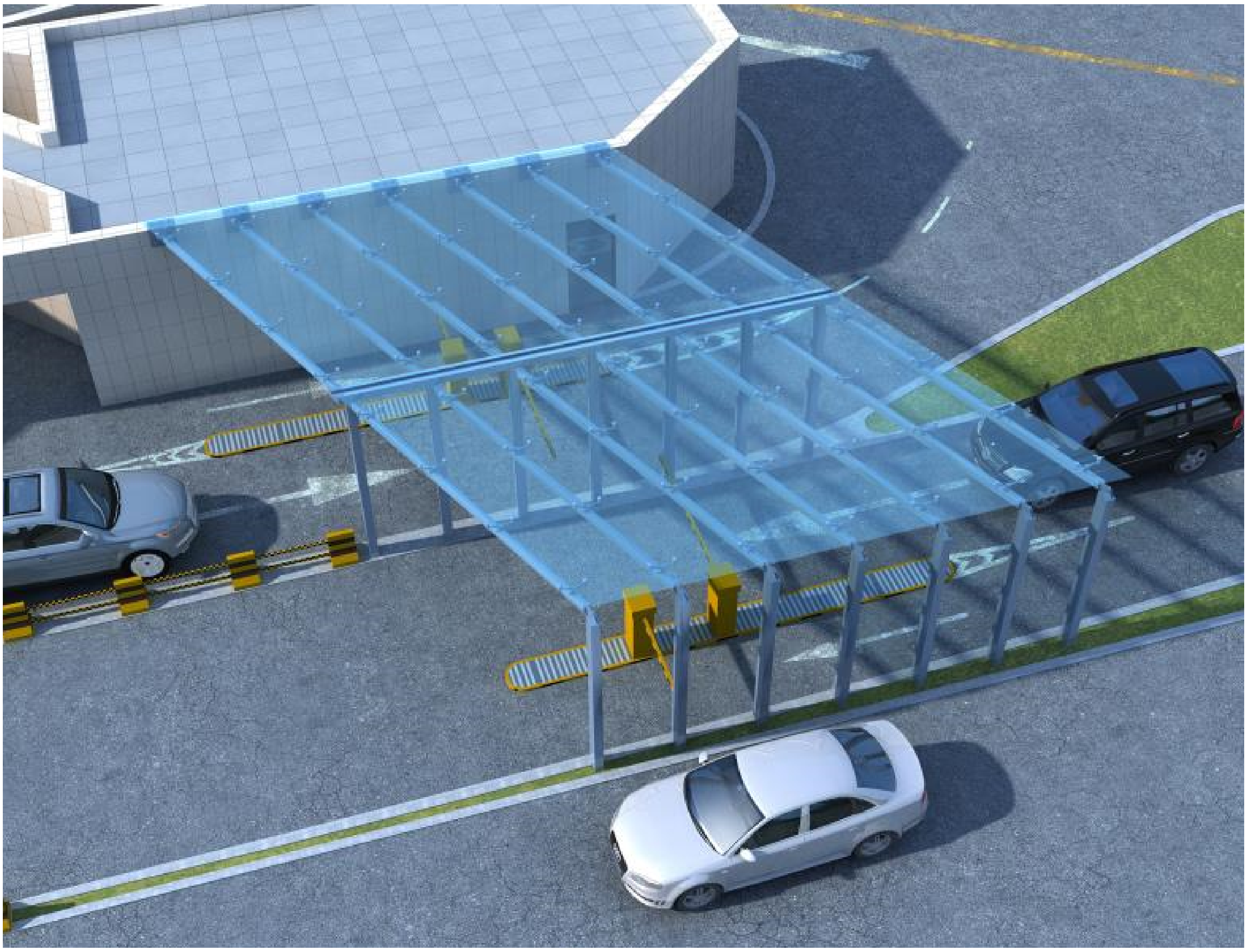
DIMON
TECHNOLOGY

Technical Datasheet

JOHSUA@HC 778

UK DESIGN · CE · IK 10 · IP67 · 0-10V · DALI

Spider fitting frame-less glass Canopy Integrated with LED Lighting system



- Spider system fitting frame-less glass Canopy Design to Comply below Specification
- Building (Construction) Regulations Chapter 123-1990 ;
- Code of Practice on Wind Effects Hong Kong -2004
- Code of Practice for the structural use of Steel -2011
- Code of Practice for the structural use of Concrete-2004 (2nd Edition)
- Code of Practice for the structural use of Aluminium -BS8118: Part 1:1991
- Practice Note for Authorized person, registered structural engineers and registered geotechnical engineers: BD APP-37 (PNAP 106)
- Code of Practice for Dead and Imposed loads-2011
- Integrated with Continuous LED Linear Lighting and Softening Filter System make light effect more comfortable

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Spider fitting frame-less glass Canopy Integrated with LED Lighting system

Technical Data

Major Material:	• S.S 316 Spider System • Supporting structure made of hot-dip galvanised steel profiles • Steel Hollow section Material Grade: S355 comply with BS EN-100210; Steel hot Rolled section grade S355 comply wiht BS EN 10025, T<16mm Design Strength =355Mpa;T>16mm Design Strength =345Mpa; • 10 mm THK Clear Laminated Tempered Glass comply BS 952 Part 1 and BS 6262 , Allowable Stress 50MPa • Welding comply BS EN 1011-1; BS EN 1011-2; BS EN ISO 15614 • Stainless Steel Fasteners A4-70 comply wiht BS EN ISO 3506-1. Permanent Stain 450Mpa • Sealants -Dow Corning 795/995/983 or Equivalent Material • HILTI Anchor Bolt
Tempered Glass color	• Clear • Dark Grey, • Euro grey; • Ocean blue, • Ford blue, • Dark blue
Structure Materials And Finishes	• Hot Dip Galvanised Steel-BS EN ISO 1461:2009 • Other Painting Color Option : White RAL 9003 , Grey RAL 9006 or Matte Black RAL 9005 • Painting System with AkzoNobel acrylic polyurethane RAL 9006 Printing for 10 years durability.
Design Basic Wing Pressure	2.04KPa
Color Finishes	Hairline Finish for S.S 316 Material
LED Luminaire Surface Linear Light General Specification QTY: 56 set per Pergola	• Power: 1120 W LED System 56 set x 20W LED Linear Light • Input : AC100-240V 50/60Hz • Dimming Control : 0-10V or Dali • Total Luminaire luminous flux: >80000 lm • Power Factor : >0.95 • THD: <20% • Extruded Aluminium S6063 alloy body with low copper content • Nano Ceramic surface conversion, resistant to corrosive environment. Luminiare primarily coated with epoxy resin and top coated with UV stabilized polyester powder and cured in digital temperature controlled chamber at 200°C. • Softening Filter Diffuser • Protection: IP67 • IK Rating: Protection against mechanical impact IK10 • Impact resistant safety tempered glass cover. • Color: Black RAL9005 / Graphite RAL 7024 / Dark Gray RAL 7021 / Aluminium Silver RAL 9006 / White • LED Luminaries: LVD: IEC 60598-1; IEC 60598-2-1;IEC62471;IEC 62031; IEC62471 • LED Driver: IEC/EN 61347-1; IEC/EN 61347-2-13; IEC/EN 62384; IEC/EN 61000-3-2; IEC/EN 61000-3-3;IEC/EN61574;EN 55015 ; IEC /EN 62384
Certificate	ISO 9001:2008 · UK DESIGN · CE · IK 10 · IP67 · 0-10V · DALI

Project	Fixture#	Date
		Firm

DIMON TECHNOLOGY

Ordering Information

Choose the option that suits your need and write its corresponding code on the appropriate line to form the product code.

Example product code:

JOHSUA @ HC-778 -

GENERAL NOTES FOR GLASS CANOPY

DESIGN REFERENCE

1. BUILDING (CONSTRUCTION) REGULATIONS CHAPTER 123 – 1990
2. CODE OF PRACTICE ON WIND EFFECTS HONG KONG – 2004
3. CODE OF PRACTICE FOR THE STRUCTURAL USE OF STEEL – 2011
4. CODE OF PRACTICE FOR THE STRUCTURAL USE OF CONCRETE – 2004 (2nd EDITION)
5. CODE OF PRACTICE FOR THE STRUCTURAL USE OF ALUMINIUM – BS8118 : PART 1 : 1991
6. PRACTICE NOTE FOR AUTHORIZED PERSON, REGISTERED STRUCTURAL ENGINEERS AND REGISTERED GEOTECHNICAL ENGINEERS : BD APP-37 (PNAP 106)
7. CODE OF PRACTICE FOR DEAD & IMPOSD LOADS – 2011

DESIGN CRITERIA

1. WIND LOADS : ABOVE ARTIFICIAL BASE LEVEL (ABL)

HEIGHT ABOVE SITE GROUND LEVEL	BASIC WIND PRESSURE qz	CP	Topography Factor	DESIGN WIND LOAD
11.15m ABOVE SITE GROUND LEVEL	2.04KPa 2.04KPa	+1.0 –1.4	1.0 1.0	+2.04 KPa –2.86 KPa
11.15m ABOVE SITE GROUND LEVEL	2.04KPa	±2.0	1.0	±4.08 KPa (FOR CANOPY & GRILLES)
11.15m ABOVE SITE GROUND LEVEL	2.04KPa 2.04KPa	+1.2 –2.2	1.0 1.0	+2.45 KPa (FOR ROOF CLADDING) –4.49 KPa

2. DEAD LOAD

DEAD LOAD ACCORDING TO PRACTICE OF DEAD & IMPOSED LOAD 2011.

DENSITY OF ALUMINIUM 27 KN/m3
DENSITY OF STEEL 78.5 KN/m3
DENSITY OF GLASS 26.0 KN/m3

3. GLASS CANOPY LIVE LOAD 0.75kPa

MATERIALS

1. GLAZING

1.1) ALL TEMPERED GLASS SHALL COMPLY WITH BS952 PART 1, AND BS6262 (ALL TEMPERED GLASS SHALL BE 100% HEAT SOAKED TEST IN 290° MIN. 2 HRS. COMPLY TO APP37/BSEN14179)

1.2) ALLOWABLE STRESS = 50 MPa
YOUNG'S MODULUS ELASTICITY = 70000 MPa

1.3) GL-01: 10mm+1.52mmSGP+10mm THK. CLEAR LAMINATED TEMPERED GLASS

1.4) GLASS ALLOWABLE DEFLECTION < L/60.

1.5) GLASS SUPPORTING MEMBERS ARE DESIGNED TO L/180 OR 20mm MAX. WHICHEVER IS LESSER.

1.6) IMPACT TEST SHALL BE COMPLY WITH BS 6262 AND GLASS SURFACE COMPRESSION > 69 MPa.

2. STEEL

STRUCTURAL STEEL GRADE S355 J0 COMPLY WITH BS EN-10025 (CLASS 1), UNLESS STRUCTURAL STEEL OF HOLLOW SECTION SHALL BE GRADE S355J0H COMPLY WITH BS EN10210.

DESIGN STRENGTH (for t < 16mm) = 355 MPa
DESIGN SHEAR = 205 MPa
YOUNG'S MODULUS OF ELASTICITY = 205000 MPa

DESIGN STRENGTH (for t > 16mm) = 345 MPa
DESIGN SHEAR = 200 MPa
YOUNG'S MODULUS OF ELASTICITY = 205000 MPa

3. CORROSION PROTECTION

A) ALL SITE WELDS SURFACE SHALL BE RECEIVE 2 COATS OF ZINC RICH PRIMER COMPLYING WITH BS 4652 : 1995 AND BS EN ISO 12944 : 1998 PART 5

B) WHERE ALUMINIUM IS IN CONTACT WITH STEEL, PLASTIC TAPE OR COATING SHALL BE PROVIDED AT CONTACT TO PREVENT GALVANIC REACTION AS PER PD 6484

C) WHERE ALUMINIUM OR STEEL IS IN CONTACT WITH CONCRETE, THE BITUMINOUS PAINT TO BE PROVIDED AT B) WHERE ALUMINIUM IS IN CONTACT WITH STEEL, PLASTIC TAPE OR COATING SHALL BE PROVIDED AT CONTACT TO PREVENT GALVANIC REACTION AS PER PD 6484

D) ALL MILD STEELS SHALL BE HOT DIP GALVANIZED FINISH CONFORMING TO BS EN ISO 1461 : 2009.

THICKNESS OF STEEL	COATING THICKNESS MIN.
STEEL > 6mm	85 µm
STEEL > 3mm TO < 6mm	70 µm
STEEL > 1.5mm TO < 3mm	55 µm

4. ALL STAINLESS STEEL SHALL BE GRADE 316
THE DESIGN STRENGTH OF STAINLESS STEEL TO BE EN10088-2

GRADE	DESIGN STRENGTH N/mm^2 (0.2% PROOF STRESS)	ULTIMATE TENSILE STRENGTH N/mm
316	205	515

5. WELDING

A) ALL WELDING SHALL BE COMPLYING WITH BS EN 1011-1;2001 & BS EN 1011-2:2001.

B) DESIGN OF WELD SHALL BE ACCORDING TO CODE OF PRACTICE FOR THE STRUCTURAL USE OF STEEL 2011 DESIGN STRENGTH OF FILLET WELD – 220 N/mm2

C) 2 COATS OF ZINC RICH PRIMER SHALL BE APPLIED AFTER WELDING ALL SLAG AND RESIDUE TO BE REMOVED BEFORE PAINTING.

D) ALL WELDING SHALL BE CARRIED OUT BY THE QUALIFIED WELDERS AND COMPLYING TO BS EN 287-1, 2004.

E) ALL WELDING PROCEDURES TO COMPLY WITH BS EN ISO 15614 : 2004

F) ALL WELD SHALL BE 4mm FILLET WELD UNLESS OTHERWISE SPECIFIED.

G) ALL SITE WELDS SHALL BE RECEIVED WITH 2 COATS OF ZINC CHROMATE PRIMER

6. FASTENERS

6.1) ALL STAINLESS STEEL FASTENERS, STAINLESS BOLTS, SPRING WASHER & NUTS SHALL BE AUSTENITIC GROUP GRADE 8.8, A4-70 (FOR EXTERNAL) COMPLYING WITH BS EN ISO 3506-1

GRADE	STRESS AT 0.2% PERMANENT STAIN	ULTIMATE TENSILE STRENGTH (Usb)	SHEAR STRENGTH (Usb)	TENSILE STRENGTH (Plb)	BEARING STRENGTH (Pbb)
A4-70	450 MPa	700 MPa	310 MPa	370 MPa	824 MPa

6.2) GRADE 8.8 BOLTS SHALL BE B.S. 4190,2001 AND THE TOLERANCE OF BS 4190 : 2001.
ALLOWABLE TENSILE STRESS 560MPa
ALLOWABLE SHEAR STRESS 375MPa
ALLOWABLE BEARING STRESS 1000MPa

6.3) STAINLESS STEEL SPIDER BRACKET SHALL BE MADE IN CASTING METHOD AND OF GRADE CF-8M IN COMPLIANCE WITH ASTM A 351.

6.4) STAINLESS STEEL SPIDER BRACKET AND ARTICULATED BOLT SHALL BE GRADE 316 RECOMMENDED
LOAD PER ARM Pt = 6.5kN (UP & DOWN DIRECTION)
– S/S SPIDER BRACKET "KINLONG" 300H21 2 ARMS TYPE (BD REF. NO. SB010)

6.5) THE STAINLESS STEEL SPIDE BRACKET 300H21 2 ARM TYPES SHALL BE CARRIED OUT A PROOF LOAD TEST IN ACCORDANCE WITH SECTION 16.2 OF THE CODE OF PRACTICE FOR THE STRUCTURE USE OF STEEL 2005.

6.6) THE STAINLESS STEEL SPIDER BRACKET INSTALLATION ERECTION AND GLASS TO SPIDER CONNECTION SHALL BE STRICTLY IN ACCORDANCE WITH MANUFACTURE'S RECOMMENDATION.

7. SEALANTS

7.1) ALL STRUCTURAL SEALANT SHALL BE DOW CORNING 795/995/983 OR EQUIVALENT IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTION AND RECOMMENDATION. (BD. REF. NO. SS-001 & 002). COLORS WILL BE STANDARD COLORS AS SELECTED BY THE ARCHITECT.
ALLOWABLE STRESS = 138 kPa

7.2) ALL NON-STRUCTURAL SEALANT (INTERNAL SEAL AND WEATHERSEAL) SHALL BE DOW CORNING 791 IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTION AND RECOMMENDATION. COLORS WILL BE STANDARD COLORS AS SELECTED BY THE ARCHITECT.

7.3) BACK-UP MATERIAL FOR PERIMETER WEATHER SEALS SHALL BE NON-GASSING OPEN CELL SILICONE COMPATIBLE BACKER ROD.

7.4) FOAM SPACER TAPES AT STRUCTURAL SILICONE ARE TO BE SILICONE COMPATIBLE AND NON-GASSING AND SHALL BE PROVEN ACCEPTABLE BY THE SEALANT MANUFACTURER.

8. ELECTROLYTIC PROTECTION

INTERFACE BETWEEN DIFFERENT METAL TO BE SEPARATED BY 2 COATS OF BITUMEN PAINT TO PREVENT BI-METALLIC CORROSION.

9. CONCRETE GRADE

STRENGTH OF EXISTING REINFORCED CONCRETE = GRADE 45D/20 (FOR INFORMATION ONLY).

10. THIS SET OF DESIGN CLADDING SYSTEM DID NOT CONTAIN ANY FIRE RATED MATERIALS.

11. NO FIRE RATED REQUIRE FOR THE PROPOSED GLASS CANOPY WORKS.

12. ANCHOR BOLT
ANCHOR BOLT TO BE "HILTI" TYPE, DESIGN AND INSTALLATION TO BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATION.

HILTI Anchor Properties Table

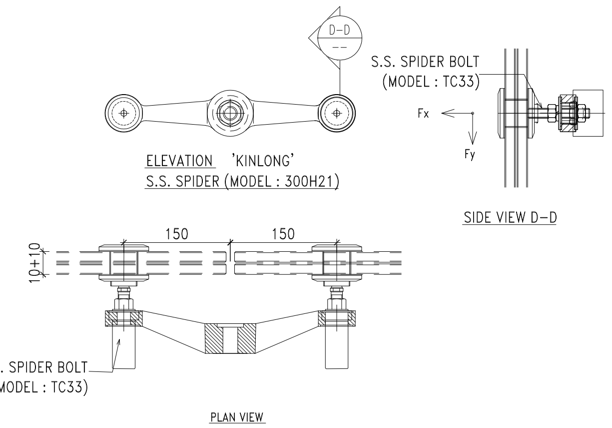
Anchor Type	Concrete Type	Recommended Load		Test Load	h_{ef} [mm] Effective anchorage depth	Minimum spacing in concrete	Minimum edge distance in concrete	BD REF NO.
		Tensile (kN)	Shear (kN)	Tensile (kN)				
M8x75 HST-R	Cracked	1.7	4.3	2.55	47	60	60	AF130.
M10x110 HST-R	Cracked	3.0	6.7	4.5	60	60	65	AF127.
M12x145 HST-R	Cracked	4.0	10	6.0	70	60	75	AF130.
M16x165 HST-R	Cracked	8.3	16.3	12.45	82	60	100	AF130.
M20x170 HST-R	Cracked	20	10	30	100	101	130	AF130.

