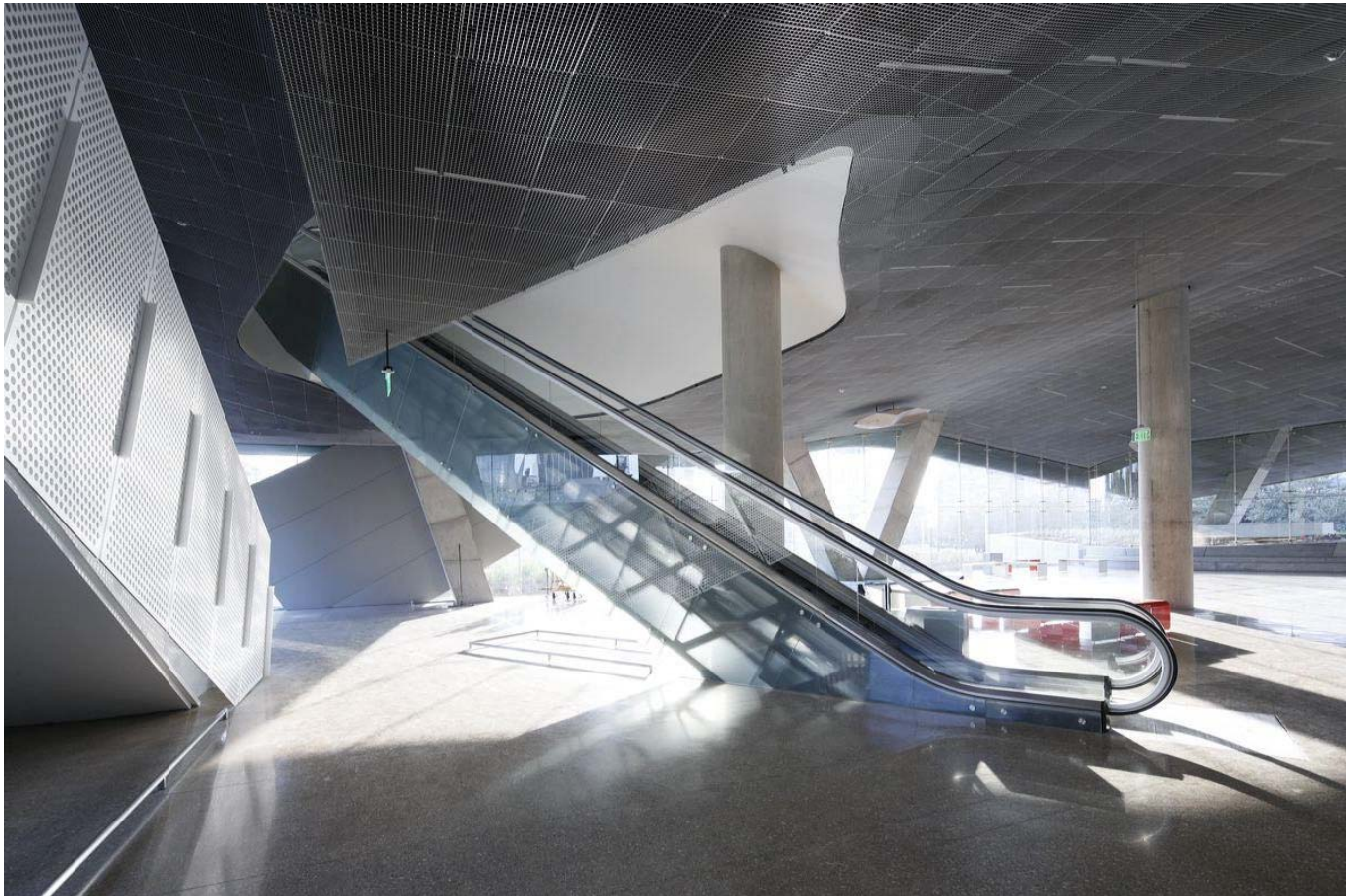


Dallas, TX

Perot Museum of Nature and Science



Tech Report 1, Part 2: Lighting Existing Conditions and Design Criteria

Yucheng Lu - Lighting | Electrical

Faculty Adviser: Dr. Kevin Houser

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Executive Summary

This report analyzed the existing lighting and spatial environment of the Perot Museum of Nature and Science, especially four major spaces including:

1. South Entrance
2. Main Lobby
3. Theater
4. Main Escalator Cartridge

Overall, the existing lighting design treated each space from a macroscopic perspective and dedicated to highlight the spatial integrity. Strategies such as creating even lighting distribution and arranging consistent lighting layout were applied to achieve this goal. In this project, a microscopic perspective will be adopted instead to highlight the asymmetrical side of each space, spending more effort on details with unique identity.

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South Entrance

Existing Condition



Image 1, South Entrance night time view

Description

Embraced by iconic concrete facades of the Cubical Tower and Landscape Plinth, South Entrance of Perot Museum of Nature and Science is offering visitors a visual feast prior to their entry. The primary task of this space is to enhance the visual identity of the museum especially at night time while minimum amount of light is also required on the ground surface for security consideration.

Space Dimension

South Façade:

Approximate Area = 19856 SF

Length = 146ft

Height = 136ft.

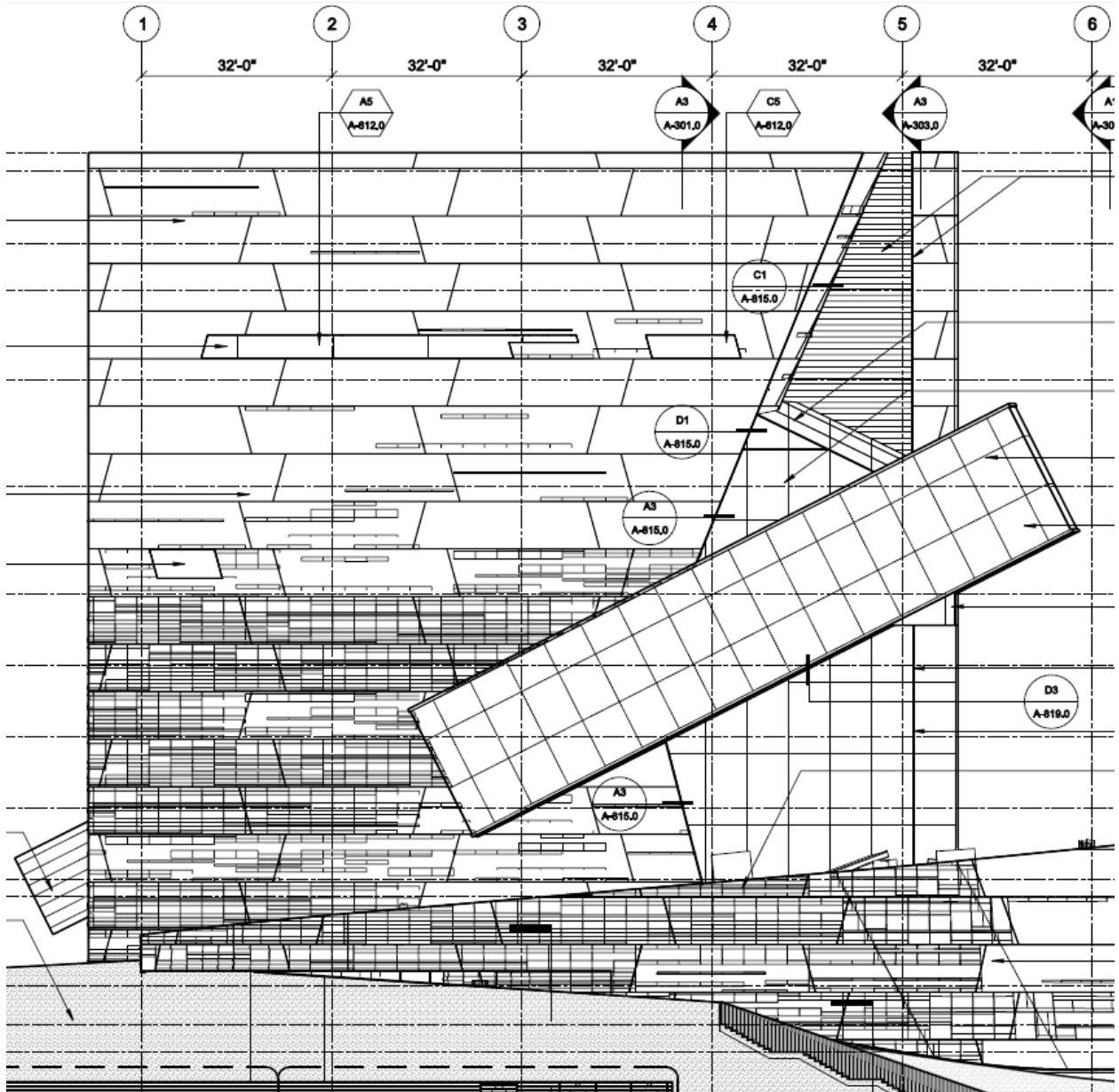


Figure 1, South Elevation - Museum Tower

Plinth Façade:

Approximate Area = 2163 SF

Length = 206ft

Height = 8ft - 13ft.

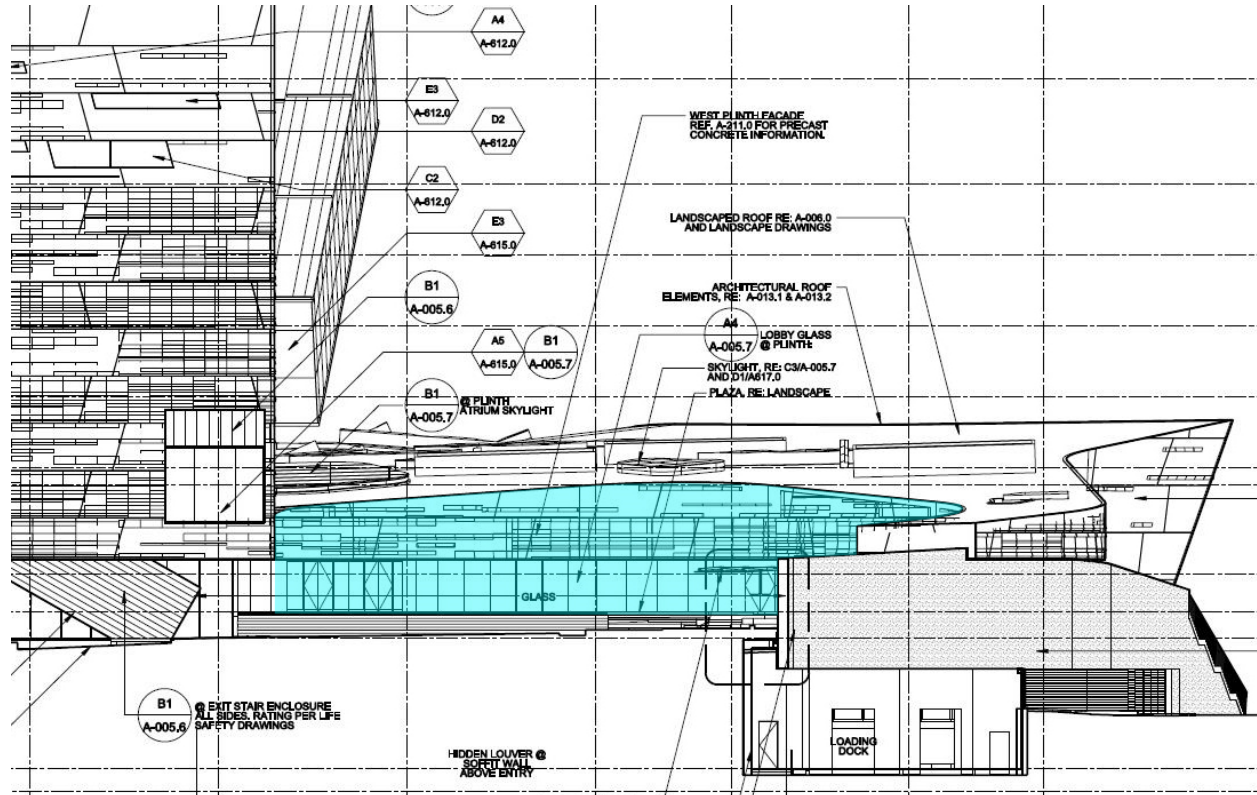


Figure 2, West Elevation – Plinth Façade

Entrance Plaza:

Approximate Area = 7517 SF

North to South Distance = 78ft to 116ft

East to West Distance = 59ft to 94ft

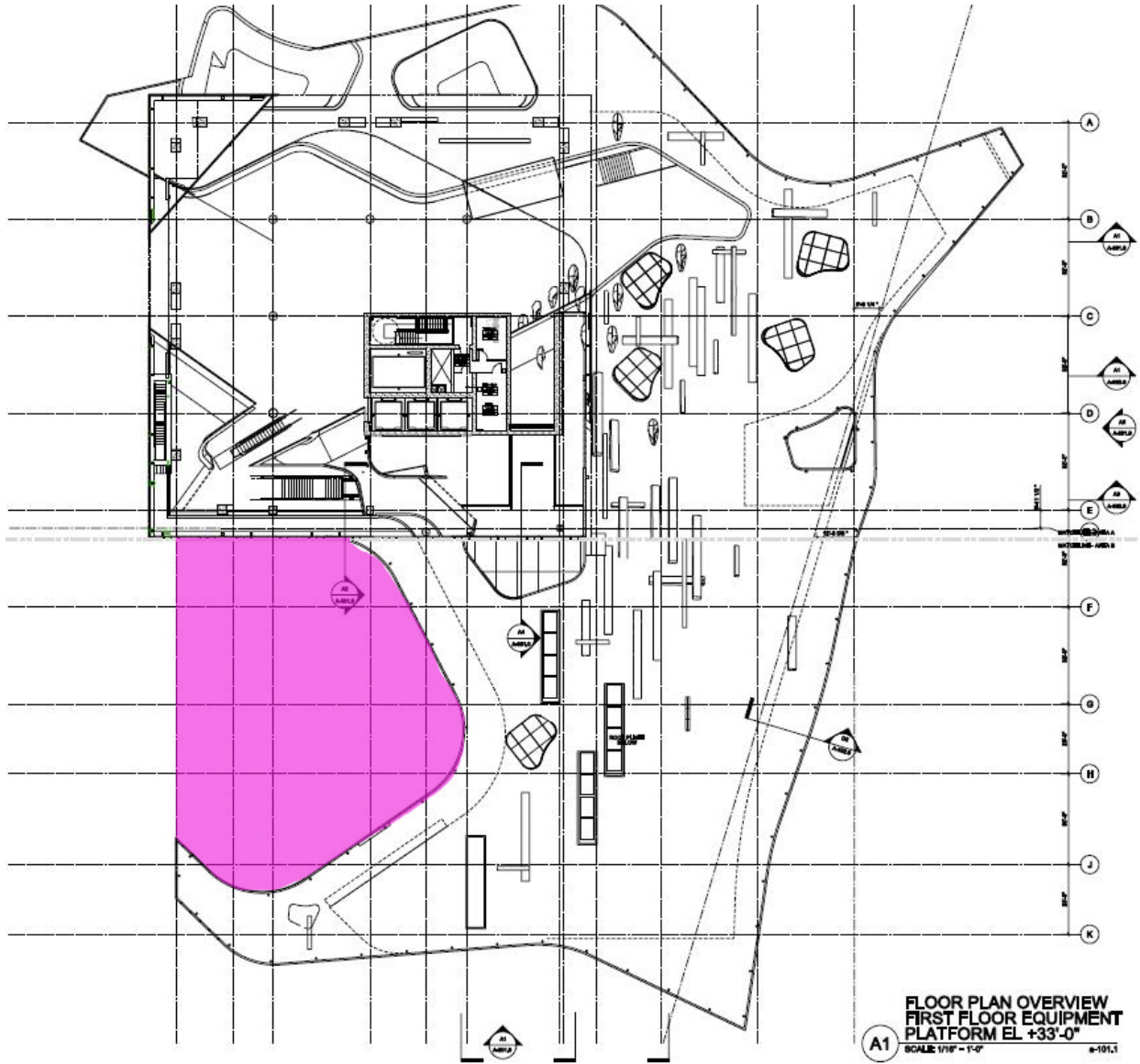


Figure 3, Ground Level Floor Plan – Entrance Plaza

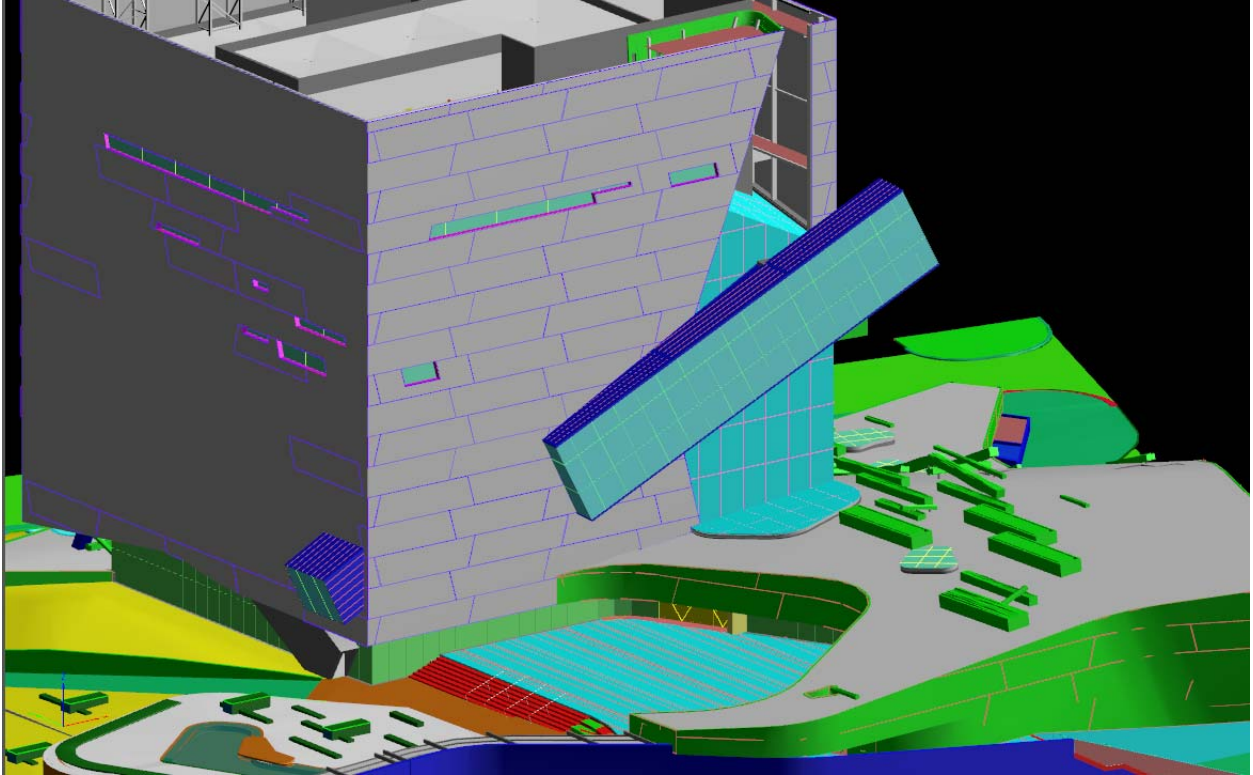


Figure 4, 3D View – Entrance Plaza

Material

	Description	Location	Color	Reflectance
Floor	Reinforced concrete	South Entrance	Grey	0.2
Wall	Precast concrete	South Façade	Grey	0.4

Glazing

Type	Location	Visual Transmittance	Exterior Reflectance
G1	Tower façade / Escalator cartridge	0.48	0.08
G3	Curtain wall at lobby level	0.65	0.07
G4	Skylight	0.47	0.08

Luminaire Schedule

Type	Lamp	Power Input	Description	Location
AL-31	T6 Metal Halide	150W / 277V	SILL 'PRO21' Exterior rated, adjustable, metal halide floodlight with narrow beam distribution, color and spread lens, integral electronic ballast.	Façade
AL-58	T5HO Fluorescent	54W / 277V	Linear Lighting Corp 'Stripe' Recessed linear fluorescent ceiling wash luminaire with flush lens, integral 120-277V universal voltage electronic ballast concealed within perimeter cove	Main Escalator



Figure 5, Ground Level Lighting Plan – South Tower Façade Lighting

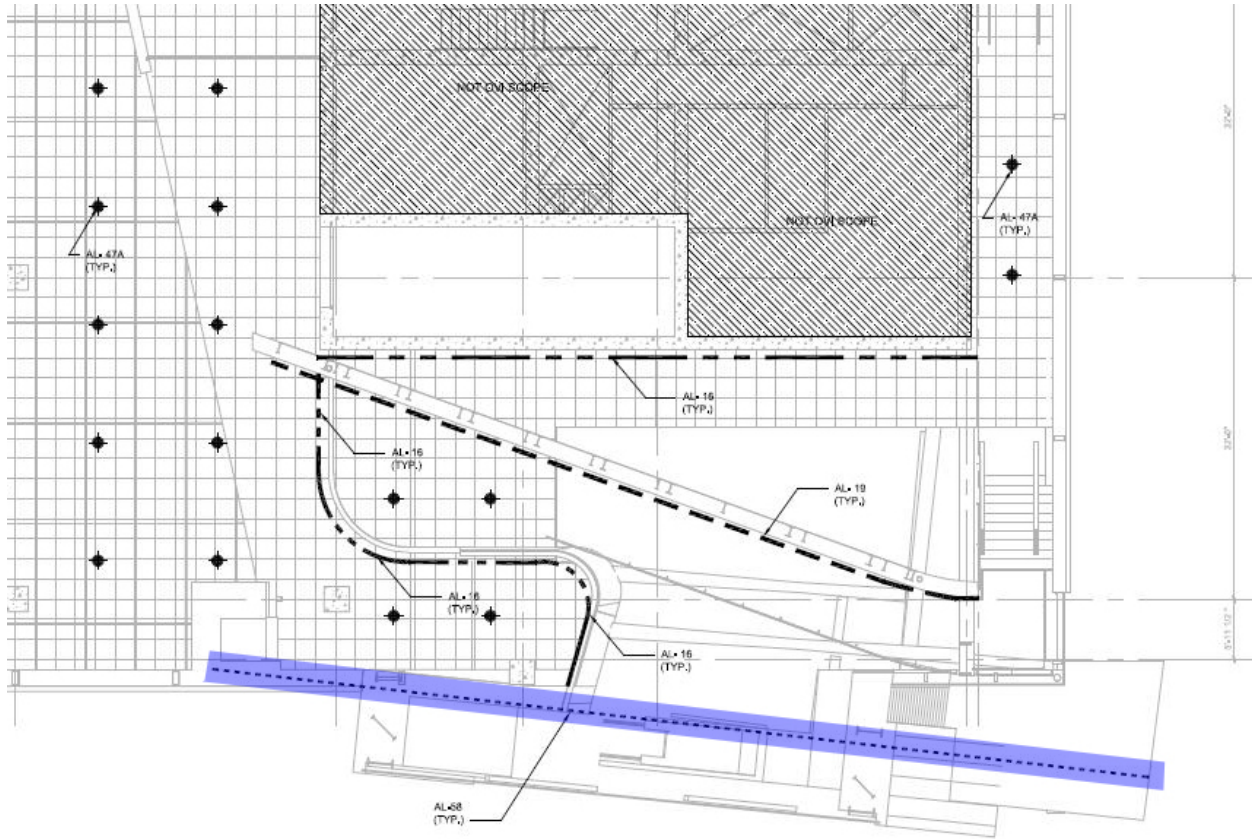


Figure 6, Level 3 Lighting Plan – Main Escalator Lighting

Design Criteria

Qualitative Criteria

In order to highlight the iconic texture on the façade concrete cladding, an obvious contrast of bright and dark should be created. Interior lighting came through the green glass should be the major light source used on grazing materials on the façade while exterior luminaire should focus on concrete portion. This approach allows a higher energy efficiency and minimized light trespass.

