On the interaction between double basses and the stage floor

by K Guettler, A Buen and A Askenfelt

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On the interaction between double basses and the stage floor

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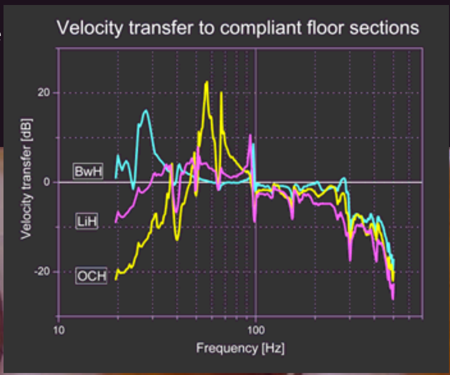
Floor impedances of three concert halls were measured: the Berwald Hall (BwH) of Stockholm, the Oslo Concert Hall (OCH), and the Lindeman Hall (LiH) of Oslo.

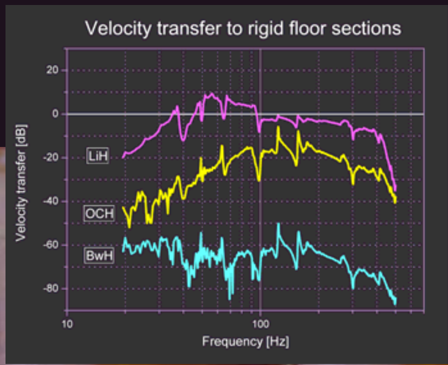
Likewise, endpin impedances of three double basses were recorded.

The calculated vibrational transfer appears to be remarkably good for compliant floors in the frequency range below 100 Hz. This is particularly true for floors with its lowest resonance well above 100 Hz.

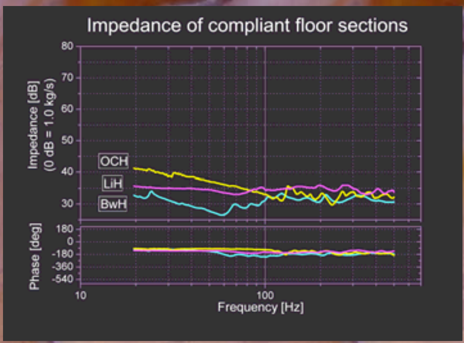


In BwH and OCH the compliant floor sections are stage lifts. Although preferred by the bassists, these give pronounced resonances.

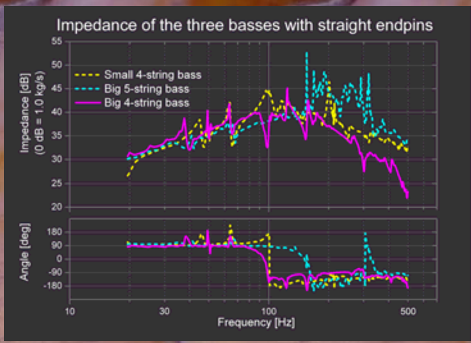
In LiH (which for double bass is the better hall) the compliant areas were measured between joists.



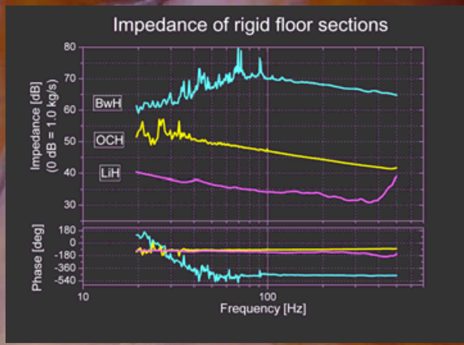
In BwH, the rigid floor sections are parquet glued onto bedrock. In OCH it is parquet glued onto concrete, while in LiH, parquet on joists, 30 cm apart, are resting on thin rubber blocks.



All the compliant floor sections show impedances with springy phase (near -90°) in the low-frequency end of spectrum.



Double basses show impedances with phase near +90° (i.e., mass) up to above 80 Hz. This provides efficient coupling to compliant, springy floors in the same range.

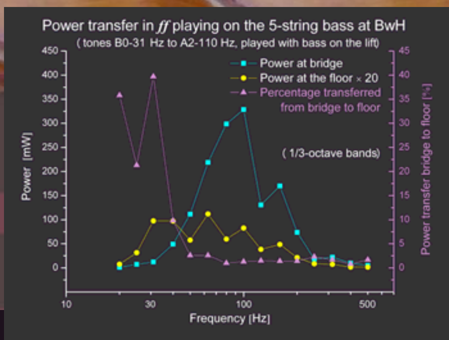


The rigid floor parts of BwH and OCH have very high impedances. In BwH, this was done intentionally to prevent the floor from "absorbing energy".

