

# LSAA

LIGHTWEIGHT STRUCTURES ASSOCIATION OF AUSTRALASIA

## ***20<sup>th</sup> Anniversary Dinner***

**&**

## ***Symposium 2001, AGM***

The 2001 Symposium and AGM of the Lightweight Structures Association of Australasia Inc.

on

**Thursday 8<sup>th</sup> November 2001**

to be at

**WatersEdge  
Pier 1, 11 Hickson Road  
Walsh Bay  
Sydney, Australia**

**Programme and Proceedings**

# LSAA

LIGHTWEIGHT STRUCTURES ASSOCIATION OF AUSTRALASIA

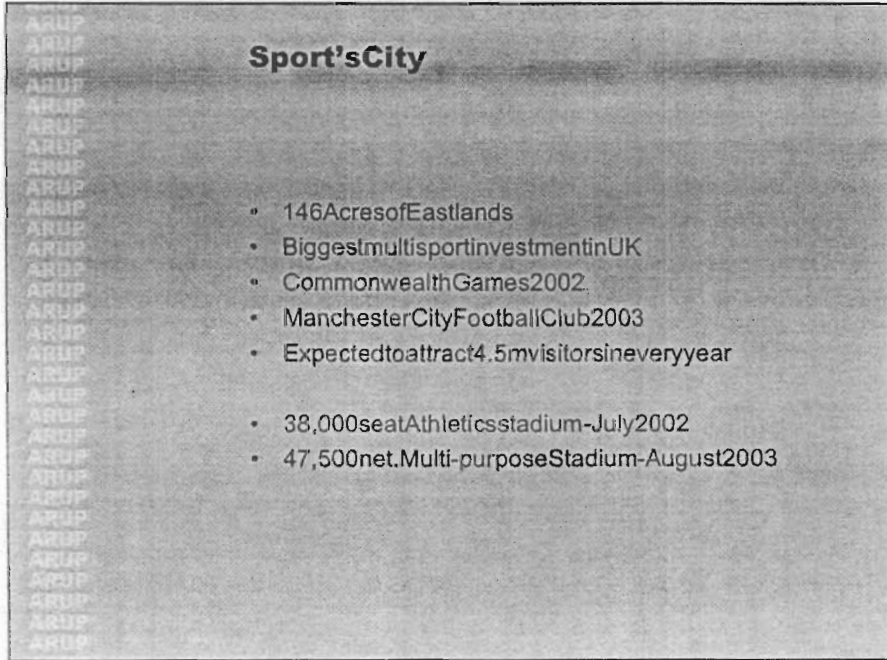
## PROGRAMME

MSAA/LSAA Conf Proceedings

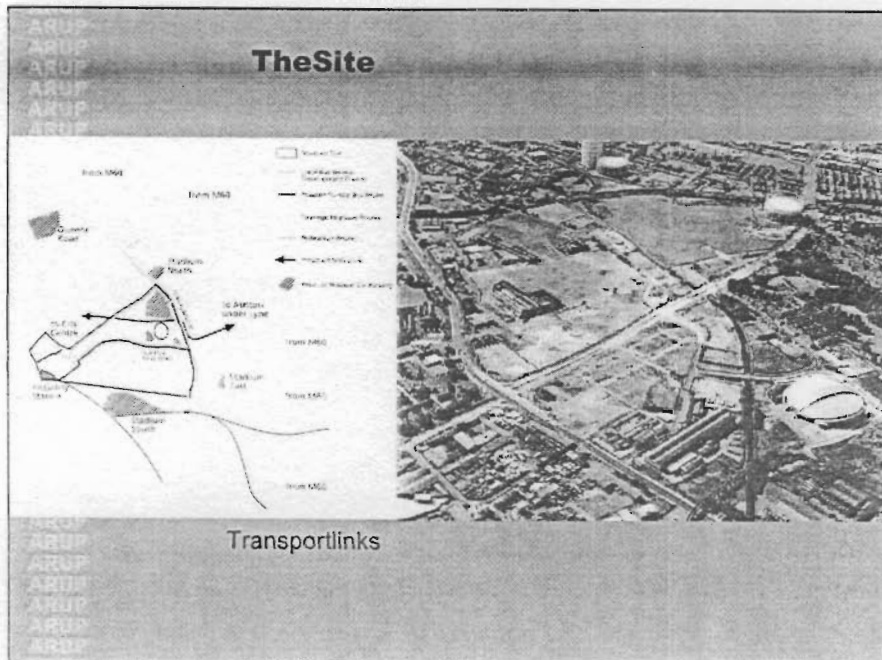
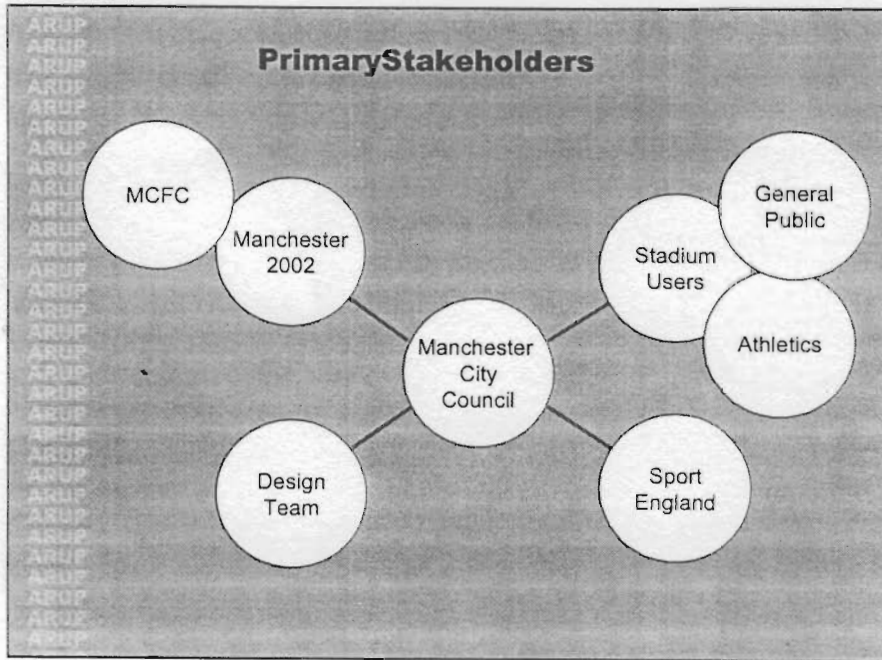
- |      |  |
|------|--|
| 1:30 | <b>Registration</b>  |
| 2:00 | <b>Welcome</b><br><i>Malcolm Barr</i><br><i>LSAA President</i><br><br><i>Vinzenz Sedlak</i><br><i>Founding President MSAA &amp; LSAA</i> |
| 2:20 | <b>Key Note Speech</b><br><i>John Richardson</i><br><i>Director, Cox Richardson Architects</i>   |
| 2:40 | <b>Presentations:</b><br>The City of Manchester Stadium<br><i>Tristram Carfrae</i><br><i>Principal-Structural Group, Arup</i>            |
| 3:00 | Roof Design for the new Wembley Stadium<br><i>Kourosh Kayvani</i><br><i>Associate, Connell Mott MacDonald</i>                            |
| 3:20 | IBP2 and SPGG, Two Recent Tensioned Membrane Structures in Singapore<br><i>Peter Lim</i><br><i>Skyspan (Pacific)</i>                     |
| 3:40 | Saida Stadium, Lebanon<br><i>Mike Lester</i><br><i>Director-Engineering,</i><br><i>Shade Structures Birdair</i>                          |
| 4:00 | Question Time  |
| 4:10 | Afternoon Tea  |
| 4:30 | A Look Back at the 20 Years of the MSAA / LSAA<br><i>Vinzenz Sedlak</i><br><i>Assoc Professor UNSW</i>                                   |
| 5:00 | <b>LSAA Annual General Meeting</b>   |
| 5:30 | Close  |
| 7:00 | Pre-Dinner Drinks  |
| 7:30 | <b>LSAA / MSAA 20<sup>th</sup> Anniversary Dinner</b>  |

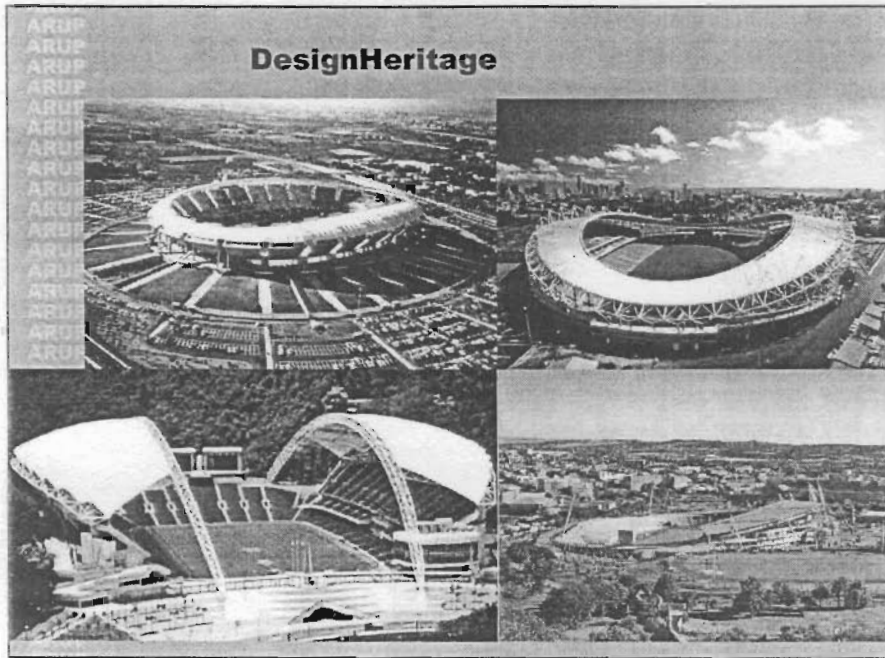
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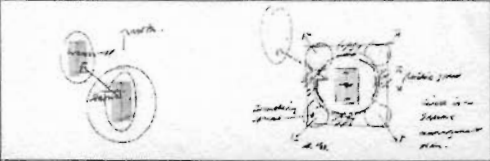


