Comparing the modal frequency results of a finite element analysis with physical tests on a suspended beam splitter structure without shear plates – 2
T070148-00-K

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Introduction

A previous report explaining the methodology is T070147, and a subsequent report continuing the work for a beam splitter with shear plates is T070148.

Modal frequencies from the finite element analysis

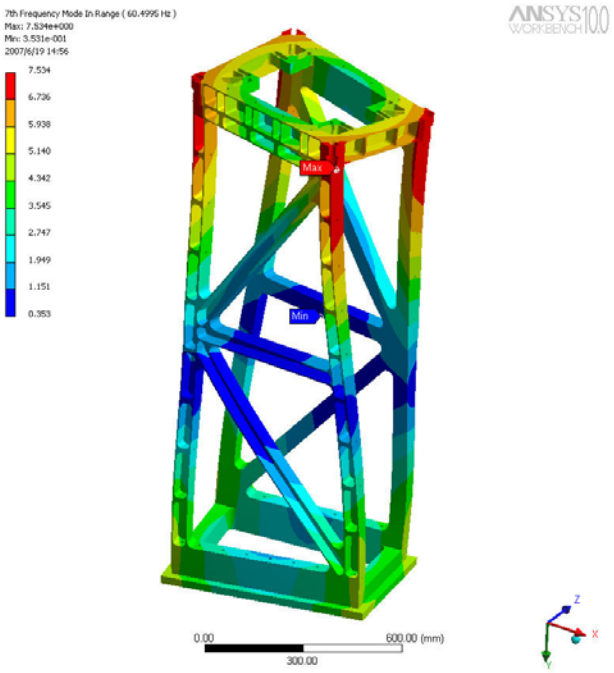

Fig 1. The 7th mode from the FEA gives the unconstrained mode at 60 Hz

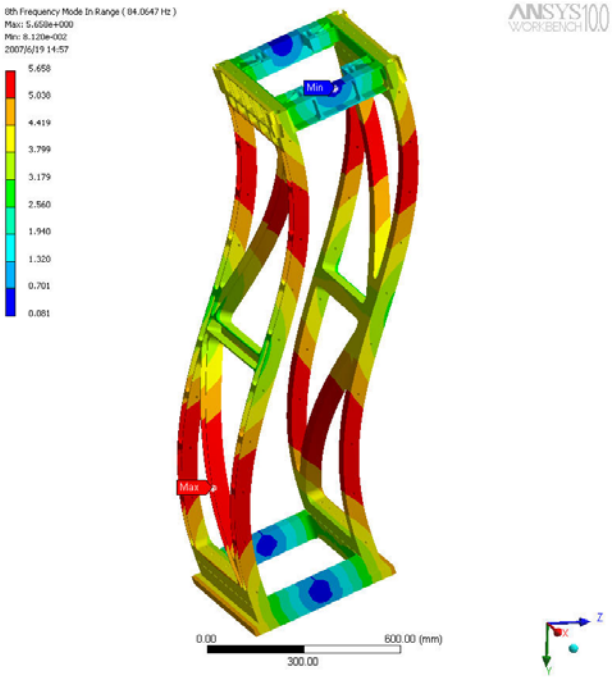

Fig 2. The 8th mode from the FEA gives the unconstrained mode at 84 Hz

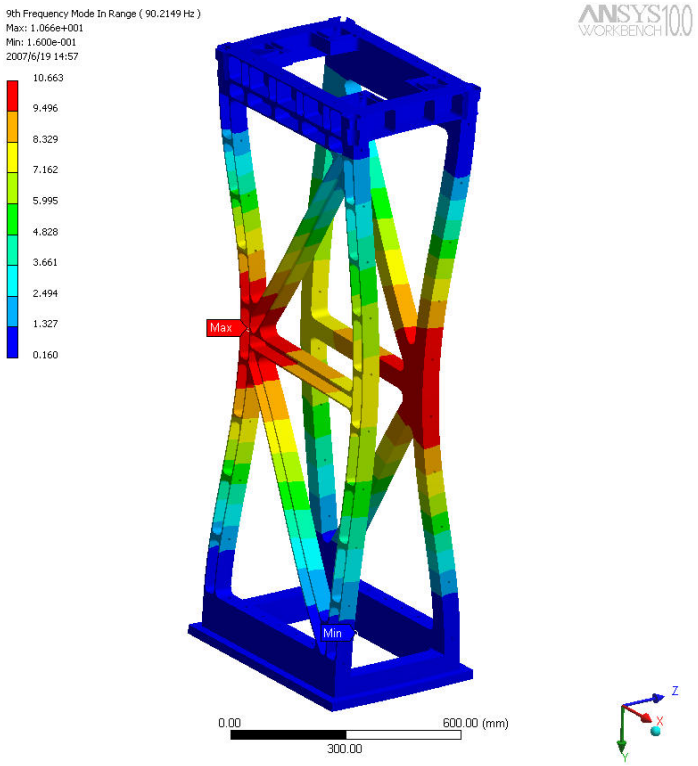