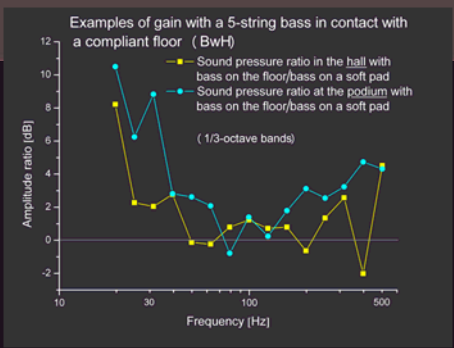
In the low-frequency end of spectrum, good transfer is ensured when the floor is springy below 100 Hz.

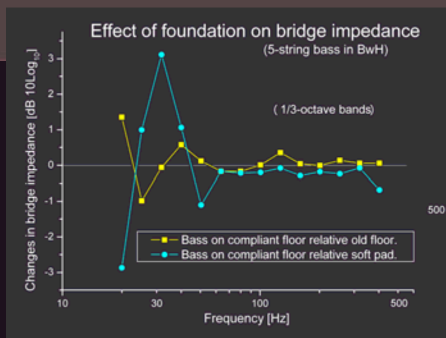
mass

spring



In the low register, the foundation has an noticeable impact on the bridge impedance, and thus the damping of the strings.





In the table below, it is seen that although the LiH shows a relatively low impedance in the range of interest, it is well damped, which ensures a smooth transfer of vibrations.

Table 1: Berwald Hall (BwH) on Rigid/Compliant Areas

Freq. band [Hz]	Decay [ms]		Loss factor		Impedance magn. [kg/s]		phase [degrees]	
20	NOT AVAILABLE	748	NOT AVAILABLE	.149	13405111	1711	120	-109
25		228		.387	16067138	1888	-14	-112
31		131		.535	28502211	1199	-238	-107
40		194		.287	63133642	868	-417	-119
50		222		.199	74056605	608	-440	-137
63		236		.149	154055451	658	-498	172
80		256		.109	147173307	875	-465	168
100		280		.079	126591163	1324	-447	155
125		108		.162	91166090	1805	-457	178
160		112		.124	76508873	1466	-459	-175
200		80		.138	65580045	1467	-459	-178
250		70		.125	52282138	1244	-460	-177
320		31		.223	44123977	1749	-463	-176
400		21		.258	38311169	1321	-465	-162
500		10		.438	32734117	1155	-463	-169

Table 3: Oslo Concert Hall (OCH) on Rigid/Compliant Areas

Freq. band [Hz]	Decay [ms]		Loss factor		Impedance magn. [kg/s]		phase [degrees]	
20	NOT AVAILABLE	296*	NOT AVAILABLE	.376*	224492	12551	-119	-98
25		169*		.523*	243329	10587	-115	-100
31		128*		.547*	187946	8405	-111	-105
40		107*		.519*	125092	7068	-98	-100
50		81		.542	92465	5290	-98	-98
63		67		.522	77416	3974	-96	-101
80		194		.144	62087	2910	-95	-103
100		251		.088	51047	2005	-94	-112
125		215		.082	40498	2198	-92	-151
160		131		.106	32743	2182	-92	-131
200		115		.096	27065	1679	-90	-139
250		108		.081	22044	1657	-87	-170
320		97		.072	18250	2032	-84	-161
400		80		.069	15369	1933	-80	-160
500		65		.067	14097	1790	-79	-169

Table 4: Lindeman Hall (LiH), On/Between Joists

Freq. band [Hz]	Decay [ms]		Loss factor		Impedance magn. [kg/s]		phase [degrees]	
20	215	356	.518	.313	9950	3554	-105	-124
25	197	255	.449	.347	7951	3293	-106	-126
31	203	189	.346	.371	6016	3155	-111	-129
40	144	140	.388	.397	5850	3090	-120	-129
50	85	110	.519	.402	4680	2785	-112	-128
63	69	55	.511	.639	3706	2208	-118	-135
80	52	87	.537	.320	3141	2434	-122	-157
100	34	105	.657	.211	2667	2985	-129	-151
125	36	54	.494	.327	2632	2995	-136	-156
160	34	68	.409	.204	2523	3487	-132	-152
200	30	72	.366	.153	2165	3465	-126	-142
250	35	38	.248	.229	1653	3274	-130	-146
320	23	49	.304	.142	1430	2754	-144	-125
400	27	48	.201	.115	1795	2472	178	-140
500	25	48	.172	.091	5085	2521	-176	-141

Although double basses of modern symphony orchestras are stringed down to 31-33 Hz, these instruments are very poor radiators below their Helmholtz resonance at approx. 64 Hz.

It is likely that a well-designed compliant stage floor can compensate for this deficiency.

When orchestra halls are tested acoustically, low-frequency reverberation times and strength tell only parts of the story.

In BwH and OCH the stage lifts are the preferred areas for double basses. Contradictory to that, the BwH was originally constructed with the flooring glued with asphalt onto solid bedrock. After a few years with musicians complaining about "lack of dynamics", "insensitivity to tone-colour variations", "lack of warmth", and "lack of contact" the stage was reconstructed and the major part of the floor furnished with stage lifts.

However, as can be seen from the transfer plots on top, stage lifts tend to produce pronounced resonances unless they are well damped.