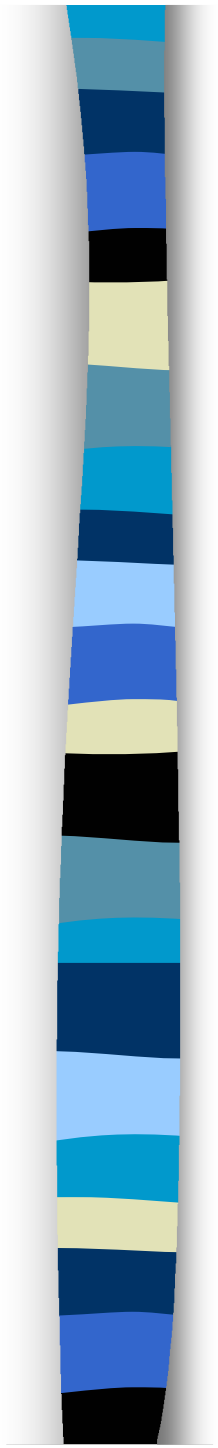

LCFI Interim results

The Mechanical Design Aspects

by

Oxford University

Wing Lau &

Kathleen Wade

LCFI Interim results

Work done in this interim period includes:

Examining the natural frequencies of the CCD plate with increased pre-tension

Effect of the butt-joint in the CCD

Further investigation into the flow induced vibration effect. This includes:

- Re-run of the previous analysis at a reduced flow speed
- The setting up of the EAGLE interface programme
- Validation of the fluid / structural model interface data handling procedures

LCFI Interim results

Natural frequencies of the CCD with increased pre-tension

Previous results already showed that the end constraint conditions did not affect the natural frequencies which are dominated by the in-plane pre-tensioning effect.

Frequency changes due to pre-tension increase are:-

Pre-tension	F1(Hz)	F2(Hz)	F3(Hz)	F4(Hz)	F5(Hz)
150g	43.5	68.9	87.7	133.2	139.1
300g	59.4	79.1	119.1	159	179
450g	72.4	89.4	145	179.5	217

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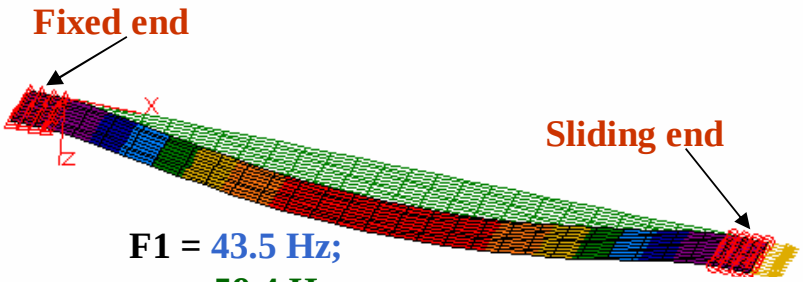
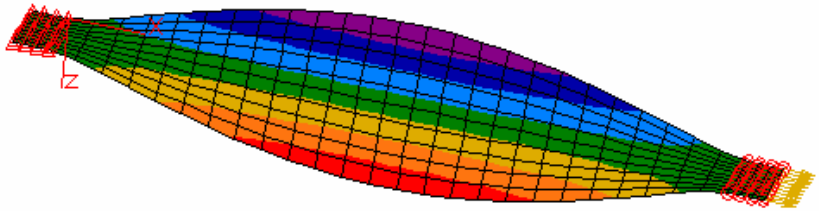
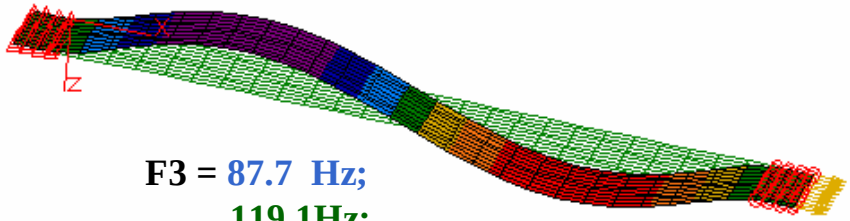


