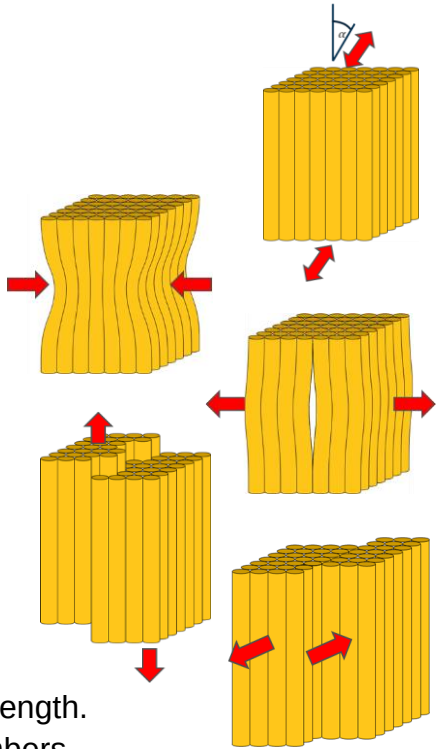
CHALMERS
UNIVERSITY OF TECHNOLOGY

TIMBER ENGINEERING - VSM196

FINAL SESSION

SPRING 2020

Lecture 1 – Mat. prop. related to EC5 - Design in ULS and SLS



Topics

- Material properties related to EC5
- Design of structural timber elements in ULS and SLS
- Literature DoTS: Ch 1, Ch 2 (2.1-2.5) and Ch 3 (3.1 and 3.2)

Content

- Introduction
  - Review and Wrap up from “Materials performance”
  - Advantages and disadvantages of timber
- Design concept for timber engineering
  - Factors influencing strength and stiffness (f & E)
  - Use of Eurocode 5 and various coefficients
- Design of member
  - Design of beams and columns in ULS & SLS

Intended learning outcomes

- You can determine the design value of strength properties.
- You can explain how to account for different influences on strength.
- You know the differences ultimate limit states of flexural members.
- You can derive the long term deformation of timber members.

Lecture 2 - Solid cr.-sec. of timber & glulam - Design of purlins

Topics

- Solid cross-sections of timber & glulam
- Design of purlins
- Literature DoTS: Ch 1, Ch 2 (2.1-2.5) and Ch 3 (3.1 and 3.2)

Content

- Modern timber products
  - Production and dimensions of solid timber
  - Production and properties of glulam
- Design of linear members
  - Purlins and design of sloping members (roof joist)

Intended learning outcomes

- You understand the limitations of solid timber.
- You can describe the production process of glulam.
- You can define important influences on the quality of glulam.
- You can describe the benefits of a Gerber system.

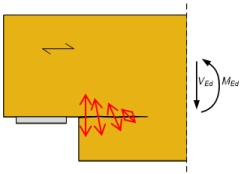
Lecture 3 - Shear, notched beams, holes, splitting & cracking

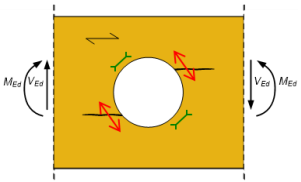
Topics

- Design of beams in shear, notched beams and holes

Content

- Design of beams in shear and with loading at the angle to the grain
- Various types and causes of fracture perpendicular to the grain
- Design of notched beams and beams with holes





Intended learning outcomes

- You understand the different types of shear failure in timber
- You can describe the problem of stress singularities at notches
- You can distinguish the impact of shear force and moment contribution on the stresses at holes in beams
- You know the benefits of reinforcement for notches and holes

Lecture 4 - EWP: plywood, boards and panels, I-beams

Topics

- Engineered Wood Products (EWP):
- Structural Composite Lumber (SCL), beams, boards and panels, plywood, Cross-laminated timber (CLT) and I-beams
- [DoTS: (2.6) 2.7 and 5.1]

