Date: 15th Jan 2024
Revision: R1

DESIGN REVIEW REPORT

FOR

SKY BRIDGE

AT

DESSERT ROCK HOTEL_SAUDI ARABIA

FOR

WARRIOR GROUP

WARRIOR

DUBAI - U.A.E.
SECD TECHNICAL SERVICES L.L.C.

Submitted By

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1. INTRODUCTION

This design review report presents design review for SKY BRIDGE structure for proposed Dessert rock hotel at Saudi Arabia. It includes codes referred for analysis & loading considerations, SAP 2000 modeling, analysis & design results and connection design. Refer below images showing layout and structural systems of proposed SKY BRIDGE structure.

Following documents were referred in review of Sky Bridge structure:

1. Architectural Drawing: Sky Bridge Structure
   (Drawing number R01-H13C13-WES-2R-ZZ-DWG-AR-00001/10001/20001/30001/50001/90001)
2. Structural drawing: Sky Bridge Structure
   (Drawing number R01-H13C13-WES-2R-ZZ-DWG-ST-10001/20001/20002/30001/50001/50002/50003/90001/90002)
3. SAP 2000 model
   (Model name: dubai new sb cable final final with sag 4.45 m from left support copy 4444 with wg 66666.sdb,
   Model name: dubai new 15 degree down HC in lower side.sdb)
4. Design Summary & Compliance Report (Ref no. WE-RSG-SKYB-DSCR, Rev: 1.0)
5. Design Summary Report of SAP Analysis of Deck Structure (Ref no. RN-WG-SKYB-DSDS, Rev: 0.0)
6. Design Summary & Compliance Report (Ref no. RN-WG-SKYB-DCCON, Rev: 0.0)
7. Ground Anchor Design Philosophy Report (Ref no. 1799/TN01)
8. Design Calculations of End Connection of Cross Beam (Ref no. RN-WG-SKYB-DCECCB, Rev: 0.0)

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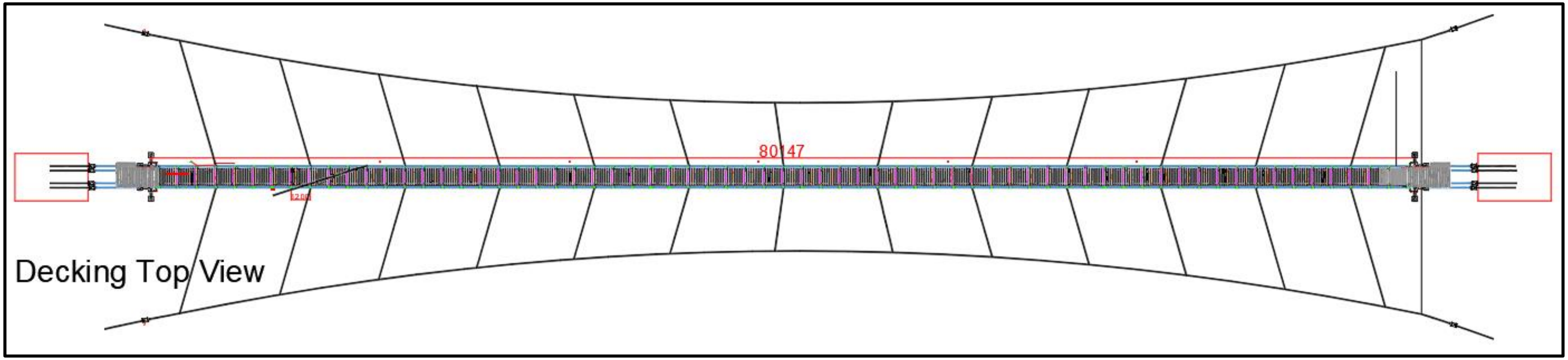
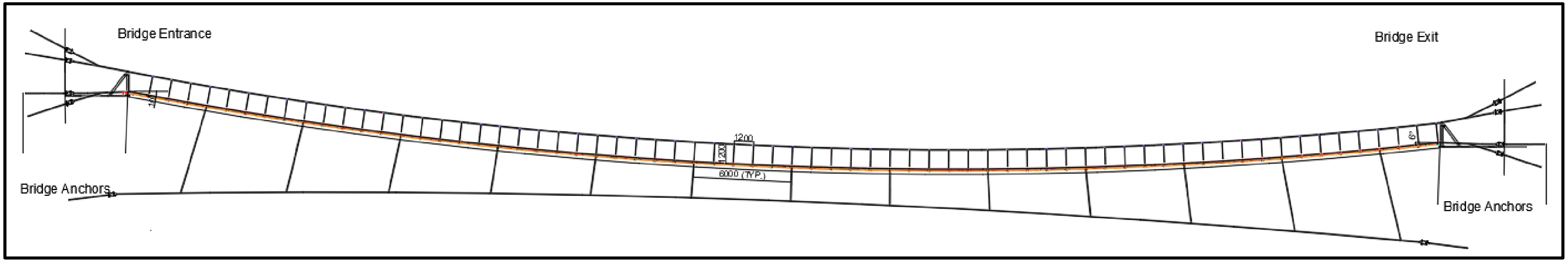
2. GEOMETRY



SKY BRIDGE *layout (Plan View)*



SKY BRIDGE *Elevation (Side View)*

- SAP 2000 model geometry

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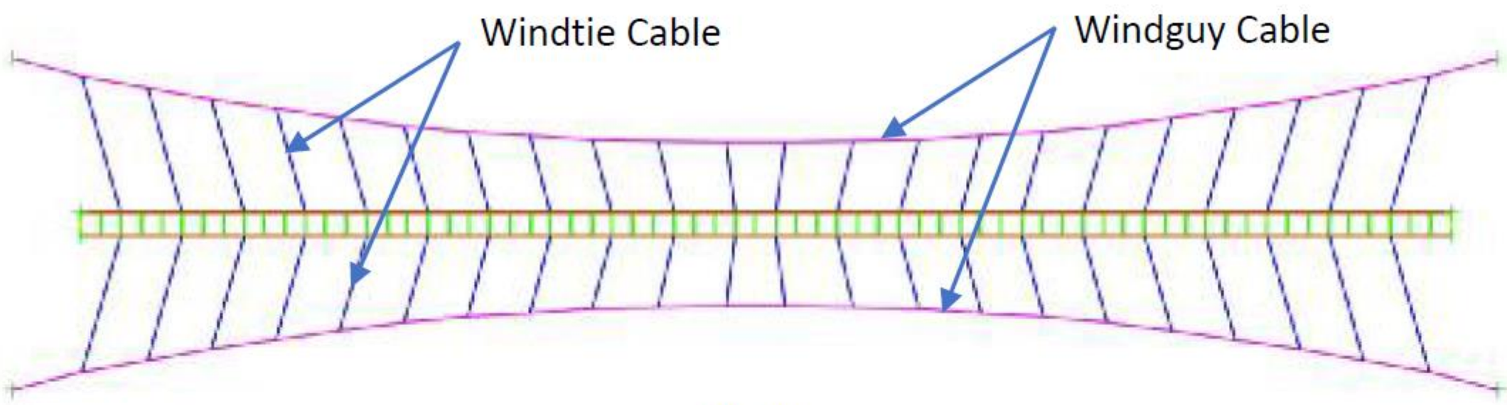
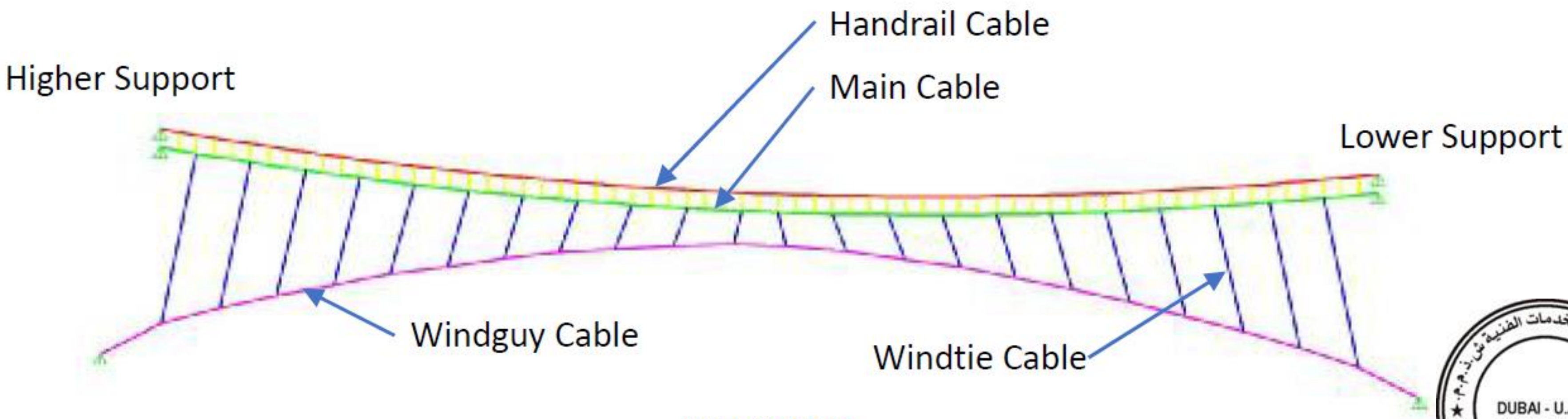


PLAN



ELEVATION

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3. PROPERTY

Assigned member property of SKY BRIDGE in SAP 2000 model.

