contents

Sourcing

Materials and labour should be sources as close as possible to the site to reduce the embodied energy of the materials. Embodied energy is affected by the cost of sourcing and transporting materials. Use standard sections and sizes to reduce cost.

Robustness

A robust building can adapt to a variety of uses over its lifespan. In this design this is realised by having a strong structure that will last many years and a flexible interior that can adapt and change to the users' needs. By using materials that can be recycled or reused the building is also more robust.

fig.6.1

Reinforced concrete

Positive: Thermal mass allows for regulation of temperatures.
Concrete can be moulded to a variety of forms
Conventional building material in South Africa, therefore skilled workers are available.
Negative: Expensive to demolish
Concrete is strong in compression and the reinforcing steel is strong in tension.

Steel

Steel elements can be taken apart and reused
Strong in tension- use smaller amount of material for spans. Can be shaped (hot rolled or plate folded) to create a variety of sections.

Glass

Glass is used to allow natural light into the building, to allow viewers to see into the building and to allow for a visual link between the different functions. Sandblasted glass is used on the southern façade as natural light is beneficial to the occupants but the glare from the adjacent home affairs could be a disturbance. Self cleaning glass (rough surface dust cannot settle on).

Timber

Many elements can be factory produced and fitted on site – this provides higher quality. Timber is light and is used for the flexible walls and floors so they can easily be moved. Timber is also used for the interior cladding of the pods. High friction surfaces such as stairs and handrails should be varnished with colourless resin.

Technical Data

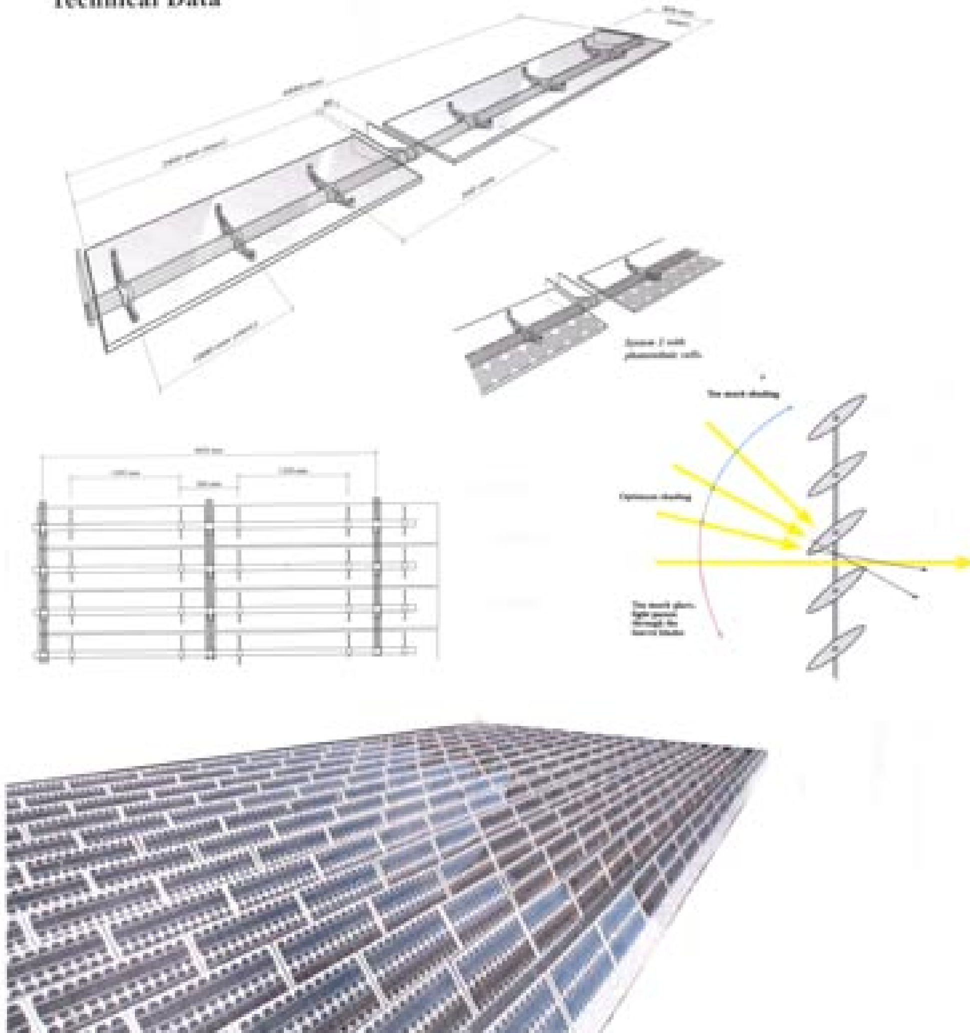


fig.6.2-6.7

Louvre System

The 'Colt' glass louver system is investigated for the roof of the circulation hub. The louvers provide sufficient shading from the sun but still allows enough light through to eluminate the entire circulation hub. The louvers are controlled by a computer system in the BMS (Building Management Services) room on Level 3, to follow the sun's path and change direction throughout the day. Louvres are also equipped with Photovoltaic Cells to generate electricity.

