CAREER EPISODE 2

INTRODUCTION

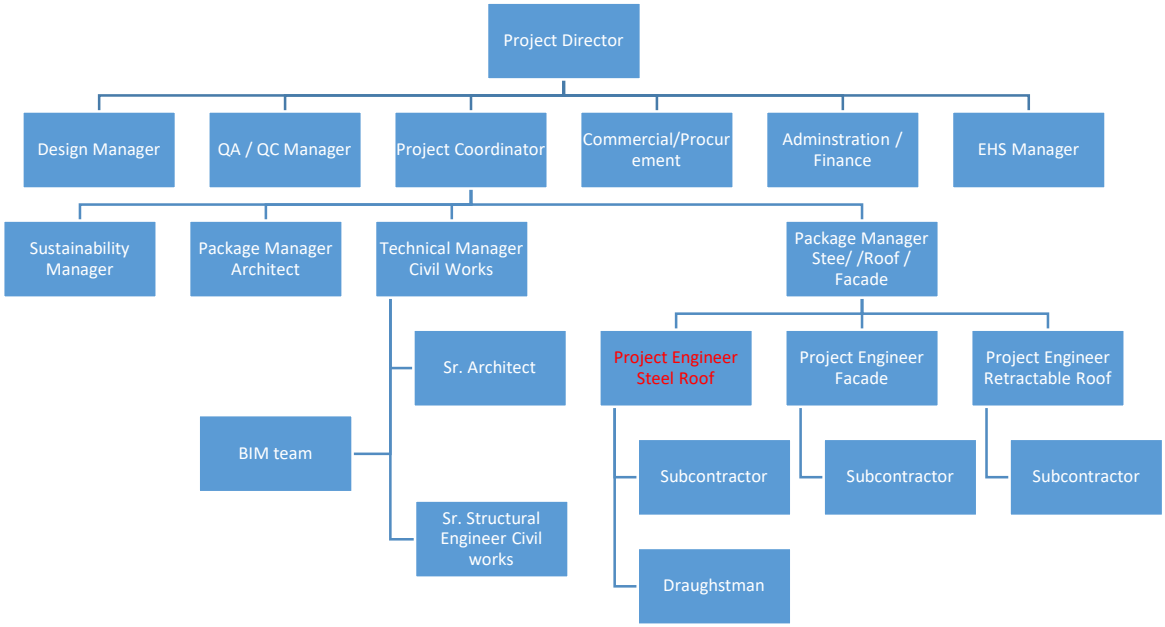
CE 2.1 In this career episode I would be discussing my project with Al Wakrah Stadium & Precinct Works and Master Plan. The project started on February 2017 and lasted till July 2018. I was working for Six Construct Qatar Ltd. W.L.L as Project Engineer – Sr. Structural Engineer and I was based in Doha, Qatar. Six Construct Ltd Qatar is part of BESIX group which is established in Middle East in 1964. Six Construct is a multi-service firm that operates in the construction of commercial and residential buildings, sport and leisure facilities, infrastructure and marine-related projects. The company currently has 9000 employees in the Middle East and a total of 15,000 worldwide.

BACKGROUND

CE 2.2 The Wakra renamed as Al Janoub is located 20 km from Doha is one of the state-of-the-art stadia designed by Zaha Hadid Architects that covers area of 580,000 m^2 and is one of the eight stadiums to host FIFA Works Cup in Doha Qatar. The Capacity of the stadium is 40,000 seats and it will host matches for the quarter finals with a total value of 587 Million Euros.

CE 2.3 The main objective of this project was to design, supply, installing, construction, completion of the works related to Al Wakra Stadium. This includes more than 25,000 m^3 concrete, 7,000 tons of steel structure for the main roof and 2,500 tons of structural steel for the upper tiers.

CE 2.4 My organization chart shows my reporting line within the company.