# MSAA/LSAA Conf Proceedings






### Design Concepts




**SITE PLANNING**

- Stadium in a place
- Generous external concourse
- Safe and good access
- Pitch orientation
- Warm-up track relationship



**BRIEF REQUIREMENTS**

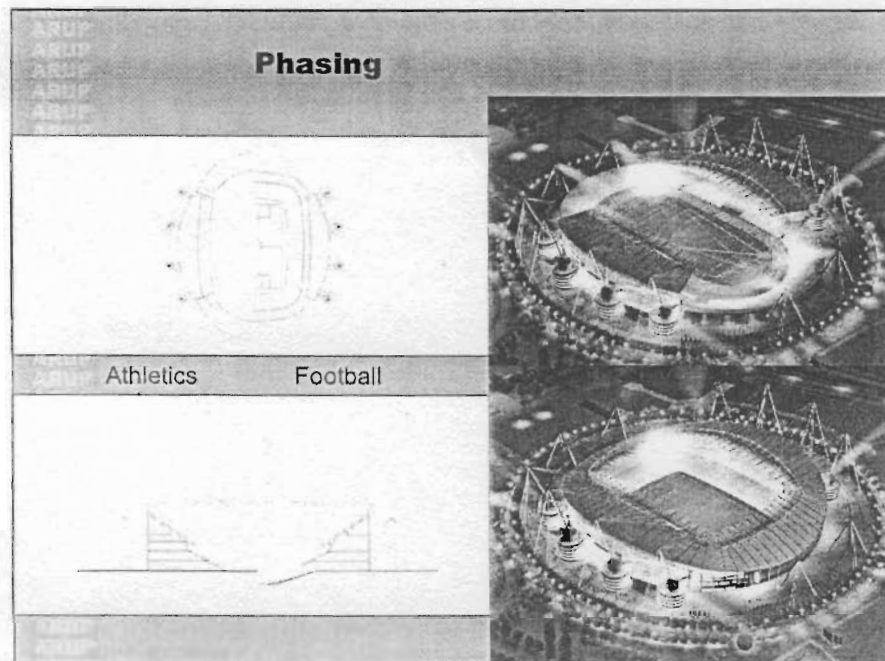
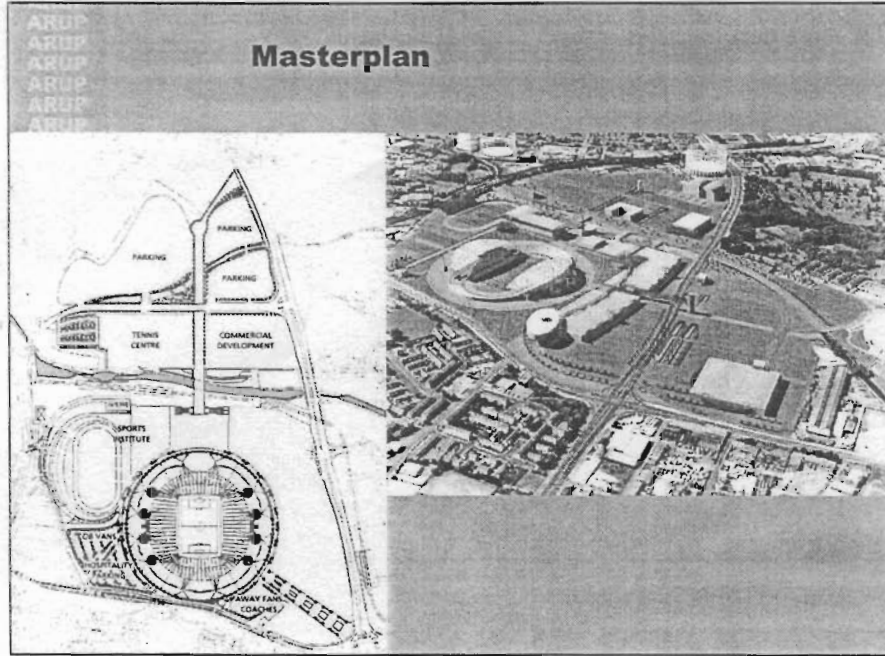
- Athletic to football transition
- Seating configuration
- Stand organisation

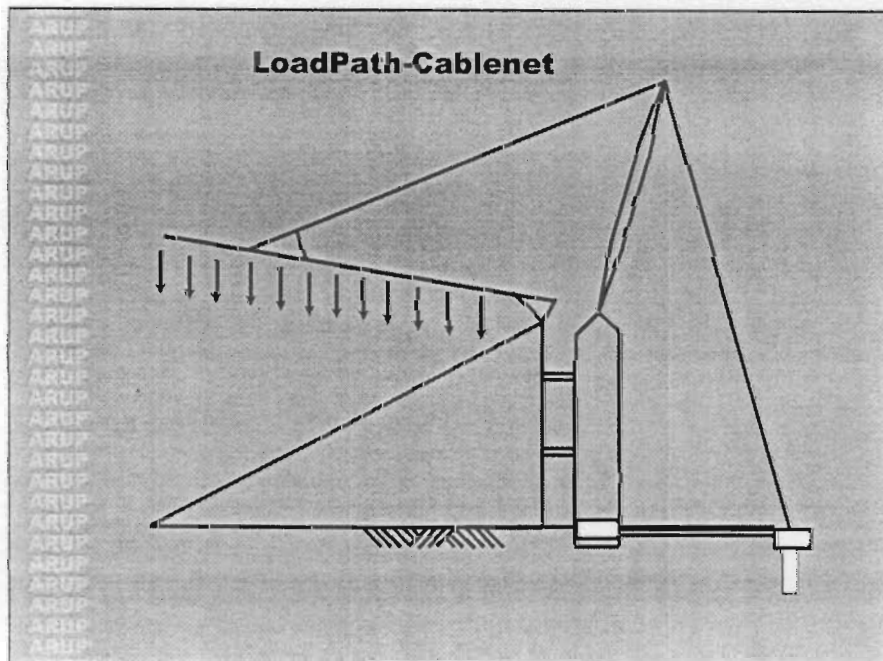
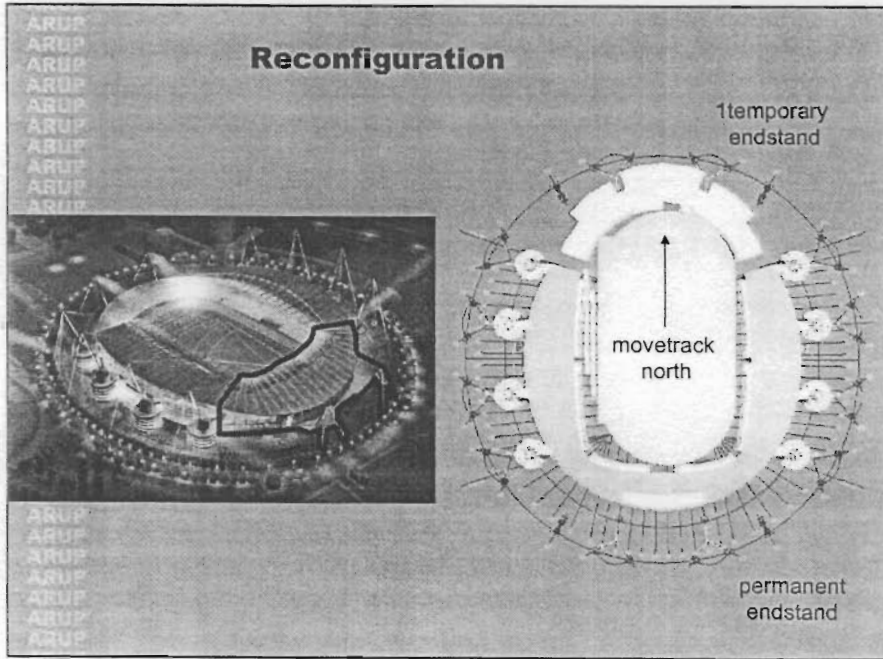


