



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

Anilkumar P. M., A. Haldar, S. Scheffler, B. N. Rao and R. Rolfes

Presented by,

P. M. Anilkumar

PMRF-DAAD Doctoral Student



Content of the presentation

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



Introduction



Fin to the Wind



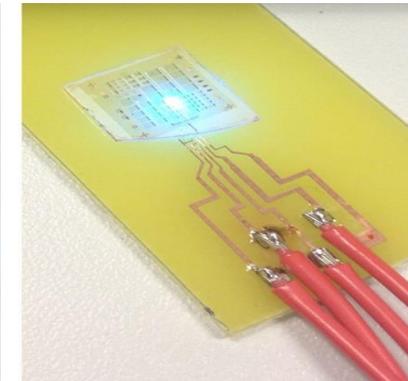
Shinkansen Bullet Train



Harvesting Desert Fog



Firefly Lightbulbs



Source: Google images

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

Normal aircraft wing →



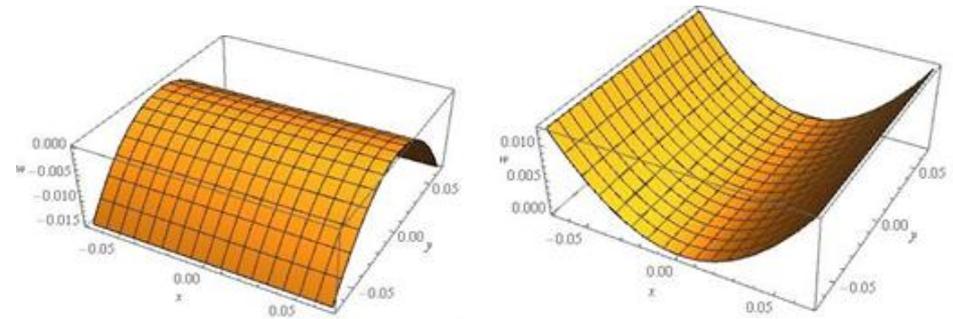
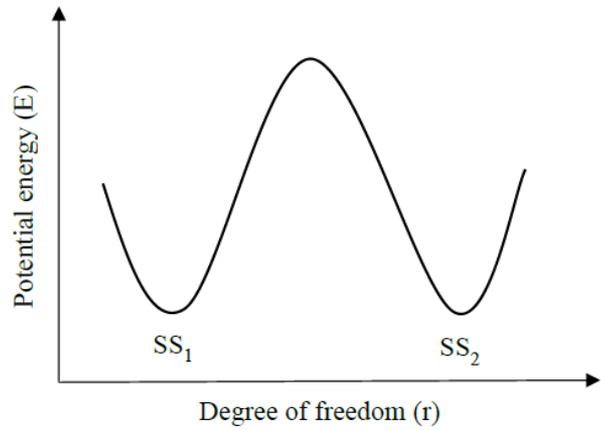
Morphing Wing →



One of the possible ways?

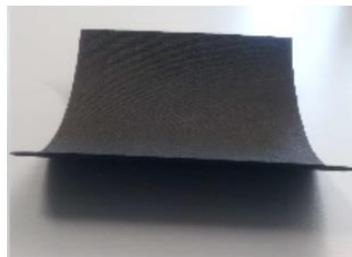
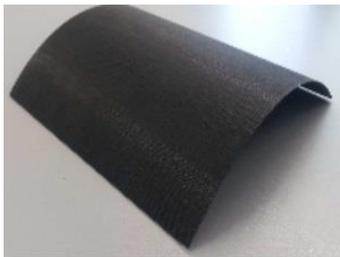
Multistable Structures

Introduction- Bistable laminates



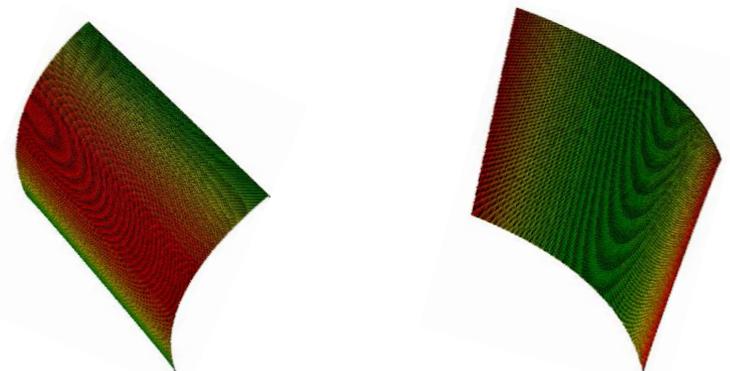
Cured shapes modelled analytically

Bistability



Cured shapes of laminates

(Reference: Haldar et al., 2018)



