## Introduction

After establishing the market standards and considering the requirements of the city (NMMM and MBDA) it becomes possible to define the criteria for a congress centre. The criteria set out here, even though presented as a logical outcome of preceding research, actually contain a great deal of design logic. It is, in fact, informed by conceptual design thinking that has so far been developed in parallel to the formal inquiry. It is the first systematical integration of these seemingly disparate processes - conceptual thinking plus formal research. For example, research might indicate a certain level of lighting required for a certain room and will be reflected as a rational value in *lux*. This might be accompanied by a certain specification for a light fitting that is already a reflection of a qualitative design effort hidden in explicit instructions. This is the 'quantum leap' -moment in the design process.

Baseline criteria is a list of requirements that the *design product* must fulfill - not the building per se. The baseline criteria becomes the problem statement that the final design seeks to be the answer to.

The layout of the criteria is a reflection of the conceptual 'parts' of the building. They are not integrated yet and the nature of inflection and compromise that each part will make is not clear yet.

Part A is a development of the market research combined with research on congress centres in general. It is a type of accommodation list. It gives the spatial requirements of a centre in order for it to function. It consists of a description of facilities with its constituent elements and features. Part B is the design requirements as set out in the brief. Part C describes an appropriate response to the built environment and Part D states the norms derived from the urban framework.

## Part A: Facilities

<u>Main Auditorium</u>

- The main auditorium will be able to accommodate large gatherings of delegates for especially formal meetings. It will consist of a flat floor with stackable chairs (and tables occasionally) to allow for flexible arrangements. The densest layout will accommodate 2400 seats in rows of not more than 22 chairs. The rows will be 850mm nose to nose. A corridor of 2500mm will be allowed between such rows.
- A balcony with tiered fixed seating to accommodate 2800 delegates. Seating will have microphones, writing tablet, data connection, earphones.
- Storage space for stackable chairs and tables.
- A permanent stage/ platform will be higher than the flat floor to allow the hindmost chair reasonable visibility with a 850mm chair spacing. The front-most chair will have a reasonable direct view of a speaker standing 2m from the front of the stage. The front of the stage will give access to storage areas below it and to backstage storage. Space for a lectern; chairman panel; control panel; demonstration bench. Rear and side walls of the platform will be supportive of its functions. Consider larger stage arrangements for dance and theatre.
- Media: allowance will be made for overhead projection via a ceiling mounted, speaker operated, proxima; video, film and slide projection; flip charts; two large format screens operated from a control room and the speaker; camera recording; voting panel.
- Acoustic performance: Acoustic treatment of wall surface materials; auditorium shape; sound amplification; Total exclusion of exterior noise.
- Specialized lighting installations.
- Interior decoration compatible with large scale formal gatherings.
- Translation booths

<u>Foyer main auditorium</u>

- Glass enclosed skin.
- Acoustic ceiling
- Highly durable floor finish
- High quality finishes
- Access control from outside
- Removable access control from the rest of the centre so that the auditorium can operate separately
- Autonomous cloak room
- Autonomous toilets
- Gives access to the main auditorium from the back.
- Interior decoration to anticipate auditorium functions but also to be an escape from it. The foyer will be a feature of the centre.

<u>Backstage to main auditorium</u>

- Lighting control room, dimmer room, sound control room, auditorium sound mixing position, tv, radio and recording control room, observation room, quick change room, properties room, scene dock, loading bay, scenery store, piano store, lighting equipment, sound equipment, stage manager, dressing rooms, green room, costume store, specialist make-up room, pre-performance practice room, pre-performance dance-studio, physiotherapy room, wig store and hairdresser's room, waiting area/ assembly area for performers and speakers close to organiser and change rooms, offices for a children's supervisor, company manager, touring manager, toilets and change rooms, projection room, translation booths for 6 translators close to sound mixer and close to autonomous toilets lounge and library.
- Independent conference organisation facility comprising offices with desks, chairs, telephones, reception area, secretary, fax, copier and internet.
- Press room: general room with desks and chairs, telephones,

fax, copier and internet. Television and radio interview rooms. Press lounge with en-suite toilets. Interior decoration will be suitable for international broadcasts.

Conference auditorium

●Tiered fixed seating for 1250 delegates. Seating will have microphones, writing tablet, data connection, earphones. Seating will be spaced 850mm nose to nose and 500mm side ways. All seats will have a clear view of a point 1m above FFL, 5 meters in front of the front seat.

●Media: allowance will be made for overhead projection via a ceiling mounted, speaker operated, proxima; video, film and slide projection; flip charts; two large format screens operated from a control room and the speaker; camera recording; voting panel.

●Acoustic performance: Acoustic treatment of wall surface materials; auditorium shape; sound amplification; Total exclusion of exterior noise.

●Specialized lighting installations.

●Interior decoration compatible with large scale formal gatherings.

●Translation booths.

Conference auditorium backstage

●Storage, lighting control, dimmer room, sound control room, auditorium, auditorium sound mixing position, tv, radio and recording control room, observation room, lighting equipment, sound equipment, green room, specialist make-up, pre-performance practice room, waiting area, toilets, speaker's room, projection room.

●Front area/ stage area will be the lowest level in the auditorium with equipment: chairman panel, control panel, demonstration bench. The rear and side walls of the platform will be appropriate for presentations.

●Large format screen.

Main Foyer

●The main foyer will serve for the arrival and departure of delegates - especially on the first day of events.

●The main foyer will serve as the gathering point for all circulation routes that are meant for delegates. The main foyer will have access from organisers and administration. All ad hoc facilities should be in easy reach of the main foyer - medical aid, security, cash dispensary,

●The main foyer will be directly linked to the porte cochere, garage parking, main auditorium foyer.

●Toilets, cloak room, bar, restaurant and main lounge will be directly adjacent to the foyer including a smoker's balcony.

●Access control

●Central enquiry desk with access to back-of-house storage and directly linked administration.

●Interior decoration will be suitable to large gatherings of delegates. Extremely high quality finishes. It will be robust enough to be adapted to event themes. It will be a feature of space. Align movement direction with views terminating at feature elements or views.

Banquet hall

●General: organisers seek a venue with character dedicated to specific events. Entertainment is the main goal of gathering in the banquet hall. Organisers and attendees seek fast service and the building must facilitate this. Equally the proprietor/ operator runs a labour-intensive business, for profit, in a competitive environment and seeks the most efficient operation to minimize expense on resources.

●The Hall will be accommodate a number of delegates equal to the auditorium at full capacity. Assume 5187people. Circular tables arranged diagonally can accommodate 0.85 people per $m^2$. This implies a seating area of 4410$m^2$

●View towards the harbour will be a feature of the hall.

●Direct access to the main kitchen is essential

●The floor space must be column-free

●The ceiling height must support the idea of abundant space.

●Interior architecture will be appropriate to large gatherings of people for the purpose of entertainment. Special consideration must be given to adaptability, staging and theme decor.

●The hall will be accesses from a foyer through a lobby with two sets of doors to ensure noise from the foyer does not enter the banquet hall

Foyer to Banquet Hall

●The foyer will have standing capacity for the banquet hall audience.

●It will be served by a bar and finishing kitchen with direct access to the main kitchen.

●Toilets

●Smoker's balcony

●Access control

●Interior architecture anticipating banquet hall excitement and grandeur. Extremely high quality finishes.

Main Kitchen

●General: food production and consumption viewed as three overlapping industrial processing circuits - cooking, dishes, customers:

1. Cooking circuit: goods inwards - food supplies; storage; processing: preparation, cooking, serving (food to circuit 2); equipment cleaned and prepared for re-use; goods outwards: disposal of waste

2. Servery circuit: Goods inwards - supplies purchased; storage; processing: food added to dishes; moved to table (food to circuit 3); returned from table; dishwashing; storage

for re-use. A dedicated servery will be required for each separate catering area: banquet hall, main restaurant, auditorium foyer, banquet hall foyer, congress auditorium foyer, level 3 congress foyer and balcony, level 4congress foyer and balcony, backstage areas.

3. Customer circuit: Customers inwards: parking, reception at banquet hall foyer, storage: bar, waiting area, foyer, balcony; processing: food transferred from circuit 2, drinks provided - access to main bottle store, billing and payment.

●Operational requirements: The kitchen should provide for the greatest variety of meals as the congress centre will be used for a great variety of events from casual to formal, from gourmet cuisine to mass buffets. Service to attendees may vary from full hand-service to each individual to a large scale buffet for a constant flow of attendees. Sit-down meals will be served in the banquet hall while tea-time snacks and refreshments may be served to standing group or to a lounging group. Each finishing kitchen will be equipped for the situation it is most likely to cater for while receiving food in large batches from the main kitchen. Alcohol will be served from the main bar, the restaurant and the banquet hall. No alcohol will be served to the conference floors

●Capacity: an estimated maximum of 9'000 meals will be served per day. Sizes based on this are as follows:

1. Preparation: 480 m²
2. Service: 840 m²
3. Staff facilities: 240 m²
4. Cooking: 700 m²
5. Washing up: 320 m²
6. Storage: 560 m²

Giving a total of 3140m².

●Storage facilities based on meals per day:

1. Vegetable store for three deliveries per weak: 160 m²
2. Dry goods store three days' supply: 120 m²
3. Deep freeze seven days' supply: 120 m²
4. Cold room daily delivery of perishable goods: 80 m²
5. Goods entry area including weighing and checking: 80 m²
6. Refuse store: 40 m²
7. Cellar, glass wash & store : 160 m²

Giving a total of 760 m².

●Bar service to the main foyer and restaurant

●Access to bar store with two separate cold stores.

Seminar rooms

●Combined capacity of seminar rooms will be equal to the main auditorium

●Seminar rooms will be sub-divideable by movable, ceiling mounted, acoustic walls.

●Storage and projection rooms.

●Stackable chairs and tables for various arrangements.

