.0, Services Drawings) assigns the systems and level of service proposed for each area to the appropriate rooms.

Floor	Occupancy	Area m2	Mechanical Services				Comments	Notes Facility Brief	Persons
			A/C	MVH	NV	EX			
Level 01									
North Stand									
	1 Temp. Bar 1	59		x			Electric Radiant Heating		
	2 WC 1	86					x		
	3 WC 2	86					x		
	4 WC 3	86					x		
	5 Temp. F&B 1	43					x	Kitchen Exhaust	
	6 Temp. F&B 2	43					x	Kitchen Exhaust	
	7 Temp. F&B 3	43					x	Kitchen Exhaust	
	8 Temp. F&B 4	43					x	Kitchen Exhaust	
	9 WC 4	86					x		
	10 WC 5	86					x		
	11 WC 6	86					x		
	12 Temp. Bar 2	59		x				Electric Radiant Heating	
	13 Concourse	2276			x			Assumed to be open to outside	
South Stand									
	1 Plant	354			x				
	2 Misc. Changing 1	236		x			x		
	3 Home Team Change	343		x					30
	4 Home Team Lockers						x		
	5 Ball Boys	28.8		x					
	6 Match Day Office	25.2	x						
	7 Medical	38	x						
	8 Audio	28.8		x					
	9 Officials Change	31	x						
	10 Officials Shower	31					x		
	11 Misc. Changing 2	236		x			x		
	12 Away Team Change	343		x					30
	13 Away Team Lockers						x		
	14 Groundsman	352.8		x					
	15 Security/Police	279	x						
	16 Event Personnel	140	x						
	17 Auxiliary Space2	105		x					
	18 Auxiliary Space3	102.5		x					
	19 CST	140	x						
	20 Family	41.8	x						
	21 Media	41.8	x						
	22 Main Kitchen, incl. Dry Store	773		x				Fresh tempered air; Kitchen Exhaust by operator	
	23 Lobby			x					
Level 02									
South Stand									
	1 Store 1	41			x				
	2 WC 1	105					x		
	3 F&B 1	61					x	Kitchen Exhaust	
	4 WC 2	66					x		
	5 Bar 1	105		x					
	6 F&B 2	105					x	Kitchen Exhaust	
	7 Bar 2	61		x					
	8 F&B 3	66					x	Kitchen Exhaust	
	9 WC 3	105					x		
	10 Store 2	41			x				
	11 Concourse	2226			x			30m ² louvre face area	
Level 03									
South Stand									
	1 Function 1, incl. Bar	572.5	x						500
	2 Kitchen 1	132.5		x				Fresh tempered air; Kitchen Exhaust by operator	
	3 WC 1	54					x		
	4 Founders Suite		x						120
	5 Founders Suite Toilet 1	156					x		
	6 Founders Suite Toilet 2						x		
	7 Pre Function Lobby	219	x						
	8 Function 2, incl. Bar	563	x						500
	9 Kitchen 2	132.5		x				Fresh tempered air; Kitchen Exhaust by operator	
	10 WC 2	54					x		
	11 Lobby	29		x					

A/C	Air Conditioning
MVH	Mechanical Ventilation & Heating
NV	Natural Ventilation
EX	Mechanical Extract

Main Bowl Ventilation

The ventilation of the main bowl will be required to promote pitch health and for occupant comfort. It is proposed to provide high level and low level openings to take advantage of the “stack” effect caused by warm air rising (refer Fig. 2.3.15.A). Detailed modelling is required to determine the size and location of these openings, and to verify the final solution.

For occupant comfort, the ventilation will be designed to reduce heat build-up in summer, and to heat the Stadium during winter by providing only minimum air change rates sufficient for safe human occupancy.

The control of these openings will have a major impact on cost. The ideal solution is to have all openings fully controllable through a Building Control System. To reduce costs consideration could be given to a combination of manually adjustable and fixed openings. This would provide an element of control to cater for occupancy, season and wind direction. For pitch health it is likely that a percentage of openings will be required to remain open at all times.

Air-conditioning systems

Air-conditioning will be provided to:

- All suites and rooms on Level 4 / limited areas on Level 1
- Function areas such as the Roaring Forties room
- Broadcasters/TV room
- Large function areas on Level 3
- Other areas where high internal heat gains are to be expected or a particularly high level of occupant comfort expected.

