Funded by the
Erasmus+ Programme
of the European Union

Sustainable, High-Performance Building Solutions in Wood (HiBiWood)

2020-1-LV01-KA203-077513

ASSIGNMENT BOOK

Assignments prepared by FH Campus Wien, Austria

June 2023

DECLARATION

The described assignments were effectively implemented during three students' workshops/ intensive courses (O2 Vienna - September 2021, O4 Cracow - May 2022, and O6 Riga - March 2023) as part of the HiBiWood project. These tasks should continue to be accessible as open-source learning materials through this publication.

TABLE OF CONTENTS

1. PREPARATORY TASKS

1.1. ANALYSIS OF CASE STUDIES: SUSTAINABLE, HIGH-PERFORMANCE TIMBER BUILDINGS

Task formulation:

Students should select a timber building (housing, 3-4 floors) from the country of origin and examine its architectural concept, structural system, building physics, assembly techniques and sustainability. They are expected to work in groups of five and gain essential understanding of the principles behind timber structures.

Components of analysis

- **Architecture:** concept, typology, plans, urban integration, flexibility
- **Statics/ Structural Grid:** deinforcement, vertical and horizontal load transfer
- **Building Construction:** details, assembly site, construction and tendering process, element sizes, joining technology, assembly work, dismantling concept
- **Building Physics:** sound-head-moisture management, fire protection
- **Sustainability Concept:** social, ecological, economical

Type of assessment: group work (national teams, group of 5 students)

Number of hours: 25h

Learning Outcome: Conducting a detailed technical analysis of a timber building enables students with diverse knowledge backgrounds to reach a common level of understanding, thereby establishing a solid groundwork for the development of the main assignment.

Applied during: O2 intensive course in Vienna, Austria (September 2021, Host University: FHCW)

1.2. ELABORATION OF TIMBER-SPECIFIC TOPICS (FACT SHEETS)

Task formulation:

The preparation for the second intensive course in Cracow includes the elaboration of 18 timber-specific topics regarding timber technologies, structural systems and building physics. Two students from different nationalities and disciplines (architecture, civil engineering and building site management) work together on one question and answer it in max. two pages (inclusive glossary, text, tables, and graphics). These students are considered “experts” on the topic during the workshop in Cracow and support the groups by solving topic related problems in the elaboration of the main assignment.

The analysis of the timber-specific topics should be submitted before the beginning of the intensive course. The students will receive the answers to all questions at least one week before the course, so they will have time to prepare theoretically for the workshop.

Components of the analysis (topics):

1. **Vertical load transfer - spans and systems for timber construction**

Planning aspects in relation to structural grid, primary/secondary structure and load transfer across floors, influence on degree of prefabrication. Differences in different constructions and explanation of advantages/disadvantages about load-bearing behaviour.

2. **Horizontal load transfer - bracing in timber construction**

Planning aspects regarding bracing concepts, load transfer within the storey (roof/ceiling and wall) and across the storeys (internal, external and partition walls) into the building ground. Differences in different constructions and explanation of advantages/disadvantages about load-bearing behaviour.

3. **Sound insulation vs. load transfer**

Principle solutions for the node connection of wall and ceiling components, considering influencing factors on the part of architecture and statics, special features of timber construction / differences to solid construction.

4. **Cantilevers**

From e.g., balconies / loggias to living space. Overview of structural systems, cross-references about waterproofing and thermal separation, and problems with cantilevered building components (e.g., staggered storey).

5. **Roof systems**

Options for roof systems: pitched (steep) roof / flat pitched roof / flat roof. Cross-references about building physics (warm roof vs. cold roof/ventilated constructions).

6. **Ceiling systems**

Possibilities of ceiling systems (e.g., bar-shaped, or flat components, mixed forms) and bracing of the same. Differences in single span/multi span beam systems. Consideration of the vibration issue of wood ceilings, also in relation to wet/dry screed.

7. **Wall systems**

Possibilities of wall systems (e.g., bar-shaped, or flat components, mixed forms) and bracing of the same. Economic size for prefabricated elements / modules. Limits for standard systems and possibilities for special constructions (e.g., room height, span, etc.) if not built with standard elements.

8. **Airborne sound insulation of partition walls in timber construction**

Basic component systematics, solid timber construction / timber frame construction, facing shells / multi-shell constructions.

9. **Impact sound insulation of partition ceilings in timber construction**

Basic component systematics, bar-shaped or flat components, mixed forms

10. **Decoupling possibilities in timber construction**

Separation joints and their formation, decoupling materials, types of decoupled bearing (point, line, etc.) and their effect on the quality of decoupling. How to achieve the best decoupling / how hard must a bearing be (compressive strength vs. elasticity), dimensioning of decoupling materials. Design options for decoupling fasteners in timber construction.

11. Constructive solutions for the reduction of indirect (flank) transmission

Structural measures to avoid indirect (flank) transmission, influence of the measures on architecture and structural design. Description of flank paths; qualitative evaluation in comparison with the quality of separating components.

12. Summer suitability in timber construction

Elaboration of the decisive parameters about summer suitability (storage mass, solar inputs, ...) and their influence on the characteristic thermal development of the room air temperature in timber construction. Thermal balance of a room on a summer day

13. Moisture protection and air tightness in timber construction

Moisture transport by diffusion and convection. Basic concepts of components (superstructure) systems for fault-tolerant constructions regarding tightness, moisture protection and thermal insulation in solid wood construction and timber frame construction. Use of vapor barriers in wood construction.

14. Constructive moisture protection in timber construction

Overview of the decisive areas (plinth, facade, wet rooms, connection points, etc.) and the decisive parameters about constructive moisture protection.

15. Timber building system – systematization.

Variant study of construction systems - products, details + advantages/disadvantages, technical consequences.

