Full scale vibration tests on a long span timber floor

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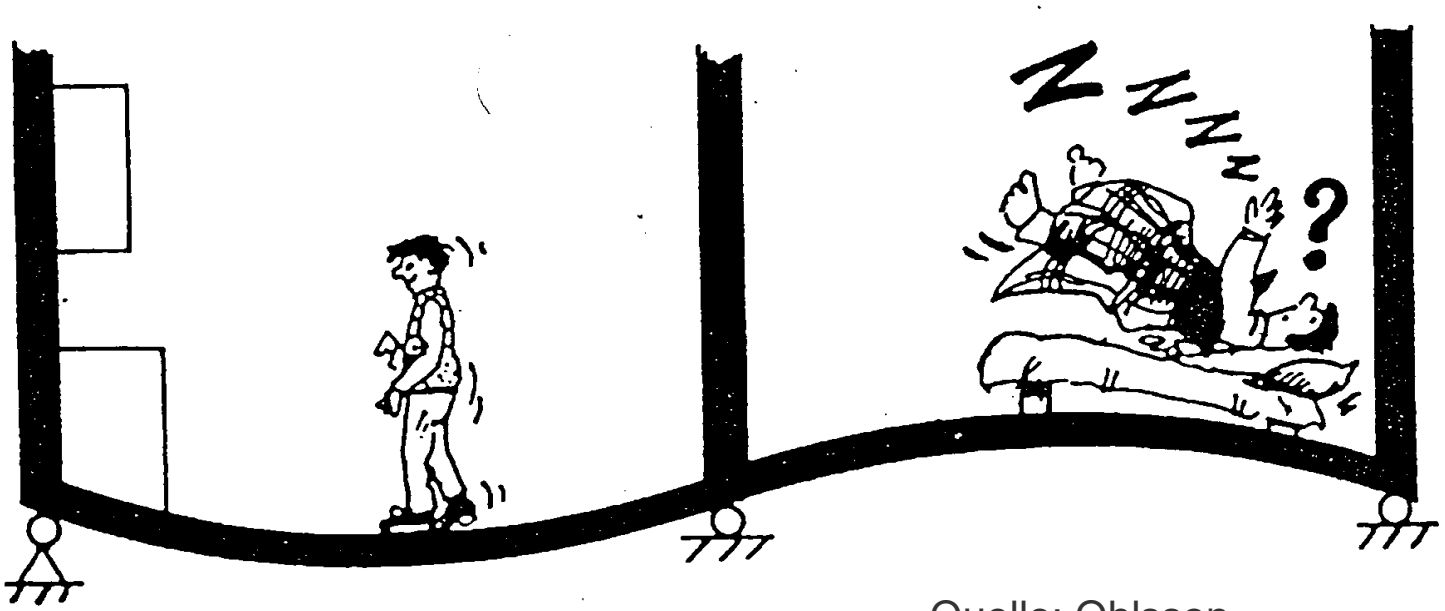
Structure

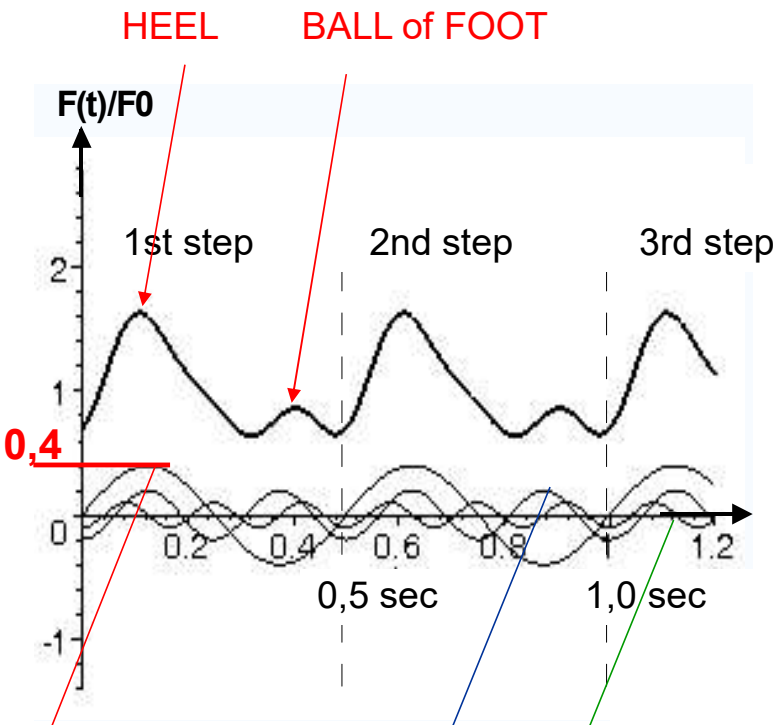
1. Introduction
2. Existing design rules
3. Overview
4. Full scale vibration tests
5. Next steps