Technical Investigation

Structure

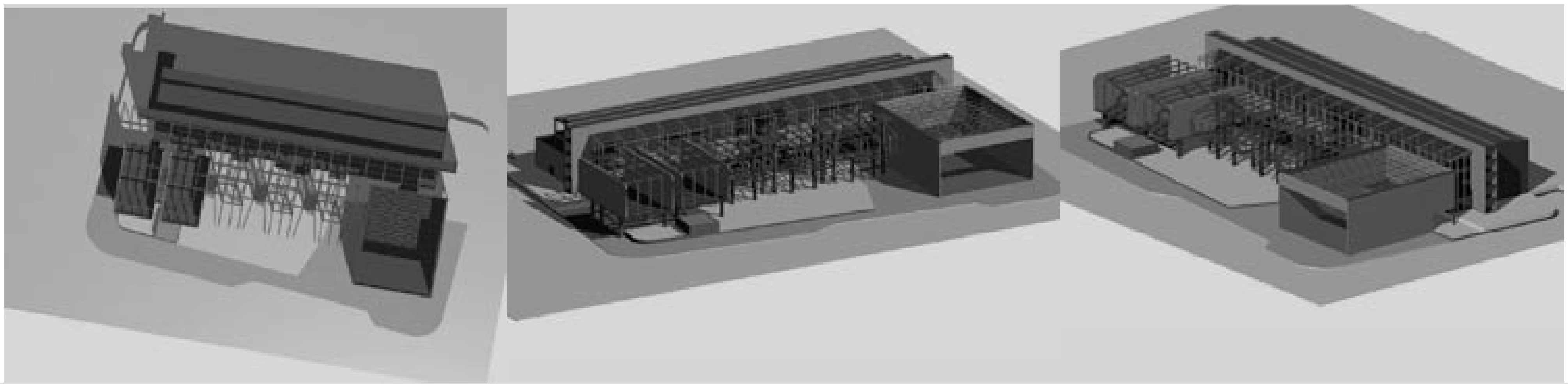


fig.6.8

Technical Investigation

Structure

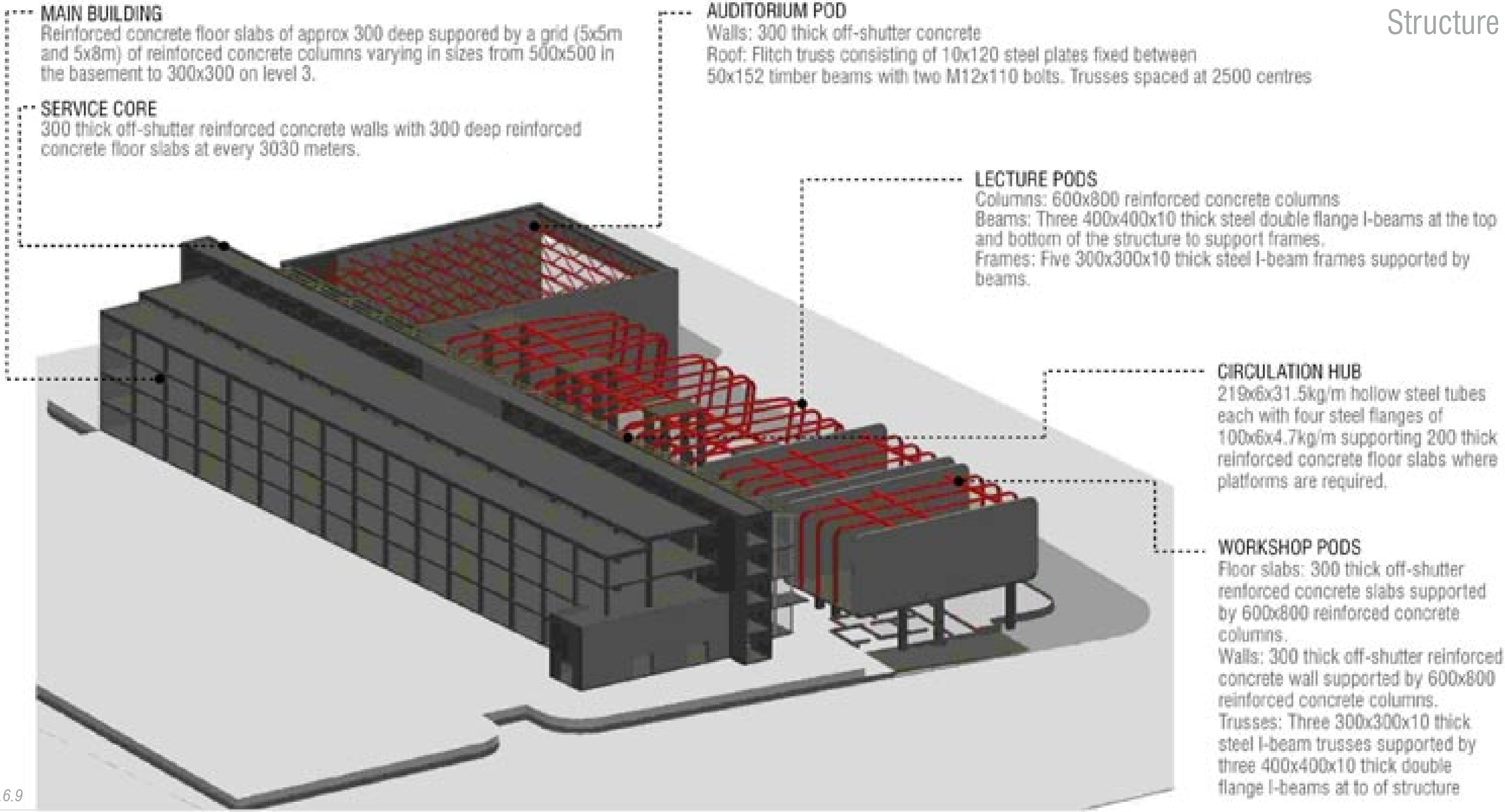


fig.6.9

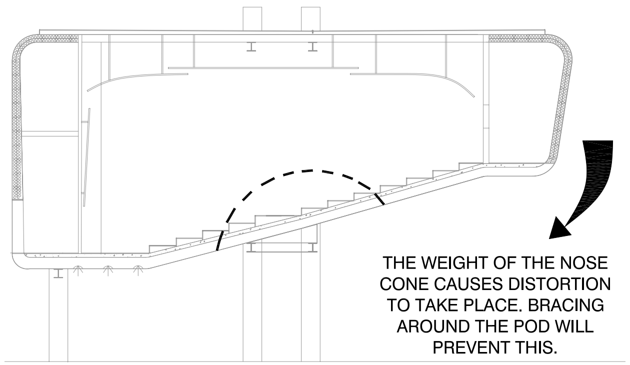
Technical Investigation

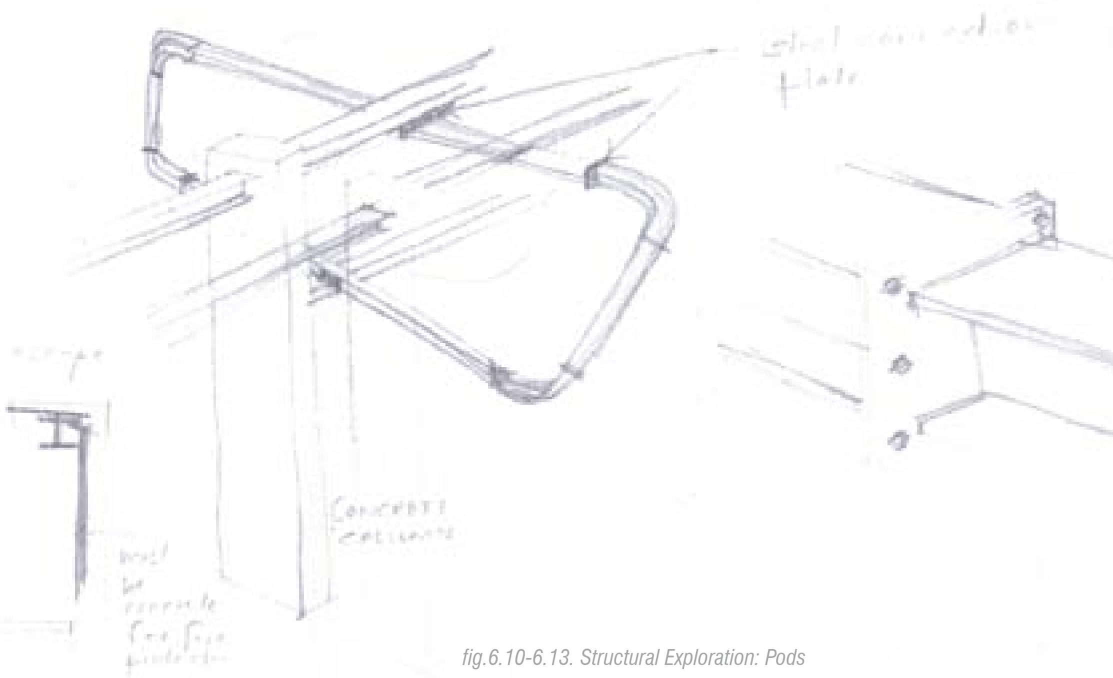
Structure

Pods

The structure of the pods consists of steel frames supported by steel beams. Beams, in turn, are supported by concrete columns. The materials were chosen according to their structural qualities. Concrete is strong in compression and is therefore used in the columns where the strongest compressive forces are