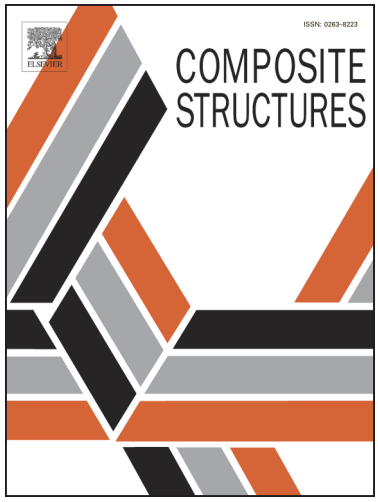

Naturally stabilized nodal integration meshfree formulations for analysis of laminated composite and sandwich plates

Chien H. Thai, A.J.M. Ferreira, H. Nguyen-Xuan

PII: S0263-8223(17)31203-5
DOI: http://dx.doi.org/10.1016/j.compstruct.2017.06.049
Reference: COST 8636

To appear in: *Composite Structures*

Received Date: 15 April 2017
Revised Date: 13 June 2017
Accepted Date: 20 June 2017

Please cite this article as: Thai, C.H., Ferreira, A.J.M., Nguyen-Xuan, H., Naturally stabilized nodal integration meshfree formulations for analysis of laminated composite and sandwich plates, *Composite Structures* (2017), doi: http://dx.doi.org/10.1016/j.compstruct.2017.06.049

Naturally stabilized nodal integration meshfree formulations for analysis of laminated composite and sandwich plates

Chien H. Thai[1,2*], A.J.M. Ferreira[3], H. Nguyen-Xuan[4,5*]

[1]*Division of Computational Mechanics, Ton Duc Thang University, Ho Chi Minh City, Vietnam*

[2]*Faculty of Civil Engineering, Ton Duc Thang University, Ho Chi Minh City, Vietnam*

[3]*Departamento de Engenharia Mecanica, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal*

[4]*Institute of Research and Development, Duy Tan University, Da Nang, Vietnam*

[5]*Department of Architectural Engineering, Sejong University, 98 Gunja-dong, Gwangjin-gu, Seoul 143-747, South Korea*

ABSTRACT

This article addresses a naturally stabilized nodal integration (NSNI) meshfree formulation for static, free vibration and buckling analyses of laminated composite and sandwich plates based on the higher order shear deformation theory (HSDT). The crucial idea is to directly compute integrations at nodes similar to the direct nodal integration (DNI) but the instability existing in DNI is avoided and the computation cost is significantly reduced when compared to traditional high-order Gauss quadrature schemes. Due to the displacements, strains and stresses directly computed at nodes, computation time of the present approach is equivalent with the DNI. Being different from the stabilized conforming nodal integration technique using a divergence theorem to evaluate gradient strains by the surface-to-boundary integration, NSNI is a naturally implicit gradient expansion. Variational consistency in Galerkin weak form is explicitly described. Thanks to the satisfied Kronecker delta function property, the moving Kriging integration (MKI) shape function is used to impose directly essential boundary conditions as same as the finite element method (FEM). A variety of numerical examples with various complex geometries, aspect ratios, stiffness ratios and boundary conditions are studied. Numerical results show the effectiveness of the present method in comparison with some existing ones in the literature.

* Corresponding author at: Division of Computational Mechanics, Ton Duc Thang University, Ho Chi Minh City, Viet Nam (Chien H. Thai, Email: thaihoangchien@tdt.edu.vn) and Institute of Research and Development, Duy Tan University, Da Nang, Vietnam (H. Nguyen-Xuan, Email: nguyenxuanhung@duytan.edu.vn).