Asymptotic modelling of size effects in nanoindentation

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Widely used analytical solutions of elastic contact problems for analyzing nanoindentation load-displacement data to determine elastic modulus of a thin specimen does not account for the size of specimen. In order to model the substrate effect, the unilateral contact problem for a spherical indenter pressed against an elastic layer on an elastic half-space is analyzed for different types of boundary conditions imposed at the interface between the specimen and the substrate. Approximate (asymptotically exact) solutions are obtained in explicit form. The influence of the substrate effect on the incremental contact stiffness is described in terms of the asymptotic constants possessing information about the thickness of the specimen and depending on the relative stiffness of the substrate.