Relationship between finite element method and contact friction problems based on ANSYS

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Abstract

In this paper, we mainly analyze the nonlinear problems in contact problems, including rigid body-flexible body contact and flexible body-flexible body contact. The contact method is point - point, point - face, face - face contact. And the use of hemispherical soft body and the plane of the flexible body contact as an example to operate.

Keywords

Nonlinear, contact, hemispherical.

1. Introduction

The finite element method is an approximation method for solving differential equations[1]. The starting point is a differential equation established for physical or engineering problems, including control engineering and boundary conditions. And the finite element method mainly solves two kinds of problems. The first kind is the linear elasticity problem under the small deformation condition[2]. The small deformation means that the strain and the rotation are very small. Therefore, the geometric equation is linear and the column equilibrium condition does not need Taking into account the changes in the shape and size of the object; in addition, the constitutive equation of the material is linear, that is, using the generalized Hooke law[3].The second kind is non-linear problem. The nonlinear problem includes three cases: 1, some materials exhibit non-linear properties such as plasticity and viscosity under small deformation conditions, and the material should be considered as nonlinear problem. The case of the set of nonlinear problems, then use the nonlinear geometric equation deformation after the shape and position of the object on the balance equation[4];3, in contact and collision problems, the contact boundary is variable, the contact condition is a highly nonlinear boundary nonlinear problem[5].

In this paper, we mainly analyze the nonlinear problem in contact problem. Contact is a very general non-linear behavior. It is a special and important subset of state change nonlinear type, which is a highly nonlinear behavior[6].

The classification of the contact is as follows:

Contact is divided into soft body - flexible body contact and rigid body - flexible body contact,Among them, soft body - flexible body contact is divided into surface - surface contact, point - surface contact, point - point contact[7].

In order to model the contact problem, it is important to know which parts of the model may be in contact with each other, and if the point is in contact, the corresponding component of the model is a node. If the surface is in contact, the corresponding component of the model is a unit, such as a beam unit, a shell element, or a solid element.

2. The two objects that produce contact must meet the non-penetrating constraintsSection Headings

$\Delta u_A \bullet n \le D$

Δu_A-A point incremental displacement vector

n-Unit normal vector

D-Contact distance tolerance

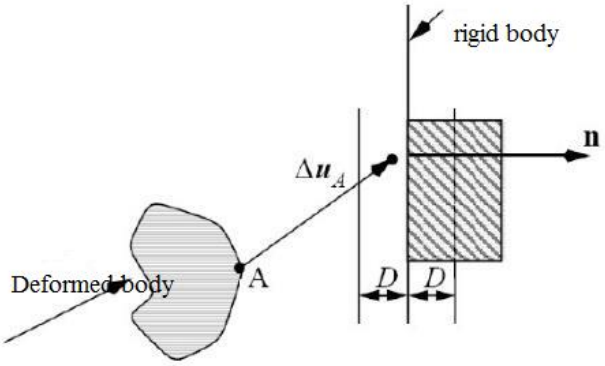

Fig. 1 No penetration contact constraint

3. Three states of contact with a plane

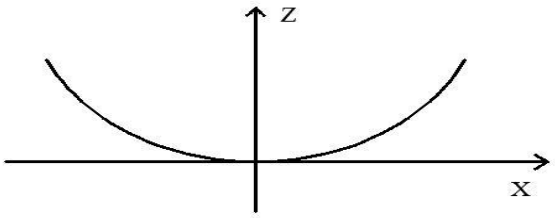

Fig. 2 When the hemisphere does not load

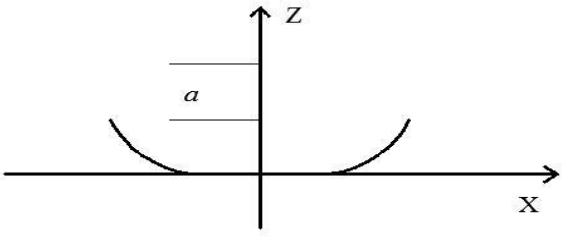

Fig. 3 When the hemisphere is subjected to positive pressure P

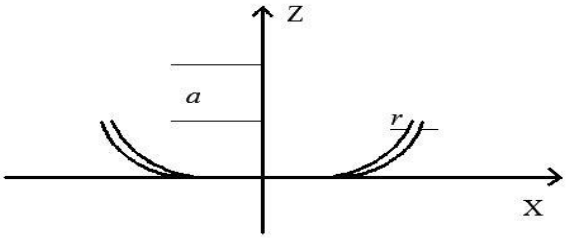

Fig. 4 When the hemisphere receives the positive pressure P and the horizontal force F

4. Analysis of Contact Friction Problem by Finite Element Method

(1) The establishment of the model

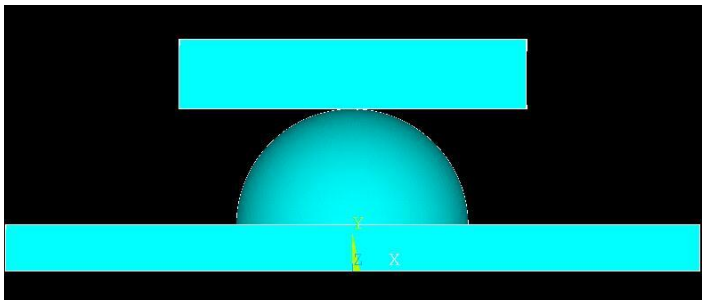

Fig. 5 Hemispherical model

(2) Select the unit type

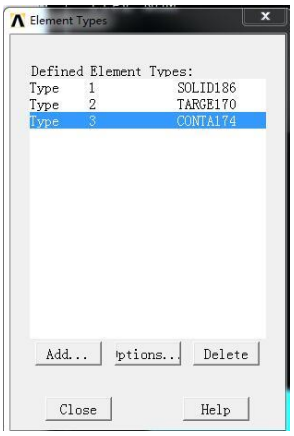

Fig. 6 unit type

(3) Set the contact surface and target surface

Note: ① When the concave surface and the concave surface or concave contact, should specify the plane or concave as the target surface

② If the aerial surface of the grid is relatively small, and the other side of the grid is relatively thick, should specify the fine grid as the contact surface, the rough grid as the target surface.