Mechanical Ventilation and Heating Systems

Mechanical ventilation systems, comprising supply and exhaust, will be provided to:

- Home/Away and miscellaneous changing rooms
- Kitchen areas and Groundsman room
- Lobby areas and Corridors Level 1 and Level 4
- Areas where natural ventilation is not available to comply with the New Zealand Building Code (NZBC)

In-duct direct electric heating will temper the supply air before it enters the rooms.

Mechanical Extract Ventilation systems

Mechanical extract ventilation systems will be provided to:

- F&B rooms
- Toilets
- Hazardous Chemical Storage

For the food and beverage concessions, provision for kitchen exhaust ductwork terminating at roof level will be made. F&B operator requirements are required to enable kitchen exhaust systems to be designed.

Floor	Occupancy	Area m2	Mechanical Services				Comments	Notes Facility Brief	Persons
			A/C	MVH	NV	EX			
Level 04									
South Stand									
1	Suite 1	29	x					Heating with individual control	24
2	Suite 2	29	x					Heating with individual control	24
3	Suite 3	29	x					Heating with individual control	24
4	Suite 4	29	x					Heating with individual control	24
5	Suite 5	29	x					Heating with individual control	24
6	Suite 6	29	x					Heating with individual control	24
7	Suite 7	29	x					Heating with individual control	24
8	Suite 8	29	x					Heating with individual control	24
9	Suite 9	29	x					Heating with individual control	24
10	Security Room	44	x						
11	Kitchen 1	66		x			Fresh tempered air; Kitchen Exhaust by operator		
12	WC	27				x			
13	Store 1	27			x				
14	Hirers Suite	59	x						48
15	Coach 1	18	x						
16	TV	18	x					Air Conditioning	
17	Suite 10	29	x					Heating with individual control	24
18	Suite 11	29	x					Heating with individual control	24
19	Suite 12	29	x					Heating with individual control	24
20	Suite 13	29	x					Heating with individual control	24
21	Suite 14	29	x					Heating with individual control	24
22	Suite 15	29	x					Heating with individual control	24
23	Suite 16	29	x					Heating with individual control	24
24	Suite 17	29	x					Heating with individual control	24
25	Suite 18	29	x					Heating with individual control	24
26	Media	39	x						
27	Coach 2	18	x						
28	Radio	18	x					Air Conditioning	
29	Plant 1 AHU for Level 3				x				
30	Plant 2 AHU for Level 3				x				
31	Store 2	27			x				
32	WC	27				x			
33	Kitchen 2	66		x			Fresh tempered air; Kitchen Exhaust by operator		
34	Operation / Control Room	44	x						
35	Lobby			x					
Level 05									
South Stand									
1	WC 1	50							x
2	WC 2	43							x
3	WC 3	43							x
4	F&B 1	39						Kitchen Exhaust	
5	WC 4	43							x
6	WC 5	43							x
7	WC 6	50							x
8	F&B 2	39						Kitchen Exhaust	
9	Bar	43				x			
10	Concourse	952				x		8m ² louvre face area	

Alternatively kitchen exhaust systems could be left for the F&B operator to design and install to their requirements.

Natural Ventilation

Natural ventilation will be provided to:

- Concourses
- Plantrooms
- Store Rooms

Heating

It is proposed that a mixture of radiant, convective and in-duct direct electric heating will be provided. This will likely offer the lowest capital cost.

Smoke Control and Pressurisation Systems

Smoke control and pressurization systems will be developed in consultation with the fire engineer and relevant authorities.

Smoke Control and Pressurisation Systems

Smoke control and pressurization systems will be developed in consultation with the fire engineer and relevant authorities.

