

Quality Control – Table of Physical Parameters

- Homogeneous sample testing: two infill patterns tested: ± 45 degrees and 0/90 degree infill angles alternating. Shown below
- 6 homogeneous samples tested for each material: 3 with ± 45 deg and 3 with 0/90

Illustration 1: ± 45 degree infill pattern

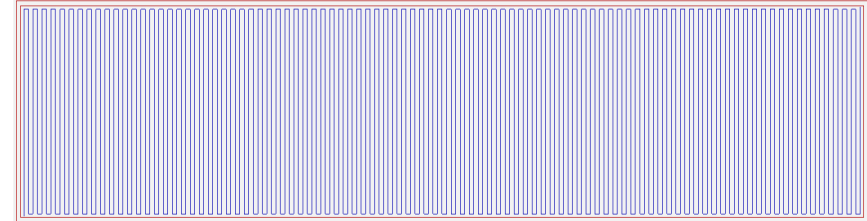


Illustration 2: 0/90 degree infill pattern

Steelfill

Sample No.	L[mm]	ΔL[mm]	t[mm]	Δt[mm]	w[mm]	Δw[mm]	V[mm ³]	ΔV[mm ³]	m[grams]	ρ[kg/m ³]	Δρ[kg/m ³]
1	80.4	0.1	4.0	0.1	20.3	0.1	8152.5	254.1	23.8	2919.4	91.0
2	80.1	0.1	4.0	0.0	19.9	0.1	7968.0	50.0	23.8	2987.0	18.7
3	80.1	0.1	4.1	0.1	20.1	0.1	8209.0	251.3	23.9	2911.4	89.1
4	80.0	0.1	3.9	0.1	20.1	0.1	7879.2	251.1	23.5	2982.5	95.0
5	80.0	0.1	3.9	0.1	20.2	0.2	7918.4	291.3	23.6	2980.4	109.7
6	80.0	0.1	3.8	0.1	20.2	0.1	7756.8	252.2	23.5	3029.6	98.5
									AVG	2968.4	83.7

Flex

Sample No.	L[mm]	ΔL[mm]	t[mm]	Δt[mm]	w[mm]	Δw[mm]	V[mm3]	ΔV[mm3]	m[grams]	ρ[kg/m3]	Δρ[kg/m3]
1	79.2	0.1	3.8	0.1	19.7	0.0	7504.9	207.0	8.6	1145.9	31.6
2	78.8	0.1	3.8	0.1	19.6	0.1	7437.0	243.1	8.6	1156.4	37.8
3	79.0	0.2	3.9	0.0	19.5	0.2	7568.0	96.8	8.6	1136.4	14.5
4	78.8	0.0	3.8	0.1	19.6	0.0	7437.0	195.7	8.7	1169.8	30.8
5	78.8	0.1	3.9	0.1	19.6	0.1	7591.5	243.0	8.6	1132.9	36.3
6	79.0	0.1	3.8	0.1	19.5	0.1	7413.9	242.5	8.5	1146.5	37.5
									AVG	1148.0	31.4

