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## A meshfree Hermite radial point interpolation method for thin plates buckling analysis

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## Abstract

Buckling of a thin plate is a geometrically nonlinear problem that requires higher order continuity shape functions. In the present study Hermite-type radial point interpolation method (HRPIM) is combined with a high order continuation (HOC) solver to approximate transverse displacements component and its derivatives. The governing partial differential equations are discretized using the Galerkin method, and a solver based on Taylor series expansion and a continuation procedure. Numerical examples are studied to demonstrate the efficiency, accuracy, and robustness of this approach for different geometric shapes, nodal discretization, boundary conditions, and loadings.

## Methodology

In order to avoid the singularity problem faced with the polynomial method PIM [2], the Gaussian radial basis function (RBF) with (q=0.5) has been augmented by bilinear polynomial basis interpolants to develop the shape RPIM functions, and by the bi-cubic polynomial basis functions for the HRPIM ones:

$R(x,y) = e^{-(qr)^2}$

$Pl^T(x) = [1 \; x \; y \; xy]$

$Pc^T(x) = [1 \; x \; y \; x^2 xy \; y^2 \; x^3 \; x^2 y \; xy^2 \; y^3 \; x^3 y \; xy^3 ]$

The High Order Continuation algorithm used to solve the nonlinear equilibrium equations has the following parameters: truncation order $N = 13$, tolerance parameter $\varepsilon = 10{-}6$ and an arc-length parameterization.

The global form of the equilibrium equations for thin plates stability, can be written as : $\boldsymbol{K_T} \boldsymbol{u} + \boldsymbol{F}^{nl} = \lambda \boldsymbol{F}$

where, $K_T$ is the global tangent stiffness matrix, u is global vector of degrees of freedom, $\boldsymbol{F}^{nl}$ is a vector of nonlinear forms and the second membre $\boldsymbol{F}$ is the vector of external forces.

The high-order continuation solver uses a method that constructs the solution curve branch-by-branch through a continuation process

## Context

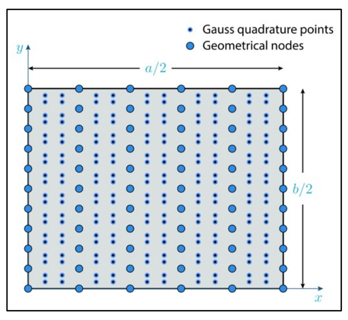
Meshfree methods are being developed to achieve more precise approximate solutions in a more efficient manner, even for highly complex systems and to overcome the limitations of FEM, such as mesh locking, element distortion, the need for re-meshing during large deformations, and the challenge of generating meshes.

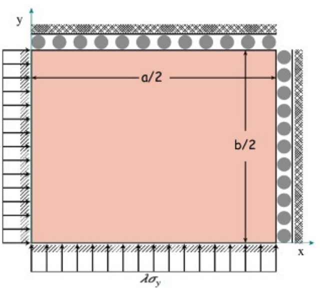
They can be classified to 2 categories: collocation-type shape functions methods based on weak formulation such as EFG, WLS, MLS, etc. and interpolation-type shape functions methods based on strong formulation such as RBF, PIM, and RPIM.

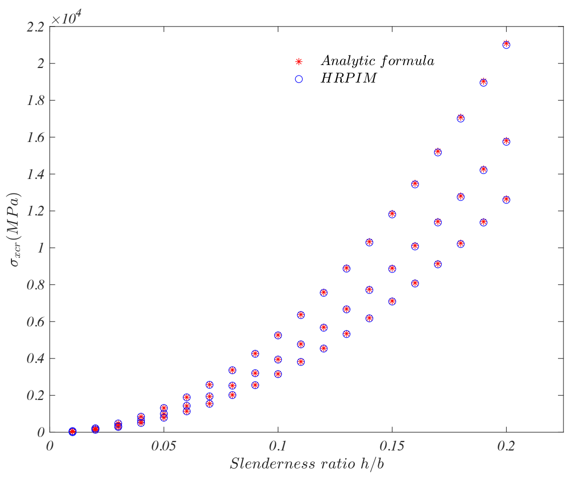
## Results

An isotropic rectangular with the following geometrical and mechanical parameters (The length=250*mm*,width=500mm, height=5 mm. Young's modulus $E$ = 70 GPa and Poisson's ratio $\nu$ = 0.3 ) is analyzed to test the performance of the proposed method

The variation of critical buckling load versus the slenderness ratio $h/b$ *and* the aspect ratio $a/b$ *has been studied*. The results obtained by the proposed HRRPIM are close to those of the analytic formula and the finite element method in the case of clamped and Simply supported boundary conditions respectively and also for uniaxial and biaxial compressive loading







## Conclusion and perspectives

To demonstrate the stability of the HRPIM method for arbitary descritization and others plate form, a clamped and simply supported circlar plate subjected to a compressive effort is studied.

The variation of critical buckling load versus the slenderness ratio h/b obtained with the proposed approach will be compared with analytic formula and the finite element method

## References

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