Analysis on Cracked Commuter Aircraft Wing Under Dynamic Cruise Load By Means of XFEM

N Wirawan[a(*)], N A Abdullah[b,c], M Akbar[b(**)], J L Curiel-Sosa[b]

[a] Indonesian National Institute of Aeronautics and Space (LAPAN)
[b] The University of Sheffield
[c] Department of Mechanical Engineering
   International Islamic University Malaysia

(*) nanda.wirawan@lapan.go.id
(**) makbar2@sheffield.ac.uk

Computer-Aided Aerospace &
Mechanical Engineering (CA²M)
Research Group
http://www.jlcurielsosa.org/

Department Of
Mechanical Engineering.

Presented at **MPSVA**
3 July 2018
Cambridge

Contents

- Introduction
- Computational Scheme
- Wing Model
- Numerical Investigation
- Conclusion

Introduction

N219 aircraft

A 19-seater multi-purpose commuter aircraft dedicated for operation in remote areas
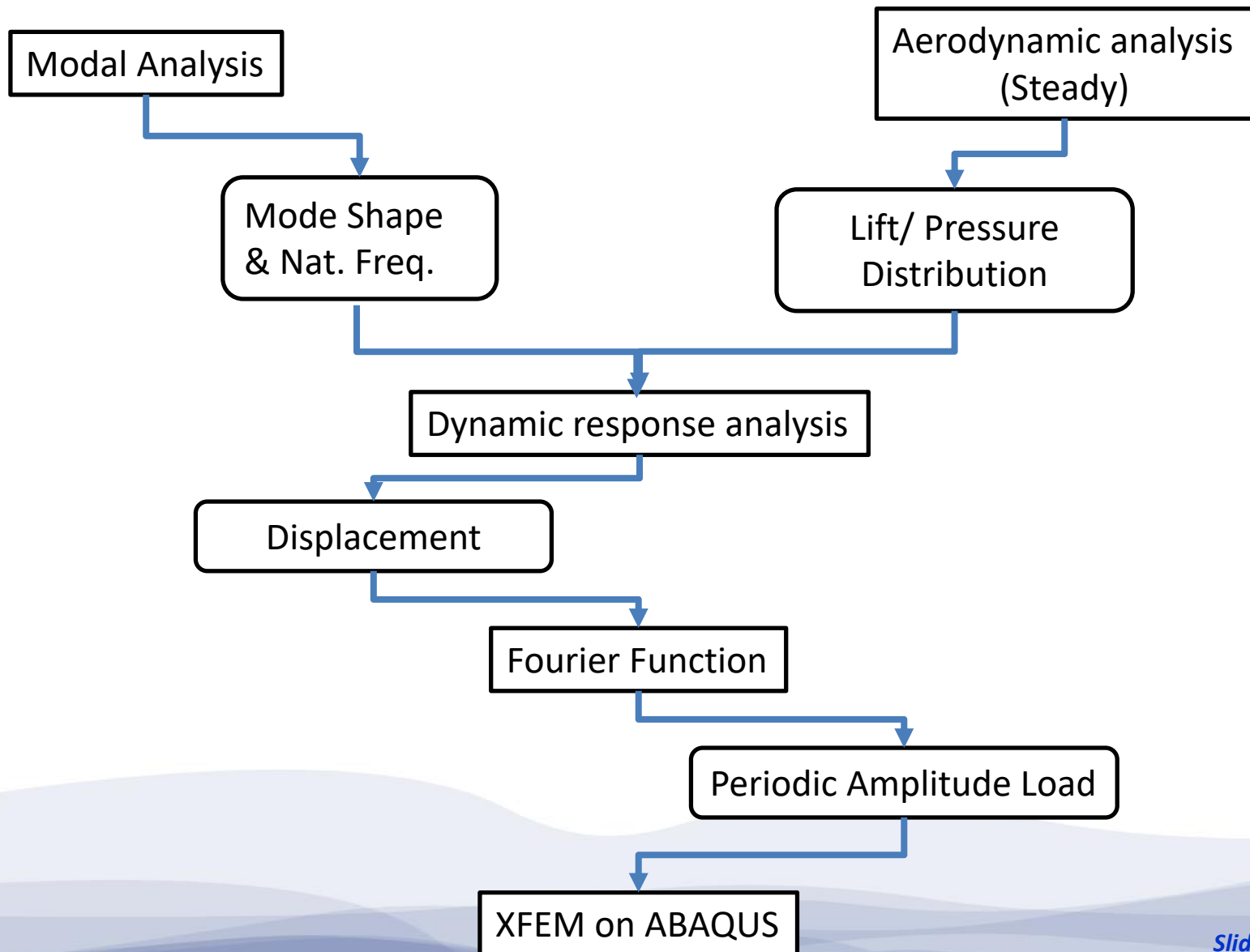
Introduction

