Hammerhead Flood Control System Evaluation

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Garrison Flood Control

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Especially qualified discipline:
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Expiration Date
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1. OBJECTIVE

Garrison Flood Control requested an analysis of their Hammerhead Flood Control System. Recognized for its high modularity, this system accommodates various openings. It is designed for safe installation in spaces up to 3050 mm (10 ft) wide and suits both interior and exterior mounting configurations. Utilizing Simcenter Femap and Nastran, the system was assessed for hydrostatic loading across different heights and widths. The evaluations covered the following scenarios:

- Case 1: 1020 mm (40 in) wide opening with 5 planks
- Case 2: 3050 mm (10 ft) wide opening with 5 planks

Figure 1 presents the two mounting design layouts of the Hammerhead Flood Control System.

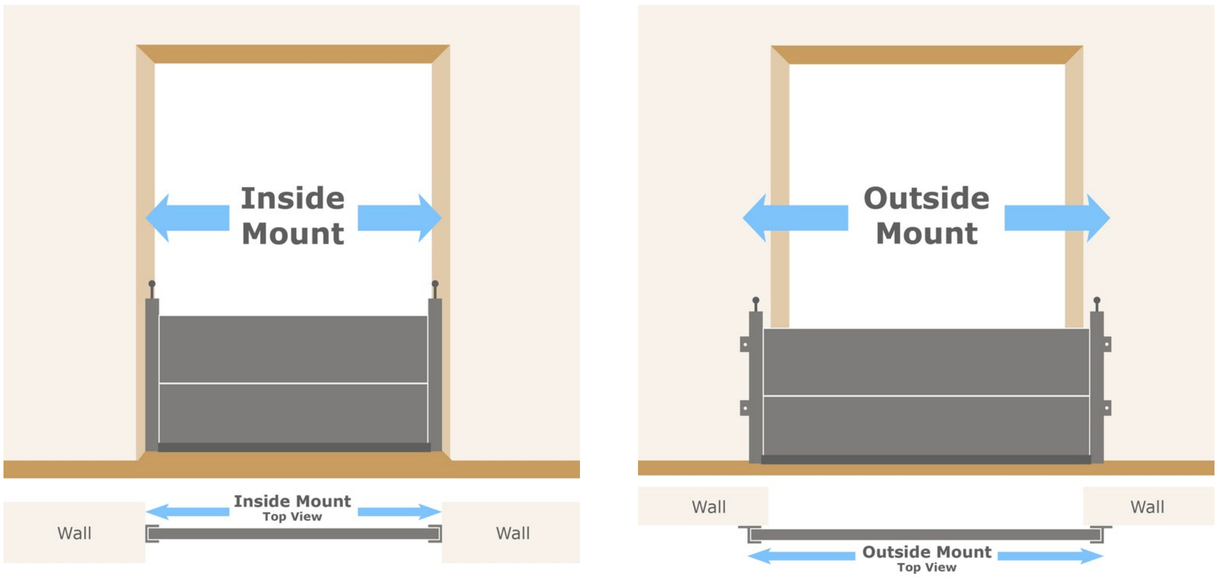


Figure 1: Garrison's Hammerhead Flood Control System designs

2. EXECUTIVE SUMMARY

The results of the analysis showed that in Case 1, which pertains to a 1020 mm (40 in) wide opening with 5 planks, both the inside and outside mount scenarios successfully passed the FEA evaluation. This success was evident as the maximum stress observed was lower than the material's yield stress.

For Case 2, involving a 3050 mm (10 ft) wide opening and 5 planks, the findings were positive for both inside and outside mount cases. In this scenario, the maximum stress was again found to be below the material's yield stress, indicating a successful FEA evaluation.

Figure 2 provides a visual representation of these results. Table 1 presents a summary of the stress results of the cases studied in this investigation.

