

Strukturdynamiska beräkningar, 7.5hp

Structural Dynamic Computing

Per-Erik Austrell

Introductory lecture

Disposition:

- What do we want with the course?
- Some applications
- Course outline and tasks

What do we want with the course?

- **Structural dynamics:** theory, mechanics
- **Computations:** numerical methods, software, computers etc
- **Applications:** measurements on real structures, modelling, and simulations
- **Presentation:** writing reports and also orally (project 2)

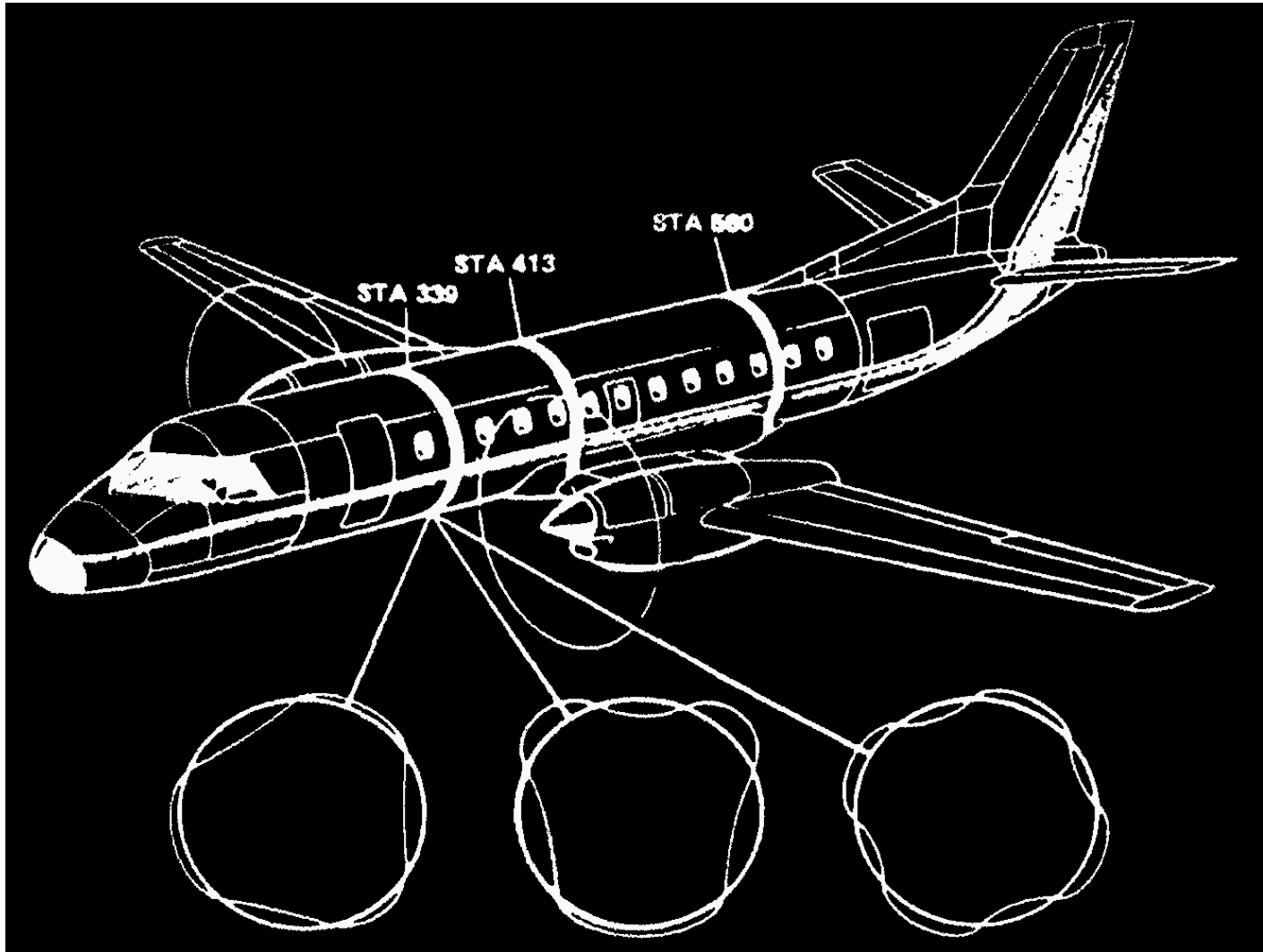
Some applications

- Sound and vibration damping in an aircraft
- Max IV research facility
- Light weight building vibrations
- Selected PhD works
- Earth-quake engineering

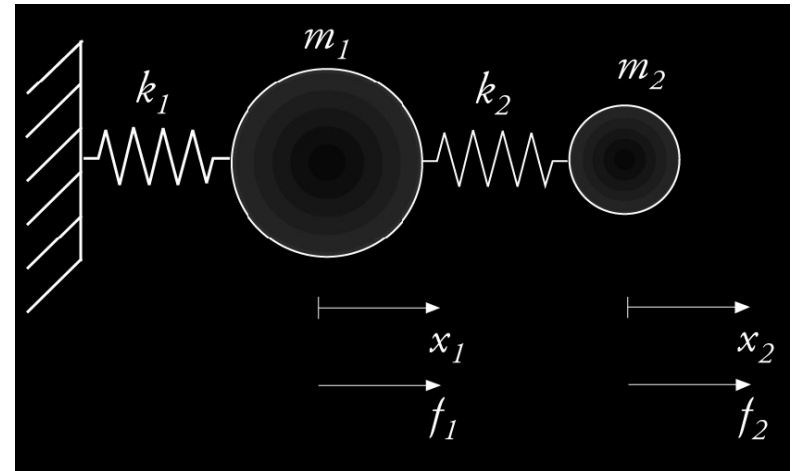
Vibro-acoustics in an aircraft



Vibro-acoustics in an aircraft cont.



Vibro-acoustics in an aircraft cont.

