07_TECHNICAL DEVELOPMENT:

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7.1 INTRODUCTION

The technical investigation is the focus of this chapter.

- South African (SA) projects are investigated as technical precedents for a clay screen.
- This is followed by an investigation into the manufacturing, specifications and detailing of typical clay screens, done through a study of well known international projects.
- The chapter continues with the technical development of the design. Principles guiding the facade and screen design of the new building are illustrated.
- Selected materials, construction details and services are discussed.

7.2 SOUTH AFRICAN PRECEDENTS FOR THE CLAY SCREEN

As discussed in Chapter 6 the new addition, Block E, will incorporate a screen. It was decided to instead of timber or metal investigate clay profiles as possible materiality of the new screen.

The use of clay screens in existing local projects are thus investigated. Firstly two of Norman Eaton's projects are investigated. This is followed with another local example, that of the Mangosuthu Technikon by Hallen Theron & Partners. Thirdly the DTI competition scheme and relevant research of Christopher Malan from Meyer Pienaar are discussed.

7. 2. 1 NETHERLANDS BANK, DURBAN

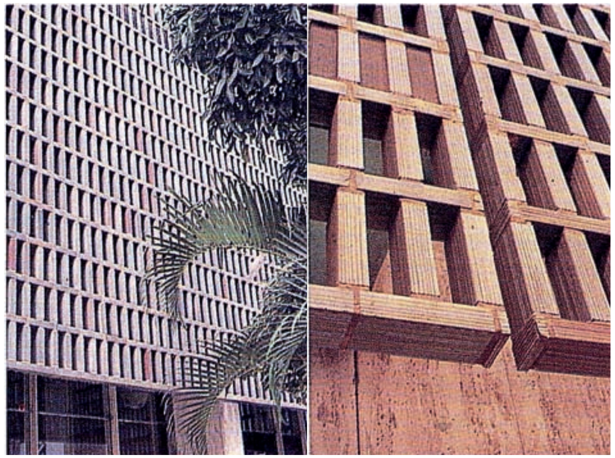

Figure 7.1: The Netherlands Bank building with a hollow clay brick sunscreen designed by Eaton

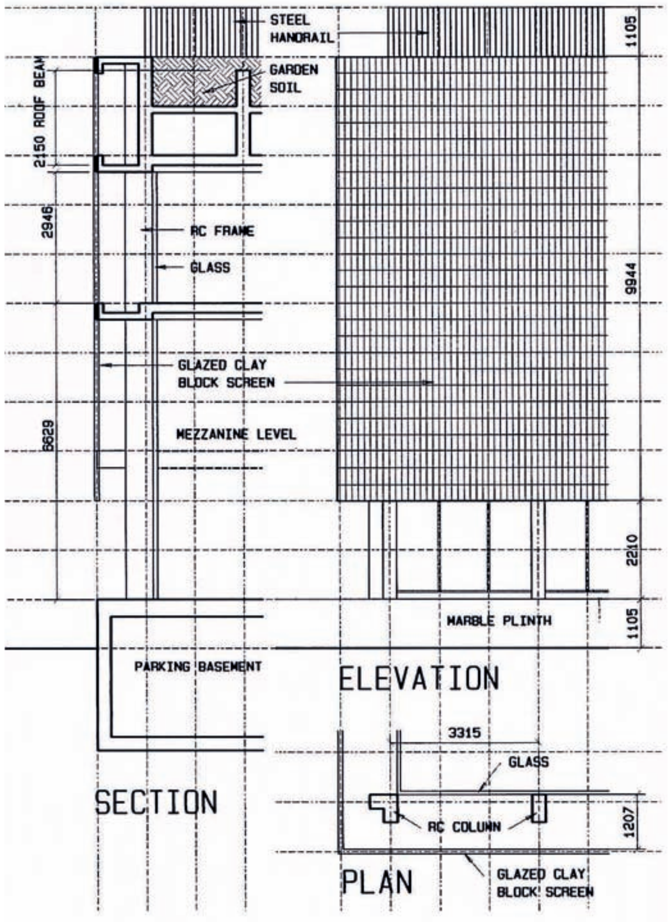

Figure 7.2: Partial elevation, section and plan of the building

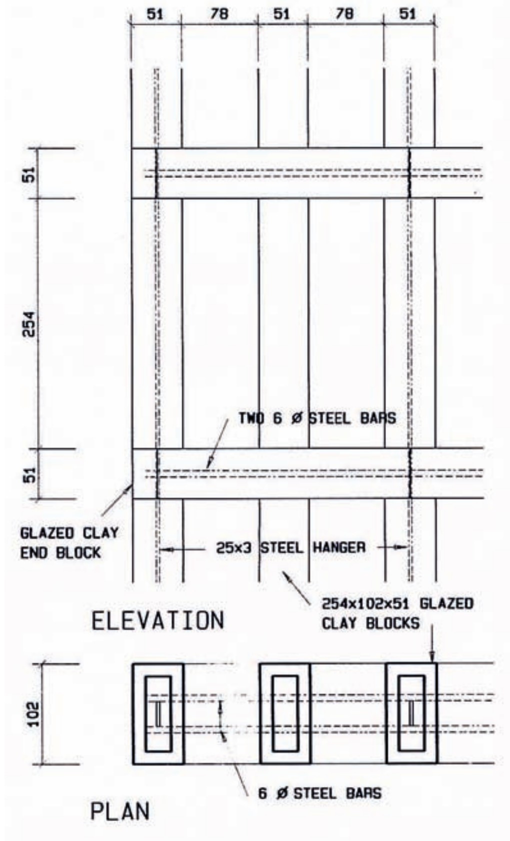

Figure 7.3: Elevation and plan of the clay sunscreen

(a) Project information

Project name: Netherlands Bank
Location: Durban
Date: 1965
Architect: **Norman Eaton**
Clay product manufacturer: Briti, in Alberton

(b) Material

Eaton's external sunscreen is constructed of hollow clay bricks. The bricks were manufactured by Briti in Alberton and were very similar to their standard spacer blocks used for reinforced concrete floor construction. After manufacturing it was glazed on the outside by Dykor in Pretoria, then railed to Durban.

(c) Structure and installation

The screen is supported from projecting floor slabs by 25x3mm vertical steel hangers in every second vertical clay block. Each horizontal course is reinforced with two 6mm diameter steel rods welded to the vertical steel hangers. The hangers and rods were welded together in 900mm intervals as the work proceeded. This enabled the clay blocks to be stringed over the rods as the screen was installed.

The screen was erected from the bottom up, bedded in plaster on correctly levelled scaffolding. Each block was filled with mortar and tamped to ensure positive coverage of the steel before the next block was put in place.

(d) Condition

Remedial work was done five years after completion. Inadequate coverage in some places led to the rusting of the steel hangers and rods, resulting in spalling some of the blocks. The screen is in excellent condition.

7. 2. 2 NETHERLANDS BANK, PRETORIA

Figure 7.4: The Netherlands Bank building with clay brick cladding designed by Eaton

(a) Project information

Project name: Netherlands Bank
Location: Pretoria
Date: 1954
Architect: **Norman Eaton**
Clay product manufacturer: not mentioned
Builder: Engel & Ruyter

(b) Material

In this project Eaton designed a terracotta cladding system. He had three special bricks made to clad the concrete structure. Two of these bricks were reeded faggots, giving the bricks a finer texture and scale. See type 1 and 2 in figure 7.5. The third type was a chamfered unit, which lends depth to the facade by the shadows created in the narrow horizontal recesses. See type 3 as well as Detail Section A in figure 7.5.