Homoeogeneous Frequency Spectrums

Steelfill – Sample 1

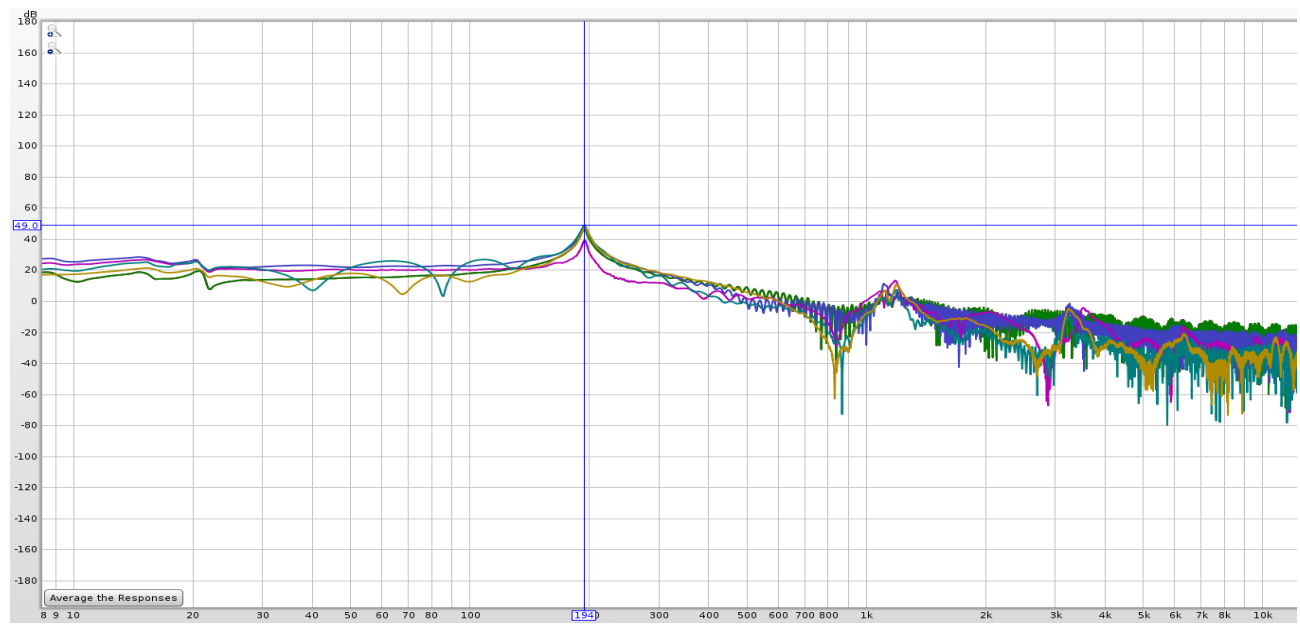


Illustration 3: Collected Responses



Illustration 4: Averaged Response

Steelfill – Sample 2

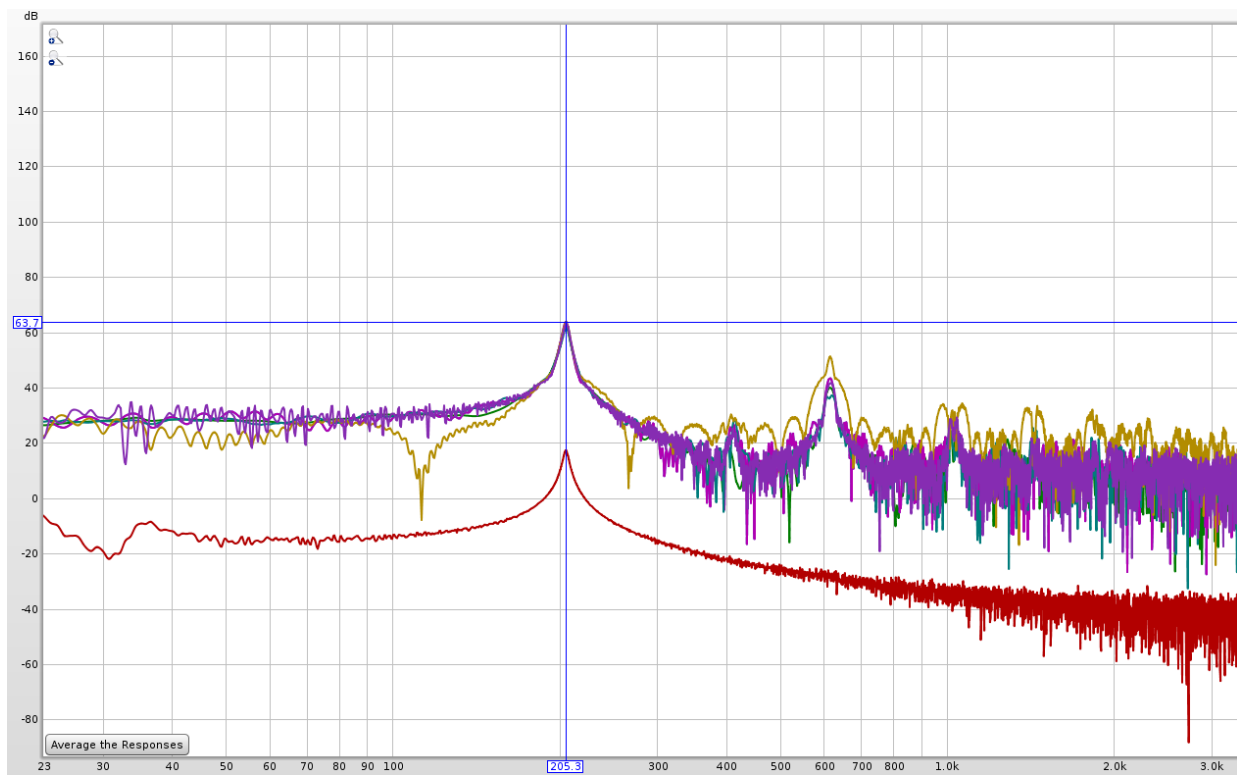


Illustration 5: Collected Responses

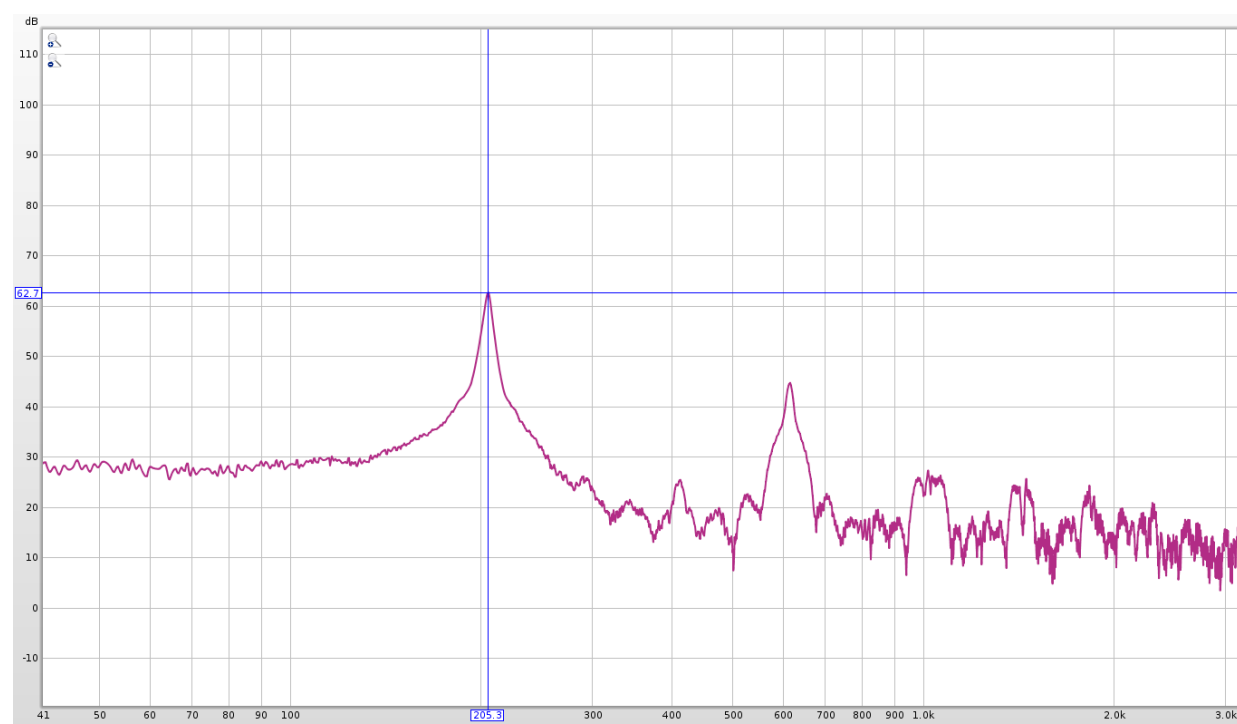


Illustration 6: Averaged Resposne

Steelfill – Sample 3

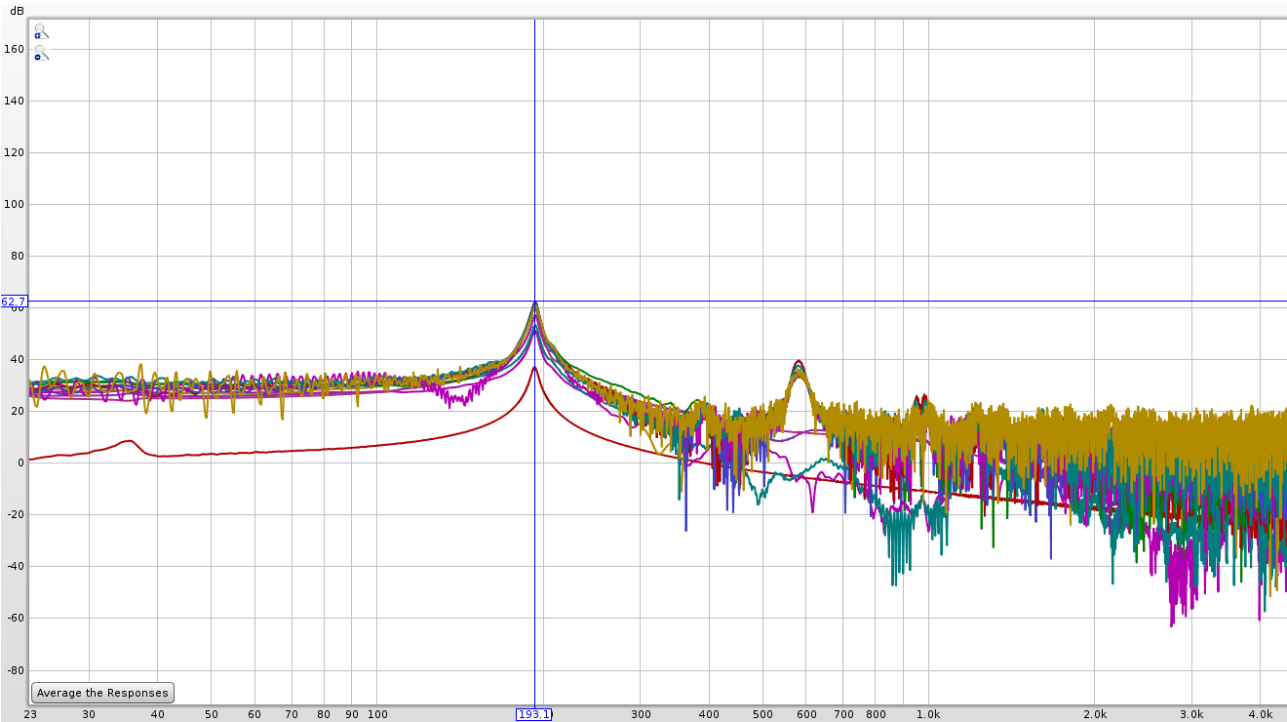


