

6. TECHNICAL RESOLUTION

6.1 HVAC – heating, ventilation and air-conditioning

Air conditioning units should be used as a last resort as they use a vast amount of energy resources. The type of facilities situated in the building makes HVAC systems an integral part of this dissertation's design and technical resolution to meet the comfort and acoustic requirements - especially in the cinema auditoria. A comfortable interior temperature for moderate activity is from 20°C to 26°C. (Napier 2000: 2.3)



After consulting to Patrick Köhler from Spoomaker and Partners Inc. (Mechanical engineers who specialise in HVAC systems) it was decided to use an individual air-conditioning system for the different zones of the cinema. This will prevent the discomfort of the people in all the auditoria if the unit malfunctions or breaks. Each auditorium will have its own system with the cooling unit on top of the building where the amount of polluted air and dust are at a minimum. This system uses only 5l/s/ person fresh air and the rest of the air will be filtered and recirculated, as the volume of the space is larger. The unit cools the air down and this air is then transported to its specific zones through 1200 x 600mm ducts. A decision had to be made whether air should be supplied in the auditoria from under the seats or from ducts in the ceiling. Air is cooled to 13°C by the unit and if the users are positioned too close to the duct, it can lead to discomfort. This will be experienced if the air is supplied from under the seats. To correct this problem, the cool air will have to be warmed again to at least 18°C, which will increase the amount of energy use. If the cool air is supplied through the ceiling, it does not need to be warmed and more energy will be saved. Thus, in all the zones the cool air will be circulated through vents in the ceilings or direct from the ducts, that will be fixed to the soffit where the services are exposed as in the entrance and foyer area.

To overcome the noise problem that is caused by the air-conditioning systems, sound filters will be fitted into the ducts that lead from the main air cooling unit. These noise filters will also be fitted into the ducts that extract warm air from the building and transport it back to the unit to be cooled down again.

A positive air pressure should be maintained in a cinema auditorium to prevent dust from collecting on the screen. This can be achieved by supplying more air to the space than what is removed from it. More clean air prevents contaminated air from entering the space and a positive air pressure is maintained. The air from the air conditioning unit is kept clean by sending it through dust filters before it enters the cooling unit as well as the air that is being recirculated.

During winter this same system will be used to warm air. The process operates similarly to when cool air is transported through the building. In this case the unit warms the air and it is then circulated through the building.

6.2 Acoustics

Acoustic considerations had a direct effect on the design and technical decisions of this dissertation. Acoustic design controls intrusive noise and by choice of materials, dimension and shape auditoria, comfortable noise levels can be enjoyed. (Jones *et al* 1980: 18) Rectangular rooms with parallel floor and ceiling surfaces especially if

long and narrow, give the worst result. The ideal is a fan shape auditorium, which is also ideal as regards viewing conditions. (Tutt and Adler 1979: 200) Other key acoustic design issues in cinema auditoria are sound insulation between auditoria, isolation to the outside, a good sound system, 'dead' room acoustics and moderate ventilation noise. (Nel 2003: 8.3)

The ideal material characteristics required for sufficient **sound absorption**:

- Surface porosity to allow sound wave penetration
- Integral porosity
- Soft resilient blankets or panels

The two aspects that have an impact on the **sound insulation** are the mass of the material and the stiffness of the material. To prevent the spread of sound one needs high mass and low stiffness.

Experimental cinema

Room: 8 x 8 x 3 meter

Floor: 150mm concrete floor, 200mm joists with 20mm plank floor, 100mm average air gap with 50 glass wool, 20mm laminated wood.

Ceiling: 20mm laminated wood, 100mm average air-gap with 50mm glass wool.

Walls: 110mm brick wall unplastered, 12mm gypsum board, 63mm air gap with 50mm glass wool, double 12mm gypsum board

Interior covering of walls: 50% carpets and 50% laminated wood with 100mm average air-gap

Doors: two special 60mm solid wood door with seal (1.2 x 2.1)

Windows: none

Audience: 20 seated on soft chairs.

