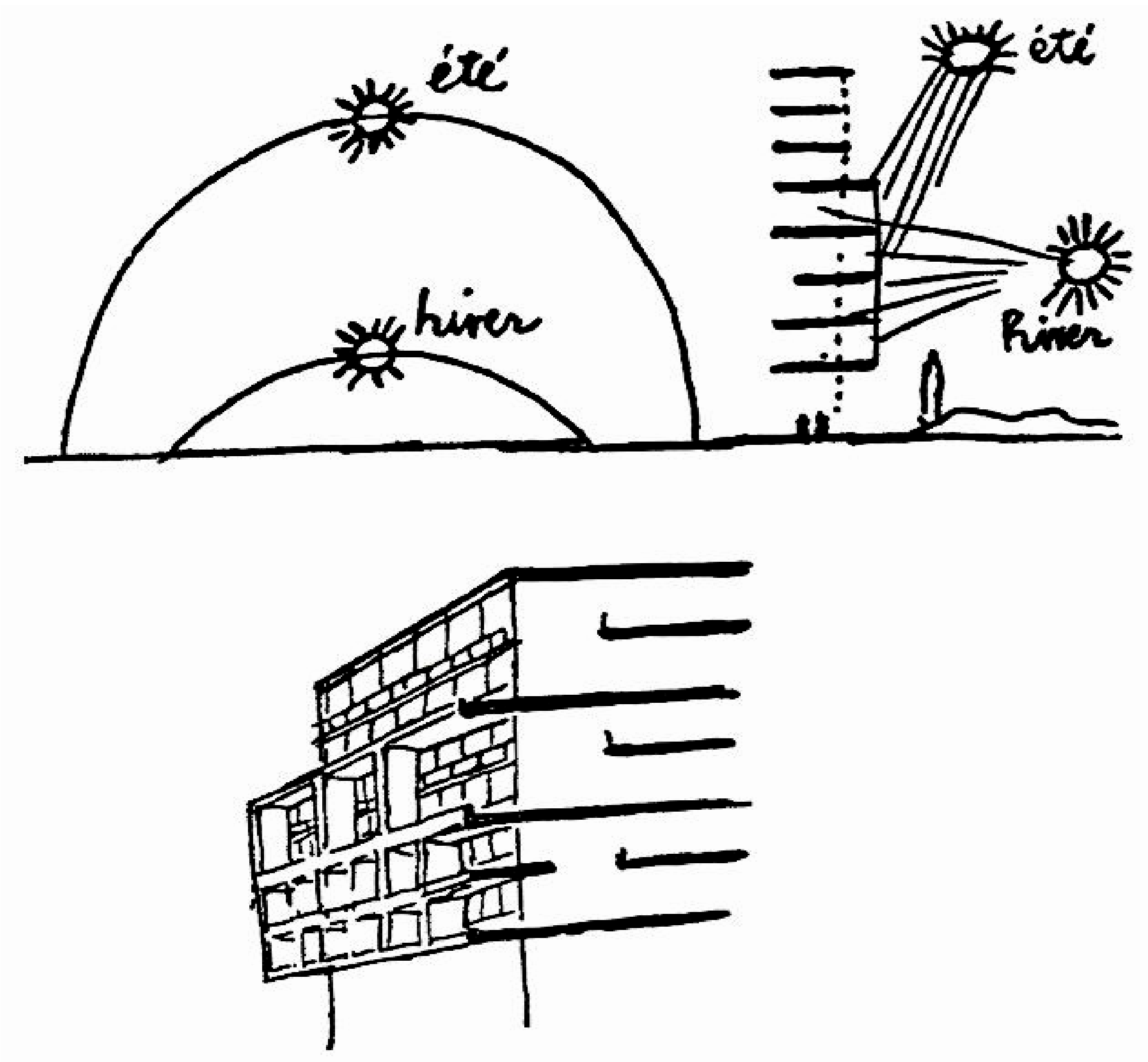


LeCorbusier – 20th century

[Gibberd, 2000:SBAT]

1.1.2 VENTILATION:

Ventilation comes from the Latin word, ventus, and means the movement of air.

Ventilation serves three ends in the environmental control of buildings: it is used

- to satisfy the fresh air requirements of the occupants ("health ventilation")
- to increase the rate of evaporative and sensible heat loss from the body ("comfort ventilation")
- to cool the building interior by exchanging warm indoor air to cooler outdoor air ("structural ventilation")

Air is made to move by differences in density and differences in pressure. When a mass of air is heated, as in a fireplace, it expands and, becoming less dense, rises. Conversely, a cold mass of air, as in a draft falling along a cold window, seeks it lowest level, thereby displacing surrounding warmer air upward. Under such conditions, we say that the air is driven by thermal force, thermal buoyancy, or buoyant draft. Then thermal force discharges air form a building, the action is referred to as the chimney effect, or stack effect. [Watson, Labs, 1983:53]

The building envelope separates the indoor and outdoor environment. In winter, ventilation and infiltration should be limited to prevent heat loss. Infiltration often occurs at construction joints. In summer, the building will be cooled by the removal of heat by convection. The air movement will be especially desirable for occupant comfort. Air movement through the building depends on the differences in air pressure. Cross ventilation will be induced by placing the openings on opposite sides of the spaces. The velocity of wind distribution is uneven. The required changes in air will be achieved through passive systems as:

- **cross ventilation**
- **stack effect (atriums)**

Cool air will enter the spaces through operable windows. Warm air will rise and enter the atrium. The warm air will escape through the openings at the top. It is very important to provide openable windows otherwise the building will be stuck with unwanted warm air. Controllable louvers will minimize solar gain during summer temperatures. The openings can be closed during winter temperatures to keep warm air inside the building.

Six extractor fans on top of the roof, above columns, will remove hot air, dust and fumes. It is waterproof and will make the interior space of the building a healthier and more productive environment. They require no maintenance and are adjustable to the pitch of the roof and will be closed during winter, by means of a damper which will be operated form floor level, so that there is no heat loss during winter time. It is a wind driven ventilator and will improve ventilation in the building. A small (standard 350mm) model extractor fan will work over an area of 50m. Internal air temperatures may be reduced by 3 – 5 degrees Celsius.

A stack effect will be achieved by artificial air movement. Air velocity of 1m/s and 1,5m/s give a cooling effect of 5K and 6,5K respectively. [Holm, 1996:12]

In Johannesburg, the night time dry bulb temperature will be below 20 degrees Celsius for a maximum of 11 hours and a minimum of 5 hours during summer months. During these periods the building will be structurally cooled by using ventilation fans to cool the high mass walls and floors that heat up during the day. During this period will mechanical fans and extractor fans be operating. The sufficient temperature will have been reached when entering the building the next morning. The cooling fans will be switched off during the day to save cost and to minimize energy use. Night ventilation will be implemented to compensate for insufficient mass.

Air for ventilation will enter the spaces (offices, shops etc.) through grills in the floor. Each grill can be individually opened or closed to suit specific needs. Separate fresh air, which will be introduced through the access floor, will provide a high degree of air quality to the building.

A large "gabion wall" in the atrium will have a cooling effect on the building as well. (To be further discussed).

The main features of the ventilation-system-policy are:

- flexibility
- adaptability
- choice

The whole ventilation/heating system will make provision for tenants to select from different systems/options. To minimize the loss of floor space in the basement for ventilation/heating equipment, and to create an open environment free of visual and structural obstacle will be achieved by integrating the ventilation rooms with the roof structure of the basement.

