1. Steel column structure and bracing
2. GKD Media Mesh screens
3. Suspended translucent roof
4. Skylight
5. Central exhibiiton space
6. Video rooms
7. Hydraulic stage
8. Timber deck viewing platforms
9. Public Square

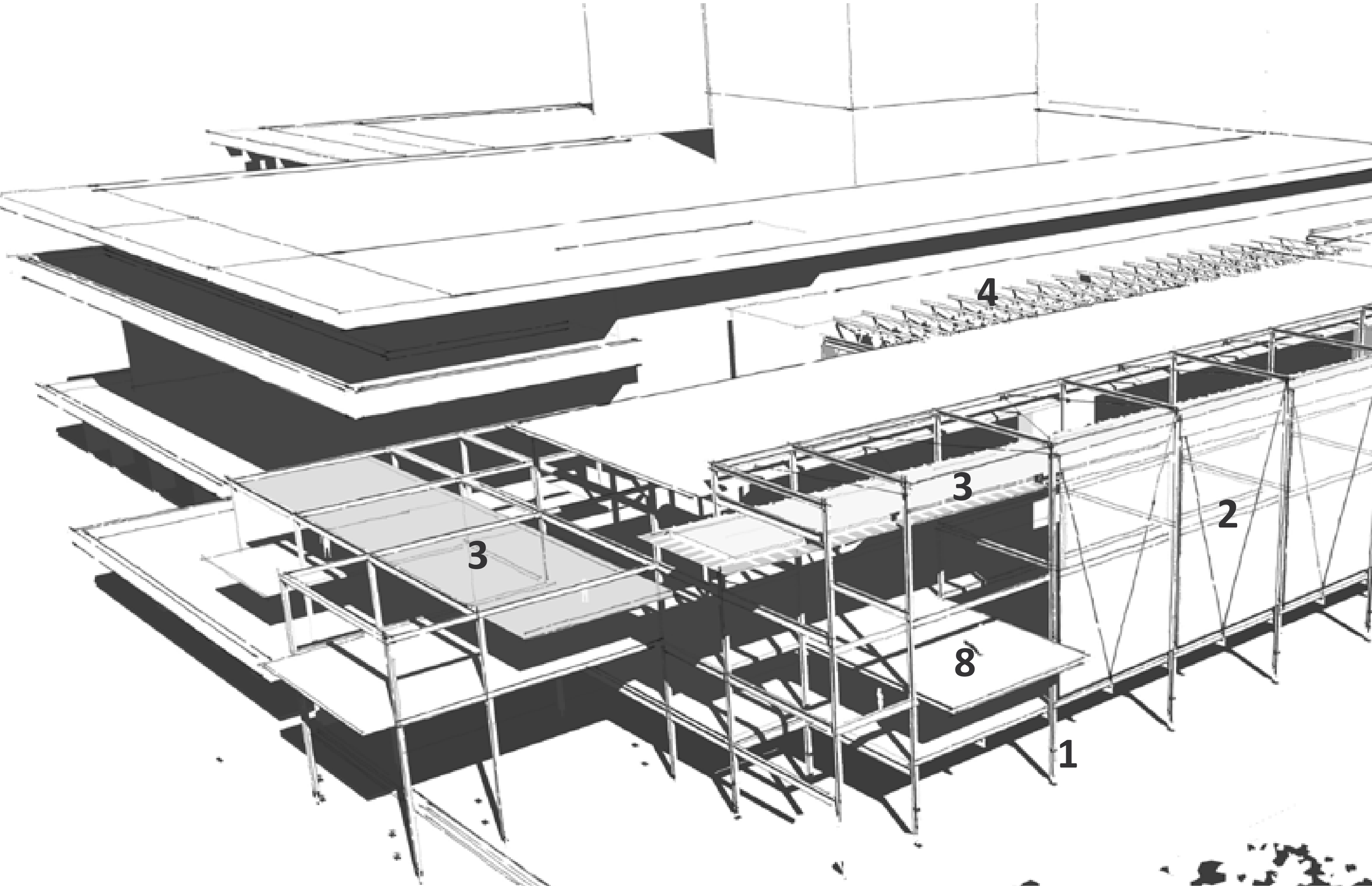
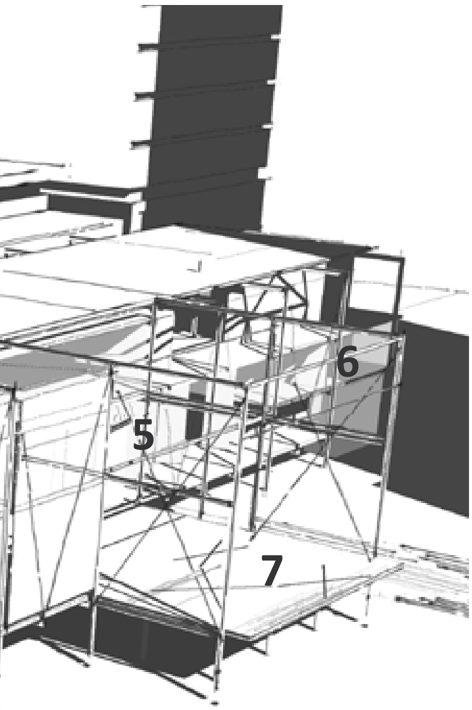


Fig. 8.1. 3D View of Building Elements



9

STRUCTURE

The structure comprises mostly of a primary steel structure of columns and beams with composite concrete floors. The steel structure on the exterior of the building acts as a temporary exhibition space and has the capacity to carry the load of temporary floors (constructed from light-weight materials). Steel members will be braced according to engineer's specifications in all directions.

A central stage/exhibition area protrudes from the main steel structure. This "stage" consists of a light-weight floor structure on six hydraulic lifting columns. They allow the stage to move up or down to allow better visibility of performances from different areas in and around the new building.

TEMPORARY EXHIBITION SPACE

The building is orientated towards the public square to the west. This creates problems of unwanted heat gain on summer afternoons. A series of stainless steel mesh curtains with interwoven LED lamps are suspended from the external steel framework. These curtains act as shading devices to the restaurant and exhibition spaces, and act as large media screens to the public square. The patented mesh system will be discussed at length later in this chapter.

A light-weight translucent roof with a 1° pitch and with its highest point towards Sammy Marks Square, is suspended from the steel structure. This roof structure will cause large wind loads on the steel structure and will be securely tied back from both above and below through the use of steel cables.

GALLERY

The southern half of the building is a gallery. Natural ventilation is allowed through a system of folding/stackable doors that can be individually rotated. These doors consist of low UV-absorbent polycarbonate cellular panels in an aluminium frame. Each panel can be individually rotated to prevent direct sunlight from entering the building. Doors can be moved away to open the interior space completely.

The upper floor of the gallery contains two video rooms that consist of coloured PAN-ELITE glass panels in fixed aluminium frames around the entire façade.

Cool air is allowed to move through louvered windows on the western façade of the dance studios on the third floor. Warm air is allowed to exit through a louvered skylight that forms a light well between the existing and new buildings.

08_ TECHNICAL INVESTIGATION

STEEL STRUCTURE AND BRACING

The extension to the State Theatre consists of a steel structure placed directly on the existing column grid of the basement below Lillian Ngoyi Square. The steel structure contrasts with the heavy and solid appearance of the existing State Theatre building. Steel has been widely used throughout the city of Pretoria as a material for extension e.g. the new State Library and Sammy Marks Square shopping centre.

Steel columns are constructed with two steel channels welded to either side of a rectangular hollow profile (see image). The hollow profile acts as a rainwater downpipe.