CE 2.5 My main responsibilities for this project were:

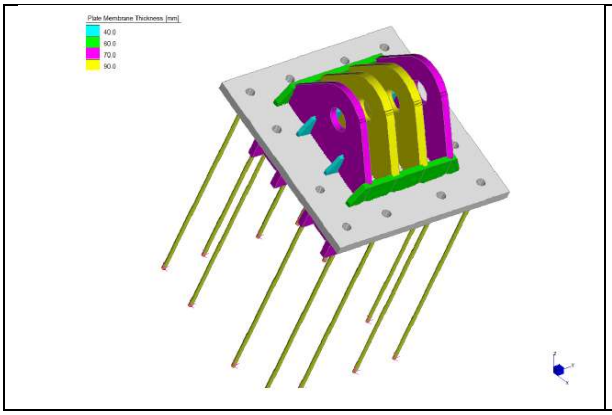
- Review and approval of structural design and detailing of complex connections
- Review and approval of structural calculations for the permanent and temporary works
- Coordination of interface models/details with the other trades
- Review and assessment of Lifting Studies for Heavy and Medium Lifts
- Develop and approve site related documents to ensure that the completion of the works is done in accordance with the project specification and related standards.
- Solving interface issues on time between the main steel structure subcontractor and facade subcontractor for achieving successful completion of the project.
- Cooperate and coordinate with all relevant parties such as HSE and QC departments.
- Coordinate and control the execution of the subcontract, proactively set objectives for the subcontractor, timely flag issues and propose solutions.

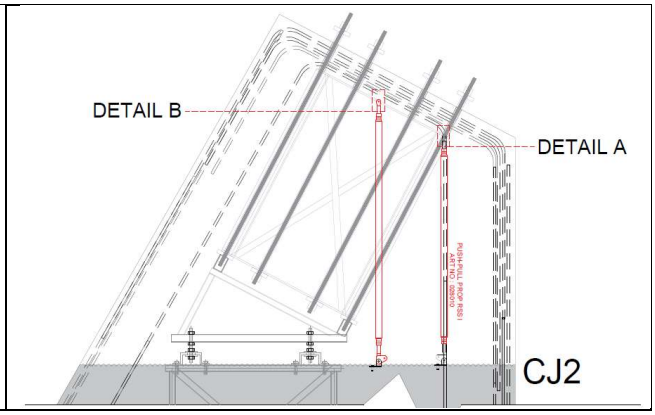
PERSONAL ENGINEERING ACTIVITY

CE 2.6 One of the issues I faced during the project was casting of main base plates for the bespoke columns and issues related to tolerances. During the starting phase of the project when the main baseplates for the bespoke needed to be casted, I was assigned to see and monitor the casting the anchor bolts. Since the tolerances for casting these anchor bolts (un-bonded tendons) were quite stringent, I had to

develop a temporary frame that need to be kept during the pouring of the concrete process.

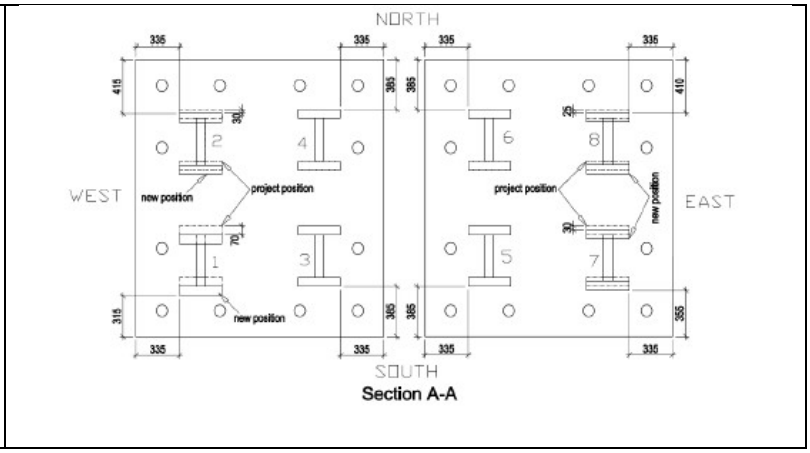
CE 2.7 The temporary frame contained accurate location of the anchor bolts. The construction manager for the shear keys wanted to use pure foam to leave voids. During the casting of the second phase the site team constructed the voids for the shear keys however they didn't place them in the correct position, which listed to more than 70mm movement on lateral side.





CE 2.8 After curing the concrete I instructed the surveyors to check the position of the shear keys and found deviations on the tolerances. I called for an internal meeting with the construction team and the subcontractor to see what can be done in order not to delay the installation of the base plates.

CE 2.9 I used my engineering judgment and suggested readjusting the shear keys location by cutting and welding them back as per the location of the as build. All stakeholders agreed to this approach and I instructed the subcontractor to submit a design change document (the output of the design is shown below) and proceed with the changes. The work was approved by the client and the main designer.



