BNAM 2008
Volume dependent impact sound insulation

Commonly use in the Nordic countries: $L'_{n,w}$

Weighted normalized impact sound pressure level

"Example from court" (2003 - 2005)

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Situation

- Old requirements (project started before 1997)
  - $L'_{n,w} \leq 58$ dB

  (this example is however still relevant)

- Structure*:
  - 200 mm concrete
  - 3 mm polyurethane foam
  - Parquet

*Today the minimum requirement is $L'_{n,w} \leq 58$ dB,
=> f.i. 250 mm concrete w/parquet on 5 mm foam

Intital measurements

- Acceptable values in small rooms
- Exessive values in larger room
- Detailed evaluations based on:
  - Vibration measurements*
  - Parquette on different sheets*
  - Calculations with BASTIAN

INDICATE STRONG VOLUME DEPENDENCE*

Bastian/EN 12354 shows less volume dependence with ”standard” input values.

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WHY ANNOYANCE

- Impact sound is one of the most common reason for annoyance in dwellings.
- Expectations have changed (This case was brougt to court several years after the 5 dB change in the regulations)
- NS 8175 indicates that 20 % can be annoyed even with the latest minimum requirements, Class C: $L'_{n,w} \leq 53$ dB

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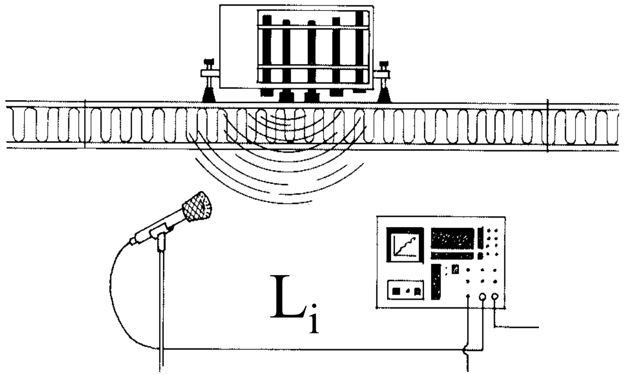
Field measurements

- $L'_n = L_i + 10\lg(A/A_o)$
  - A = absorption area
  - $A_0 = 10\ m^2$

- Weighting:
  - $L'_{n,w}$ is found by use of a reference curve



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Requirements <=> measured

Situation	$L'_{n,w}$
Between rooms in flats1987	≤ 58 dB
Between rooms in flats1997 (2008)	≤ 53 dB
Living room to sitting room (typical)	60 dB
Sleeping room to sleeping room (typical)	54 dB

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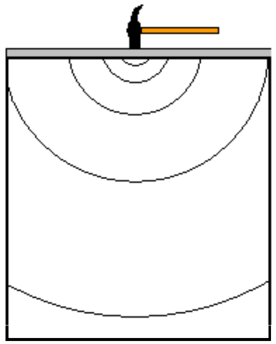
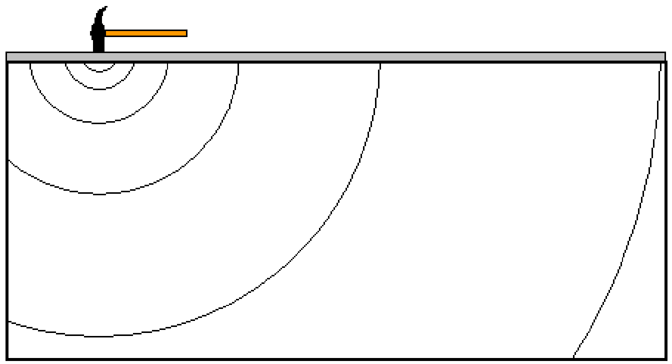
Expected sound energy distribution





- Light weight floor structures tends to be local reacting.
- Thus the sound level is reduced with increasing room volume.

