

Figure 23 Von mises stress results at 270° crane rotation

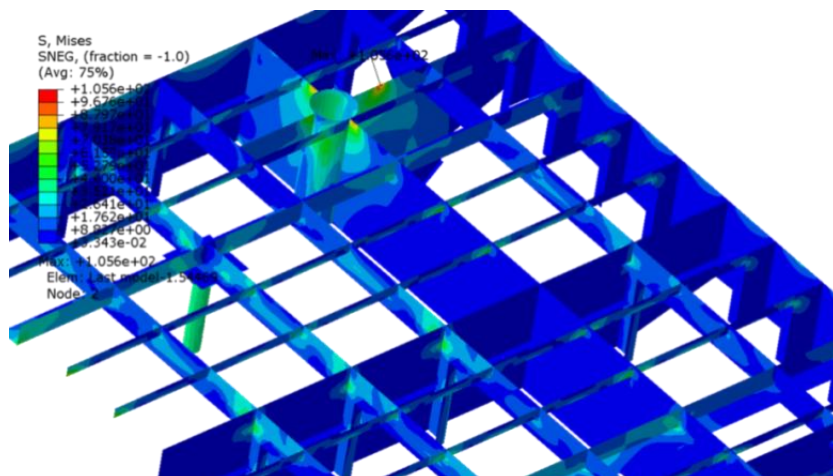


Figure 24 Von mises stress results at 315° crane rotation

Several limitations of the present study should also be acknowledged. First, the analysis was based on a simplified geometric model in which local details such as cutouts, scallops, snipes, and other small discontinuities were not included, although such features may affect local stress concentration in practice. Second, the present assessment was limited to linear static analysis under calm sea conditions, and therefore did not consider dynamic effects associated with vessel motions, impact loading, or oscillation of the lifted load. Third, the study focused on rule-based strength verification and did not include a detailed fatigue assessment of the identified hot-spot regions. For these reasons, the present conclusions are suitable for preliminary structural verification, but they do not fully represent the complete long-term service behavior of the crane foundation structure.

Future work should therefore extend the present analysis in several directions. A fatigue assessment should be performed for the most highly stressed regions identified in Figure 21 and the other critical contour plots. Dynamic loading conditions caused by vessel motion and crane operation in realistic sea states should also be considered in order to provide a more complete structural evaluation. In addition, local sub-modeling of the hot-spot regions would help capture stress concentration more accurately than the current global shell model. If higher lifting loads or more demanding operating conditions are expected in future service, structural optimization measures such as local plate thickening, bracket addition, or improved stiffener continuity may be investigated to increase the available safety margin and improve fatigue resistance. Moreover, refined local stress assessment methods should be considered for welded joints around the crane foundation, since hot-spot stress prediction can vary with the adopted finite element formulation and extraction technique (Li and Choung, 2021). Overall, by combining the numerical comparison in Table 7 with the stress contour interpretation in Figure 17, Figure 18,