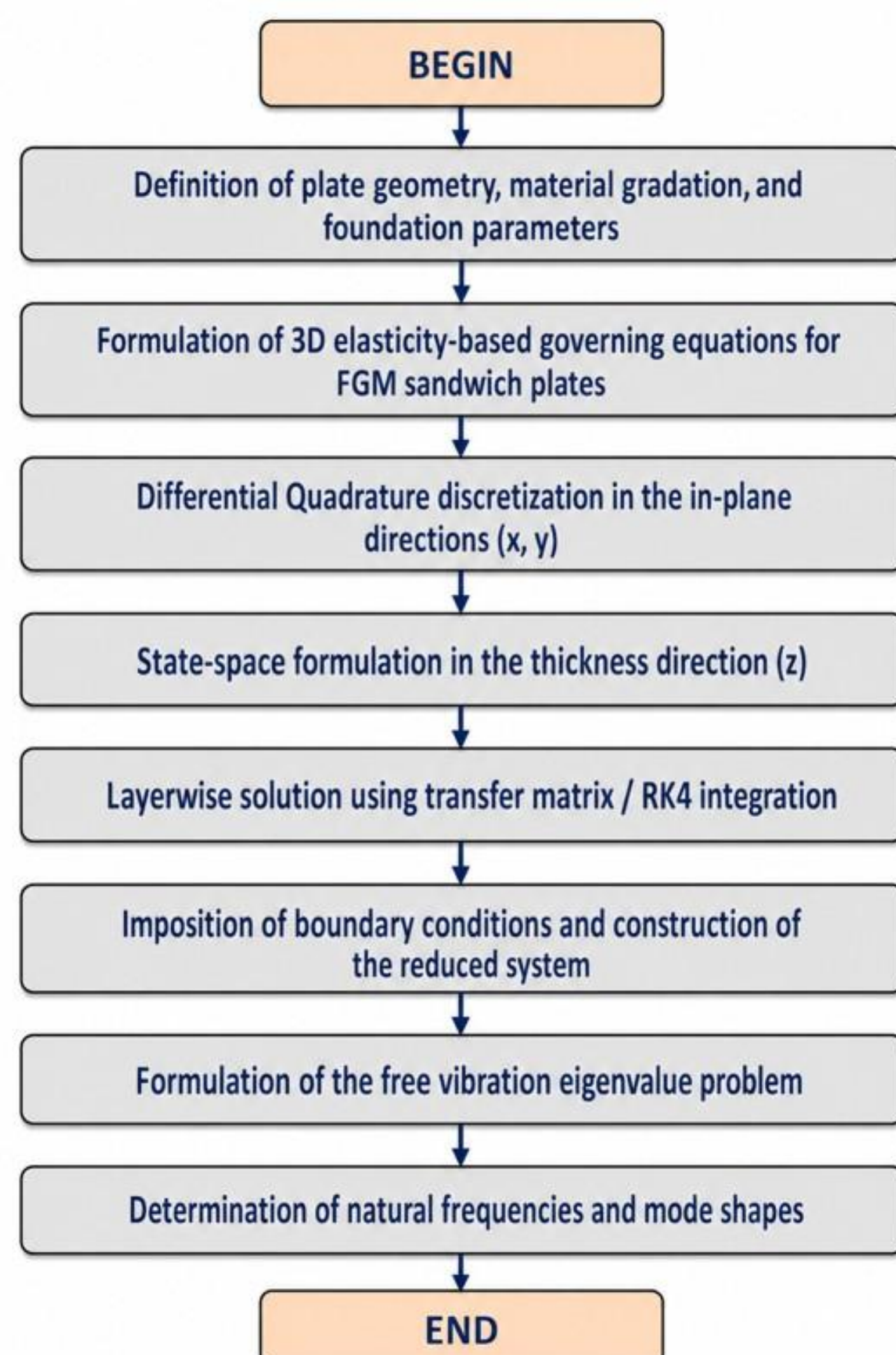
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## Introduction