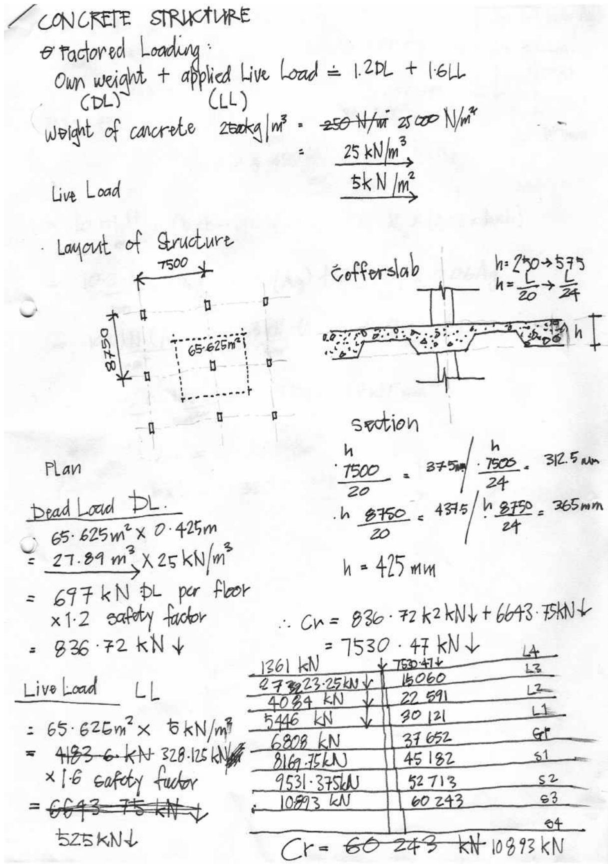
●Interior decoration appropriate to more informal meetings of focussed presentations and face-to-face sessions

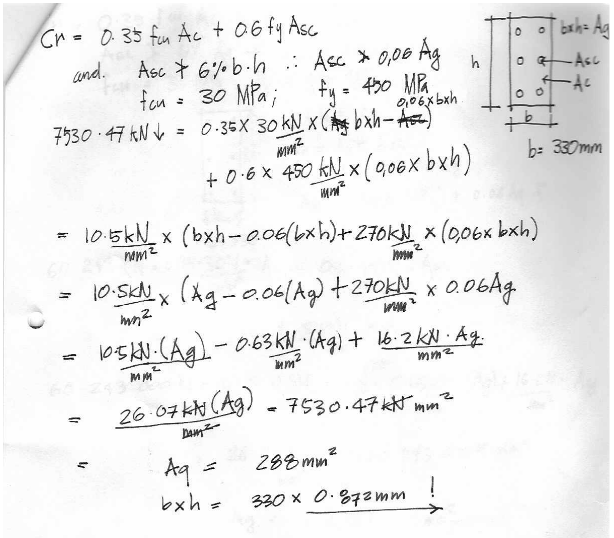
## Part B: Design Requirements

Structural safety, stability and serviceability.

The structure must be able to withstand not only the large masses of people that will rapidly move through the structure but also exhibitions creating concentrated loads. This load-profile is not common and an oversized design load will therefore be used 5kN/m².

The calculations give the magnitude of downward forces from dead weight/own load plus imposed loads/live loads. A load is calculated for each level. Each level will have columns





$Cr = 0.35 f_{cu} A_c + 0.6 f_y A_{sc}$

and. $A_{sc} \ngtr 6\% b \cdot h$ ∴ $A_{sc} = 0{,}06\,A_g$

$f_{cu} = 30$ MPa; $f_y = 450$ MPa

$b \times h = A_g$, $A_{sc}$, $A_c$, $b = 330$ mm

$7530.47\ kN = 0.35 \times 30 \frac{kN}{mm^2} \times (bxh - 0{,}06 \times bxh) + 0.6 \times 450 \frac{kN}{mm^2} \times (0{,}06 \times bxh)$

$= 10.5 \frac{kN}{mm^2} \times (bxh - 0.06(bxh)) + 270 \frac{kN}{mm^2} \times (0{,}06 \times bxh)$

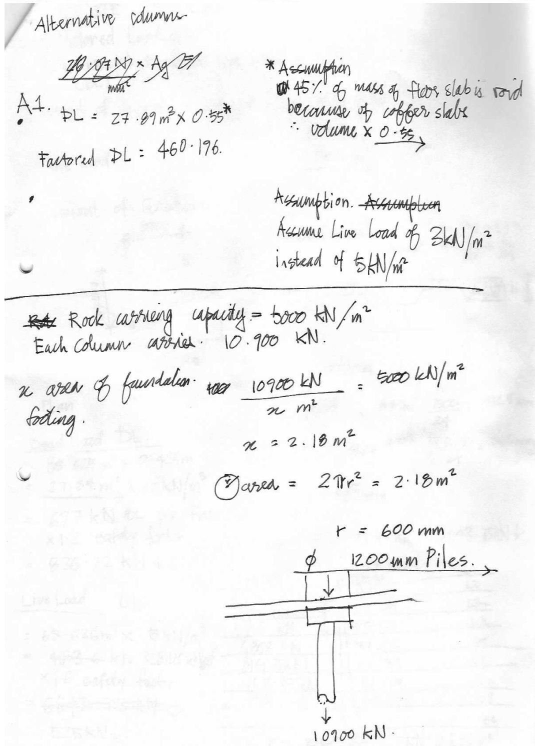
$= 10.5 \frac{kN}{mm^2} \times (A_g - 0.06(A_g)) + 270 \frac{kN}{mm^2} \times 0.06 A_g$

$= 10.5 \frac{kN}{mm^2} \cdot (A_g) - 0.63 \frac{kN}{mm^2} \cdot (A_g) + 16.2 \frac{kN}{mm^2} \cdot A_g$

$= 26.07 \frac{kN}{mm^2} (A_g) = 7530.47\ kN\ mm^2$

$= A_g = 288\ mm^2$

$b \times h = 330 \times 0.872\ mm$ !



Alternative column

* Assumption
45% of mass of floor slab is void because of coffer slabs ∴ volume × 0.55

A1. $DL = 27.89\ m^3 \times 0.55$ *

Factored $DL = 460.196$.

Assumption.
Assume Live Load of $3\,kN/m^2$ instead of $5\,kN/m^2$

Rock carrying capacity $= 5000\ kN/m^2$
Each Column carries 10.900 kN.

x area of foundation footing. $\frac{10900\ kN}{x\ m^2} = 5000\ kN/m^2$

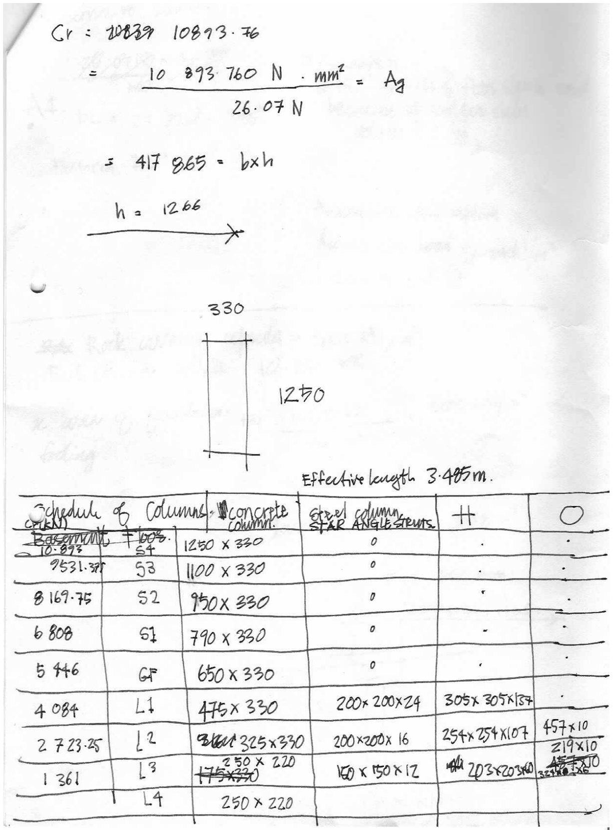
$x = 2.18\ m^2$

area $= 2\pi r^2 = 2.18\ m^2$

$r = 600$ mm

$\phi$ 1200 mm Piles.

10900 kN.



$Cr: 10893.76$

$= \frac{10\ 893\ 760\ N}{26.07\ N} \cdot mm^2 = A_g$

$= 417\ 865 = b \times h$

$h = 1266$

330

1250

Effective length 3.485m.

| Schedule of Columns Cr(kN) | Floors | concrete column | Steel column STAR ANGLE STRUTS | H | O |
|---|---|---|---|---|---|
| 10.893 | S4 | 1250 x 330 | 0 | . | . |
| 9531.375 | S3 | 1100 x 330 | 0 | . | . |
| 8 169.75 | S2 | 950 x 330 | 0 | . | . |
| 6 808 | S1 | 790 x 330 | 0 | - | . |
| 5 446 | GF | 650 x 330 | 0 | . | . |
| 4 084 | L1 | 475 x 330 | 200 x 200 x 24 | 305 x 305 x 137 | . |
| 2 723.25 | L2 | 325 x 330 | 200 x 200 x 16 | 254 x 254 x 107 | 457 x 10 |
| 1 361 | L3 | ~~175 x 330~~ 250 x 220 | 150 x 150 x 12 | 203 x 203 x 60 | 219 x 10 ~~457 x 10~~ 324 x 6 |
| | L4 | 250 x 220 | | | |

that are smaller than the level beneath. This does not apply for the top three floors where the amount of reinforcing is merely diminished but the column size stays the same. Also, on the higher levels the loads become light enough for standard steel stanchions or columns to carry the load allowing greater freedom of structural material on the higher public levels.

Fire safety and compliance with fire safety regulations

1. Fire poses a very real threat to people and property. In view of the increased awareness of terrorist activities it has also become important to protect people and property against the effects of especially bombs. If the Nelson Mandela Forum seeks international clientele it will need to cater for their increased exposure to risk at large gatherings. Meetings of international organizations like the International Monetary Fund (IMF), the World Bank and the G8 are lately under direct terrorist threat. Rioting by Interested and Affected Parties (I&AP's) also plague these meetings. In light of the above serious consideration should be given to fire safety.

2. The following questions must be addressed:

i) How will the risk of a fire starting be lessened?
ii) How will a fire be stopped from growing?
iii) How will a fire threaten property, life or both?
iv) How will the fire be fought?
v) How will people escape?
vi) How will fire regulations be met?

2. To answer these questions Menzies (1999) proposes the following precautions:

a) Protection of loadbearing structure to prevent untimely collapse.
b) Limitation of combustibility of key structural elements.
c) Adequate and appropriate provisions for means of escape.
d) Access for fire-fighters up to and through the building to reach the seat of the fire and extinguish it.
e) Compartmentation and separation to restrict spread of fire.
f) Maintenance of these by protection of openings, fire stopping and cavity barriers within concealed spaces.
g) Safe installation and maintenance of services, heat-producing equipment and user equipment.
h) Separation of different uses.
i) Enclosure of high risks with fire-resisting construction to protect adjacent areas.
j) Active fire-extinguishing installations to detect and/or contain fire in its early stages and restrict its spread and growth.
k) Limitation of flame spread by selective use of materials.

l) Fire-resisting external walls and/or space separation to prevent spread of fire to adjacent properties, protection of openings in external walls, limited flame spread across external walls and roofs, use of insulation with limited combustibility to restrict ignition and spread.

m) The provision of natural or mechanical ventilation, smoke extraction and/or smoke control measures to facilitate means of escape and firefighting.