Natural ventilation will be combined with direct evaporative cooling where air will be drawn over a gabion wall inside the atrium. It is important to notice that the openings orientated directly towards the ruling wind direction will receive greater air speed than openings oblique to the direction of the wind. No air will flow into the building through openings situated parallel to the direction of the wind.

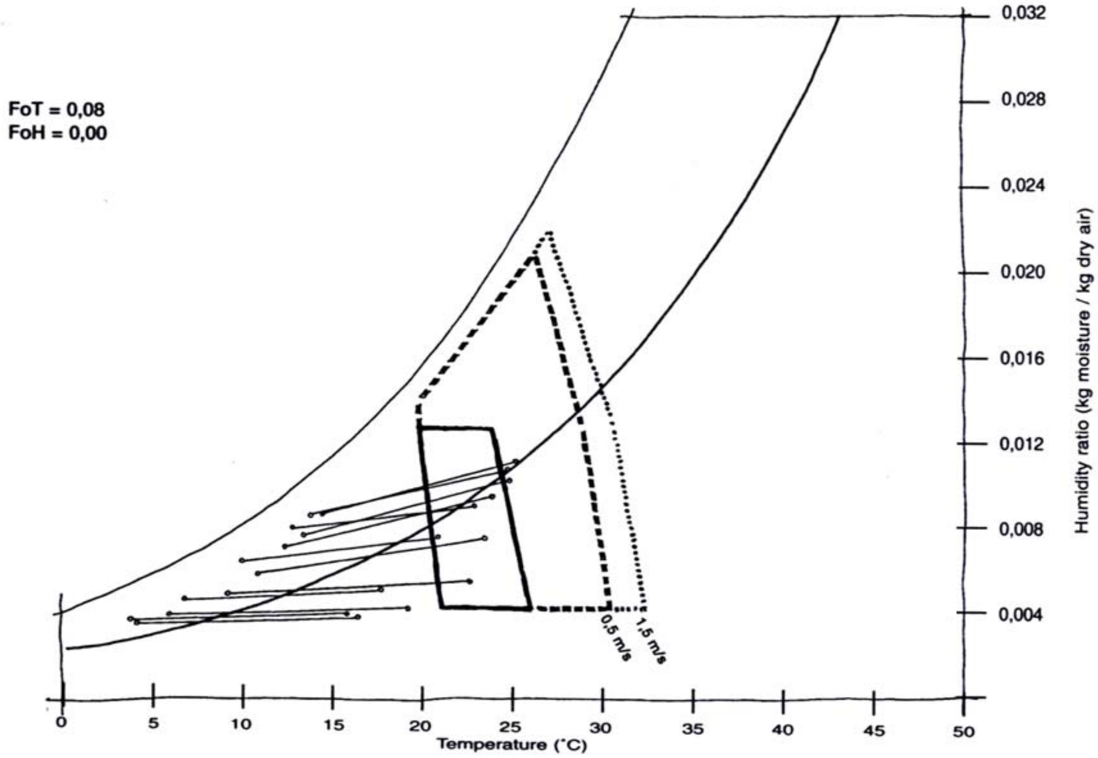


Fig. 36 – Psychrometric chart with ventilation. A minimum requirement is 28,6% of the effect of 1m/s required to deal with the worst case in summer condition.

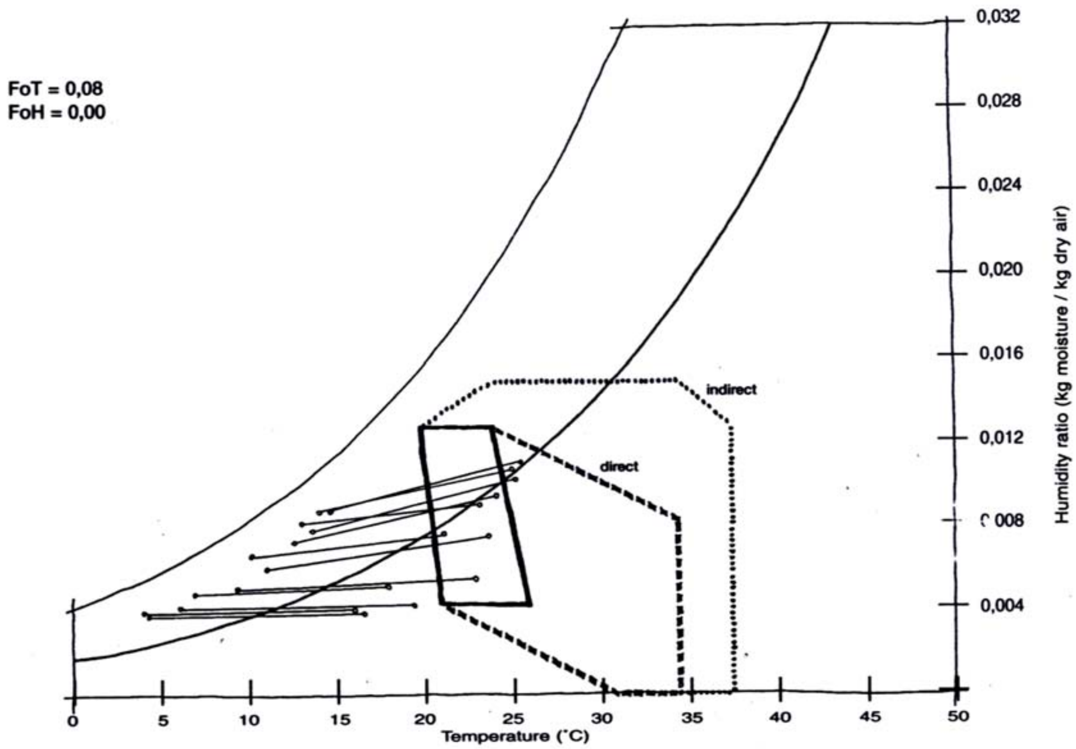
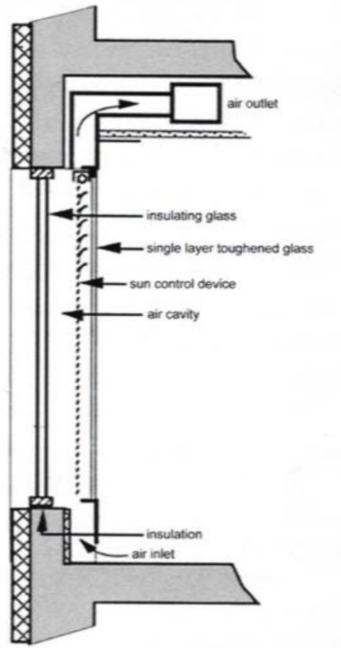


Fig. 37– Psychrometric chart with evaporative cooling. 12,0% of direct evaporative cooling is effective.



The air cavity is ventilated mechanically. Lower pressure inside the cavity draws part of the exhaust air from the room into this cavity. This is where the air warms up, taking most of the heat from the solar control device, and is then drawn off by means of mechanical ventilation. Although it is possible in principle to choose the direction of the flow either up or downwards, it is better and more 'natural' to create an upward flow. The advantages of these ventilated cavity walls are multiple:

- the main advantages lies in the minimalisation of the temperature differences between the air in the room and the surface of the glass wall
- this improves the thermal comfort conditions in the office space nearer to the wall, and thus reduces energy costs for heating in the winter and cooling in the summer
- it also improves the efficiency of floor use, because working close to the wall is more comfortable
- the heat insulation properties are much better than that of a normal, double-glazing façade, because of the extra insulating properties of the ventilated cavity
- the noise reduction is also better than normal
- a heat exchanger can be used to reclaim energy from the exhaust air
- the ventilated cavity is one of the few feasible possibilities of using a fully-glazed wall [Hope, 2001:23]

Fig. 38 – Air cavity method – a system to enhance the properties of glass.