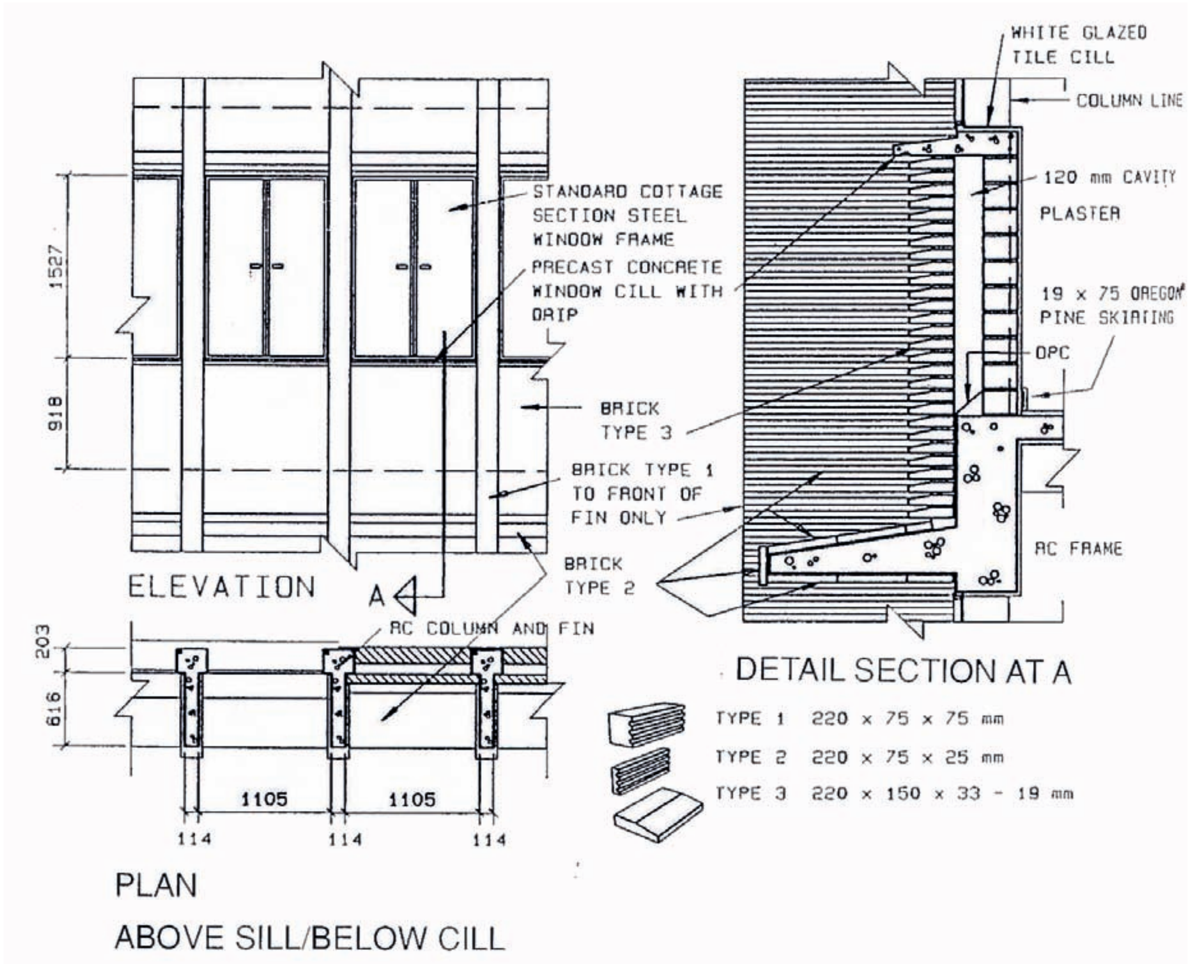

Figure 7.5: Drawing showing the three brick types, and a section through brick type 3

(c) Structure and installation

The bricks were fixed to the concrete structure with wire ties cast into the concrete and bedded into the joints between the faggots.

(d) Condition

The cladding has stood up well over fifty years, and the building seems to be in good condition.

7. 2. 3 MANGOSUTHU TECHNIKON

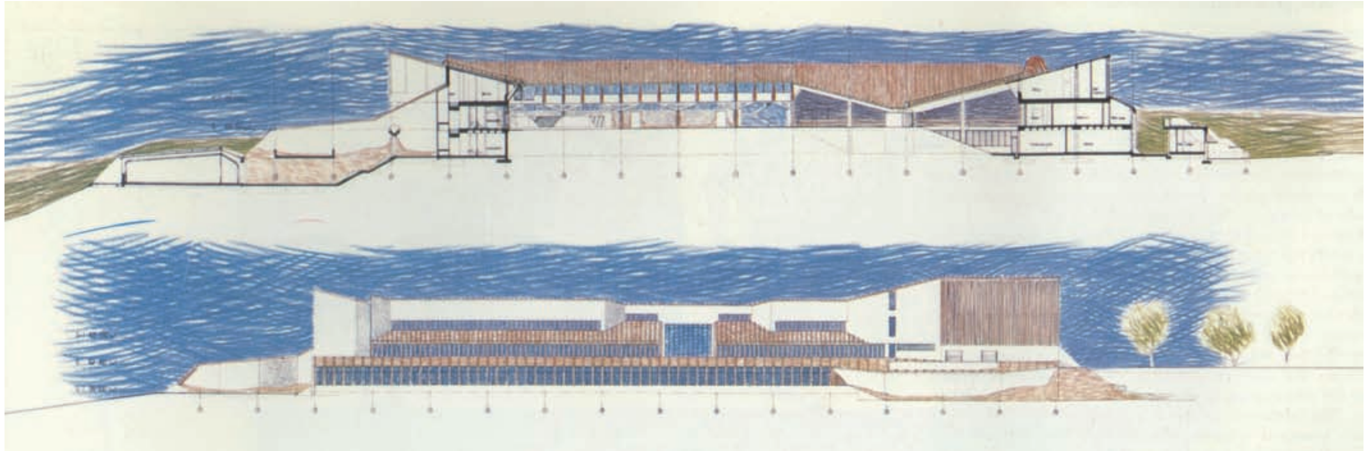

Figure 7.6: Drawn section and elevation of the Mangosuthu Technikon designed by Hans Hollen

(a) Project information

Project name: Mangosuthu Technikon
Location: Umlazi, Natal
Date: 1979-82
Architect: **Hallen Theron & Partners**
Clay product manufacturer: not mentioned

(b) Material

One of the guidelines concerned to create the building was that of longevity and low-maintenance. Unfortunately no information could be found on the material, the fixing or the manufacturer.

(c) Structure

The cross section has been designed to provide deep roof overhangs and shading devices and to use natural ventilation both by cross ventilation and by induced updraft.

