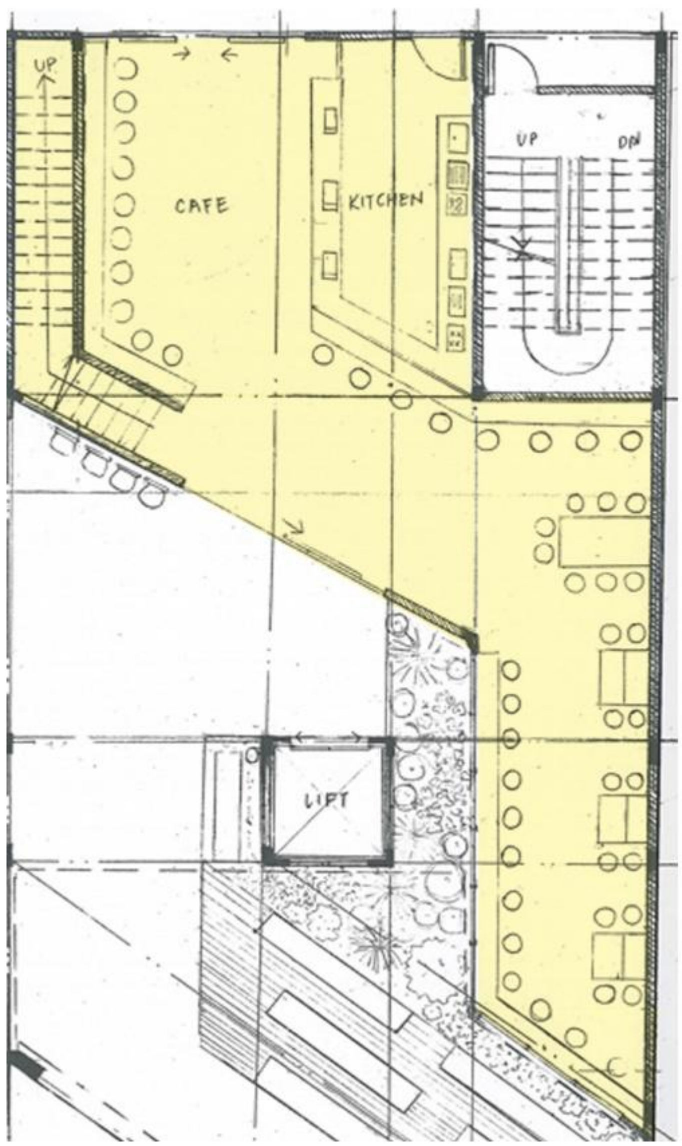
1.0 ACOUSTIC CALCULATIONS

1.1 GROUND FLOOR CAFÉ



The café is adjacent to back alley and it has an open kitchen area, hence a significant amount of noises might be generated due to activities and traffic. Reverberation time, combined SPL sound transmission loss are being calculated to determine the acoustical comfort of the space.

1.1.1 REVERBERATION TIME CALCULATION

Room height: **4.0m**

Optimum reverberation time for cafeteria: **0.8-1.3s**

Assume that,

Peak hour: 55people

Non-peak hour: 20 people

Volume of ground floor café:

[(6.3 + 10.5) x 8.2/2 + (10.8 + 13) x 3.8/2] x 4.0 = **399.35 m³**

Material	Function	Area [A] (m2)	Absorption Coefficient in 2000 Hz [S]	Sound Absorption [SA]
Plaster	Ceiling	99.84	0.04	3.99
Brick	Wall	179.6	0.05	8.98
Steel	Column	10.8	0.01	0.11
	Furniture (Bar)	25.6	0.01	0.26
Glass	Door	26.6	0.07	1.86
	Glass Panel	36.4	0.07	2.55
Timber	Door	1.8	0.1	0.18
	Furniture (Table)	12.62	0.1	1.26
Fabric	Cushioned Chair	6.28	0.7	4.40
Concrete Cement	Floor	99.84	0.02	2.00
Total sound absorption by materials				**25.58**

Time	Number of People	Absorption Coefficient in 2000 Hz [S]	Sound Absorption [SA]
Peak hour	55	0.5	27.50
Non-Peak hour	20	0.5	10.00

Table 1.1.1.1: Material Absorption Coefficient at 2000 Hz

According to table 1.1.1.1, the total sound absorption at 2000 Hz during peak hour and non-peak hour are **53.08** and **35.58** respectively.

Reverberation time [Peak hour]

RT = 0.16xV / A

= 0.16 x 399.35 / 53.08

= **1.2s**

Reverberation time [Non-Peak hour]

RT = 0.16xV / A

= 0.16 x 399.35 / 35.58

= **1.8s**

The reverberation time for ground floor café during peak hour is **1.2s.** According to Acoustic Standard ANSI (2008), the reverberation time of ground floor café during peak hour **achieved** the optimum reverberation time for restaurant which is **0.8-1.3s.**The reverberation time for ground floor café during non-peak hour is **1.8s.** According to Acoustic Standard ANSI (2008), the reverberation time of ground floor café during non-peak hour **exceed** the optimum reverberation time for restaurant which is **0.8-1.3s.** To **reduce the reverberation time**, drapery curtains with 0.7 absorption coefficient is added in around glass panels. The updated total sound absorption by materials during peak hour and non-peak hour are **78.56** and **61.06** respectively.

Material	Function	Area [A] (m2)	Absorption Coefficient in 2000 Hz [S]	Sound Absorption [SA]
Plaster	Ceiling	99.84	0.04	3.99
Brick	Wall	179.6	0.05	8.98
Steel	Column	10.8	0.01	0.11
	Furniture (Bar)	25.6	0.01	0.26
Glass	Door	26.6	0.07	1.86
	Glass Panel	36.4	0.07	2.55
Timber	Door	1.8	0.1	0.18
	Furniture (Table)	12.62	0.1	1.26
Fabric	Cushioned Chair	6.28	0.7	4.40
	Curtain	36.4	0.7	25.48
Concrete Cement	Floor	99.84	0.02	2.00
Total sound absorption by materials				**51.06**

Time	Number of People	Absorption Coefficient in 2000 Hz [S]	Sound Absorption [SA]
Peak hour	55	0.5	27.50
Non-Peak hour	20	0.5	10.00

Table 1.1.1.2: Material Absorption Coefficient at 2000 Hz [updated]

Reverberation time [Peak hour]

RT = 0.16xV / A

= 0.16 x 399.35 / 78.56

= **0.81s**

Reverberation time [Non-Peak hour]