found. Steel, which performs well in tension, is used for the beams. For extra stability the steel beams are braced together at 1250 centres using a steel plate.

Due to the weight of the nose cone, distortion may take place in the steel frames. To prevent this, bracing is placed around the pod.





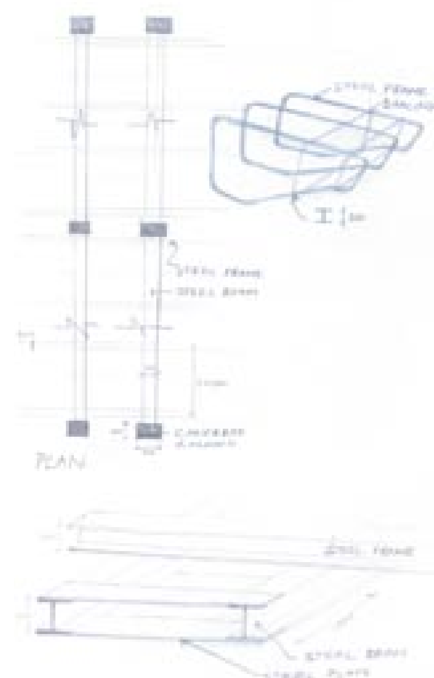
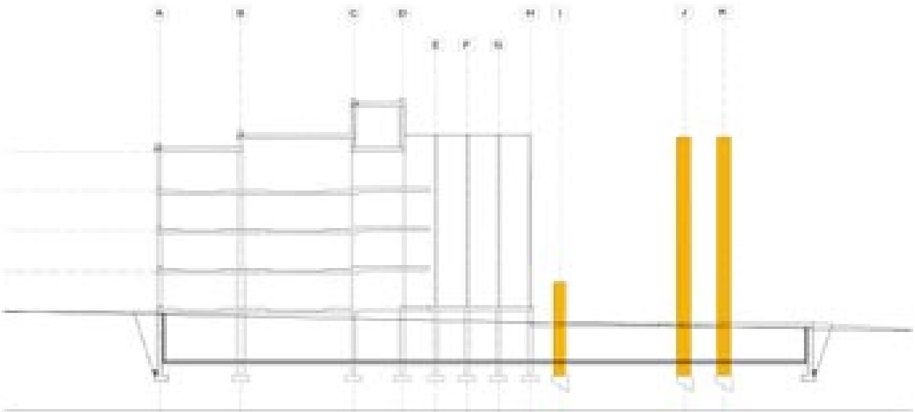
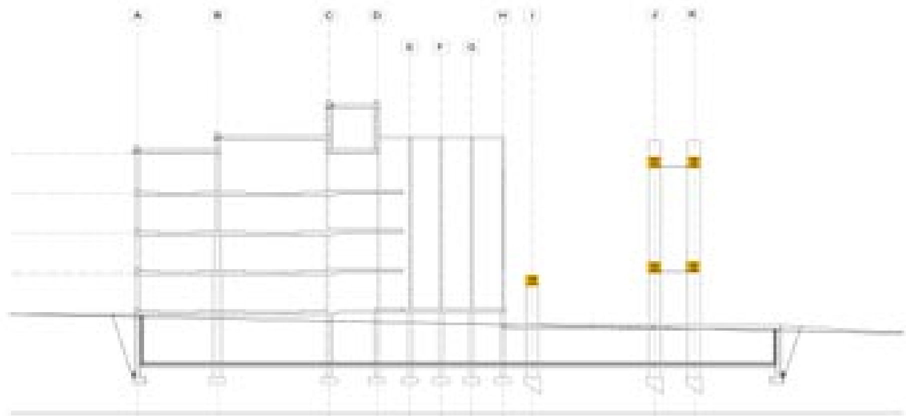


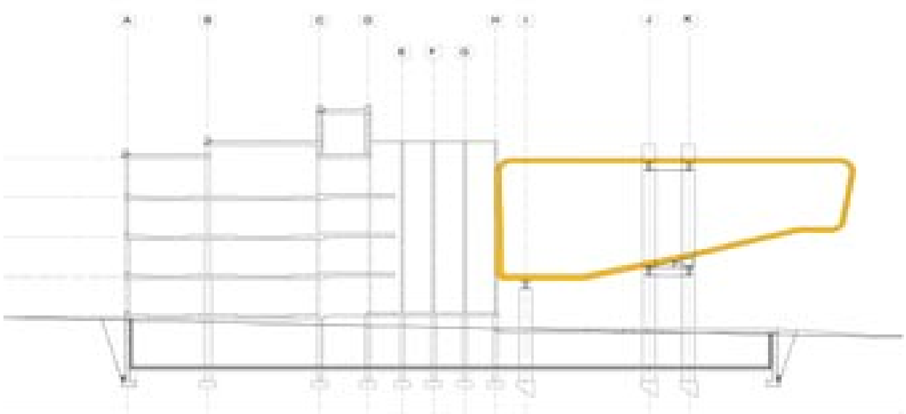
fig.6.10-6.13. Structural Exploration: Pods



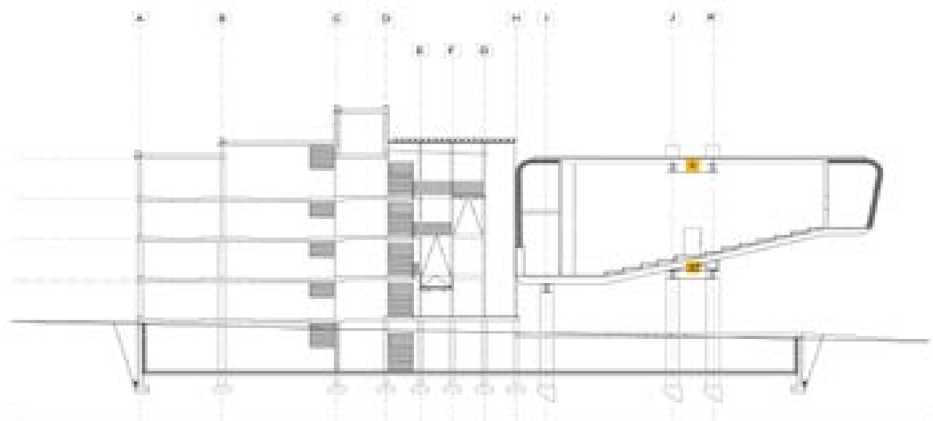
STEP 1: Reinforced concrete columns are erected.



