

Adding the Central fan brace and results of 3 shaping options
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This study seeks to answer the following questions :

1. What does a (fan) brace do to the top modes?
2. What does the shape of the brace do to the top nodes?
3. What does all this do to the main top resonance(s) ?

Technical aspects of this study:

In this study, all the modifications were done without removing the soundboard from the “rack” . The purpose of the rack is to simulate the sides as glued to the soundboard. The two main transverse braces (aka Harmonic bars) are in place, the lower one on the long dipole node.

Data is presented in a way that makes sense to me and may differ from models used by other researchers. Soundboards vibrate in a complex series of modes that combine divisions of the longest and widest points of the soundboard. I use the lengthwise divisions (long poles) as the first level of reference and further specify the number of widthwise divisions (cross poles) that appear in each long pole. The long poles (5, from top to bottom) are UB (upper bout), SH (Sound Hole), W (waist), LB (lower bout) and LLB (lowest lower bout). The cross poles are simply numbered by how many divisions are present across that particular long pole. For example:

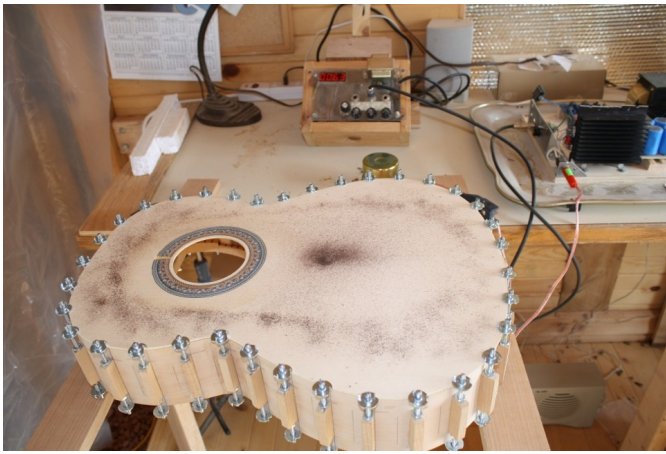


Illustration 1: 63Hz, Monopole (1p)

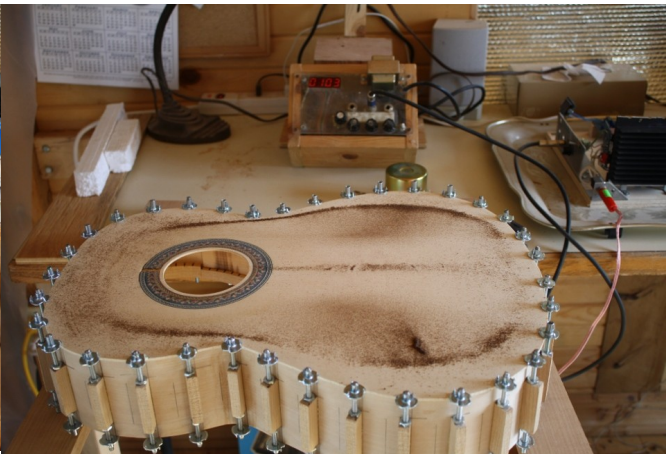


Illustration 2: 103Hz Cross Dipole (X2p)

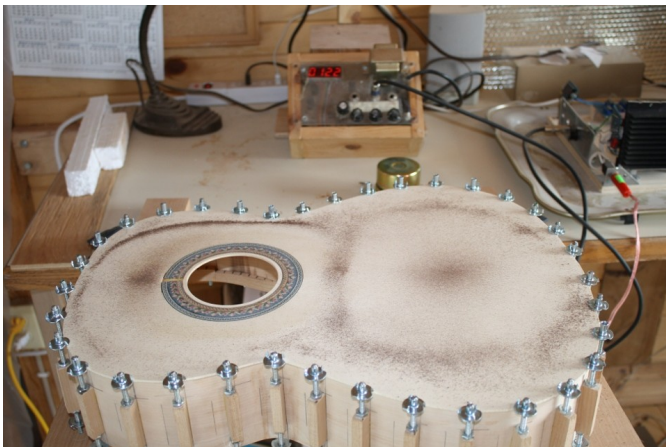


Illustration 3: 122Hz Long Dipole (2p or 1/1)