Fig 3. The 9th mode from the FEA gives the unconstrained mode at 90Hz

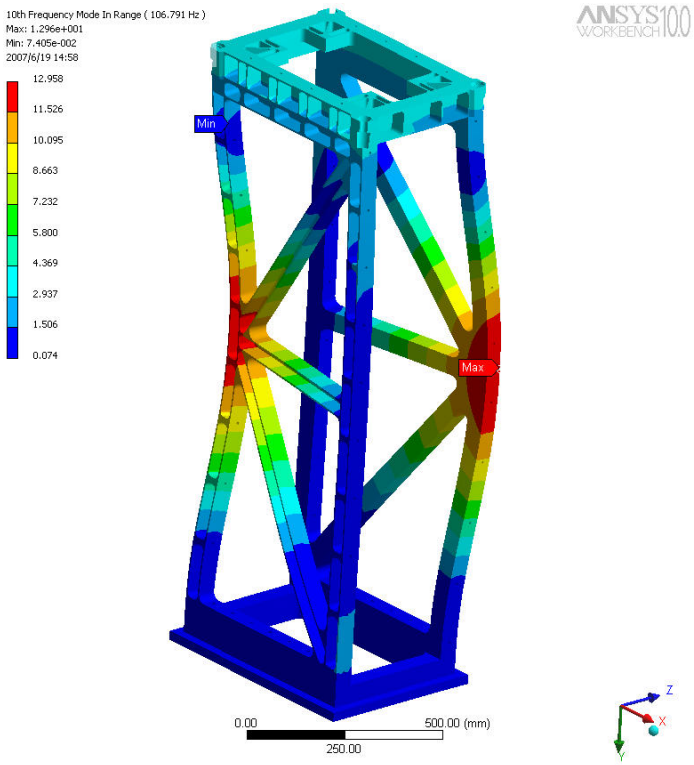

Fig 4. The 10th mode from the FEA gives the unconstrained mode at 107 Hz

Physical tests on the structure

Validating the 7th mode

The structure is suspended from its centre so not to constrain the 7th mode.

Figure 5. The Beam splitter structure suspended at its centre by a sling.

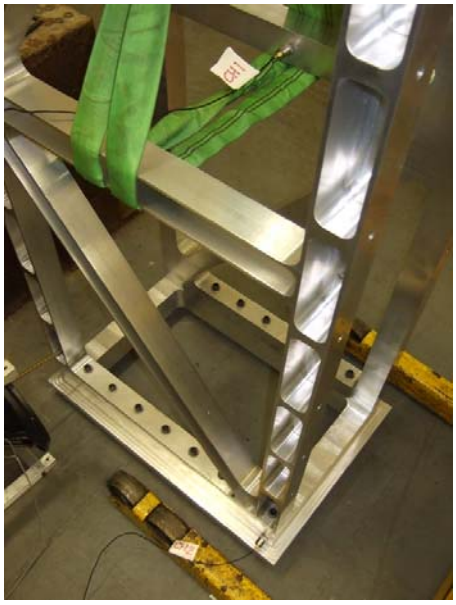

Fig 6. Accelerometers are positioned mid-span of the middle member (shown at the top of the picture) representing channel one, and at the bottom right corner of the ring (shown at the bottom of the picture) representing channel two. The input from the shaker is at the bottom of the ring (shown on the left of the picture).

