‘We experience buildings in terms of their form, their structure, their aesthetic and how we and others use them. This constitutes the reality of our physical experience, but buildings not only have existence in reality, they also have a metaphorical existence. They express meaning and give certain messages, just as the way we dress or furnish our homes gives people a certain message about us.’ [Conway + Roensisch 1995:22]

‘Architecture is the masterly, correct and magnificent play of masses seen in light’ - Le Corbusier

… ‘an emotional and aesthetic experience’ [Conway + Roensisch 1995:9]
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The materials allocated for the following dissertation come from a palette responding to:

- current trends in South Africa and around the world
- local materials available
- Local skills available determining the appropriate construction methods, and
- Materials which are technologically advanced and incorporate innovation such as post tensioning, reinforcing, nanotechnology and smart surfaces.

**Materials 8.1/ Tectonics**

All solid and robust elements forming the structure and dividing walls are to be constructed from concrete. Tilt-up construction is to be used for main walls. Pre-cast concrete columns are to be constructed in a controlled environment to ensure a high quality finish.

**Light Elements/ Solid Elements/**

Floating and expressive roofs are to be constructed in steel and supported steel trusses on concrete columns. All steel elements are to be bolted and be as slender as is engineeringly possible. The light quality and a minimal materiality is to be expressive of our technologically advanced society which strives to reduce things to their simplest forms and stretch their capabilities to achieve efficiency.

**Transparency + Interactive Elements/**

Visual connection between spaces or from inside to outside are to achieve through the use of glass elements such as windows or glass curtain walling. Advance materials such as smart glass gives glass even more potential as a material to be able to change qualities from transparent to opaque with the switch of a button or the stimulation of a light sensor. Nanotechnology is to be incorporated into the building to further expresses the advances of materials and surfaces, to reduce general maintenance and to provide new and exciting environments.

**Concrete/ Structural Concrete/ Cement/ Foundations**

All structural concrete is to comply with SABS standards regarding the ‘design of the structural system’ SABS 0160 and structural concrete SABS 0100.

The scale of this project requires a large number of basements and medium to large spaces and surfaces. Concrete seems the most appropriate material to use. Reinforcing allows for stronger concrete requiring less mass.

Any local reputable cement supplier may be used either PPC Cement, Holcim Cement or Lafarge Cement with. If ready-mix concrete is to be used it must comply with SABS 878 and the supplier is to be responsible for the quality of the material. Cement for ‘Concrete floors must be type CEM 1 to comply with SABS ENV 197-1’. [Wegelin1998-8]

**Foundations/**

Soil conditions for the location of this facility in Pretoria call for Pad Foundations. These are to be reinforced 400mm thick concrete to carry the concrete elements mentioned above to below the last basement level. The basement is to be used a tanking construction system with a reinforced concrete retaining wall with weep holes at 1/m² and secured with rock anchors to engineering specifications. Special attention ‘must be paid to material, density and placing of concrete to render it inherently waterproof’. [Wegelin 2005: 1.28] This form of construction requires; a drainage layer sloping to a sump, with a damp-proof membrane of 0.5mm polyolefin placed just under the floor slab[Wegelin 2005: 1.28] The damp proof sheeting must be laid on smooth surfaces and joined by lapping and solvent welding. The basement floor is to be laid with concrete blocks or geopipes in a herringbone pattern to fall towards sumps covered with a removable steel grating grill. Sumps are to be evenly distributed along the basement to catch no more than 400m² of floor area. Refer to drawing for details.
Materials 8.1/
Surface Beds/
Precast Elements/

All surface beds are to be reinforced 200mm thick or cast according to engineer’s specifications, with a 75mm screed. 'Isolation joints' must be created with soft material like 'polystyrene or soft board'. [Wegeline 2005:2.10] Structural Expansion joints are also required for the following building and need to be detailed according to Engineer requirements. The positions of these are shown on page 121 further in this chapter. Due to Columns being 1200 x 300mm thick, expansion joints can only be cut running North-South through columns and East-West cutting through slabs. Expansion Joints running North-South cut columns to 600 x 300 mm thick dimensions. East-West Expansion Joints are to cut through slabs only with extra re-enforcing cast into the edges of the slabs.

Lift core shafts are to be constructed out of concrete too and will extend 2800mm below the last basement level to accommodate a shaft pit for lift engineering requirements. A Plant room will be located on the roof for each lift core with sufficient access to perform maintenance.