TABLE: Frame Section Properties 01 - General

SectionName	Material	Shape	t3	t2	tf	tw	FilletRadius	Area	TotalWt	TotalMass
Text	Text	Text	m	m	m	m	m	m2	KN	KN-s2/m
Cross Beam ISMC100	Fe250	Channel	0.1	0.05	0.0075	0.0047	0	0.00117	7.961	0.81
Hand Rail Cable 1x48mm	Fe250	Circle	0.04					0.001257	15.536	1.58
Main Cable 2x48mm	Fe250	Circle	0.056					0.002463	30.45	3.1
Suspender 16mm	Fe250	Circle	0.016					0.000201	2.451	0.25
Wind Guy 40mm	Fe250	Circle	0.033					0.000855	11.81	1.2
Wind Tie	Fe250	Circle	0.011					0.000095	2.604	0.27

TABLE: Area Section Properties

Section	Material	MatAngle	AreaType	Type	Thickness
Text	Text	Degrees	Text	Text	m
deck	Fe250	0	Shell	Membrane	0.007

SKY BRIDGE – *Property*

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4. LOADING

<u>Summary of loadings in SAP2000</u>

Loads		Values	Unit	Remarks
Live Load		5.20	kN/m	In vertical down direction
Dead Load				
	Self-weight of overall bridge components excluding utility load	Equivalent section/frame sizes.		
	Utility Load	0.60	kN/m	Loaded along the main cable in vertical down direction
	Wind Load	0.50	kN/m	Loaded along the one wind guy cable in horizontal direction

5. LOAD CASES

TABLE: Load Case Definitions			
Case	**Type**	**DesignType**	**RunCase**
Dead	LinStatic	Dead	Yes
MODAL	LinModal	Other	Yes
utility load	LinStatic	Dead	Yes
Live	LinStatic	Live	Yes
Winy	LinStatic	Wind	Yes

6. LOAD COMBINATIONS

As per the AISC-LRFD93, following load combinations are considered for the SAP2000 analysis.

TABLE: Combination Definitions

ComboName	ComboType	CaseType	CaseName	ScaleFactor	SteelDesign	Notes
COMB1	Linear Add	Linear Static	Dead	1	None	
COMB1		Linear Static	utility load	1		
COMB1		Linear Static	Live	1		
UDSTL1	Linear Add	Linear Static	Dead	1.4	Strength	Dead Only; Strength
UDSTL1		Linear Static	utility load	1.4		
UDSTL2	Linear Add	Linear Static	Dead	1.2	Strength	Dead + Live; Strength
UDSTL2		Linear Static	utility load	1.2		
UDSTL2		Linear Static	Live	1.6		
UDSTL3	Linear Add	Linear Static	Dead	1.2	Strength	
UDSTL3		Linear Static	utility load	1.2		
UDSTL3		Linear Static	Live	0.5		
UDSTL3		Linear Static	Winy	1.3		
UDSTL4	Linear Add	Linear Static	Dead	1.2	Strength	
UDSTL4		Linear Static	utility load	1.2		
UDSTL4		Linear Static	Live	0.5		
UDSTL4		Linear Static	Winy	-1.3		
UDSTL5	Linear Add	Linear Static	Dead	1.2	Strength	Dead + Wind; Strength
UDSTL5		Linear Static	utility load	1.2		
UDSTL5		Linear Static	Winy	1.3		
UDSTL6	Linear Add	Linear Static	Dead	1.2	Strength	Dead - Wind; Strength
UDSTL6		Linear Static	utility load	1.2		
UDSTL6		Linear Static	Winy	-1.3		
UDSTL7	Linear Add	Linear Static	Dead	0.9	Strength	Dead (min) + Wind; Strength
UDSTL7		Linear Static	utility load	0.9		
UDSTL7		Linear Static	Winy	1.3		
UDSTL8	Linear Add	Linear Static	Dead	0.9	Strength	Dead (min) - Wind; Strength
UDSTL8		Linear Static	utility load	0.9		
UDSTL8		Linear Static	Winy	-1.3		
UDSTL9	Linear Add	Linear Static	Dead	1	Deflection	Dead Only; Deflection
UDSTL9		Linear Static	utility load	1		
UDSTL10	Linear Add	Linear Static	Dead	1	Deflection	Dead + Live; Deflection
UDSTL10		Linear Static	utility load	1		
UDSTL10		Linear Static	Live	1		

7. ANALYSIS & DESIGN RESULTS

7.1. Summary of SAP 2000 results with bridge design standard of Nepal

1. BASIC INFORMATION				
Span	L	80.00	m	
Difference in Elevation between saddles	h	3.00	m	
2. CABLE CONFIGURATION				
No of Main Cable		4		
Dia of Main Cable		48	mm	
No of Handrail Cable		2		
Dia of Handrail Cable		48	mm	
No of Windguy Cable		2		
Dia of Windguy Cable		40	mm	
3. LOADS				
Hoisting Load (Main Cable)	gh	0.565	kN/m	
Total Dead Load	gd	1.578	kN/m	
Load from Utility Pipe		0.600	kN/m	
Live Load		5.20	kN/m	
Total Full Load	**gf**	**7.378**	**kN/m**	
4. SAG CONSIDERED FOR MAIN CABLES				
Dead Load Sag	bd	2.75	m	
Full Load Sag	bf	3.469	m	
5. CABLE INCLINATION (HIGHER SUPPORT)				
Dead Load	bd	9.93	Degrees	
Full Load	bf	11.913	Degrees	
Standard Requires angle of inclination to be less than 12 Degree in Dead Load Case				
		OK		
6. CABLE TENSION				
6.1 Cable Tension from SAP Analysis (Unfactored)				
Tension on Main Cable for Two Cable	879.48	kN		
Tension on Handrail Cable for Single Cable	157.44	kN		
Minimum Braking Load for Two 48 mm Cable	3228	kN		Wire Strength of 1960 N/mm2
Factor of safety of Main Cable	3.67	>		
Standard requires a safety margin of >3				
Result		OK		
Minimum Braking Load for Single 48 mm Cable	1614	kN		Wire Strength of 1960 N/mm2
Factor of safety of Handrail Cable	10.25			
Result		OK		

7.2. Analysis of Cables using LSTB Standard Technical Manual Volume A

BASIC INFORMATION			
Span	L	80.00	m
Difference in Elevation between saddles	h	3.00	m
CABLE CONFIGURATION			
No of Main Cable		4	
Dia of Main Cable		48	mm
No of Handrail Cable		2	
Dia of Handrail Cable		48	mm
No of Windguy Cable		2	
Dia of Windguy Cable		40	mm
Modulus of Elasticity of Steel Wire Rope	E	110	kN/m^2
Design Load Calculations			
1. Hoisting Load Case			
Main Cable and Handrail Cable	**gh**	**0.565**	**kN/m**
2. Dead Load Case			
Hoisting Load (main cable)		0.565	kN/m
Deck including Longitudinal Beam, Cross Beam and utility supports		0.720	kN/m
Windguy Cable with Windtie		0.292	kN/m
Total Dead Load	**gd**	**1.578**	**kN/m**
3. Load from Utility Pipe		**0.600**	kN/m
4. Full Load Case			
Dead Load		1.578	kN/m
Live Load		5.20	kN/m
Utility Load		0.60	kN/m
Total Full Load	**gf**	**7.378**	**kN/m**
Sag Calculation			
Dead Load Sag	bd	2.75	m
Length of Cable at Dead Load Case	Ld	80.308	m
Constant Factor,	C	0.3470	
Hoisting Load Sag (By Iteration)			
b*		2.558	m
g*		0.565	kN/m
new b*		2.558	m