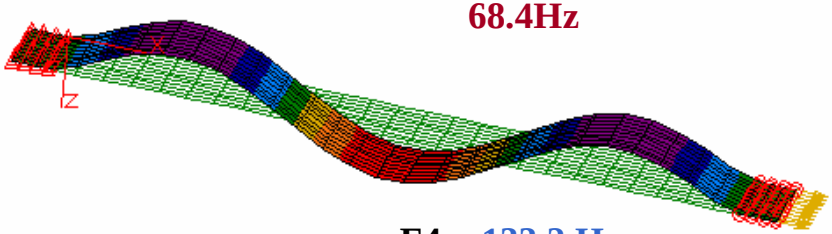
F1 = 43.5 Hz;
59.4 Hz;
72.4 Hz



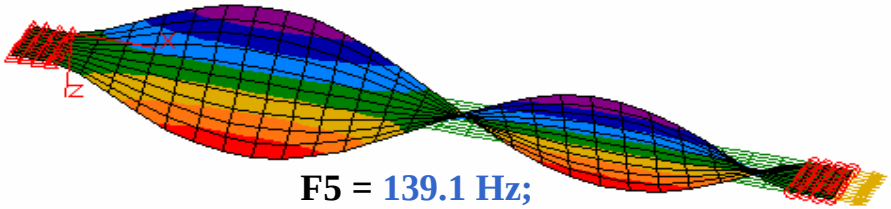
F2 = 68.9 Hz;
79.1Hz;
68.4Hz



F3 = 87.7 Hz;
119.1Hz;
145 Hz



F4 = 133.2 Hz;
159 Hz;
179.5 Hz



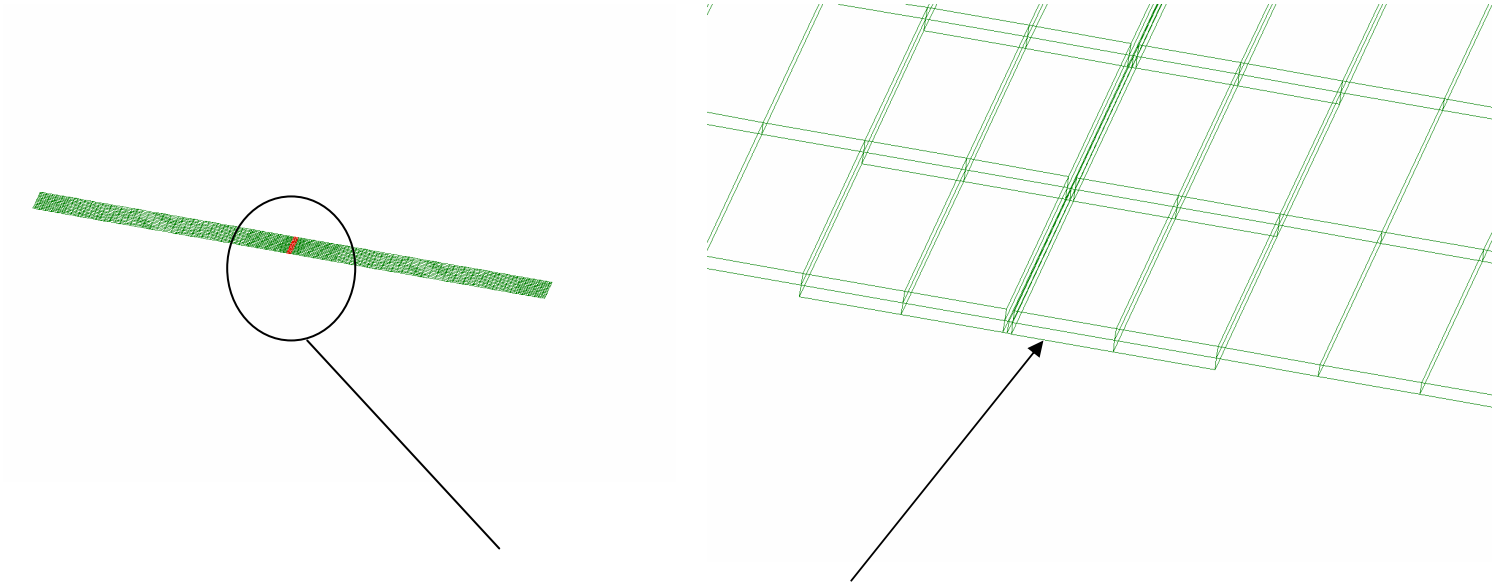
F5 = 139.1 Hz;
179 Hz;
217 Hz

Natural frequencies of a tensioned CCD with end blocks

LCFI Interim results

Butt-joint effect:

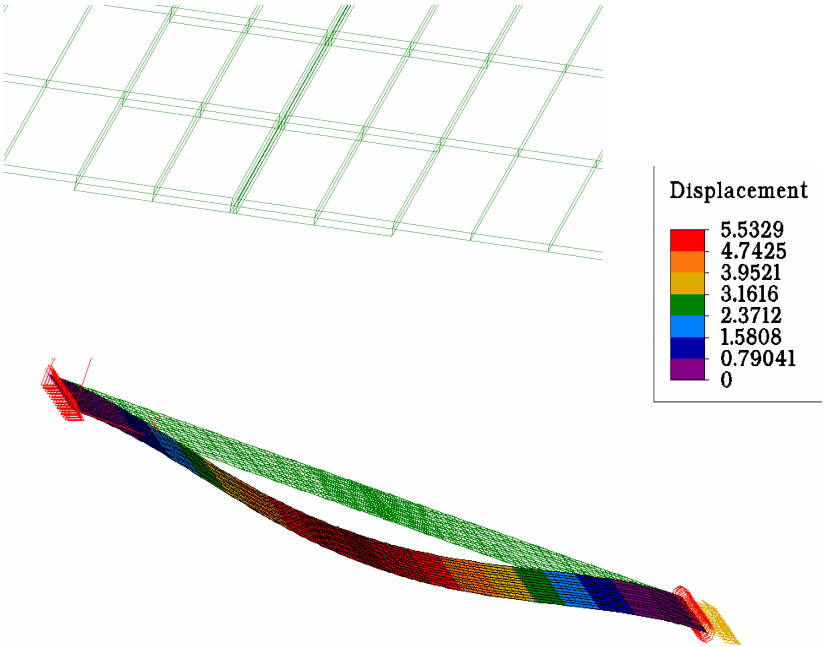
Previous analyses of the CCD plate had been conducted using plate elements. However, since the butt joint is off-set from the centre line of the CCD plates, a 3-D brick model would be required to study its effect.

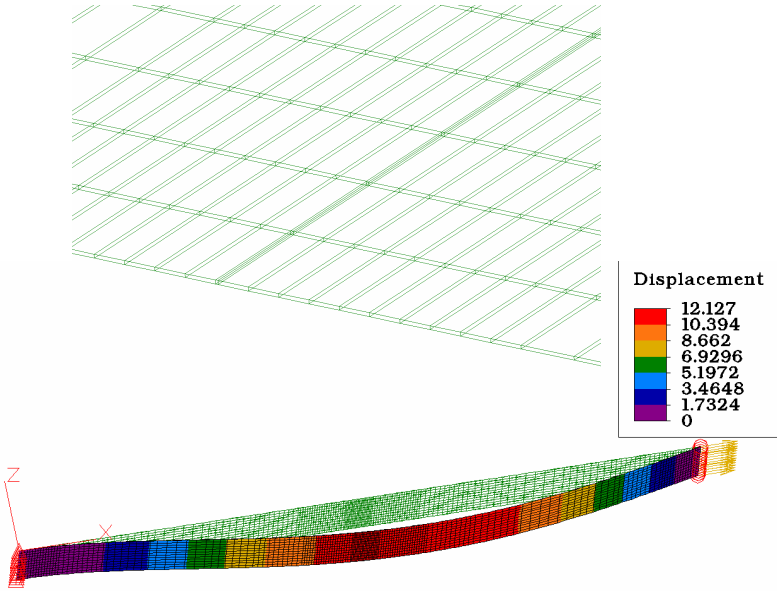


Detail modelling of the butt-joint

LCFI Interim results

The FEA result shows that the max. deflection due to self-weight load was reduced to 5.53mm (from 12.15mm without the joint)





