TECHNICAL INVESIGATION

07: TECHNICAL INVESTIGATION

Jane Mushwana 67.

I am part of the community

07: TECHNICAL INVESTIGATION
1 - PASSIVE TEMPERATURE CONTROL

Passive temperature control will be achieved by incorporating the following aspects:
- Materials;
- Passive ventilation;
- Sun control;
- Mechanical ventilation system for the auditoriums.

1.1 - MATERIALS

CONCRETE:
Concrete is a mixture of cement, coarse and fine aggregate, and water. Concrete is dense and low cost and will be used for the main structure, slabs, columns and retaining walls. The walls of the auditorium will be concrete with a smooth surface, 600 x 300 mm steel shuttering will be used with timber letters attached.

BRICK:
Clay and shales are extracted, crushed, blended, ground, screened and mixed with water. This mixture is then extruded, wire-cut, set to dry and then burned in clamp kilns (Wegelin 2006: 6.2).

GLASS:
Glass is made up of soda lime and silicate and heated to a fluid and flattened on a molten tin surface and cooled. Glass transmit light and solar radiation and is translucent. 13mm Laminated glass will be used for the project with three different applications, frame-less glazing, shop fronts and winbloks. Laminated glass consists of two panes of glass that are joined with an inner layer of polyvinyl butyral. Laminated glass reduces sound transmission and blocks out solar radiation (Wegelin 2006: 6.10).

STEEL:
Steel is a ferrous alloy of iron mixed with carbon. Steel will be used for the roof and for the secondary functions of the building, the ramp, balustrades and the louvers. 0,8 mm CQ Steel "Brownbuilt" roof sheeting will be used (Wegelin 2006: 8.3).

FLYWHEEL PRINCIPLE
For the project, materials have been chosen with heavier mass, like concrete and bricks. In the sunny winter, the building will remain warm after sunset, because of the absorptive and emissive qualities of the heavier mass. These same materials and qualities will cool the building during the day in summer, based on the reasoning that the building mass cool during the night (Napier 2000: 3.6).

1.2 - PASSIVE VENTILATION

CROSS VENTILATION
For cross ventilation to happen openings are needed on low levels for air inlet and openings on high levels for air outlet. The air inlet openings should be on the predominant wind direction side of the building. The opening should ideally be on opposite sides of a room to create a flow.

STACK EFFECT
The basic principle that under calm conditions, warm air rises towards the ceiling and the cooler air stays low. The auditoriums have high ceilings to create enough height for the warm air to rise above the lower seating areal. All the pitched roofs slope upwards towards openings for hot air to escape.

VENTURI EFFECT
A projection of deflecting air will draw air from the interior because of the lower pressure zone (Napier 2000).