Difference between b* and new b*			0.000	
Hoisting Load Sag	**bh**		**2.558**	**m**
Full Load Sag (By Iteration)				
b*			3.469	m
g*			7.378	kN/m
new b*			3.469	m
Difference between b* and new b*			0.000	
Full Load Sag	**bf**		**3.469**	**m**
Maximum Tension at Full Load	Tmax		1738.58	kN
Factor of Safety for Cable Tension			4.41	
Calculation of Final Data				

Description	Unit	Hoisting Case	Dead Load Case	Full Load Case
Span, L	m	80		
Elevation Difference, h	m	3		
Metallic Area of Main Cable, Am	mm2	4053.41		
Metallic Area of Handrail Cable, Ah	mm2	2026.70		
Total Metallic Area of Cable, A	mm2	6080.11		
Load, g	kN/m	0.5652	1.578	7.378
Sag, b	m	2.558	2.75	3.469
Final Results				
Cable Inclination at Higher Side, β1	Deg	9.39	9.93	11.91
Cable Inclination at Lower Side, β2	Deg	5.17	5.71	7.74
Distance of lowest point of Parabola from Higher Side, e	m	51.726	50.909	48.647
Maximum Sag, f	m	4.278	4.250	4.969
Length of Cable, L	m	80.274	80.308	80.457
Horizontal Component of Cable Tension, H	kN	176.729	458.938	1701.137
Maximum Tension, Tmax	kN	179.131	465.913	1738.584
Maximum Tension on Main Cable, TMmax	kN	119.421	310.608	1159.056
Tension on Main Cable, TM	kN	118.300	307.485	1144.527
Maximum Tension on Handrail Cable, THmax	kN	59.710	155.304	579.528
Tension on Handrail Cable, TH	kN	59.150	153.742	572.264

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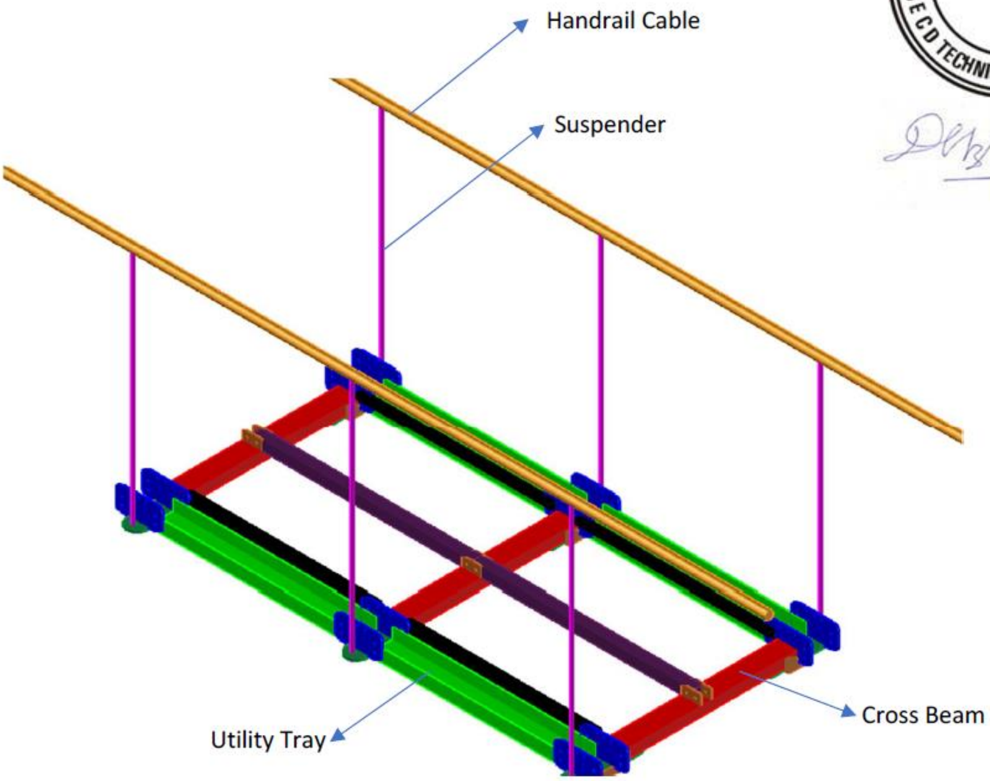
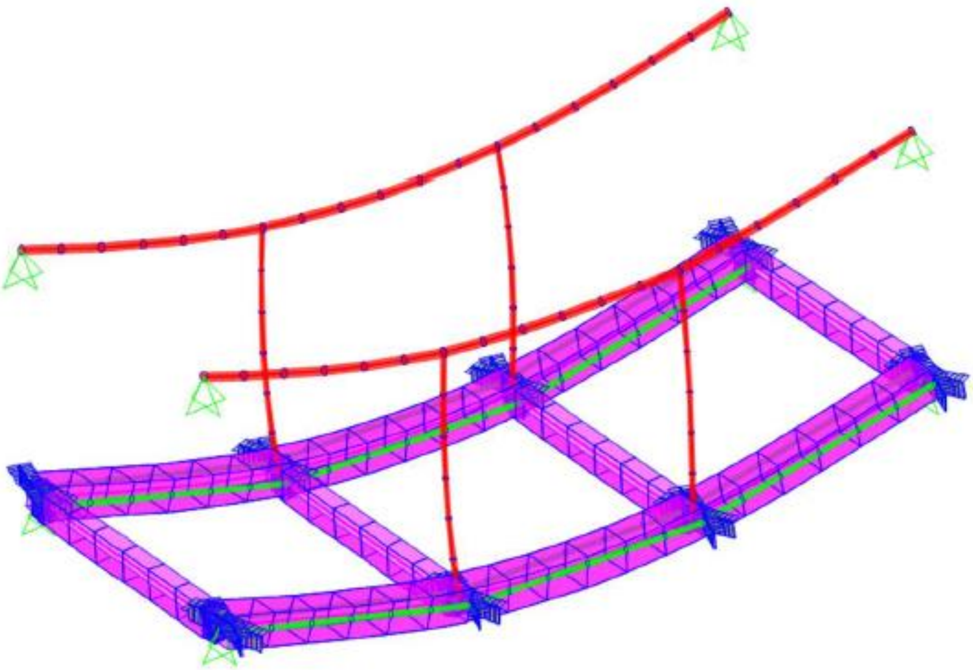
7.3. Analysis & Design results of Deck Structure

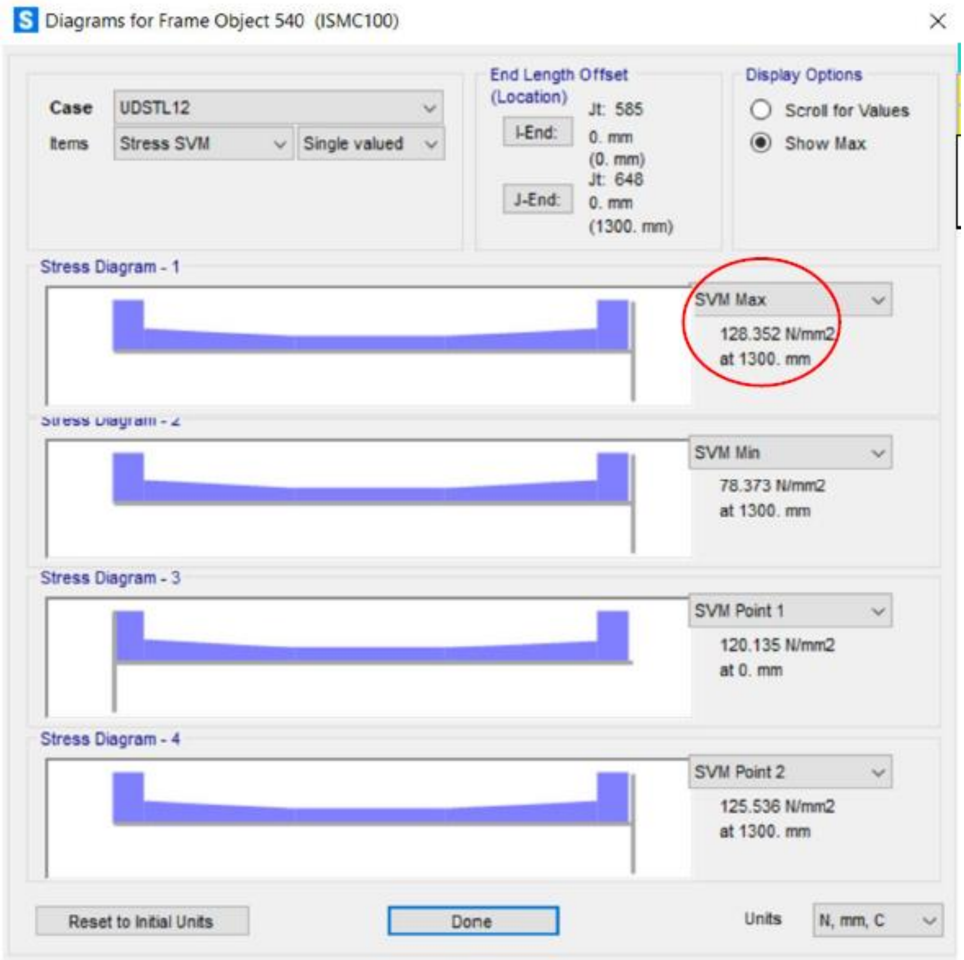
7.3.1. 3D model of Deck Structure for Sky Bridge