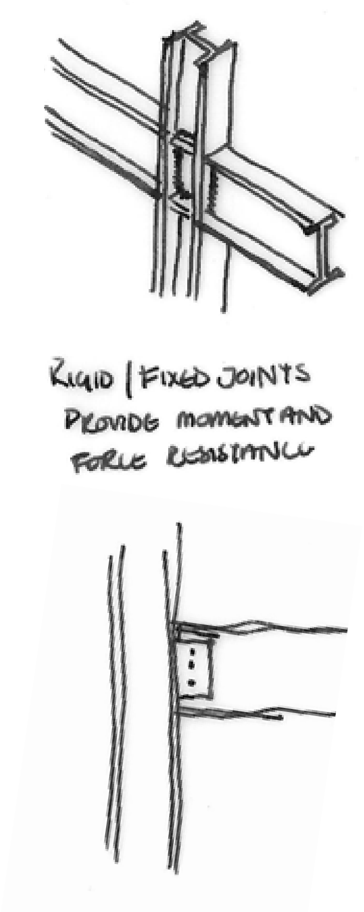


Fig. 8.2. Steel connections

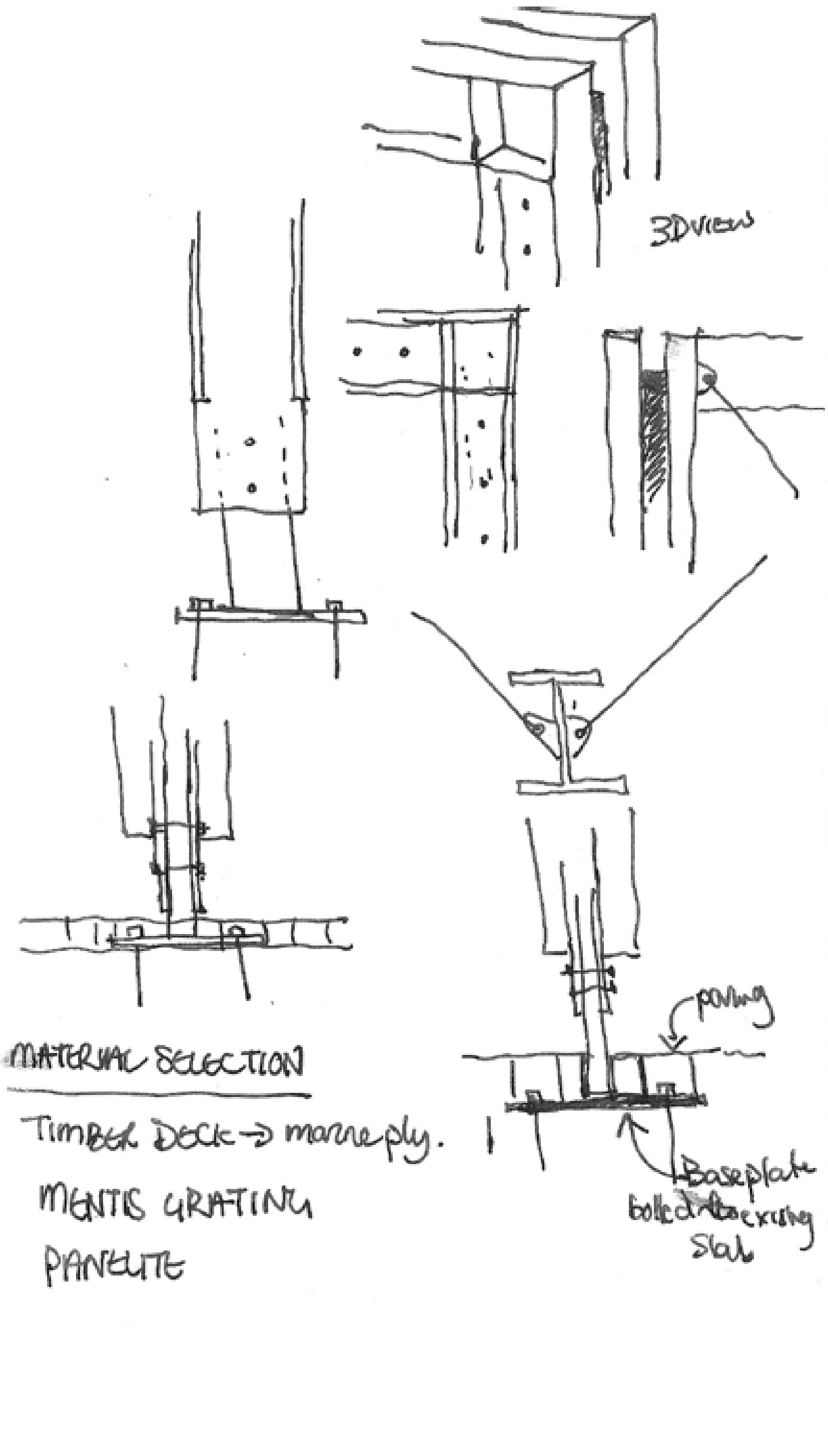


Fig. 8.3. Column and bracing details

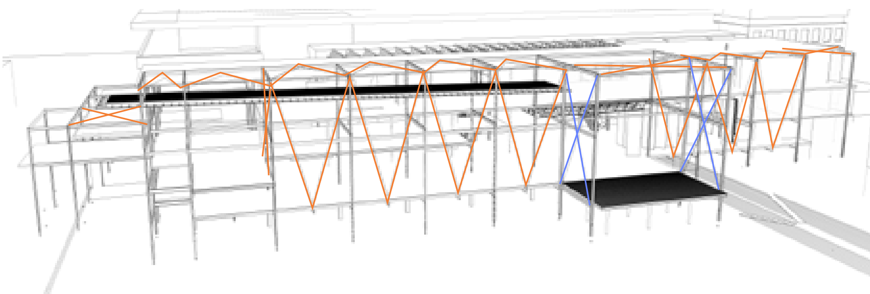


Fig. 8.4. Bracing diagram

Columns are placed on top of existing column grid. In instances where new columns are added, new columns are continued from lower basement level where new column footings are constructed.

Existing columns may need to be strenghtened. This can be done by casting an additinal outer layer of concrete around the column, or strengthening through the insertion of new steel columns next to existing columns.

Bracing insures lateral stability of the steel structure and should be applied at a minimum of 20m intervals. Bracing must be aplied in all directions. Figure 8.7 indicates placement of bracing in the steel structure.

The steel structure consists of a system of primary and secondary steel beams. The primary structure as indicated in Fig. 8.8. consists of deeper beams that span between columns. The primary structure carries the load to the beams, while the secondary or intermediate beams provide shorter spans and carry the floor structure.

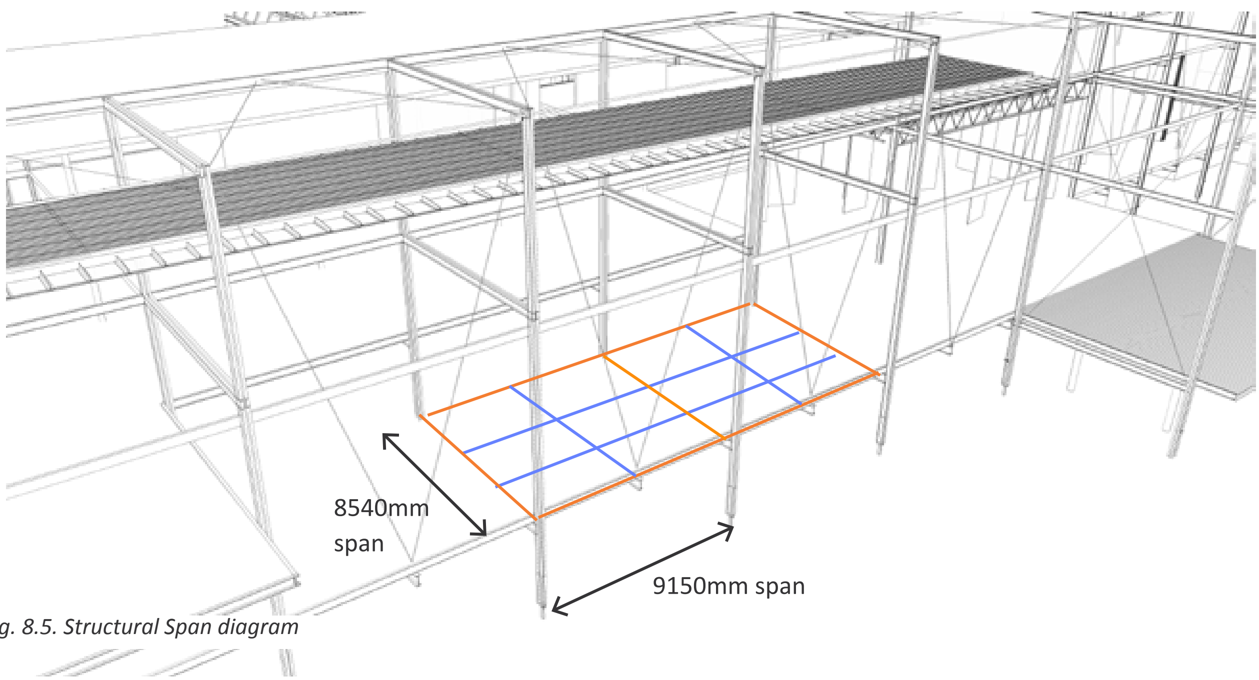


Fig. 8.5. Structural Span diagram

FLOOR SYSTEMS

Two floor systems are commonly used in the construction of steel structures, namely: 1. Precast concrete planks and 2. Corrugated metal decking with a concrete slab cast on top. (See Fig. 8.6).Metal decking serves as permanent shuttering to a cast-in-situ concrete slab. The decking is placed on steel beams and steel mesh or reinforcing bars may be cast into slab to give it additional stability. Composite action between the concrete slab and steel beams can be achieved by welding shear studs through the decking to the steel I-beam below. Although precast steel planks can span further, cables can be carried in the cavities of the corrugated decking. Decking can also serve as an acoustic ceiling.

The square's surface currently consists of concrete and brick paving on top of a layer of screed on a reinforced coffered slab. The existing slab has been designed to carry normal live loads and not the constant dead load of a new slab. For this reason it was decided to construct the new shop floors with a lightweight system. Access floors have the advantage of serving as additional storage and service space. Panels can easily be removed individually to access services under the floor surface.

All existing screed and paving is to be removed and slab is to be cleared. The access floor is to be raised 255mm above the slab's surface and stopped against a low threshold wall. New screed and paving must slope away from the shop entrances