Illustration 7: Collected Responses

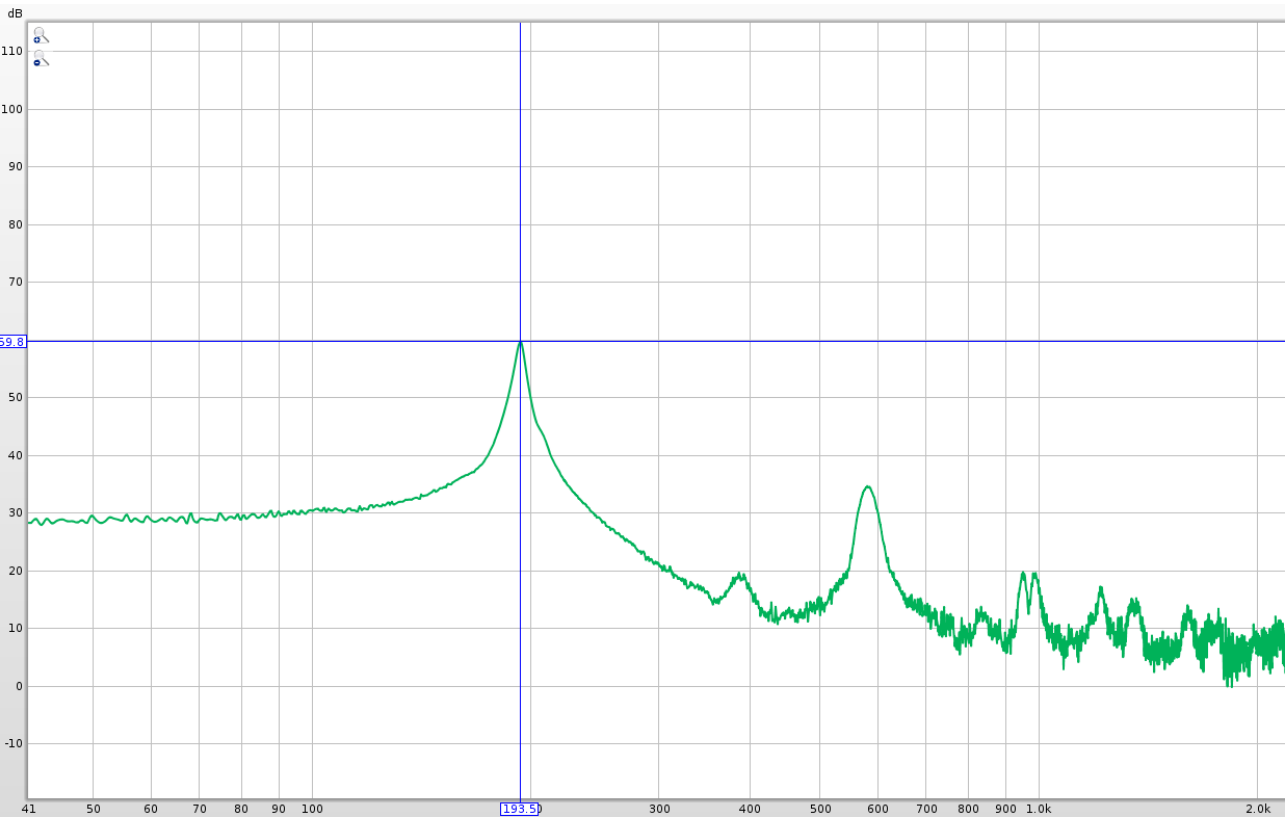


Illustration 8: Averaged Response

Steelfill – Sample 4

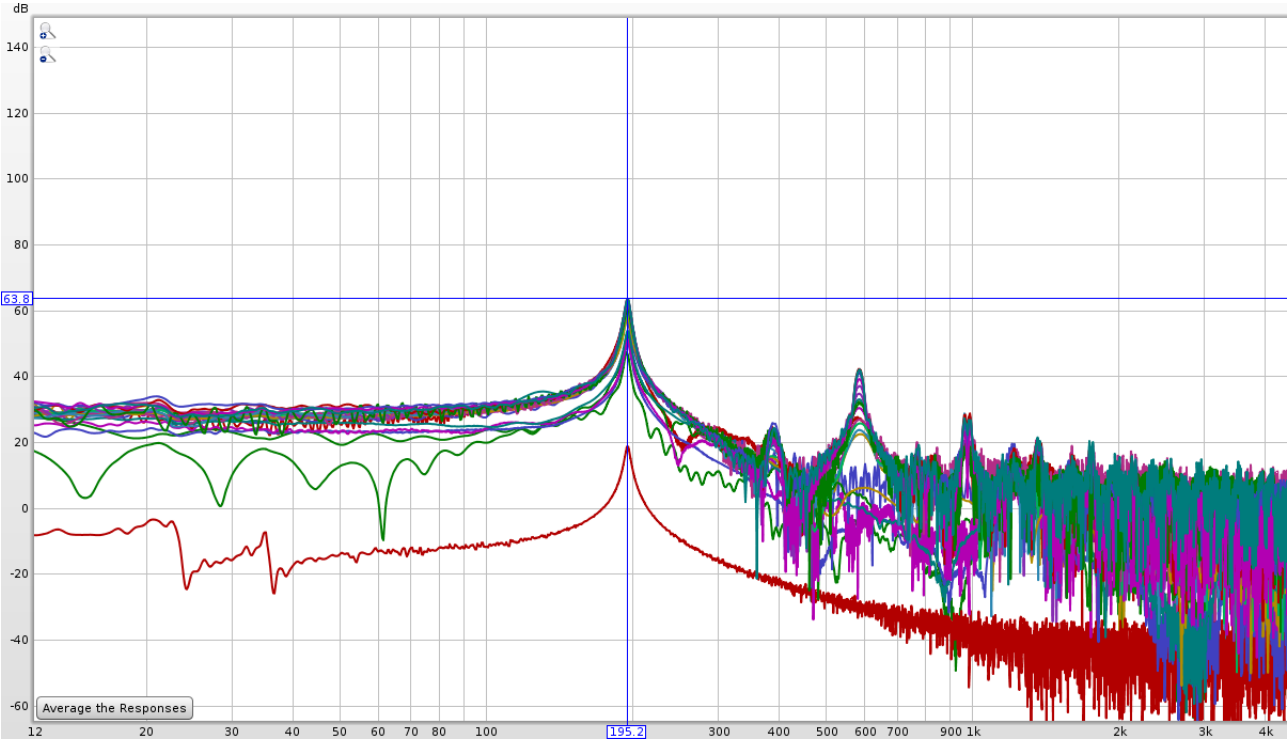


Illustration 9: Collected Responses

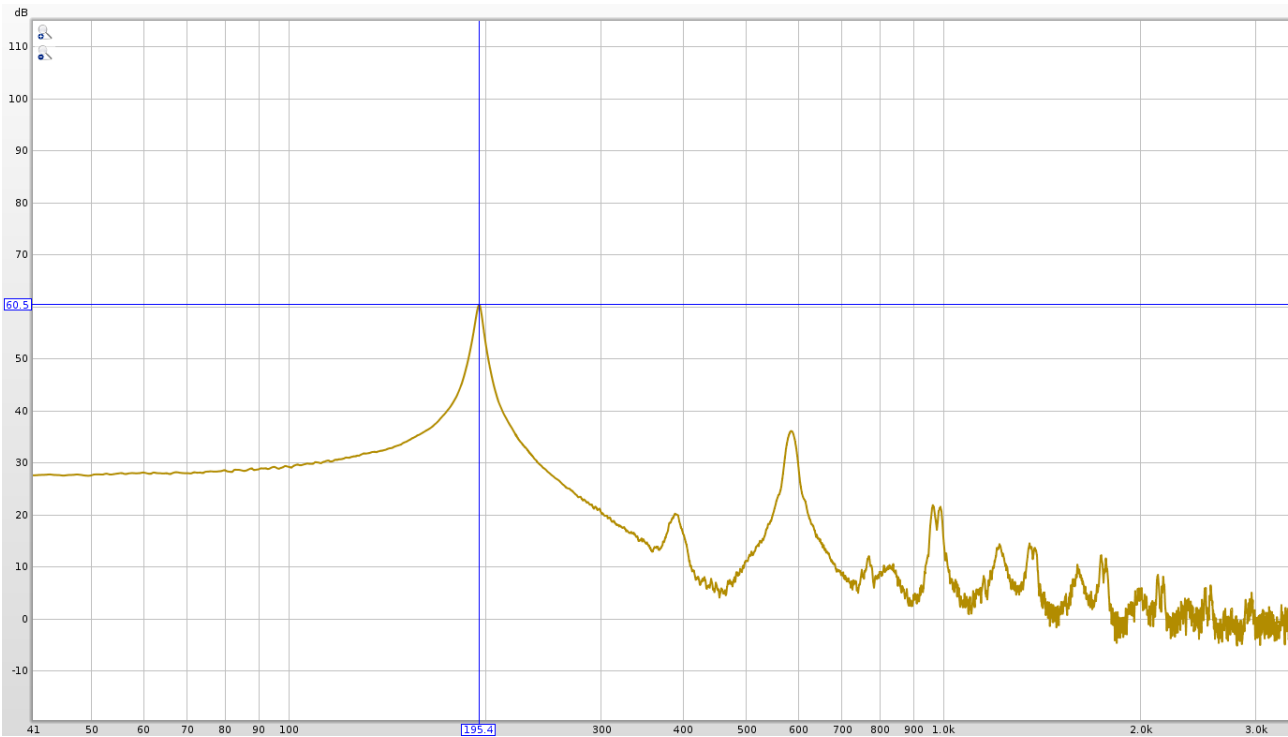
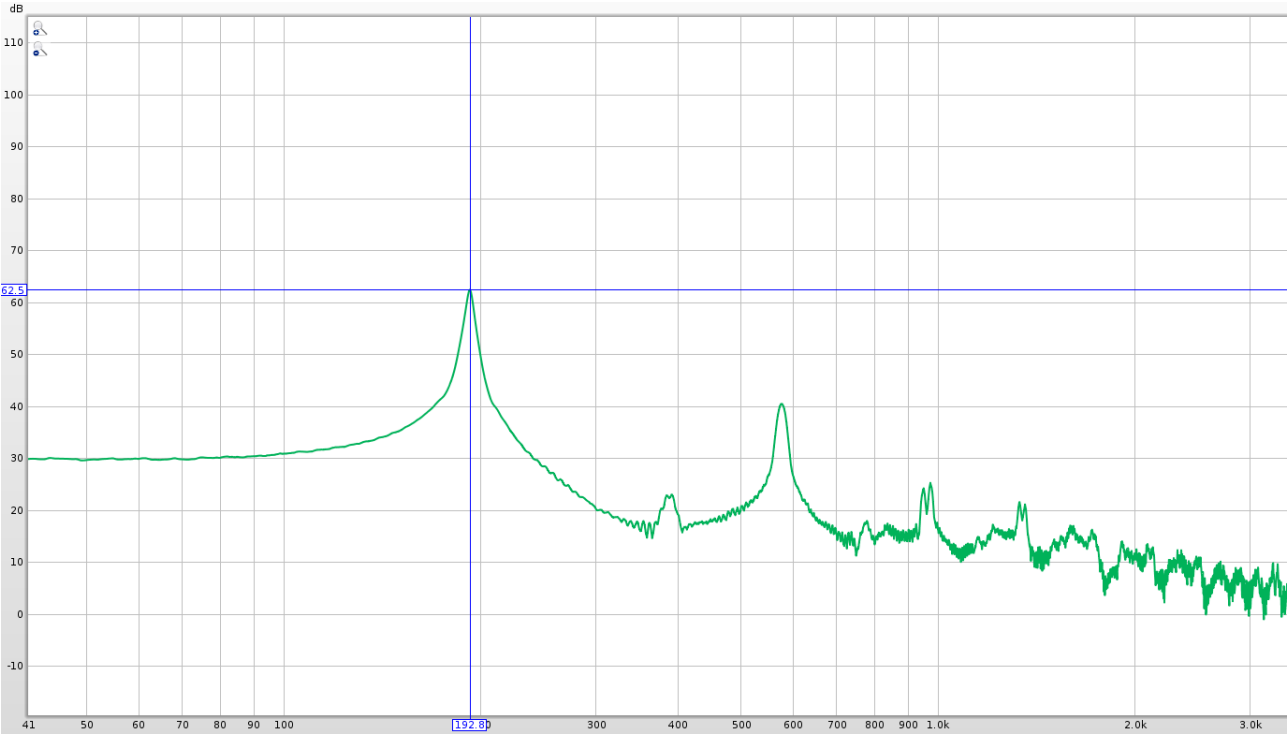
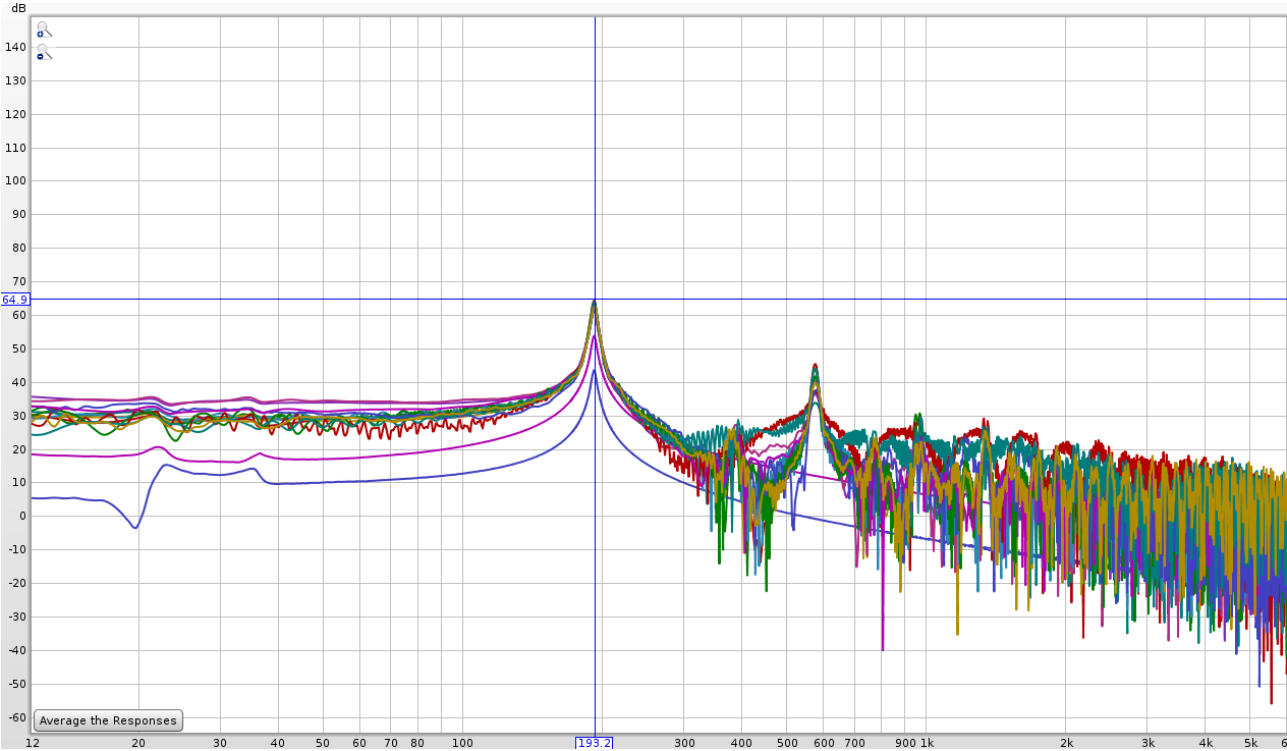
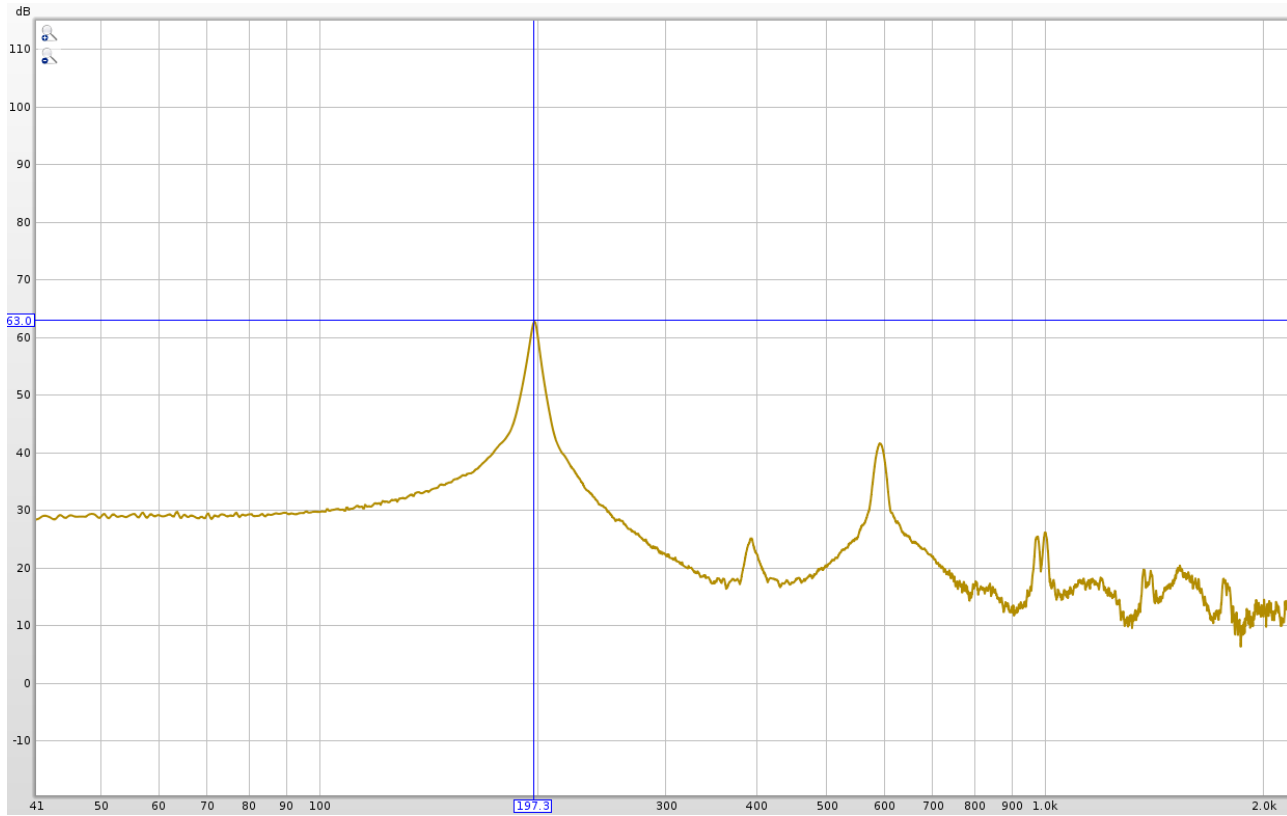
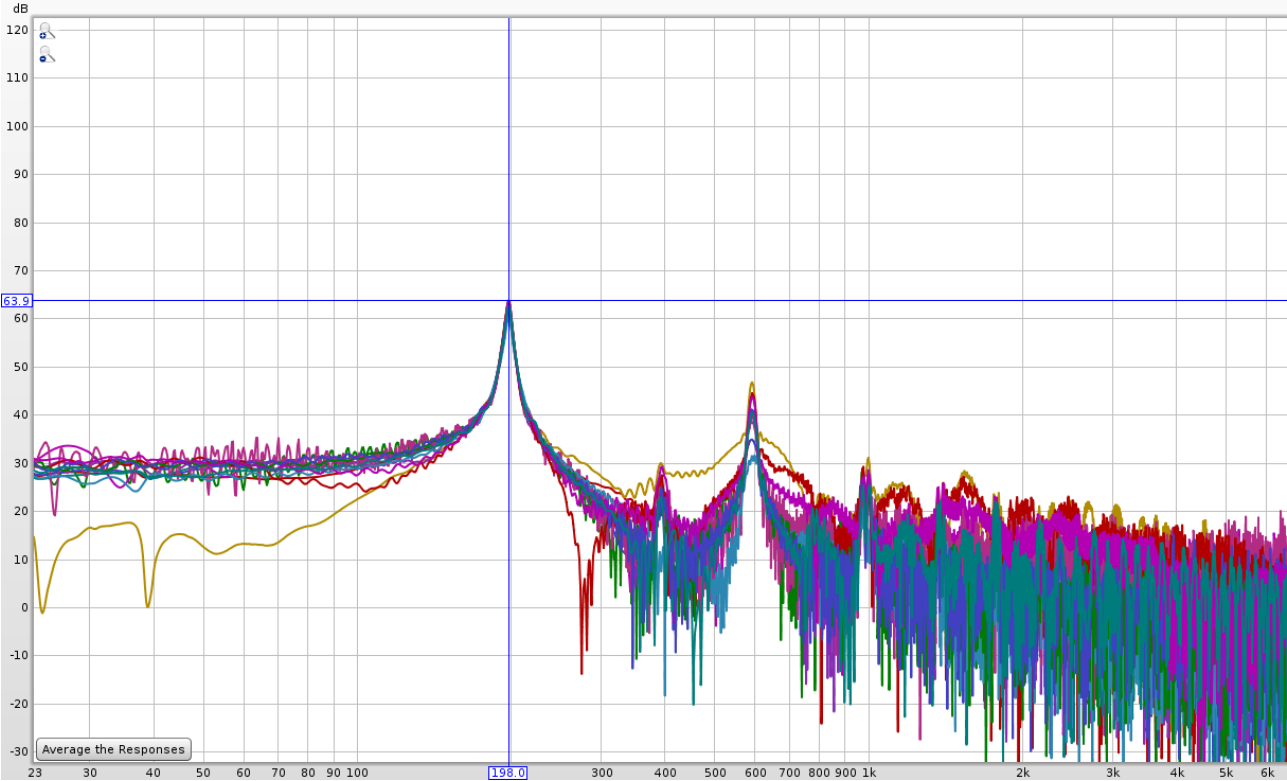