STEP 2: Steel beams are fastened to concrete columns



STEP 3: Steel frames are fastened to beams.



STEP 4: Bracing is fastened around frames.

fig.6.14

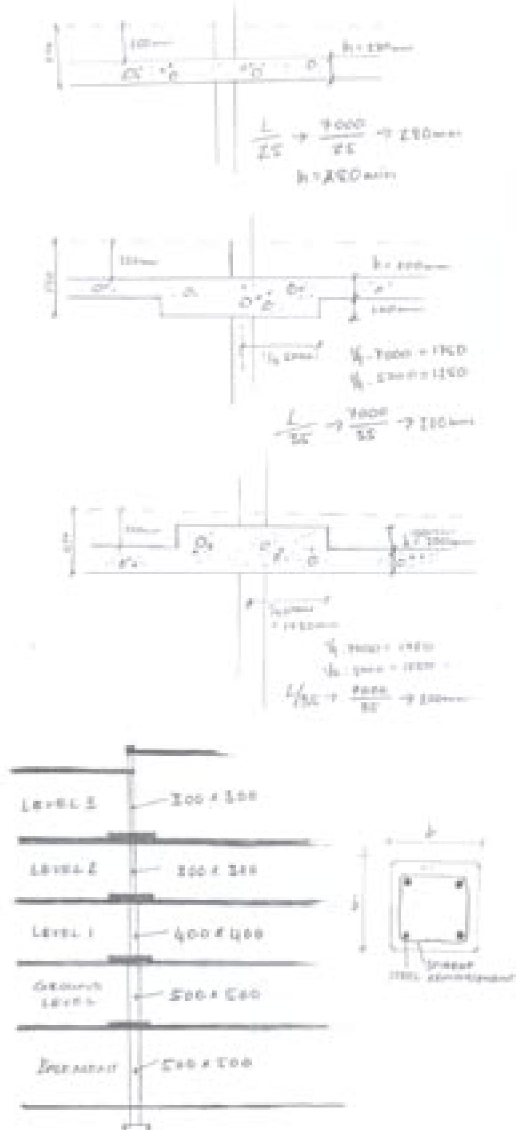


fig.6.15. Structural Exploration: Main Building

TECHNICAL INVESTIGATION
STRUCTURE

SLABS IN MAIN BUILDING

A conventional slab should have a depth of about 280-300mm and has a recommended span of 6 - 7.5m.

Slab thickened at columns: This method is used due to the fact that the slab can be more slender than a conventional slab. Only the part of the slab that meets the column is thickened to the depth of a conventional slab. This slab has a recommended span of 7-10m.

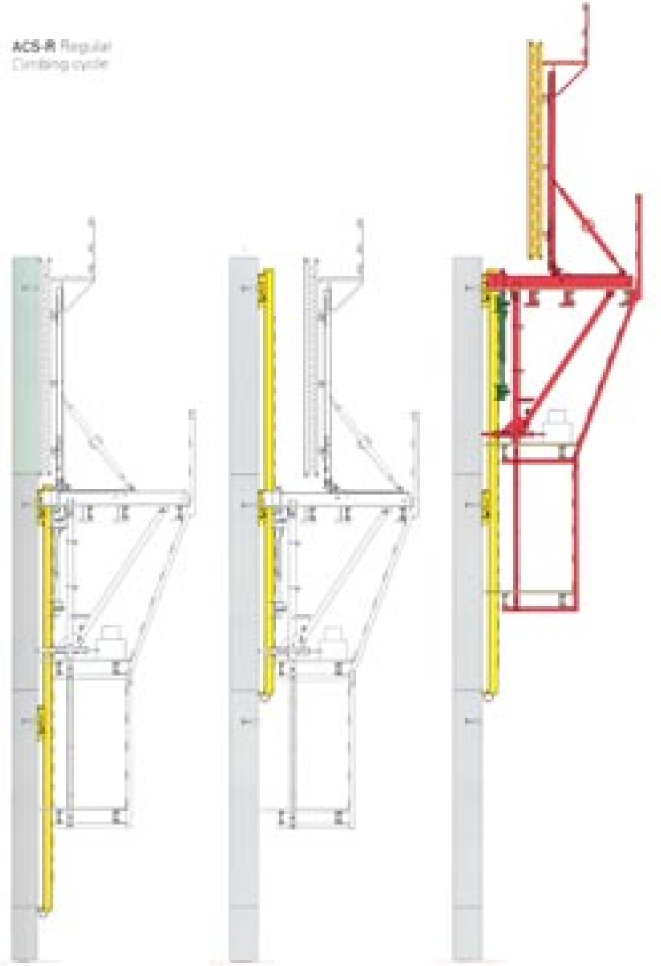
Reverse slab with thickened columns: The strength and calculations stay the same when the slab is reversed. The decision was made to reverse it to accommodate the access floor. This option results in the smallest overall depth for the floor and therefore allows for more headroom.

COLUMNS IN MAIN BUILDING

The columns in the main building are constructed of reinforced concrete. The sizes of the columns are determined by the load it carries; therefore those on the top floors are smaller than those on the bottom floors. Sizes range from 500x500mm in the basement to 300x300mm on Level 3. This will be sufficient in carrying the heavy load of the books which has a service load value of 5kN/m².

Technical Investigation

Structure



Phase 1:
– Finished concrete wall

Phase 2:
- Formwork moved back
- Wall scaffold hinge is fitted
- Climbing rail is moved up and secured

Phase 3:
- Climbing unit is moved upwards
- The formwork is ready again

QUATTRO column formwork 3.25 m high.
Complete with ladders and concreting platform for safe working at any height and on any cross-section

fig.6.16 & 6.17

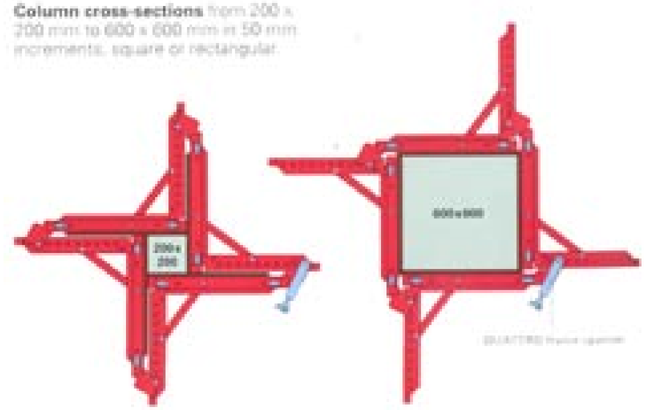
Formwork

Two formwork systems by Peri Wehahn have been explored. The first of which is the ACS (Adjustable Climbing System) which will be used for the reinforced concrete work supporting the pods. This system proves to be least time consuming and also more economic as one cladding system can be used for all columns in the pods.

