Just the Facts…

Small-Sliding Contact in ANSYS Mechanical

ANSYS, Inc.

2600 ANSYS Drive

Canonsburg, PA 15317

29 March 2018

Summary

Small sliding for contact analysis was introduced in ANSYS Mechanical at Release 18.2 as an alternative to finite sliding. Finite sliding remained the default contact behavior, with small sliding as an option.

At Release 19.0, small-sliding contact became the *default* behavior for all contact types used in small-deflection models.

Small-sliding contact can solve problems that finite-sliding contact may have difficulty solving.

Analysis results using small-sliding contact maintain sufficient accuracy despite a significantly lower computational cost and solution time.

ANSYS, Inc. has performed numerous and extensive contact-analysis tests using small sliding with small-deflection models. Where large sliding did not occur, no issues related to results accuracy were found.

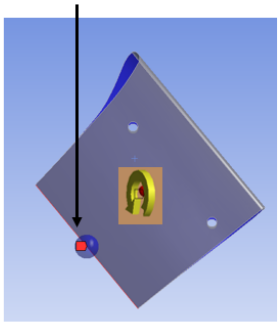
Applicability

The default small-sliding option improves both solution robustness and efficiency:

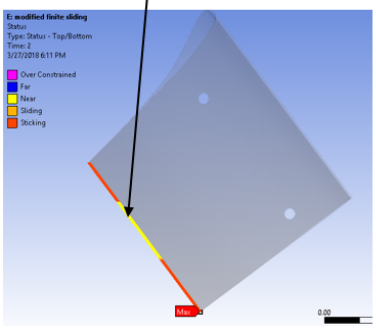
- The small-sliding logic can solve complex contact models for which the finite-sliding logic might have difficulty, especially models having a low-quality geometry or mesh and non-smooth contact interfaces.
- The nodal connectivity of the contact element is formed only once at the beginning of the analysis and remains unchanged throughout. (Prior to Release 18.2, the program tracked only finite-sliding contact, reforming nodal connectivity of the contact element at each equilibrium iteration.)
- The sparse solver can reuse the same matrix structure throughout the simulation, avoiding the costly sequential step of equation-ordering at every equilibrium iteration and leading to significant performance improvements and better scalability in a distributed-memory parallel run.
- The contact node never slips off the edge of target segment or encounters penetration shock.

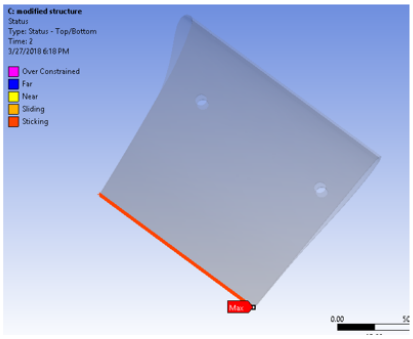
Applying Rotation Velocity on an Edge-to-Surface Bonded Contact Model