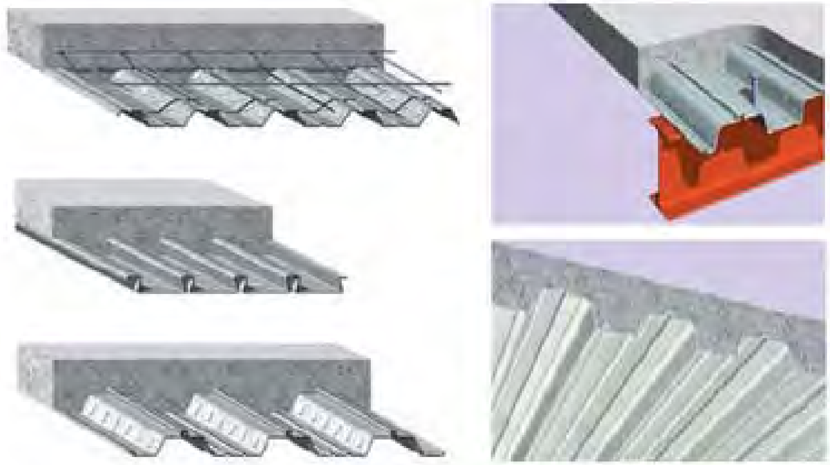


Fig. 8.6. Composite floor construction

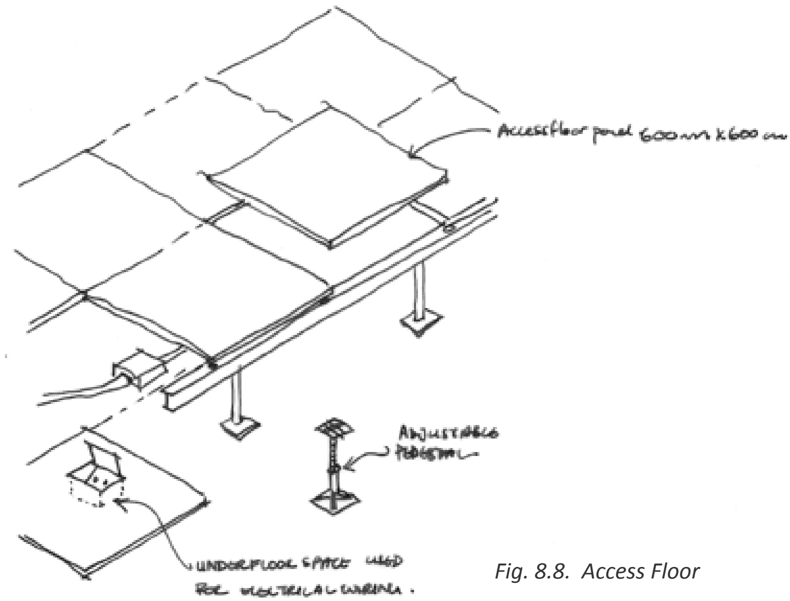


Fig. 8.8. Access Floor

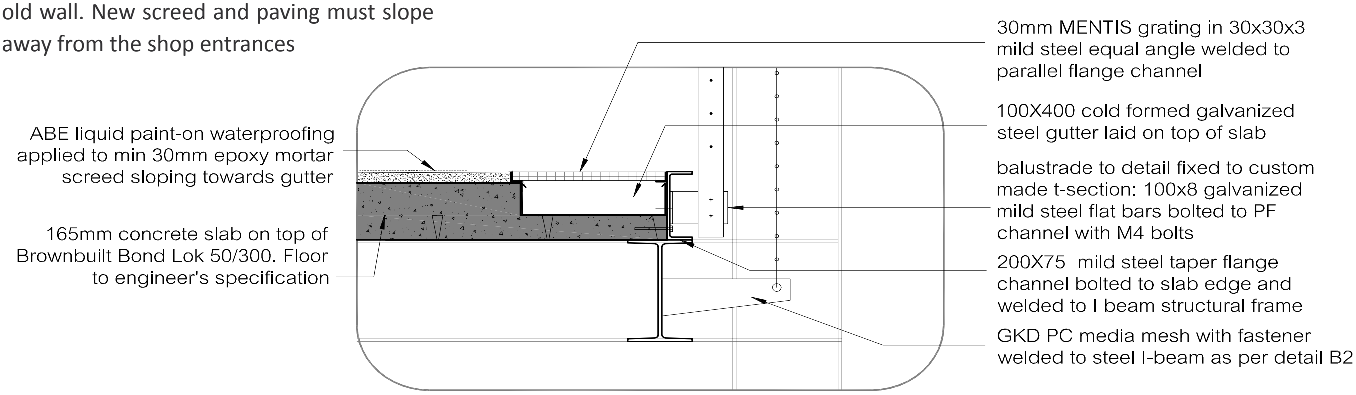


Fig. 8.7. Slab edge detail (not to scale)

HYDRAULIC STAGE SYSTEM

An hydraulic lift system was selected for the movable stage (see appedix B for considerations). Six hydraulic piston cylinders are placed in a mechanical room in the basement level directly beneath the stage. The system consists of cilindrical telescopic pistons that can be lowered to a height of 700mm above ground level, and raised to well above the first floor level.

The stage consists of a steel frame structure with a plywood finish. A collabsible balustrade

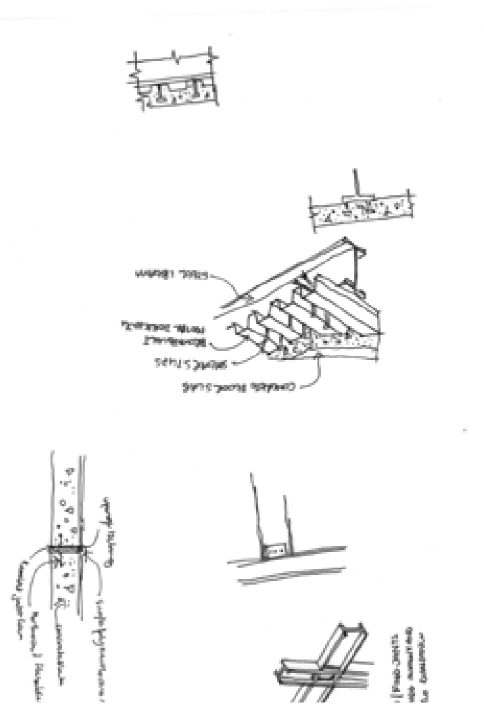


Fig. 8.12. Hydraulic stage with collapsible balustrade

SQUARE ELEMENTS

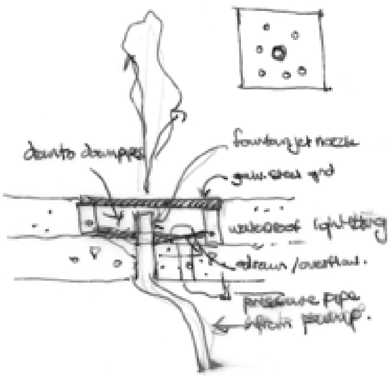


Fig. 8.9. Water feature detail

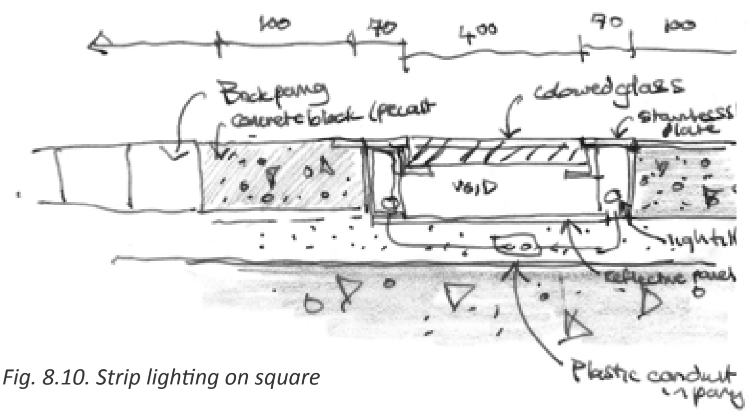


Fig. 8.10. Strip lighting on square

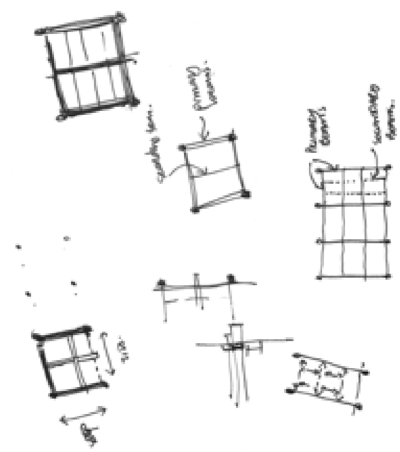


Fig. 8.11. Plan view of strip lighting

MATERIAL STRATEGY

Glass

Fig. 8.13. Laminated Clear Glass

Fig. 8.14. Laminated frosted glass

Fig. 8.15. PANELITE glass

Fig. 8.16. Printed glass

Wood

Fig. 8.17. Timber decking

Fig. 8.18. Marine Grade Plywood

Stone

Fig. 8.19. Concrete

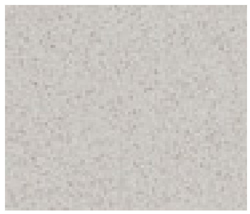


Fig. 8.20. Ceasarstone

Fig. 8.21. Existing sanblasted concrete

Plastic

Fig. 8.22. Translucent polycarbonate

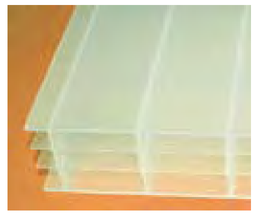


Fig. 8.23. Plexiglass Heatstop

Metal

Fig. 8.24. GKD Media Mesh

Fig. 8.25. MENTIS steel grating

Fig. 8.26. Painted Steel

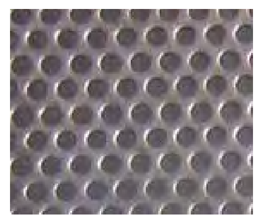


Fig. 8.27. Perforated Steel

Material palettes of public buildings are generally required to be durable and easy to clean. The materials selected for the extension of the State Theatre are displayed on the facing page arranged according to type. These materials were selected to create an effect of transparency.

The palette was selected to complement the existing theatre and surrounding buildings and give the building a high-tech appearance and contrast the old and new. Material consideration further included solar heat gain, durability, U value, and sustainability. Wood, Plastic and metals are recyclable. Glass products are strong and durable but will not be recyclable, however, they may be reusable.

GLASS

The brief requires a building that acts as a filter between the old and the new. Glass is used extensively throughout the project including staircase walls, lift shaft, partitioning panels, stairs and sliding walls.

The material acts as a filter material which allows the user a visual connection to the existing context without necessarily allowing a direct physical connection. Glass comes in a variety of finishes and options that will be discussed in this chapter.

Panelite (Fig.8.16) is an insulating glass unit that has been developed for exterior glazing applications. Panels consist of a UV-stabilized honey come core of polycarbonate which allows the glass to act as a shading device. Panelite is available in a range of colours.

WOOD

Timber is a visually pleasing material which is warm to the touch. Timber slats is used throughout the building as sunscreens and sliding screens.

Timber decking is used on upper floor exhibition areas. Floor boards can be spaced up to 10mm apart allowing water runoff though the boards and eliminating the need for drains and storm water channels. Plywood is used as a floor material on the movable stage. The material was selected for its durability and ability to last when exposed to sun and rain. Plywood is available in large panels and can be used to create a large even surface which is ideal for dance floors.

STONE

Stone materials are hard and cold. Concrete and stone was chosen for its durability and visual effect. The existing textured concrete facade of the Theatre is exposed celebrated.

Floors are constructed of concrete with a polished screen finish. This finish was chosen because of its durability as heavy sculptures and stage equipment may be moved around on the floor surface.

Ceasarstone is used for bar counters. The product is strong and easy to clean. It comes in a variety of colours and edge finishes and is ideal for use as counter tops in kitchens and bars.

PLASTIC

Backlit polycarbonate sheeting can disperse light over a great distance, acting as a large light source while hiding unattractive light fittings. This material is hard wearing and can be recycled at the end of its usable life. Polycarbonate is used in restaurant areas as ceiling panels (see Fig.8.22).

Cellular polycarbonate sheeting (Fig.8.23) is used as material for the floor and door surfaces in the Gallery (Plexiglass HEATSTOP), as well as a translucent screen in the restaurant and cafe spaces (plexiglass RESIST). Plexiglass HEATSTOP is a UV-absorbing multi-skin cellular panel with a U-value of 4.4 and less for 12mm panels. This is an excellent rating which is comparable to UV resistant glass.

METAL

GKD media mesh is used on the western facade as both a media screen to the public square, and a shading device to the restaurant/temporary exhibition space. These screens can act as an additional source of income as they could display advertisements.

Steel grating is used as floor and wall surfaces throughout the project. The material acts as a filter, a visual connection and free movement of air.

Steel columns are painted a dark grey colour and perforated steel is used for the underside of the translucent suspended roof in the gallery space. Perforated steel panels are used as a shading device as the underside of the suspended roof in the temporary exhibition space facing the public square.

GKD MEDIA MESH

Advantages of media mesh

- Maximum transparency is possible
- Functions as both a media screen and a shading device to a western façade
- Long life and low energy consumption of LED lights
- Pixel pitch can be chosen
- Low maintenance
- Can be used for the screening of media events
- Can be used as a source of income as media screens can be used for advertising

Fig. 8.28.