Absorption coefficients:

Frequency	(Hz)	250	500	1 k	2 k
Floor:		0.16	0.28	0.30	0.28
Walls:		0.16	0.26	0.28	0.29
Ceiling:		0.30	0.15	0.13	0.1
Door:		0.05	0.05	0.05	0.05
Seats upholstered empty 20%(per seat)		0.05	0.05	0.10	0.15
Seats occupied 80% (per seat)		0.32	0.38	0.35	0.38
Air (per m ³)		0.001	0.003	0.006	0.011
Absorption m²					
Floor:	64 m ²	10.24	17.92	19.2	17.92

Walls:	90.96 m ²	14.55	23.65	25.47	26.38
Ceiling:	64 m ²	19.2	9.6	8.32	6.4
Doors:	5.04 m ²	0.25	0.25	0.25	0.25
Seats empty	4 people	0.20	0.2	0.4	0.6
Seats occupied	16 people	5.12	6.08	5.6	6.08
Air	192 m ³	0.192	0.576	1.152	2.112
Total absorption in room (A)		49.75	<u>58.28</u>	60.40	59.74

Room total surface (S)	224m²				
Average absorption coefficient T60(1)		0.22	0.26	0.27	0.27
Reverberation time (Norris-Eyring) (2)		0.55	<u>0.46</u>	0.44	0.44s

1. $\alpha = A/S$
2. $T60 = \frac{0.161 \times \text{volume}}{-2.3 \times S \log(1 - \alpha)}$

“Reverberation time is defined as the time that it takes for sound pressure level to fall by 60 dB after the source has been switched off.” (Nel 2003: 8.2)

Reverberation time is an important parameter in the design and performance assessment of rooms that are intended for a specific use. According to graph 24.11 in The New Metric Handbook (Tutt & Adler 1979: 200), the reverberation time over 500Hz for the experimental cinema with an area of 192 m³ should be 0.725 seconds and currently it is 0.46 seconds. To increase the reverberation time the average absorption coefficient needs to decrease. This can be achieved by lowering the total absorption in the room. Reducing the adsorption in this case is not a possibility as the absorption prevents the leakage of sound outside the cinema, which will be distracting for the people in the individual booths. It also prevents sound from outside too enter the cinema auditorium. It is practice to solve the problem of reverberation time that is to fast by placing more speakers in the cinema, from the front as well as from the back, which will enable the viewers to receive the sound at the same time.

6.3 The design of a cinema auditorium

When designing a cinema auditorium there is a vast number of aspects to take into account like sightlines and seating layouts. “In commercial cinemas, every member of the audience should have an unobstructed view of the entire picture area without visual and physical discomfort and without picture distortion. The auditorium must be suitable for the sound reproduction used, which must be free from distortion and colouration arising from architectural deficiencies. In this, shape and nature of

the surface play an important part: opposite surface of walls and floor and ceiling should not be parallel.” (Tutt and Adler 1979: 195)

Viewing conditions

In this dissertation semi-stadium cinema have been designed. (Fig 124) This is a cinema that has stepped seating. In designing the step seating sight lines had to be taken into account to make sure that each viewer has an unobtrusive view from the bottom to the top of the screen. The guidelines given in “Ernst Neurfert – Architects’ data” have been used in this regard.

Eye height of viewer: 1120 ± 100

Row spacing (T): 800 – 1150

Head clearance (C): 130 allows viewer to see over the head of the viewer in front. (Jones *et al* 1980: 349) (Fig 122)

In a cinema auditoria the seat blocks do not normally exceed 14 chairs. The distance from the screen to the front row of seats are determined by the maximum allowable angle between sightlines from the first row to the top of the screen and perpendicular to the screen at that point. This angle ranges between 30° and 35°. An angle of 35° produces a shorter distance from the first row of seat to the screen and is used more often because of the more extensive use of space. (Jones *et al* 1980: 354) (Fig 126)

In viewing a flat screen the seating area is represented by an area common to the

