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Bi-cubic Hermite enrichments of FE contact surfaces

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Parametric model order reduction (PMOR) techniques have recently demonstrated great potential to deal with contact simulations. In [1], an efficient reduced-order model of two meshing gears was constructed by interpolating among a set of pre-computed contact shapes based on the angular configuration parameter of the gear pair. In [2] these contact shapes were adapted to represent only the global deformation patterns of the gears whereas the local deformation and the related stiffness was captured more efficienlty by an analytic formulation. However, both above mentioned cases [1, 2], and in general in Finite Element (FE) contact problems [3] several fundamental challenges arise. Using Lagrange elements, the contact surfaces exhibit C^0 continuity at the element boundaries, which drastically impacts convergency, especially in sliding contact problems. Moreover, the non-smooth discretization leads to potentially highly oscillatory contact interactions even when mesh convergence is achieved.

Similarly to existing surface smoothing techniques [4], or other approaches relying on higher order geometric descriptions [5, 6], we recently proposed [7] an approach in order to alleviate the above mentioned challenges. The main idea is to refine dynamically the geometrical description of the elements around the contact zone by means of Hermite bi-cubic interpolants.

The proposed technique has the potential to reduce the computational complexity of FE contact problems, by alleviating the need of ultra-detailed meshes. This work discusses its pros and cons in term of computational efficiency, accuracy, and convergency, by means of numerical tests.

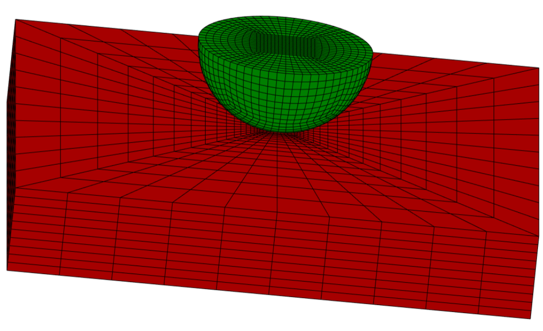

Figure 1: FE representation of the Hertzian contact benchmark

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