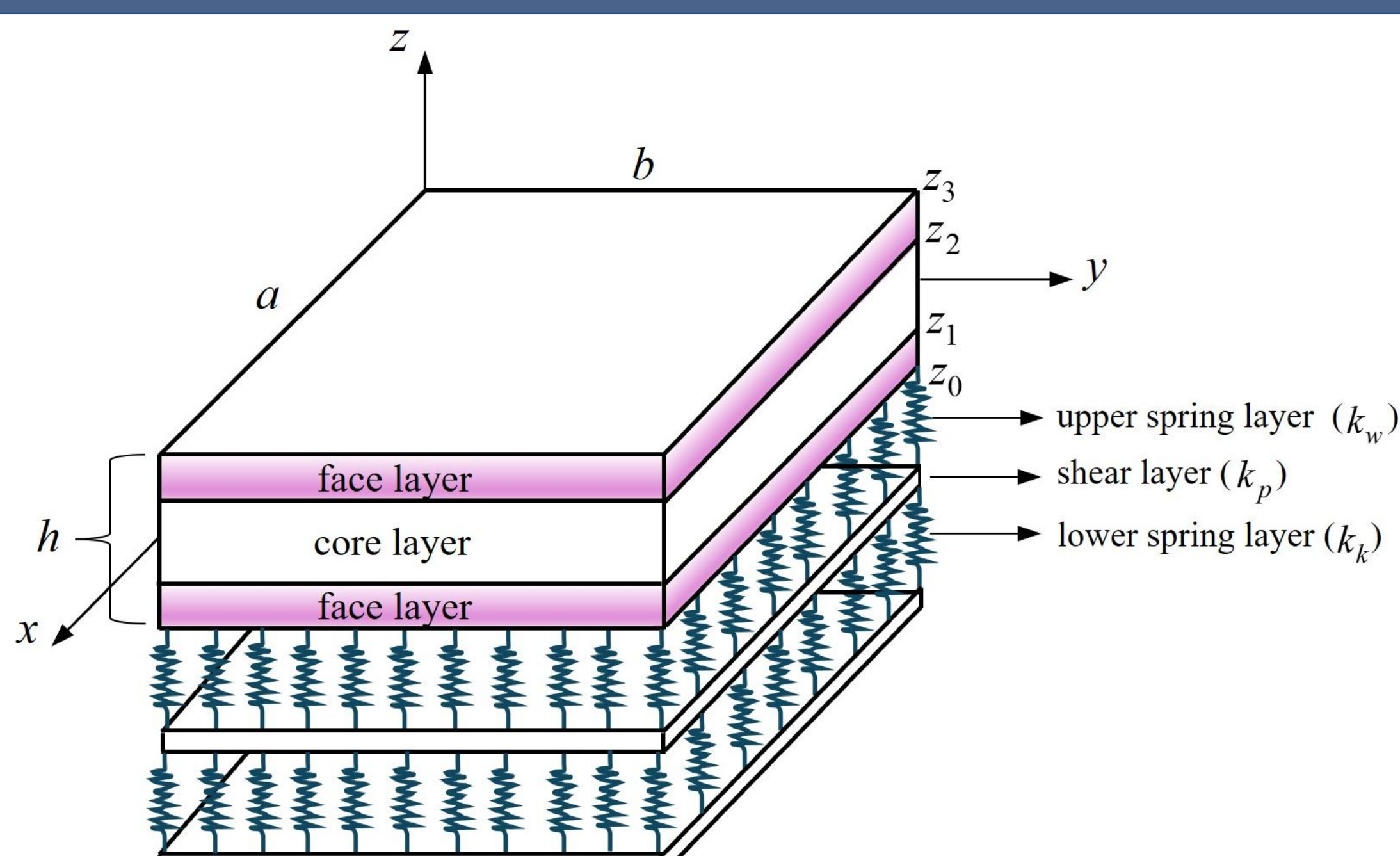
Functionally graded sandwich plates are widely used in advanced engineering structures due to their enhanced mechanical performance and continuous material variation through the thickness. Accurate prediction of their free vibration behavior is important, especially for structures resting on elastic foundations.

Since classical and higher-order plate theories rely on assumed displacement fields, they may lose accuracy for thick plates or strong foundation-structure interaction. Therefore, this study develops a full three-dimensional elasticity-based State Space-Differential Quadrature framework for the free vibration analysis of FG sandwich plates on elastic foundation.