13 SETTING BLOCK :

13.1 SETTING BLOCK SHALL BE 85°±5 SHORE A SLICONE RUBBER NO LESS THAN 150mm L AT 1/8 POINT OF GLASS

13.2 DOUBLE COHESIVE TAPE COMPLIED WITH ASTM D-2240 HARDNESS : SHORE A = 30.

14) S.S. SPIDER DETAIL



FOR GLASS CANOPY

WORKING TENSILE LOAD Fx =2.59 KN
WORKING SHEAR LOAD Fy =0 KN

DRAWING LIST

	DRAWING No.	REVISION					DRAWING TITLE	REMARKS
		20	21	Y	Y	Y		
		06	01	M	M	M		
		30	25	D	D	D		
1	GC-GN01	–	2				GENERAL NOTES & DRAWING LIST FOR GLASS CANOPY	
2	GC-EM01	–	2				GLASS CANOPY TYPE EMBER	
3	GC-PL01	–	2				GLASS CANOPY LAYOUT PLAN	
4	GC-PL02	–	2				GLASS CANOPY LAYOUT PLAN	
5	GC-PL03	–	2				GLASS CANOPY LAYOUT PLAN	
6	GC-EL01	–	2				GLASS CANOPY ELEVATION	
7	GC-DE01	–	2				GLASS CANOPY DETAIL	
8								
9								
10								
11								
12								
13								
14								
15								

Drawing Status :

Ref NO.:

Client

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Project:
工程2 - 修改停車場閘臂位置
INTERVENÇÃO 2 - REVISÃO DA LOCALIZAÇÃO DAS CANCELAS DE ESTACIONAMENTO

Job Title:
CANOPY FOR MOTORCYCLE AND CAR TICKETING MACHINE

Drawing Name:
GENERAL NOTE

Drawing NO.: QPBE20034-GN01

Drawing Scale: AS SHOW

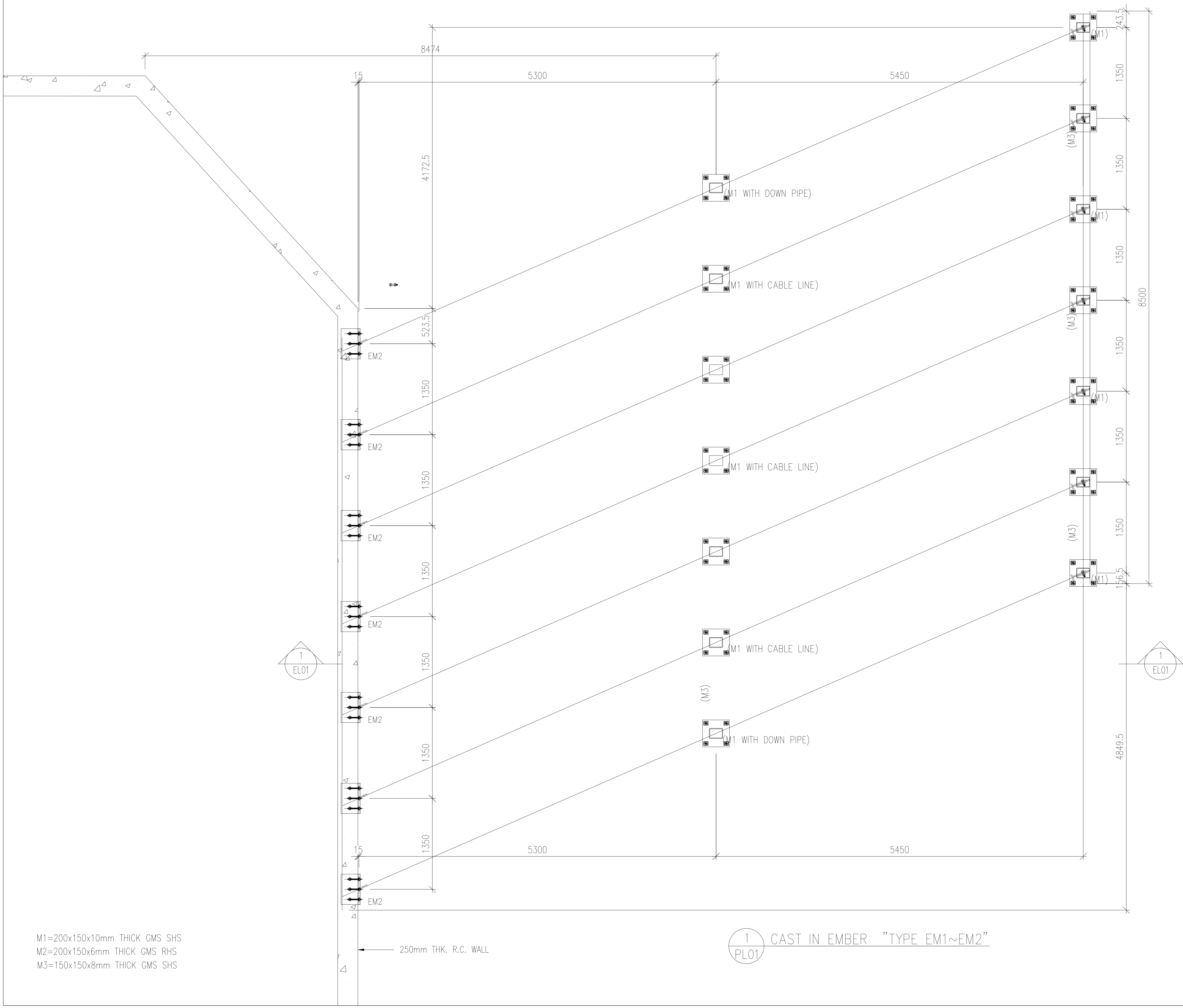
Drawing Date: 2021/01/25

Drawing: KP

Collate: Joyi

Auditing: Gray Hui

Drawing Version: 2



M1=200x150x10mm THICK GMS SHS
M2=200x150x6mm THICK GMS RHS
M3=150x150x8mm THICK GMS SHS

1 / PL01 CAST IN EMBER "TYPE EM1~EM2"

Drawing Status :

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Job Title:
CANOPY FOR MOTORCYCLE AND CAR TICKETING MACHINE

Drawing Name:
LAYOUT PLAN FOR EMBED

Drawing NO.: QPBE20034-PL01

Drawing Scale: AS SHOW

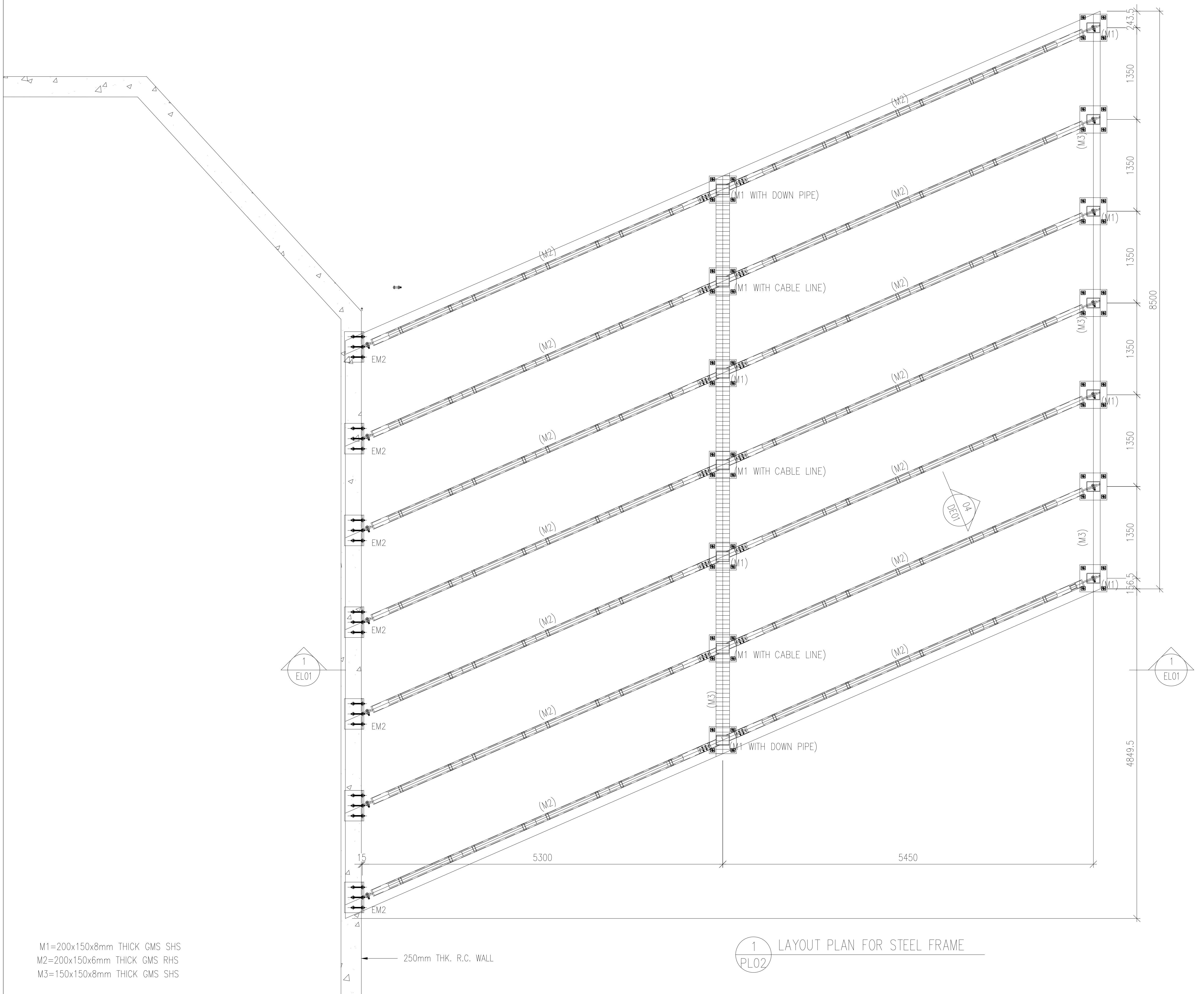
Drawing Date: 2021/01/25

Drawing: KP

Collate: Joyi

Auditing: Gray Hui

Drawing Version: 2



1 PL02 LAYOUT PLAN FOR STEEL FRAME

Drawing Status :

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Job Title:
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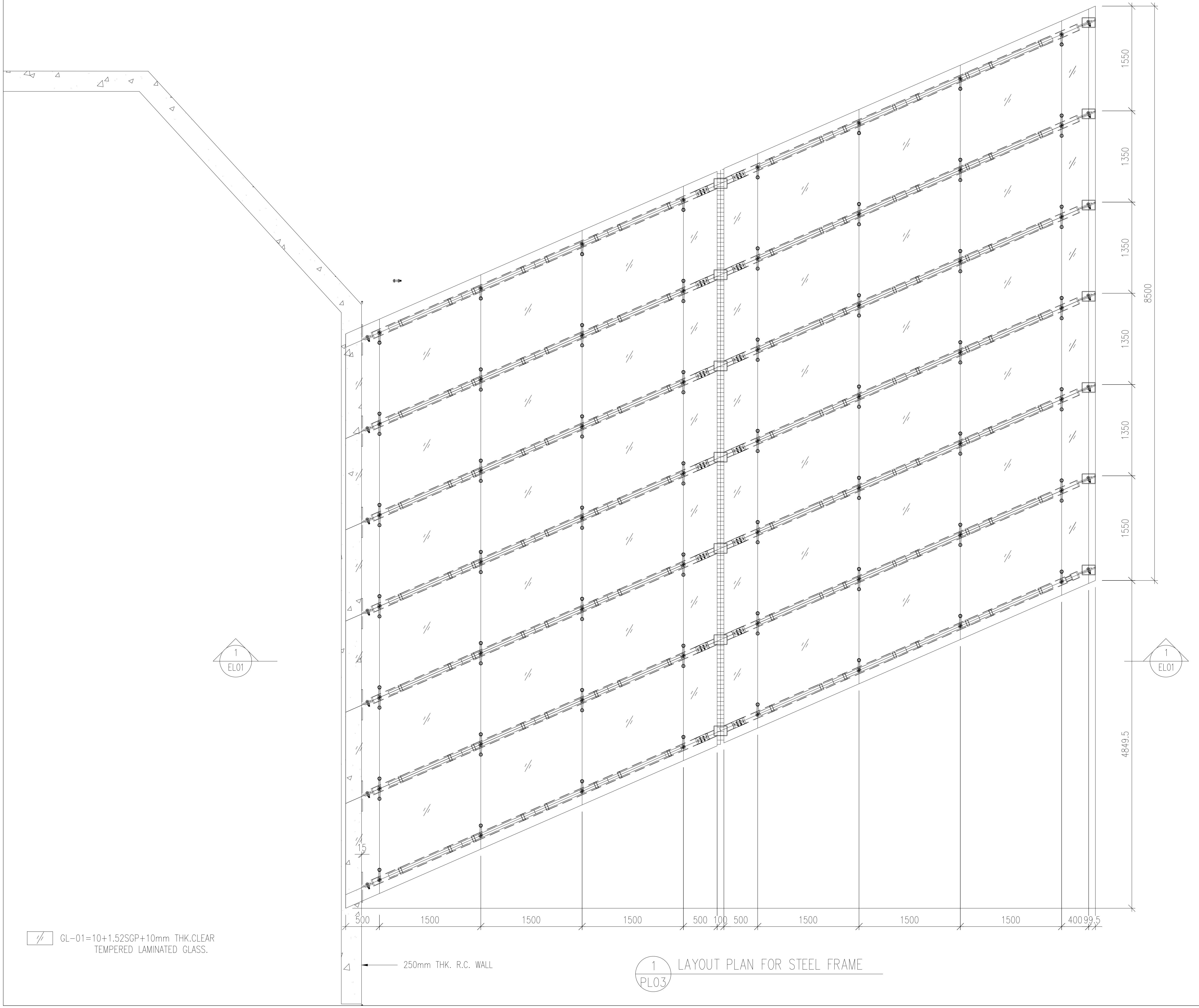
Drawing Name:
LAYOUT PLAN FOR STEEL FRAME

Drawing NO.: QPBE20034-PL02
Drawing Scale: AS SHOW
Drawing Date: 2021/01/25
Drawing: KP
Collate: Joyi
Auditing: Gray Hui
Drawing Version: 2



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Job Title:
CANOPY FOR MOTORCYCLE AND CAR TICKETING MACHINE

Drawing Name:
LAYOUT PLAN FOR GLASS ROOF

Drawing NO.: QPBE20034-PL03

Drawing Scale: AS SHOW

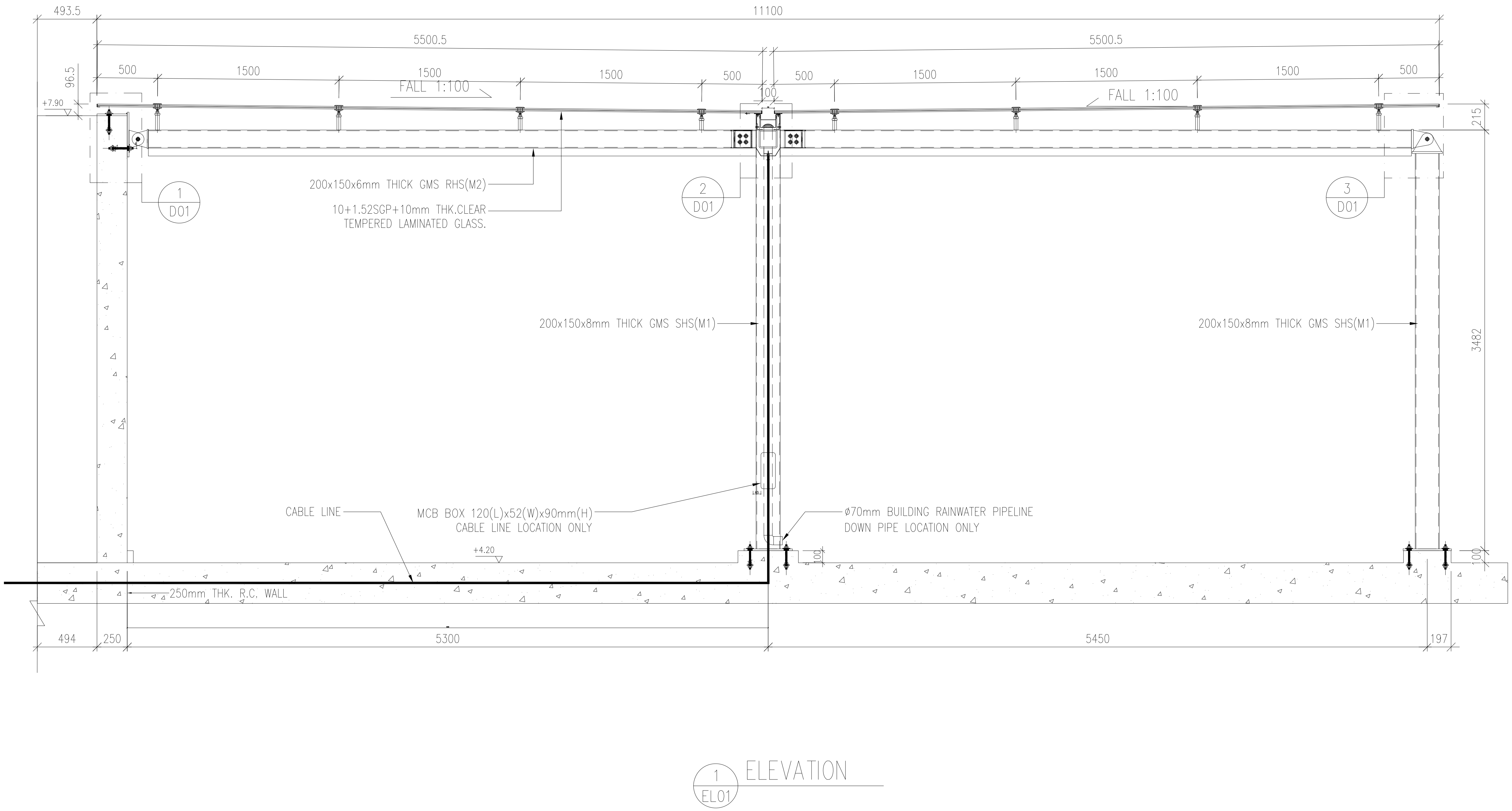
Drawing Date: 2021/01/25

Drawing: KP

Collate: Joyi

Auditing: Gray Hui

Drawing Version: 2



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Job Title:

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Drawing Name:

ELEVATION

Drawing NO.: QPBE20034-EL01

Drawing Scale: AS SHOW

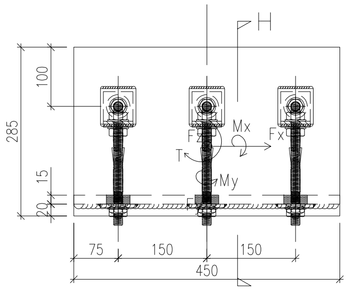
Drawing Date: 2021/01/25

Drawing: KP

Collate: Joyi

Auditing: Gray Hui

Drawing Version: 2



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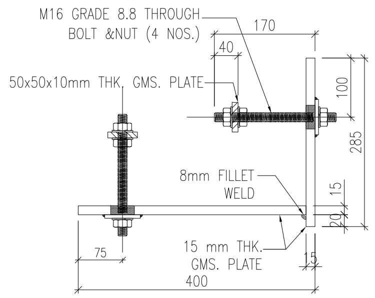

