Chapter 7

Technical Investigation

Introduction

Tectonic decisions are influenced by the parti diagram through response to architecture as communication activator, extension of public space and gateway formation. *Entopia* is created through response to context, thereby influencing material selection, roof design, hierarchy of space and selection of passive systems.

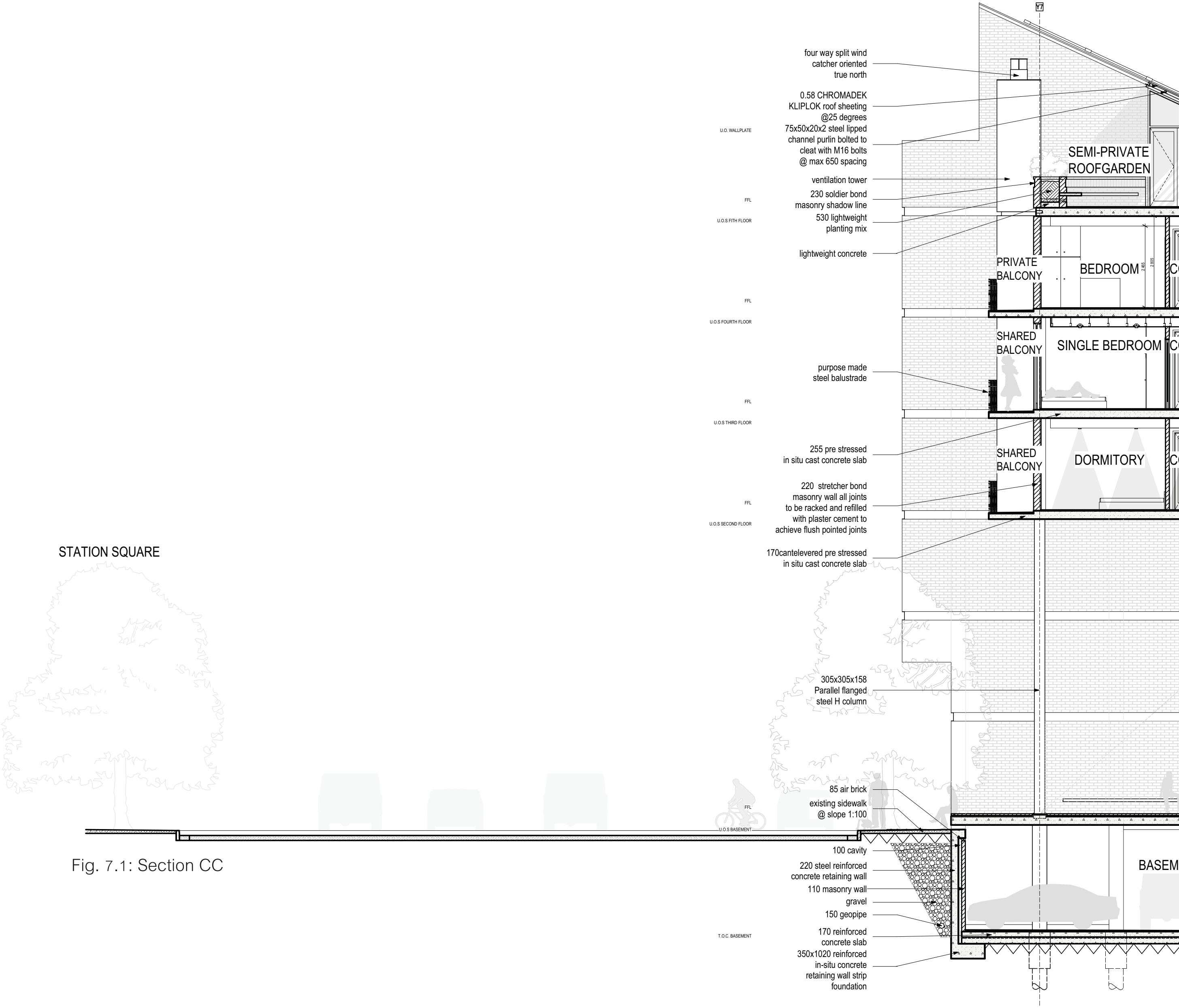
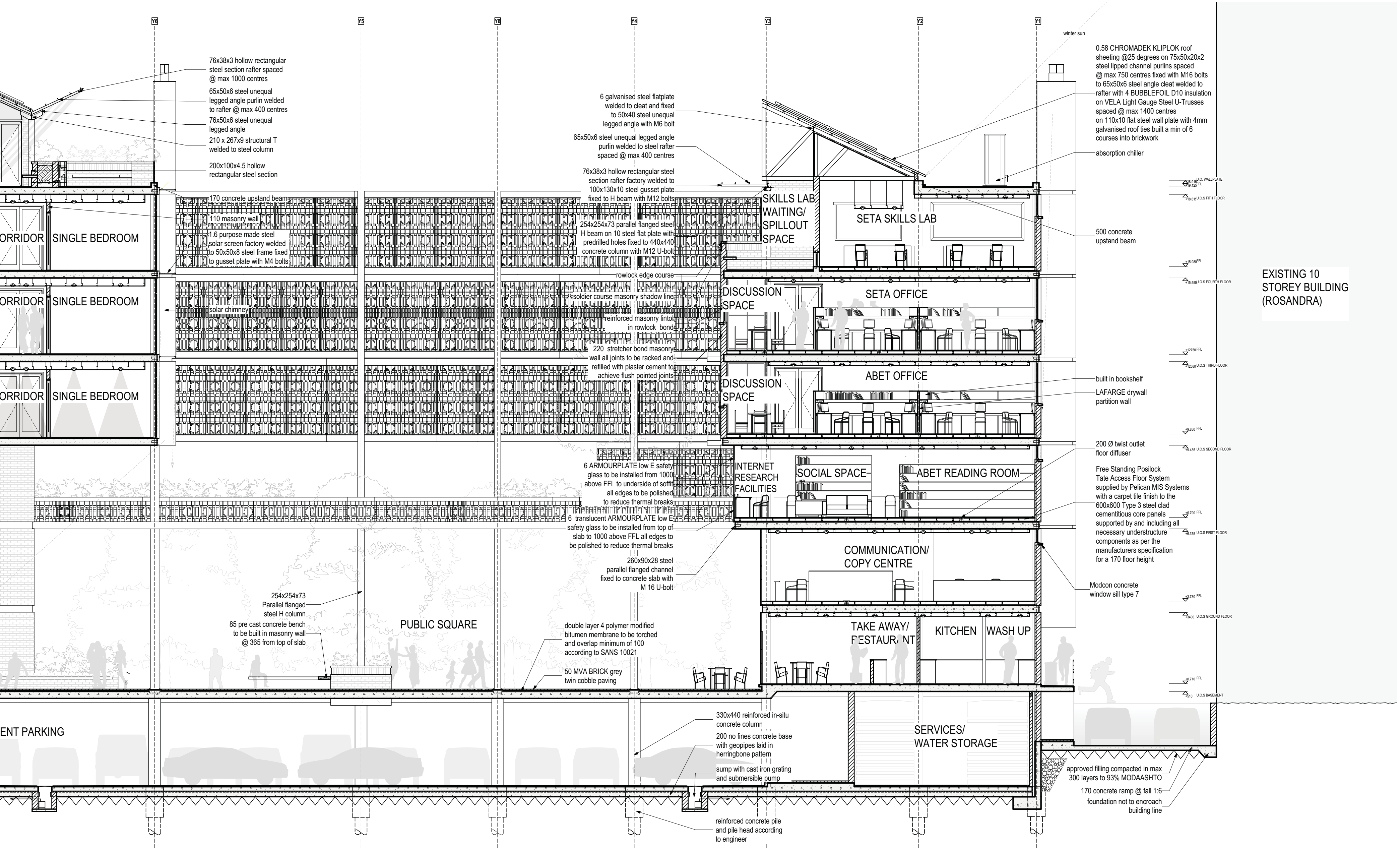