Considering that the façade is 170 feet tall, high output luminaire will possibly be used as the exterior luminaire. Intense beam generated from such luminaires will be extremely harmful for human eyes. Therefore, luminaires need to be carefully concealed to avoid any potential glare hazard. Light trespass should also be controlled Power consumption of these high output luminaires should be minimized by applying appropriate control strategy.

As a transportation space, color rendering is not a major concern. However, there should be enough light on the ground to guarantee visitor’s safety. Illuminance on the ground should gradually increase as visitor approaches the main gate, making light function as a navigation tool while also help visitor adjust to the brighter interior space.

Quantitative Criteria

Illuminance Recommendation (IES Lighting Handbook 10th Edition, P22.6):

Space Type	E _h	E _v	Avg : Min
Entries/Exits	10 lux @ floor	20 lux @ face	4 : 1

Light Loss Factor:

(LLD/BF: Adopted data from identical lamps on Orsam Sylvania Lamp and Ballast Catalogue
LDD: Assume 12 months cleaning interval, Clean for interior rating, Medium for outdoor rating)

Type	Lamp Lumen Depreciation	Luminaire Dirt Depreciation	Ballast Factor	Light Loss Factor
AL - 31	0.8	0.9	1	0.72
AL - 58	0.93	0.94	1	0.87

Energy Allowance (ASHRAE 90.1 version 2010, TABLE 9.4.3B at P81):

Space Type	Area	Power Density	Maximum Wattage
Entries/Exits	2163 SF	0.2 W/SF	4526 W

Design Evaluation



Image 2, South/East Façade

The existing lighting on South Façade uses high output Metal Halide floodlight located over 100 feet away from the façade. Long horizontal distance allows the beam to spread out and project on the façade evenly. From the image above we can see an obvious hotspot on the East Façade due to reduced distance between façade and luminaire. The contrast of warm white on the concrete surface and cool white from the interior resulted in a beautiful color combination.

One of the potential alternatives of façade lighting is to move flood light closer to the façade and create a scheme similar to wall grazing. Instead of overall uniformity the focus here is the iconic texture on the concrete cladding. Reduced mounting distance also eliminated the limit of site dimension, allowing a consistent scheme on all four façades.

Main Lobby

Existing Condition



Image 3, Main Lobby

Description

The Main Lobby can be divided into two sections located on South and North side of the museum tower. The South section is designed as a circulation space, from where visitors can travel to upper levels using escalators and elevators. For this project, the focus will be on the North section designed as an open exhibition area. The use of curtain wall not only increased the daylight gain but also made the space perimeter more flexible independent from the tower's structural system, allowing capsized curvatures being created as well as the integration of lobby floor and the end of landscape plinth. The primary task of this space is to host exhibition and events activities.

Space Dimension

Main Lobby:

Approximate Area = 5600 SF

North to South Distance = 80ft - 118ft

East to West Distance = 112ft

Ceiling Height = 20ft

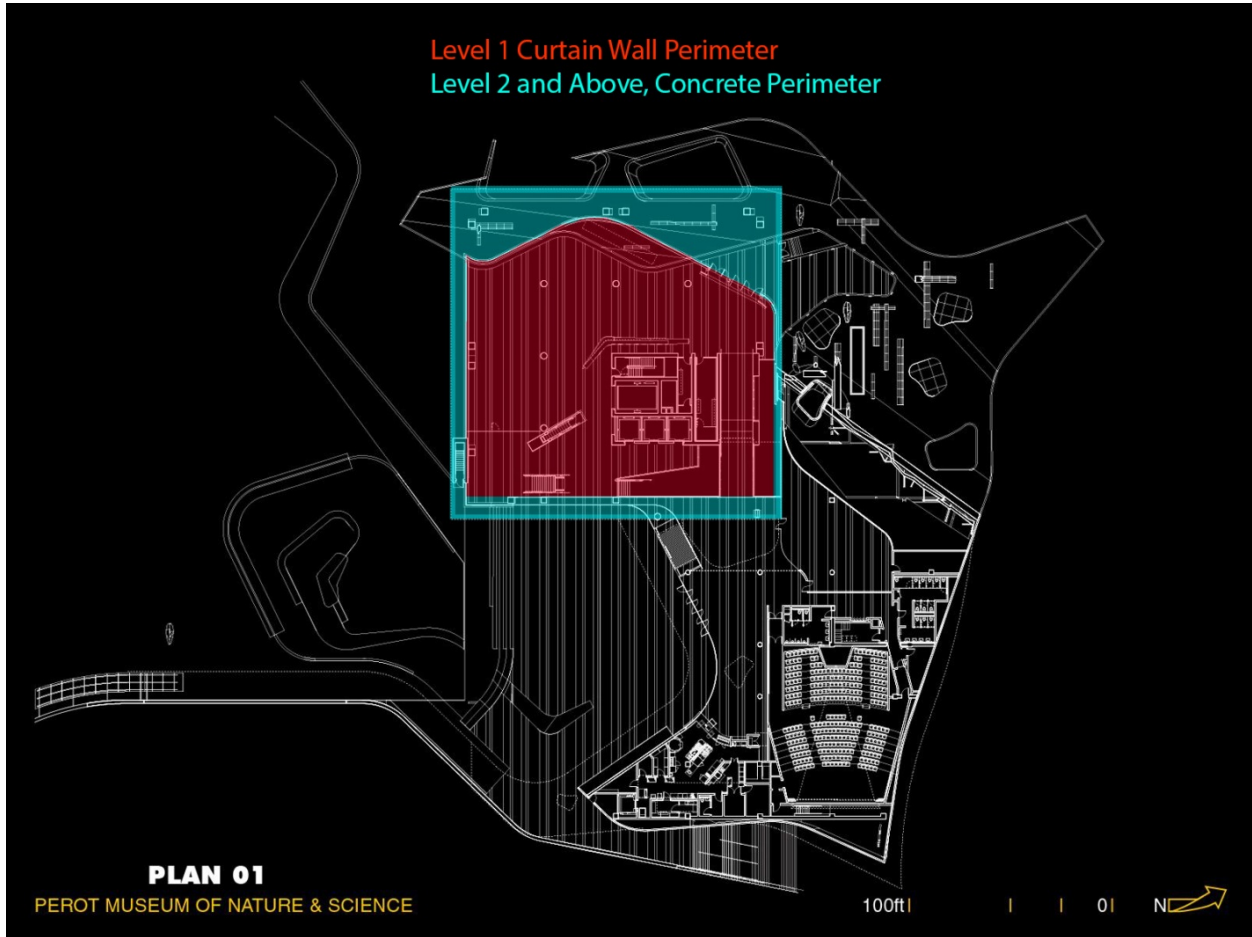


Figure 7, Ground Level Floor Plan - Building Perimeter Diagram

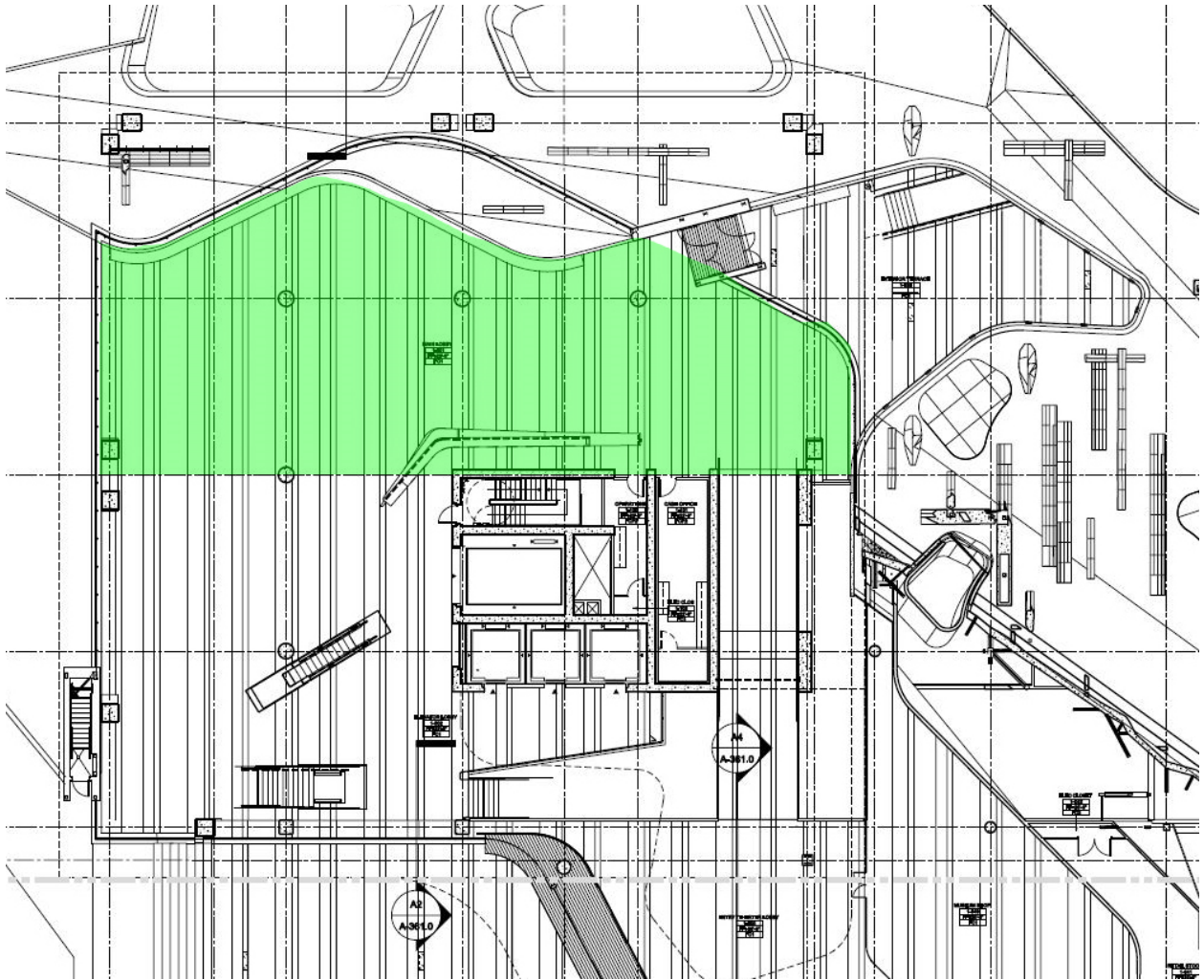


Figure 8, Ground Level Floor Plan – Main Lobby, North Section

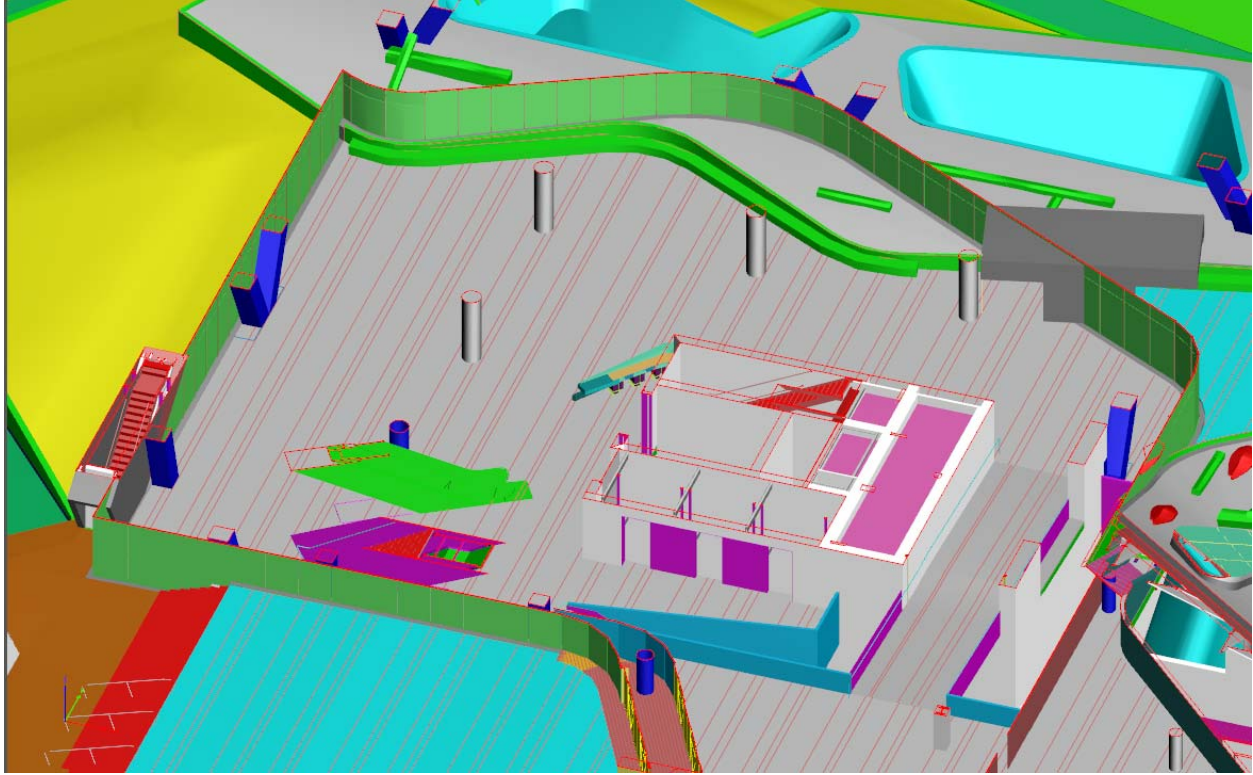


Figure 9, 3D View – Main Lobby Perspective View

Material

	Description	Location	Color	Reflectance
Floor	Masonry Tile	Main Lobby	Grey	0.25
	Rock	Landscape Plinth	Brown	0.15
Wall	Paint	Center Atrium	White	0.5
	Reinforced concrete	Lobby Column/Stair	Grey	0.4
Ceiling	Metal wire mesh panels	Main Lobby	Black	0.7 (50% Open)

Glazing

Type	Location	Visual Transmittance	Exterior Reflectance
G3	Curtain wall at lobby level	0.65	0.07

Luminaire Schedule

Type	Lamp	Power Input	Description	Location
AL-12	LED	4.32W / ft 24V DC 277V AC	Electrix 'L101' - Modified Interior rated, surface mounted linear low voltage, high output LED luminaire concealed within architectural cove. Provide remote 277/24V transformer.	Under Bench
AL-15	Compact Fluorescent	42W / 277V	Stonco Lighting 'Roughlyte' Exterior, wet location compact fluorescent luminaire with integral 277V ballast enclosed in pod shaped objects located indoors and outdoors by mOrphosis. Lighting control system required for pulsing/on/off effect.	Pods
AL-27	T5 Fluorescent	28W / 277V	Regent 'Tool T5 Baffle' Ceiling suspended linear fluorescent luminaire with miniature 2" aperture with integral electronic ballast and concealed above grey wire mesh ceiling detail by Architect. Mounting height above finish floor at 23'-6" max.	Main Lobby
AL-39	PAR 38 Halogen	90W / 120V	Lightolier 'Lytespan Track Lighting Alcyon' Track mounted halogen spotlight. For use in conjunction with Type AL-41 track.	Main Lobby
AL-41	N/A	N/A	Lightolier 'Prospec' Track 2-circuit track with narrow profile nominally 1-3/16" wide and concealed above metal mesh ceiling.	Main Lobby

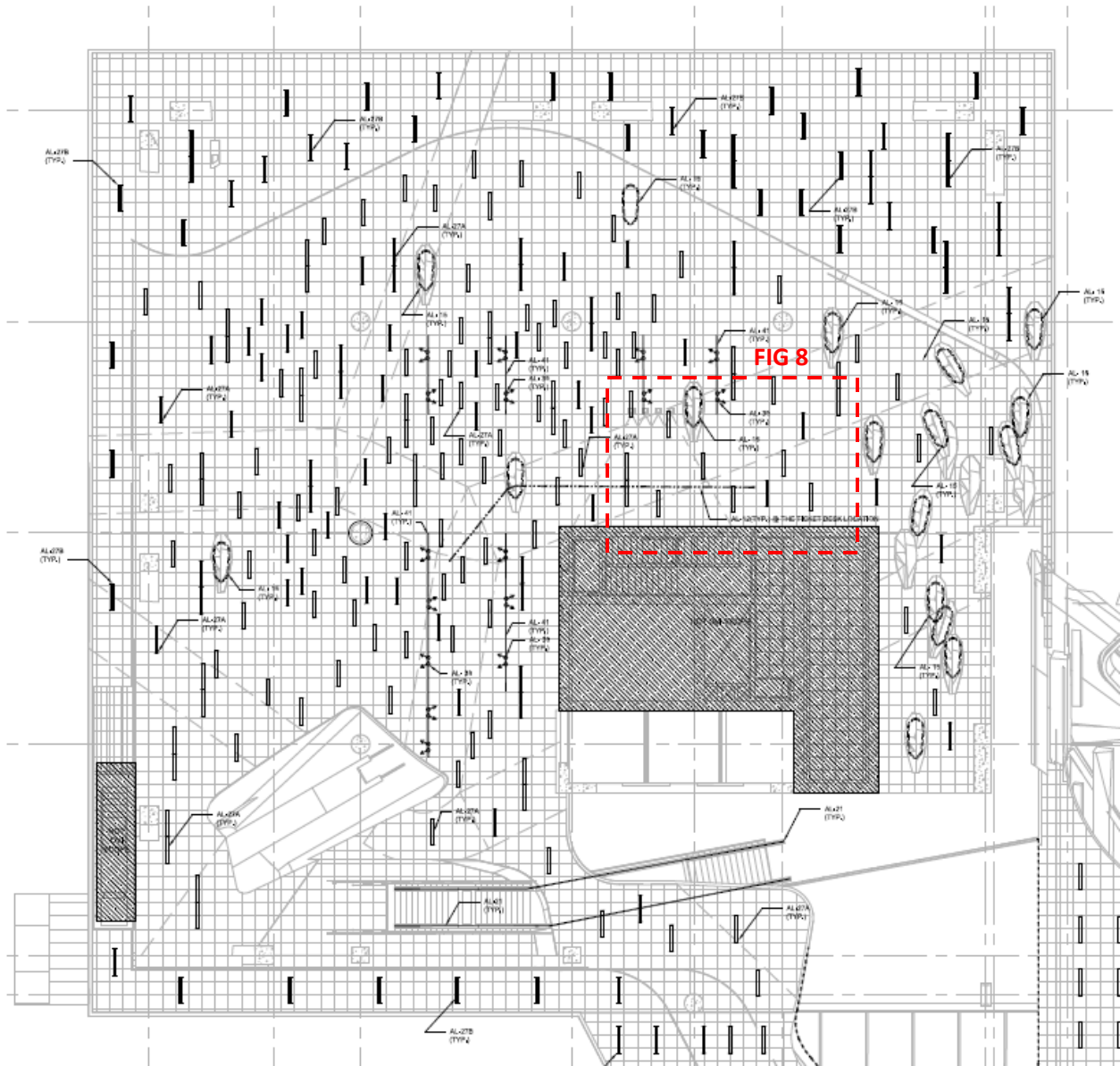


Figure 10, Ground Level Lighting Plan – Main Lobby

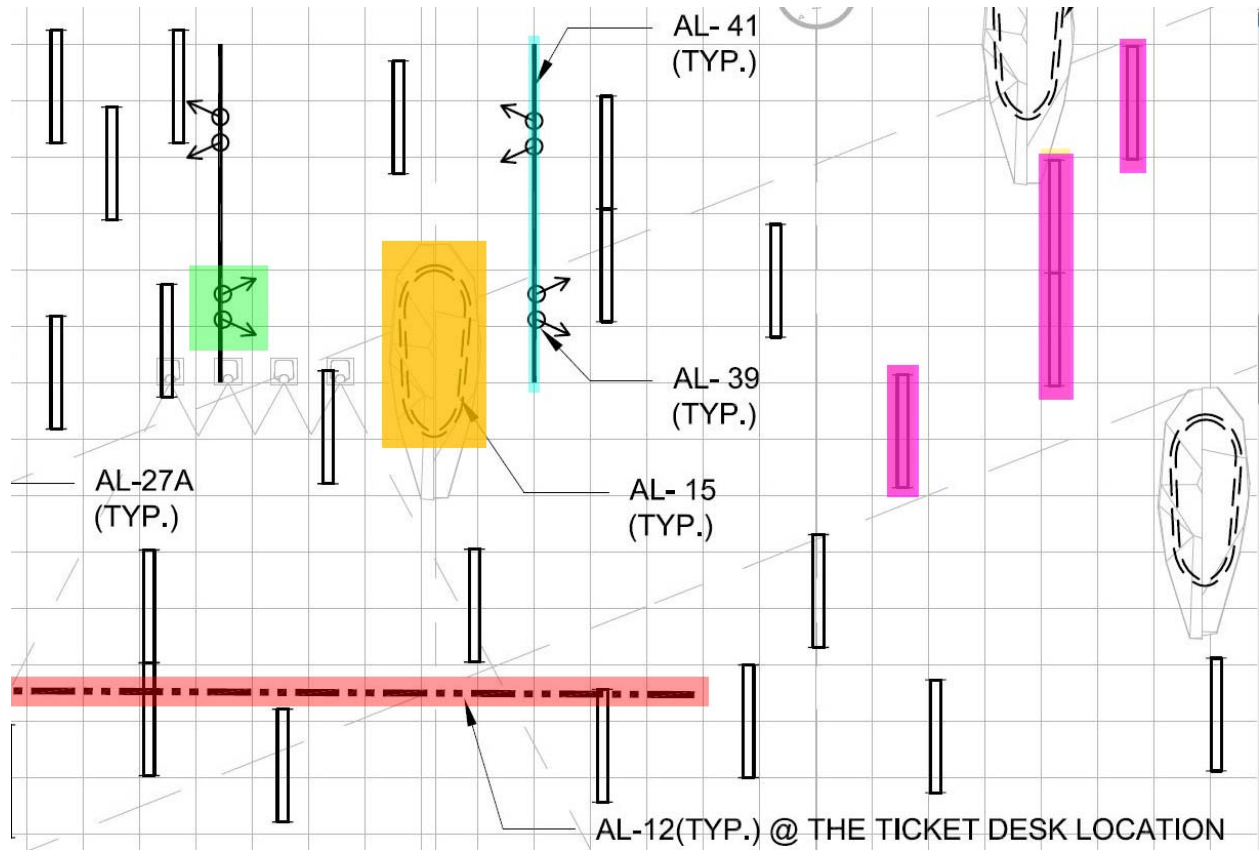


Figure 11, Ground Level Lighting Plan Call Out – Exhibition Area

Design Criteria

Qualitative Criteria

In order to express the vividness of exhibits, color rendering should be treated as a major design criterion. High uniformity in the general circulation area also avoids potential distraction. Similarly, visitors should not be distracted by any glare caused by exposed light source.