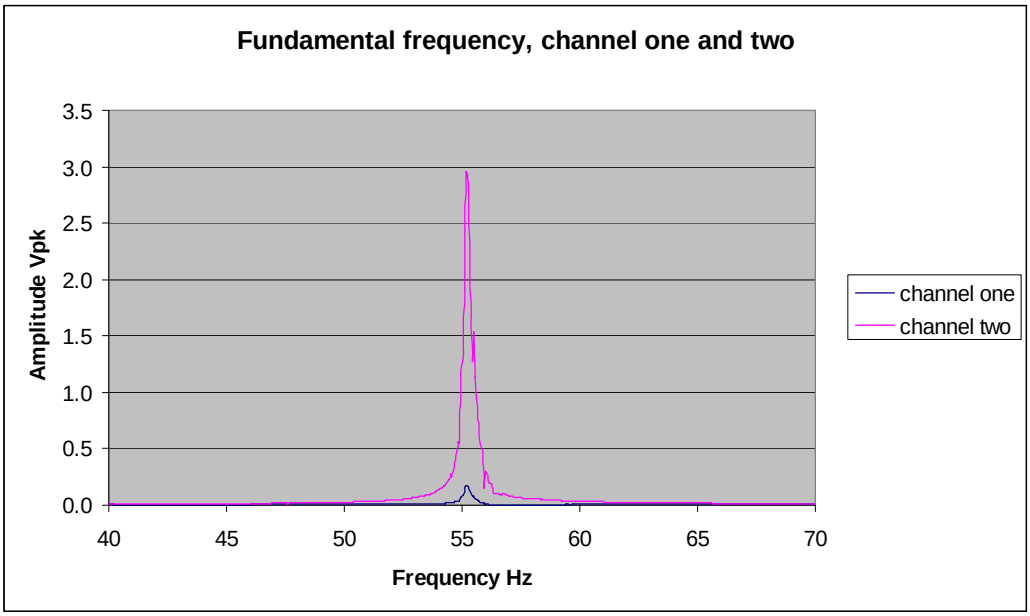

Fig 7. Measured output from channels one and two.

Channel two shows a frequency peak at 55Hz with an amplitude of 3Vpk while channel one only shows an indication of the same peak with an amplitude of

0.156Vpk. The results indicate that the mode shape is that of the 7th modal frequency from the FEA.

Fig 8. Beam splitter structure suspended at its end ring by at a sling.

Validating the 8th FEA mode

Fig 9. Accelerometers are positioned at the middle left hand side of the face plate, in the direction of the beam (bottom left in the picture), representing channel one, and at the top right hand side of the ring, normal to the beam (top right of the picture), representing channel two.

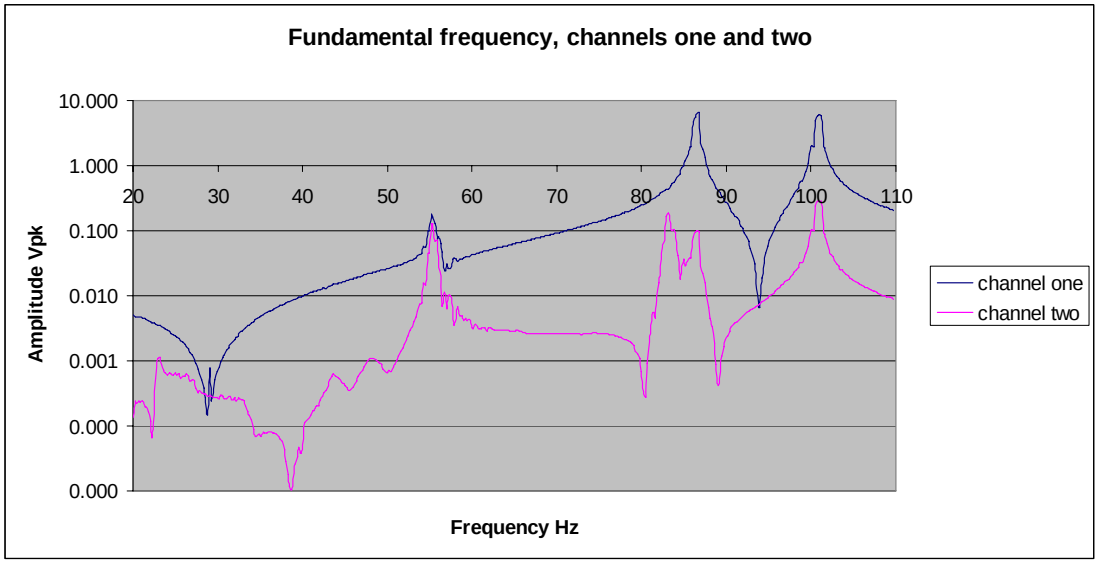

Fig 10. A sine sweep between 20 and 110Hz, output from channels one and two on a logarithmic scale, accelerometers positioned as shown in figure 9.