The second cladding system to be used is the Quatro Cladding System. This will be used for the construction of the columns in the main building and is most economic due to the fact that it is adjustable to a variety of sizes ranging from 200mmx200mm to 600mmx600mm.

(Peri Wehahn Catalogue 2002)

Column cross-sections from 200 x 200 mm to 600 x 600 mm in 50 mm increments, square or rectangular



Technical Investigation

Accoustics

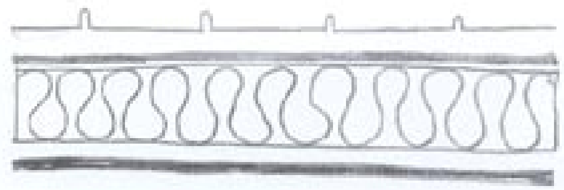
Sound Quality

Sound quality in a building is affected by two factors, the first is the quality of the sound generated inside the building and the second is the amount of outside noise (unwanted sound) transmitted into the building.
Part of the sound is absorbed when it strikes a surface, part is deflected and part is transmitted. Soft, porous materials absorb a large amount of sound, therefore reduce the reverberation and improve sound quality inside the building. These materials include insulation materials, perforated timber, and furniture.
Materials that deflect most of the sound are good insulators. These are materials with high density and thermal mass such as masonry and concrete.
The average noise level in the CBD is 75-80dB but the accepted amount of background noise in an auditorium is 45dB. This is achieved by using materials with high sound insulation values.

Auditorium & Lecture Halls

Roof: The roof of the auditoria especially should be sound insulating to block out noise of a rain- or hail storm.
Two options were explored for the roof. (See calculations)
Shape: Parallel walls can cause sound waves to get trapped. This will result in distortion of the sound. To avoid this, the side walls of the auditorium and lecture halls are non-parallel and open up from the speaker towards the audience.
Profile plywood acoustic board: The roof and floor are parallel to each other at the end where the speaker stands. This will

OPTION 1:



Option 1:

1mm Copper cladding:	9dB
16mm Plywood,	
230mm High Density Polyurethane Foam,	
16mm Plywood	53dB
TOTAL:	**62dB**

If the average noise level outside is accepted to be 80dB, Option 1 will transmit 18dB which is well within the accepted range for auditoria.

OPTION 2:

Option 2:

40mm cement mortar screed:	5dB
150mm precast concrete slab:	45dB
250mm cavity with 16mm plywood:	39dB
TOTAL:	**89dB**

If the average noise level outside is accepted to be 80dB, Option 2 will transmit no sound into the auditoria.

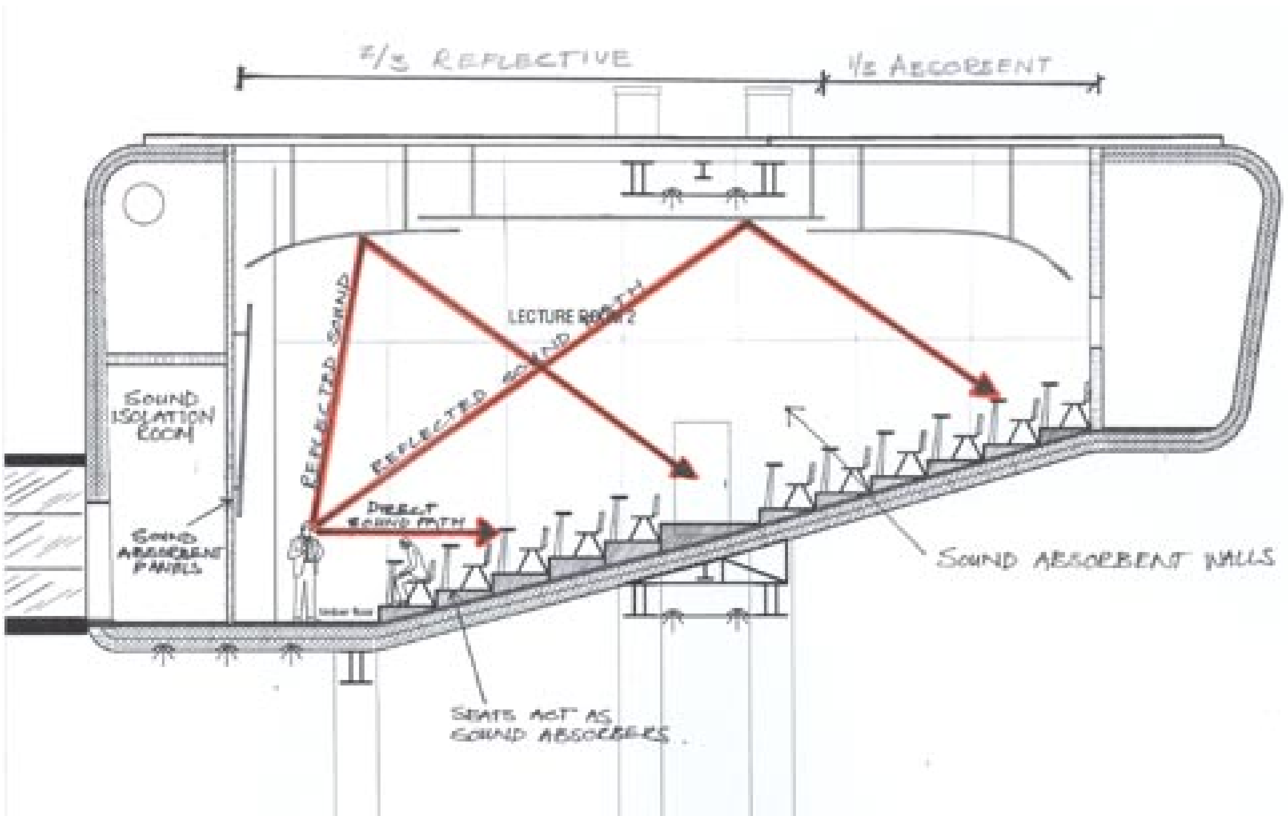


fig.6.18. Accoustics: Pod

cause flutter echoes that could confuse the speaker. This is avoided by placing curved reflective panels above, that will reflect the sound to the audience instead of back to the speaker. The boards are fixed to a lightweight steel frame, welded to flat steel bars which in turn are bolted to the steel frames which form the structure of the pods.

Ceiling: Two thirds of the ceiling, from the speaker to the audience, is reflective so that the sound will be reflected to the audience. The back third of the ceiling is absorbent as it is not desirable for sound to reflect from here.

