Dong Jin PARK
to Jin, RINA, Han, me

09:35 (1 hour ago)

Dear Sir,

I hope this email finds you well.
Reference is made to the e-mail as below.
At this purpose, please be informed that the A1, A2 type remarks on the approved drawing (PUST-27528) have been confirmed/closed based on the email below.

Thank you and best regards,

Dong-Jin PARK
Structure Engineer
Korea Plan Approval Centre

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MAIN PARTICULARS

LENGTH (OA)	:	98.00	M
LENGTH (LWL)	:	95.515	M
LENGTH (BP)	:	93.50	M
BREADTH (MOULDED)	:	18.00	M
DEPTH (MOULDED)	:	8.00	M
DRAFT (DESIGN)	:	4.00	M
FRAME SPACING	:	0.7	M
SERVICE SPEED	:	10.00	Knot

REV	DESCRIPTION	DATE	MOD.BY	CKD.BY

REVISIONS

DESIGN BY

OFFSHORE & MARINE ENGINEERING LTD

(Your Ultimate Companion for the Road Ahead)

DRAWING TITLE

STRENGTH ANALYSIS OF THE SUPPORTING HULL STRUCTURE FOR THE 50 KN CRANE

CLIENT	MEGHNA SHIPBUILDERS & DOCKYARD LTD. (MSDL)
BUILDER	
HULL NO	MSDL-110
CLASS	RINA
PROJECT	3940 CBM GAS CARRIER
PREPARED	MYA
SCALE	NTS
DRAWING NO:	OMEL-MSDL-3940 M3 GC-B62.1
REV	0
CHECKED	MGK
SIZE	A4
PAGE	1 of 8
DATE-	23-01-2025

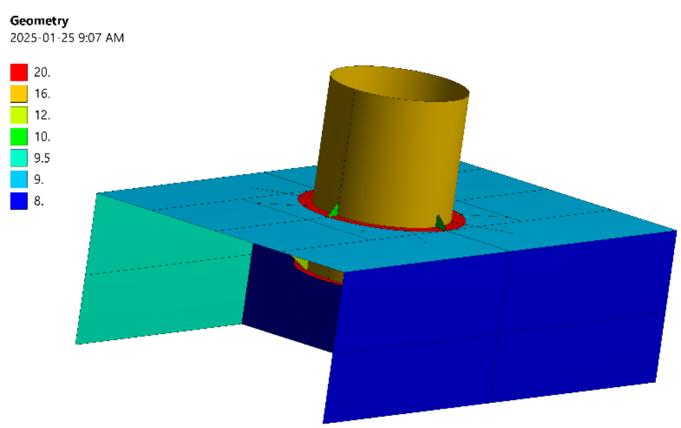
STRENGTH ANALYSIS OF THE SUPPORTING HULL STRUCTURE FOR THE 50 KN CRANE OF MSDL-110

Introduction:

The structural integrity of a crane's supporting hull structure plays a critical role in ensuring its safe and efficient operation. This study focuses on the structural strength calculation of the supporting hull framework for the 50 kN crane of the MSDL-110, 3940 m^3 Gas Carrier. By evaluating the load-carrying capacity, stress distribution the analysis aims to provide insights into the design's reliability under various operating conditions.

Model Description:

The crane operates with a turning moment of 65 kN·m and an overturning moment of 618 kN·m, while a vertical downward force of 120 kN acts on it and the self-weight of the crane is 8000 kg or, 78.45 kN. The supporting structure is made of RINA A-grade steel, which has a yield strength of 235 MPa. The numerical model incorporates both beam and shell elements (quadrilateral). Aspect ratio was kept close to 1. The stiffeners, designed using Holland Profiles, are modeled as beam elements, while the remaining structural components are modeled as shell elements with actual designed thickness. The corrosion allowance will be considered at stress result. The thickness distribution of the shell elements is illustrated in the accompanying plot. The doubler plate under crane foundation is replaced by an insert plate.



Ansys Static Structural V.18.1 was used to perform the strength analysis. The computation was done in mm unit system. Average mesh size was taken as 40 mm. The total number of elements are 20932 and number of nodes are 21298. The forward side, aft side (Frame 61 & Frame 67) and bottom (Bellow 1200 mm from main deck) were kept fixed as line segment. Transverse extension of the model is from the side shell to the first boundary before the LPG tank (6500 OCL). Loads were provided at the base of the crane and stresses were mapped at structures under the crane that was affected most.

Strength Criteria:

The equivalent stress of the structural components must remain below the yield stress of the material, which is 235 MPa. Taking into account a 25% corrosion margin in this analysis, the maximum allowable strength limit has been set to 175 MPa.

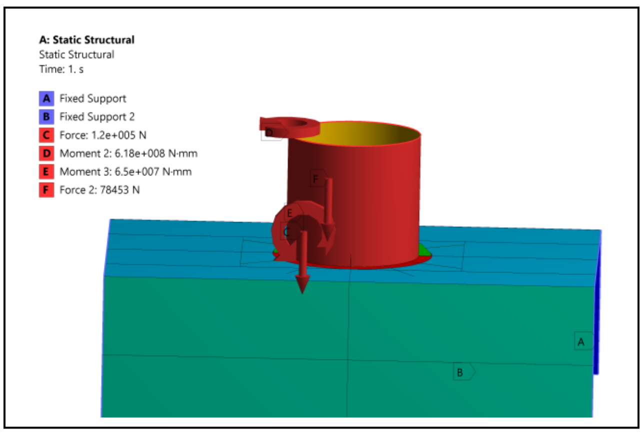
Load cases:

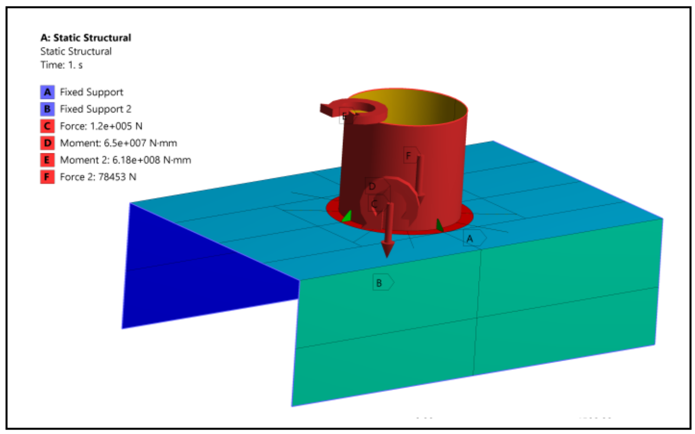
The analysis takes into account the following load cases to ensure the crane can safely operate at any angle with all loads and moments.