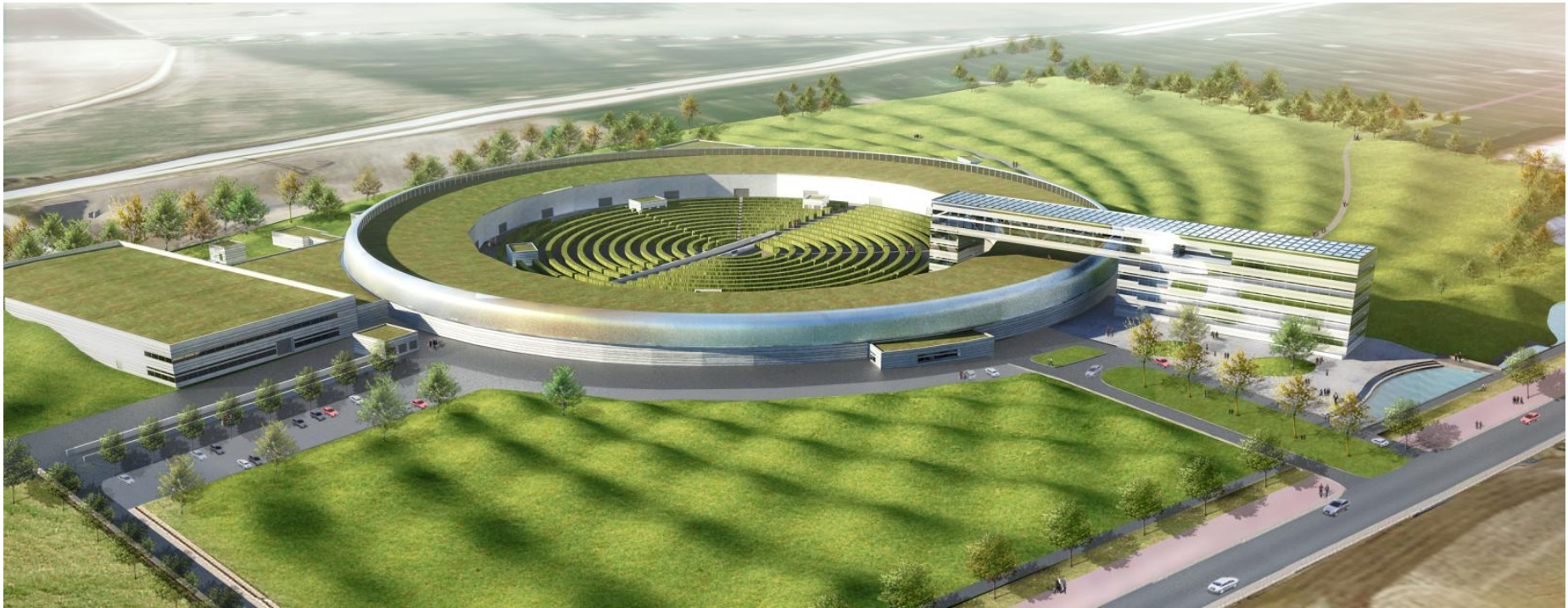


$$\begin{pmatrix} m_1 & 0 \\ 0 & m_2 \end{pmatrix} \begin{pmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{pmatrix} + \begin{pmatrix} k_1 + k_2 & -k_2 \\ -k_2 & k_2 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} f_1 \\ f_2 \end{pmatrix}$$



MAX IV facility

Synchrotron light research with linear
electron injector and storage ring



FE model of the ring

Soil (coarse mesh)
three layers,
 $D=300\text{ m}$ $t=6\text{ m}$

Concrete (fine mesh)
 $D=210\text{ m}$ $d=170\text{ m}$

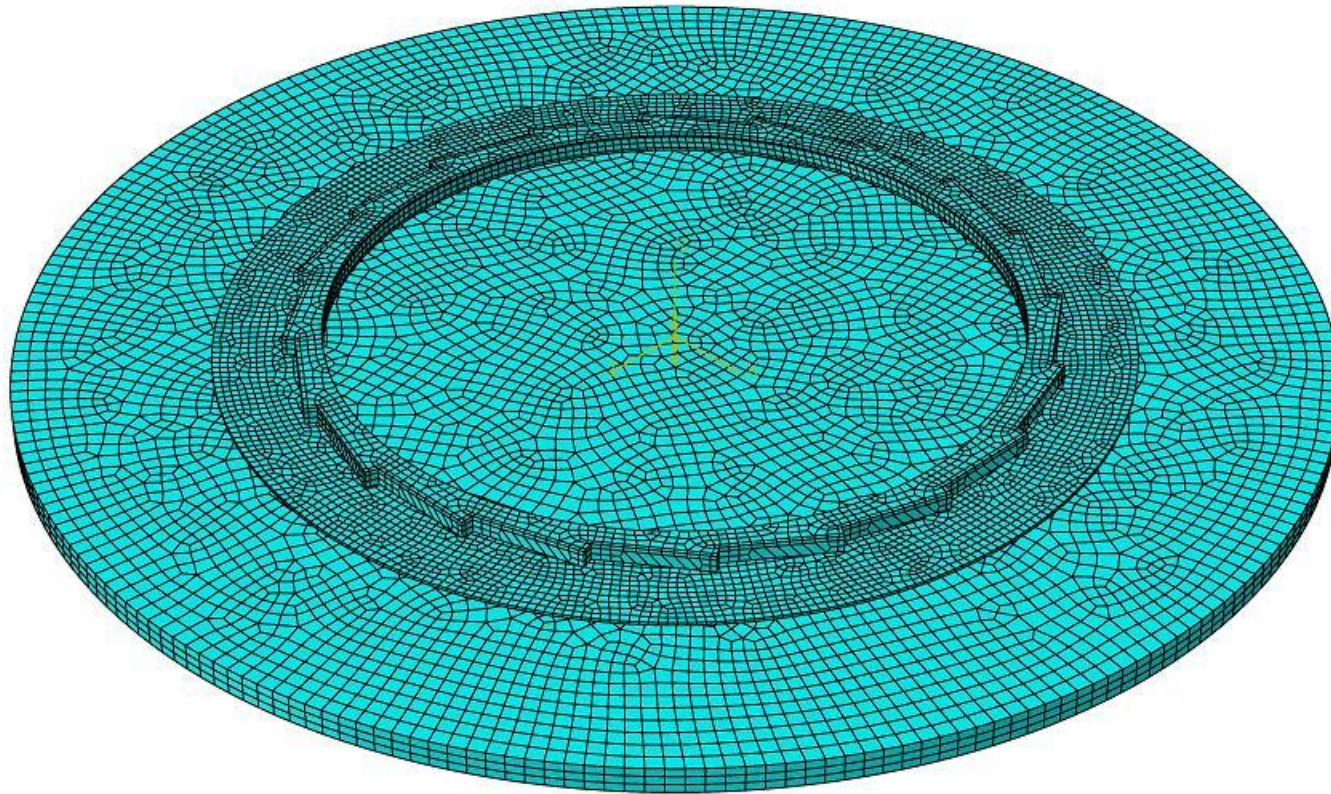


Requirements for
vertical displacements
in the ring:

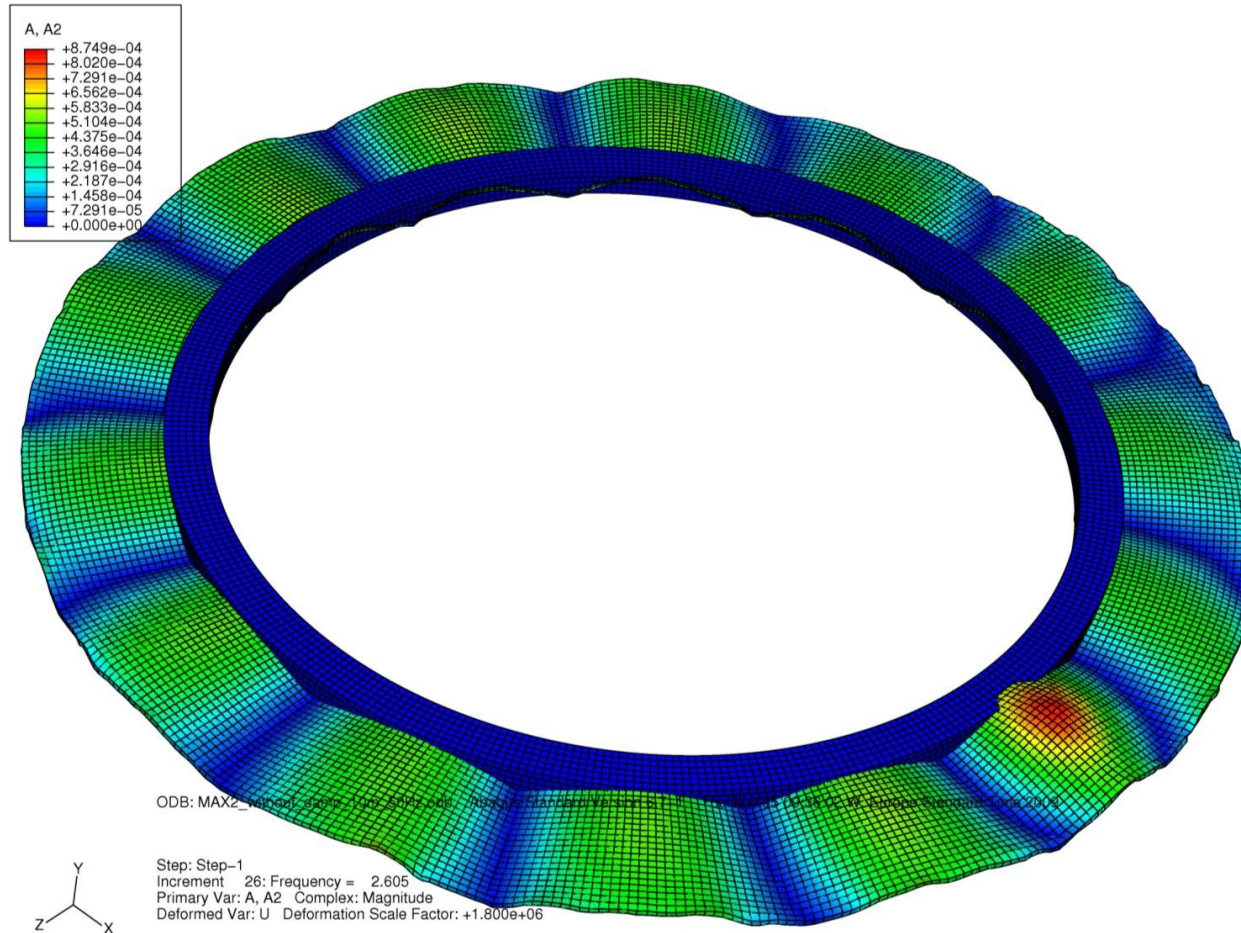
26 nm

How much is 26 nm?

The thickness of a hair
divided by 3500 !

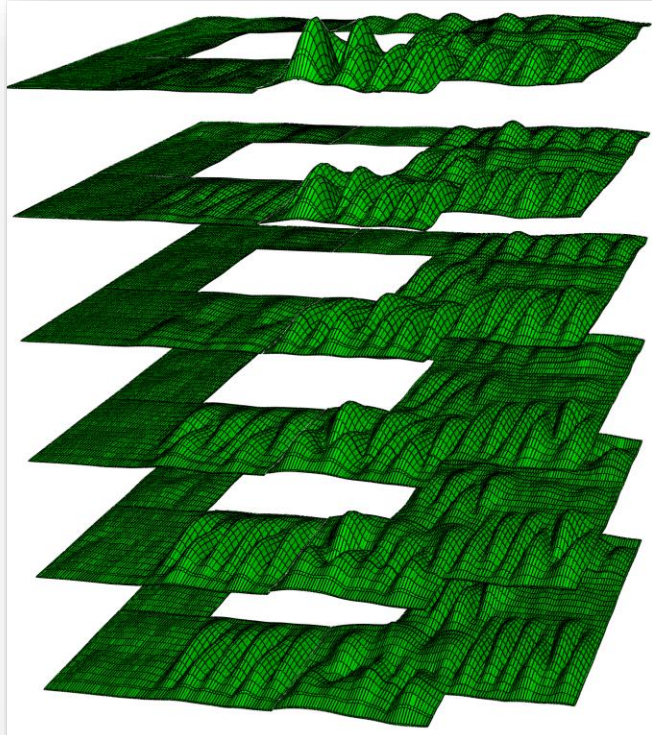


MAX IV steady state dynamics

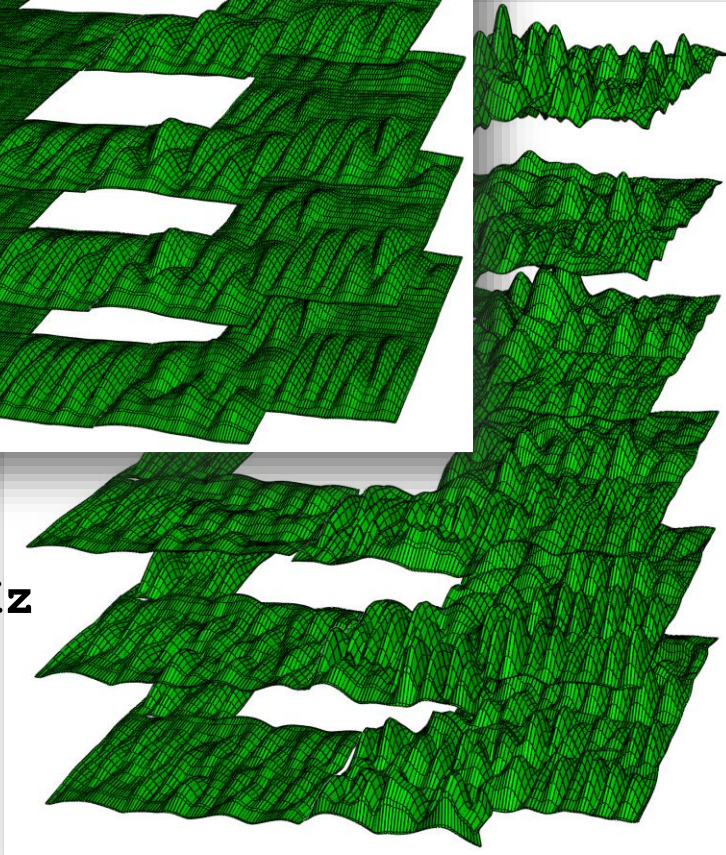
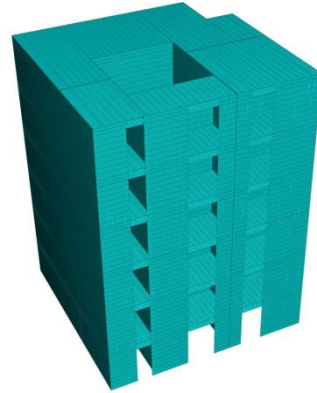


