Chapter 7

Technical Development

General Guidelines

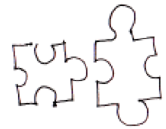
- The design of roof systems should be able to facilitate rain water collection to be used to supplement the municipal water source.
- Especially on the public building, the roof should be able to accommodate the future installation of photo-voltaic panels for the generation of electricity.
- The building should not need artificial means of ventilation, and where possible building systems are to be achieved through passive means.
- The concept of "waste = food" should be employed and encouraged as far as possible through recycling of natural waste.
- Storm water should be encouraged to re-enter the sub soil, instead of being channelled to municipal drainage systems.
- Any planting on site should be indigenous, non-poisonous and provide adequate shading.
- Materials and structural system chosen should be able to reflect the two different conditions that the buliding interacts with, Fig.163.

Materials

The materials chosen had to satisfy certain criteria:

- The structural system and its infill elements must be able to be constructed by an unskilled or semi-skilled labour force
- The primary structural system must allow for flexibility of internal spaces and both outward and upward expansion of the complex over time.
- The materials must be able to optimise efficiency and decrease wastage during construction
- The materials should be able to be deconstructed with relative ease, and should be able to be reused or recycled into other building projects.
- They must also be able to be used in a construction method that is human labour driven, using mechanical equipment as little as possible.
- As far as possible, the materials must be aesthetically pleasing in their natural state, and should not need regular maintenance or extensive finishing added to them

Materials: Structural System



A cold formed steel structural frame system was chosen because:

- This system allows for large spans to be supported by an aesthetically light structural frame.
- The structural system allows for internal flexibility of space as walling systems will not be load bearing.
- It also allows for flexibility of expansion as the basic system is already in place, should an extra floor level be needed.
- It is able to be prefabricated and galvanised off site, fixing holes will be predetermined allowing for a higher degree of accuracy.
- Prefabricated, standard elements will ensure that the structure is erected quickly and efficiently with minimum wastage.
- The majority of the junctions will be bolted to allow for ease of deconstruction or re-use.
- Steel is able to be recycled more easily as compared to concrete.
- Aesthetically steel as a material is drawn from the informal zozo shacks that are numerous in the surrounding area as well as drawing from 'high technology' as the intervention is a catalytic one, also in terms of architectural language.

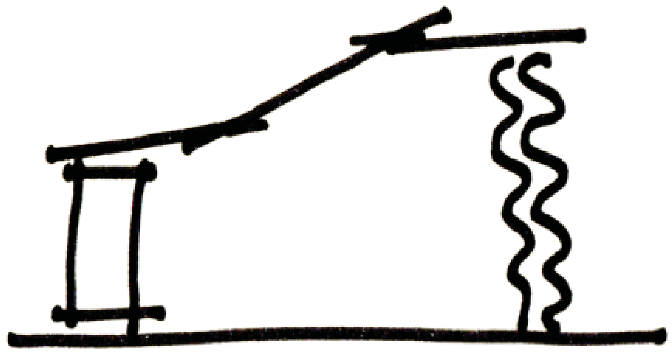


Fig.163.(By Author) Concept Sketch

Materials: Infill systems

Walling

Hydraform Dry Stacking Blocks are compressed soil cement blocks made from a Compressed Earth Block technology. This is the chosen walling system because:

- They are able to be made locally by the community as there are two existing concrete block makers in the vicinity, they will be supplied with the mobile block making machine, Fig.164, and employed to make blocks for the intervention. This in turn will expose the community to a different block technology available to them.
- Hydraform blocks, Fig.165, use 50% less cement [as little as 5% of the block is composed of cement] than conventional concrete blocks. Since 75% of the wall is dry stacked, there is a further saving on mortar needed., therefore they are efficient in terms of both cost and materials.
- The dry stacking method is quicker and easier to construct by unskilled labour, saving on time and human energy.
- The dry stacking blocks will also be more easily removed and possibly reused than conventional mortared walling systems.
- Transportation costs are greatly reduced as the block making takes place on site, where the local sub-soil is the main component.
- The Hydraform system has less than a third of the embodied energy and CO^2 content, as compared to fired clay face or clay stock brick work.

Hydraform, Accessed Accessed 20 September 2010

Fig.164.(Hydraform) Mobile block making machine

Fig.165.(Hydraform) 220mm Hydraform dry stacking block

First Floor Slab

The flooring system for the first floor slab is the composite steel and concrete slab system from QC Brownbuilt Flooring. The Permenant shuttering, in the form of QC panels, provides the following features:

- The panels provide shuttering to supporting the mass of the wet concrete and construction loads
- Together with the concrete fill, the panels provide the necessary tensile reinforcement, saving on additional construction materials.
- No additional ceiling is needed as the panels are ready for painting with PVA compound. This saves money that would otherwise be necessary for ceiling finishes.
- This system is able to be installed by semi-skilled labour and is adaptable to steel
- The system is able to achieve the spans necessary without the additional structure being installed.

Roof Sheeting

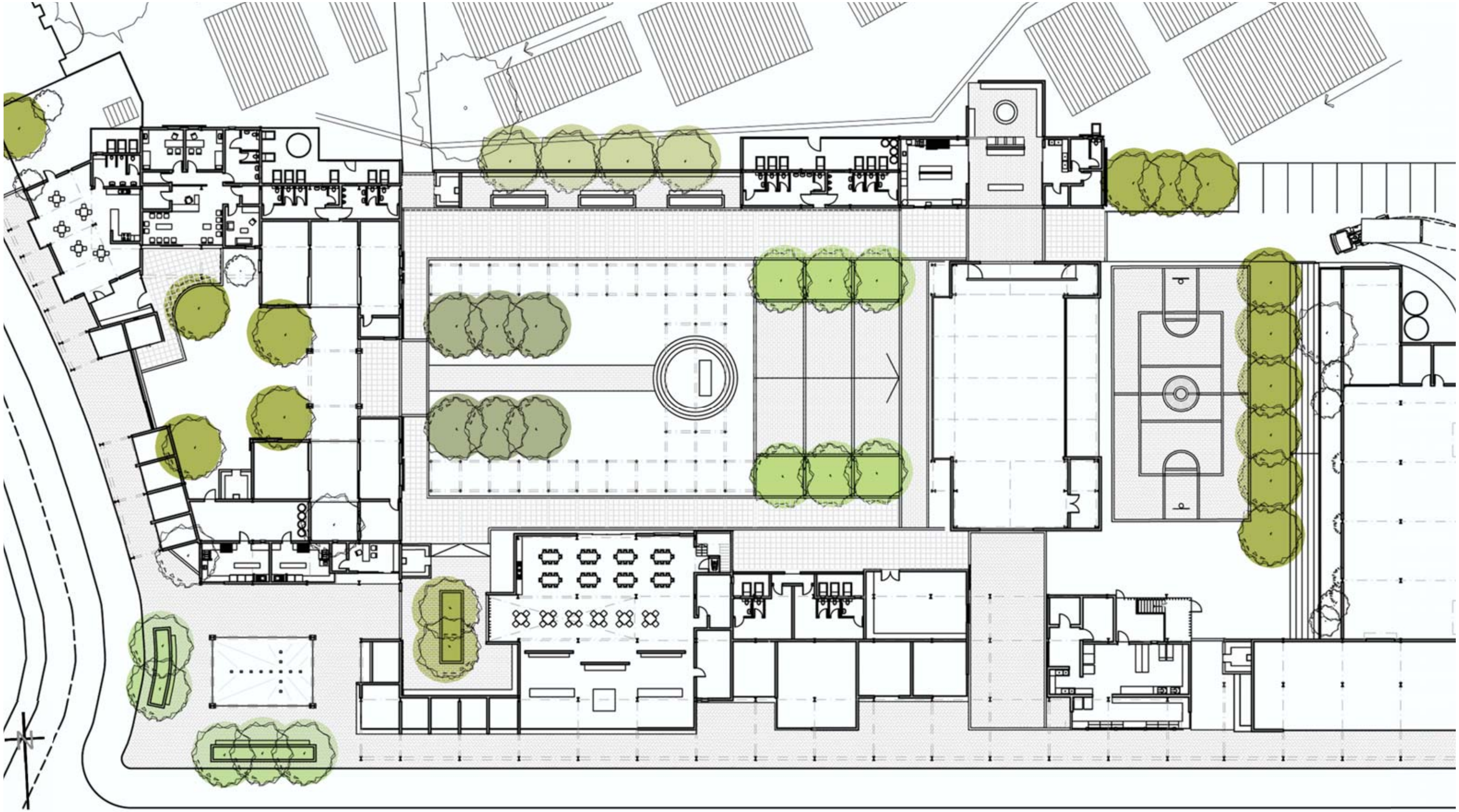
Roof sheeting was chosen as the desired roofing material as it is able to achieve many varied pitches. It is lightweight, easy to transport and is able to reflect sunlight, reducing heat gain.

Craftlock, deep profile sheeting is ideal for the intervention because:

- The roof sheets can be profiled on site, reducing transportation costs.
- The sheets comes in thinner widths but has deeper profiles so spans further and results in less wastage.
- The deep profile is able to achieve a much lower ideal roof pitch.
- The fixing system is also more difficult to break in through- reducing the risk of vandalism or burglary.

Fig.166.(By Author) Opposite Page- Plan showing location & tree species

Location and Choice of trees

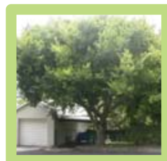


Oleia Africana
[Wild Olive]

Acacia Karroo
[Sweet Thorn]

Euclea Crispa
[Blue Guarri]

Acacia Sieberiana
[Paperbark Thorn]



Celtis Africana
[White Stinkwood]

Rainwater Harvesting

Rainwater collected from rainwater tanks will supplement water used for irrigation of the vegetation and agriculture.

The approximate calculation below is used to determine the maximum harvesting capacity:

> *1mm of rain allows you to harvest 1lt of water per m² of roof area*
> *Allow for 15% wastage* (Jojo Tanks, Accessed 4 September 2010)

Maximum average monthly rainfall for Pretoria is 136mm, experienced in January, however less than 10mm of rainfall is experienced between June and August. This means that rainwater cannot be relied upon as the sole irrigation source.

South African Weather Service, Accessed 4 September 2010

Water from municipal sources will be used for hand washing, kitchen areas, showering and to supplement any rainwater defecit. To conserve water, flow control taps and shower heads will be installed.

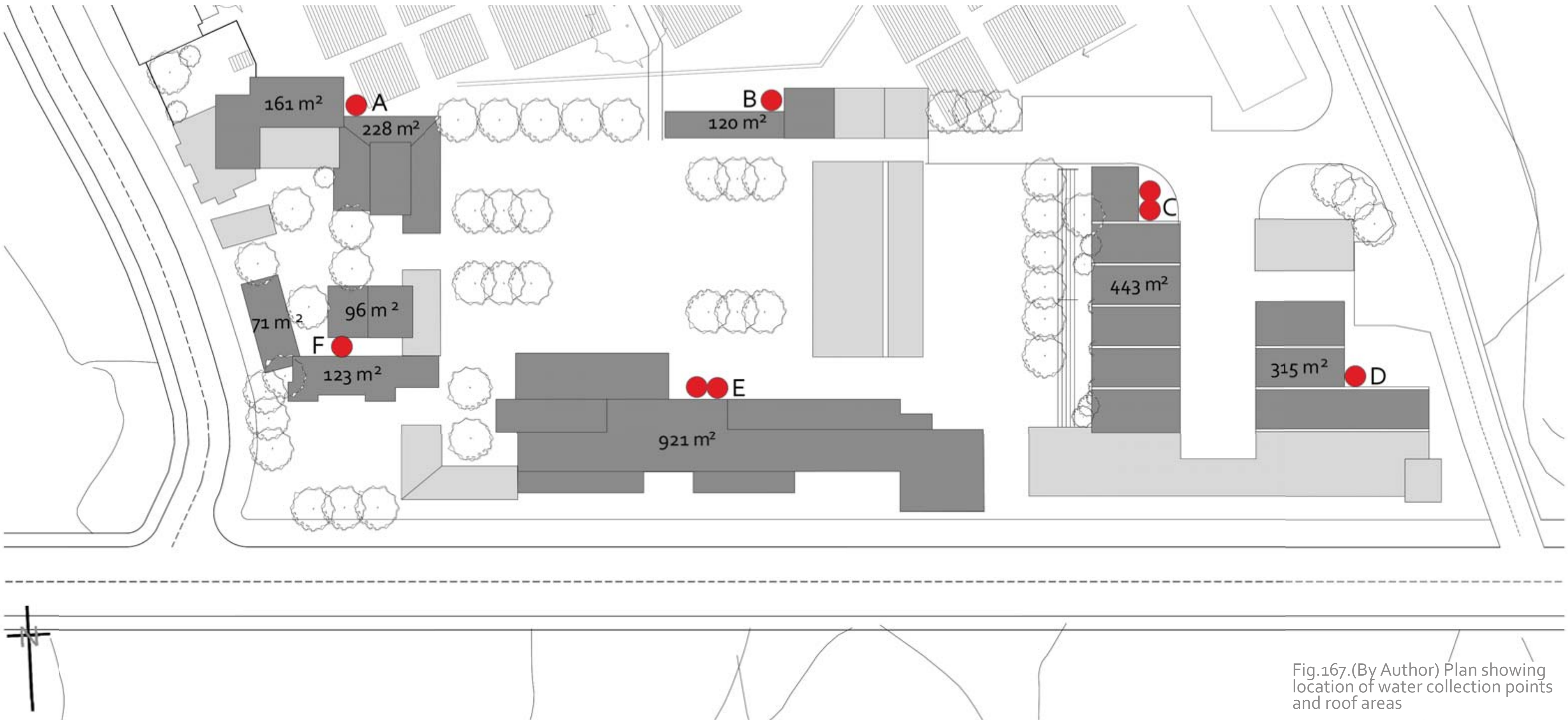


Fig.167.(By Author) Plan showing location of water collection points and roof areas