RT = 0.16xV / A

= 0.16 x 399.35 / 61.06

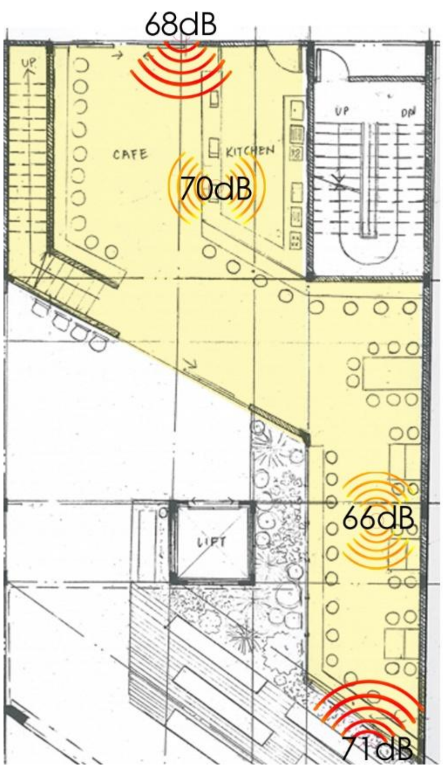
= **1.05s**

After adding in drapery curtain, the reverberation time for peak hour and non-peak hour are successfully reduced to the optimum range of reverberation time, 0.8s-1.3s.

1.1.2 COMBINED SPL CALCULATION

The sound level assumption are made during non-peak hour (9am) which the cafe is on-going preparation work and during peak hour, which is lunch time (12pm). Noise sources had been categorized as external traffic noise and internal noises which create by human activities.

1.1.2.1: Non-peak hour (9am) combined SPL



(i) External noise sources:

Back Alley: 68dB

Sound penetrate from main road: 71 dB

Combined SPL for external noise sources:

$68 = 10 \log (I_{backalley}/I_o)$

$\text{Log} (I_{backalley}/1x10^{-12}) = 6.8$

$\text{Log}^{-1}\text{Log} (I_{backalley}/1x10^{-12}) = \text{Log}^{-1}6.8$

$(I_{backalley}/1x10^{-12})=6.31x10^{6}$

$\mathbf{I_{backalley}= 6.31x10^{-6}}$

$71 = 10 \log (I_{mainroad}/I_o)$

$\text{Log} (I_{mainroad}/1x10^{-12}) = 7.1$

$\text{Log}^{-1}\text{Log} (I_{mainroad}/1x10^{-12}) = \text{Log}^{-1}7.1$

$(I_{mainroad}/1x10^{-12})=1.26x10^{7}$

$\mathbf{I_{mainroad}= 1.26x10^{-5}}$

Total intensities, I_{Total}

$= 6.31x10^{-6}+1.26x10^{-5}$

$= \mathbf{1.89 \times 10^{-5}}$

SPL=10 log (I_{total}/I_o)

$= 10 \log (1.89 \times 10^{-5}/1x10^{-12})$

$= \mathbf{72.76dB}$

(ii) Internal noise sources:

Kitchen zone: 70dB

Dining zone: 66dB

Combined SPL for internal noise sources:

$70 = 10 \log (I_{kitchen}/I_o)$

$\text{Log} (I_{kitchen} /1x10^{-12}) = 7.0$

$\text{Log}^{-1}\text{Log} (I_{kitchen} /1x10^{-12}) = \text{Log}^{-1}7.0$

$(I_{kitchen} /1x10^{-12})=7.0x10^{7}$

$I_{kitchen} = \mathbf{7.0x10^{-5}}$

$66 = 10 \log (I_{dining}/I_o)$

$\text{Log} (I_{dining}/1x10^{-12}) = 6.6$

$\text{Log}^{-1}\text{Log} (I_{dining}/1x10^{-12}) = \text{Log}^{-1}6.6$

$(I_{dining}/1x10^{-12})=3.98x10^{6}$

$\mathbf{I_{dining}= 3.98x10^{-6}}$

Total intensities, I_{Total}

$= 7.0 \times 10^{-5} + 3.98 \times 10^{-6}$

$=7.40 \times 10^{-5}$

SPL=10 log (I_{total}/I_o)

$= 10 \log (7.40 \times 10^{-5}/1x10^{-12})$

$= \mathbf{78.69dB}$

Combined SPL for ground floor café at non-peak hour:

$72.76 = 10 \log (I_{extermal}/I_o)$

$\text{Log} (I_{external} / 1x10^{-12}) = 7.276$

$\text{Log}^{-1}\text{Log} (I_{external}/1x10^{-12}) = \text{Log}^{-1}7.276$

$(I_{external} / 1x10^{-12})=1.89x10^{7}$

$I_{external} = 1.89x10^{-5}$

$78.69 = 10 \log (I_{internal}/I_o)$

$\text{Log} (I_{internal}/1x10^{-12}) = 7.869$

$\text{Log}^{-1}\text{Log} (I_{internal}/1x10^{-12}) = \text{Log}^{-1}7.869$

$(I_{internal}/1x10^{-12})=7.40x10^{7}$

$I_{internal}= 7.40x10^{-5}$

Total intensities, I_{Total}

$= 1.89x10^{-5} + 7.40x10^{-5}$

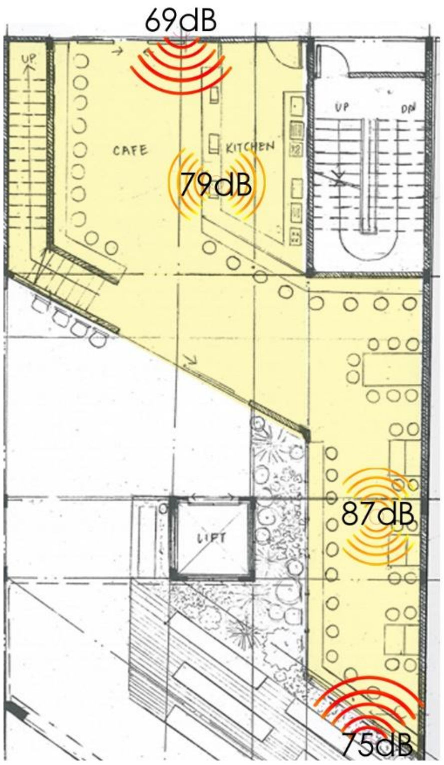
$=$**$9.29 \text{ x } 10^{-5}$**

SPL=10 log (I_{total}/I_o)

$= 10 \log (9.29 \text{ x } 10^{-5}/1x10^{-12})$

= **79.68dB**

1.1.2.2: Peak hour (12pm) combined SPL



(i) External noise sources:

Back Alley: 69dB

Sound penetrate from main road: 75 dB

Combined SPL for external noise sources:

$69 = 10 \log (I_{backalley}/I_o)$

$\text{Log} (I_{backalley}/1\text{x}10^{-12}) = 6.9$

$\text{Log}^{-1}\text{Log} (I_{backalley}/1\text{x}10^{-12}) = \text{Log}^{-1}6.9$

$(I_{backalley}/1\text{x}10^{-12})=7.94\text{x}10^{6}$

$\mathbf{I_{backalley}= 7.94x10^{-6}}$

$75 = 10 \log (I_{mainroad}/I_o)$

$\text{Log} (I_{mainroad}/1\text{x}10^{-12}) = 7.5$

$\text{Log}^{-1}\text{Log} (I_{mainroad}/1\text{x}10^{-12}) = \text{Log}^{-1}7.5$

$(I_{mainroad}/1\text{x}10^{-12})=3.16\text{x}10^{7}$

$\mathbf{I_{mainroad}= 3.16x10^{-5}}$

Total intensities, I_{Total}

$= 7.94\text{x}10^{-6}+3.16\text{x}10^{-5}$

$= \mathbf{1.11 \times 10^{-4}}$

SPL=10 log (I_{total}/I_o)

$= 10 \log (1.11 \times 10^{-4}/1\text{x}10^{-12})$

= **80.45dB**

(ii) Internal noise sources:

Kitchen zone: 79dB

Dining zone: 87dB

Combined SPL for internal noise sources:

$79 = 10 \log (I_{kitchen}/I_o)$

$\text{Log} (I_{kitchen} /1\text{x}10^{-12}) = 7.9$

$\text{Log}^{-1}\text{Log} (I_{kitchen} /1\text{x}10^{-12}) = \text{Log}^{-1}7.9$

$(I_{kitchen} /1\text{x}10^{-12})=7.94\text{x}10^{7}$

$I_{kitchen} = \mathbf{7.94x10^{-5}}$

$87 = 10 \log (I_{dining}/I_o)$

$\text{Log} (I_{dining}/1\text{x}10^{-12}) = 8.7$

$\text{Log}^{-1}\text{Log} (I_{dining}/1\text{x}10^{-12}) = \text{Log}^{-1}8.7$

$(I_{dining}/1\text{x}10^{-12})=5.01\text{x}10^{8}$

$\mathbf{I_{dining}= 5.01x10^{-4}}$

Total intensities, I_{Total}

$= 7.94 \times 10^{-5} + 5.01 \times 10^{-4}$

$=5.81 \times 10^{-4}$

SPL=10 log (I_{total}/I_o)

$= 10 \log (5.81 \times 10^{-4}/1\text{x}10^{-12})$

= **87.64dB**

Combined SPL for ground floor café at peak hour:

$80.45 = 10 \log (I_{extermal}/I_o)$

$\text{Log} (I_{external} /1x10^{-12}) = 8.045$

$\text{Log}^{-1}\text{Log} (I_{external}/1x10^{-12}) = \text{Log}^{-1}8.045$

$(I_{external} /1x10^{-12})=1.11x10^{8}$

$I_{external} = 1.11x10^{-4}$

$87.64 = 10 \log (I_{internal}/I_o)$

$\text{Log} (I_{internal}/1x10^{-12}) = 8.764$

$\text{Log}^{-1}\text{Log} (I_{internal}/1x10^{-12}) = \text{Log}^{-1}8.764$

$(I_{internal}/1x10^{-12})=5.81x10^{8}$

$I_{internal}= 5.81x10^{-4}$

Total intensities, I_{Total}

$= 1.11x10^{-4} + 5.81x10^{-4}$

$=\mathbf{6.92 \times 10^{-4}}$

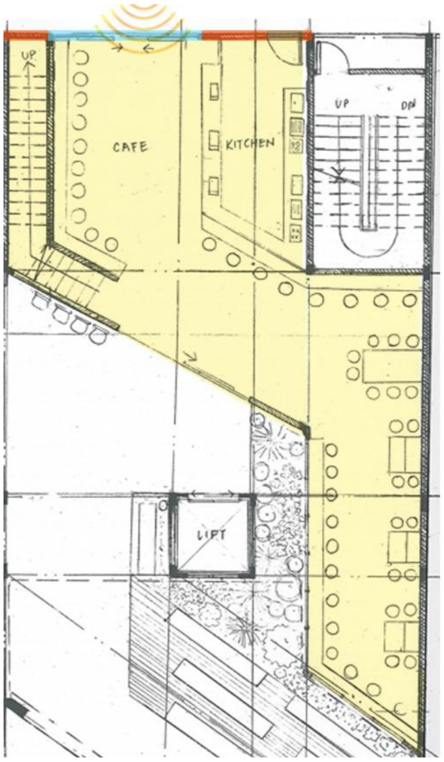
SPL=10 log (I_{total}/I_o)

$= 10 \log (6.92x\ 10^{-4}/1x10^{-12})$

= **88.40dB**

According to the calculations, the combined SPL of ground floor café is **79.68 dB** during **non-peak hour** and **88.4 dB** during **peak hour**. These sound levels had far more exceeded the recommended sound level for restaurant by ANSI which is **48-52dB.** This is due to the café is facing the busy street and also adjacent to the back alley and market. Implement **buffer zone with plants** to absorb noises shall reduce the noise level. Besides that, Indoor noises caused by the open kitchen had contributed significant amount of noises to the space too, hence **partition** should be installed.

1.1.3 SOUND TRANSMISSION LOSS CALCULATION



Wall type 1: Brick wall with insulation

SRI=10 log (1/T)

SRI_{brick}=45

45 = 10 log (1/T_{brick})

Log^{-1}4.5=(1/T_{brick})

T_{brick} =3.16x10^{-5}

Wall type 2: Glass Panels/ Doors

SRI=10 log (1/T)

SRI_{glass}=26

26 = 10 log (1/T_{glass})

Log^{-1}2.6 =(1/T_{glass})

T_{glass} =2.51x10^{-3}

Wall type 3: Plywood door

SRI=10 log (1/T)

$SRI_{plywood}$=28

28 = 10 log (1/$T_{plywood}$)

Log^{-1}2.8 =(1/$T_{plywood}$)

$T_{plywood}$=1.58x10^{-3}

Surface Material	Surface Area (m2) [S]	Transmission coefficient [Tcn]	Surface area x Transmission coefficient [ST]
Glass Panels/Doors	13.3	2.51x10^{-3}	3.34x10^{-2}
Brick Wall	19.34	3.16x10^{-5}	6.11x10^{-4}
Plywood Door	1.8	1.58x10^{-3}	2.84x10^{-3}
Total	**34.44**		**0.036851**