3. Furthermore, the South African National Building Regulations also specifies steps to be taken to:

i) provide safe evacuation of occupants;

ii) minimize the spread and intensity of fire:

iii) ensure structural stability of the building during a fire;

iv) limit the generation and spreading of smoke

v) and provide adequate means of access , and equipment for detecting, fighting, controlling and extinguishing a fire.

4. Also, the author recognises that the following regulations (South African Standard Code of Practice for the Application of the National Building Regulations SABS 0400-1990) have specific reference to the current study: TT2; TT4-8; TT10; TT11; TT13-TT51; TT54-TT57. Special mention is made in the 'commentary' to part T of the NBR. It says that atrium-buildings, which the Nelson Mandela Forum essentially is, should be subject to a rational design for fire safety due to high risk. Smoke is said to be the main threat. It proposes:

"The methods of smoke control that may be considered include direct ventilation of the rooms around the atrium, throughflow ventilation of the atrium space, depressurisation ventilation of the atrium space and hybrid ventilation space".

It further states that the use of fire-resistant glass to close the atrium may be considered but that it will not be effective if the glass shatters due to heat pressure, if the glazing seals are poor or if a fire occurs on the atrium floor. Therefore other measures must be taken to avoid the spread of smoke to or from the atrium. Mention is also made of a downstand beam at the end of floors

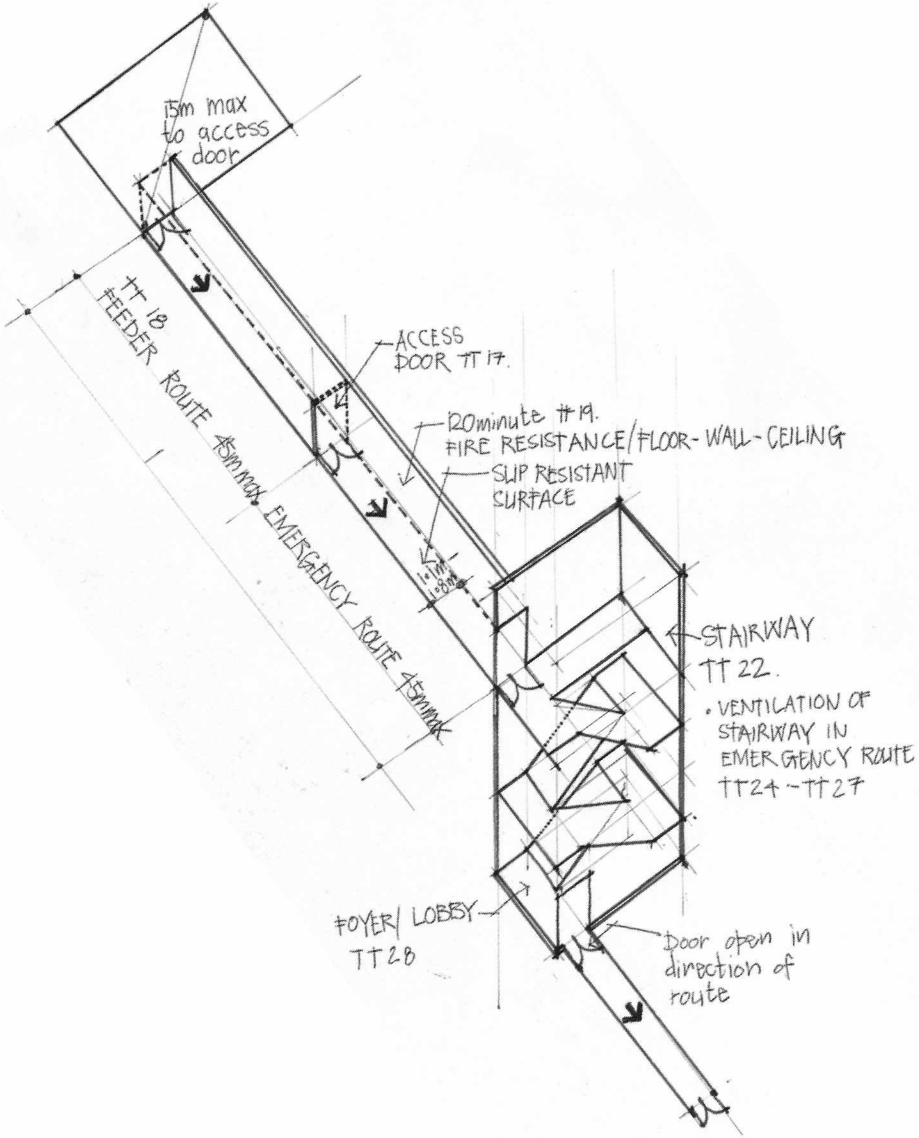



Figure 43. Emergency path diagram

opening up to the atrium that blocks high level smoke escaping into the atrium.

5.It should be understood that adequate provision for all the abovementioned requirements fall outside the scope of this study. Clearly a specialist study is required for compliance in this regard. Here, an attempt will be made to provide only for the following:

5.1 Means of escape during fire - Escape Routes: The Planning implications for an escape route are summarized in the Figure 000. It amounts to a considerable design-constraint. There is however recognition, in the comment to TT21 of the NBR, of the fact that the building type considered here must be subject to a rational design and can not be subjected to simplistic guidelines.

5.2 Fire-fighting installation:

The requirement for the provision of fire-fighting equipment can be met with the installation of a) Hose reels, b) Hydrants, c) Sprinkler systems d) Portable Fire Extinguishers and e) Mobile Fire Extinguishers.

a) Hose Reels at a rate of 1 hose reel for every 500m².

b) Hydrants at a rate of 1 for every 1000m². No point in the building will be further than 90m away from a hydrant.

c) Sprinkler system throughout the building, including the basement

d) Portable Fire Extinguishers at a rate of 1 PFE for every 200m². 1PFE will be a 9l water-type, a 9l foam-type, a 4.5kg Carbon Dioxide-type, 4.5kg dry chemical-type or a 2.5kg Halogenated Hydrocarbon-type extinguisher.

e) Mobile Fire Extinguishers can replace 50% of the PFE's on one floor within one division smaller than 1000m².

5.3 Material selection in line with a reduced fire risk.

*Steel:* The use of steel should be restricted from tall structures exceeding 2 storeys unless it can be protected from heat. Steel can buckle and collapse in as little as 15minutes (Menzies, 1999). The most spectacular example of structural failure of steel in fire was the collapse of the twin towers of the World Trade Centre in New York, the event being commonly referred to as '9/11".

*Aluminium* looses stability fairly quickly but is relatively resistant to the spread of flame (ibid.) making it appropriate on large surfaces where frame-spread may be critical. One example will be a glass pane that could stop the spread of flame from a room to the floor above it on the exterior surface of the building.

*Concrete* loses its crushing strength in heat and coverage to the reinforcement is essential in the protection of its structural bearing capacity.

*Clay brick or masonry*, being a ceramic, performs very well at high temperatures but some expansion takes place.

*Timber* performs better than steel in a fire it is a slow conductor of heat and it chars, giving it a protective layer of charcoal. Timber studwork with plasterboard can achieve a 30 minutes fire rating and with additional protection up to 1 hour.

*Protective boards* like plasterboard and mineral fibre board can give the members it protects up to 2hours fire protection.

*Glass:*

- plain glass (depending on whether it is toughened or laminated) has negligible fire ratings but can give up to 15 minutes of insulation.
- Wired glass gives 1 hour fire rating but little insulation
- Insulating, fire resisting glass can give more than 2 hours fire rating, but the size of the panels is restricted (Menzies, 1999).

5.4 In conclusion it should be noted that planning for fire is a considerable task and the author does not consider the abovementioned criteria as comprehensive. The study conducted for the fire installations at the recently completed (July 2003) Cape Town International Convention Centre required consultation by a respected consultant in partnership with the CSIR who closed their fire division during that inquiry!

Some similarities with that project, regarding fire safety, can be identified. Sprinklers were not put in multi-volume spaces in view of a smoke risk. Rather, materials were selected with very low fire consumable loadings. Rational design helped to limit the number of fire escapes and doors required for the evacuation of large numbers of people out of the ballroom and exhibition halls. The study found alternatives for the termination of escape routes on the facades of the building without them having to be fire-rated (Architect and Builder, July/ August 2003, pp85).

Environmental control:

a) Moisture in its free liquid form must be totally excluded from the interiors of the centre. Vapour and moisture content of building materials must be controlled to within acceptable limits. Consideration will be given to precipitation, condensation and ground water control.

Precipitation

Port Elizabeth falls within a region receiving 574 725mm mean annual precipitation per quaternary catchment and forms part of the Swartkops River catchment area. Rain typically falls in low volumes over periods lasting up to several days resulting in low but continuous flows of run-off. Rain coupled with extreme west-south-westerly winds during spring and autumn results in driving rain. The city's residential architecture is characterized by steeply pitched tile roofs invariably with little or no overhang and gutters and down pipes indicating the need for a controlled storm water strategy with a minimum retention time especially on highly populated surfaces.

- Flat roof storm water run-off
- Pitched profiled metal roof storm-water run-off
- Pedestrianised paving storm water run-off
- Parking garage storm water run-off
- Parking garage operational leakage run-off
- Building skin: driving rain resistance Glass.
- Building skin: driving rain resistance, staining Face brick.
- Building skin: driving rain resistance, staining Profiled metal.
- Porte cochere: rain, driving rain.
- Structurally integrated potted vegetation seepage run-off.
- Loading bays/ docks storm water run-off.

Condensation:

- Constant heat in materials reduces risk of condensation
- Ventilate rooms and construction cavities at risk of condensation where possible. Small amounts of ventilation will reduce condensation without significant heat loss.
- Insulation towards outer skin of walls, insulation on inner skin if not vapour barrier increases condensation risk.
- Vapour barriers on inside surfaces.
- Adequate jointing of sheet-type vapour barriers.
- Insulation must be toward the cold side of vapour barriers.

Ground water

- Temporary exclusion of ground water during construction via deep-bored wells. If the soil's clay content proves to be too high for this method to be effective, electro-osmosis should be considered. Electro-osmosis becomes cheaper as the site to be drained becomes larger. Power consumption is usually the most expensive component but electricity in South Africa is the second cheapest in the world after Bolivia. It uses a minimum of 1KW per $m^3$.
- Permanent exclusion of ground water from the basement. If the basement is used for non-habitable spaces only, like parking, water vapour is acceptable and a cavity retaining wall becomes a feasible solution.

b) Air movement

Port Elizabeth's wind is perceived to decrease its marketability as a tourist destination. that the largest percentage of winds is from the west-south-west. The strongest wind is also from the south-west and west-south-west. On the Beaufort scale these predominant winds are described as a “strong breeze” “Umbrellas used with difficulty, difficult to walk steady, noise in ears, large branches in motion. Attempts to avoid the occurrence of wind are not feasible but one could attempt to lower the experience of wind for as many people as is possible.