Fig. 7.1: Section CC


Y6
Y5
Y8
Y4
Y3
Y2
Y1
winter sun
76x38x3 hollow rectangular steel section rafter spaced @ max 1000 centres
65x50x6 steel unequal legged angle purlin welded to rafter @ max 400 centres
76x50x6 steel unequal legged angle
210 x 267x9 structural T welded to steel column
200x100x4.5 hollow rectangular steel section
170 concrete upstand beam
110 masonry wall
1.6 purpose made steel solar screen factory welded to 50x50x8 steel frame fixed to gusset plate with M4 bolts
solar chimney
ORRIDOR
SINGLE BEDROOM
ORRIDOR
SINGLE BEDROOM
ORRIDOR
SINGLE BEDROOM
6 galvanised steel flatplate welded to cleat and fixed to 50x40 steel unequal legged angle with M6 bolt
65x50x6 steel unequal legged angle purlin welded to steel rafter spaced @ max 400 centres
76x38x3 hollow rectangular steel section rafter factory welded to 100x130x10 steel gusset plate fixed to H beam with M12 bolts
254x254x73 parallel flanged steel H beam on 10 steel flat plate with predrilled holes fixed to 440x440 concrete column with M12 U-bolt
rowlock edge course
soldier course masonry shadow line
reinforced masonry lintol in rowlock bond
220 stretcher bond masonry wall all joints to be racked and refilled with plaster cement to achieve flush pointed joints
SKILLS LAB WAITING/ SPILLOUT SPACE
SETA SKILLS LAB
DISCUSSION SPACE
SETA OFFICE
DISCUSSION SPACE
ABET OFFICE
0.58 CHROMADEK KLIPLOK roof sheeting @25 degrees on 75x50x20x2 steel lipped channel purlins spaced @ max 750 centres fixed with M16 bolts to 65x50x6 steel angle cleat welded to rafter with 4 BUBBLEFOIL D10 insulation on VELA Light Gauge Steel U-Trusses spaced @ max 1400 centres on 110x10 flat steel wall plate with 4mm galvanised roof ties built a min of 6 courses into brickwork
absorption chiller
500 concrete upstand beam
built in bookshelf
LAFARGE drywall partition wall
200 Ø twist outlet floor diffuser
Free Standing Posilock Tate Access Floor System supplied by Pelican MIS Systems with a carpet tile finish to the 600x600 Type 3 steel clad cementitious core panels supported by and including all necessary understructure components as per the manufacturers specification for a 170 floor height
Modcon concrete window sill type 7
+18.915 U.O. WALLPLATE
+19.125 FFL
+18.615 U.O.S FITH FLOOR
+15.980 FFL
+15.555 U.O.S FOURTH FLOOR
+12750 FFL
+12580 U.O.S THIRD FLOOR
+9.850 FFL
+9.435 U.O.S SECOND FLOOR
+6.790 FFL
+6.375 U.O.S FIRST FLOOR
+3.730 FFL
+3400 U.O.S GROUND FLOOR
+0.710 FFL
+510 U.O.S BASEMENT
EXISTING 10 STOREY BUILDING (ROSANDRA)
6 ARMOURPLATE low E safety glass to be installed from 1000 above FFL to underside of soffit all edges to be polished to reduce thermal breaks
6 translucent ARMOURPLATE low E safety glass to be installed from top of slab to 1000 above FFL all edges to be polished to reduce thermal breaks
260x90x28 steel parallel flanged channel fixed to concrete slab with M 16 U-bolt
INTERNET RESEARCH FACILITIES
SOCIAL SPACE
ABET READING ROOM
COMMUNICATION/ COPY CENTRE
TAKE AWAY/ RESTAURANT
KITCHEN
WASH UP
254x254x73 Parallel flanged steel H column
85 pre cast concrete bench to be built in masonry wall @ 365 from top of slab
PUBLIC SQUARE
double layer 4 polymer modified bitumen membrane to be torched and overlap minimum of 100 according to SANS 10021
50 MVA BRICK grey twin cobble paving
ENT PARKING
330x440 reinforced in-situ concrete column
200 no fines concrete base with geopipes laid in herringbone pattern
sump with cast iron grating and submersible pump
reinforced concrete pile and pile head according to engineer
SERVICES/ WATER STORAGE
approved filling compacted in max 300 layers to 93% MODAASHTO
170 concrete ramp @ fall 1:6
foundation not to encroach building line

Parti Diagram

The role of architecture as communication activator is expressed in the building envelope. The building envelope responds to function and hierarchy of space and allows the nature of the program to be legible from the outside of the building.