IN BRIEF BUT NOT ON DRAWINGS

1	Retail Shop				x		location TBC	2.8.1	
2	Merchandise Outlets				x		location TBC	2.8.2	
3	Storage Area for Vending Service				x		aprox. 25m ² per floor - location TBC	3.1.2	
4	Main Server Room		x				location TBC	7.4.1	
5	CS1 Administration Server Room		x				location TBC	7.4.2	
6	Scoreboard & Audio Visual and BMS Control Room		x				location TBC	7.5	
Level 01									
South Stand									
1	Catering Staff Facilities (offices, kitchenette, toilets, showers)				x		location TBC	3.3	
2	Drug Testing Room		x				location adjacent to the team changing room	5.8	
3	Merchandise Central Storage Area				x		location near to the loading bay TBC	2.8.2	
4	Photographer's Room		x					6.2.2	
5	Player Interview / Conference Room		x					6.6	
6	Event Storage for Rugby/Soccer Equipment					x	location adjacent to the Grounds Keeping Store	7.8.1	
7	Event Storage for Entertainment Equipment					x	location TBC	7.8.2	
8	Hazardous Chemical Storage					x	location adjacent to the Grounds Keeping Store	7.9.1	
9	Main Storage Area					x	location under the south west lower seating tier	7.9.2	
10	Cleaning Staff Facilities				x		location part of the Grounds Keeping Store	7.10.7	
11	Maintenance Facilities				x		location part of the Grounds Keeping Store	7.11	
12	Maintenance Shops				x		location part of the Grounds Keeping Store	7.11.1	
13	Maintenance Storage					x	location part of the Grounds Keeping Store	7.11.2	
Level 02									
South Stand									
2	Gaming/Betting Facility				x		in the main public concourse	2.7.4	

A/C	Air Conditioning
MVH	Mechanical Ventilation & Heating
NV	Natural Ventilation
EX	Mechanical Extract

Fig. 2.13.15.B

Design Criteria

Item	Design Parameters	
Internal Conditions	Air-conditioned areas	22.0 + 2.0°C. No humidity control.
	Heated areas	20 °C minimum.
	Concourse areas	not heated
	Main bowl:	unconditioned
Ambient Conditions	Summer: 23°C DB/18°C WB (based on Dunedin 2.5 percentile for 8am – 6pm Nov to April)	
	Winter: -3°C DB (based on Dunedin 2.5 percentile for 24 hour May to October)	
Occupancy	Corporate boxes	1 person / 2m ²
	Offices	1 person / 10m ²
	Concourse	1.7 person / 1m ²
	Function Rooms	1.5 person / 1m ²
Outside Air	Minimum 10 l/s/person	
Internal Heat Gains	80 watts / person sensible	
	60 watts / person latent	
	15 W/m ² equipment (offices), Other areas specific design	
	10 W/m ² lighting	
Toilet Exhaust	To AS1668 Part 2	
Kitchen Exhaust	A separate fire rated kitchen exhaust riser with ductwork, fan and discharge for F&B outlets.	
Smoke Control	Smoke hazard management system in accordance with NZBC and fire engineering report.	
Noise Levels	Internal noise levels – the building services designed to limit noise levels to:	
	Boxes	NR 40
	Office	NR 35
	Public areas	NR 40
	Changing rooms	NR 40
	Broadcasting	NR 30

2.4 District Plan Change

Detailed commentary on the District Plan Change is beyond the scope of this report. However from a Master programme perspective this work and lodgement of the Plan Change to DCC is critical to being able to make a meaningful construction start in November next year.

The detail of the district plan change has been programmed, however there are a number of potential unknown issues such as the outcome of the submission process and the possibility of appeals. While strategies are being implemented to mitigate or eliminate these issues, it should be noted that any significant delays in the process will directly impact on the CST's ability to have the stadium fully operational to meet the RWC deadlines.

2.5 Programme

Master Programme

The overall project completion is still forecast in February 2011 but will be affected depending on the impact of the District Plan Change process, as mentioned in the previous section.

The following key milestones identify simply what has been achieved to date and some of the significant upcoming and overall project milestones.

- Submit Masterplan Feasibility to Project Stakeholders
February 2007 (complete)
- CST Decision to Proceed with Multipurpose Options
March 2007 (complete)
- Concept Design
July 2007 – October 2007
- Preliminary Design
September 2007 – December 2007
- DCC Commitment to Project
December 2007
- Lodge Plan Change and Resource Consents
December 2007
- Continue Developed and Detailed Design
January 2007- September 2008
- Construction Partner Procurement
March 2008
- ORC Commitment to Project
March 2008
- Unconditional Land Purchase
July 2008
- Plan Change finalised
October 2008
- Commence Construction on site
November 2008
- Construction Practical Completion
February 2011
- Stadium Trials Complete and Stadium Ready for RWC
April 2011

Understanding the Programme Risks and Assumptions

From an overview perspective, the critical path for the master programme currently runs through the District Plan Change process and lodgement in early to mid December 2007.