Cured shapes modelled Numerically

- Design of an active bistable cross-shaped laminate

Concern 1: *How to attain multistable structure?*

Approach: 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

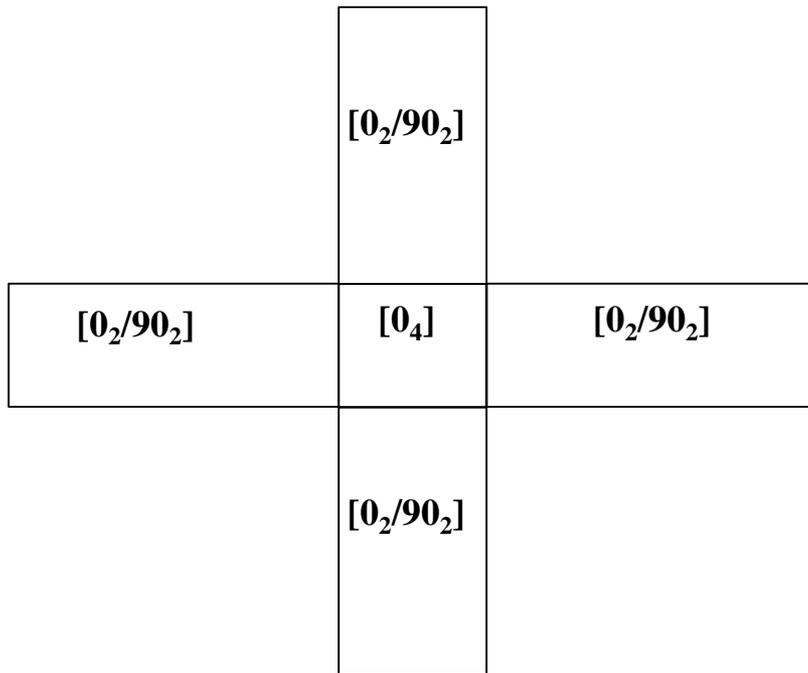
1. How to design ? Important questions

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

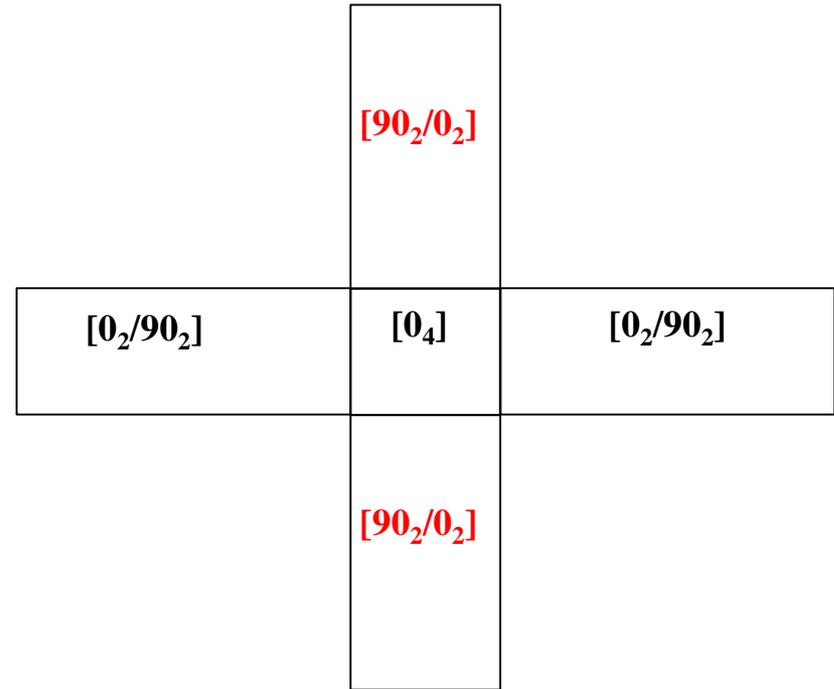
Numerical Study

- Using FE Software, Abaqus
- To obtain multistable shapes

Geometry considered



(a) Geometry-1



(b) Geometry-2

Cool-down shapes, geometry-1

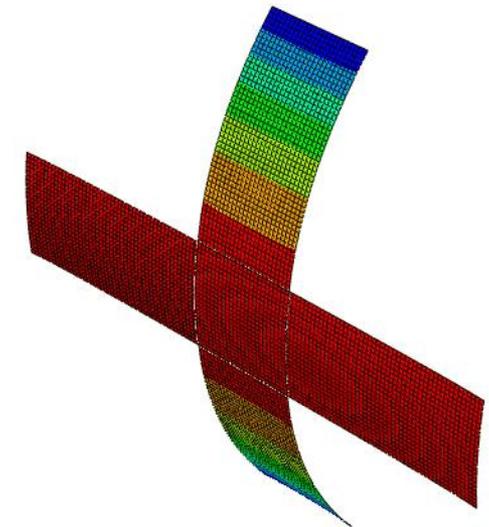
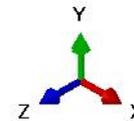
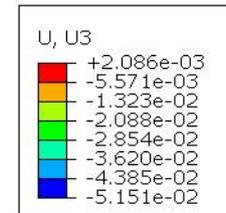
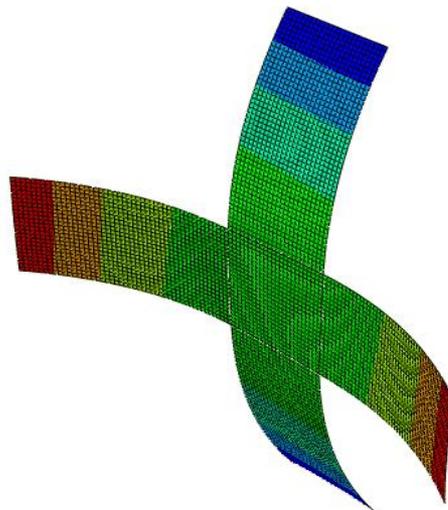
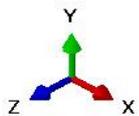
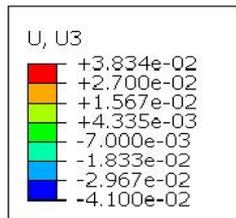