7.3.2. Deformed shape of Deck Structure



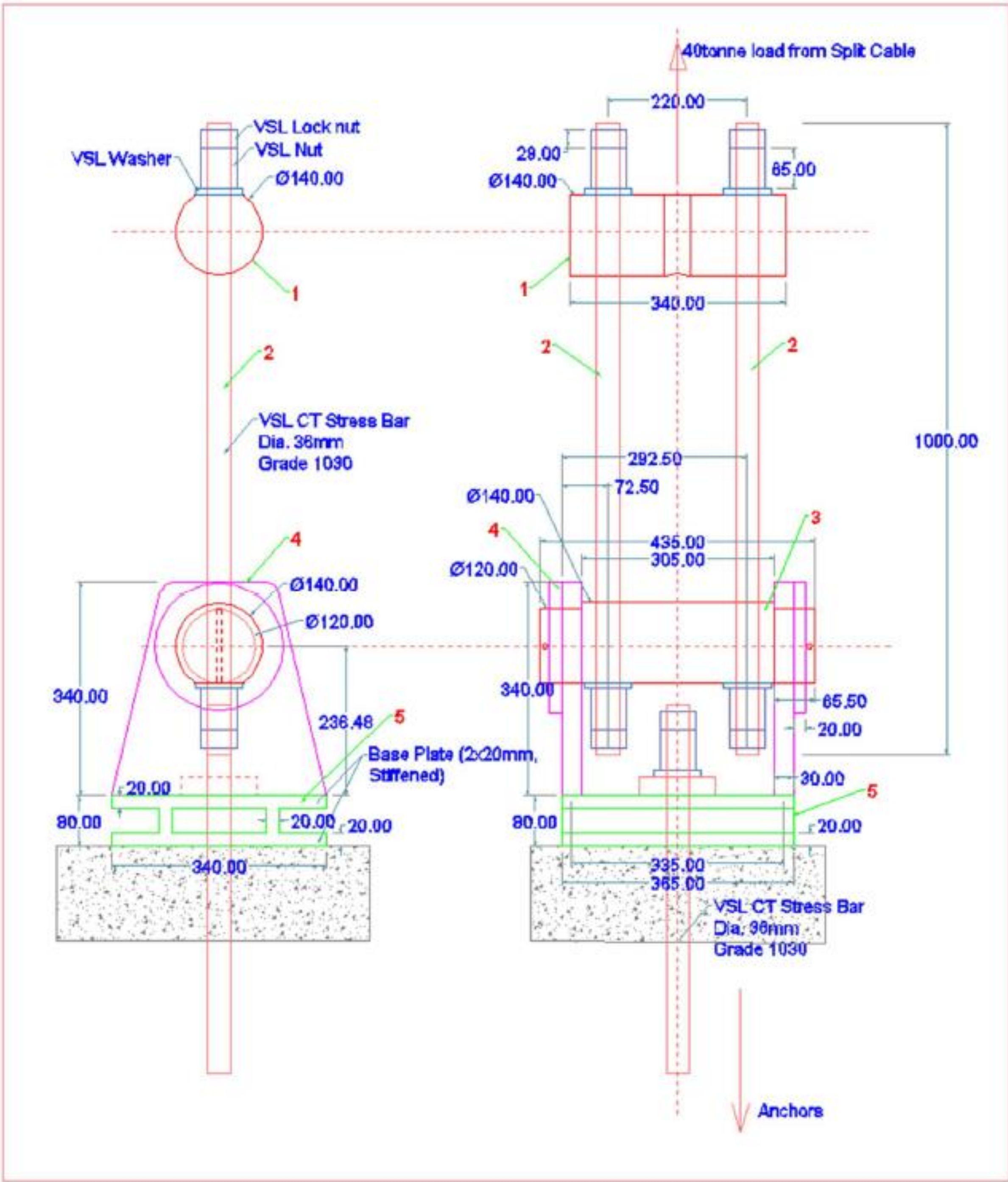
7.3.3. Stress Diagram of the cross beam for SVM



Actual von mis stress (SVM) = 128.352 MPa
Maximum allowable stress = 150 MPa
Actual stress of the cross beam < Maximum allowable stress (Hence OK)

8. CHECK FOR CONNECTION DESIGN

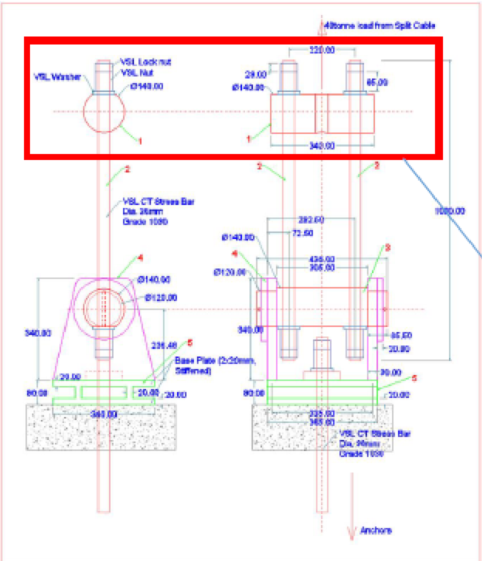
8.1. Cable – Anchor Connection

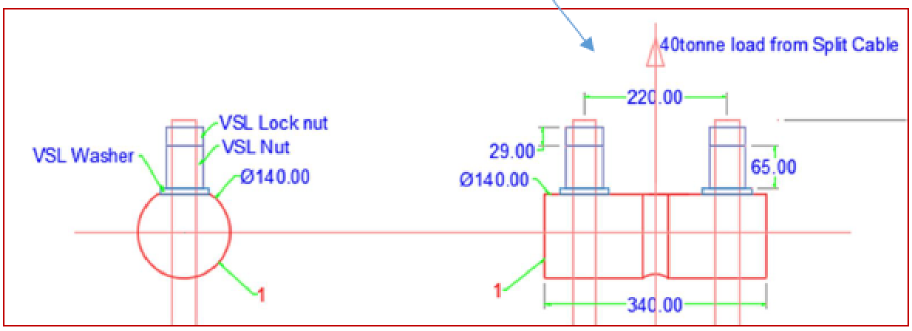


Cable-Anchor Connection						
Part List						
S.N.	Part Name	Material	Section	Dimensions (mm)	Qty.	Remarks
1	Adjustable Pin	Fe250	Round Bar	140 dia., L=340	1	
2	Thread Rod	VSL CT Stress Bar, Grade 1030	Thread rod	36 dia, L=1000	2	
3	Hinged Pin	Fe250	Round Bar	140 dia., L=340	1	
4	Brakcet	Fe250	Plate 30	340x340x30	2	
5	Base Plate	Fe250	2x stiffened Plate 20	2x (340x365x20)	1	

8.1.1. Adjustable Pin Connection

Cable-Anchor Connection						
Part List						
S.N.	Part Name	Material	Section	Dimensions (mm)	Qty.	Remarks
1	Adjustable Pin	Fe250	Round Bar	140 dia., L=340	1	
2	Thread Rod	VSL CT Stress Bar, Grade 1030	Thread rod	36 dia, L=1000	2	
3	Hinged Pin	Fe250	Round Bar	140 dia., L=340	1	
4	Brakcet	Fe250	Plate 30	340x340x30	2	
5	Base Plate	Fe250	2x stiffened Plate 20	2x (340x365x20)	1	