Fig. 8.29.

Fig. 8.30.

Fig. 8.31.

Fig. 8.32. Proposed design with media screens

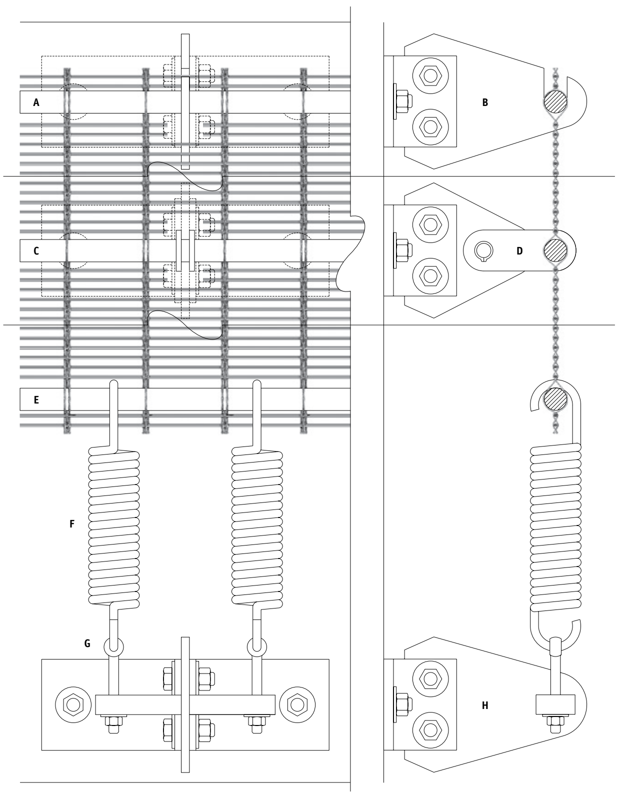


Fig. 8.33. Connection detail

LED Media mesh curtains on the western façade serve as information screens to passers-by. They could serve as large screens on which live video feeds of the performances held on the stage may be displayed. On occasion, the square could act as a large outdoor cinema on hot summer nights. The Media mesh system is a transparent media screen system consisting of GKD stainless steel wire mesh with interwoven LED lights. LEDs are only visible from one side (the public square), while the mesh acts as a shading device that protects the restaurant/café spaces from the harsh western sun. With up to 90% transparency, the mesh maintains a visual link between the square and the restaurant and balcony spaces.

GKD Media Mesh is available in three different options; namely Media Mesh (with the Tigris type mesh), PC media mesh (a modified rod mesh) and Illumesh, which is merely a coloured and illuminated façade that cannot display a clear image.

Greater distance from the media mesh curtains allows a better resolution of the image displayed; therefore, the mesh is best viewed from the seating/steps provided on the edges of the square. Pixel pitch is adjustable and resolution of the image displayed depends on the spacing of LEDs. A higher resolution is equal to greater cost.

GLASS

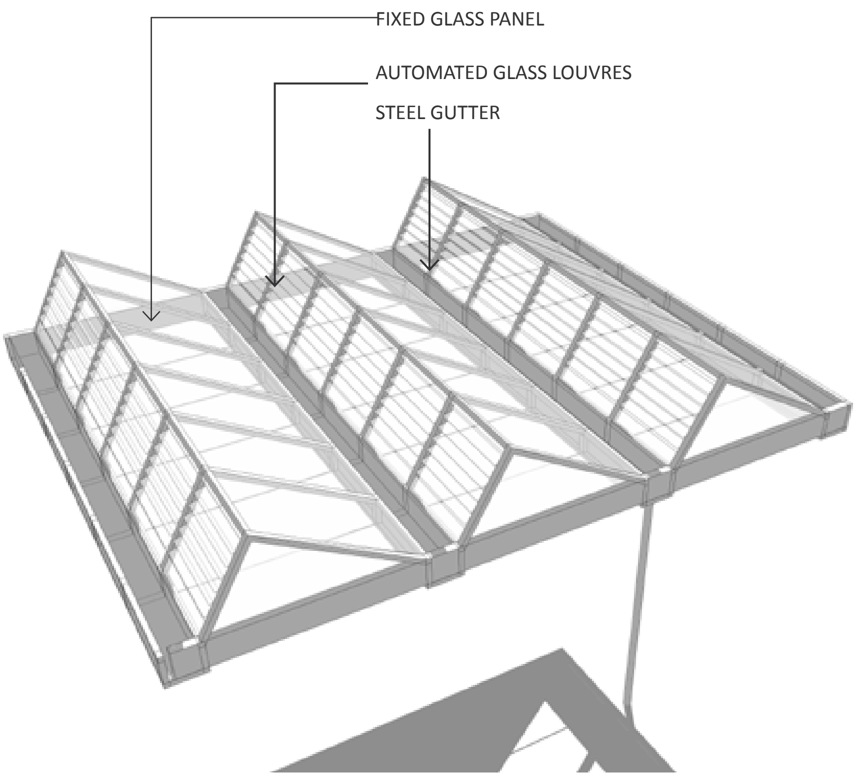


Fig. 8.34. 3D View of skylight from above

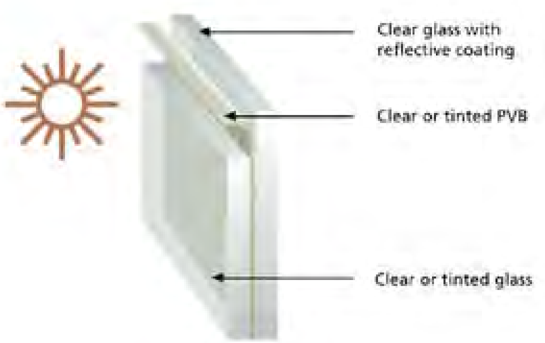


Fig. 8.35. Smartgralls Solar Shield

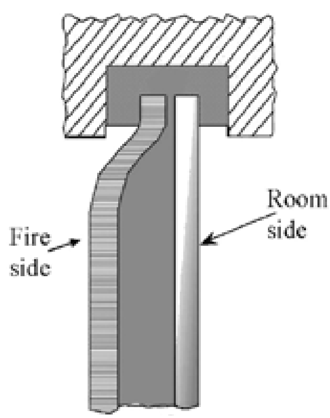


Fig. 8.36. Fire Resistant Glass behaviour

UV RESISTANT GLASS

Smartglass Solarshield® is a glass with a metallic coating and a clear or tinted PVB (polyvinyl butyral) interlayer that is designed to reduce solar heat gain. This glass type also prevents up to 99% of harmful UV radiation from entering the building. Solarshield is a laminated safety glass that is widely used in sky/roof-light applications. Its U-value is 5.8 in all available colours.
Heat gain can be further prevented by applying a white perforated film layer to the glass, which allows light to permeate through the penetrations while reflecting the rest of the light.

Section TT of SABS 0400 requires an atrium space of more than two storeys in height to have an automatically operable opening for smoke extraction in case of a fire. The skylight between the existing building and new extension will be equipped with an automatically operable louvre system that acts as a ventilator and a smoke extraction window. Ventilation louvres are orientated towards north, while larger fixed glass panels are orientated towards the south.

FIRE RESISTANT GLASS

Although glass is not a combustible material, ordinary laminated glass is not an effective barrier to prevent fire, as it can crack or melt at high temperatures. Pilkington and Schott of the United Kingdom are manufacturers of fire resistant glass that can last as long as 120 minutes in a fire, and therefore complies with section TT of the SABS 0400 as an effective fire barrier. Fire resistant glass consists of two layers of glass with a transparent insulating layer between them. Fire-proof glass must be installed in steel window frames with a special beading and tape (Aluminium only lasts approx. 30minutes in a fire). When the glass and steel expand, the glass is held firmer in the frame, making it safer.

Due to the organization on the building around a central double volume exhibition space, an exit on either side of each section was provided. In the gallery/dance studio section, an emergency exit was provided on the southern edge, exiting onto Pretorius Street. Central staircases may be used as alternative exit points, as well as an emergency escape route on the North West corner.

Exhibition spaces and atriums are to be equipped with sprinkler systems and an automatically operated louver skylight to prevent smoke spreading through the building during a fire.

Fire hydrants and portable fire extinguishers are provided in restaurants and shops.

STABILITY OF STRUCTURAL ELEMENTS	
TABLE TT7 SABS 0400	
A1	120 min. stability
A2	120 min. stability
C2	90 min. stability
F2	90 min. stability
BASEMENT	120 min. stability