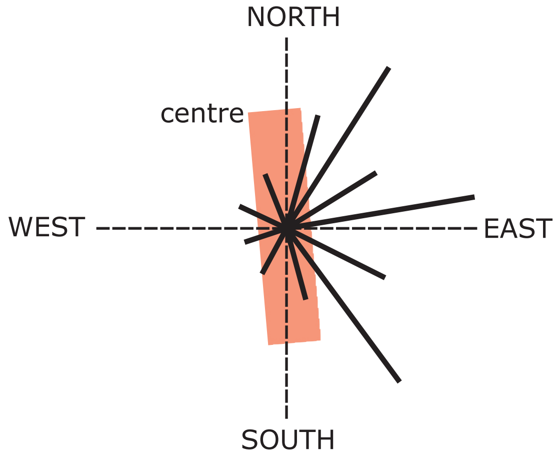


Figure 7.2: Summer wind directions - Pretoria

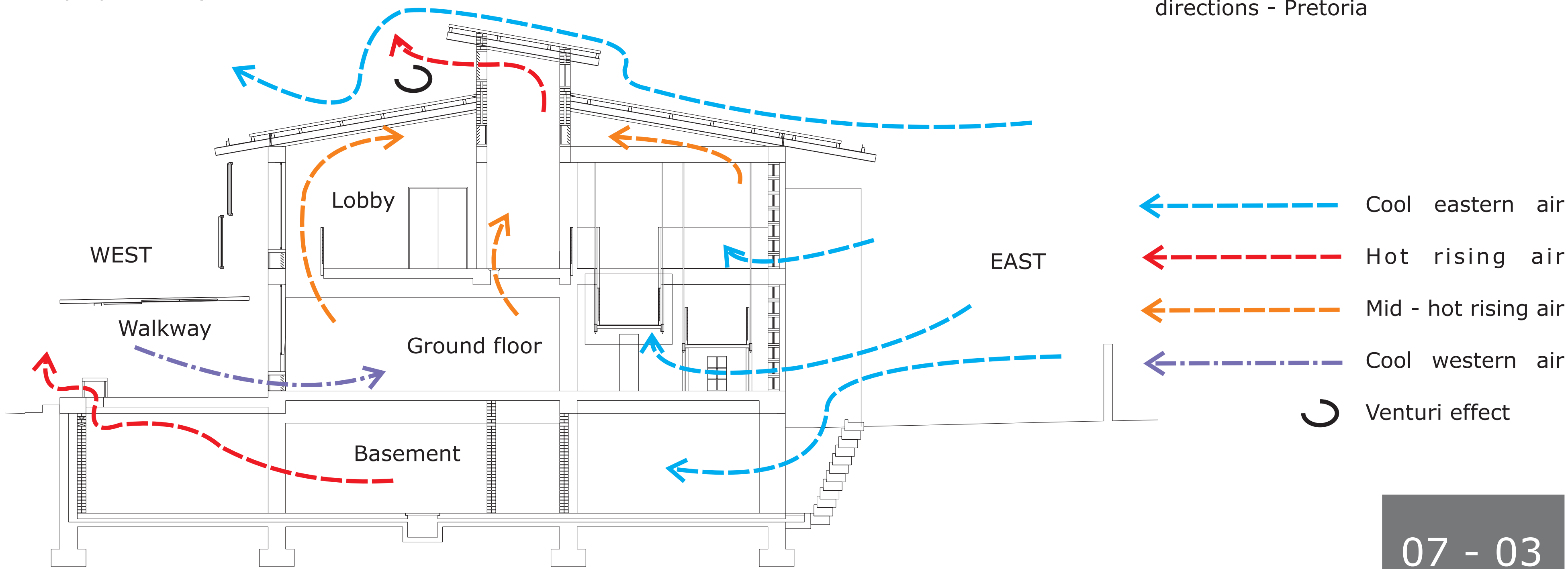


Figure 7.1: Section through Lobby

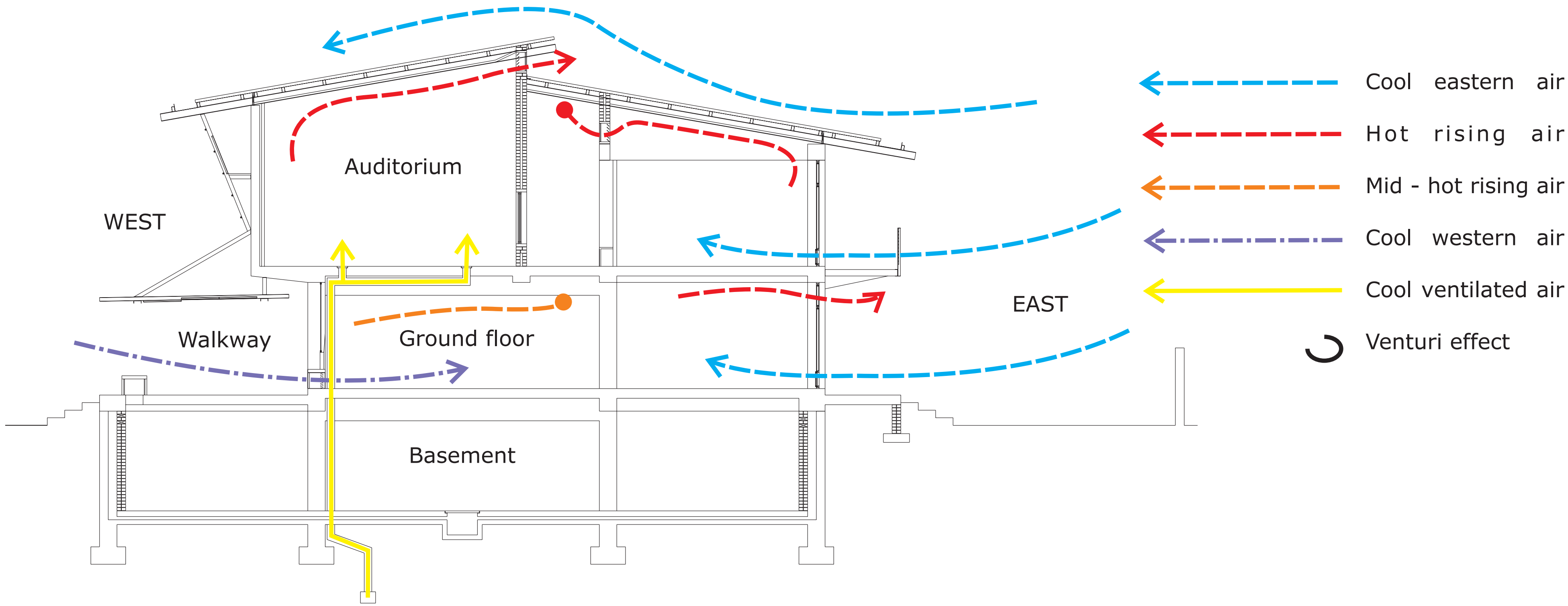


Figure 7.3: Section through Auditorium

1.3 - SUN CONTROL

The predominant elevations face east and west. The building should be shaded in the summer and heated in the winter. The control of sun shading will be achieved by the following:

- Treatment of elevations;
- Heat transmission prevention;
- Adjustable louvres.

1.3.1 - TREATMENT OF ELEVATIONS

North elevation = shaded with the roof overhang.
East elevation = Admin Section = Roof overhang and balcony.
= Ramp Section = Winbloks arranged in groups.
West elevation = The western elevation is the front facade of the building facing towards the street. Adjustable louvres will screen the building and the passing pedestrian. The louvres need to be carefully designed for the building to be visible and readable.

After studying the proposed building and site on a computer simulation, the following times and sun angles were relevant.

Eastern sun onto the building: Summer = 06h00 – 09h00 (50º)
Winter = 07h00 – 12h00 (40º)

Western sun onto the building: Summer = 17h00 - 19h00 (20º)
Winter = 12h00 - 17h30 (40º)

The figure below illustrated the use of moveable louvre panels to control the sun unto the building.

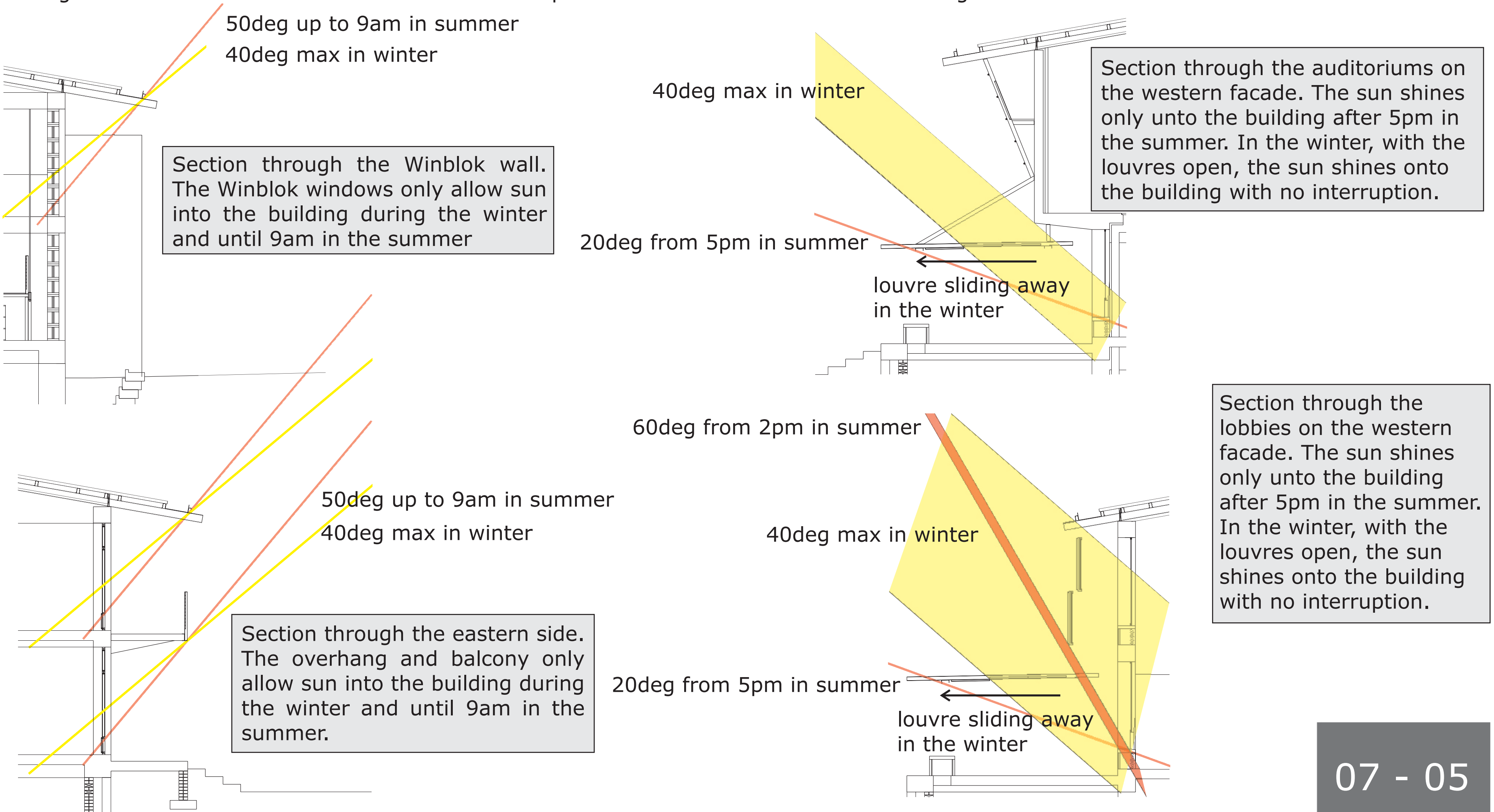


Figure 7.4: Sun control - Elevation treatment

1.3.2 - HEAT TRANSMISSION PREVENTION

The figures below illustrate the importance of isolation to prevent heat transmission into the building. Isolation is used underneath the roof sheeting and between the 280mm cavity wall.