Illustration 10: Averaged Response

Steelfill – Sample 5



Steelfill – Sample 6



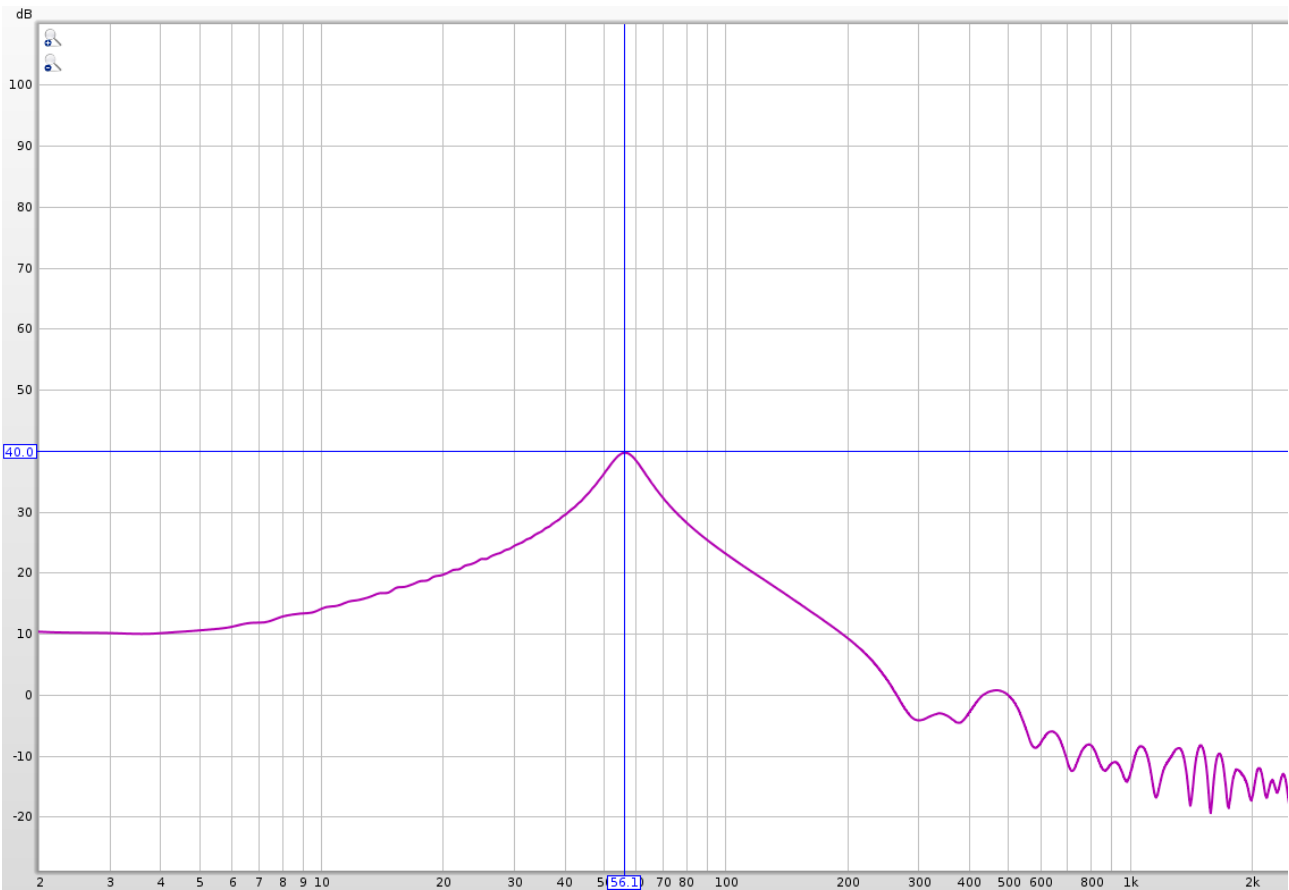
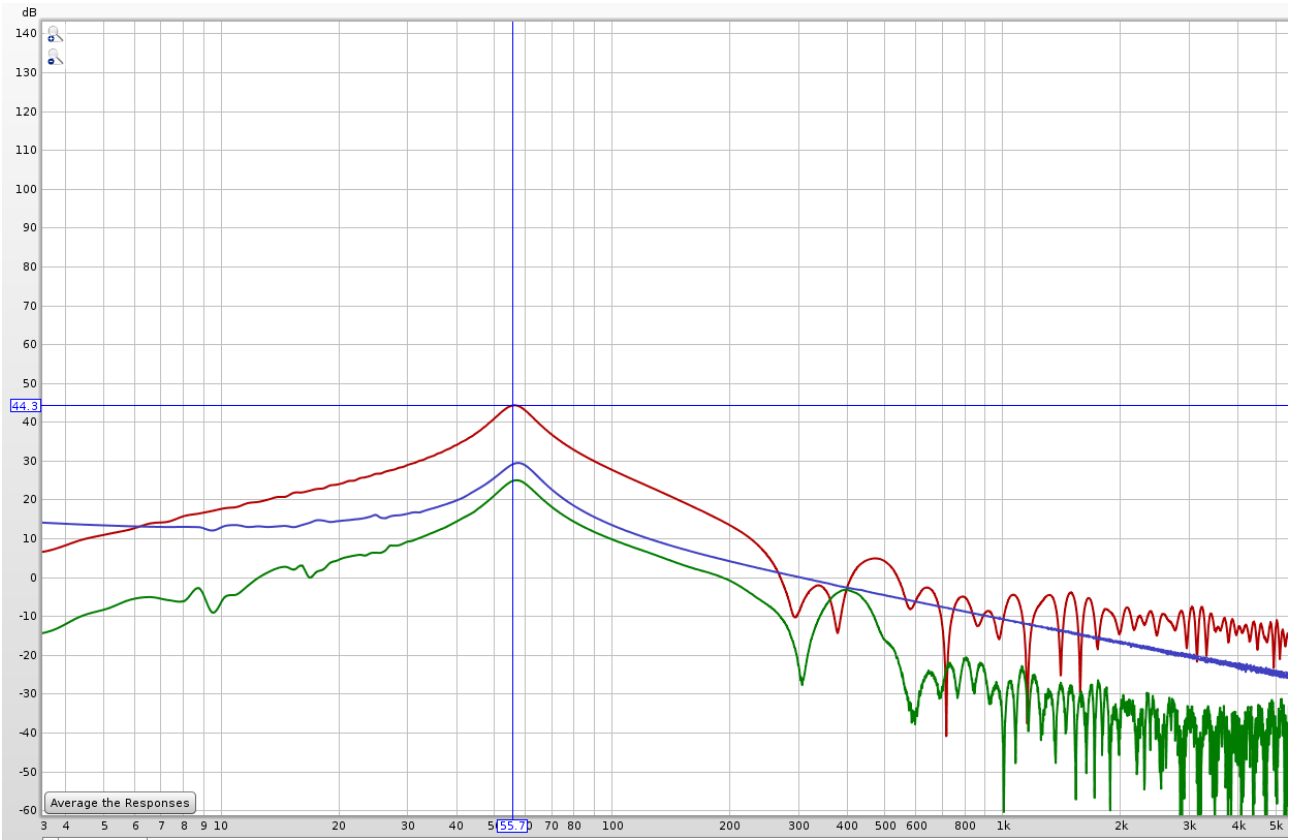
Elmer solutions for homogeneous steelfill

n	f [Hz]	Mode Type
1	198.74	In-Plane Bending
2	902.68	Out-Of-Plane Bending
3	1092.24	Torsional
4	1216.99	In-Plane Bending
5	3310.83	In-Plane Bending
6	3391.18	Torsional

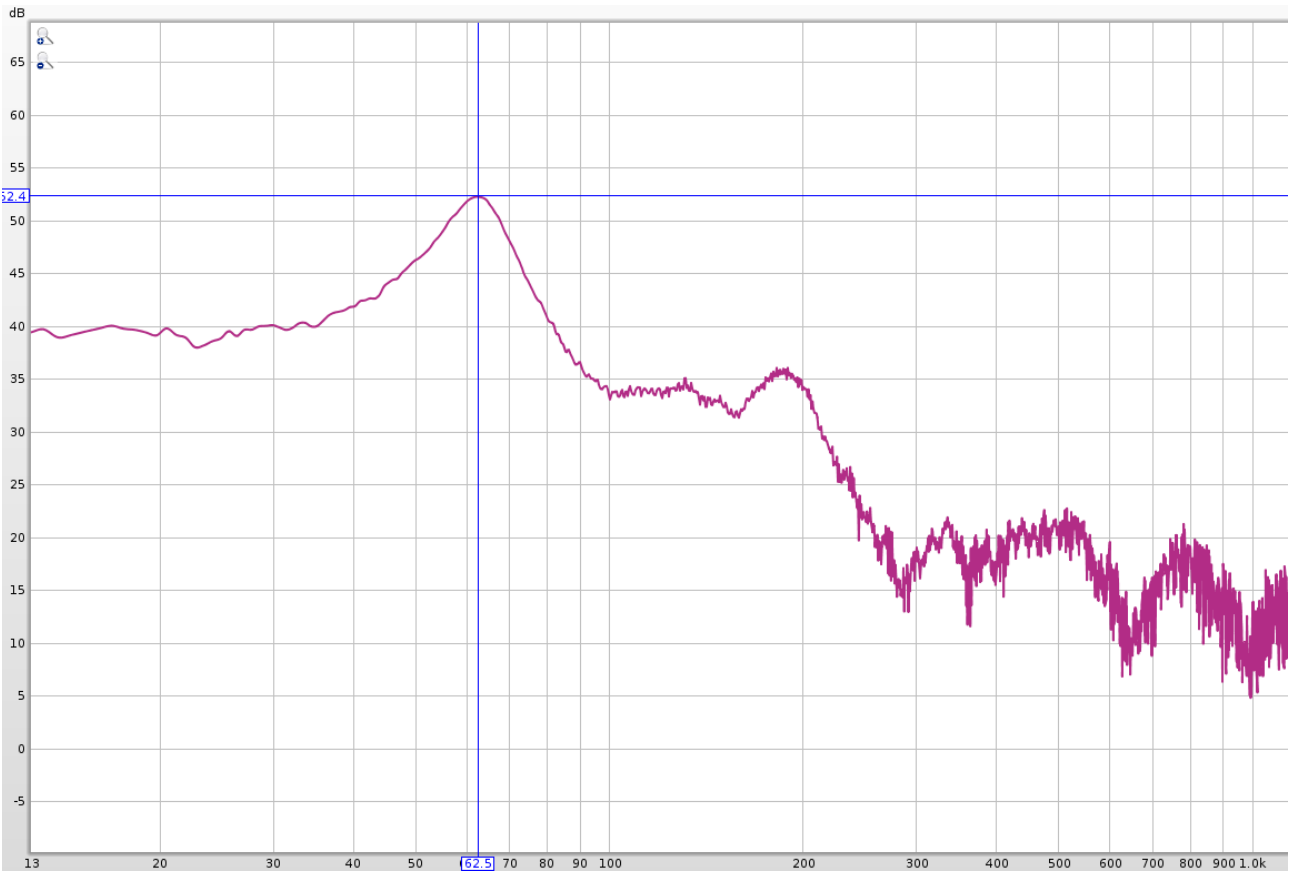
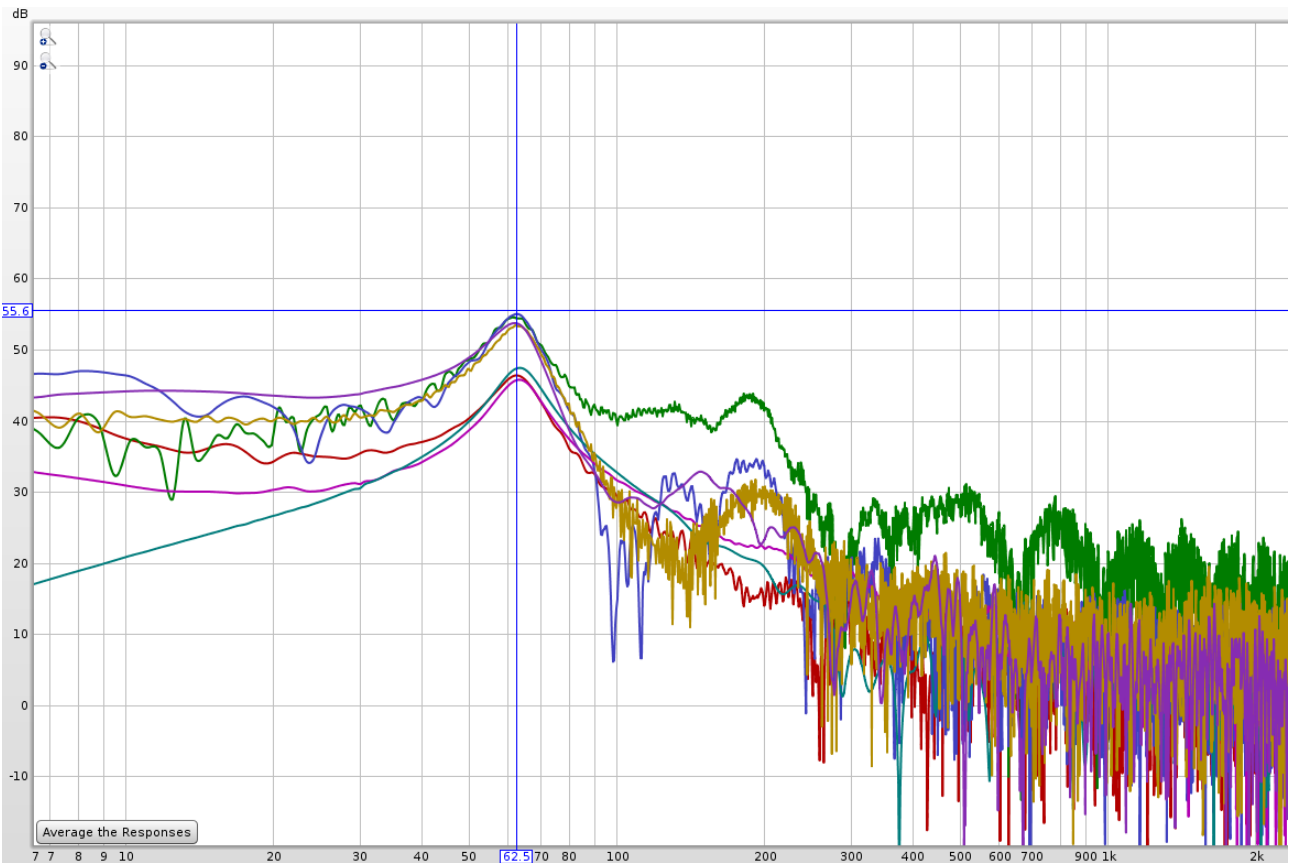
Illustration 11: Using $E = 3.45e9$ GPa, $\rho = 2950$ kg/m³

