Numerical studies on the design of self-resetting active bistable cross-shaped structure for morphing applications

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Presented by,

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Content of the presentation

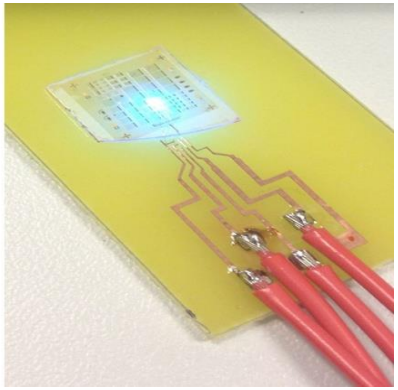
- Introduction
- Motivation
- Aim of research
- Content of the work
- Conclusion

Introduction

Fin to the Wind

Shinkansen Bullet Train

Harvesting Desert Fog



Firefly Lightbulbs

Source: Google images

Introduction

Morphing structures are used in reconfigurable structures, solar tracking models, energy harvesters, etc..

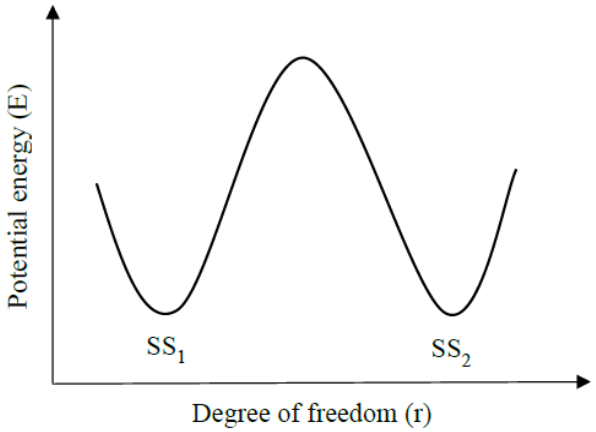
Normal aircraft wing →

Morphing Wing →

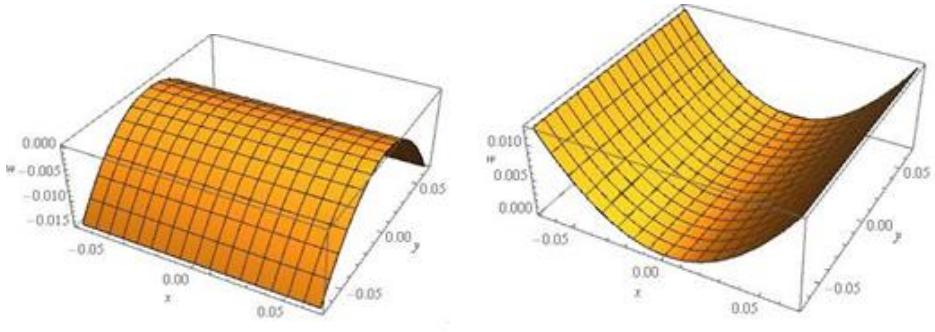
One of the possible ways?