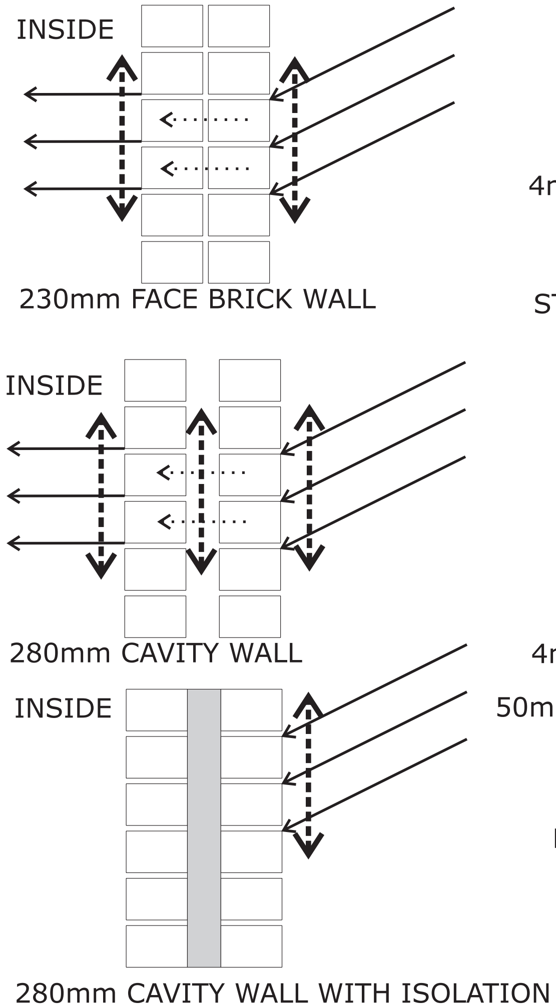


Figure 7.5: HEAT TRANSMISSION-WALL

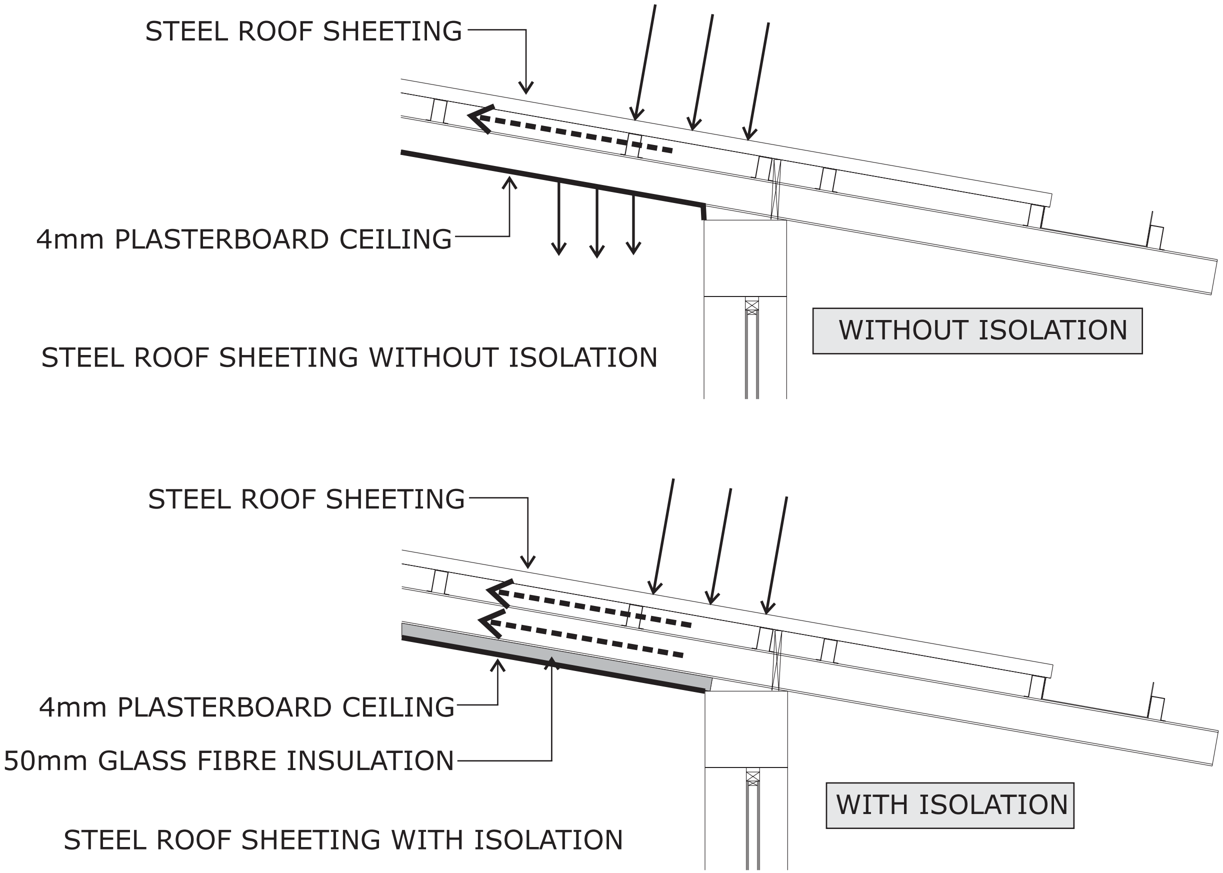


FIGURE 7.6: HEAT TRANSMISSION - ROOF

1.3.3 - ADJUSTABLE LOUVRES

The louvres will be located on the western side all along the facade, except in front of the entrance. A Horizontal louvre structure is needed to shade the ground floor and the passing pedestrian. Vertical louvre structure is needed between the auditoriums to shade the first floor. A few considerations had to be taken into account before designing the louvres:

- Horizontal directed louvres prevent visibility.
- Vertical directed louvres allow sun through.
- Louvres should be on the outside of the building.
- Louvers should be painted a light colour to reflect maximum light.
- Louvres should be a distance from the windows to prevent warmed air from entering the building.
- To allow sun into building in winter, louvres should slide away.

(Napier 2000)

After investigating various options, the author decided to use Vitaloc screens. The screen is made up of a 40 x 40mm grid and 20mm deep, allowing for shade from all directions and visibility from the front.