1. Introduction



Quelle: Ohlsson

1. Introduction – Load on timber floors



step frequency = 2,0 Hz

$$\frac{1}{T} = \frac{1}{0{,}5\ \text{sec}} = 2{,}0\ \text{Hz}$$

$$0{,}4 \cdot F_0 \cdot \sin(2\text{Hz} \cdot 2\pi \cdot t)$$

$$0{,}2 \cdot F_0 \cdot \sin(2 \cdot 2\text{Hz} \cdot 2\pi \cdot t - \pi/2)$$

$$0{,}1 \cdot F_0 \cdot \sin(3 \cdot 2\text{Hz} \cdot 2\pi \cdot t - \pi/2)$$

FOURIER SERIES

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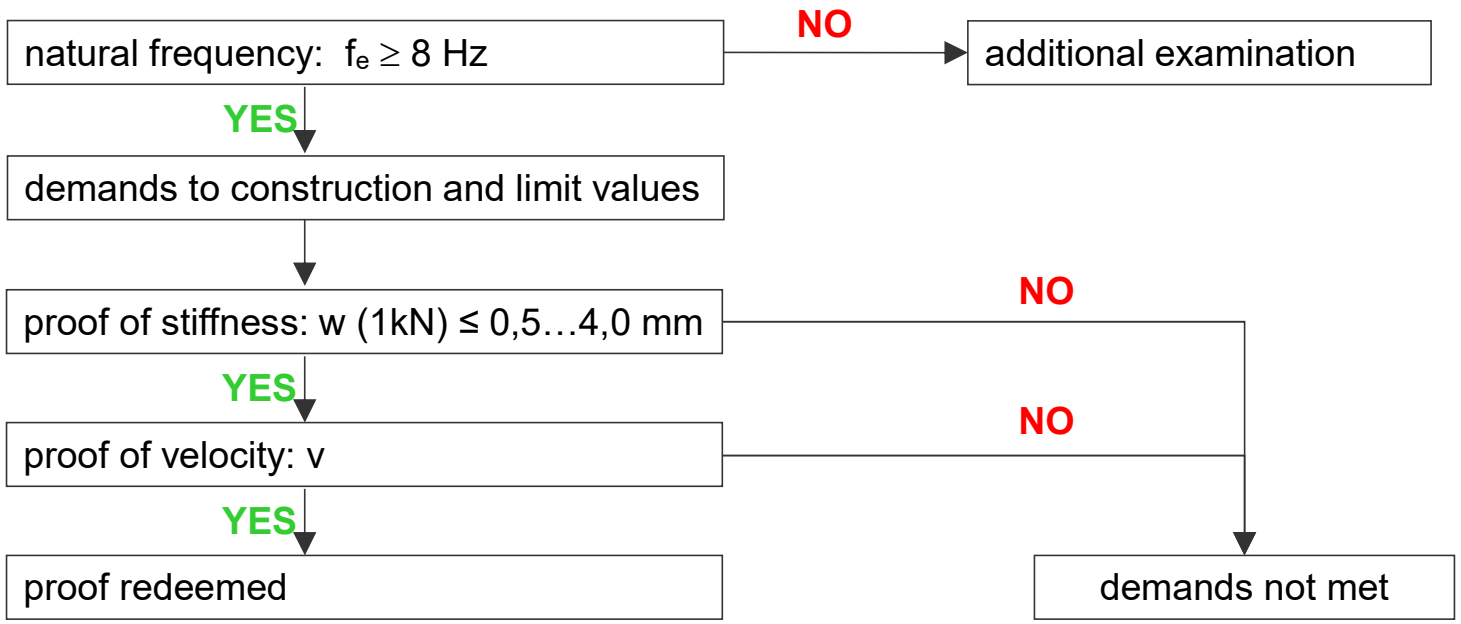
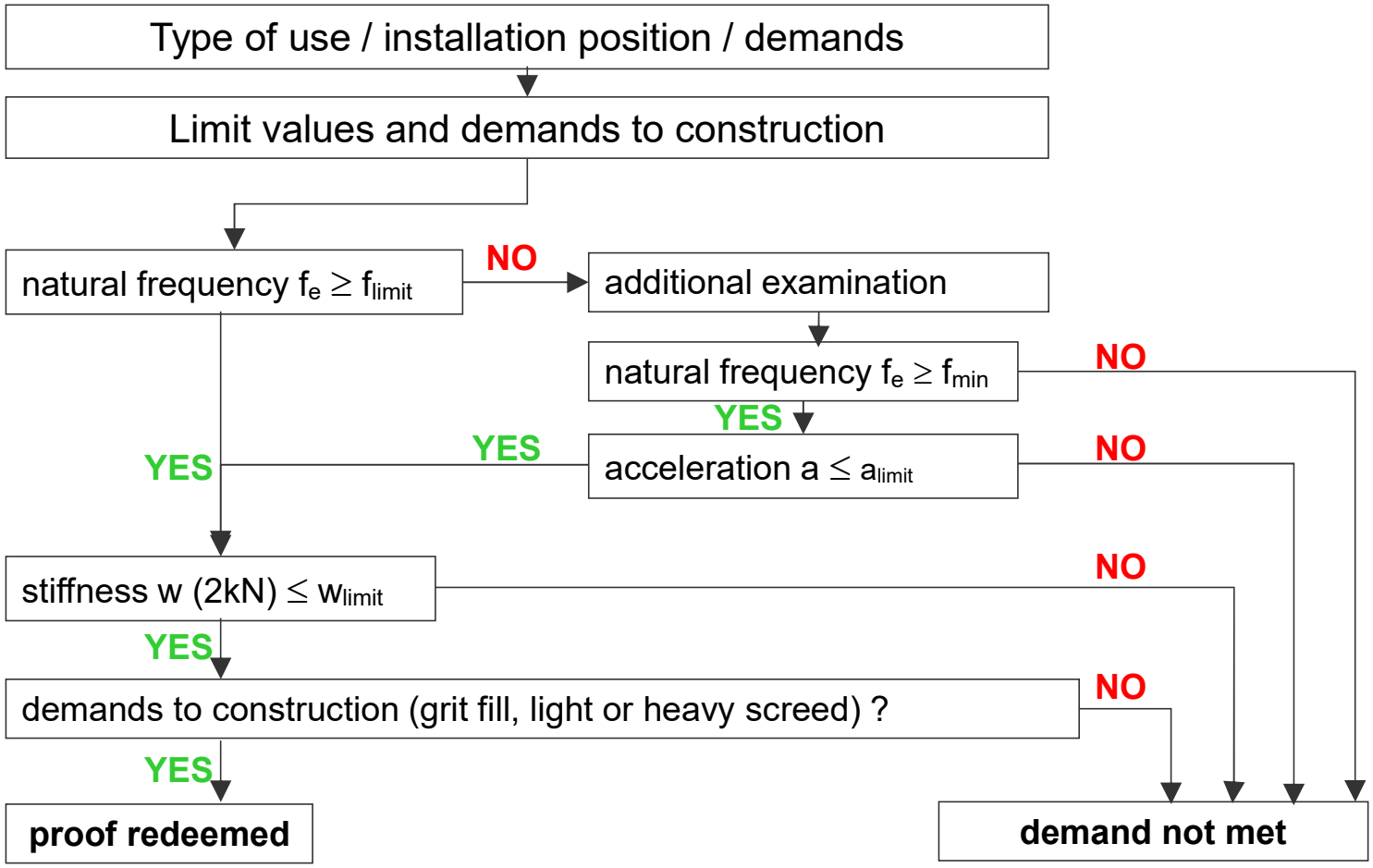
2. Eurocode 5 - EN 1995-1-1:2010(D)

Avoid resonance → Avoid floor frequencies less than 8,0 Hz

EUROCODE 5 (EN 1995-1-1) :