Hammerhead Flood Control System Stress, MPa

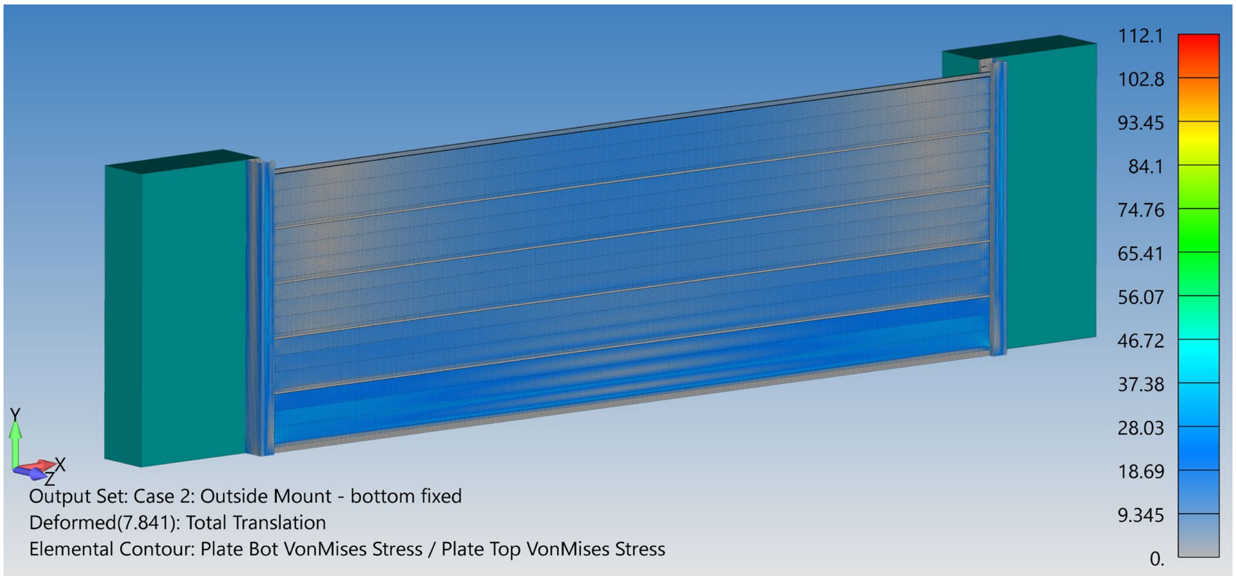


Figure 2: Example of stress results covered in this report

Table 1: Summary of Stress Results

Case	Mounting	Plank Width, mm	Height, mm	Number of Planks	Max. Stress, MPa	Result
1	Inside Mount	988	1,000	5	16	Pass
	Outside Mount	1,110	1,000	5	23	Pass
2	Inside Mount	3,020	1,000	5	87	Pass
	Outside Mount	3,140	1,000	5	112	Pass

3. FEA MODELING

3.1 Engineering Units and Software

This analysis is based on the SI system with length as mm's, force as N's, mass as Tonne (kg), time as seconds and temperature as C. In this unit system, the nominal mass density of aluminum is 2.710E-9 Tonne/mm3 with deflections in mm's and stress in MPa. The FE model was built with Femap v2301 MP1 and analyzed with Simcenter Nastran.

3.2 Significance Units

Analysis results are reported to three significant digits and analysis inputs are likewise rounded to three significant digits. Fundamental physical constants are set to four significant digits (e.g., gravity is 9,807 mm/s^2). The imposed limitation on the number of significant digits implies, at best, a relative numerical precision of 1%.

3.3 CAD Geometry

Figure 3 shows the CAD geometry of the plank received from Garrison including a reference measurement.

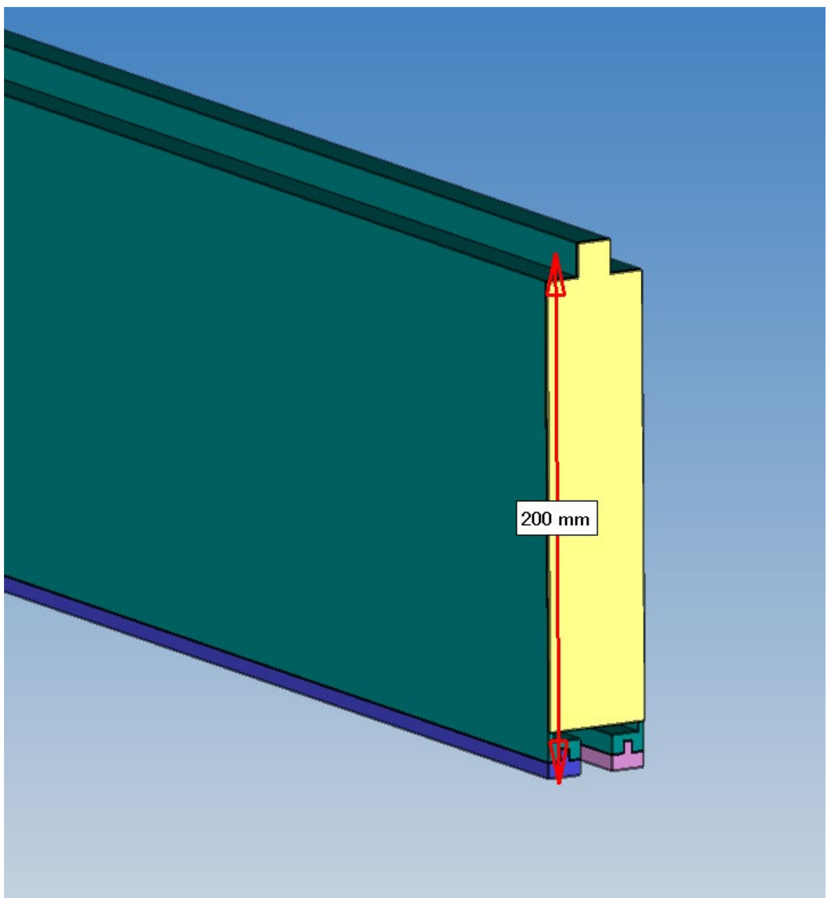


Figure 3: CAD geometry provided by Garrison

3.4 Materials

Table 2 contains a list of the materials used within the model.