Any barrier or partition located in the internal air flow path between ventilating inlets and outlets will impede air circulation and the ventilation of the interior. In order to promote unrestricted air movement, therefore, partitioning should be adjustable and located so as to offer least resistance to airflow when it is desired for natural ventilation cooling. The open partitionless interior is the surest way of achieving good air movement.

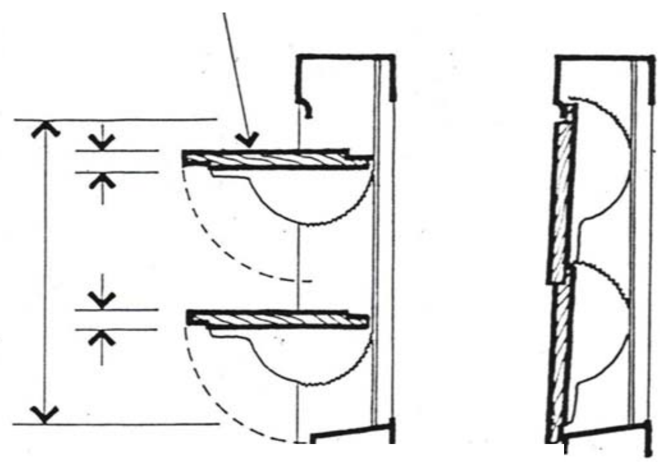
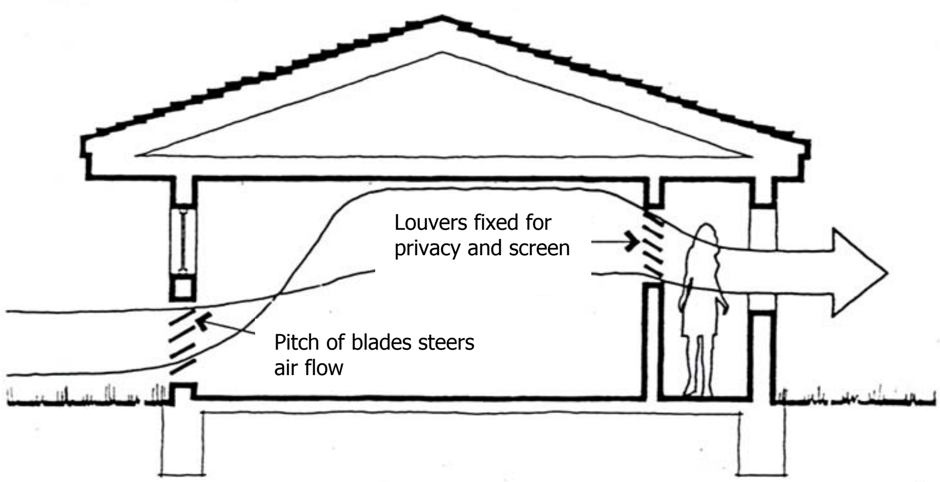
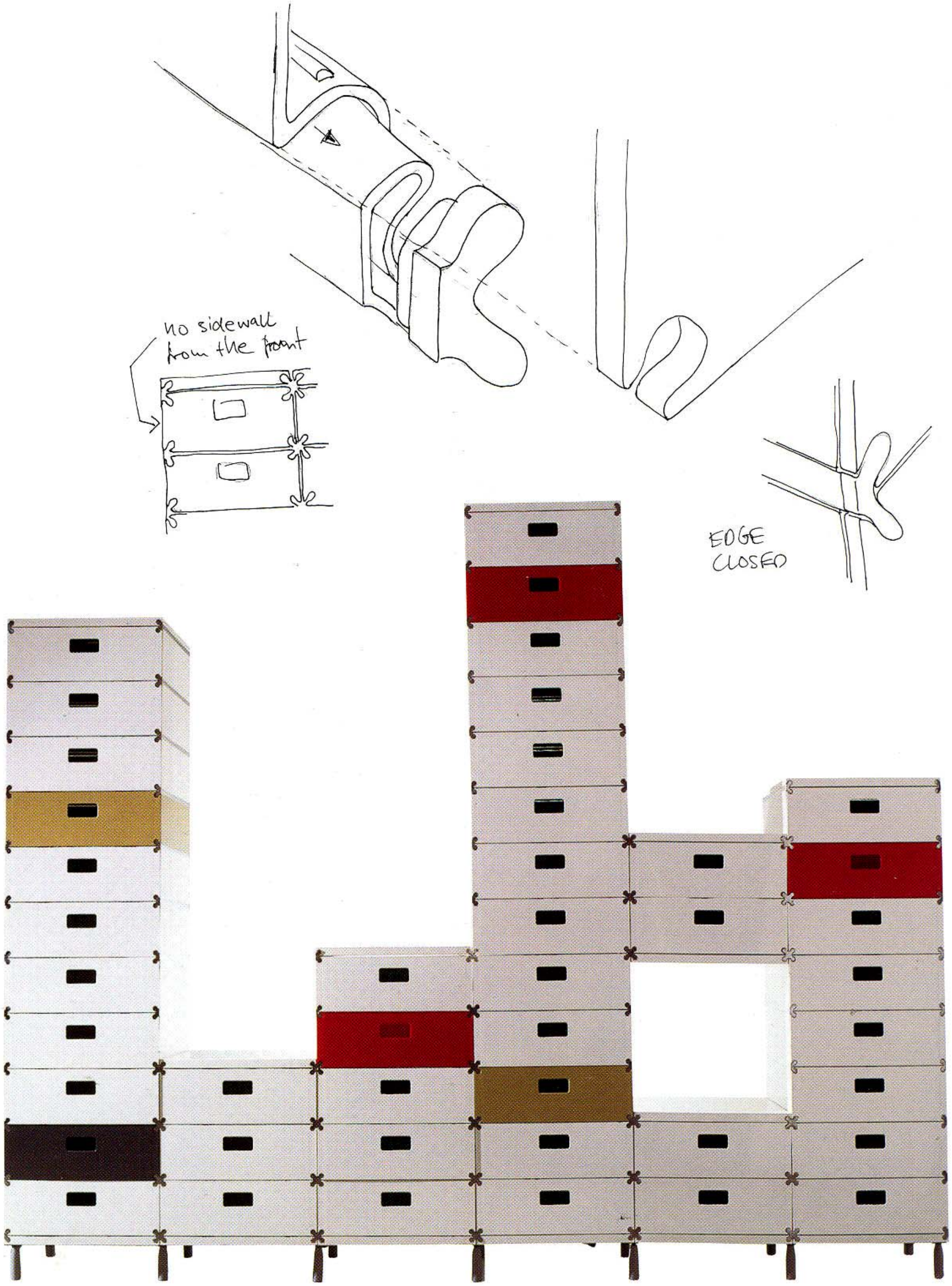


