CADFEM Consulting

Tolerance Study of an Antenna Foundation with ANSYS®

Investigation of the Influence of Manufacturing Tolerances on the Stiffness

Your Contact Person:

Dr. –Ing. Heiko Schüler
Phone: 0371-334262-12
E-Mail heiko.schueler@cadfem.de

Task

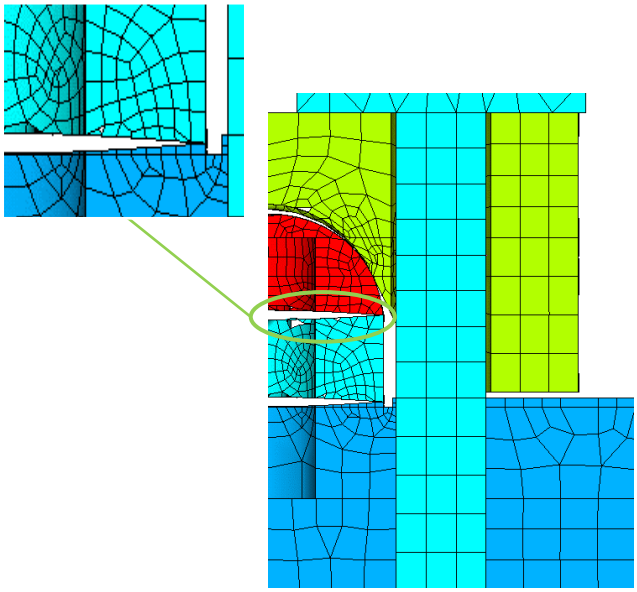
The Atacama Large Millimeter Array (ALMA), located in the Atacama Desert in northern Chile, is an astronomical interferometer, which consists of 66 single radio-telescopes ("antenna") of 12 m and 7 m diameter. The antenna foundation base plates are embedded in concrete. The antenna itself is mounted on the three base plates by ridges, consisting of a flat lower part and a half-cylindrical upper part. The antenna feet have a recess to rest on the ridges. The assembly is kept together by M52 bolts. There are high tolerances of planarity in all contact areas between the parts. Given the number of foundations to be realized (more than 200 antenna stations), these tolerances should be relaxed to reduce manufacturing costs. Therefore the influence of the tolerance of planarity on the stiffness of the antenna foundation has to be investigated. To simulate inaccuracies caused by manufacturing, convex and concave deformations of these contact areas are generated by moving the x-coordinate of the surface nodes according to a sine function with respect to the z-coordinate.

ALMA (Atacama Large Millimeter Array)

Solution

Nonlinear contact analyses with very high resolution of contact stiffness (penetration) have been performed. The contact penetration had to be an order of magnitude below the tolerance of planarity of 20 µm (typical edge length: about 300 mm). The bolt loads and the antenna mass have been applied to the model. A linear-elastic material model with small deformations has been assumed for this analysis. Three different solution models had to be compared:

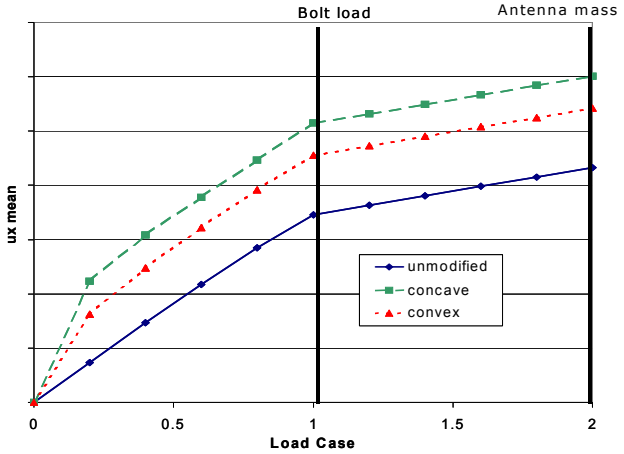
- the unmodified geometry without manufacturing tolerances,
- the model with concave modifications of the contact areas
- and the model with convex modifications of the contact areas.



Concave modifications of contact areas (scaled to 5mm gap)

Results and Conclusions

The deformation of the structure is dominated by the applied bolt pretension. The stiffness during that first load step is different for all three models. But as soon as the contact regions are closed, the stiffness of the structure is the same for all three model variants. Therefore the influence of the tolerance of planarity on the stiffness of the antenna foundation is negligible for the manufacturing tolerances investigated.



Figures Courtesy of European Southern Observatory (ESO)