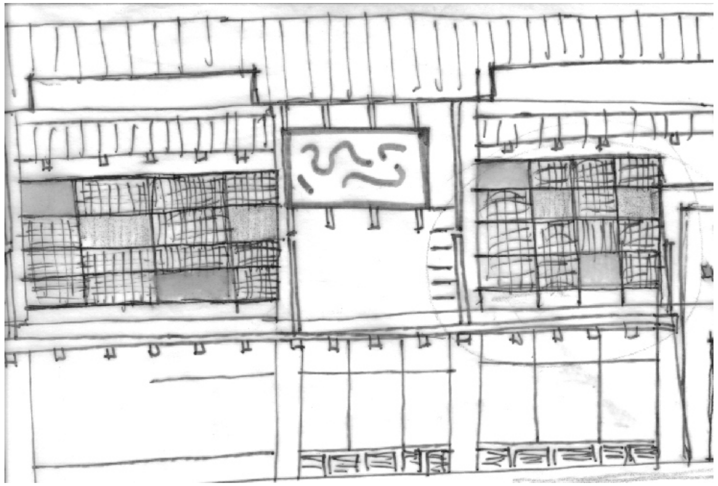


Figure 7.8: Elevation - vertical louvre proposal

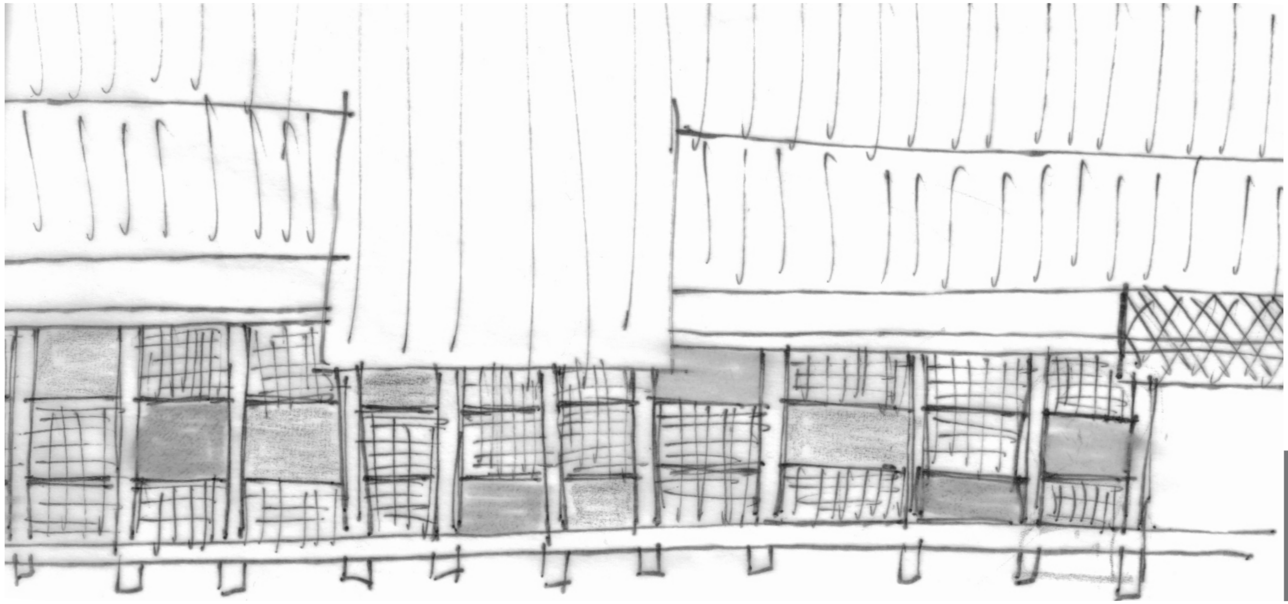


Figure 7.7: Plan - horizontal louvre proposal

LOUVRE DEVELOPMENT

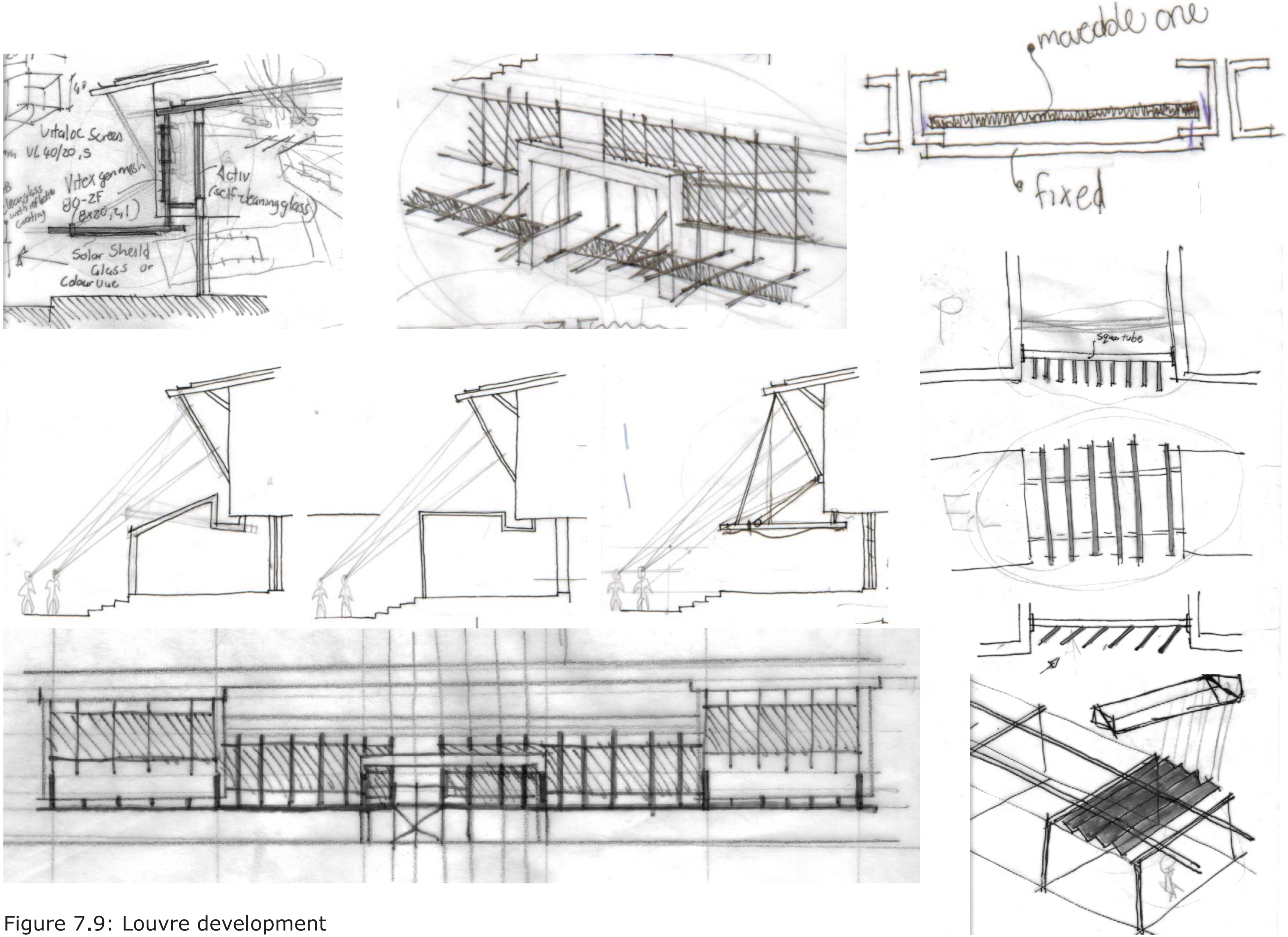


Figure 7.9: Louvre development

HORIZONTAL LOUVRE

The panels slide away from the building to allow sun unto the building in the winter.