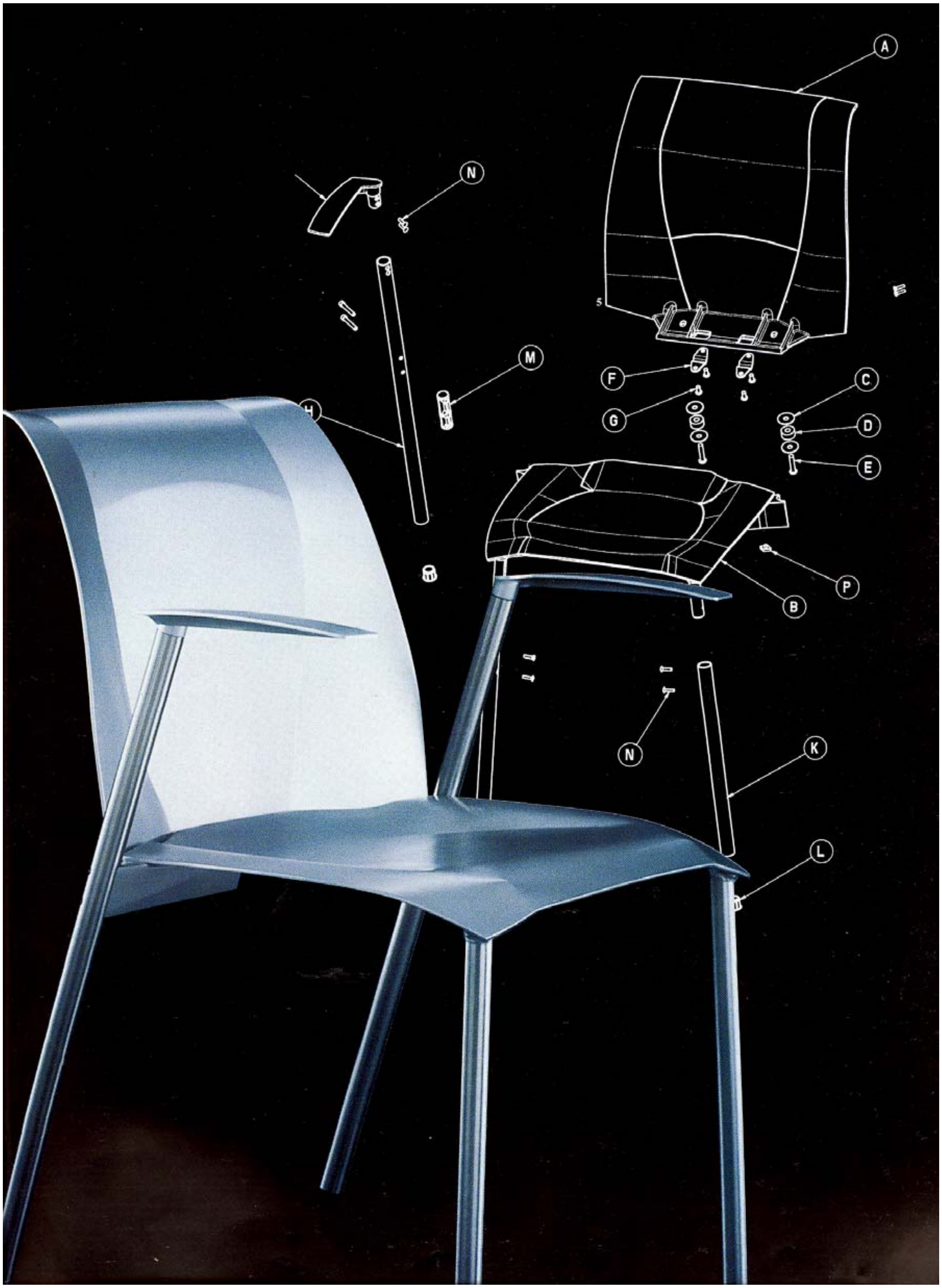
Fig. 39 – A major advantage of the louvred window is the almost unrestricted free area in the open position. For glass louvers, a free area of up to 86% is obtainable in the open position, 46% at 30 degrees, 22,5% at 15 degrees.

Fig. 40 – Another major benefit of louvred windows is rain control, and with opaque or heat absorbing glass louvers, sun screening is also achieved.

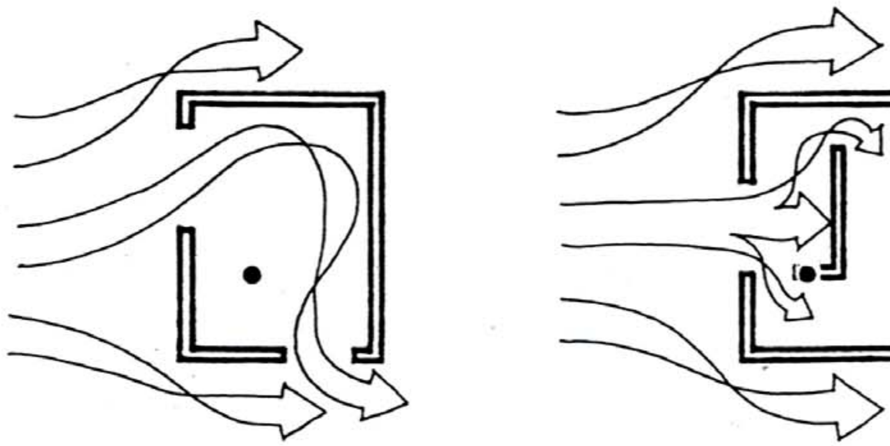




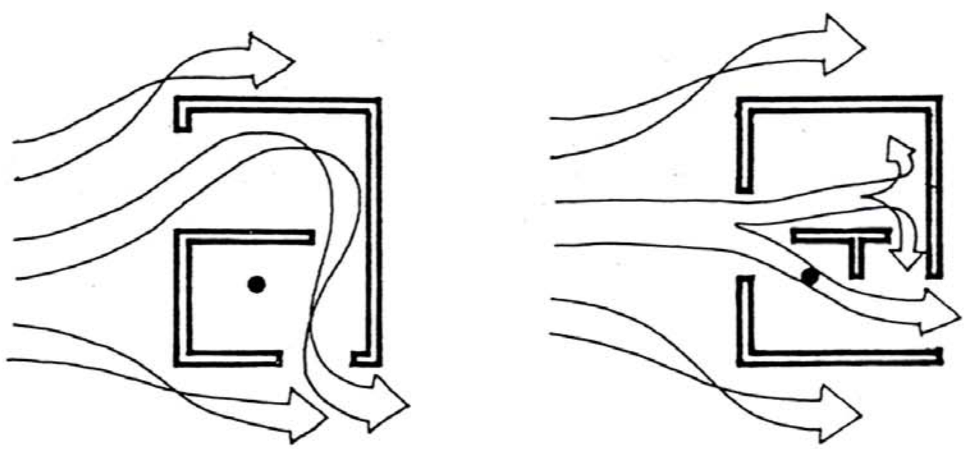
[Domus No 827-828, 2000:74]



[Domus No 819-820,1999:59]



Unobstructed air flow path will be determined by location of intake vent in façade. (Note static area).



Placing partition in static area will have little effect on air flow pattern.

Partition placed in flow zone absorbs dynamic force. Neither room receives adequate ventilation.