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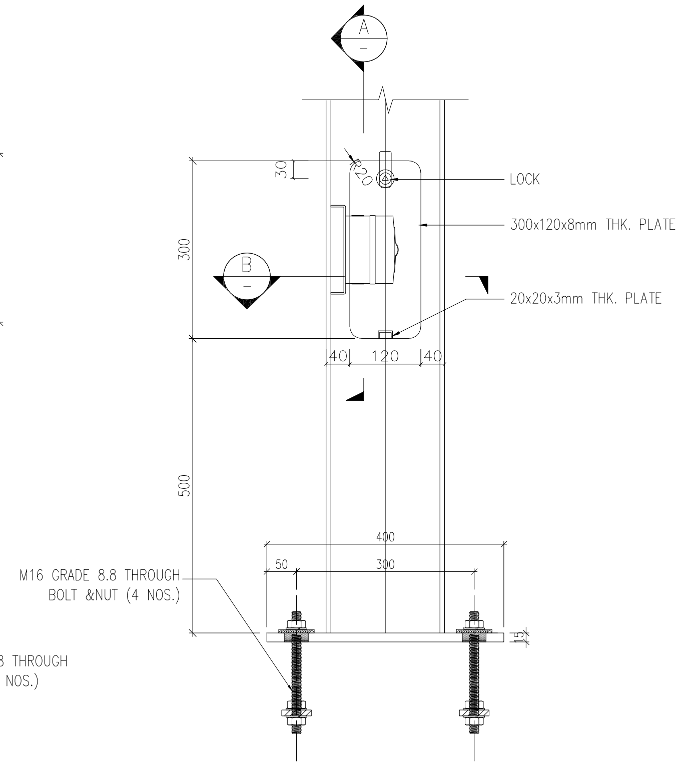
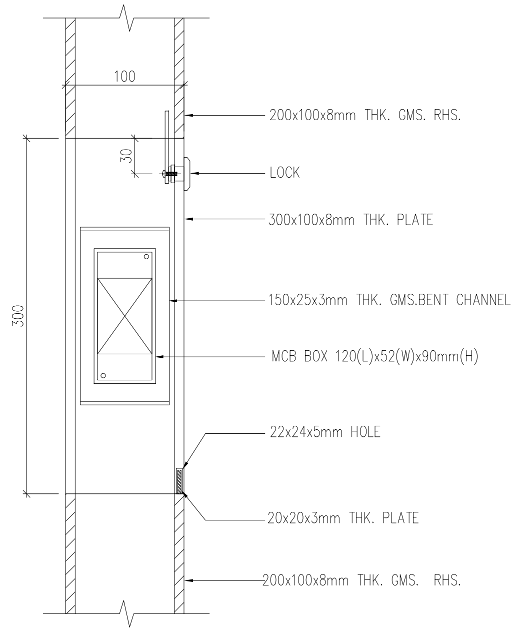
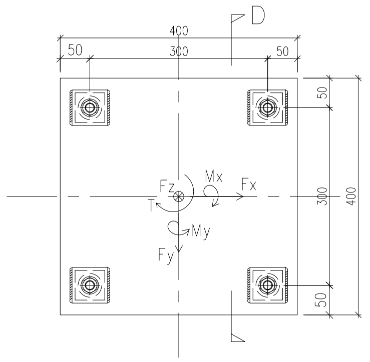


DETAIL FOR MCB BOX



SECTION A-A



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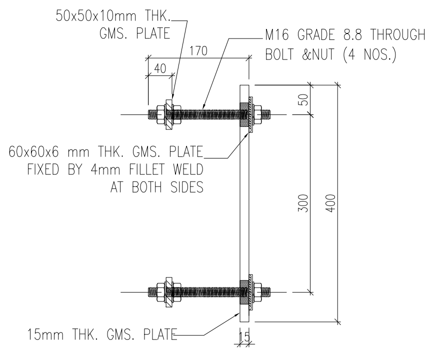

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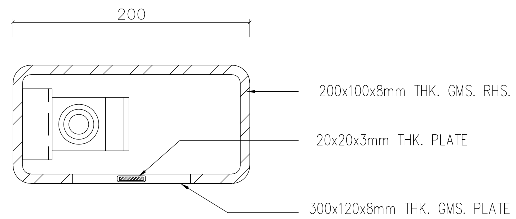

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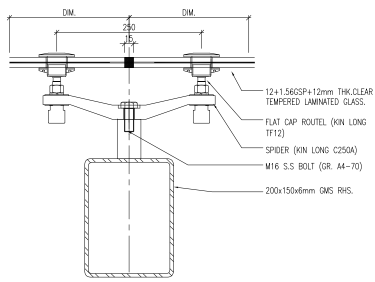

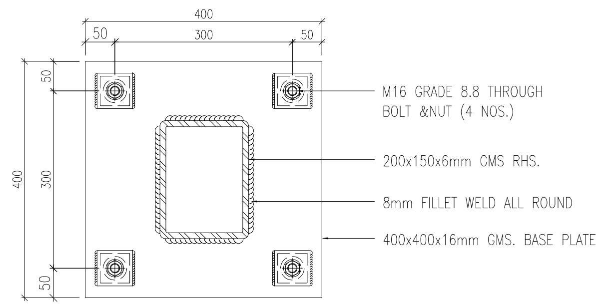

Drawing Status :

Ref NO.:

Client

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Project:
工程2 - 修改停車場閘臂位置
INTERVENÇÃO 2 - REVISÃO DA LOCALIZAÇÃO DAS CANCELAS DE ESTACIONAMENTO

Job Title:
CANOPY FOR MOTORCYCLE AND CAR TICKETING MACHINE

Drawing Name:
DETAIL FOR EMBED

Drawing NO.: QPBE20034-EM01

Drawing Scale: AS SHOW

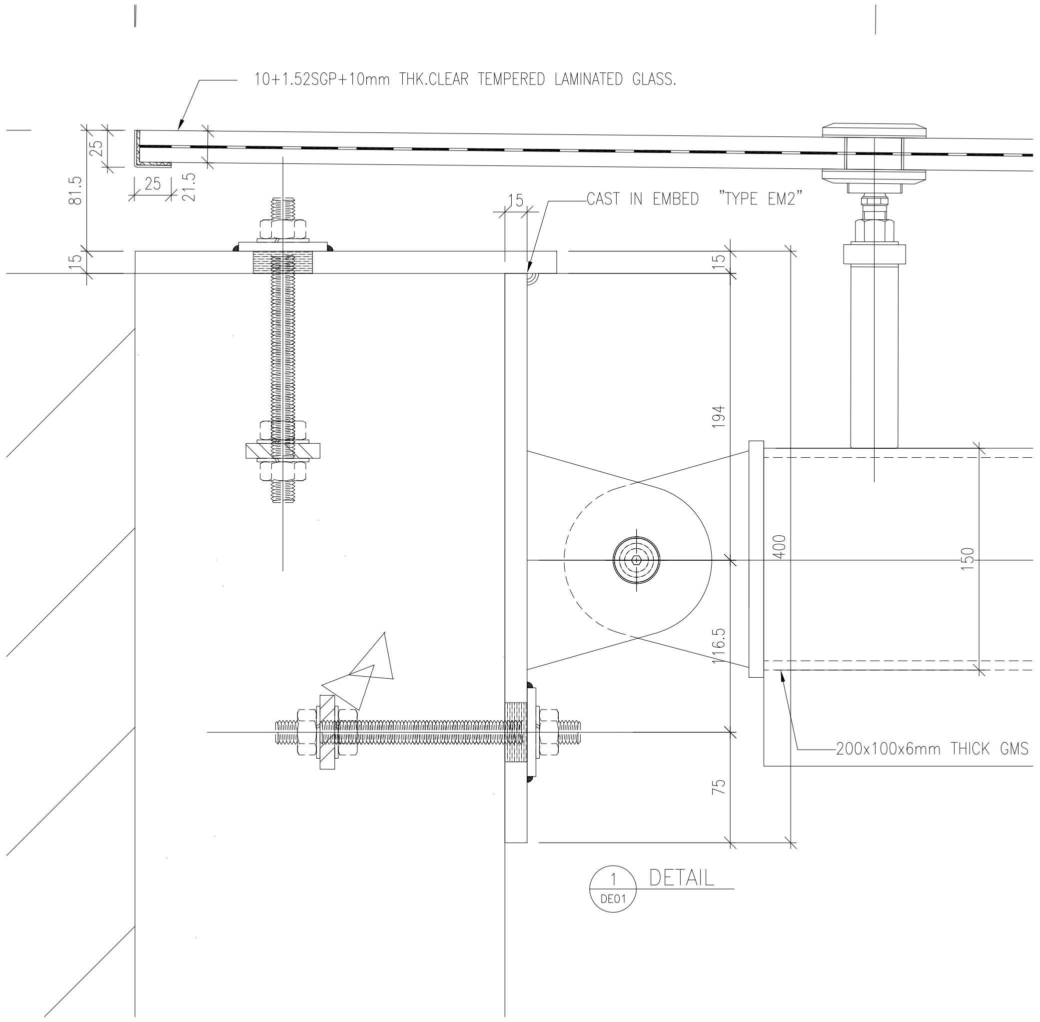
Drawing Date: 2021/01/25

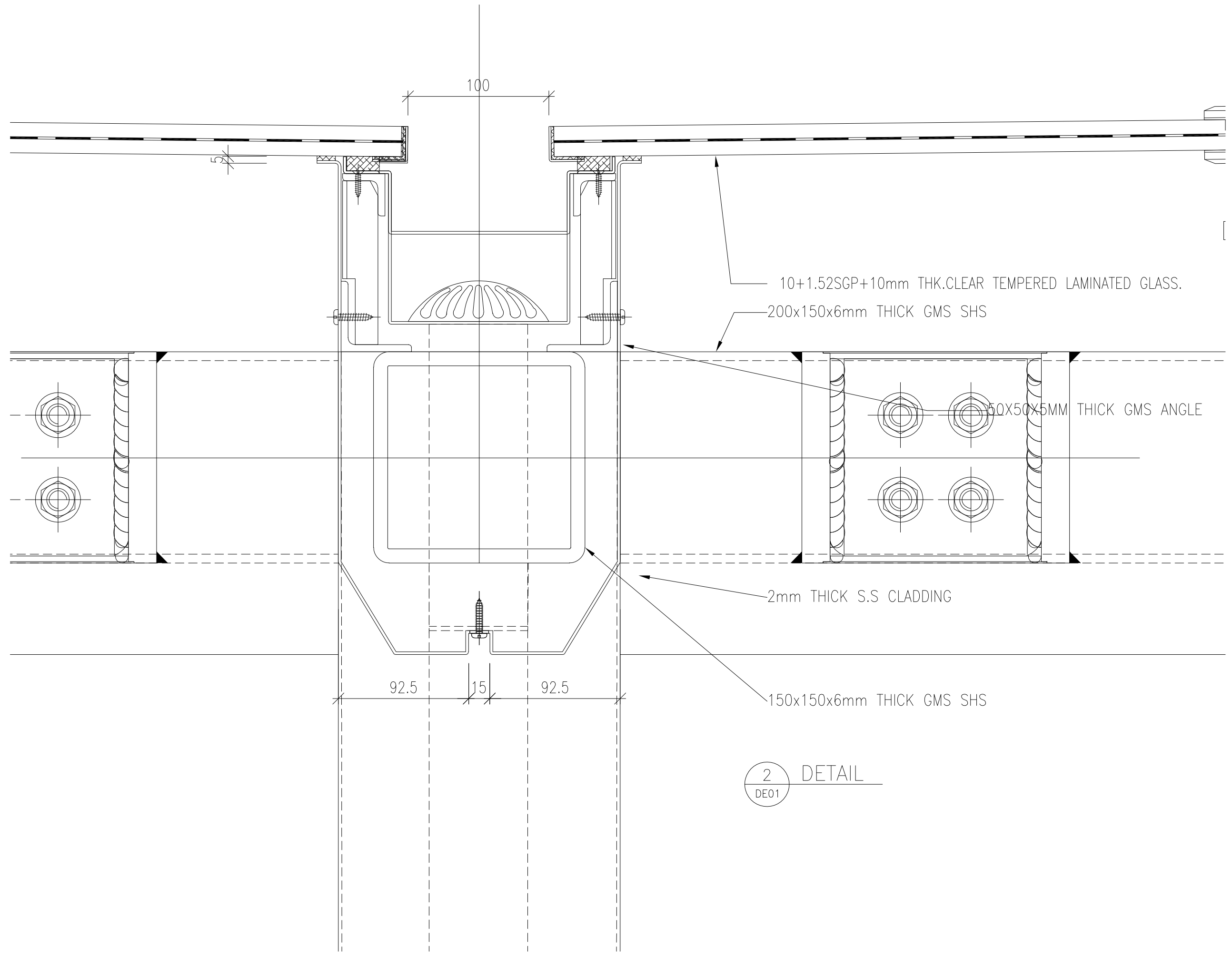
Drawing: KP

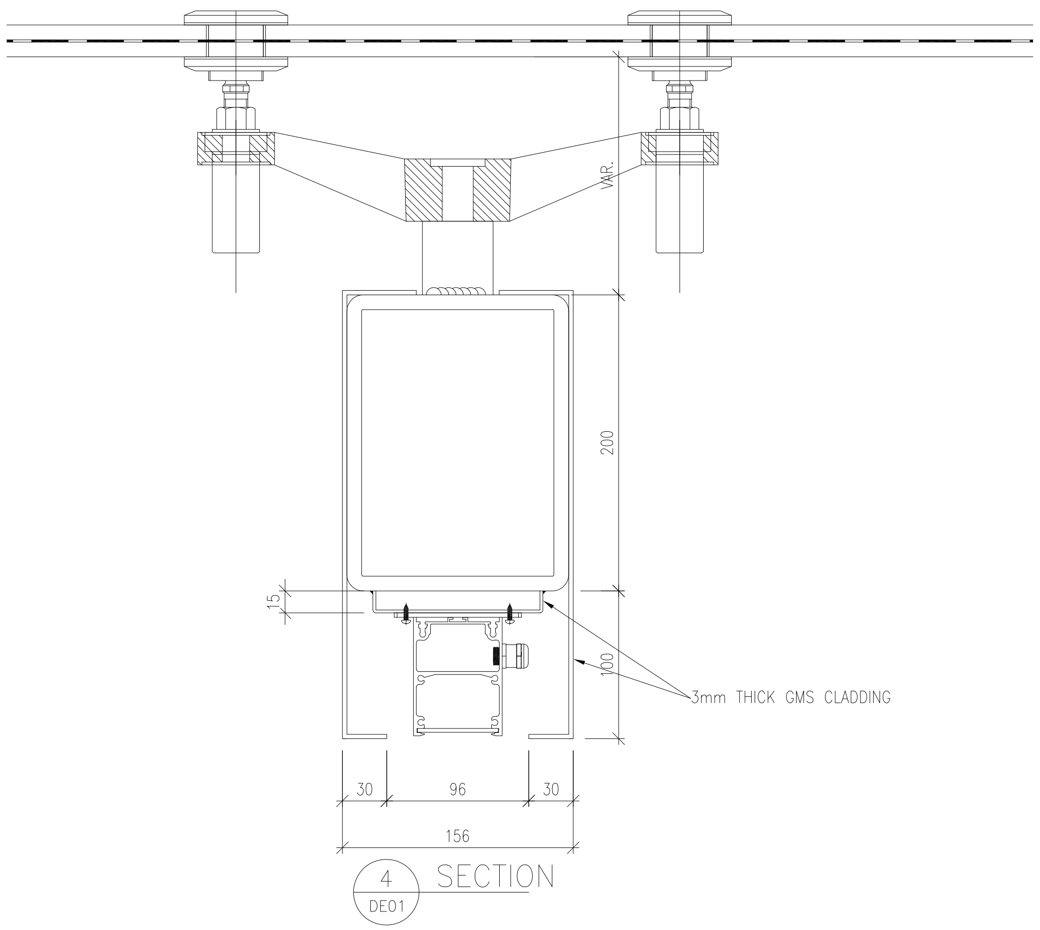
Collate: Joyi

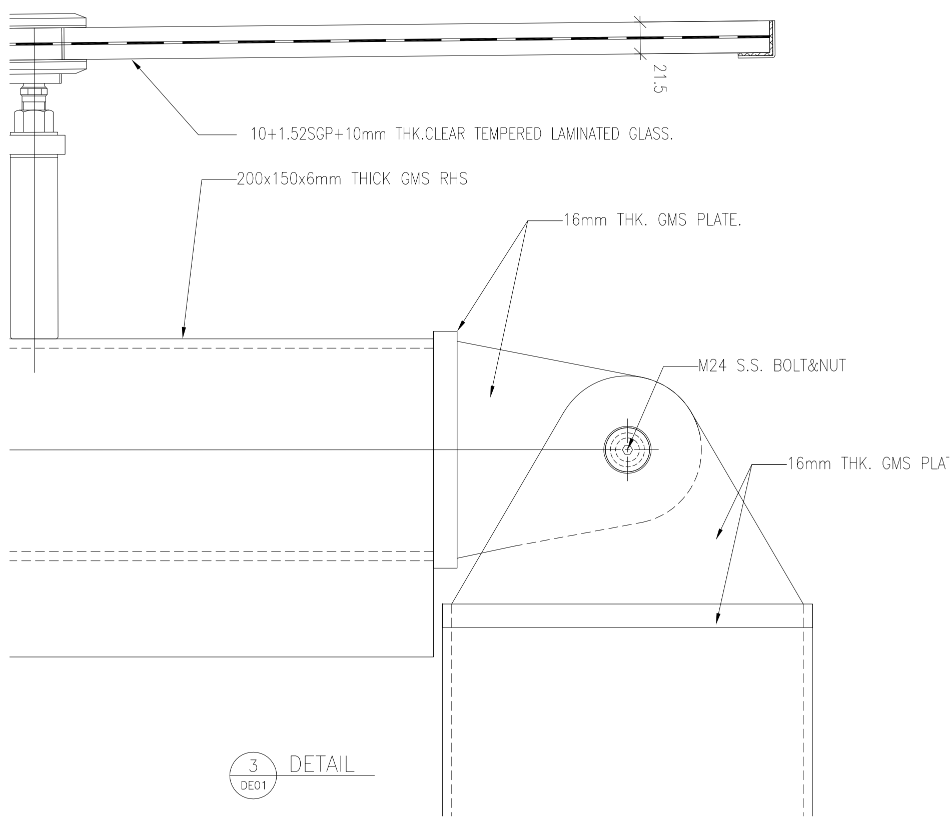
Auditing: Gray Hui

Drawing Version: 2









Drawing Status :

Ref NO.:

Client

澳 門 特 別 行 政 區 政 府
GOVERNO DA RAEM
運輸基建辦公室
G.I.T. - Gabinete para as Infra-estruturas de Transportes

Contractor:

Supplier:

DIMON
Technology

DIMON Technology Ltd.

