Three different loadings for an elastic disk, constrained on the boundary with an isoperimetric Cosserat coating

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abstract

The mechanical behaviour of a solid body is chiefly influenced by the way the applied loads depend on the deformation. Nevertheless, loads are often simplified as 'dead' or, in other cases, reduced to 'hydrostatic pressure', while different loading systems are usually not introduced.

For the bifurcation problem of an elastic disk coated with an Euler-Bernulli elastic rod, the effects of the following three different types of radial loading is analyzed.

(i.) 'Hydrostatic' or 'pressure' load, which always remains orthogonal to the structural element to which it is applied in any configuration (undeformed or deformed);

(ii.) 'Centrally directed' load, which acts on the structural element remaining always directed towards the initial centre of the ring;

(iii.) 'Dead' load, which remains aligned parallel to the unit normal to the structural element to which it is applied in its undeformed configuration.

All three above loads are conservative and the difference between them emerges in the incremental equations, holding for departures from the trivial configuration, so that they lead to remarkably different bifurcation loads. The latter are analyzed through complex potentials to treat the disk's interior and incremental Lagrangian equations to describe the prestressed elastic rod modelling the coating. In this way, a closed-for solution for the bifurcation problem is obtained, valid for all different loads (i.)—(iii.).

references
[1] Gaibotti, M., Mogilevskaya, S.G., Piccolroaz, A., Bigoni D. (2024) Bifurcations of an elastic disc coated with an elastic inextensible rod. *Proceedings of the Royal Society A*, 480: 20230491.