1) LC1: Self-weight + Vertical Force + Turning Moment + Overturning Moment (0 Degrees)
2) LC2: Self-weight + Vertical Force + Turning Moment + Overturning Moment (45 Degrees)
3) LC3: Self-weight + Vertical Force + Turning Moment + Overturning Moment (90 Degrees)
4) LC4: Self-weight + Vertical Force + Turning Moment + Overturning Moment (135 Degrees)
5) LC5: Self-weight + Vertical Force + Turning Moment + Overturning Moment (180 Degrees)
6) LC6: Self-weight + Vertical Force + Turning Moment + Overturning Moment (225 Degrees)
7) LC7: Self-weight + Vertical Force + Turning Moment + Overturning Moment (270 Degrees)
8) LC8: Self-weight + Vertical Force + Turning Moment + Overturning Moment (315 Degrees)

Results:

By combining all of the forces, the following loads were carefully mapped to ensure an accurate representation of the stress and moment distribution across the structure. The figures below illustrate a typical representation of the





load cases at various angles, providing a comprehensive view of how the loads interact with the crane at different orientations. These visual representations are crucial in understanding how the crane performs under varying operational conditions and angles of use. The moment values were adjusted by distributing the forces into their respective vector components for different angels.

In the following pages, the results for each load case will be presented in two tables. The first table will display the overall stress of the shell and beam structure, providing a summary of the total stress experienced by these key components. The second table will present a detailed stress mapping for the individual structures, showing how the stress is distributed across each part of the crane. This approach allows for both an overview of the general structural behavior and a more in-depth analysis of specific components, ensuring a thorough understanding of how each element performs under varying load conditions.

I. Load Case 1

In this load case, the highest stress value was found at a bracket, reaching 109.06 MPa, while the bulkhead experienced a stress of 64.091 MPa, the deck had 87.782 MPa, and the ring encountered 23.681 MPa.

Table 1: Equivalent Stress on the structures

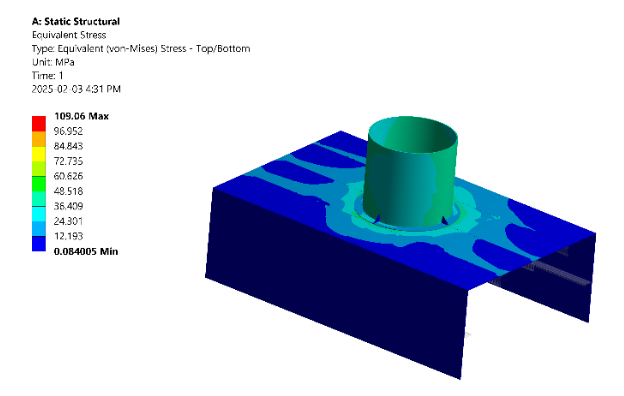
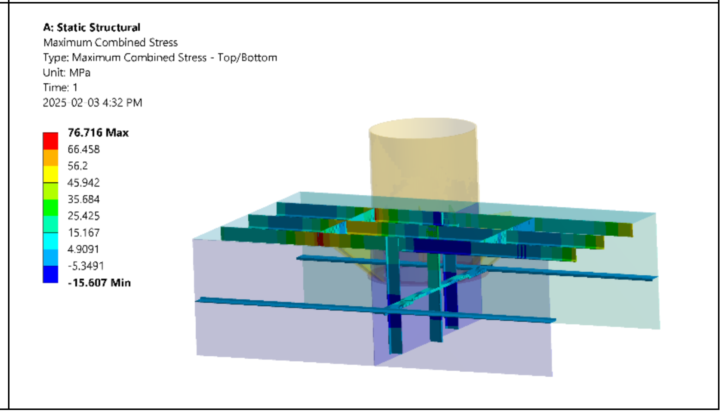
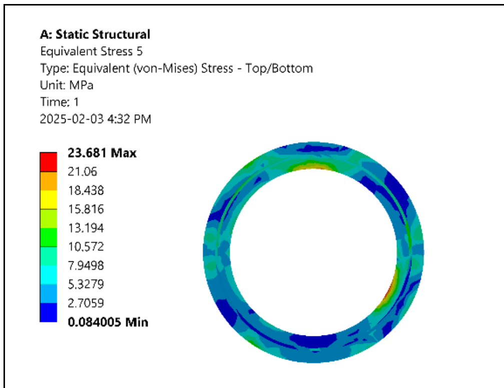
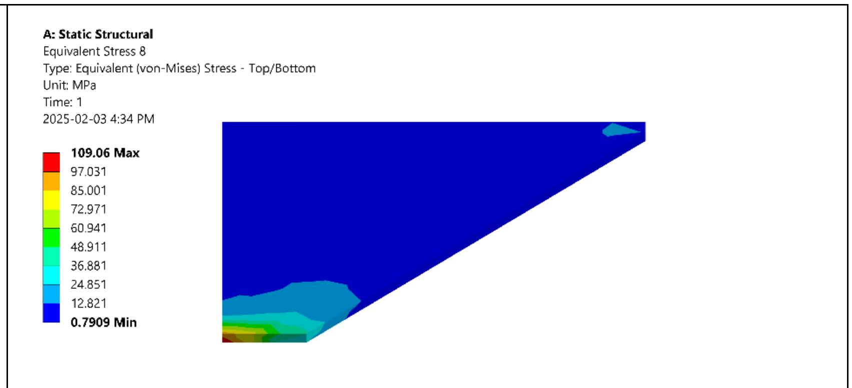
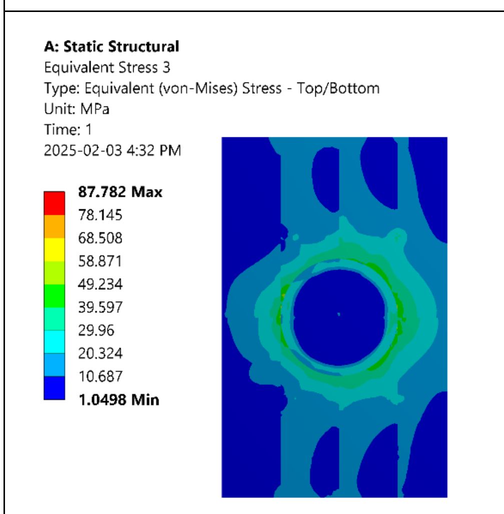
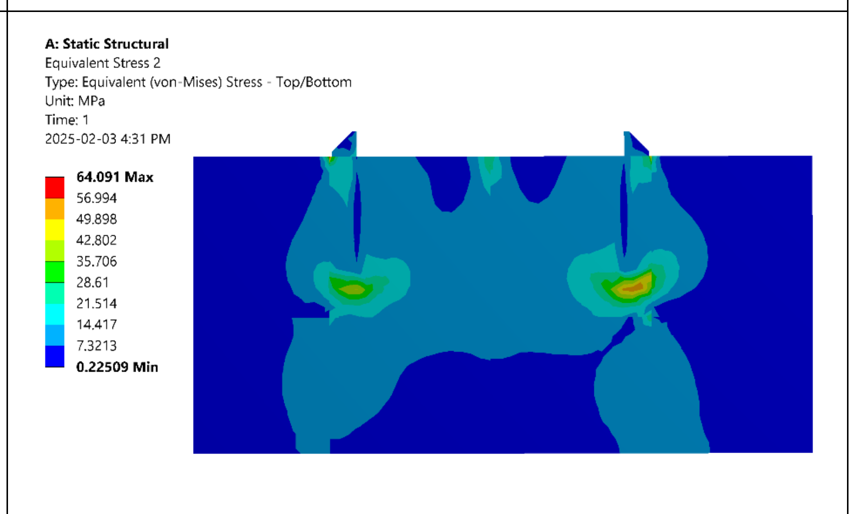
Shell Elements (109.06 MPa)	**Beam Element (76.716 MPa)**
	