Table 2: Analysis Materials

Usage	Material	E, MPa	Poisson's Ratio	Yield Strength, MPa	Ultimate Strength, MPa
Planks	6063-T5 Aluminum	70,000	0.33	145	186
Posts	6063-T5 Aluminum	70,000	0.33	145	186
Rubber Seals	Rubber EPDM	16.50	0.49	-	-

3.5 FEA Idealization

Figure 4 shows the assembly of the 1020 mm wide inside mount system for Case1.

Case 1 Flood Control System Assembly

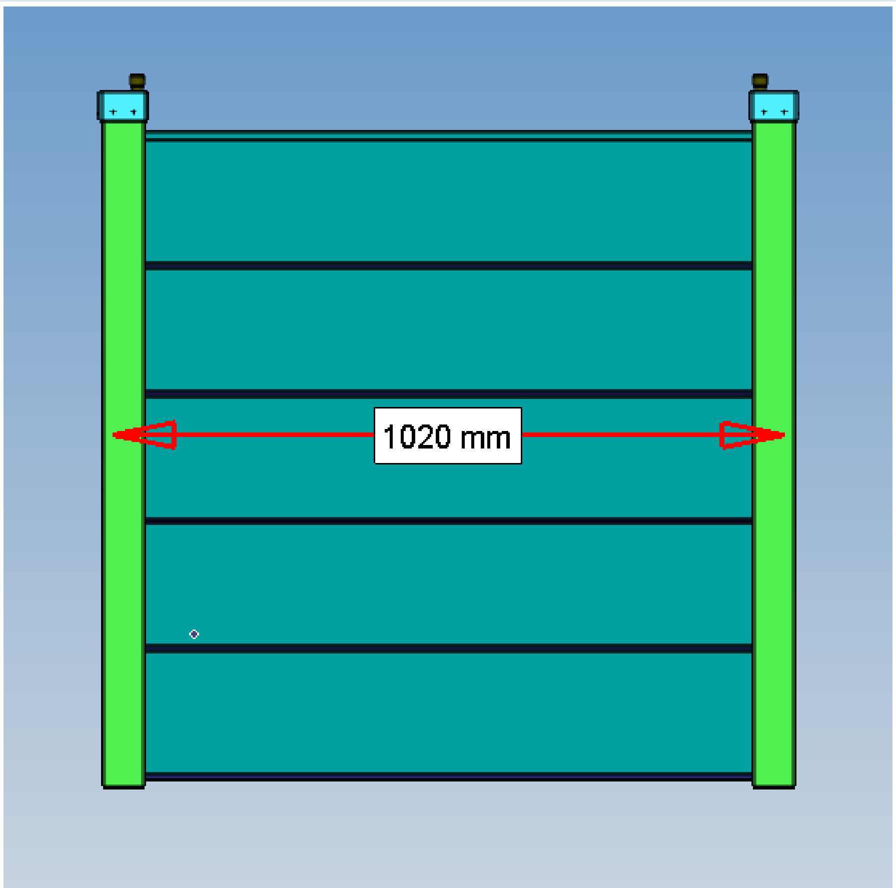


Figure 4: Assembly of Case 1 system for inside mounting of 1020 mm wide door

Figure 5 depicts the FEA idealization of the assembly's CAD geometry. Chamfers are defeatured for simplicity, and both planks and posts are represented as plate structures for streamlined analysis.