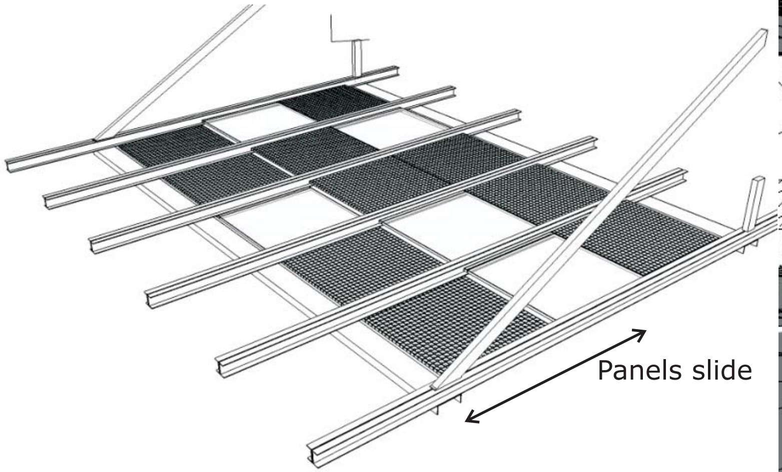


Figure 7.10: Horizontal louvre - summer

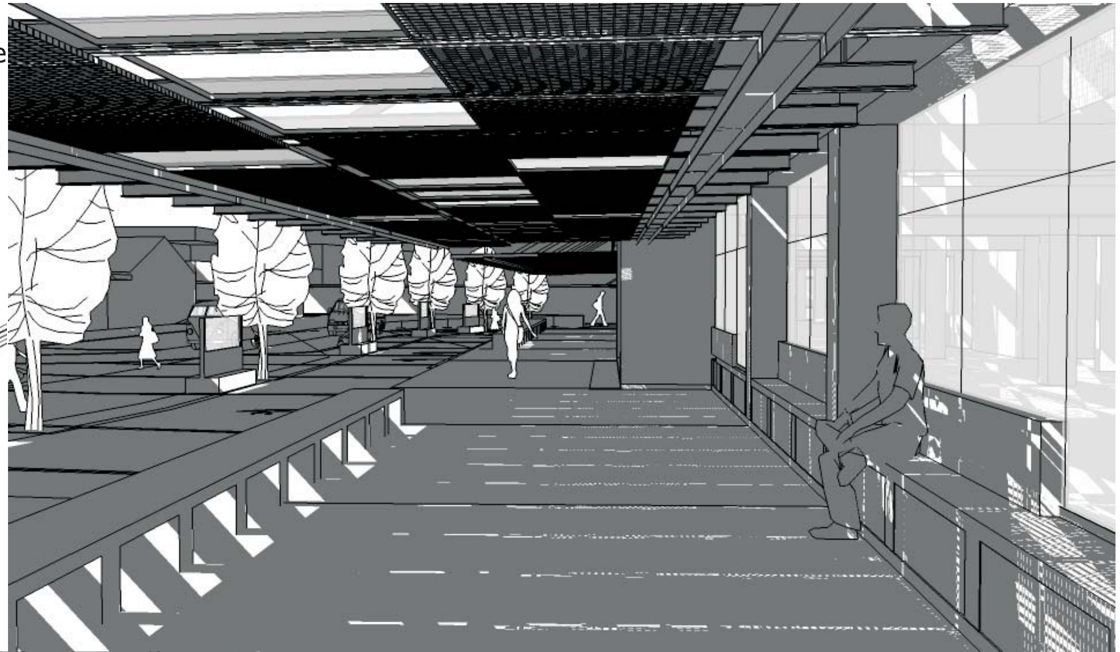
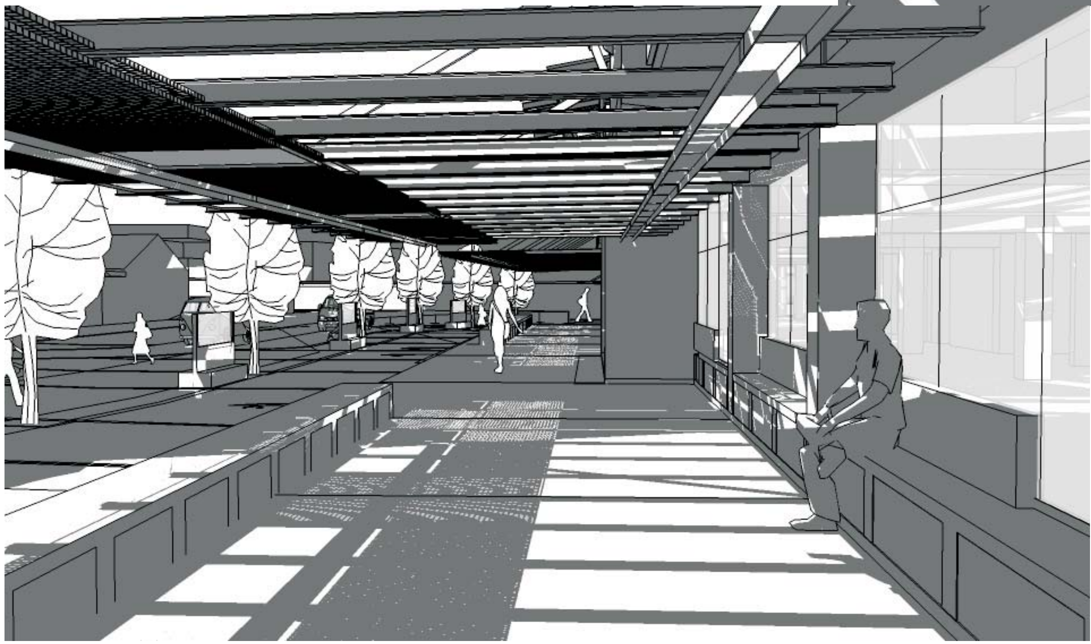


Figure 7.11: Canopy walkway - summer



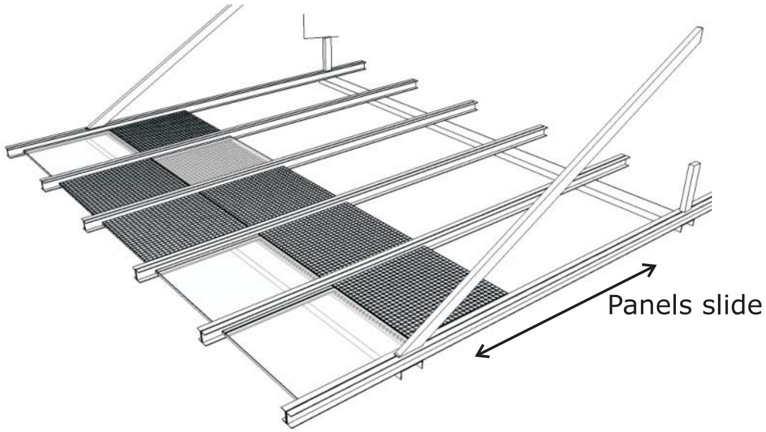


Figure 7.12: Horizontal louvre - winter

Figure 7.13: Canopy walkway - winter

VERTICAL LOUVRE
The panels slide to the side to allow sun unto the building in the winter.