- Avoid doors to the outside near areas with high turbulence and increased wind speeds: corners, ground floor near higher buildings.
- Ventilation system exhaust to be positioned on the roof with inlets on the façade.
- Strategies should be proposed for increased wind near the lower parts of buildings; corners of buildings; gaps in the vertical mass of buildings; large open areas.
- Building mass should resemble, as much as possible, the mass of adjacent structures to placate winds blowing above.

Levels of ventilation will be discussed as part of the section on *human comfort* and specified in appendix A.

HUMAN COMFORT: VENTILATION, DAYLIGHTING, THERMAL COMFORT AND SOUND

This section is grouped together because they share the same goal - to make people comfortable and allow attendees to concentrate on the topic of under discussion or to avoid being distracted from the entertainment presented. Both these imperatives are driven by the need for a more luxurious setting. The following pertains

c) Daylighting

The general requirements and characteristics of lighting are discussed under Electric lighting. Suffice to say under this heading that certain levels of lighting are essential for human comfort. These minimum criteria are specified in Appendix A.

d) Thermal comfort and thermal installations

Temperature is an important factor in achieving the most desirable environment in terms of temperature and humidity. Port Elizabeth is fortunate in having a very moderate temperature fluctuation throughout the day but also throughout the year. However, the thermal requirements in the Nelson Mandela Forum will be of a high standard due to the formality and character of events foreseen. These levels are made hard to achieve and predict because of the high volumes of attendees and the sporadic time-frames of their attendance. This automatically excludes most passive environmental control systems that are ideal for buildings with little variation (author's perception is formed by informal discussions with those who have dealt with passive environmental control systems on a professional level and a general suspicion of the validity of the theory behind it)

Appendix A specifies the criteria for thermal comfort to be achieved by mechanical Humidity Ventilation

e) Sound

The Nelson Mandela Forum is a medium of communication. The quality of verbal and sound-carried communication will contribute to the overall experience of conferencing. The prevention of noise is critical for concentration. A generally less noisy environment will create an environment of focus, dignity and calm.

*Noise reduction.*

- The elevated expressway is a considerable source of longitudinal noise from the west to south-west of the centre. Placing the Parking garages between the habitable spaces and the expressway will reduce the effect of the expressway. Some form of attenuation however, will be required for the square beneath the Campanile to lend the space a sense of gravitas and to lower the impact on the Main Auditorium. This has been achieved successfully at the Cape Town International Conference Centre.
- Baffles fixed to the side of its structure screen noise from the highway
- A shell-within-a-shell approach created a cavity around the auditorium.
- Sound attenuators will be installed for all air handling equipment where they interface with habitable space.
- Acoustic absorption must decrease the noise levels in the Main Foyer atrium, the Main Auditorium Foyer the Conference Foyers, the Exhibition Hall and the Banquet hall.
- Noise from the diesel locomotives shunting freight carriages beneath the building will be attenuated within the depth of the structural mass of a service level between the ground floor and Level 2, where the Main Auditorium and the Main Foyer is located. These trains move at a very low speed and is not considered to cause distracting structural vibration. Nonetheless, the sound implications of locating a convention centre over a railway line should be the focus of an in-depth study which falls outside the scope of this course. Suffice to say that there is precedent in a recent convention centre in Adelaide in Australia that was built across a 9-line metro-rail track. Here the column-heads were fitted with high shear rubber elastomeric bearings. It is common for convention centres in Europe and America to have their own Metro stations obviating the question of "real life practicality"- however, the author is not familiar with the mechanics of such an assembly beyond the provision of minimum structural guages.

*Acoustics.*

Satisfactory use of spaces proposed for large gatherings depend on acoustic performance. The practice of acoustic design is very complex and deserves specialist consultation. There are three principles however, that will limit the damage an architect does before a more knowledgeable person intervenes:

●Directing the path of sound as direct as possible from source to audience member (direct path or first reflection) by means of the shape and direction of interior components.

-Raking seating towards the back not only improves sightlines but makes the path of sound travel more direct.

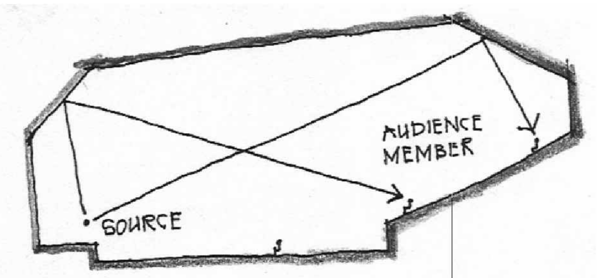



Figure 000. Sound distribution will be directed from the speaker to audience members by forming the interior surfaces of the auditorium.

Figure 000. Sound baffles against the edges of the N2 highway that passes through the central courtyard of the CTICC.

- Reflecting planes behind the source of sound towards the audience improves sound path direction.
- Reflecting planes above the audience directs upward sound waves down towards the audience.

●2 Unless the sound is absorbed it will keep on reflecting and make the source incomprehensible. The time it takes for the sound to decrease by 60dB is called the reverberation time and is an indicator of how 'alive' the space will seem acoustically. For speech the reverberation time should be low for, for music it can be longer. The following reverberation times will be maintained through the selective use of absorptive finishes to the hindmost third and sides of all auditoria and throughout conference venues and foyers generally: Refer to Appendix A.

●Standing waves will be obtained by parallel walls less than 10m apart and generally simple ratios of interior spaces like 1:2 or 1:3. Although these ratios were thought to inherently have harmonious spatial characteristics, during the European Renaissance, it should be avoided in current construction.

*Sound Amplification*

Electronic sound amplification will be required in both auditoriums and the conference rooms. These systems should be integrated into the planned interior components (ceiling, wall assemblies, roof and wall mounted frames), but should not be made part of structural components. This is to ensure that they can be easily replaced when a newer system becomes feasible. It is unacceptable to have loose standing sound amplification equipment.

*Public address systems.*

A discreetly detailed public address system should be integrated with security and fire-safety systems but should also be available for general announcements for the everyday functioning of the centre. Critical points of address will include: Porte cochere, Bus drop-off point, Parking garage, Main Foyer, Main Auditorium Foyer, Conference Foyer, Restaurant.

Furthermore, a separate communication system could be necessary for staff and management. This should however be inaudible to attendees.

Conclusion: the section on human comfort concludes with the specification of human comfort criteria in appendix A.

f) Electric lighting

The location of public spaces adjacent to open views is important because most people will express a need to observe signs of the diurnal and seasonal cycles and views significant landscape events such as a harbour or city lights are prized features of any building. The implications of the need for visual access to exterior views are solar heat gain, sky glare and large windows that must be covered at night, risk condensation, needs constant cleaning and easily fall victim to vandalism. Furthermore, because sunlight is only effective up to a depth of about 12m in most buildings it has serious implications for building shape. Additionally, certain tasks can not be done effectively with the limitations of daylight, therefore electric lighting will be required for the following applications:

*Carrying out of certain tasks:*

Reading, writing, assembling and repairing instruments, operating equipment and communication: Intensity of light, known as illuminance, measured in lux:

Recreation and catering spaces should not be less than 250 lux. Populated assembly spaces should be dimmable for effect with a minimum of 50lux. Offices and other working environments should not be less than 500lux. Conference rooms should be dimmable for effect with a minimum of 500lux.

The strategy for interior task lighting will be Permanent Artificial Lighting (PAL), with windows used purely for view out and ventilation where applicable. This implies that windows can be smaller thus eliminating problems of solar heat gain, wintertime heat loss, sky glare and loss of privacy. It also has the benefit of more freedom for the building shape. A more square building is cheaper to construct and maintain than a building of similar volume and shallower shape. Less window area has to be maintained and tinted glass can be used. It is however necessary that full standby power be available.

*Creation of amenity as a supplement to daylight and pleasant general illumination of interiors:*

Direct sunlight, although not directly a lighting issue does cater for a distinctly felt psychological need and will therefore affect building orientation and glazing. Large dramatic glazed curtain walling will be installed at all large public assembly spaces like the Main Auditorium Foyer, Main Foyer, Conference Foyers, Restaurant and Banquet Hall. All these spaces are likely to be used at night as well and to maintain amenity lighting levels, electric lighting should be used. To avoid the negative aspects of large glazed surfaces especially in the South African context like solar heat gain, sky glare and winter time heat loss these glazing systems will have to cater for some sort of sun protection and thermal insulation (probably double glazed with horizontal louvers). It is important to note that this glazing is purely for view. It would seem therefore that these spaces would need artificial lighting to supplement daylight.

Electric luminaires will be the main source of amenity lighting in the centre. To ensure that interiors are appropriately and pleasantly lit four aspects need to be addressed: the relative brightness of surfaces; modelling characteristics of illumination; glare control; and colour rendering

i) Brightness in a room, measured as scalar illuminance in lux, should be not less than ½ that of the planar illuminance measurement. Brightness will be enhanced by enhanced reflectances. The author is of opinion though, that an unlimited effort towards brightness is not necessarily positive and might lead to a senselessly artificial, stressed, science-fiction “planet-Krypton” environment. Spaces should rather be lit to feel like dusk or even late dawn but not like the centre of a nuclear explosion. Reflectances of materials should therefore be moderately light.

BZ-classification is an indication of the spread of a light fitting: a low BZ value will indicate a concentrated light where a high BZ-value indicates a dispersed light. Light with high BZ values will reflect off walls and ceilings and therefore contribute to a brightly lit room. Generally, populous rooms will be brighter with less modelling, more intimate rooms the inverted.

ii) Modelling characteristics are influenced by the relationship between the intensity and direction of light in a room. Intense lighting from above need to be offset from the side by either daylight or light reflecting off walls. Considering that a PAL (permanent artificial lighting) approach is followed allowances should be made in all public rooms and for horizontally directional light other than mere brightness and high BZ. This calls for wall washing lights that simulate the modelling effect of daylighting through windows. If light is distributed evenly in all directions throughout the room, shapes in that space will seem flat very clean, impersonal and safe. If a strong focused light is lit in a room with little brightening, shapes in that room will have extreme contrast but detail in the shadowed area will be unclear very dramatic, intense and obscure. Furthermore, intense down-lighting could be offset by locating luminaires closer to walls so that some horizontal offset can be obtained from the reflection from these walls this would be effective in creating anticipation but still retain effective levels of task lighting in corridors like the Concourse and between the Conference Rooms.

iii) If a light source is very much brighter than other light sources in a room it leads to glare. The horizontal light required for modelling to offset down-lighting could add to this. It is therefore important to moderate the effect horizontal light sources like brightly lit or reflecting walls and especially windows. This further strengthens the argument for a moderate glazing schedule and comprehensive solar control. Glare is also a problem in rooms with large length to height ratios like the auditoriums, Conference Rooms, Banquet Hall and Restaurant. Luminaires with lower BZ values (BZ 2-4) more vertical down-lighting will decrease the risk of glare from luminaires. Dark finishes also increase the opportunities for glare as it contrasts with light coming through windows and luminaires.

iv) For reasons of efficacy fluorescent and discharge lighting will be used. These lights have a tendency to make objects appear unnatural. Advances in technology have made it possible to control the colour characteristic of the light emitted from these luminaires with a concurrent loss in efficacy.