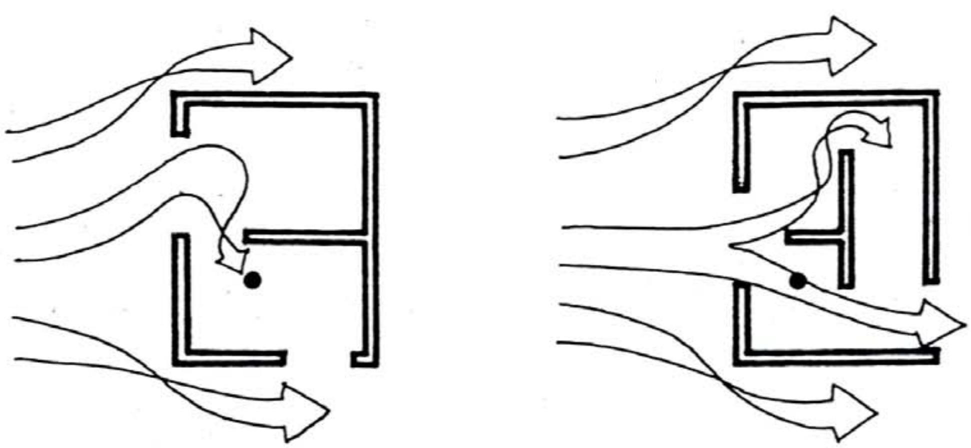


Fig. 41 – Open plan interior, to promote air- flow.

Ventilation is used to exchange the air inside the building with fresh air form outside. That will ensure sufficient oxygen supply and the removal of carbon dioxide, which is unsatisfactory beyond a concentration of 0,5%. Adequate ventilation will also ensure that unwanted heat, moisture, smells etc. will be removed. [Tutt, Adler, 1998:384]

The furniture warehouse, with a area of 2 361m2 (without basement), and an average of 650 people, will require a minimum amount of ventilation of:

2361m2 x 12m high = 28 332m2
= 33,3m3/p.
= 8.0 liter/s x 650
= 5 200 liter/s
= 5,2m3/s
= 18 720 m3/hour
= 7,93 air change/hour

The corresponding minimum fresh air supply is 4,72 liter/s/person.

Type of building	Tei (degrees Celsius)	Air infiltration rate	Ventilation allowance (W/m2 degrees Celsius)
Art galleries and museums	20	1	0,33
Exhibition halls:			
Large (height >4m)	18	0,25	0,08
Small (height<4m)	18	0,5	0,17
Service rooms	16	0,5	0,17
Staircase and corridors	16	1,5	0,50
Entrance halls and foyers	16	1,5	0,50
Public rooms	21	1	0,33
Libraries:			
Reading rooms (height >4m)	20	0,5	0,17
(height<4m)	20	0,5	0,25
Store rooms	15	0,25	0,08
Offices:			
General	20	1	0,33
Private	20	1	0,33
Restaurants and tea shops	18	1	0,33
Shops and showrooms:			
Small	18	1	0,33
Large	18	0,5	0,17
Store rooms	15	0,5	0,17
Warehouses:			
Working and packing spaces	16	0,5	0,17
Storage space	13	0,25	0,08

Fig. 42 – Recommended design values for internal environmental temperatures and empirical values for air infiltration and ventilation allowances (for normal site and winter heating).

Range of speeds m/min	Effect
0-15	Not noticeable, less than 1 degree Celsius of apparent cooling as air passes over skin
15-30	Just noticeable cooling effect equivalent to 1-2 degrees Celsius
30-60	Effective and pleasant cooling effect
60-100	Maximum wind speed for cooling without undesirable side effects
100-200	Too fast for desk word; paper start to blow around
Over 200	Too fast and uncomfortable for internal conditions

Fig. 43 – Effect of internal wind speeds in warm humid climates.

Many plants, climbers and trees will provide shade during the summer months and drop their leaves during the cool winter allowing the sun to provide heating.

COMFORT CRITERIA:
The room temperatures for load calculations will be based on 24 degrees Celsius in summer, 20 degrees Celsius in winter with a maximum humidity of 57% Rh.

The parking basement will be mechanically ventilated by means of a supply and extract system to comply with the Building Regulations.

Mechanical ventilation will be used in all the ablution facilities. Air speed will be increased to 2 m/s to facilitate adequate comfort ventilation.

CLIMATE CONDITIONS:
It is not economical to design for the actual extremes and the proposal is to design within parameters which occur 97,5% of the time. The climatic data can be summerised as follows:

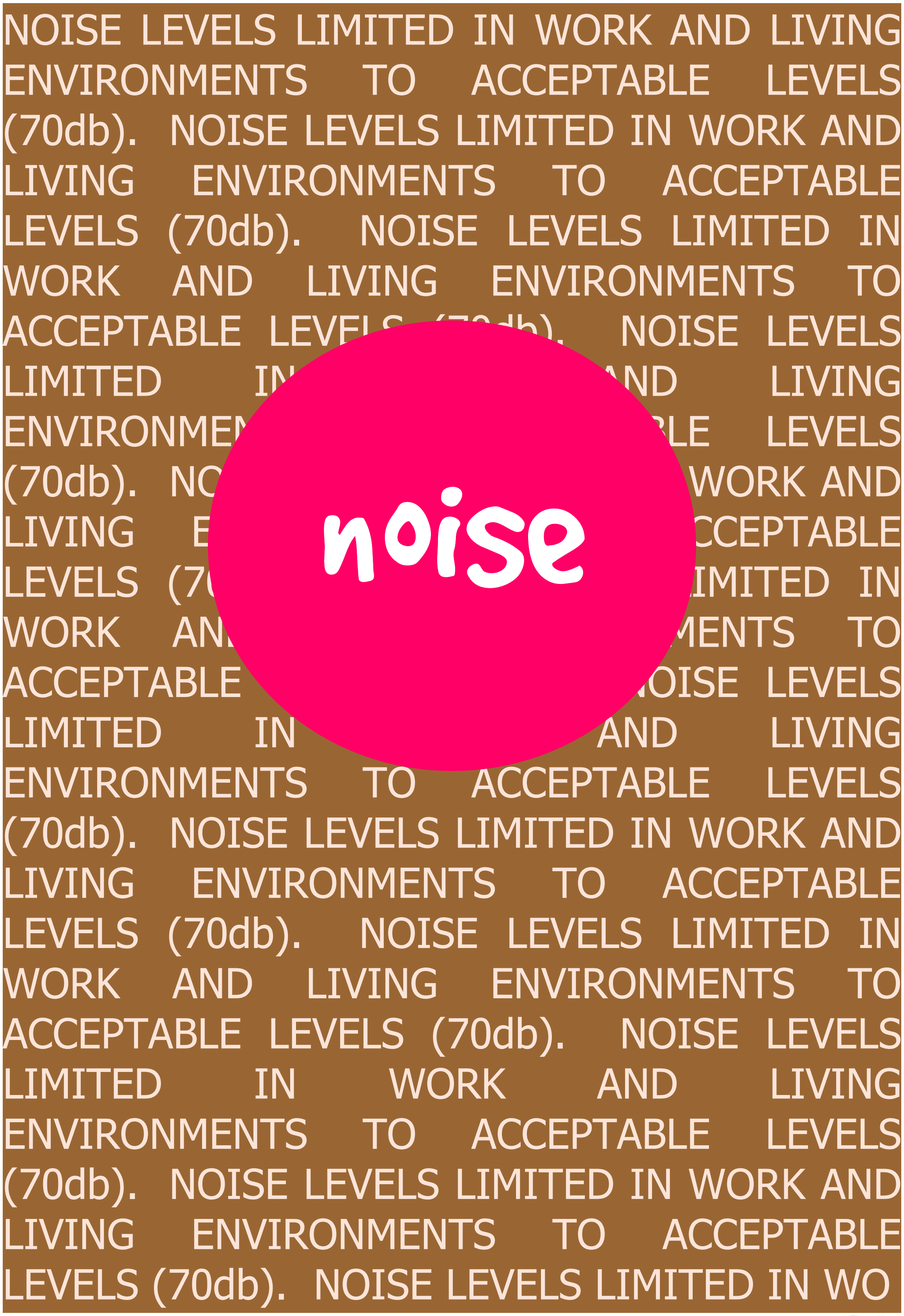
Location	**Johannesburg**
Classification	Composite
Altitude	1 692m
Max. Solar Radiation	1 007W/m2
Max. Summer Dry Bulb	30 degrees Celsius
Max. Summer Absolute Humidity	0,012kg/kg
Max. Energy Content	61KJ/kg
Min. Winter Dry Bulb	0 degrees Celsius
Min. Winter Absolute Humidity	0,0042kg/kg

Fig. 44 – Climatic data of Johannesburg.