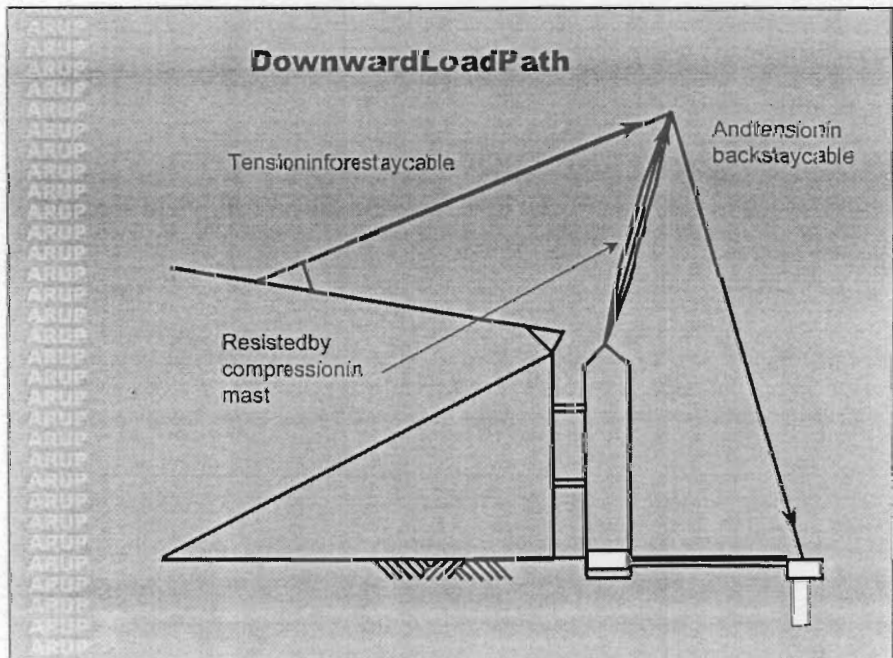
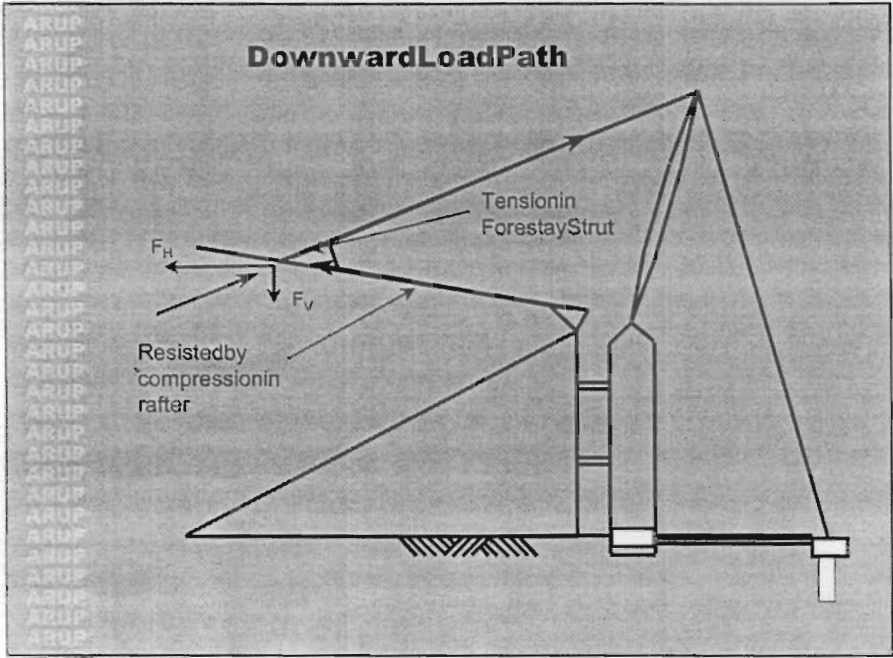
**ARCHITECTURAL EXPRESSION**

- Stadium in a landscape
- Clarity of entrances and circulation
- Integration of structure and function

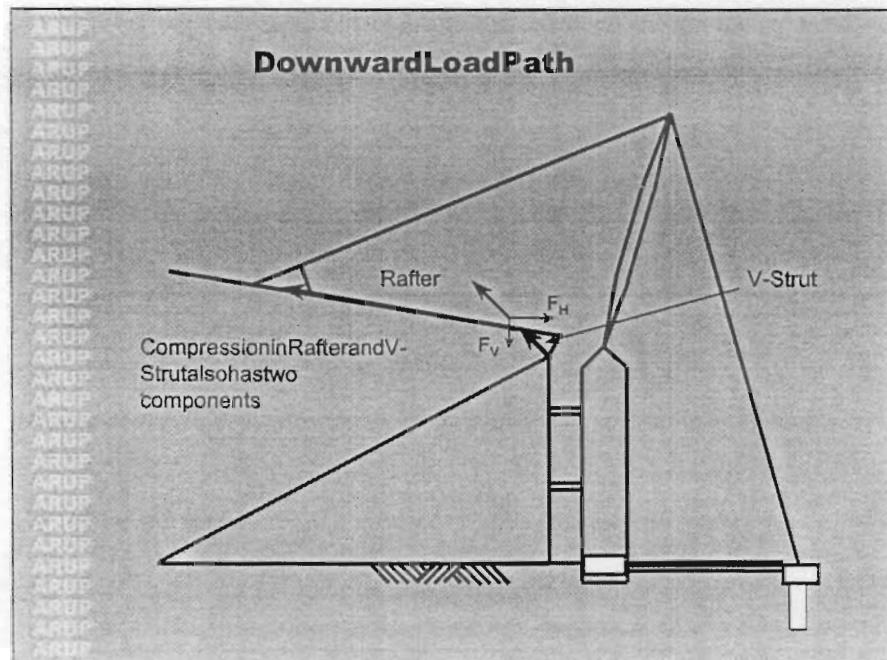
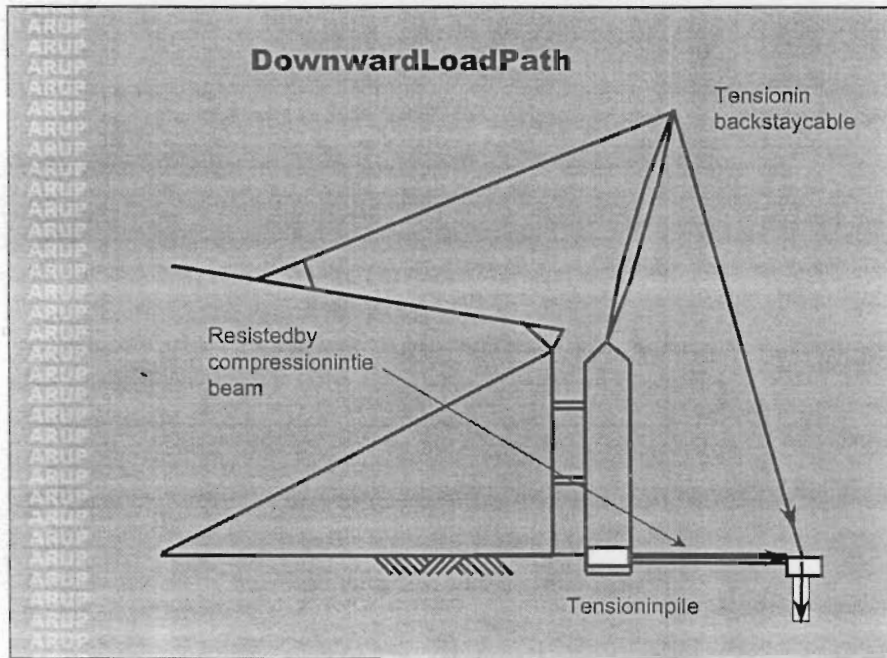
# MSAA/LSAA Conf Proceedings

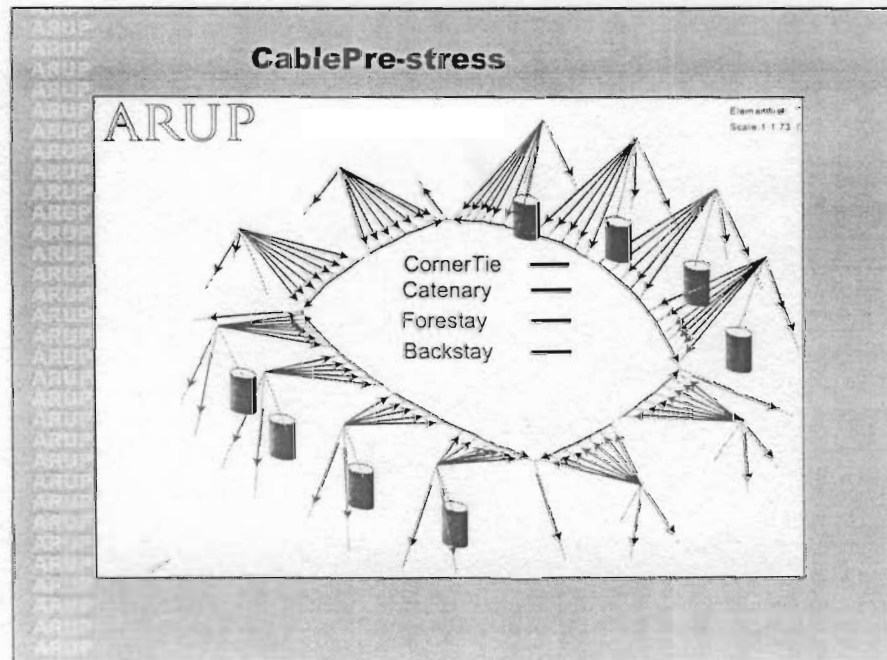
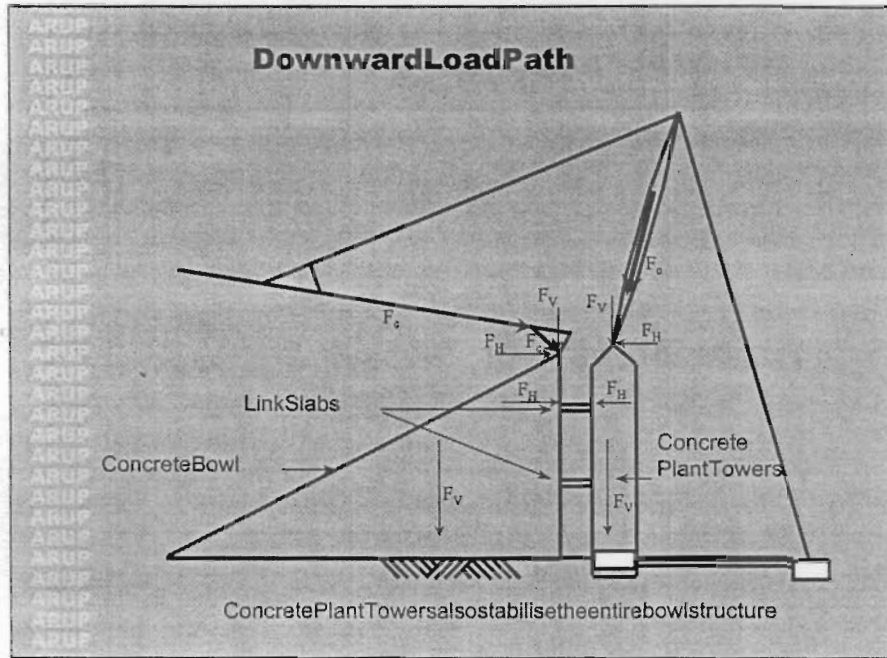