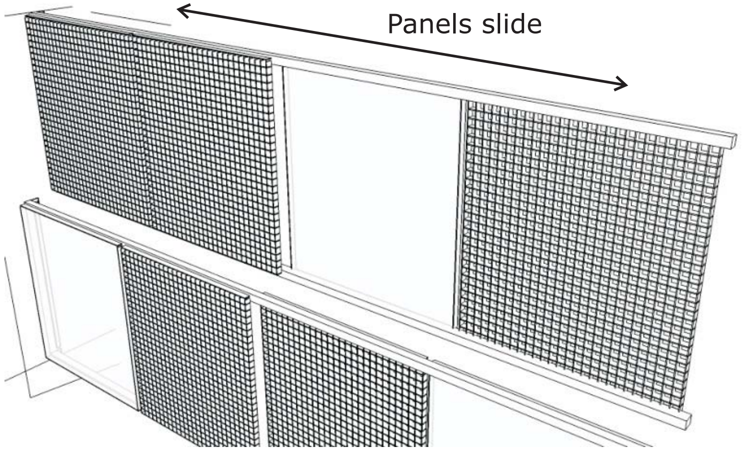


Figure 7.15: Vertical louvre - summer

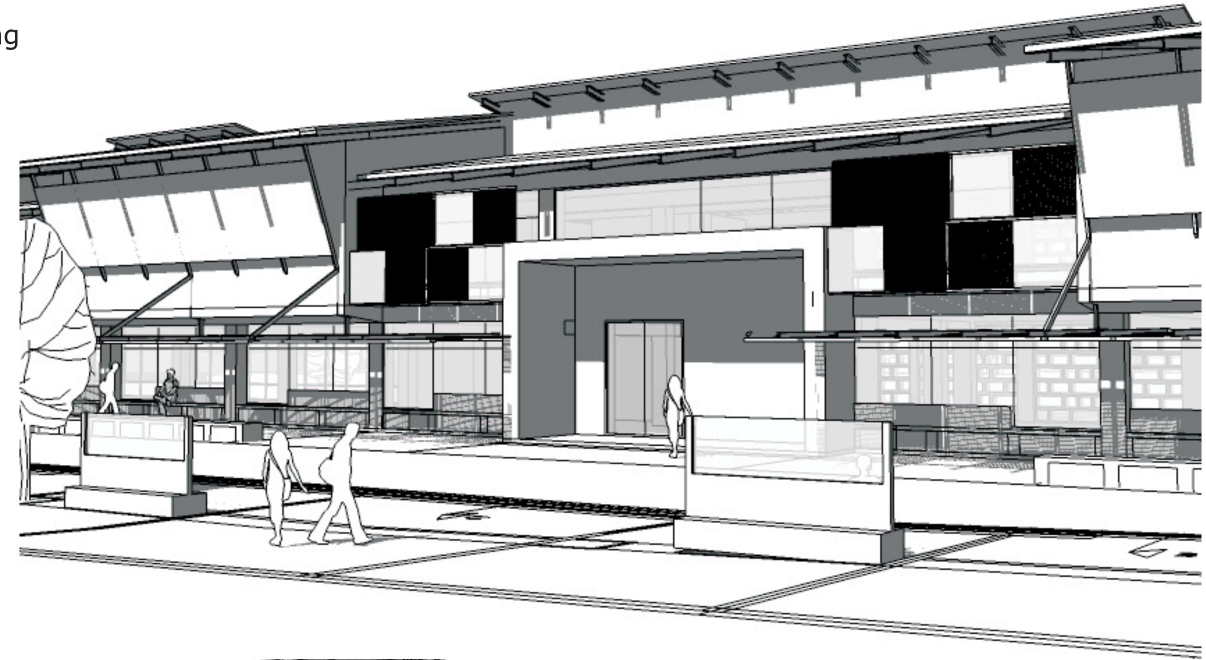


Figure 7.16: Front facade - summer

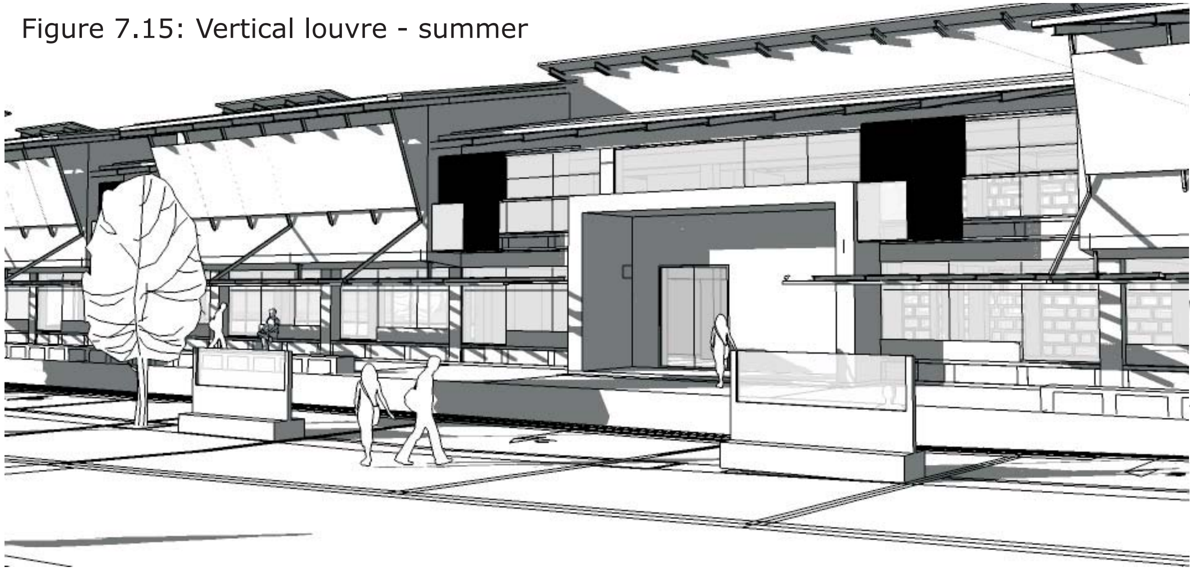


Figure 7.17: Front facade - winter

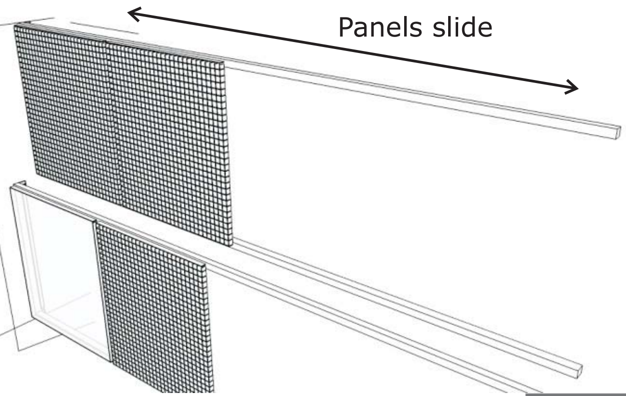


Figure 7.18: Vertical louvre - winter

1.4 - MECHANICAL VENTILATION SYSTEM FOR THE AUDITORIUMS

The auditoriums will mainly be used for adult literacy classes and need to be isolated from the city noise. For this reason, vertical openings for air inlet will not be considered due to the lack of noise isolation. A ventilation specialist have advised the author to use floor inlets for ventilation. Natural air will be forced down a pipe on the southern side of the site with a mechanical fan. The air will be channeled underneath the basement to the relevant auditoriums.

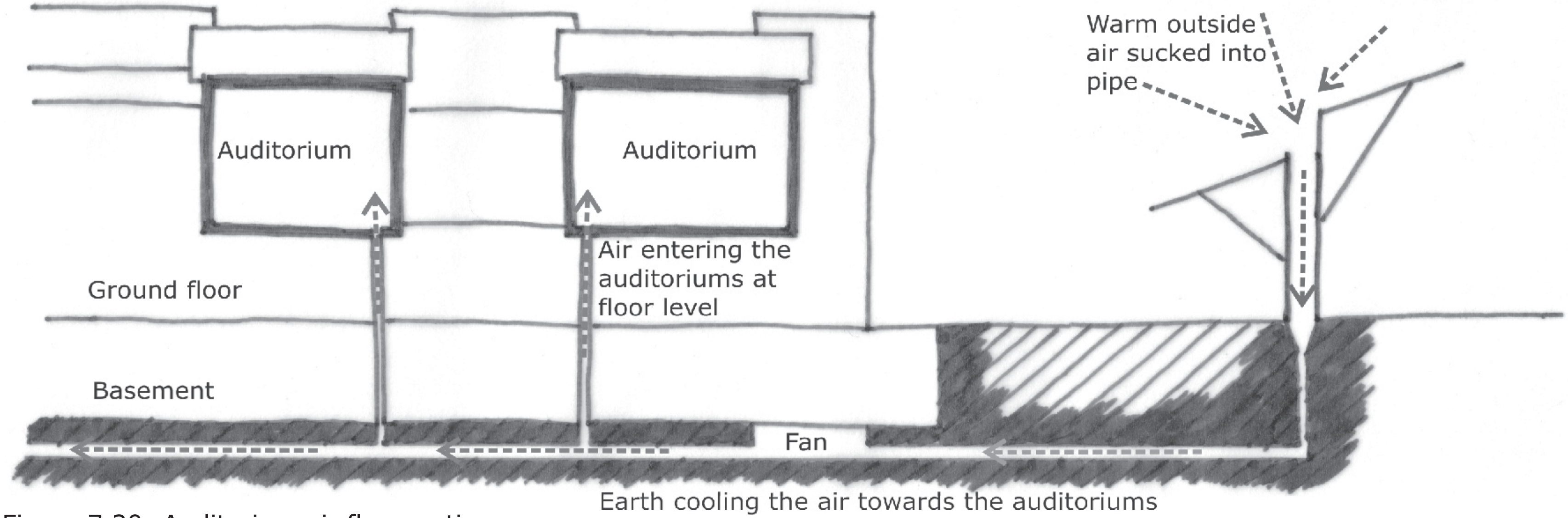


Figure 7.20: Auditorium air flow section

1.4.1 - AUDITORIUM AIR FLOW CALCULATION

Room sizes:
2 x type a: 5.5 x 7 x 5m high
2 x type b: 11 x 7 x 5m high

population:
2 x type a: 16 learners (16 x 2 = 32)
2 x type b: 32 learners (32 x 2 = 64)
total: 64 + 32 + 4 teachers = 100 people

distance (between room and fan)
type a1 = 15m, type a2 = 25m
type b1 = 45m, type b2 = 55m

Air flow:
Requirement: 5m/sec per person
100 PEOPLE X 5m/sec = 0.5 m2/sec + 50%(distance) = 0.75m2/sec

1.4.2 - MECHANICAL VENTILATION CALCULATION

After consulting with a ventilation engineer company, Luft industries, 2 different fans were considered which would provide the amount of air for the auditoriums.
● a cased axial industrial fan, 7.5kw, 400pascal pressure, 1m dia fan, ducting: 680 x 800mm.
●centrifugal fan, 3kw, 500pascal pressure, ducting: 240 x 360mm

2 options for obtaining the energy needed to run the fan was considered, a wind turbine and solar panels.

Wind turbine: the lack of consistent strong winds in Pretoria makes a wind turbine inefficient to create 3 or 7.5kw of energy.