Post-tensioned Flat slabs are to be 20-30 MPa cast according to engineers detail specifications to a thickness of 200mm with steel reinforcing to comply with SABS 1024 requirements. In considering the nature of the basements in the following dissertation and the nature of post-tensioned concrete sufficient manoeuvrability space needs to be catered for when tensioning the slab. The intention is to provide ventilation shafts which run along the external perimeter of the basement. [8/028] This allows for tensioning of the slab at the same time as catering for design providing light and ventilation to the basements. Details of this are shown in the drawings. For more construction information see www.sapta.co.za or www.amsteelesystems.com.

Materials 8.1/
Concrete
Surface Beds/
Post-Tensioned Flat Slabs/
Precast Elements/

Precast environment controlled concrete has the potential to be of highest quality in finish and precision in concrete production. The intention is to assemble the building using Tilt-Up Construction with pre-cast 300 mm thick concrete wall elements and 1200mm or 1500mm x 300mm thick concrete columns. The building elements produced are an attempt to maximize quality finish and minimize material required through incorporating technological advances in building construction. Tilt-up construction is relatively new to South Africa but is ideal considering our low skill level workforce. The quality of off shutter concrete for South Africa is relatively low in comparison to countries such as Germany and Switzerland and holds high risk failure due to uncontrolled environments in which the concrete is set. Shuttering and high quality finishes require a high skilled workforce.

Tilt up [8/018] construction ensures a faster rate of production essentially and relatively controlled final product. Tilt-up panels can be cast on site and tilted into place. This eliminates transportation costs for precast elements and scaffolding and formwork needed for off shutter concrete.

Precast elements must comply with SABS 1200 GE 1984 and be ‘stored separately on their designed end bearing surfaces in the position they will adopt when built in. Cure for at least 10 days.’ [Wegelin 1998:15]

All concrete edges are to be chamfered edges to obtain a neat finish.

Most concrete elements are to covered by roofing and will not suffer from direct rain damage however due to concrete being a very absorbent and easily stained material all concrete wall surfaces need to be protected. Drip joints are to be made deep enough in all under edge conditions. All Fair-face concrete is to be treated with a Nanotec Product, Nanoprotect CS. This is a hydrophobic Impregnation for concrete or stone to stop water penetrating the materiel. For further information see www.nanotec.com.au.

Concrete roofs are to be to engineer’s detail according to SABS 794. These are to be treated with Nanotec protect CS or according to Engineer’s Specification with waterproofing to comply with SABS requirements. Aggregate for fair-face concrete must be chosen with care and must be checked by principle agent and architect as to resistance to weathering if exposed. Aggregate used must comply with SABS 1083 standards.
Steel Construction is to be used as a secondary supporting system and in the support of steel roofing, steel louvres and glass for balustrades and curtain walling. Steel is to be used as a connecting material between concrete and glass and concrete and steel. All primary elements are to be hot-rolled H and I profiles and must be to grade 300W to comply with SABS 1431. “Steel tubes are to comply with SABS 657 part 1 of type, coating, grade, size and wall thickness.” [Wegelin 1998:59]

All steel elements are to comply with SABS fire resistance requirements and engineering specifications. All steel is to be finished in intumescent paint which creates an insulating foam during a fire. A coating of 1mm gives a fire protection of 60 minutes. [Wegelin: 2005:3.5] Steel structure geometry and sizing is to be in accordance with SANS 10160 for loads and SANS 10162 for steel structure.

M20 size bolts, Class 8.8 and Class 8 Nuts are to be used in all on-site fixing which must comply with SABS 1700 requirements. Class 8.8 bolts have a tensile strength of 800MPa and a yield strength of 0.8 of 800 = 640 MPa” [Wegelin 2005:3.3] and allow for high-strength friction. Where high-strength friction bolts are required by engineer these must comply with SABS 1282 in strength and grade. A minimum of one thread and a maximum of 25mm of bolt must protrude above the nut. Bolt connections are to include connections between structural elements including: angle cleat, end plate, base plate and fin plate. Grouting is to be applied under base plates once structure has been aligned, levelled, plumbed and braced.

Steel is to be used in staircases with steel treads in vertical circulation and general floor changes. A mono-pitched steel roof over the connecting access link in the building is to be supported by steel trusses which will carry the load to concrete columns. The roofing system incorporates steel IBR roof sheeting on Steel Purlins to engineering specifications on Steel I-Beams with C-Section closers. Refer to drawings for details. The use of Steel Angles and Steel Hollow tubes will formulate the kit of parts for both the roof structure and balustrades of the building.

