Free vibration study of laminated carbon nanotube reinforced composite shell panels

Shuvendu Narayan Patel # and Rajesh Kumar

Department of Civil Engineering, BITS Pilani, Pilani Campus, Pilani-333031, Rajasthan, India.
#Email: shuvendu@pilani.bits-pilani.ac.in

The free vibration study of laminated composite shell panels reinforced with carbon nanotube (CNT) is presented in this paper, using finite element method. The laminated composite shell panels are composed of perfectly bonded CNT-reinforced layers. The distribution (volume fraction) of single walled carbon nanotube (SWCNTs) is considered uniform throughout the thickness of the panels. The eight-noded degenerated shell element with isoparametric formulation with C^0 continuity (FSDT) of the nodal variables is used to model the panels. The material properties of Carbon Nanotubes Reinforced Composite layer is estimated by extended mixture rule. The eigen value analysis is carried out for the free vibration analysis. The frequencies obtained in the present study for plate are compared with available results in the open literature. It is observed that the present results of free vibration analysis are matching well with the available results. The results of free vibration study for other panels will be reported in the full length paper.

A laminated composite plate reinforced with single walled carbon nanotube is considered in the present study for validation purpose. This plate consists of five perfectly bonded layers with the orientations of CNTs as 90/0/90/0/90 from layer 1 to 5 respectively (Lie *et al.*, 2015, Table-1). The numbering of layers is from bottom to top. The distribution of single walled carbon nanotubes (SWCNTs) is considered uniform throughout the thickness of the plate, *i.e.* in each layers the volume fraction of CNTs are same. The material properties of armchair (10, 10) type SWCNTs are, E= 5.6466 TPa , E= 7.0800 TPa and G= 1.9455 TPa and ν=0.175. The properties of matrix are, = 3.52 GPa and = 0.34. The volume fraction of CNTs is taken as 0.11. For this volume fraction of CNTs the efficiency parameters are, = 0.149, = 0.934 and = 0.934. The material properties are taken in line with Lie *et al.* (2015) and Shams and Soltani (2016). The free vibration analysis of this plate is performed, with 8×8 mesh size of the full plate, for two boundary conditions. The results are presented in Table 1. The present results are matching well with the results of Lie *et al.* (2015).

Table.1. Non-dimension frequencies of the plate.

V_{CNT}	Mode	Simply supported		Fixed support	
		Present (8×8)	Lie *et al.* (2015)	Present (8×8)	Lie *et al.* (2015)
0.11	1	12.973	14.277	19.736	19.680
	2	19.656	19.414	31.222	30.906
	3	19.656	19.419	33.973	32.736
	4	25.374	27.098	41.849	40.554
	5	30.766	30.579	47.140	46.315
	6	37.881	38.312	51.611	49.209

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The results of free vibration study for other panels (cylindrical and doubly curved) will be reported in the full length paper.

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Biography: Shuvendu Narayan Patel is currently working as an Asst. Prof. in the Department of Civil Engineering, in Birla Institute of Technology and Science, Pilani, Pilani Campus, India. After obtaining his PhD from IIT Kgaragpur, India, he worked as a Post-Doc fellow in Politecnico di Milano, Italy, in the field of Structural Engineering. He worked two years in CAE Software Testing Industry before joining BITS Pilani. His research interest is in the domain of static and dynamic stability study of laminated composite stiffened/un-stiffened structures, Nonlinear static and dynamic analysis, Finite Element Method. Computational Mechanics, Nano-composites, Non-local stress- strain behavior, Failure and Damage of composites etc. He has 10 publications in different journals of international repute and more than 25 publications the conferences (National/Internationals).

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