*Provision of safety*:

Lighting will be required in outside areas, dangerous internal areas and areas at risk of theft, break-in and pilferage. These lighting installations must be protected from the possibility of power interruption.

Alleys, courtyards and all pedestrian areas must be well lit at all times with fittings positioned out of reach and evil-doer proof.

Internal areas that are dangerous without the normal lighting system must be fitted out for nominal lighting capabilities. These are normally battery-powered luminaires in places like escape routes and public assembly areas.

All areas where theft, break-in, robbery, attack or assault may occur will be identified and supplied with lighting.

*Provision of lighting for deliberate aesthetic effect*

will be used for display or dramatic or even deliberately misleading effect.

The Restaurant and Banquet Hall will use lighting to make tables glow warmly and invitingly within a generally warm glaze at dinner but at breakfast and lunch a cool, light and refreshing ambience will be sought.

The Main Auditorium Foyer, the Main Foyer, the Conference Foyers and the Concourse should be the subject of a specialist's inquiry.

It is important to decide which areas are to receive what kind of effect. Dramatic lighting and good task and amenity lighting do not combine well.

Two specific goals must be reached by the lighting design:

i) Multifunctional spaces with atmospheres that are adjustable or at least robust enough to cater for sobriety and brightness on the one hand and “mood” and festivity on the other. This can be achieved by using a combination of lighting systems in each room consisting of compact fluorescent, metal halide, neon and low-voltage luminaires. Typically rooms will be fitted with a primary set of linear fluorescent lamps, directed towards the ceiling to give a spacious, lofted feel. Secondly, a combination of metal halide (or compact fluorescent for lower ceilings) and dimmable low-voltage luminaires will be fitted to provide the working light.

ii) Establishing a layered interior for depth, interest and a generally feminine, non-minimalist interior aesthetic. This can be done by washing a wall with warm light and overlaying it with a lightweight screen highlighted by narrow-beam cool spots.

The luminaires referred to in Appendix A by letters are described in Table VI of Maritz Vandenberg’s section on Light in Tutt and Adler 1979.

Utility services:

a) Water supply

Adequate provision of potable water is important for the maintenance of hygiene wherever human consumption and use is concerned. Planting also requires enough water to sustain growth which in turn must be provided as a means of creating humane environments. Water is also prerequisite for some industrial and manufacturing process in the centre. These include cooking, cleaning, environmental conditioning and for aesthetic features such as fountains and pools. The requirements are as follows:

Even though most personal hygiene requirements (bathing and showering) of guests will be met at their respective hotels and guesthouses, large amounts of water will be required for processes that are much harder to predict Building maintenance including repair work; painting; surface cleaning with soluble detergents; mechanical flushing of interior and exterior surfaces; washing the garage pavement; washing public pavements; washing interior walls and floors, cleaning as part of catering including dishes; tables; linen; equipment, and a considerable amount of cooking. This, combined with the normal quantities required for sanitary requirements the biggest of which is certainly the flushing of wc's, amounts to a considerable need for potable water.

0.18m³ per person per day: Maximum of 10'000 people at peak time = 1'800m³

Furthermore an amount of water will be required for the maintenance of landscaping vegetation both interior and exterior. 0.012m/m² per weak is considered enough for irrigation. Assume a landscaped area of 10% of total site area = 30'000m²/ 10 = 3000m² to be irrigated of which, say, 85% receives rain at 0.010m/m² per weak = (3'000m² X 0.012m/m²) - (2'550m² X 0.01m²/m) + (2'550 X 0.002m/m²) = 36m³ - 25.5 + 5.1 = 15.6m³ water required for irrigation per weak. 15'600 litres of water per weak. This could be amply provided for by the recovery and filtration of greywater in subterranean tanks. This implies a daily recovery rate of 2.23 m³ of grey water. Four patented electrified filtration tanks processing 700litres a day would be sufficient.

Because the Nelson Mandela Forum is prone to sudden high demands for water, provision should be made for water storage. This will contribute to economic use of water mains and sizes of service pipes and reduce the risk of mains pressure dropping to nothing which could lead to back-syphonage of water from sanitary appliances into the main. It will reduce pressure on the installation to minimise noise and wastage and enables economical appliances to be used. Furthermore, heating and hot water supply apparatus can be vented to the storage cistern, thereby minimising safety valve requirements.

The water storage tank should be placed high within the isolating skin of the building. The actual capacity, which is around 70% of the nominal storage capacity, should be around 50% of the daily requirement. This would imply roof-top storage for 900m³ X 1.43 = 1'285m³ nominal storage capacity.

Water for use within the building should in all cases be potable. Roughly this implies a purity of less than 1000 particles per million of ammonia, oxygen absorbed, nitrates, nitrites and chlorine; less than 10 degrees of Clark as an indication of soft water; a pH of around 7 and should regularly be checked for bacteriological purity especially considering the consequences of water being infested.

Hot water for use in the kitchens and sanitary appliances throughout the building will be provided by a central heating installation which comprises a boiler fired by cheap fuel (preferably gas) heating water in a hot water storage cylinder. Assuming a requirement of half that of cold water, the system must supply 900m³ of hto water per day.

b) Sanitary appliances

The provision of sanitary appliances in commercial buildings in South Africa is not comprehensively regulated beyond the needs of the disabled, but falls to the discretion of developers. This is done on the assumption that their profit making imperative will force them to make adequate provision. However, predicting the actual population flows and their sanitary needs can be quite a daunting task. Estimates are based in part on the recommendations by Alan Tye (Tye, 1990) and precedent studies of European convention facilities. After spending a little time in the company of these figures and plans one develops a sense of the scale of provision.

*Appliances for guests*

Provision of sanitary appliances for males, wc's urinals, whb's

- Wc: 1/100 males up to 400, thereafter 1/250 @ 2594 males = 4+8= 12wc's
- Urinals: 1/50 males = 50 urinals (?)
- Whb's: 1/wc + 1/5 urinals = 12 + 10 = 22 whb's

Provision of sanitary appliances for females, wc's and whb's

-Wc: 2/50 up to 200, thereafter 1/100 @ 2594 females = 8 + 24 = 32 wc's

-Whb's: 1/wc = 32 whb's

Provision of sanitary appliances for the disabled

- 4unisex compartments

Bucket and cleaner's basin, cleaning facilities & cleaner's sink

These are the requirements for one facility - like the Banquet Hall or the Main Auditorium. It is a rough calculation for what would be required should the facility stand on its own. This is however, not the case. In the Nelson Mandela Forum various facilities are located in close proximity. It is reasonable to assume that peak time flows can be absorbed through different toilets throughout the centre.

calculations are complicated by the unpredictability of the number of attendees. The irregularity of their spread through the building further contribute to this problem. Consider the following scenario. A plenary session is held in the main auditorium followed by a buffet breakfast in the banquet hall followed by break-out sessions in the seminar rooms on floor 3 and 4. When are attendees most likely to use the rest rooms? After the plenary session or just before breakfast. After breakfast or just before the break-out sessions? This is offset by the single event use of these facilities where the banquet hall, for instance, is used for a gala event on its own. Assume that the proximity of all the large facilities to the main foyer allows for peak time numbers to use its rest rooms as a supplement to other facilities' rest rooms.

*Staff toilets and change rooms*

Provision of sanitary appliances for unisex toilets: 5 wc's + 5 washing stations for first 100 staff members, thereafter 1 wc and washing station for every 25 staff or part thereof. Occupancy D3 population 1/15m² = 294 staff

- 5 + 10 = 15 wc's and washing stations

Provision of showers: 1 per 15 personnel. 294/15 = 20 showers = 10 per sex plus a changing room.

c) Drainage

Implied here are the control of waste water, soil flows, rain-/ storm water through gutters, downpipes and syphonage systems and the control of ground water.

The control of waste water is fairly standardised practice. The most important considerations here are that flows should be estimated so that economic pipe sizes can be used and ensuring that excessive pressure fluctuations do not occur. Care should be taken so that water seal is not broken in any of the fittings by evaporation, self-syphonage, induced syphonage or back pressure.

Furthermore, waste-water should be collected and filtered until suitable for irrigation. This will be done by patented, electrified processing tanks operating at 700litres a unit.

Soil water drainage is also rather standardized fair but here too, nevertheless, provision must be made to ensure satisfactory but economical pipe sizes and the avoidance of excessive pressure fluctuations.

Under no circumstance should a door leading to a sewer/ service duct open onto a space accessible by guests/ attendees.

Horizontal sewer pipes will not be taken through ceiling voids of spaces accessible by guests.

All sewer runs and turns must be fully accessible to service men without disturbing the functionality of the spaces they serve.

Surface water run-off from roof areas must be controlled and fed to municipal storm water disposal. The following requirements will be met:

- Internal gutters will be located within walls so that no noise emanating from it will be audible inside the building.
- Exterior gutters must be protected against the strong winds that prevail in Port Elizabeth.
- All gutters will at some time overflow and allowance must be made as to where any overflow must go.
- Gutters must be accessible for cleaning.

18.3.6.1 Provision will be made for the adequate sizing of gutters and downpipes for all flat roof areas. Assume the formula 100mm² for every m² of roof with a maximum downpipe diameter of Ø600mm. Assume a flat roof area of 12'000m² = 100mm²/1m² X 12'000m² = 1'200'000mm² of accumulated downpipe. One maximum downpipe with a radius of 300mm has an area of 565'486mm² (A=2.pi.r²). Therefore allow for 3 downpipes. These downpipes must be able to draw water over the total area of the diameter. Normally this is not possible but with the use of 'syphonics' it is a feasible solution. Patented systems are available and are routinely installed at all hotels of a well known international chain.

Paved areas are prone to accumulating water so that everyone approaching the building can be seen splashing through puddles formed on the paved surface This will be avoided.

- All paved areas must be laid to a fall of minimum 1:60, preferably away from buildings and collected in a storm water drainage system.
- Storm water drainage will not be aggregated to sewer drainage.
- All drainage flows will be propelled by gravity alone.

Drainage of the basement.