Table 1.1.3.1: STC calculation table

Average Transmission loss, T_{av} = (0.036851/34.44)

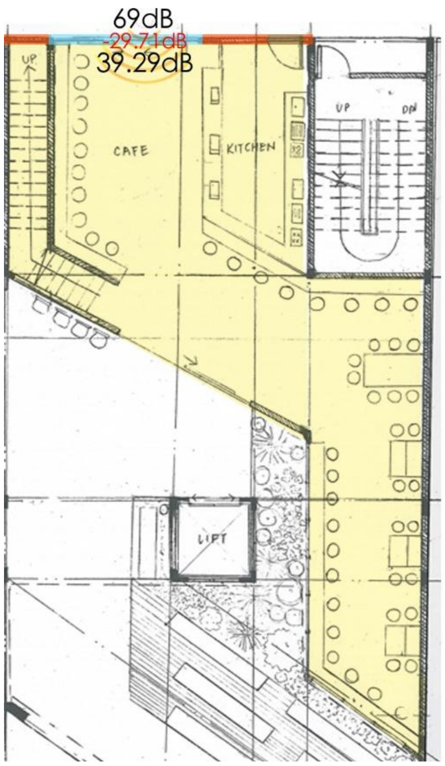
= 1.07x10^{-3}

$SRI_{overall}$ = 10 log (1/T_{av})

= 10 log(1/1.07x10^{-3})

=29.71dB

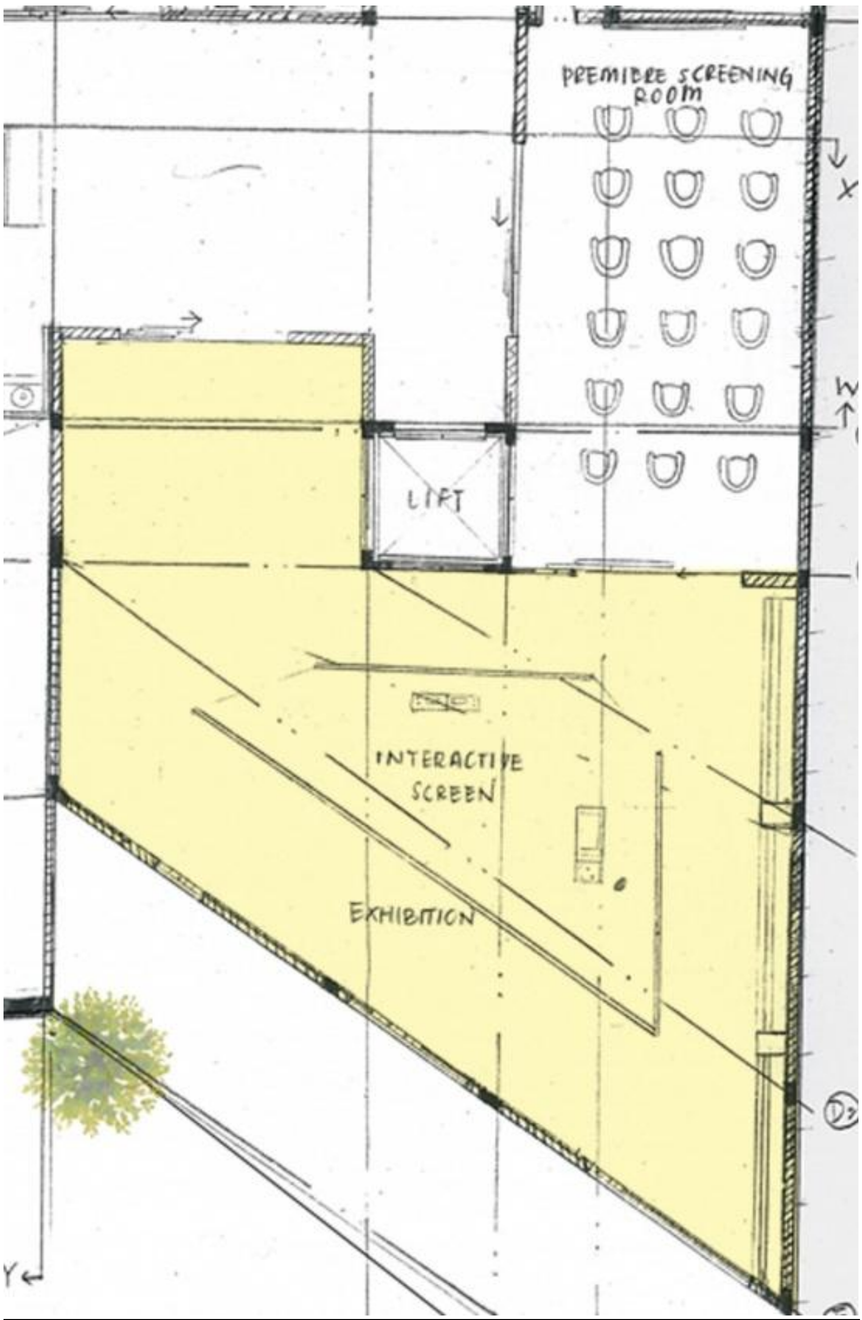
As shown in calculations above, **29.71dB** of noise level can be reduce during transmission from back alley to the interior of ground floor café.



Therefore, the exterior noise at back alley (69dB) during peak hour, is reduced by 29.71dB during transmission, resulting in a sound level of 39.29dB when it reaches the interior of café.

39.29dB is within the range of recommend level for restaurant. Hence, acoustical comfort can be achieved by having walls as external sound barriers.

1.2 EXHIBITION HALL



The exhibition hall located at second floor. It is double volume in height and is adjacent to a screening room. Due to there are an interactive exhibition area, it might generate significant amount of noise. Therefore, reverberation time and sound transmission lost are calculate to examine the acoustical comfort of the space.

1.2.1 REVERBERATION TIME CALCULATION

Room height: **7.4m**

Optimum reverberation time for motion exhibition hall: **1.0-1.6s** (similar to auditorium as there is visual/audio-based kind of exhibition)

Assume that,

Peak hour: 30 people

Non-peak hour: 15 people

Volume of motion exhibition hall:

[(3.5 + 10.8) x 11.3/2 + (3.5 x 4.8)] x 7.4 = **722.203 m³**

Material	**Function**	**Area [A] (m2)**	**Absorption Coefficient in 2000 Hz [S]**	**Sound Absorption [SA]**
Plaster	Ceiling	97.6	0.04	3.90
Brick	Wall	188.82	0.05	9.44
Steel	Column	24.42	0.01	0.24
Glass Brick	Wall	67.34	0.07	4.71
Glass	Panel	24.42	0.07	1.71
	Door	28	0.07	1.96
Timber	Panel	105	0.1	10.50
	Furniture (Table)	4.8	0.1	0.48
Fabric	Carpet	97.6	0.7	68.32
Total sound absorption by materials				**101.27**

Time	**Number of People**	**Absorption Coefficient in 2000 Hz [S]**	**Sound Absorption [SA]**
Peak hour	30	0.5	15.00
Non-Peak hour	15	0.5	7.50

Table 1.1.2.1: Material Absorption Coefficient at 2000 Hz

According to table 1.1.2.1, the total sound absorption at 2000 Hz during peak hour and non-peak hour are **116.27** and **108.77** respectively.