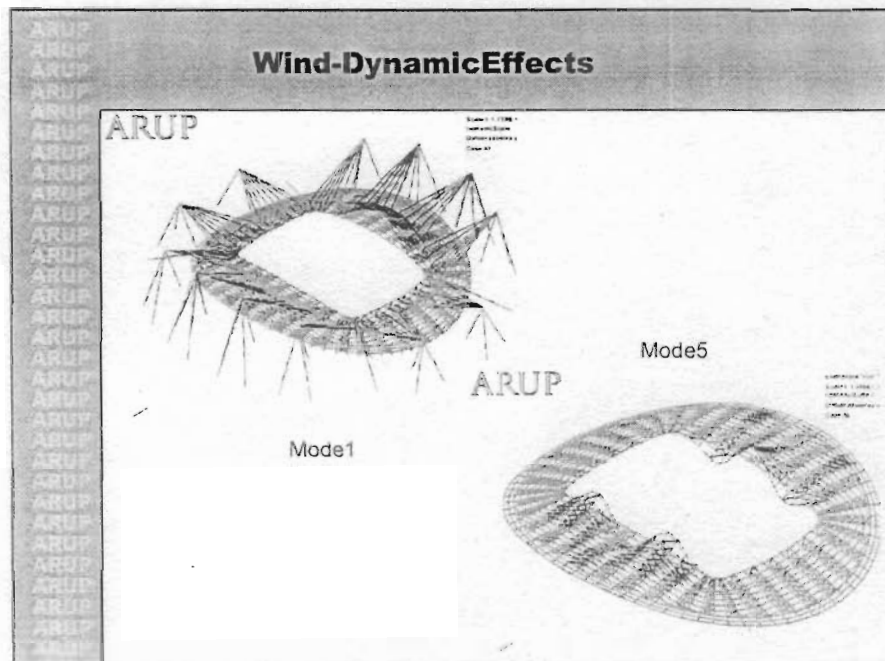
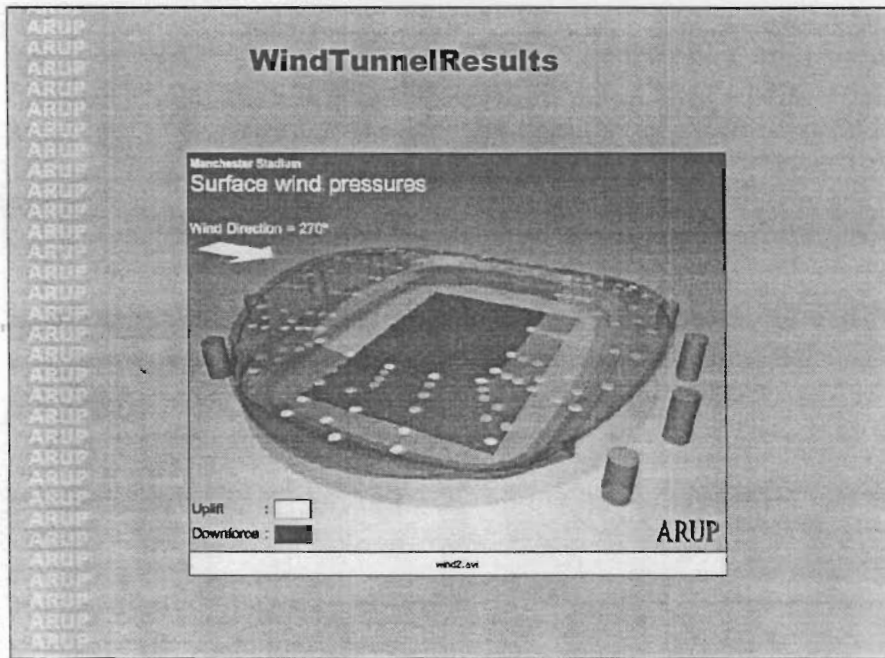


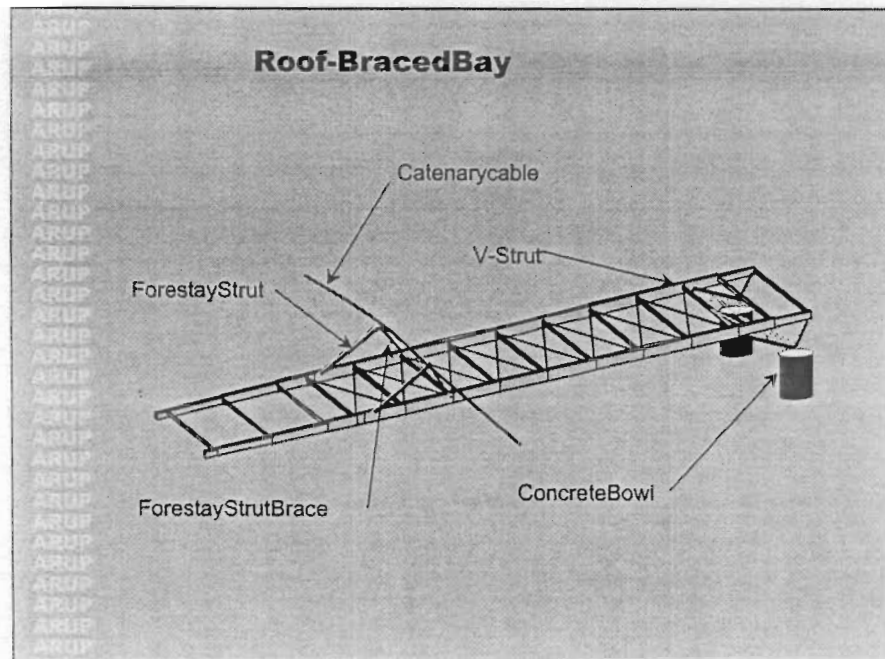
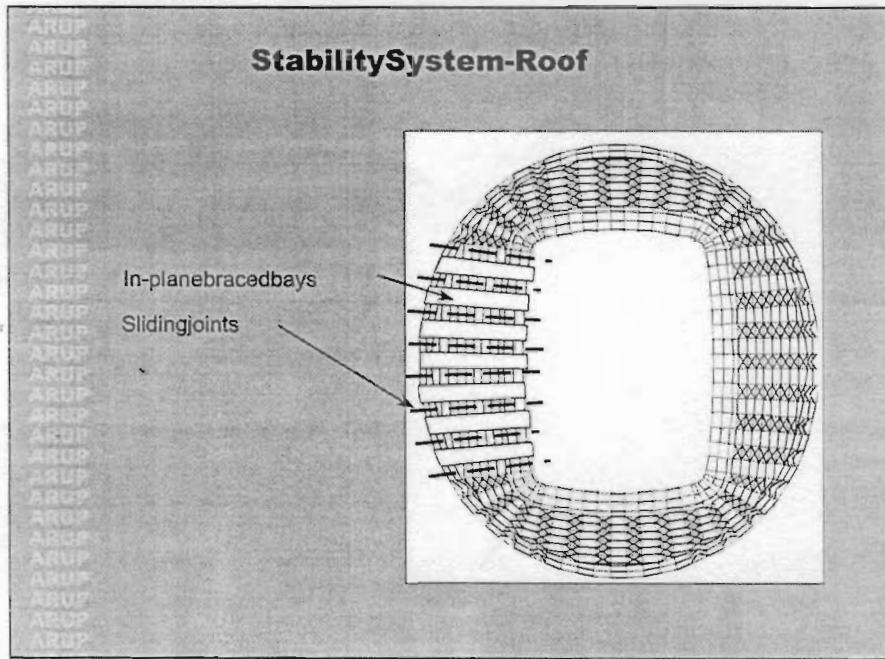






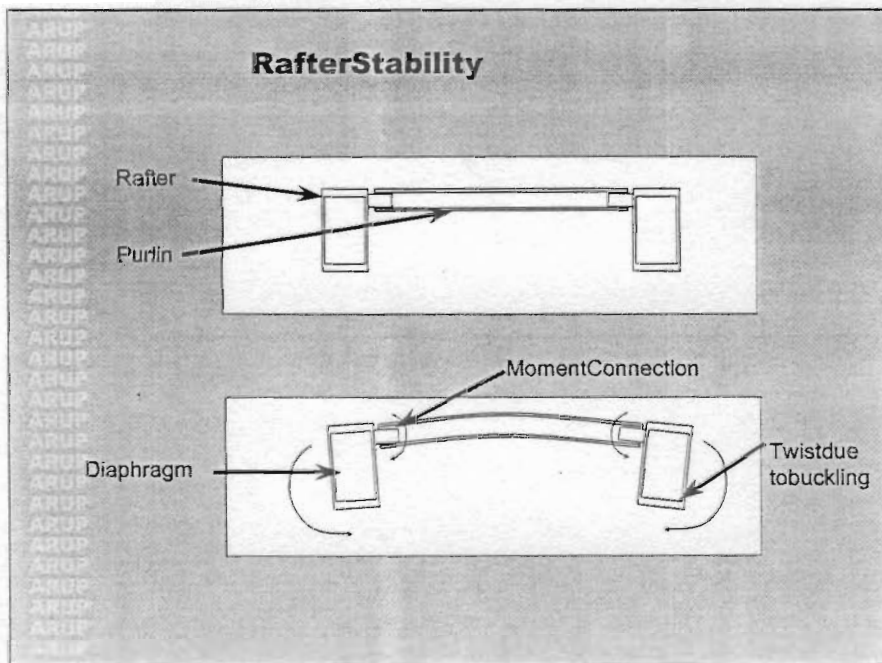
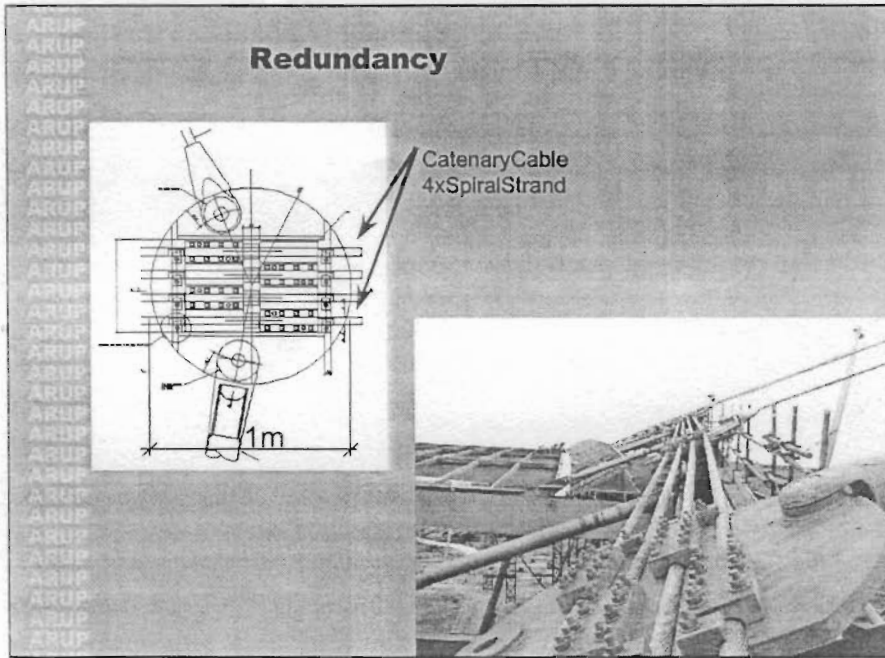


