Course:
Computational Structural Mechanics and Dynamics

Assignment-9

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Exercise 1

Describe in extension how can be applied a non-symmetric load on this formulation.

A revolution-shell structure loaded by a non-axisymmetric loading makes the formulation of the problem (in particular concerning the right-hand-side vector *f*) far more complicated than a simple axisymmetric load. In this case it's possible to use the Fourier series in order to decompose the load into a sum of sines and cosines depending on the circumferential angle θ, and then, once calculated the symmetric and anti-symmetric terms, combine them into a homogeneous harmonic formulation. Thus, it's important to remark that the response of the structure (in terms of displacements and forces) must be entirely harmonic (as a sum of sines and cosines).

Exercise 2

Using thin beams formulation, describe the shape of the $B^{(e)}$ matrix and comment the integration rule.

In case of thin beam, it's possible two use two different formulations, that are based on the main deformation of bending. The first option is to use an Euler-Bernoulli formulation, in which the $B^{(e)}$ is directly formulated in order to consider as main problem the bending deformation, and also a Timoshenko formulation, in which it's important to consider the possible shear locking effect, so it's needed to reduce the integration of the shear part of the $B^{(e)}$ matrix. In fact, while for the bending and the membrane problem, the final revolution-shell stiffness matrix is calculated using a full integration rule (and two Gauss points inside the element), it's possible to reduce the shear effect using only one Gauss point that "underestimates" the shear value of the stiffness. As for the Euler-Bernoulli element, it's needed to use both for bending and membrane two Gauss points. In this particular case, since it's the formulation for revolution-shell structures is made that the rotation is around the z axis, in many cases it's not possible two use a Lobatto integration rule because it uses a problematic location for the integration points (one of the two points stays on one node of the element, and can present a radial coordinate equal to 0 when that element stays close to the revolution axis. In this case some values of the $B^{(e)}$ matrix goes to infinite and the formulation present a numerical block.