Programs with public functions opening onto the square directly or visually makes use of glass curtain walls, thereby creating continuous visual activity to internal spaces. Programs where higher levels of privacy is required such as overnight facilities, classrooms and discussion spaces within the offices are constructed from a masonry envelope thereby solidifying the facade and achieving higher levels of privacy.

The expression of hierarchy on facade and establishing visual connection to activity within the building contributes to pedestrian legibility and understanding of the design as well as counteracts the experience of abandoned public space that reigns in numerous public squares within Pretoria CBD.

Extension of public space and the urban floor are expressed tectonically at thresholds to the square and internal spaces.

At thresholds to the square, extension of public space is articulated through material choice which continues the palette used in Station Square and the cantilevered slab of the new public square floor plate. This blurs the boundary firstly between the site and Station Square, and secondly the threshold between the sidewalk and newly created public space. The threshold to internal spaces is also blurred through the use of shadow lines at entrances. Shadow lines are created by extending the floor slab 100mm over the square with the slab thinning to 85mm to accommodate the shadow line underneath.

Gateway formation is translated tectonically through the resolution of the screen which responds to context, shades the site from western sun and announces entrance onto site and into the city.

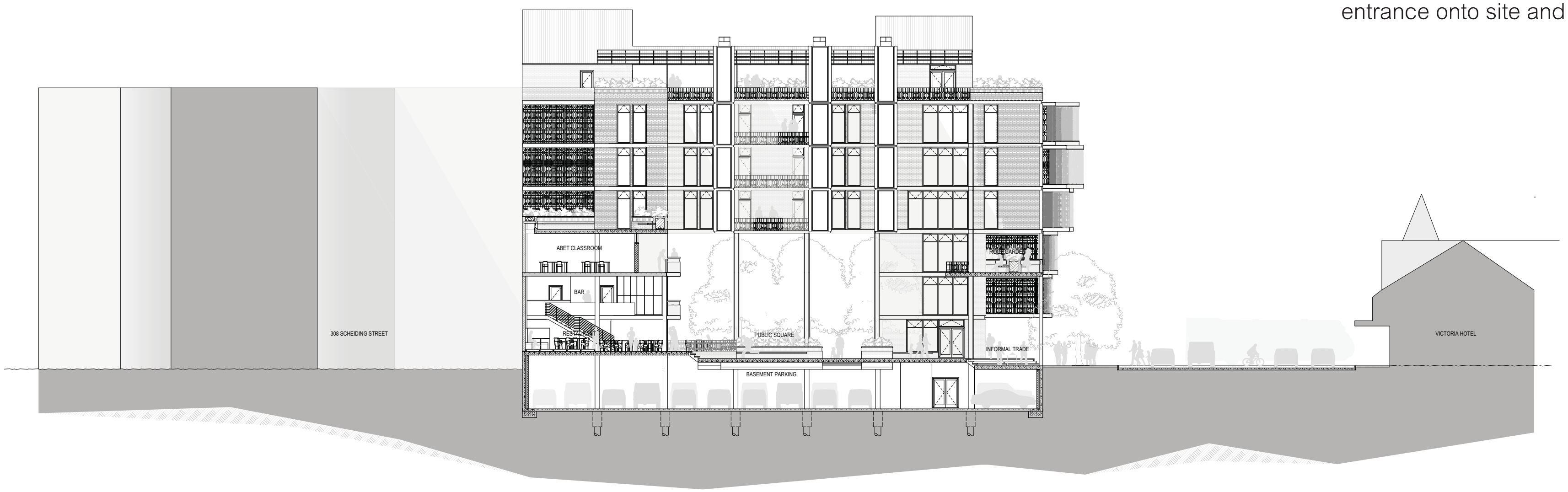


Fig. 7.2: Section BB

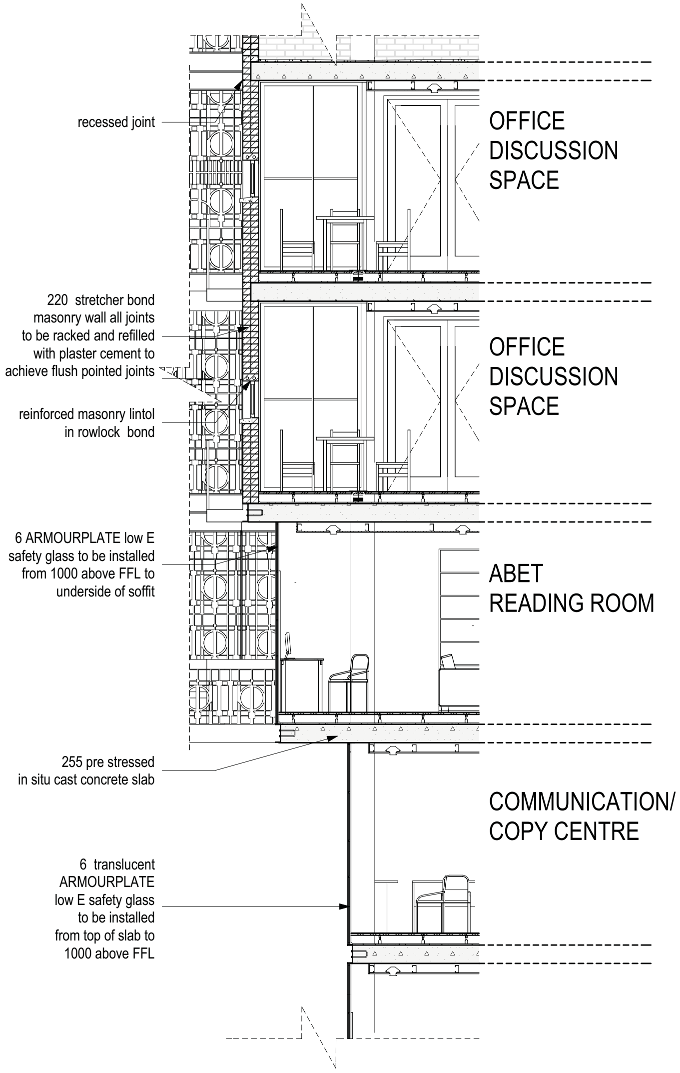


Figure 7.3: Strip section indicating response to function and hierarchy through building envelope