Content

- Introduction (what are EWP?)
- Types used as beams and panels
- Some facts related to properties of common EWP
- Plywood – an specific example of layered board
- Cross-laminated timber (CLT)
- I-beams from different wood-based materials

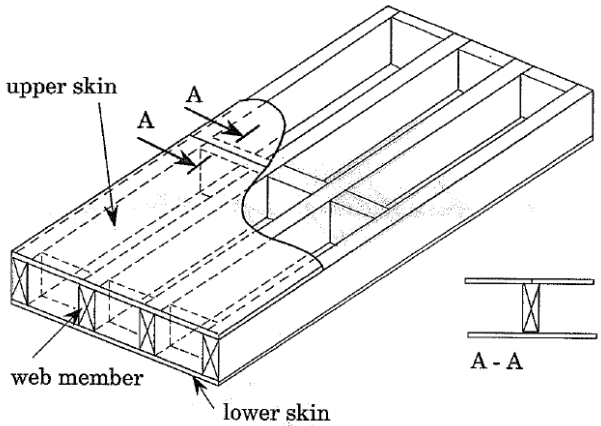
Intended learning outcomes

- You understand the benefits of Engineered Wood Production (EWP)
- You can distinguish and describe different EWPs
- You can describe the production of EWPs
- You can determine the stress distribution and capacities of EWPs
- You know the possible failure modes of different EWPs
- You can choose an adequate EWP

Lecture 5 - Build-up panels (SSP) as floors – Box beams

Topics & Content

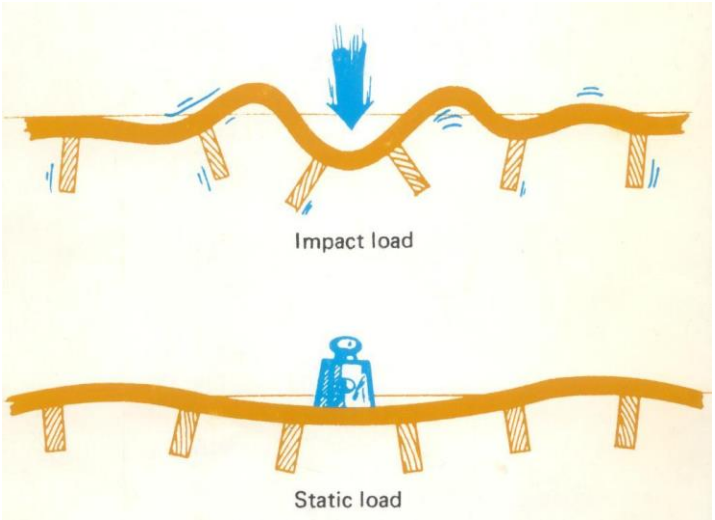
- Glued thin-webbed I-beams
- Structural elements with full composite action
- Linear elastic analysis & two different design methods
- Stressed-skin panels (SSP) with different material properties
- Application and material combinations
- Concept of effective flange width
- Design of I-beams and SSPs (ULS and SLS)



Lecture 6 – Vibration and springiness in floors

Topics & Content

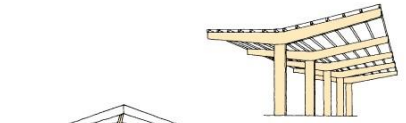
- Vibration serviceability
- Vibration source
- Vibration path
- Receiver
- Performance evaluation

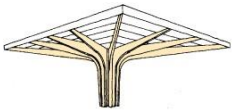


Lecture 7 – Structural systems

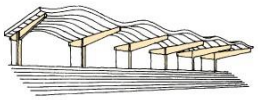
Topics & Content

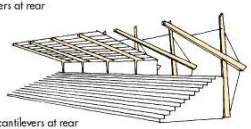
- Timber building system
- Glulam: background and history
- Beam and columns
- Various beam types & application
- Three-pin trusses (with rods)
- Arches
- Portals
- Cantilevers
- Glulam system
- Orthogonal grid


