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SEPARATION AT A PRECOMPRESSED FRICTIONLESS INTERFACE DUE TO ASYMMETRIC LOCALIZED LOADS

*** H. Schmidt [1], A.P.S. Selvadurai [2] and K.Willner [3]**

[1] Lehrstuhl für Technische Mechanik, Universität Erlangen-Nürnberg,
91058 Erlangen, Germany
hans.bernd.schmidt@gmx.li

[2] Department of Civil Engineering and Applied Mechanics, McGill University,
Montréal, QC, Canada
patrick.selvadurai@mcgill.ca

[3] Lehrstuhl für Technische Mechanik, Universität Erlangen-Nürnberg,
91058 Erlangen, Germany
willner@ltm.uni-erlangen.de

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ABSTRACT

Introduction

The problem of the unilateral frictionless contact between compressed elastic bodies has useful applications in the engineering sciences ranging from geomechanics of fluid saturated interfaces to biomechanics of soft tissue contacts. The mathematical study of unilateral contact problems also represents an important area of theoretical solid mechanics. We consider the category of frictionless unilateral contact problems, which can occur only in the presence of normal contact forces. The analysis of such frictionless unilateral contact problems reduces essentially to the determination of the zone of separation that can be induced by forces applied either at the interior of the contacting zones or induced by anomalies such as inclusions located at the interface. Analytical solutions for unilateral contact problems can be conveniently developed only in situations where the interaction configurations result in states of axial symmetry [1,2] and all other situations invariable require computational treatments [3,4].
This paper examines the problem of separation at smoothly compressed identical halfspace regions by normal tractions of equal magnitude. The results are invariant to the given coordinate system and depend only on the positions in the separation plane, hence the problem reduces to the specification of the absolute distance $2d = \sqrt{(x_2 - x_1)^2 + (z_2 - z_1)^2}$ between the forces (*Figure 1*).

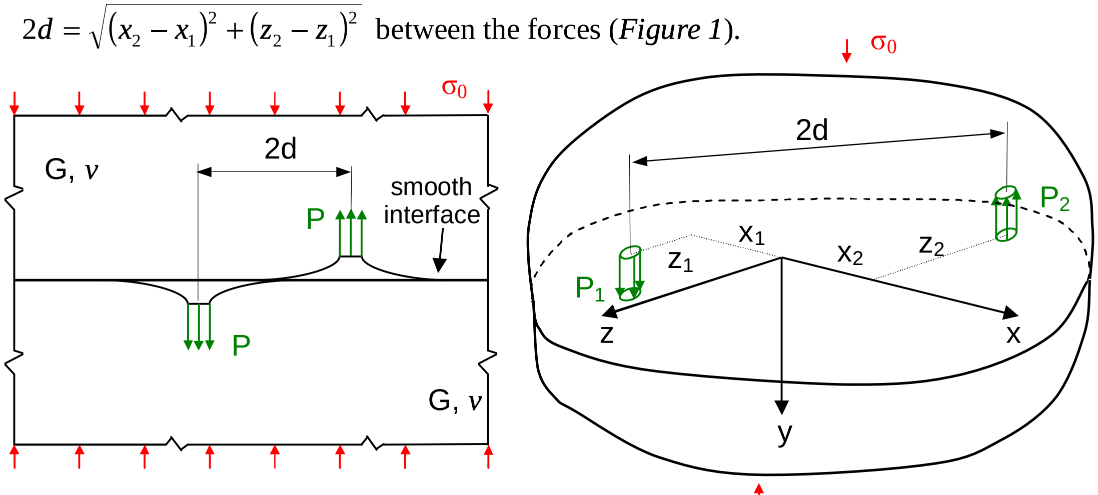

Figure 1: Geometry of the problem

Modelling

The three-dimensional computational modelling of the problem is performed using the general purpose finite element code ABAQUS/Standard (*Figure 2*). Singularities are avoided by representing the forces (P) inducing separation by uniform tractions applied over circular areas, the radii of which (a) are small in comparison to those of the separation zone (i.e. $a\sqrt{s_0 / P} \approx 0.04$).

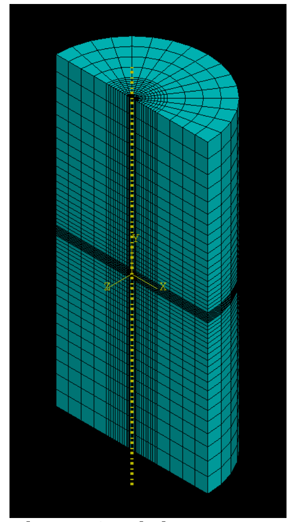

Figure 2: Finite element model of interacting halfspaces

Validations

The accuracy of the computational modelling procedure is established through comparisons with known analytical solutions for unilateral contact problems available in the literature [1,2].

Results

The study of the problem provides results, which illustrate the evolution of the shape of the unilateral contact and the extent of separation between the two elastic halfspace regions as a function of the distance between the asymmetrically placed localized tractions (*Figure 3*).

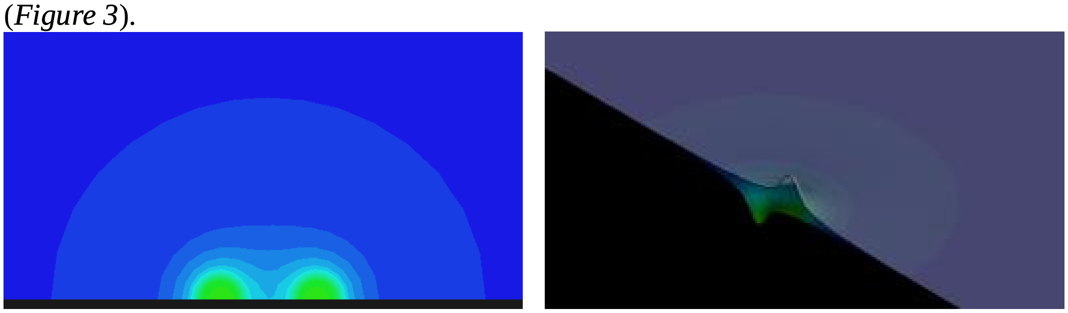

Figure 3: Typical result for the separation zone: non-zero separation distance

Conclusions

The objective of the study is to illustrate the effciency of computational scheme for examining a relatively straightforward problem involving smoothly interacting halfspace regions. The scope of the unilateral contact problem can be extended to include a nesting of concentrated forces of unequal magnitude. The methodology can be applied to examine multiple inclusions that can be embedded in frictional contact between bimaterial halfspace regions, which have useful applications in tribology.

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