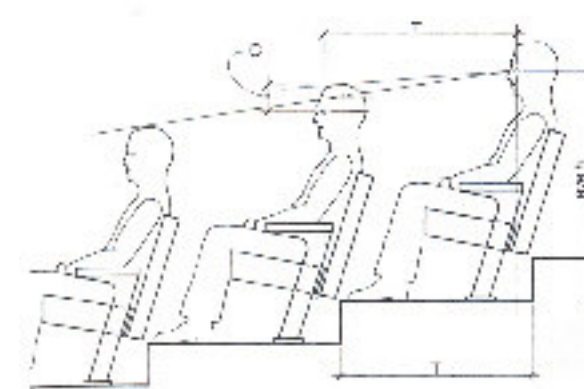


Fig 127. Typical seated spectator

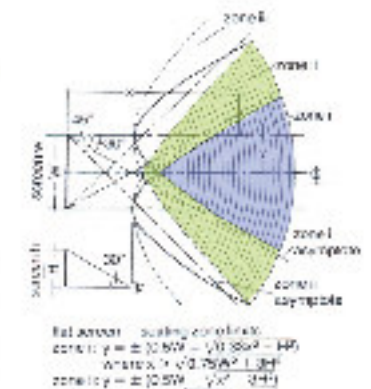


Fig 128. Film projection planning

space within two hyperbolas, which form certain zones on plan. These zones act as guidelines to where a viewer might experience distortion of the image. Zone I is where distortion exists but is not noticeable from seats falling within the hyperbola. Zone II is where distortion is noticed but tolerated from the seats falling outside zone I and zone III (seating beyond limit of zone II) is where distortion of the projected image will not be tolerated. (Jones *et al* 1980: 355) (Fig 123)

6.4 Baseline criteria (SBAT)

A cinema complex is not a sustainable responsible entity. This is mainly due to the large amount of equipment and materials that need to be imported, as this equipment is not available in South Africa. Another aspect against sustainable cinema development is the amount of energy used. All the equipment needs vast amounts of valuable energy to operate and the air conditioning systems also contribute to the energy usage. Thus sustainability has to be taken into account in other fields like the social and economical issues.

This design is based on the following criteria set up with regard to the context of the project and a sustainable approach according to Jeremy Gibbert's Sustainable Building Assessment Tool (SBAT).