Chamfers defeatured	Planks and posts are idealized into plates

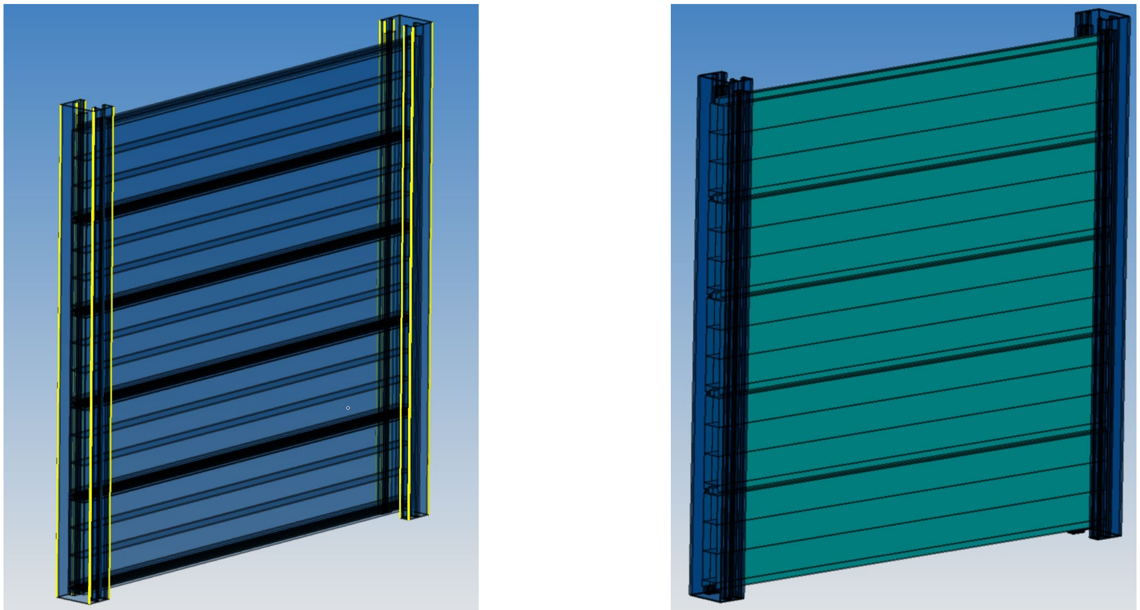


Figure 5: Structural Components for FEA

Figure 6 showcases the FEA idealization of the assembly's CAD geometry, complete with the FEA mesh. The illustration also highlights the planks' tight connection facilitated by a slide-in plate and rubber seal.

FEA mesh	Planks connection with slide in plate and rubber seal

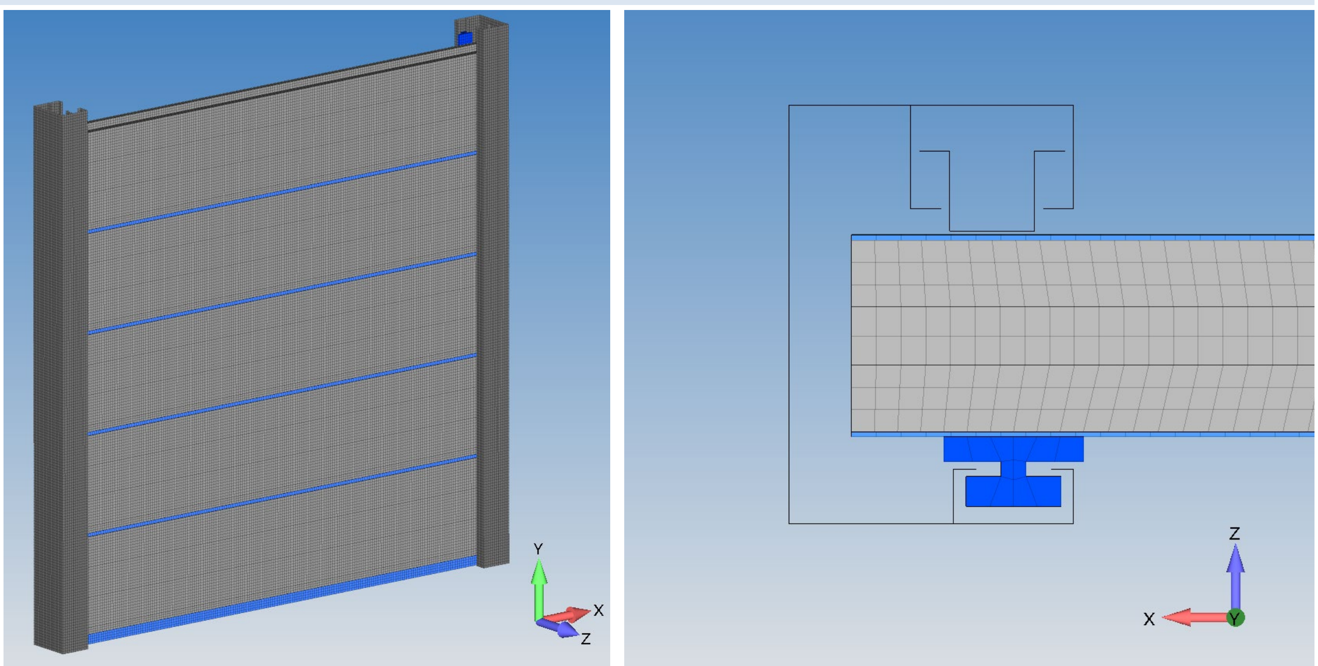


Figure 6: FEA Mesh and Connections

Figure 7 illustrates the boundary conditions for the Inside Mount, as well as the application of hydrostatic load on the system. The planks are tightly pressed together, ensuring a water-tight seal. Consequently, the system's base is assumed to be firmly anchored to the ground.