Tel: 00852-3916 5876
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E-mail:gary@dimontechnology.com

Project:
工程2 - 修改停車場閘臂位置
INTERVENÇÃO 2 - REVISÃO DA LOCALIZAÇÃO DAS CANCELAS DE ESTACIONAMENTO

Job Title:
CANOPY FOR MOTORCYCLE AND CAR TICKETING MACHINE

Drawing Name:
DETAIL

Drawing NO.: QPBE20034-DE01

Drawing Scale: AS SHOW

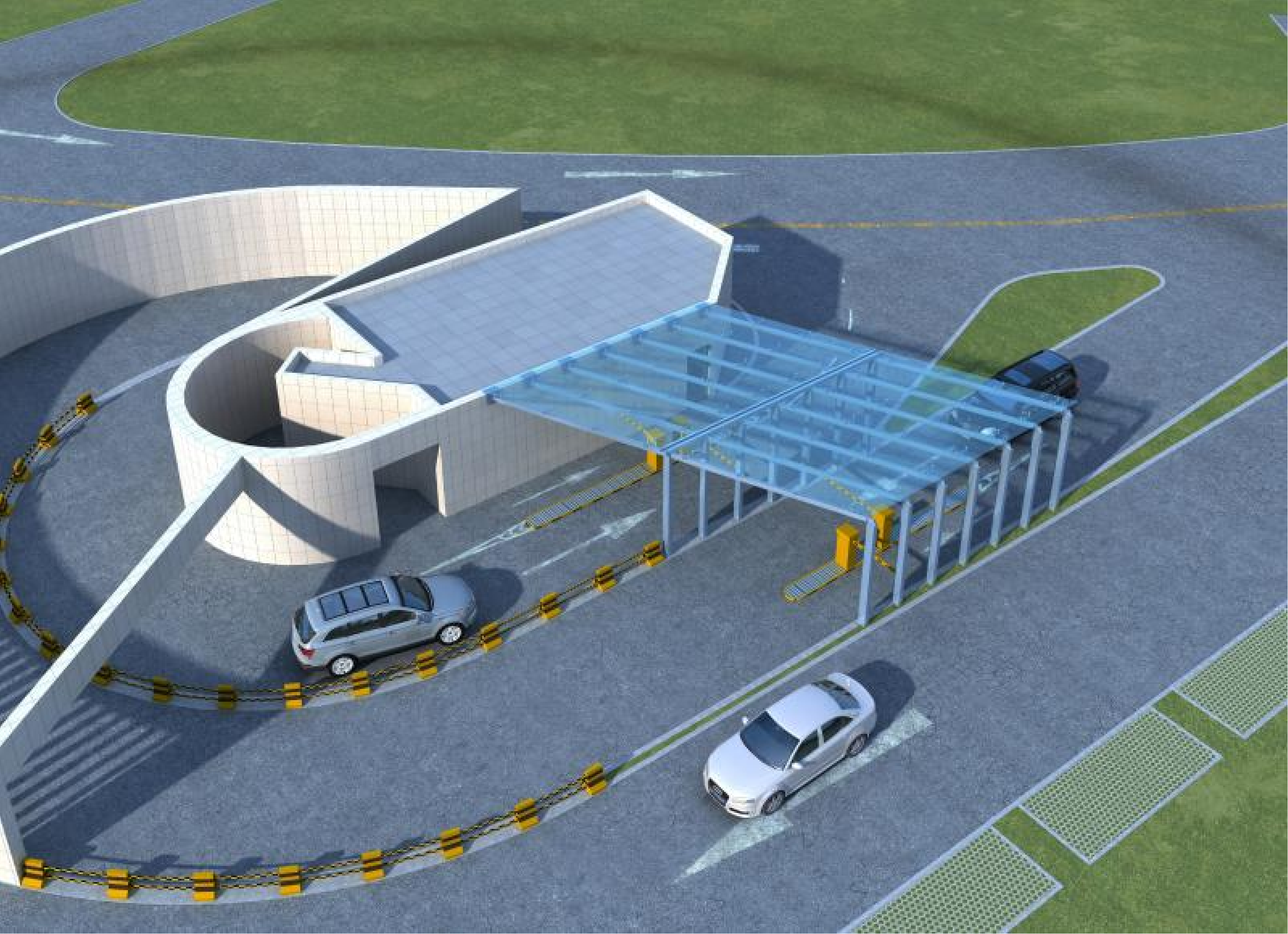
Drawing Date: 2021/01/25

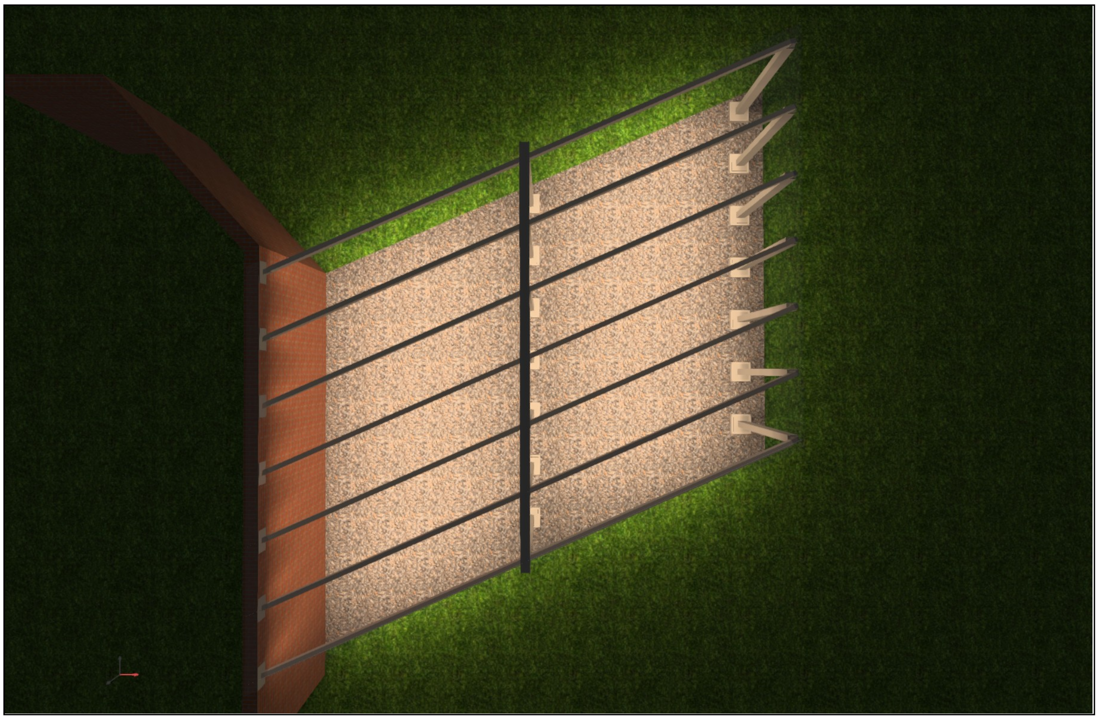
Drawing: KP

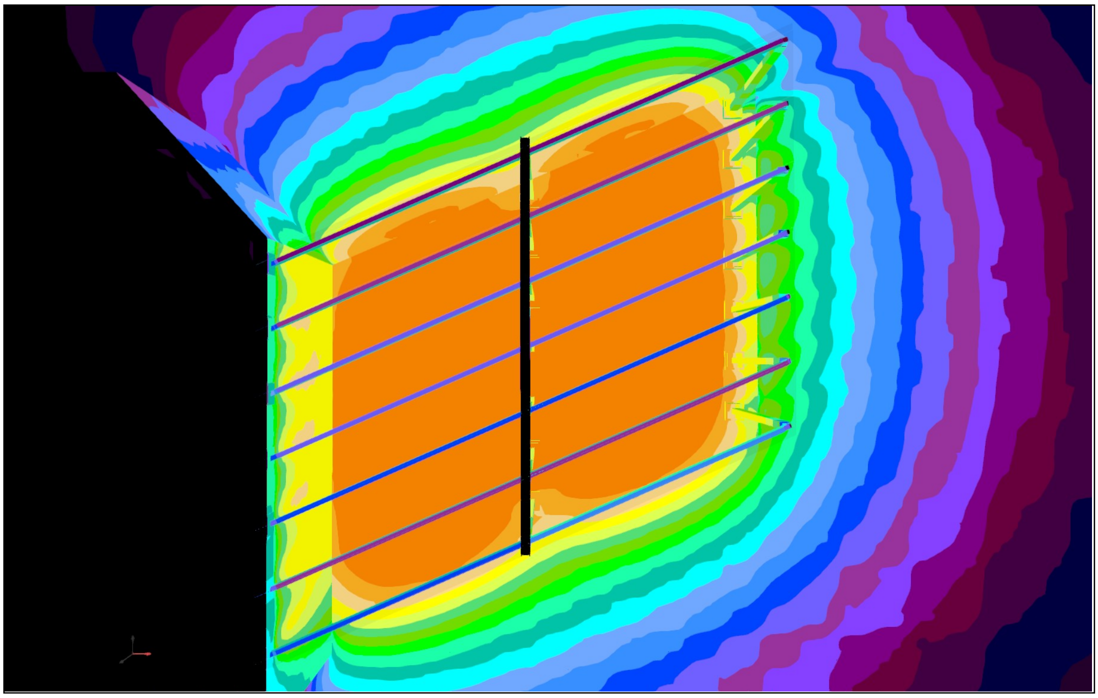
Collate: Joyi

Auditing: Gray Hui

Drawing Version: 2



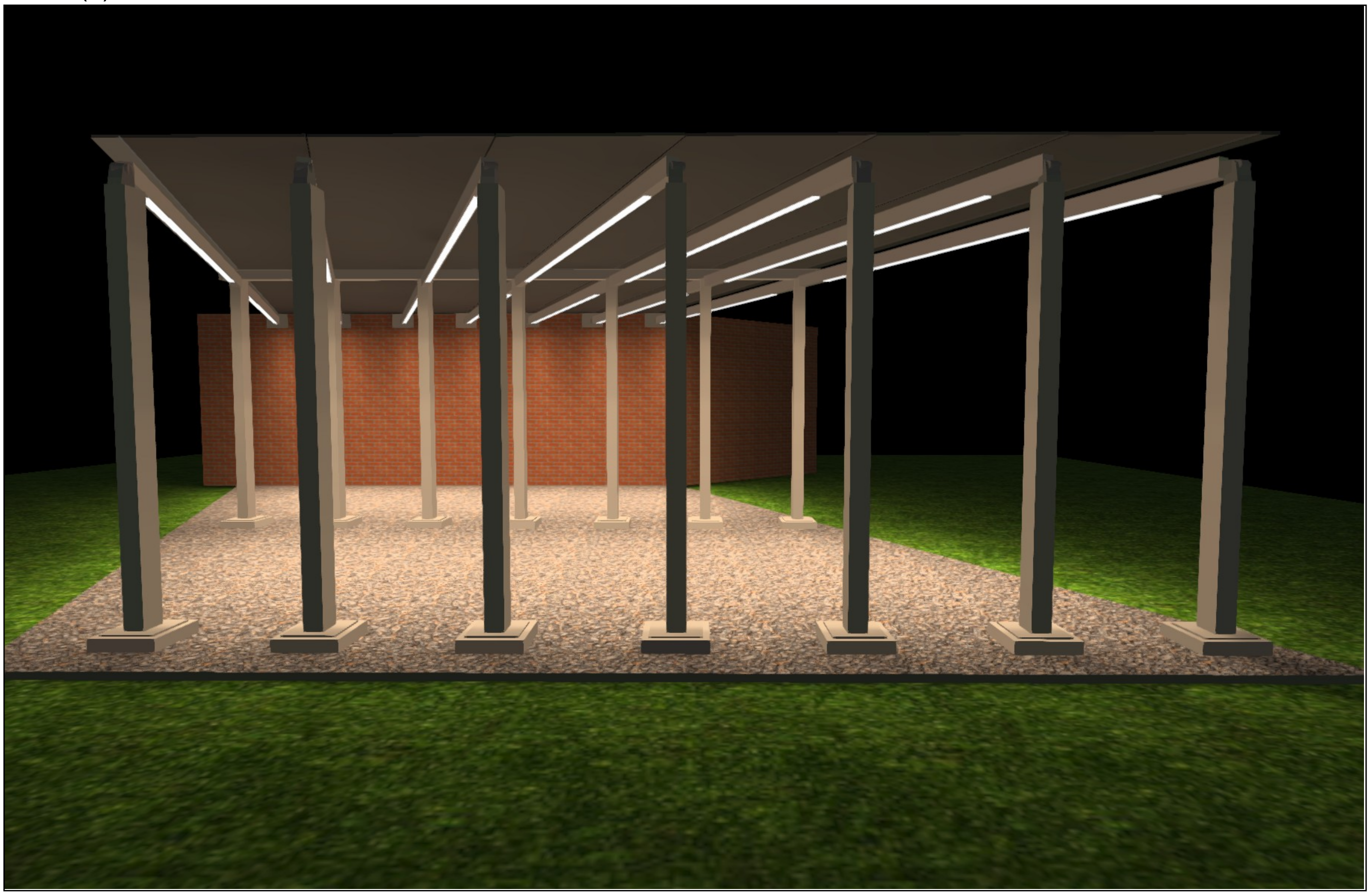




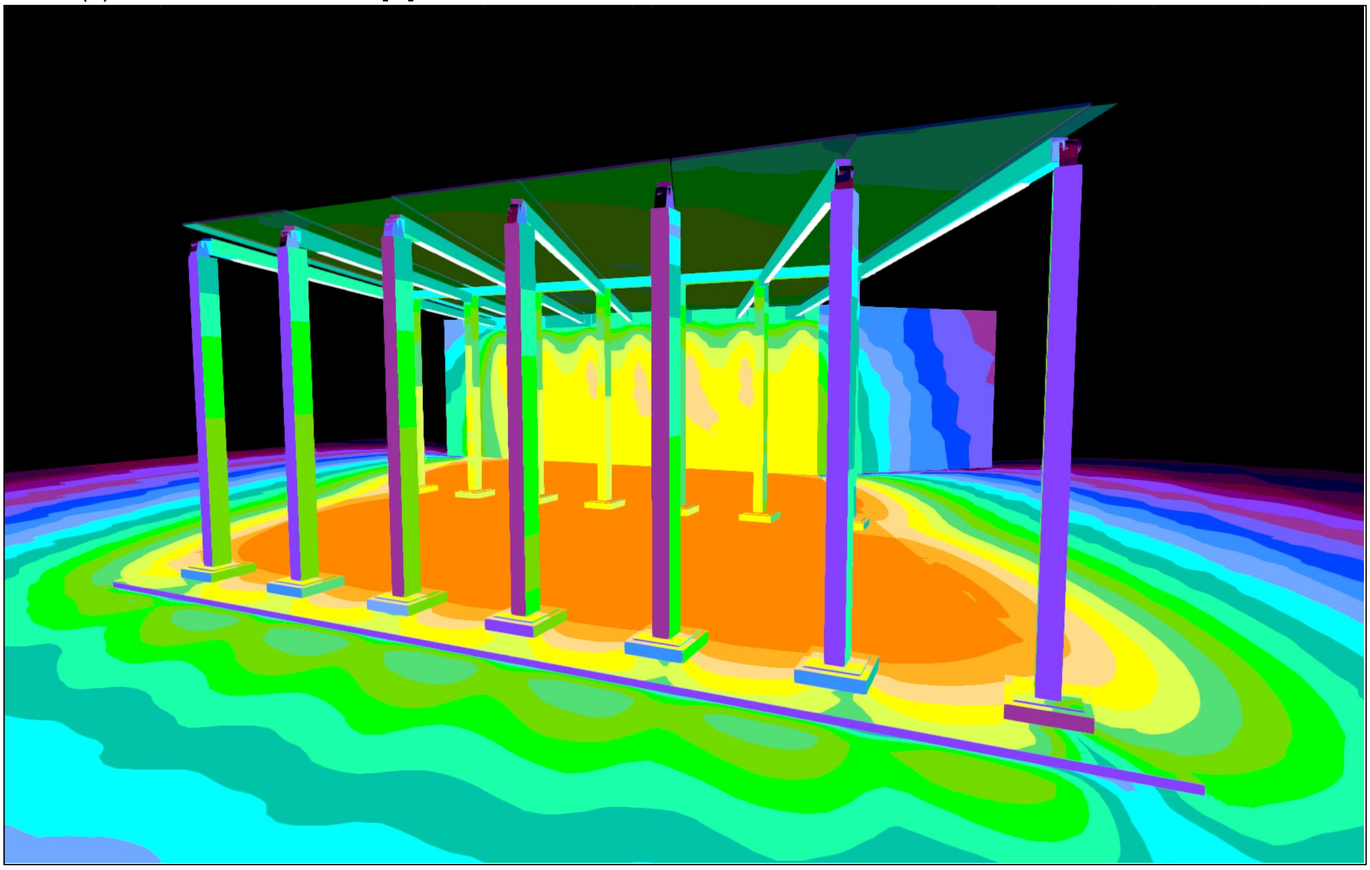
0.10	0.20	0.30	0.50	0.75	1.00	1.36	1.86	2.54	3.47	4.75	6.48	8.86	12	17
23	31	42	57	79	107	146	200 [lx]							

Lux Simulation_V7_200716

Site 1 (3)



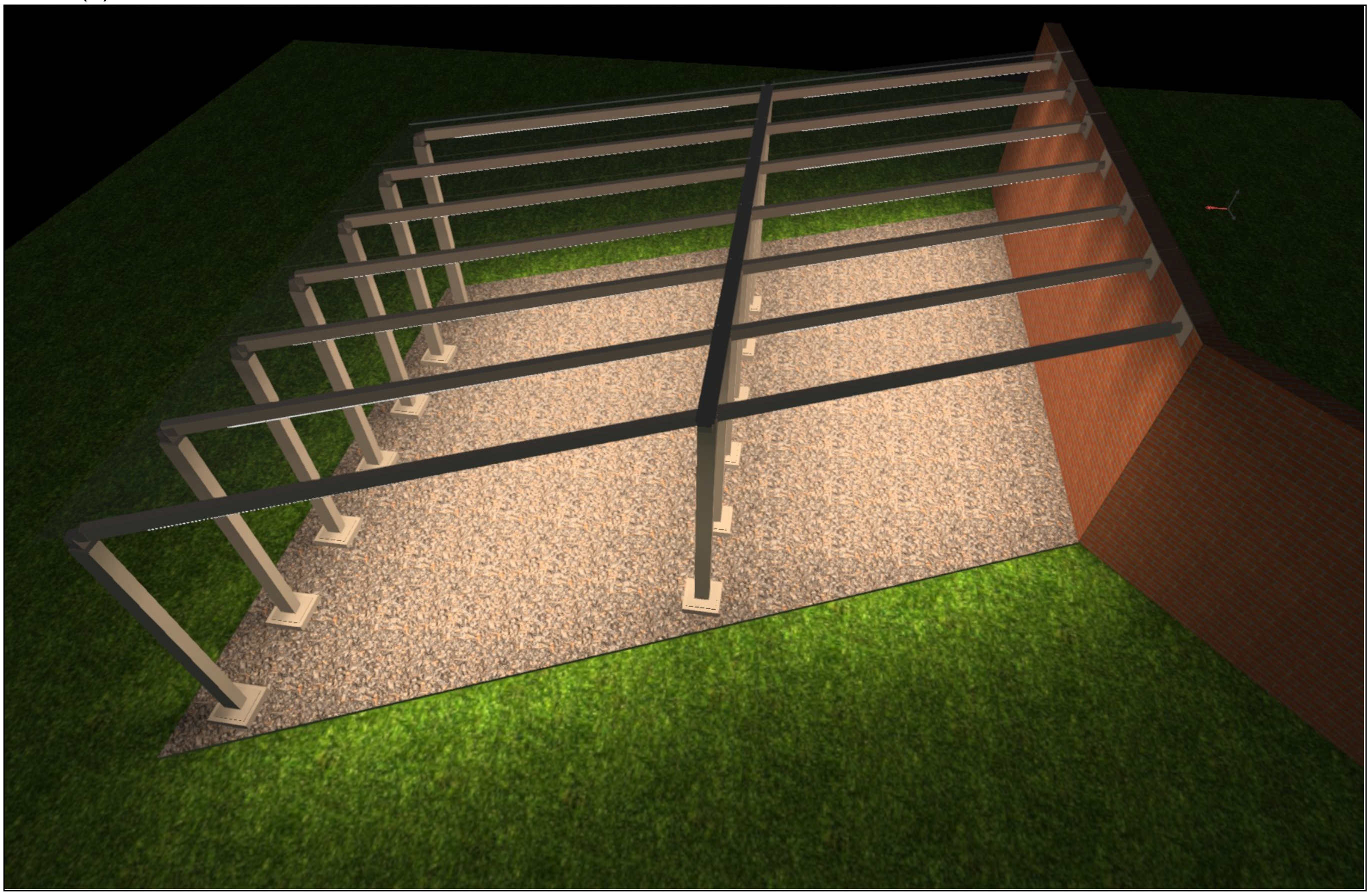
Site 1 (4), Illuminance values in [lx]