2. Construction rules: Winter/Hamm/Richter 2010



2. Eurocode 5 - EN 1995-1-1 Draft (2022)

Stiffness criteria:

$$w_{1kN} = \frac{F L^3}{48 (EI)_L B_{ef}}$$

≤ limit value [mm]

Frequency criteria:

$$f_1 = k_{e,1} k_{e,2} \frac{\pi}{2L^2} \sqrt{\frac{(EI)_L}{m}}$$

≥ 4,5 Hz

$f_1 < 8$ Hz

Acceleration criteria:

$$a_{rms} = \frac{k_{res} \mu F_h}{\sqrt{2}\, 2 \zeta M^*}$$

≤ 0,005·R [m/s²]

$f_1 \geq 8$ Hz

Velocity criteria:

$$v_{rms} = v_{tot,peak} (0{,}65 - 0{,}01 f_1) (1{,}22 - 11{,}0 \zeta) \eta$$

≤ 0,0001·R [m/s]

→ **Response factor R, depending on the performance level**

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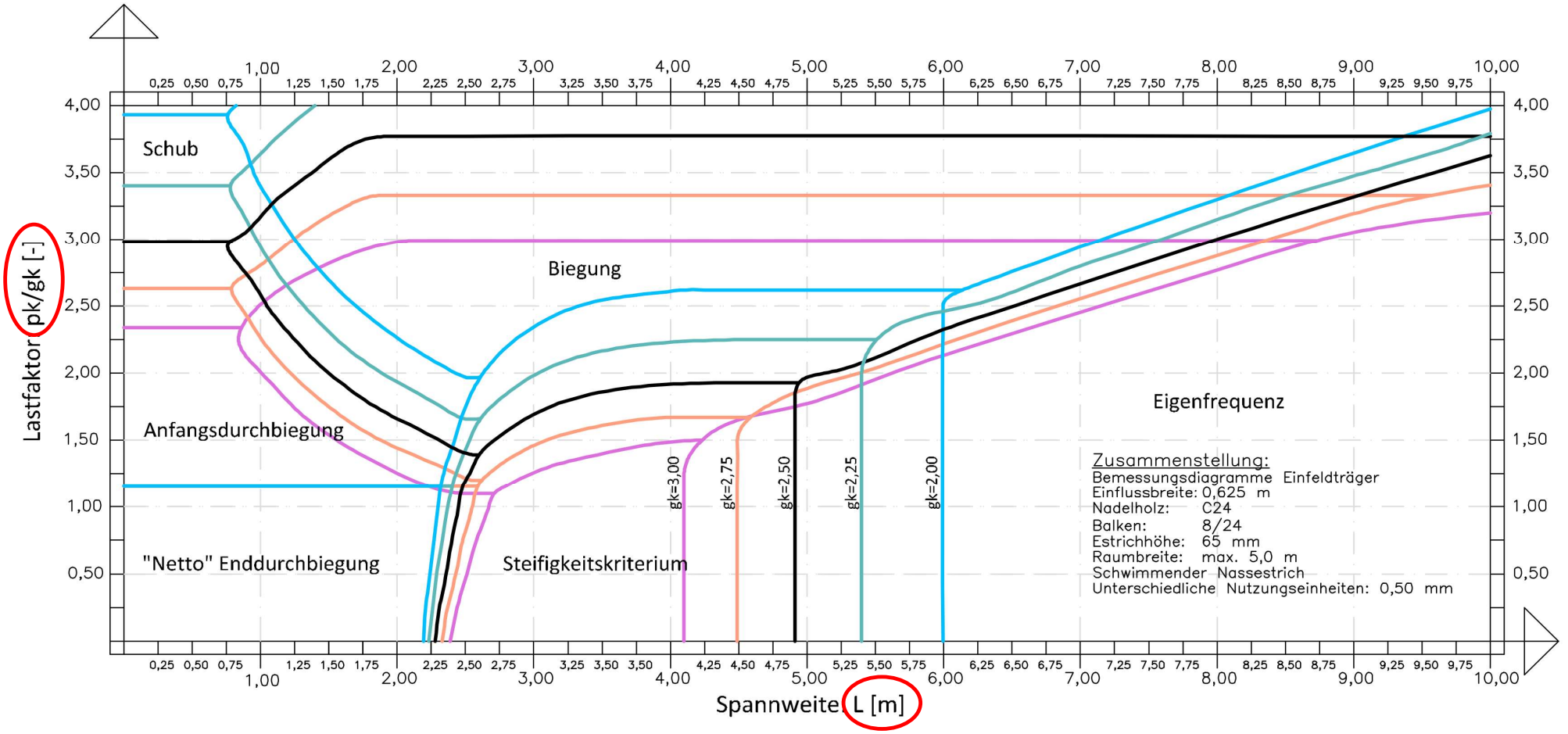
3. Overview