Figure 7.7: North-east elevation

Figure 7.8: Photos showing the clay sunscreen and the terracotta roof tiles laid on asbestos

7. 2. 4 DTI COMPETITION SCHEME

Figure 7.9: The DTI competition scheme by Meyer Pienaar

(a) Project information

Project name: Department of Trade and Industry Competition Scheme
Location: Pretoria
Date: not built
Architect: **Christopher Malan from Meyer Pienaar Architects**
PROPOSED clay product manufacturer: Corobrik

(b) Material

A terracotta screen was proposed.

(c) Manufacturer

Chris Malan did the research into the design and manufacturing of the clay screen with the collaboration of Corobrik.

7.2.5 CONCLUSION

Although SA do not currently have these clay profiles readily available in the market we have the knowledge and capability to manufacture clay profiles to be used in screen installations.

7.3 INTERNATIONAL PRECEDENTS

To design and specify the terracotta sunscreen system, one must understand the manufacturing process, structure and components necessary as well as the installation procedure.

Although we know that South Africa has the capability and means in place to manufacture these products, the product doesn't exist in the local market yet. To understand the product international projects and manufacturers were studied.

During an investigation of projects done by Renzo Piano it was discovered the two main manufacturers used are Palagio Engineering, in Italy but also represented in the USA, and Shildan in Germany. It was decided to research these two companies' products to gain knowledge into the product.

Figure 7.10 shows the fixing details of a selected few projects.

Information and conclusions of the manufacturers' products and projects researched are discussed next.

fixing

(a) New York Times Building, New York USA by Renzo Piano. Screen manufactured by Shildan.

fixing

(b) New York Times Building, New York USA by Renzo Piano. Screen manufactured by Shildan.

fixing

(c) Screen manufactured by Shildan.

fixing

(d) Building in Germany designed by Renzo Piano. Screen manufactured by Palagio Engineering.

fixing

(e) Screen manufactured by Palagio Engineering.

fixing

(f) Screen manufactured by Palagio Engineering.

Figure 7.10: Colleague with international precedents.

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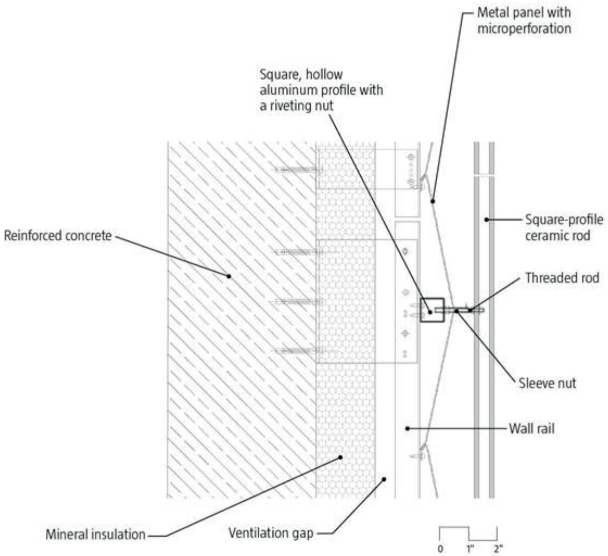
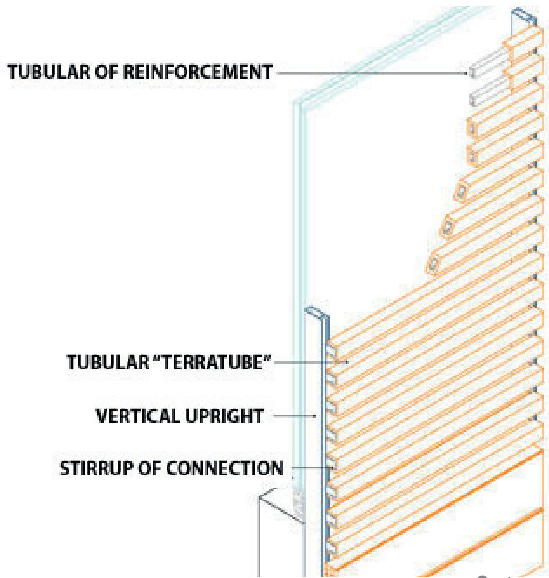


fixing

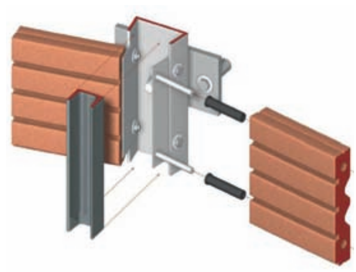
(g) Diagram showing the fixing detail at the Brandhorst Museum designed by Sauerbruch Hutton



fixing

(h) Diagram showing the structure by manufacturer Pelagio Engineering, Italy.

fixing

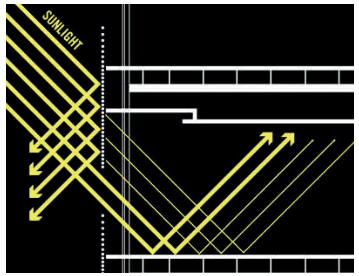


(i) Diagram showing Palagio Engineering's vertical support, end plates, neoprene gaskets, aluminium bar and terracotta profile

sunscreen

(j) Examples of how sunscreen effectiveness can be modulated by adjusting the distance between the parts.

sunscreen



(k) Diagram showing how the sun can be regulated by the screen

TECHNICAL DATA SHEET

Material	Cotto pregiato Imprunetino IL PALAGIO ®
Manufacturer	VIVATERRA
Method of moulding	EXTRUSION
Freeze/thaw resistance	UNI EN ISO 10545-12 Guaranteed
Linear thermal expansion	UNI EN ISO 10545-8 <6x10-6 c°- 1
Resistance to thermal shocks	UNI EN ISO 10545 - 9 Guaranteed
Bending tension strength	UNI EN ISO 10545-4 19 N/mm2
Treatment	"Water Resistant": exclusive special treatment applied by immersion of the slabs. It reduces the water absorption and allows easy cleaning of graffiti.

Figure 7.11: Technical Data Sheet from Palagio Engineering manufacturer.

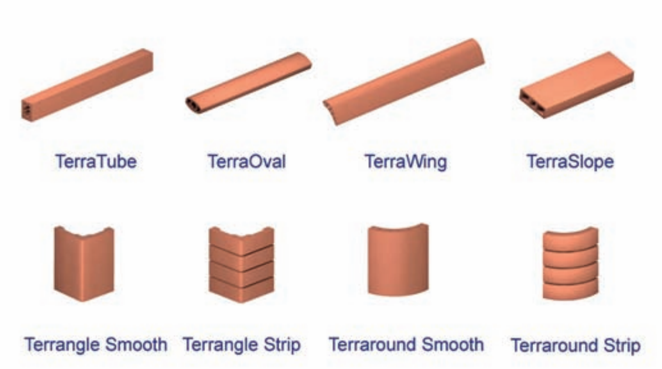


Figure 7.12: Typical sunscreen profiles, as well as corner profiles for wall cladding systems.

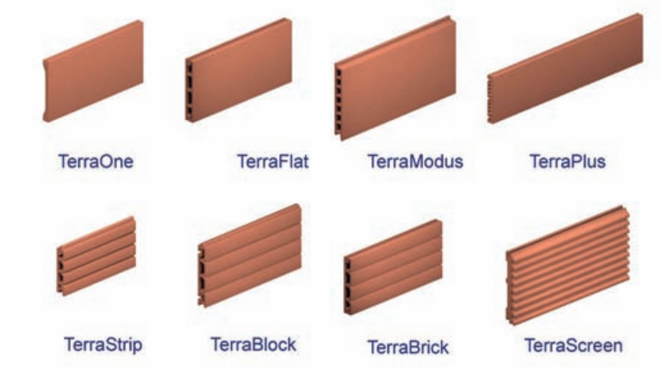


Figure 7.13: Typical wall cladding profiles in the market.