FIRE STRATEGY

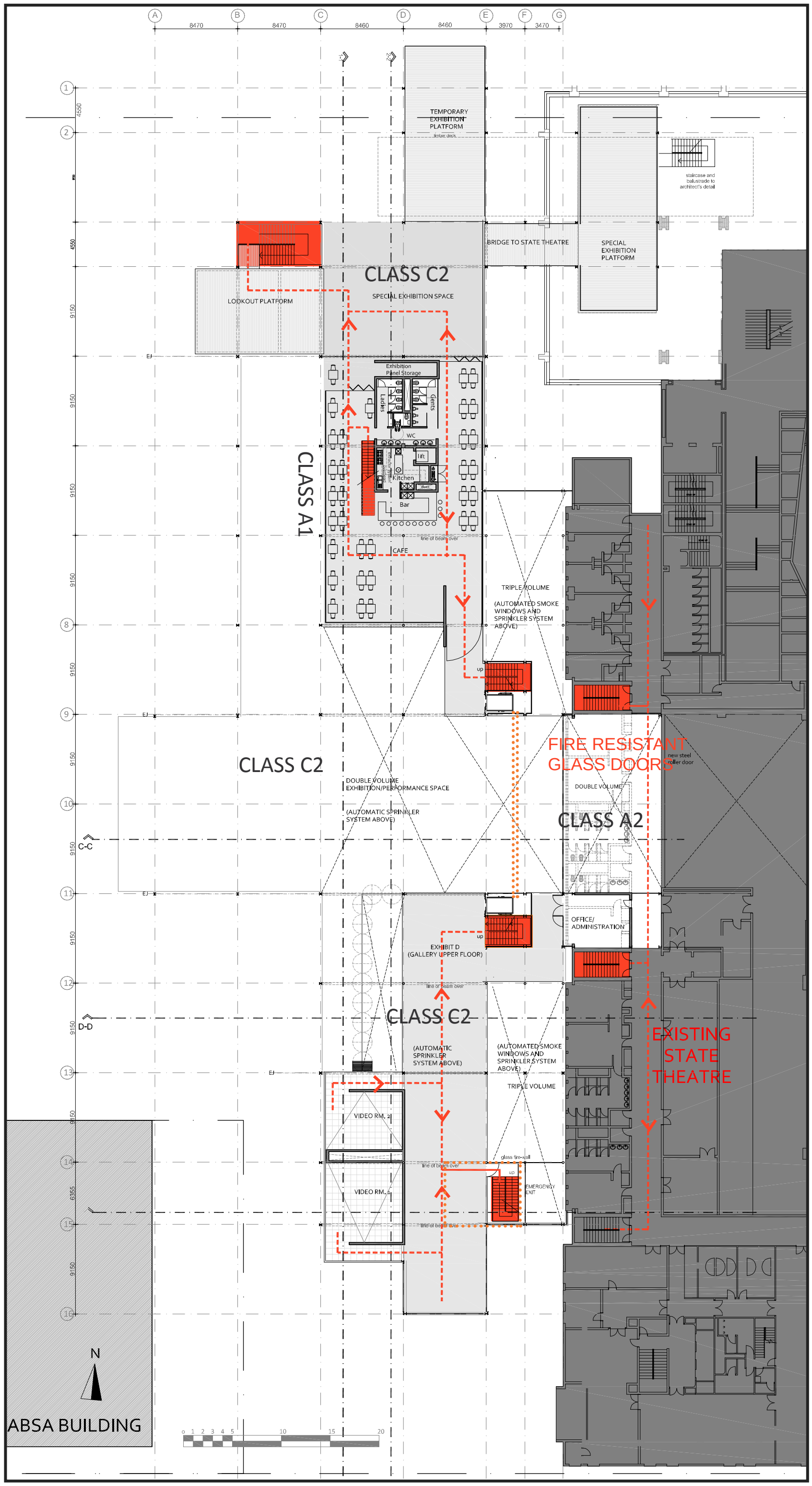


Fig. 8.37. Second Floor Fire Plan

PANELITE CLEARSHADE CELLULAR INSULATED GLASS

The Panelite CLEARSHADE range of insulated glass is a glass type developed for exterior glazing, containing a UV-stabilized honeycomb structured polycarbonate layer sandwiched between two glass panels. The honeycomb structure allows a degree of transparency when viewed directly at eye level, but distorts the view in any other angle, allowing more privacy and a large degree of climate control, as displayed in images on this page.

The honeycomb structure allows the material to have a U-value of only 0.3, compared to Smartglass Solarshield (discussed elsewhere in this chapter) with a U-value of 5.8. It also achieves a Solar Heat Gain Coefficient of 0.18 at midday. According to manufacturer, this is 75% lower than that of other insulating glass types.

In the proposed design, 25mm thick Panelite glass panels will be used as exterior glazing material in Video rooms, creating a coloured light effect with limited direct sunlight entering these spaces. As with ordinary glass, a film can be applied to the exterior of the glass, displaying an image. The prevention of direct sunlight entering the room will ensure a minimum glare on surfaces where video images are projected.

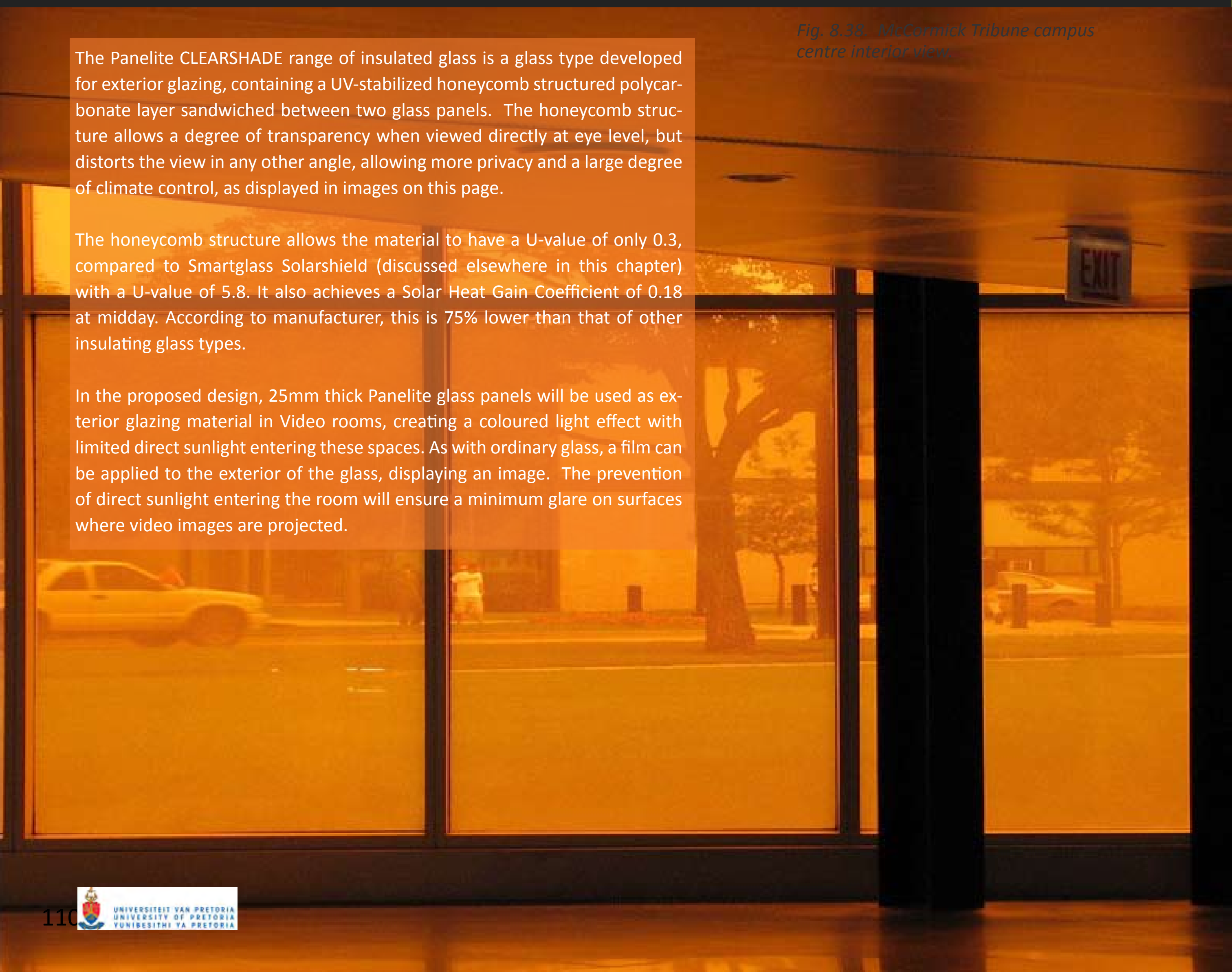


Fig. 8.38. McCormick Tribune campus centre interior view.

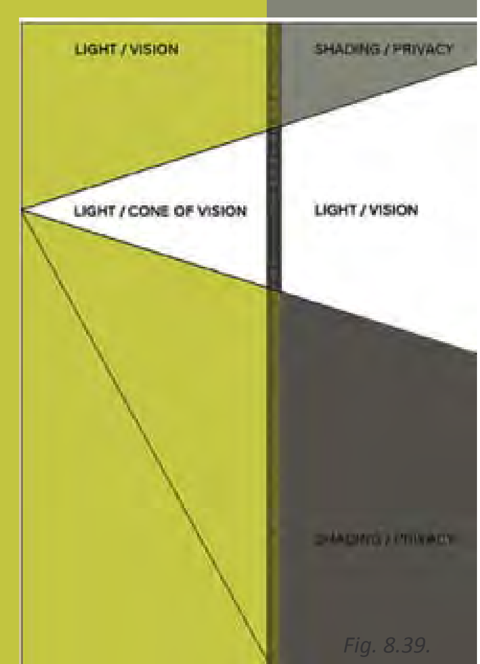


Fig. 8.39.

Panelite glass was used as exterior glazing material at the Mc Cormick Tribune Campus Center, Chicago, USA by OMA. This case study illustrates the use of coloured Panelite and printed glass panels to create an aesthetically pleasing façade and an interesting colour effect on the interior.