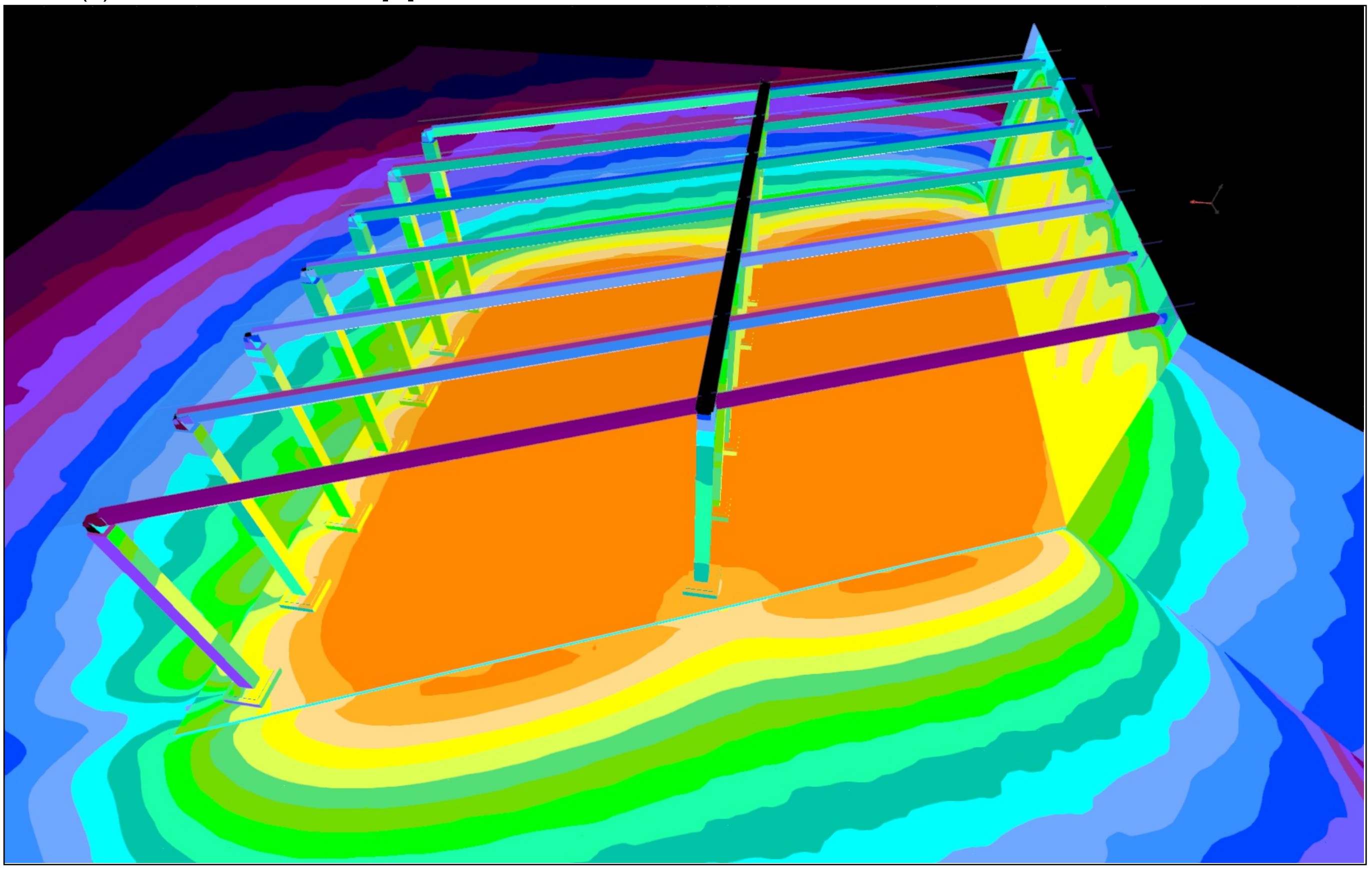
0.10	0.20	0.30	0.50	0.75	1.00	1.36	1.86	2.54	3.47	4.75	6.48	8.86	12	17
23	31	42	57	79	107	146	200 [lx]							

Site 1

Site 1 (5)



Site 1 (6), Illuminance values in [lx]

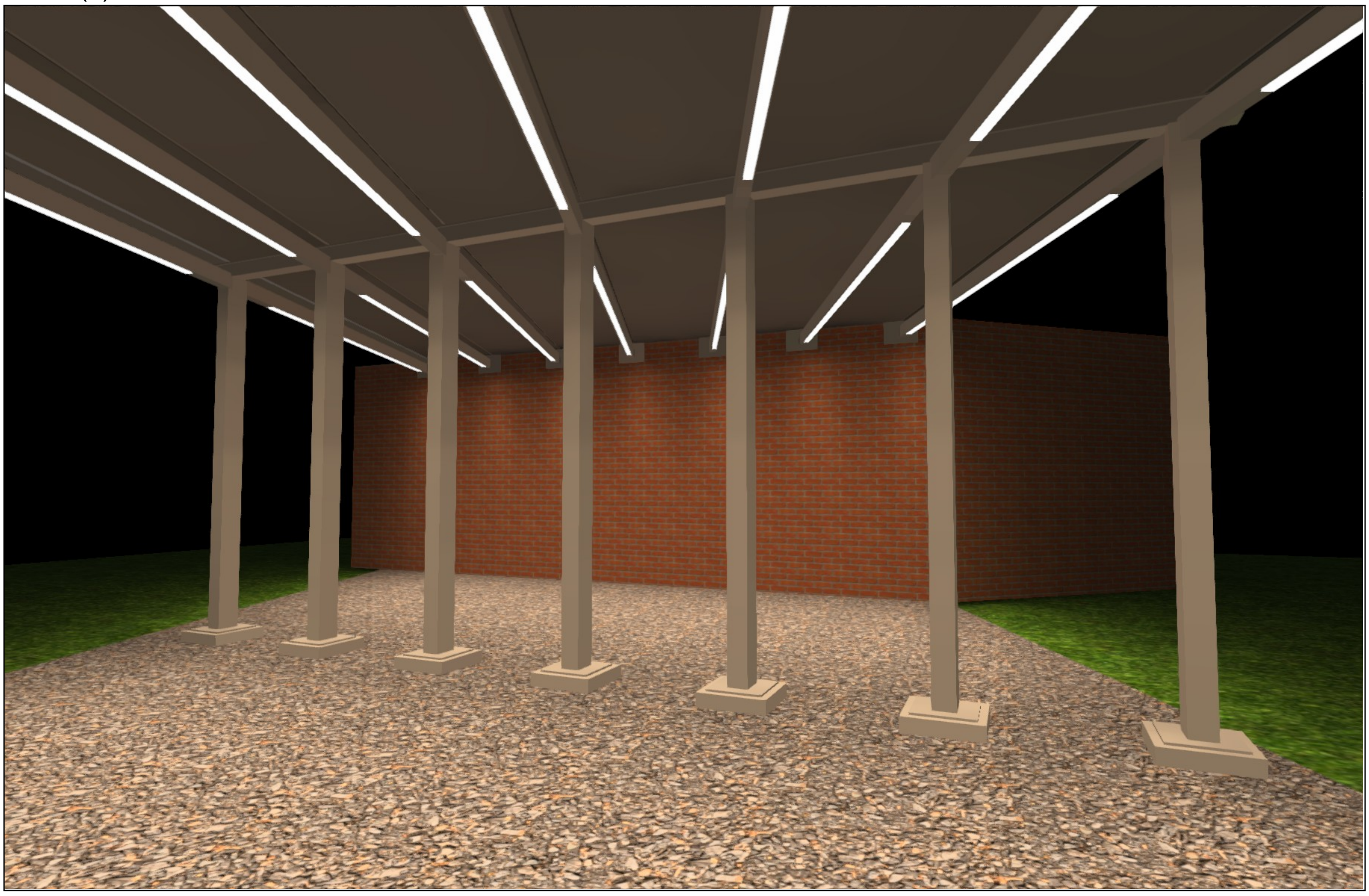


0.10	0.20	0.30	0.50	0.75	1.00	1.36	1.86	2.54	3.47	4.75	6.48	8.86	12	17
23	31	42	57	79	107	146	200 [lx]							

Assessment zone 1

Site 1 (7)

Site 1 (8)



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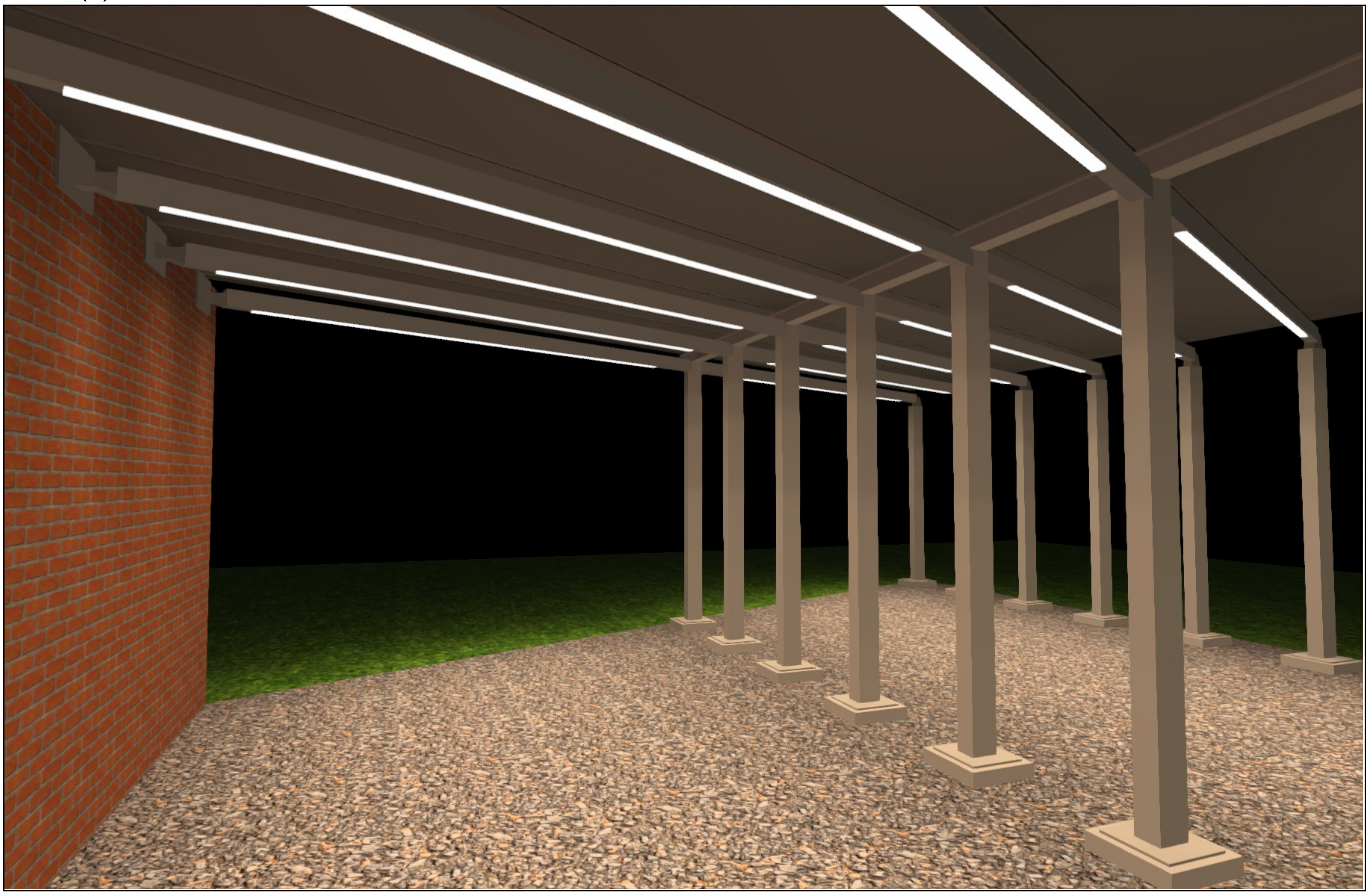
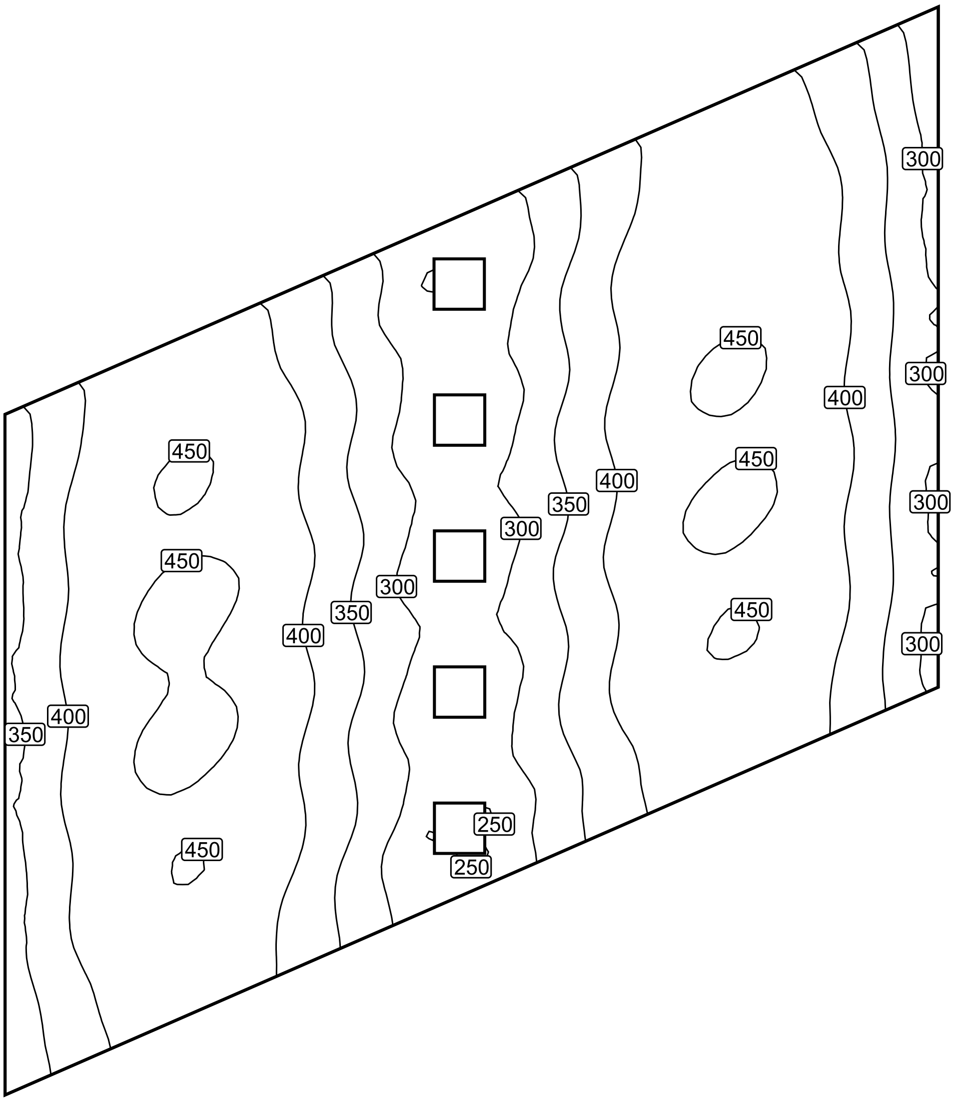
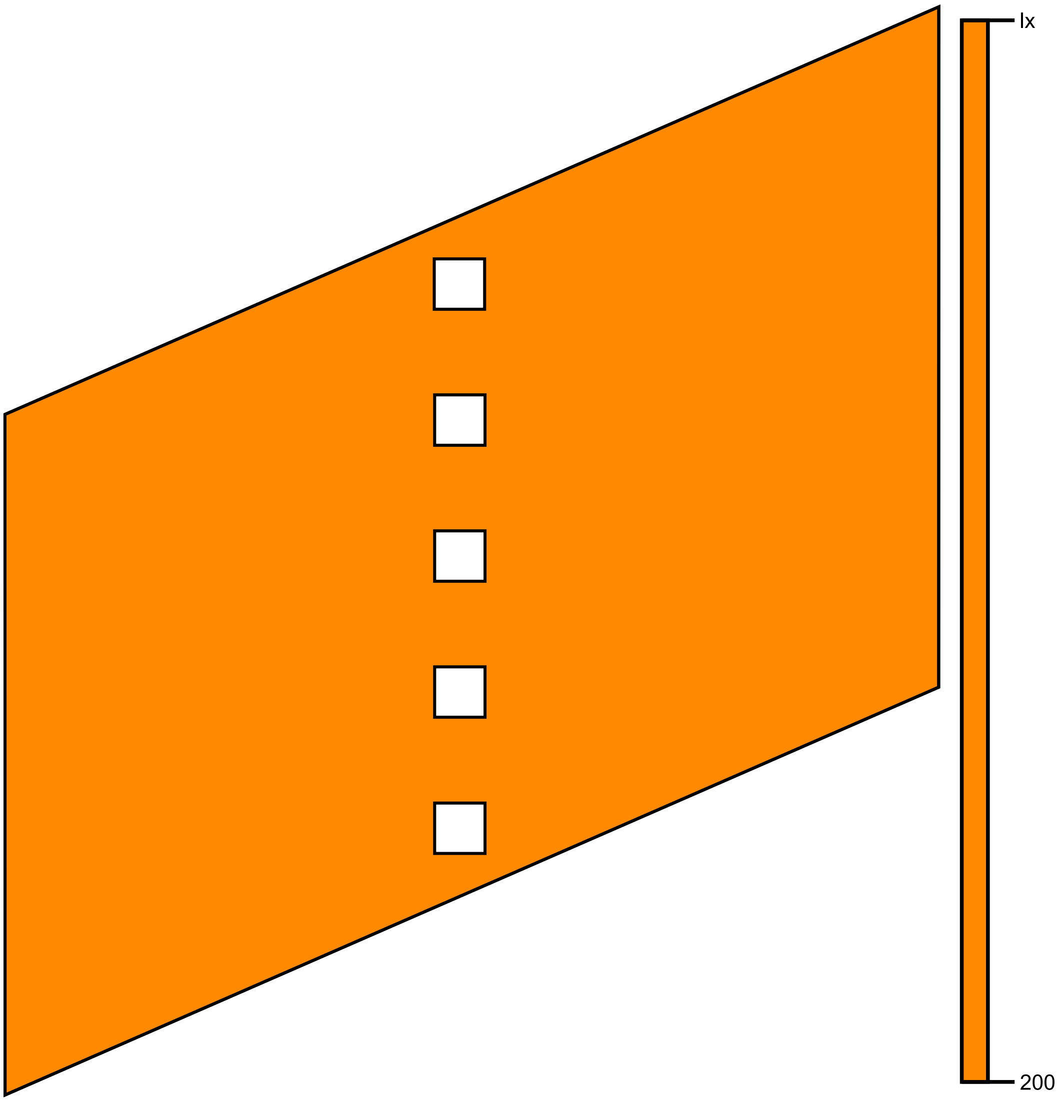


Isolines [lx]



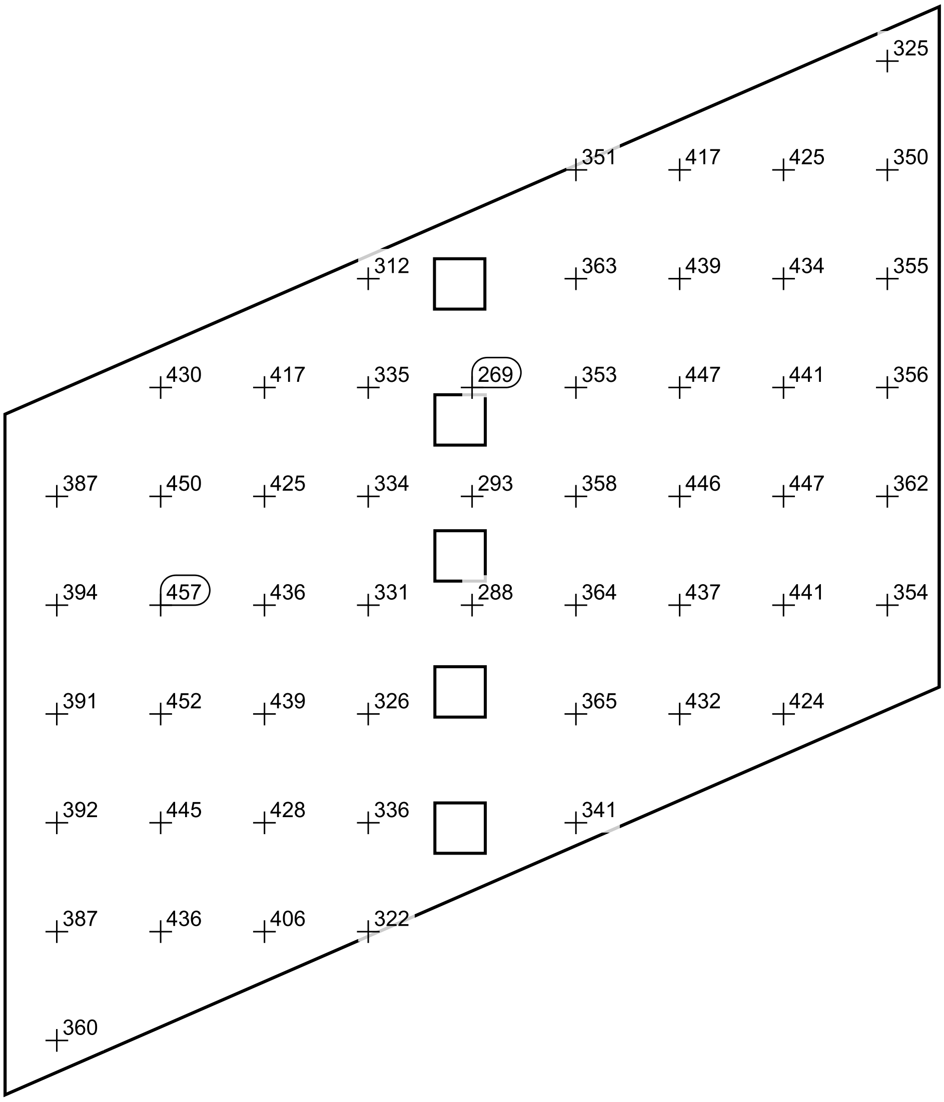
Scale: 1 : 75

False colours [lx]