Multistable Structures

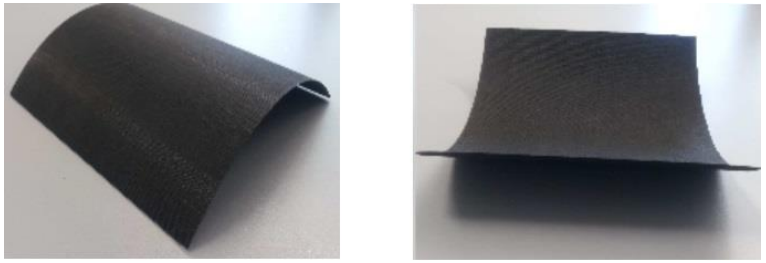
Introduction- Bistable laminates



Bistability

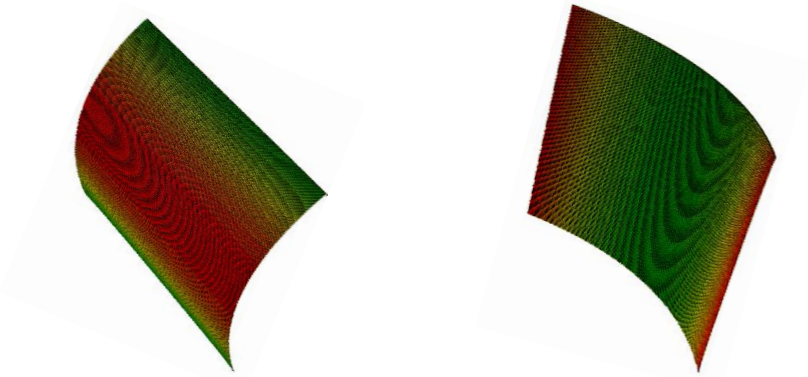


Cured shapes modelled analytically



Cured shapes of laminates

(Reference: Haldar et al., 2018)



Cured shapes modelled Numerically

Motivation

- Design of an active bistable cross-shaped laminate

Concern 1: *How to attain multistable structure?*
Approcach: Only by connecting laminates

Concern 2: *How to connect this bistable laminates ?*
Approach: Without any external aids

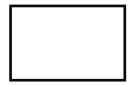
Concern 3: *Design of size and location of MFCs?*
Approach: With a parametric study

Concern 4: *Potential application?*
Approach: Energy harvesting

Aim of Research

1. How to design ? Important questions

   - ✓ **Selection of an appropriate geometry**
   - ✓ **Selection of size and location of MFCs**