Maximum Collection Capacities:

Tank A

161m² + 228m² = 389m²
389m² x max. average 136 litres of rainfall collected= 52 904 litres of water
52 904 - 15% wastage = 44 968.4 litres

Tank B

120m² x max. average 136 litres of rainfall collected = 16 320 litres of water
16 320 - 15% wastage = 13 872 litres

Tank C

443m² x max. average 136 litres of rainfall collected = 60 248 litres of water
60 248 - 15% wastage = 51 210.8 litres

Tank D

315m² x max. average 136 litres of rainfall collected = 42 840 litres of water
42 840 - 15% wastage = 36 414 litres

Tank E

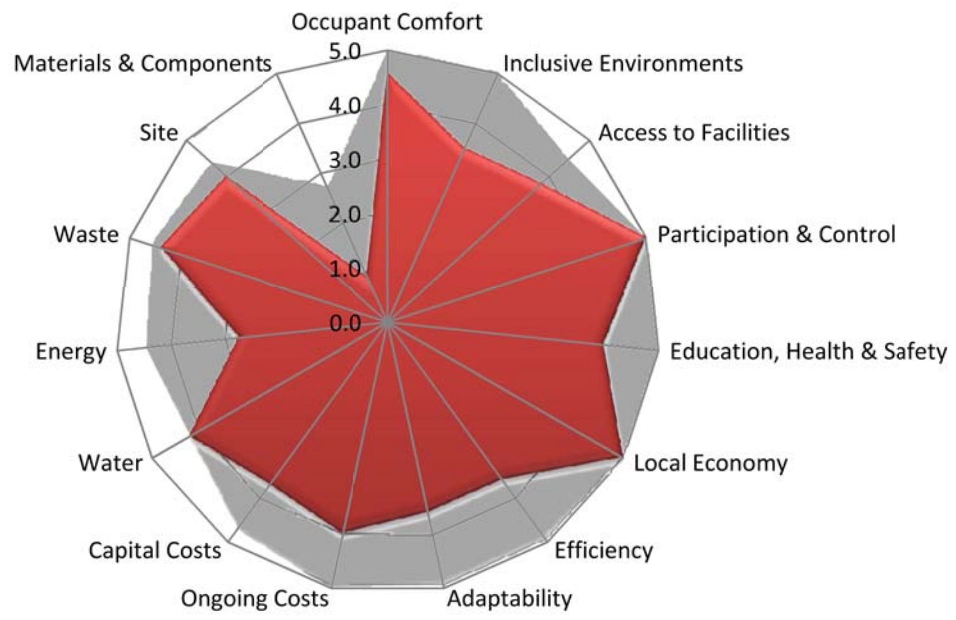
921m² x max. average 136 litres of rainfall collected = 125 256 litres of water
125 256 - 15% wastage = 106 467.6 litres

Tank F

96m² + 123m² + 71m² = 290m²
290m² x max. average 136 litres of rainfall collected = 39 440 litres of water
39 440 - 15% wastage = 33 524 litres

SUSTAINABLE BUILDING ASSESSMENT TOOL (SBAT- P) V1

PROJECT	ASSESSMENT
Project title:Multi- Service Centre for Mamelodi East	Date: 2010
Location: Mamelodi East, Pretoria	Undertaken by: Tamryn Nel
Building type: Mixed Use	Company / organisation: University of Pretoria
Internal area Ground Floor (m2): 3197.93m²	
Internal area First Floor (m2): 912.79m²	Total Internal area (m2): 4110.72m²



Social	4.2	Economic	4.0	Environmental	3.3
Overall	3.8	Classification			

Fig.168.(By Author) SBAT goals and projected results

Sustainable Building Assessment Tool

The intention of the intervention is to design a complex that uses as many passive systems as possible. This is largely due to the location, scale and function of the buildings.

Although the buildings do not utilise many recycled materials, the intention is to use as many materials that are able to be recylced or re-used as possible. The structure has been designed so that it is relatively easy to dismantle or expand through the use of a regular steel frame and infill system. It is unfortunate that the SBAT does not take this into consideration- and therefore the project scores very low in terms of materiality.

The steel frame is manufactured and galvanised off site and assembled upon arrival through the Building Trade Training initiative. As far as possible, the elements are bolted instead of welded together.

It was intended to score highly with regard to 'Community and Access to Facilities', however lacking services such as a bank brought the score downwards.

Universal access is difficult, as to gain access to the second floor would either require a large ramp or a lift - neither of which are financially viable for such an intervention. A platform lift, specifically to accommodate the disabled is cheaper and less structurally intensive than an elevator.

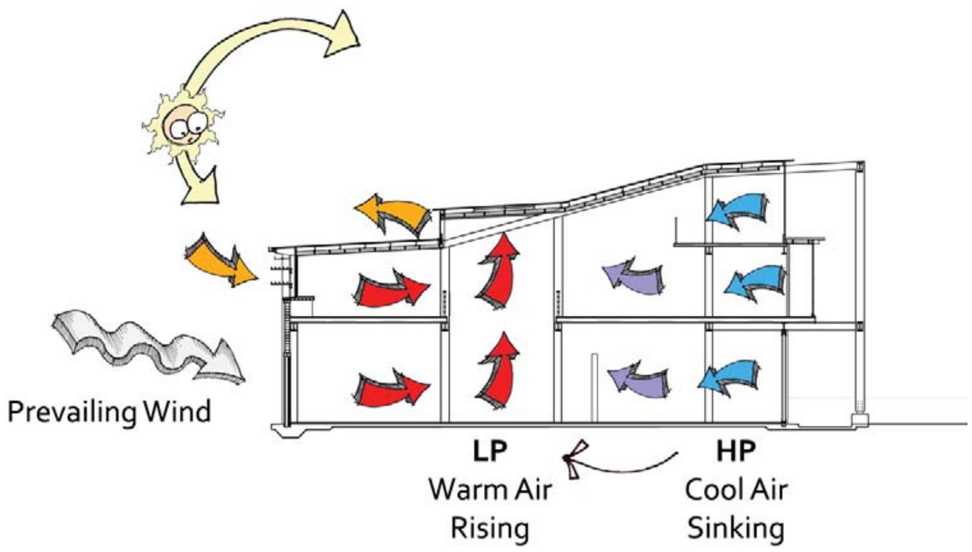
Passive Ventilation

The North facade of the structure is positioned to be able to take advantage of both the prevailing wind direction and the ideal orientation.

The prevailing wind which is from a North Easterly direction will be able to travel through the building and encourage natural cross ventilation.

The Northern face will naturally be warmer as it would be heated by the sunlight, this creates a relative Low Pressue, where the warm air rises. The Southern face does not recieve direct sunlight and therefore will hold a relative High Pressure, where the cooler air sinks.

The warm air rises to escape from the vent in the roof eaves, drawing the cooler air through the buliding as air naturally moves from a High Pressure to a Low Pressure.



Solar Testing

The Public Edge has a desirable orientation for the local climate. It has its major faces orientated North-South, while the smaller East -West faces are able to be easily sheilded from harsh low angle morning and afternoon sunlight.

The dates tested were the summer and winter solstices because these are the two extremes of sunlighting conditions. The solar path over time will vary between these two extremes.

The times modelled were 10am, 12pm and 2pm. These times are seen to be good representitives of morning, midday and afternoon daylighting conditions. Times that are earlier than 10am and later than 2pm would see the sun moving towards the Eastern or Western portions of the sky, thus having less of a direct impact on the major faces and internal spaces.

The design aims to shield the North facing rooms from too much direct sunlight, as this could result in thermal discomfort during summer. This is done through the use of large roof overhangs, horizontal solar control and relatvely small openings.

The Southern facade employs large amounts of transparent glazing as harsh incoming solar radiation is not a problem and large amounts of ambient light can be permitted. The light shelf, formed by the projecting window boxes, bounces this ambient light into the internal spaces.

This modelling exercise was deemed to be successful as minimal direct summer sunlight enters the spaces, while in winter the sun is able to enter more freely, due to the sun's relatively lower angle.

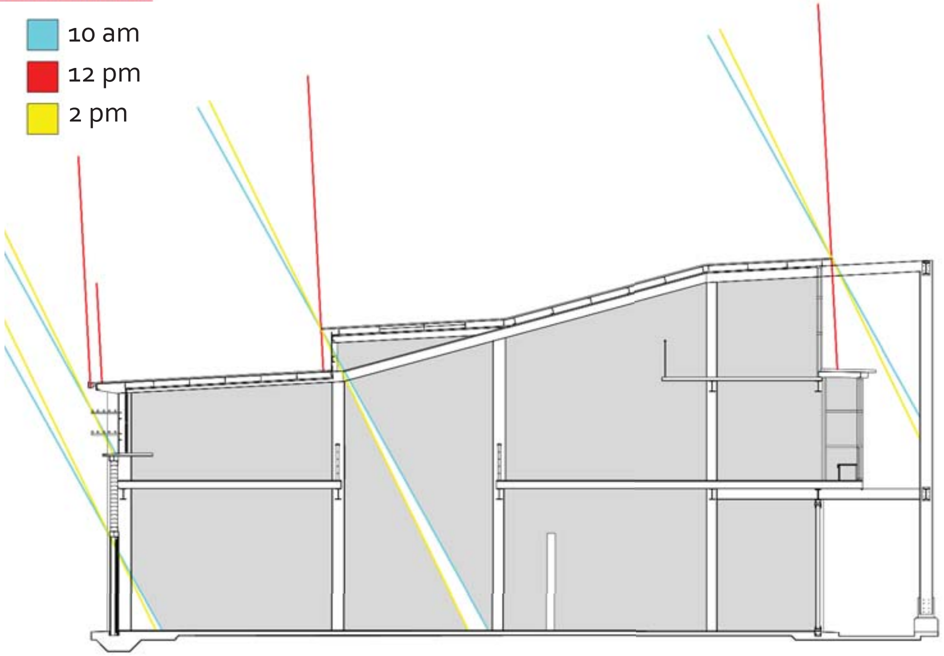


Fig.169.(By Author) Section showing the sun paths at 10am, 12pm and 2pm on December 22nd.

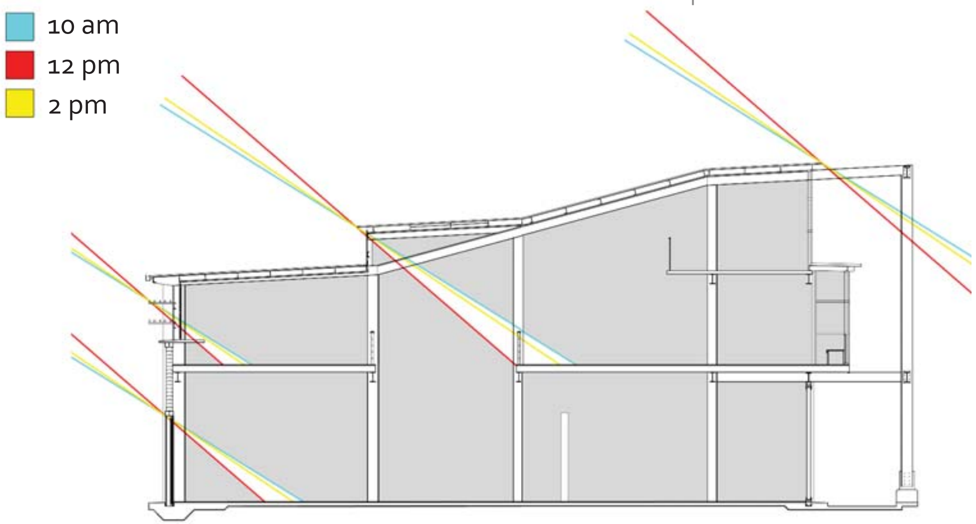


Fig.170.(By Author) Section showing the sun paths at 10am, 12pm and 2pm on June 22nd.

Waste

Within the centre itself, education and the practice of recycling will be encouraged.

Sewage

As laid out in the design guidelines, it was chosen to incorporate a passive sewage system using composting toilet technology. This will allow for the compost generated to be used as fertiliser in the agricultural fields

The Enviro-Loo system:

- Does not use water.
- Does not use chemicals.
- Is a closed circuit system.
- Is odourless.
- Does not require expensive sewage treatment plants.
- Does not attract flies.
- Requires no power.
- Has minimum monthly operating costs.

Enviro Options , Accessed 16 October 2010

Fig.171.(Enviro-Options) View of installed enviro-loos

Organic Waste

Organic waste produced in the kitchens or discarded by the public is to be disposed of in a worm farm. Earthworms turn the organic waste into nutrient rich compost to be used in the agricultural fields.