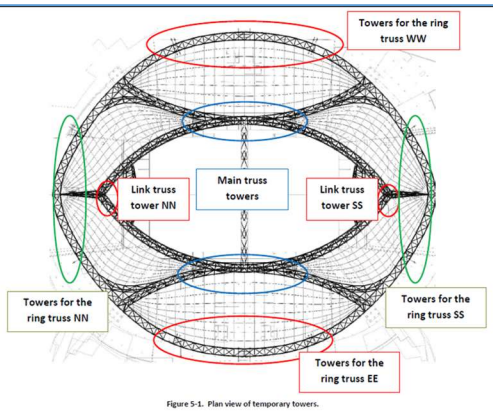
CE 2.10 I developed the method statement for the grouting and tensioning of the un-bonded bars. For the grouting since the quantity of the grout was significant the grouting was poured in two phases without stopping to ensure that the grout material reached to all of the areas.

CE 2.11 I sent samples for testing to ensure that the grouting mix was as per the required strength (the minimum strength requirement was 23MPa). The tensioning of the un-bonded base was also completed by the specialist in a phase described by the manufacturer. From this situation I revised the methodology for the other casting of the other base plates.

CE 2.12 After completion of the steel roof and alignment in accordance with Eurocode 1 & 3 and BS EN 1090, I scheduled technical meeting with the subcontractor's structural engineer and the main designer to discuss the way and the methodology of de-propping. During this review complete FEM model was used in Straus 7 for the verification as per the code Eurocode 3 (postprocessor was used).

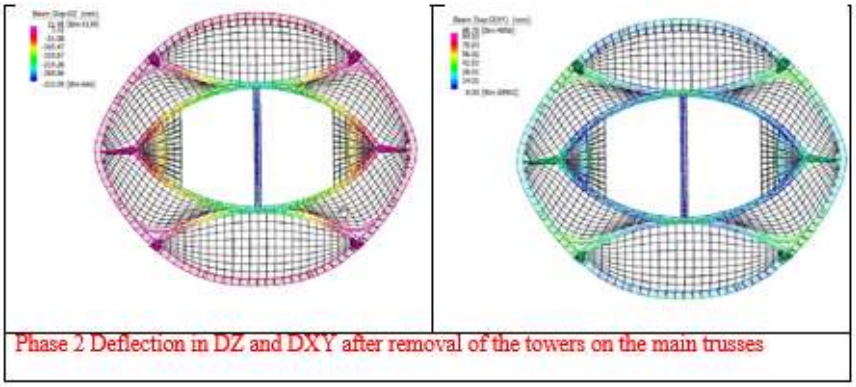
CE 2.13 I instructed the subcontractor to submit a detailed calculation study to verify the details and analyze if the permanent sections will experience higher stresses during the propping phase. The scheme and the methodology for de-propping and was reviewed and approved and I submitted the final study and developed method statement to the client.

CE 2.14 During the review process I had several meetings with the structural engineer from the subcontractor where we discussed internal forces, stresses on the temporary towers and if changes of these forces had any impact on the foundations. At the same time, I also organized a meeting with all concerned parties to go through and see and answer all the aspects of structural integrity as well as the safety aspects.

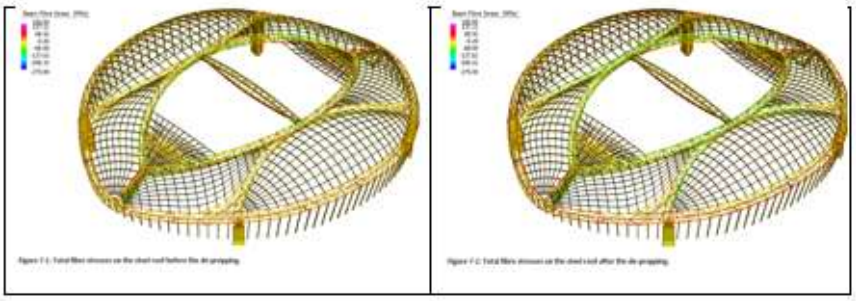
 Figure 5-1. Plan view of temporary towers.	Phase 1 – Removal of the temporary towers for the ring truss. Removal temporary towers on ring truss NN and SS symmetrically Removal of temporary towers on ring truss EE and WW symmetrically Phase 2 – Removal of temporary towers on main truss and link truss Removal temporary towers on main truss WW and EE symmetrically Removal temporary towers on link truss NN and SS symmetrically

CE 2.15 To see the consequence of the deflection that needed to be monitored during the de-propping phase FEM model was done for Phase 1 and Phase 2 and the visual output is reported below:

Phase 1 Deflection in DZ and DXY after removal of the towers on the ring truss.