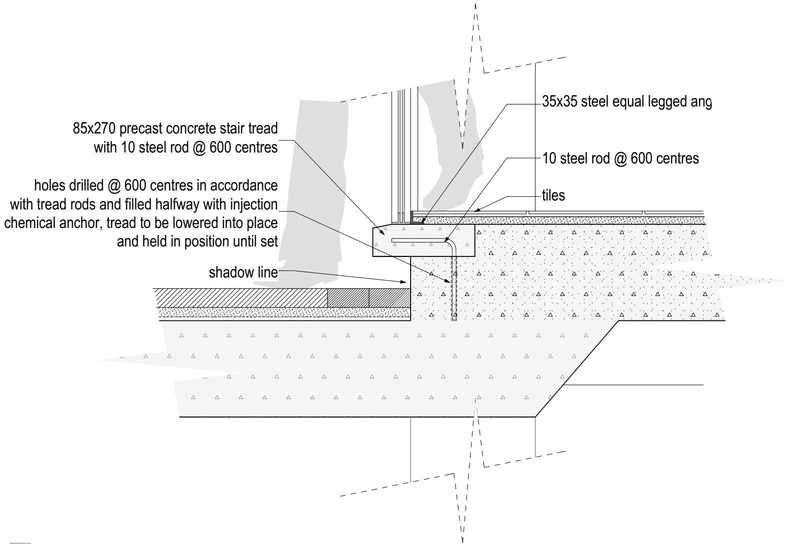


Figure 3.24: Detail: shadow line at entrance to internal space

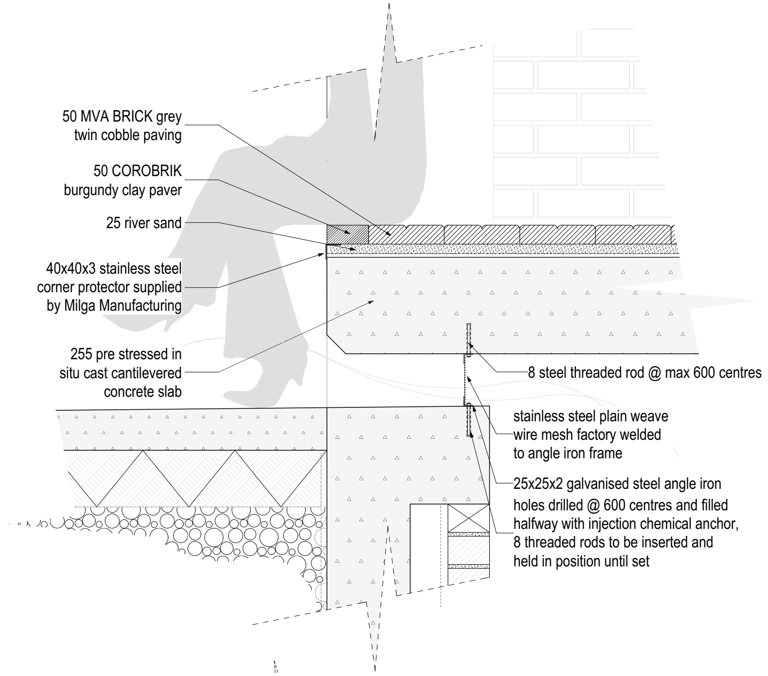


Figure 7.4: Detail: cantilevered slab of new public square

Building Structure

During the technical investigation the building structure was developed through consultation with Civil Engineers Professor Walter Burdzik and Carl von Geyso.

Column spacing has been determined by the basement layout in combination with programmatic spatial requirements. The grid allows parking and circulation within the basement while accommodating modular sized units within the overnight facilities and preferred sized classrooms and still allows the structure to be adaptable in order to accommodate possible future change in program or envelope. This allows the building to adapt to changing needs within the environment thereby strengthening *entopia* and extending the building lifetime.

As is the case in most of the buildings within the context, building structure is expressed on facade. The structure is exposed through the use of shadow lines and steel channels fixed directly to the concrete slabs allowing a recessed connection. The channel acts as permanent shuttering for the floor slabs and additionally facilitates fixing of elements to the building facade such as the screen, solar shading devices and ventilation towers.

Primary Building Structure

The primary building structure consists of 255 deep pre-stressed concrete slabs with 330x440 reinforced concrete columns.

Steel columns are used in part for the southern and western wings of the structure to accommodate deflections that will occur due to the lack of horizontal support. In the southern wing where the columns span three storeys, 305x305x158 Parallel flanged steel H columns has been selected with smaller H columns used to support the screen and bridge the two storeys without lateral support in the western wing.

Use of steel columns in these areas allows the use of less material and prevents large columns intruding within the urban waiting rooms.