Scale: 1 : 75

Value grid [lx]



Scale: 1 : 75

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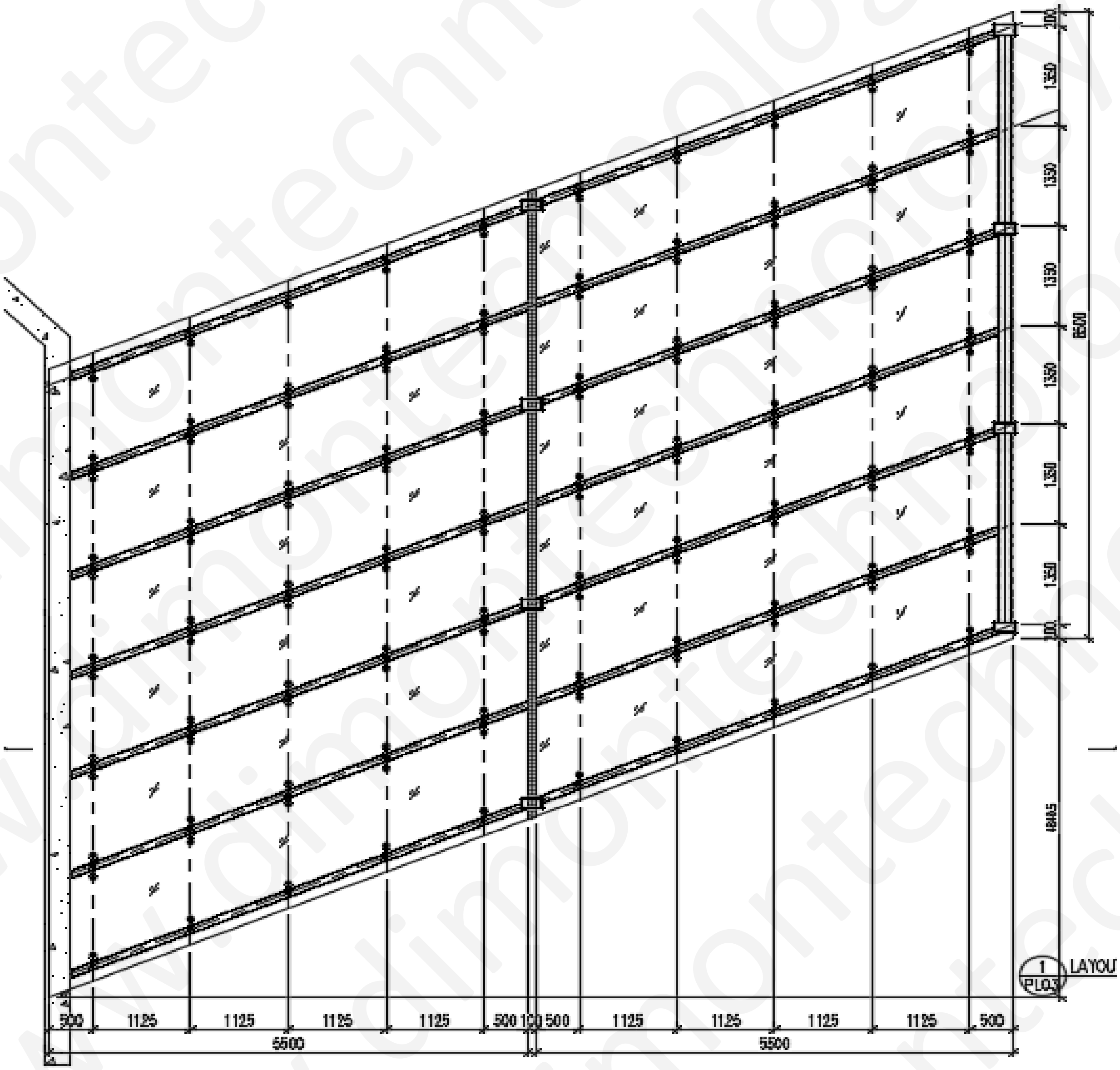
1. Introduction

The skylights are made of 12+12mm thick laminated tempered glass fixed to s.s. RHS by means of stainless steel spider system. The objective of this calculation is to check the design of skylight to be safe against the dead load, live load and wind load.

Load path

Wind load to skylight ➞ glass panels ➞ s.s. spiders ➞ steel RHS frame ➞ gms embeds ➞ r.c. structures



2. Design Code, Design Data

2.1 Design Code

a) Hong Kong Building (Construction) Regulation 1990 (Amendment 2011).
b) Code of Practice on Wind Effect 2008, Macau.
c) Code of Practice for the Structural Use of Steel 2011, Hong Kong
d) Code of Practice for the Structural Use of Concrete 2004, Hong Kong
e) Code of Practice for Dead and imposed Loads 2011, Hong Kong
f) Code of Practice for the Structural Use of Steel GB 50017-2003
g) Load Code of the design of buliding structure GB 50009-2012

2.2 Design Data

2.2.1 The design of steelwork to be complied with 'Code of Practice for the Structural Use of Steel 2011, Hong Kong' and 'Code of Practice for the Structural Use of Steel Macau The Steel sections to be grade Q345 complied to comply with GB/t 706-2008 and GB/t 3274-2007.

steel grade			Q345
thickness		(mm)	≤16
ultimate tensile strength,	U_s	(N/mm^2)	400
design strength,	p_y	(N/mm^2)	310
design shear strength,	v_c	(N/mm^2)	180
Modulus of Elasticity,	E_s	(N/mm^2)	206000

2.2.2 All welding to be complied with complied to GB50661-2011

steel grade		E50xx
design strength of filled weld	(N/mm^2)	200

2.2.3 ALL ordinary bolts to be complied with BS 4190

grade		8.8
ultimate tensile strength,	(N/mm^2)	800
design strength,	(N/mm^2)	450
design shear strength,	(N/mm^2)	375
design bearing strength,	(N/mm^2)	1000

2.2.4 Concrete

concrete strength,	f_{cu}	(N/mm^2)	45	
anchorage bond strength, (= $\beta\ f_{cu}^{0.5}$)	f_{bu}	(N/mm^2)	1.878	β = 0.28 for cast-in threaded rod
design concrete shear stress,	v_c	(N/mm^2)	0.4	
compressive strength, (= 0.6 f_{cu})		(N/mm^2)	27	

2.2.5 The date refer to SAP2000 program.

3. Design Load

3.1 Wind load

Wind pressure, q_z = 2.12 kPa (height above ground level ≤20m)

Pressure coefficient, = 2 (open frame)

Design wind load = 2.12 x 2.0
= 4.24 kPa

3.2 Live load

Live load = 0.75 kN/m^2

3.3 Dead Load

Weight of glass	= (12 + 12) x 26.5 / 1000	=	0.636	kPa
Others,	=	=	0.064	kPa
	Total	=	0.7	kPa

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4. Check for laminated tempered glass

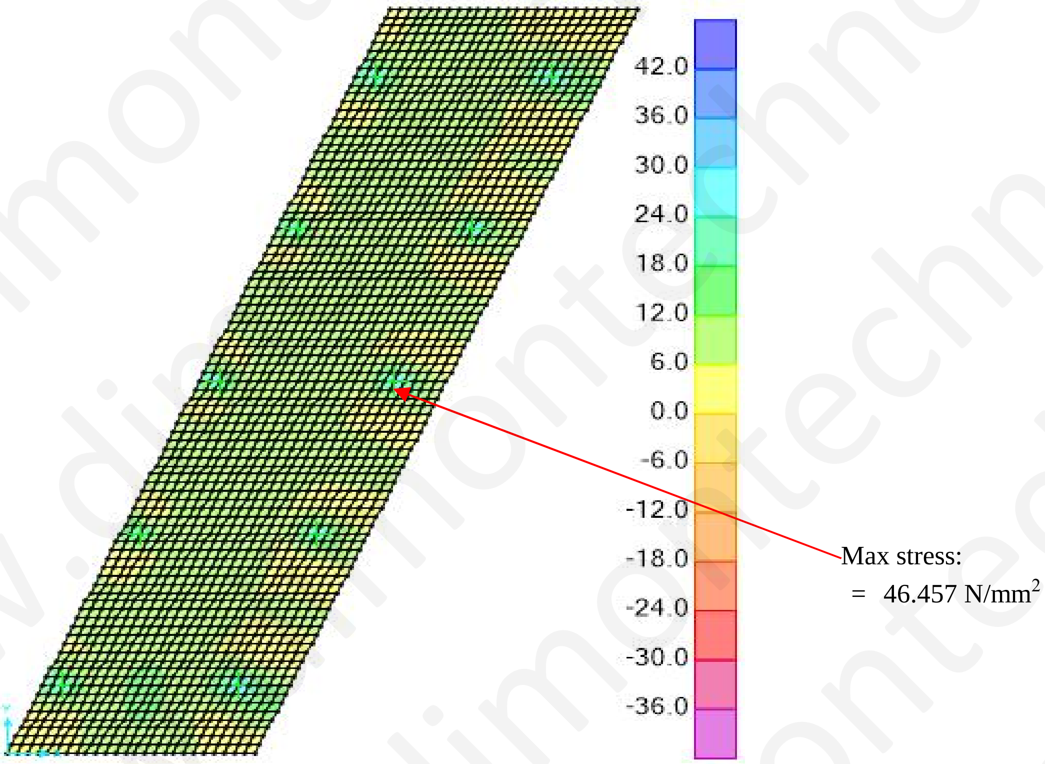
4.1 Check for 12mm+1.56PVB+12mm clear laminated tempered glass

Glass density,	ρ	=	2650	kg/m^3				
Nominal thickness of glass pane 1		=	12	mm	Min. thickness of glass pane 1, t_1	=	11.91	mm
Nominal thickness of glass pane 2		=	12	mm	Min. thickness of glass pane 2, t_2	=	11.91	mm

Glass type for pane 1 & 2	:	tempered	Ultimate design strength, p_y	=	80	N/mm^2
Load duration	:	short term	Reduction factor, γ_d	=	1	
Surface treatment	:	clear	Reduction factor, γ_s	=	1	
			Material factor, γ_m	=	1	

Ultimate resistance strength, $R_{ult} = p_y \gamma_d \gamma_s / \gamma_m = 80$ N/mm^2

Comb 1: 1.3DL + 1.05LL + 0.9WL;



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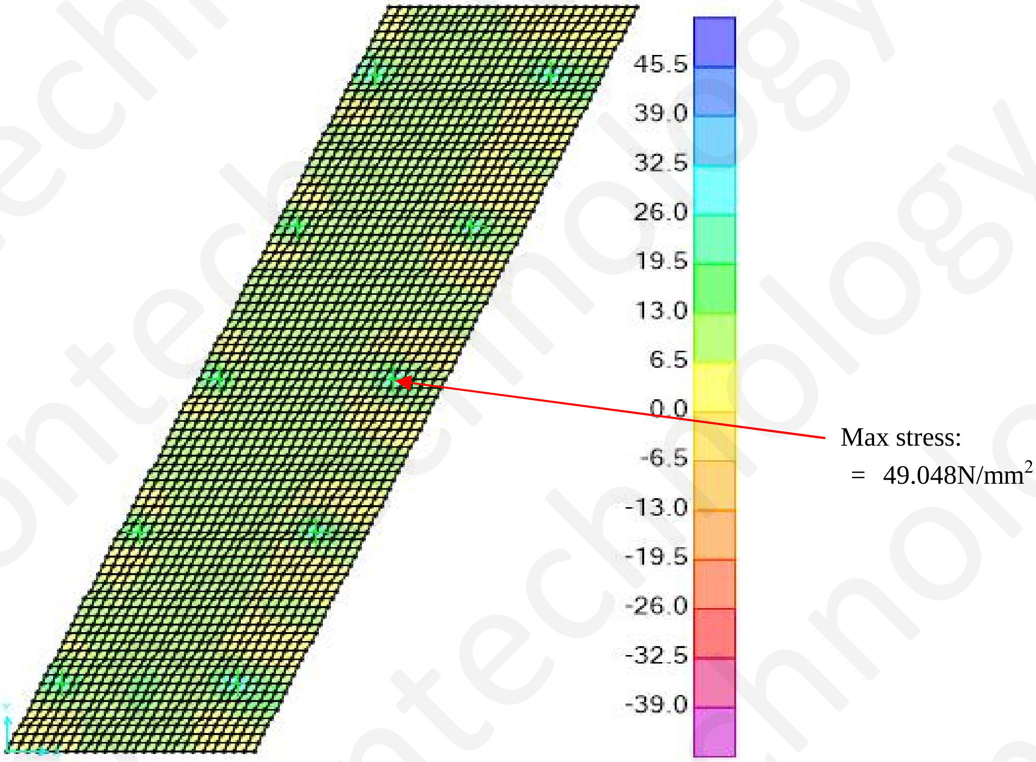
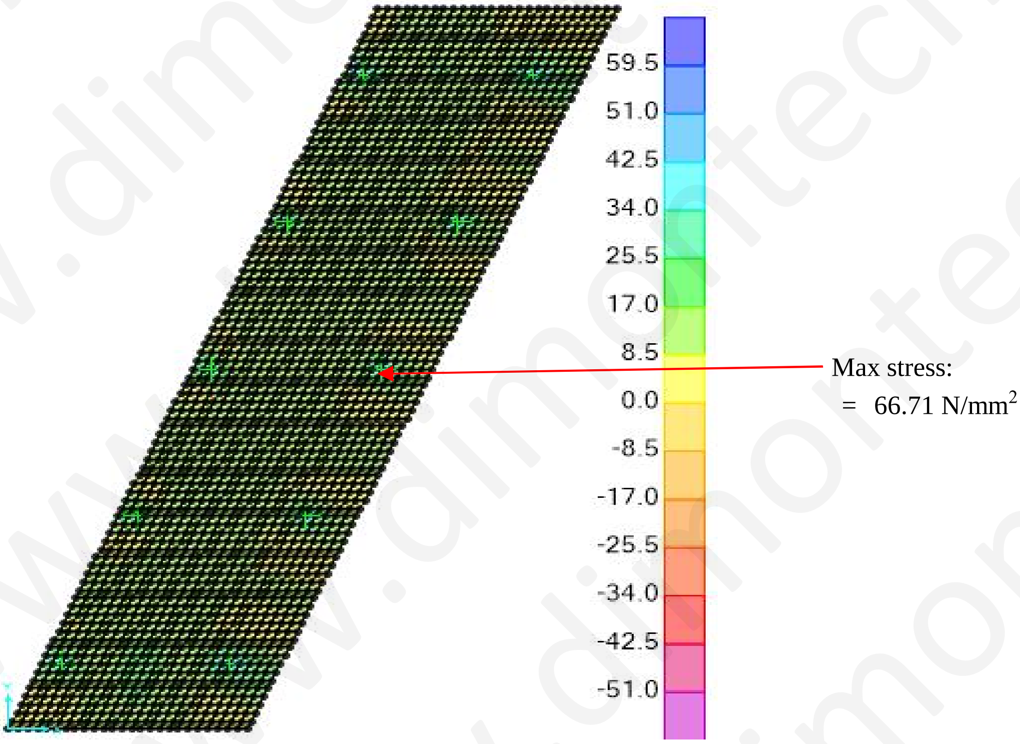
Comb 2: 1.2DL + 1.5LL + 0.9WL;



Comb 3: 1.2DL + 1.05LL + 1.5WL;



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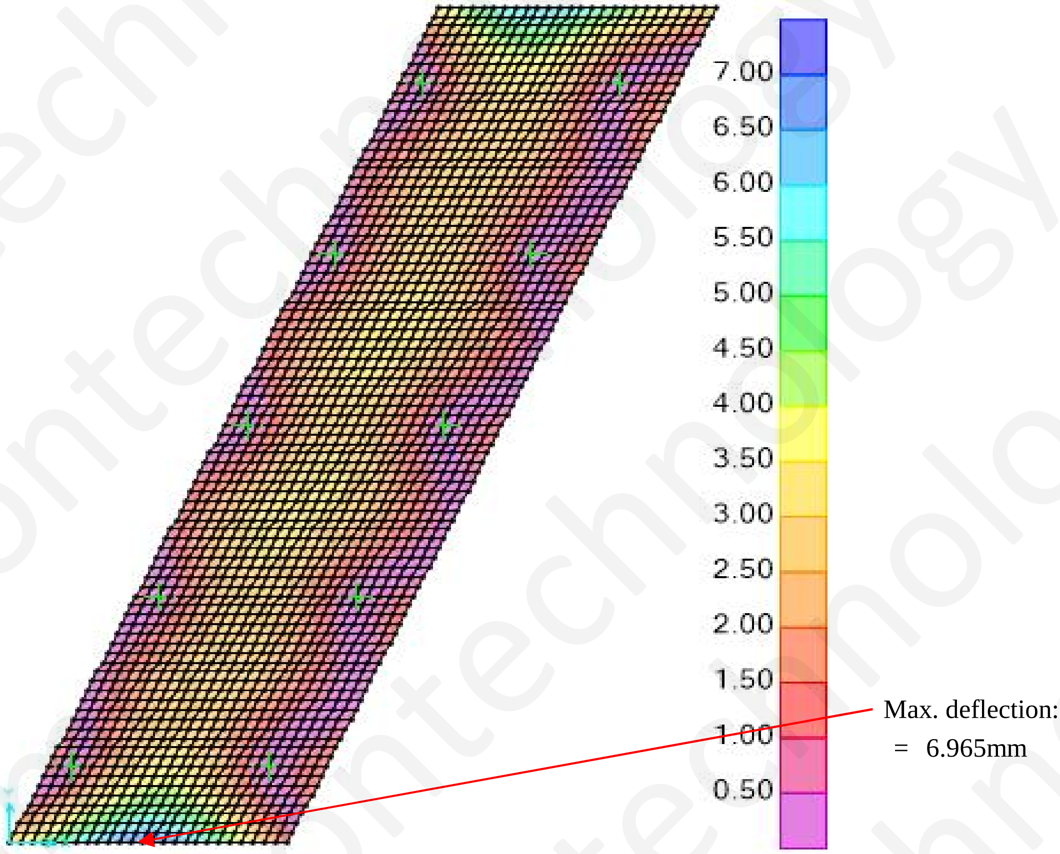
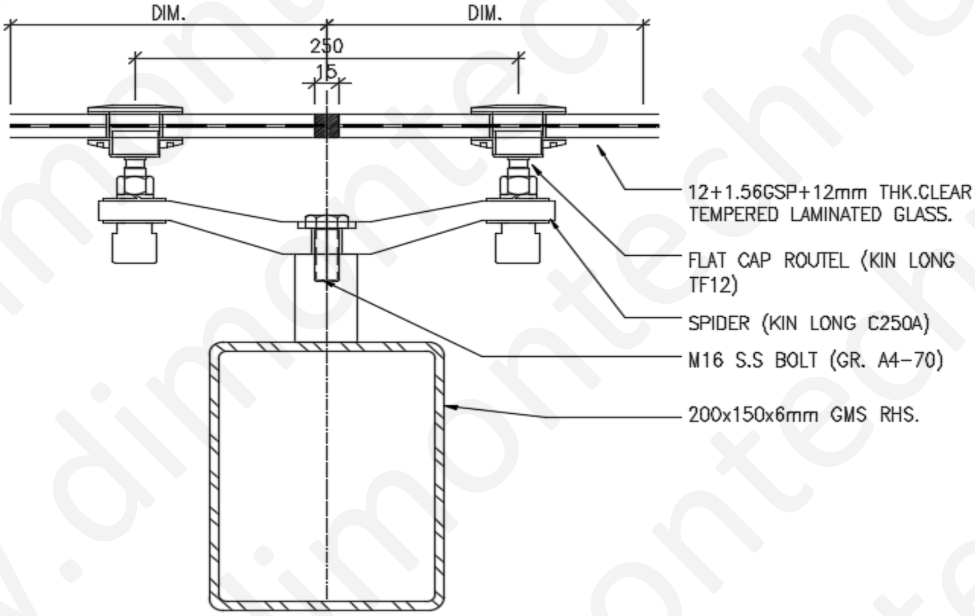
Comb 4: 1.0DL + 1.0WL; (for deflection checking)



Max. bending stress of glass pane,	σ_{c1}	=	66.71	N/mm^2		
		≤	80	N/mm^2		O.K.
Max. deflection,	δ_c	=	6.965	mm		
		≤	1100 / 60	= 18.33	mm	O.K.