The use of curtain wall allows a great potential for daylight harvesting. Knowing that there are over 200 luminaires used in the main lobby, day lighting should definitely be used to improve energy efficiency.

Quantitative Criteria

Illuminance Recommendation (IES Lighting Handbook 10th Edition, P28.6):

Space Type	E _h	E _v	Avg : Min
Exhibit Halls	500 lux @ floor	200 lux @ 5' AFF	2 : 1

Light Loss Factor:

(LLD/BF: Adopted data from identical lamps on Orsam Sylvania Lamp and Ballast Catalogue

LDD: Assume 12 months cleaning interval, Clean for interior rating, Medium for outdoor rating)

Type	Lamp Lumen Depreciation	Luminaire Dirt Depreciation	Ballast Factor	Light Loss Factor
AL - 12	0.7	0.94	0.95	0.63
AL - 15	0.86	0.94	0.95	0.77
AL - 27	0.93	0.94	1	0.87
AL - 39	0.9	0.94	N/A	0.85

Energy Allowance (ASHRAE 90.1 version 2010, TABLE 9.6.1 at P85):

Space Type	Area	Power Density	Maximum Wattage
Entries/Exits	5600 SF	1.45 W/SF	8120 W

Design Evaluation

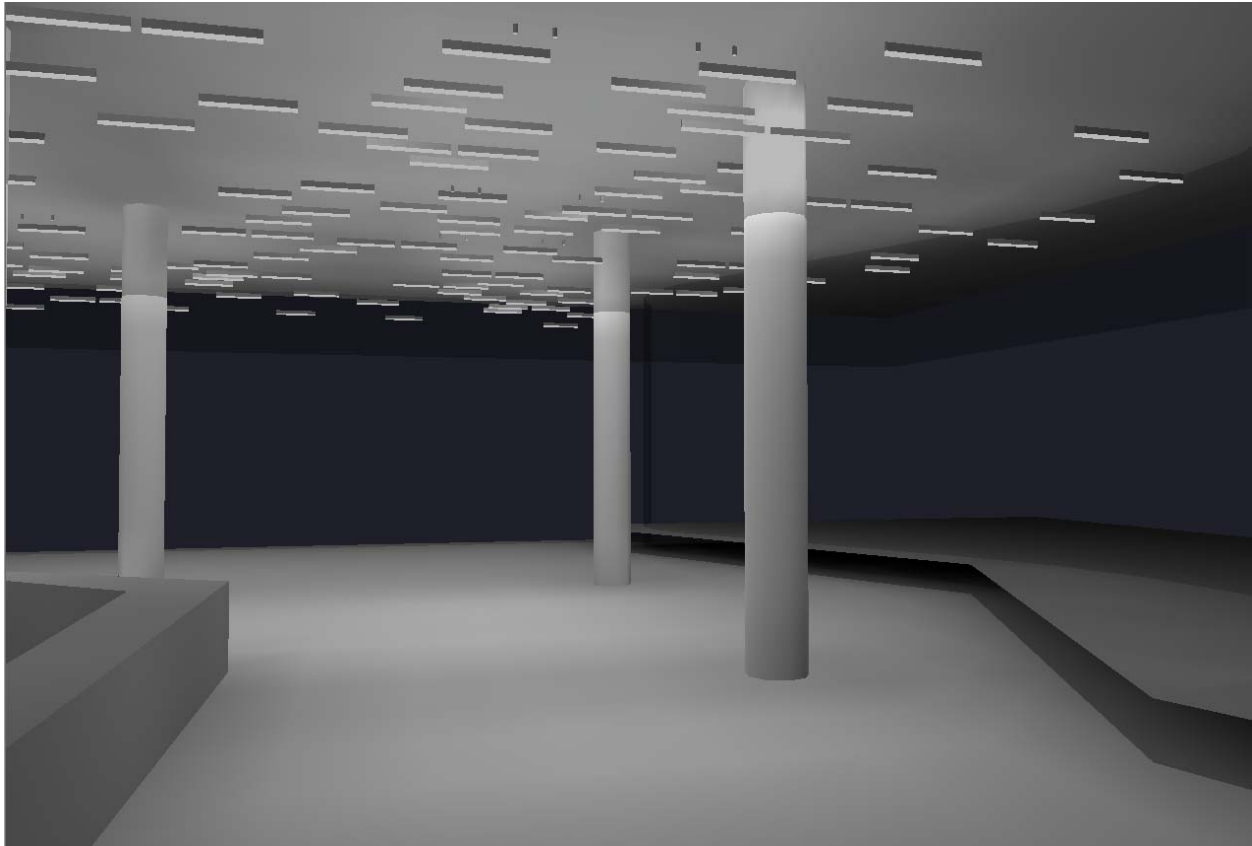


Image 4, Rendering Image – Main Lobby RGB Mode

The existing lighting layout distributed linear fluorescent luminaires around the ceiling randomly without following any standard geometrical patterns. This resulted in a parallel dash line pattern that guarantees a high uniformity.

Diffused by the metal mesh, light source on the ceiling become less glary and can be viewed directly by visitors. This provided an incentive to arrange luminaires into a more elegant pattern using more flexible LED luminaires.

All fixtures used in this space are ceiling mounted luminaires cast light from above except the under desk accent lighting. Different luminaire types can be integrated into this space to add variety of light.

The AGI 32 analysis focused on the overall lighting quality of the space, thus decoration luminaries are not included in the calculation. From the pseudo color rendering we can see that the light level on the passage way is fairly uniform. The landscape plinth has a lower light level on the horizontal surface, the emphasis there will be vertical illuminance projected on exhibit. Although hot spot can be seen on the top of the column, it is smartly concealed by the metal mesh.

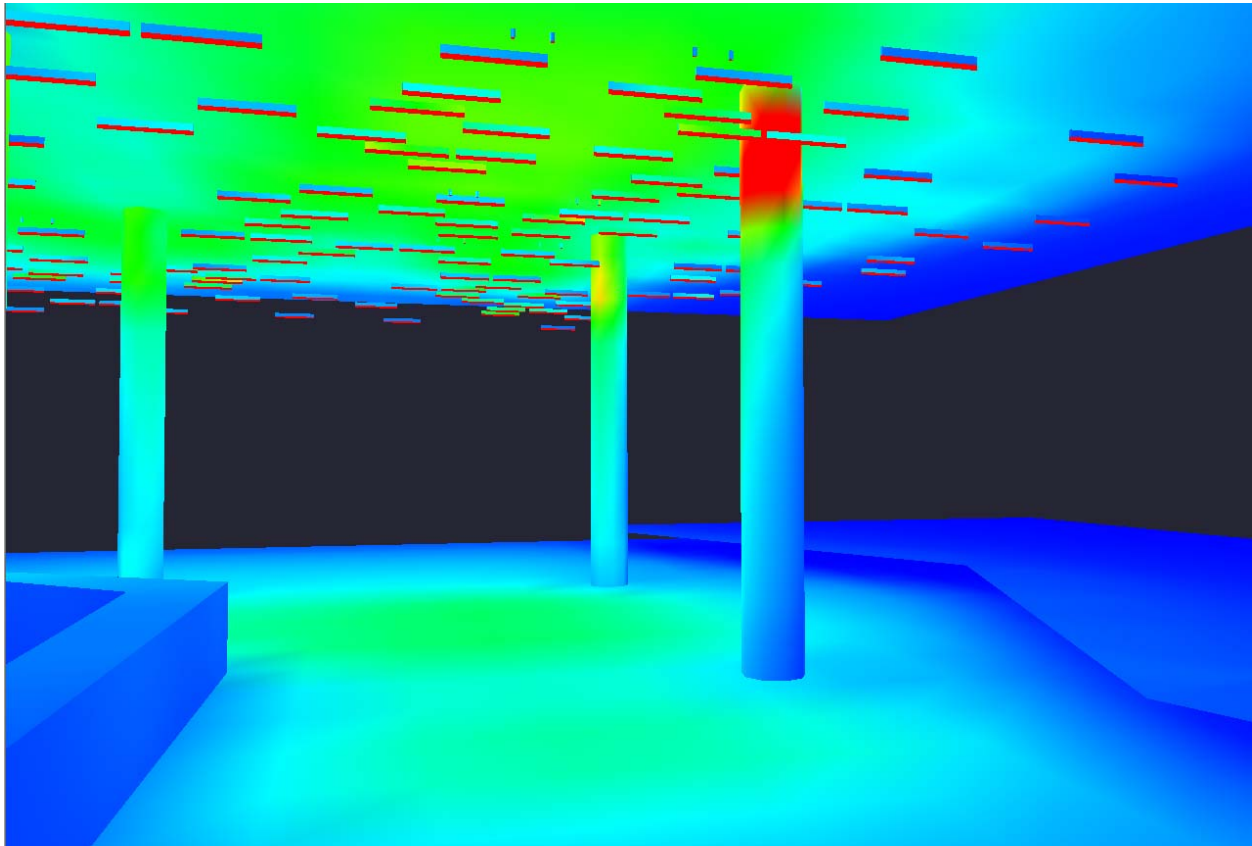


Image 5, Rendering Image – Main Lobby Pseudo Mode

3D Theater

Existing Condition



Image 6, 3D Theater

Description

The 3D Theater is a special purpose space designed for 3D movie shows. Acoustical panel covered the entire side wall and ceiling surface, providing plenty of gap space to conceal luminaires. The primary lighting task in this theater is to navigate guest to available seating area during movie intervals.