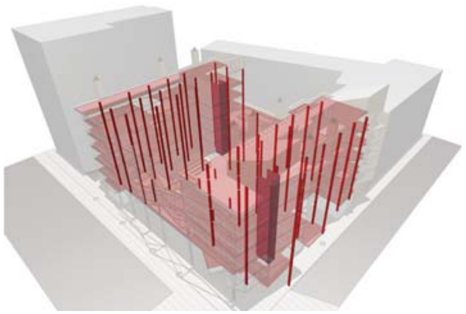


Fig. 7.5: Concrete columns and slabs

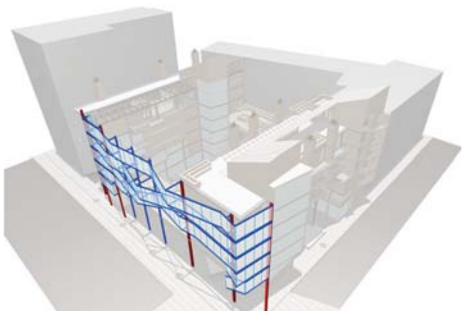


Fig. 7.6: Screen structure

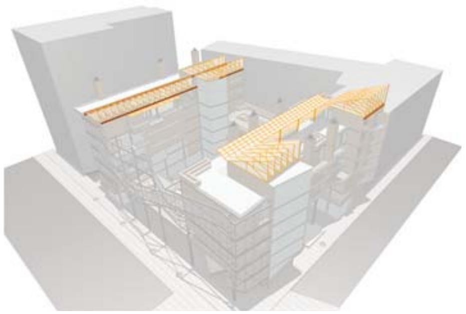


Fig. 7.7: Roof structure

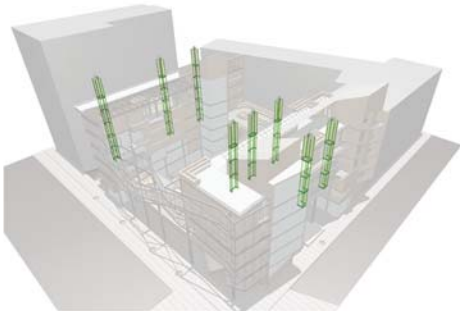


Fig. 7.8: Ventilation towers structure

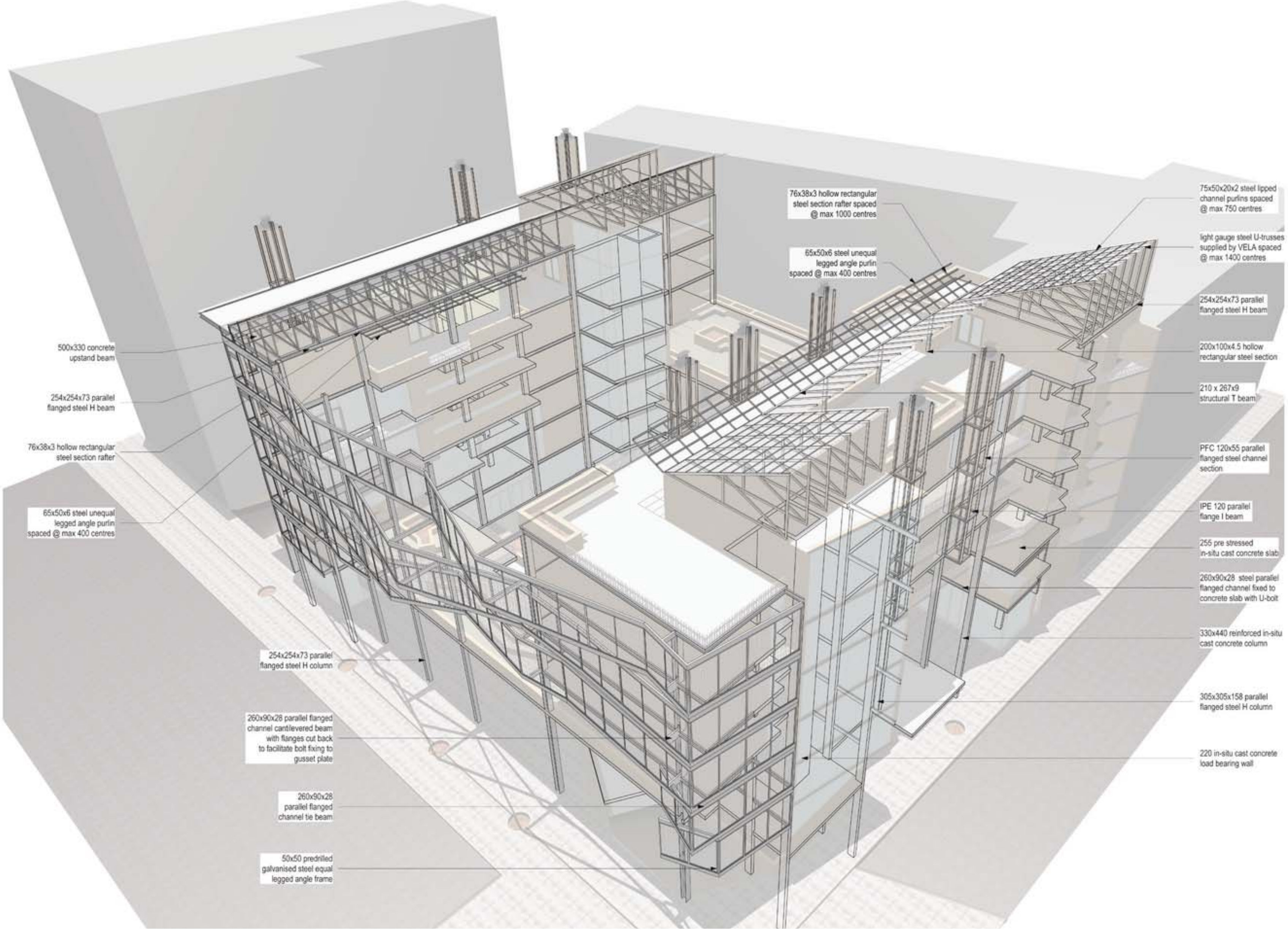


Fig. 7.9: Structural diagram of entire building

Screen Structure

Numerous structural elements have been considered during the technical investigation of the screen. Main design determinates were context, materiality, maintenance, weight and sizing as structural elements supporting the screen are not to hamper light and air moving through the shading device. During the investigation process it has been found that vierendeel girders and wide flanged rolled steel sections could not be used due to inadequate required depth, causing the supporting structure to reduce space available for the shading device drastically. Deep rolled steel sections have therefore been used for all horizontal support elements.

The structure used to support the screen are 254x254x73 Parallel flanged steel H columns for vertical support with 260x90x28 parallel flanged steel channel cantilevered beams which allows the screen to step away from the rigid column grid in order to facilitate gateway formation and way finding. The cantilevered beams then have cut back flanges to facilitate bolt fixing to gusset plates, factory welded to steel parallel flanged tie beams.

Where the cantilevered beams are required to connect directly to the building envelope without the use of columns, beams are bolted to gusset plates that are connected to a purpose made parallel flanged channel fixed to the concrete slab. The channel allows the fixing of two cantilevered beams due to the lack of shared structure to allow independent screen placement between different storeys.