③ Set the material type, select the type of friction and set the friction coefficient

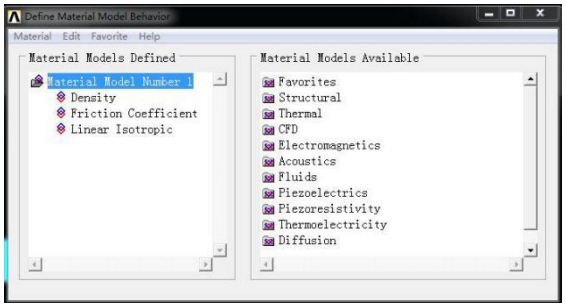

Fig. 7 Simulation process

(5). Select the location of the contact check

The contact checkpoint is located at the integration point of the contact unit. The contact element can not penetrate into the target face at the integration point, however, the target face can penetrate into the contact surface.

The face-to-face contact unit uses the GAUSS integration point as the default, and the Mewton-Cotes / lobatto uses the node itself as the integration point.

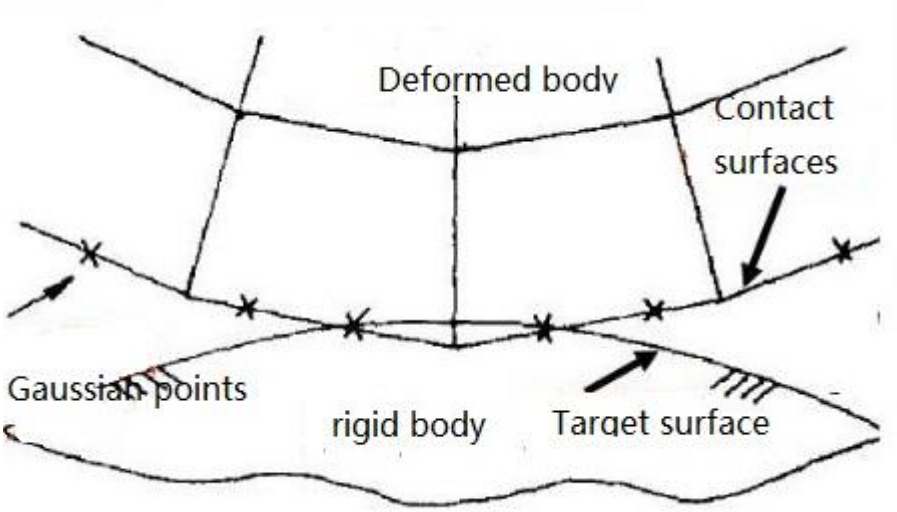

Fig. 8 Contact checkpoint location

⑹. Divide the grid (for saving time, roughly divided the grid)

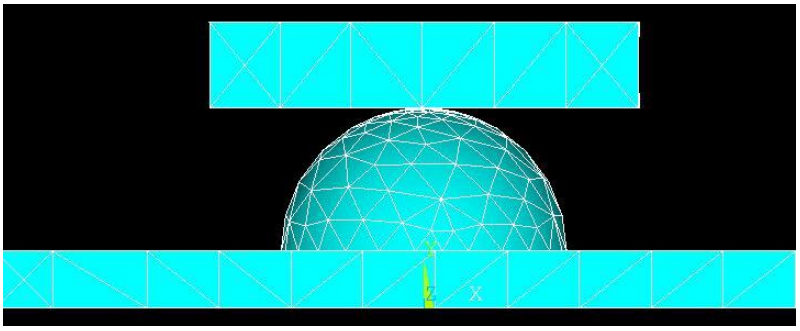

Fig. 9 meshing results

⑺. Add a constraint

① Add a displacement constraint to the bottom, restraining all its degrees of freedom

② To the upper surface to add uniform load

③ To the top of the box to add a level of tension

⑻.Solution

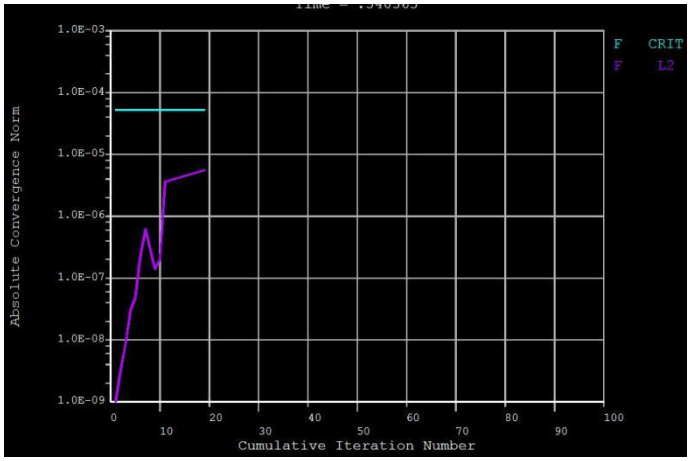

Fig. 10 Simulation results

5. Conclusion

Through the simulation analysis of the flexible body - flexible body model, it can be seen that the deformation of the rubber is nonlinear, and with the increase of the pressure, the deformation changes with the nonlinearity.

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