Inorganic Waste

Inorganic waste is to be sorted at the recycling depot and transported to a recycling centre.

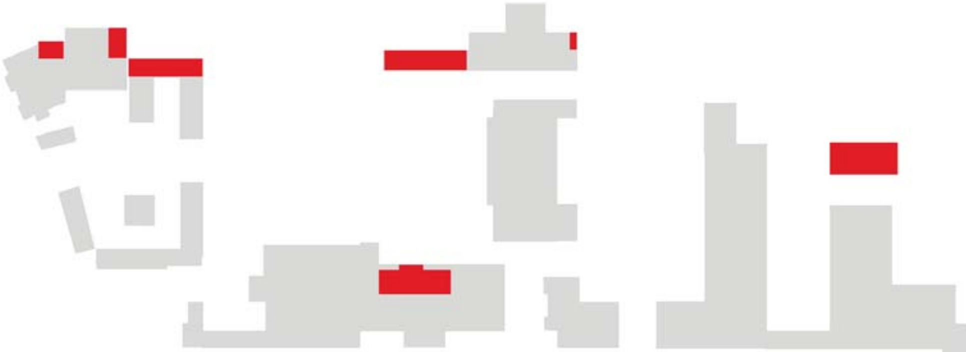


Fig.172.(By Author) Graphic plan showing the location of ablutions

Fire

In any building of two or three storeys in height shall not be required to include any emergency route: Provided that where such building is -

i. any building of two storeys in height where the population of the upper storey is more than 25 persons; or

ii. any building of three storeys in height; such building shall be provided with not less than two such escape routes.

SABS 0400 Part TT 16.2b

Furthermore as indicated it is ensured that there is a Fire Hose Reel provided to service public and higher risk areas as per Part TT34.1, these are indicated by 30m radius circles, Fig.173. Portable fire extinguishers are to be provided as per Part TT 37.2.

The first floor of the public building is catered for by a dedicated escape stair, to the east of the structure.

The maximum structural stablilty time, as outlined in Part TT7d, required for any structure is for :

Class C2 - Museum - 60 mins of Stablility

Occupancy comprising a museum, art gallery or library

Class A5- Outdoor sport - 60 mins of Stablility

Occupancy where persons view outdoor sport events

The rest of the functions contained in the intervention all require 30 mins of Stablility:

Class D2- Moderate risk industrial

Class F2 -Small shop

Class G1 -Offices

Class J2 - Moderate risk storage

Part TT7f states that

When tested in accordance with SABS 0177: Part II, satisfy the requirement for stability for a period not less than that given in (Part TT7d) for the height of the building so given.

(c) The structural elements it shall be permissible for structural components to be of -

(i) unprotected steel

(aa) In any single storey building;

(bb) In any double storey building where the occupancy is classified:

- A3 - Places of instruction
- A4 - Worship
- A5 - Outdoor sport
- B2 - Moderate risk commercial service
- B3 - Low risk commercial service
- C2 - Museum
- D2 - Moderate-risk industrial
- D3- Low-risk industrial
- D4 - Plant Room
- G1 - Offices
- H4 - Dwelling house
- J2 - Moderate-risk storage
- J3 or J4 - Low-risk storage or parking garage

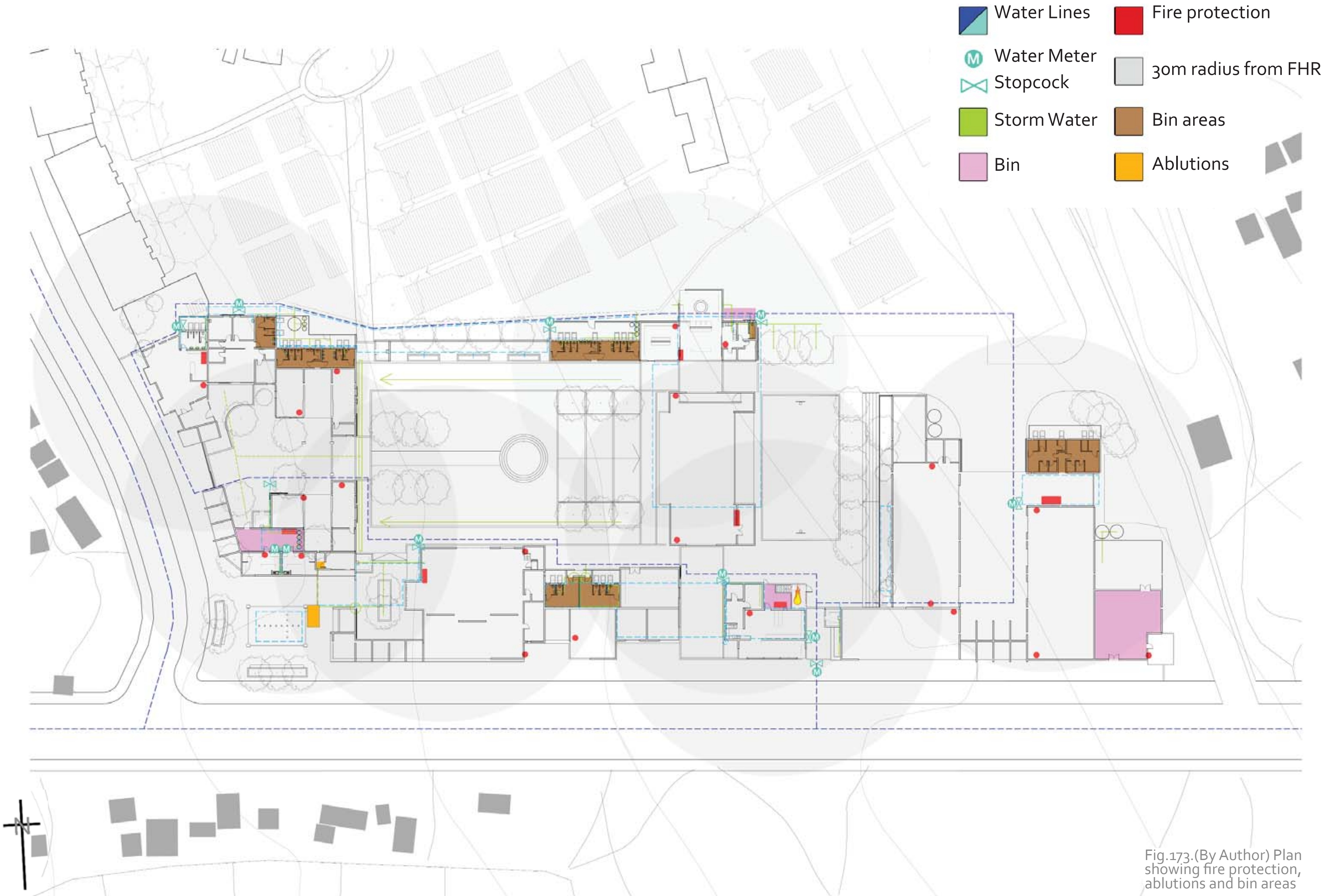


Fig.173.(By Author) Plan showing fire protection, ablutions and bin areas

Defensible Spaces

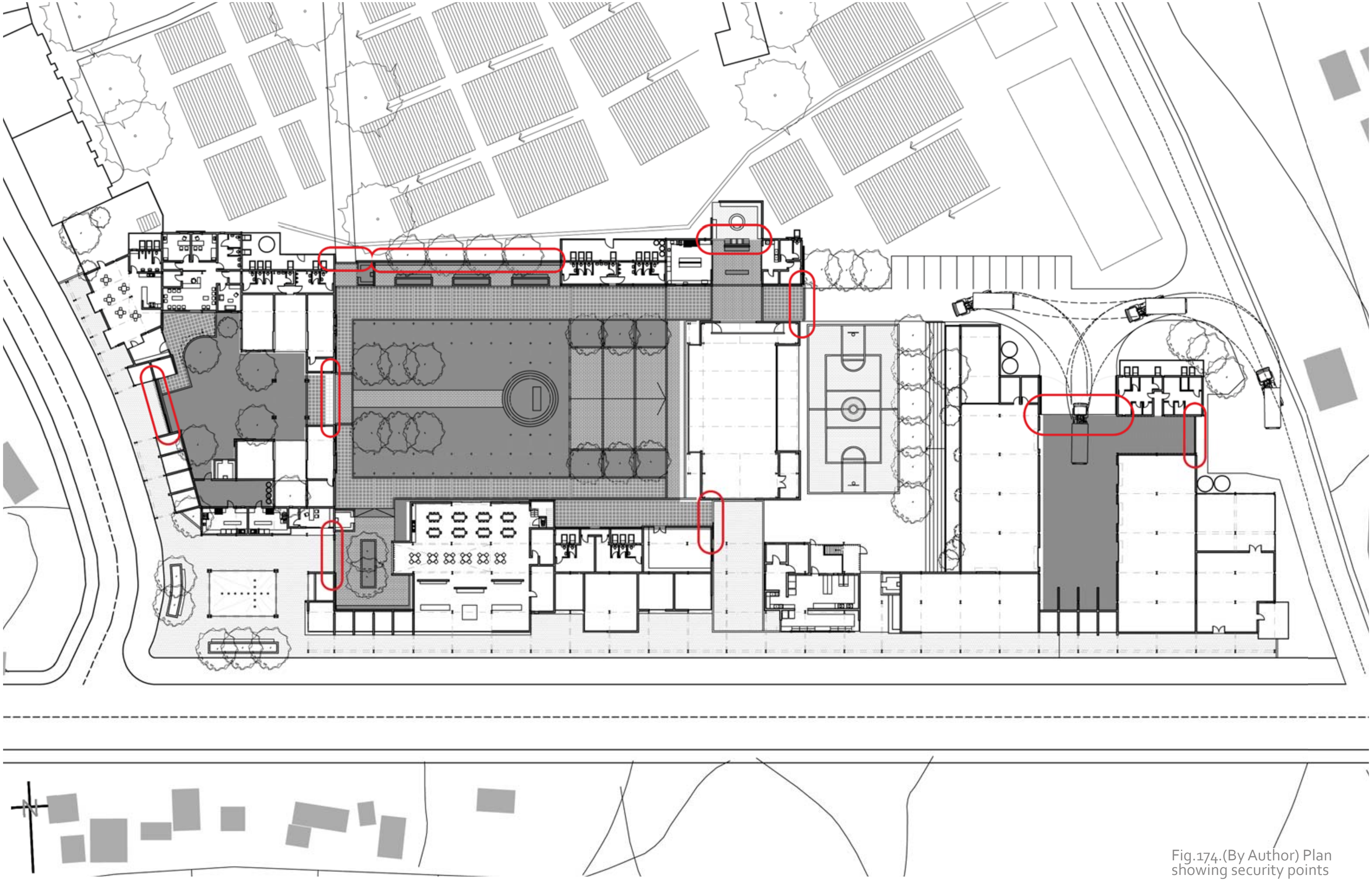


Fig.174.(By Author) Plan showing security points

Structural System & Construction Process

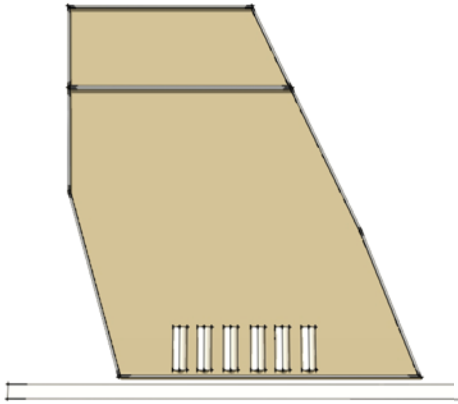


Fig.175.(By Author) Existing Structures

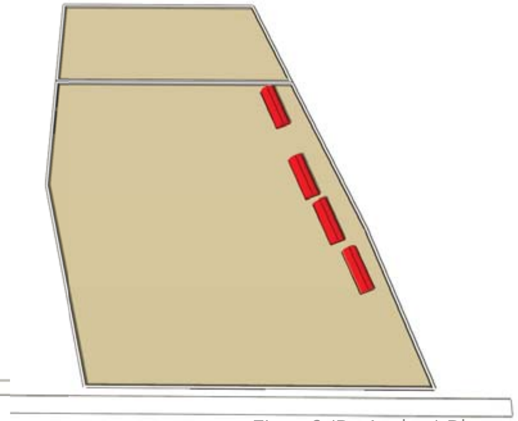


Fig.176.(By Author) Phase 1

Phase 1

Four of the six existing agricultural sheds that are deemed to be in the best condition are made good and moved alongside the existing service road, Fig.176.

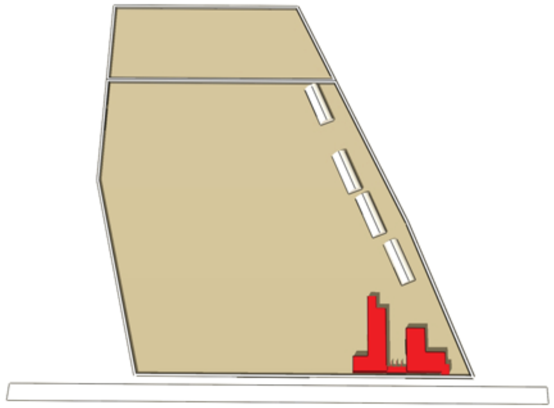


Fig.177.(By Author) Phase 2

Phase 2

The production complex is constructed as these functions are able to act independently of the functioning of the others, also the building trade training assists with training labour to be used in the construction of the rest of the buildings, Fig.177. The food packing and processing plant is directly related to the existing functions on site. Access remains via the existing service entrance.