- First mode consistently occurring at 195 – 202Hz range from data.
- Hard to pick up on the higher order modes – other following peaks are likely harmonic responses(?)

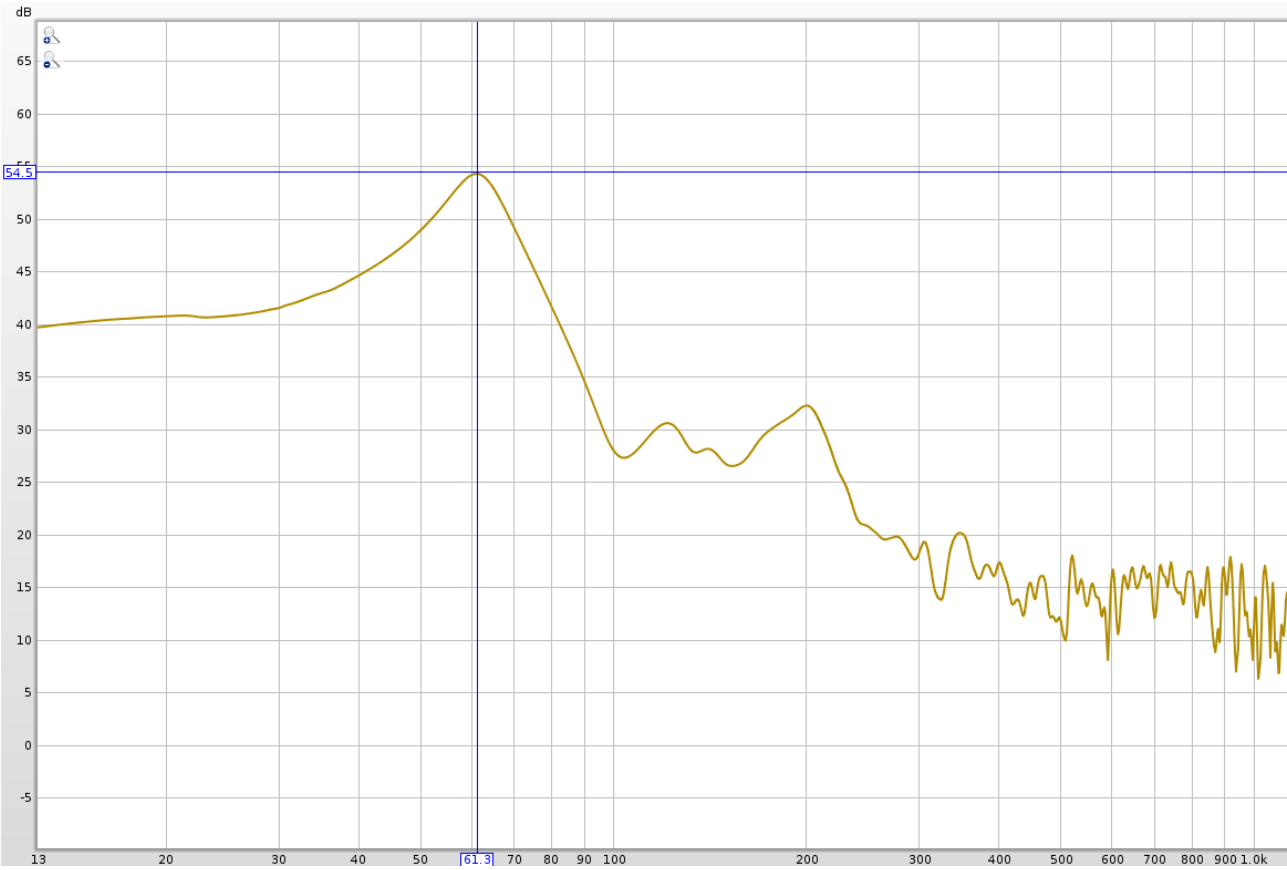
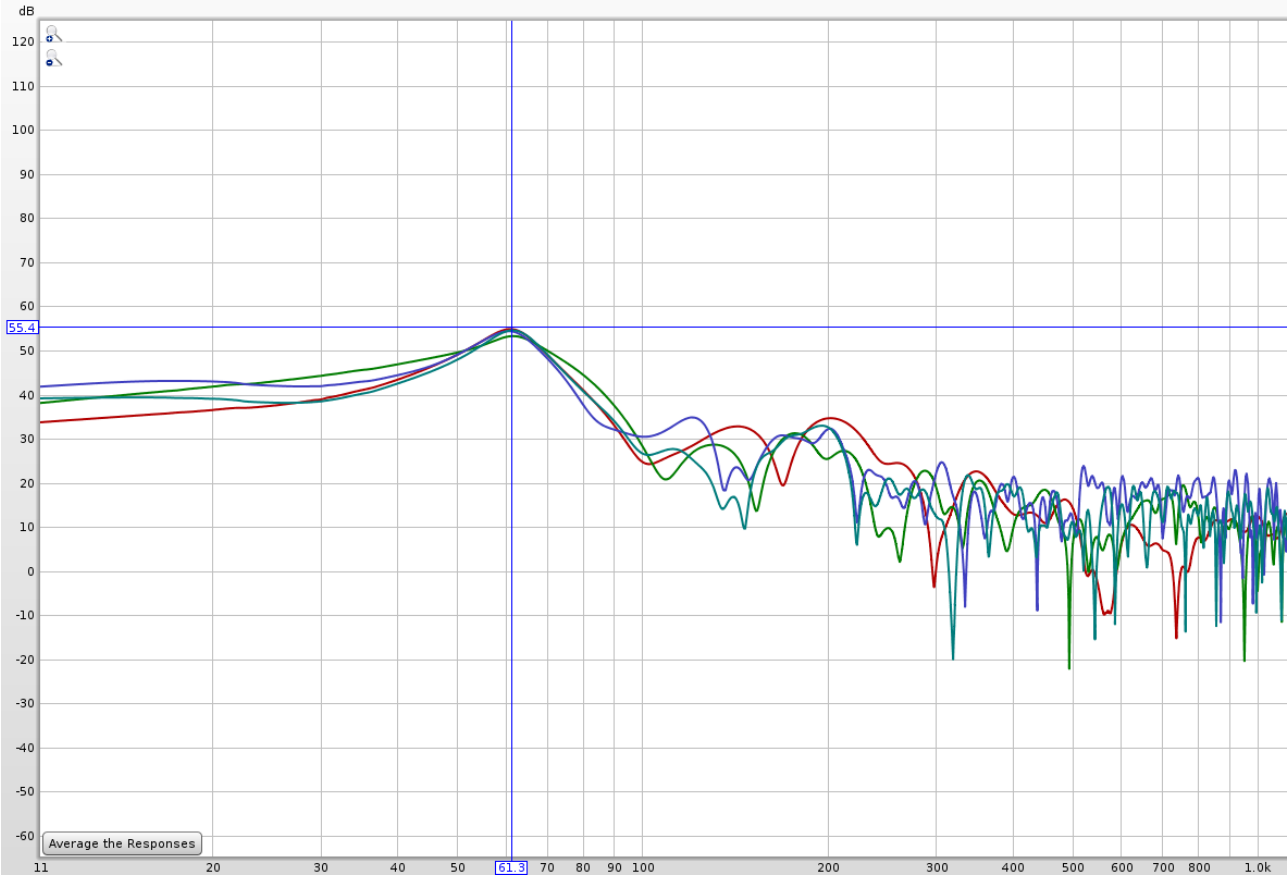
Flex – Sample 1