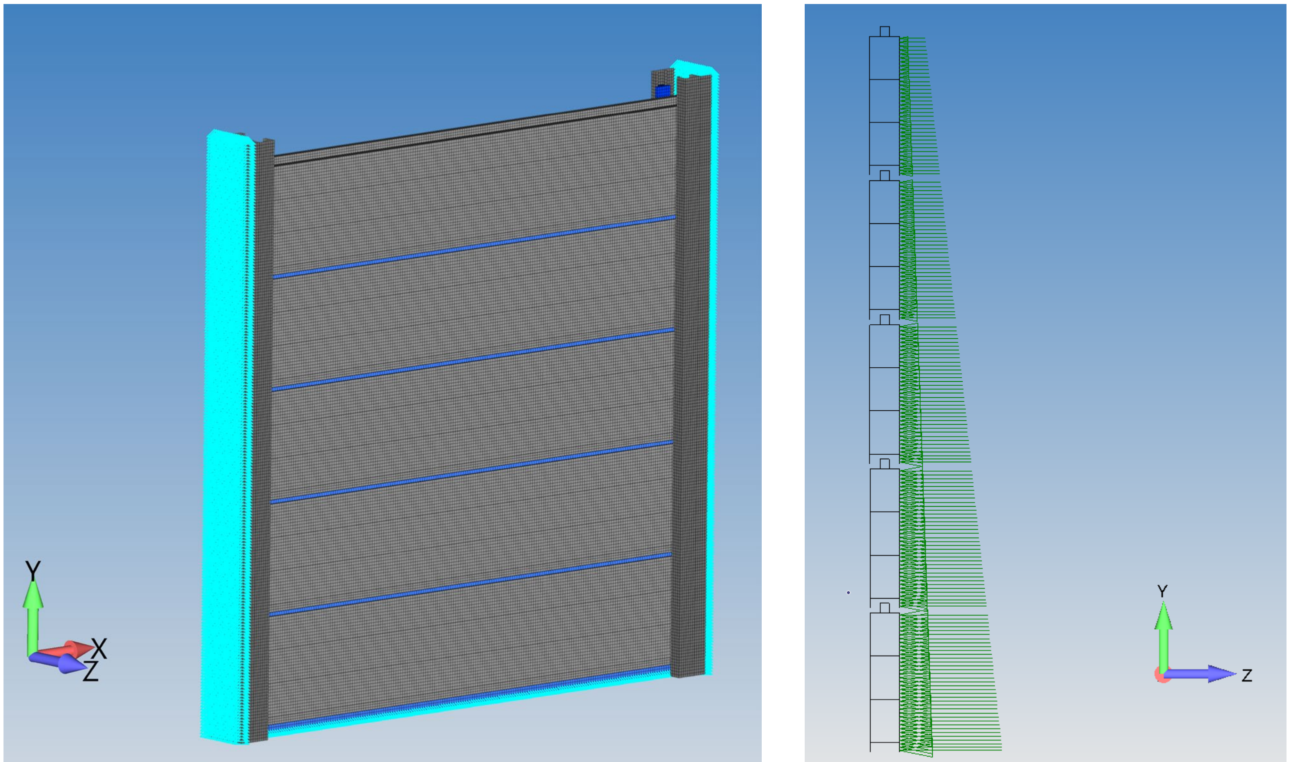
Inside Mount Constraints	Hydrostatic Load
	

Figure 7: Constraints and Loads

4. FEA SIMULATION RESULTS

4.1 CASE 1: STRESS RESULTS

4.1.1 INSIDE MOUNT

Figure 8 shows the von Mises stress of Hammerhead Flood Control Barrier. The maximum von Mises stress is 16 MPa which is lower than the material's yield stress.

