Application Brief

Small-Sliding Contact in ANSYS Mechanical

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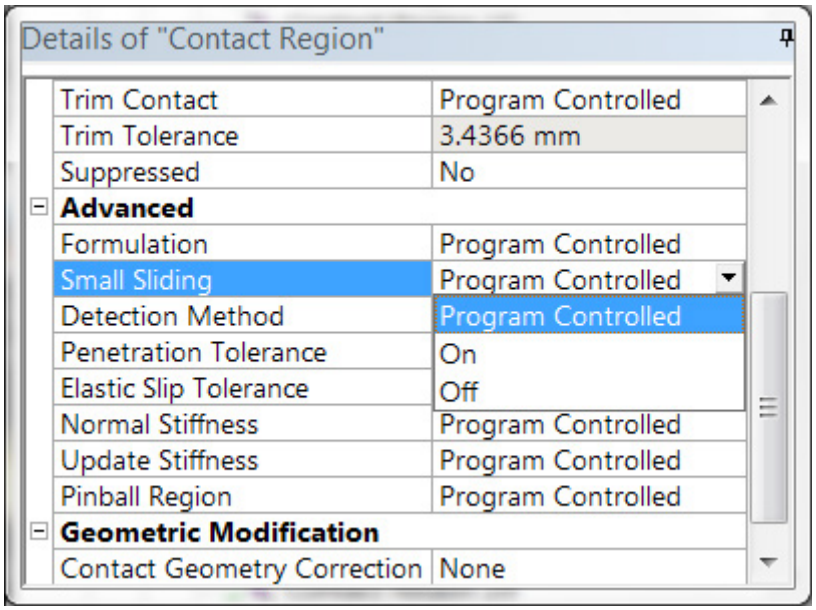
Summary
In the latest version of ANSYS Mechanical, small-sliding contact became the default behavior for all contact types used in small-deflection models or any bonded contact pairs. Small-sliding contact can solve problems that finite-sliding contact may have difficulty solving. Analysis results using 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 for bonded contact pairs. Where large sliding did not occur, no issues related to results accuracy were found.



Concept

The small-sliding contact simply assumes the contact interface will have relatively-small sliding motion (less than 20 percent of the contact length) during the entire analysis. For large deflection analysis, this option still permits arbitrary large rotation. Each contact detection point always interacts with the same target element which is determined from the initial configuration. Coordinates (ξ_0,η_0) are fixed throughout the analysis as shown in the following figure.

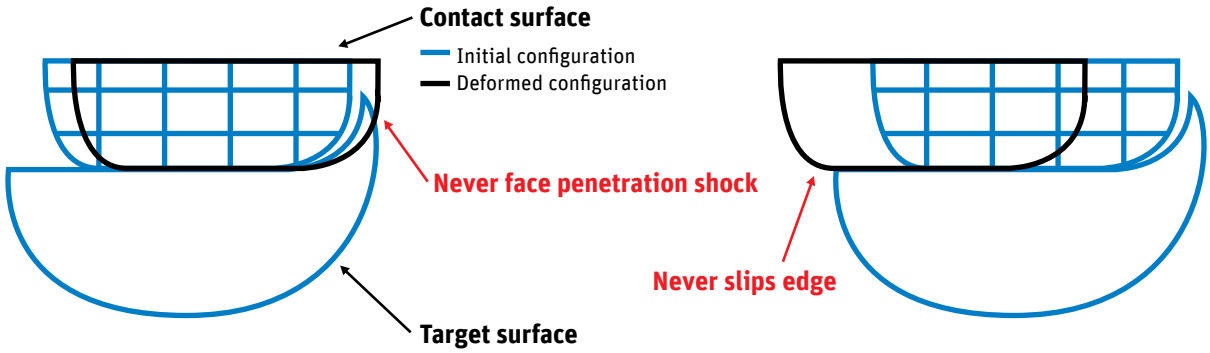
(a) Initial configuration **(b) Deformed configuration**

Gap and slip are measured from the contact detection point to its original nature coordinator of intersection on target.

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. (In earlier versions of the software, 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 the target segment and never encounters penetration shock as shown in the following figure and example:

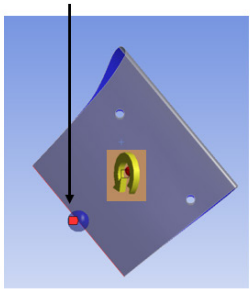


Applying Rotation Velocity on an Edge-to-Surface Bonded Contact Model

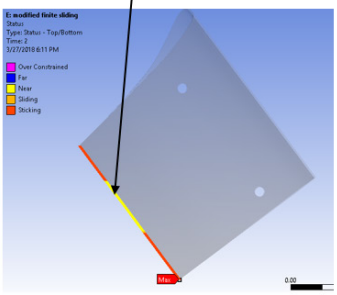
Finite Sliding
Contact nodes slip off target edge