7.3.1 BENEFITS AND CAPABILITIES

- easy installation
- faster and more accurate installation time
- available sizes: from brick sizes to 2700mm
- engineered to resist wind forces, change in temperature, freeze-thaw cycle, fire, impact, hurricane, seismic raking, shear movement
- easy to repair by replacing a single element
- low to no maintenance
- long life-span
- design flexibility
- custom made production possible according to design

7.3.2 ECOLOGICAL BENEFITS

- raw natural material, with a recycled material content
- completely recyclable
- local material from local quarries; excavation, manufacturing and production possible on same premises
- lightweight and no heavy equipment needed for installation; need less fuel for transportation
- acts as sunscreen: reduction of solar radiation; decrease demand on air-conditioning system in summer without sacrificing positive contribution from sun in winter
- optimise energy performances inside building
- reduces heat island effect
- no V.O.C. emissions; no adhesive, corks, sealants, mortar, no toxicity
- innovation in design possible
- current manufacturers like Palagio Engineering are members of the Green Building Council

Sunscreen technique

The sunscreen system in this case is a wall of which the external covering consists of terracotta materials which are dry-assembled and installed through mechanical fixing to form a grilled screen, its effectiveness can be modulated by adjusting the distance between the parts.

The sunscreen system is an important architectural solution for the thermal regulation of the building.

The use of large, glass covered surfaces are today being called into question due to overheating problems as a result of direct exposure to the sun's rays during the summer months, and consequently high air-conditioning costs, and higher levels of discomfort for users.

The sunscreen, produced with different sized and shaped terracotta parts can be adapted for each project in order to create light and shading effects, to filter the sun's rays and also to achieve the correct lighting levels.

7.3.3 PRODUCTION CYCLE

- excavation
- dry grinding (less energy than wet grinding)
- mix with water (no chemical additive)
- extrusion
- drying through exhausted thermal energy from kiln
- firing (ecological combustible, CH4)

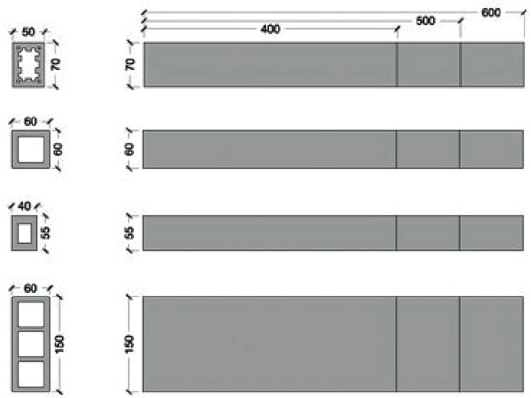


Figure 7.14: Drawing showing typical terracotta profiles.

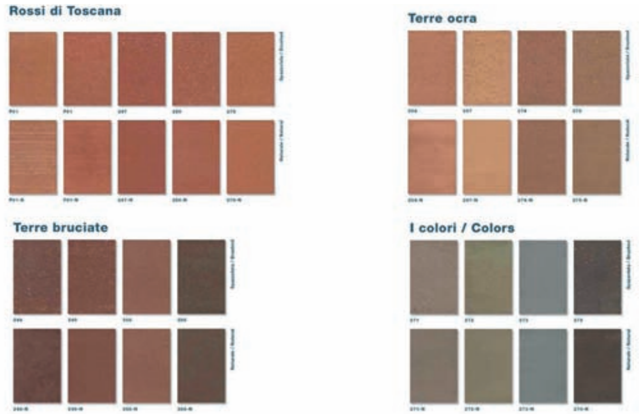


Figure 7.15: Typical extruded terracotta colours available

Figure 7.16: Typical extruded terracotta glazed elements available

7.3.4 SPECIFICATION

Please see figure 7.11 for a technical data sheet.

7.3.5 PROFILE AND COLOURS

Typical profiles currently in the market, as well as colours are shown in figures 7.12 - 7.16.

7.3.6 SYSTEM DESCRIPTION AND INSTALLATION

This is a basic design and can be adjusted according to the building design.

1. The system is composed of hollow terra-cotta (square, round or oval) tubes.
2. The tubes have a continuous aluminium cross shape bar running through it.
3. The aluminium bar fits into the channels, which are located on the four interior sides of the terracotta tube. This prevent the terracotta pieces from falling in case of breakage.
4. The aluminium bar is connected to aluminium plates (closure pieces), which close the terracotta tube. Silicone/neoprene gaskets are installed between the aluminium bar and the terracotta tube.
5. The terracotta tubes including the aluminium bar and plates are preassembled by the manufacturer.
6. The plates are attached to vertical aluminium studs, which are attached with aluminium clip angles to the building structural system.

- installation is easy and quick, and no heavy equipment is necessary
- support structure allows for necessary adjustment, and thermal expansion
- system is designed to remove and replace damaged tubes at any location
- under no circumstances shall it be possible to remove individual tubes without the necessary tools
- neoprene gaskets keep the clay profile from rattling and allow for thermal movement
- gaskets between terracotta and aluminium bar shall be silicone with Shore A hardness as required to keep water from leaking through terracotta joints and to maintain structural and alignment requirements
- through a study of the local shadows and sun angles, the screen design can be optimised by increasing or decreasing the space between the profiles
- the system is typically also in mild steel, with the aluminium bar inside the channels, together with all the necessary gaskets at the joints between the steel and the aluminium

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7.4 SCREEN DEVELOPMENT

Wall section conditions were used as design guidelines to develop and design the screen.

7.4.1 DESIGN GUIDELINES: WALL SECTION CONDITIONS

- **Wall Section Condition 1:**
Condition between the screen, a walkway and a public/accessible active programme (conference facilities/information offices).
- **Wall Section Condition 2:**
Condition between the screen, a walkway and a public/private inactive programme (conference lunch area/staff break room)
- **Wall Section Condition 3:**
Condition between the screen, a walkway and the archives.
- **Wall Section Condition 4:**
Condition between the screen and the bathrooms.
- **Wall Section Condition 5:**
Condition between the screen and a private/unaccessible programme (archive offices).