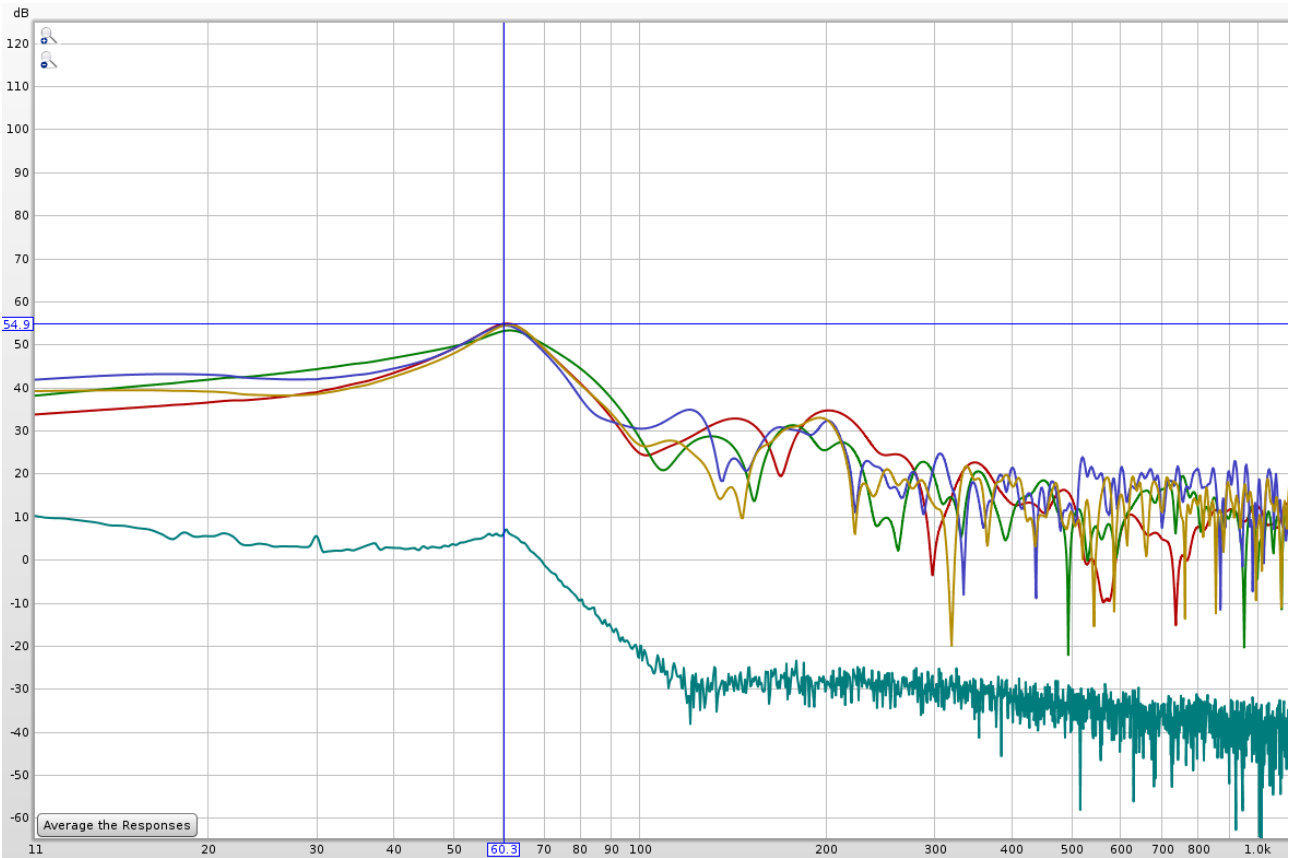
Flex – Sample 2



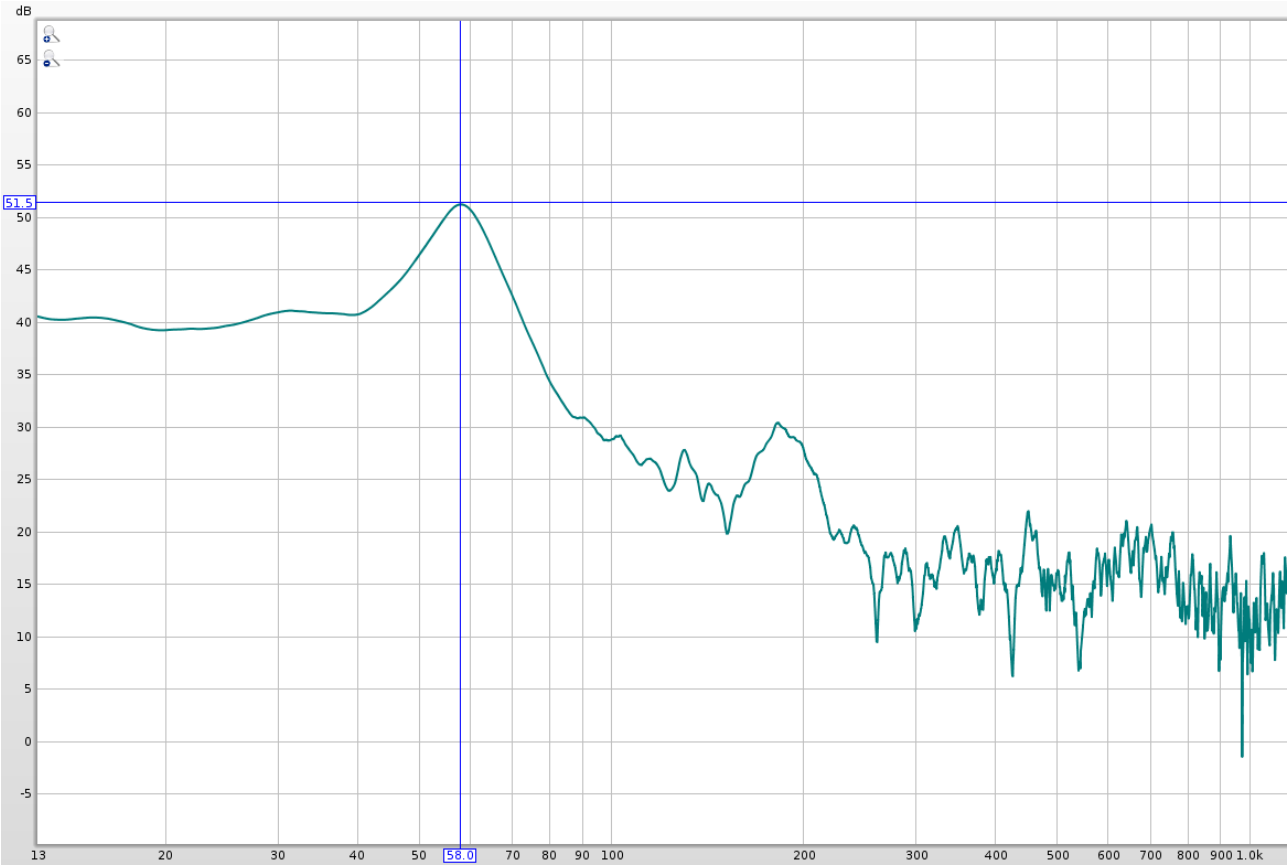
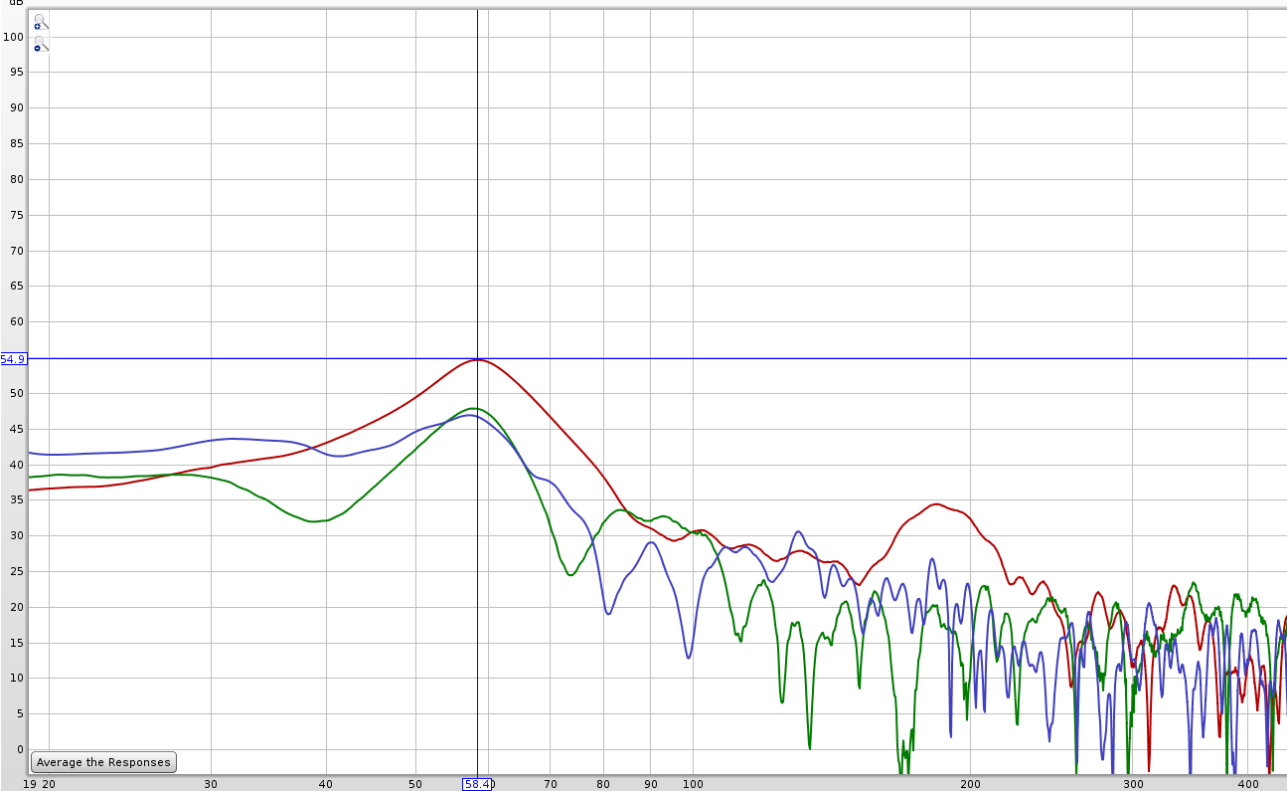
Steelfill – Sample 3