- Check for Bending Stress:

Beam material				
List of materials		Structural steel EC 3, EN 10025; Fe 360 (210000)		
Density	γ	7850.0	☑	[kg/m^3]
Modulus of elasticity in tension	E	210000	☑	[MPa]
Permissible bending stress	σ_h	141	☑	[MPa]

Results section

☑ **Calculation results**

Support number from left	R1	R2				
Reaction in supports	200114.61	200114.61				[N]

		Min.	Max.	
Bending moment Min. / Max.	Mo	0.00	22006.30	[Nm]
Beam deflection Min. / Max.	y	-0.030	0.000	[mm]
Bending stress Min. / Max.	σ_h	0	102	[MPa]
Weight of the beam	m		22.9	[kg]
Max. length of the free end (buckling).	Lmax		0.0	[mm]
Relative beam deflection Max.	y'		0.014	[%]

- Check for Shear Stress:

Max. Shear Force	:	20 ton
Shear Area	:	10152 mm2

Now, the shear stress is calculated as

Permissible shear stress is

	=	Yield Strength*0.4
	=	250 MPa*0.4
	=	100 MPa
Max. Shear Stress	=	Max. Shear Force / Shear Area
	=	20 ton/10152 mm2
	=	19.70 MPa

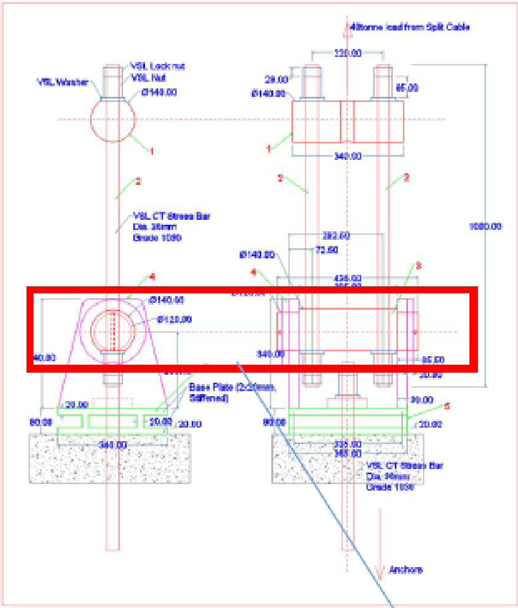
Which is less than the permissible shear stress, hence the selected size and material of this part is safe for shear strength.

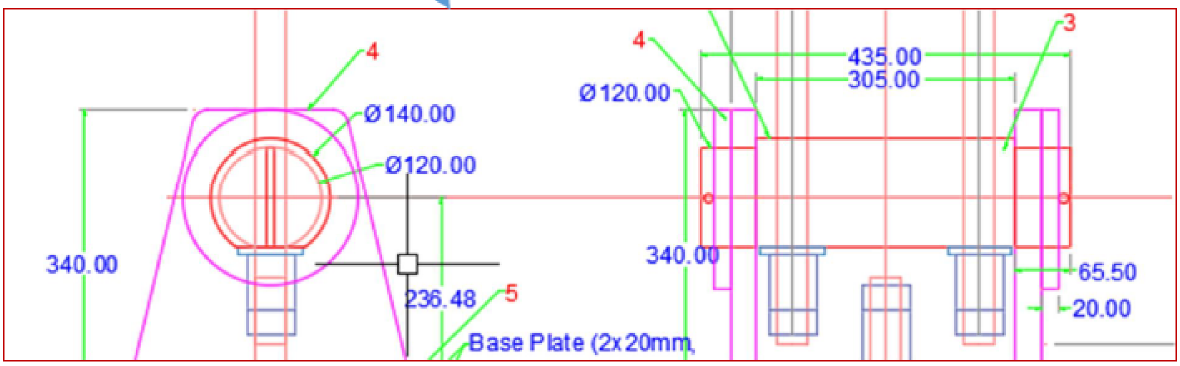
8.1.2. Hinged Pin Connection

Cable-Anchor Connection

Part List

S.N.	Part Name	Material	Section	Dimensions (mm)	Qty.	Remarks
1	Adjustable Pin	Fe250	Round Bar	140 dia., L=340	1	
2	Thread Rod	VSL CT Stress Bar, Grade 1030	Thread rod	36 dia, L=1000	2	
3	Hinged Pin	Fe250	Round Bar	140 dia., L=340	1	
4	Brakcet	Fe250	Plate 30	340x340x30	2	
5	Base Plate	Fe250	2x stiffened Plate 20	2x (340x365x20)	1	





- Check for Bending Stress:

☑ Beam type, dimensions and loading

Calculation units: SI Units (N, mm, kW...)

Left beam end: B_Support

Number of supports betwe: 0

Right beam end: B_Support

Beam field no: **L1**

Length of beam fielc	L	354.0	[mm]

Beam material

List of materials: Structural steel EC 3, EN 10025; Fe 360 (210000)

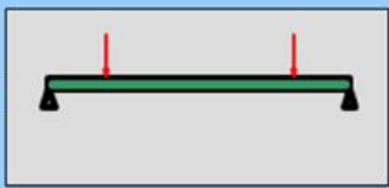
Density	γ	7850.0	☑	[kg/m^3]
Modulus of elasticity in tension	E	210000	☑	[MPa]
Permissible bending stress	σ_b	141	☑	[MPa]

Results section

☑ Calculation results

Support number from left	R1	R2				
Reaction in supports	199619.45	200749.40				[N]

Bending moment Min. / Max.	Mo	0.00	13471.92	[Nm]
Beam deflection Min. / Max.	y	-0.068	0.000	[mm]
Bending stress Min. / Max.	σ_b	0	62.5	[MPa]
Weight of the beam	m		36.9	[kg]
Max. length of the free end (buckling).	Lmax		0.0	[mm]
Relative beam deflection Max.	y'		0.019	[%]



- Check for Shear Stress:

Maximum shear force resulted as

Max. Shear Force : 20 ton

Shear Area : 10152 mm2

Now, the shear stress is calculated as

Permissible shear stress is

= Yield Strength*0.4

= 250 MPa*0.4

= 100 MPa

Max. Shear Stress = Max. Shear Force / Shear Area

= 20 ton/10152 mm2

= 19.70 MPa

Which is less than the permissible shear stress, hence the selected size and material of this part is safe for shear strength.

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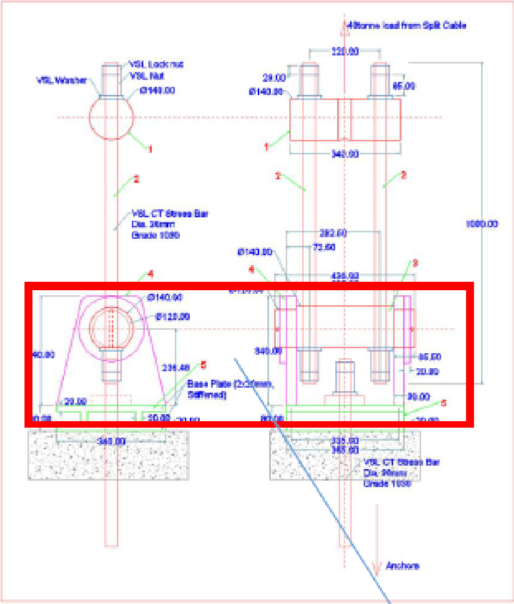
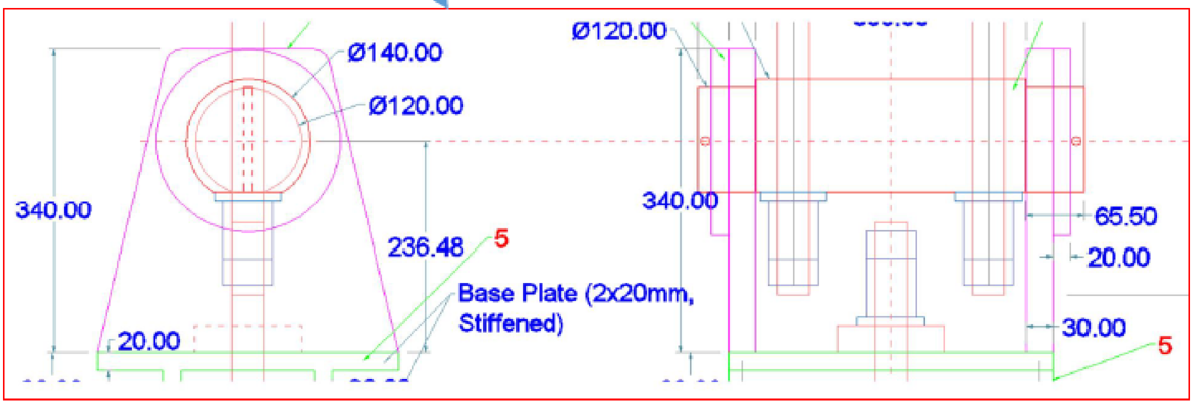
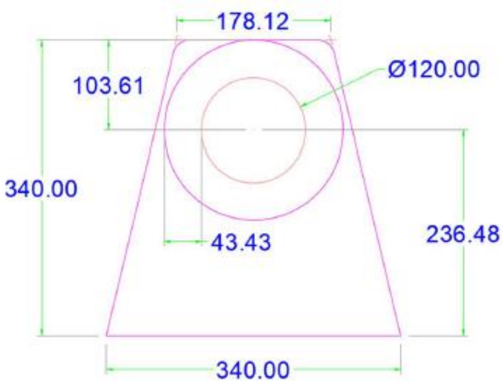
8.1.3. Bracket Connection