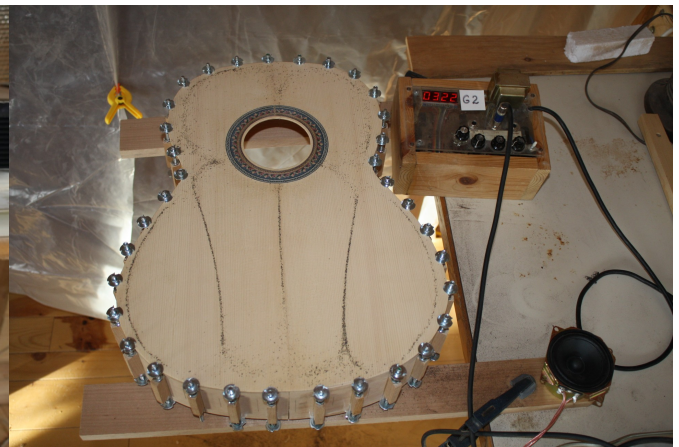


Illustration 4: 322Hz (2/4)

The above photos show **unbraced top** patterns at various frequencies. The last photo is of a different soundboard from the first three. The first examples utilize ebony saw dust to display the patterns, the last one uses ground pepper, which forms finer node lines and is quite aromatic as well. It should be noted that **NONE** of the above patterns manifest in this study, due to the presence of the two transverse braces at the waist and upper bout respectively. As can be seen in previous studies, the presence of a strong brace has the effect of stifling mode formation other than those modes that have a node (non vibrating) line where the brace is located.

A 2 ½ inch diameter speaker was used to drive these patterns from under the soundboard using a frequency generator and an amplifier. The same volume setting was used for every pattern, but the location of the speaker varied considerably as it had to be placed away from nodes in order to manifest the mode pattern. A smaller speaker could pinpoint complex patterns better and a larger speaker obscures most complex patterns, so the 2 ½ inch size is a good compromise for my purposes.

Definitions:

Mode – A specific pattern of vibration.

Node – The non vibrating areas within a specific mode. These can be lines, patches or points.

Anti-Node – The vibrating areas within a specific mode. These can be quite oddly shaped.

Peak – When viewing a frequency plot (spectral analysis), the highest points

Valley - When viewing a frequency plot (spectral analysis), the lowest points

The Data:

I present the data in a table form. The left side of the table shows the mode pattern as described above. The right side shows the frequencies those modes occur at for each stage of the study. So far I have not found a way to present this data in an easy visual format, so the viewer is required to think about this a bit harder to understand what is going on.

Modes – number of cross poles in each area					xform	Frequencies for each mode					Long form
Upper Bout	Soundhole	Waist	Lower Bout	Lowlow bout		No fan	tall center fan	Tapered	Scalloped	Even – low	
			1		1p	28					Main Top Freq
			1			46	54		52	47	
			1			135	147	147	144	135	
			2		x2p		28	29	27	27	
			2				39	39	39	38	
			2				48		61		
			2				65	65	65	64	
			2				96				
			2			203	181	182			
			3		x3p	86		53		83	
			3			258	239	267	257		
			4		x4p	321	410	314	316	306	
			5		x5p			397	391	388	
			5					443		407	
			6		x6p	499		473	472	470	
			6					489	491	491	
			7		x7p	603		576			
1			1			40					Long dipole
1			1			238					
1			2				241	197	194	191	
1			3				276			248	
1			3							258	
1			5				399				
1			6				473			477	
1			1	2			337	336	335	331	Long tripole
1	1		5			401					
2			2	2		443		516			
2			2	2		525					
2		2	2				512				
2			4	2		477					
2			3	3			638				
3			5	5		756					
1	2		3	3		560					Long Quadpole
3	1		3	3		628	626				
1	2		4	4		669					
2		2	6	6		864					

Not every set of data is complete. While some show patterns up to 800+Hz, others were only sampled to 400Hz. Most Luthiers will want to simplify things down to manageable levels of work and complexity, so 400Hz may be adequate for the vast majority of readers.

As I look over this data set a few things appear to be obvious:

1. The main top frequency (MTF) raises 12 Hz with the initial placement of the full brace.
2. The MTF reduces successively with each modification until it's back to the initial value.
3. The number of x2p modal forms increase dramatically with this brace placement
4. The initial (main) x2p mode drops ~20Hz with this brace placement

5. Reducing the fan structure has the effect of lowering the modal frequency for almost all modes.
6. The modal frequency for two x6 modes increase with fan reduction.

It is impossible to say at this point what this study and the modifications inherent in it will have to the sound of the overall instrument, which relies on the interaction of its component parts to amplify the sound of string driven frequencies. However, certain inferences can be made pointing to further research in various areas of inquiry.