Table 2: Individual stress mapping of the structures

II. Load Case 2

In this load case, the highest stress value was found at a bracket, reaching 89.007 MPa, while the bulkhead experienced a stress of 51.44 MPa, the deck had 78.957 MPa, and the ring encountered 25.414 MPa.

Table 3: Equivalent Stress on the structures

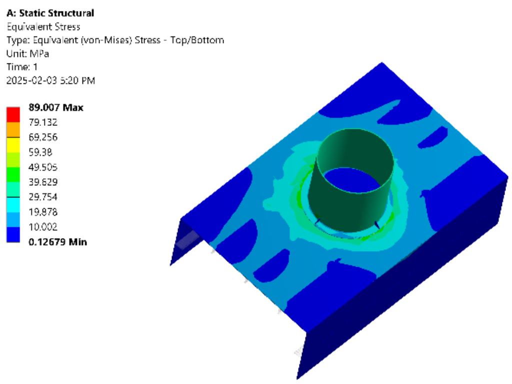
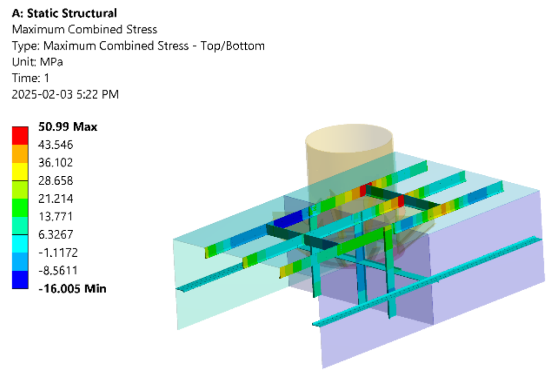
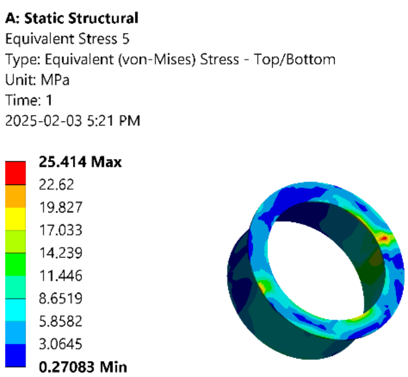
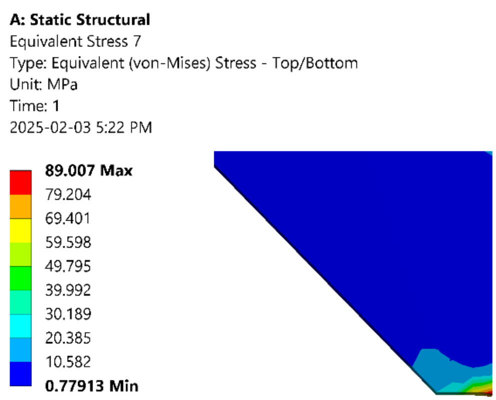
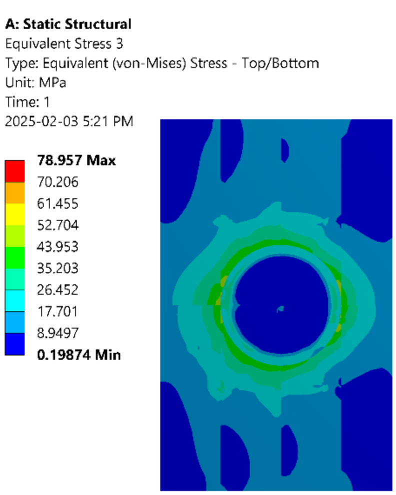
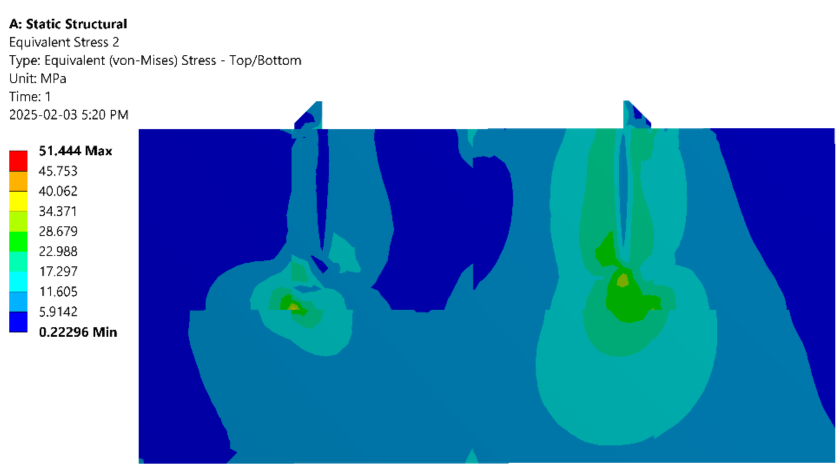
Shell Elements (89.007 MPa)	Beam Element (50.99 MPa)
	

Table 4: Individual stress mapping of the structures

III. Load Case 3

In this load case, the highest stress value was found at a deck, reaching 85.96 MPa, while the bulkhead experienced a stress of 49.15 MPa, the bracket had 33.393 MPa, and the ring encountered 27.071 MPa.