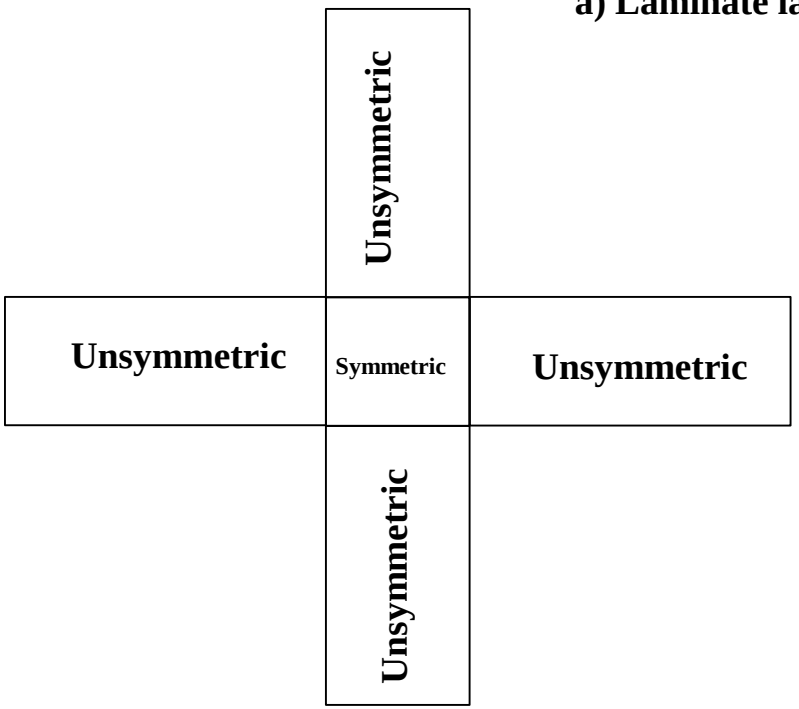
Steps followed

Numerical Study

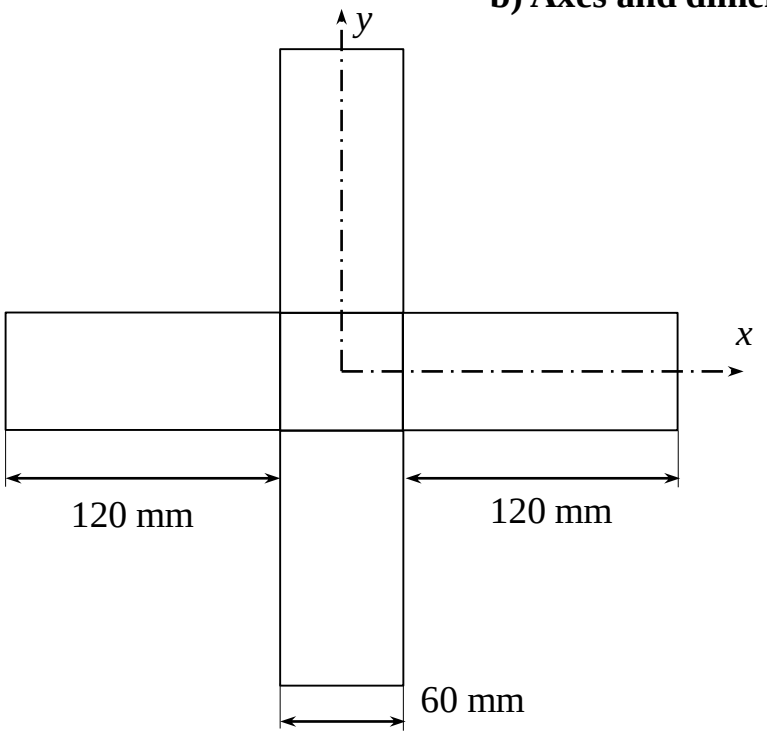
- Using FE Software, Abaqus
- To obtain multistable shapes