Phase 2 Deflection in DZ and DXY after removal of the towers on the main trusses



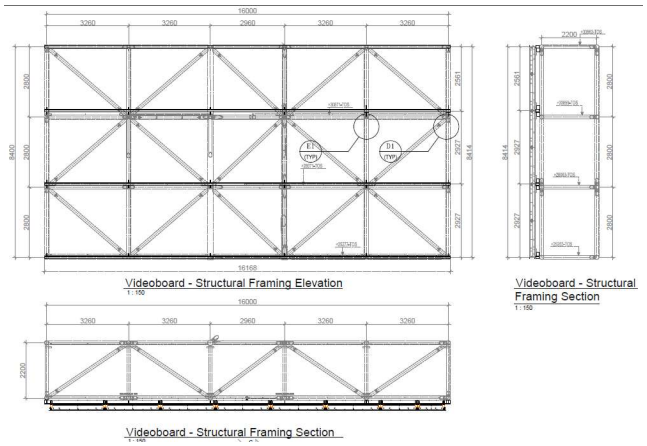
CE 2.16 From the analysis it could be seen that the stresses imposed by the de-propping were not exceeding the allowable limits. Prior to starting the de-propping phase I verified the installation and completion of all the essential work by IRW and QC verifications.

CE 2.17 During the de-propping process, I went and supervised the site team and monitored the deflection and behavior of the structure. I developed a checklist that was included in the method statement and it was signed off for each activity. The work finished successfully and after this phase another survey was done to confirm if the deflections were as anticipated.

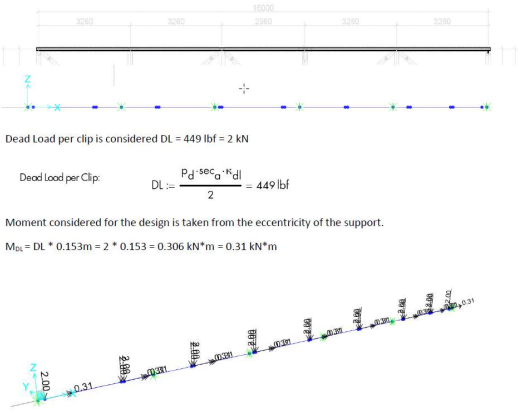
SURVEY AND CALCULATION BEFORE DE-PROPPING (Absolute values)															SURVEY AND CALCULATION AFTER DE-PROPPING (Absolute values)															COMPRARISION "BEFORE DE-PROPPING" vs "AFTER DE-PROPPIN							
	PRECAMBERED COORDINATES			SURVEY 21-04-18 BEFORE DE-PROPPING			Δ S-T			ELASTIC DEFORMATION			DIFFERENCE BETWEEN CALCULATED AND MEASURED				SURVEY 27-04-18 AFTER DE-PROPPING			Δ S-T (mm)			ELASTIC DEFORMATION			DIFFERENCE BETWEEN CALCULATED AND MEASURED				MEASURED DISPLACEMENTS FROM PROPPEED TO DE-PROPPED CONFIGURATION			CALCULATED DISPLACEMENTS FROM PROPPEED TO DE-PROPPED CONFIGURATION			DIFFERENCES CALCULATED AND		
													Construction tolerances:	± 55	± 55	± 50									Construction tolerances:	± 55	± 55	± 50							Construction tolerances:	± 55	± 55
POINT	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	ΔX	ΔY	ΔZ	point	X	Y	Z	X	Y	Z	X	Y	Z	ΔX	ΔY	ΔZ	point	X	Y	Z	X	Y	Z	ΔX	ΔY
GNL1	-13,831	72,407	43,405	-13,835	72,372	43,346	-4	-35	-59	-1	-20	-76	-2	-14	17	GNL1	-13,837	72,417	43,344	-6	10	-61	-1	10	-73	-4	1	12	GNL1	-2	45	-2	0	30	3	-2	15
GNL2	-0,001	71,435	43,122	-0,005	71,412	43,057	-4	-23	-65	0	-23	-83	-4	-1	18	GNL2	-0,003	71,436	43,062	-2	1	-60	0	2	-80	-2	-1	19	GNL2	2	24	5	0	25	3	2	0
GNL3	13,831	72,407	43,405	13,830	72,385	43,351	-1	-26	-54	1	-20	-76	-2	-5	22	GNL3	13,831	72,411	43,352	0	4	-53	1	10	-72	-2	-6	19	GNL3	1	30	1	0	30	4	1	0
GNL4	0,001	79,719	40,812	0,006	79,690	40,743	6	-29	-68	0	-20	-75	6	-9	5	GNL4	0,005	79,709	40,740	3	-10	-71	0	5	-68	3	-15	-3	GNL4	-3	19	-3	0	25	5	-4	-6
GNU1	-14,367	71,056	50,349	-14,382	71,029	50,288	-15	-28	-61	0	-32	-78	-15	5	17	GNU1	-14,383	71,067	50,289	-16	11	-61	-1	-7	-78	-15	18	16	GNU1	-1	38	1	0	25	2	-1	13
GNU2	0,000	69,906	51,133	-0,004	69,899	51,068	-4	-7	-65	0	-36	-86	-4	28	21	GNU2	-0,004	69,925	51,072	-4	19	-61	0	-12	-83	-4	32	22	GNU2	0	26	-4	0	23	3	0	3
GSL1	-13,831	-72,408	43,405	-13,818	-72,376	43,295	13	32	-110	-2	20	-77	14	12	-33	GSL1	-13,814	-72,413	43,280	17	-5	-125	-1	-10	-73	18	5	-52	GSL1	4	-37	-15	1	-30	3	-4	-6
GSL2	-0,001	-71,436	43,122	0,000	-71,396	43,002	9	40	-120	0	21	-83	9	17	-37	GSL2	0,009	-71,433	43,004	10	3	-118	0	-2	-80	9	5	-38	GSL2	1	-37	2	1	-25	3	1	-12
GSL3	13,831	-72,408	43,405	13,840	-72,368	43,304	8	41	-101	1	20	-76	7	20	-25	GSL3	13,841	-72,415	43,311	10	-7	-94	2	-10	-72	8	3	-22	GSL3	1	-47	7	0	-30	4	1	-17
GSL4	0,001	-79,692	40,821	0,003	-79,649	40,725	3	43	-95	0	20	-73	3	23	-22	GSL4	0,005	-79,678	40,729	4	14	-92	0	-5	-68	3	19	-24	GSL4	1	-29	3	1	-25	5	1	-4
GSU2	0,000	-69,908	51,133	0,010	-69,846	51,007	10	61	-126	0	36	-86	11	26	-40	GSU2	0,012	-69,877	51,007	12	31	-126	0	12	-83	12	19	-42	GSU2	2	-30	1	0	-23	3	2	-7
GSU3	14,367	-71,058	50,349	14,373	-70,984	50,230	6	73	-120	0	32	-78	6	41	-41	GSU3	14,375	-71,027	50,234	8	31	-115	1	7	-78	7	23	-36	GSU3	2	-43	0	1	-25	3	1	-13

