Mesh Size	Stress Limit	
	Static + Dynamic	Static
1 × stiffener spacing (SS)	0.90 S_mF_y	0.63 S_mF_y
1/2 × SS	0.95 S_mF_y	0.67 S_mF_y
1/3 × SS	1.00 S_mF_y	0.70 S_mF_y
1/4 × SS (1)	1.06 S_mF_y	0.74 S_mF_y
1/5 × SS ~ 1/10 × SS (1)	1.12 S_mF_y	0.78 S_mF_y

Figure 16 Mesh size and stress limits (American Bureau of Shipping (ABS), 2019)

Since the forces due to hull girder strength were not applied in the model, and in accordance with the aforementioned ABS rules, the allowable stress has been reduced by 10%. Consequently, the maximum permissible stress for the deck structure is considered to be 165 MPa.

4 Conclusion

4.1 Simulation results

The finite element results demonstrate that the forecastle deck structure in the crane foundation region satisfies the ABS allowable stress requirement under all investigated crane loading conditions. Tthe maximum Von Mises stress among the eight slewing cases occurs at a crane rotation angle of 180°, where the stress reaches 160.4 MPa, while the second highest value is obtained at 0° with 154.3 MPa. By contrast, the lowest stress is recorded at 315°, with a value of 105.6 MPa (Table 7). Since all calculated stresses remain below the allowable limit of 165 MPa, the deck structure can be regarded as structurally adequate for the considered static operating conditions. At the same time, the 180° case leaves only a limited safety margin of about 4.6 MPa, indicating that this loading direction governs the strength assessment of the crane foundation region.

Table 7 Maximum von mises stress under different crane loading angles

No.	Angle Relative to Bow (°)	Von Mises Stress (MPa)	Figure No.
1	0	154.3	15
2	45	111.0	16
3	90	139.3	17
4	135	112.8	18
5	180	160.4	19
6	225	117.0	20
7	270	137.6	21
8	315	105.6	22

The stress contour plots shown in Figures 17-24 further clarify the structural behavior behind the values listed in Table 7. In particular, the stress cloud corresponding to the 180° slewing condition (Figure 21) identifies the most critical stress concentration in the crane-supporting region, whereas the contours for 0° (Figure 17) and 270° (Figure 23) also show relatively high stress levels compared with the other loading cases. By comparison, the stress distributions for 45°, 135°, 225°, and 315° (Figure 18, Figure 20, Figure 22, Figure 24) are more moderate, indicating that these slewing directions produce a more favorable load-transfer path through the deck structure. Taken together, Table 7 and Figure 17, Figure 18, Figure 19, Figure 20, Figure 21, Figure 22, Figure 23, Figure 24 show that the structural response is strongly dependent on crane orientation and that a single loading direction would not be sufficient to identify the governing condition.

Similar orientation-dependent stress redistribution has also been reported in crane-supporting marine structures, where different crane positions lead to different load-transfer paths and local reinforcement demands (Hernández-Ménez et al., 2023; Dragatogiannis et al., 2024). From the engineering point of view, these results indicate that the deck plating, girders, stiffeners, and supporting pillars are able to work together to transfer the crane load effectively into the surrounding structure. The highest stresses appear only in specific orientations,