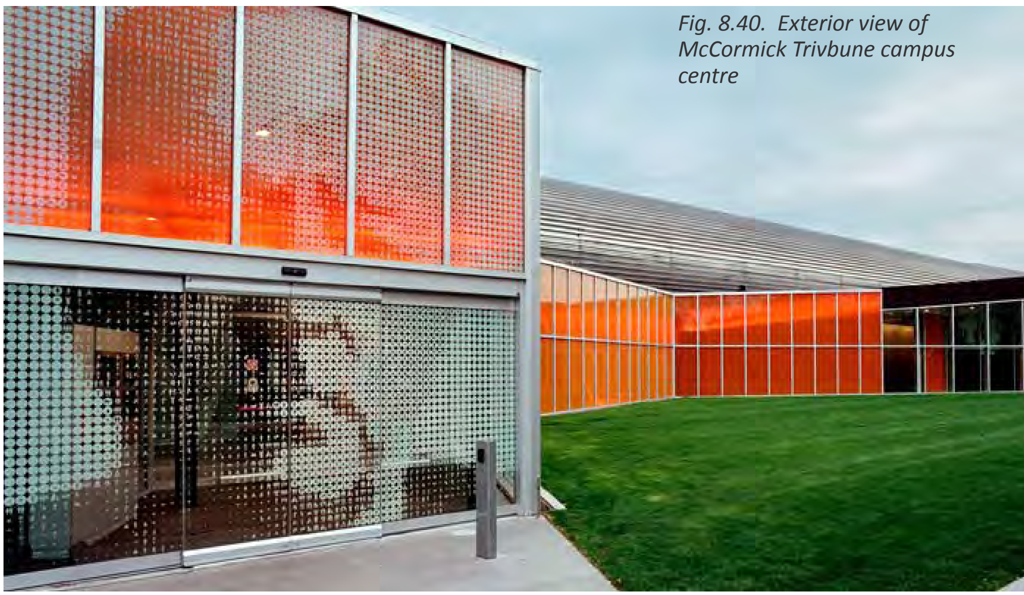


Fig. 8.40. Exterior view of McCormick Trivbune campus centre

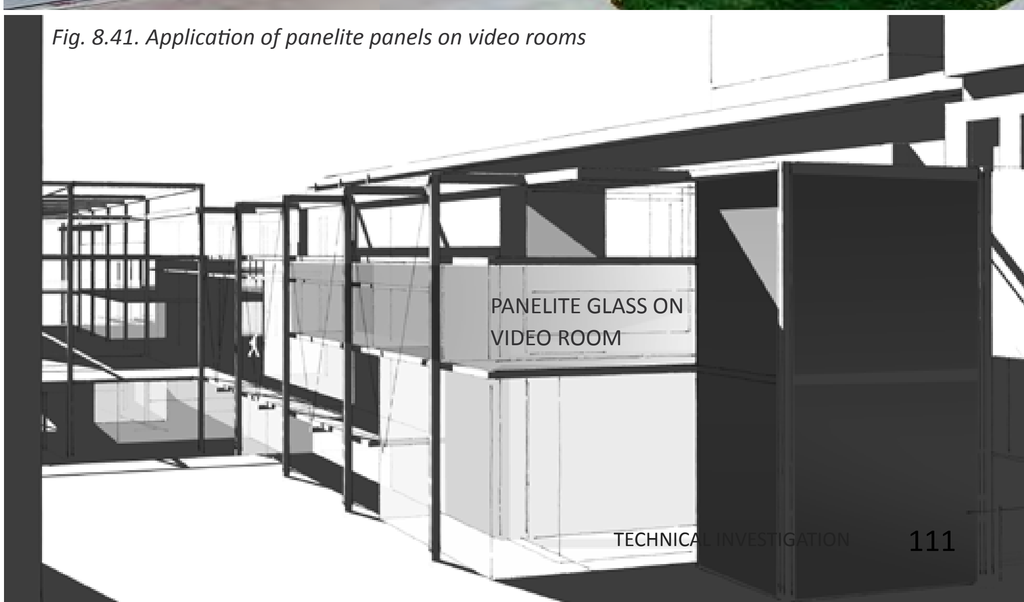


Fig. 8.41. Application of panelite panels on video rooms

GLASS ELEMENTS

LAMINATED GLASS: GLASS STAIRCASE AND LIFT SHAFT

GLASS ELEMENTS
A glass staircase and lift shaft is placed on either side of the central exhibition area serve as the main structural features. Glass walls around the circulation cores allow views to the existing building and exhibition space. Laminated glass is used as cladding as it can withstand impacts. Stair floors are also constructed of frosted laminated glass in custom made steel frames that are welded to the staircase structure.

LIGHTWEIGHT ROOF
A lightweight translucent roof is suspended from the steel structure with a 1° pitch. The roof structure will cause large wind loads on the steel structure, and will be securely tied back from both above and below through the use of steel cables.

The roof is constructed as follows;
A steel structure supports a policarbonate upper layer, protecting from rain, and a perforated steel panel underside

Fig. 8.42.

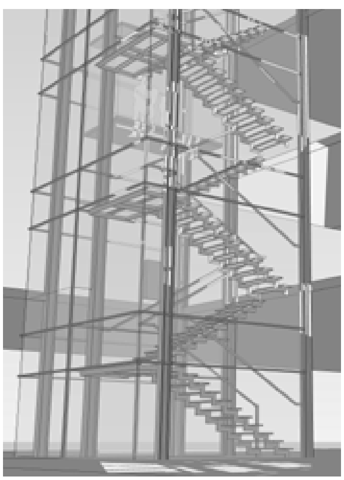


Fig. 8.43. 3D View of Staircase and liftshaft

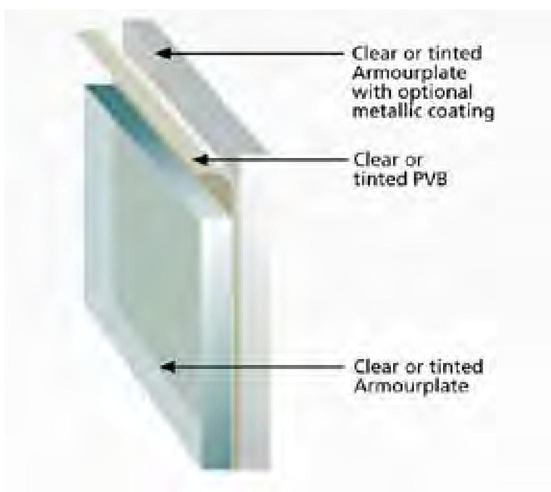


Fig. 8.44. Smartglass Armourlam

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

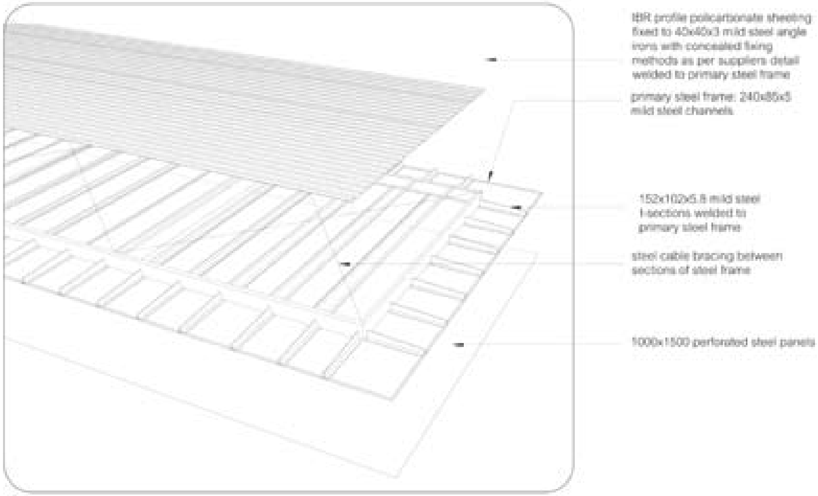


Fig. 8.45. 3D detail: Suspended Roof

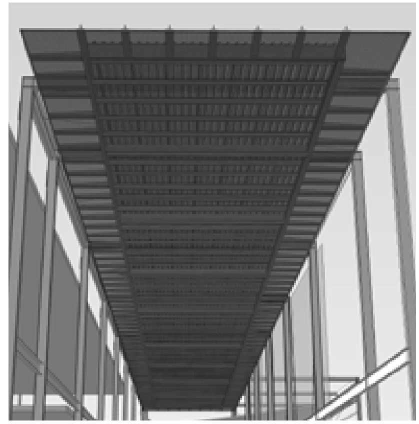


Fig. 8.46. 3D View: Suspended Roof

Fig. 8.47. Door sliding track integrated with webbed truss system at the Linda Goodman Gallery

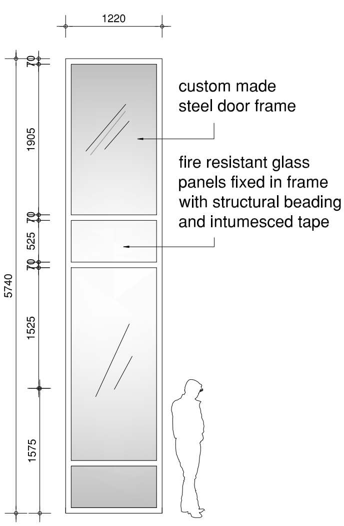


Fig. 8.48. Glass Fire doors

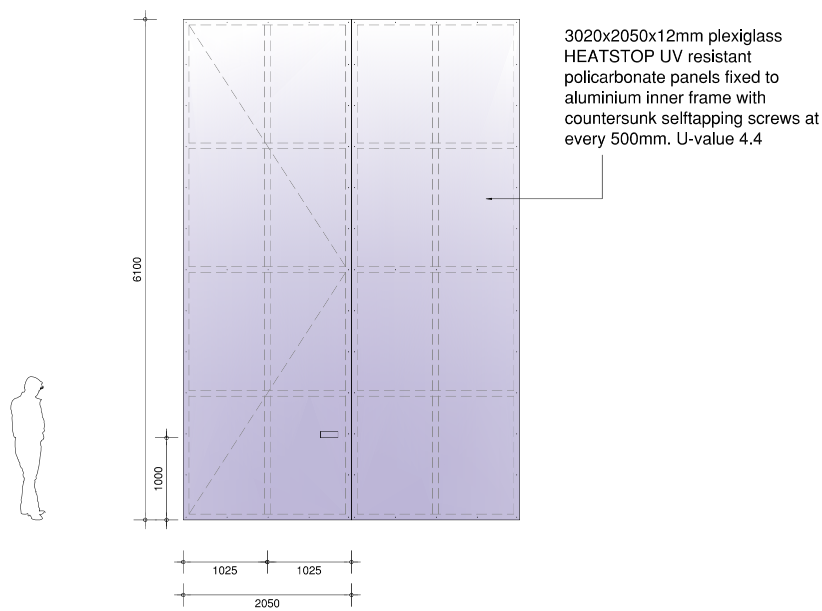


Fig. 8.49. Translucent Plexiglass doors around gallery

GREEN STRATEGIES

SBAT RATING

The SBAT rating tool was used to evaluate the design. The Sustainable Building Assessment Tool provides an indication of the performance of a building or the design of a building in terms of sustainability. Although the tool is ideally used on a building that has recently been completed, it can be used on other stages as well, but may not be relevant.

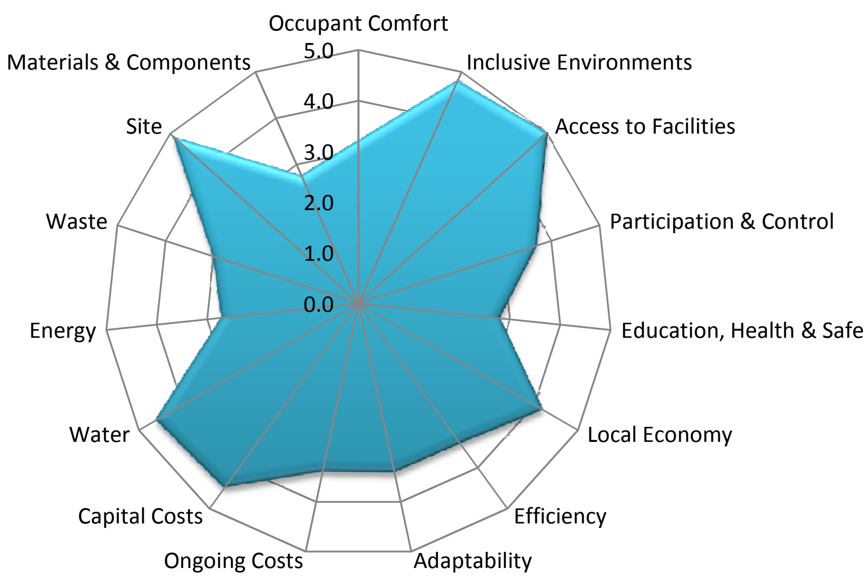
The tool was used with the assumption that all the requirements would be met once the building is completed, even though many factors such as local workmanship cannot be determined at this point. The rating tool is divided into three components namely social, economic, environmental components.