CE 2.18 The main purpose for installation of the video screen structures was that everything had to be installed on the ground, to avoid the risk of installation at height and requirement of additional resources for access scaffolding. There was urgent requirement from MEP department to design and verify secondary steel structure supporting the video screens.

CE 2.19 I designed, fabricated and installed the secondary steel runners supporting the screens. I reviewed the main structure shop drawings and the BIM model, and the design calculation of the brackets that supported the screens. I then proceeded with modelling and prepared a finite element model.



Extract from the shop drawing

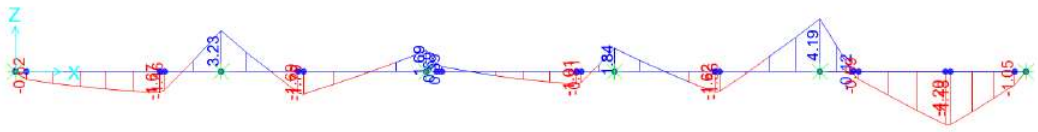


Sample of the dead loads applied on member.

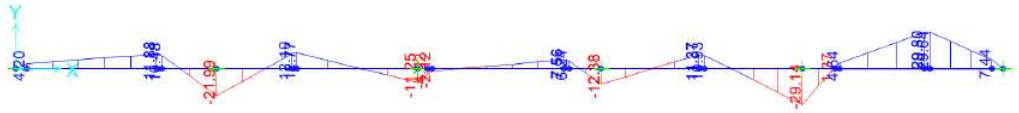
CE 2.20 After applying the required forces and moments from the eccentricities, I applied the combinations as per Eurocode 3 as well as verification of the members of the same code using SAP2000.