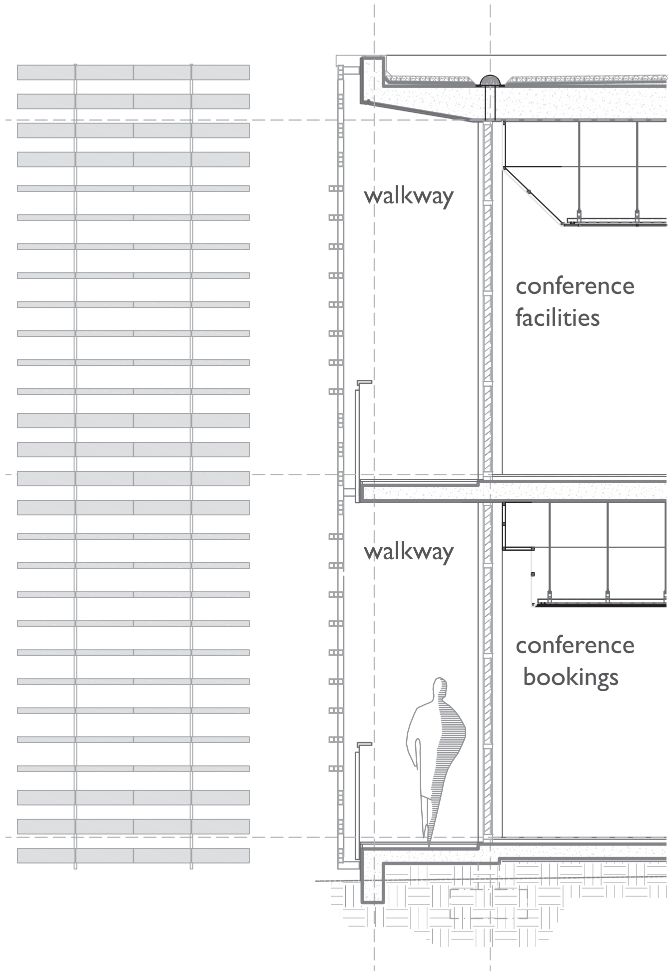

Figure 7.17: Wall section condition 1

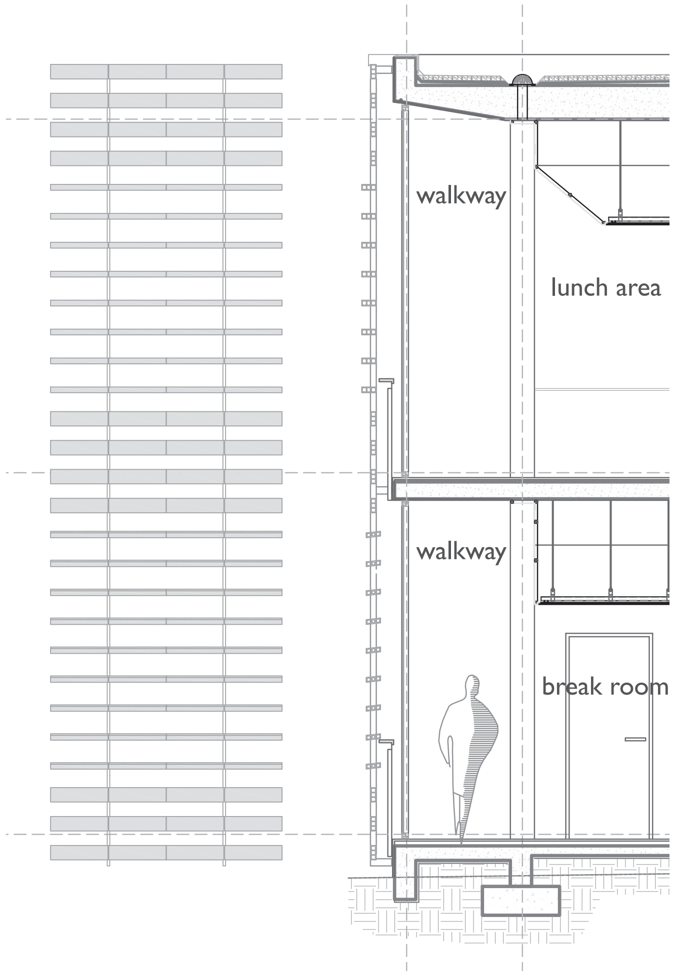

Figure 7.18: Wall section condition 2

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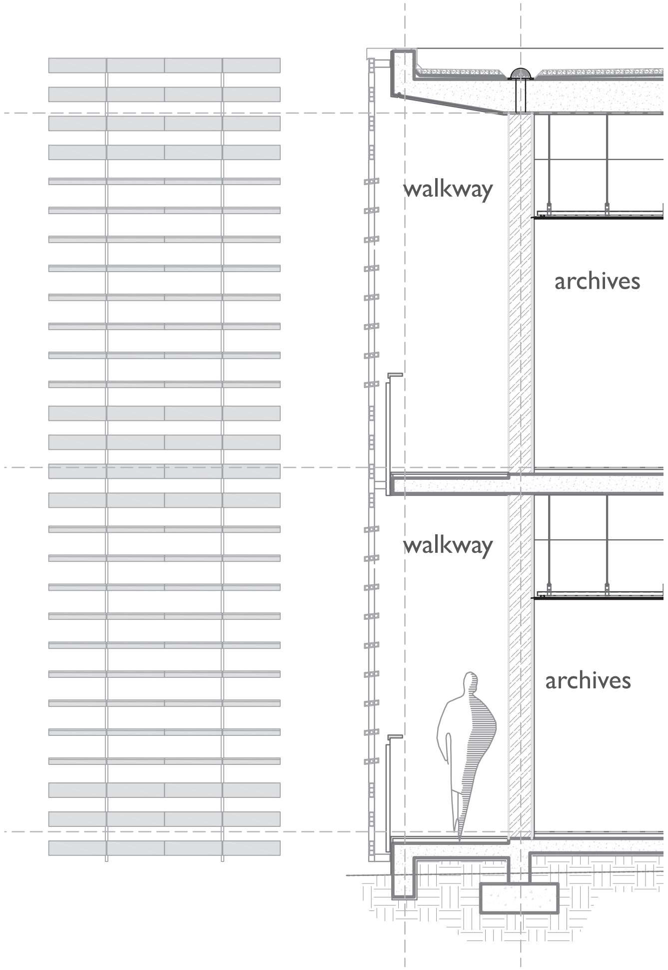