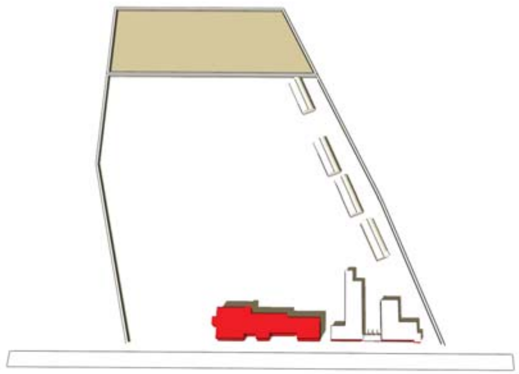


Fig.178.(By Author) Phase 3

Phase 3

The students from the building trade training initiative assist in construction and assembly of the rest of the intervention, beginning with the public edge. The frame system and ground floor slab are erected first,Fig.178, thereafter the first floor slab is poured. Once the primary structure is completed, the walling and roof will be installed.

At this phase the Southern boundary fence is removed, allowing for public interface to take place.

Phase 4

The hall, kitchen, ablution block and sacred space are constructed, Fig.179. Structural elements needed for the hall's structural system are pre-fabricated and assembled on site using equipment at the building trade training centre.

Public access is directly from the South of the site.

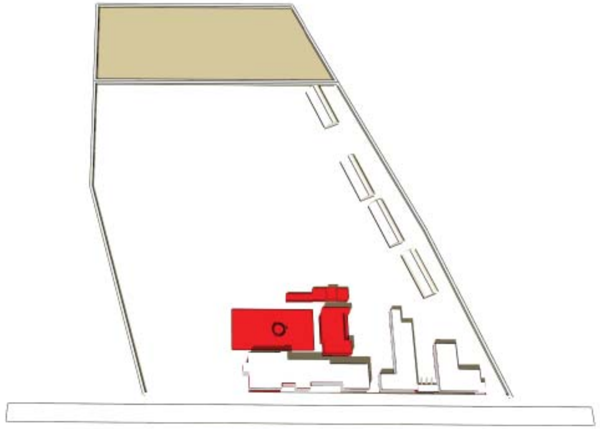


Fig.179.(By Author) Phase 4

Phase 5

The public square and community functions are constructed, Fig.180. The remaining boundary walls are removed. Access is via the entry points provided by the structural configuration.

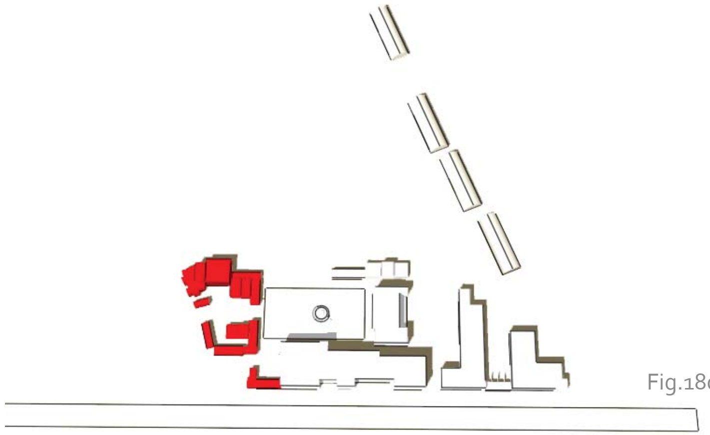


Fig.180.(By Author) Phase 5

Phase 6

Students from the building trade training will then begin construction of the social housing scheme proposed for the Northern portion of the site, Fig.181. It will be made available to them to be able to gain a unit in exchange for their services.

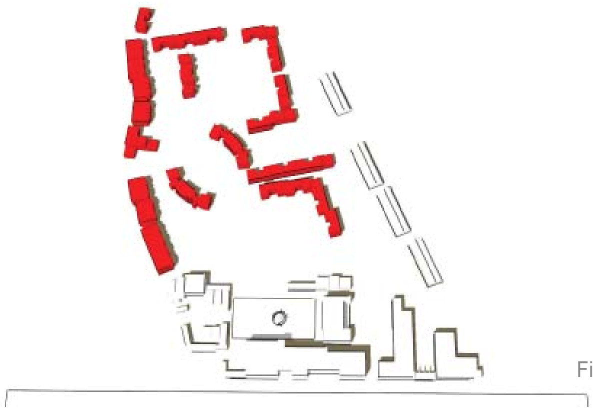


Fig.181.(By Author) Phase 6

Within keeping to the guidelines set out, as much as possible should be constructed using manual labour in order to further job creation and training. This manual labour force will be sourced from the community, and the construction process will tie into the learning curriculum hosted by the building trade training centre.

The supervising contractor should also be from the local community. This process will take longer than mechanically driven building processes but it will provide much needed income and skills benefits to the local inhabitants, while also fostering a sense of ownership.

Foundations & Ground Floor Slab

All foundations and ground floor slabs, Fig.182, will be prepared through manual labour, Fig.183. Concrete will be poured using a concrete mixer to achieve a uniform surface and prevent cracking.

Primary Structure

The structural elements will be manufactured off-site. This will allow for fixing points to be prepared and efficient galvanising to be carried out. The steel elements will then be transported to site. To allow for easy transportation, it is ensured that no element, with the exception of the hall, is longer than 13m. Upon arrival, the system is assembled on site, through the guidance of the building trade training center.

The column system along Tsamaya Road will be constructed first, as it requires a continuous feature beam, Fig.184. Thereafter, each grid line of columns will be fixed together on the ground and pulled into place, Fig.186. Once positioned, the base plates are bolted to their footings, and fixed to the feature beams and column system, providing stability, Fig.185.

This process will take place along the grid lines in a process running East to West. This will allow for the space needed without endangering the existing structure, as built in Phase 2.

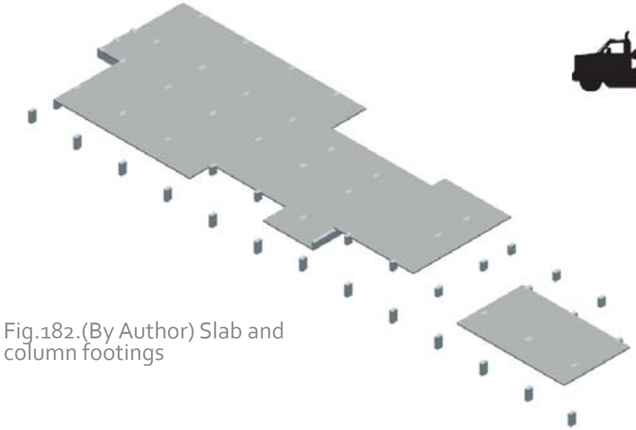


Fig.182.(By Author) Slab and column footings

Fig.183.(By Author) Sketch showing construction scene

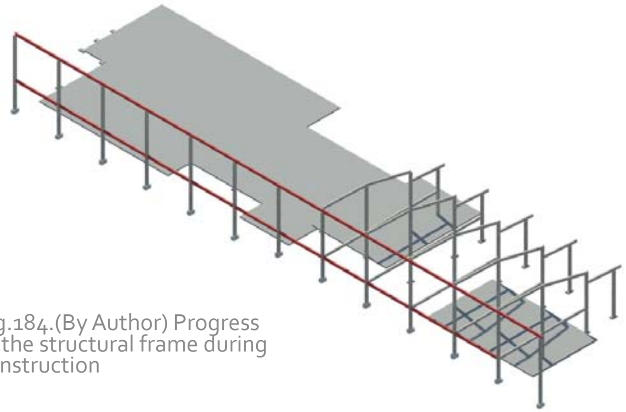


Fig.184.(By Author) Progress of the structural frame during construction

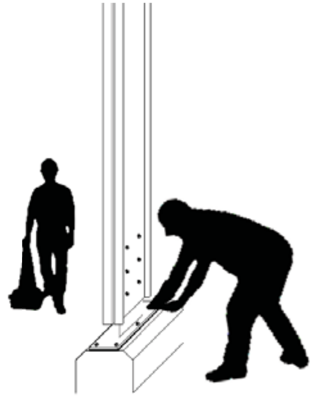


Fig.185.(By Author) Sketch showing construction scene

Fig.186.(By Author) Sketch showing construction scene

First Floor Slab

The first floor slab, Fig.187, is composed of a QC Brown Built reinforced composite steel and concrete slab system. This system uses steel shuttering to provide tensile reinforcing and to support the mass and loading of the wet concrete. The shuttering will be installed and bolted, as per manufacturers specifications, to the steel frame. These elements will be fixed into position using a manual labour force, sourced from the local community, Fig.188.

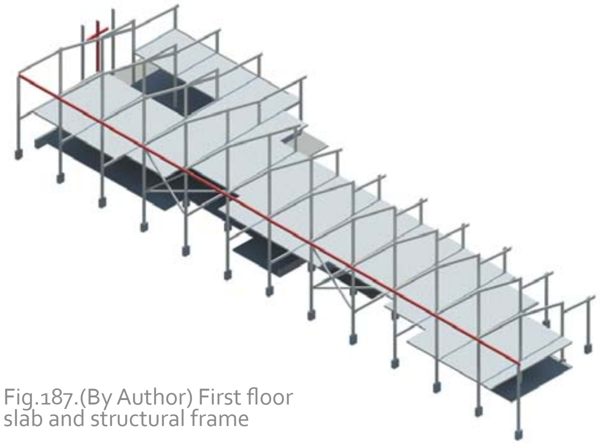


Fig.187.(By Author) First floor slab and structural frame

Fig.188.(By Author) Sketch showing construction scene

Roof

The roofing system will be installed before the infill walling materials as the installation of a roof will allow work to continue through most weather, also this system is an extension of the same structural learning process, Fig.189, Fig.190.

The roof sheeting materials will be transported to the site. The sheets will be profiled as needed to reduce wastage and potential damage.

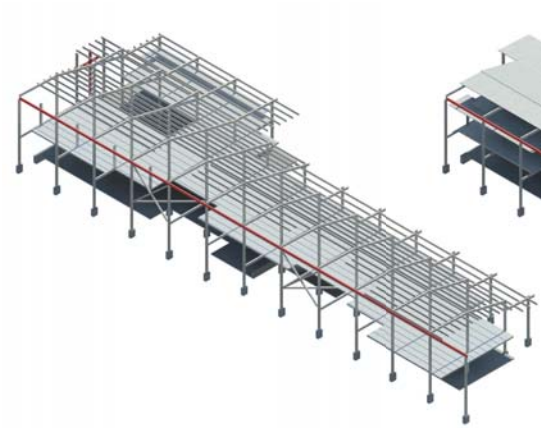


Fig.189.(By Author) Installation of purlins

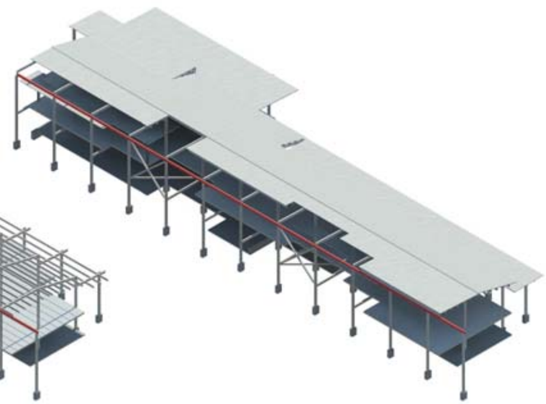


Fig.190.(By Author) Structural frame and roof

Infill

While the construction process has been taking place, the local block makers would have begun the manufacture of the dry stacking hydraform bricks.

This system will allow an unskilled labour force to quickly and easily construct the internal and external walls, Fig.192.

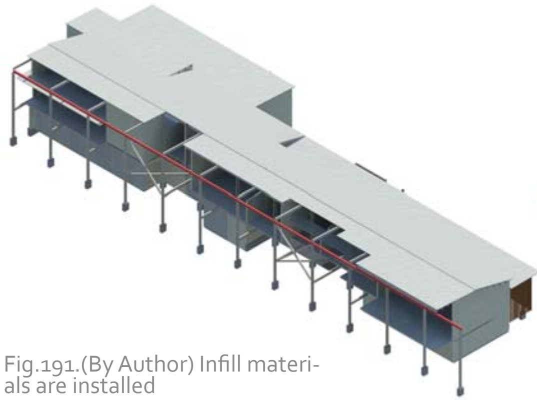


Fig.191.(By Author) Infill materials are installed

Fig.192.(By Author) Building process with Hyraform blocks

Note: Where possible, building materials will be stored within the building trade training building and its associated courtyard as a safety precaution, and to reduce the risk of theft.