Walls: Apart from being non-parallel, the walls consist of a layer of high density polyurethane foam insulaton with plywood panelling over.

The absorption quality of the walls are worked out as follows:

1mm Copper Cladding:	0.01 per m^2
16mm Plywood:	0.15 per m^2
230mm High Density Polyurethane Foam:	0.4 per m^2
16mm Perforated plywood:	0.15 per m^2
TOTAL:	**0.8 per m^2**

(optimum for auditoria)

Furniture: Seating and other furniture, within the auditorium and lecture halls, are chosen to be made of absorbent material. The audience also acts as sound absorbers.

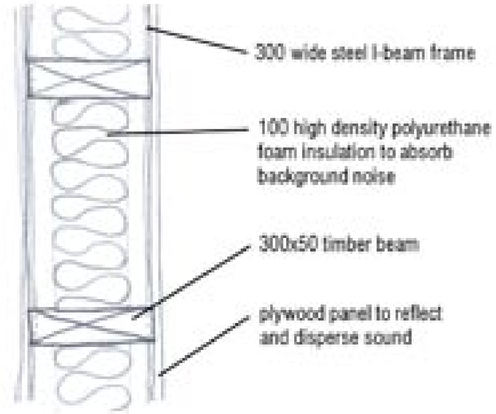
Sound insulation room: The lobbies of the auditorium and lecture halls are designed to act as sound portals and are

Technical Investigation

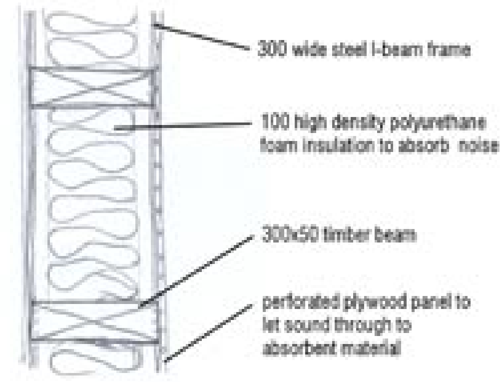
Accoustics

covered with sound absorbent material on the walls and ceilings.
All windows will be double-glazed for further sound insulation.

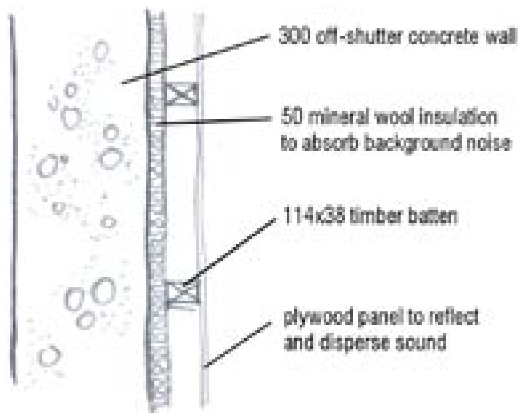
Audio Rooms
Walls: Complete sound proofing is required to avoid loud noises filtering through to the library and office space. This is done by using a 300mm concrete wall. Because of the high thermal mass of concrete, no sound will be transmitted. Absorbent panels are placed on the walls and ceilings to avoid sound distortion and flutter echoes between parallel surfaces.
Sound isolation portals: To avoid sound pollution into the library and office space all entrances into the audio rooms are fitted with double doors and sound insulation portals. This is also done because recordings are taken within the rooms and any noises from outside could be disturbing.
All windows will be double glazed for further sound insulation.