Figure: Cool-down stable shapes obtained for geometry-1 after curing stage

Cool-down shapes, geometry-2

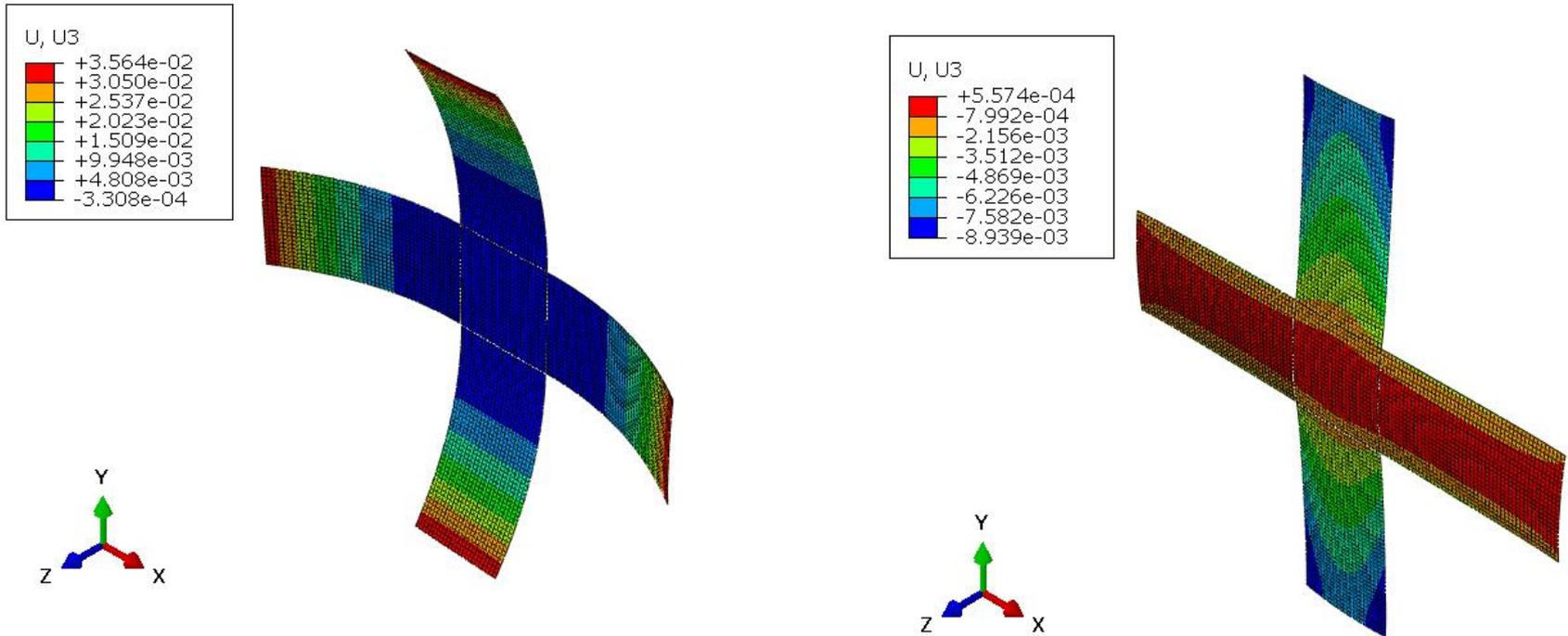
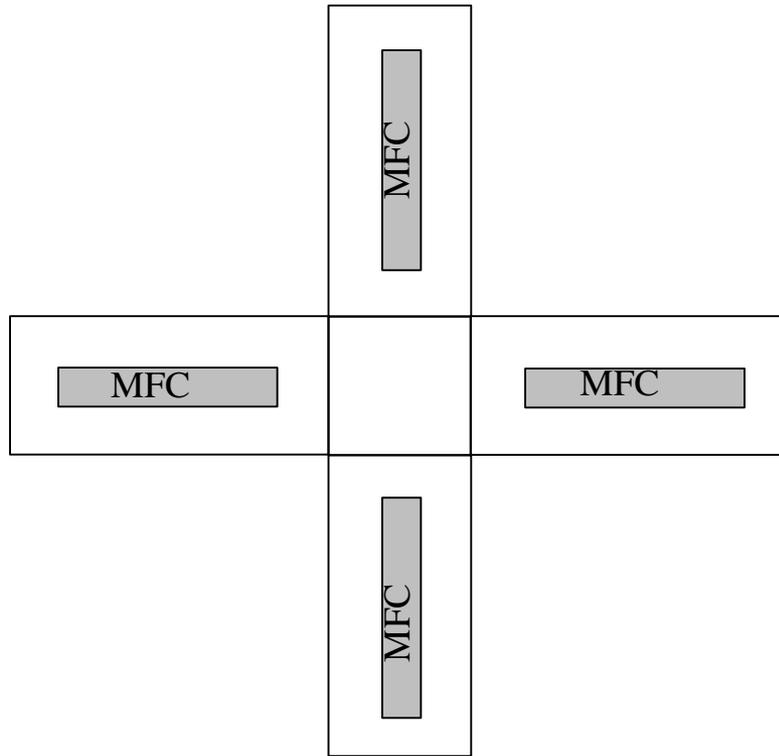
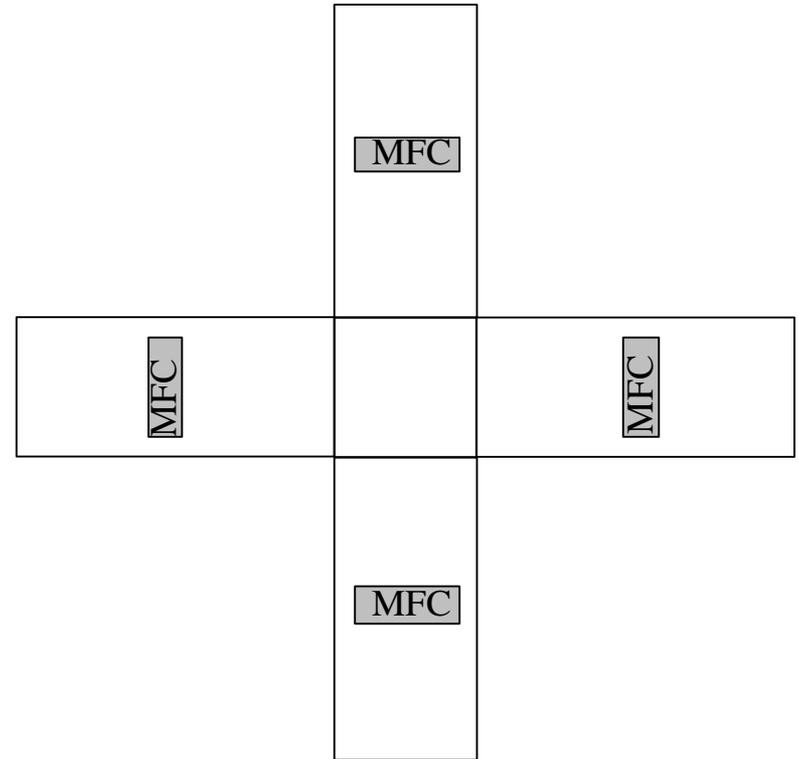


