The 38th JUACEP Seminar

第 38 回 名古屋大学日米協働教育プログラムセミナー

Date: Oct. 26 (Wed), 2016 13:00-

Venue: Lecture Room 231, Eng.Bldg-2

On the Role of Scale in Computational Contact Mechanics: from Atomistic to Continuum

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Contact stresses play an important role in dictating the mechanical integrity of most systems, including the ones mentioned above. This is in essence how loads are transmitted between the different components of a system. Increase in these contact stresses beyond the safe limit could lead to plastic deformation, scuffing, pitting, fretting fatigue and excessive noise. One may argue that the subject of contact mechanics began with the publication of the classical work of Hertz in 1882. Hertz theory is restricted to small elastic deformation and frictionless contact of an idealized body. In order to overcome these limitations, most contact problems are treated using computational mechanics. Great strides have recently been made in the application of computational contact mechanics to the design of highly complex engineering and bioengineering systems.

It has now become abundantly clear that advanced modelling techniques are central to the advancement and competitiveness of the industrialized nations. Excellent examples of this assertion are the computer-integrated design of Boeing 777 and 787 aircraft, the collapsible shock absorber for electrically powered vehicles and the new prosthetic implants for Rheumatoid Arthritis. The treatment of frictional contact problems are challenging since they are non-linear even in the elastic range, the actual contact area is unknown a priori and the presence of the friction term, which is typically non-differentiable, adds more complexity to the problem.

Undoubtedly, the focus of most existing research has been on contact mechanics of a continuum with little or no effort in addressing the role of scale. Whilst continuum modelling of frictional contact has served us well in the past, the applicability of these models at the atomic scale is questionable due to several inherited nanoscale phenomena (e.g., discreteness, quantum manifestations). Atomistic simulations such as molecular dynamics could provide better insight into the contact mechanics of nanoscale systems. At the atomic scale, other physical phenomena come into play such as van der Waal and electrostatic forces, the associated atomistic deformation patterns, atomic pile up as well as the atomic adhesion that result during the retraction stage of the indenter.

In this talk, Professor Meguid will discuss the role of scales (from atomistic to continuum) in computational contact mechanics.

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