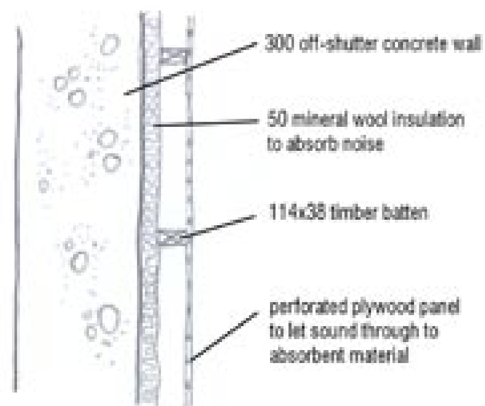
LECTURE ROOM REFLECTIVE WALL



LECTURE ROOM ABSORBENT WALL



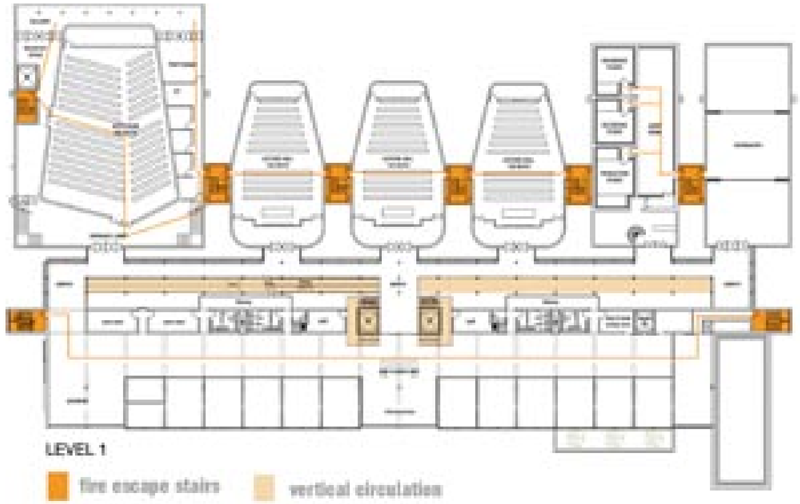
AUDIO ROOM REFLECTIVE WALL

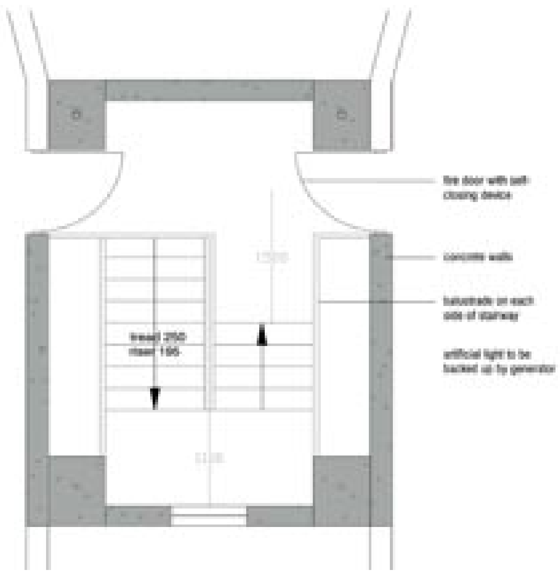


AUDIO ROOM ABSORBENT WALL

Technical Investigation

Fire Regulations

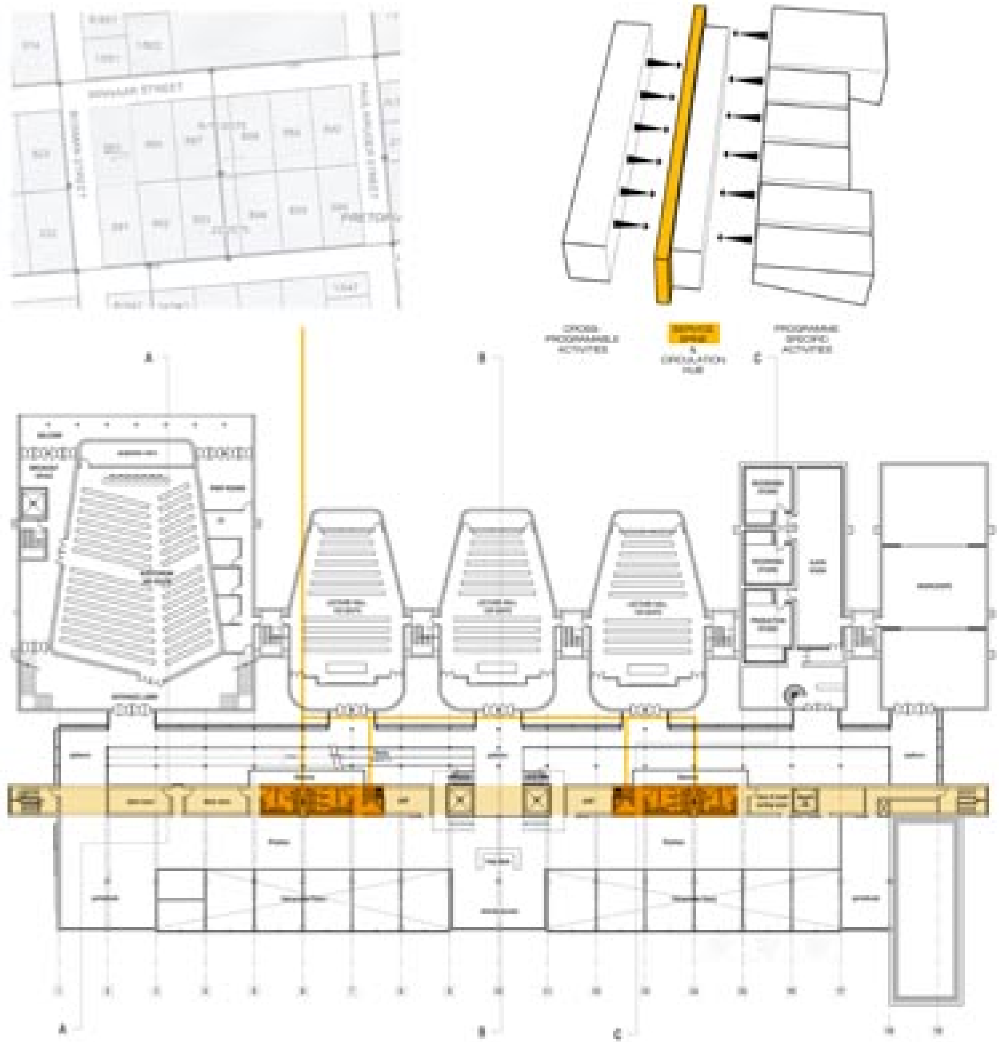




An interview was conducted with Mr A. Steyn of the Tshwane Fire Department. All structural steel used for the pods will be treated with fire proofing paint according to NBR TT7 (SABS 0400) Sufficient escape routes are provided in accordance with SABS 0400. The main building has two fire escape stairs provided, thus ensuring that the maximum travel distance to a fire escape staircase does not exceed 45 meters. Each pod is provided with two to three escape routes of which at least one is a fire escape staircase. The auditorium is provided with two separate fire escape staircases due to the amount of users. Staircases comply with the national building regulations. All fire escape routes are fitted with fire doors with self-closing devices according to SABS 1253.

WIDTH OF ESCAPE ROUTES ACCORDING TO NBR TT21.2 (SABS 0400)	
Maximum number of Persons	Minimum width of escape route
120	1100mm
150	1400mm
No individual escape route shall be designed for more than 150 people. Provide two separate escapes.	

A sprinkler system is fitted throughout the building and fire hose reels are provided throughout the building at a rate of 1 hose reel per 500m² according to SABS 534. The concrete structure provides sufficient fire resistance according to the fire regulations. Signage will clearly mark escape routes and exits throughout the building.



services   service core

TECHNICAL INVESTIGATION
SERVICES

A service core gathers all services in a central location allowing freedom to the surrounding spaces in terms of space planning, cross-programming and improved usability. A service core also makes the building more readable and is more economic as infrastructure can be grouped together. The services act as constants for the rest of the building to refer to. The correct placement of the services allows for design opportunities and can emphasise the concept.

Sewerage System

1 Stack system with no more than five appliances per branch pipe.
Stack pipes 150mm diameter
Soil pipes 100mm diameter
Waste pipes 50mm diameter.

Water

Water heated with solar power in service core with backup electricity. Water to be heated up in close proximity to where it will be required.

Electrical

1 distribution board per 2500m^2
Emergency generator for power failure and for lighting of escape routes for minimum 60 minutes