BACKGROUND & OBJECTIVES

The needs of **evaluating damage behaviour**, i.e., crack propagation, on aircraft structure under **operating flight load** condition, i.e., aerodynamic and gust loads.

➢ Numerical investigation by means of **XFEM** combined **with dynamic response analysis**
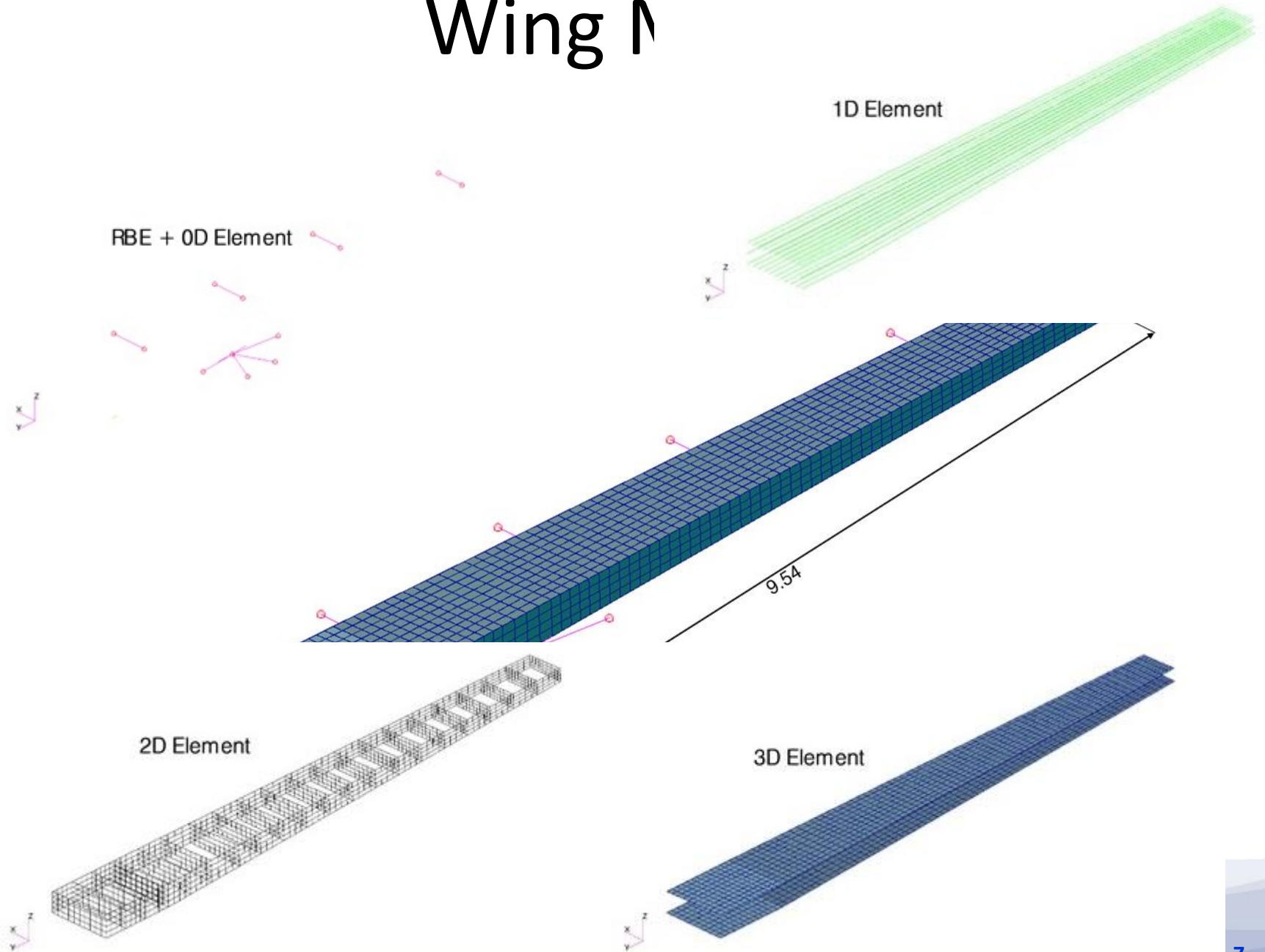
Computational Scheme

