

First Evaluation

MIN-300 (Spring 2021) (Lab Based Project)

‘Hybrid Finite Element Method for Guided wave propagation in a 3D Elbow Joint’

Group Number: D4

Members:

- ☐ Putluru Deshik Reddy 18119026
- ☐ Soumyajeet Jaiswal 18118069
- ☐ Mangali Balasivakumar 18119016
- ☐ Shrey Shukla 18111028

Advisor:

Prof. Dhanashri M
Joglekar

Motivation and Problem Definition

- The geometrical features, such as bends can alter the propagation characteristics of guided waves travelling through the waveguides.
- When excited with certain force or disturbance, lamb waves are produced in the thickness of pipe extensions. These lamb waves are free to move along the geometry, but a part of the wave front reflects and is transmitted in various modes when geometric discontinuities are encountered such as joints.
- Test Case: 3 inch Schedule 40 Mild Steel Elbow Joint with bend radius 133.35 mm, bend angle 90 degree with semi- infinite extensions on both faces

Problem Definition

To study the guided wave propagation in an 3D elbow joint using Hybrid Semi Analytic Finite Element Method.

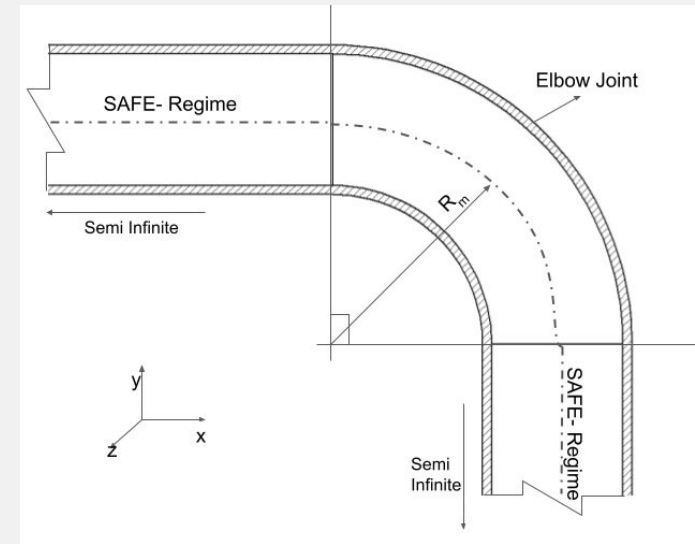


Figure 1. Schematic of Elbow Joint with two semi-infinite tubes.

Methodology and Deliverables

- A hybrid implementation of the Semi Analytical Finite Element framework and the conventional FEM framework is employed to address the problem statement.
- Stiffness, mass matrix and DOFs of elbow joint is determined using the conventional finite element method using sample eigenfrequency study on COMSOL.
- The semi-infinite regions will be modelled using SAFE approach leading to the determination of DOFs on the common interface between pipe ends and elbow joint using MATLAB.
- The corresponding DOFs will be mapped from conventional and semi analytical finite element regimes.

M, K, DOF Extraction using Conventional FEM for simplified geometry(cuboid)



M, K, DOF extraction for elbow joint



Development of SAFE Framework for 3D pipes will be attempted

Deliverables

- DOF extraction for 2D and 3D geometries.
- Development of SAFE for cylinders will be attempted.
- Coupling SAFE and FE will be attempted.

Progress made

- Literature review on DOF Extraction, Guided wave propagation through bent metallic plates [1].
- Software familiarization – MATLAB, COMSOL and CAD modelling.
- Extraction of stiffness and mass matrices (K and M) for 3D elbow joint using Comsol and MATLAB.
- Extraction of DOFs for a simple cube and cuboid to ease our understanding.
- Extraction of DOFs for 3D elbow joint using Comsol and MATLAB

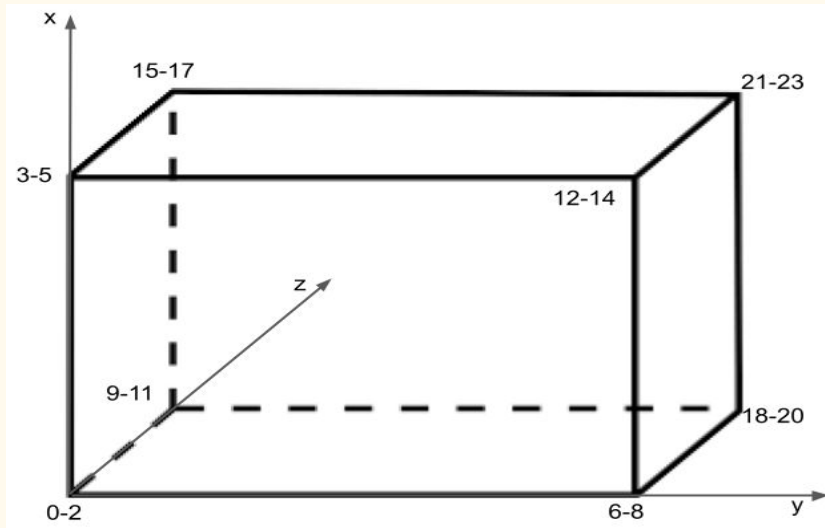


Figure 2: Results from DOF extraction for a cuboid

References

1. Joglekar DM, Guided Wave propagation through bent Metallic Plates