Table 5: Equivalent Stress on the structures

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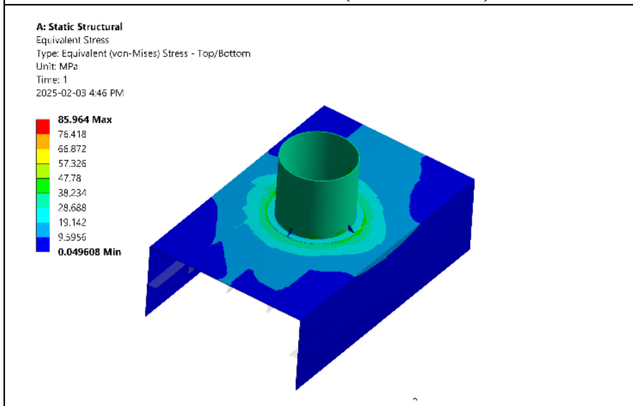
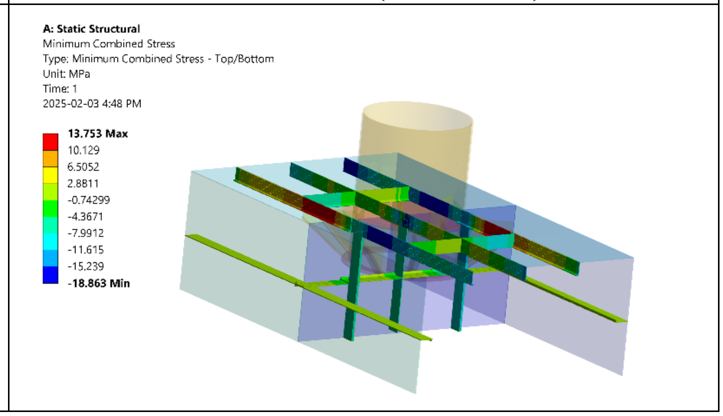
<tr><th>Shell Elements (85.96 MPa)</th><th>Beam Element (13.753 MPa)</th></tr>
<tr><td>
</td><td>
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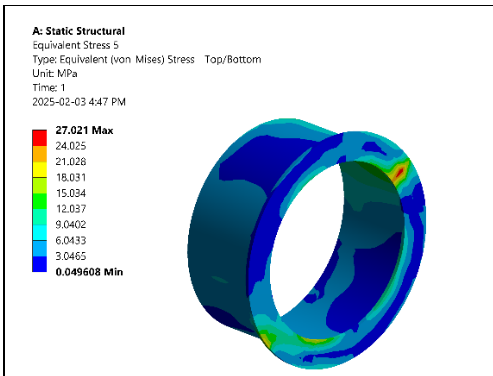
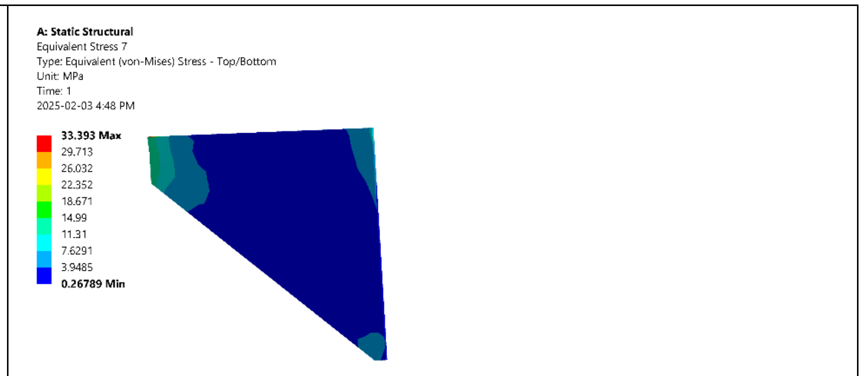
Table 6: Individual stress mapping of the structures

<table>
<tr><td>
</td><td>
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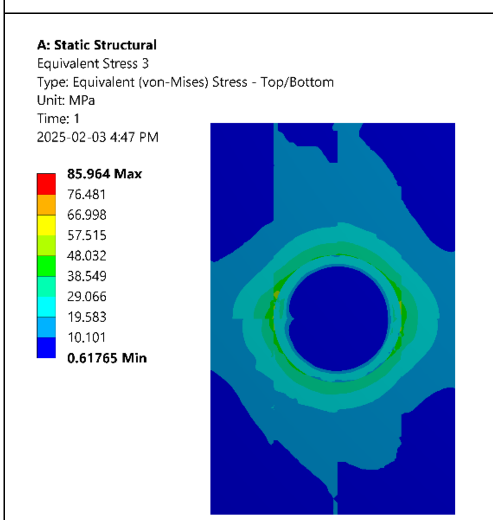
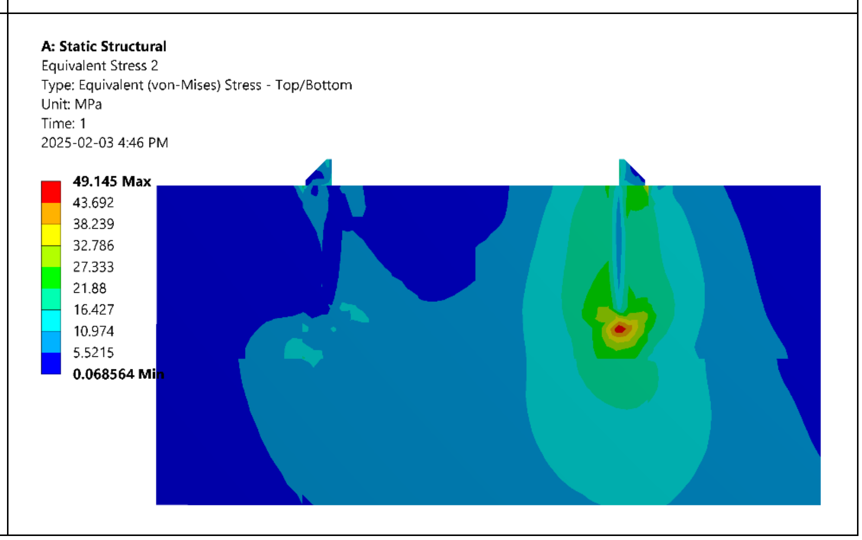
<tr><td>
</td><td>
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</table>

IV. Load Case 4

In this load case, the highest stress value was found at a bracket, reaching 82.4 MPa, while the bulkhead experienced a stress of 58.31 MPa, the deck had 81.596 MPa, and the ring encountered 24.462 MPa.