Solar panels: a solar power company, Plan my Power, was consulted.
Information used:
Solar panels = 80watt,4.6amps, 1,1 x 0,6mm
Regulator = 20a (1 per 3 x 80w solar panels)
Batteries = 105ah (only 50% efficient = 50a)
(http://www.planmypower.co.za)

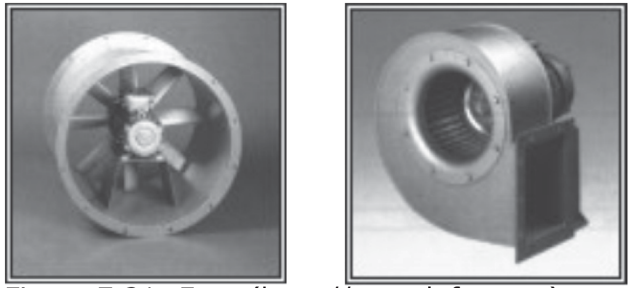


Figure 7.21: Fans (http://www.luft.co.za)

	cased axial fan (7.5kw)	centrifugal fan (3kw)
Usage/day	7 500 w x 8hours = 60 000 w.day	3000 w x 8hours = 24 000 w.day
Dayusage/ sunhours	60 000/5.6hours = 10 714 + 20%	24 000/5.6hours = 4 285 + 20%
+ 20%(inefficiencies)	= 12 857 w	= 5 142 w
W/80 w solar panel	12 857 w/80 = 160 solar panels	5 142 w/80 = 64 solar panels
Inverter	2 x 3000w and 1 x 1500w inverter	1 x 3000w inverter
Batteries	160 x 4.6a =736 x 5.6hours =4121ah	64 x 4.6a =294 x 5.6hours =1646ah
	4121/50a = 82 batteries	1646/50a = 32 batteries
Regulator	160 / 3 = 54 20a regulators	64 / 3 = 22 20a regulators

Result: lsb 325/43 centrifugal fan
Solar panel sqm = 64 x 80w solar panels,1.1 x 0.6m x 64 = 42.24sqm

1.4.3 - THE BEACON

The ventilation inlet and the 64 solar panels were incorporated into a beacon. The beacon has a tree shape and form part of the line of trees above the storm water channel that is underground on the eastern boundary. The main core is an air tight glass and steel structure with only an air inlet at the top. The air inlet allow air to enter the core and pass down the core towards the mechanical fan and auditoriums. The beacon is a kinetic sculpture that acts as the mouth of a body, providing air to the auditoriums.

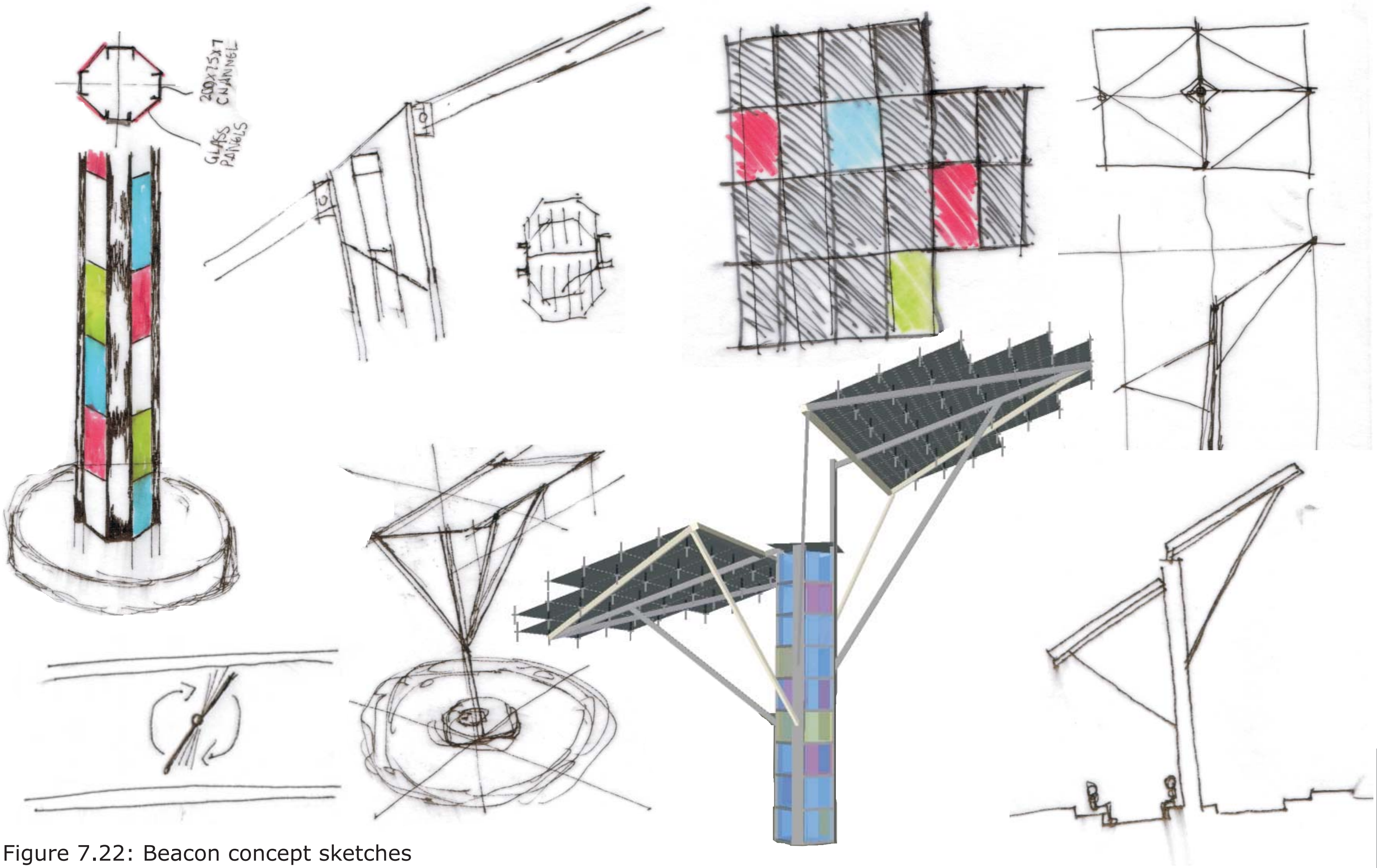
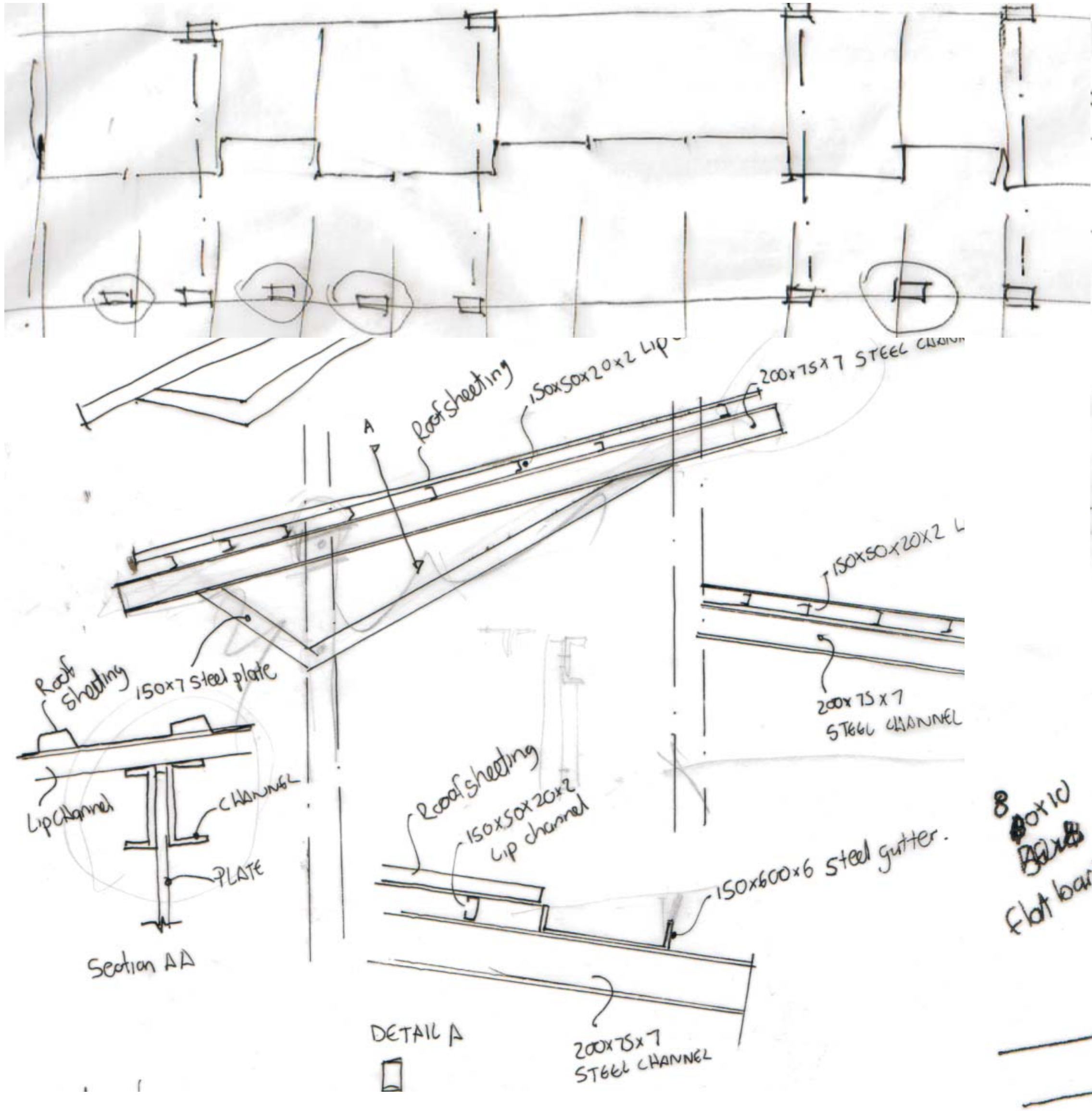