➢ **XFEM** provided ease of **minimum/ no remeshing** to perform crack propagation simulation

➢ **XFEM** module is available in **commercial software**, i.e., ABAQUS

➢ **However**, only **general static** and **implicit dynamic** modules are available

Computational Scheme

Modal Analysis → Mode Shape & Nat. Freq.

Aerodynamic analysis (Steady) → Lift/ Pressure Distribution

Mode Shape & Nat. Freq. + Lift/ Pressure Distribution → Dynamic response analysis

Dynamic response analysis → Displacement → Fourier Function → Periodic Amplitude Load → XFEM on ABAQUS

Wing N

1D Element

RBE + 0D Element

2D Element

3D Element

9.54

Wing Model

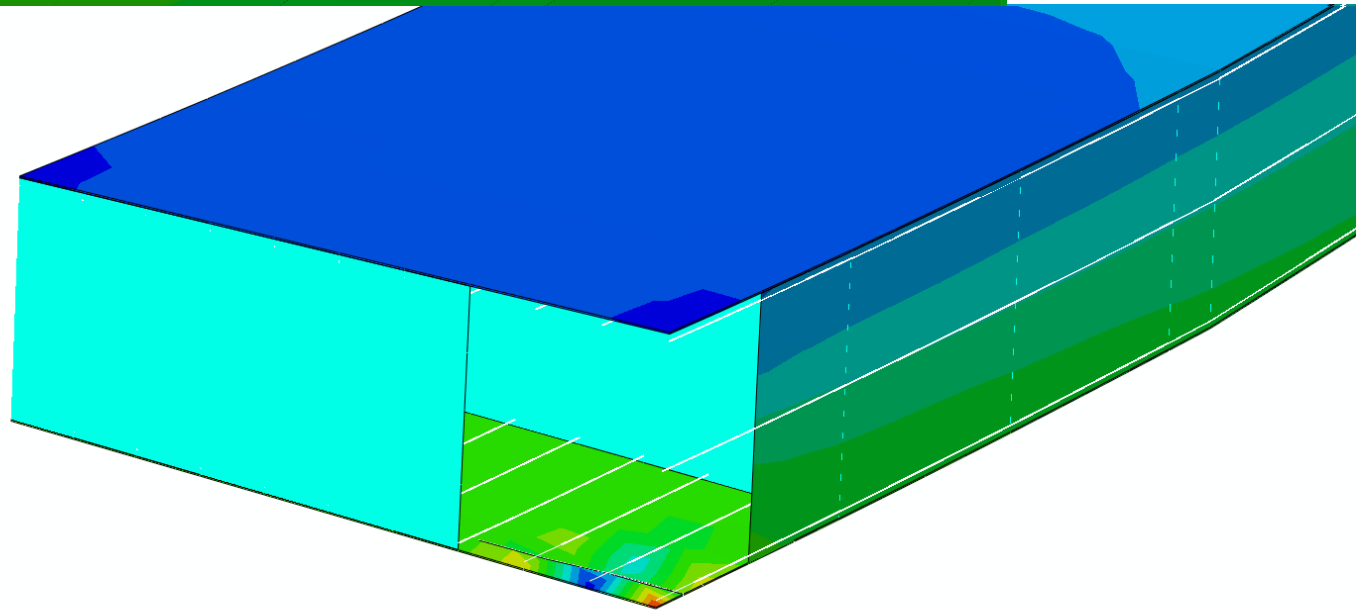| Mode	Natural Frequency (Hz)			Remarks
	Experiments	Stick Model	3D Model	
1	2.49	2.47	2.59	Wing Vertical Bending
2	4.65	4.58	5.58	Wing In-plane Bending
3	8.40	8.28	8.74	Second Wing Vertical Bending
4	11.62	11.56	12.76	Wing Torsion
5	17.05	16.38	15.57	Second Wing In-plane Bending