Von Mises Stress Contour, MPa

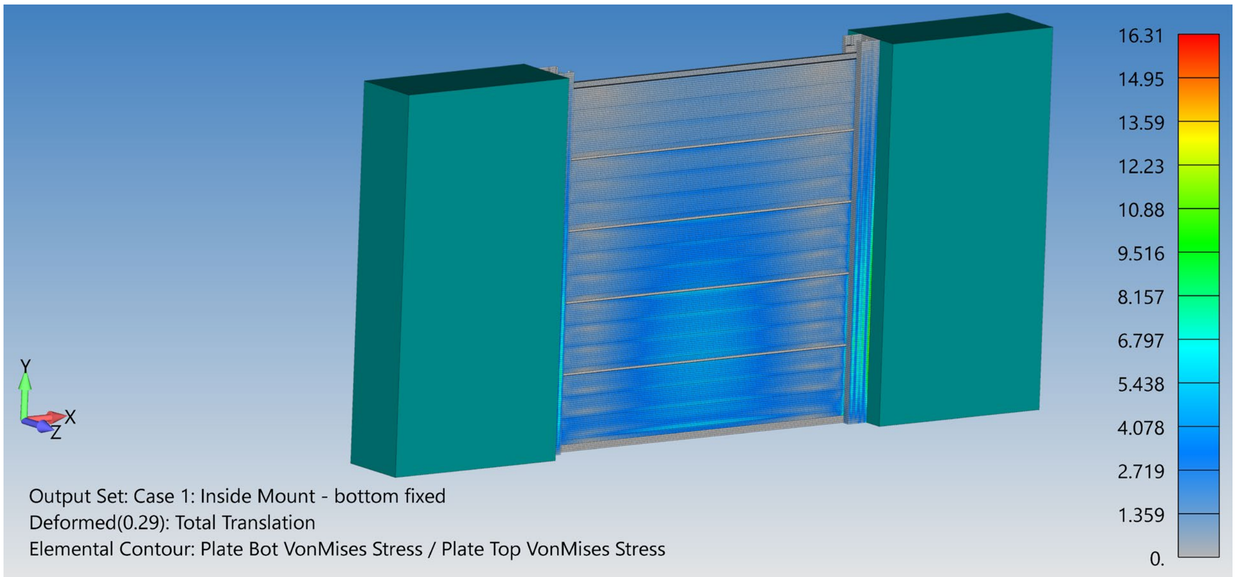


Figure 8: Case 1: Inside Mount FEA Results

4.1.2 OUTSIDE MOUNT

Figure 9 shows the von Mises stress of Hammerhead Flood Control Barrier. The maximum von Mises stress is 23 MPa which is lower than the material's yield stress.

Von Mises Stress Contour, MPa

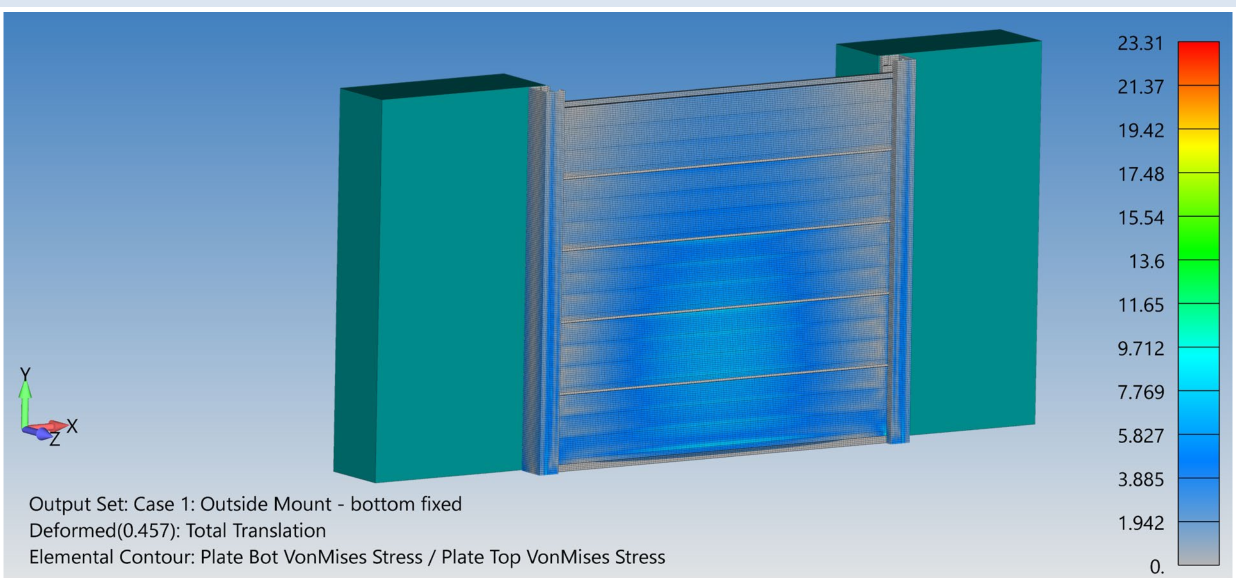


Figure 9: Case 1: Outside Mount FEA Results

4.2 Case 2: Stress Results

4.2.1 Inside Mount

Figure 10 shows the von Mises stress of Hammerhead Flood Control Barrier. The maximum von Mises stress is 86.9 MPa which is lower than the material's yield stress.