Table 7: Equivalent Stress on the structures

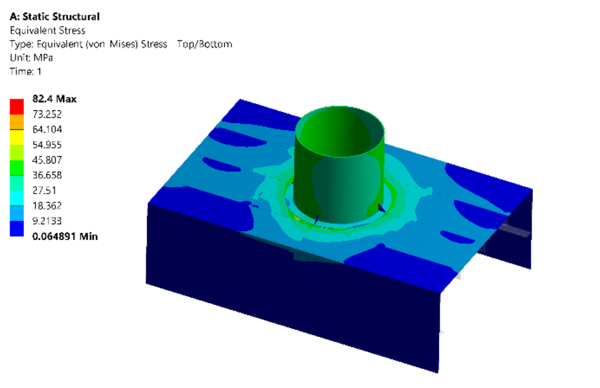
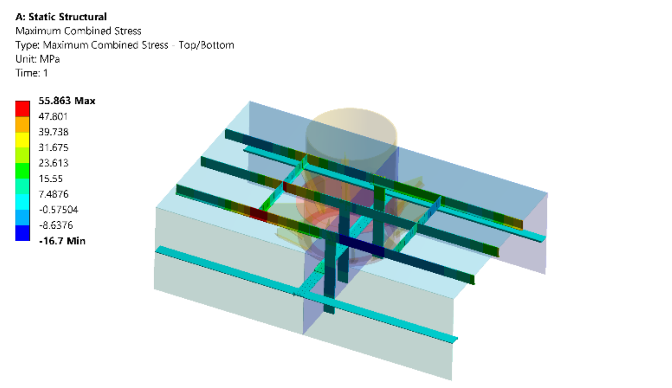
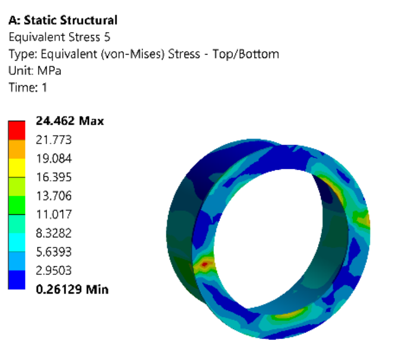
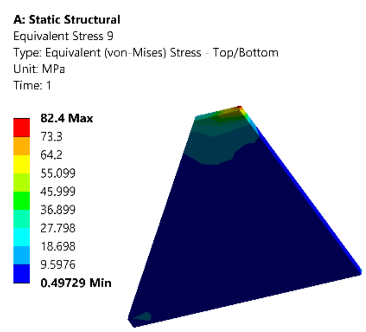
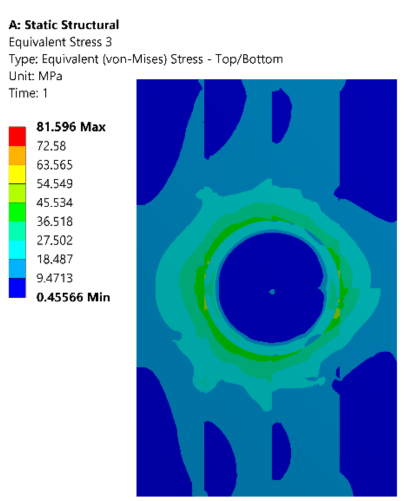
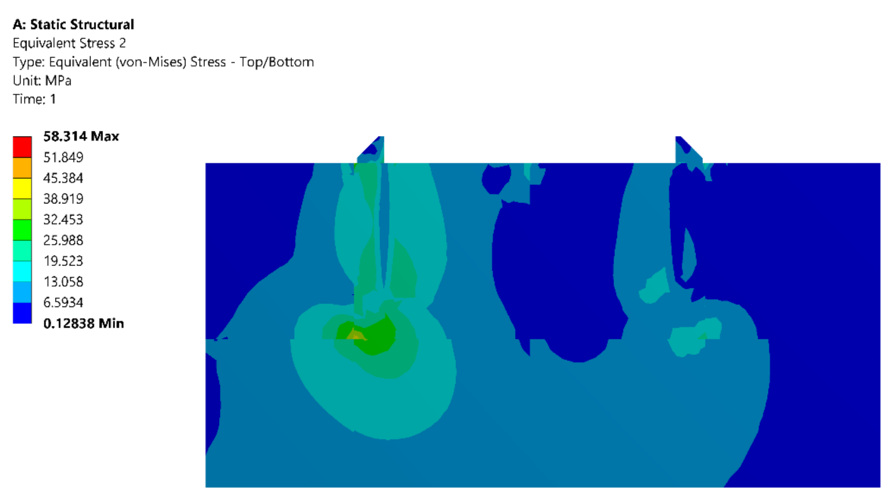
Shell Elements (82.4 MPa)	**Beam Element (55.863 MPa)**
	

Table 8: Individual stress mapping of the structures

V. Load Case 5

In this load case, the highest stress value was found at a bracket, reaching 109.37 MPa, while the bulkhead experienced a stress of 59.297 MPa, the deck had 80.958 MPa, and the ring encountered 22.415 MPa.