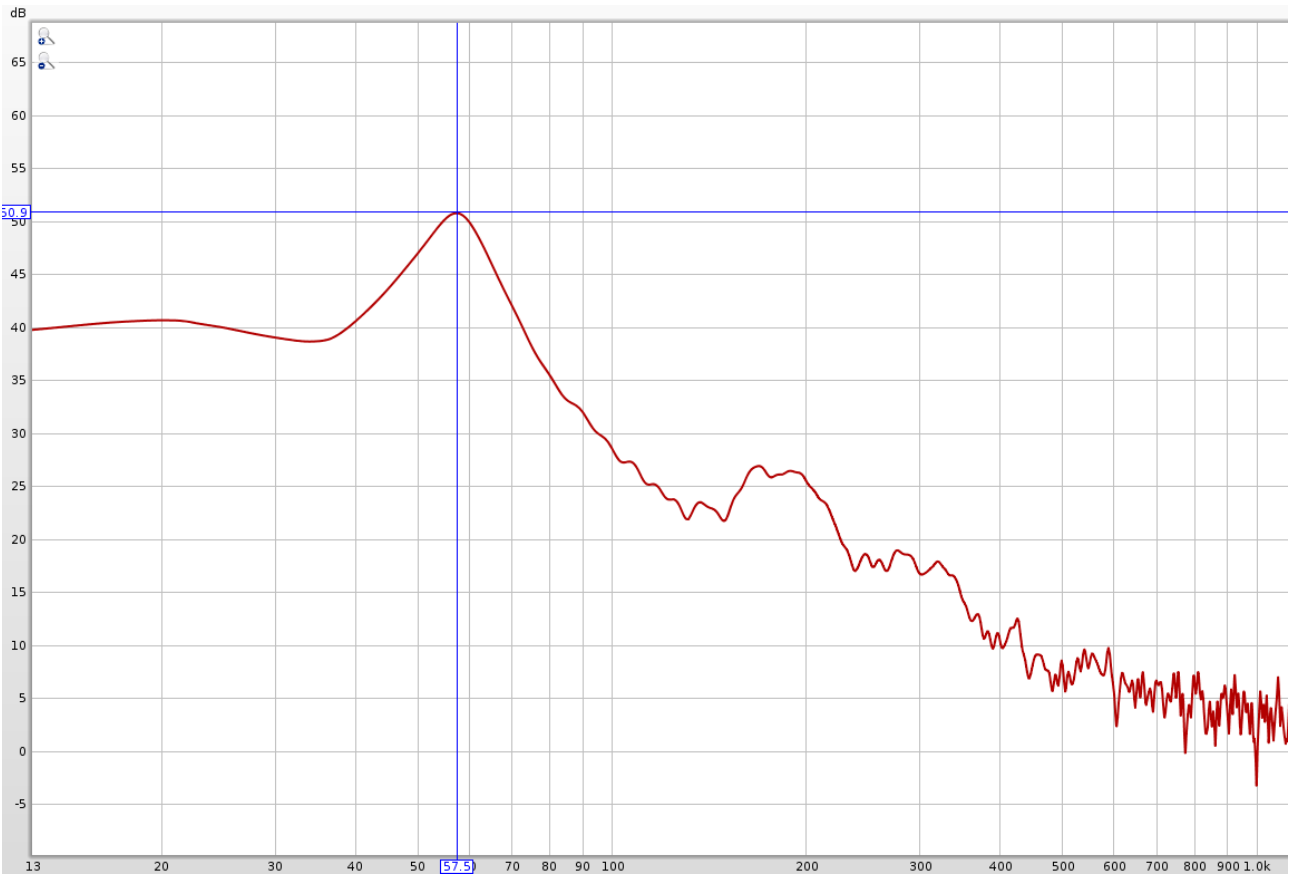
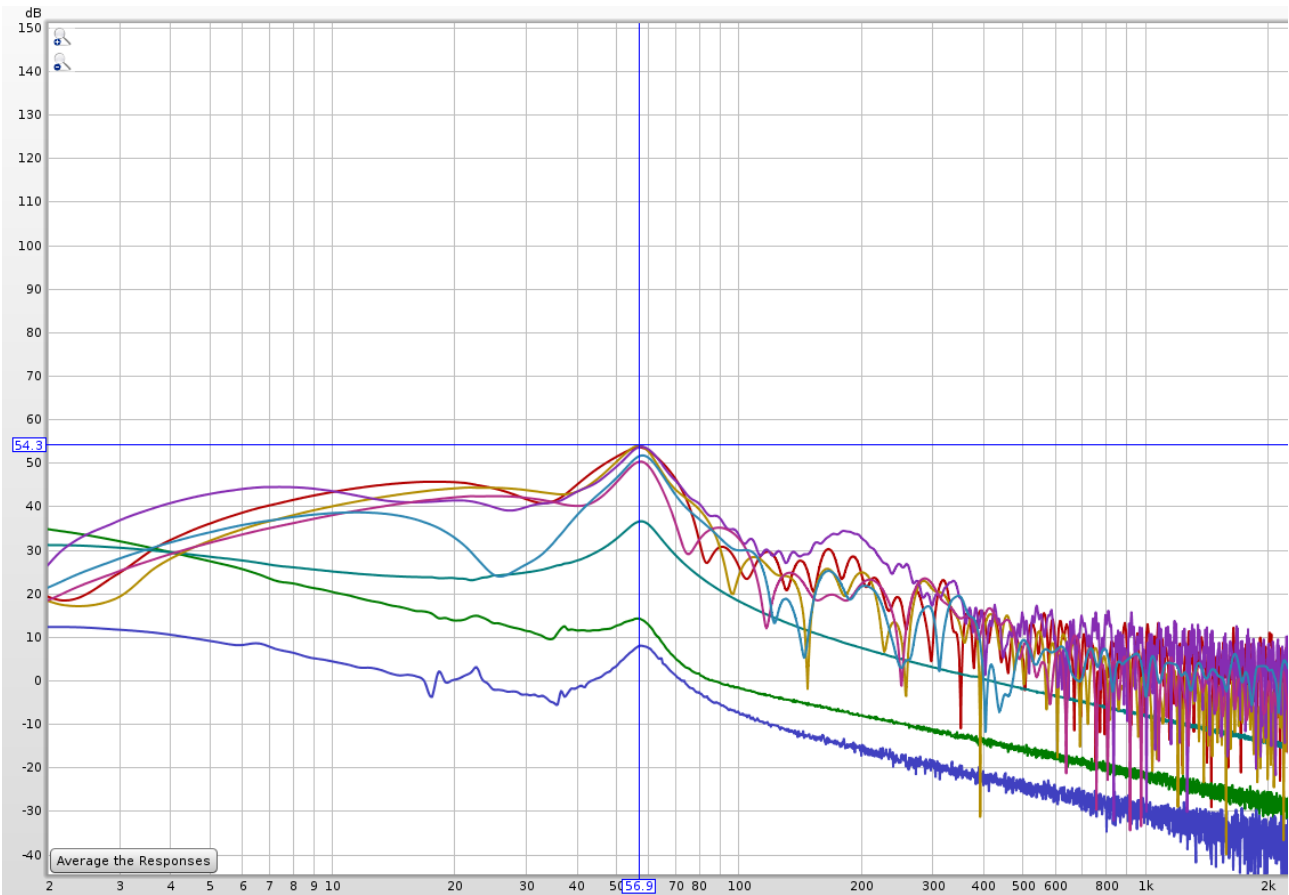
Flex – Sample 4



Flex – Sample 5



Flex – Sample 6



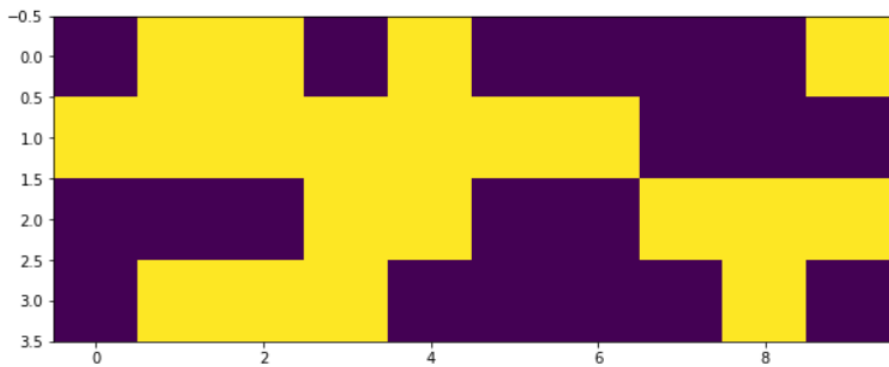
Elmer solutions for homogeneous flex:

n	f [Hz]	Mode Type
1	60.18	In-Plane Bending
2	273.33	Out-Of-Plane Bending
3	330.73	Torsional
4	368.50	In-Plane Bending
5	1002.51	In-Plane Bending
6	1026.84	Torsional

- Samples consistently in 55 – 60Hz range
- Non-sharp peak formations – poor laser dispersion behaviour of flex:



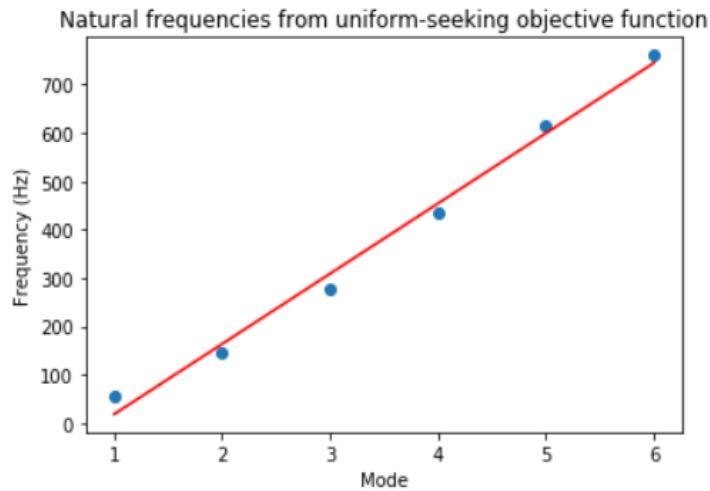
Voxel Beam Solution 1-1
Purple = Flex, Yellow = Steelfill



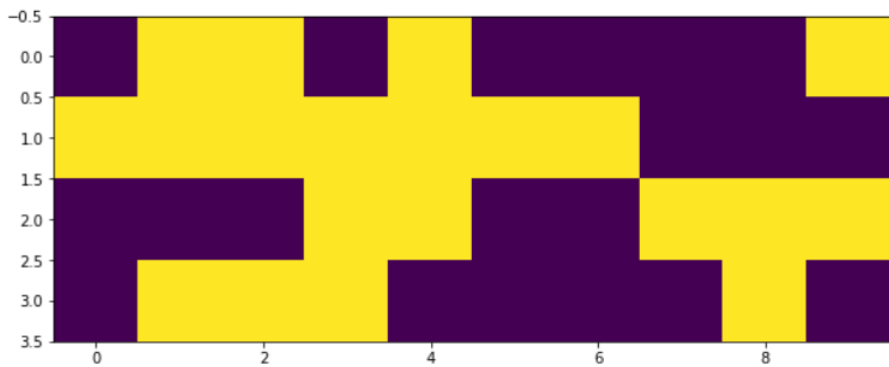
Natural frequencies:

- 1: 55.47 Hz
- 2: 146.82 Hz
- 3: 277.71 Hz
- 4: 434.75 Hz
- 5: 613.59 Hz
- 6: 760.65 Hz

Elmer solutions:

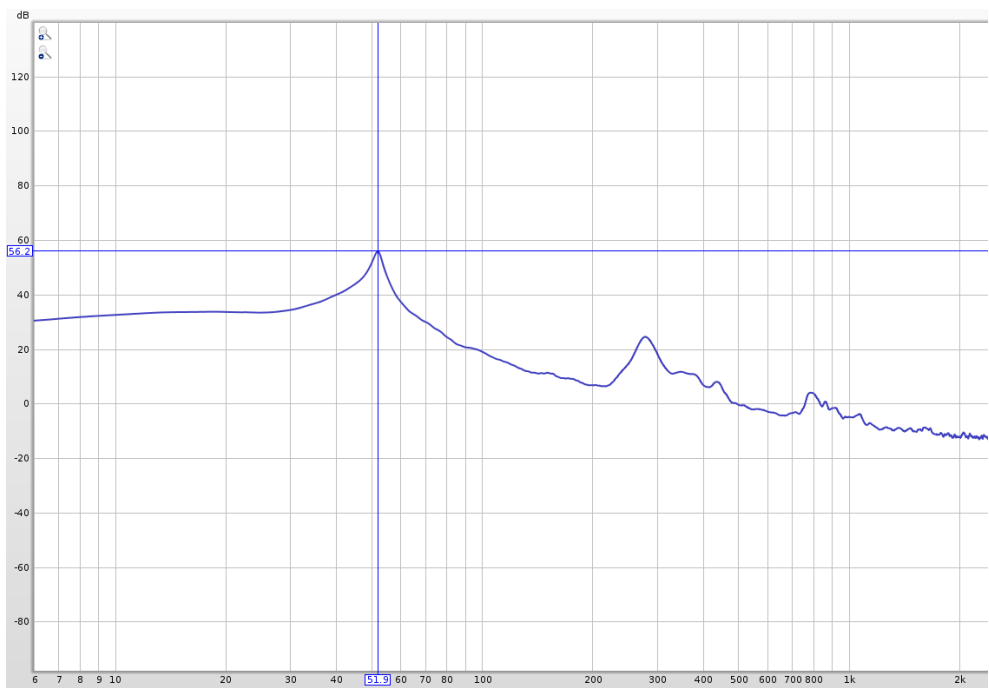
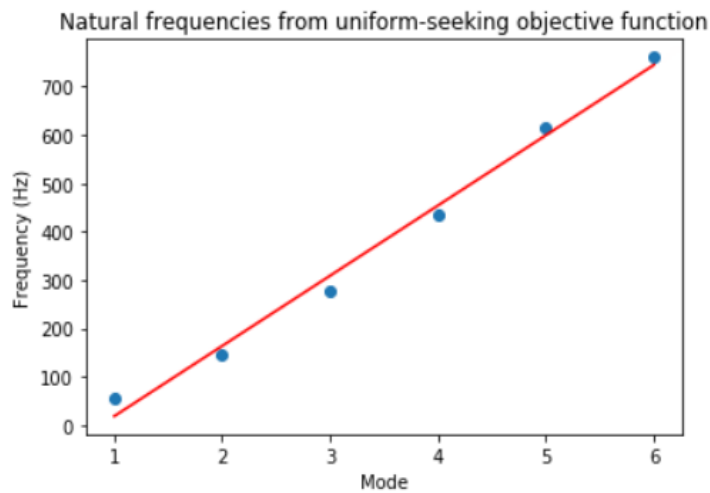