6.4.1 Social criteria

Occupants Comfort

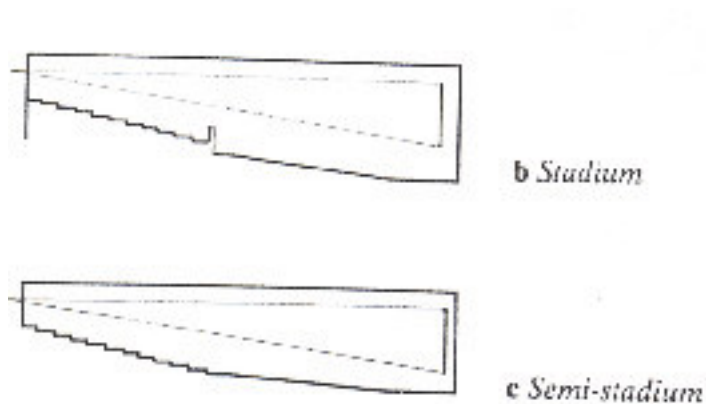


Fig 129. Stepped seating

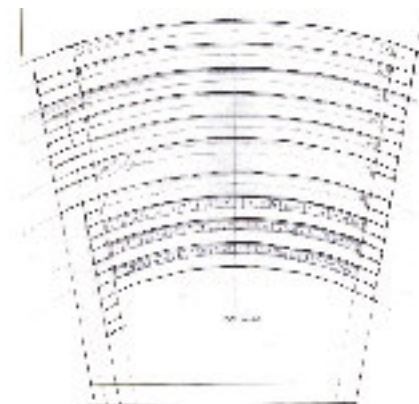


Fig 130. Layout of traditional cinema

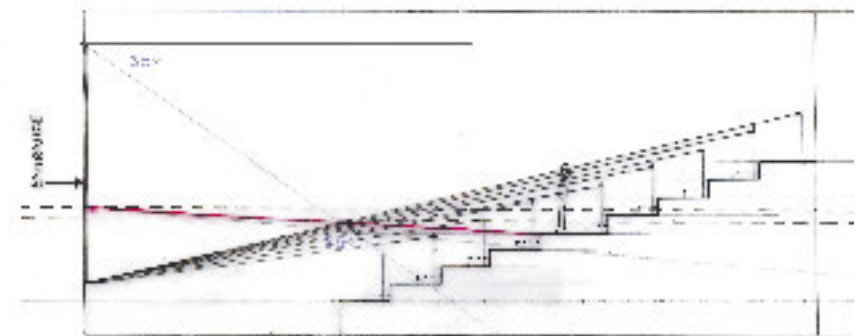


Fig 131. Sight lines

The use of natural lighting will be promoted throughout the building where possible and attention will be given to the minimisation of glare that can have an impact on user comfort. In cinema auditoria that are known to be black boxes, no natural lighting is used and this brings about a high dependence on artificial lighting. Where artificial lighting will be used, low energy lamps will take preference. With the large glass façade on the south side of the building the entrance and foyer part of the cinema are illuminated with natural light, and the light ray penetration are controlled, as there are display surfaces throughout the space.

The cinema area of the building depends on the use of an air-conditioning system to cool down the equipment and to create a comfortable environment for the users. Through the design of the building the amount of air-conditioned air can be kept to a minimum by minimising the east and west facing windows. With the south facing glass façade natural light enters the cinema area but its still kept at relatively comfortable temperature levels. Throughout the rest of the building it will be proposed to use passive systems that are ecologically friendlier and economically more viable in the long term.

Acoustic design is an important aspect to prevent the noise from the cinema auditoria from spilling from one to the other, or the noise of the parking basement from entering the cinema auditoria. This design approach has been discussed in 6.2.

Inclusive environments

Any building or space should be designed to accommodate everyone. Ensuring that a building is inclusive supports sustainability and any replication or changes that have to be done after the design process has been finalised, is avoided. On all the public spaces the necessary ramps that have a fall of 1:12, or lifts, as well as adequate toilet facilities have been designed to accommodate people in wheel chairs. The lighting and signage have been designed to be readable and understandable for people that may have other impairments. All flooring is designed even and where change of level takes place, it will be clearly indicated. Ramp surface is also treated with a non-slip treatment to ensure easy movement.

In the cinema auditoria people in wheel chairs will be accommodated near the entrance where they can stay in their wheelchairs or be seated in one of the cinema seats. One of the individual booths will be designed that a person in a wheel chair can stay in his or her seat and still be able to enjoy a movie on his or her own.

Another important aspect is that people with disabilities have easy access to the escape routes. This has been taken into account with the design of these spaces. All the spaces that are designed for people with disabilities comply with the regulations of the design of facilities for disabled people. (SABS Building Regulations 0400)

Access to facilities

As the project is situated in the Melrose Arch precinct it is closely situated to other retail possibilities, banks as well as residential areas, which include flats and lofts in the precinct. The N1 also passes the precinct. This motorway connects the site to Johannesburg, Midrand and Pretoria. The precinct also has public telephones, Internet and e-mail facilities.

Another aspect that enhances the access in the precinct is that pedestrian movement is being encouraged throughout the precinct and people feel safe and at ease.

Education health and safety

The cinema complex and its various components have been designed to be used as an educational tool as much as for entertainment. The main aim with regards to education is to encourage learning through the use of new technologies and innovatively designed spaces. Institutions and schools can book an auditorium for a day or a show, for the presentation of educational material. These auditoriums can also be used by the businesses in the precinct for presentations, launches or conferences. This will contribute to the multiple use of the building.

Safety in the precinct has been discussed in the context study of the document and was one of the factors used to determine an appropriate site. In the building the necessary escape routes and fire prevention precautions have been taken into account and designed according to the fire regulations in the SABS 0400.

6.4.2 Economic criteria

Sustainable development does not just mean a cleaner environment; it also requires a stable and healthy economy. The following economic issues have been taken into account in this project.

Local economy

Through the cinema the local economy will be supported. Promoting South African produced films in the cinema will create an awareness of the impressive quality of work achieved in the South African film industry. Until recently the general public was unaware of this fact, because international films received more exposure. South African art and art clips will also be favoured in the digital gallery to promote South African artists.