OPERATING HOURS
Occupancy hours have an impact on the energy consumption of the building and the following schedule is proposed:

Item	**Time Schedule**
General floor lighting	07:00 – 21:00
Entrance lighting	24 h/day
Cooling/Heating fans	07:00 – 19:00 weekdays 07:00 – 14:00 Saturdays and Sundays Automatically controlled
Extractor fans	Automatically controlled as required Summer: 16:00 – 05:00 Winter: 03:00 – 06:00
Lifts, ramps, staircases	06:00 – 21:00 weekdays 06:00 – 15:00 Saturdays and Sundays After hours minimum with occupancy control
Basement ventilation	Programmed for morning and afternoon traffic rush hours Minimum fans for balance of time
Basement lighting	06:00 – 21:00 normal lighting After hours minimum with occupancy control to activate balance

Fig. 45 – Operating hours of lighting in building – A time schedule.



[Gibberd, 2000:SBAT]

1.1.3 NOISE:

NOISE IMPACT:
Noise is unwanted sound. The annoyance or noise impact caused by a specific noise depends on the amount by which that noise causes the noise level (dBA) to rise above the ambient noise level (dBA). [Van Zyl, 2001:4-1]

NOISE LEVEL:
In accordance with National Noise Regulations, the Noise level is the total sound level in dBA, including the effect of any specific source under investigation. [Van Zyl, 2001:4-1]

Because the building is situated next to the N3-highway, traffic noise will be a problem and have to be taken into consideration. There isn't exact traffic statistics available on the amount of vehicles per day, but by looking at the following table, one can see that the freeways carry thousands of traffic per day.

	To Johannesburg CBD				From Johannesburg CBD			
	Car	**Minibus**	**Bus**	**Total**	**Car**	**Minibus**	**Bus**	**Total**
M1 North of CBD	23795	6661	977	91433	25737	13196	3555	42488
M1 at Buccleach	48756	3493	826	53075	19830	4750	1399	25979
Louis Botha Ave	2368	10418	407	13193	4816	5680	2777	13273
Gordon	8694	316	517	9527				
Jules	4008	1911	1831	7750				
M2 at Benrose	21353	11595	2778	35726	4838	5849	291	10978
M2 at Heriotdale	19313	15419	3120	37852	10818	4515	1423	16759
Lombardy Link at Kelvin	9857	831	405	11093				

Fig. 46 - Existing peak period (05:00 to 08:00) passenger volumes.

The first major precaution against the traffic noise will be to minimize glazing on the western façade of the building because glass provides no attention to sound.

The noise spectrum of road traffic noise will be influenced by factors such as the percentage of heavy vehicles, speed, road surface, road gradient etc., but the overall typical spectrum will always exhibit the strongest component at low frequencies. City center noise is typical at around 80 dBA, as well as in the case, close to highways.

Rooms are not necessarily designed to have the lowest possible background noise level, since this could lead to unsatisfactory environments and would be costly. The glazing should attenuate the outside noise to a level which does not annoy, but is still efficient to mask the ambient, internally generated noises.

Acceptable maximum levels of background noise are roughly:
- Quiet areas 30 – 35 dB
- Low-noise areas (staff areas, enquiries desks etc.) 45 – 50 dB
- Noisy areas (lobbies, stairs etc.) 50 – 60 dB.

[Matthews, 1991:81]

The computer room in the building will have greater noise level than the reading room (library). Say for example there are three computers with noise levels of (52,5 dBA), (46,8 dBA), (56,2 dBA), the average noise level will be:

$LP_{Average} = 10 \log (1/3)(10(52,5/10) + 10(46,8/10) + 10(57,2/10)$
$= 54,0$ dBA

The total noise level of all 3 computers running:
$LP_{Total} = 10 \log (10(52,5/10) + 10(46,8/10) + 10(57,2/10)$
$= 58,8$ dBA

The total noise level that will be produced by 15 of type 1 computers:
$LP_{15} = 52,5 + 10 \log (15)$
$= 64,3$ dBA

[Van Zyl, 2001:4-3]

It will be very important to make the computer room more sound proof than for example the library. (Especially because the computer room will be situated near offices and exhibition spaces). Walls and screens must be designed to act as acoustic barriers attenuating the sound level.

A noise screen located between the source and the receiver reduces the sound pressure level by an amount which is a function of the difference in path length traversed by the sound wave with and without the presence of the screen.

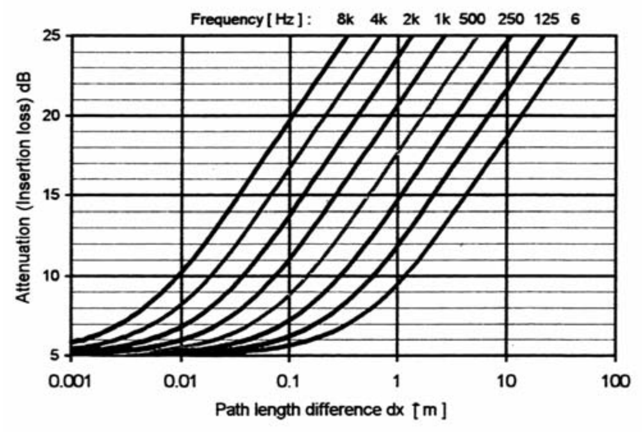


Fig. 47 – Attenuation by screen.

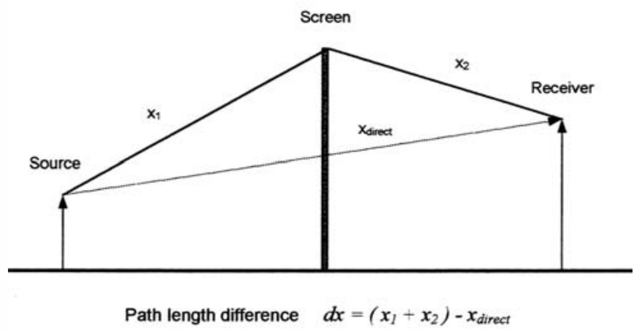


Fig. 48 – Attenuation by screen – the principle.

Say the average peak-hour traffic noise level measured at a distance 5m from the highway is 82,0 dBA, what will the noise level be in the building, 100m from the highway?