Table 9: Equivalent Stress on the structures

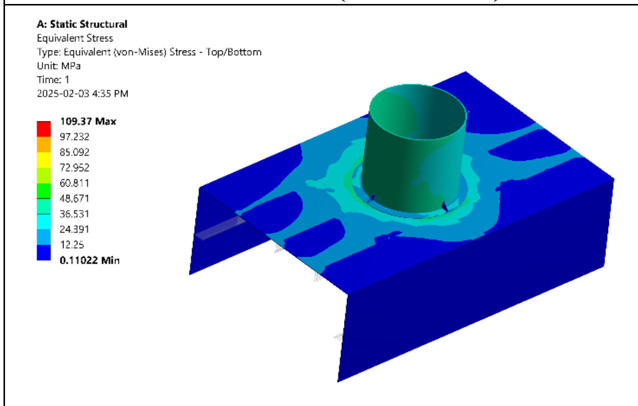
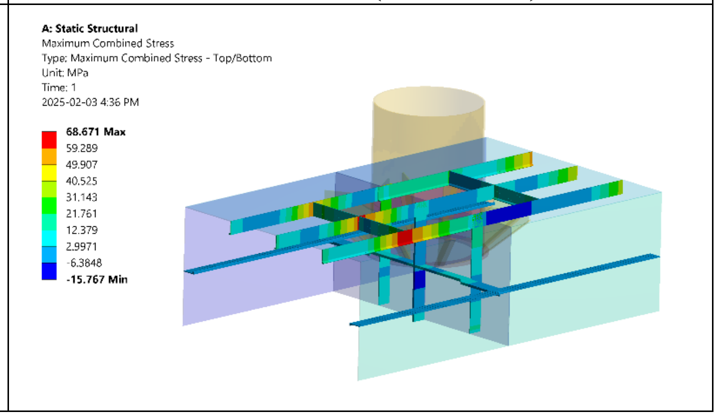
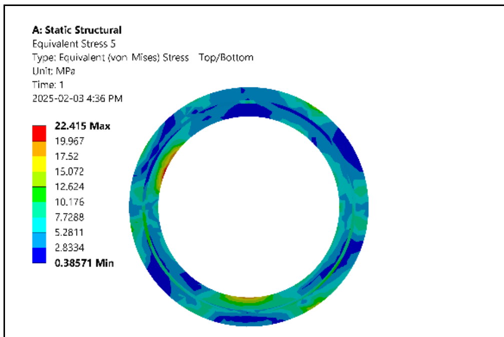
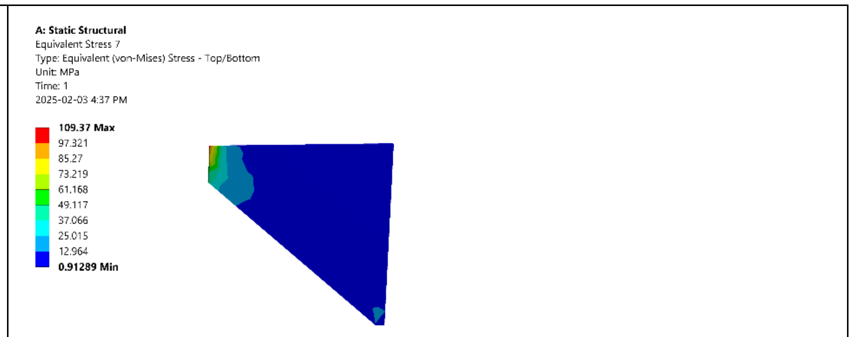
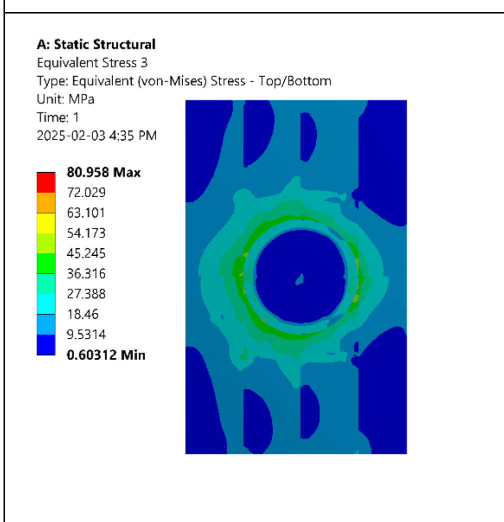
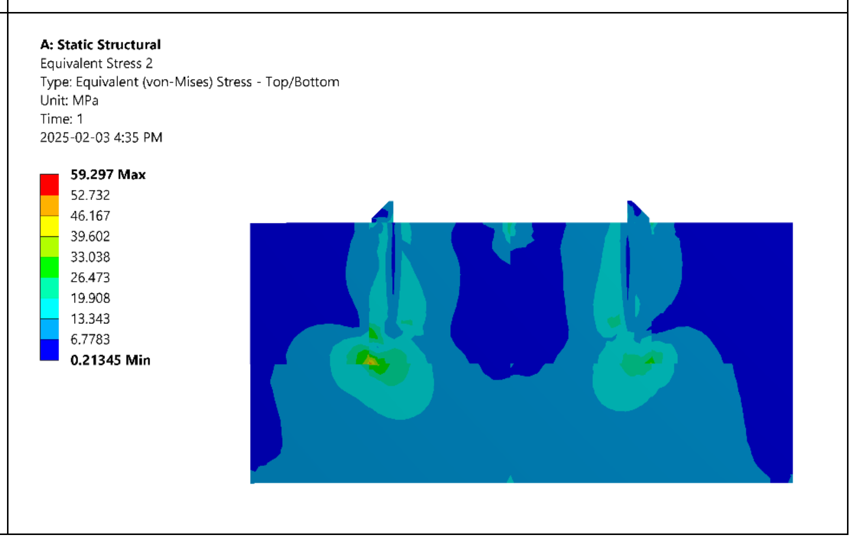
Shell Elements (109.37 MPa)	Beam Element (68.671 MPa)
	

Table 10: Individual stress mapping of the structures

VI. Load Case 6

In this load case, the highest stress value was found at a deck, reaching 89.614 MPa, while the bulkhead experienced a stress of 57.165 MPa, the bracket had 81.413 MPa, and the ring encountered 24.225 MPa.

Table 11: Equivalent Stress on the structures

<table>
<tr><th>Shell Elements (89.614 MPa)</th><th>Beam Element (61.493 MPa)</th></tr>
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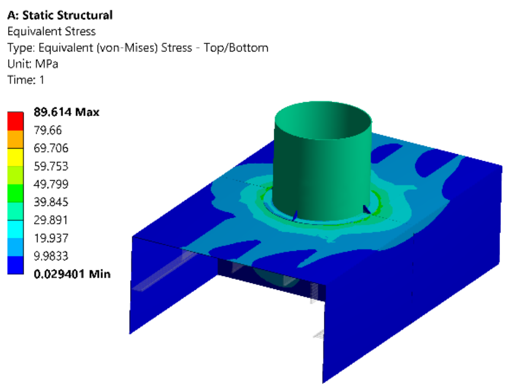

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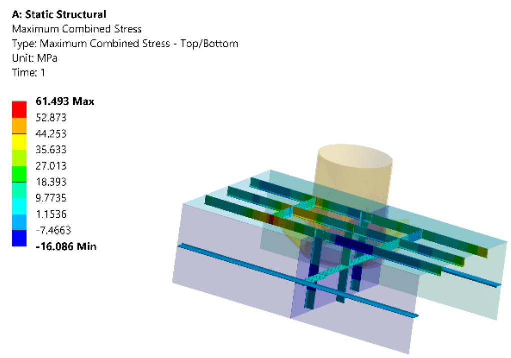

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Table 12: Individual stress mapping of the structures

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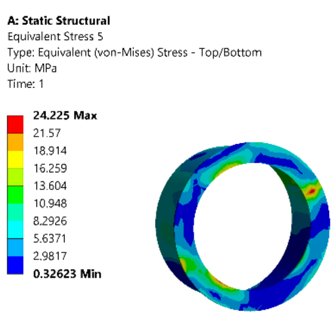

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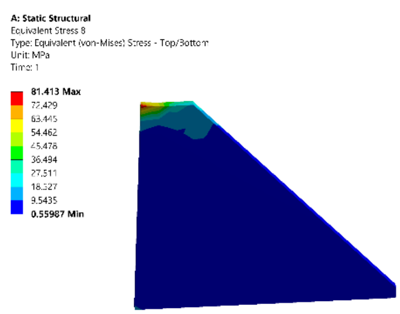

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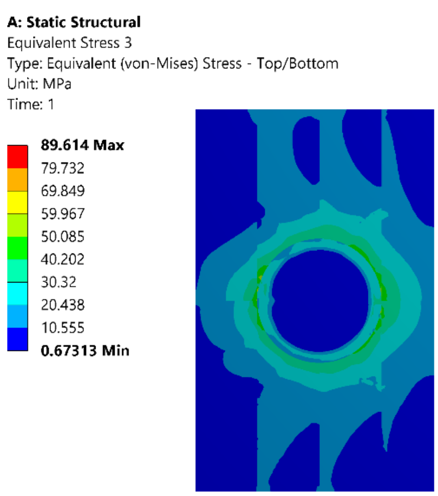