Figure 7.19: Wall section condition 3

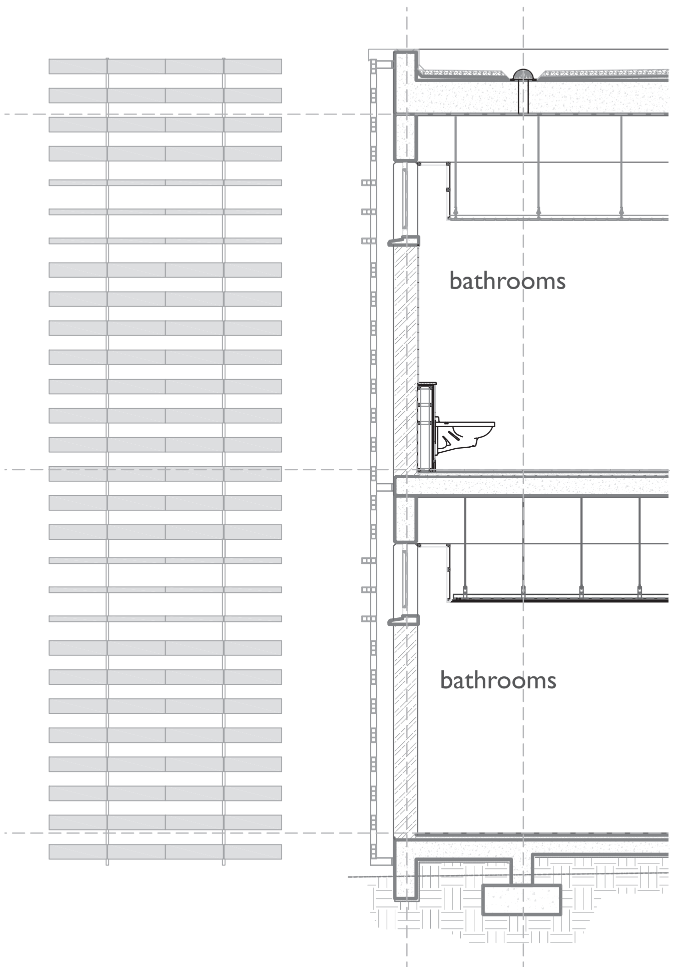

Figure 7.20: Wall section condition 4

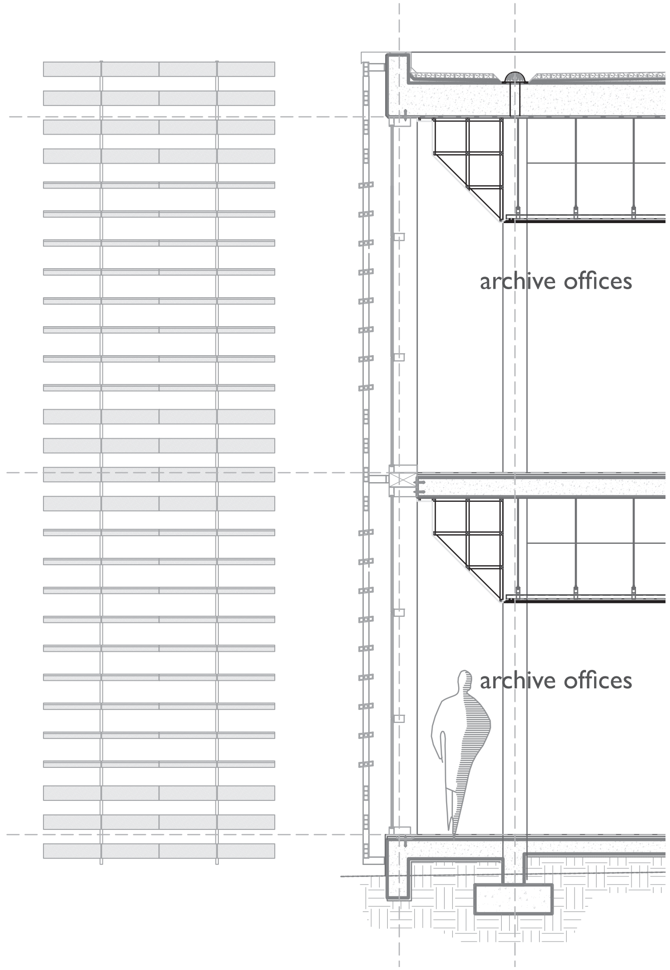

Figure 7.121 Wall section condition 5

7.5 SELECTED BUILDING SERVICES

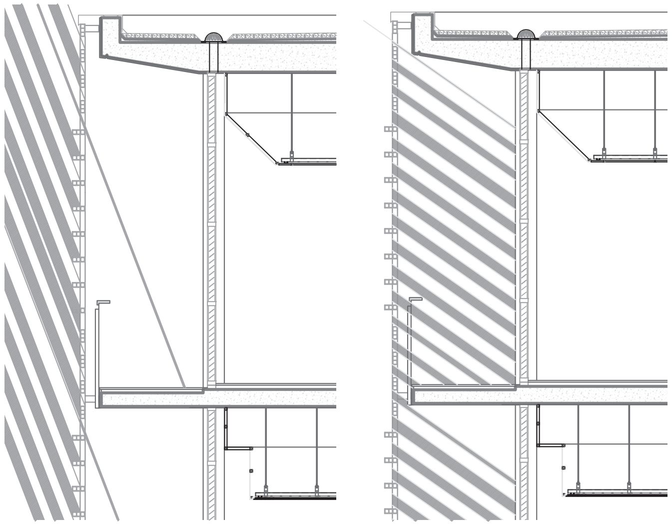

Figure 7.22: The screen blocks harsh summer sun (88-64 sun angle) from entering the building (left), but letting sun in early in the morning and late afternoons (35 sun angle) (right).

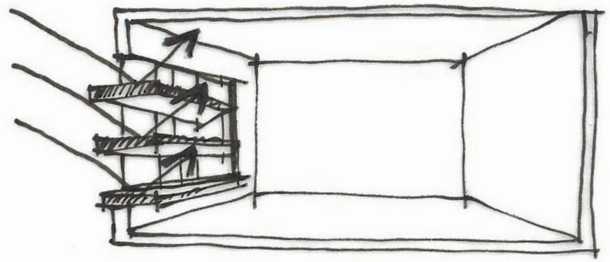

Figure 7.23: New light shelves layered inside the existing. The light shelves diffuse the direct sunlight.

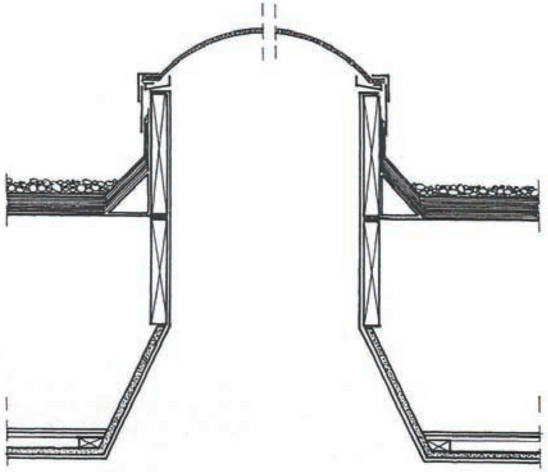

Figure 7.24: A light well associated with a skylight. The bottom of the light well is opened up to distribute more indirect light into the building.

7.5.1 LIGHTING

Lighting accounts for 20% of an average building's energy consumption. Optimising the building's fenestration for the influx of daylight is desirable, also known as daylight harvesting. Day lighting methods will therefore be implemented. Pretoria is blessed with high solar irradiance, typically 1kW/m2 in direct sunlight. These high energy levels, while excellent for maximizing natural lighting in the work spaces of the offices and other areas of the building, will have an undesirable effect on the solar heat gain of the building.

Window shading and other devices and architectural techniques will therefore be employed to control the influx of direct sunlight while still encouraging the less aggressive diffuse skylight. The mechanical engineer, skilled in the estimation of internal heat gain, which incidentally varies depending on the geographical location of the site, will be consulted in order to arrive at a suitable compromise.

Offices, Block E

A sunscreen is incorporated into the design of the new building, Block E. This will keep harsh summer sun out and allow early morning and afternoon sun to filter through. Double glazing walls with integral blinds will take advantage of the natural lighting let in, whilst direct sunlight is blocked before entering the building. (Figure 7.22).

The offices of the new building will be filled with ambient (general) lighting, sufficient to meet building codes. Electric lighting will be used to supplement the harvested daylight and allow for early morning and night work. The electrical engineer will typically specify efficient luminaires, typically fluorescent lamp fittings installed in a grid layout in the ceiling plane. The lamps will automatically adjust the light output through the day to compensate for daylight, and by doing so save energy.