Channel one shows frequency peaks at 56Hz, 87Hz and 101Hz , these correspond to the finite element predictions of the 7th mode at 60Hz, 9th mode at 90Hz and 10th mode at 107Hz respectively.
Channel two shows all the peaks previously seen by channel one with the addition of a frequency at 83Hz, this peak corresponds to the FE prediction of the 8th mode at 84Hz. The absence of the 83Hz peak from channel one and its presence in channel two is what one would expect from the mode shape of the 8th modal frequency shown in figure 2.

Validating the 9th and 10th FEA mode

Placing the accelerometers on the central member of the face plate to confirm the 9th and 10th mode shapes.

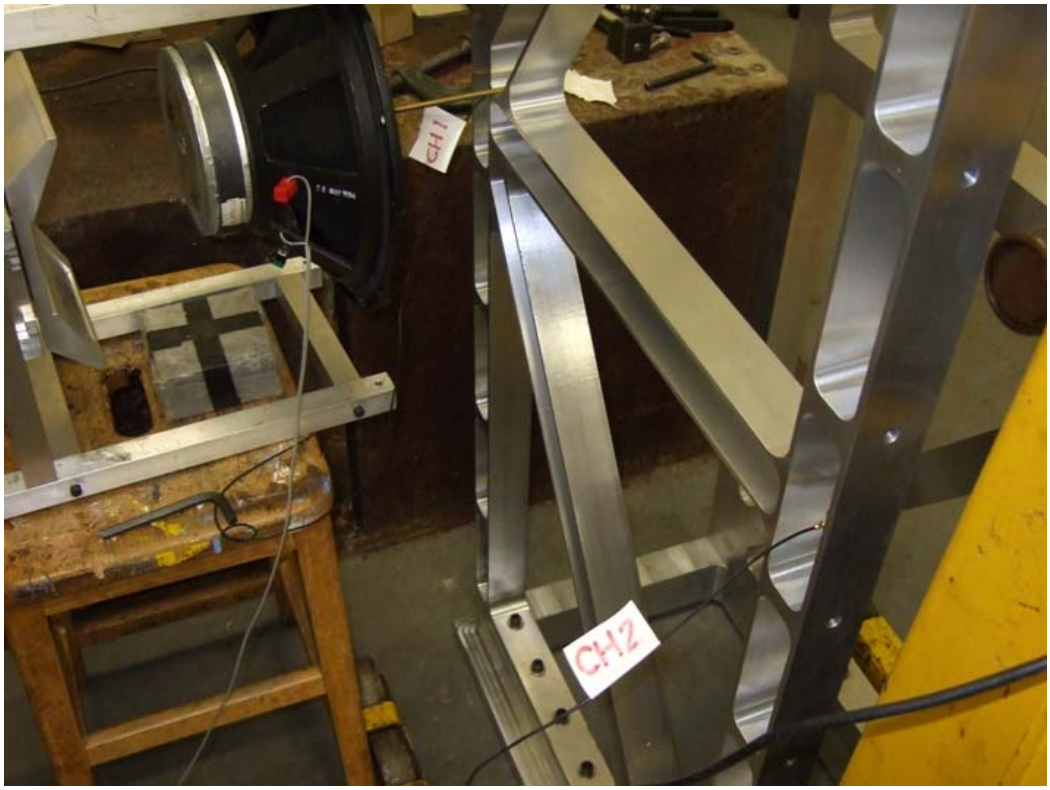

Fig 11. An accelerometer is positioned at the middle left hand side of the face plate (top of the picture), and at the middle right hand side of the face plate (bottom of the picture).