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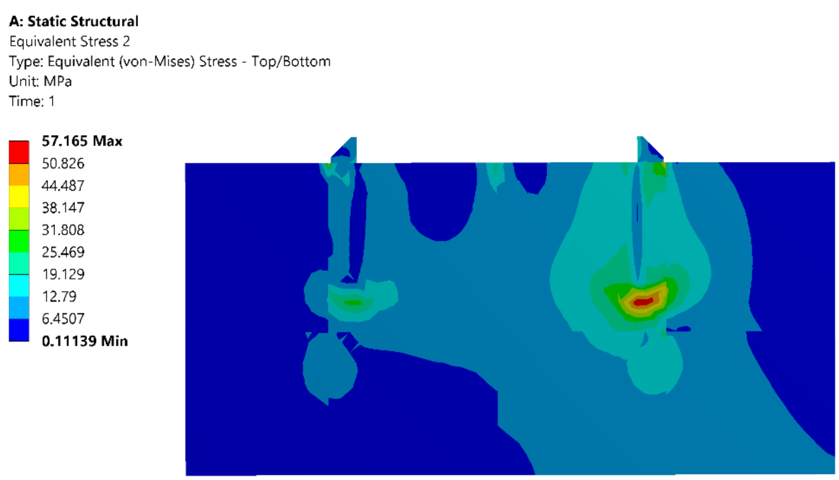


</td></tr>
</table>

VII. Load Case 7

In this load case, the highest stress value was found at a deck, reaching 79.155 MPa, while the bulkhead experienced a stress of 55.567 MPa, the bracket had 31.205 MPa, and the ring encountered 26.05 MPa.

Table 13: Equivalent Stress on the structures

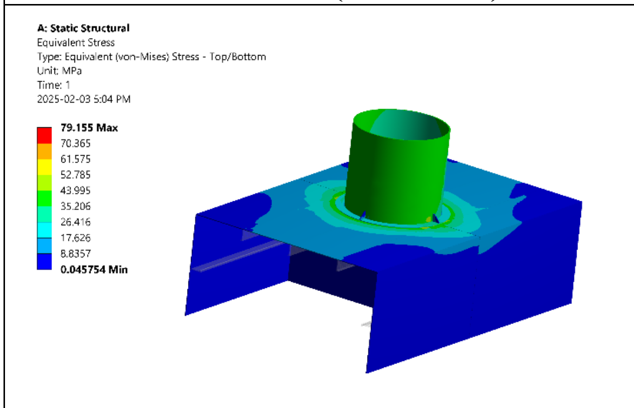
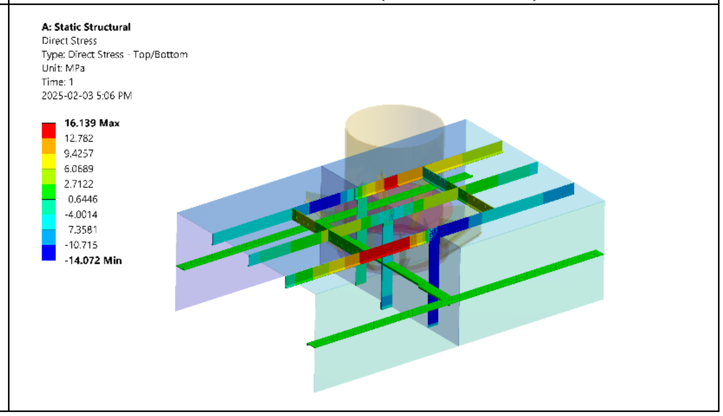
<table>
<tr><th>Shell Elements (79.155 MPa)</th><th>Beam Element (16.139 MPa)</th></tr>
<tr><td></td><td></td></tr>
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Table 14: Individual stress mapping of the structures

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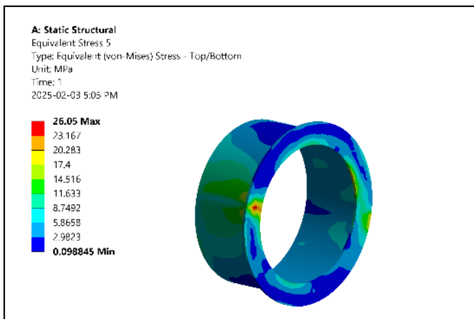
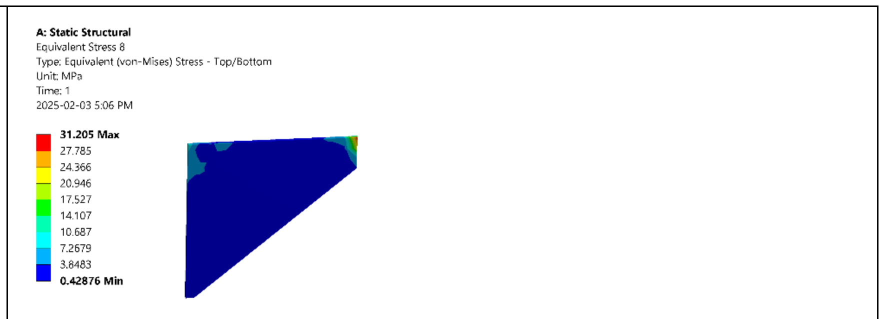
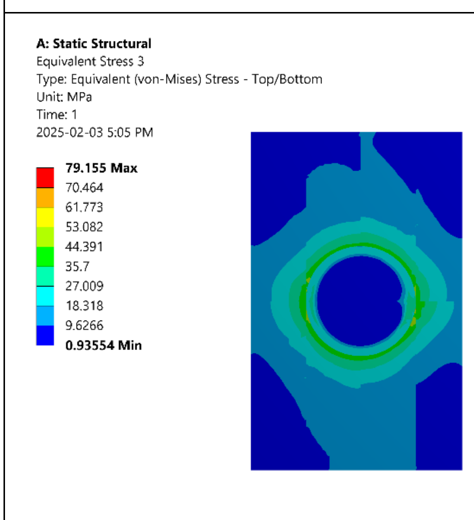
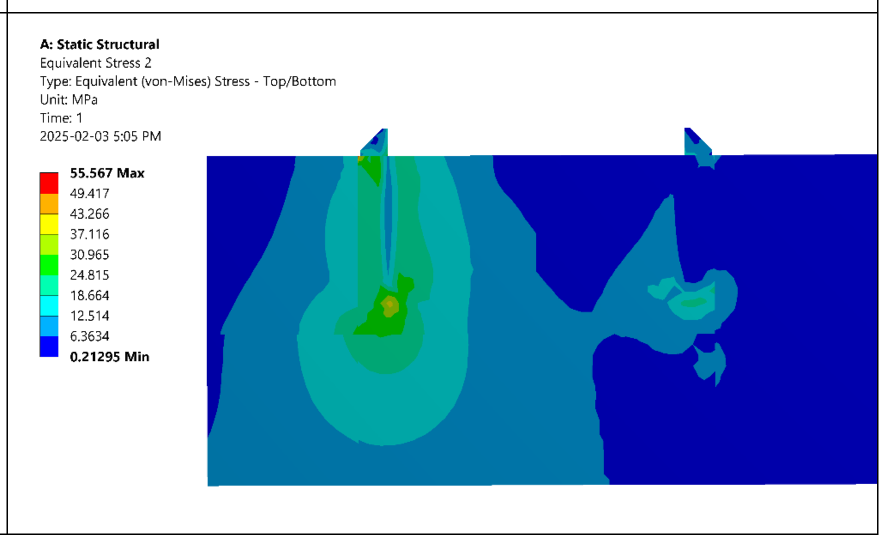
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
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VIII. Load Case 8

In this load case, the highest stress value was found at a bracket, reaching 88.182 MPa, while the bulkhead experienced a stress of 66.725 MPa, the deck had 81.603 MPa, and the ring encountered 23.365 MPa.