Cable-Anchor Connection						
Part List						
S.N.	Part Name	Material	Section	Dimensions (mm)	Qty.	Remarks
1	Adjustable Pin	Fe250	Round Bar	140 dia., L=340	1	
2	Thread Rod	VSL CT Stress Bar, Grade 1030	Thread rod	36 dia, L=1000	2	
3	Hinged Pin	Fe250	Round Bar	140 dia., L=340	1	
4	Brakcet	Fe250	Plate 30	340x340x30	2	
5	Base Plate	Fe250	2x stiffened Plate 20	2x (340x365x20)	1	







- Check for Tensile Stress:

Max. Tensile force in each bracket	= 20 tons
Tensile area	= 4343 mm^2

Permissible tensile stress	= Yield strength x 0.6
	= 250 MPa x 0.6
	= 150 MPa
Tensile stress	= Max. Tensile force / tensile area
	= 200000/4343
	= 46 MPa

The calculated tensile stress is less than permissible tensile stress value of 150 MPa and hence selected size and material of this part is safe for the tensile strength.

- Check for Shear Stress:

Max. Shear Force	:	20 ton
Shear Area	:	10361 mm2

Permissible shear stress is

	=	Yield Strength*0.4
	=	250 MPa*0.4
	=	100 MPa

Now, the shear stress is calculated as

Max. Shear Stress	=	Max. Shear Force / Shear Area
	=	20 ton/10361 mm2
	=	19.30 MPa

Which is less than the permissible shear stress, hence the selected size and material of this part is safe for the shear strength.

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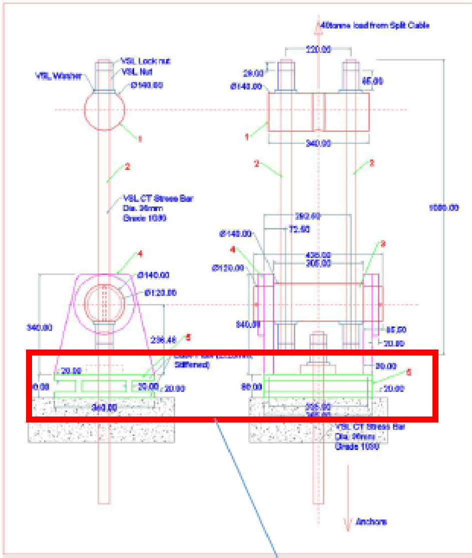
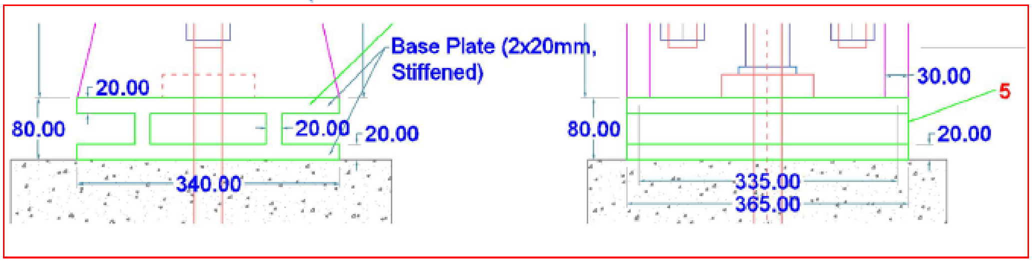
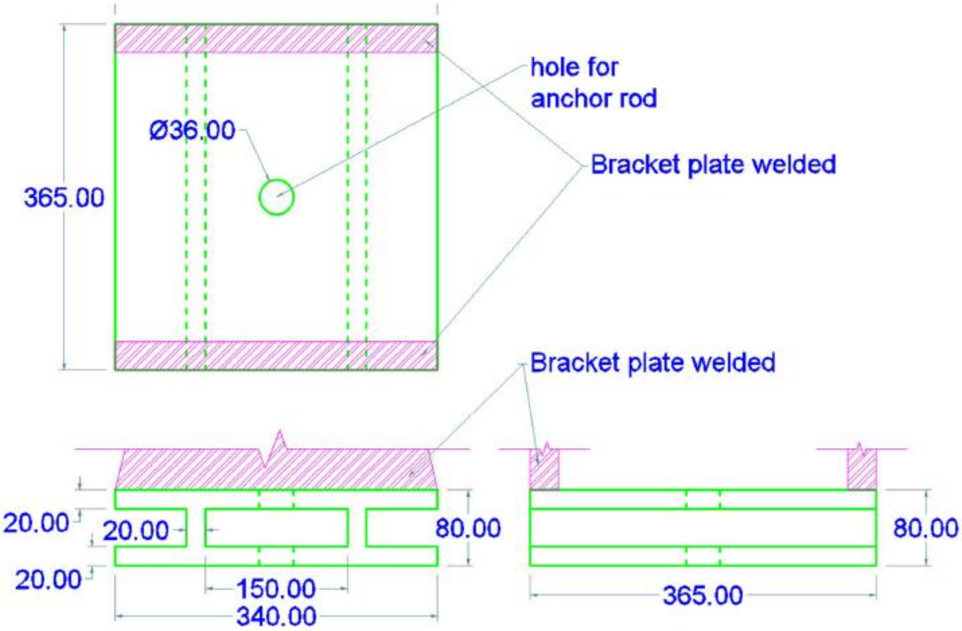
8.1.4. Base-plate Connection

Cable-Anchor Connection						
Part List						
S.N.	Part Name	Material	Section	Dimensions (mm)	Qty.	Remarks
1	Adjustable Pin	Fe250	Round Bar	140 dia., L=340	1	
2	Thread Rod	VSL CT Stress Bar, Grade 1030	Thread rod	36 dia, L=1000	2	
3	Hinged Pin	Fe250	Round Bar	140 dia., L=340	1	
4	Brakcet	Fe250	Plate 30	340x340x30	2	
5	Base Plate	Fe250	2x stiffened Plate 20	2x (340x365x20)	1	







- Check for Bending Stress:

3.0	Calculation results				
3.1	Support number from left		R1	R2	
3.2	Reaction in supports		200198.59	200198.59	[N]
3.3	Bending moment Min. / Max.	Mo	0.00	33516.63	[Nm]
3.4	Beam deflection Min. / Max.	y	-0.116	0.000	[mm]
3.5	Bending stress Min. / Max.	σ_b	0	104.1	[MPa]
3.6	Weight of the beam	m		39.7	[kg]
3.7	Max. length of the free end (buckling).	Lmax		1630.3	[mm]
3.8	Relative beam deflection Max.	y'		0.035	[%]

Max. Bending Stress is calculated as 104 MPa, which is less than the permissible value i.e. 141 MPa. Hence the selected size of this part is safe for bending strength.

- Check for Shear Stress:

Max. Shear Force : 20 ton

Shear Area : 15200 mm2

Now, the shear stress is calculated as

Permissible shear stress is

= Yield Strength*0.4

= 250 MPa*0.4

= 100 MPa

Max. Shear Stress = Max. Shear Force / Shear Area

= 20 ton/15200 mm2

= 13.16 MPa

Which is less than the permissible shear stress, hence the selected size and material of this part is safe for shear strength.