The design process will be progressed into developed design before a construction partner is formally engaged in March 2008. Contractor, Subcontractor and Supplier procurement will then be undertaken leading up to enabling works being completed before a meaningful construction start in November 2008.

Unconditional land purchase by July 2008 will be fundamental to being able to start the enabling works prior to the main construction.

Construction Period

Based on the information available, the construction period has been estimated to be 26 months working with a construction partner in a preferred contractor process. This period assumes CST place an enabling works package to complete necessary demolition and site works to provide adequate access into and around the site. An off site pre-fabrication contract will also be placed to accelerate construction on site. During this stage of the project, the construction periods have been and continue to be tested with local subcontractors and suppliers. This will continue through preliminary design and the development of the detailed construction report.

Stadium Trials – Following Practical Completion a period of 6 weeks has been identified to perform stadium trials and identify any aspects that may require minor modification to ensure a successful running of a full capacity event.

2.6 Key Challenges & Risks

Following on from the MP+F Challenges and Risk section, we have identified below some specific risk items related to the Design and Construction phases of the project.

The focus of the design team is obviously the risk items that impact upon design and construction related matters. Accordingly the table below focuses on these areas only. Other risk areas such as funding, the commitment of the stakeholders, and land acquisition are being dealt with directly by CST.

Rev 1: Concept Design Report – Applicable items marked with an #

Design and Construction Risks

The items marked with a * can be considered both a risk and an opportunity

ID	Risk	Impact	Action
1 #	Site contamination - ground	High	Minimise excavations. Encapsulate spoil on site.
2 #	Site contamination – existing buildings	High	Test for asbestos, PCBs etc.
3 #	Soil conditions – insufficient load bearing capacity	High	Bore log investigations <i>Geotech work has started although full site coverage cannot be achieved.</i>
4 #	Site flooding	Moderate	Building to be built at grade or above
5* #	Dunedin Construction market conditions	High Moderate	Discussions with local main contractors to identify capacity. <i>Preferred supplier required.</i>
6* #	Availability of materials	High Moderate	Mixed materials where appropriate to mitigate potential demand pressures. Investigate <i>Initial enquiries confirm ability to meet programme.</i>
7 #	ETFE material availability, cost and performance criteria.	High	Obtain written quotes and commitments. <i>Preferred supplier required. Input to design fundamental.</i>
8* #	Availability of labour. Skilled labour for specialist structure, roof & cladding.	High	Discussions with local contractors re design specifics.
9* #	Programme – compressed construction period	Moderate	Construction programme reviewed with local main contractors when appropriate.
10 #	Programme – inflationary pressures	High	Avoid delay to project timescale. Allow sufficient Escalation Contingency
11 #	Escalation in costs	High	Allow sufficient Escalation Contingency. Monitor escalation during design period.
12 #	Programme delays (consent issues etc.)	Moderate	Manage consent process. Monitor programme.
13 #	Resource Consent / re-designation issues	Moderate High	Manage consent process. <i>Mitigation strategies required.</i>
14 #	Pitch roof – services design issues	Moderate	Further investigation into ventilation and fire hazard issues. <i>CFD modeling now engaged.</i>

Design and Construction Risks

ID	Risk	Impact	Action
15* #	Pitch roof – option selection	High	Select option ASAP.
16* #	Pitch roof – Contractor experience	Moderate High	<i>Roof options reported completed.</i> Commence discussions with contractors with respect to constructability. <i>Preferred supplier process to be completed.</i>
17 #	Surrounding infrastructure upgrade requirements	High	Review traffic management reports.
18 #	Realignment of State Highway 88. Costing, timing and effects on site planning.	High	Consult with Council. <i>Part of Plan Change process.</i>
19*	Land cost	High	Consult with owners and explore options for acquisition. Report variance to budget allowance.
20	Existing land occupiers lease exit / relocation costs	High	Continue negotiations and firm up ASAP
21* #	Design development / scope creep	Moderate	Allow sufficient design development Contingency in budgets.
22 #	University requirements – change in brief	Moderate High	Establish scope ASAP. <i>Engage as a user group now.</i>
23 #	University requirements – separate from stadium	Moderate High	Consult with University <i>Engage as a user group now, although separate project.</i>
24*	Funding allocation and confirmation	Moderate	Identify sources. Obtain commitments.
25* #	<i>Major plant availability and capability</i>	Moderate	<i>Consult local and international providers – pencil book.</i>
26	<i>Grass Growth – The requirements for grass growth under a fixed roof increase s the Construction values of the project.</i>	Moderate	<i>The project team have completed an ETFE stadium roof test rig and have engaged specific turf consultants to test the performance of the grass growth. Natural ventilation issues and the further requirement for mechanical solutions could affect the current contingency.</i>
27	<i>Design – Delays to the design process</i>	Moderate	<i>CST are the only key user group being consulted effectively at this stage. DCCs input form an operational perspective is important and without further clarity on the project moving forward. Effective consultation is difficult. At this stage best practice and similar experience inform the design.</i>