Design relevant proof for a floor with floating heavy screed with “higher” demands

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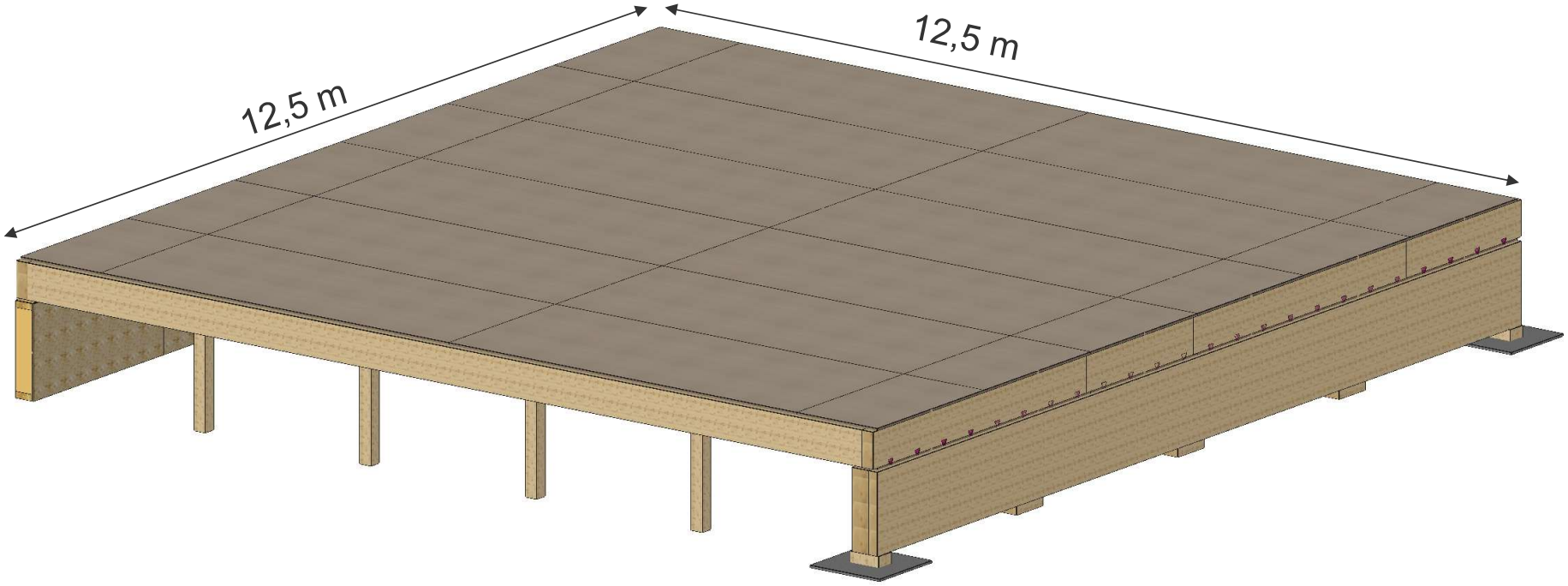
4. Full scale vibration tests



Test bench scale 1:1 with an area of 12,5 m x 12,5 m:
Research project „ZIM Projekt“ - HBC and Pirmin Jung Deutschland