Reverberation time [Peak hour]

RT = 0.16xV / A

= 0.16 x 722.203 / 116.27

= **1.0s**

Reverberation time [Non-Peak hour]

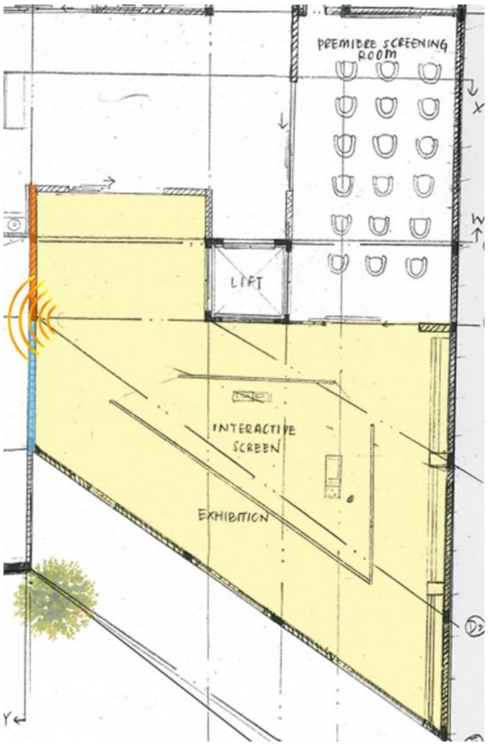
RT = 0.16xV / A

= 0.16 x 722.203 / 108.77

= **1.06s**

The reverberation time for motion exhibition hall during peak hour is **1.0s** and for non-peak hour it is **1.06s.** According to Acoustic Standard ANSI (2008), the reverberation time of exhibition hall **achieved** the optimum reverberation time for exhibition hall which is **1.0-1.6s.** The exhibition hall has carpeted floor which can absorb most noise and create an optimum environment for users.

1.2.2 SOUND TRANSMISSION LOSS CALCULATION



Wall type 1: Painted Brick Wall

SRI=10 log (1/T)

SRI_{brick}=46

46 = 10 log (1/T_{brick})

Log^{-1}4.6=(1/T_{brick})

T_{brick} =2.51x10^{-5}

Wall type 2: Glass Bricks

SRI=10 log (1/T)

SRI_{glass}=26

26 = 10 log (1/T_{glass})

Log^{-1}2.6 =(1/T_{glass})

T_{glass} =2.51x10^{-3}

Surface Material	Surface Area (m2) [S]	Transmission coefficient [Tcn]	Surface area x Transmission coefficient [ST]
Glass Bricks	24.42	2.51x10^{-3}	6.13x10^{-2}
Painted Brick Wall	25.9	3.16x10^{-5}	8.18x10^{-4}
Total	**50.32**		**0.062118**

Table 1.2.2.1: STC calculation table

Average Transmission loss, T_{av} = (0.062118/50.32)

= 1.23x10^{-3}

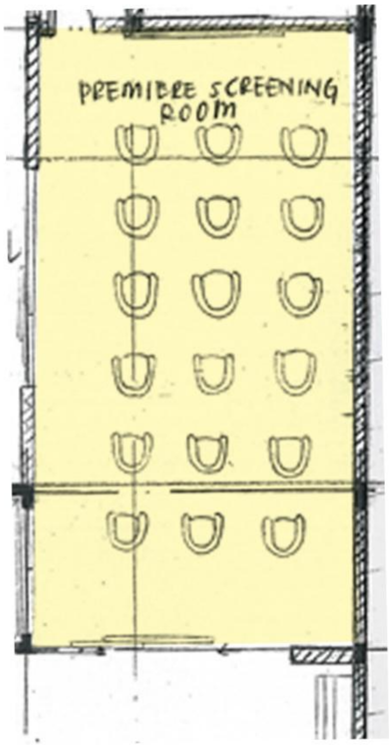
$SRI_{overall}$ = 10 log (1/T_{av})

= 10 log(1/1.23x10^{-3})

=29.1dB

As shown in calculations above, **29.1dB** of noise level can be reduce during transmission from interior of exhibition hall to the other spaces.

1.3 PREMIERE SCREENING ROOM



The premiere screening room located right beside the motion exhibition hall. It is a continuous block from the exhibition hall hence it is in double volume too. To ensure optimum screening experience, the control of reverberation time is very important as well as sound transmission class. The control of STC is to ensure the sound from premiere screening room wouldn't affect the acoustical comfort of exhibition hall.

1.3.1 REVERBERATION TIME CALCULATION

Room height: **7.4m**

Optimum reverberation time for premiere screening room: **1.0-1.6s**

Assume that,

Peak hour: 18 people

Non-peak hour: 5 people

Volume of premiere screening room:

4.5 x 8 x 7.4 = **266.4 m^3**

Material	Function	Area [A] (m2)	Absorption Coefficient in 2000 Hz [S]	Sound Absorption [SA]
Plaster	Ceiling	36	0.04	1.44
Brick	Wall	115.11	0.05	5.76
Glass	Panel	11.84	0.07	0.83
	Door	22.05	0.07	1.54
Fabric	Carpet	36	0.7	25.20
	Cushioned Chair	3.53	0.7	2.47
Total sound absorption by materials				**37.24**

Time	Number of People	Absorption Coefficient in 2000 Hz [S]	Sound Absorption [SA]
Peak hour	18	0.5	9.00
Non-Peak hour	5	0.5	2.50

Table 1.1.3.1: Material Absorption Coefficient at 2000 Hz

According to table 1.1.3.1, the total sound absorption at 2000 Hz during peak hour and non-peak hour are **46.24** and **39.74** respectively.