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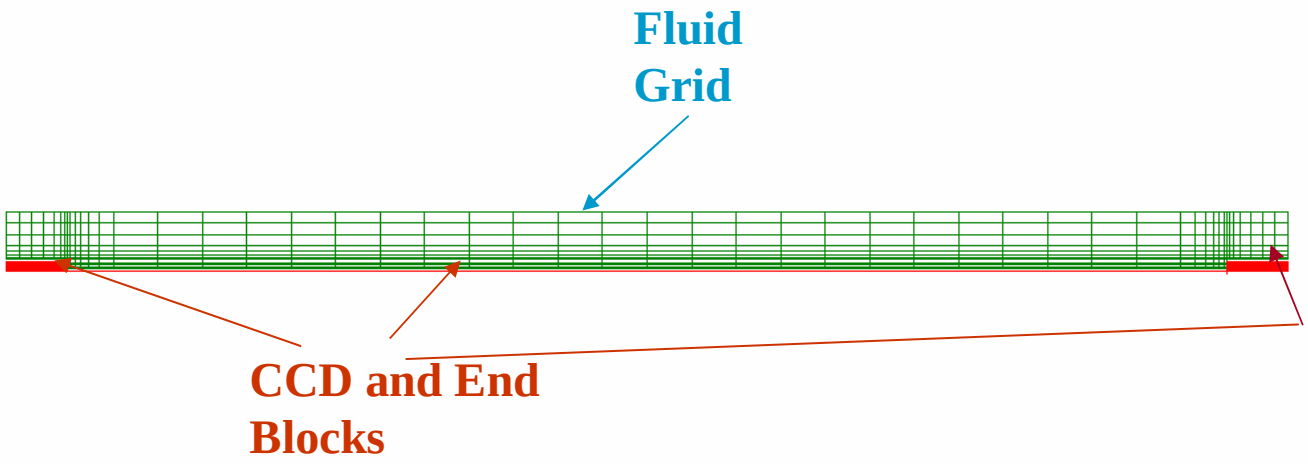
Assumptions made in the Fluid flow simulations:

Air properties at room temp. were used throughout;

Flow velocity assumed at 0.2 m/s

Fluid depth is 50mm



LCFI Interim results

Correct Air properties:

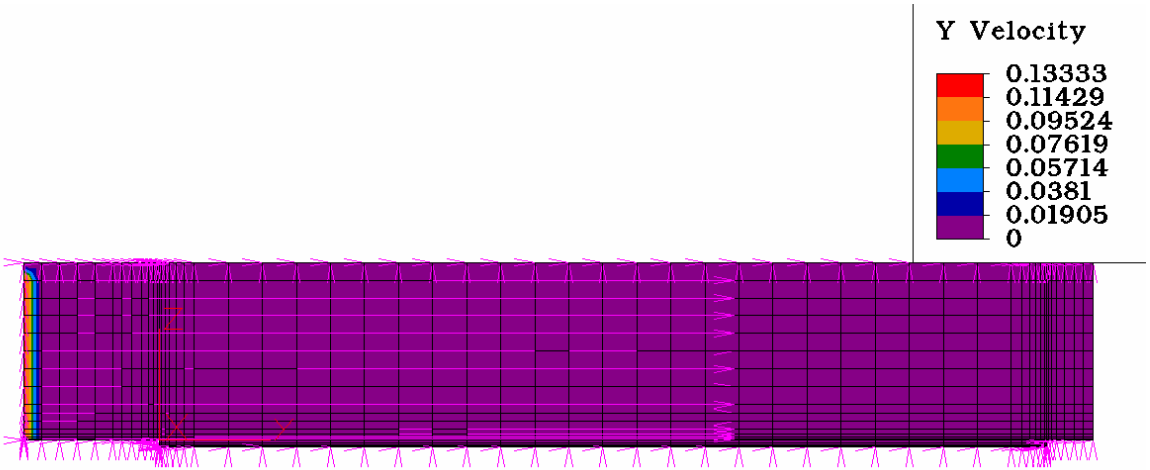
Fluid depth of 50mm with a 2mm step at end block joints:

Sequence of results:

First clip shows the horizontal flow velocity;

Second clip shows the vertical velocity (-ve value indicates formation vortex shedding),

Third clip shows the pressure build-up.



