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ELASTO-PLASTIC ANALYSIS OF THE BONE TISSUE USING A MESHLESS METHOD

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In this work the Natural Neighbour Radial Point Interpolation Meshless Method (NNRPIM) [1,2] is extended to the non-linear analysis of bone tissue patches submitted to compression loads considering the two-dimensional stress plane approach.

In the NNRPIM the Natural Neighbour concept is used in order to enforce the nodal connectivity. Using the Voronoï diagrams, constructed from the unstructured set of nodes discretizing the problem domain, it is possible to obtain the “influence-cells”, which are in fact influence-domains entirely nodal dependent. From the Delaunay triangles, the dual of the Voronoï cells, a node-depending background mesh is created. This integration mesh is used in the numerical integration of the NNRPIM interpolation functions, which are constructed using the Radial Point Interpolators (RPI). The obtained interpolation functions possess the delta Kronecker property, which simplify the imposition of the natural and essential boundary conditions

Since the scope of this work is to extend and validate the NNRPIM in bone tissue elasto-plastic analysis, the used non-linear solution algorithm is the Newton-Raphson initial stiffness method and the efficient “forward-Euler” procedure is used in order to return the stress to the yield surface. Experimental studies reveal that the bone tissue show a distinctive yielding followed by a constant nominal stress plateau for both uniaxial and confined compression [3]. The same research work concluded that the Drucker–Prager and Mohr–Coulomb plasticity models fails to capture the confined compression behaviour of trabecular bone. In this work, as suggested in the literature [3], it is used the von-Mises yield surface to characterise the plastic behaviour of trabecular bone. In this work two loading configurations are investigated, uniaxial and confined compression, providing two distinct loading paths in the von Mises–pressure stress plane.

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