- Seepage holes in the basement's retaining wall will allow ground water pressure to drop. The seepage from these walls will then flow along the exposed interior of the basement retaining wall and be collected in a perimeter canal. Upwards pressurised ground water will also seep through no-fines concrete sub floor. This seepage must also be connected to channels that collect all the ground water to a single sump pump. This pump must be duplicated and will pump water to a surface level gulley that feeds to the municipal storm water disposal.
- Provision must also be made in the basement for rain water entering the garage from the perimeter and joint leakage throughout to be collected in gutters and downpipes. This is to avoid free flow of water in the basement that is the inevitable consequence of cheaper garage construction.

d) sewage disposal

Sewage will be disposed of by the sewer processing plant operated by Harbour authorities towards the north of the site. All sewer of the Congress Centre (excluding the Exhibition Centre) will be gravity fed to a central point from were it will be pumped to the Harbour's sewer works.

e) refuse collection and storage

Adequate provision for storage of refuse is hardly ever made in commercial buildings. Furthermore the system for the collection of refuse, cleaning of receptacles and the distribution of refuse collection points must be adequately provided for and robust enough so that inevitable expansion of the service can take place.

- Refuse chutes must be allocated where their noisy content will not be a noticeable to guests.
- Refuse chutes must be ventilated.
- Space for refuse containers on ground floor must be provided for with access for daily emptying.
- Refuse will be compacted by the use of mechanical equipment. The machinery that performs this are to be located where the noise and smell associated with them, will not be noticed by guests and where it is not a disturbance to personnel and staff.
- Space must be made for sorting of refuse so that a responsible approach concerning the recycling of glass, papers, metals, plastic and organic waste can be followed.

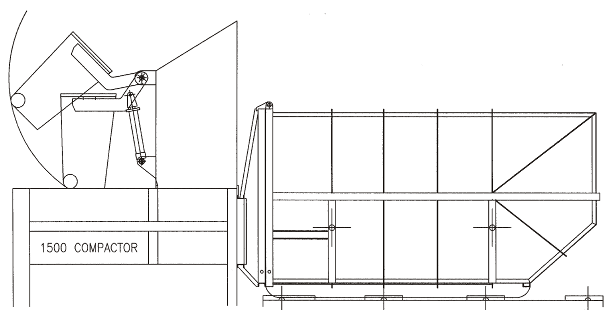



**Figure 000. Refuse compactor**

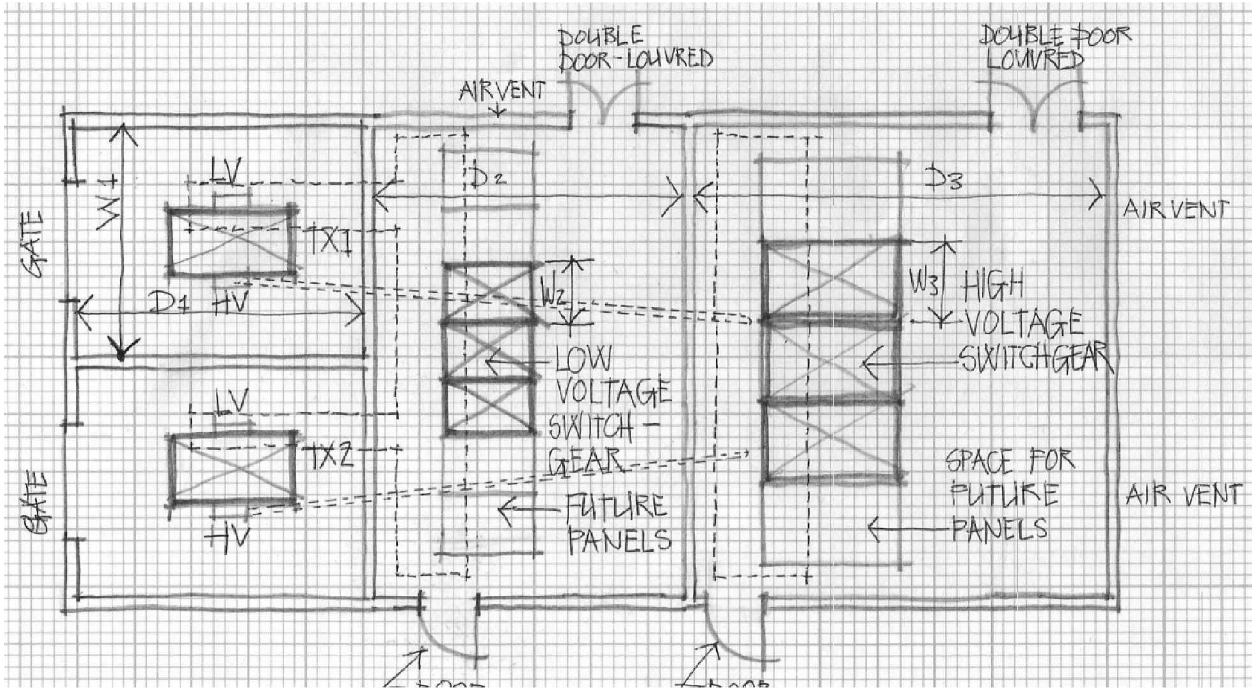
ensure hygienic conditions are maintained.
- Securing the contents of refuse containers is a priority since it is liable to become a commodity to the poor.
- Waste should be managed so that those who find benefit from it can do so with dignity.

f) electric power

Electric service is one of the fundamental tools characterising western civilization production of most commodities in the market is dependent on it. Its presence in buildings, conventionally, is confined to distribution through cabling and access by sockets. A new component, that of electricity generation, has now also been added to the repertoire of building services but remains on the margins of construction practice due to initial cost and socio-psychological inertia. The following will need to be considered in the 'wiring' of the Nelson Mandel Forum:

18.6.1 Provision will be made for the following sources of electric energy: Municipal supply, combustion-generated electric current for emergency use, solar power converted to electric current and Uninterrupted Power Supply (UPS) in the form of battery storage.

a) Electric power can be bought from the local service provider, the Nelson Mandela Metropolitan Municipality, at a very cheap rate. It is currently a reliable source but Eskom (the national supplier) has warned that energy demands might not be met by 2010. Local electric power is provided as 250 Volts at 50hz 3-phase current. After power has entered the building from the municipal line, main switch gear will divide the circuitry into a 'mains, sub-mains and final circuits' system. This implies dividing the power demands of the building into separate end-circuits for each logical unit of end-user, and branching them in a hierarchical system. Special provision must be made for the heavy loads imposed by the kitchen, auditorium and congress



centre not to mention the exhibition centre which should operate separately from the Congress Centre. It will be important to be able to make connections without interrupting the service. This is most effectively done by means of a 'bus-bar' distribution system.

The quantity of electricity required for the centre is estimated to be similar to a 'High Tech Office' as described by Adler (Adler, 1999). He estimates 190-460 kVA for a 2'000m² building implying 95-225W/m²; and 2900-6500 kVA for a 20'000m² building implying 145-325W/m². This extrapolates as follows for Nelson Mandela Forum which has a total built area of roughly 275'000m²:

95W/m² for 2'000m² = 145W/m² for 20'000m² = 305W/m² for 275'000m²

therefore 275'000m² X 305W/m² = 8'388'703 VA(Volts X Ampere)

8'388'703Watt/ 240Volt = 34'952 Amps

This then amounts to a design load of 34'952Amps at 240 Volts. This is about 635 times more than an average domestic load of 55Amps!

It can be expected that the local service provider would deliver this current at high voltage to limit energy losses due to higher resistance in lower voltage cables Assume 415V.

Estimated sizes of sub-station space requirements extrapolated from Adler (Adler, 1990):

D1 4m; D2 4.65m; D3 7m; W1 3.5m; The sub-station must accommodate the following:

6 transformers, 17 High Voltage switch gear panels; 14 Low Voltage switch gear panels.

g) telecommunication

One of the chief drivers for the initiators of the scheme is the development of a so called “high-tech” facility that can compete on the international market. The most incredible development took place in the field of information technology in the last decade or so and it is mainly in this regard that the term “high tech” is used. Four

a) Digital conference program

Attendees can download digital conference programs onto handheld devices. In advance of the event programs are downloaded from show organizers' Web sites. Attendees then download program updates from infrared touch-screen kiosks in the convention centre.

b) LAN, VLAN, WAN and VPN connections

Fibre-optic infrastructure, called a fibre-optic backbone, allow the use of Local area networks (LANs), virtual local area networks (VLANs), wide area networks (WANs), and virtual private networks (VPNs. LANs are used to transmit voice and data between various areas of the building; WANs, to transmit voice and data to remote locations. VPNs create dedicated, private, fully encrypted Internet-based connections inside convention facilities or between these facilities and other entities. VLANs permit multiple classes of network service to be delivered, and to send voice and data locally over an Internet-based network. It is important to ensure that the convention centre's fibre-optic structure allows for network redundancy.

c) Wireless and high-speed Internet connections

Wireless Internet access is made available access points that are connected to wireless local area networks (WLANs) linked to the Internet. WLANs use the WiFi (wireless fidelity) protocol to transmit data at speeds of up to 11 megabits per second. Individuals with laptops or network interface card-equipped PDAs can obtain high-speed Internet access within about 300m of an access point.

d) Sophisticated broadcasting capabilities

Fibre-optic cabling also allows Webcasting and streaming video. Webcasting is the transmission of live or pre-recorded audio or video to PCs that are connected to the Internet. Streaming video is usually sent from pre-recorded video files, but can be distributed as part of a live broadcast feed.

e) Improved telephone service

Upgraded wireless telephone service, provided by wireless signal distribution networks that support service from multiple wireless service providers rather than only one. Such networks collect carriers' signals, using dedicated fibre-optic cabling to low-power radio signals throughout a building. And although voice-over-IP (VoIP) has yet to become a mainstream technology, convention centre managers cite increased interest among groups. VoIP allows telephone calls to be placed and forwarded through the Internet.

It is clear that the most important infrastructural installation is a fibre-optic “back-bone”. The space requirements will be assumed to be similar to that of the customary telephone installation. In addition to the above-mentioned services a comprehensive Building Management System (BMS) will be required for the integrated management of building performance and diagnostics co-ordinated with operational information.

Circulation:

a) programmatic functions.

It has become the norm in modern convention centres that a centralised concourse gives attendees access to all major public facilities. In fact, the central corridor or concourse has become synonymous with conferencing and can be said to characterise the type. The concourse is also an indicator of the central operational continuum of the centre: attendees vs. staff/ personnel; public space vs. 'backstage'; service space vs. served space. The concourse is, and connects, the most public spaces - further from it are the more intimate spaces. Juxtaposed to this are the cores of service space. In the service cores space is compacted and efficient on the concourse and foyers space is stretched and turbulent. It is essential to the efficiency of the service operations, and to the presentable-ness of the public areas, that these two circuits never cross.

Capacities

Vertical and horizontal circulation elements must be able to handle peak time flows of attendees. There will be roughly 5187 attendees, at maximum capacity, in the Main Auditorium or 5187 attendees at the Conference Centre. All these people will move vertically or horizontally through the building at especially the beginning and conclusion of Events.