Double click on plot to view animated results

LCFI Interim results

Previous results:

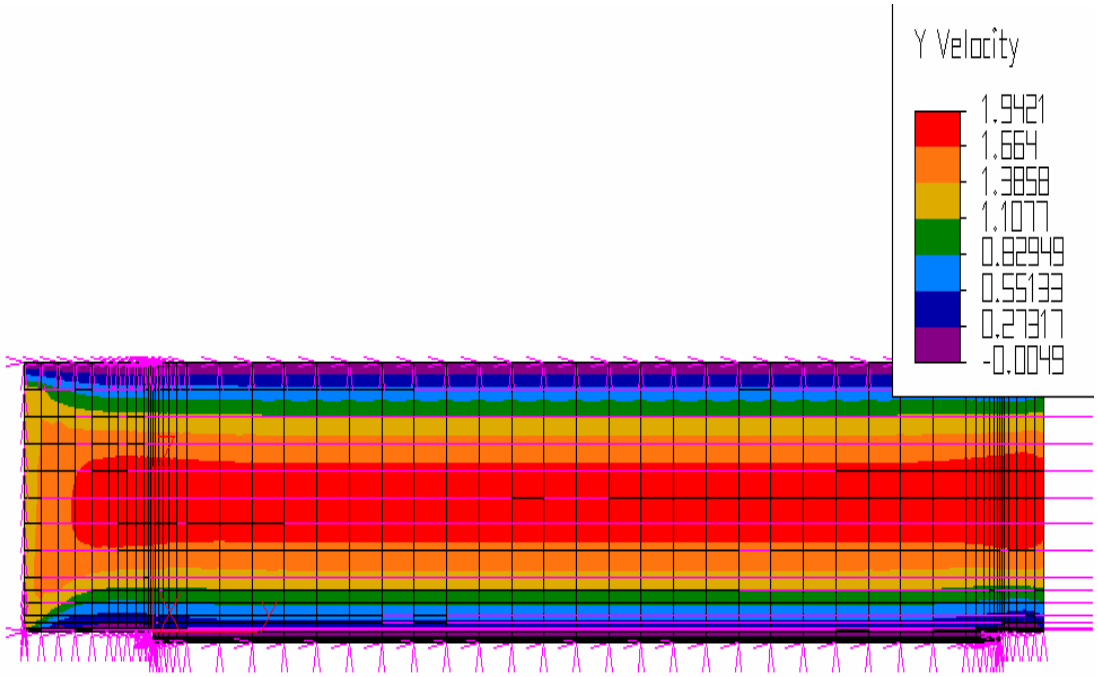
With fluid thickness increased to 50mm deep

Sequence of results:

First clip shows the horizontal flow velocity;

Second clip shows the vertical velocity (-ve value indicates formation vortex shedding),

Third clip shows the pressure build-up.



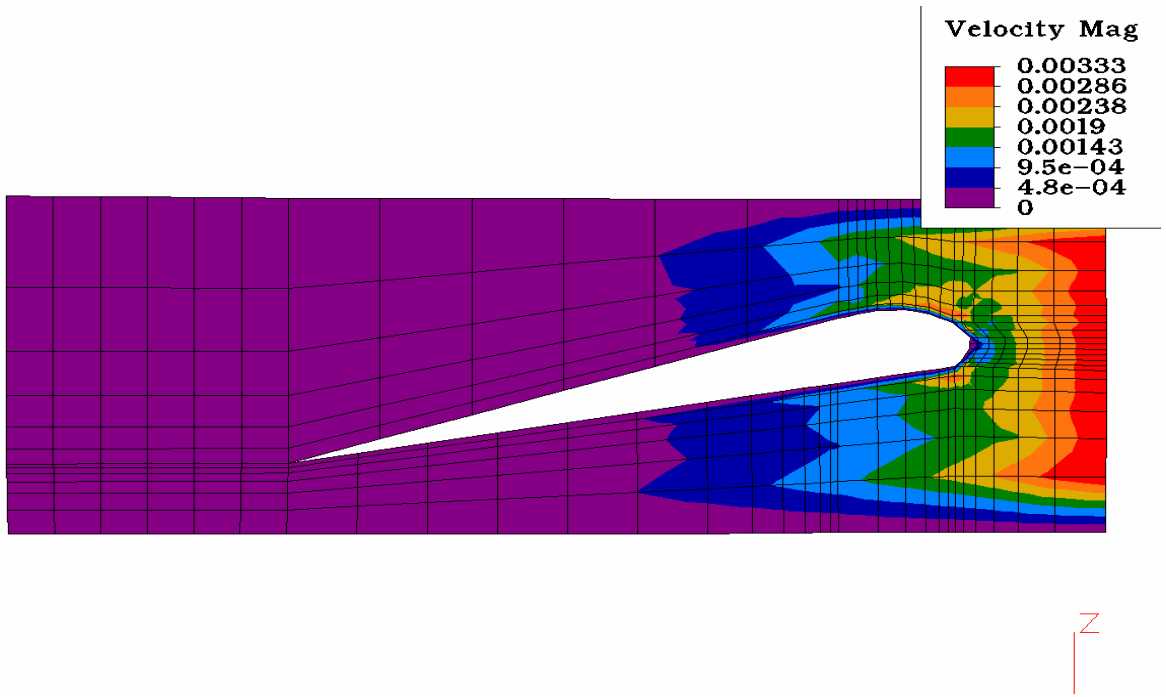
Double click on the plot to view animated results