LPx2 = LPx1 – 10 log (kx) [dBA]
LP100m = LP5 – 10 log (100/5) [dBA]
LP100m = LP5 – 13,01
= 82,0 – 13
= 69 [dBA]

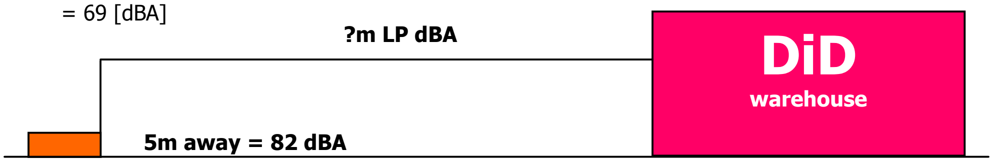
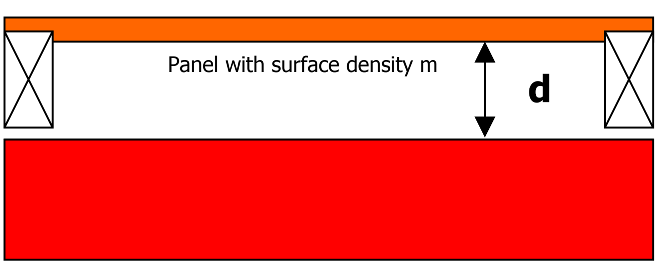


Fig. 49 – The influence of the N3-highway on DiD-warehouse.

INSULATION:
Glass wool, mineral wool, open-cell polyurethane foam or underfelt – that must be employed in acoustic design for the control of reverberation time and control. Used in conjunction with insulating materials to construct walls and panels. Examples of acoustically translucent protective cover are: [Van Zyl, 2001:6-2]

- perforated vinyl
- perforated steel
- woven cloth
- shade netting
- wooden slats with openings
- expanded materials

PANEL ABSORBER:
A sound wave incident on a panel will set it into vibration. A panel over an air gap constitutes a resonating system with resonance frequency determined by panel mass and air stiffness. If the sound wave contains energy at the resonance frequency, the panel will resonate and extract (absorb) energy from the sound wave. [Van Zyl, 2001:6-3]



d = air gap [mm]
m = panel surface density [kg/m2]

- provides narrow band absorption
- not suitable for wide-band applications
- particularly effective at low frequencies

Fig. 50 – Panel absorber.
(plywood panel, gypsum ceiling)

Description	125	250	500	1k	2k	4k
Brick unplastered	0,02	0,03	0,03	0,04	0,05	0,07
Brick plastered	0,01	0,02	0,02	0,02	0,03	0,03
Concrete smooth painted	0,01	0,01	0,01	0,02	0,02	0,02
Plastered wall unpainted	0,03	0,03	0,02	0,03	0,04	0,05
4mm glazing	0,35	0,25	0,18	0,12	0,07	0,04
6mm glazing	0,18	0,06	0,04	0,03	0,02	0,02
12,7mm gypsum on brandering under pitched roof	0,33	0,15	0,08	0,04	0,07	0,09
12,7mm gypsum on 38mm brandering against concrete roof	0,29	0,10	0,05	0,04	0,07	0,09
50mm 48kg/m3 glass wool against solid backing	0,23	0,47	1,09	1,05	1,02	1,08
100mm 48kg/m3 glass wool against solid backing	0,83	0,78	1,20	1,09	1,07	1,15
50mm 60kg/m3 mineral wool against solid backing	0,28	0,60	0,99	1,06	1,02	1,02
100mm 60 kg/m3 mineral wool against solid backing	0,69	1,13	1,08	1,04	1,05	1,02

Table 51 – Sound Absorption of different materials.

Use a material that is thin and high in density for insulation.

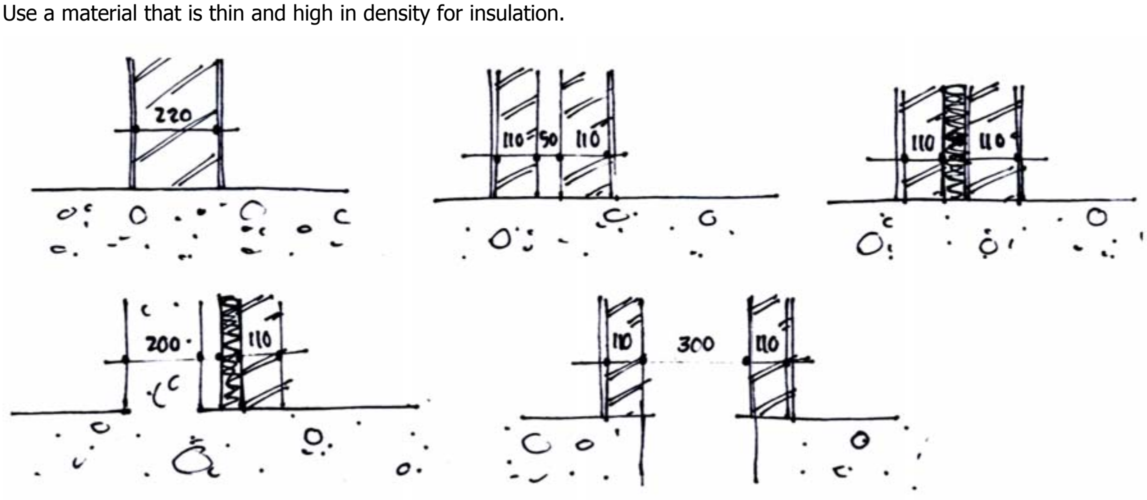


Fig. 52 – Cavity Walls.

The bigger the cavity, the better the isolation capability. The cavity must be filled with isolation material (glass wool) to gain maximum results.

Provide the entrance on the west façade with a mechanical glass entrance door to limit the amount of traffic noise that will enter the building in the case of an open standing door. The door will open when entering and will close immediately. Use double-glazing to limit the amount of noise outside the building. All the windows on the west façade should be 6mm or 10mm with a cavity >40. (A smaller cavity won't be effective).

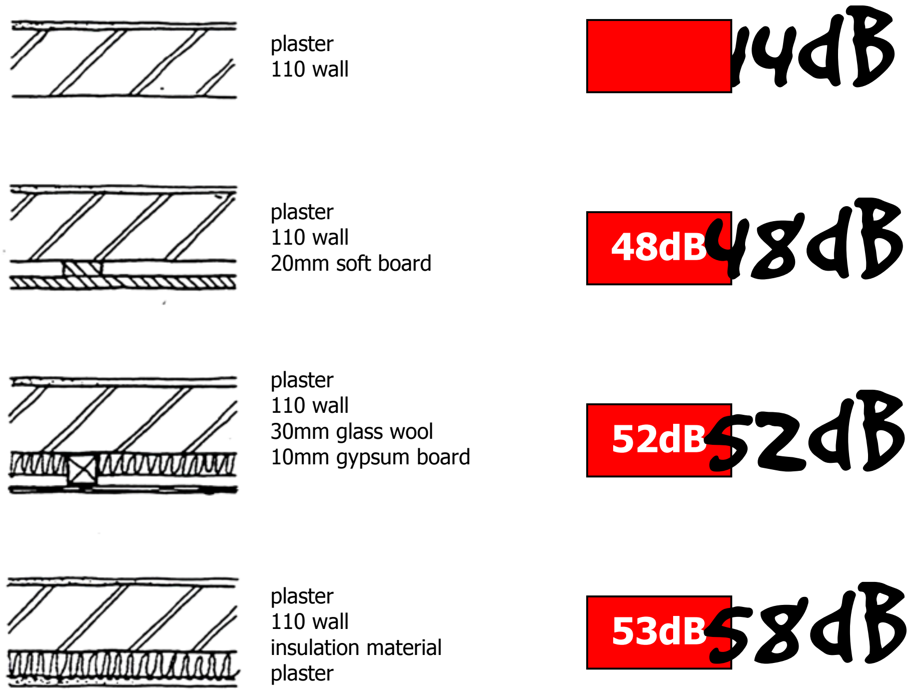


Fig. 53 – Improvement of the average isolation value of a 110mm wall.