Archives, Block E

The archive spaces will not be required to be especially aesthetically pleasing, but function is important. Inexpensive luminaires will likely be used. Due to the close spacing of the tall archive shelves consideration of the type of light fitting is nevertheless necessary. Luminaires with a suitable photometric, ideally having a horizontal vector component that throws a large proportion of its light on vertical surfaces, will be employed in order to ensure the shelf wares are adequately lit.

Exhibition spaces, Block A

Exhibition spaces are molded to enhance the works on display and to suit the owner or client's needs. The client will not only want the works to be optimally displayed but he will also want the visitor to experience the work in a setting he has in mind. Together with sound, lighting therefore plays a pivotal role in setting the mood of the exhibition space.

Figure 7.25: Examples of sky lanterns acting as skylights letting light in through glazing located on the sides with incorporated diffusers.

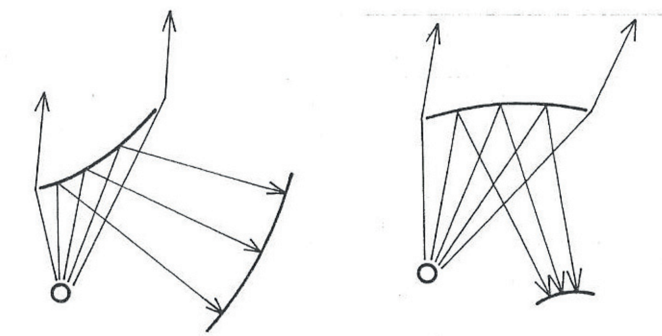

Figure 7.26: Reflectors made to disperse or concentrate sound; note that the angle of incidence is equal to the angle of reflection.

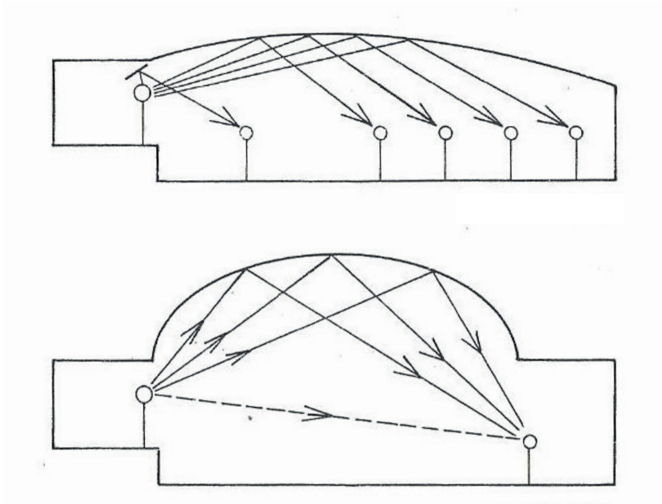

Figure 7.27: Ceiling shape giving good distribution of sound (top), and a ceiling shown causing excessive focusing (below).

In order to provide as much control as possible preference will be given to electric lighting, whilst indirect day lighting will be harvested to supplement ambient lighting.

Window shading in the form of light shelf apertures (figure 7.23) will be employed at the existing window openings to control the influx of direct sunlight. Sky lanterns with light pipes channelling diffuse skylight through the deep ceiling void into the high ceiling vault is also proposed (figures 7.24 - 7.25).

Electric lighting will generally be layered. Ambient lighting will be provided by ceiling, non-directional luminaires. This will serve for way finding and general tasks. The colour of the lamp output is important and will be carefully considered. The exhibitor may have his special requirements, but in most situations, lamps with high colour correlation index will be employed in order to accentuate all colours of the spectrum.

Accent lighting will serve as the second layer of lighting. Spots will be employed to highlight models and sculptures. Spots on a flexible track system will be employed along the walls and under the mezzanine floor structure to highlight the vertical displays along the walls and the moveable exhibition panels. The spots will typically employ low voltage tungsten halogen lamps in dichroic reflectors. The tracks enable the spots to be positioned to suit the orientation and location of the displays. The dichroic reflectors will be specified to minimize the heating effect on sensitive works. The choice of lamps will mainly be fluorescent and incandescent. While the latter is less efficient, the light output of these point sources is easily contained and ideal for precise lighting. These lamps are also easily dimmed and therefore suitable for mood setting.

External lighting

Like many living organisms on this planet, humans are photo topic creatures. Landscape lighting in the courtyard will be designed to draw visitors to areas of importance, such as building entrances, sitting areas and other amenities. Facade lighting to accentuate the features of the detailed building, such as the entrance and the clock tower will be employed, attracting interest from passing pedestrians and motorists, and offering the approaching visitor a pleasant introduction to the treasure it holds.

7.5.2 ACOUSTICS

Auditorium, Block A

Architectural form plays an important role in good acoustic design. Careful consideration of surface finishes and form is necessary to ensure speech is intelligible and uniformly projected.

Some sound reinforcement may be required in order to supplement weak voices or add dramatic effect to visual presentations. The ceiling will be constructed of a hard surface – elastic

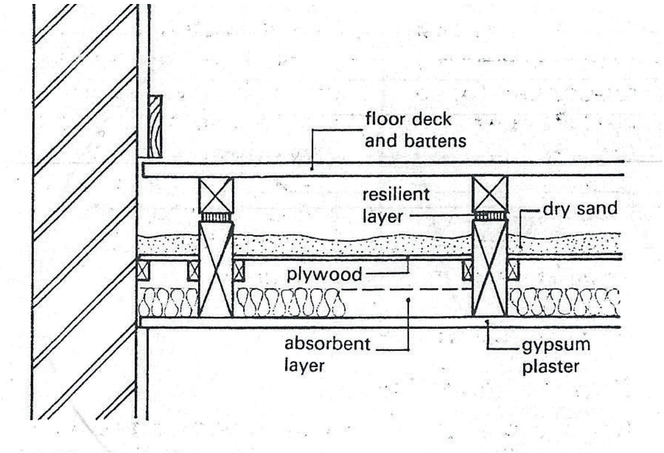

Figure 7.28: Typical construction used in timber floors to limit air-borne and structure-borne sound transmission.

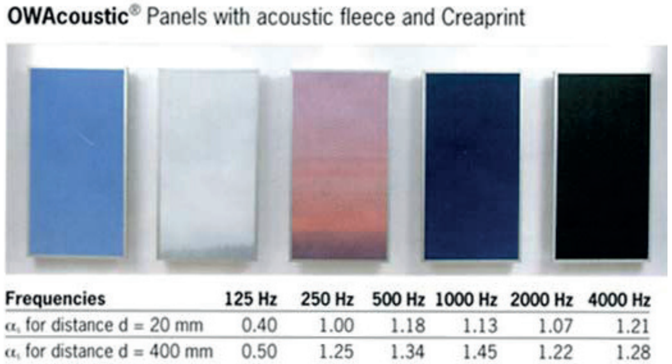

Figure 7.29: Acoustic absorbing material: OWAcoustic Panels with acoustic fleece.