Geometry considered

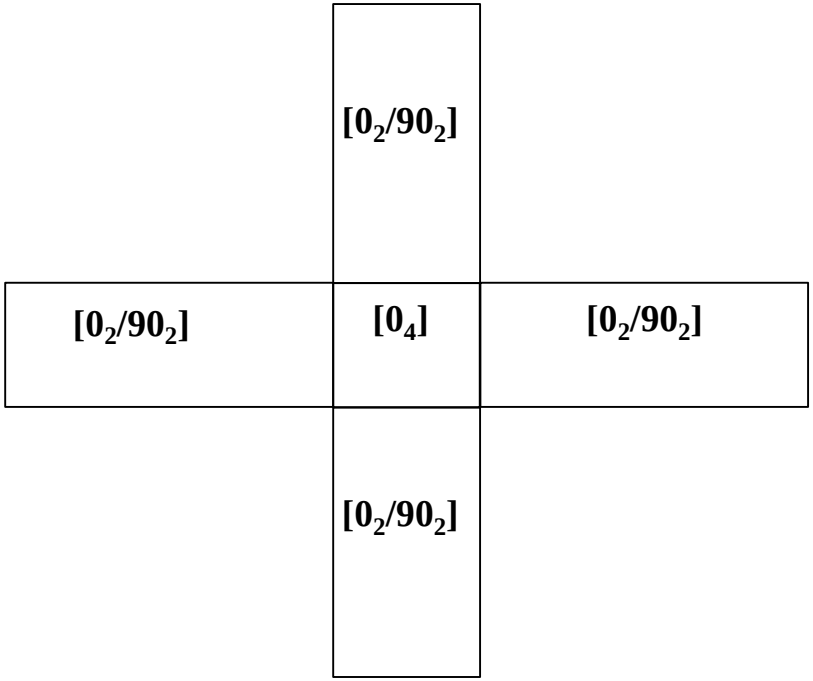
a) Laminate layup



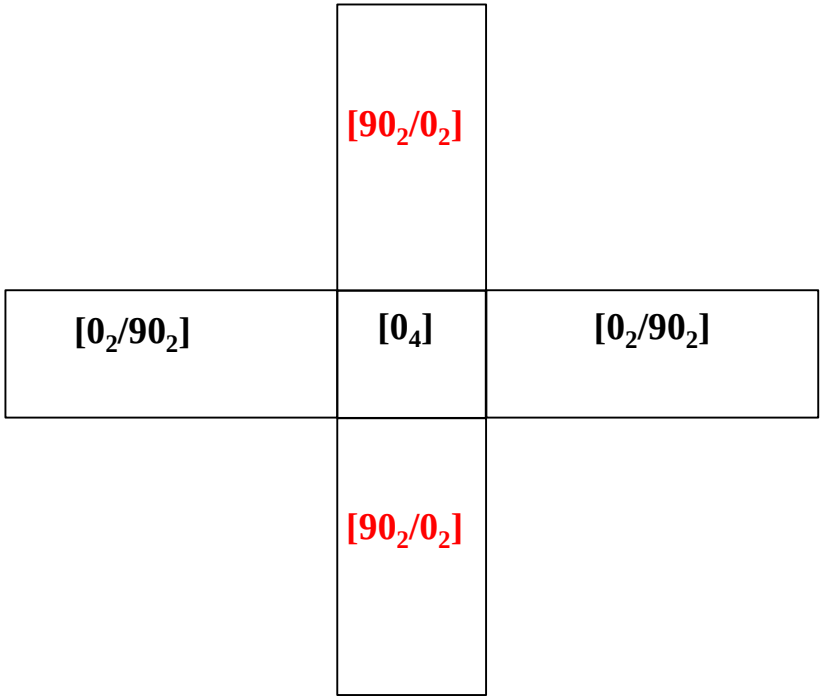
b) Axes and dimensions



Geometry considered