8.2. Ground Anchor Connection

The ground anchor design will check for numerous scenarios / failure modes, and different factors of safety are applied. The ground anchor design shall utilise different factors of safety for different failure mechanisms, minimum factors of safety are summarised below:

- Tendon capacity – 1.5
- Grout / Ground Interface – 3.0
- Grout / encapsulation interface 3.0
- Grout / tendon Interface 3.0

Anticipated Factored Loads are summarised below:

Factoring	**Factored Lads for Various Cables (kN)**		
	Main Cable (twin anchors)	**Hand Cable**	**WindGuy Cable**
Unfactored Load	260*	158	158*
Tendon capacity (factored) **	381*	237	237*
Grout / Ground Interface	762*	474	474*
Grout / encapsulation interface	762*	474	474*
Grout / tendon Interface	762*	474	474*
* Loads to be confirmed be Bridge Designer ** Tendon Capacity also needs to be checked for potential corrosion / loss of capacity over design life			

The required fixed length to achieve the factored capacity on the ground/grout interface for the various cable anchors is summarised below:

Anchor Descriptions	'R' per Metre (kN)	Required Factored Capacity (kN)	Calculated Fixed Length (m)
Main Cable (two anchors per cable)	804.25	762	0.95
Hand Cable	804.25	474	0.59
WindGuy Cable	804.25	474	0.59

The calculated fixed anchor lengths are all less than the minimum recommended in BS8081, therefore a minimum 2m fixed length shall be adopted.

9. CONCLUSION

1. As per received Design Summary & Compliance Report (Ref no. WE-RSG-SKYB-DSCR, Rev: 1.0) for Sky Bridge structure, below mentioned points has been noted.

    - Maximum cable tension in main cable for each cable = 439.74 kN
    - Maximum cable tension in each handrail cable = 157.44 kN

    The Minimum Breaking Loads (MBL) for the selected cables are as follow;
    - MBL for main cable – 48mm dia. 6x19 IWRC, 1960 N/mm2 = 1614 kN
    - MBL for handrail cable – 48mm dia. 6x19 IWRC, 1960 N/mm2 = 1614 kN

    With the above values, the factor of safety of the cables are resulted as;
    - For main cable = 3.67
    - For handrail cable = 10.25

- The total tension on main cable considering the load factors as per AISC LRFD-93, the factor of safety on main cable comes to be 2.46. However, safety factor of the main cable of 3.67 has been achieved. Hence both main cable & handrail cable are safe in tension.

2. As per received Design Summary Report of SAP Analysis of Deck Structure (Ref no. RN-WG-SKYB-DSDS, Rev: 0.0) for Sky Bridge structure.

    - Maximum von mis stress (SVM) cross beam (ISMC 100) as 128.35 MPa noted from SAP 2000 analysis result which is within the permissible limit of maximum stress of 150 MPa.

3. As per received Design Summary & Compliance Report (Ref no. RN-WG-SKYB-DCCON, Rev: 0.0) for Sky Bridge structure, below mentioned points has been noted.

    - All parts of Cable Anchor Connection are checked against the strength such as Bending, Shear & Tensile whichever is applicable and critical. The summary of strength check is shown below.

Sr. No	Part Name	Material	Section	Dimension (mm)	Qty.	Design Checks			
1	Adjustable Pin	Fe250	Round Bar	140 dia. L=340	1	Bending Strength	OK	Shear Strength	OK
2	Hinged Pin	Fe250	Round Bar	140 dia. L=340	1	Bending Strength	OK	Shear Strength	OK
3	Bracket	Fe250	Plate 30	340 x 340 x 30	2	Tensile Strength	OK	Shear Strength	OK
4	Base Plate	Fe250	2 x stiffene r plate 20	2 x (340 x 365 x 20)	1	Bending Strength	OK	Shear Strength	OK

4. As per received Ground Anchor Design Philosophy Report (Ref no. 1799/TN01) for Sky Bridge structure, below mentioned points has been noted.

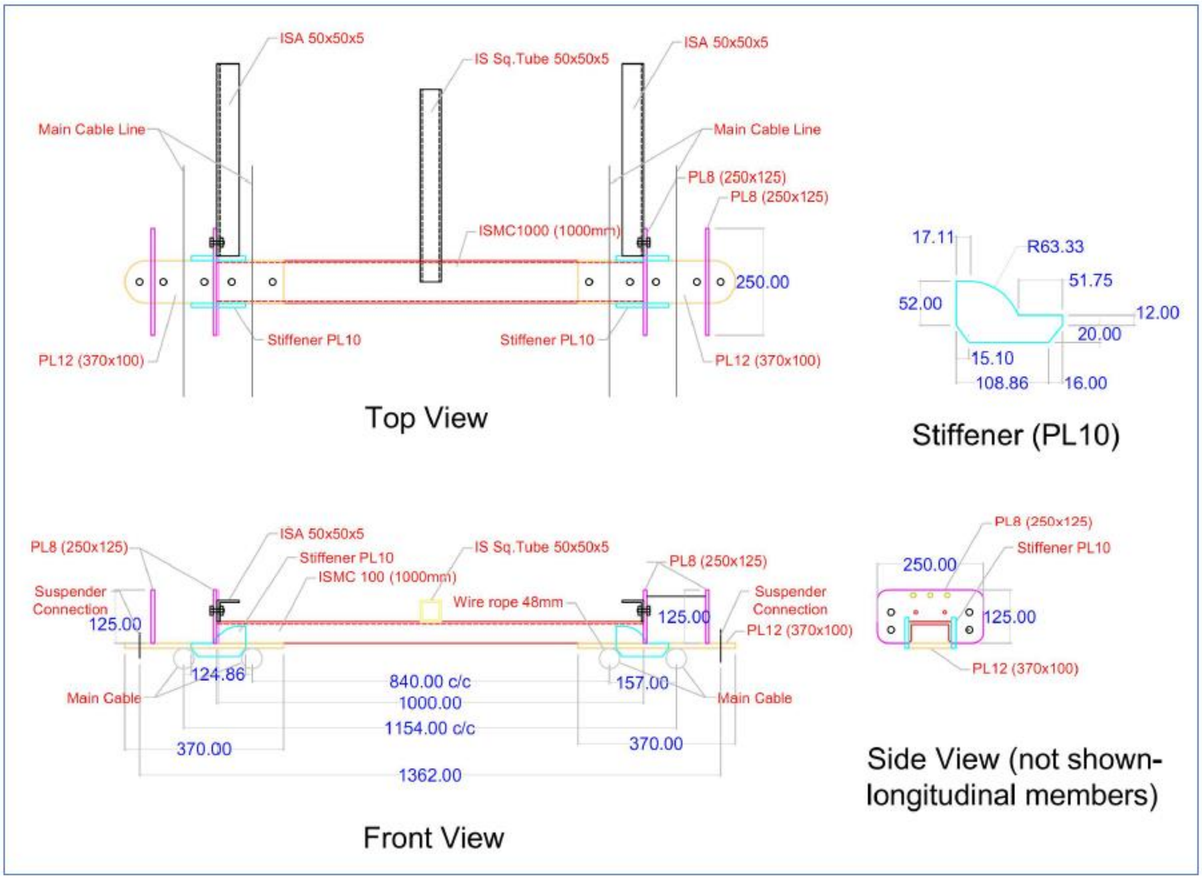
- The ground anchor design will check for different factor of safety are applied.
    - Tendon capacity = 1.5
    - Grout / Ground Interface = 3.0
    - Grout / encapsulation interface = 3.0
    - Grout / tendon Interface = 3.0

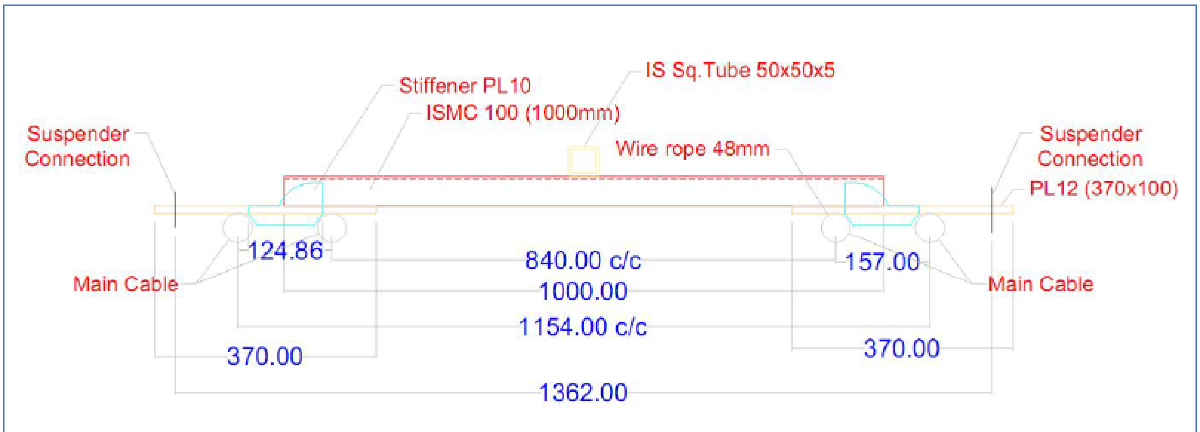
Anticipated Factored Loads are summarized below,