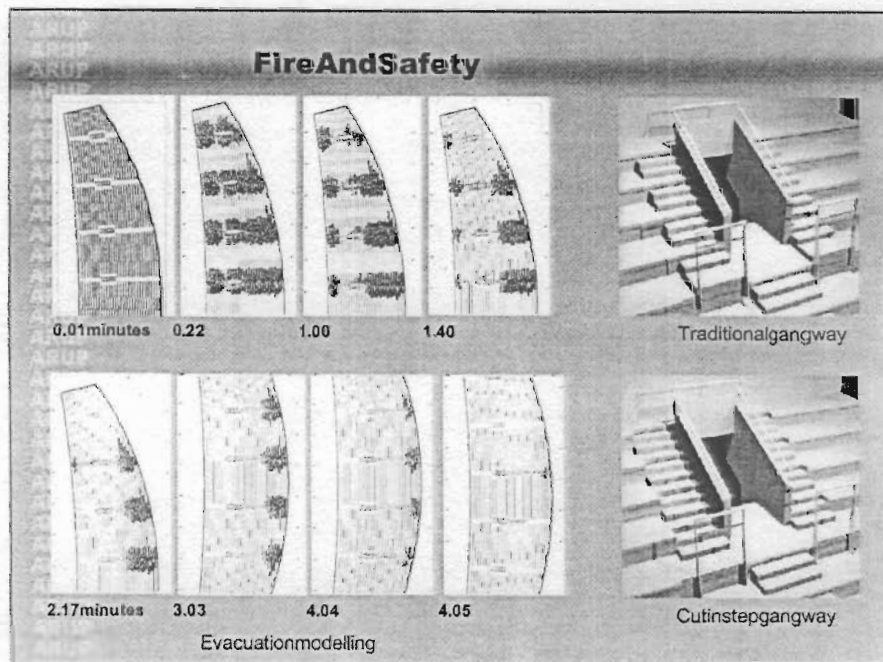
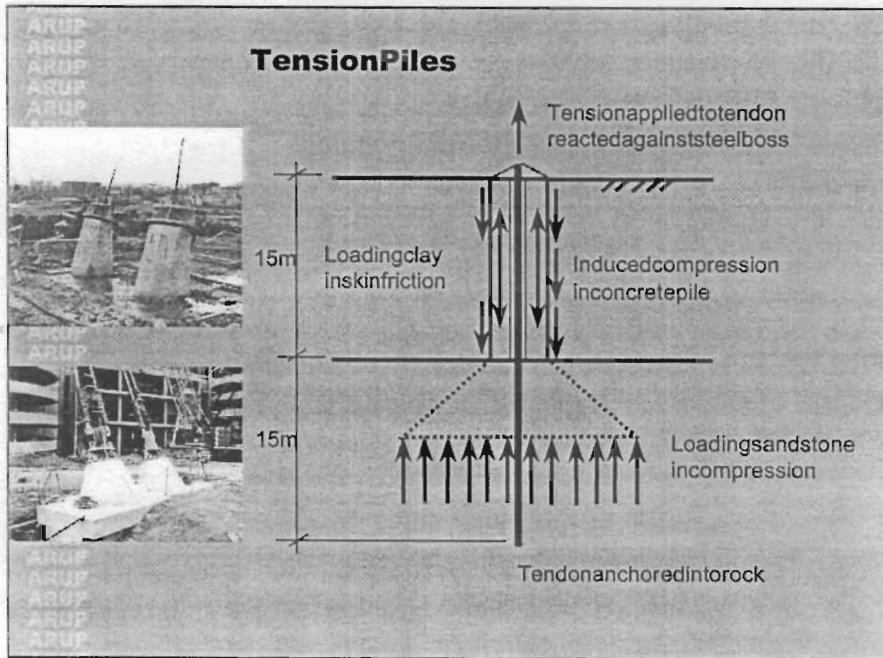




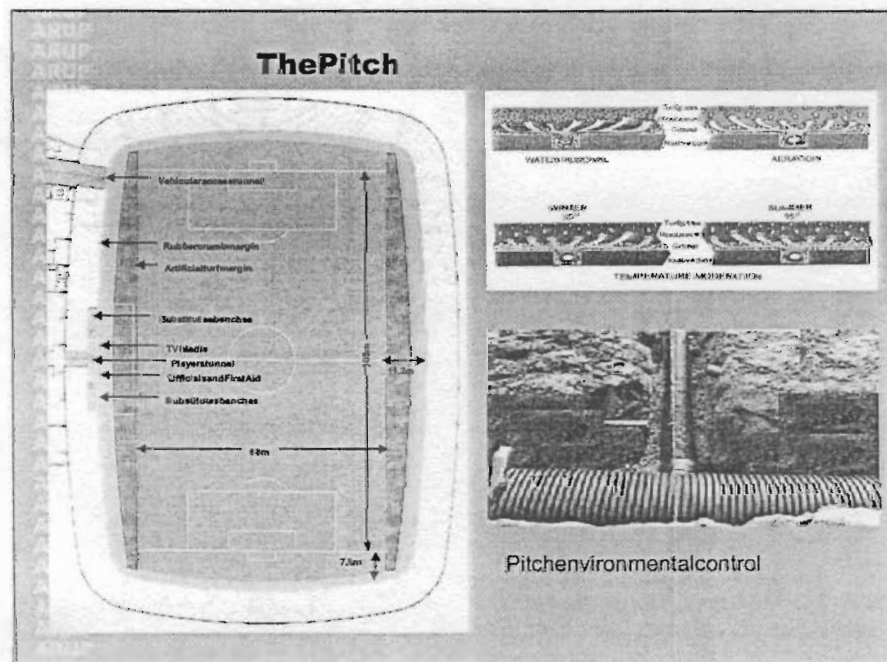
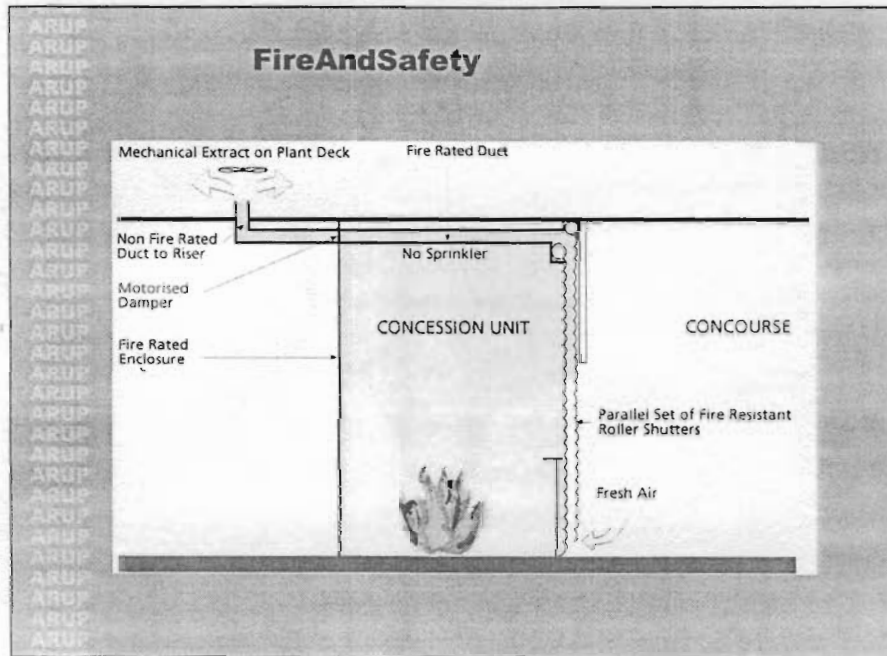