Numerical Investigation
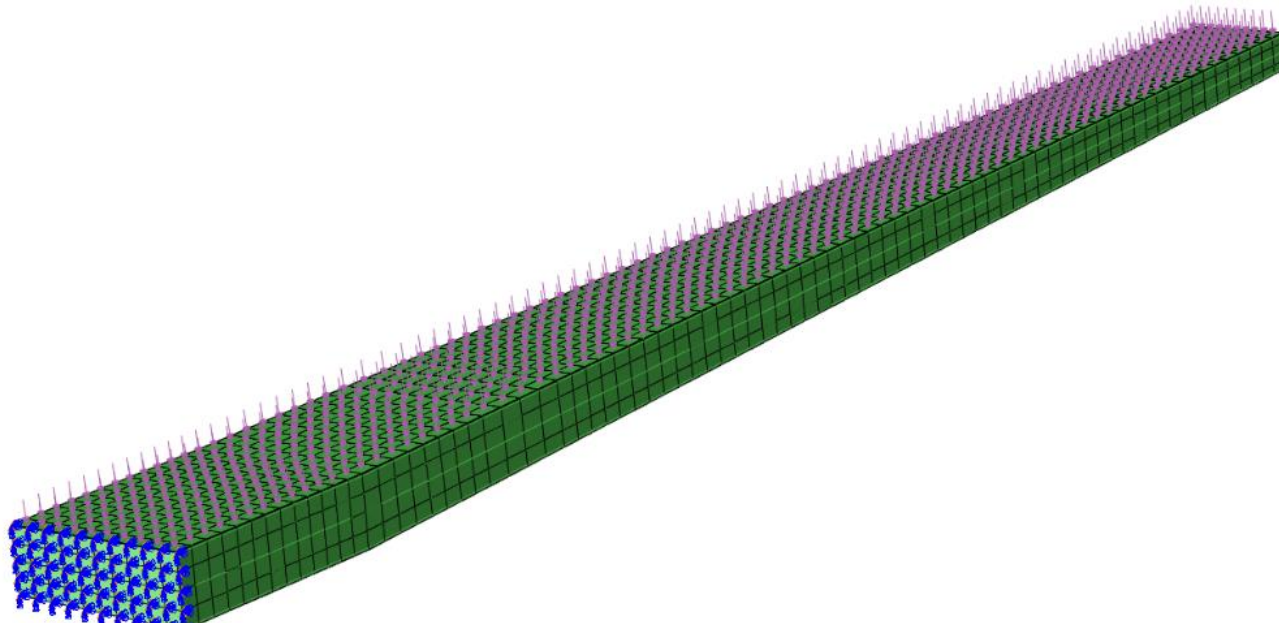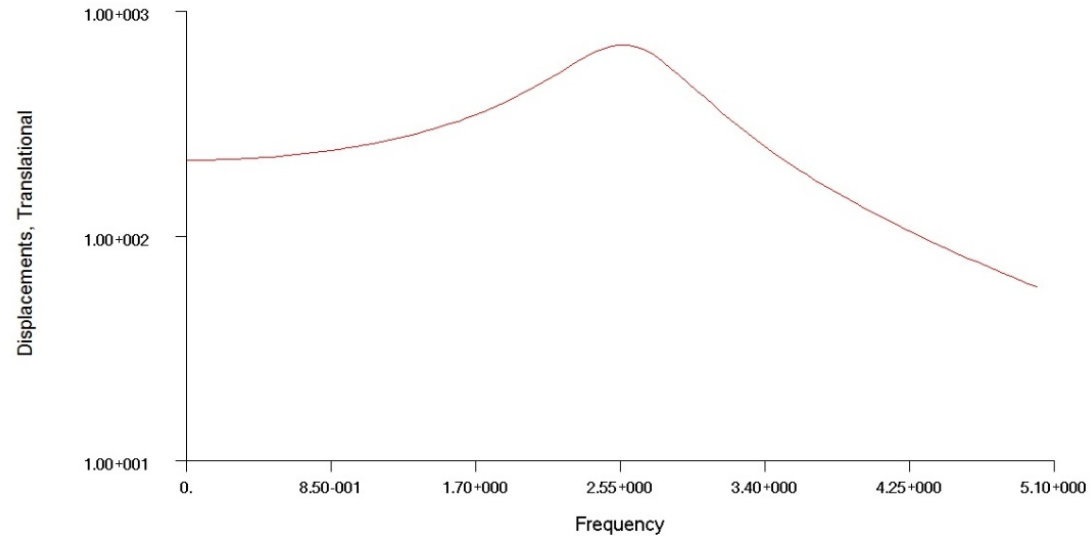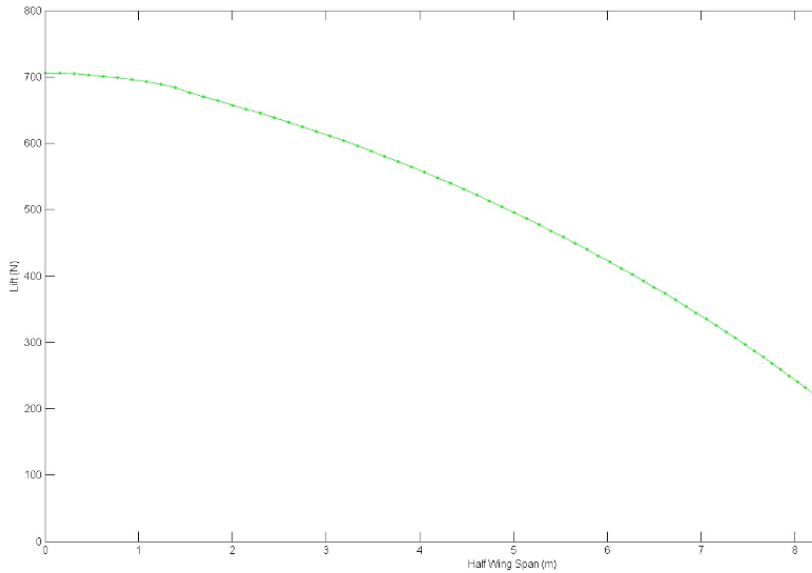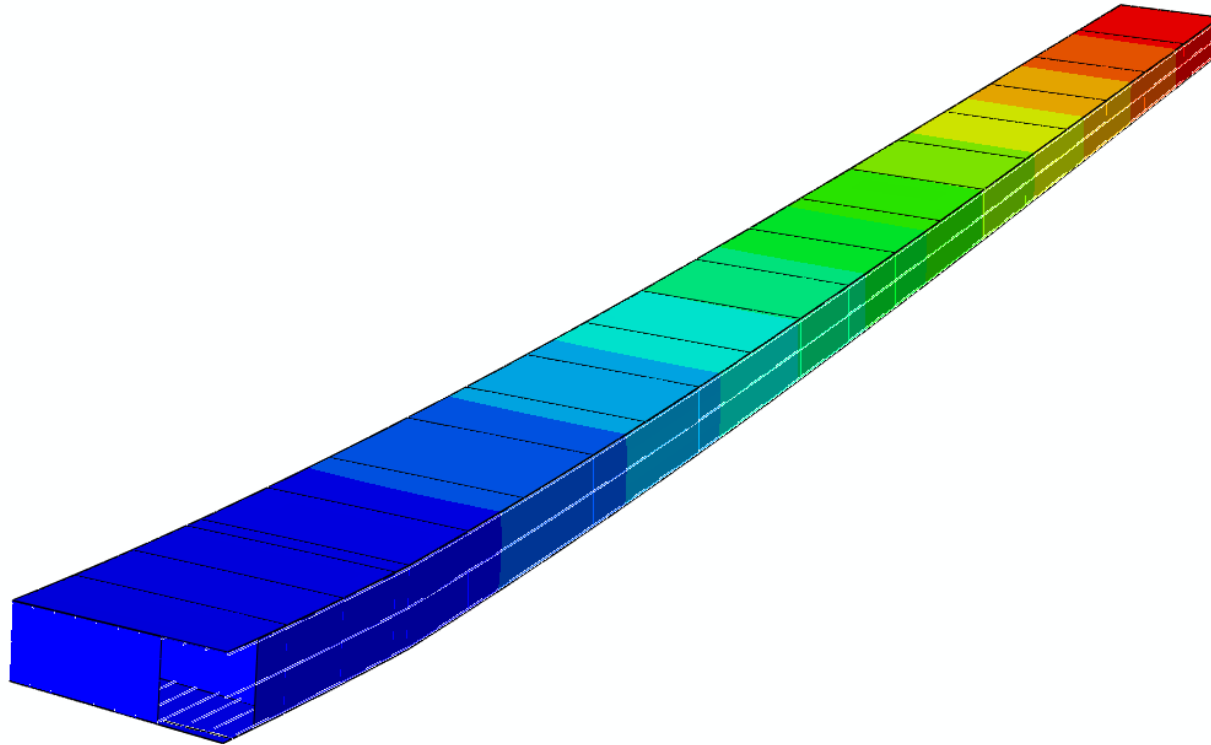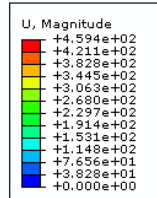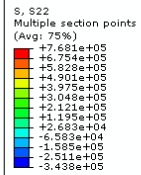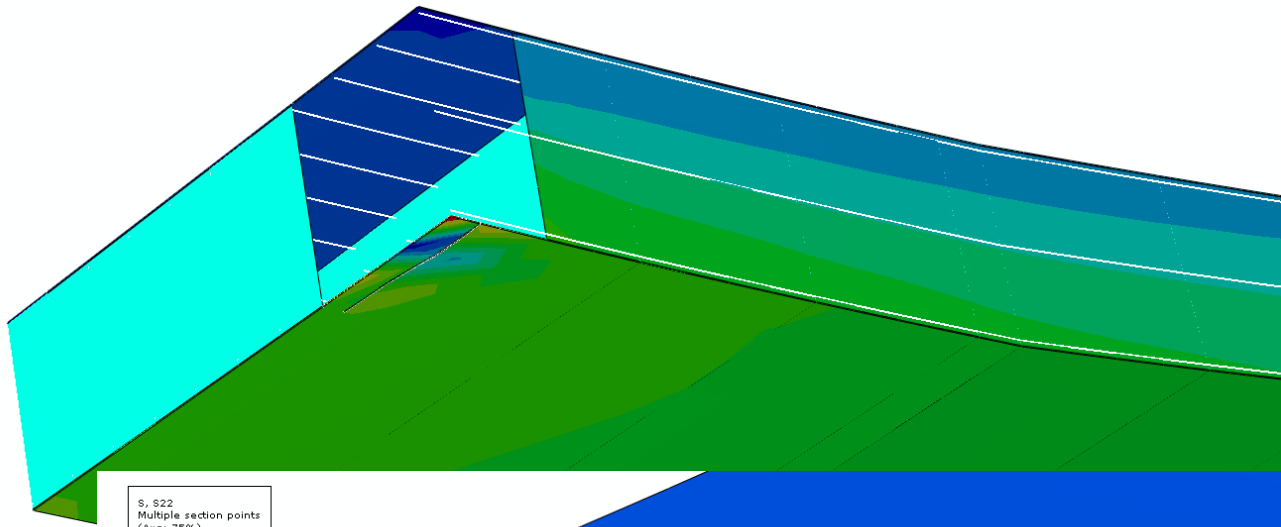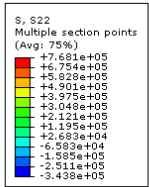
Numerical Investigation

Numerical Investigation

CONCLUSION

- A **computational scheme** has been developed to evaluate crack propagation by means of **XFEM** for **dynamic load** condition

- The computational scheme has been **implemented** to an **aircraft wingbox** structure under **dynamic cruise** condition and the **crack propagation** proven can be **observed**

Future Work:

- Combination with an unsteady aerodynamic model coupled with FEM for aeroelastic condition, i.e., cruise + gust loads.

Selected Author's Publications

1. **N A Abdullah, J L Curiel-Sosa,** Z A Taylor, B Tafazzolimoghaddam, J L Martinez, C Zhang, " Transversal crack and delamination of laminates using XFEM" Composite Structures, Vol.173, pp.78-85, 2017.

2. **N A Abdullah, J L Curiel-Sosa, M Akbar**, " Aeroelastic assessment of cracked composite plate by means of fully coupled finite element and Doublet Lattice Method" Composite Structures, *in press*, 2018.

Thank You