(a) Geometry-1



(b) Geometry-2

Cool-down shapes, geometry-1

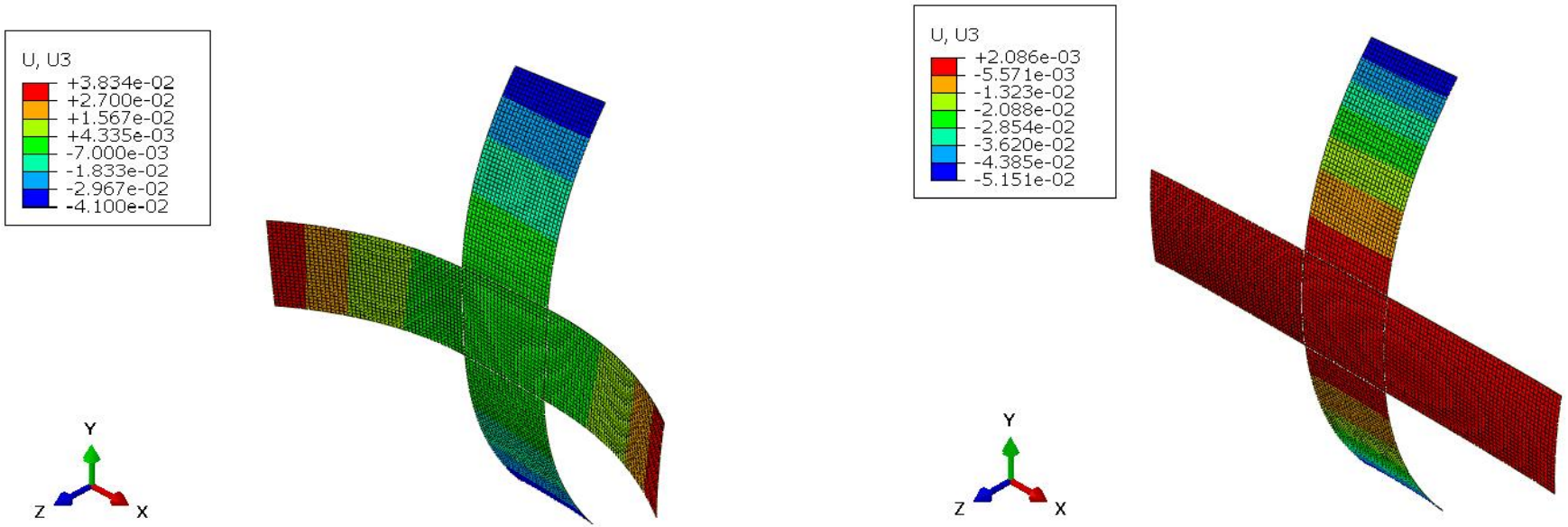


Figure: Cool-down stable shapes obtained for geometry-1 after curing stage