Von Mises Stress Contour, MPa

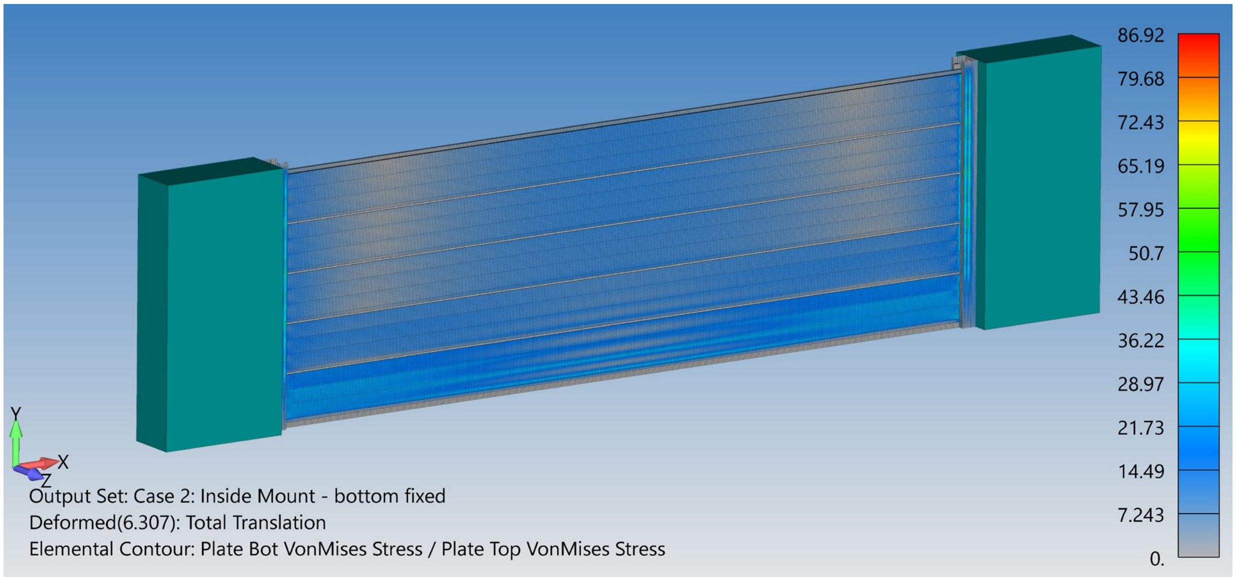


Figure 10: Case 2: Inside Mount FEA Results

4.2.2 Outside Mount

Figure 11 shows von Mises stress of Hammerhead Flood Control Barrier. The maximum von Mises stress is 112 MPa which is lower than the material's yield stress.

