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PRIMARY CALIBRATION OF REFERENCE STANDARD BACK-TO-BACK VIBRATION TRANSDUCERS USING MODERN CALIBRATION STANDARD VIBRATION EXCITERS

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Abstract: Following, and in addition to several papers e.g. [1] and [2], exercises and thorough research concerning the topic of primary calibration of back-to-back vibration transducers in the frequency range >5kHz, this paper aims to raise the question if the conventional method using slotted mass, is mandatory when using modern commercial calibration standard vibration exciters in fully optimized system setup.

Keywords: vibration, calibration, interferometry, dissemination.

1. INTRODUCTION

In the process of striving for optimal calibration result, corresponding well to theoretical calculated result based on simple well known single degree formula, a focus has been put to understanding transition from transducer sensitivity measured while vibration stimuli are measured on mounting surface diameter surrounding mounting hole, and in the centre of the transducer as close as possible to the mounting surface plane.

The exercises preceding this paper have been carried out on an air-bearing shaker (PCB 396C11) and are based on following basic assumptions:

- Negligible influence from vibration exciter armature material.
- Negligible or minor influence from reflecting surface (Brüel & Kjær type YS-0920, 10grams steel mirror used as mass load and reflecting surface - mass load of 10grams resembling modern SE-reference standard accelerometers).
- Some or apparent influence on frequency response from vibration stimuli (type dependent on DUT and cross motion being the main contributing factor).
- Resonance frequency of DUT is measured under circumstances as close as possible to those of primary calibration (referred to as apparent resonance frequency). Measurements are performed using Endevco type 2270M8.

2. BASICS

A simple setup based on assumptions mentioned can be described by:

$$S_{Calculated} = S_{Ref}\,\frac{1}{1-\left(\frac{f_e}{f_{app}}\right)^2}$$

$S_{calculated}$: *Calculated sensitivity at frequency examined*

S_{ref}: *Sensitivity at reference frequency*

f_{app}: *Apparent resonance frequency (measured prior exercise)*

f_e: *Frequency examined*

This model does not consider damping or the higher order terms thus has its drawback in this sense if *significantly* present.

3. RESULTS

A good correspondence is found between PTB and DPLA when performing calibration using slotted mass on several units. Having repeated measurements on several DUTs a clear systematic arises as shown in calibration result of DUT selected for this exercise, DPLA reference standard accelerometer type 8305, SN: 1592160.

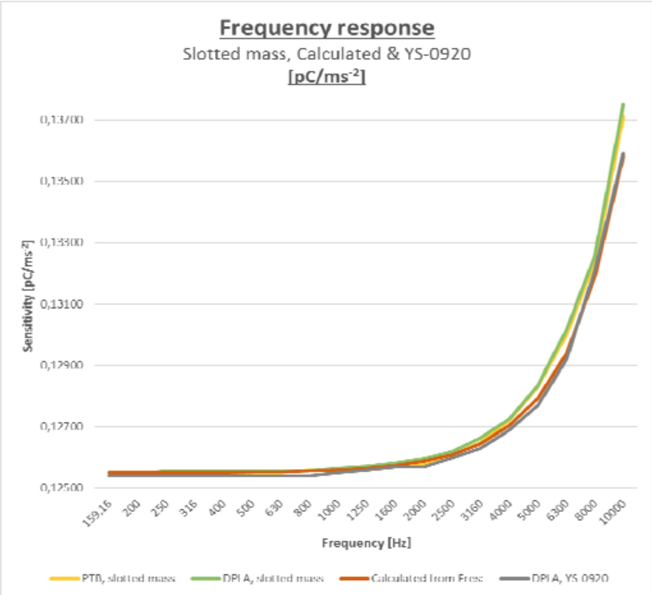

Figure 1. Systematic difference between measurements by PTB and BKSV-DPLA using slotted mass and BKSV-DPLA small mirror with beam in centre

The difference between calibration with beam centred on type YS-0920 and when using slotted mass is shown below.

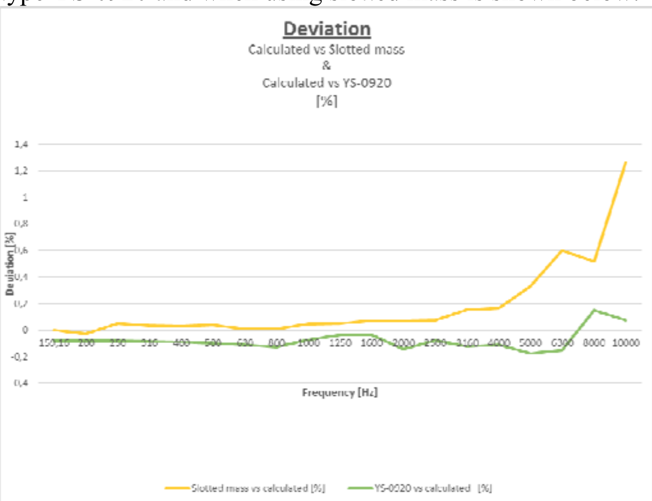

Figure 2. Difference between measurements using slotted mass and small mirror with beam in centre

Further measurements were performed using a 20-gram stainless steel load mass (WS-3790) and using the 2270M8 as reference in a back-to-back configuration.

The results were compared to the best fit theoretical curve just using the resonance frequency as variable parameter. Damping was included but has no significant influence on the results. The results are shown in Figure 3.

The used frequencies for the results, except for the WS-3790, are less than 1 kHz from the observed apparent resonances that were only given with 0.25 kHz resolution (and were found to be different for the four slots on the slotted mass!).

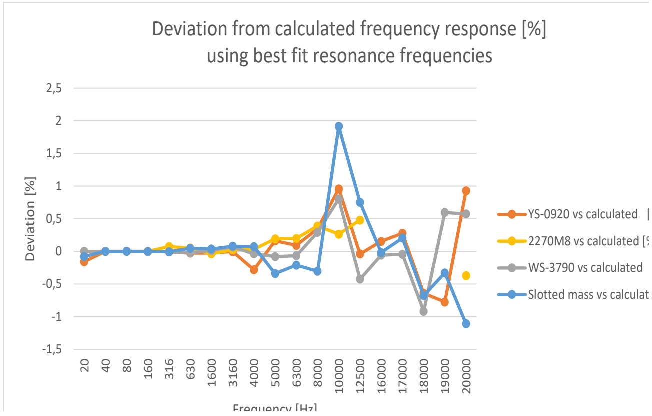

Figure 3. Deviation from theoretical response using optimised resonance frequency**.**

4. CONCLUSION

The simple parameter model described in section 2 can be used to compensate/compare measurement results obtained by different loading schemes used for laser calibration of back-to back reference accelerometers.

The accelerometer has a transverse resonance at about 9 kHz which creates some differences at that frequency and its harmonic. If these are disregarded all the results are within 0.5% of the theoretical curves up to 20 kHz.

More measurements on this type of accelerometer and on similar back-to-back reference accelerometers might provide the tools for proper dissimination of the results to the users of the high accuracy calibrations made at the NMIs.

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