Max IV design calculations

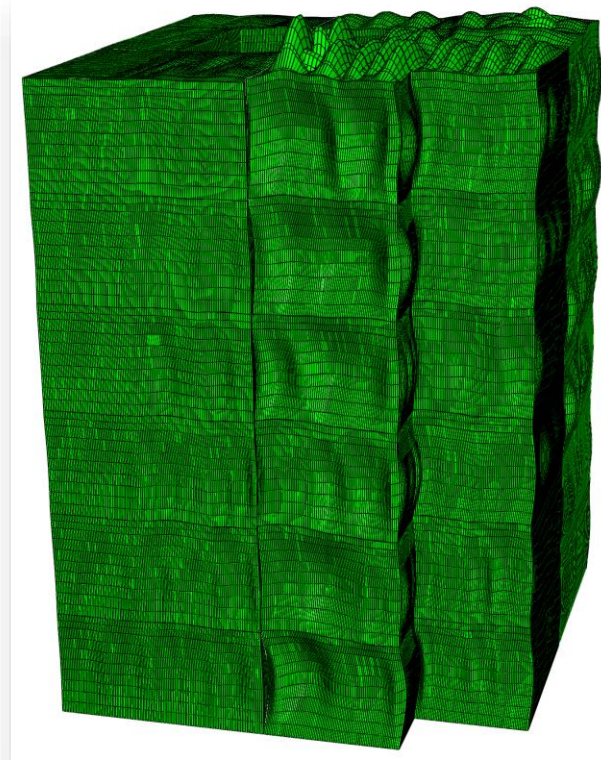
Vibrations in wooden buildings



96 Hz

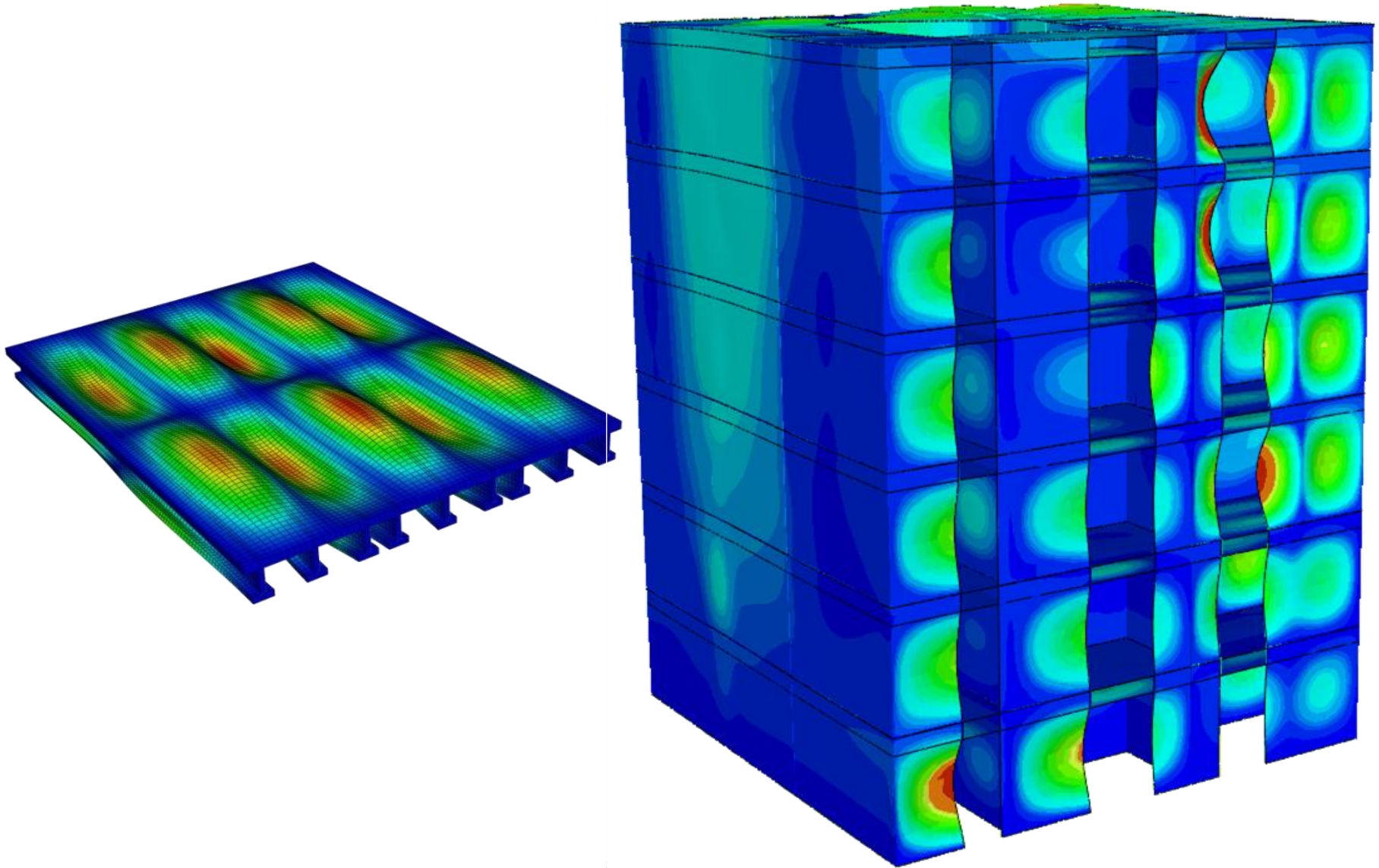


178 Hz

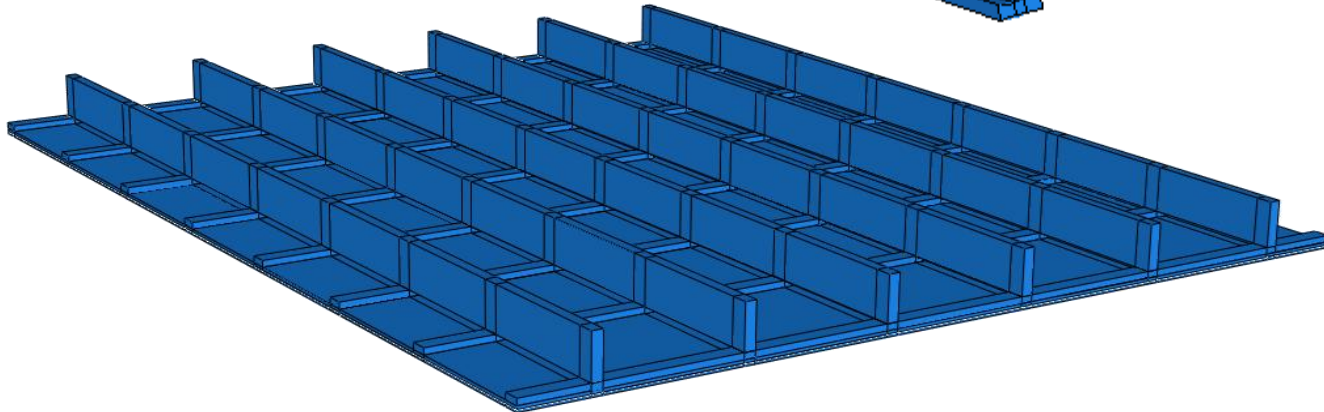
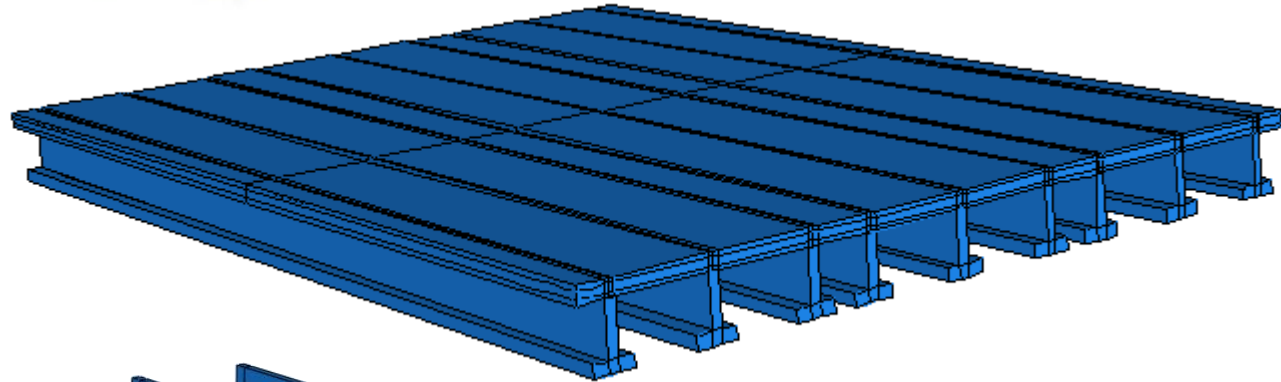
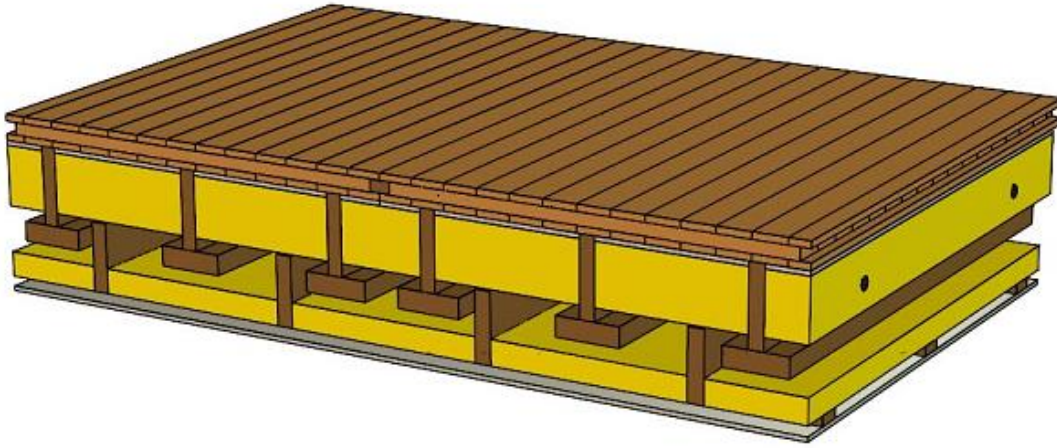


96 Hz

Vibrations in a seven-storey building



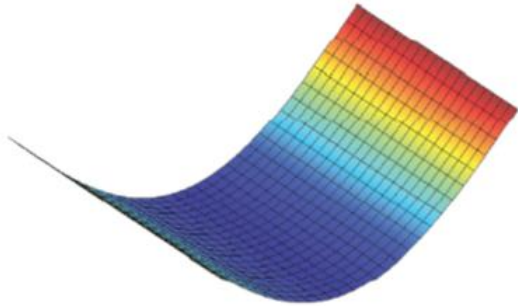
Wooden floor/roof



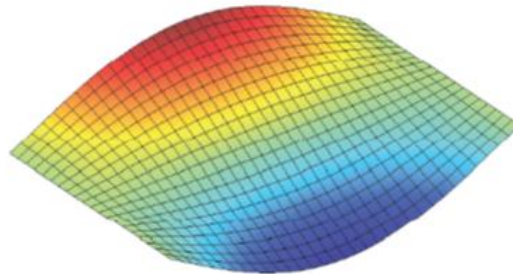
Wooden floor/roof cont.

At particular frequencies (resonance) the basic modes of vibration can be seen:

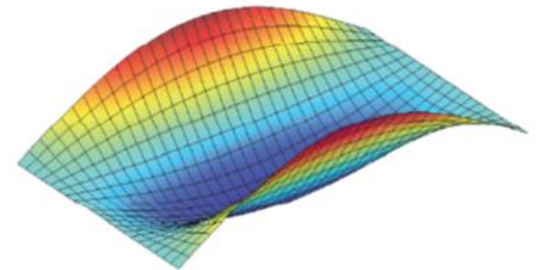
Mode 1



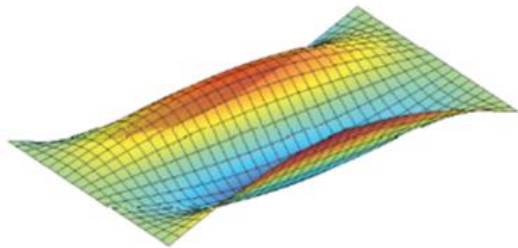
Mode 2



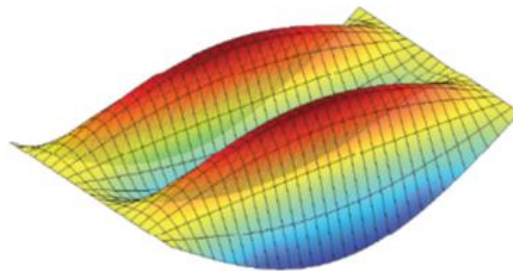
Mode 3



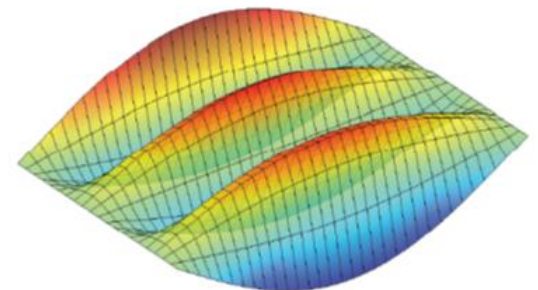
Mode 4



Mode 5

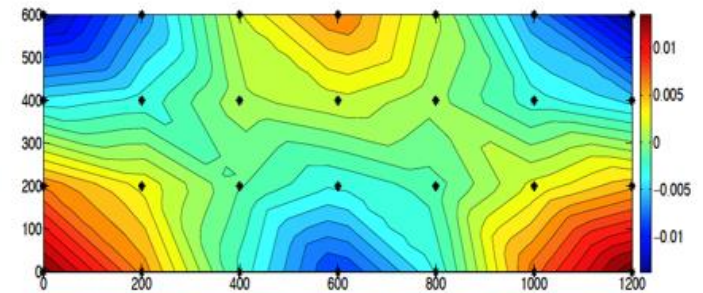
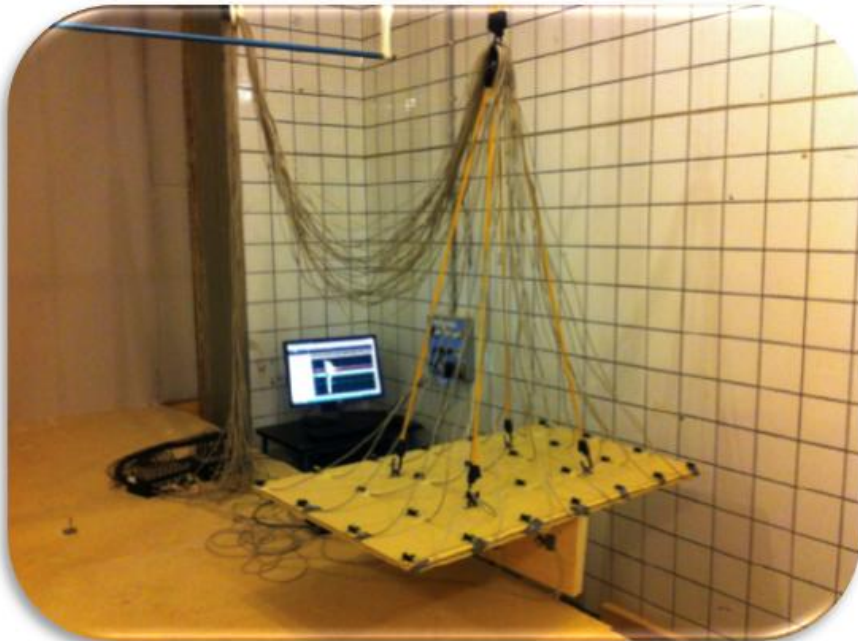
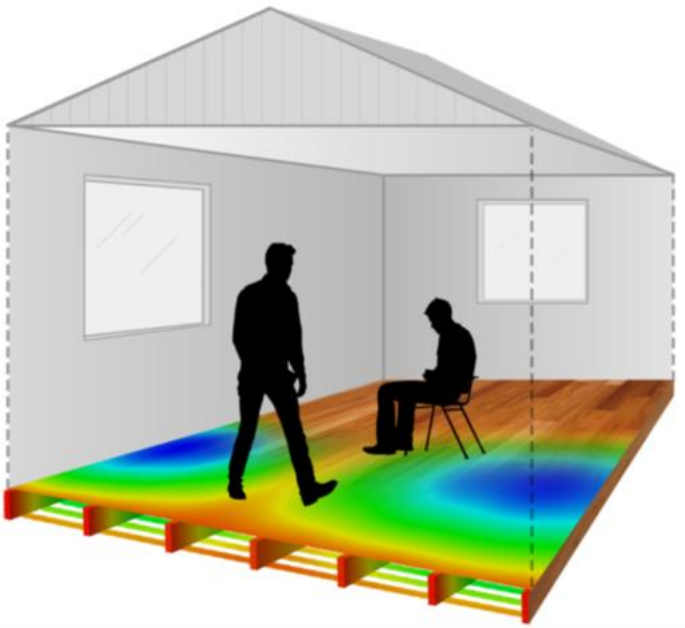


Mode 6

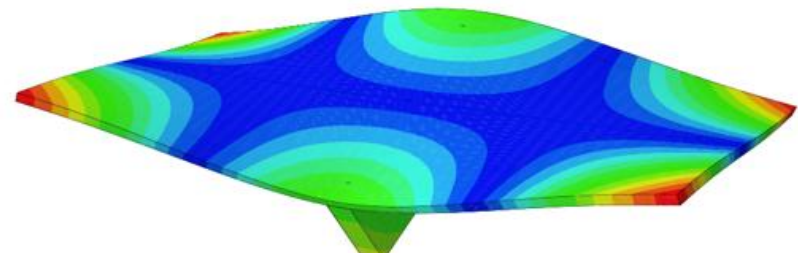


Juan Negreira PhD work

Measurements and simulations of sound and vibration transmission in light weight buildings