LCFI Interim results

Aim of Kathleen's work is to devise a data interface programme between the Fluid Flow and the structural models.

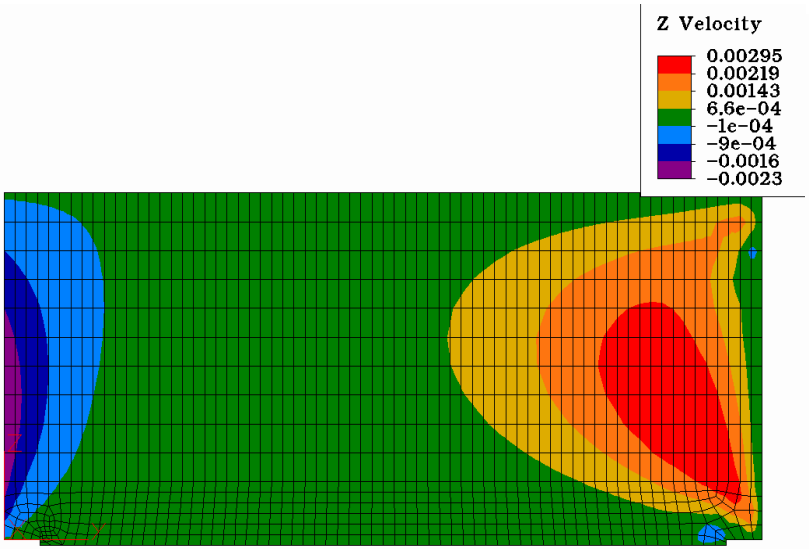
The work is in three parts:-

Part one:- Set up a typical fluid flow model, I.e. an aerofoil, to validate the result of the software package;

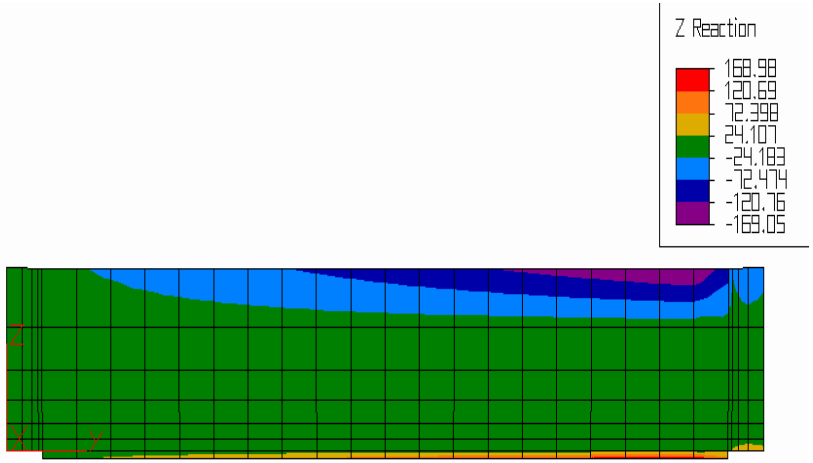


LCFI Interim results

Study the effect between a steady and an unsteady flow on the current CCD model;



Steady Flow model



Unsteady flow model

Part two:-

Produce the EAGLE interface programme. The flow diagram of this is shown:

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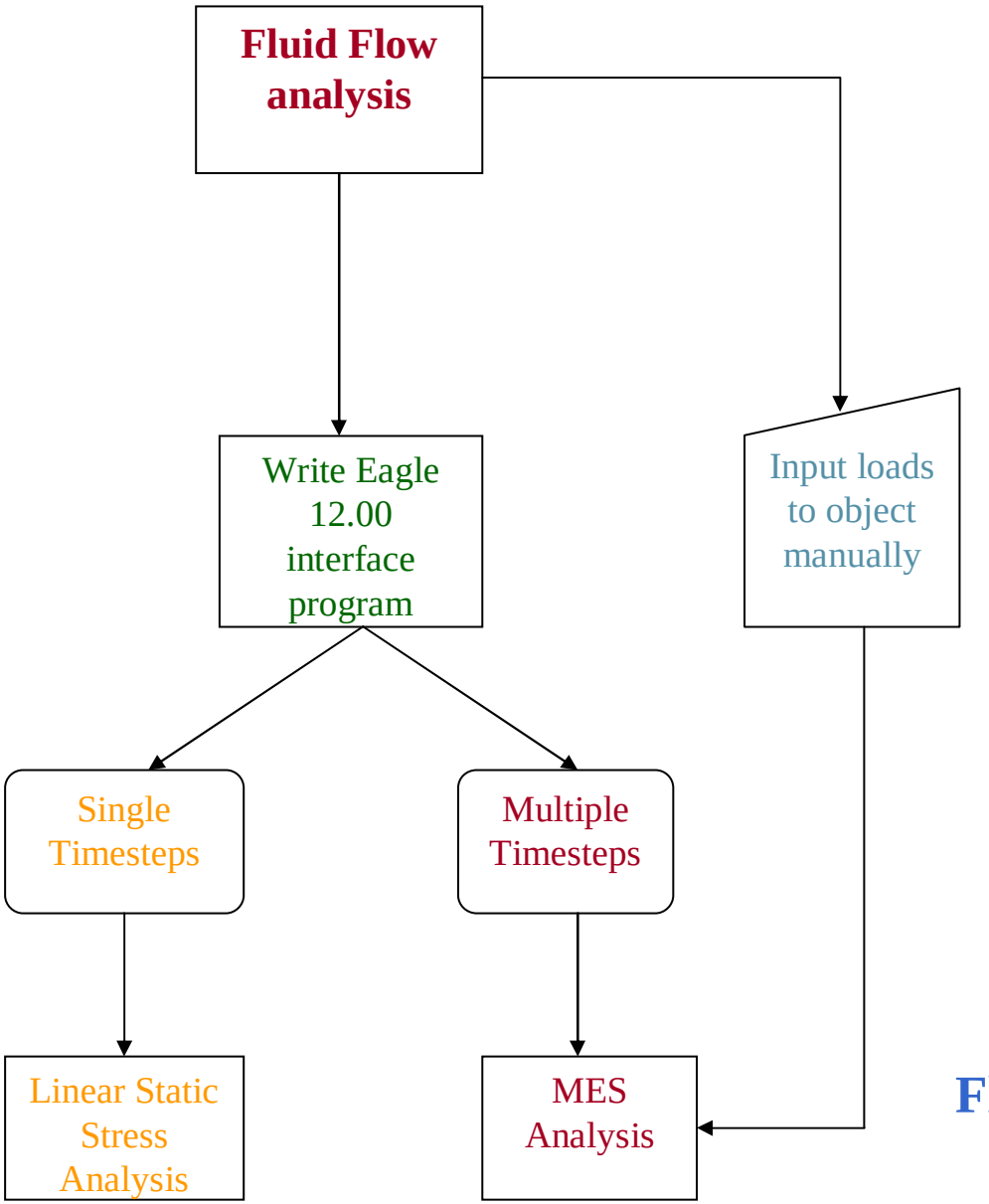