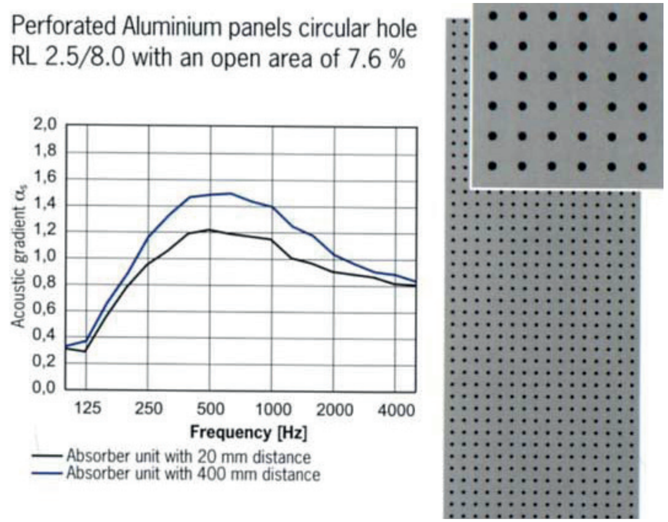

Figure 7.30: Acoustic absorbing material: OWA Perforated Aluminium panels.

in physics terms, such as high density concrete. The surface will be efficient in reflecting sound off its surface at an angle complementary to the angle of incidence. The ceiling form will be such that all sound is reflected back towards to audience. (Figure 7.27).

In order to avoid reverberation (echo), acoustic sound absorbing surfaces are specified at strategic surfaces such as the side walls and back of the auditorium. Absorbing these extraneous sound waves will minimize the echo effect. An acoustic engineer will assist in profiling the shape of the internal architecture. Reverberation can be minimized with the correct specification of surface finishes, but resonance, an undesirable characteristic that also impairs speech intelligibility, can only be predicted by complex calculations or software modelling.

Exhibition spaces, Block A

The focus for acoustics in the exhibition spaces is that of structure-borne sound and reducing noise. Figure 7.28 illustrates how to reduce structure-borne sound in floors.

Sound absorbing surfaces are specified for noise reduction. Typical materials are OWA's Impressions Range with acoustic ceilings, OWA's fleeces and perforated panels and ISOVER mineral wool and fibreglass ceilings. (Figures 7.29 - 7.30).

7.5.3 HEATING ,VENTILATION + CONDITIONING

A measured amount of natural ventilation is a statutory requirement in all occupied buildings. This is typically specified at 8 liter/second of fresh air. While not a statutory requirement, conditioning of internal air is important for the thermal comfort of the building's occupants. Gauteng experiences temperatures in both extremes and requires some mechanical conditioning, both heating and cooling.

These HVAC (heating, ventilation and conditioning) services are typically designed and specified by the mechanical engineer. In consultation with the consultant, space for services will be provided. Energy efficient systems will be employed as far as possible, such as natural ventilation during temperate weather conditions. Ambient temperatures of 21 degree Celsius is ideal. The mechanical services will be accommodated on the roof, and the refrigerant piping will be run inside ceiling plenums to the locations of the air handling units.

Occupants of buildings desire an environment that they can control. Open able windows are therefore highly desirable, and temperatures exceeding 21 degree Celsius are generally acceptable with this kind of control. All the buildings have a narrow footprint with no internal obstacles making natural ventilation conceivable.

Heat pump technology, an efficient heating system, can be employed for introducing heat into the recycled air. A building

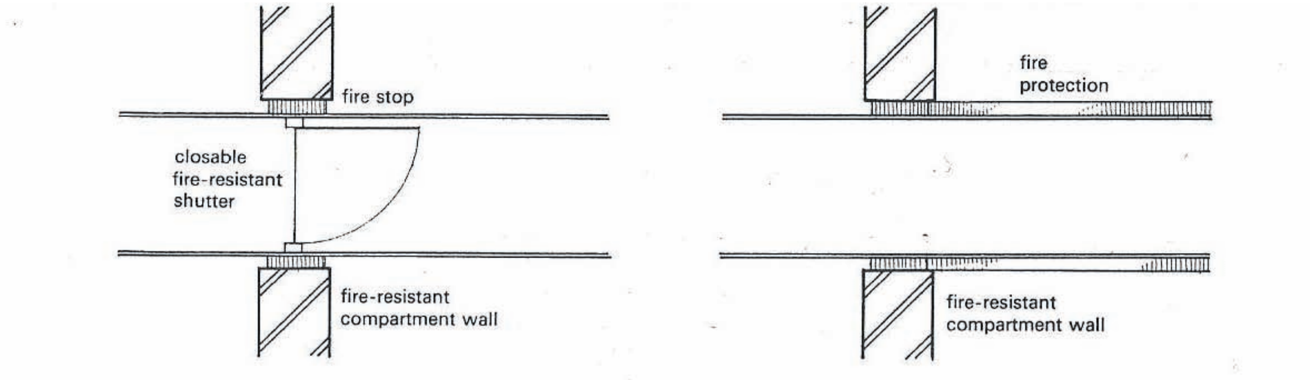

Figure 7.31: Air-conditioning ducts penetrating fire compartments should have fire shutters (left), or be fire protected (right) to prevent smoke and fire from spreading.

management system (BMS) will ensure the HVAC system operates efficiently and adapts the environment to the building application, for instance switching off heating after hours.

7.5.4 FIRE

Archives, Block E

Early smoke detection with fire extinguishers and fire hose reels are important for the archives, as well as a flooded gas fire sprinkler system, like Inergen Gas.

Compartmentation of a building consists of subdividing it into compartments, with fire-resisting walls, floors or roofs. The subdivision is made to limit the spread of fire and restrict damage to the building and its contents.

Due to the concept of block-in-block of the new building, the archives are already compartmentalised, with a walkway around the archive rooms.

In the case of air ducts, fire dampers must be installed inside the ducts or the ducts must be fire insulated (figure 7.31).

7.5.5 ENVIRONMENTAL CONTROL

Archives, Block E

Temperature and humidity should be controlled inside the archives. Approximately 45% relative humidity (RH) at 22.5 degree Celsius is needed. This means that although thermal comfort is not necessary, allowances must be made for ventilation ducting for humidity requirements.

7.6 MATERIALITY

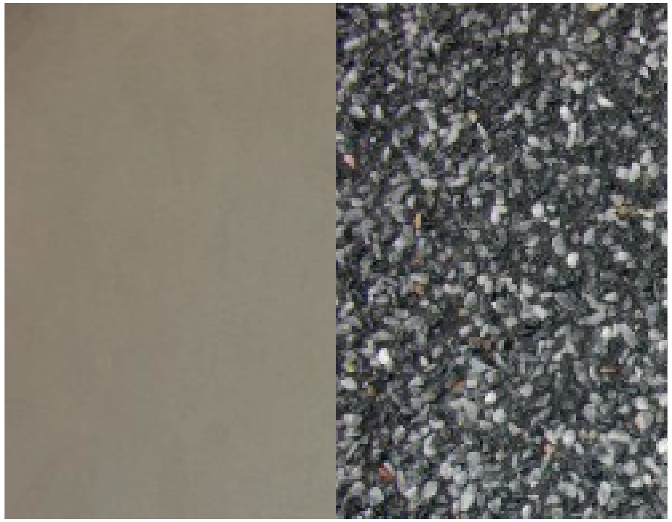

Figure 7.32: Versus Suede Paint on the left, and Versus Paint Stone Finish on the right.

7.6.1 EXTERNAL WALL FINISH

Exterior wall finish, Block E

Due to the close proximity of the screen to the wall in some areas (wall section condition 5) a low maintenance external wall finish was chosen.

Typical low maintenance wall finishes are Versus Suede plasticised paint or Versus Paint Stone Finish. Both are applied using a steel trowel (figure 7.32).