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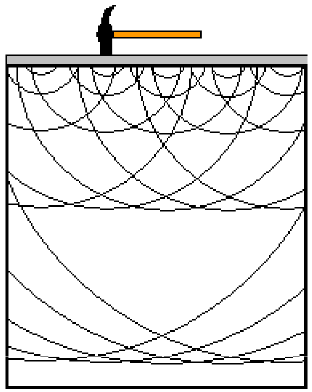
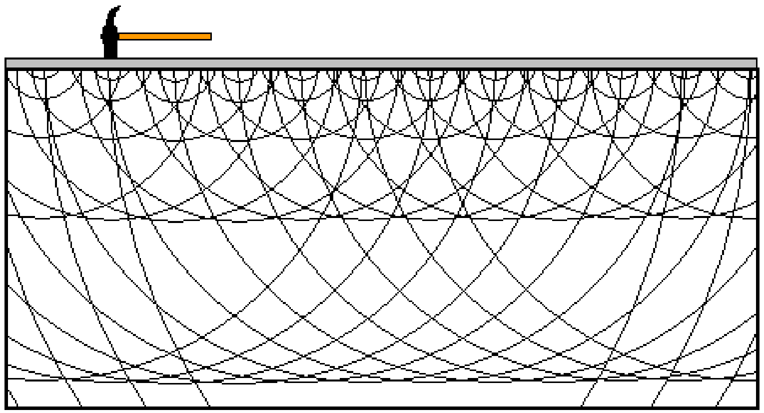
Expected sound energy distribution





- Heavy floor structures as concrete slabs tends to spread energy due to the stuctural reverberation
- Thus the sound level is less dipendant on the room size.

Consequence of ”Normalization”

1. Definition: $L'_n = L_i + 10\lg(A/A_o)$
2. $A = 0{,}161\ V / T$
   - V = Volume of receiving room
   - T = Reverberation time in receiving room
3. Inserting (2) in to (1) gives:
   - $L'_n = L_i + 10\lg V - 10\lg T - K$
   - Where $K = 10\ \lg(A_o/0{,}161) = 18$ dB

- The normalized impact sound pressure level L'_n increases with the volume V, if the sound level Li, and the reverberation time T, is unchanged.

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Realities in this case?

- Expectively acceptable solution.
- No ”mistakes” revealed in the workmanship.
- ”Unpredictable” effect of large volumes.
- Sweden had included volume limitations in their requirements at this time.
- Norway started such discussions at the beginning of these measurements.

Relevant changes in regulations

- Sweden introduced a volume limitation of 31 m^3 in feb. 04, together with a restriction of 2 dB => ”flat” limit above 50 m^3
- Norway introduced a volume limit of 100 m^3 in april 05.
- Standardized impact sound pressure level is discussed in other countries:
  - e.g: $L'_n = L_i + 10\lg(T/T_o)$
- Both alternatives leads to

  ”Volume independence” at least for larger volumes

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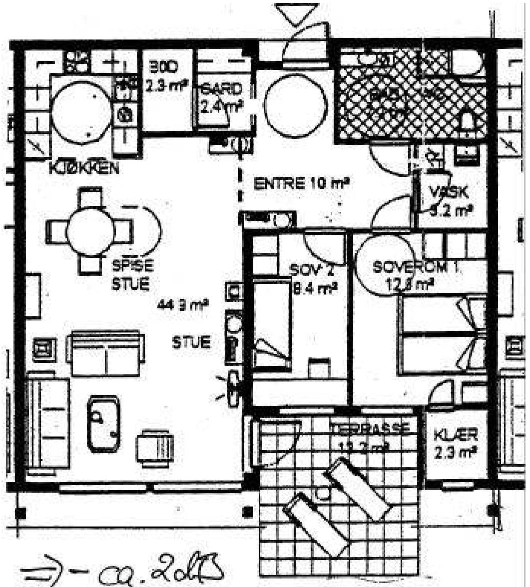