Flow diagram of the Eagle interface programme

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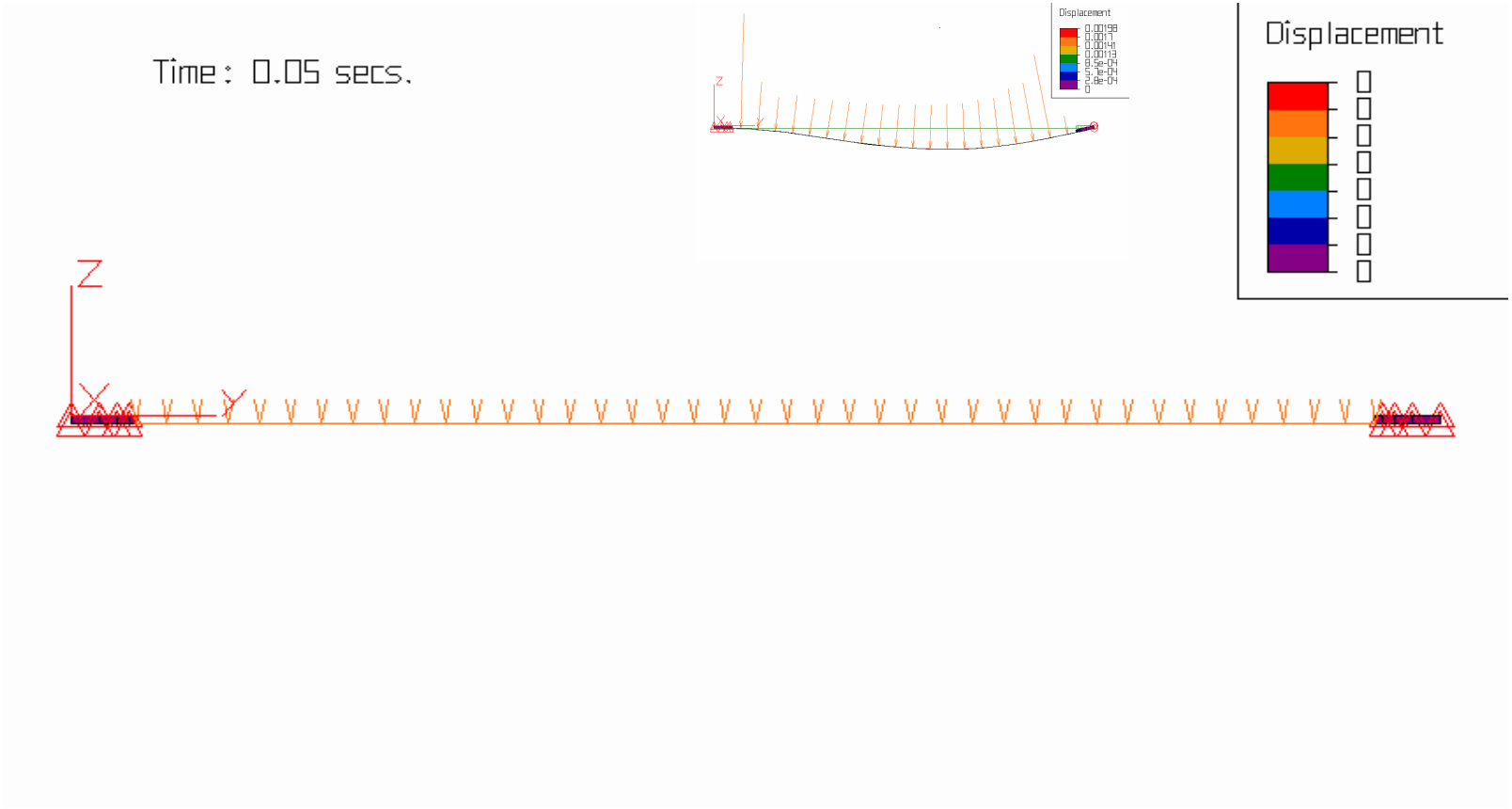
Part three:-

To verify the results / output of the EAGLE interface programme using the current CCD model. The verification was done via:-

Manual handling of the data-



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Part three (conti-):-

Auto data input and output facilities-

This is currently in progress pending on the successful outcome of the first part of the EAGLE interface programme.

LCFI Interim results

Summary statements:

The pre-tensioning on the CCD would need to be increased to at least 300g in order to avoid any resonance at around 50 Hz.;

The butt-joint at the mid-span is seen to have a strong effect on the rigidity of the CCD;

When the correct air properties are used, then the pressure built-up along the plate span is seen to be at a reasonable level. Further work is needed to see its impact on the structural model;

The complexity of the data handling process between the Fluid and the Structural models requires checking to be done in a structured manner. Steps have been taken to ensure that this has been followed properly and relentlessly;

The development of the EAGLE interface programme is making good progress. Kathleen is on target to conclude this work before she leaves us.