For this dissertation it will be proposed that small business initiatives should be contracted rather than large, well-established companies, to benefit and promote them. It will also be stipulated that only black economic empowered companies should be used or companies that encourage black empowerment. There is no charter/law stipulating that such companies need to be used but it will demonstrate the commitment to be socially responsible.

Local labour within close distance will be contracted to do all the construction on the project. This will have a positive impact on our local economy and will provide these people with skills to make them independent. Local contractors will also run the cinema and any subsequent maintenance to be performed will be carried out by local contractors, trained by the overseas suppliers in the use and maintenance of the cinema equipment. Low-embodied energy materials that are produced locally, will be used as intensively in the building as possible. Materials such as concrete, glass and standard sized steel I-beams that are sourced locally as well as their applications, are familiar to contractors and workers. Another positive impact from the use of locally produced materials is that it minimises the transport energy consumed. Recycled materials will also be preferred.

Efficiency of use

As this is a retail and recreation development with additional office space, it is imperative that the space use efficiency is raised to a maximum as investors are counting on a profitable return of their investment. The use of the cinema part of the building will be visited seven days a week anytime of the day and evening, as visitors can choose their own viewing times or fall into a already scheduled time slots. This will create a high occupancy for the cinema part of the building. The non-useable spaces are kept to a minimum. The air conditioning plant rooms are situated on the roof of the building, which also lowers the non-usable spaces in the building. By situating the traditional cinemas that are referred to as black boxes in the basement, more opportunity for retail and profitable spaces are created.

The cinema will be technologically advanced and the cinema auditoria can also be used by companies in the building as well as in the precinct for conferences or launches which will boost the multiple use of the building. Both parties will benefit from this arrangement as it creates an additional income for the cinema. Moreover, the companies will not have to rent huge spaces for conference rooms or make large capital outlay to buy the expensive equipment.

Adaptability and flexibility

Buildings that can accommodate change easily support sustainability by reducing the requirement for change and the need for new buildings.

As the building has a column structure to support the floors as well as the roof, the use of easily removable partitioning and no-load bearing walls will be used inside the building. This will increase the lifespan of the building through adaptability of use. The digital gallery and the experimental cinema booths are designed to be lightweight and easily removable. This is done to accommodate rapid technological change and future innovations. All the floors are also at least 3m from the floor to the underside of the slab of the floor above, with the ground floor double volume. This makes the space more adaptable for different uses.

Ongoing cost

The materials used inside the building will be specified to be low in maintenance cost and minimal cleaning cost. For example, the floor will be finished with concrete and epoxy which is easy to clean and hard wearing. The more public areas of the building such as the entrance and foyer area of the cinema centre will have exposed air-conditioning systems that will offer easy access for maintenance. With

the plant rooms on the roof of the building any disturbance created by maintenance will be kept to a minimum.

Cinemas consume a large amount of energy for the running of the equipment, which will increase the cost of energy use in the building. This effect will be equalised by promoting the use of alternative low energy sources in the rest of the building.

As the building lies within a secured precinct, the cost of security is kept to a minimum. This will also have an impact on the ongoing costs.

6.4.3 Environmental criteria

Energy

The site is situated in an urban environment and is within walking distance of public transport.

Heating, cooling and passive ventilation principles will be incorporated as extensively into the existing structure as possible. However, mechanical ventilation will also be used, especially in the basement and the cinema auditoria as discussed in 6.1. Natural lighting should be preferred and energy efficient light fittings are to be used wherever appropriate. It is, however, important to establish mechanisms, which will reduce excessive direct sunlight during summer months.

Recycling and reuse

It will be proposed that all building material used in the interior design of the building should be reused or recyclable after the life cycle of the cinema. The stainless steel used in the balustrades is recyclable as well as the Plexiglas *satinice* panels. These panels are non-toxic and recyclable and can also be reused. The laminated wood used as flooring and wall coverings can also be reused in other applications or again as flooring or wall coverings. The necessary arrangements will also be made for the safe disposal and recycling of toxic/harmful substances from the cinema centre.