1.35DL
1.35DL + 1.5 WL
1.35DL + 1.0 EQ

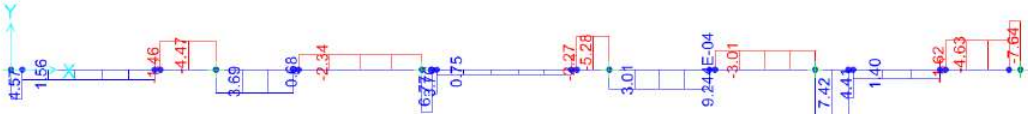
Moments Y-Y



Moments Z-Z

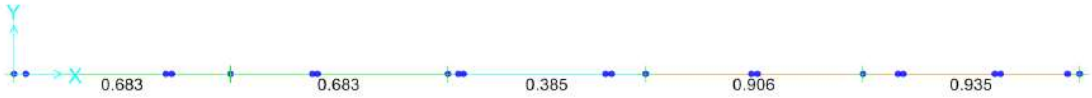


Torsion



Maximum Forces and Moments – plot

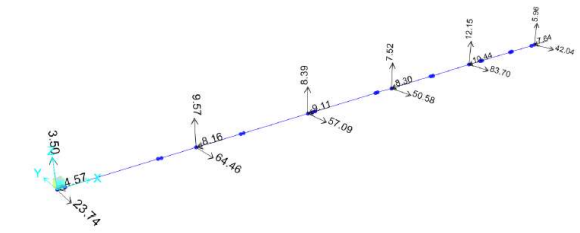
EN 1993 Check Ratio



Code Verification EN 1993

CE 2.21 Once I verified that the member was satisfying the core requirements I proceeded with the design of the connection. For this purpose, I used the software IDEA Statica.