Figure 7.22: Beacon concept sketches

2 - DETAILS

2.1 - DETAIL DEVELOPMENT



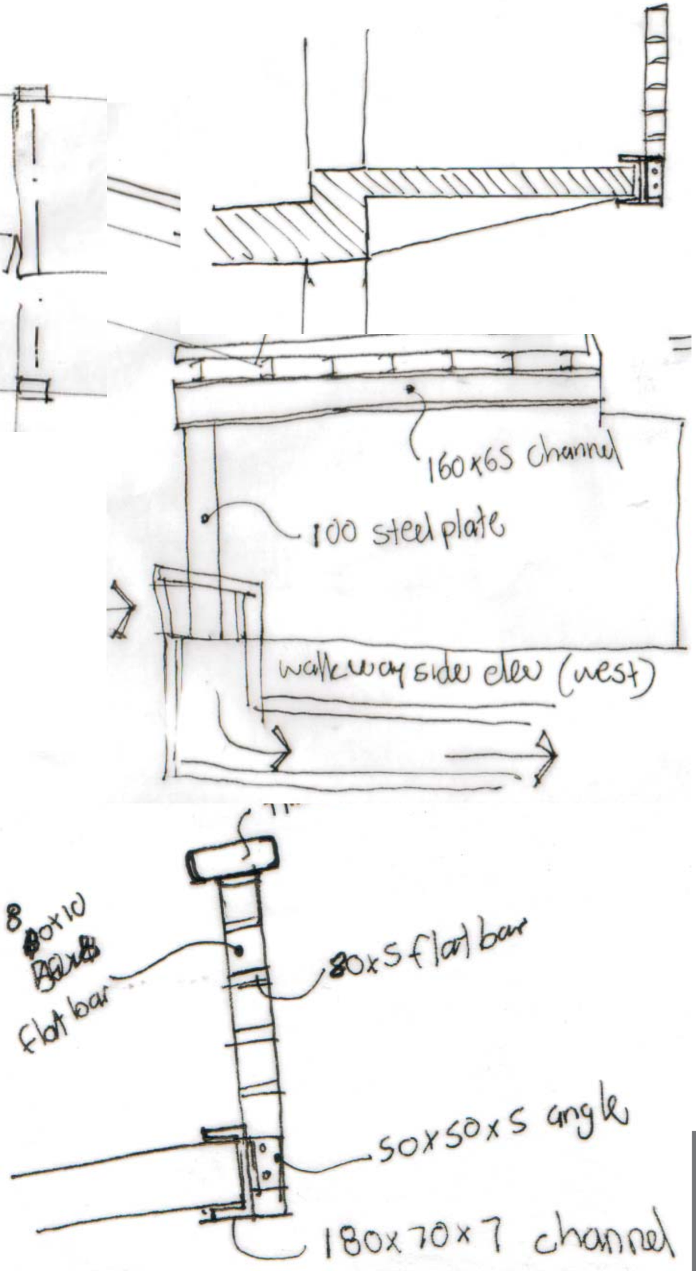


Fig 7.24: Detail development 1

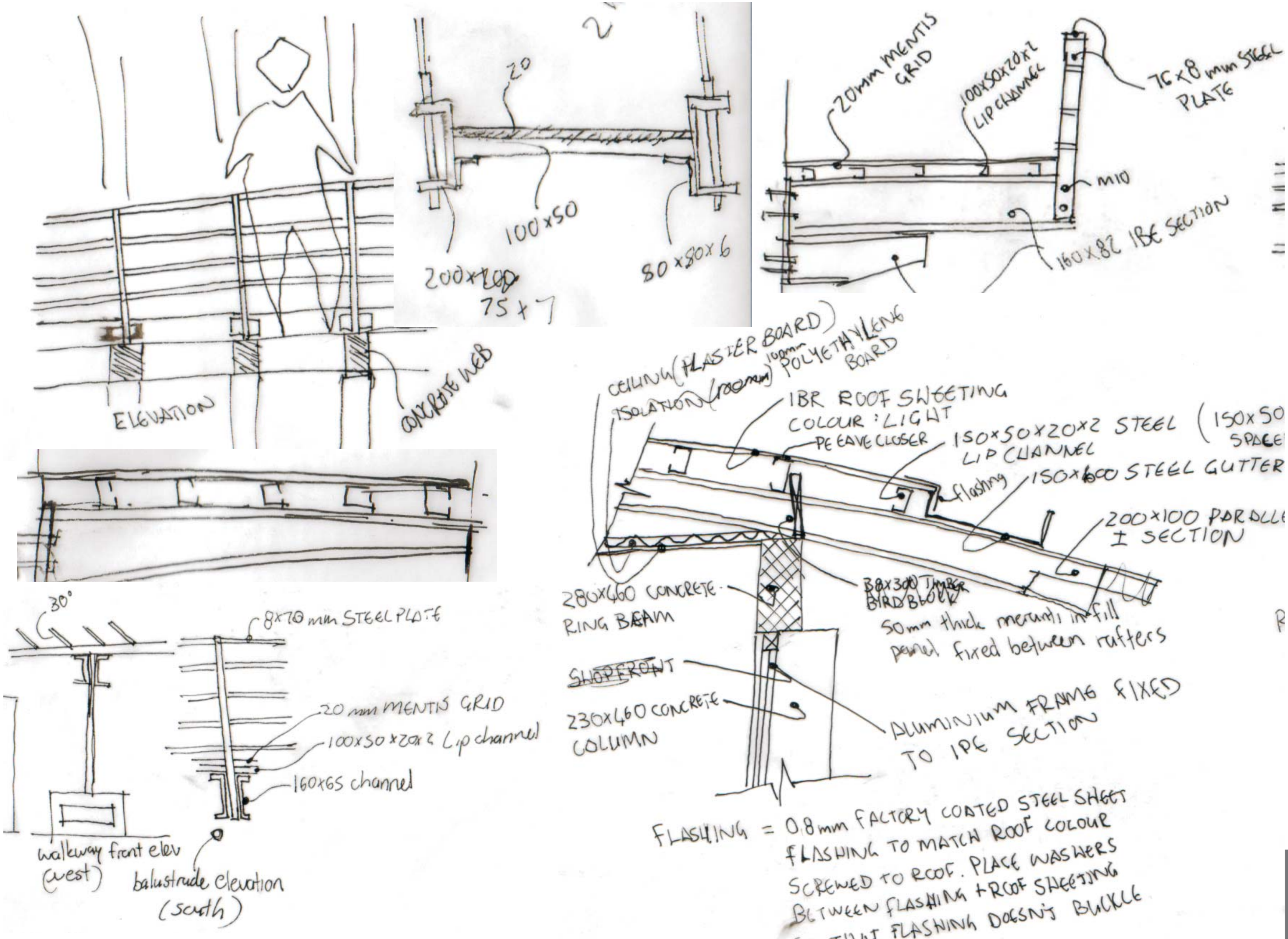


Fig 7.25: Detail development 2

3 - TECHNICAL DRAWINGS