Reverberation time [Peak hour]

RT = 0.16xV / A

= 0.16 x 266.4 / 46.24

= **0.92s**

Reverberation time [Non-Peak hour]

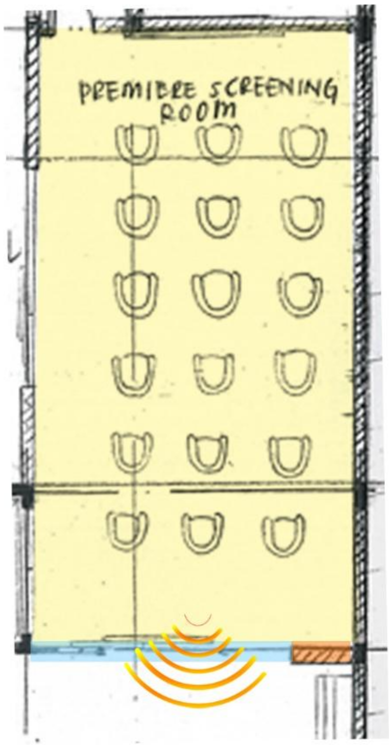
RT = 0.16xV / A

= 0.16 x 266.4 / 39.74

= **1.07s**

The reverberation time for motion premiere screening room during peak hour is **0.92** and for non-peak hour it is **1.07s.** According to Acoustic Standard ANSI (2008), the reverberation time of premiere screening room during non-peak hour **achieved** the optimum reverberation time for auditoriums which is **1.0-1.6s.** The premiere screening room has carpeted floor which can absorb most noise and create an optimum environment for users. However, the reverberation time of premiere screening room during peak hour, **0.92s** is **slightly falls out** from the optimum reverberation time. To enhance the acoustical experience of users while watching movie, **acoustical reflector panel** can be installed to **lengthen the reverberation time.**

1.3.2 SOUND TRANSMISSION LOSS CALCULATION



Wall type 1: Painted Brick Wall

SRI=10 log (1/T)

SRI_{brick}=46

46 = 10 log ($1/T_{brick}$)

$Log^{-1}4.6=(1/T_{brick})$

$T_{brick}=2.51\times10^{-5}$

Wall type 2: Glass Panels

SRI=10 log (1/T)

SRI_{glass}=26

26 = 10 log ($1/T_{glass}$)

$Log^{-1}2.6=(1/T_{glass})$

$T_{glass}=2.51\times10^{-3}$

Surface Material	Surface Area (m2) [S]	Transmission coefficient [Tcn]	Surface area x Transmission coefficient [ST]
Glass Panel	13.65	2.51×10^{-3}	3.43×10^{-2}
Painted Brick Wall	19.65	3.16×10^{-5}	6.21×10^{-4}
Total	**33.3**		**0.034921**

Table 1.3.2.1: STC calculation table

Average Transmission loss, T_{av} = (0.034921/33.3)

= 1.05×10^{-3}

$SRI_{overall}$ = 10 log ($1/T_{av}$)

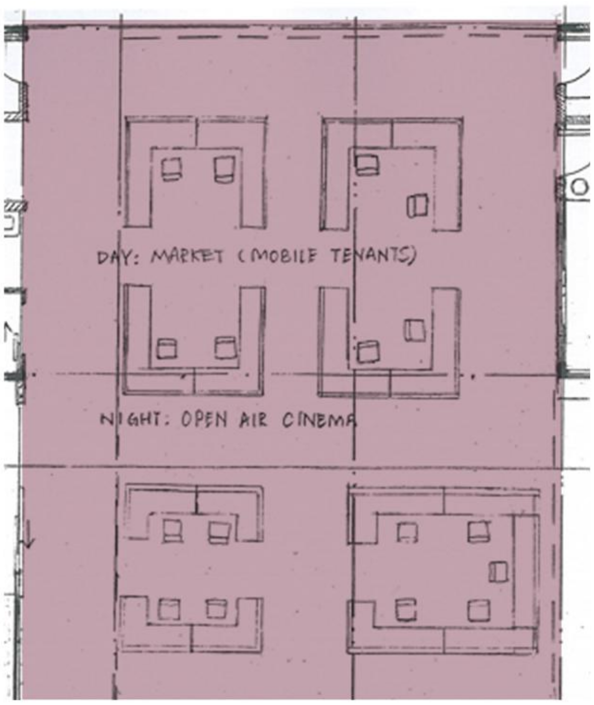
= 10 log($1/1.05\times10^{-3}$)

=29.79dB

As shown in calculations above, **29.79dB** of noise level can be reduce during transmission from premiere screening room to exhibition spaces. According to hearing perception table, the following STC values allow loud speech to be heard, hence **sound attenuator** or **insulation** needed to be install to enhance the soundproof quality.

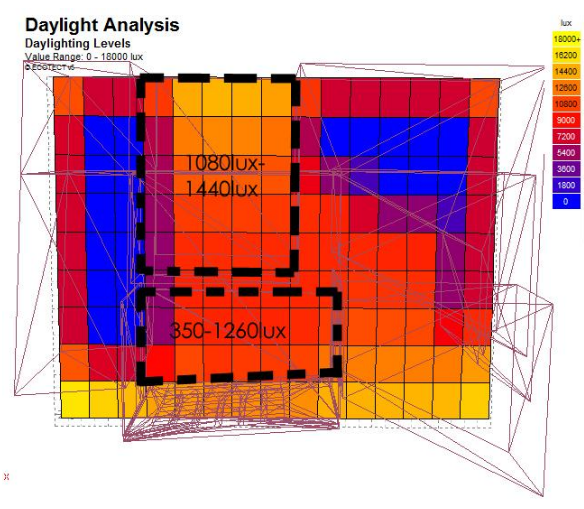
2.0 LIGHTING CALCULATIONS

2.1 MARKET AREA



The ground floor spaces are cleared for market space, and is open to the back alley. Therefore abundance of daylight are allowed to enter the space.

2.1.1 DAYLIGHTING FACTOR



DF = (E_i/E_o) x 100%

Average value of market area = 1260lux

DF= (1260/20000) x 100%

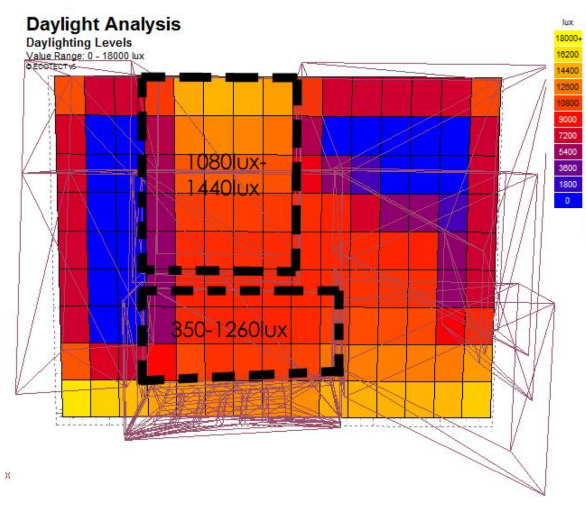
= **6.3%**

According to MS1525, average daylight factor of 5% gives the impression of generous day lighting. However, market area with the daylight factor of **6.3%** had potential to cause thermal and glare problem, thus, **proper shading** such as **retractable roof** is recommended to avoid thermal and glare problem

2.2 READING LOUNGE

The reading lounge located at first floor is right beside the east-facing windows and it has double volume hence receive great amount of sunlight during day time.