All metal work concerning window, door and louvre frames are to comply with SABS 727. Tilt-up doors are to be used for all workshop venues and are to be made of pressed mild steel with a balanced counterweight as specified by the manufacturer. Doors will be as follows: ‘a 0.8mm mild steel door pressed to troughed pattern, reinforced at the back with 1.2mm mild steel braces and channel surround, all welded together.’ [Wegelin 1998:62] Doors to be painted with one coat of zinc phosphate primer to comply with SABS 1319. Channels are to bolted to door jambs of door openings in concrete tilt-up panels.

Steel louvres systems will run along the visually active edges of the building with display being incorporated into the design whereby the louvres become a display surface. Nanotechnology and LED’s are to be placed on the surface of each individual louvre to form the large screen display. The relationship between steel and glass is such that wherever glass is required to create transparent edges, steel needs to support the glass either in the form of clipping panels of glass along the edges to steel elements. The concept of clipping glass allows for less movement of glass and the steel structure being expressed as a supporting material. Louvres are to be both steel and glass within galvanized steel frames to comply with SABS-CKS 413. The mechanism is to be operated by a remote control system. Glass louvres are to be 115mm wide with long edges polished. Adjustable louvre frames are to be fitted after the fixed window frame has been painted, with stainless steel plated brass dome-head screws.

On completion ‘the steelwork contractor must provide a completion certificate stating that all connections are completed and the steelwork has been erected in accordance with the specification and contract requirements.’ [Wegelin: 1998:60]
The intention of glass is to allow for visual connection between people inside the building and the outside environment. With the South Facing connecting entrance access, Glass louvres are to be incorporated with steel louvres. The intention is to provide a fully adjustable façade composed of two skins. The interior skin is to be glass louvres and the exterior skin is to be steel louvre screens to act as a large screen and as a wind shield.

Laminated safety Glass is to be used for all balustrades, to be side mounted or recessed when connecting to facility. Laminated safety glass must comply with SABS 1263 part 1, 2 or 3. The intention is to reduce the amount of steel needed to surround the glass with ‘Cover Frameless Glass’. Stronger engineered glass requires less framing. Polycarbonated and acrylic sheeting can be used instead of glass. Sealants that can be used include polysulphide to comply with SABS 110 [part 2], Silicone to comply with SABS 1305 or Polyurethane to comply with SABS 1077.

Where the roof meets with supporting structure the idea of a glass band enables a visual connection with the sky and city skyline. Glass panel louvre windows are used to emphasize connection points along the buildings elevation between thresholds creating a complete glass slot with no balustrades or disrupting features. The intention is to use glass panels in a steel supporting system to emphasis complete visual connection along the circulation strips along Mears Street and Elandspoort Road

Interactive and display elements such as large screens will incorporate a mixture of screen projection and surface display. LED’s shown in illustration 8/033 can be used as strips of lighting placed on each individual louvre as used in the Crown Fountain Display Towers. LED’s can be inserted into the louvre skin and covered with a protective glass or plastic layer. Nanotechnology is also to be incorporated into surfaces throughout the building. Nanotechnology is a science concerned with the control of matter at an atom and molecular level. With molecular technology we can make smart materials which are able to change their properties in relation to surroundings as well as by instruction by people. Products of Nanomolecular controlled matter include; smart materials, nanopowders, carbon nanotechnologies and molecular electronics. Imagine surfaces that clean themselves, or surfaces that can read our identity and eliminate keys. Surfaces have the power to generate and give opportunities to so many things. Pilkington Active Glass was used in the Glass House for the Houses of the future competition 2004 in Sydney Australia. This type of glass uses ‘Nanotechnology with a transparent exterior coating that uses the forces of nature—natural ultra violet and rain– to keep the glass free of any organic dirt.’[www.housesofthefuture.com.au 13/10/2006] The glass is laminated to provide safety, reduce noise and control fading. For further information refer to Chapter 10/ for sources including:

- www.pilkington.com.au
- www.nano.uts.edu.au/nanohouse
- www.nano.csiro.au
- www.myretsu.com
- www.v-lool.com

Illustrations:
- www.iscor.co.za 02/10/2006
- www.pilkington.com.au
- www.nano.csiro.au
- www.myretsu.com
- www.v-lool.com
All structural concrete is to comply with SABS standards regarding the ‘design of the structural system’ SABS 0160 and structural concrete SABS 0100 and constructed to engineering detail specifications.