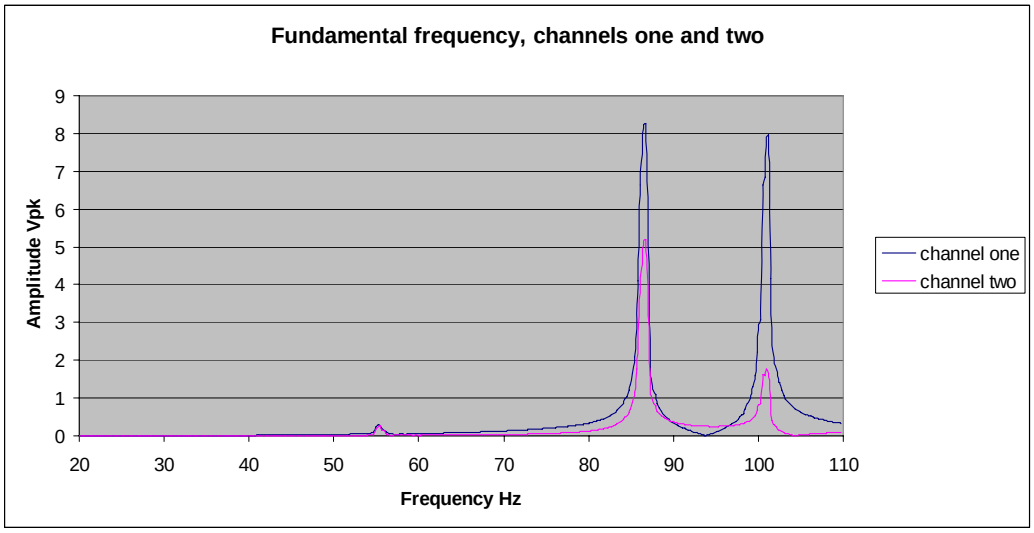

Fig 12. A sine sweep between 20 and 110Hz, output from channels one and two, accelerometers positioned as shown in figure 11.

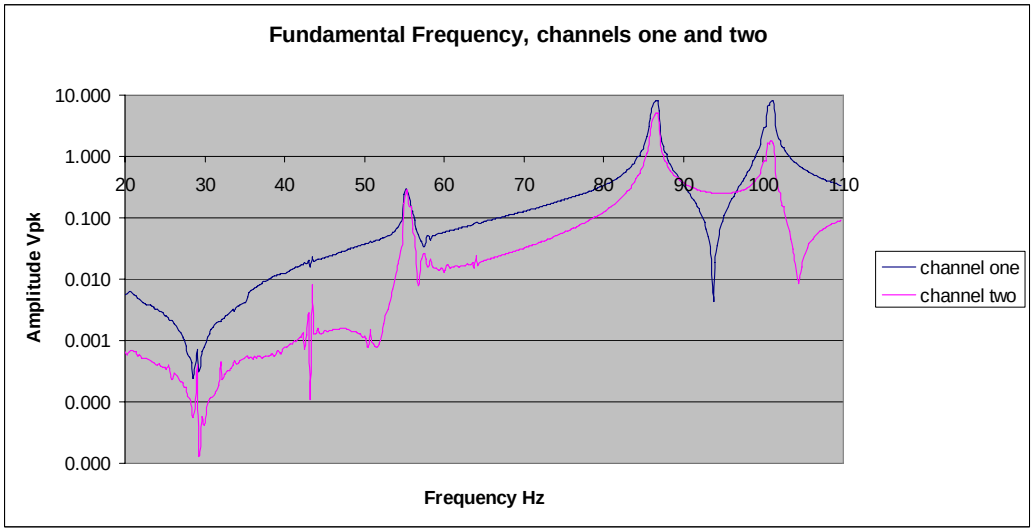

Fig 13. A sine sweep between 20 and 110Hz, output from channels one and two on a logarithmic scale, accelerometers positioned as shown in figure 11.

The FE predictions for the 9th and 10th modal frequencies show that for both cases the maximum displacement occurs at the same place, where the diagonal and horizontal members meet at the centre of the face plate, as shown in figures 3 and 4. The accelerometer represented by channel one is located at the place of maximum displacement and confirms that the peaks attributed to the 9th and 10th modes are of similar amplitude, as shown in figure 10. The accelerometer represented by channel two is located at the other end of the horizontal member and shows that for the 9th mode, at this position, the structure moves similar to the maximum displacement measured by channel one. However, for the 10th mode, at this position, the structure moves by much less compared to channel one. These measured results agree favourably with the finite element predictions for the 9th and 10th modal frequencies shown in figures 3 and 4.

Conclusion

Modal frequency	FEA Hz	Measured Hz	Discrepancy %
7th	60	56	7
8th	84	83	1
9th	90	87	3
10th	107	101	6