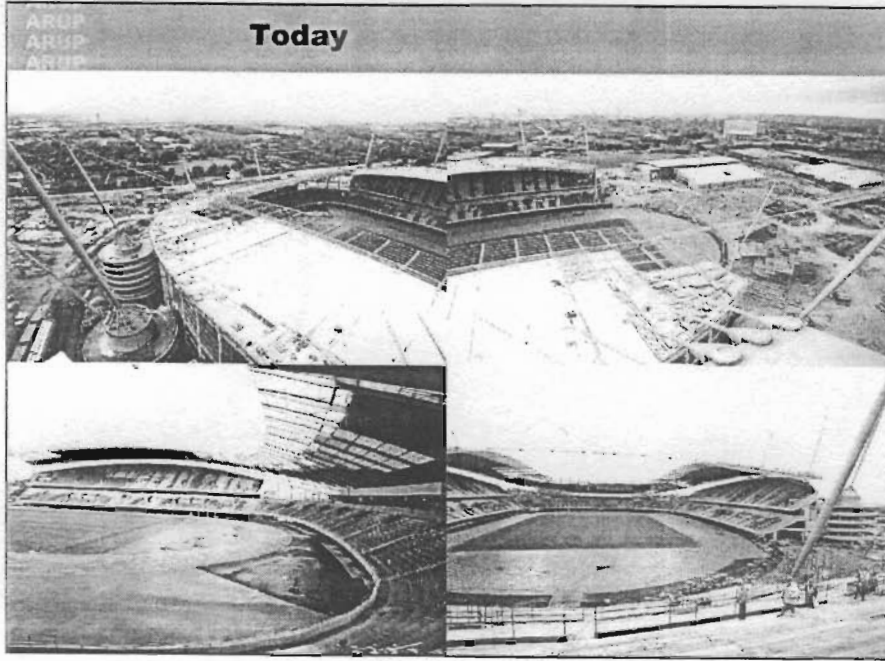








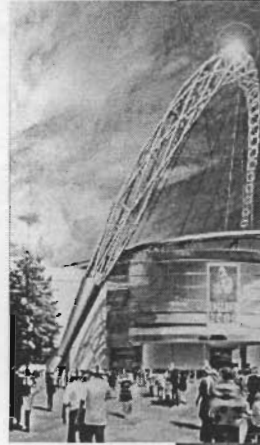
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**Connell Mott MacDonald**  
...building the future

# **ROOF DESIGN FOR THE NEW WEMBLEY STADIUM**

*Dr Kourosh Kayvani*  
*Associate*  
*Connell Mott MacDonald*

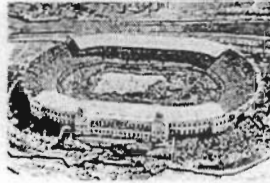


**Connell Mott MacDonald**  
...building the future



**Existing Wembley Stadium**

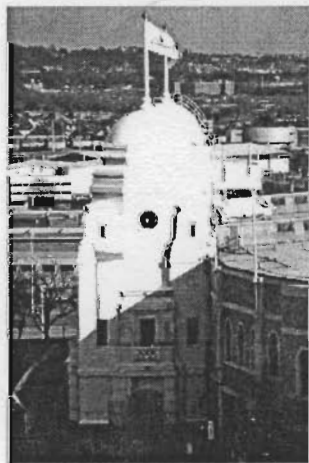
**Connell Mott MacDonald**  
...building the future



• Built in 1923



**Connell Mott MacDonald**  
...building the future



**The Twin Towers - an icon of  
English Football**

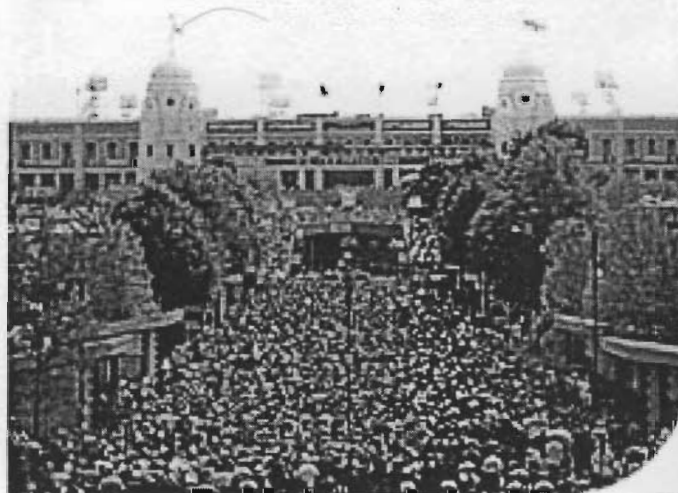
**Redevelopment of the Wembley Stadium**

**CLIENT:** *Wembley National Stadium Limited (WNSL)*

**ARCHITECTS:** *World Stadium Team (WST)*  
*Norman Foster & Partners & HOK Sports*

**ENGINEERS:** *Mott Stadium Consortium (MSC)*

**ROOF STRUCTURAL ENGINEERS:** *Connell Mott MacDonald - Sydney*



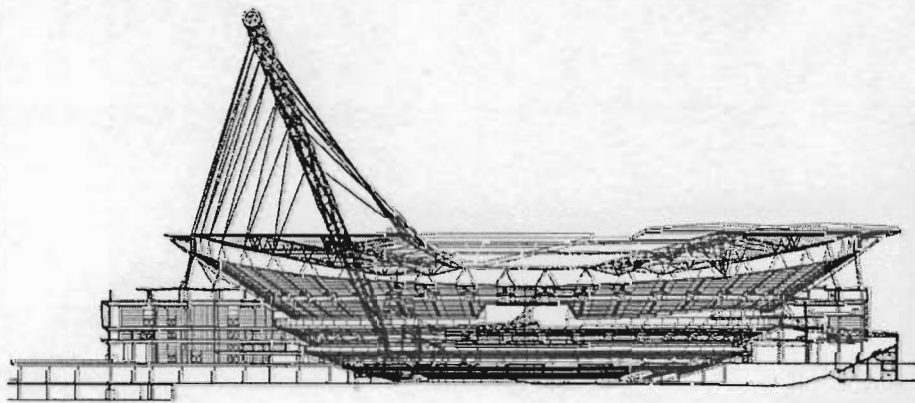
**Key View Before**

**Connell Mott MacDonald**  
...building the future



**Key View After**

**Connell Mott MacDonald**  
...building the future



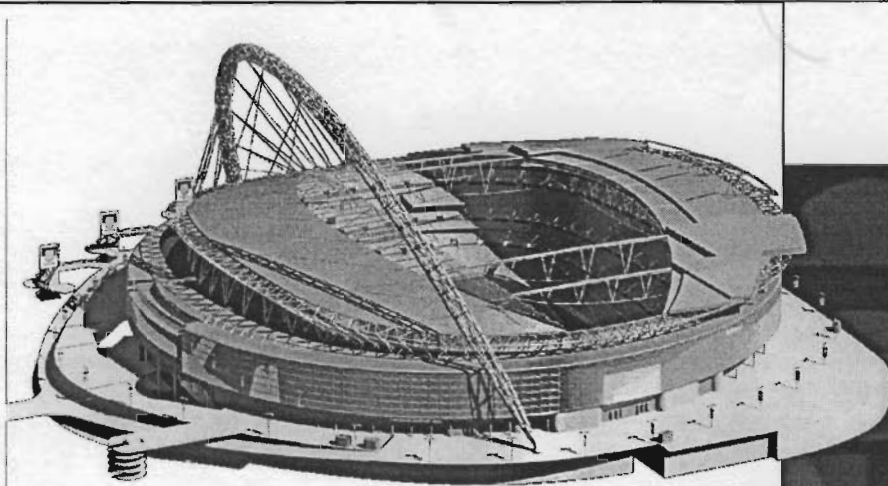
**Old versus New**

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...building the future



• 90,000 covered seats close to the pitch

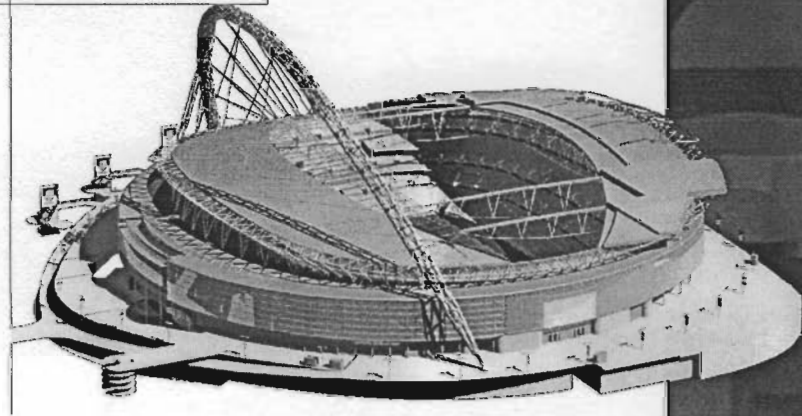
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**The New Wembley Roof**

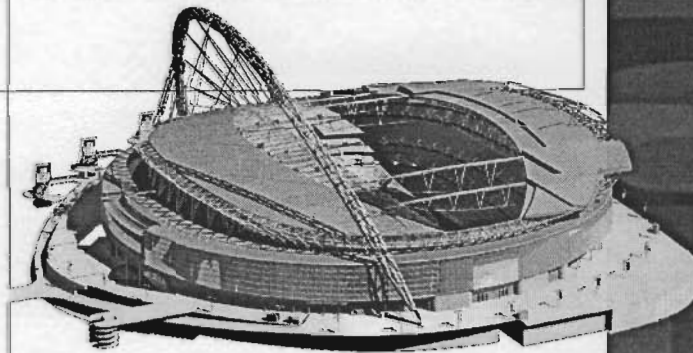
## GENERAL ROOF CONCEPT

- A) **FORM**
- B) **FUNCTION**



## ROOF FORM

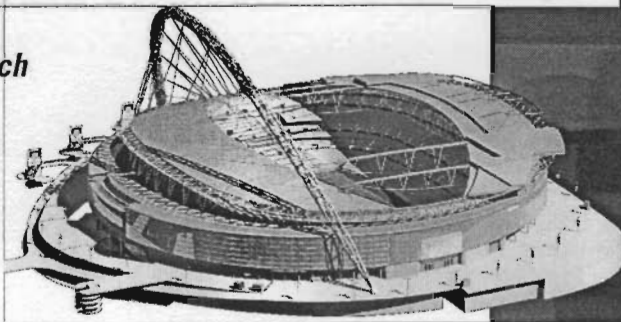
- > *Toroidal shape*
- > *Fixed roof & sliding panels*
- > *Structure beneath the roof plane*
- > *Iconic arch supporting the roof through cable stays*