Structural Model: Public Edge

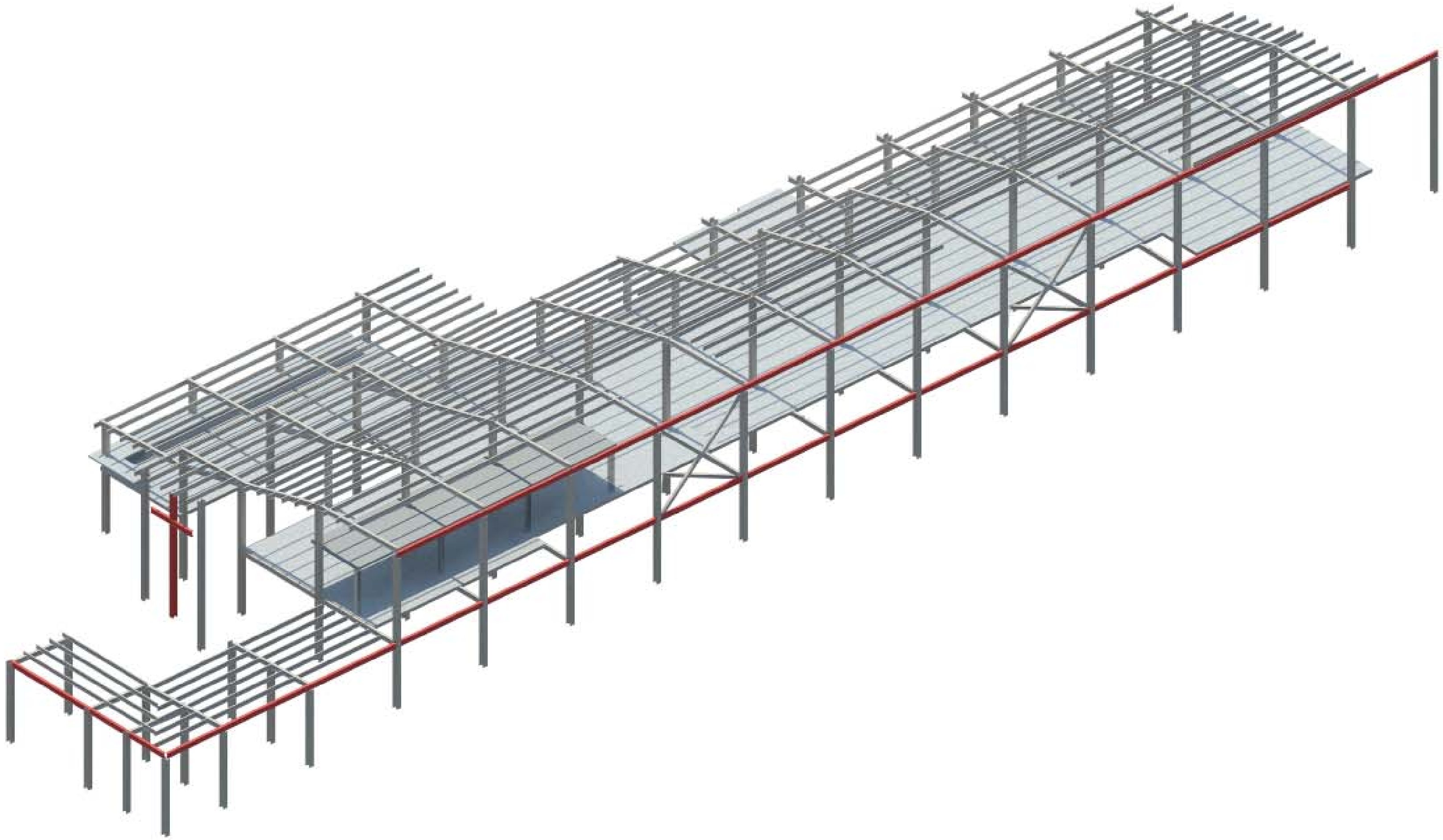


Fig.193.(By Author) 3D structural model of the public edge

Structural Model: Hall

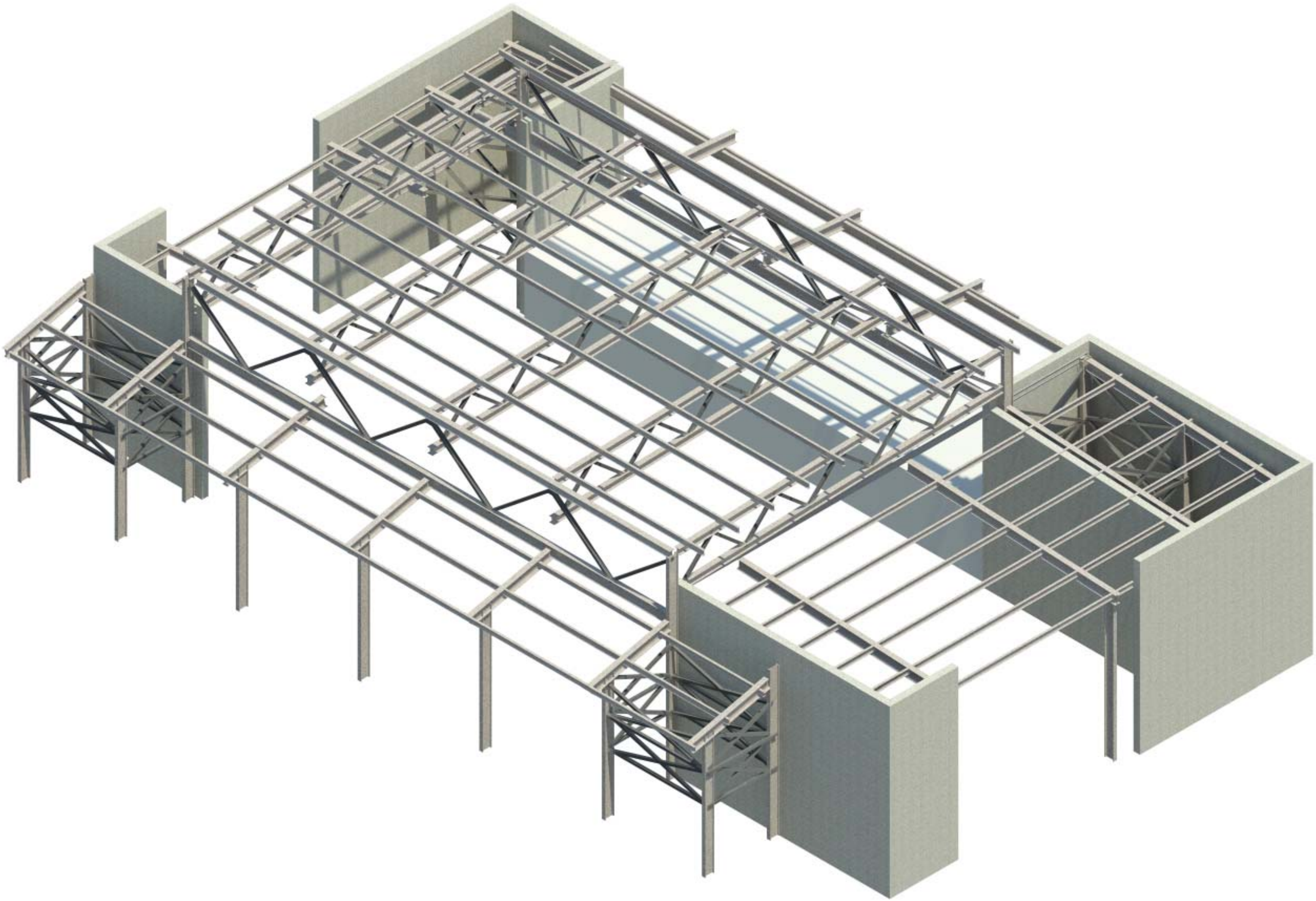


Fig.194.(By Author) 3D structural model of the hall

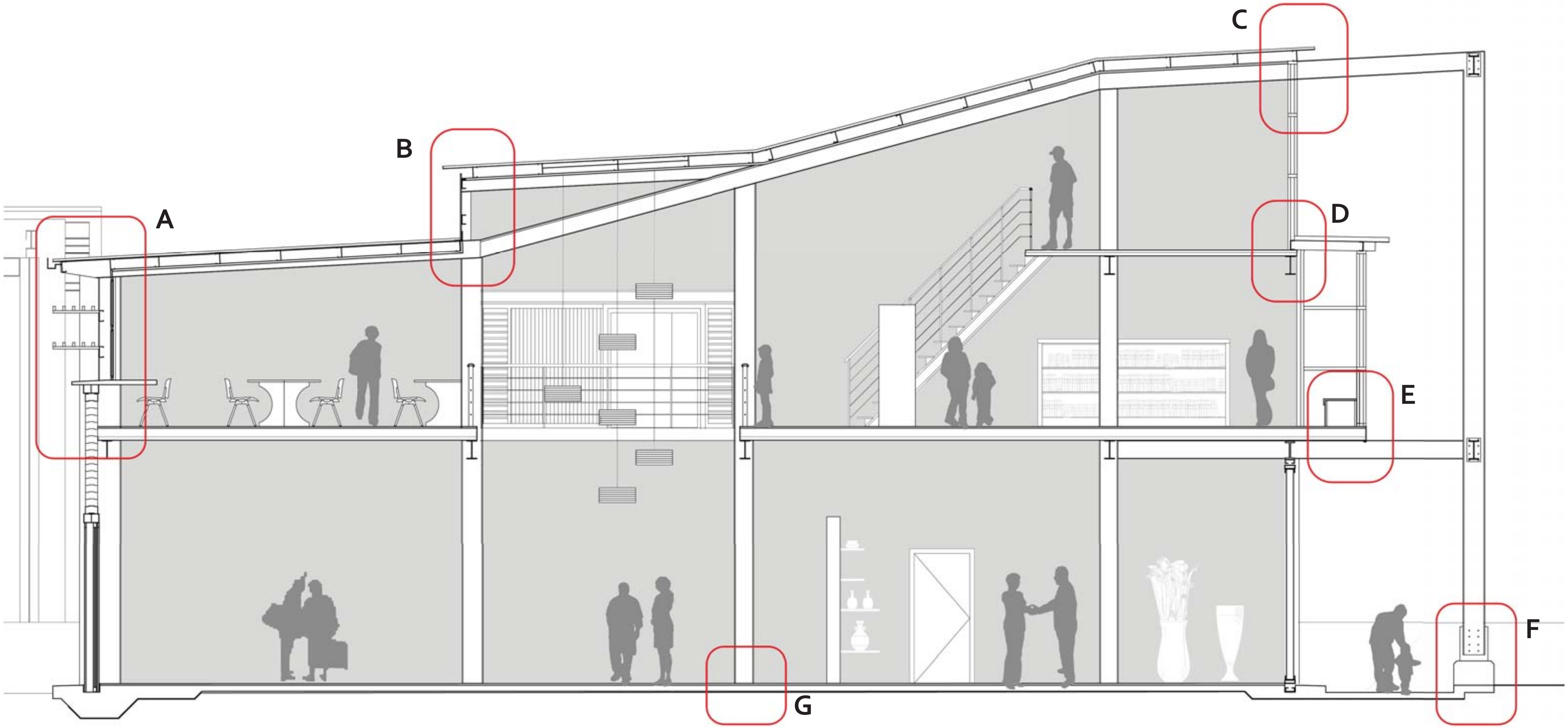


Fig.195.(By Author) Detailed section of the Public Edge through resource centre and craft training