Single walls:	**Average 100 – 3150Hz.**
110 wall (unplastered)	43
110 wall (plastered – both sides)	48
220 wall (plastered)	54
330 wall	55
Cavity walls:	
110 – 50 – 110 (plastered)	55
110 – 80 – 110 (plastered)	52
220 – 120 – 220 (plastered, glass wool)	101
Windows: (closed)	
Single 3mm glass	23
Single 4mm glass	24
Single 6mm glass	26
Single 10mm glass	28
Single 6mm laminated glass	30
Double 10 – 50 – 10mm	35
Double 3 – 100 – 3 mm	35
Double 6 – 100 – 4mm	39
Double 6 – 100 – 6mm	38
Windows: (openable)	
4mm glass in steelframe	18
6mm glass louvers	17
4mm – 30 degrees	8
Doors:	
Hollow core	16
60mm solid core	34

Table 54 – Isolation values against noise.

Heat transfer through insulation material occurs by means of conduction, while heat loss or heat gain from the atmosphere occurs by means of convection and radiation.

In the case of solvent based vapour barriers the manufacturer's application procedures must be carefully followed, as the danger of solvent entrapment exists due to premature over-coating resulting in surface "bubbles". Condensation occurs when water vapour in the atmosphere comes in contact with a surface at a temperature of less than or equal to the dew point. Therefor, it the surface temperature is less than the dew point, condensation will occur. The presence of condensation on the warm side of the vapour barrier has no detrimental effect on the insulation but must, nevertheless, be avoided. To prevent condensation, the insulation thickness should be so designed that temperature on the warm side of the vapour is above the dew point.

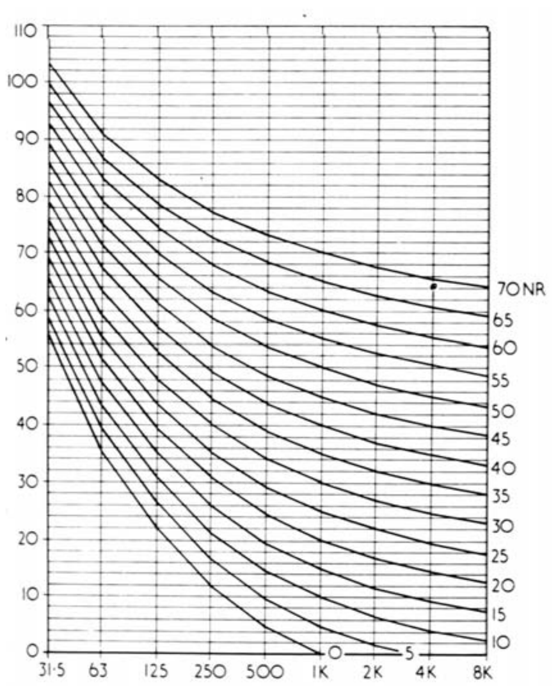
Aerolite will be used for the acoustical and thermal insulation of the cavity wall on west façade as well as on the ceilings. Aerolite and factorylite are the ideal products for temperature control of ceilings and roofs, with Aerolite being the preferred product to use for acoustics (in dry walling as well). The heavier density mineral wool insulation can be used in walls, and under plinths supporting fans, etc. for noise control.

required, the insulation system is only as good as its vapour barrier and the care with which it is installed.

[African Heating and Cooling – March-April 2002:44-46]

BIDIM USED AS AN ACOUSTIC CURTAIN:
A geotextile, Kaytech's bidim A4, has been successfully used as an acoustic curtain. The structure comprised 137m long steel arches which, at the time, were believed to be the longest spans of their type in Africa. The fabric can be attached to masts manufactured specially by a yacht sail-maker and then be hung form the roof. The specified geotextile – made from 100% polyester – will be the perfect choice for acoustical and fire purposes. It has a melting point of between 250 and 260 degrees Celsius. It can be implemented when considering factors such as privacy, acoustic, flexibility spaces etc. in the atrium or exhibition spaces. [www.smartglass.co.za]

Octave band sound pressure level



Octave – band center – frequency Hz

Fig. 55 – Noise rating curves.

Any kind of opening in a partition will seriously impair the sound insulation. Two single walls of 30 dB sound insulation combined would not produce 60 dB but only about 35 dB; the doubling of the mass per unit area adding 5 dB by the mass law. By separating the two walls several meters apart will provide insulation of nearly 60 dB. The suspended floors will act as insulation against sound caused by footsteps on hard-surfaced floors.

As mentioned, windows are the weakest part of the envelope where sound insulation is concerned. The mass per unit area of the glazing is small compared with the rest of the envelope. All openable windows on the west façade must be sealed with rubber or silicone strips.

Suitable wall constructions for sound insulation to Building Regulations 1976, G2(2):
[Tutt, Adler, 1998:439]

1. A solid wall consisting off -
   - bricks or blocks with plaster not less than 12,5mm thick on at least one face; or
   - dense concrete cast in situ or panels of dense concrete having all joints solidly grouted in mortar; or
   - lightweight concrete with plaster not less than 12,5mm thick on both faces of the wall,

in each case the average mass of the wall (calculated over any portion of the wall measuring 1 metre square and including the mass of any plaster) being not less than 415kg/m2.

2. A wall having a cavity not less than 50mm wide constructed of two leaves each consisting of bricks, blocks or dense concrete with plaster not less than 12,5mm thick on both faces of the wall, and having any wall ties of the butterfly wire type, the average mass of the wall (calculated over any portion measuring 1 metre square and including the mass of the plaster) being not less than 415kg/m3.

3. A wall having a cavity not less than 75mm wide constructed of two leaves each consisting of lightweight concrete with plaster not less than 12,5mm thick on both faces of the wall and having any wall ties of the butterfly wire type, the average mass of the wall (calculated over any portion of the wall measuring 1 metre square and including the mass of the plaster) being not less than 250kg/m2.
[Tutt, Adler, 1998:439]

1.1.4 VIEWS AND ACCESS TO GREEN OUTSIDE:

ALL LIVING AND WORK AREAS HAVE ACCESS TO A VIEW OUT. ALL USERS LOCATED IN 6M OR LESS FROM A WINDOW. EASY ACCESS PROVIDED TO EACH USER TO GREEN OUTSIDE SPACES.

A view to the outside, have a calming effect on people sitting inside a building. The restaurant and coffee shops in the building have outside spaces and balconies that will provide great views from different angles around the building. Although slightly separated, will there be a view from the coffee shop towards the atrium.

Because of the large amount of glass in the façade and glass partitions that will be between the shops (to separate them), will different objects and horizontal and vertical openings interplay each other.

The views inside the building are equally important and occupants will see different objects intersect each other through their viewports.

The upper exhibition spaces and ramps will give unrestricted views into the rooms and spaces below. Views into the central exhibition spaces will show impressive interplays of light falling from different directions. Another important view will be the one from the N3-highway towards the building. It is very important to get a glamorous glimpse that will reflect the character of the building (interior and function) and force people to notice it.

By providing a pleasant, easily accessible space, one can increase productivity by enabling people to be refreshed by spending a short time in a different environment. (temperature, light, humidity, air movement). Provide adequate sitting space on balconies and around the building on ground floor level. Use deciduous trees to provide shade in summer and allow sun the penetrate through during winter. (umbrellas, spray pipes etc. to make it a pleasant and comfortable environment). "Sunwalls" for example during the winter will give people the opportunity to go out for 5 min.
to get warm and relax.

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