2.2.1 DAYLIGHT FACTOR



DF = (E_i/E_o) x 100%

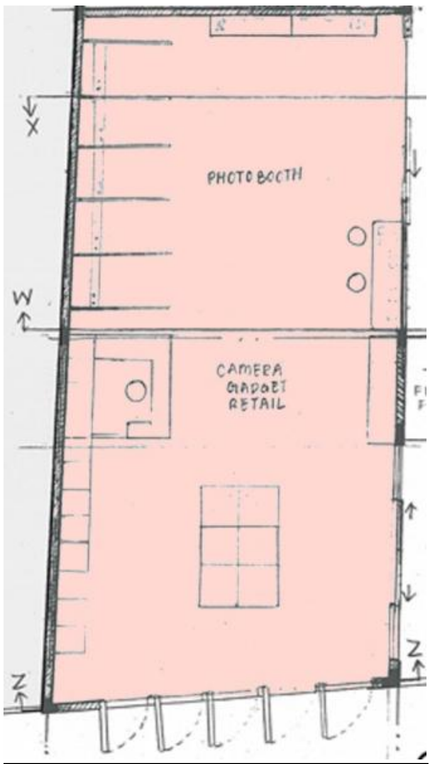
Average value of market area = 805lux

DF= (805/20000) x 100%

= **4.025%**

According to MS1525, average daylight factor of 5% gives the impression of generous day lighting. Reading lounge with the daylight factor of **4.025%** provides a natural lit space with cause no glare and thermal problem to users.

2.3 CAMERA GADGET RETAIL



The camera gadget retail located at ground floor runs business from day to night time. Although natural light can be acquired but it is insufficient, hence artificial light is vital for the space.

MATERIAL	FUNCTION	COLOUR	AREA (m²)	SURFACE TYPE	REFLECTANCE VALUE (%)
Concrete Finish	Ceiling	Grey	84.5	Reflective	15-40
Brick	Wall	Brown	106.61	Absorptive	30
Glass	Panel	Transparent	43.4	Reflective	6-10
	Window	Transparent	6.65	Reflective	6-10
Anodised Aluminium	Door and window frame	Black		Reflective	75-95
Concrete Cement Finish	Floor	Grey	84.5	Reflective	15-40
Fabric	Chair	Beige	2.36	Absorptive	25-35
Timber	Furniture (Shelf)	Brown	14.75	Absorptive	30
	Furniture(Table)	Brown	9	Absorptive	30
	Partition	Brown	19.2	Absorptive	30

Table 2.3.1: Material properties table

2.3.1 Lumen Method Calculation (from 1.5m height)

Location	Camera Gadget Retail (Ground Floor)
Dimension of Room, LxW	13.0 x 6.5
Total Floor Area (m^2)	84.5
Mounting Height , h_m (m)	4.0-0.5–1.5 = 2
Room Index, K	K $= \frac{L \, x \, W}{(L+W)hm}$ $= \frac{13.0 \, x \, 6.5}{(13.0+6.5) \, x \, 2.0}$ = 2.167
Room Reflectance (%)	C:50, W:30, F:30
Utilisation Factor (UF)	0.45
Maintenance Factor (MF)	0.75
Standard Illuminance Level Required (lux)	300
Number of Fittings Required, N	N$= \frac{E \, x \, A}{F \, x \, UF \, x \, MF}$ $= \frac{300 \, x \, 84.5}{(1300x2) x \, 0.45 \, x \, 0.75}$ = 28.88 ≈ 29 29 LED floodlight are needed to meet the standard illuminance required in Camera Gadget Retail according to MS 1525, standard illuminance for retail.

Types of Light

Type	Specifications	Quantity	Luminous Flux(lm)
Power Reflector R30 LED Floodlight Bulb 	Wattage: 26W Colour Temperature: 2700K Bulb Finish: Warm White	29	1300 lm per lamp 2600 lm per grid lighting

Assume SHR ratio is 1:1, H_m = 2m, therefore maximum spacing =2m

Width/Maximum Spacing = 6.5/2

= 3.25 ≈4 rows of lamps

29/4= 7.25 ≈ 8 lamps each row

Therefore, total 32 luminaires needed.

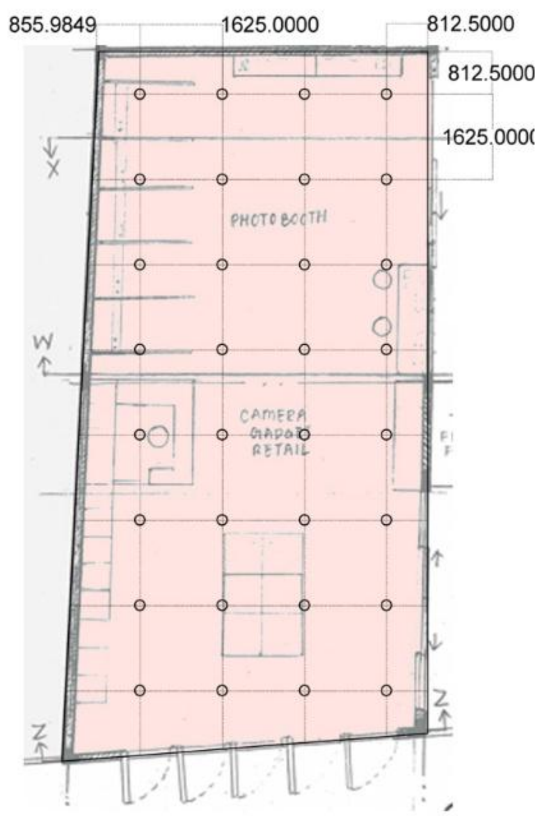
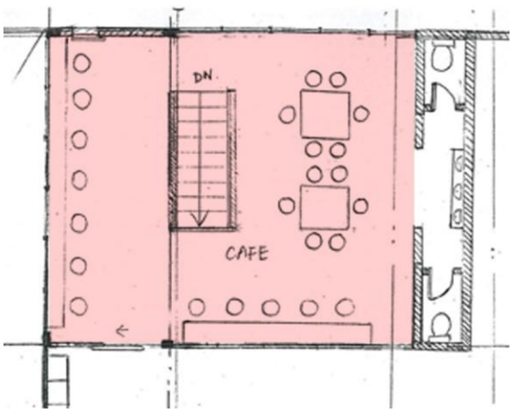


Diagram 2.3.1.1: Reflected ceiling plan

To achieve uniformity, 32 luminaires are needed.