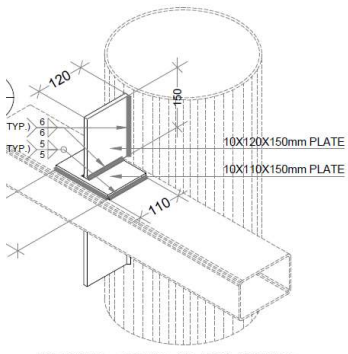
Reactions COMB4



Fz = 12.15 kN

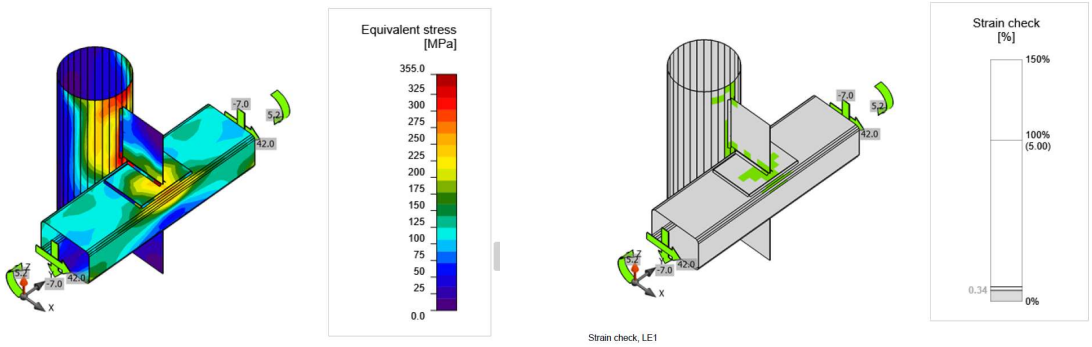
Fy = 83.7 kN

Mx = 10.44 kNm



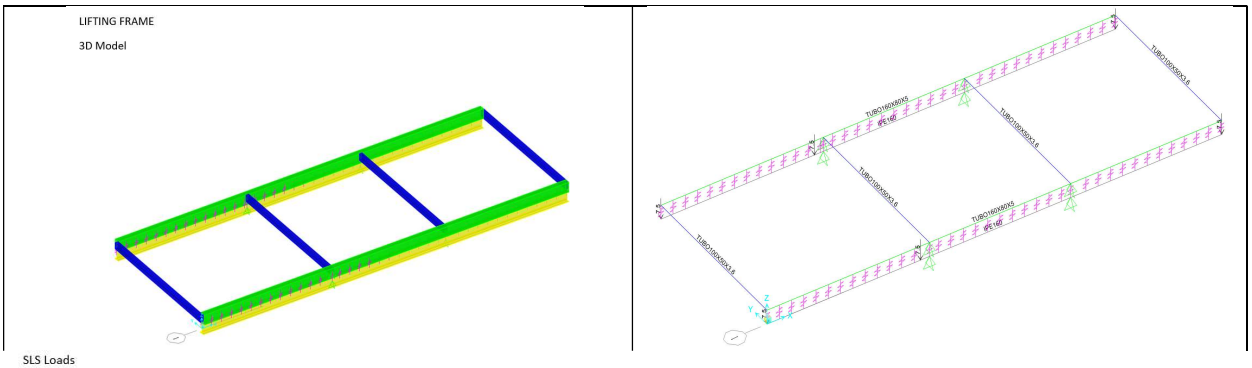
TYPICAL STIFF PLATE DETAIL

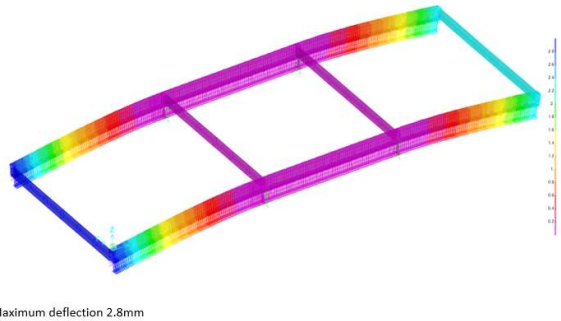
CE 2.22 The reactions obtained from the SAP2000 were applied as forces in the IDEAS Statica software and verified the allowable stresses as well allowable strains based on 5% plasticity as per the code allowance.



CE 2.23 Once the analysis was completed, I gave hand sketches to the draughtsman and he developed a fabrication drawing and submitted both documents to the client engineer for approval. After approval, I proceeded with the procurement of the material specified in the calculation and fabrication and installation at site.

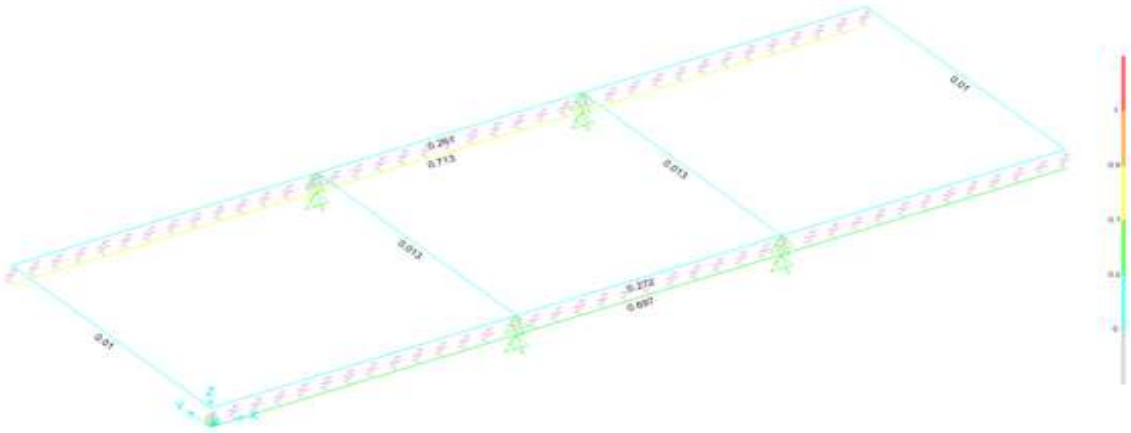
CE 2.24 I designed steel structure for the video beams as specified in the Situation 3 in addition I designed several temporary frames for installation of the facade structures ACP panels and verification of the connections.



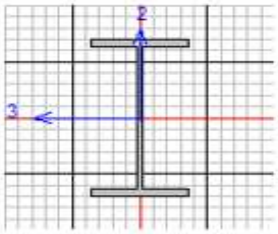


MAX Von Misses = 140 Mpa < 235 Mpa – Safe

Code check Euro code 3



MAX Utilization Ratio 0.713 – Safe

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Eurocode 3-2005 STEEL SECTION CHECK  (Summary for Combo and Station)
Units  : KN, m, C

Frame : 15        X Mid: 2.965     Combo: COMB1          Design Type: Beam
Length: 5.930     Y Mid: 2.130     Shape: IPE160         Frame Type: DCH-MRF
Loc   : 2.120     Z Mid: 0.000     Class: Class 1        Rolled : Yes

Country=CEN Default               Combination=Eq. 6.10              Reliability=Class 2
Interaction=Method 2 (Annex B)    MultiResponse=Envelopes           P-Delta Done? No
Consider Torsion? No