Detail A

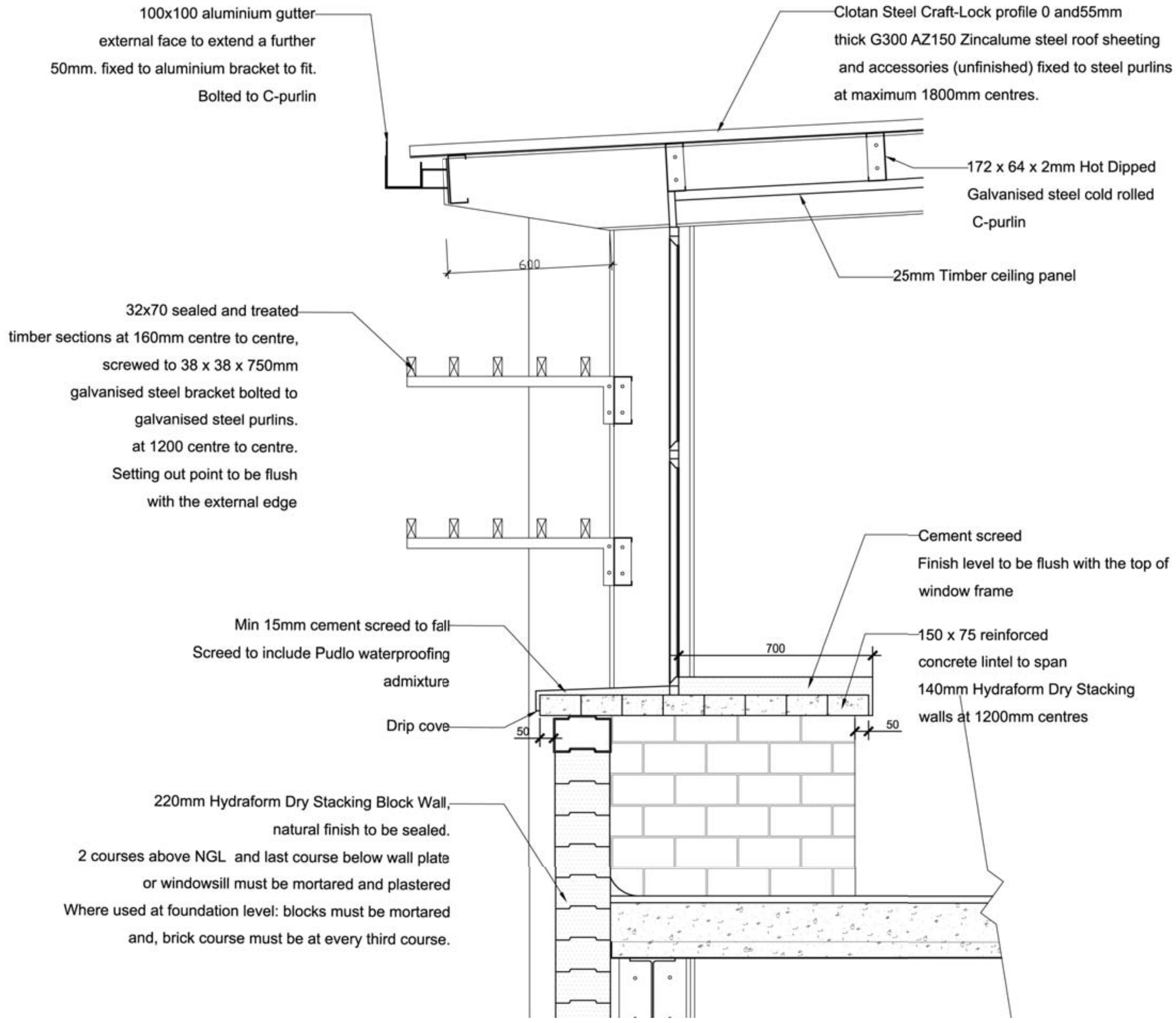


Fig.196.(By Author) Detail A

Detail B

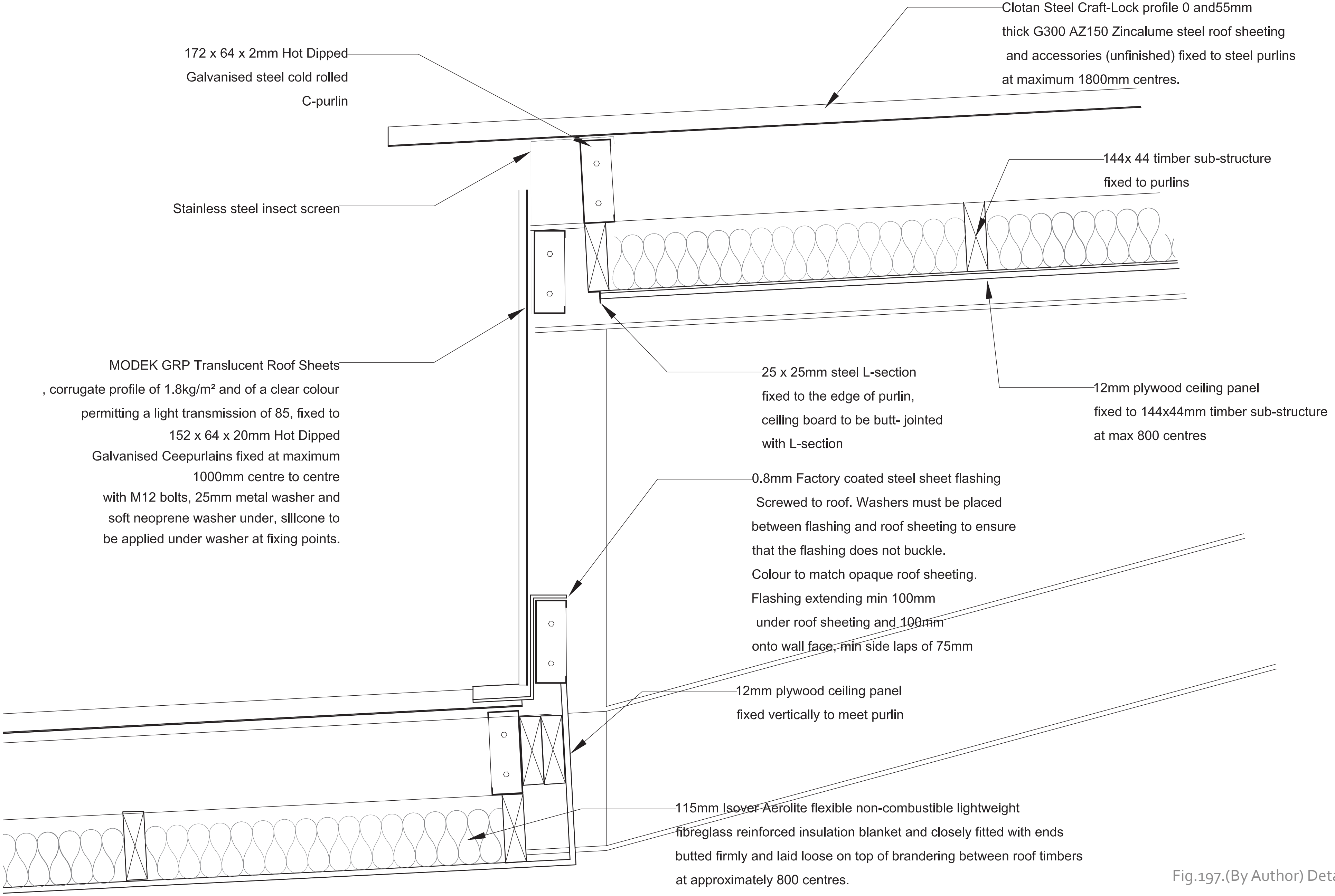


Fig.197.(By Author) Detail B

Detail C

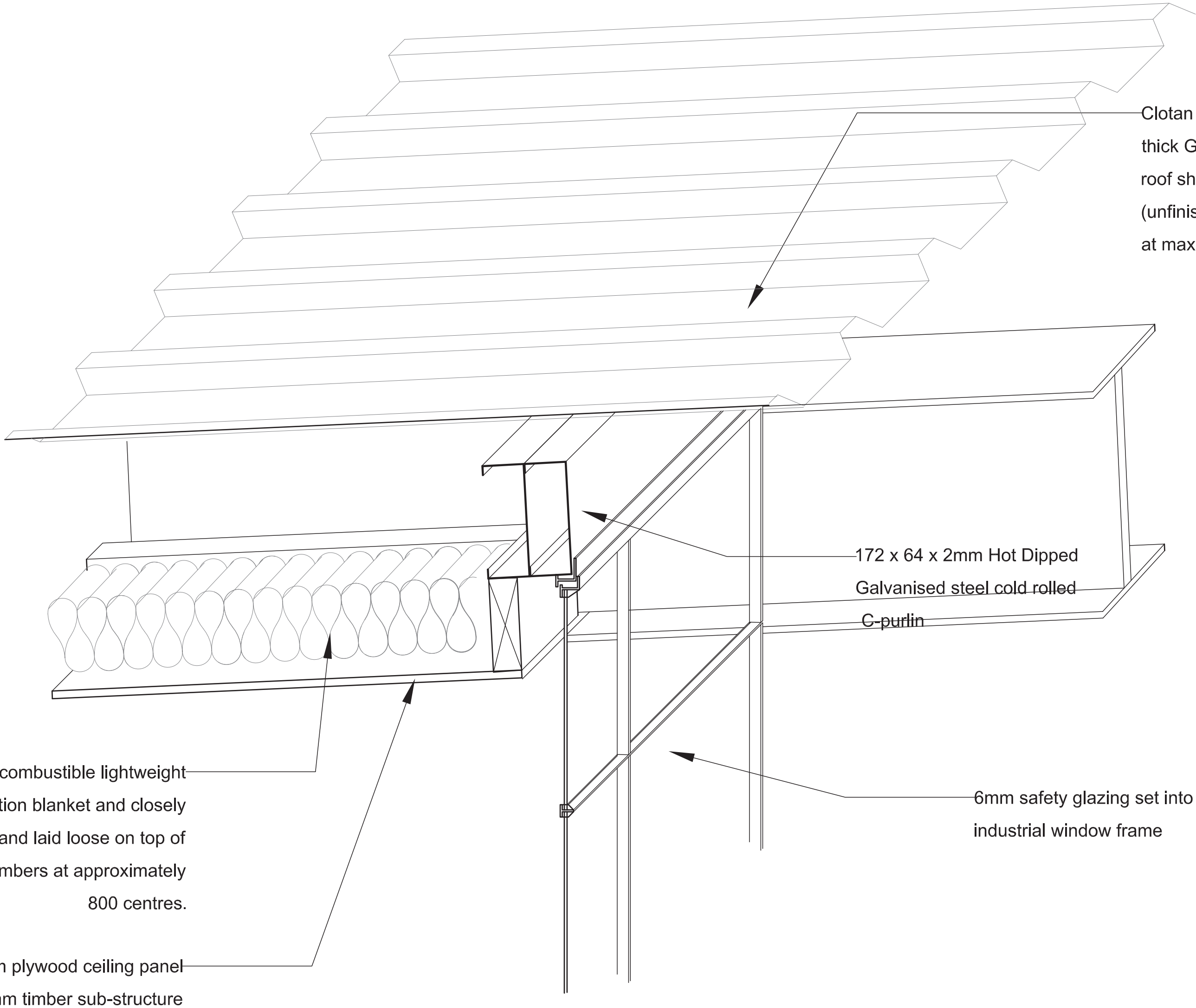


Fig.198.(By Author) Detail C

Detail D

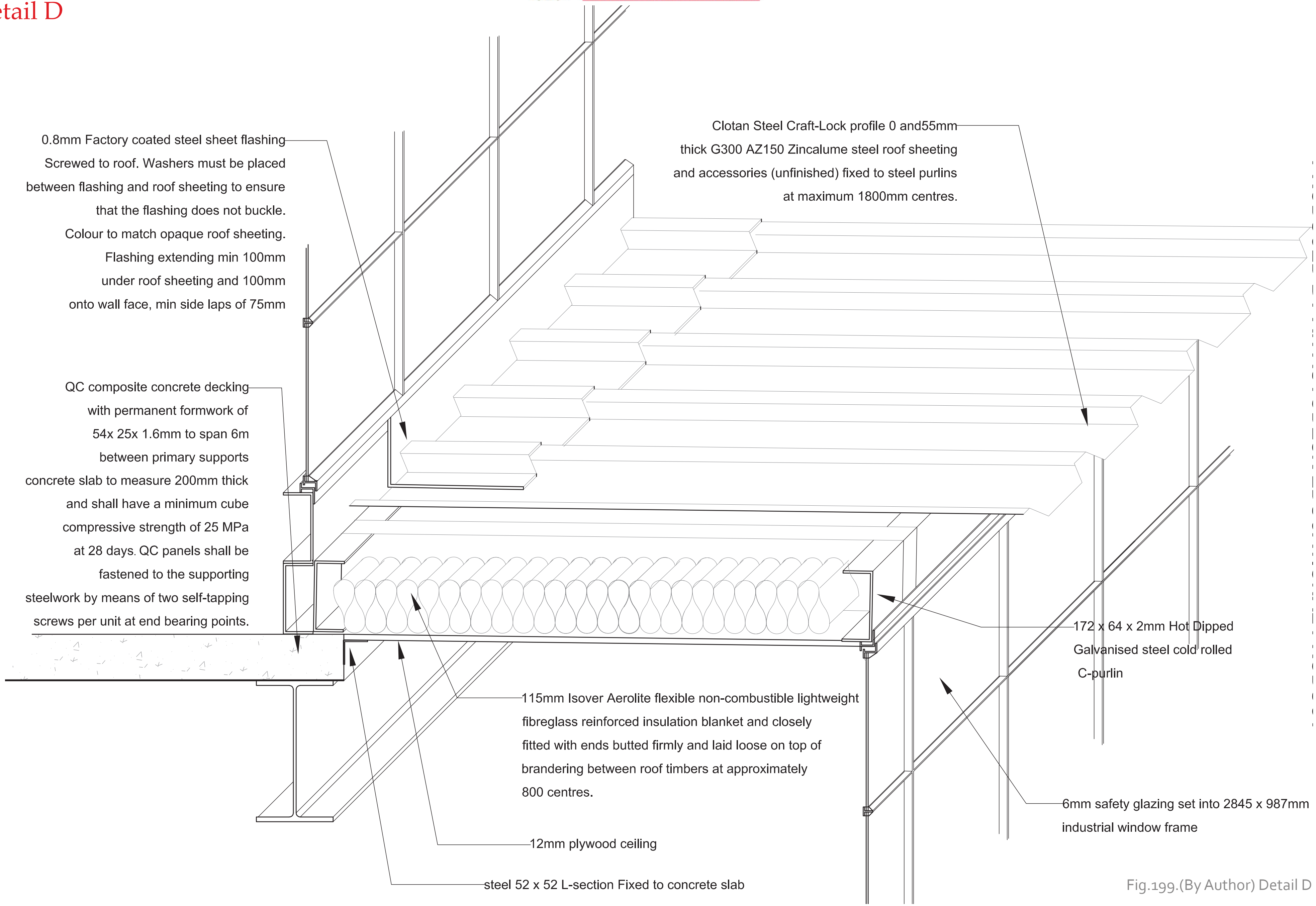


Fig.199.(By Author) Detail D

Detail E

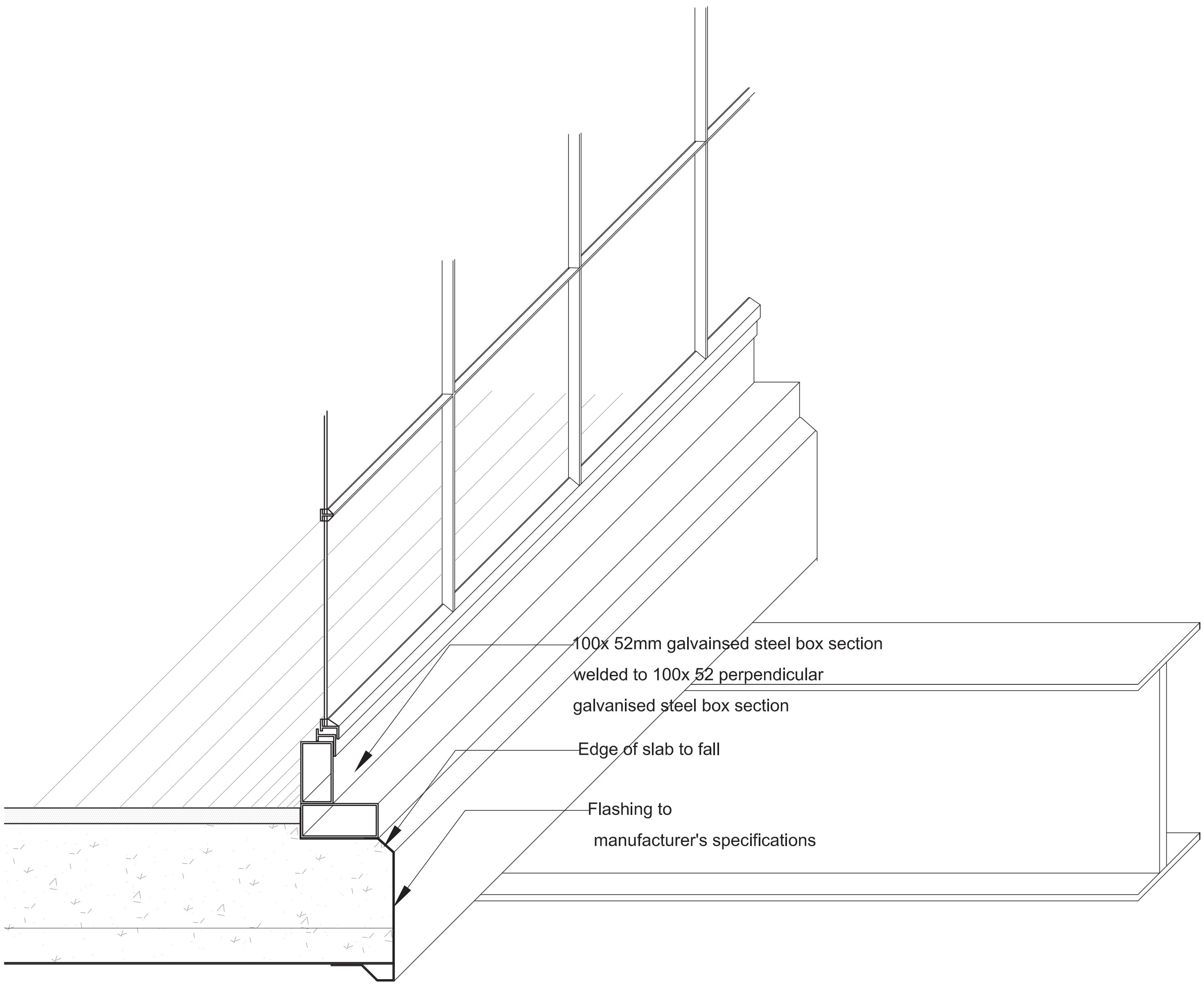


Fig.200.(By Author) Detail E

Detail F

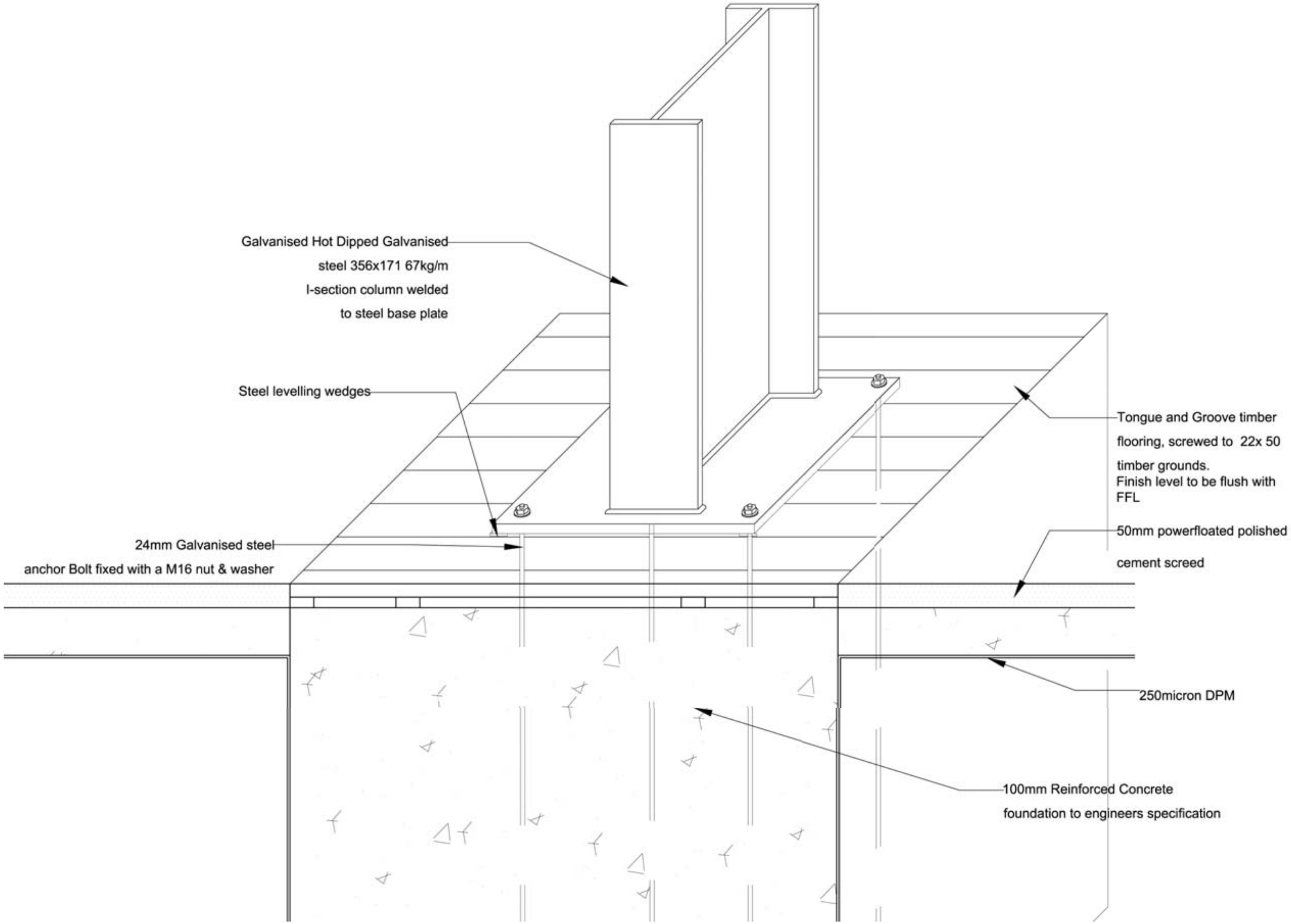


Fig.201.(By Author) Detail F

Detail G

As mentioned earlier, the structural grid represents God, the question regarding the footings on the exposed public area is:

How does God touch the ground?

The column is split into two back-to-back C profiles and bolted together with a plate between them.

At the footing level the C- section columns stop before they touch the footing , "transforming" into the plate, which then extends to meet the footing - which in turn, rises up to meet it.

This is symbolic of the Holy Trinity, where the Father and the Holy Spirit are represented by the C-sections and Jesus comes from them, transforming into another element, man, and touches the earth. In turn the earth rises up to meet Him.