Level 2 public floor capacity = 2.3m² per attendee = 15'800m² Foyer required.

Level 3 Congress Foyer capacity = 0.5m² per attendee allowing 25% seating and 75% standing = 3444m²

Level 4 Congress Foyer capacity = 0.5m² per attendee allowing 25% seating and 75% standing = 3444m²

Vertical circulation of attendees: All attendees (assume 5187) should be mechanically circulated from Level 2 to Level 3 to level 4 within half an hour by elevators and escalators.

Assuming lifts with a capacity of 24 people/ 1800kg moving at a maximum speed of 3.5 m/s the following extrapolations are made from the recommendations by Williams (Williams, 1979):

1 Lift for 60 people; 2lifts for 202 people.

200/ 60 = 3.36

2/1 = 2

therefore 3.36/2 = 1.683 = ratio of difference in population to difference in number of lifts

5100/ 200 = 25

therefore 25/ x.lifts/ 2lifts = 1.683

60/ 1.683 = lifts required = 30 lifts.

35/2 = 15 (lifts have twice the capacity in example). Therefore 15 lifts, each carrying 353 people per half hour, will be required between levels 2-4.

It is clear that the speed of an escalator becomes a necessity if the foyer is not to be crowded with lifts. Furthermore, lifts are not ideal for situations where floor to floor heights exceed 3.3m, there is more than one main floor, there are levels below the ground floor requiring normal service for passengers or there are large numbers of visitors all of which occurs in the present study. To decrease the amount of lifts by 7 an alternative will need to cater for 2400 people within half an hour.

An escalator can circulate 1600 people in 30 minutes for every 600mm of step width. An escalator of 900mm step-width would be able to carry 2400 people.

8 lifts each carrying 24people at 0.75m/s and one escalator of 900mm step-width will be sufficient to handle peak time traffic.

Additionally a staircase should also serve attendees when mechanical circulation is not available during emergency. Chudley and Greeno (Chudley and Greeno, 1999) proposes the following formula for calculating the minimum width of a staircase: P = 200 X width of stair +50(width of stair 0.3) (no. of storeys 1).

6'000 = 200.x + 100(x-0.3)

6'000 = 200.x + 100x 30

5970 = 300x

19.9 m = width of staircase.

This 20m of staircase will be divided and spread throughout the floor area to serve as fire escapes. The provision of a 20m staircase when there are already 10 lifts and an escalator present in the same foyer seems redundant. This 20m of staircase width must, however, still be provided as a means of escape when mechanical services are unavailable and will be spread over the floor as a number of staircases. A nominal staircase will therefore be provided for those who prefer to climb stairs and its width will respond to what seems fitting to the spatial quality of the foyer. This staircase will not be a fire escape.

b) service.

c) arrival and departure.

d) Parking requirements

Private motor vehicle ownership in South Africa is common among the rich in South Africa. Furthermore, transport in the country is mostly centred on cars. Therefore parking for attendees is essential. Additionally Port Elizabeth's central business district is said to suffer from a lack of parking. It is critical to the pedestrianization of the area, and for the success of public transport nodes in the vicinity of the centre, that additional parking is provided for use by the general public. The formulae here quoted are rough estimates based on population of the centre and represents only minimum requirements. The number to be provided additionally will be determined by conducting an in-depth feasibility analysis taking into account such factors as site capacity, resistance to parking fees, traffic and congestion and aesthetics.

*Capacity*

- Auditorium attendee parking: 1 space per 3 seats = 1729 parking bays
- Conference attendee parking: 1 space for 4 attendees. Number of attendees assumed to be similar to auditorium capacity = 1297 parking bays
- Staff population varies with season and operations of the centre. Furthermore staff is more likely to use public transport. Staff population assumed to be 1/10th attendee population.= 900 parking bays
- TOTAL: 3925 parking bays required

Building Elements:

a) Substructure/ foundation:

The weight of the building will be transmitted to a level where material with a sufficient carrying capacity can be found. The Nelson Mandela Forum is located on an area with soils described as having a "marked clay accumulation, strongly structured and a reddish colour" (Environmental Potential Atlas for South Africa ENPAT). Without referring to any analysis of such soils, the "clay accumulation" indicates to the author that bearing capacity will not be readily found in shallow conditions.

The area is also described as having Arenite geology. Assuming this is sandy sub-soils it will inherently have a low carrying capacity 100-150kN/m². This is further reduced by the fact that the soil will be drenched due to being within 1kilometer of the ocean further reducing the carrying capacity to 50-75kN/m². Furthermore, the Centre will be partially built on regained soil that was built to extend the harbour into the ocean. The capacity of backfilled soil is nominally zero and must be investigated before any load is put on it (SABS 0161-1980). This indicates to the author that the substructure will have to transmit the load of the building to a solid rock base The depth of which is not readily known. Even the Engineering Dept of the Nelson Mandela Metropolitan Municipality was unable to give information in this regard (telephonic inquiry August 2005). The author will assume a depth of 16 m below the current Natural Ground Line being 6 m higher than the Low Tide Water Mark and 4 m higher than the High Tide Water Mark.

In light of the above the following considerations will be important for the layout of the sub-structure:

i) Ground-water control

ii) Deep trench excavation

Ground water control and the method to be used for deep trench excavations can be economically combined in the present inquiry. Because the scale of the project it is unlikely that any contractor in the region will be able spread the cost of temporary cofferdam-sheet piling over several similar projects because these will probably not exist. Therefore a method that combines ground-water control with the method of excavation with the eventual structure would be ideal if somewhat idealistic. The proposed technique must also be compatible with the adjacent foundations of the elevated expressway to the South and the Campanile to the West and the Railroad to the North and East.

The only method that can fulfil this wish-list is that of diaphragm walls. It has low installation noise and vibration, can be used in restricted space and can be installed close to existing foundations. This method must however form part of the permanent structure; otherwise it is not economical (Chudley, Greeno, 1999, pp136). This single construction item will fulfil the purposes of ground-water control during construction of the basement, protect the construction cavity during construction and will also form the eventual deep basement perimeter retaining wall.

The trench for the diaphragm wall will be excavated using the bentonite slurry method (see Figure 000). The bentonite slurry method allows a greater freedom of shape for the perimeter wall than any other excavation method. The concrete used must be high strength, 20-40 N/mm². This also allows for the wall to be a load-carrying member for transmitting loads from the superstructure in addition to its main function of resisting lateral bending due to ground water pressure. The diaphragm wall thus formed is assumed to be waterproof whilst not requiring any waterproofing membrane. High density concrete is still essential to the wall to protect its steel reinforcing against corrosion.

iii) Piling

Piling will be used to transmit the design loads from columns to the rock bed because the sub-soil is assumed to be too weak as previously mentioned. The preferred piling method will be 'replacement piles' or 'bored piles. This method is suitable for the Nelson Mandela Forum construction site because it will be carried out in close proximity to the elevated expressway, the rail

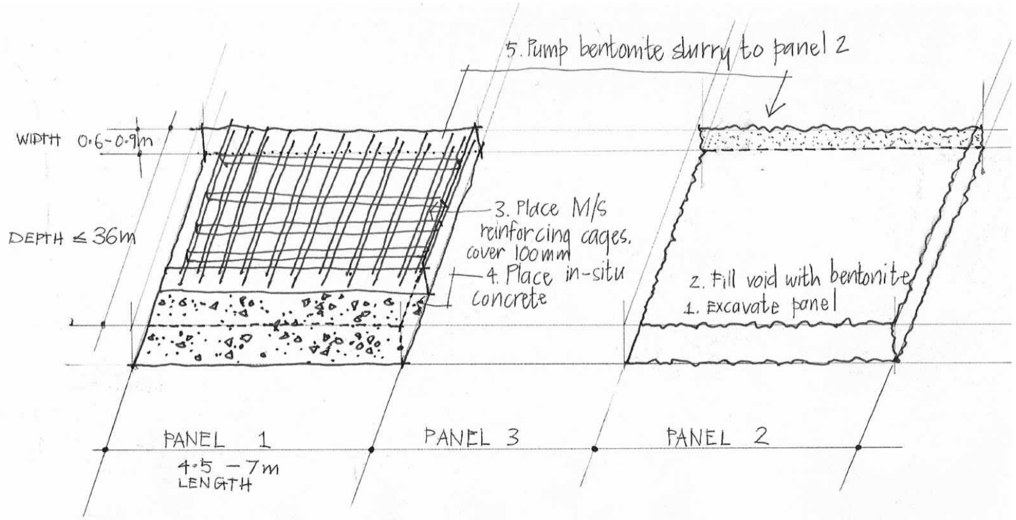



**Figure 44. The Bentonite slurry method for the construction of deep trenches.**

track, the Campanile and the Railway station. The piles will be formed using rotary-bored piling as this is the only method available that can carry the 10'900kN design-loads that the piles will receive from columns (see structural calculations below). A telescopic Kelly bar, housed in a Derrick, drives either a Chesire/ helix auger or a Flight auger. The pile will probably be Ø1200mm or 2 piles per cap of Ø600mm each. Reinforcement, according to a specialist's design, is lowered into the pile cavity and filled with in-situ concrete (or a combination of precast and in-situ concrete should the specialist decide on 'prestcore' piles) which is gravity-compacted. Reinforcing is extended beyond the piles for fixing the pile-cap to. Roughly 400 columns will transmit 10'900kN each to the pile-caps at the head of the piles.