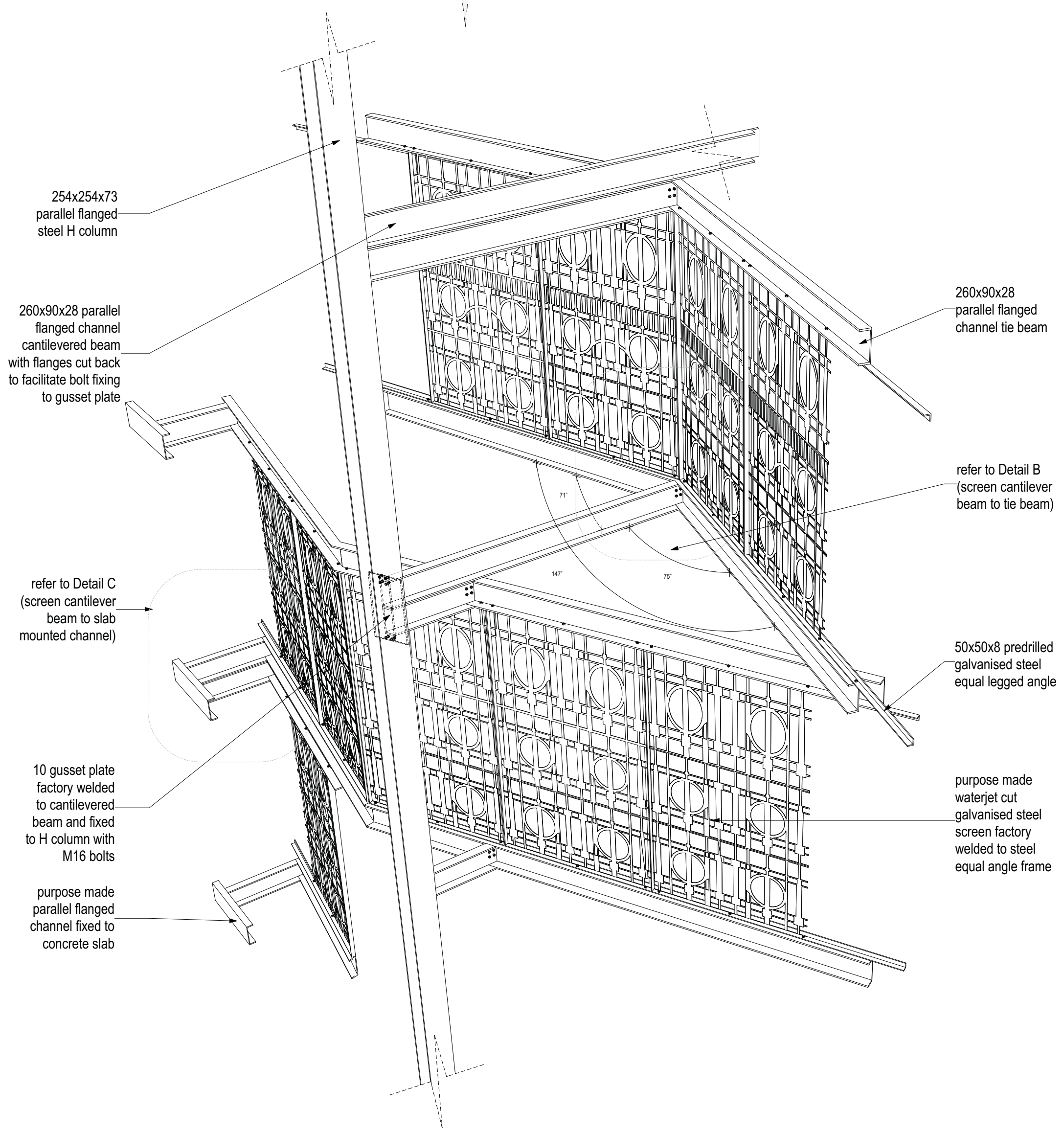


Fig. 7.10: Detail: screen construction

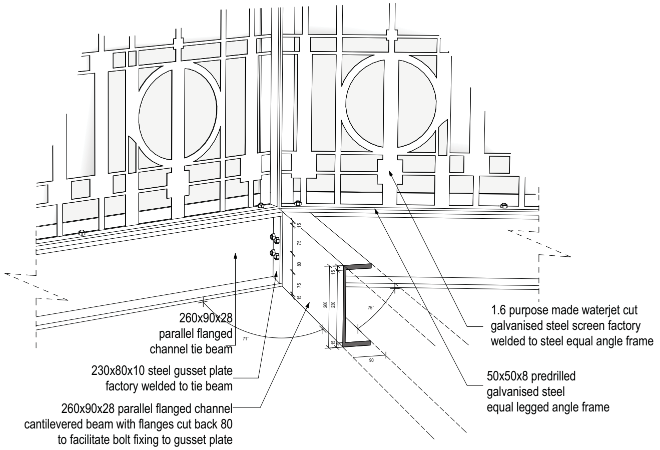


Fig.7.11: Detail: cantilever beam to tie beam

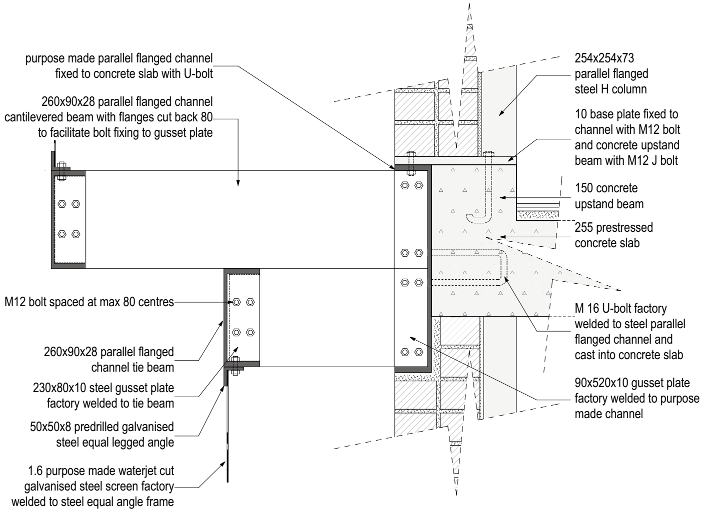


Fig. 7.12: Detail: cantilever beam to slab mounted channel

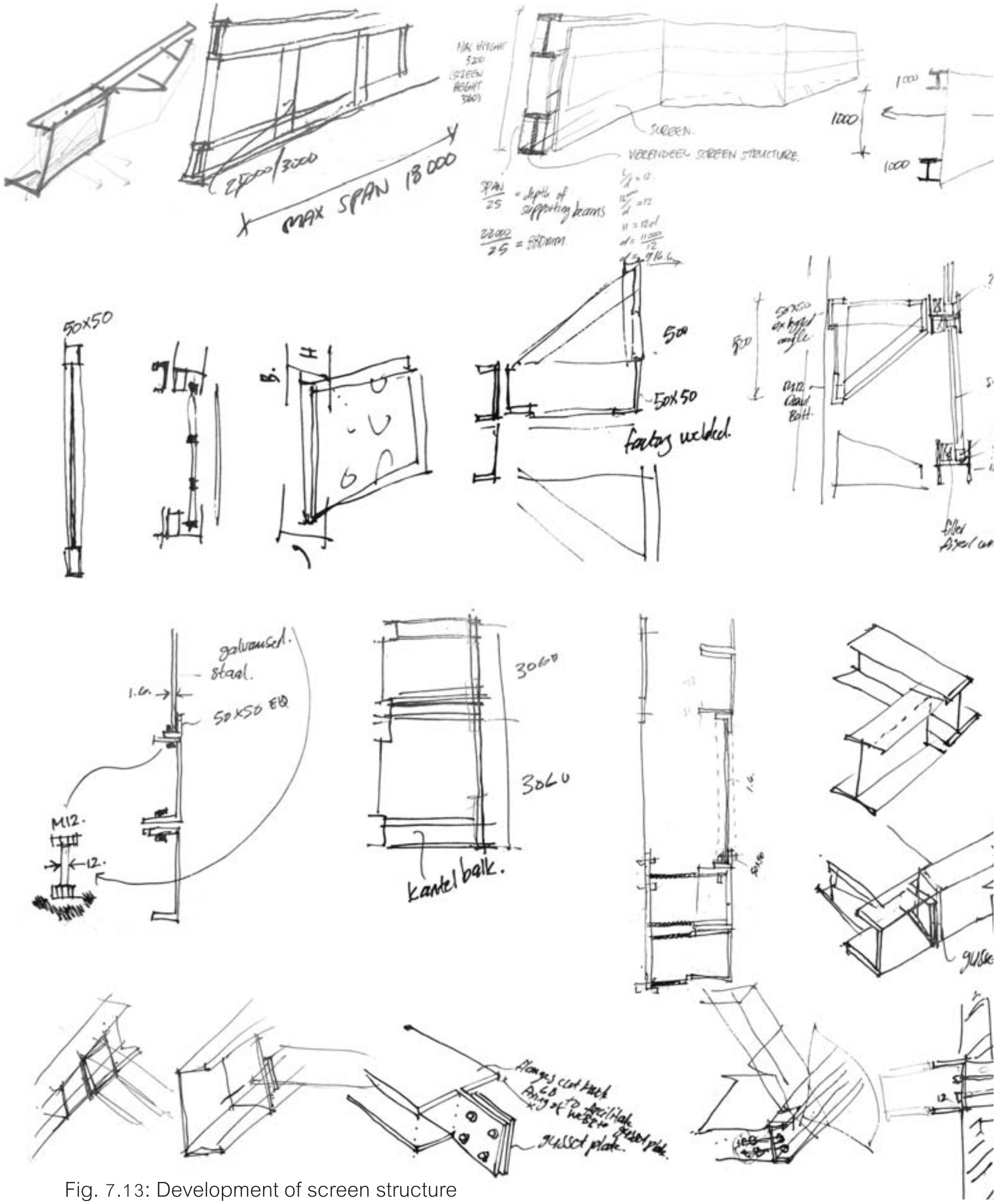


Fig. 7.13: Development of screen structure

Solar Studies + Response

Comparative solar studies has been done in order to determine shading conditions on site and serve to illustrate improvement on current conditions.

The new design provides 5 times the amount of public external space currently available to pedestrians. During summer, shaded space per m^2 on site is increased by 240% while in winter external public sunlit space is increased by 5020%

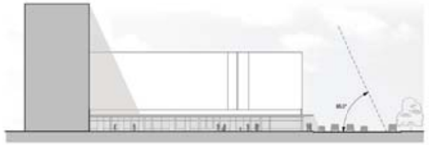
From the solar studies it can be seen that shade created by the ten storey residential building neighbouring the site to the north completely eliminates direct sun on the northern facade during winter thereby reducing natural light within the building and negating the use of numerous sustainable strategies with regards to heating and cooling.

Lack of northern sun during cold months influenced decision making during the roof design and selection as well as placement of sustainable heating and cooling systems. Low light conditions during winter months led to the introduction of an atrium in the northern wing which allows natural light to enter the building from the roof.

In response to context and shading conditions on site a combined roof has been decided upon. The roof is in part an accessible flat roof with mono pitched sections orientated north. Mono pitched roofs are placed to miss shadows created by the neighbouring building in order to facilitate the use of passive solar strategies and are angled at 25° in order to ensure proper functioning of sun driven systems. Clerestory windows have been added to the mono pitched roof sections to allow diffused southern light to enter spaces thereby increasing natural light within the building.