4. Full scale vibration tests

25 beams 16 cm x 44 cm
axle spacing 51 cm

4. Full scale vibration tests

boards with 3 layers

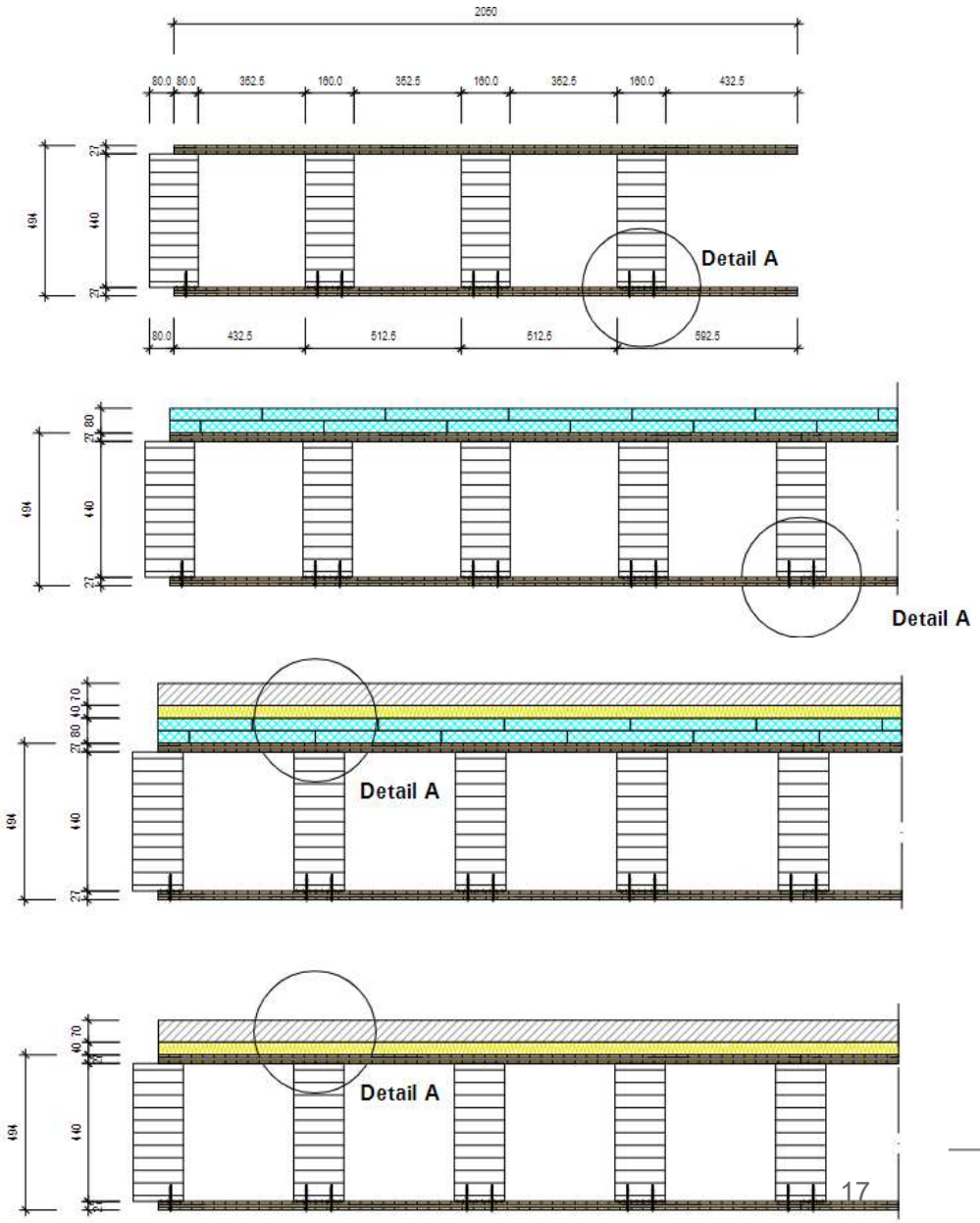
4. Full scale vibration tests

boards with 3 layers
at the bottom

and at the top
to get the box

4. Full scale vibration tests - modifications

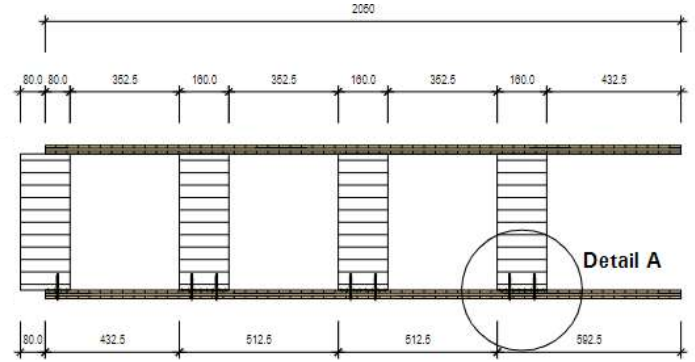
Heavy screed made by concrete elements
Sound isolation
Paving Stones
Box