Factoring	**Loads for Various Cables (kN)**		
	Main Cable	**Hand Cable**	**Windguy Cable**
Unfactored Load	260	158	158
Tendon Capacity (Factored)	381	237	237
Grout/Ground Interface	762	474	474
Grout/Incapsulation Interface	762	474	474
Grout/Tendon Interface	762	474	474

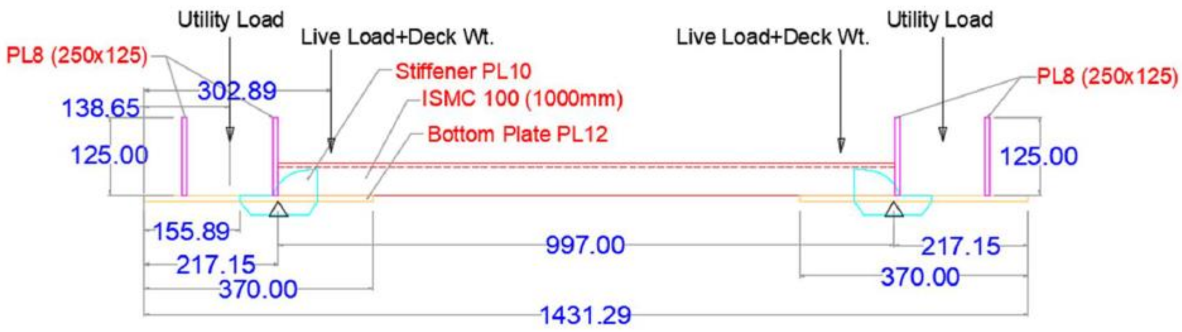
- Detailed design will determine the required bar diameter. The proposed diameter high grade steel bar has a Yield Load of 960kN and Ultimate Load of 1070kN, which is significantly greater than the factored tendon strength requirement identified in the table above.
- The required fixed length to achieve the factored capacity on the ground/grout interface for the various cable anchors is 0.95m. However, the calculated fixed anchor lengths are all less than the minimum recommended in BS8081, therefore a minimum 2m fixed length shall be adopted. Hence it is safe for above stated load capacity.

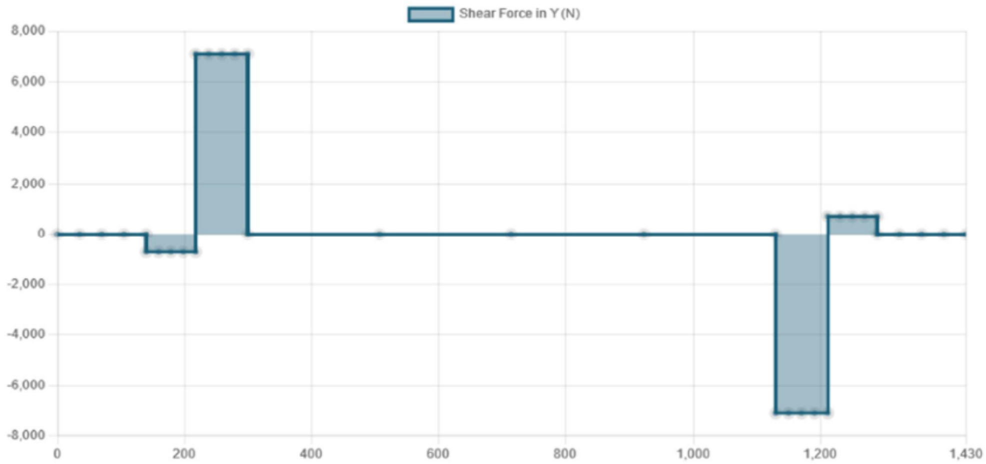
5. As per received Design Calculations of End Connection of Cross Beam (Ref no. RN-WG-SKYB-DCECCB, Rev: 0.0) for Sky Bridge structure, below mentioned points has been noted.





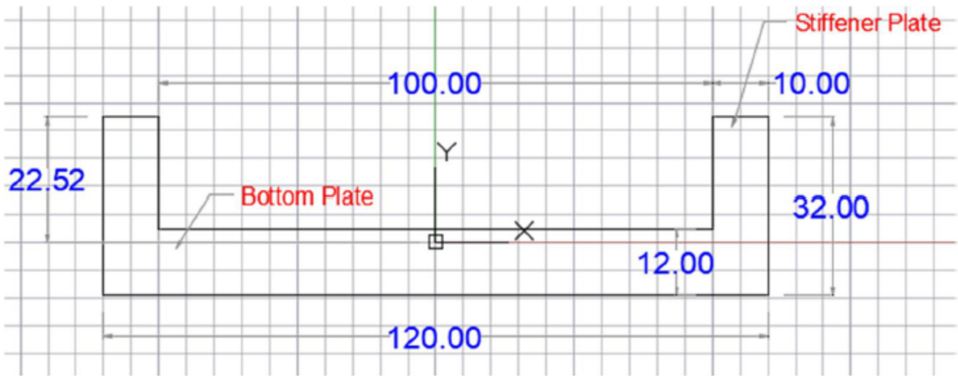
Front View
(Cross Beam for SAP Analysis)





Now, the bending moments and shear forces at each section-change positions are being calculated from the bending moment diagram (above), the values of which are

Location	Bending Moment	Shear Force
At stiffener location @ 218mm	56 Nm	7104 N
At end of the beam @ 156mm	13 Nm	720 N



The section properties are

Cross Section Area	Area Moment of Inertia (X)	Section Modulus (X)
1840.00 mm2	110752.469 mm4	4917.96 mm3

Bending stress is calculated a

Bending Stress = Bending Moment/Section Modulus

= 56 N-m/4917.96mm3

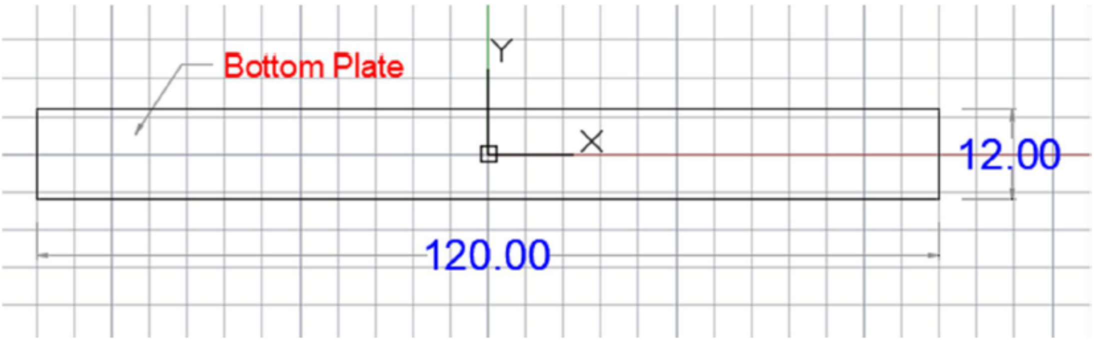
= 11.39 MPa < 150 MPa, Hence SAFE

Shear Stress = Shear Force/Cross Section Area

= 7104 N/1840.00 mm2

= 3.86 MPa <140 MPa, Hence SAFE

The cross section at the bottom plate location is



The section properties are

Cross Section Area	Area Moment of Inertia (X)	Section Modulus (X)
1440.00 mm2	17280 mm4	2880 mm3

Bending stress is calculated a

Bending Stress = Bending Moment/Section Modulus

= 13 N-m/2880mm3

= 4.52 MPa < 150 MPa, Hence SAFE

Shear Stress = Shear Force/Cross Section Area

= 720 N/1440.00 mm2

= 0.5 MPa <140 MPa, Hence SAFE