### FUNCTION

- > *Covers spectators against adverse weather*
- > *Retracts fully over the Eastern & Western stands & partially over the Southern stand*
- > *Retraction allows sunlight to reach the pitch to:*
  - (a) facilitate grass growth during non-match days*
  - (b) allow clear pictures in bright sun (ie, no shadows at 3pm Cup Final Day)*
- > *No roof over the pitch*



### ROOFING LAYERS

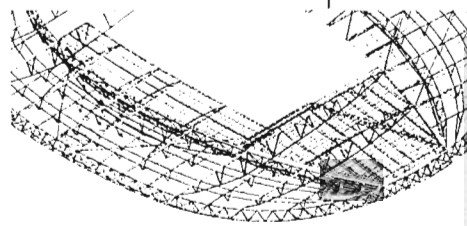
- *Metal/Translucent Cladding*



- *RHS Purlins*



- *Parallel Bowstring Rafters & Runway Beams*

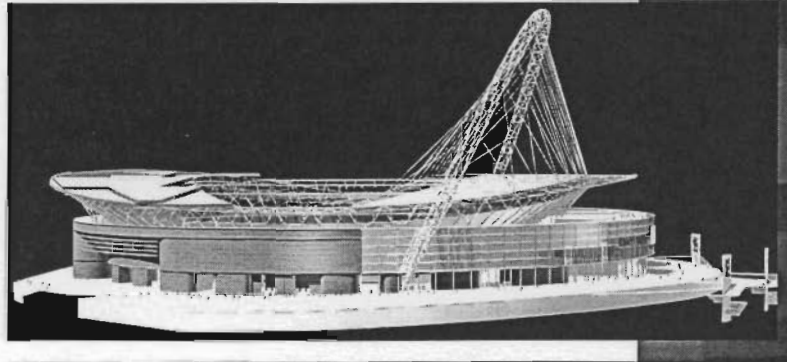


**ROOFING LAYERS (cont.)**

- **Vierendeel Bowstring Trusses & Runway Trusses**



- **Cable-stayed Arch**



**KEY DESIGN CRITERIA**

- **Relatively high live/snow loads (0.6kPa versus 0.25kPa as required in Australia)**
- **Relatively low wind uplift loads (around 0.5)**
- **Requirement to avoid disproportionate collapse**
- **Need to conform with the architectural intent in nearly all structural elements**
- **Need for minimum sectional dimensions for members casting shadow on the pitch**

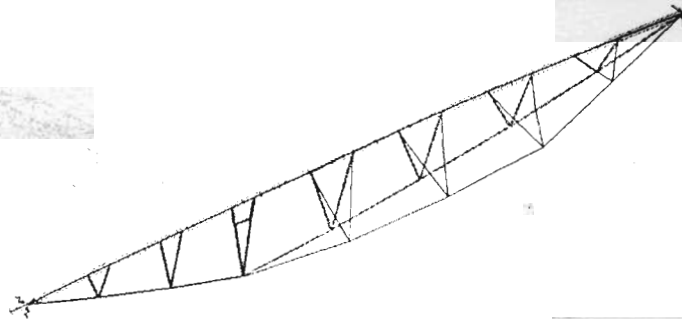
### **SPECIAL DESIGN CONSIDERATIONS**

- **Forestay Cable Net**
  - *Form Finding*
  - *Minimising Prestension Requirements*
  - *Design against wind-induced vibrations*
- **Deformation Studies**
  - *Ensured operability of moving roof under all loading conditions*
- **Secondary actions**
  - *Design against purlin arching (ie, cladding plane acting as a shallow shell)*
- **Interaction/interface with the bowl structure**

### **VIERENDEEL BOWSTRING TRUSSES**

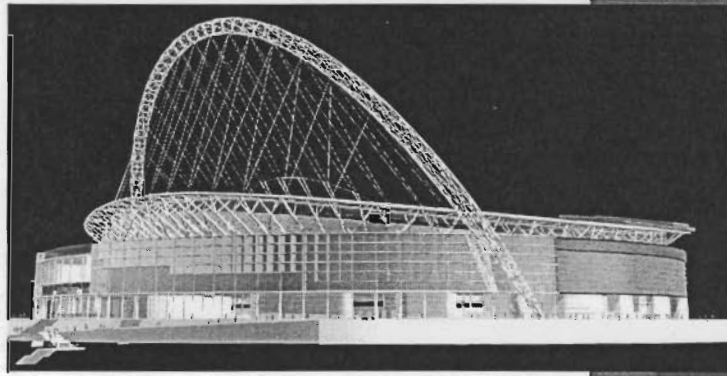
- > *Cable profile optimised for minimum bending in top chord*
- > *Design by Buckling Analysis*

Buckling  
Mode  
Shape



**THE ARCH**

- > **140m High, ie, as high as Harbour Bridge**
- > **Spans 300m, ie, as far as Gladesville Bridge**
- > **Elliptical shape**



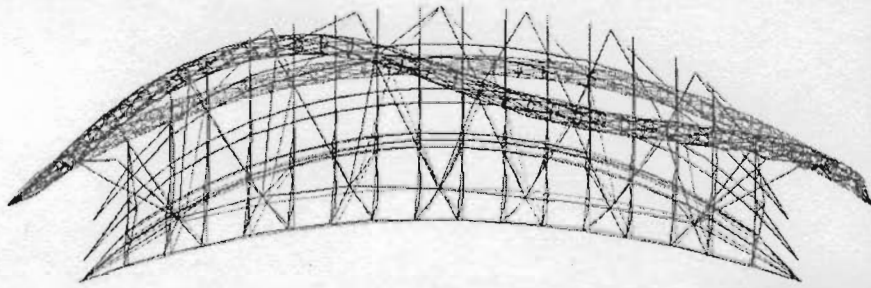
**THE ARCH (cont.)**

- > **7m diameter hexagonal lattice of 450 CHS members**
- > **10m centred diaphragms**
- > **Pin-based pencil end**



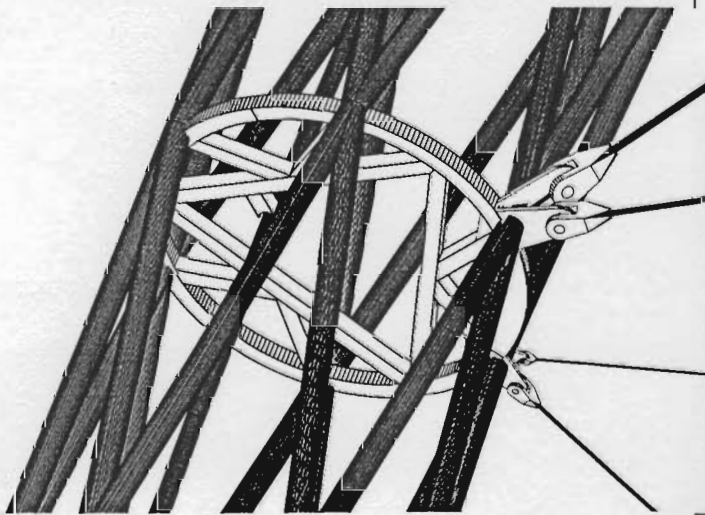
**THE ARCH (cont.)**

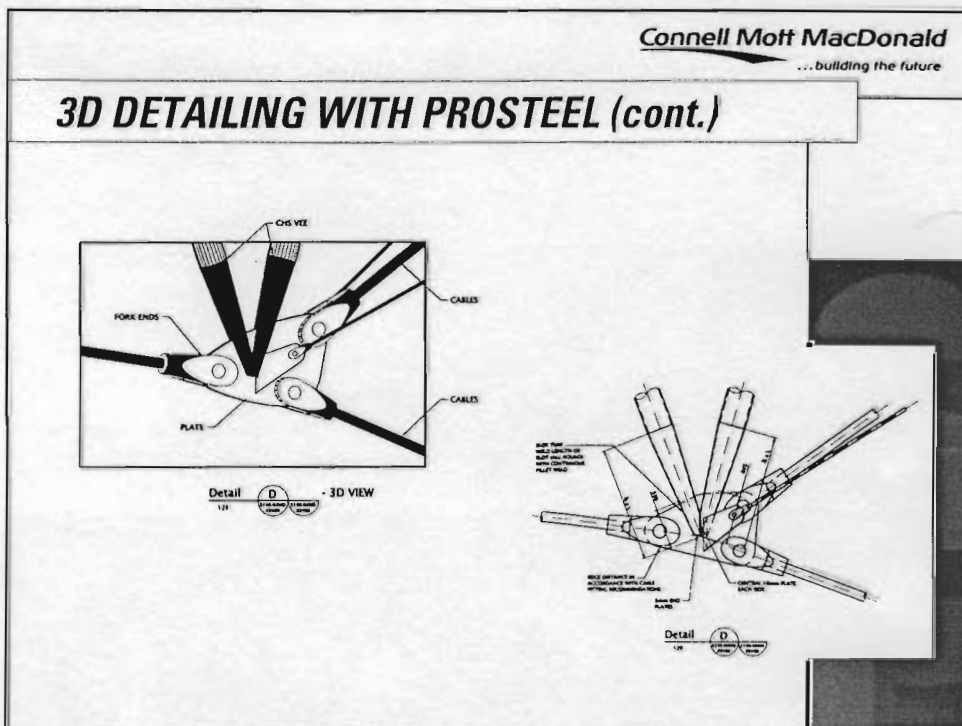
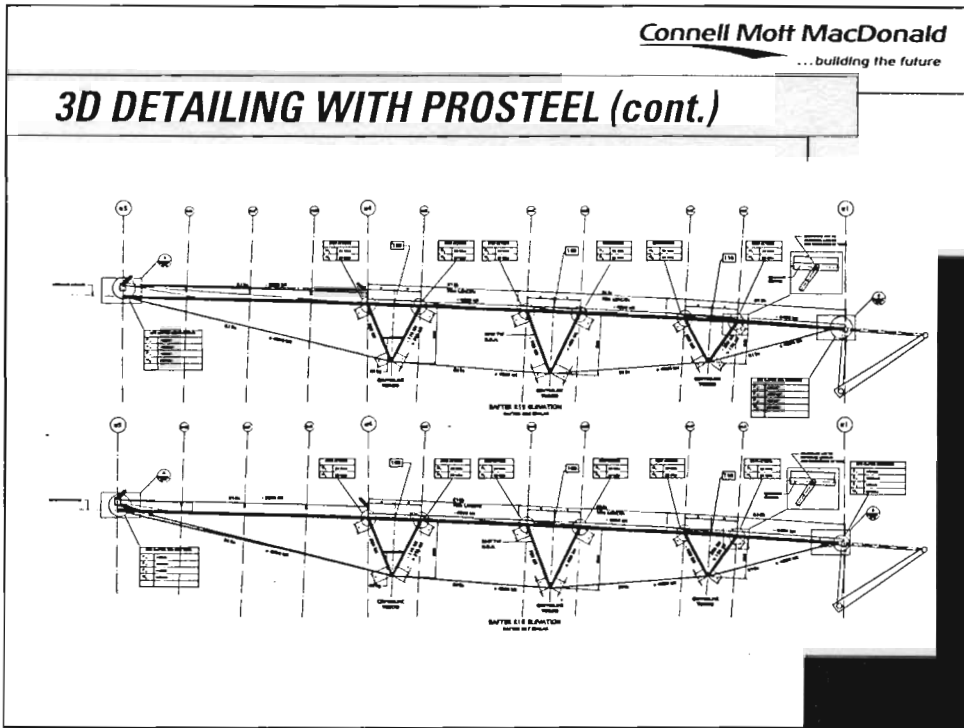
**An Optimum Design based on Nonlinear Buckling Analysis  
(accounting for the exact restraining effects of the cables)**