GammaM0=1.00      GammaM1=1.00    GammaM2=1.25
An/Ag=1.00        RLLF=1.000      PLLF=0.750      D/C Lim=0.950

Aeff=0.002        eNy=0.000       eNz=0.000
A=0.002           Iyy=8.690E-06   iyy=0.066       Wel,yy=1.086E-04    Weff,yy=1.086E-04
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CE 2.25 I performed several tests including random tests on steel structures, onsite tests of welding, connection and anchor bolts, pull out tests and testing of on Intumescent and Cementitious fire protection paint

CE 2.26 I handled the material delivery inspection. All the material submission as well as material delivered to site form the subcontractor needed to be inspected and material certificates to be presented during inspection.

CE 2.27 For the access and lifting equipment used by the subcontractor I was coordinating with the remaining activities at site. For lifting of the main trusses I handled 2 crawler cranes with capacity of 400 tons.

CE 2.28 During my works in Al Wakrah stadium, I participated in several trainings that helped me to perform my job better. Concrete Technology training helped me to know better about the performance of different mix design and impact on the durability of the concrete, and Site supervisor training – working at height where it helped me to know more about the lifting studies as well as all the elements of high risk working at height activities.

CE 2.29 From my engineering knowledge and previous experience, I contributed in the design and execution of steel structures and temporary structures. I also searched internet for latest research to find pertinent solutions. In addition, I introduced the quality dossier from the beginning of the project where it contributed to less time spend on the end of the project and all the documents were in place when the installation of the structural steel was completed. For the installation of the main trusses I introduced FEM modeling of the elements together with the ropes for finding the COG and forces in the ropes to optimize the utilization.

CE 2.30 I ensured that my work complied with the engineering standards of BS EN 1993, BS EN 1090, BS EN 1992 and BS EN 12944. Relevant standard was followed in viable outputs as per standards.

CE 2.31 For the installation of the steel structure and secondary beams I followed the internal and standards safety procedures for lifting, working at height, working in confined space and all the associated risks.

CE 2.32 I was interacting with my colleagues was on daily and weekly basis, I was properly coordinating the work with the construction manager for civil works, project engineer for façade and project engineer for retractable roof systems. Coordination prior heavy lifting activity was with HSE department as well as with certified lifting lead supervisor. From the design aspects I had several meetings with the technical manager as well as with the BIM team for coordination.

CE 2.33 I was coordinating with my line manager and the project coordinator almost every day and with the project coordinator twice a week in order to discus and evaluate the changes in the design at site at the assembly area and to make sure that work was being carried out as per project schedule.

CE 2.34 At the beginning of the project, the subcontractor didn't have sufficient resources to organize meetings and site activities that includes the necessary documents, so my line manager requested me to guide and lead the technical and QC team from the subcontractor in order to assist them to have all the necessary documents for the start of the main activities. I organized meeting on a daily basis to discuss with the team and find the best possible solution for every difficult situation they were facing.

CE 2.35 As part of the desiring process, I prepared a follow-up report for the design as well for the execution. I also prepared Assembly and Erection KPI and Factory Visit Reports.

CE 2.36 I gave presentation for the design and methodology of the installation of the steel roof to other subcontractors organized by the supreme committee. The main purpose for this presentation was to explain and elaborate the key factors that are important including the design aspects, assembly and erection methodologies and the HSE key hazards.

CE 2.37 The project in particular the installation works for the structural steel was completed successfully. The client was satisfied with the works performed by myself and the team.

CE 2.38 My engineering knowledge for the structural steel, knowledge in the design and fabrication experience give me an opportunity to implement and follow up on all the aspects of the project starting from design, fabrication, assembly and installation to manage and complete the works successively. Having a good knowledge in finite element software's as well as implementing with my experience allowed me to check and verify in no time the works performed by the subcontractor as well as providing a design verification and report to other works as well.

CE 2.39 In this project I gained experience in concrete technology, design of connection using specific FEM software which is advance technique for design on nonstandard connections, design and execution of arc space structures and trusses further development of planning, leadership and project management.

SUMMARY

CE 2.40 Working as a Project Engineer – Sr. Structural Engineer Structural Steel package my contribution in this project was quite large, with experience and expertise in this field I have contributed in all areas. Starting from planning, design,

fabrication, assembly, execution and handover to following activities. At the end of the project, I have received quite positive feedback and evaluation from my line manager and project director with they have further recommended me to stay and work for Six Construct in Dubai.