The social component deals with the social performance of the building in terms of sustainability, including aspects such as access to natural light, proximity and access to public transport, disabled access to functions, noise and air pollution. The economic component provides an indication of the economical performance including cost of construction and material, locally sourced materials and the use of local labor instead of specialized labor. The environmental component deals with recycling of waste, water consumption and reuse, greening of the site and the percentage of users who make use of public transport systems, etc. Water and energy systems will be discussed in this chapter.

RESULTS

SOCIAL: 3.9
ECONOMIC 3.8
ENVIRONMENTAL: 3.6
OVERALL: 3.8

CLASSIFICATION: GOOD



Overall value	0-1	1-2	2-3	3-4	4-5
Classification	Very Poor	Poor	Average	Good	Excellent

Fig. 8.50. SBAT rating results

1. SUSTAINABLE DANCE FLOOR

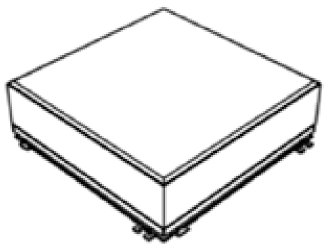


Fig. 8.52. Axonometric of SDF tile

Fig. 8.51. SDF diagram

Fig. 8.53. View of current design SDF

An energy generating dance floor system is suggested for the dance studios on third floor level. No such system is currently available in South Africa, however, an energy generating dance floor has recently been developed by students of the University of Rotterdam.

Dance studios are fitted with specially designed dance floor made of springs and a series of power generating blocks. The upwards/downwards movement of the blocks when danced on produces an electrical current. The current is fed into nearby batteries that are constantly recharged by the movement of the floor and are used to power lights in the studios/the rest of the building

CURRENT TECHNICAL DATA:
size: 650x650x195mm
Maximum deflection: 10mm
Materials: Reused PVC, hardened glass
Weight 45kg
Energy Generated: 10W continuous output at 18VDC for adults dancing on the module.
20W continious output at 18VDV for adults jumpin on the module

A hardwood finish is suggested for the application in the dance studios. The dance studios are designed to accommodate the structure as it is available now, however a standard sprung dance floor system can be inserted into the dance studios immediately and can later be replaced by energy generating floors when the technology becomes available in the desired finish or is locally available.

A sprung dance floor is a hardwood floor that is layed on top of a foam layer that absorbs the shock when jumped on. The floor feels softer and prevents injury to legs due to continious jumping.

Fig. 8.54. Sprung dance floor

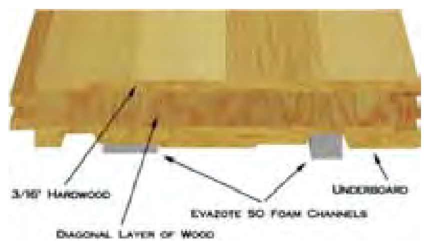


Fig. 8.55. Detail section of Sprung floor

2. VENTILATION STRATEGY

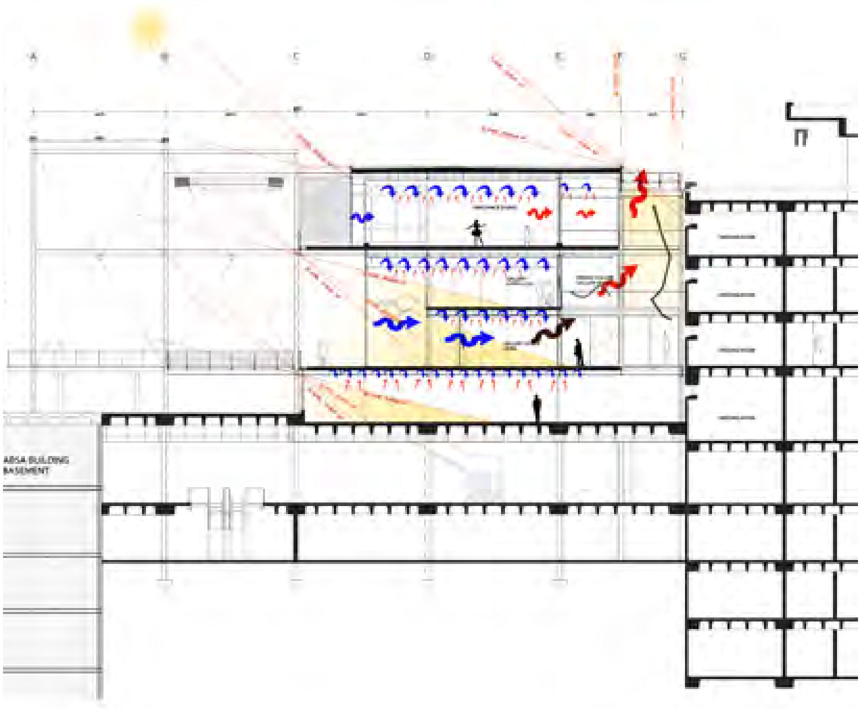


Fig. 8.56. Ventilation diagram: Gallery

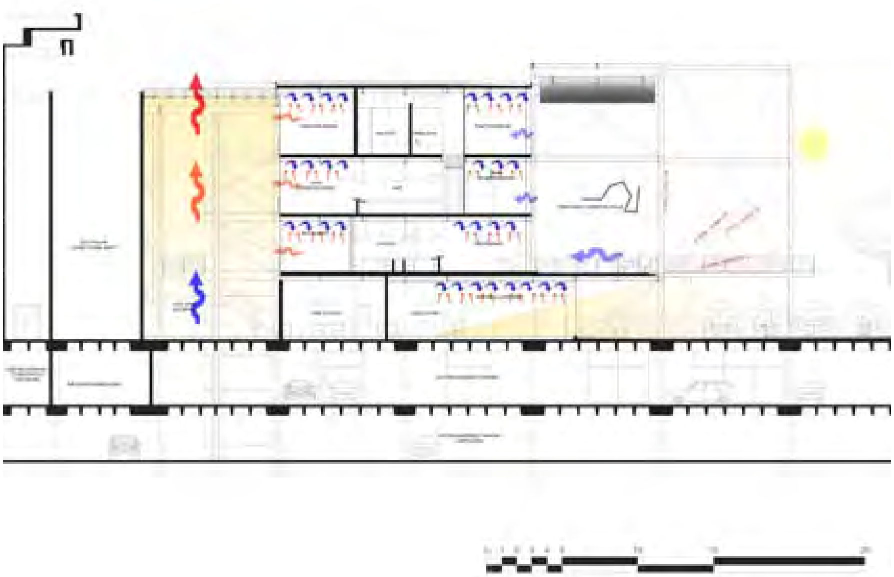


Fig. 8.57. Ventilation diagram: Restaurant

NATURAL VENTILATION:
Spaces are allowed to ventilate naturally through the use of fully operable stacking doors. Each door panel can be opened individually and rotated in any direction. This allows the user full control of his/her environment. An automatically operated skylight in the connection between the old and new building allows warm air to escape as it rises.

The building's western facade is designed in layers to maximize control of the environment while minimizing heat gain. Facade elements in restaurant and gallery spaces are fully operable and door panels can be rotated to minimize solar heat gain, while allowing maximum natural ventilation and lighting.

MECHANICAL VENTILATION:
Mechanical ventilation systems will be required in museum spaces, dance studios, foyers and parts of restaurant spaces. Such a system is required in museum spaces due to heat generation form lighting and electronic equipment, and western orientation. The system is used in addition to natural ventilation in dance studios to increase comfort levels.

A radiant cooling system was selected to be used in theses spaces. The system requires a chiller room where water in a closed system is cooled to the desired temperature. Water is distributed through ducts to the areas needed. Basement levels will be mechanically ventilated. An extension of the existing theatre air-conditioning situated on basement levels will be continued. Additional space currently used as storage is available for the extension of the existing air conditioning system.

RADAINT COOLING/HEATING CEILING SYSTEM

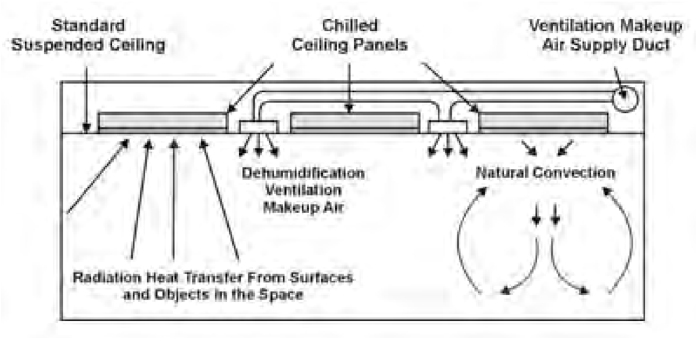


Fig. 8.58. Radiant cooling ceiling system

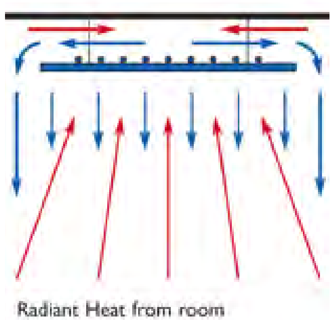


Fig. 8.59. Thermasail cooling

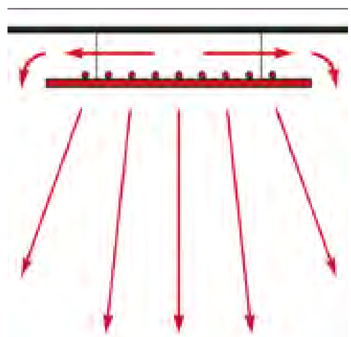


Fig. 8.60. Thermasail heating

COOLING
Cold water is passed through coils on top of the ceiling panel. The underside of the ceiling panel is cooled and it in turn cools the air against it. The panel also absorbs radiant heat gains from the room. The air above the panel is cooled and cool air moves around the edges.

HEATING
Warm water is passed through copper coils on top of the ceiling panel, whereby the lower surface of the sail acts as a radiant heater.