Current conditions during Summer solstice

New conditions during Summer solstice

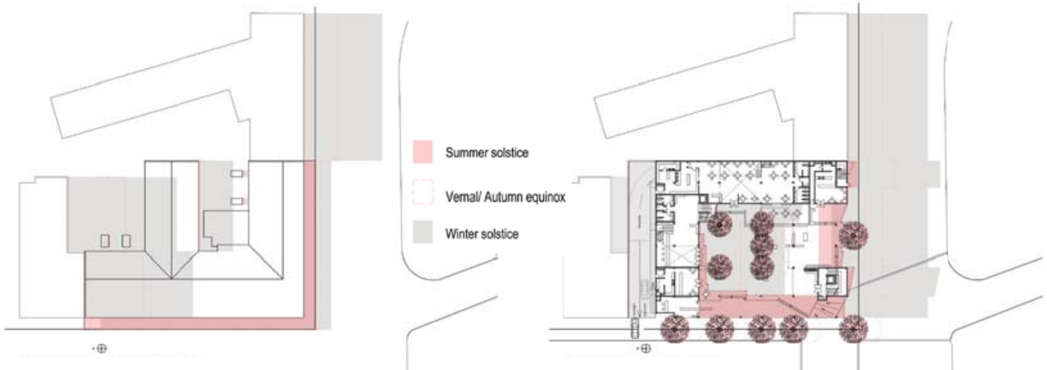


Current conditions during equinox

New conditions during equinox

Current conditions during Winter solstice

New conditions during Winter solstice



Current shade on site

New shade on site

Fig. 7.14: Solar study

Sustainability

The local ambient environment is known to have both a direct physical and emotional effect on man and is therefore of central importance in building design and development (Rabah & Mito 2003).

Buildings incorporating passive systems have indicated a decrease in energy use of up to 90% and an increase in worker productivity by 6-15%. Apart from decreased energy consumption and increased productivity, buildings making use of passive systems have indicated an increase in occupant health and social interaction (Stitt, 1999).

System Selection

Ecosystemic thinking is to think of systems as nested. Each system is seen as part of a larger system (Fisher and Clarke, [2010]). The passive design strategy follows an ecosystemic approach where different passive strategies are combined in order to increase their functionality and make them better suited for the Pretoria climate.

Pretoria is characterised by calm winds. The city has 41.1% wind still days during summer and 57.2% wind still days during winter (Wegelin, 2009). Pretoria CBD is therefore not suited for passive strategies that are wind driven. High insolation rates and a relatively low amount of cloud cover however, makes Pretoria a suitable environment for passive solar driven systems. These systems can be used in conjunction with wind based strategies in order to cool buildings during summer and heat them during winter as well as increase wind intake.

With Pretoria having an average relative humidity between 29 and 75% (BBC, 2011) evaporative cooling systems making use of exposed water are not always functional within the environment due to unfavourable levels of humidity (Air & Water, 2011). It has therefore been decided to use indirect evaporative cooling that does not increase humidity, thereby increasing levels of functionality during summer months when air needs to be cooled. During winter months, air will be treated using the same ducts and pipes while diverting them through an evacuated-tube solar collector system in order to generate heat.

During the technical development of sustainable systems mechanical engineer Peet Pelser has been consulted in order to ensure functionality of the selected systems.

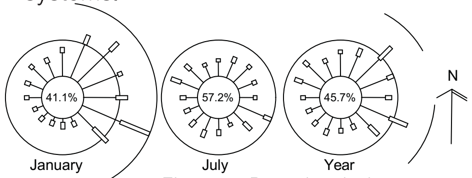


Fig.7.18: Pretoria wind roses

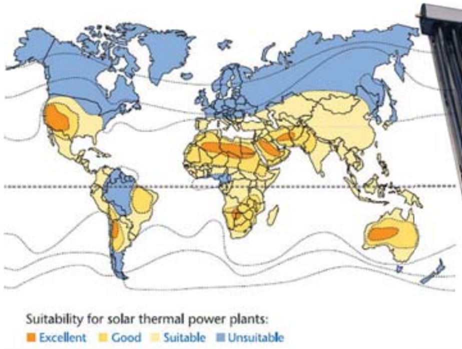
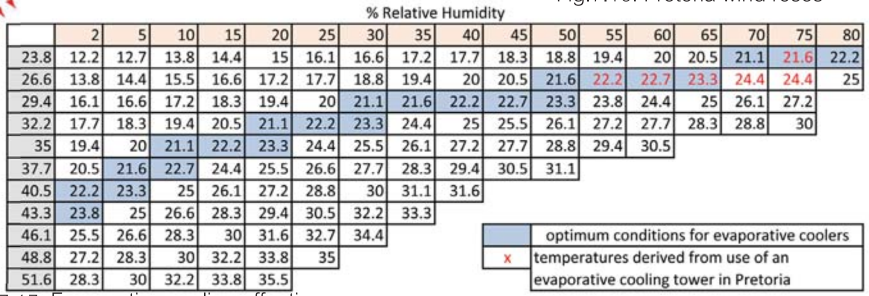


Fig. 7.15: Solar suitability

Fig. 7.16: Evacuated-tube solar collector



% Relative Humidity

Air Temperature

	2	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
23.8	12.2	12.7	13.8	14.4	15	16.1	16.6	17.2	17.7	18.3	18.8	19.4	20	20.5	21.1	21.6	22.2
26.6	13.8	14.4	15.5	16.6	17.2	17.7	18.8	19.4	20	20.5	21.6	22.2	22.7	23.3	24.4	24.4	25
29.4	16.1	16.6	17.2	18.3	19.4	20	21.1	21.6	22.2	22.7	23.3	23.8	24.4	25	26.1	27.2	
32.2	17.7	18.3	19.4	20.5	21.1	22.2	23.3	24.4	25	25.5	26.1	27.2	27.7	28.3	28.8	30	
35	19.4	20	21.1	22.2	23.3	24.4	25.5	26.1	27.2	27.7	28.8	29.4	30.5				
37.7	20.5	21.6	22.7	24.4	25.5	26.6	27.7	28.3	29.4	30.5	31.1						
40.5	22.2	23.3	25	26.1	27.2	28.8	30	31.1	31.6								
43.3	23.8	25	26.6	28.3	29.4	30.5	32.2	33.3									
46.1	25.5	26.6	28.3	30	31.6	32.7	34.4										
48.8	27.2	28.3	30	32.2	33.8	35											
51.6	28.3	30	32.2	33.8	35.5												

▨	optimum conditions for evaporative coolers
x	temperatures derived from use of an evaporative cooling tower in Pretoria

Fig. 7.17: Evaporative cooling effectiveness