2.7 Cost Plan

From an overall cost plan perspective, our construction and design budget remains at \$165.4 M..

Item	Costs
Stadium Works	\$92,000,000
Escalation	\$13,150,000
Contingency	\$9,900,000
Consultancy Fees	\$13,000,000
Sub Total	\$128,050,000
ETFE Roof – (including risk, P&G, Fees)	\$37,350,000
Construction & Design Total	\$165,400,000

The detailed revised cost plan reflecting the temporary seating and standing options will be completed as part of our Preliminary Design Report. We have however completed a detailed assessment of the roof in order to establish a direction forward on this issue and the structures below. For clarity the entire team has been working from top down, knowing that the roof has an impact on the stadium structure, which in turn will determine the substructure requirements. From a cost perspective, we have taken a similar approach with attention focussed on the ETFE roof. The AMI Stadium, where applicable has also driven the basis of our revised budget understanding moving forward, where actual cost information can be more accurately used for benchmarking and new budget development.

ETFE Roof

Since the Masterplan and Feasibility Report the roof requirements have changed to now reflect a 30m height requirement and the ability to retrofit the roof. The work on the roof over the past few weeks has confirmed that if compared to a revised budget, both the lens truss and arched truss options would be within budget. However, we understand that regardless of the changes the budget is limited and therefore only the arched truss option would comply.

To gain further certainty in the roof design we are commissioning wind tests to confirm current design assumptions and potentially optimise the design further with preferred roof material supplier and installer. AMI and Waikato Stadium structures have been the subject of the recent Focus Group Meetings and will be developed in detail as part of the preliminary design.

Final approval of the roof design options and costs will be required from CST before we proceed.

The Stands and Substructure

These are the next elements to focus on through the cost plan. The geotechnical information has provided a better understanding of the foundation options which are being evaluated at present. Concrete (precast and insitu) and structural steel options remain the most feasible. We have reviewed both the AMI and Waikato structures in detail to establish a better under-

standing of appropriate costs and construction methodologies.

Peer Review

The independent Peer Review will access our current cost plan information as well as attend some of the key design team meetings and design control group meetings to understand in detail the various assumptions to date. We are also providing a detailed construction report supporting our preliminary and general development to date. It is our understanding that an initial report by the Cost Peer Review will be provided to DCC in early December 2007.

Challenge

Ensuring our budget is achievable remains a significant challenge and although there are some substructure design issues to resolve as part of the current concept, we remain confident that we can afford some of the workable solutions being reviewed at present. \$165.4M is still our budget and based on our current work achievable.