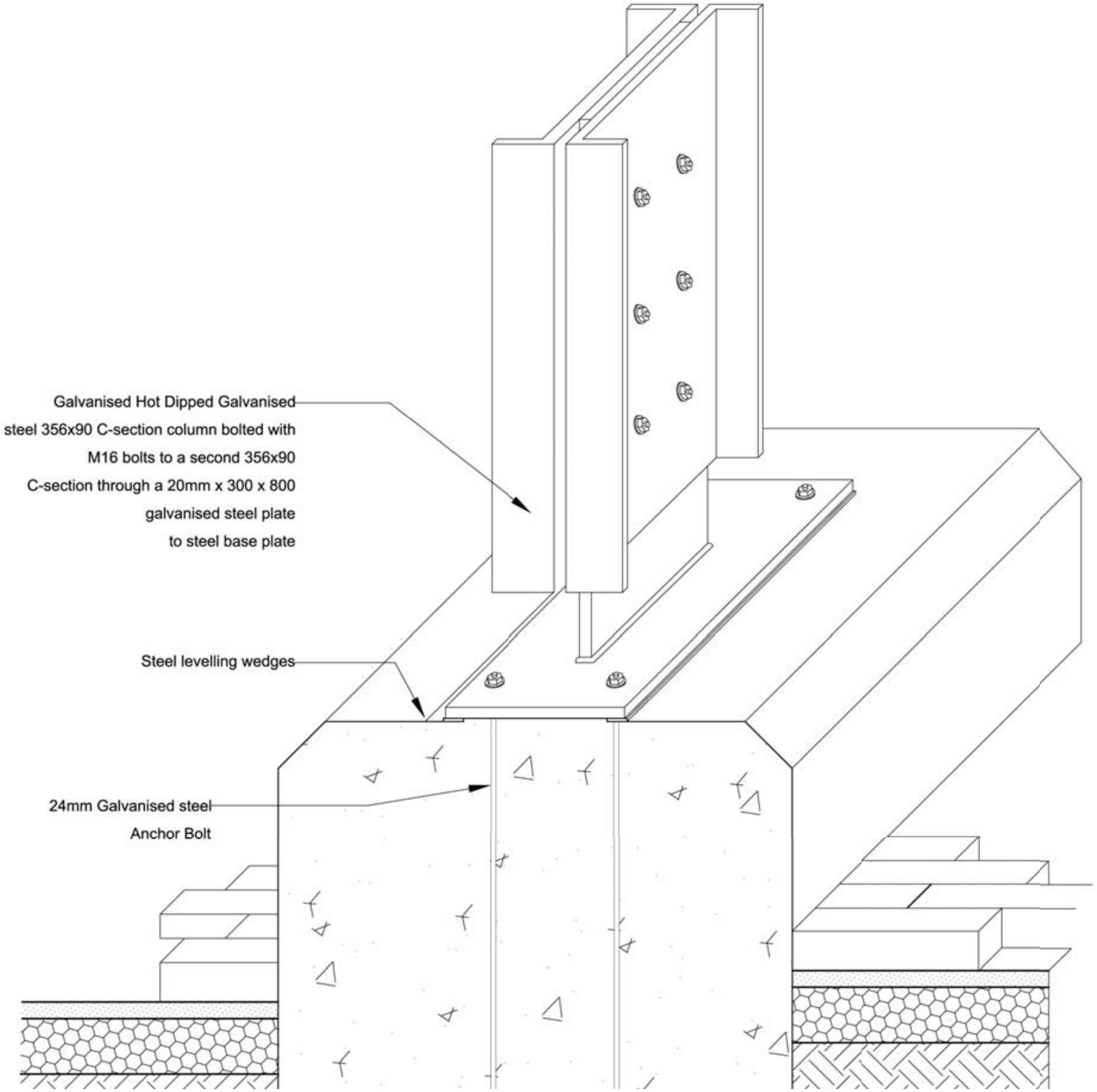


Fig.202.(By Author) Detail G

Section through Pump Room

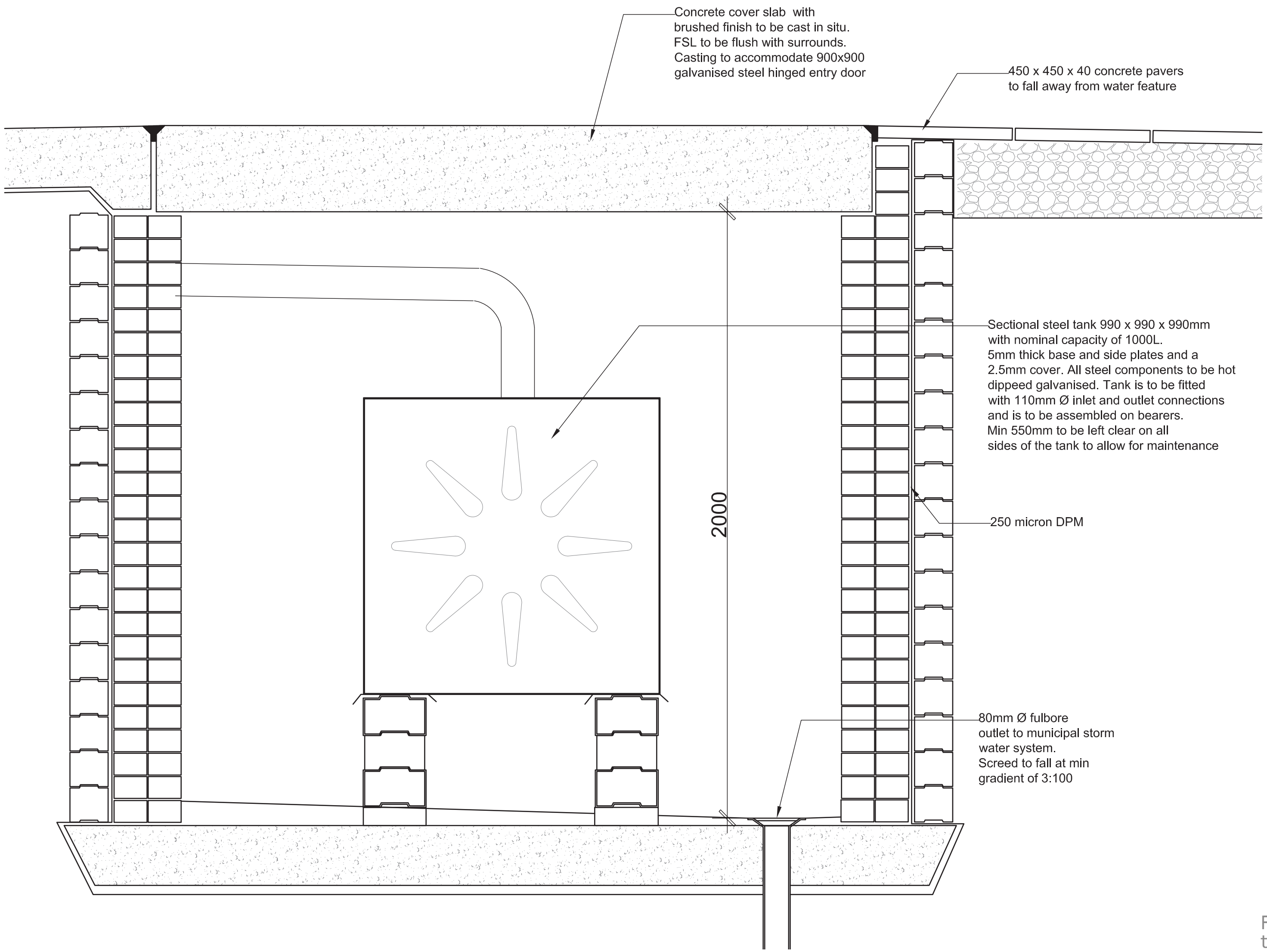


Fig.203.(By Author) Section through pump room

Plan of water feature

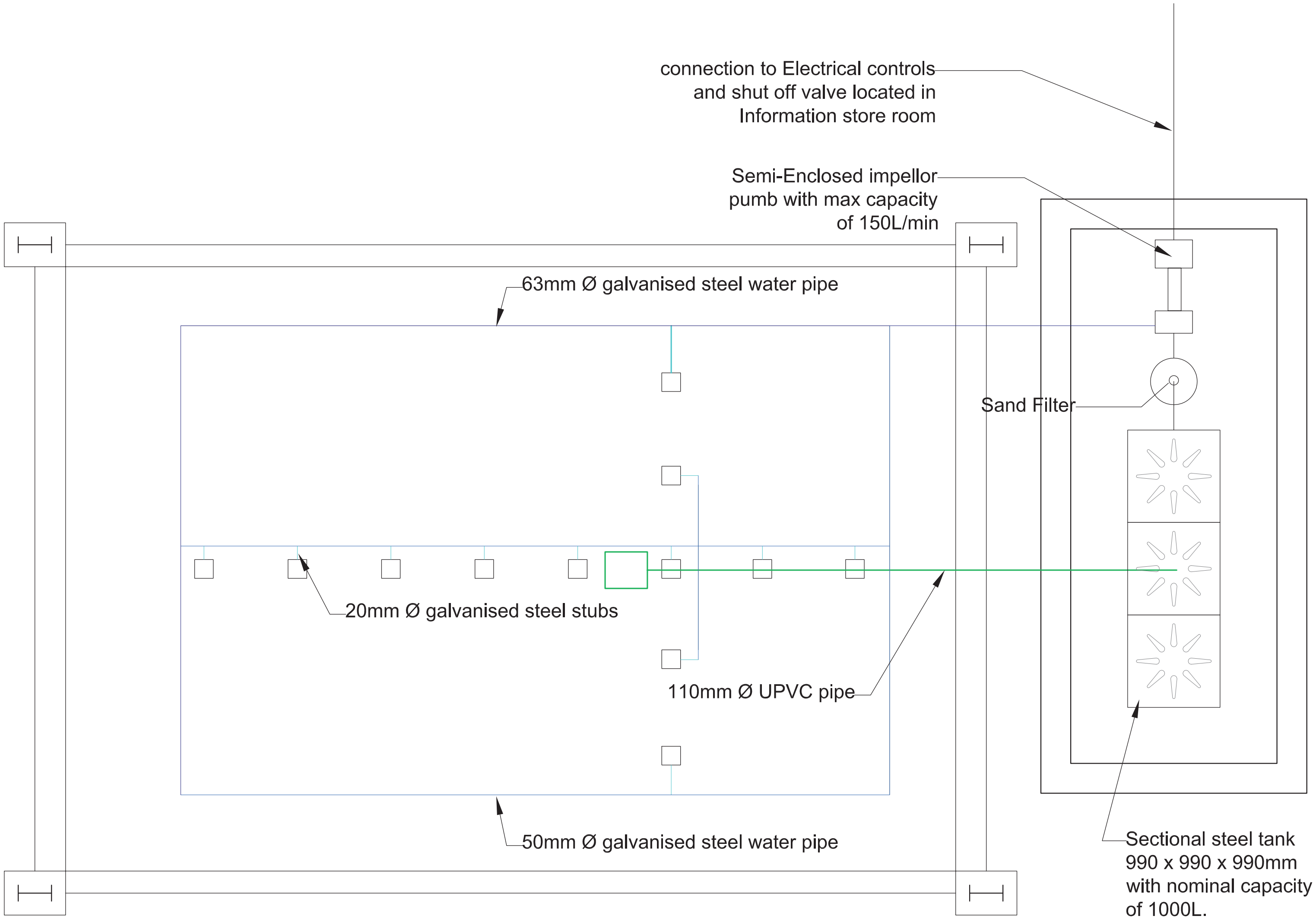


Fig.204.(By Author) Plan of water feature

Section through water feature

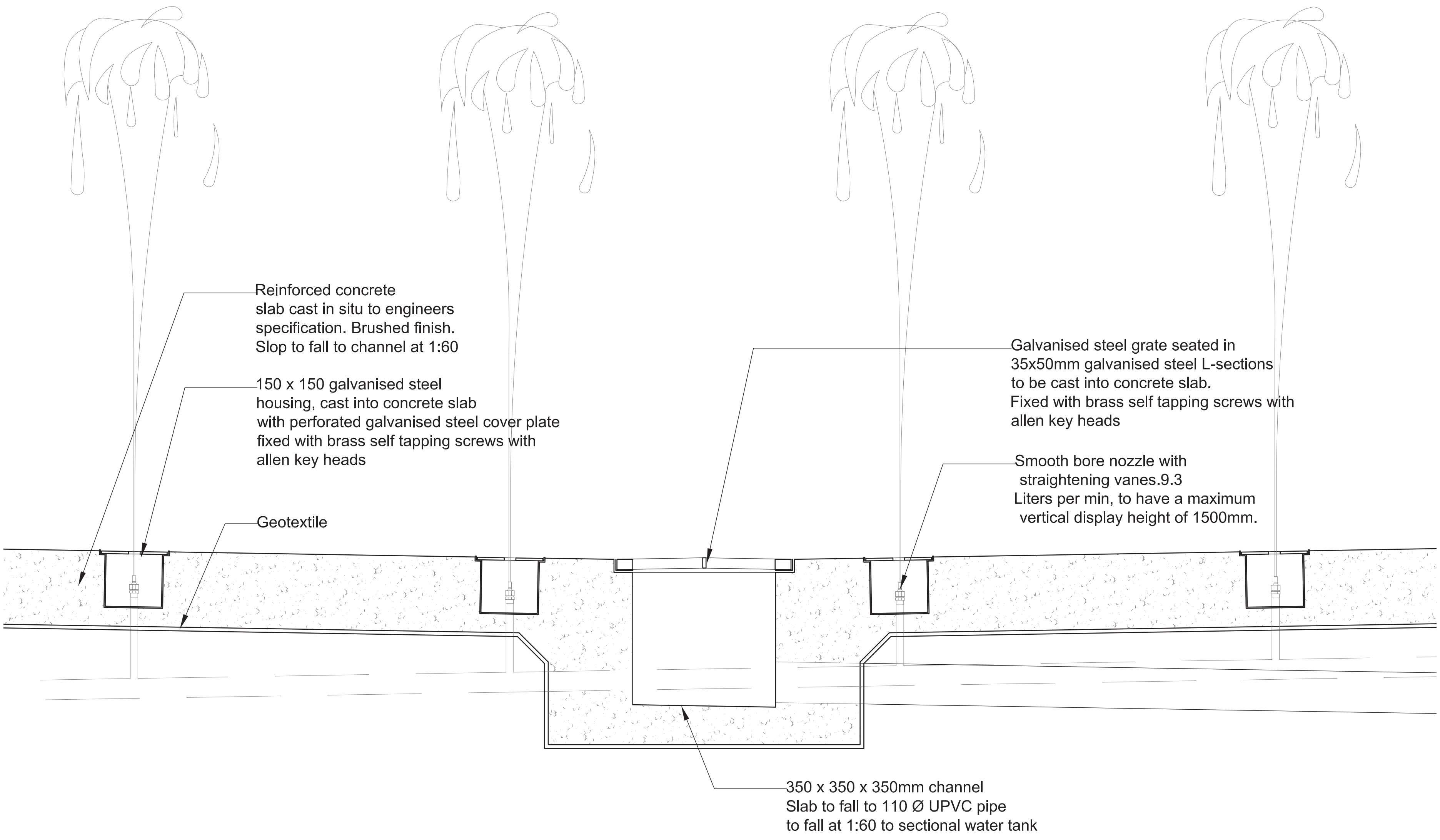


Fig.205.(By Author) Section through water feature

3D view of column in sacred space

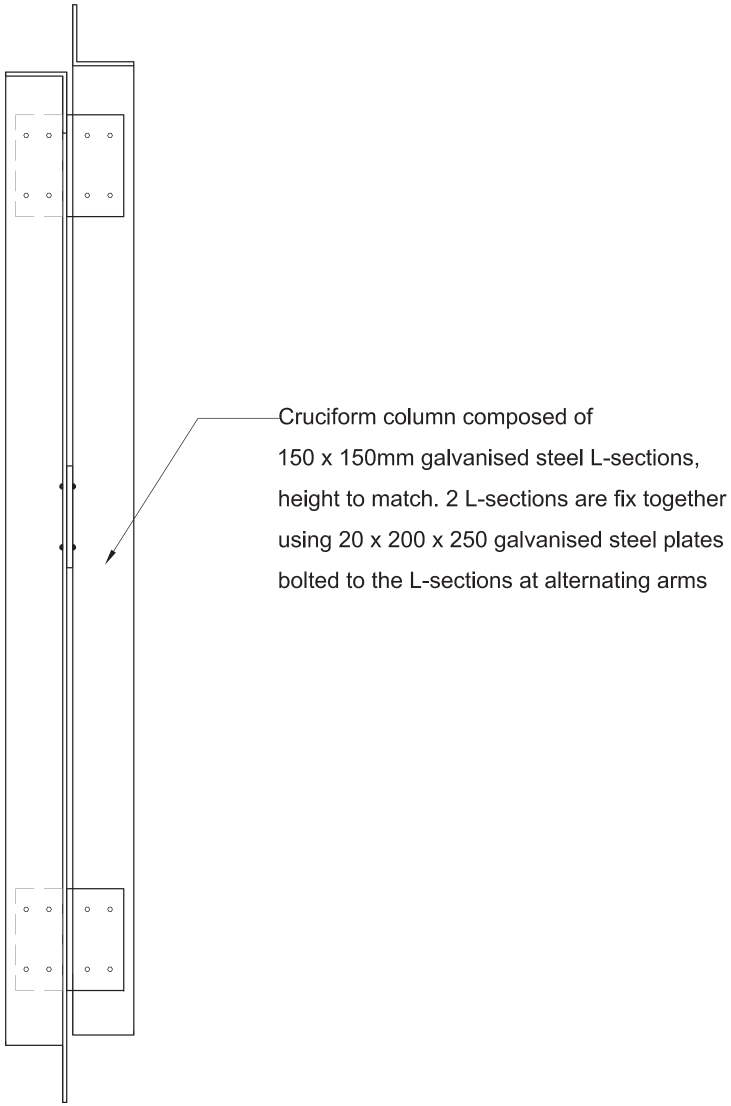


Fig.206.(By Author) 3D view of column in sacred space