4.2 Check for flat cap routel (Kin Long TF12)

TABLE: Joint Reactions								
Joint	OutputCase	CaseType	F1	F2	F3	M1	M2	M3
Text	Text	Text	KN	KN	KN	KN-m	KN-m	KN-m
7	COMB1	Combination	0	0	1.619	0	0	0
7	COMB2	Combination	0	0	1.71	0	0	0
7	COMB3	Combination	0	0	2.325	0	0	0
7	COMB4	Combination	0	0	1.419	0	0	0
8	COMB1	Combination	0	0	2.573	0	0	0
8	COMB2	Combination	0	0	2.717	0	0	0
8	COMB3	Combination	0	0	3.695	0	0	0
8	COMB4	Combination	0	0	2.255	0	0	0
15	COMB1	Combination	0	0	1.805	0	0	0
15	COMB2	Combination	0	0	1.905	0	0	0
15	COMB3	Combination	0	0	2.592	0	0	0
15	COMB4	Combination	0	0	1.581	0	0	0
16	COMB1	Combination	0	0	2.386	0	0	0
16	COMB2	Combination	0	0	2.519	0	0	0
16	COMB3	Combination	0	0	3.426	0	0	0
16	COMB4	Combination	0	0	2.091	0	0	0



Vertcal load = 3.695 kN

Vertical load = 0.7 + 0.75 + 3.68 (DL+LL + WL)
= 5.13 kN/m^2 (unfactored)

= 1.2 x 0.7 + 1.05 x 0.75 + 1.5 x 3.68 (1.2DL+1.05LL +1.5 WL)
= 7.15 kN/m^2 (factored)

Vertical load on routel at centre = 3.695 x 5.13 / 7.15
= 2.65 kN

Reaction on each routel point tension/compresion	= 2.65	kN	(refer to Appendix)	
	< 4.5	kN		O.K.

4.3 Check for spider (Kin Long C250A)

Vertical load on spider	= 2.65	kN	(refer to item 4.2)	
Reaction on each spider tension/compresion	= 2.65	kN	(refer to Appendix)	
	< 4	kN		O.K.

4.4 Check for M16 s.s. bolt, A4-70

Vertical load	= 2 x 3.695			
	= 7.39	kN	(refer to item 4.2)	
Tensile area of M16 bolt	= 156	mm^2		
Tensile strength of M16 bolt	= 373	N/mm^2		
Shear strength of M16 bolt	= 280	N/mm^2		
Tensile capacity of bolt	= 156 x 373 / 1000			
	= 58.19	kN		
	> 7.39	kN		O.K.
Pull out capacity on connected part,	= 16 x 3.1416 x 10 / 2 x 127 / 1000			
	= 31.919	kN		
	> 7.39	kN		O.K.

<u>Check for 5mm fillet weld connector channel to steel frame</u>

Horizontal load,	= 7.39	kN	
Effective length of fillet weld,	= 2 x 3.14 x 23		
	= 144.44	mm	
Capacity of fillet weld	= 160 x144.44 x 5 x 0.7 / 1000		
	= 80.886	kN	
	> 7.39	kN	O.K.

5. Check for steel frame

5.1 Combination loads

Design wind load = 3.68 kN/m^2

Live load = 0.75 kN/m^2

Dead load = 0.7 kN/m^2

<u>Load cases</u>

Dead = Dead Load (gravity)
DL = Dead Load (gravity)
Live = Live load (gravity)
Wx = Wind load in x direction (horizontal)
Wy = Wind load in y direction (lateral)
Wz = Wind load in z direction (vertical)
EQ = Earth Quake
Tem = Tempurature

TABLE: Combination Definitions

ComboName	ComboType	CaseType	CaseName	ScaleFactor
Text	Text	Text	Text	Unitless
COMB1	Linear Add	Linear Static	DEAD	1.3
COMB1		Linear Static	DL	1.3
COMB1		Linear Static	LL	1.05
COMB1		Linear Static	Wz	0.9
COMB1		Linear Static	EQ	0.65
COMB1		Linear Static	Tem	0.72
COMB2	Linear Add	Linear Static	DEAD	1.3
COMB2		Linear Static	DL	1.3
COMB2		Linear Static	LL	1.05
COMB2		Linear Static	Wx	0.9
COMB2		Linear Static	EQ	0.65
COMB2		Linear Static	Tem	0.72
COMB3	Linear Add	Linear Static	DEAD	1.3
COMB3		Linear Static	DL	1.3
COMB3		Linear Static	LL	1.05
COMB3		Linear Static	Wy	0.9
COMB3		Linear Static	EQ	0.65
COMB3		Linear Static	Tem	0.72
COMB4	Linear Add	Linear Static	DEAD	1.2
COMB4		Linear Static	DL	1.2
COMB4		Linear Static	LL	1.5
COMB4		Linear Static	Wz	0.9
COMB4		Linear Static	EQ	0.65
COMB4		Linear Static	Tem	0.72

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ComboName	ComboType	CaseType	CaseName	ScaleFactor
Text	Text	Text	Text	Unitless
COMB5	Linear Add	Linear Static	DEAD	1.2
COMB5		Linear Static	DL	1.2
COMB5		Linear Static	LL	1.5
COMB5		Linear Static	Wx	0.9
COMB5		Linear Static	EQ	0.65
COMB5		Linear Static	Tem	0.72
COMB6	Linear Add	Linear Static	DEAD	1.2
COMB6		Linear Static	DL	1.2
COMB6		Linear Static	LL	1.5
COMB6		Linear Static	Wy	0.9
COMB6		Linear Static	EQ	0.65
COMB6		Linear Static	Tem	0.72
COMB7	Linear Add	Linear Static	DEAD	1.2
COMB7		Linear Static	DL	1.2
COMB7		Linear Static	LL	1.05
COMB7		Linear Static	Wz	1.5
COMB7		Linear Static	Tem	0.72
COMB8	Linear Add	Linear Static	DEAD	1.2
COMB8		Linear Static	DL	1.2
COMB8		Linear Static	LL	1.05
COMB8		Linear Static	Wx	1.5
COMB8		Linear Static	Tem	0.72
COMB9	Linear Add	Linear Static	DEAD	1.2
COMB9		Linear Static	DL	1.2
COMB9		Linear Static	LL	1.05
COMB9		Linear Static	Wy	1.5
COMB9		Linear Static	Tem	0.72

ComboName	ComboType	CaseType	CaseName	ScaleFactor
Text	Text	Text	Text	Unitless
COMB10	Linear Add	Linear Static	DEAD	1.2
COMB10		Linear Static	DL	1.2
COMB10		Linear Static	LL	1.05
COMB10		Linear Static	EQ	1.3
COMB10		Linear Static	Tem	0.72
COMB11	Linear Add	Linear Static	DEAD	1
COMB11		Linear Static	DL	1
COMB11		Linear Static	LL	1
COMB11		Linear Static	Wz	0.6
COMB11		Linear Static	EQ	0.2
COMB11		Linear Static	Tem	0.2
COMB12	Linear Add	Linear Static	DEAD	1
COMB12		Linear Static	DL	1
COMB12		Linear Static	LL	1
COMB12		Linear Static	Wx	0.6
COMB12		Linear Static	EQ	0.2
COMB12		Linear Static	Tem	0.2
COMB13	Linear Add	Linear Static	DEAD	1
COMB13		Linear Static	DL	1
COMB13		Linear Static	LL	1
COMB13		Linear Static	Wy	0.6
COMB13		Linear Static	EQ	0.2
COMB13		Linear Static	Tem	0.2

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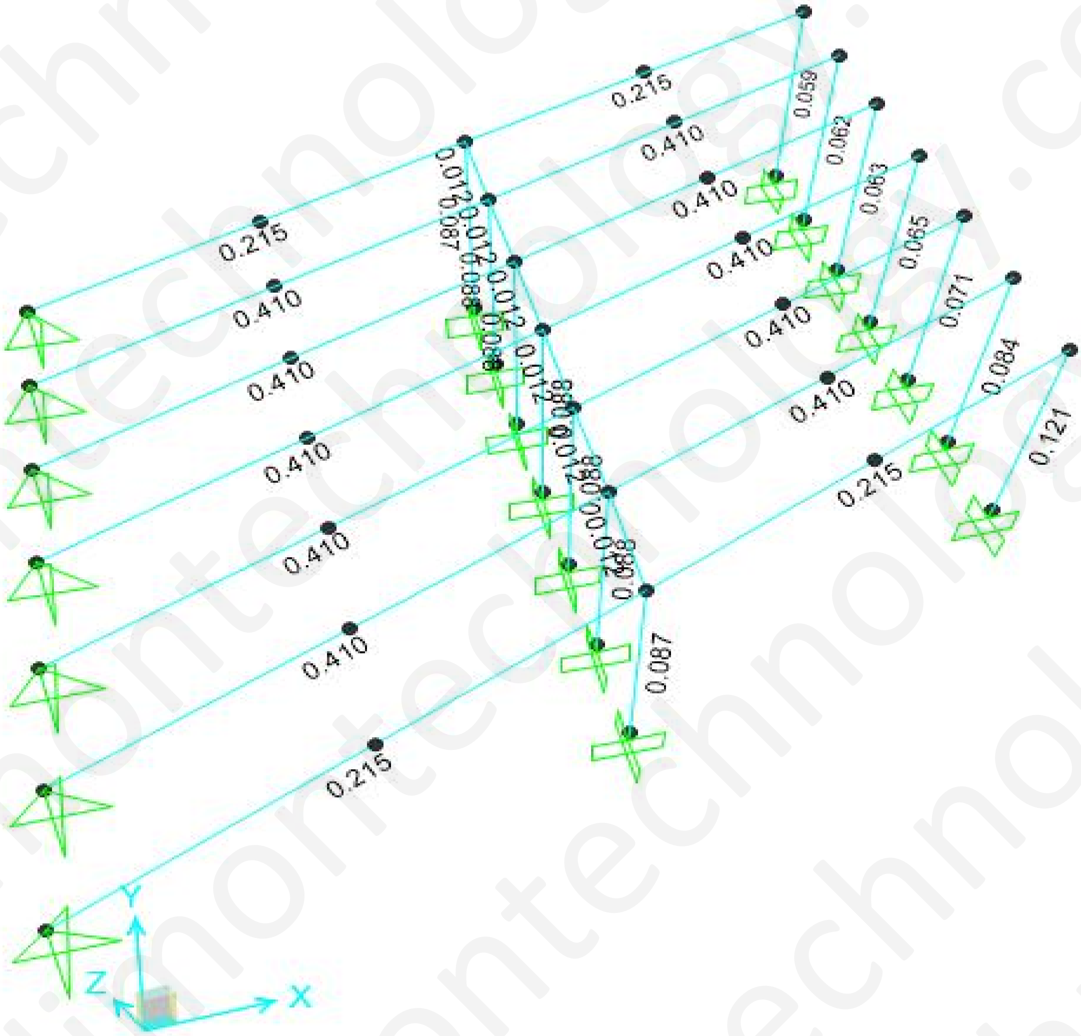

5.1 Check for 200x150x6mm GM. RHS， Q345

The output data refer to sap2000 (Appendix)

Max. Axial load,	P	=	6.428	kN	(frame 23, COMB 10)
Shear load,	V_2	=	24.676	kN	(frame 27, COMB 7)
Shear load,	V_3	=	3.053	kN	(frame 21, COMB 9)
Max. torsion	T	=	0	kNm	
Max. moment,	M_2	=	4.5561	kNm	(frame 28, COMB 9)
Max. moment,	M_3	=	40.5305	kNm	(frame 27, COMB 7)

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TABLE: Element Forces - Frames									
Frame	Station	Output Case	CaseType	P	V2	V3	T	M2	M3
Text	m	Text	Text	KN	KN	KN	KN-m	KN-m	KN-m
21	0	COMB9	Combination	3.808	-3.707	-3.053	0	0	0
21	2.98513	COMB9	Combination	2.519	-0.02	-4.7E-07	0	4.5561	6.123
21	2.98513	COMB9	Combination	2.519	-0.02	-4.7E-07	-8.8E-16	4.5561	6.123
21	5.97026	COMB9	Combination	1.23	3.933	3.053	-8.8E-16	-1.7E-15	7.69E-16
23	0	COMB10	Combination	6.428	-6.5	0.42	0	0	0
23	2.98513	COMB10	Combination	6.428	9.75E-06	0.42	0	-1.2532	10.5436
23	2.98513	COMB10	Combination	4.439	9.75E-06	-0.42	-1.6E-15	-1.2532	10.5436
23	5.97026	COMB10	Combination	4.439	6.5	-0.42	-1.6E-15	-2.6E-16	3.09E-15
27	0	COMB7	Combination	-1.2E-13	-24.676	0	0	0	0
27	2.98513	COMB7	Combination	-1.2E-13	-2.4E-06	0	0	0	40.5305
27	2.98513	COMB7	Combination	-1.2E-13	-2.4E-06	0	9.21E-17	0	40.5305
27	5.97026	COMB7	Combination	-1.2E-13	24.676	0	9.21E-17	0	-3.6E-14
28	0	COMB9	Combination	5.719	-3.707	-3.052	0	0	0
28	2.98513	COMB9	Combination	4.43	-0.02	-3.1E-07	0	4.5561	6.123
28	2.98513	COMB9	Combination	4.43	-0.02	-3.1E-07	-1.6E-15	4.5561	6.123
28	5.97026	COMB9	Combination	3.141	3.933	3.052	-1.6E-15	-2.2E-16	-5.1E-15

Properties of200x150x6mm RHS

Moment of inertia, I_x	= 2358	cm^4	Moment of inertia, I_y	= 1507	cm^4
Elastic modulus, Z_x	= 235	cm^3	Elastic modulus, Z_y	= 201	cm^3
Plastic modulus, S_x	= 280	cm^3	Plastic modulus, S_y	= 229	cm^3
Radius of gyration, r_x	= 7.63	cm	Radius of gyration, r_y	= 6.1	cm
Area	= 40.56	cm^2			

Shear stress = 24.676 x 1000 / (2 x 6 x 200) + 3.053 x 1000 / (2 x 6 x 150)
= 11.98 N/mm^2
< 0.6 x 180 = 108 N/mm^2 (low shear)

Moment capacity = min(1.2 p_y Z_x, p_y S_x)
= (1.2 x 310 x 235 /1000 , 310 x 280/ 1000)
= 86.8 kNm (factored)
> 40.5305 kNm O.K.

Moment capacity = min(1.2 p_y Z_y, p_y S_y)
= (1.2 x 310 x 148/1000 , 310 x 229 / 1000)
= 70.99 kNm (factored)
> 4.5561 kNm O.K.

Slenderness,λ L_e / r_y = 5970 / 61
= 97.87

Design compressive strength p_c = 150 MPa

Compression resistance P_c = 150 x 4056/ 1000
= 608.4 kN
> 6.428 kN O.K.

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Combined loads		=	6.428 / 608.4 + 4.5561 / 70.99 + 40.5305 / 86.8		
		=	0.542		
		<	1		O.K.
Deflection		=	16.874 mm		(Joint 44, COMB11)
		<	5970 / 250 = 23.88 mm		O.K.

<u>Check for lateral torsional buckling</u>

Design strength,	p_y	=	310	N/mm^2	Parameter,	$\varepsilon = (275 / p_y)^{0.5}$	=	0.9419	
Modulus of Elasticity,	E	=	206000	N/mm^2					
Overall width,	B	=	150	mm	Overall depth,	D	=	200	mm
Wall thickness,	t	=	6	mm	Area,	A	=	40.56	cm^2
Moment of inertia,	I_x	=	2358	cm^4	Moment of inertia,	I_y	=	1507	cm^4
Section modulus,	Z_x	=	235	cm^3	Section modulus,	Z_y	=	201	cm^3
Plastic modulus,	S_x	=	280	cm^3	Plastic modulus,	S_y	=	229	cm^3
Torsional constant,	J	=	7.63	cm^4	Radius of gyration,	r_y	=	6.1	cm
Effective length,	L_E	=	5970	mm					

Slenderness ratio,	λ	=	L_E / r_y	=	97.9	
	γ_b	=	$(1 - I_y / I_x)\,[1 - J / (2.6\, I_x)]$	=	0.3604	
Buckling index,	$\varnothing_b$	=	$[S_x^2\, \gamma_b / (A\, J)]^{0.5}$	=	9.5552	
Ratio,	β_w	=	1			for plastic section
Equivalent slenderness,	λ_{LT}	=	$2.25\, (\varnothing_b\, \lambda\, \beta_w)^{0.5}$	=	68.82	
	P_E	=	$\pi^2\, E / \lambda_{LT}^2$	=	429.28	
	α_{LT}	=	7			
	λ_{L0}	=	$0.4\, (\pi^2\, E / p_y)^{0.5}$	=	32.39	
Perry factor,	η_{LT}	=	$\alpha_{LT}\, (\lambda_{LT} - \lambda_{L0}) / 1000$	=	0.255	≥ 0 O.K.
	$\varnothing_{LT}$	=	$[p_y + (\eta_{LT} + 1)\, P_E] / 2$	=	424.37	
Bending buckling strength,	p_b	=	$P_E\, p_y / (\varnothing_{LT} + (\varnothing_{LT}^2 - P_E\, p_y)^{0.5})$			
		=	207.54 N/mm^2			
Bending buckling resistanceh,		=	207.54 x 280 /1000			
		=	58.111 kNm			
		>	40.5305 kNm			O.K.