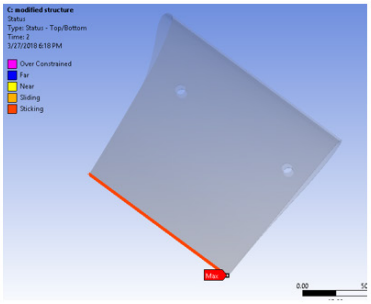
Small Sliding
Contact nodes do not slip off target edge

Edge-to-surface bonded contact



Contact nodes slip of edge of the target



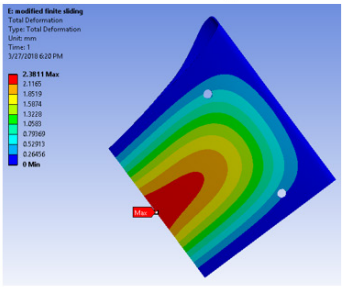


Apply rotation velocity on the whole body

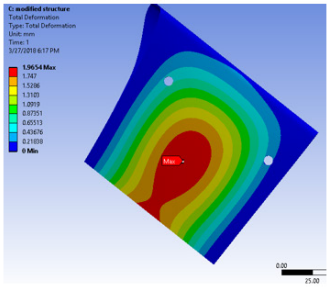
Finite Sliding:
51 iterations, 254 Sec

Small sliding
28 iterations, 138sec

Finite sliding

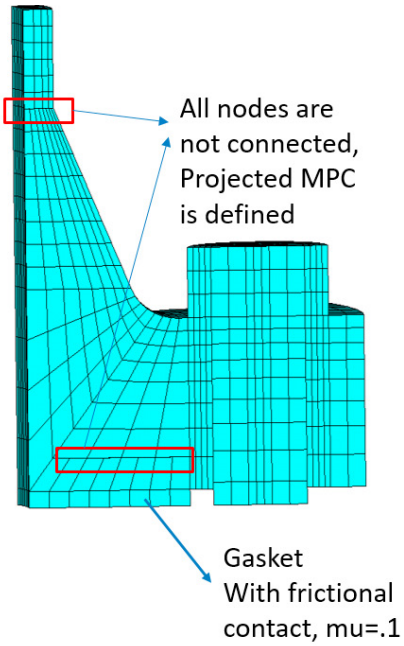


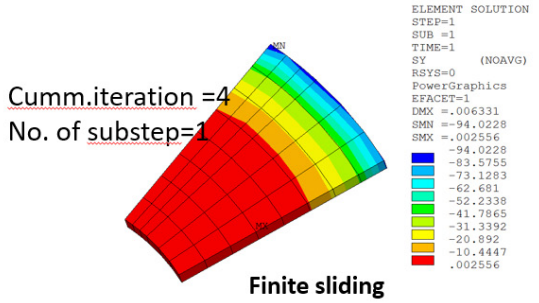
Small sliding



Accuracy Assessment

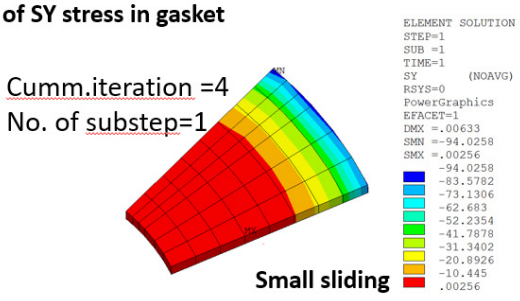
In general, small sliding achieves results very similar to those of finite sliding when the small-sliding assumption remains valid:





Finite sliding

Plot of SY stress in gasket



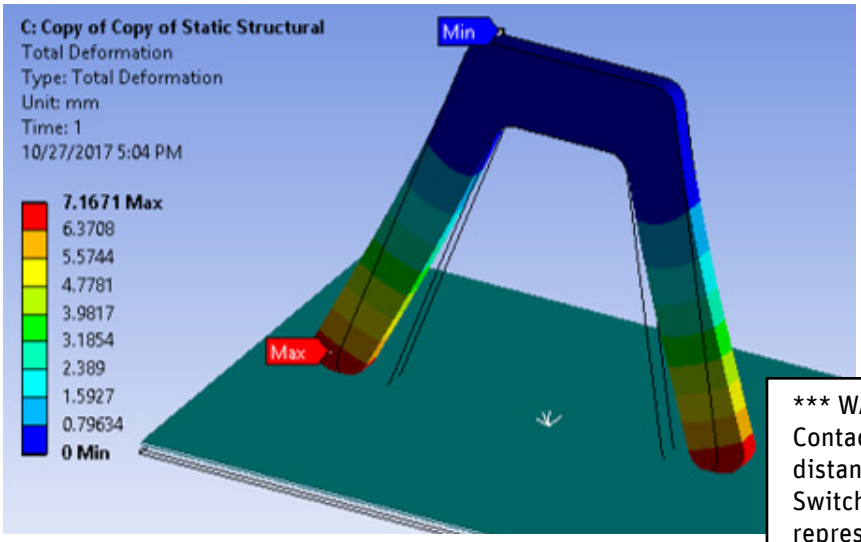
Small sliding

However, 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, as shown in the following example:

Small sliding contact affects solution accuracy or even convergence if true large sliding occurs.



Finite sliding, finite deflection

*** 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.

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.

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