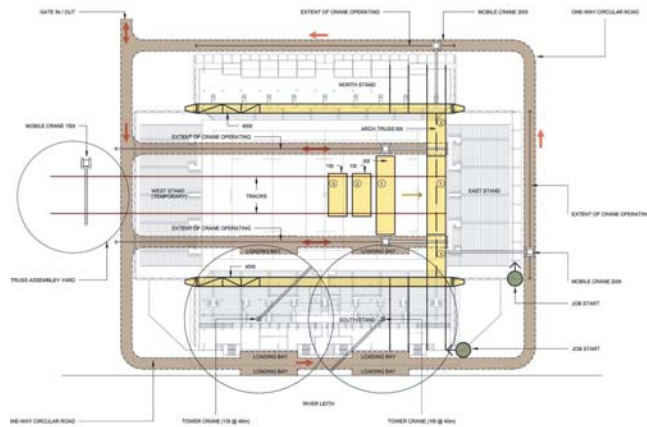


Fig. 2.8.A
Craneage - Methodology and Sequence

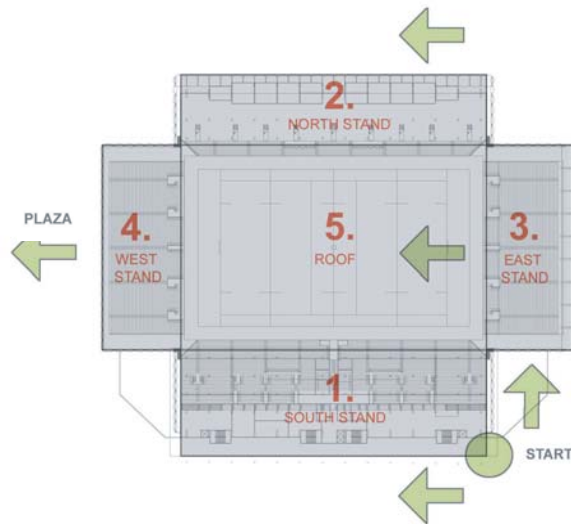


Fig. 2.8.B
Workflow strategy

2.8 Buildability

Since the Masterplan and Feasibility Report, the buildability review has continued in parallel with the design to ensure the detailed methodology for the construction can inform the design. The inter-relationship between these elements is critical to ensuring that throughout the various stages of the development, and as early as possible, the building strategy is understood by the project team and key stakeholders.

Given how tight the overall master programme is for the project, every efficiency in integrating the design and construction phases is fundamental. This detailed input would not normally occur until a construction team had been selected but, given the level of accuracy demanded by the cost plan at this early stage it is imperative.

Objectives

- To develop a construction methodology that would enable the successful completion of the stadium within 26 months from commencement on site.
- To inform the design in relation to the most effective form of construction.
- To develop a construction methodology and strategy that is cost effective.
- To provide innovative construction solutions as early as possible to allow debate and discussion within the overall project team.
- To research local, national and international technology and methodologies for other similar projects to adopt as far as practicable, "best practice".
- To develop buildability strategies that maximise the use of local materials, technologies and manpower.
- To understand and develop the optimum solution for the construction of the fixed roof.

Strategy

Although a detailed construction report will not be completed until the preliminary design phase, the current construction strategy is summarised below.

Building Blocks - Stadium Only

Although there are others works like civil works and infrastructure, the project is simplified into five (5) major elements:

1. South Stand
2. North Stand
3. East Stand
4. West Stand
5. Roof

To achieve programme much of the work for the five elements are overlapped or concurrent. It is envisaged that each element would operate as a separate job within the overall project with its own dedicated resources for the most part. However, control of the main resources (cranes) will be fundamental to

controlling the programme tempo with several big lifts (tandem) proposed (refer Fig. 2.8.A).

This strategy is consistent with our contractor procurement strategies and options.

Workflow

The simplified workflow starts with the construction of the south stand then the north, east and west stands. The roof could start prior to the commencement of the east and west stands and installed concurrently. The workflow then completes out through the west end and plaza (refer Fig. 2.8.B)

The pitch construction follows the roof structure and toward the plaza.

The south stand is the critical path for the project with all other elements being undertaken concurrently. Work within the stand starts at the south eastern corner and heads west. At this stage the structure methodology is conventional, working through the substructure, structure, envelope, building services then fitout.

The work on the north stand starts after the south stand with the east following closely behind. Again the structure and construction methodology is conventional and will be built from the east to west.

In the various development stages (1-5) the east and west stands will always follow the south and north stands which allows maximum construction traffic access from either end of the site. At this stage the main work in the east and west stands is the enclosure or envelope.

The main driver for the north and south stands being constructed concurrently and running east to west is the roof construction. In both the lens or arch truss options, much of the structure (stands) must be in place to allow the roof work to flow. The start of the roof is not affected by the construction of the east stand.

The fitout within each of the north and south stands will also run east to west with site works potentially being completed in two directions exiting to the east carpark and the west plaza.

Roof

The roof structure, depending on the option finally confirmed along with the roof cladding (ETFE), has not been built at this scale in New Zealand before. The principles and fundamental construction sequence are understood.

For either the lens or arch truss option, the majority of the solid structure is constructed on the ground and then lifted into position.

- The two main trusses (east-west) that border the north and south stand pitch edge will be split into 3 parts (approximately 120 tonne each) and "combined" lifted into place with 4 No. 200 tonne mobile cranes. Crane tower sections will provide temporary support structures and a crane concrete base will be used to land each section of the main truss to enable their connection in location.