5.2 Check for 200x150x8mm GM. RHS， Q345

The output data refer to sap2000 (Appendix)

Max. Axial load,	P	= -58.044	kN	(frame 9, COMB 7)
Shear load,	V_2	= 2.759	kN	(frame 7, COMB 8)
Shear load,	V_3	= 5.081	kN	(frame 1, COMB 9)
Max. torsion	T	= 0.14	kNm	(frame 9, COMB 9)
Max. moment,	M_2	= 10.9831	kNm	(frame 1, COMB 9)
Max. moment,	M_3	= -6.0966	kNm	(frame 1, COMB 9)

TABLE: Element Forces - Frames

Frame	Station	Output Case	CaseType	P	V2	V3	T	M2	M3
Text	m	Text	Text	KN	KN	KN	KN-m	KN-m	KN-m
1	0	COMB9	Combination	-6.495	-1.742	5.081	-0.067	10.9831	-6.0966
1	1.75	COMB9	Combination	-5.407	-1.742	3.138	-0.067	3.7919	-3.0483
1	3.5	COMB9	Combination	-4.319	-1.742	1.196	-0.067	-1.5E-12	4.77E-15
7	0	COMB8	Combination	-6.181	2.759	-0.477	-0.00048	-1.6686	2.8565
7	1.75	COMB8	Combination	-5.093	0.816	-0.477	-0.00048	-0.8343	-0.2714
7	3.5	COMB8	Combination	-4.005	-1.126	-0.477	-0.00048	2.4E-13	3.59E-14
7	0	COMB9	Combination	-6.181	-0.738	3.551	-0.0122	5.6287	-2.5841
7	1.75	COMB9	Combination	-5.093	-0.738	1.608	-0.0122	1.1147	-1.292
7	3.5	COMB9	Combination	-4.005	-0.738	-0.334	-0.0122	4.84E-13	2.02E-13
7	0	COMB10	Combination	-6.181	0.393	-0.56	0.0148	-1.9604	1.3747
7	1.75	COMB10	Combination	-5.093	0.393	-0.56	0.0148	-0.9802	0.6873
7	3.5	COMB10	Combination	-4.005	0.393	-0.56	0.0148	-4E-13	2.56E-14
9	0	COMB7	Combination	-58.044	5.37E-14	-8.2E-15	-2.9E-16	-1.1E-14	6.17E-14
9	1.75	COMB7	Combination	-56.956	5.37E-14	-8.2E-15	-2.9E-16	3.54E-15	-3.2E-14
9	3.5	COMB7	Combination	-55.868	5.37E-14	-8.2E-15	-2.9E-16	1.79E-14	-1.3E-13
9	0	COMB9	Combination	-17.058	-1.178	4.205	0.14	7.9181	-4.1238
9	1.75	COMB9	Combination	-15.97	-1.178	2.262	0.14	2.2594	-2.0619
9	3.5	COMB9	Combination	-14.882	-1.178	0.32	0.14	-3.4E-12	1.63E-15

Properties of 200x150x8mm RHS

Moment of inertia, I_x	= 3043 cm^4		Moment of inertia, I_y	= 1935	cm^4
Elastic modulus, Z_x	= 304 cm^3		Elastic modulus, Z_y	= 258	cm^3
Plastic modulus, S_x	= 365 cm^3		Plastic modulus, S_y	= 299	cm^3
Radius of gyration, r_x	= 7.55 cm		Radius of gyration, r_y	= 6.02	cm
Torsional constant, J	= 3560 cm^4		Torsional constant,C	= 436	cm^3
Area	= 53 cm^2				

Shear stress = 5.081 x 1000 / (2 x 8 x 200) + 2.759 x 1000 / (2 x 8 x 150) + 0.14 x 10^6 / 436 / 1000

= 3.3 N/mm^2

< 0.6 x 180 = 108 N/mm^2 (low shear)

Moment capacity = min(1.2 p_y Z_x, p_y S_x)

= (1.2 x 310 x 304 /1000 , 310 x 365/ 1000)

= 113.15 kNm (factored)

> 6.0966 kNm O.K.

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Moment capacity = $\min(1.2\ p_y\ Z_y, p_y\ S_y)$
= (1.2 x 310 x 258 /1000 , 310 x 299 / 1000)
= 92.69 kNm (factored)
> 10.9831 kNm O.K.

Slenderness,λ L_e / r_y = 3500 / 60.2
= 58.14

Design compressive strength p_c = 240 MPa

Compression resistance P_c = 240 x 53000 / 1000
= 1272 kN
> 58.044 kN O.K.

Combined loads = 58.044 / 1272 + 10.9831 / 92.69 + 6.0966 / 113.15
= 0.218
< 1 O.K.

Deflection = 2.96 mm (Joint 2, COMB131)
< 2 x 3500 / 250 = 28 mm O.K.

<u>Check for lateral torsional buckling</u>

Overall width,	B	= 150	mm	Overall depth,	D	=	200	mm
Wall thickness,	t	= 8	mm	Area,	A	=	53	cm^2
Moment of inertia,	I_x	= 3043	cm^4	Moment of inertia,	I_y	=	1935	cm^4
Section modulus,	Z_x	= 340	cm^3	Section modulus,	Z_y	=	258	cm^3
Plastic modulus,	S_x	= 365	cm^3	Plastic modulus,	S_y	=	299	cm^3
Torsional constant,	J	= 3560	cm^4	Radius of gyration,	r_y	=	6.02	cm
Effective length,	L_E	= 3500	mm					

Slenderness ratio, $\lambda = L_E / r_y$ = 58.1
$\gamma_b = (1 - I_y / I_x)\ [1 - J / (2.6\ I_x)]$ = 0.2003
Buckling index, $ø_b = [S_x^2\ \gamma_b / (A\ J)]^{0.5}$ = 0.3761
Ratio, β_w = 1 for plastic section

Equivalent slenderness, $\lambda_{LT} = 2.25\ (ø_b\ \lambda\ \beta_w)^{0.5}$ = 10.52
$P_E = \pi^2\ E / \lambda_{LT}^2$ = 18371.11
α_{LT} = 7
$\lambda_{L0} = 0.4\ (\pi^2\ E / p_y)^{0.5}$ = 32.39
Perry factor, $\eta_{LT} = \alpha_{LT}\ (\lambda_{LT} - \lambda_{L0}) / 1000$ = -0.1531 < 0
$ø_{LT} = [p_y + (\eta_{LT} + 1)\ P_E] / 2$ = 7934.25

Bending buckling strength, $p_b = P_E\, p_y / (\phi_{LT} + (\phi_{LT}^2 - P_E\, p_y)^{0.5})$

$= 367.4$ N/mm^2

> 310 N/mm^2

5.3 Check for 8mm fillet weld all round connection to base plate

TABLE: Joint Reactions

Joint	OutputCase	CaseType	F1	F2	F3	M1	M2	M3
Text	Text	Text	KN	KN	KN	KN-m	KN-m	KN-m
1	COMB1	Combination	-0.23	0.331	13.376	-1.1578	-0.8061	-0.00092
1	COMB8	Combination	-2.755	0.473	6.495	-1.6554	-2.845	0.000594
1	COMB9	Combination	1.742	-5.081	6.495	10.9831	6.0966	0.067
1	COMB10	Combination	-0.461	0.662	6.495	-2.3155	-1.6123	-0.0018
13	COMB1	Combination	-0.196	0.28	12.408	-0.9802	-0.6873	-0.0074
13	COMB7	Combination	5.08E-14	2.42E-14	15.894	-1.4E-14	6.61E-14	-1.8E-16
13	COMB8	Combination	-2.759	0.477	6.181	-1.6686	-2.8565	0.000479
13	COMB9	Combination	0.738	-3.551	6.181	5.6287	2.5841	0.0122
13	COMB10	Combination	-0.393	0.56	6.181	-1.9604	-1.3747	-0.0148
17	COMB1	Combination	-0.391	0.57	42.584	-1.9946	-1.3687	0.009
17	COMB9	Combination	1.178	-4.205	17.058	7.9181	4.1238	-0.14
17	COMB10	Combination	-0.782	1.14	17.058	-3.9892	-2.7374	0.0179
25	COMB1	Combination	-0.391	0.57	42.584	-1.9951	-1.3693	0.0139
25	COMB6	Combination	0.312	-1.949	19.564	2.7415	1.0932	-0.0098
25	COMB7	Combination	-4.7E-14	-5.3E-14	58.044	5.92E-14	-5.4E-14	2.65E-17
25	COMB8	Combination	-2.736	0.45	17.058	-1.5761	-2.7757	0.0137
25	COMB9	Combination	1.173	-4.198	17.058	7.8943	4.1042	-0.0395
25	COMB10	Combination	-0.782	1.14	17.058	-3.9903	-2.7387	0.0279

The output data refer to sap2000 (Appendix)

Shear load, $F_1 = -2.759$ kN (joint 13, COMB8)

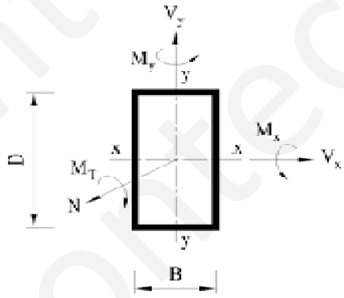
Shear load, $F_2 = -5.081$ kN (joint 1, COMB9)

Axial load, $F_3 = 58.044$ kN (joint 25, COMB 7)

Moment, $M_1 = 10.9831$ kNm (joint 1, COMB9)

Moment, $M_2 = 6.0966$ kNm (joint 1, COMB9)

Moment, $M_3 = 0.14$ kNm (joint 17, COMB 9)



Properties for unit throat thickness of fillet weld (effective length)

Breadth, $B = 150$ mm

Height, $D = 200$ mm

Area, $A = 2\,(B + D) = 700$ mm^2

Moment of inertia, $I_x = B\,D^2 / 2 + D^3 / 6 = 4333333$ mm^4

Moment of inertia, $I_y = B^2\,D / 2 + B^3 / 6 = 2812500$ mm^4

Polar moment of inertia, $J = I_x + I_y = 7145833$ mm^4

Shear load, $V_x = 2.759$ kN　Moment, $M_x = 10.9831$ kNm

Shear load, $V_y = 5.081$ kN　Moment, $M_y = 6.0966$ kNm

Tensile load, $N = 58.044$ kN　Torsional moment, $M_T = 0.14$ kNm

Leg length of fillet weld, $t = 8$ mm

Shear stress,	τ_x	$= V_x / (0.7\ t\ A) + M_T\ (D / 2) / (0.7\ t\ J)$	=	1.05	N/mm^2
Shear stress,	τ_y	$= V_y / (0.7\ t\ A) + M_T\ (B / 2) / (0.7\ t\ J)$	=	1.56	N/mm^2
Tensile stress,	σ	$= N / (0.7\ t\ A)$	=	14.81	N/mm^2
Tensile stress,	σ_x	$= M_x\ D / (2\ I_x) / (0.7\ t)$	=	45.26	N/mm^2
Tensile stress,	σ_y	$= M_y\ B / (2\ I_y) / (0.7\ t)$	=	29.03	N/mm^2

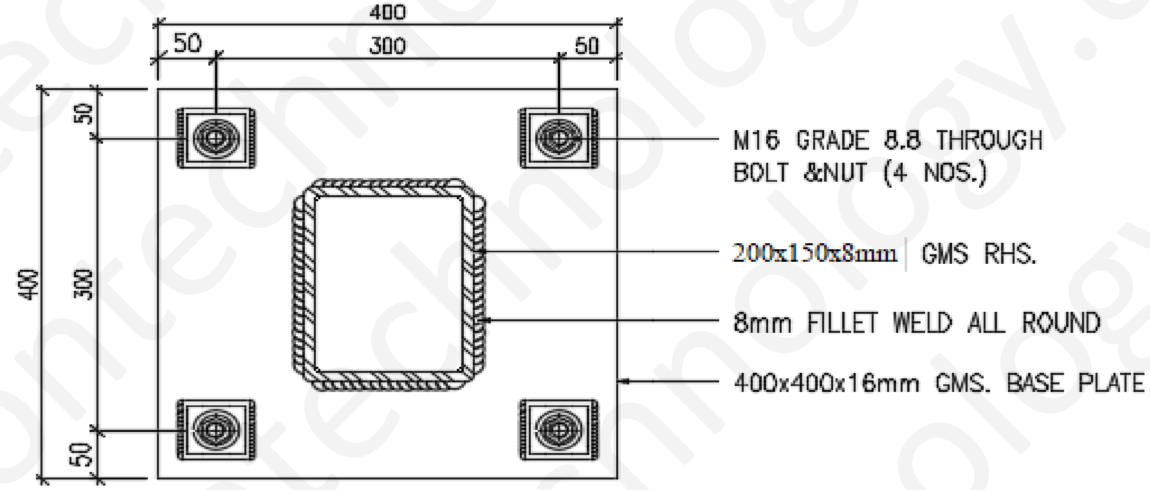
Resultant , $f_w = [\tau_x^2 + \tau_y^2 + (\sigma + \sigma_x + \sigma_y)^2]^{0.5}$

$= 89.12$ N/mm^2

≤ 200 N/mm^2 O.K.

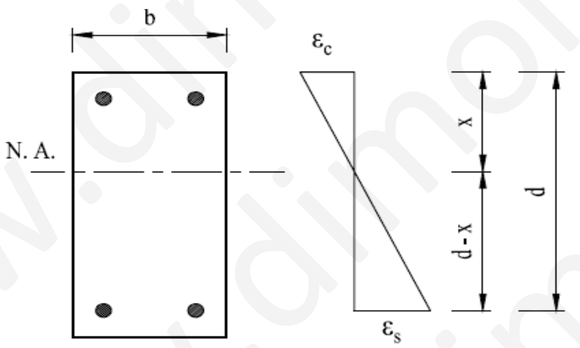
6. Check for embed

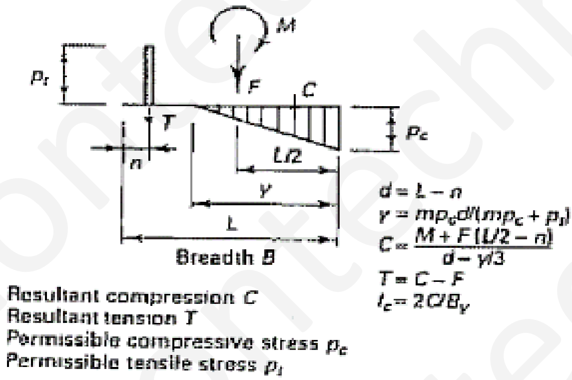
6.1 Check for ME1 M16 holding down bolt, Gr 8.8



The output data refer to sap2000 (Appendix)

Shear load,	F_1	=	-2.759	kN	(joint 13, COMB8)
Shear load,	F_2	=	-5.081	kN	(joint 1, COMB9)
Axial load,	F_3	=	58.044	kN	(joint 25, COMB 7)
Moment,	M_1	=	10.9831	kNm	(joint 1, COMB9)
Moment,	M_2	=	6.0966	kNm	(joint 1, COMB9)
Moment,	M_3	=	0.14	kNm	(joint 17, COMB 9)





$$\varepsilon_c / \varepsilon_s = x / (d - x)$$

$$\varepsilon_c / \varepsilon_s = (f_c / E_c) / (f_s / E_s)$$
$$= m\, f_c / f_s$$

$$m\, f_c / f_s = x / (d - x)$$

Thus, $$x = m\, f_c\, d / (m\, f_c + f_s)$$

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Breadth of plate,	b	=	400	mm	Concrete strength,	f_{cu}	=	45	N/m
Distance,	d	=	350	mm					
Conc/Grout Comp strength,	f_c	=	27	N/mm^2	(for $f_c = 0.6\ f_{cu}$)				
Holding down bolt strength,	f_s	=	450	N/mm^2					
Modulus of Elasticity, steel,	E_s	=	205	kN/mm^2					
Modulus of Elasticity, conc,	E_c		26.42	kN/mm^2	(for $E_c = 3.46\ f_{cu}^{0.5} + 3.21$)				
Modular ratio,	$m = E_s / E_c$	=	7.76						
Moment,	M	=	10.9831	kNm					

$x = m\ f_c\ d / (m\ f_c + f_s)$

$= 111.19$ mm

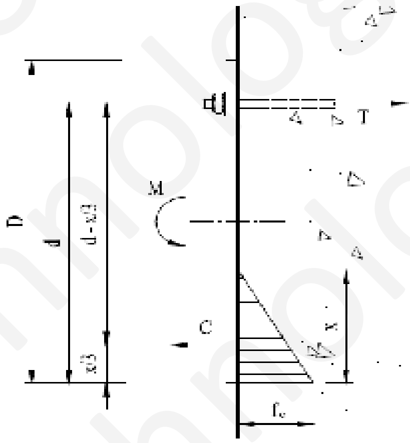
$d - x / 3 = 312.94$ mm

Taking moment at C, $T = M / (d - x / 3)$

$= 35.1$ kN

Bearing pressure on concrete $= 2\ C / (b\ x)$

$= 1.58$ N/mm^2



Similarly for M_y

Breadth of plate,	b	=	400	mm	Concrete strength,	f_{cu}	=	45	N/m
Distance,	d	=	350	mm					
Conc/Grout Comp strength,	f_c	=	27	N/mm^2	(for $f_c = 0.6\ f_{cu}$)				
Holding down bolt strength,	f_s	=	450	N/mm^2					
Modulus of Elasticity, steel,	E_s	=	205	kN/mm^2					
Modulus of Elasticity, conc,	E_c		26.42	kN/mm^2	(for $E_c = 3.46\ f_{cu}^{0.5} + 3.21$)				
Modular ratio,	$m = E_s / E_c$	=	7.76						
Moment,	M	=	6.0966	kNm					

$x = m\ f_c\ d / (m\ f_c + f_s)$

$= 111.19$ mm

$d - x / 3 = 312.94$ mm

Taking moment at C, $T = M / (d - x / 3)$

$= 19.48$ kN

Bearing pressure on concrete $= 2\ C / (b\ x)$

$= 0.88$ N/mm^2

Total bearing pressure on concrete	=	1.58 + 0.88		
	=	1.86	N/mm^2	
	<	27	N/mm^2	O.K.

Tensile load on each bolt	=	58.044 / 4 + 35.1 / 2 + 19.48 / 2		
	=	41.801	kN	
Shear load on each bolt	=	$[(2.759 / 4)^2 + (5.081 / 4 + 0.14 / 0.424)^2]^{0.5}$		
	=	1.166	kN	
Tensile area of M16bolt	=	156	mm^2	
Shar strength of M16 bolt	=	375	N/mm^2	
Tensile strength of M16 bolt	=	450	N/mm^2	
Tensile capacity of M16 bolt	=	156 x 450 / 1000		
	=	70.2	kN	
	>	41.801	kN	O.K.
Shear capacity of M16 bolt	=	450 x 375/ 1000		
	=	58.5	kN	
	>	1.166	kN	O.K.
Combined tensile & shear loads	=	$(41.801 / 70.2)^2 + (1.166 / 58.5)^2$		
	=	0.355		
	<	1		O.K.

<u>Check for 16mm thick gms base plate</u>

Distance between edge of gms SHS & cg of compression,	=	50	mm	
Bending moment at edge of gms SHS	=	2 x 41.801 x 50		
	=	4180.1	kNmm	
Moment resistance of gms plate	=	$1.2 \times 310 \times 400 \times 16^2 / 6 / 1000$		
	=	6348.8	kNmm	
	>	0	kNmm =	O.K.

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6.2 Check for ME2 M16 holding down bolt, Gr 8.8

TABLE: Joint Reactions									
Joint	OutputCase	CaseType	F1	F2	F3	M1	M2	M3
Text	Text	Text	KN	KN	KN	KN-m	KN-m	KN-m
30	COMB1	Combination	-3.427	-1.02	19.834	0	0	0
30	COMB6	Combination	-4.587	-1.613	8.436	0	0	0
30	COMB7	Combination	9.09E-14	3.86E-14	27.676	0	0	0
30	COMB8	Combination	-2.279	-0.918	7.183	0	0	0
30	COMB9	Combination	-1.934	-0.989	7.183	0	0	0
30	COMB10	Combination	-6.853	-2.04	7.183	0	0	0
34	COMB1	Combination	-3.407	-1.013	19.834	0	0	0
34	COMB6	Combination	-4.425	-1.543	8.436	0	0	0
34	COMB7	Combination	1.08E-13	4.61E-14	27.676	0	0	0
34	COMB8	Combination	-2.278	-0.918	7.183	0	0	0
34	COMB9	Combination	-1.696	-0.883	7.183	0	0	0
34	COMB10	Combination	-6.815	-2.026	7.183	0	0	0
35	COMB1	Combination	-2.012	-0.701	10.051	0	0	0
35	COMB8	Combination	-2.105	-0.953	4.005	0	0	0
35	COMB9	Combination	-4.359	-4.907	4.005	0	0	0
35	COMB10	Combination	-4.024	-1.403	4.005	0	0	0

The output data refer to sap2000 (Appendix)

Shear load, F_1 = -6.853 kN (joint 30, COMB10)
Shear load, F_2 = -4.907 kN (joint 35, COMB 9)
Axial load, F_3 = 27.676 kN (joint 34, COMB 7)

Tensile load on each bolt = 6.853 / 6
= 1.142 kN

Shear load on each bolt = $[(4.907 / 6)^2 + (27.676/ 6)^2]^{0.5}$
= 4.685 kN

Tensile area of M16bolt = 156 mm^2
Shar strength of M16 bolt = 375 N/mm^2
Tensile strength of M16 bolt = 450 N/mm^2

Tensile capacity of M16 bolt = 156 x 450 / 1000
= 70.2 kN
> 1.142 kN O.K.

Shear capacity of M16 bolt = 450 x 375/ 1000
= 58.5 kN
> 4.685 kN O.K.

Combined tensile & shear loads = $(1.142 / 70.2)^2 + (4.685 / 58.5)^2$
= 0.007
< 1 O.K.