Tilt-Up construction allows for a controlled form of concrete casting at a very fast rate of production in comparison to off-shutter [8/ 050 + 8/ 051] concrete production.[www.tlttech.co.za 02/10/2006] Tilt-up construction allows for jobsite prefabrication and involves the casting of walls in a horizontal position using the building slab as a flat surface to cast onto. This building method allows for a relatively low skilled workforce to be used in producing the product with a high quality finish. Quality finish in South Africa is difficult to produce because it requires specialized expertise and highly skilled workmen which is not readily available. A reinforcing steel cage as shown in 8/ 054 is created onto which concrete is poured. The step-by-step casting process is shown in order in the illustrations 8/ 062 to 8/ 066 and in the sketches 8/ 045 to 8/ 048. After casting, the walls are then tilted to a vertical position and held in place by steel cables whilst the adjoining walls, slabs and roof are cast and tilted into place. Once all the elements are in place the final connection of each of the concrete elements is possible.

Tilt-Up Construction is promoted as a relatively low skill requiring construction, with no need for formwork or scaffolding. The end product requires minimum maintenance, has a high level of fire resistance and allows for flexibility in removal of walls or for relocation. For further information refer to Chapter 10/ ‘Sources’ including:

- www.cnri.org.za/structural_concrete.htm
- www.tiltupnews.com
- www.tlttech.co.za

Tilt-up construction is to be built in conjunction with Post-tensioned concrete slab construction. Connections between these two building methods and built elements needs to be handled with care. Contraction joints must be spayed around columns where the slab and column connect alternatively ‘isolation joints’ must be created with soft material like ‘polystyrene or soft board’. [Wegeline 2005:2.10] All insulation joints are to be designed for points at which Tilt-Up panels and slabs abut with slabs. Expansion joints are also required for the following building and need to be detailed according to Engineer requirements.
Post-Tensioned Concrete Flat slabs are to be constructed by specialised Contractors such as Amsteele Systems. This Construction method is used to reduce the thickness of the concrete slab and the need for coffering. All concrete slabs are to be 20-30 MPa concrete with Unbonded Monostrand steel tendons in the concrete, creating a post tensioned system. The building character is to be expressed throughout the building with sleek, straight, flush, unpainted or covered, fair-face surfaces. The intention is to create defined straight lines of surface. All concrete floors are to be abraded with a grinder for a smooth surface three days after casting or to specified detailing.

The intention is to make use of a suspended concrete floor enabling larger spans with thinner floors, controlled definitions, speed of construction and economy of material use and handling. Ground anchoring is the technique to be used with CCL Anchorage type S9 reinforcement. All live-end anchorage is to be correctly protected against corrosion and according to manufacturers specifications.

Post Tensioned concrete slabs require sufficient space for the tensioning of the slab once the concrete has been poured. From ground to third floor the casting of slabs is not a problem however in the two basements sufficient room needs to be provided for the process of tensioning. The proposed method for construction would be to cast the lowest level of the basement with a 200mm thick reinforced concrete surface bed on top of well compacted soil, with a waterproofing system to engineering specification on 400mm thick reinforced pad foundations column footings.

The retaining walls are to be Cavity construction with masonry walls ad the internal leaf with 1500mm x 300mm reinforced columns acting as piers sitting perpendicular to the retaining wall. The basement post tensioned slabs are to be terminated with concrete uprights to protect cars from falling into the perimeter edge spacing allocated for post tensioning and providing later ventilation and lighting to the basements. Refer to drawings on slab detailing and foundation wall condition connection. For further information on Post-Tensioned slabs refer to Chapter 10/

Sources including:
- www.sapta.co.za
- www.amsteelesystems.com

Post-Tensioned Concrete Flat Slabs

Structuring Systems 8.2/

Structuring Systems 8.2/

Post Tensioned Concrete Flat Slabs

Structuring Systems 8.2/

Tilt–Up Construction

Post Tensioned Concrete Slabs

Steel Louvre Systems

Illustrations/ Illustrations/ Illustrations/ Illustrations/

Construction Workers [EQF Project Managers, at Maponya Mall]

Site Equipment [EQF Project Managers, at Maponya Mall]

Amsteele Systems [www.amsteelesystems.com 02/10/2006]

Slab Arrangements [www.amsteelesystems.com 02/10/2006]

Steel Connection [EQF Project Managers, at Maponya Mall]

Steel + Concrete System [EQF Project Managers, at Maponya Mall]

I-beams and haunch connections ready for roofing system [EQF Project Managers, at Maponya Mall]

Reinforced Conc. Columns [EQF Project Managers, at Maponya Mall]

SAPTA Logo [www.sapta.co.za 02/10/2006]
Steel construction is to function as a secondary supporting system within the following building with concrete load bearing columns and tilt-up panel walls being the primary supporting system. The intention is to express connections with the use of prefabricated steel profiles bolted into place on site. All Structural Steel is to be drawn and detailed according to SAIC [South African Institute of Steel Construction] standards.