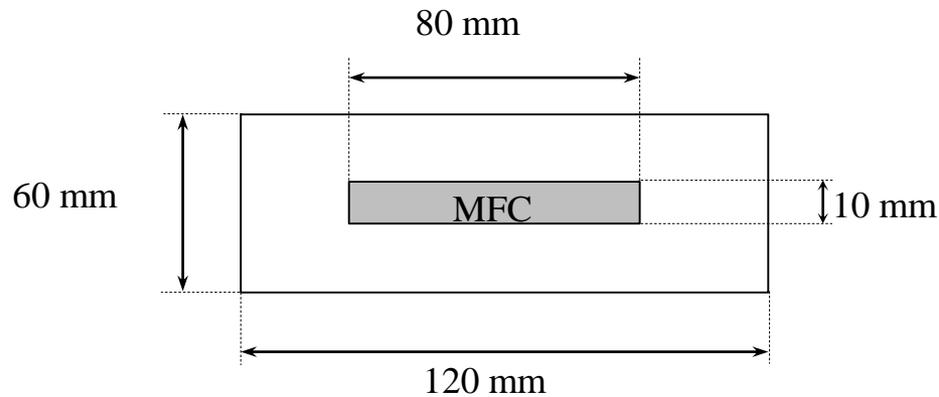
Figure: Cool-down stable shapes obtained for geometry-2 after curing stage