Space Dimension

Theater:

Approximate Area = 3726 SF

Length = 69ft

Width at front row = 43ft

Width at back row = 64ft

Ceiling Height = 12ft



Figure 12, Ground Level Floor Plan – 3D Theater

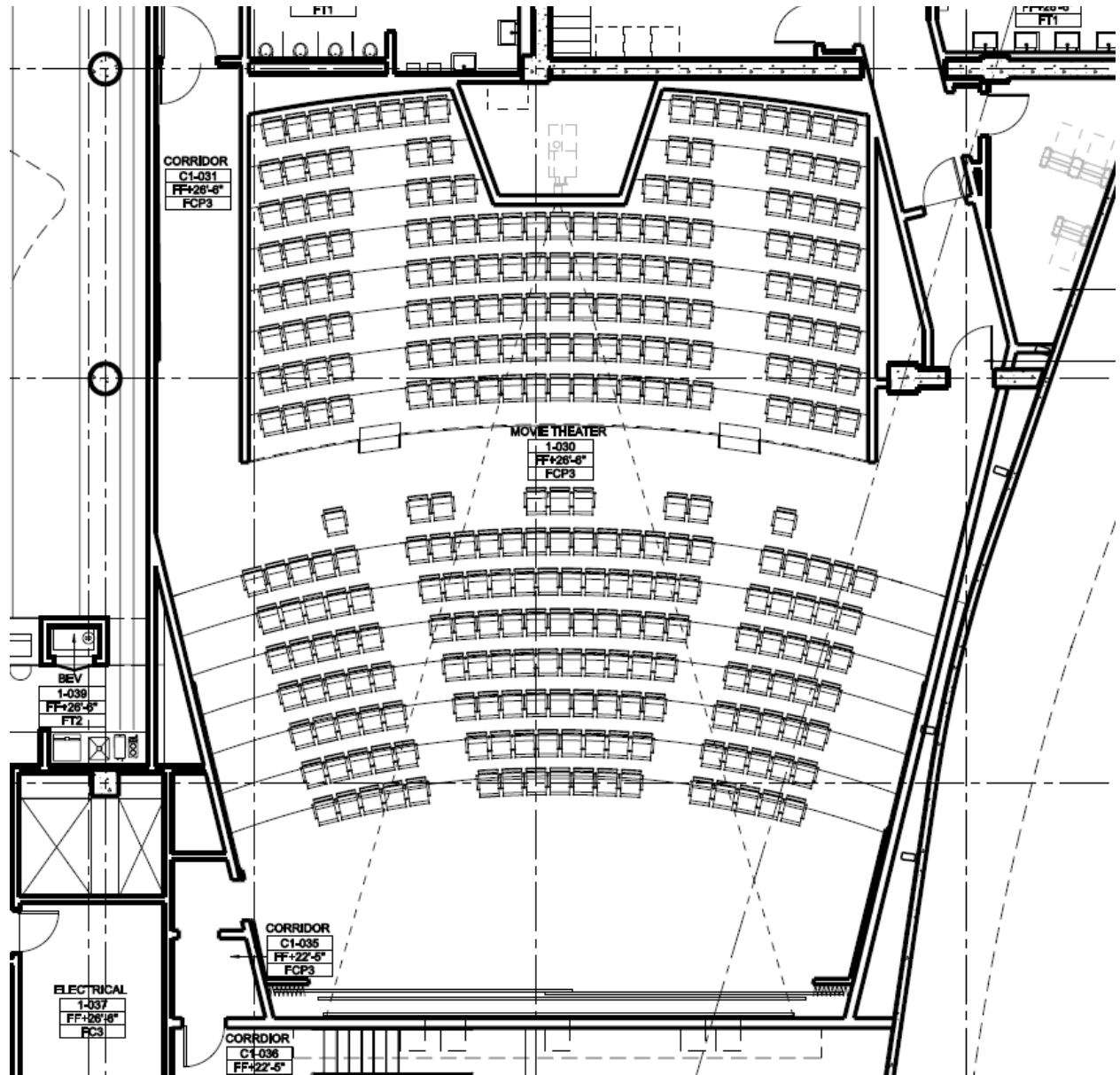


Figure 13, Ground Level Floor Plan – 3D Theater

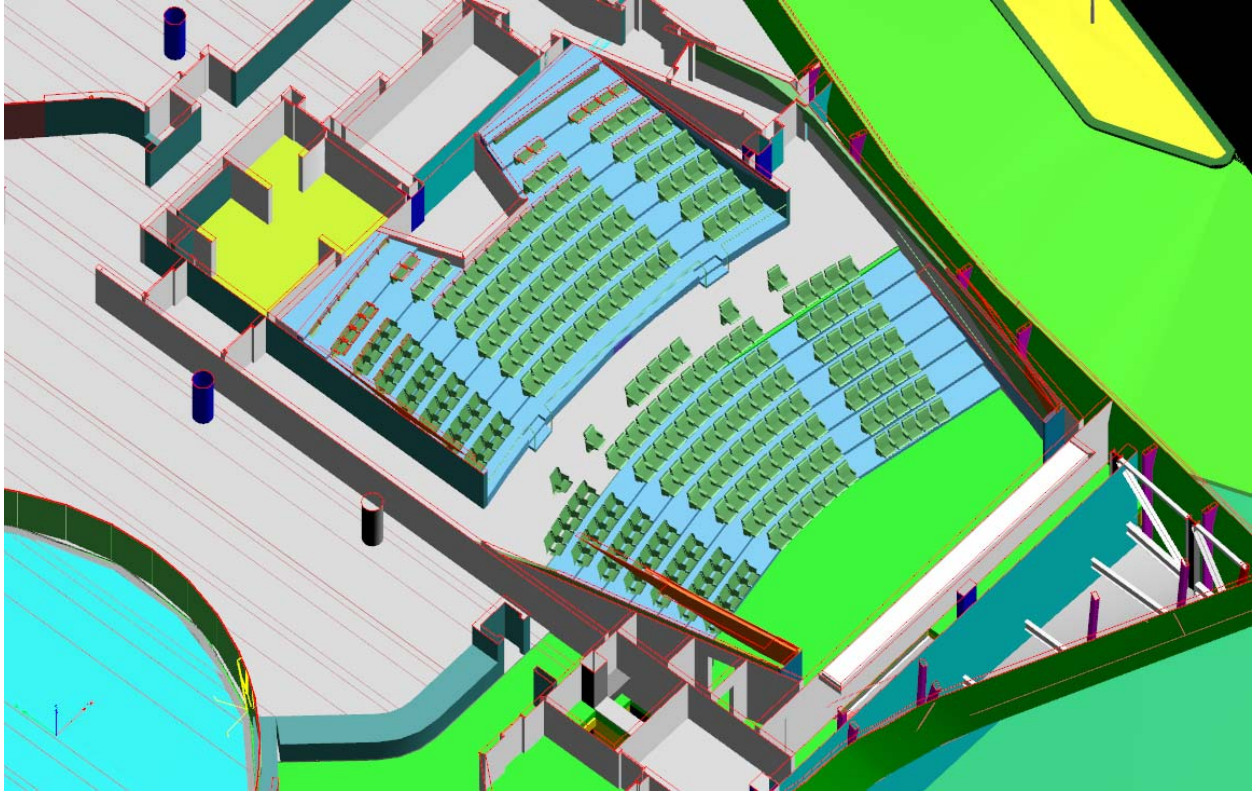


Figure 14, 3D View – 3D Theater Perspective View

Material

	Description	Location	Color	Reflectance
Floor	J+J Invision carpet tiles	Theater	Grey	0.2
Wall	Fabritrak system with Knoll and Maharem fabric acoustic wall	Theater	Grey	0.9
Ceiling	Fabritrak system with Knoll and Maharem fabric acoustic ceiling	Theater	Grey	0.9

Glazing

N/A

Luminaire Schedule

Type	Lamp	Power Input	Description	Location
AL-12	LED	4.32W/ft 24V DC 277V AC	Electrix 'L101' - Modified Interior rated, surface mounted linear low voltage, high output LED luminaire concealed within acoustic panel. Provide remote 277/24V transformer.	Theater

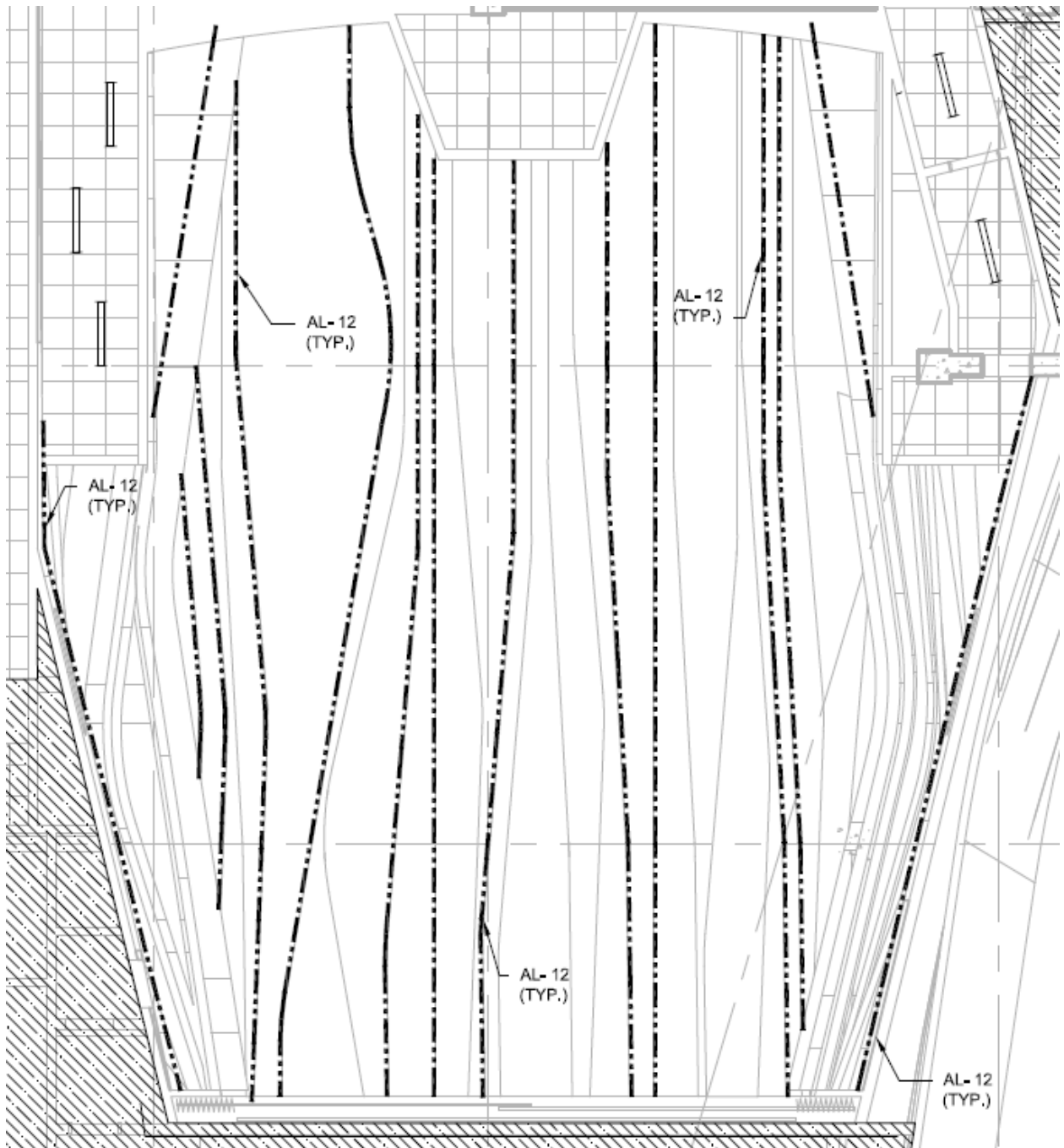


Figure 15, Theater Lighting Plan – AL-12

Design Criteria

Qualitative Criteria

Glare in the theater should be carefully controlled to neutralize the visual contrast between the movie mode and interval, so that the audience can adjust to scene change quickly without experience any discomfort.

Lighting layout should synchronize with the curvature of acoustical panel to maintain a special consistency. In this project, alternation of acoustic layout might be used as a lighting design strategy.

Lighting control should be designed in a way that interacts with the occupancy sensor of certain space. Dim the light of certain zone when it is fully occupied, for example.