All steel is to be sourced from South African Steel producers such as Mittal Steel formerly known as Iscor Steel or Highveld Vanadium Steel.

All primary elements are to be hot-rolled H and I profiles and must be to grade 300W to comply with SABS 1431. "Steel tubes are to comply with SABS 657 part 1 of type, coating, grade, size and wall thickness." [Wegelin 1998:59] All structural steel design, slender ratios and profiles are to be according to Engineers specifications and need to comply with SABS 14713 and SANS 10160 for loads and SANS 10162 for steel structure. Structural steel needs to comply with SABS 1200H or 1200A and SABS 0162. [Wegelin: 1998:59] All surfaces must be primed by brushing and blast cleaning according to SABS 064 and painted two coats zinc phosphate primer to comply with SABS 1319. Galvanising of steel needs to comply with SABS 1319.

Roofing is to comprise of Steel I-Beams as supporting elements for most roof systems. Steel Pitched Trusses are to be used for the Main Connecting Entrance Access. Steel C-section purlins are to be used in conjunction with Steel Cleats and to create a haunch connection. Steel IBR profile roof sheeting is to be used fixed with hook bolts and spaced no more than 1.5 meters with a 6° pitch.

Such elements include:
- I-Beams
- H-Sections
- Square Hollow Tubes
- L-Angles
- C-Sections
- Pitched Trusses
- Cleats
The Connecting Access Link is accessible on Ground Level and is to clip together the Northern and Southern parts of the building. Steel stairs are to connect levels in a cross-bracing pattern connecting floors. The concrete columns are used as the connecting base for landings similar to illustration 8/094 in the University of Pretoria, High Performance Centre.

The South Edge of the Access Link is highly visible from Elandspoort Road and will incorporate a Steel Louvre Display System.
The Circulation edge is located on the Eastern edge of the building facing onto Mears Street. Shading and display is required along this edge. This is responded to with the location of a concrete strip access route with cut outs to accentuate it as a threshold connecting spaces and to create a semi shading device. Steel Louvre screens are inserted between columns on the Façade facing Mears Street. Each individual Louvre is lined with a Nano technologically advanced material in bedded glass with electrical power connected to allow for screen display. LED’s can be used creating individual screens on each louvre. The intention is create a changing display screen similar to the Screen Display’s used in the Crown Fountain at Chicago’s Millennium Park. This precedent can be found in Chapter 6. Glass and steel balustrades are to be attached to the concrete slabs between columns and uprights are to be spaced between 1200 to 1500mm centers. Refer to Details 02, 03 and 04 for further detailing information.
The following facility supports four venues for audiovisual display; two are Outdoor Theaters essentially to be used at night and two are internal cinemas which can be used during the day or night. Each require:

- raking of the floor to elevate viewers
- sound absorptive materials clad to all internal services for internal venues
- acoustic appropriate ceilings and
- necessary power supply for audio and lighting requirements
All courtyards are to allow for deep soil planting for trees and vegetation. All circulation is to be paved with storm water collection systems. Water troughs with steel grill covers are located at all thresholds into and out of venues and spaces.

900 Deep and 500mm high Concrete seating is provided for students to use between lectures. The courtyards are connected to the circulation strip running along the Eastern edge of the building. This provides a semi-public environment which allows for visual connection between people in the courtyards and pedestrians passing along Mears Street.
The basement slabs are to be constructed with concrete retaining walls secured with Rock Anchors. Rock Anchors to be post tensioned post cast 3000 x 400 mm thick and according to Engineering specifications. The basements are to be constructed with concrete retaining walls secured with Rock Anchors. Rock Anchors to be post tensioned post cast 3000 x 400 mm thick.

Due to the scale of the following building four Structural Expansion Joints are required. These are shown in the Diagram Plan 8/142. Where Expansion Joints occur running East to West through Slabs, creating an equal distance of 600mm carrearking Edge from the nearest. Column/steel columns are to be used. Where Expansion Joints run North to South these are to be cut through columns 1200 x 300. Columns are to be cut down the centre line to 600 x 300mm.

Concrete Elements

- Specifications or using Concrete Columns as sufficient supporting piers. A Cavity system for drainage is to be used with concrete blocks raising the floor slab and allowing drainage to sumps with steel grill covers. The layer on top of 230 x 230 x 460mm Concrete Blocks; laid on a 75mm screed with a slope towards a sump. All column foundations are to be reinforced pad foundations doubled up to carry the load of column pairs. These are to be the Diagram Plan 8/142. Where Expansion Joints occur running East to West through Slabs, creating an equal...