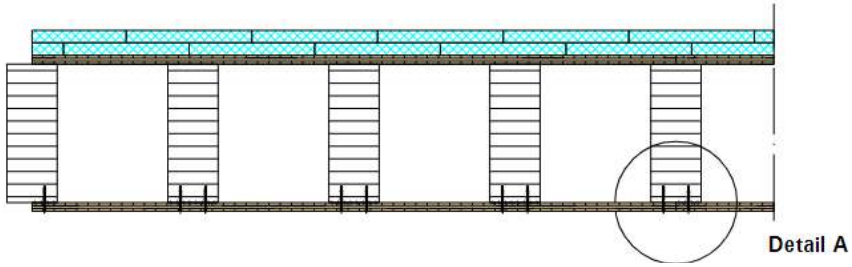


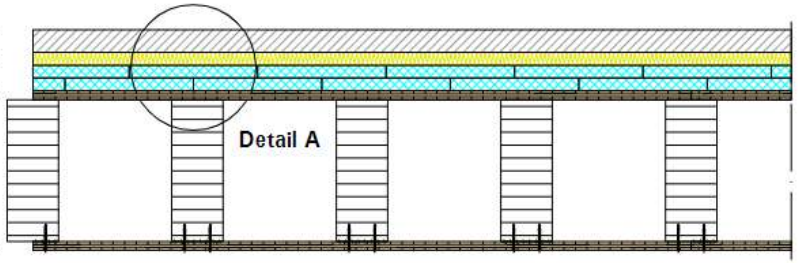
4. Full scale vibration tests – measurements

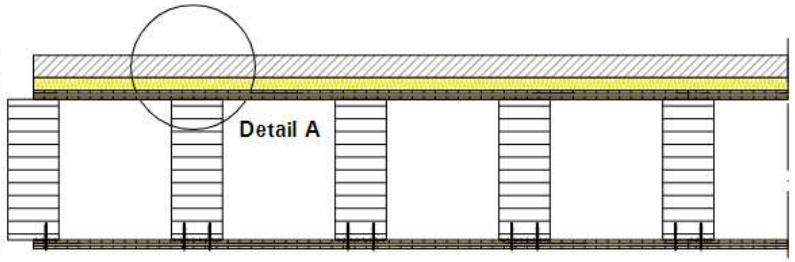
Aufbau	12m	zweiseitig	Balken
			Elemente
Rohdecke Unterzug 240mm	12m	vierseitig	Unterzug
		zweiseitig	Unterzug
			obere DSP lose
			obere DSP 80cm
			obere DSP 40cm
			obere DSP 20cm
			obere DSP 10cm
	10m	vierseitig	Unterzug
		zweiseitig	Unterzug
			Unterzug+X-Fix
	9m		Unterzug+Stahl
			Unterzug+Stahl+X-Fix
Rohdecke Masse Unterzug 240mm	12m	vierseitig	
		zweiseitig	Unterzug
			Unterzug + Stahl
	10m	vierseitig	Unterzug
			Unterzug+X-Fix
		zweiseitig	Unterzug
			Unterzug+X-Fix

Rohdecke Masse Estrich Unterzug 360mm	12m	vierseitig	Unterzug
		zweiseitig	Unterzug
			Unterzug+2xDäm
			nicht verschraubt
	10m	vierseitig	Unterzug
		zweiseitig	Unterzug
			Unterzug + Stahl
	9m		3m Auskragung
Rohdecke Estrich Unterzug 240mm	12m	vierseitig	Unterzug
		zweiseitig	Unterzug
	10m	vierseitig	Unterzug
		zweiseitig	Unterzug









4. Full scale vibration tests

In spite of great mass (50 – 60 to) excitation of floor is possible.

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5. Next steps

- Final evaluation of measurement data
- Elements have been stored, if necessary test bench can be rebuilt
- Some more experiments with vibration dampers?
- Some more tests with stiffener perpendicular to span?
- Collecting ideas from you?
- → Aim of the research project:
  Optimized design for long span wooden floors

Thanks for listening!