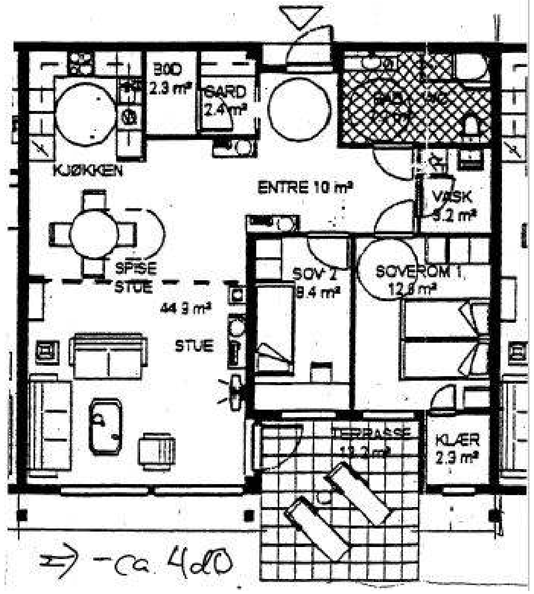

This case: Large and complex volumes

- The first measurements where made by Stavanger Technical School. They decided to use the complete volume.
- The ISO standard allows to close of parts of the room when the situation is complex.
- Limitations as shown with dotet lines could have given
  -2 dB (top) or -4 dB (bottom)

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Results

- Impact sound pressure levels – various methods:

Room	$L_{p,A}$	$L'_{n,w}$	$L'_{n,w}$ (<100m^3)	$L'_{n,w}$ (<31 m^3)	$L'_{n,T,w}$
Living room	61 dBA	60 dBA	58-59 dB	53 dB	53 dB
Sleeping room	61 dBA	54 dBA	54 dB	54 dB	55 dB

$L_{p,A}$, is the measured sound pressure level – directly without weighting

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Similar examples

Eks	Bygn.type	LA	V	L'n,w	Krav NO	Overskridelse	L'n,w når V=31m3	Møblert?
1,1	Kontor	64,8	344	66	63	3 dB	55	Ja
1,2	Kontor	64,9	32	55	63	-	55	Ja
2,1	Bolig (-87)	63,1	86	56	58	-	51	Nei
2,2	Bolig (-87)	59,4	53	53	58	-	51	Ja
3,1	Bolig (-97)	60,3	85	53	53	0	49	Nei
3,2	Bolig (-97)	59,4	58	52	53	-	49	Nei
3,3	Bolig (-97)	61,2	26	49	53	-	50	Nei
							L'n,w når V≤31m3	
4,1	Bolig (87)	60,7	138	60	58	2	53	Ja
4,2	Bolig (87)	60,9	26	54	58	-	54	Ja
5,1	Bolig (97)	41,3	17	37	53	-	37	Ja
5,2	Bolig (97)	47,1	102	46	53	-	41	Ja
6,1	Bolig (97)	58,5	35	48	53	-	48	Lite (nei?)
6,2	Bolig (97)	57,5	110	52	53	-	47	Lite (nei?)
7,1	Bolig (97)	73,8	7	61	53?	8	61	Ja
7,2	Bolig (97)	70,1	22	63	53?	10	63	Ja
7,3	Bolig (97)	68,6	83	66	53?	13	61	Ja
8,1	Bolig (97)	52,0	27	51	53	-	51	Nei?
8,2	Bolig (97)	51,4	87	53	53	-	48	Nei?

* Merk: I resultatene fra 4,1 til 8,2 er det bare korrigert for romvolumer som er større enn 31 m3

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Our technical conclusion for this ”CASE”

- Recognized acceptable solutions are used
- Good workmanship is performed
- $L'_{n,w}$ in small rooms are well within limits
- $L'_{n,w}$ in large rooms exceeds requirements mainly *due to the definition of the term*.

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Juridical Decision

The impact sound pressure level
must be reduced
in the large rooms
to fullfill the requirmements to
$L'_{n,w}$

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Questions

- Is it possible that higher annoyance is claimed in the large rooms than in the small (even if the actual sound pressure level is accepted to be similar)?
- Does the court understand the ”weak part” better than technical explanations?

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TECHNICAL CONCLUSION

- $L'_{n,w}$ increases significantly with V
- With no volume limitations, ΔL must be better / higher in larger rooms
- Even with a volume limit of 100 m^3 (as in Norway), it is relevant to distinguish between solutions in small and large rooms.