Cool-down shapes, geometry-2

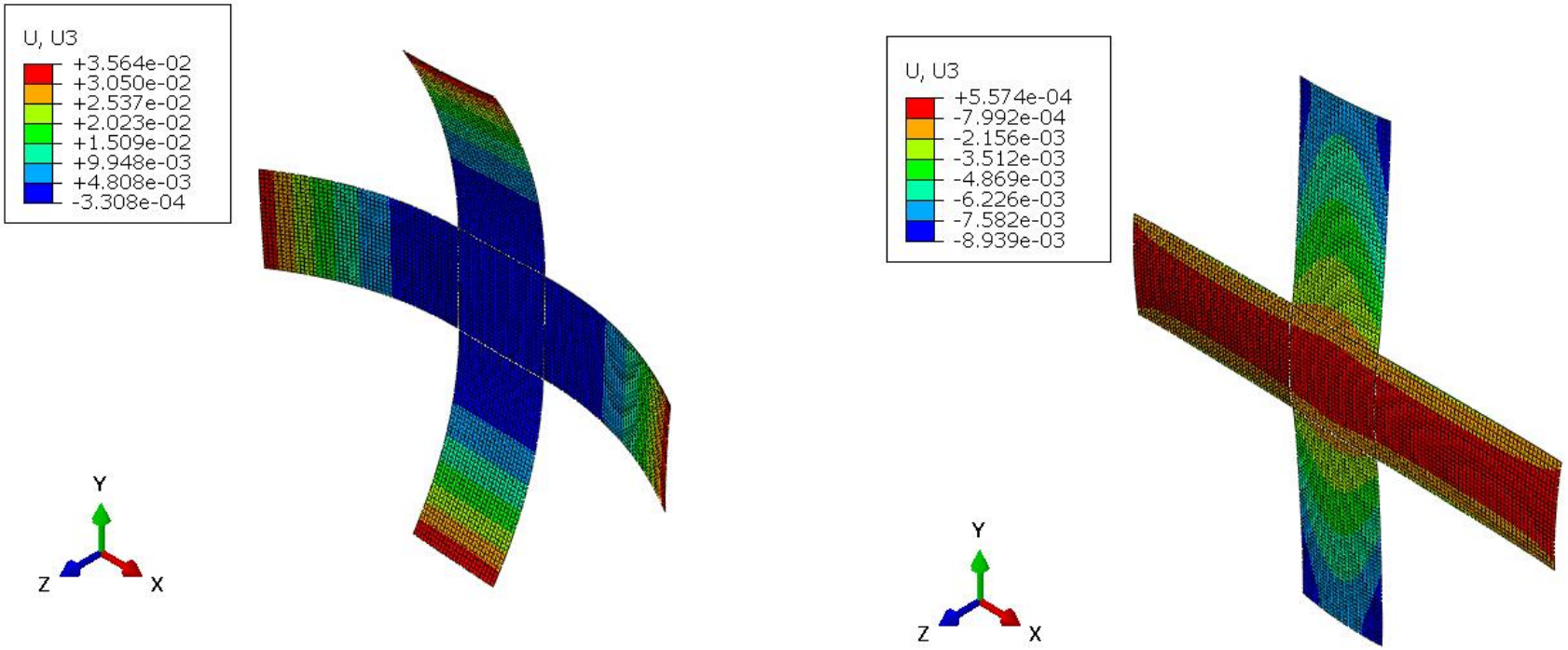
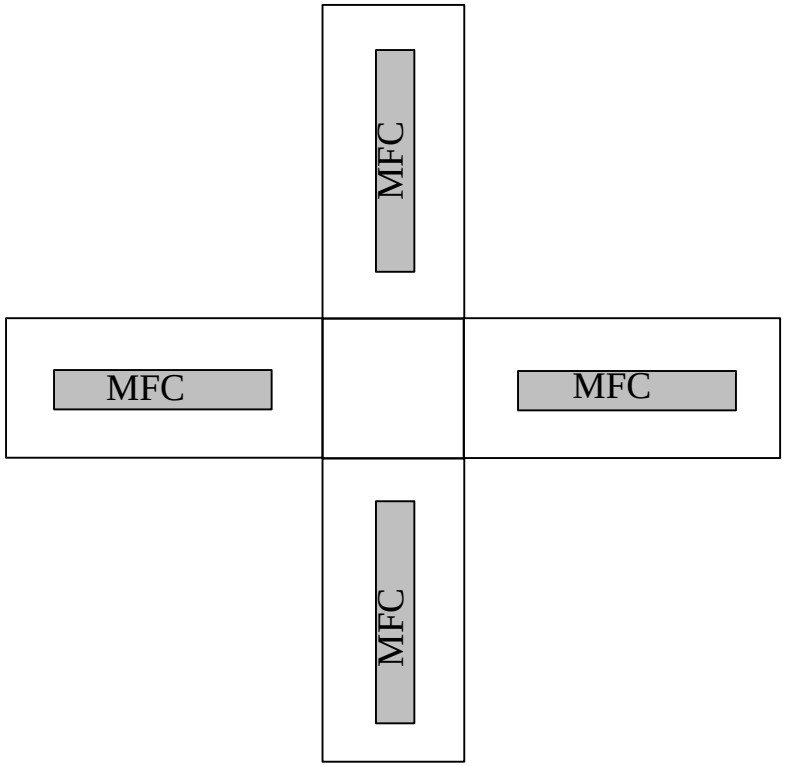
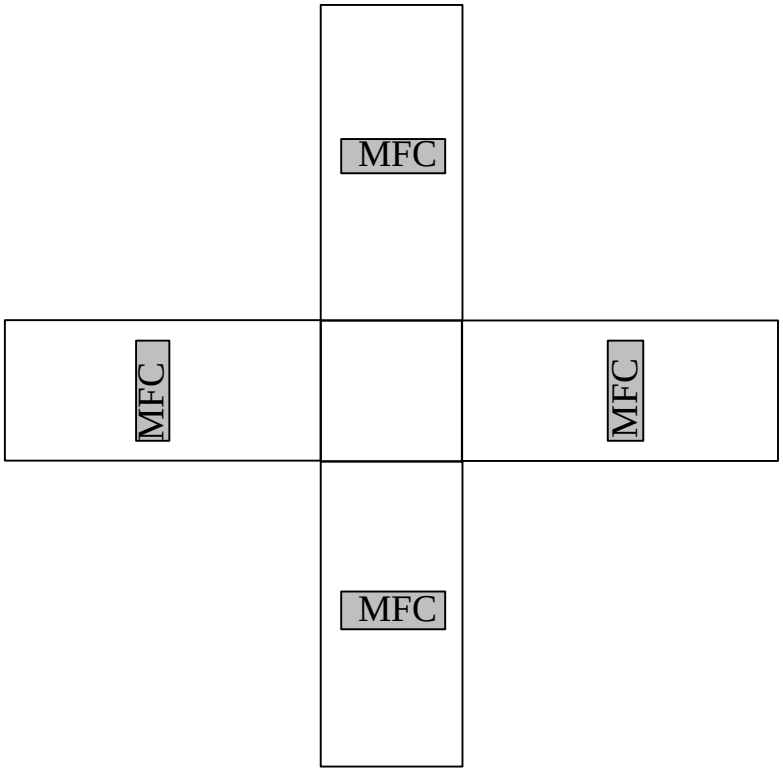