Canopy with clamped columns

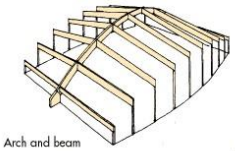

Canopy with clamped cantilevers

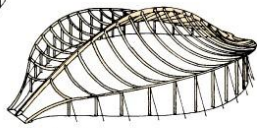

Grandstand

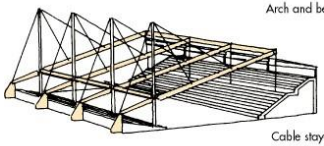

Grandstand with clamped cantilevers at rear


Grandstand with clamped cantilevers at rear


Saw-tooth roof


Arch and beam


Arch and beam


Cable stayed roof

Lecture 8 – Timber-framed walls, Bearing str., SLS, Settlement

Topics

- Timber-framed walls
- Bearing stresses
- SLS, Settlement
- [DoTS: Chapter 3 (3.1.4) and Chapter 7 (7.2.1)]

Content

- Wall and construction types of timber buildings
- Assembly of light frame timber walls
- Design of timber-framed wall in ULS and SLS

Intended learning outcomes

- You know different construction systems for timber buildings
- You can choose adequate wall systems for timber buildings
- You can determine the capacity of timber in compression perp. to grain
- You can calculate the vertical deformation of walls and timber members

Lecture 9 – Tapered, curved and pitched glulam beams

Topics

- Tapered, curved and pitched glulam beams
- [DoTS: Chapter 3.3]

Content

- Background and finger joints
- Pitched and curved glulam beams
- Stresses - distribution
- Failures of glulam structures

Intended learning outcomes

- You understand the benefits of curved and tapered beams
- You can identify the distribution of different stresses in such beams
- You can calculate the relevant stresses and verify the strength
- You can choose the adequate geometry of beams for different situations

Lecture 10 – Joints – Overview & laterally-loaded connection

Topics

- Joints
- Overview
- laterally-loaded connections
- [DoTS: Chapter 4]

Content

- Overview of different joints
- Design ULS
- Tapered, curved and pitched glulam beams

Intended learning outcomes

- You understand different loading conditions of connections
- You can identify different demands on connections
- You can calculate the load-carrying capacity of dowel-type fasteners
- You can choose the adequate fasteners for connections in shear

Lecture 11 – Joints – axially loaded nails/screws - SLS design

Topics

- Joints – axially loaded nails/screws
- Mechanical and glued connections, SLS design
- [DoTS: Chapter 4]

Content

- Axially loaded fasteners
- Moment resisting connections
- Design for SLS

Intended learning outcomes

- You know different fasteners with for axial load-transfer
- You can calculate the axial load-carrying capacity of different fasteners
- You can determine the actions on fasteners in moment resisting connections
- You can calculate the deformation and slip of connections

Lecture 12 – Stability- stabilizing walls, tilting and hor. stability

Topics

- Stability
- stabilizing walls
- tilting
- horizontal stability
- [DoTS: Chapter 6 & 8]

Content

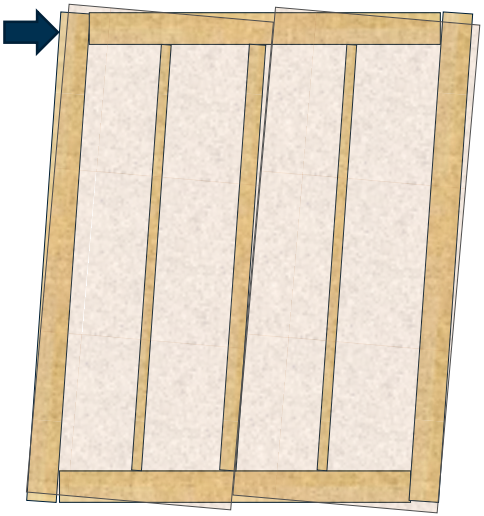
- Global stability of multi-storey timber building
- Bracing of structures – general issues