## Methods

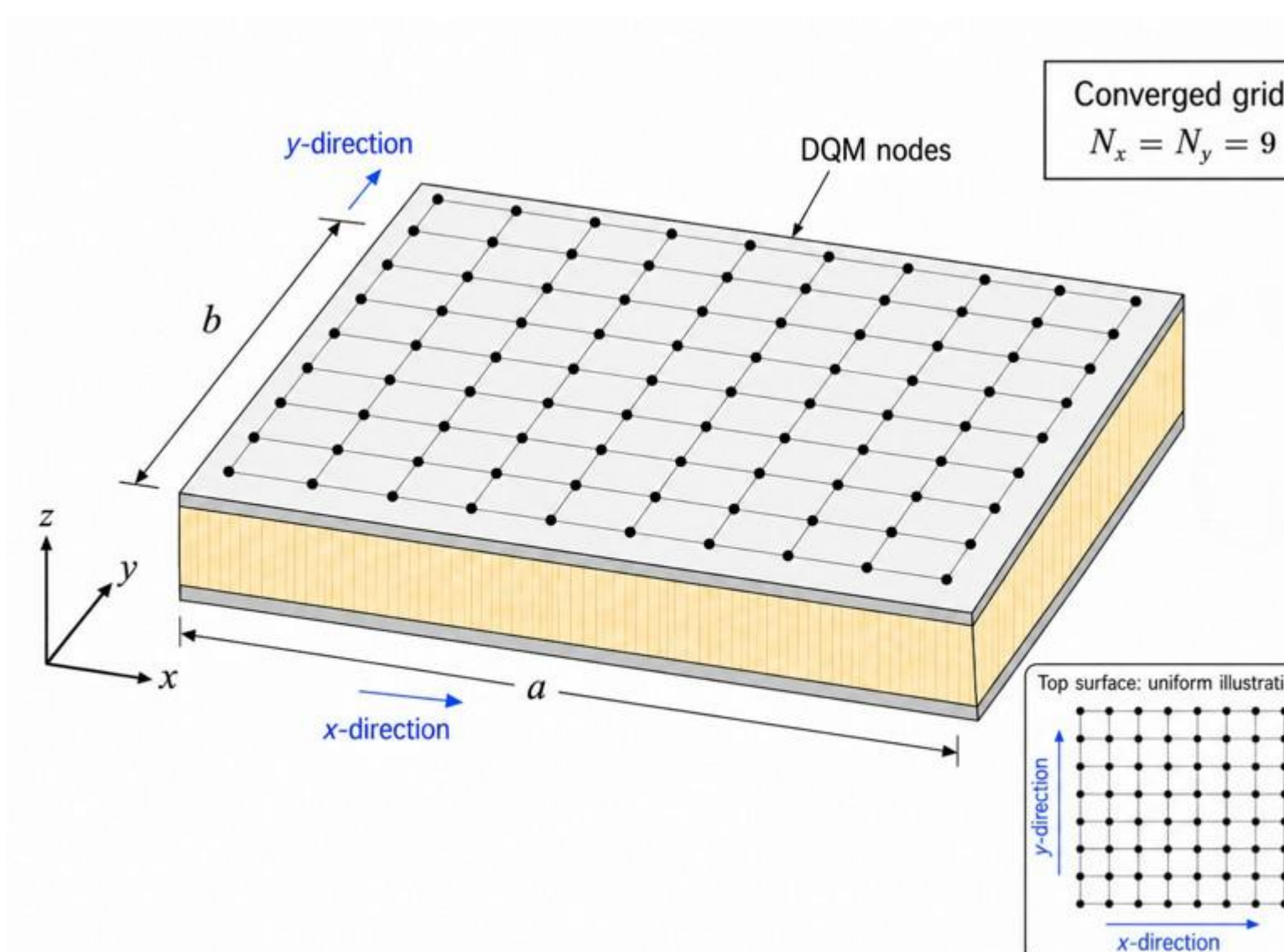


## Graphics / Images



Convergence analysis

Method	$\omega$
Alibeigloo and Alizadeh (2015)	1.2400
(Analytical solutions)	
Present DQM (5x5)	1.2706
(6x6)	1.2654
(7x7)	1.2511
(8x8)	1.2411
(9x9)	1.2406
(10x10)	1.2406



Validation of the Present Results for SSSS Boundary Condition

	$p$	Scheme				
		1-0-1	2-1-2	1-1-1	2-2-1	1-2-1
H.-T. Thai et al. (2014) (Analytical solutions)						
SSSS	0	1.8244	1.8244	1.8244	1.8244	1.8244
	0.5	1.4442	1.4841	1.5192	1.5471	1.5745
	1	1.2429	1.3000	1.3533	1.3956	1.4393
	2	1.0605	1.1218	1.1882	1.2436	1.3023
	5	0.9431	0.9796	1.0435	1.1077	1.1735
	10	0.9246	0.9390	0.9932	1.0587	1.1223
Present study						
SSSS	0	1.8262	1.8262	1.8262	1.8262	1.8262
	0.5	1.4461	1.4853	1.5237	1.5487	1.5773
	1	1.2448	1.3011	1.3579	1.3987	1.4409
	2	1.0619	1.1230	1.1865	1.2443	1.3057
	5	0.9449	0.9808	1.0434	1.1102	1.1736
	10	0.9259	0.9402	0.9931	1.0597	1.1226

Effect of Kerr foundation parameters on the dimensionless fundamental frequency of the FG sandwich plate for  $p = 10$ , 1-1-1 scheme, SSSS boundary condition

$K_u$	$K_l$	$K_s$	$\omega$
0.10	0.10	0.05	1.0621
0.20	0.20	0.10	1.1265
0.40	0.40	0.20	1.2460
0.80	0.80	0.40	1.4560

## Conclusions

- A 3D elasticity-based SSDQ framework was developed for FG sandwich plates resting on elastic foundations.
- The State Space-Differential Quadrature Method was successfully applied by combining DQM in the in-plane directions with the state-space formulation through the thickness.
- The proposed method provides accurate and stable free vibration results.
- Good agreement was obtained with analytical reference solutions, especially for SSSS boundary conditions.
- The elastic foundation increases the fundamental natural frequency of the plate, with the Kerr foundation producing the strongest stiffening effect due to its three-parameter representation.