Table 15: Equivalent Stress on the structures

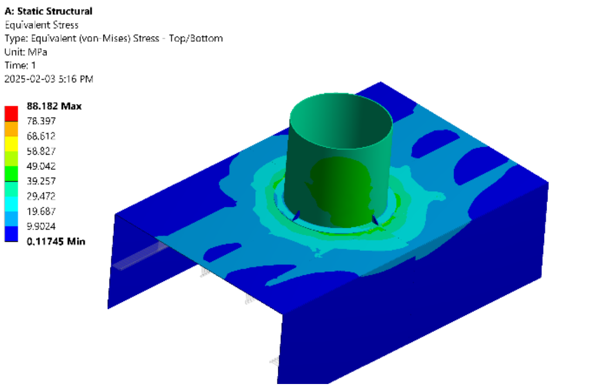
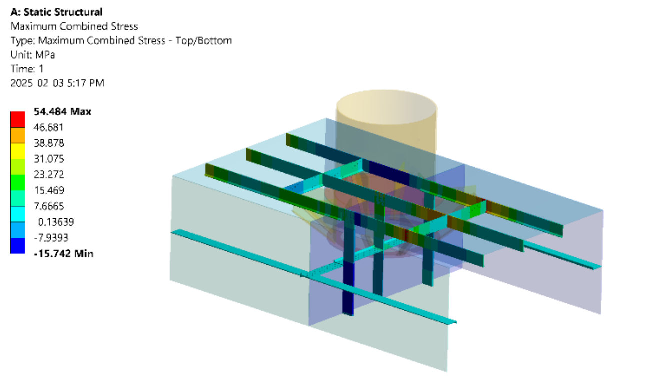
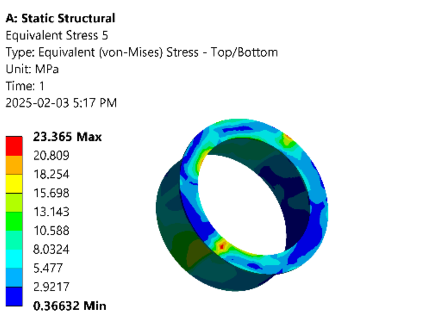
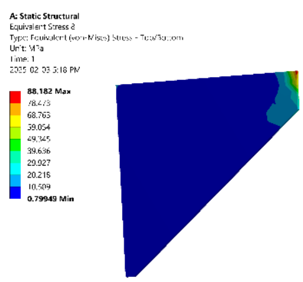
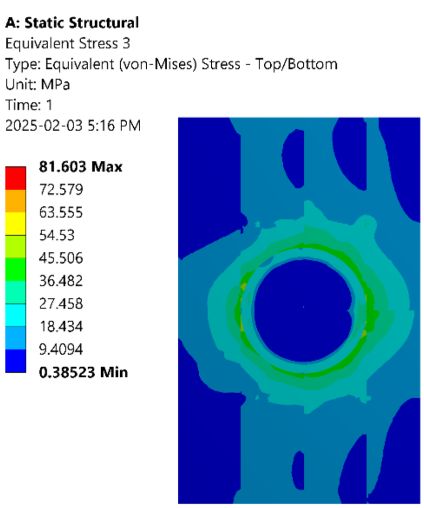
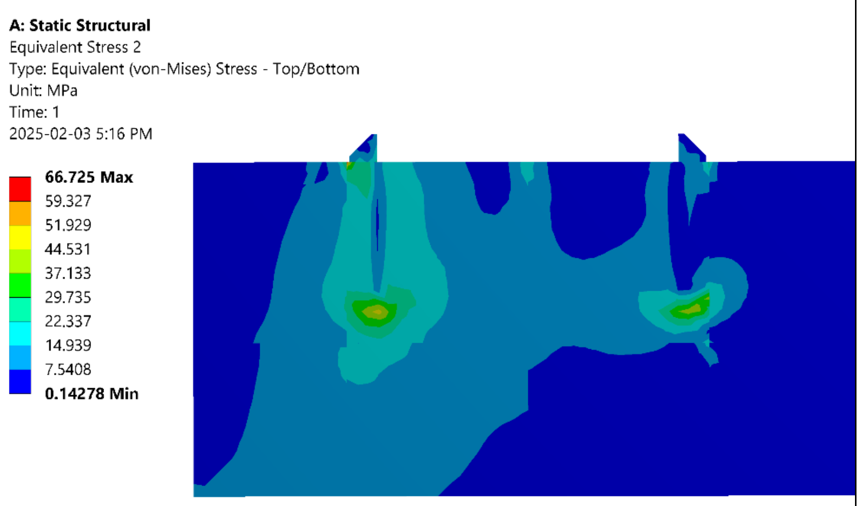
Shell Elements (88.182 MPa)	Beam Element (54.484 MPa)
	

Table 16: Individual stress mapping of the structures

Conclusions:

Table-17 summarizes all the mapped stress analysis results, providing a clear overview of the stress distribution across the structure. It indicates that, in most cases, the maximum stress occurs either at the deck or at the bracket, which are the critical load-bearing points. The stress levels in other structures, such as the bulkhead and various supports, remain relatively low, highlighting the effective load distribution across the system. Notably, the ring girder consistently experiences minimal stress due to its substantial thickness, which allows it to effectively absorb and distribute the loads with little deformation.

Table 17: Result summary

Cases	LC-1	LC-2	LC-3	LC-4	LC-5	LC-6	LC-7	LC-8
Equivalent Stress Unit	MPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa
Stress on Main Deck	87.782	78.957	85.964	81.596	80.958	89.614	79.155	81.603
Stress on Bulkhead	64.091	51.444	49.145	58.314	59.297	57.165	55.567	66.725
Stress on Brackets	109.060	89.007	33.393	82.400	109.37	81.413	31.205	88.182
Stress on Ring	23.681	25.414	27.021	24.462	22.415	24.225	26.050	23.365
Stress on Beams	76.716	50.990	13.753	55.863	68.671	61.493	16.139	54.484

Based on these results and the strength criteria, all structural members show sufficient strength to withstand the various loading conditions. None of the structural components reach stress levels approaching 175 MPa, which is the established limit. This confirms that the design is robust and capable of handling the applied forces without posing any risk of failure. The stress distribution indicates that the structure is well-engineered, ensuring that each member performs within safe limits under all considered loading scenarios.