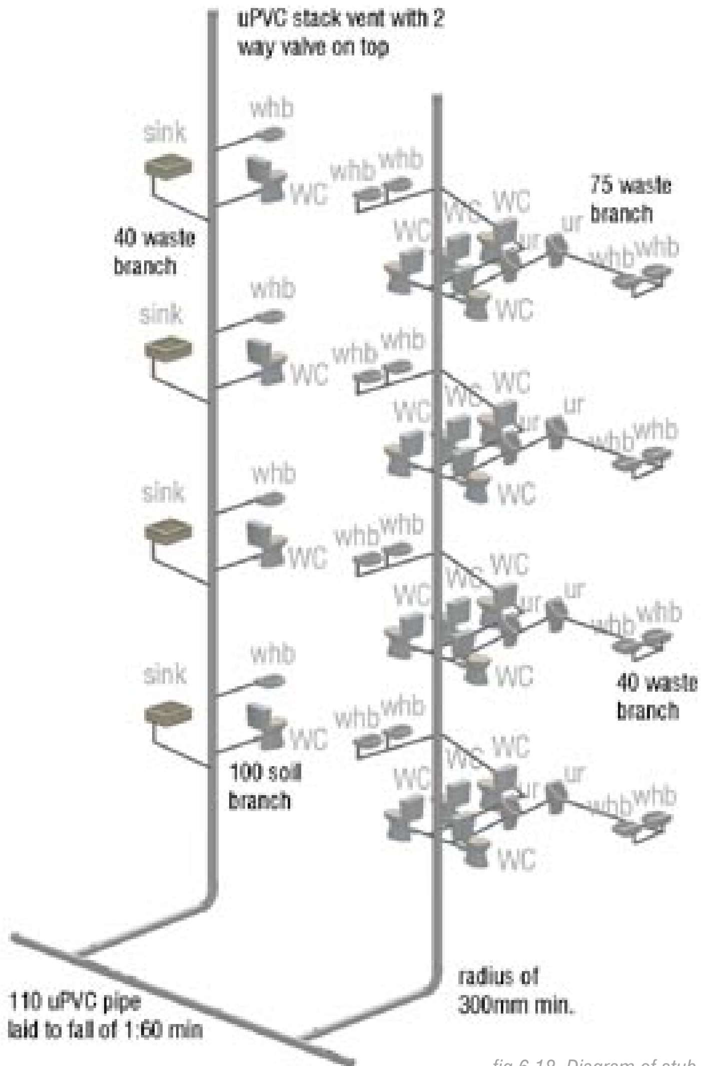


fig.6.18. Diagram of stub stak system

SEWERAGE SYSTEM

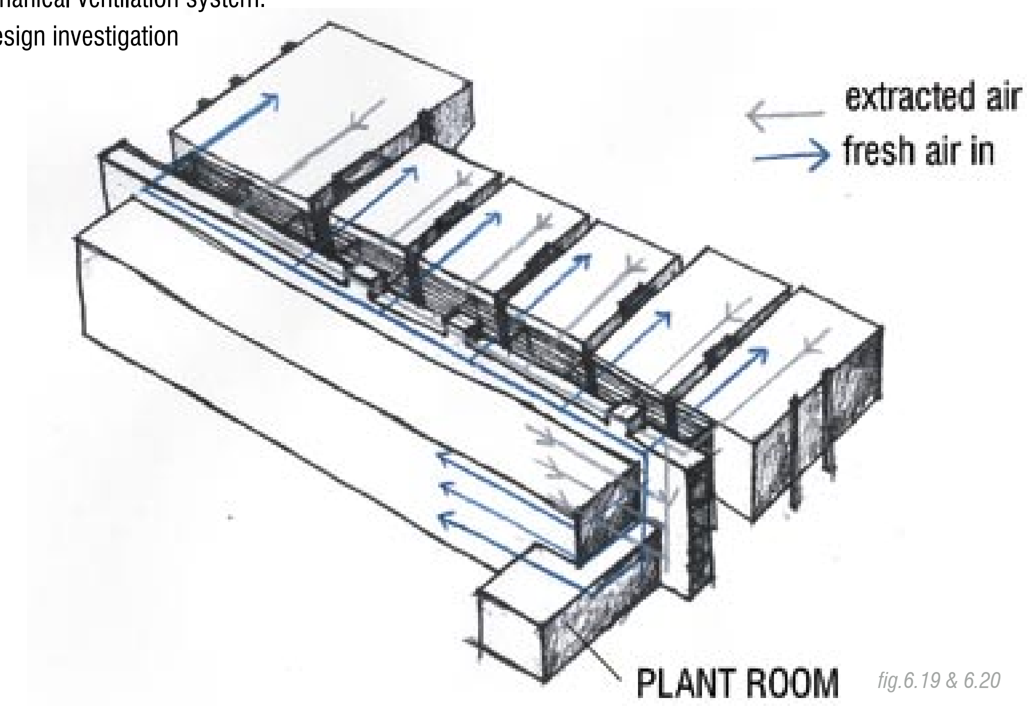
Above Ground
Single stack system where the stack serves as both the diacharge and ventilation component. No more than five applyances are permitted per branch. Each waste applyance shall have a 'P' trap with a water seal of no less than 75mm.
The 2 way vent must be located minimum 2500mm above any surface used for pedestrian circulation.
A minimum radius of 300mm must be provided at the foot of the diacharge stack.
Stack pipe: PVC 150mm diameter
Soil pipe: PVC 100mm diameter
Waste pipe: PVC 40mm diameter

Below Ground
The invert level at the foot of the stack may not be less than 450mm.
Drain pipes must be laid in a streight line with a minimum slope of 1:60. Rodding eyes and inspection eyes must be provided as stipulated by SABS 0400.

Technical Investigation

Ventilation

Because of the functions housed in the building, it could not rely solely on passive ventilation. The temperature in the library has to be kept constant and mechanical ventilation is required. Mechanical ventilation is required for the auditorium, lecture halls and offices to obtain optimum comfort levels because of the large volumes of people that will use them at a time. However, other passive design techniques can be used to reduce the demand on the mechanical ventilation system. These were discussed in the design investigation chapter.



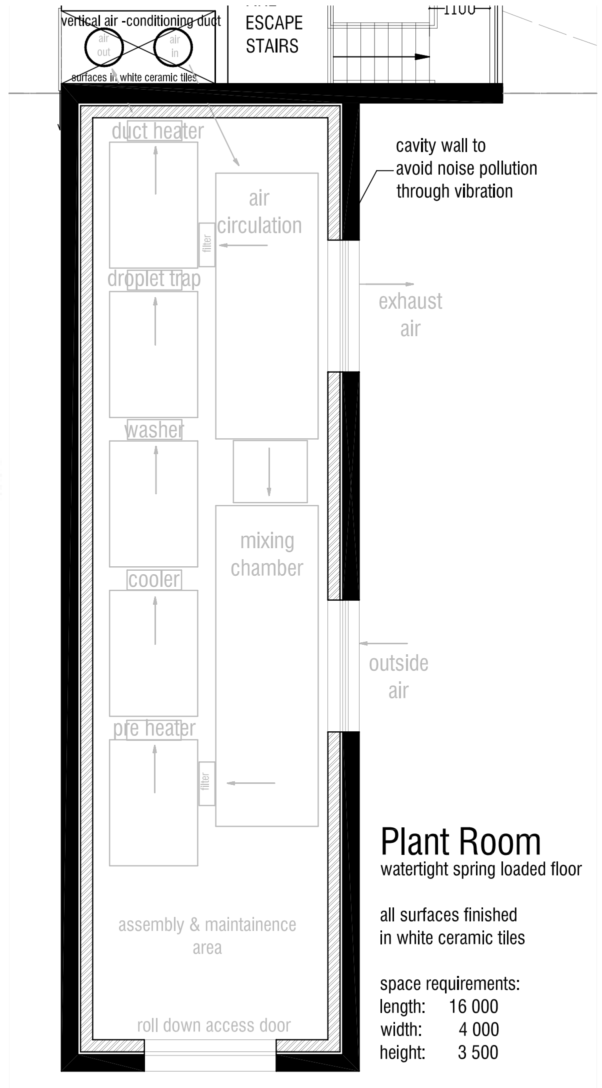


fig.6.19 & 6.20

Centre Pompidou, Paris, France.1971-1977 by Renzo Piano and Richard Rogers. The services are placed on the outside of the building, freeing up the interior to allow for flexibility.

fig.6.21 & 6.22