Quantitative Criteria

Illuminance Recommendation (IES Lighting Handbook 10th Edition, P24.4):

Space Type	E _h	E _v	Avg : Min
Circulation (AV)	2 lux @ floor	10 lux @ 5' AFF	5 : 1
Stage (Non - AV)	500 lux @ floor	200 lux @ 5' AFF	3 : 1
Seat (Non - AV)	100 lux @ floor	40 lux @ 5' AFF	3 : 1

Light Loss Factor:

(LLD/BF: Adopted data from identical lamps on Orsam Sylvania Lamp and Ballast Catalogue
LDD: Assume 12 months cleaning interval, Clean for interior rating, Medium for outdoor rating)

Type	Lamp Lumen Depreciation	Luminaire Dirt Depreciation	Ballast Factor	Light Loss Factor
AL - 12	0.7	0.94	0.95	0.66

Energy Allowance (ASHRAE 90.1 version 2010, TABLE 9.6.1 at P85):

Space Type	Area	Power Density	Maximum Wattage
Entries/Exits	3726 SF	1.14 W/SF	4247 W

Design Evaluation

The AIG analysis proved a uniform light distribution on the seating area and the bottom surface of acoustic panels. This is made possible by conceal the light source and use purely accent lighting to provide illumination.

Alternatively, a more direct lighting scheme might be considered to improve the energy efficiency. Possibility of recess luminaire into the acoustic panel will be further researched.



Image 7, Rendering Image – 3D Theater RGB Mode

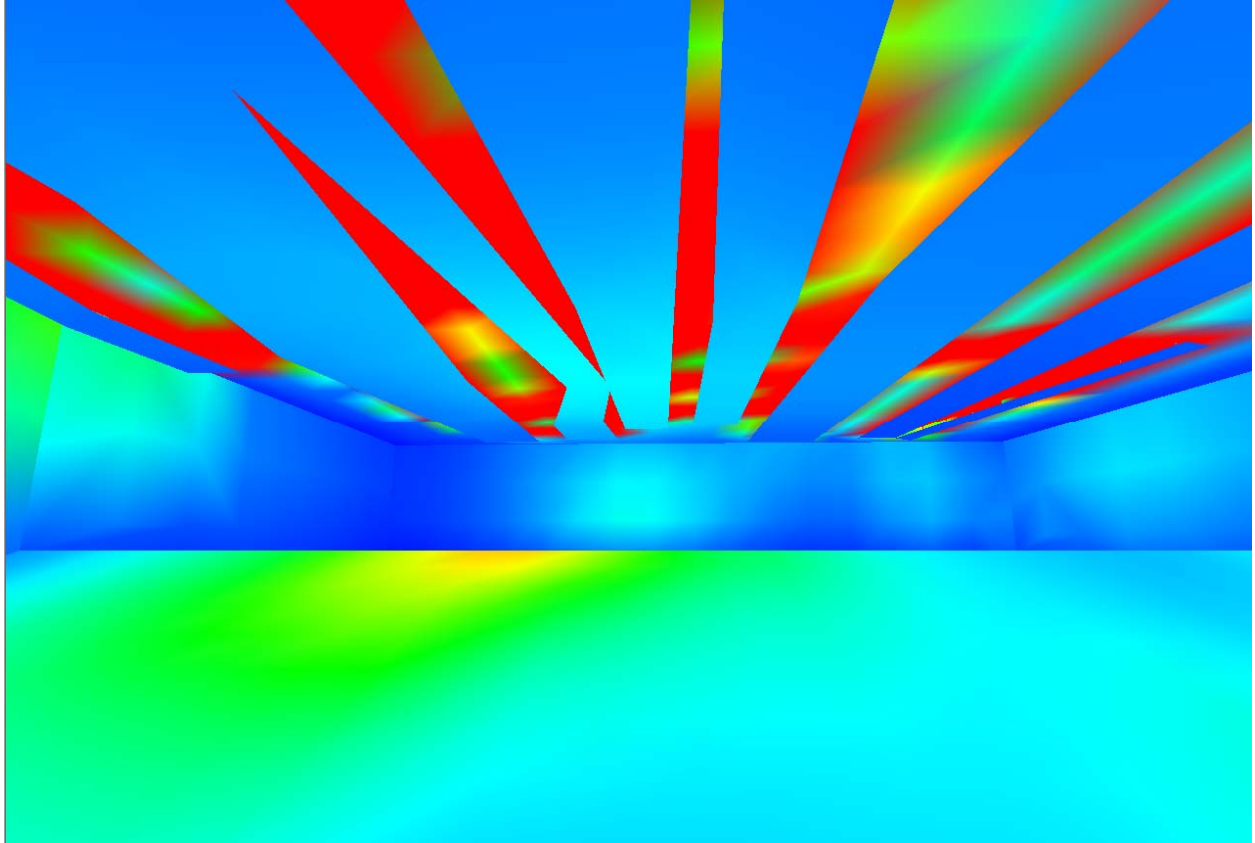


Image 8, Rendering Image – 3D Theater Pseudo Mode

Glass Escalator Cartridge

Existing Condition



Image 9, South Façade day time view

Description

Glass Escalator Cartridge is a unique space that 'attached' on the cubical museum tower. Its unique structural layout creates not only a visual impact but also impact from a physiological level. No activity is going on in this space since escalator will automatically carry visitors up. The only task visitors have is to enjoy the view from a 70 feet tall platform.

Space Dimension

Glass Escalator Cartridge:

Approximate Area = 1272 SF

Length = 113.6ft

Width = 11.2ft

Height = 24ft

Tilt Angle = 26 deg

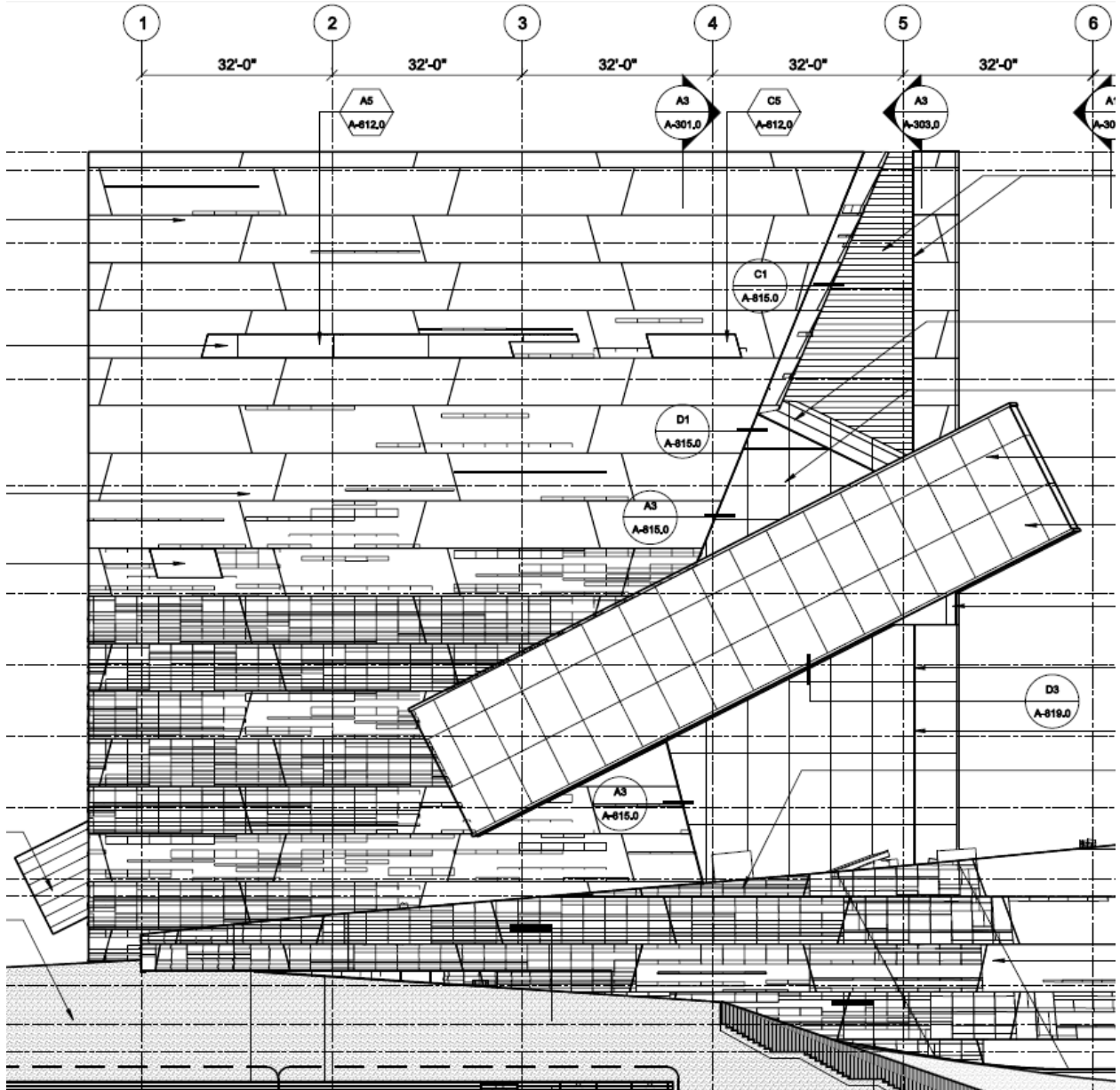


Figure 16, South Elevation - Glass Escalator Cartridge

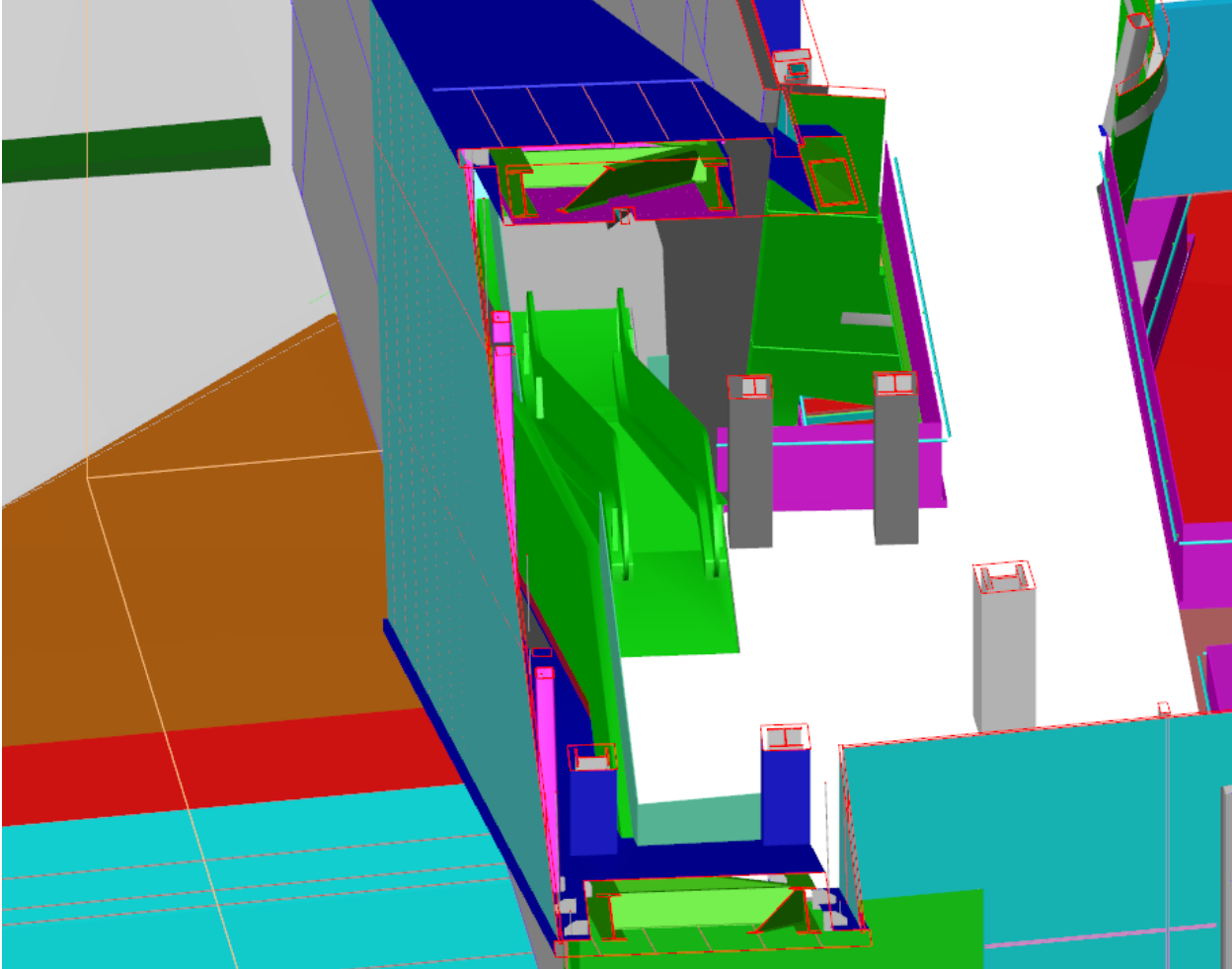


Figure 17, 3D View – Interior view of Main Escalator

Material

	Description	Location	Color	Reflectance
Wall	Reinforced concrete	Concrete Wall / Column	Grey	0.4
Ceiling	Metal Panel	Escalator Ceiling	Black	0.8