Figure: Cool-down stable shapes obtained for geometry-2 after curing stage

Design of MFCs

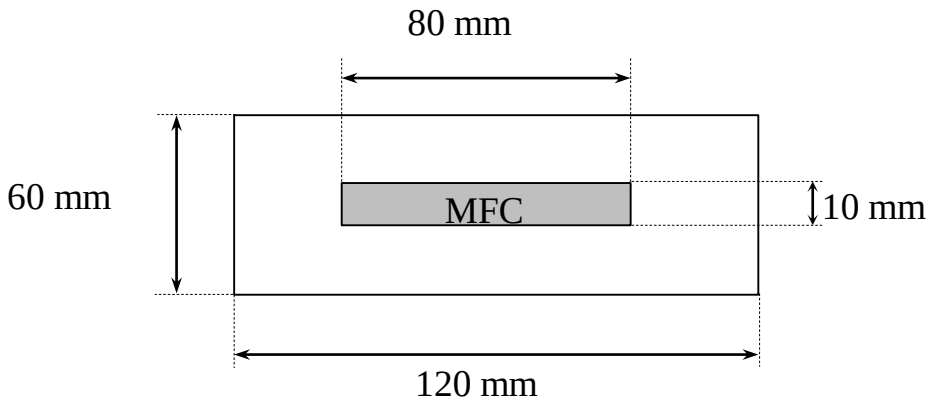


Top side of bistable part

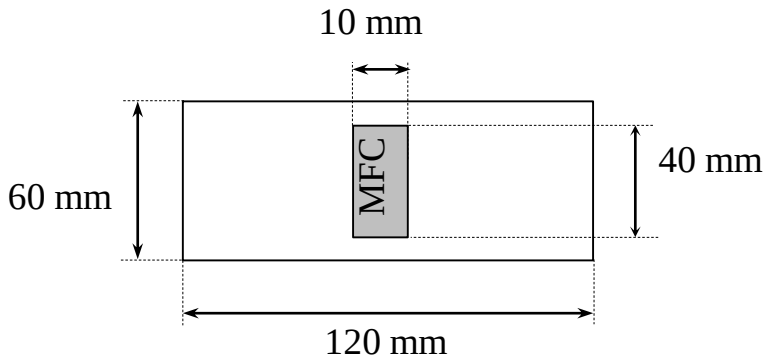


Bottom side of bistable part

Design of MFCs



Top side of bistable part



Bottom side of bistable part

MFC bonded shapes

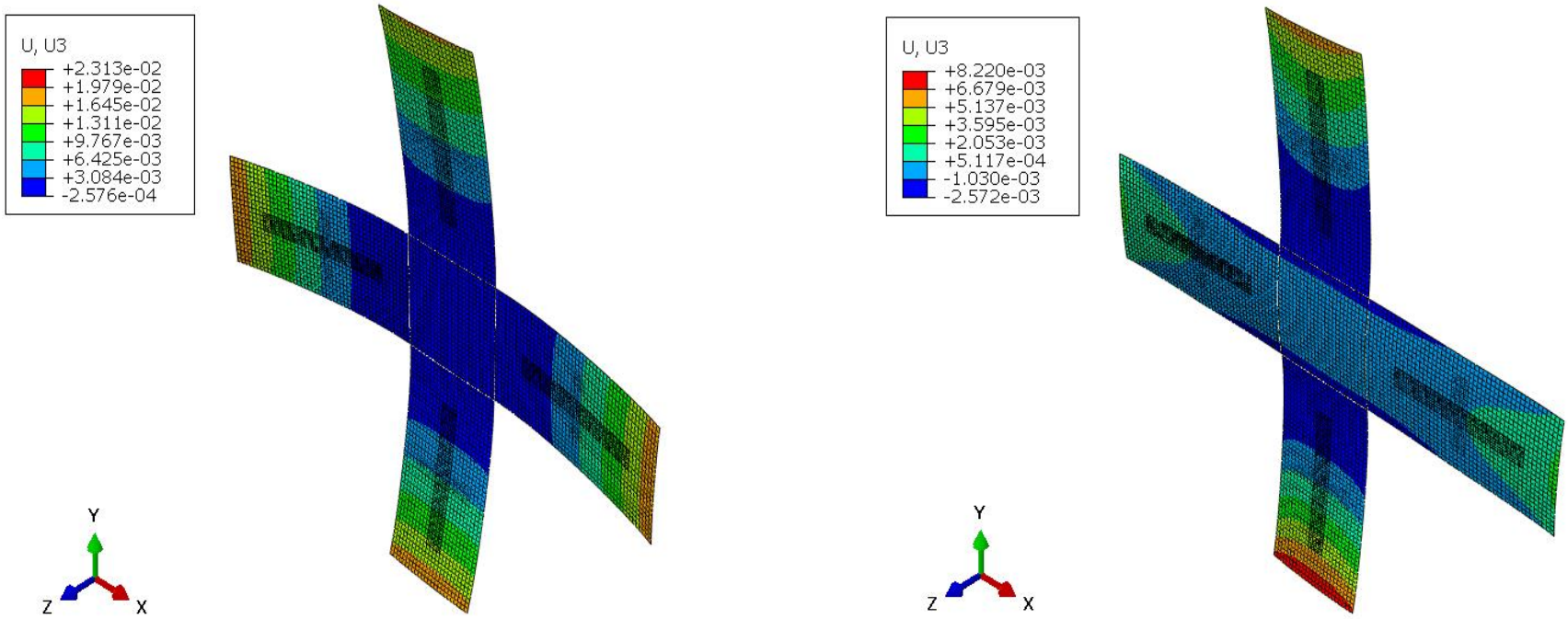
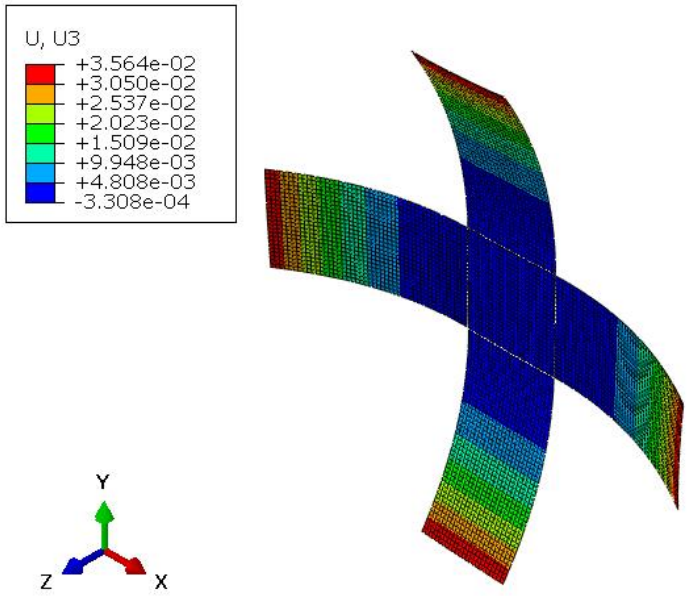
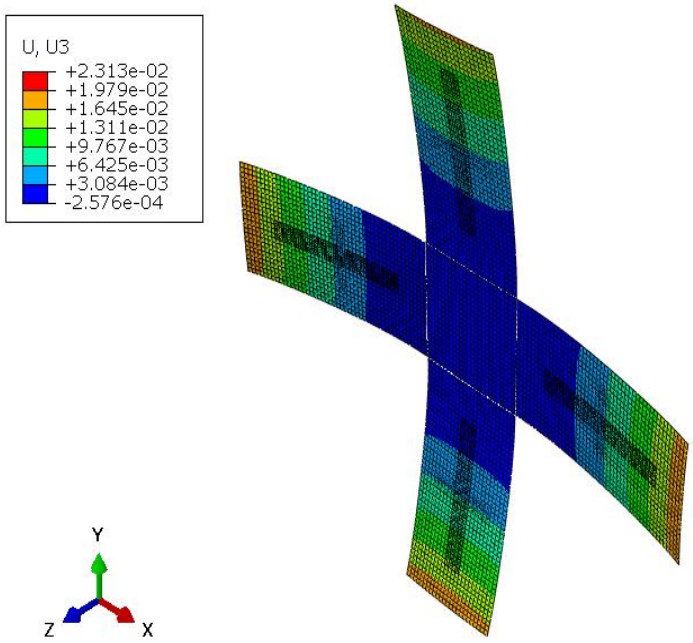


Figure: MFC bonded stable shapes obtained for geometry-2 after curing stage

MFC bonded shapes



MFC bonding



Cool-down shape

MFC bonded shape

Snap-through voltages

Snap action	Voltage (V)	
Snap-through	Top MFC	3196
	Bottom MFC	-799
Snap-back	Top MFC	3640
	Bottom MFC	-910

Conclusion

- Numerical study of an active bistable cross-shaped structure consisting of symmetric and unsymmetric laminate actuated using Macro Fibre Composite (MFC) actuators has been proposed.
- A set of MFCs are identified to trigger the snap-through and snap-back actions
- As the calculated snap voltages are higher than the working range of MFC actuators, an optimization scheme is recommended as future scope to identify suitable positions and size of MFC actuators.

Thank you

DAAD

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