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On the accuracy of meshless collocation methods for modeling of heterogeneous structures

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In this contribution, the Meshless Local Petrov-Galerkin Collocation Method (MLPG2) [1] and the Radial Point Interpolation Collocation Method (RPICM) [2] are considered for the modeling of heterogeneous structures consisting of two homogeneous subdomains with isotropic linear elastic material properties. These subdomains are discretized by two sets of grid points in which the equilibrium equations may be imposed, while a double node concept is employed along their interface. Independent variables in each subdomain are approximated using meshless interpolating functions, IMLS and RPIM , in such a way that each subdomain is treated as a separate problem [3]. The solution for the entire heterogeneous structure is attained by enforcing displacement continuity and traction reciprocity conditions in the nodes positioned on the interface of two homogeneous subdomains.

A standard fully displacement (primal) and a mixed approach are both considered for solving the linear elastic boundary value problem for each subdomain. Using both approaches final system of discretized equations with displacement components as only unknowns is obtained. In the primal approach, this is achieved simply by using only the interpolations of displacement components. In the mixed approach, both displacement and stress components interpolations are utilized simultaneously. The nodal stress values are then expressed in terms of the approximated displacement components using the kinematic and constitutive relations in order to obtain solvable system of equations in terms of nodal displacements only.

It is well known that the accuracy of the meshless collocation methods is often governed by parameters used in the analysis of each separate problem. Hence, in this contribution the dependence of several parameters, such as the support domain size and radial basis function shape parameters, on the accuracy of the solution is explored. The analysis of accuracy and numerical efficiency of both primal and mixed approach are demonstrated by a set of suitable numerical examples for which analytical solutions can be derived.

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References

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