Glazing

Type	Location	Visual Transmittance	Exterior Reflectance
G1	Tower façade / Escalator cartridge	0.48	0.08
G4	Skylight	0.47	0.08

Luminaire Schedule

Type	Lamp	Power Input	Description	Location
AL-58	T5HO Fluorescent	54W / 277V	Linear Lighting Corp 'Stripe' Recessed linear fluorescent ceiling wash luminaire with flush lens, integral 120-277V universal voltage electronic ballast concealed within perimeter cove	Main Escalator

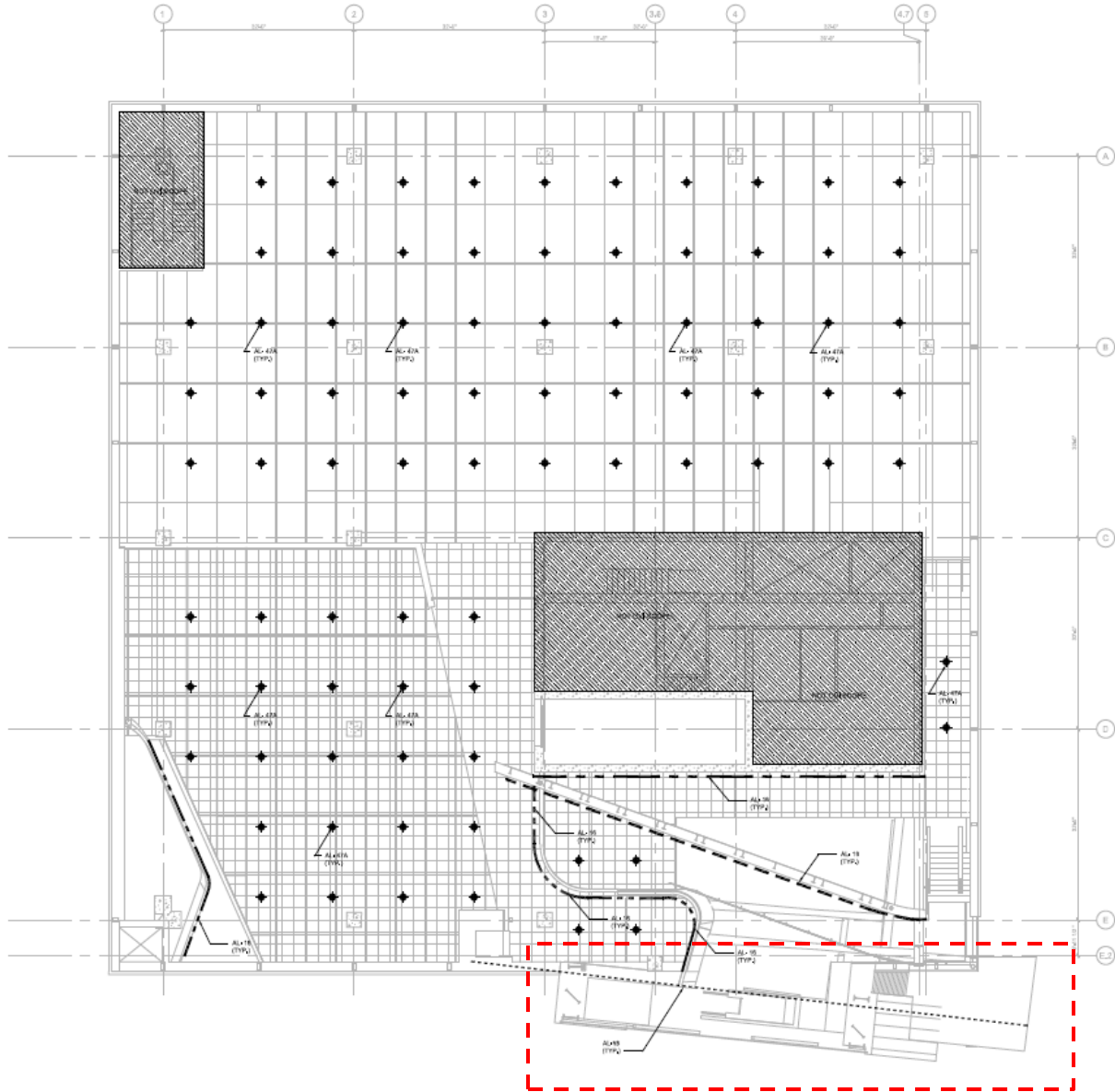


FIG 14

Figure 17, Level 3 Overall Lighting Plan

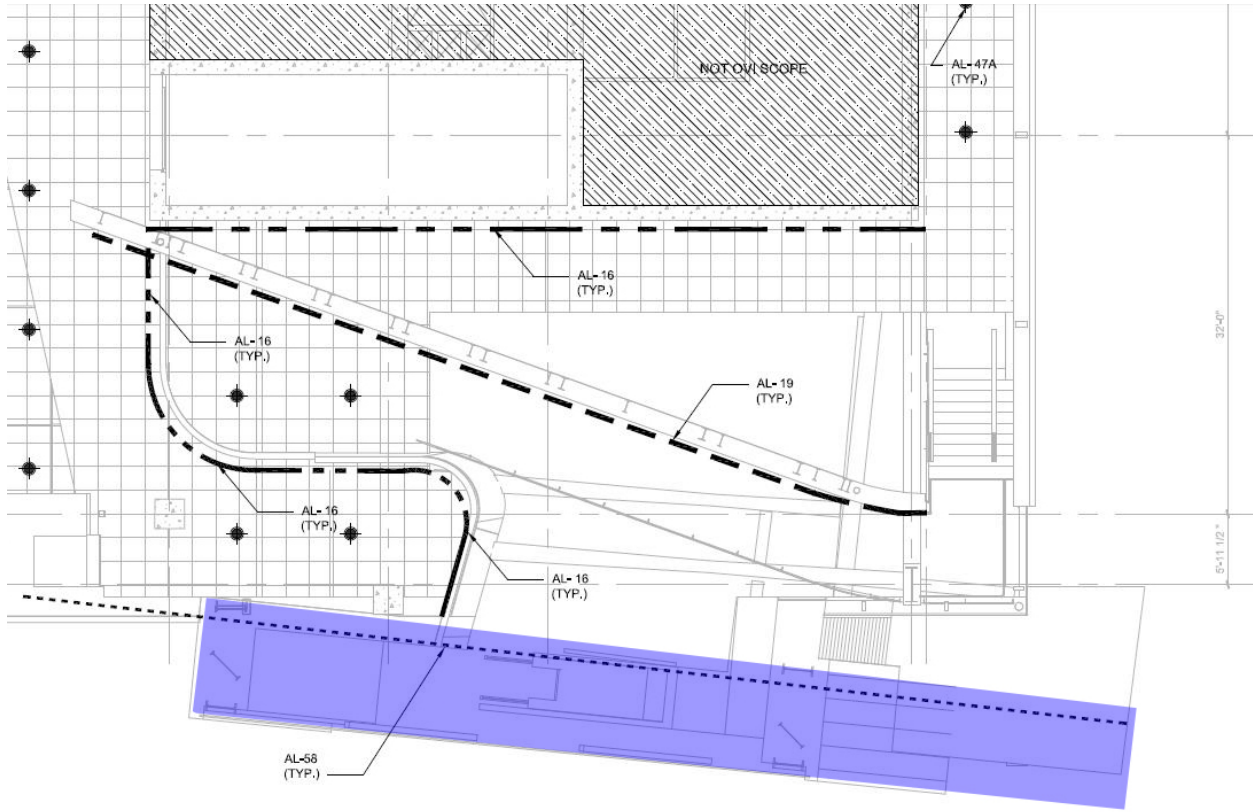


Figure 18, Level 3 Lighting Plan Call Out – Escalator Lighting

Design Criteria

Qualitative Criteria

The magnificent glass wall used in this space diluted the boundary between interior and exterior, expanded this space to the outside. Daylight integration is definitely a possible way to increase energy efficiency in this space. Target illuminance might also need to be raised from the standard criteria due to its contrast with sunlight.

For this project, physiological reinforcement will be applied to affect people's sense of space. According to John Flynn's article '*Interim study of procedures for investigating the effect of light on impression and behaviors*', a bright, peripheral, and uniform light distribution tends to make observer overestimate the size of certain space. Therefore, brightness, uniformity and spatial layout of lighting will be treated carefully to achieve the physiological effect desired.

Quantitative Criteria

Illuminance Recommendation (IES Lighting Handbook 10th Edition, P34.34):

Space Type	E _h	E _v	Avg : Min
Escalator	50 lux @ floor	30 lux @ 5' AFF	2 : 1

Light Loss Factor:

(LLD/BF: Adopted data from identical lamps on Orsam Sylvania Lamp and Ballast Catalogue
LDD: Assume 12 months cleaning interval, Clean for interior rating, Medium for outdoor rating)

Type	Lamp Lumen Depreciation	Luminaire Dirt Depreciation	Ballast Factor	Light Loss Factor
AL - 58	0.93	0.94	1	0.87

Energy Allowance (ASHRAE 90.1 version 2010, TABLE 9.6.1 at P85):

Space Type	Area	Power Density	Maximum Wattage
Entries/Exits	1272 SF	0.66 W/SF	840 W

Design Evaluation

The only light source in this space is an overhead LED fixture, which is a great feature that not only provides enough visual comfort but also contributes to the façade lighting.

So far, the light in this space is purely static. Considering that the escalator itself is continuously moving, it will be interesting to have animated light in the space that synchronizes with escalator motion.

Reference:

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3. John E. Flynn, Terry J. Spencer, Osyp Martyniuk, Clyde Hendrick. *Interim Study of Procedures for Investigating the Effect of Light on Impression and Behavior*. 1973.
4. Orsam Sylvania Lamp and Ballast Catalogue
<http://ecom.mysylvania.com/onlinemedial/ihdp/Professional-Lighting-Catalog-2012>