Von Mises Stress Contour, MPa

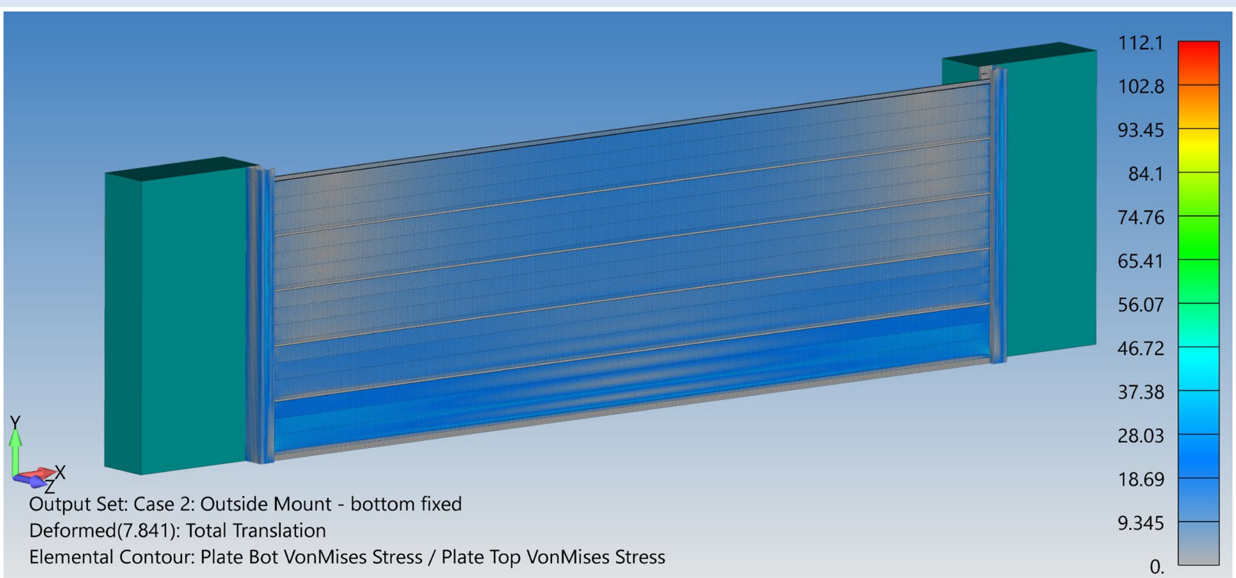


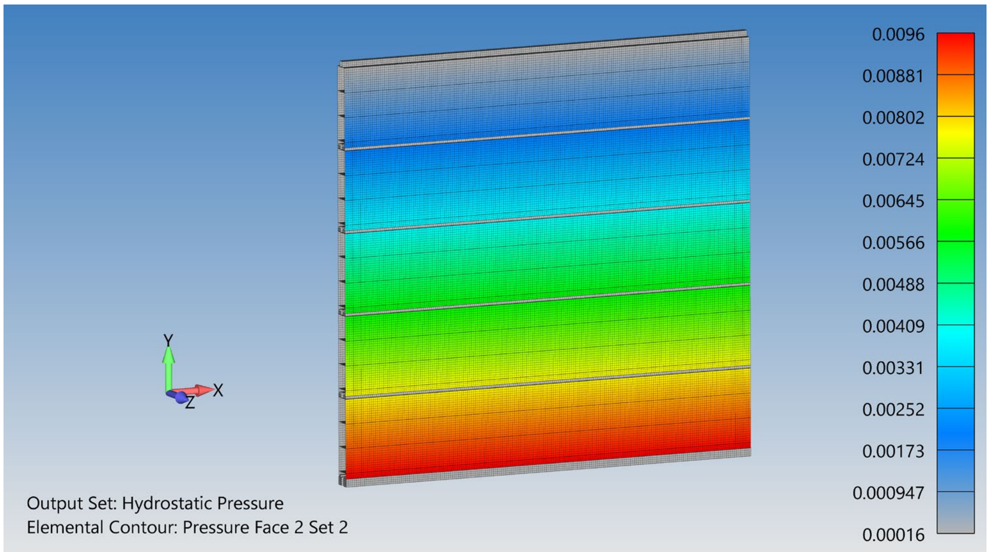
Figure 11: Case 2: Outside Mount FEA Results

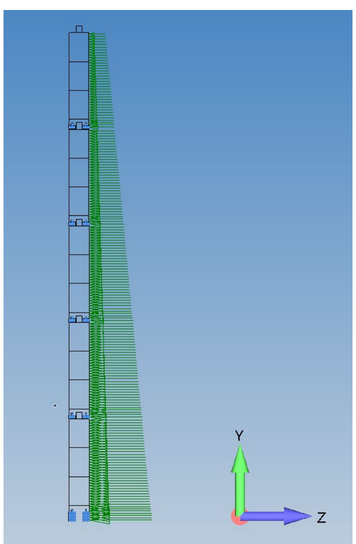
4.1 APPENDIX

4.2 LOAD APPLICATION VERIFICATION

To verify the hydrostatic pressure exerted on the planks in the FE model, we hand-calculated the pressure at the barrier's bottom and the total force on the planks for Case 1: Inside Mount. This data was then compared to the information derived from the model for consistency and accuracy.

$$P = \rho g h = 10^{-9} \times 9806 \times 961.85 = 0.0094\ MPa$$





$$F = \frac{\rho g h}{2} \times h \times w = \frac{10^{-9} \times 9806 \times 961.85}{2} \times 961.85 \times 1016 = 4{,}610\ N$$

Check Sum of Forces

```
Summation of Forces, Moments, Pressures and Body Loads for Set 2 (CSys 0)
  Nodal Force                FX =           0.  FY =           0.  FZ =           0.
  Nodal Moment               MX =           0.  MY =           0.  MZ =           0.
  Pressure Force             FX =           0.  FY =           0.  FZ =    -4637.151
  Body Translational Accel   FX =           0.  FY =           0.  FZ =           0.
  Body Varying Trans Accel   FX =           0.  FY =           0.  FZ =           0.
  Body Rotational Accel      FX =           0.  FY =           0.  FZ =           0.
  Body Rotational Velocity   FX =           0.  FY =           0.  FZ =           0.

Totals (CSys 0)
  About Location              X =           0.   Y =           0.   Z =           0.
  Forces                     FX =           0.  FY =           0.  FZ =    -4637.151
  Moments                    MX =    -439195.2  MY =    -1729796.  MZ =           0.
```