Voxel Beam Solution 1-2
Purple = Flex, Yellow = Steelfill

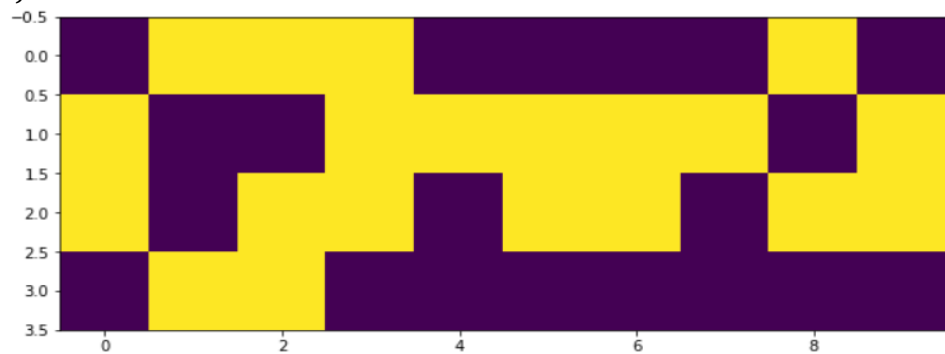


Natural frequencies:
1: 55.47 Hz
2: 146.82 Hz
3: 277.71 Hz
4: 434.75 Hz
5: 613.59 Hz
6: 760.65 Hz

Elmer solutions:

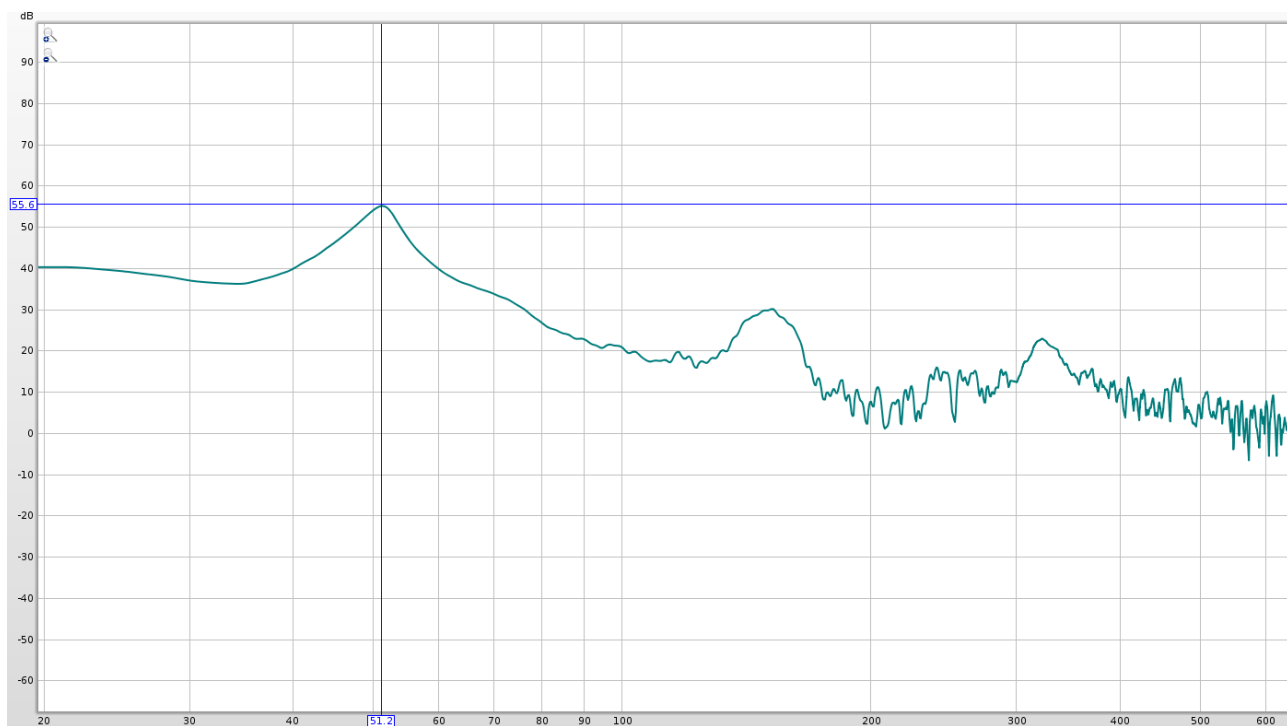
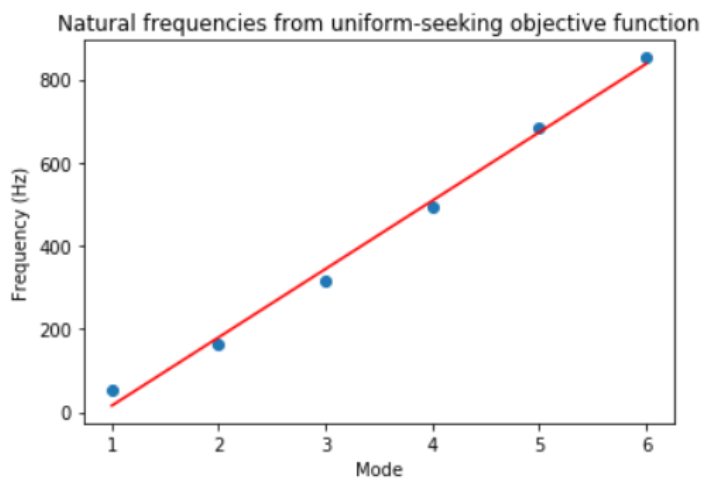


Voxel Beam Solution 3
Purple = Flex, Yellow = Steelfill

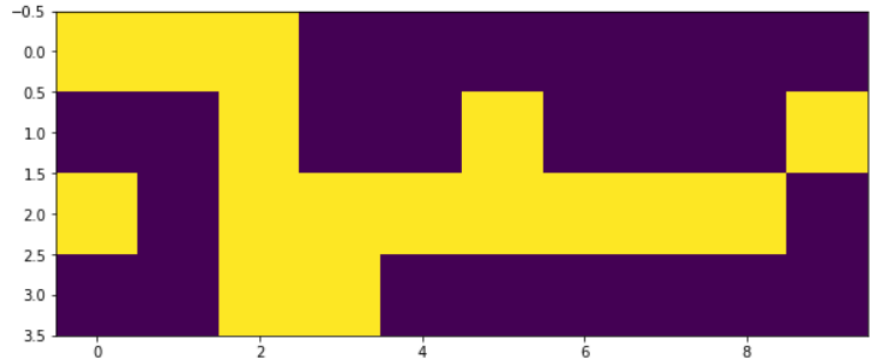


Natural frequencies:
1: 51.93 Hz
2: 161.92 Hz
3: 314.36 Hz
4: 493.03 Hz
5: 685.72 Hz
6: 851.94 Hz

Elmer solutions:

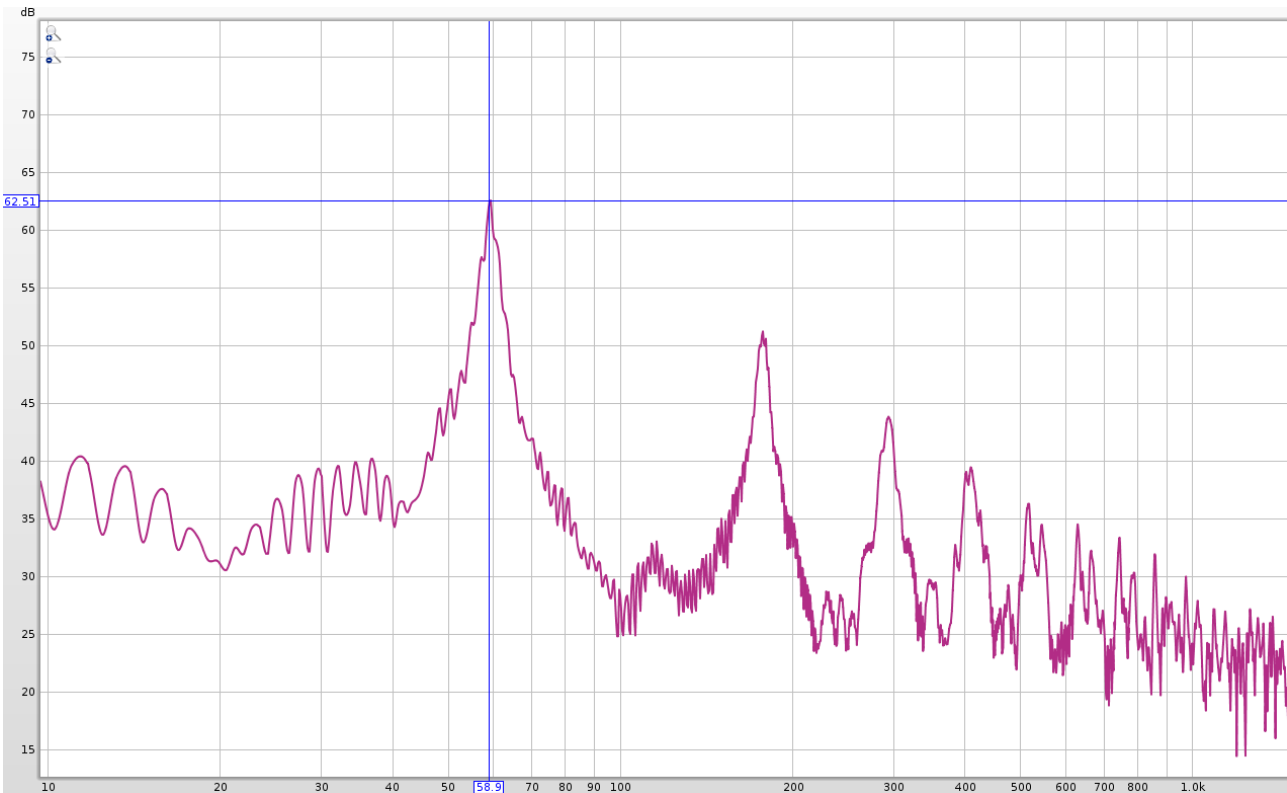
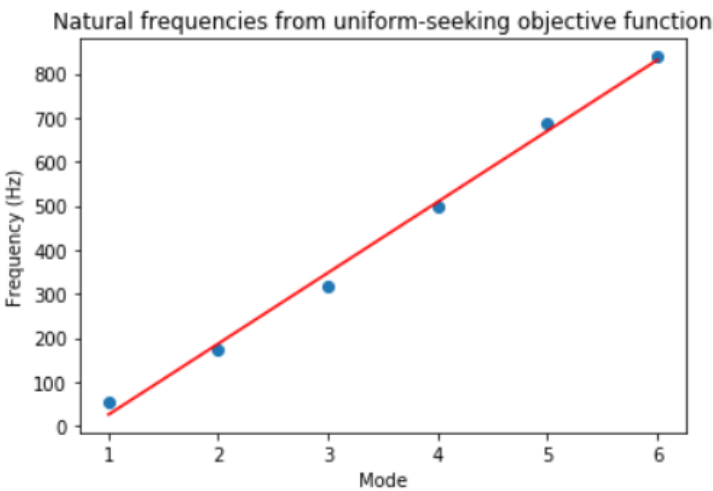


Voxel Beam Solution 4
Purple = Flex, Yellow = Steelfill



Natural frequencies:
1: 56.01 Hz
2: 173.04 Hz
3: 316.23 Hz
4: 499.97 Hz
5: 686.68 Hz
6: 838.27 Hz

Elmer solutions:



- Can be difficult to distinguish between harmonic responses and natural modes. Particularly when prescribed frequency spacing is integer multiple of the natural frequency (higher order mode and harmonic response might be identical?)
- For specific samples, difficulty encountered in exciting higher order modes
- Rectangular windowing, 50% overlap with no averaging used. Real-time analyser. Might be better to try using Hann or Blackman-Harris windowing.

Other things to-do:

- Propagate numerical errors and material parameter errors -> addition of error bars in frequency profiles and “frequency bands” overlayed onto the spectral estimation plots
- Selection of solutions from the patch of optima from Ben’s contour plot. Fix either f_1 or df , and vary the other.