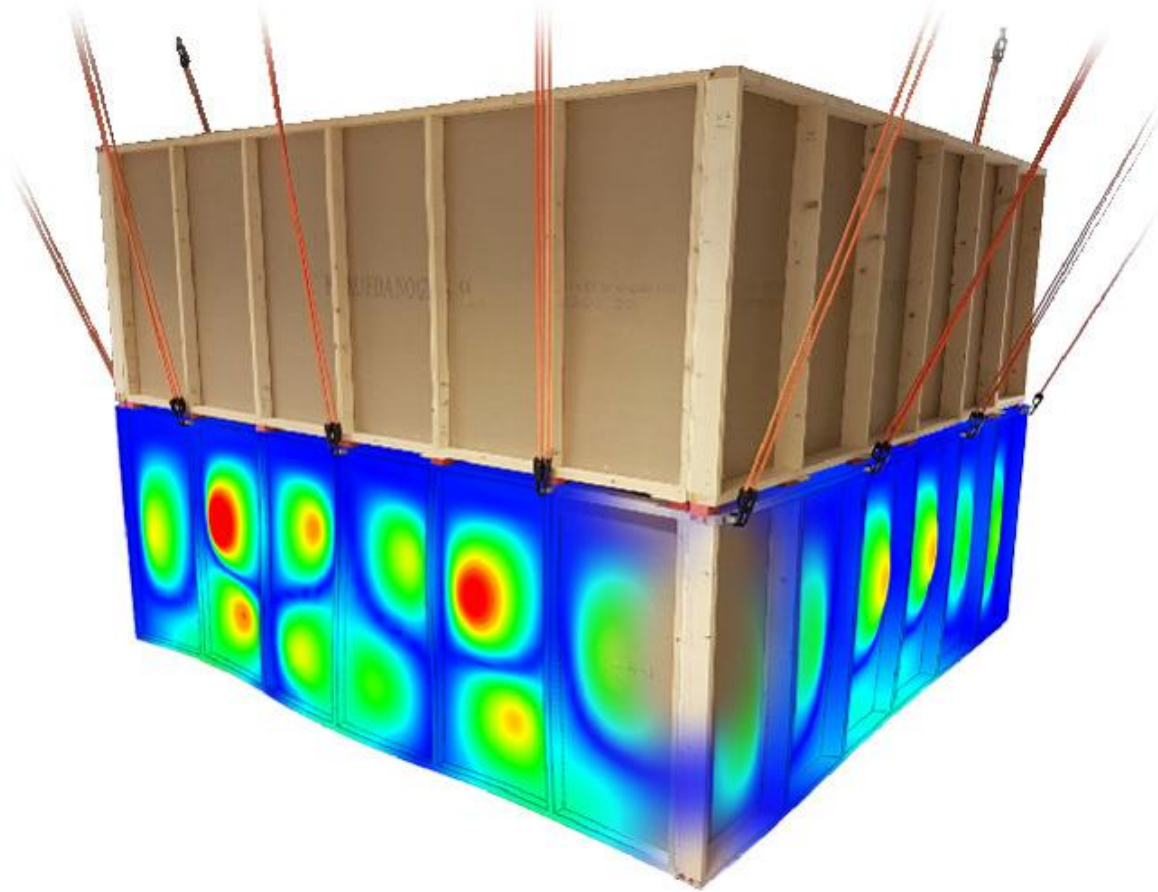


T-junction



Ola Flodén PhD work

Measurements and modelling on a scale model of a wooden house module:



Ola is now at Volvo Cars working with noise and vibrations

Vedad Alic PhD work

Connection between architecture and dynamics

British Museum Great Court

C. Williams / Foster+partners



National Maritime Museum

Ney + partners



Savill Building

Glen Howells / Buro Happold / C. Williams

Program development for finding shape of membranes by dynamic relaxation:

total iterations = 329
Number of degrees of freedom: 432
residual norm /intF_Globalnorm = 0.00985098315964075
total iterations = 329
Number of degrees of freedom: 432
2 surfaces added to selection.
Command: _Delete

Command: |

Standard CPlanes Set View Display Select Viewport Layout Visibility Transform Curve Tools Surface Tools Solid Tools Mesh Tools Render Tools Drafting New in V5

Perspective

Viewport
Title Perspective
Width 1147
Height 681
Projection Perspective
Camera
Lens Length 50.0
Rotation 0.0
X Location -17.433
Y Location 69.729
Z Location 26.426
Location Place...
Target
X Target 65.878

Rhinoceros
Sample
Geometry Boundary Load Dynamic Relaxation
Select patch/patches for analyze: Selected:
8bb4559b-c550-4f3b-8d39-d2ef275fe44 8bb4559b-c550-4f3b-8d39-d2ef275fe44
Dynamic relaxation parameters:
Nodal mass: 100000000 kg Show Selected Patches
Time step: 1 s Reset values
Maximum iterations: 2000 Calculate!
Tolerance: 0.01

Perspective Top Front Right

End Near Point Mid Cen Int Perp Tan Quad Knot Vertex Project Disable

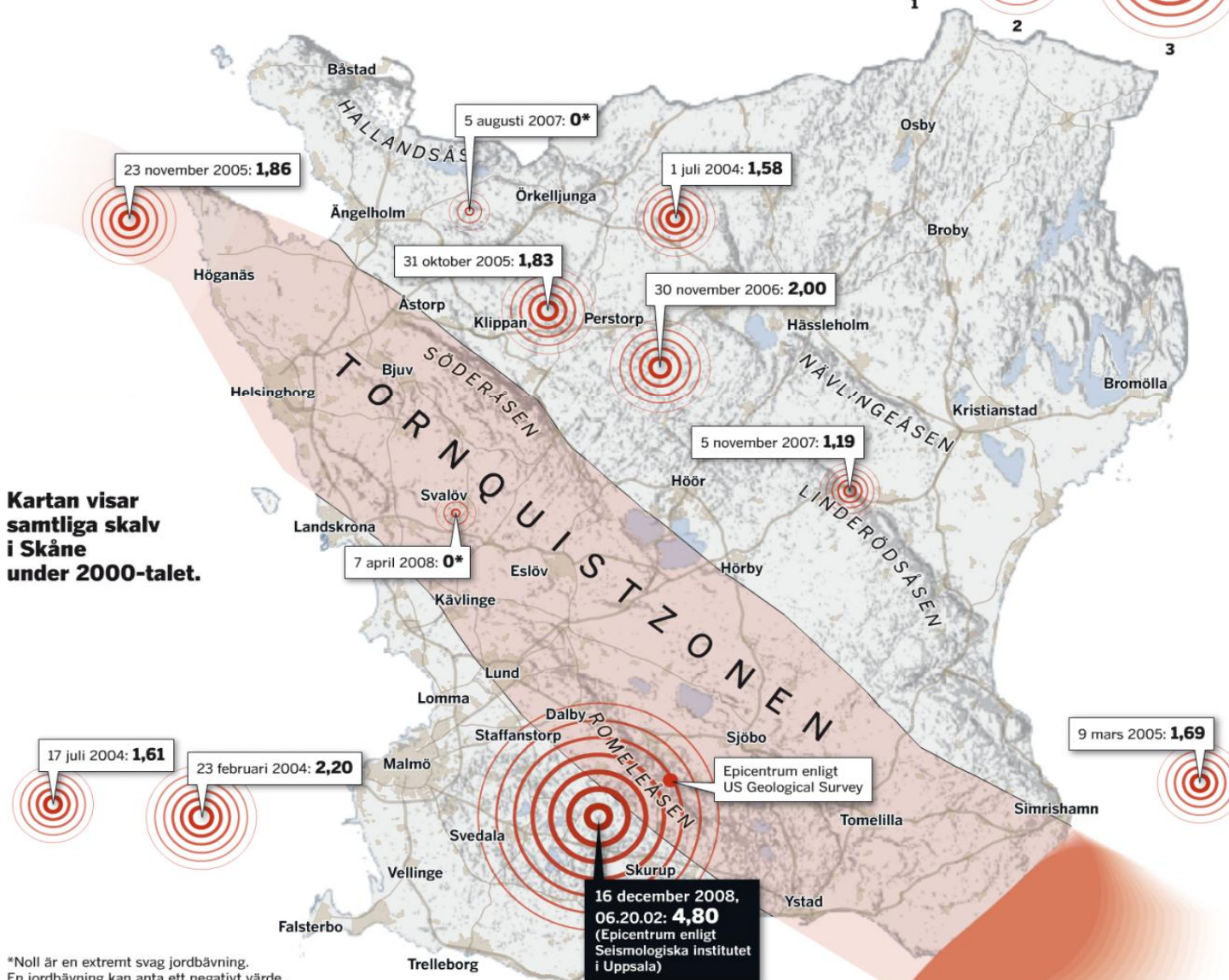
CPlane x 79.006 y 53.568 z 0.000 Millimeters Default Grid Snap Ortho Planar Osnap SmartTrack Gumball Record History Filter Absolute tolerance: 0.001

Jordskalvet skedde nära Tornquistzonen

Tornquistzonen utgörs av sprickor i berggrunden som uppstod för ungefär 400 miljoner år sedan. Då uppstod spänningar och till slut brast jordskorpan. I dag är de geologiska förhållandena lugnare.