If this method of piling cannot be used an alternative method will require smaller structural bays or lighter loading, like a steel frame, both of which have fundamental implications for the design of the structure

iv) Deep Basement construction

For the construction of a deep basement a strategy of a wet basement is most suitable because the abovementioned in-situ concrete diaphragm perimeter retaining wall's construction precludes applying a waterproofing membrane to the exterior of that wall. Furthermore the extremely long perimeter increases the risk of negligent waterproofing practice. The factory-manufactured pumps involved in wet-basements are less liable to failure, in the author's personal view, than a waterproofing membrane applied by 'semi-skilled' labour. A wet basement implies a cavity that extends the full height of the retaining wall. This cavity can simultaneously serve as a ventilating cavity for the parking garage. This technique was successfully used at the Brooklyn shopping centre in Pretoria's basement garage. The retaining wall can get lateral support from the floor slabs. Beams in line with the structural bays jut out beyond the floor slab perimeter to support vertical cantilever beams/ pillars supporting the retaining wall.

b) Superstructure:

The structural bay must accommodate all the functions of the building while being robust and repetitive. For the upper public floors, the larger the bay, the more open and uncluttered the spaces will be. The centre is in essence an assembly building and requires large spaces unlike offices and apartments where compartmentalization is common. Although beams are more expensive than columns (Foster and Harrington, 1990) it remains important for the character of the income-generating space to seem uncluttered. The next important constraint therefore is the parking basement. It is ideal to have the same column-spacing repeated on each floor. Therefore the parking bay of the motor vehicles in the basement will greatly dictate the possible locations of columns

The proposed system of large span two-way spanning floor-slabs are cheaper than rectangular grids (Foster and Harrington, 1990, pp212) but the relatively large structural bay will lead to very deep horizontal slabs and beams unless the bending moment can be reduced. One method to reduce the bending moment is to reduce the dead load/ self-weight of the structure by the use of coffer slabs. Another method of reducing the bending moment in the horizontal members is to have stiff joints as with a portal frame structure. This discussion already begs the question What structure? Where a concrete floor is cast monolithic with the slab it acts as a flanged beam making it more efficient. Less deflection results from the structure being monolithic. Also in a monolithic structure, there is a less rapid increase in dead weight with increase in span because, due to stress distribution, weight is more concentrated near the supports which will take its weight directly. The disadvantage of such a monolithic structure is the movement caused by thermal expansion and contraction and also that caused by differential settlement of the founding structure

The choice of structural material is now important. The choice of concrete is based on the comparison in Graph 000. If it

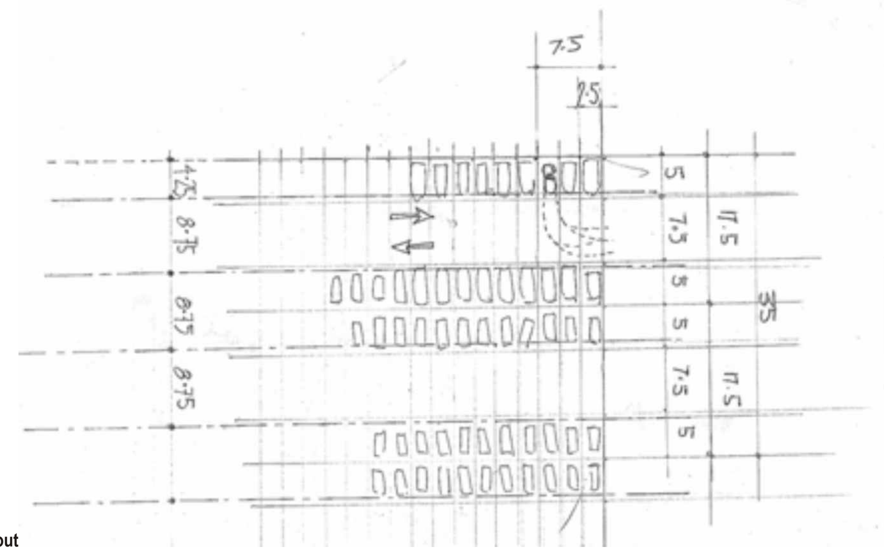


Figure 45. Parking bay layout

| STEEL OR CONCRETE STRUCTURE? | | |
|---|---|---|
| PROBLEM | Concrete | Steel |
| Portal Frame Structure | Monolithic structure is formed with greater ease. Any desired shape of member can be formed. Lateral and transverse stability is obtained by the frame being monolithic with in-fill panels like floors and walls. | Fully rigid members can be made but with extra steel components. Cross-bracing is required for lateral and transverse stability. |
| Cost | The site is not sold under high demand and therefore relatively inexpensive. Slower delivery time associated with concrete is not critical. Variations in structural members can be more cheaply manufactured. | Economy in steel is obtained by the adoption of a regular and reasonably close spacing of stanchions (columns) (Foster and Harrington, 1990, pp 189). Production time can be very little therefore cheaper than concrete if automated methods in the fabricating shop is used, hollow fire-protection methods are used, steel deck floor construction is used and modern organizational methods are used. None of these, to the author's knowledge, really characterize the South-African building industry. |
| Corrosion | Corrosion protection of concrete is achieved by deeper cover to the reinforcement and denser concrete. | Corrosion protection of steel, especially in an industrial-marine environment such as the Port-Elizabeth harbour, is comprehensive in terms of amount of layers of protective coatings and the regularity of recoating required. |
| Fire Protection | Reinforced concrete, with normal cover to the concrete, provides a substantial degree of fire resistance. | Steel requires a protective covering. |
| Manufacturability | Concrete is known to be widely available in Port Elizabeth, having its own cement kiln and plant. The quality of concrete improves with the size of batches being made. | It is uncertain whether steel products of large quantities, and the skill required to work it, it available in the region. Steel work is done under factory conditions and only needs assembly on site Quality is generally good. |
| Robust | The nature of concrete makes it more adaptable to differentiated structural members. | Variations in members require alternative steel sections which are only manufactured in large batches. |

Figure 46. Comparison between steel and concrete as structural material

seems that this evaluation is some-what distorted toward concrete it is because the architecture surrounding the site in Port Elizabeth learned that simple shed like structures are built with a steel frame and more complex structures are executed in concrete. Furthermore, concrete frame construction seems to have a strong presence in the 'Baai'. The large overhead expressways, The 'Dollosse' that line the industrial sea-front, The quays and the harbour infrastructure, the famous bridges in the area, the campus buildings of University of Port Elizabeth, the Algoa bus terminal, the deserted factory in Main Road known for its suspiciously coloured aggregate, even the roads are often made in light coloured concrete all indicating a regional preference for the practicality of concrete

c) Roof

The choice of roof system will depend on:
- Ssupport
- Desired effect below
- economy
- constructability

The areas that have to be roofed are identified as follows:

*Banquet hall:*
- Span 70m X 82.5m.
- Continuous perimeter support.
- No applied downward load.
- Significant upward wind suction.

The aspect ratio of this roof is 82.5/70 = 1.18. Because this ratio is so small, the structural load is evenly distributed. To take advantage of this fact a two way spanning structure is recommended. A space truss installation will give, structurally, the most efficient solution for this span. Special consideration must be given to the roof.

*The Main Auditorium:*

- Span 70m X 70m.
- Continuous perimeter support.
- Applied load: services and personnel gantries, lighting equipment.
- Significant upward wind suction.

Structurally the solution would be the same as with the Banquet hall. The Banquet hall would have a significantly larger downward load. Special consideration must be given to the acoustic performance of the roof. The truss will not be exposed to view. Pending finalization of the Main Auditorium, the roof might have to curve to achieve an acoustically and spatially appropriate interior. This is achievable with space truss assemblies.

*Roof over Conference and service shafts.*

- Irregular shape.
- Intermittently supported over 8750mm X 7500 bays.
- Carries extensive rooftop service plant and acute point loads like water storage.

A concrete roof would be able to accommodate the structural loads while taking advantage of the economies of repetition of the structural frame. Waterproofing will be critical especially at movement joints.

*Roof over parking garage:*

- Regular shape.
- Supported over 8750mm X 7500 bays.
- Carries point loads (cars) and live loads (moving vehicles).

A concrete roof would be able to accommodate the structural loads while taking advantage of the economies of repetition of the structural frame. Waterproofing will not be critical.

The roofscape of the centre will consist of a combination of lightweight long-span metal profile roof sheeting and concrete flat roofs.

d) walls (skin and partitioning)

The external weather-resisting component of the building will be determined by the structure of the part of the building that needs to be protected. The structure of the building is mostly in-situ concrete frame. Large sections of the façade will be glazed. The glazed areas need sun-protection. Furthermore, the environment is highly corrosive being approximately 1km from the ocean. The region is subject to driving rain and winds of up to 14m/s being described as 'near-gale' strength. The architecture of the environment teaches us that plastered brickwork faced brickwork and exposed aggregate concrete panels are the preferred method in the area along with a few sheds of metal profile panels.

The Nelson Mandela Forum, being a highly market-driven venture, is liable to be 're-designed' every 5-10 years. It is insightful to see photo's of long standing convention centres and notice the complete façade changes that they have undergone over the years. It is therefore advisable to choose a cladding strategy that does not preclude remodelling.

To break down the scale of the centre a measure of differentiation is required on the exterior of the centre. In view of the dual roofing scheme considered above, it would be sensible to choose skins that complement each separate scheme: For example: The roof over the banquet hall will be a light steel frame with large sections of the banquet façade glazed. Below the Banquet hall two service levels can be enclosed by brickwork infill. This can be given a facing that would appear solid and heavy to contrast with the lightweight hall above.

A similar approach would be followed throughout to establish intermittent areas of solid and glazed, light-weight metal sheeting with glazed areas 'cut-out'.

The skin of the centre will therefore consist of intermittent surfaces of:

- Glazed curtain walling at the Banquet hall, the Restaurant, the foyer to the Main Hall and the Main Foyer.
- Brickwork infill between the concrete frame members, faced with aluminium panels, punctured with glass panes in aluminium window frames to the exterior of the Conference Centre and Kitchen and Administration department.
- Lightweight metal sheeting as cladding on the exterior of the concrete frame to the exterior of the service shafts and workshops.

e) openings

f) finishes

Security

Security requirements for the Nelson Mandela Forum can be grouped into four categories:

a) Securing property against theft

1. Securing money. For the purpose of this study one process only will be described. Entrance fees are collected at the reception desk in the main foyer. Money received is placed on irregular intervals into a under-counter secured cash-box. The cash-box drops through a dumbwaiter to a secured room below where it is counted and balanced by the accounting department. The money is prepared in 'Smart-boxes' according to the requirements of the bank. The money is then stored in a vault in that same secured room. On irregular intervals a cash-transit service picks up the 'Smart-boxes' and delivers it to the bank. The cash-transit service should preferably not be contracted to the same company that provides the security to the centre. The

cash-transit van would preferably be received in secured garage. The cash-transit personnel receives the 'Smart-boxes' through a chute in the wall between the counting room, containing the vault, and the secured garage.

b) Securing Very Important Persons

Considering that the Nelson Mandela Forum seeks to host, amongst others, gatherings that involve heads of state and other influential people or people with high security requirements. Of specific concern for the protection of VIP's are the point of arrival and departure and the visibility of VIP's from general public outside the building.

- A secure environment must be created for the arrival of the High Risk VIP (HRVIP). A helicopter landing pad out of view of general public and neighbouring buildings is preferable. A separate secured garage for demounting from a vehicle with secured passage to the interior is a minimum requirement. Furthermore, no person outside the controlled access points of the centre will have any visual connection to the interior of the centre. This implies either no windows to the exterior or windows must all have reflective glass.

c) Minimising the risk of terrorist attack

d) Access control of and minimising risks associated with large groups of people:

Some general principles will contribute to making a centre that is easy to monitor and secure, these are:

- Design for visibility: Adequate lighting, all obscure areas to be controlled, avoid unnecessary corners and hiding places. Make places easy to monitor.

- Control access: Few as possible entrances of which all are controlled. Make fewer entrances to monitor.