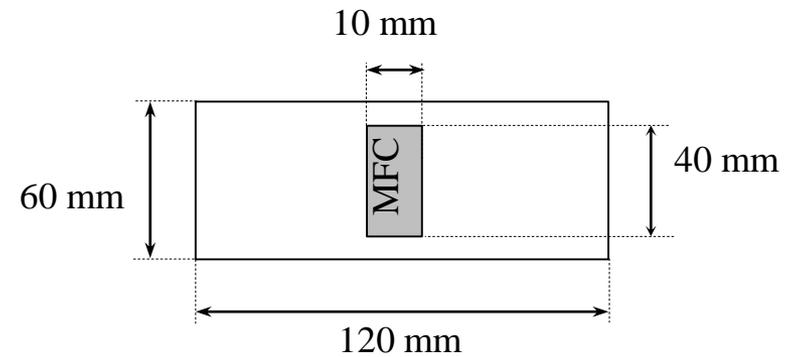
Top side of bistable part



Bottom side of bistable part



Top side of bistable part



Bottom side of bistable part

MFC bonded shapes

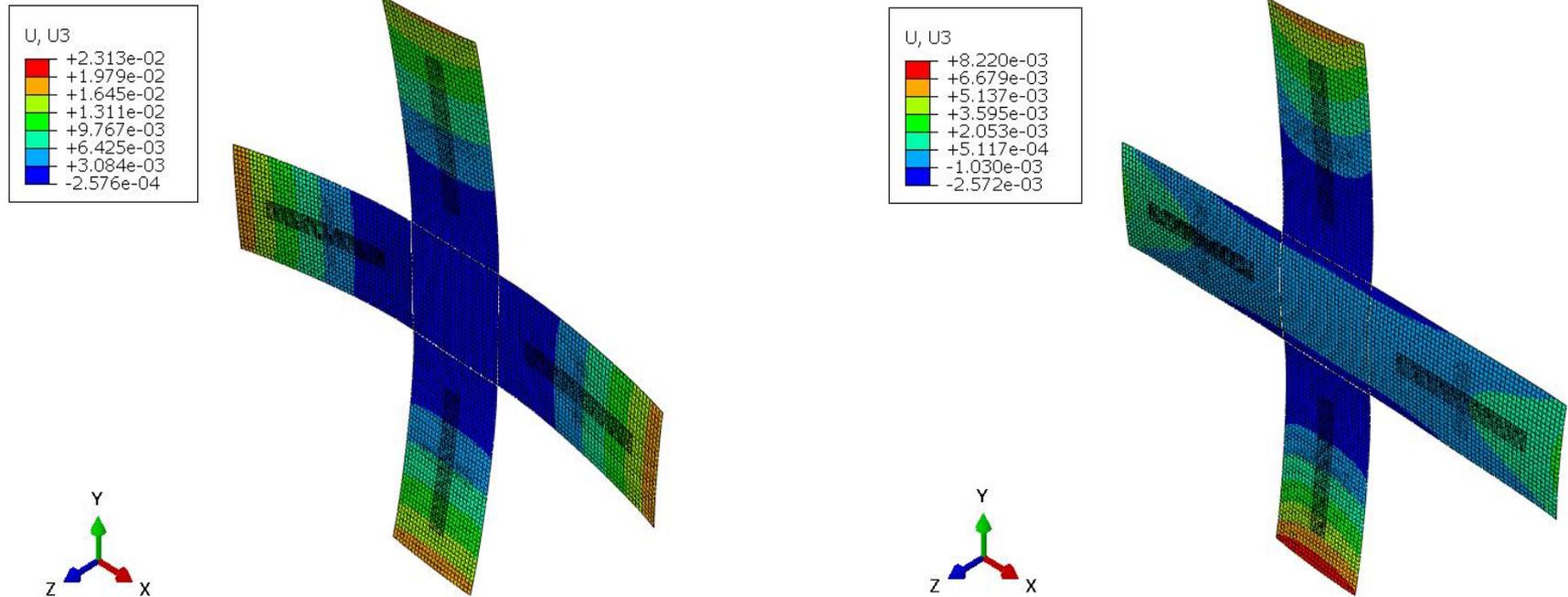
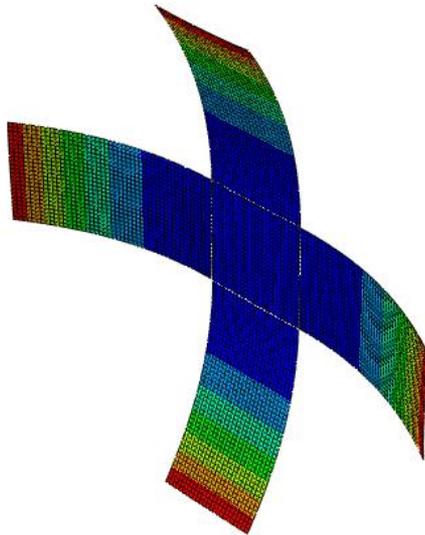
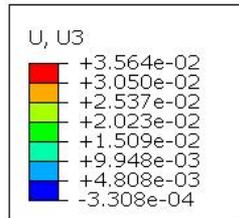


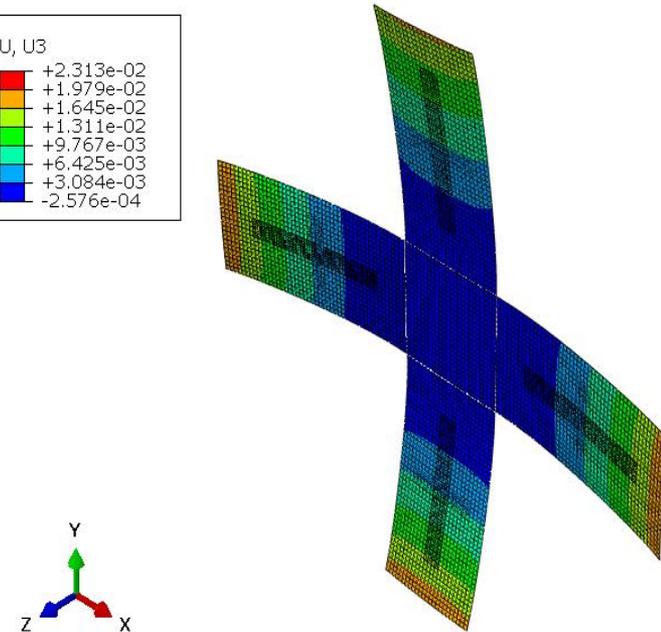
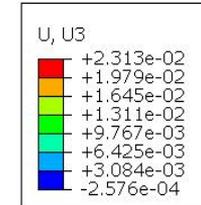
Figure: MFC bonded stable shapes obtained for geometry-2 after curing stage

MFC bonded shapes



Cool-down shape

MFC bonding



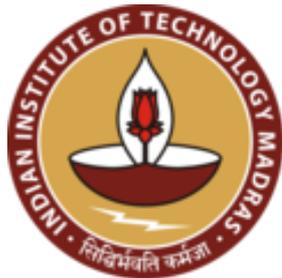
MFC bonded shape

Snap-through voltages

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

- 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



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