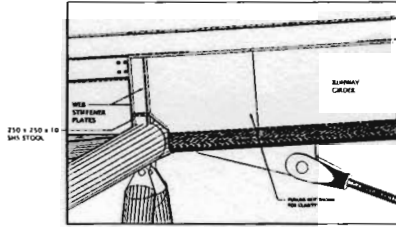
↑ Fundamental Buckling Mode Shape

**3D DETAILING WITH PROSTEEL**

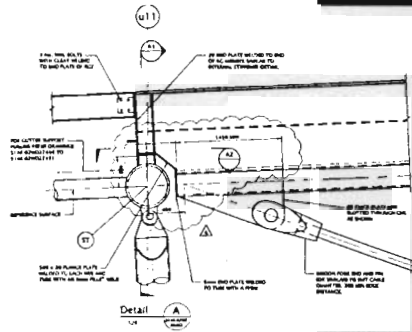




**3D DETAILING WITH PROSTEEL (cont.)**



Detail A - 3D VIEW



Detail A



The new Wembley Stadium on a sparkling summer day in London!

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## IBP11&SPPG

### TwoRecentTensionFabric StructuresinSingapore

PeterLim  
Skyspan(Pacific)PtyLtd

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### Material- Fibertop PTFE/Glass

- Polytetrafluoroethylene(PTFE)applied onto glassfibrewovenfabric. Commonlyknownas tetlon/glassfibre
- Highdurability
- Inerttomostagents - lowdirect adherence
- Flameproof FlameIndexof0
- 10-15years worldwidewarranty
- Suppliedbeigeincolour. Upon exposure to sunlightbleaches to a uniform off-white colour.



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### Agenda

- Introduction- ProjectProcess
- Material- PTFE/Glass
- InternationalBusiness Park2(IBP2)Project
- SingaporePolytechnicGraduateGuild(SPPG) Project

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### IBP11- DesignBrief

- Roofcanopyentranceto themain atriumflankedoneithersidebytwo buildings
- Conicalformstructure
- Nostructuralsupportelementsat groundlevel
- Allowanceofonlytwotiestoground level
- Allowanceoftensionanchorage positionsonadjacentbuildings

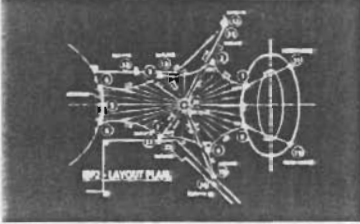
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### Introduction- ProjectProcess

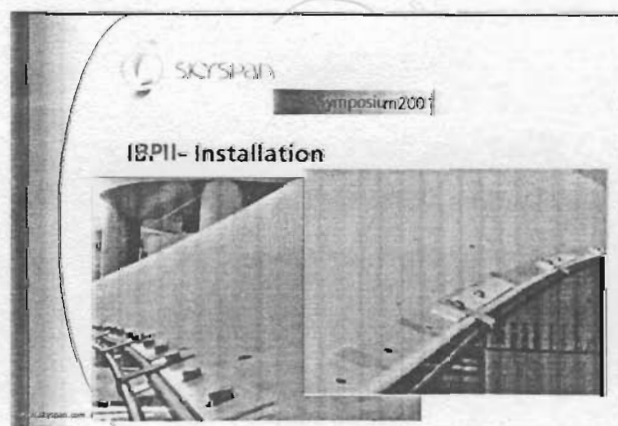
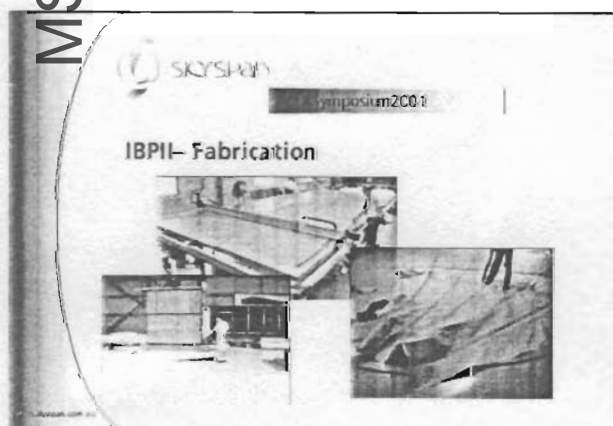
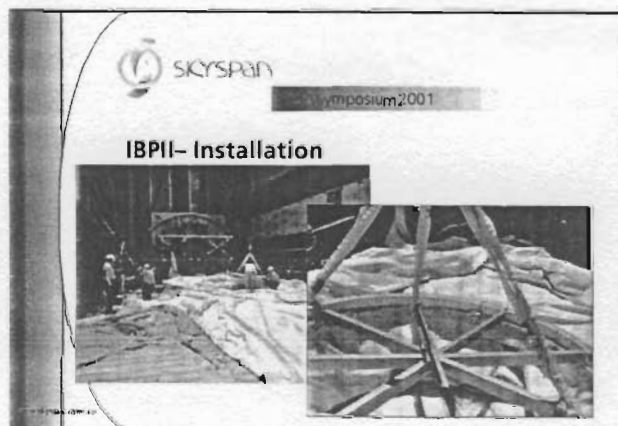
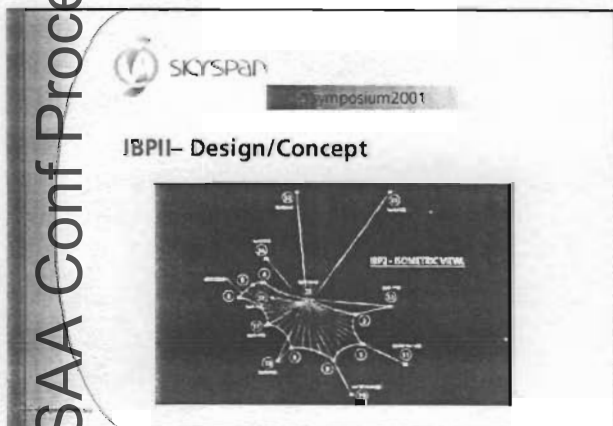
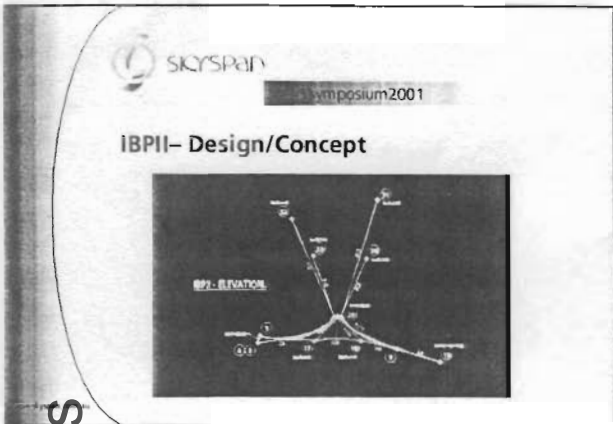
- ConceptualDesign
- EngineeringDesignAnalysis
- Procurementofmaterials
- Fabricmanufacture/conversion
- Deliverytosite
- Installationworks

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### IBP11- Design/Concept



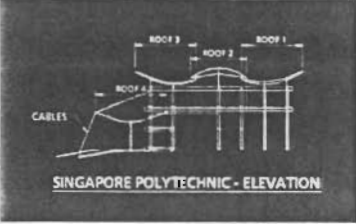






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**SPPG- Design/Concept**



SINGAPORE POLYTECHNIC - ELEVATION

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**SPPG- Installation**



SKYSPAN Symposium2001

**SPPG- Design/Concept**



SKYSPAN Symposium2001

**SPPG- Installation**



SKYSPAN Symposium2001

**SPPG- Installation**



SKYSPAN Symposium2001

**SPPG- Installation**



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### SPPG- Installation

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### PassiveEnergySystem

- Combination of geometry and fabric material physical properties
- Architectural fabrics have low thermal mass (high heat reflectance), in comparison steel roof have high thermal mass
- Creation of lamellar airflow under the shape of the fabric form
- Simulation of natural phenomenon - convection current airflow

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### SPPG

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### PassiveEnergySystem

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### SPPG

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### PassiveEnergySystem