2.4 FIRST FLOOR CAFÉ



The café at first floor, although received daylight but it is not sufficient as most of the part is shaded. Therefore, artificial lightings have to be installed.

MATERIAL	FUNCTION	COLOUR	AREA (m²)	SURFACE TYPE	REFLECTANCE VALUE (%)
Concrete Finish	Ceiling	Grey	47.25	Reflective	15-40
Brick	Wall	Brown	49	Absorptive	30
Glass	Panel	Transparent	56.7	Reflective	6-10
	Door and window frame	Transparent	8.75	Reflective	6-10
Anodised Aluminium	Door and window frame	Black		Reflective	75-95
Concrete Cement Finish	Floor	Grey	47.25	Reflective	15-40
Fabric	Chair	Beige	4.71	Absorptive	25-35
Timber	Furniture(Table)	Brown	5.64	Absorptive	30

Table 2.4.1: Material properties table

2.4.1 Lumen Method Calculation (from 1.5m height)

Location	Cafe (First Floor)
Dimension of Room, LxW	7.5 x 6.3
Total Floor Area (m^2)	47.25
Mounting Height , h_m (m)	4.2-1.5-0.4-0.3= 2
Room Index, K	$K = \frac{L \times W}{(L+W)hm}$ $= \frac{7.5 \times 6.3}{(7.5+6.3) \times 2.0}$ = 1.71
Room Reflectance (%)	C:50, W:30, F:30
Utilisation Factor (UF)	0.40
Maintenance Factor (MF)	0.75
Standard Illuminance Level Required (lux)	200
Number of Fittings Required, N	$N = \frac{E \times A}{F \times UF \times MF}$ $= \frac{200x47.25}{(670x4)x\ 0.40\ x\ 0.75}$ = 11.75 ≈ 12 12 LED pendant light are needed to meet the standard illuminance required in first floor cafe according to MS 1525, standard illuminance for self service restaurant.

Types of Light

Type	Specifications	Quantity	Luminous Flux(lm)
PHILIPS CYPRESS 4 LIGHT LED BAR CEILING PENDANT LIGHT – CHROME 	Wattage: 3W Colour Temperature: 2700K Bulb Finish: Warm White	12	670 lm per lamp 2680 lm per grid lighting

Assume SHR ratio is 1:1, H_m = 2m, therefore maximum spacing =2m

Width/Maximum Spacing = 6.3/2

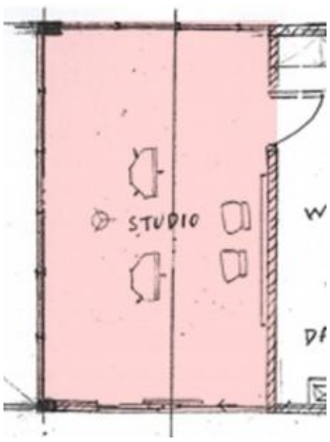
= 3.15 ≈4 rows of lamps

12/4= 3 lamps each row

Therefore, total 12 lamps needed.

Diagram 2.4.1.1: Reflected ceiling plan

2.5 STUDIO/WORKSHOP SPACE



The photography studio at second floor runs large visual task therefore having adequate lighting is very important. It also serve as work shop space occasionally.

MATERIAL	FUNCTION	COLOUR	AREA (m²)	SURFACE TYPE	REFLECTANCE VALUE (%)
Concrete Finish	Ceiling	Grey	23.94	Reflective	15-40
Brick	Wall	Brown	29.2	Absorptive	30
Glass	Panel	Transparent	39.6	Reflective	6-10
	Door	Transparent	11.2	Reflective	6-10
Anodised Aluminium	Door and window frame	Black		Reflective	75-95
Concrete Cement Finish	Floor	Grey	23.94	Reflective	15-40

Table 2.5.1: Material properties table

2.5.1 Lumen Method Calculation (from 1.5m height)

Location	Photography Studio/ Workshop (second floor)
Dimension of Room, LxW	3.8x 6.3
Total Floor Area (m^2)	23.94
Mounting Height , h_m (m)	4.0-0.5–1.5 = 2
Room Index, K	$K = \frac{L \times W}{(L+W)hm}$ $= \frac{3.8 \times 6.3}{(3.8+6.3) \times 2.0}$ = 1.185
Room Reflectance (%)	C:50, W:30, F:30
Utilisation Factor (UF)	0.36
Maintenance Factor (MF)	0.75
Standard Illuminance Level Required (lux)	500
Number of Fittings Required, N	$N = \frac{E \times A}{F \times UF \times MF}$ $= \frac{500 \times 23.94}{(1600x3) \times 0.36 \times 0.75}$ = 9.24 ≈ 10 10 Parabolic grid light are needed to meet the standard illuminance required in studio workspace according to MS 1525, standard illuminance for workspace.

Types of Light

Type	Specifications	Quantity	Luminous Flux(lm)
Parabolic T5 2X4 Grid Light Fixture 	Wattage: 32W Colour Temperature: 5000K Bulb Finish: Warm White	10	1600 lm per lamp 4800 lm per grid lighting

Assume SHR ratio is 1:1, H_m = 2m, therefore maximum spacing =2m

Width/Maximum Spacing = 3.8/2

= 1.9 ≈2 rows of lamps

10/2= 5 lamps each row

Therefore, total 10 lamps needed.

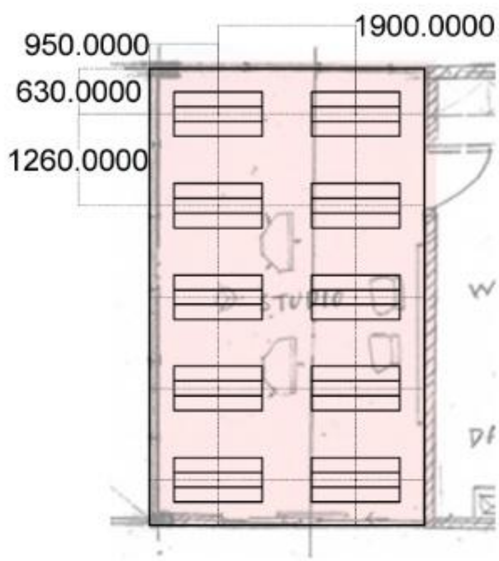


Diagram 2.5.1.1: Reflected ceiling plan