Image: Valentin Jeck & Oliver Christen Architekten GmbH

Intended learning outcomes

- You can evaluate the structural integrity of multi-storey timber buildings
- You can stabilize timber structures
- You understand bracing of structures
- You can choose and design stabilising systems for hall structures

Lecture 13 – Stabilizing timber str., design of shear walls



Graphic: R. Steiger, Empa

Topics

- Stabilizing timber structures
- Design of shear walls
- [DoTS: Chapter 6 & 8]

Content

- Stabilizing of multi-storey building
- Horizontal load transfer in buildings
- Design of shear walls
- Design of floor diaphragms

Intended learning outcomes

- You understand the transfer of horizontal forces in buildings
- You can distinguish different bracing for multi-storey timber buildings
- You can determine the resistance of shear walls under horizontal loads
- You will be able to model and design floor diaphragms and shear walls

Lecture 14 – CLT structures

Topics

- Cross laminated timber
- Material
- Structures
- [DoTS: Chapter 2], The CLT Handbook

Source: Stora Enso

Content

- Material properties
- Design of CLT elements and connections
- Examples and Structures

Intended learning outcomes

- You understand the production and properties of CLT
- You can determine the relevant stresses in a CLT element
- You know different possibilities for connection of CLT elements
- You will be able to design a simple structure made of CLT

Lecture 15 – Strengthening and Repair - Fire & Timber

Topics

- Maintenance and repair of timber structures
- Fire and timber

Content

- Maintenance and assessment of timber structures
- Rehabilitation and reinforcement of existing timber structures
- Fire and timber
- Timber connections in fire

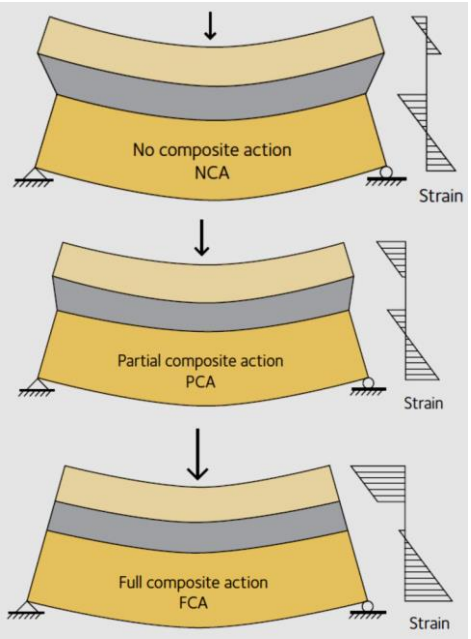
Intended learning outcomes

- You know procedures for maintenance and assessment of existing timber structures
- You can identify damages and critical aspects of existing timber structures
- You know possible intervention and reinforcement methods
- You are familiar with the fire behavior of timber
- You know the relevant parameters with influence on fire resistance
- You can follow the procedure in EN 1995-1-2

Lecture 16 – Timber members, joints with partial comp. action

Topics & Content

- Benefits of hybrid structures
- Partial Composite Theory
- Slip modulus
- Gamma method



Exam

Some comments regarding the exam

- The exam has two parts
  - one part with design problems to solve, and
    - For the calculation part, you can only use the Eurocode 5 and DoTs vol 2
    - You can only have short reference notes on these documents to be able to use them on the exam
  - one part with theoretical and descriptive questions
    - The second part consists of two descriptive questions and 12 multi-choice questions
    - Please notice that for the theoretical part of the exam, no aid is allowed.
    - Please notice that the theoretical descriptive and multi-choice questions will be from the lecture notes, and DoTs vol 1

Some comments regarding the exam

- 26 points maximum
  - 16 points coming from the first part and
  - 10 points from the second
- To pass the exam both parts have to be approved, i.e. at least
  - 6 points from the first part and
  - 4 points from the second, and
  - a total of 11 points is required.
- Registration through the Student Portal is necessary.

CHALMERS

UNIVERSITY OF TECHNOLOGY