

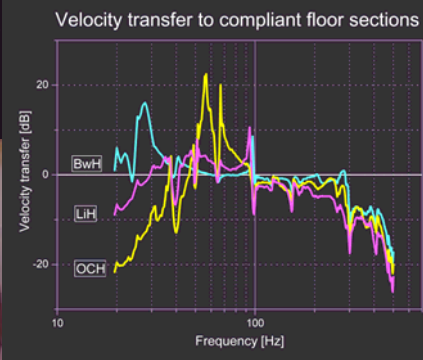
On the interaction between double basses and the stage floor

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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.

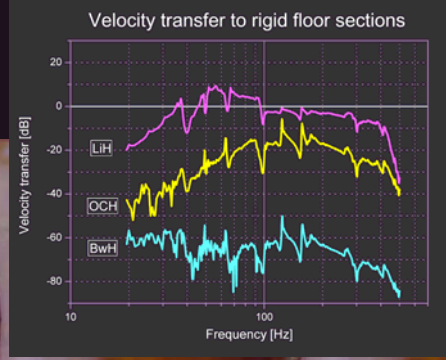
Likewise, endpin impedances of three double basses were recorded.

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.

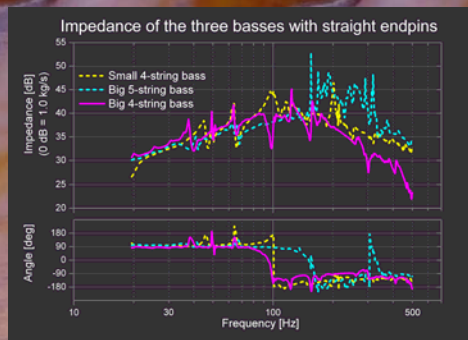
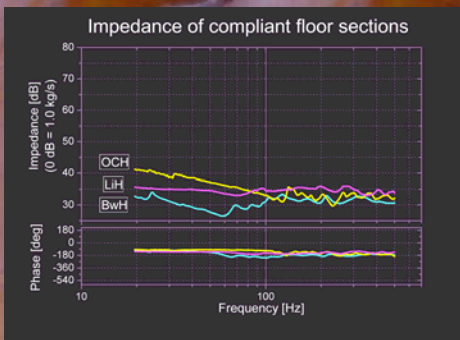


In BwH and OCH the compliant floor sections are stage lifts. Although preferred by the bassists, these give pronounced resonances.

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.



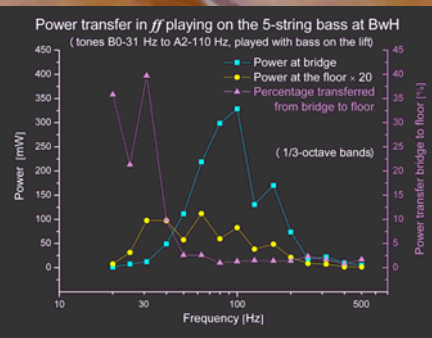
All the compliant floor sections show impedances with springy phase (near -90°) in the low-frequency end of spectrum.

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

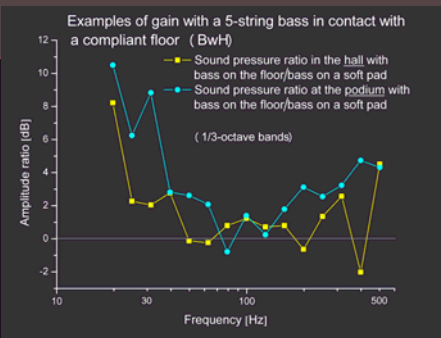
The rigid floor parts of BwH and OCH have very high impedances. In BwH, this was done intentionally to prevent the floor from "absorbing energy".

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 a noticeable impact on the bridge impedance, and thus the damping of the strings.

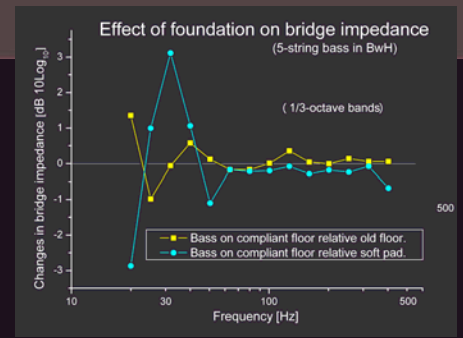


In the table below, it is seen that although the LiH shows a relatively low impedance in the range of interest, it is well damped, which ensures a smooth transfer of vibrations.

Freq. band [Hz]	Decay time [sec]	Loss factor	Impedance mag. [kg/s]	Phase [degrees]
25	1.44	0.49	134011	1311
31	1.31	0.47	126518	1288
40	1.24	0.45	120521	1269
50	1.19	0.44	115021	1252
63	1.15	0.43	110021	1237
80	1.11	0.42	105021	1223
100	1.08	0.41	100021	1210
125	1.05	0.40	95021	1200
150	1.03	0.39	90021	1190
180	1.01	0.38	85021	1180
200	1.00	0.38	80021	1170
250	0.98	0.37	75021	1160
300	0.96	0.36	70021	1150
400	0.94	0.35	65021	1140
500	0.92	0.34	60021	1130

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Although double basses of modern symphony orchestras are strung 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.