Verification of Three Friction Models for a Contact Patch with Uni-Axial Loading

CATEGORY OR KEYWORDS
Surface and Interfaces, Bouc-wen, FEA, Contact Models

AUTHORS AND INSTITUTIONS
Lawal, I.G.[1], Stanciulescu, I.[1], Higgs, C.F.[1], Brake, M.R.W.[1] – [1]William Marsh Rice University

INTRODUCTION

An interface is formed when a minimum of two parts are in contact. Loading of the interface occurs at the contact patch, which is the apparent area of contact of the two surfaces. It can range in dimension from 1 mm x 1mm and larger, depending on the contact geometry. Multiple contact patches exist for a given interface and the evolution of the contact patch depends on the frictional response. The input load on the interface can be grouped into two categories - static and dynamic. In the static case, the loads on the contact patch are known apriori and do not change with time. In the dynamic case, commonly observed in structural dynamics interfaces, the load at the interface varies dynamically. In both cases, the surface topology, and local material properties (Elastic Modulus, etc.) change in response to several variables including: loading of the interface, geometry of the interface, geometry and density of the local contact patches in actual contact, materials in contact, their material properties. How interfaces in structural dynamics evolve with uni-directional reciprocating loads is an area of Structural Dynamics with a high amount of uncertainty. [1]

Recent experiments have identified two main characteristics of interface response to these variables. When the load on the interface is uni-directional and reciprocating, "fretting" of the material is observed. This is the most visible form of defect on the surface of the interface and looks like oxidized, rust-colored points on the interface. A second effect caused by the same loading, but at high-cycles, is wear debris generated at the contact patch on the interface. [2] In addition to these two defects, the local surface topology of the interface may change in response to the above-mentioned conditions. These combined effects illustrate the complexity of how the interface in a system evolves with time. This work will verify three different friction models: Coulomb, Stribeck and Bouc-Wen to help predict how the contact patch topology and local material properties changes in response to a known loading condition. The material used for testing is AISI 304 Stainless Steel. Two types of contact geometries will be explored: An incomplete contact of a spherical indenter and complete contact of a square indenter. Modelling is based on 2-D plane strain FEM (Finite Element Method) simulations with experimental validation of the incomplete contact with a flat-on-sphere tribometer. The results of this study can provide a tool to evaluate interface response, which can be incorporated in existing jointed interface constitutive models and reduce the uncertainty in joint models in existing structural dynamics FEM models. Results can provide insights about how to design interface geometries and assemble sub-structures to limit the onset of surface defects.

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