Air above the panel is warmed and moves into the room. The ceiling system is effective for large areas. According to SPC ceiling systems, this ceiling system reacts rapidly to heating and cooling demands and ensures low energy consumption

Fig. 8.61. Daytime

Fig. 8.62. light fittings hidden above panel

3. RAINWATER RECYCLING

Rainwater on the roof is collected through rainwater down pipes in underground storage tanks situated in the lower basement level. From here, water is filtered and pumped back to be reused in toilets.

RAINWATER HARVESTING:
According to Weather SA, the average annual rain fall in Pretoria is 647mm.
Total roof area: 2593m^2

2593m^2 x 0.647
= 1677.7 Kl water is available for harvesting. Only 73 % of this water will be harvested due to evaporation. This result may not be accurate as numbers used in calculations are estimates.

See Appendix A for calculations of rainwater down pipes.

Collected water will be stored in tanks on lower basement level. Water storage happens on the lowest basement level due to the structural stability of existing floor slabs that have not been designed to carry such extreme loads.

Size of rainwater tank size is based on the amount of water consumed per day.
Average hot water consumption:
Hand basin 5 liters
Kitchen sink (per wash-up) 6 liters
Dishwasher 14 liters
1 person + household 120l

Washing of floors/sores: 50l
Toilet: 8L per flush.
Showers: 36l per person.

Total estimated daily use: 4300l per day.
Approximately 3000l is consumed by the flushing of toilets and urinals. One 9000l tank will be sufficient to store the necessary daily amount of water to be reused in toilets and urinals.

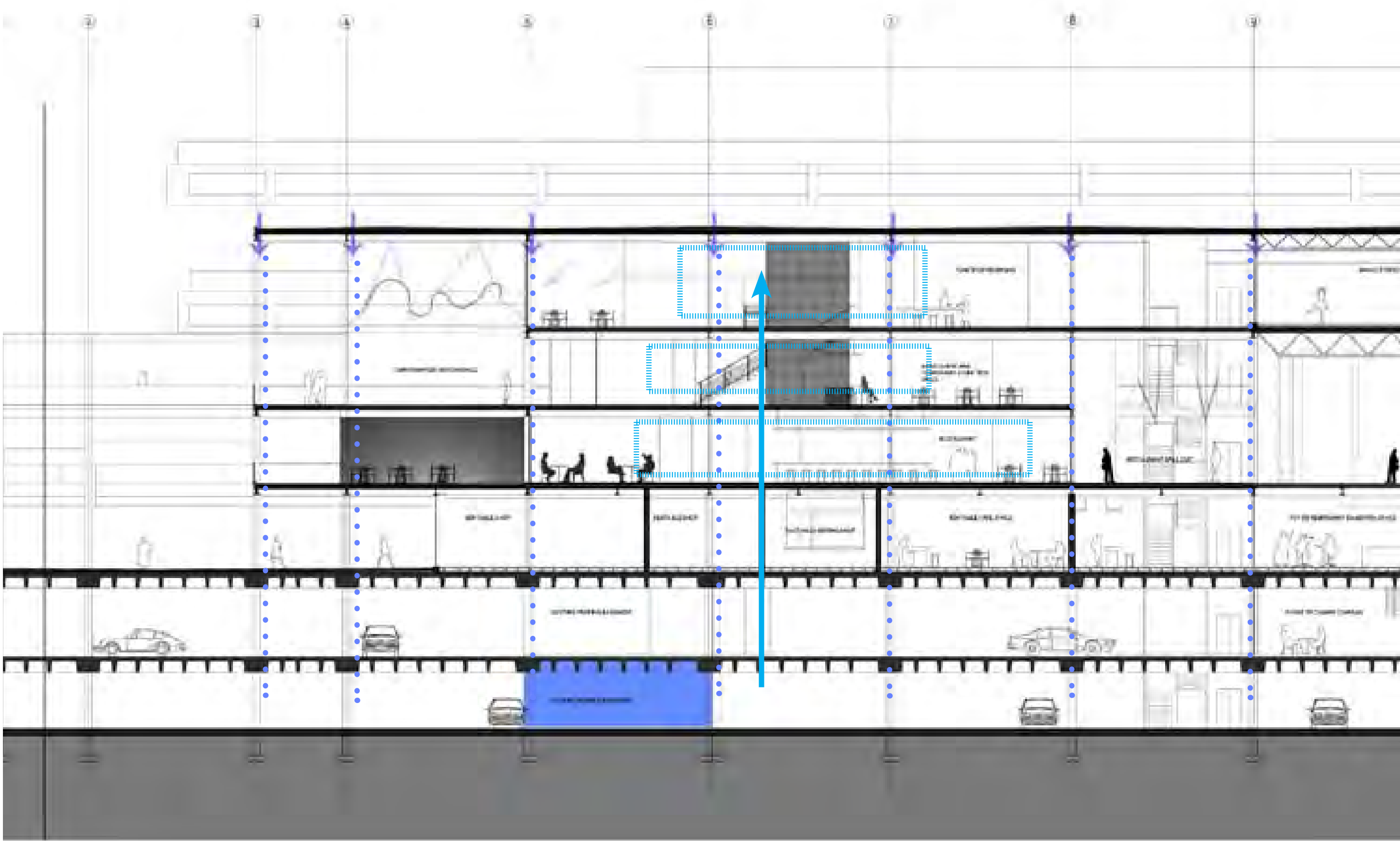
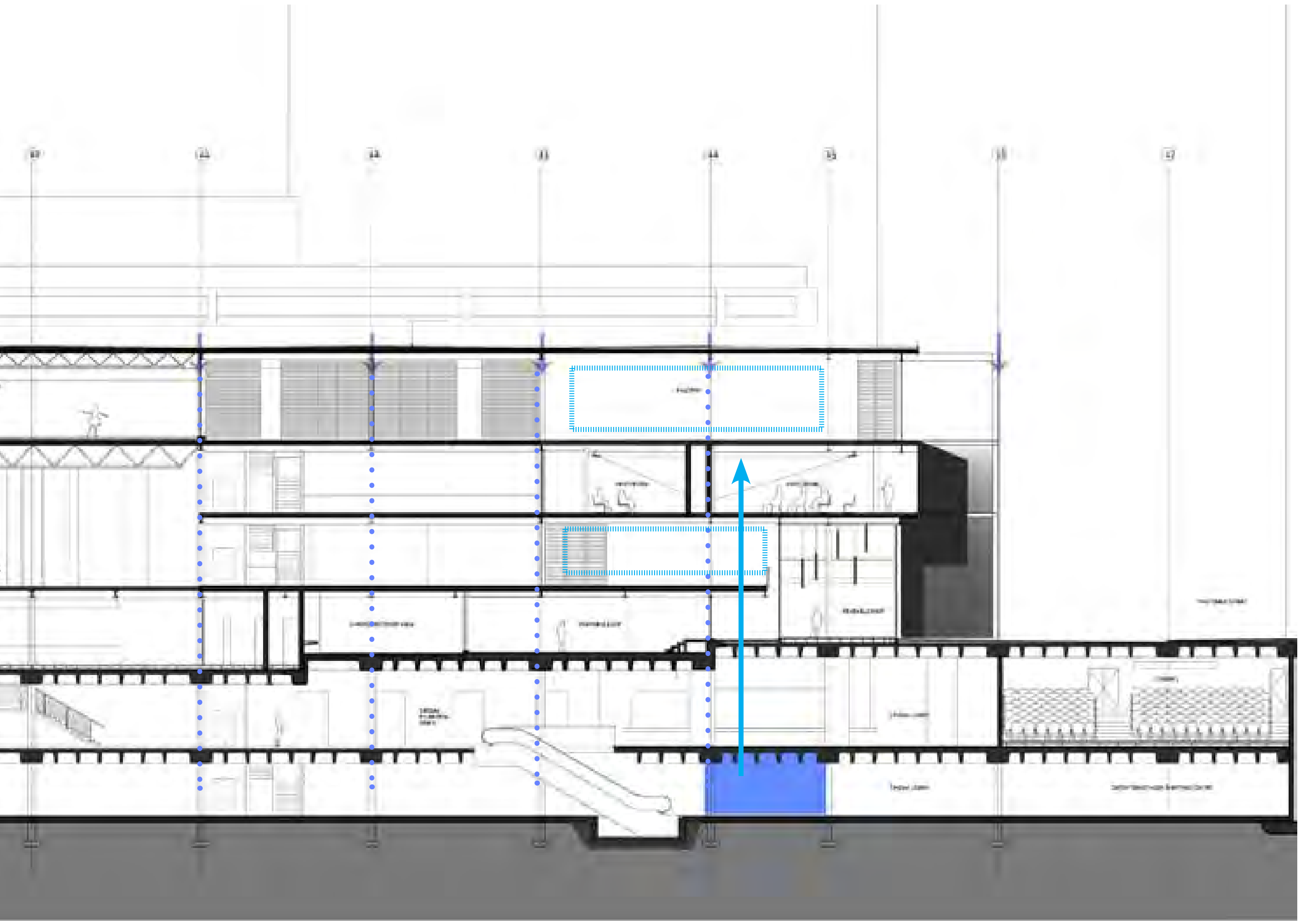


Fig. 8.63.



09_ CONCLUSION

This thesis has investigated principles in the design of successful public spaces in order to find a solution to the possible improvement of an existing public square in Pretoria, namely Lillian Ngoyi Square. Despite the square's prime location within the city, the lack of interaction between the square and its surroundings had caused a lack of activity on the square.

The design has provided a possible solution to the improvement of the quality of the square by breaking down physical and imaginary boundaries between the theatre and the public. This has been achieved by providing a western "balcony" and a new entrance to the theatre, that opens onto the public square. The design has attempted to create a more inclusive public space that would invite visitors to enjoy and experience life in the city. It has also attempted to provide a comfortable and safe public space for visitors to rest and enjoy people-watching.

The design has proposed an outdoor theatre and a number of street cafes opening onto the square that would enhance the image and tourist value of the public space. Further, the design has suggested the improvement of pedestrian access and an easier transition between the square and the surrounding streets.

The building was intended to be a filter that would create a transition between the formal theatre and the informal public square. The purpose has been for the building to draw new visitors to the site and to educate the man on the street about the arts and the opportunities provided by the State Theatre. The concept of a filter has been drawn through the urban design to the detail level of design and all building elements. Materials were specifically chosen to give the "filter" effect that would allow visual access, or a physical connection. The transparency of the structural frame was intended to be a skeleton from which the stage and decoration could be constructed during concerts and for temporary exhibitions. The scheme has provided the opportunity for investment into the future of the theatre as a factory of the performing arts.