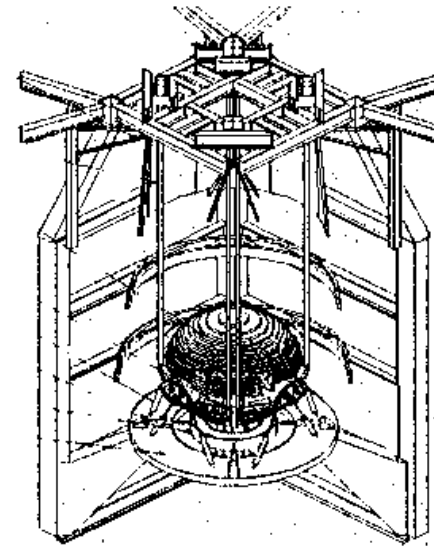
Störst spänningar blir det vid kontinentalplattornas kanter. Där sker flest jordskalv, men krafterna fortplantar sig i berggrunden och det är de som ger upphov till skalv även i Sverige. Skalven i Sverige blir inte så många och inte så stora som de vid plattornas gränser.

Teckenförklaring magnitud på richterskalan



*Noll är en extremt svag jordbävning. En jordbävning kan anta ett negativt värde.

Taipei 101- tuned pendulum



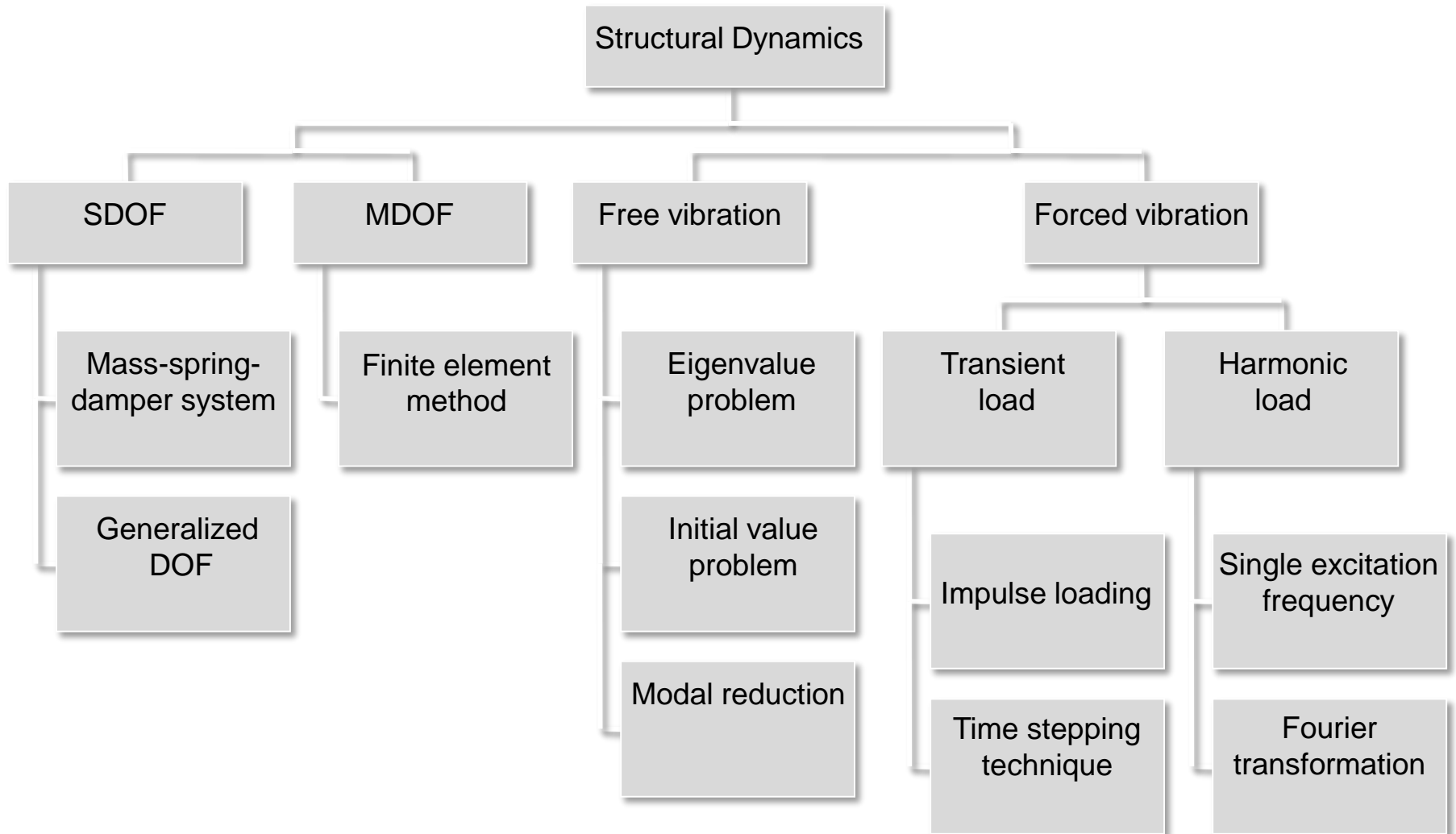
92nd floor

87th floor



Course outline and tasks

Theory contents in the course



Course overview

- Theory lectures
- Guest lecture
- Home assignments
- A short theory exam
- Laboratory data
- Project 1: Multi storey frame
- report
- Introduction to Abaqus
- Project 2: Impuls loaded
structure - report and oral
presentation

Teachers and responsibilities

- Per-Erik Austrell - Course coordinator, theory lectures, homework, and examination
- Jens Malmborg - Laboratory and measurements, consulting on Abaqus in Project 2
- Kent Persson - Abaqus finite element task and examination in Project 2

Points and grading

Weight of different course tasks:

- Home assignments 5/60
- Project task 1 15/60
- Theory exam 20/60
- Project task 2 20/60

P1 and P2; report, presentation, and grading applies to groups of 3 persons.

Grades; 3: min 30p, 4: min 40p, 5: min 50p

Website:

www.byggmek.lth.se/utbildning/kurser