Edge-to-surface bonded contact



Contact nodes slip off edge of the target



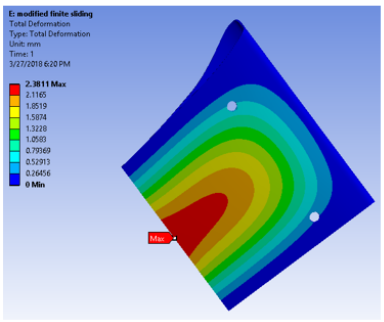


Apply rotation velocity on the whole body

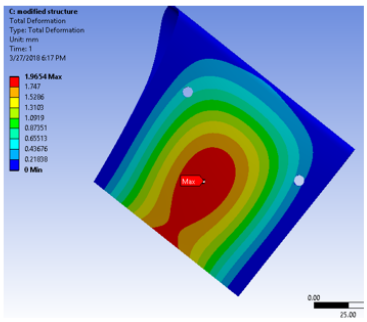
Finite sliding
51 iterations, 254 sec

Small sliding
28 iterations, 138 sec

Finite sliding



Small sliding



Assumptions

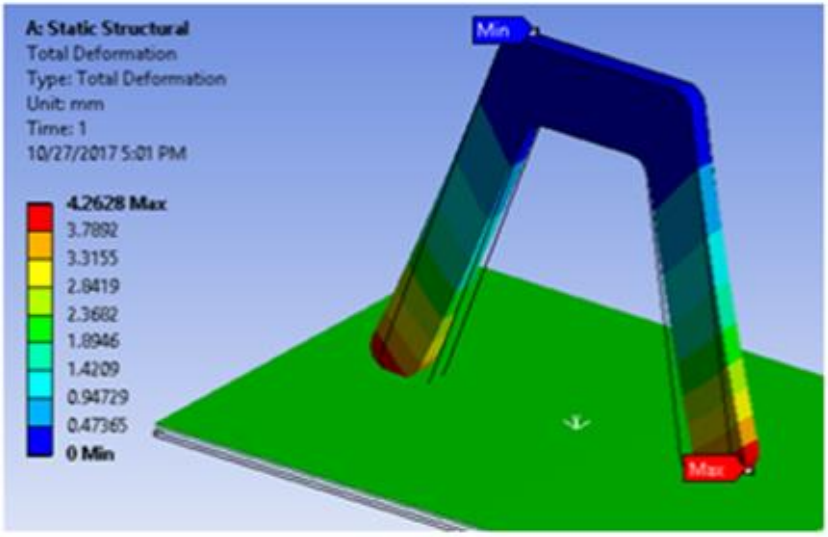
A *small* sliding motion between the contact and target surface is less than 20 percent of the contact length.

Limitations

The small-sliding logic can cause nonphysical results if the relative sliding motion does not remain small. You must therefore ensure that the small-sliding assumption is valid throughout the analysis.

Contact result-tracking and output indicate contact points that violate the small-sliding assumption. The program can monitor violations during solution.

If large sliding occurs, results accuracy is affected, and even convergence difficulties are possible. Use the finite-sliding option in such cases.

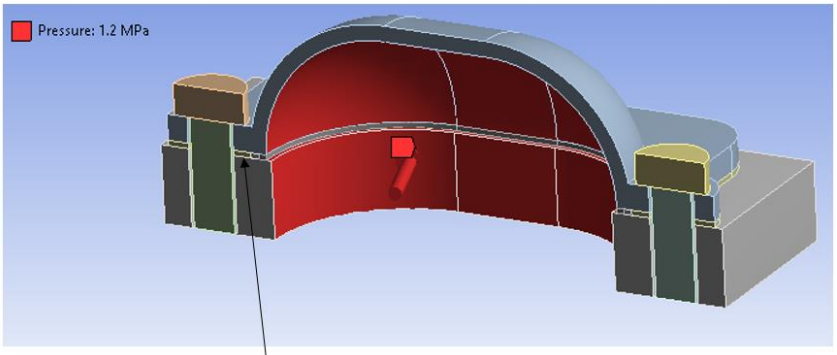


*** WARNING ***
Contact element 3803 (real ID 4) has too much sliding distance 7.29334076 relative to target element 4695. Switch to finite sliding logic (KEYOPT(18)=0) to better represent this situation if desired.

*** NOTE ***
Small sliding assumption is violated at 4 contact points.

As shown in the following example, however, small sliding achieves results very similar to those of finite sliding when the small-sliding assumption remains valid:

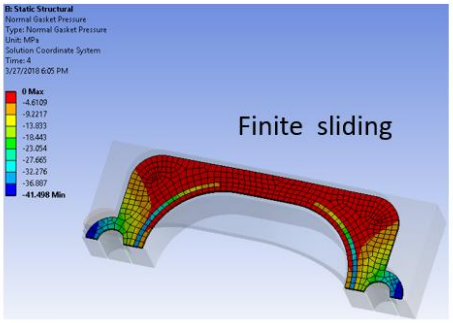
Gasket Assembly Model

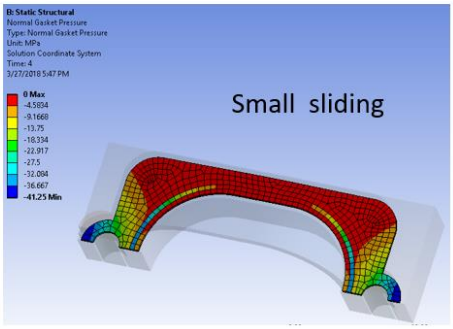


Gasket, with frictional contact, mu=.1

Apply bolt pretension of 6000 N and pressure of 1.2 Mpa in next load step

Normal Gasket Pressure Plot





Finite sliding:
429 iterations, 901 Sec

Small sliding:
432 iterations, 827sec

Conclusion

Compared to the finite-sliding contact option, the default small-sliding option offers significantly improved solution robustness, efficiency, and speed.

Small-sliding contact generates sufficiently accurate solution results if the relative sliding motion remains *small* during the entire analysis.

If you are uncertain as to whether large sliding may occur in your model, use the finite-sliding option.