16. Hybrid structures

Systems that combines different materials and structural solutions. The choice may be made for architectural, structural, environmental or economic reasons, or because of local construction practices or code requirements (the use of steel and concrete with engineered timber)

17. Prefabrication

The prefabrication of wood-based composite materials - large structural elements and components. Levels of prefabrication, advantages and disadvantages of prefabrication, the transportation issues, types of prefabricated elements (linear, planar, boxes).

18. Facades

Types of facades (loadbearing, self supporting, non loadbearing), cladding materials, proper order of layers, kinds of membranes and insulations

Type of assessment: group work (2 students per topic, international teams)

Number of hours: 20h

Learning Outcome: Through the elaboration of the topics the participants should acquire the necessary knowledge needed for the assignments during the second intensive course in Cracow (focus: construction systems and building physics).

Applied during: O4 intensive course in Cracow, Poland (Mai 2022, Host University: CUT)

1.3. SELF-LEARNING OF TIMBER-SPECIFIC TOPICS (FACT SHEETS)

As preparation for the intensive course in Riga, the students should learn 15 timber-specific topics about timber technologies, structural systems and building physics. They are elaborated by the participants of the second workshop in Cracow and peer reviewed by the HiBiWood partners.

The students will receive the learning materials one month before the intensive course during the online kick-off meeting. On the first day of the workshop, each student will be given a topic by a random principle and will have to explain it in 3-4 minutes to the other participants. It is desired, that the short presentation is completed by the other students and questions are asked.

Components of the analysis (topics):

1. Vertical load transfer - spans and systems for timber construction
2. Horizontal load transfer - bracing in timber construction
3. Sound insulation vs. load transfer
4. Cantilevers
5. Roof systems
6. Ceiling systems
7. Wall systems
8. Airborne sound insulation of partition walls in timber construction
9. Impact sound insulation of partition ceilings in timber construction
10. Decoupling possibilities in timber construction
11. Constructive solutions for the reduction of indirect (flank) transmission
12. Summer suitability in timber construction
13. Moisture protection and air tightness in timber construction
14. Prefabrication
15. Facades

Type of assessment: Individual work

Number of hours: 10h

Learning Outcome: Through the fact sheets, the participants should acquire essential knowledge about timber constructions, needed for the assignments during the third intensive course in Riga.

Applied during: O6 intensive course in Riga, Latvia (March 2023, Host University: RBC)

1.4. SELF-REFLEXION/SHORT ESSAY ON SUSTAINABILITY AND CLIMATE PROTECTION

Task formulation:

The students are expected to write a short essay, spanning 1-2 A4 pages, which addresses the following questions:

- Why is it important to build sustainably?
- How do I personally contribute to climate protection in my everyday life? What measures do I take?

Type of assessment: Individual work

Number of hours: 5h

Learning Outcome: The task facilitates personal introspection and fosters an elevated consciousness regarding climate protection, emphasizing the significance of 1) sustainable building practices and 2) individual actions.

Applied during: O6 intensive course in Riga, Latvia (March 2023, Host University: RBC)

1.5. SHORT PRESENTATION OF THE EMPHASIS OF EACH STUDY PROGRAMME

Task formulation:

All students enrolled in the same university are required to prepare a brief presentation, consisting of 3-4 slides and lasting approximately 5 minutes, explaining the focal points of their respective study programs.

Type of assessment: group work (national teams, group of 5 students)

Number of hours: 5h

Learning Outcome: getting to know each other.

Applied during: O6 intensive course in Riga, Latvia (March 2023, Host University: RBC)

2. WORKSHOP ASSIGNMENTS

2.1. DESIGN OF RESIDENTIAL TIMBER BUILDING (3-4 FLOORS)

The 30 students are divided into six international and multidisciplinary teams. Each team consists of three architects along with two students from the fields of civil engineering and/or building site management.

Task formulation

The main task during the O2 intensive course in Vienna is to design a timber building with residential units, featuring adaptable floor plans and convenient access to outdoor spaces. The building should have three to four stories, specifically tailored to the requirements of young people and families. The design should encompass individual flats ranging from 30 to 45 m2, as well as larger units approximately between 60 and 90 m2, with the option to merge two smaller flats into a larger one. The design also should incorporate shared areas, communal rooms, gardens, and a bicycle storage room to enhance the usability of the residential space and staircase.

The construction should meet the criteria of an Austrian construction class III, with a maximum building height not exceeding 11 meters. Additionally, the design needs to prioritize efficiency and affordability, employing innovative serial or modular construction methods while ensuring architectural quality and maximizing resource conservation throughout production, construction, operation, and dismantling phases. The sustainability concept of the project should emphasize life cycle considerations and highlight the importance of resource-saving practices, dismantling processes, and recycling for future reuse.

Documents to be prepared for the final presentation:

1. A3-Folder with the following contents:
- Site plan, 1:500 (urban concept)
- Floor plans, 1:200 (of one of the buildings/parts of the building, showing the different flat types)
- Sections, 1:200
- Plans with the structural grid (explanation of the static system)
- Calculation of the vertical and horizontal load transfer
- Partial section through the façade, 1:50
- Assembly/joining technology, degree of prefabrication.
- Connection details, 1:5, 1:10 (material selection)
- Calculation of the thermal transmittance of the constructions /Explanation of thermal bridges
- Concept: Heat / Sound / Moisture management & Fire resistance
- Dismantling and flexibility concept
- Sustainability concept
- Photo collages, renderings, sketches, explanatory text

2. Power Point presentation

3. Physical model, 1:500

Type of assessment: group work (international teams, group of 5 students)

Number of hours: 50h

Learning Outcome: The task provides the students with profound understanding of timber construction systems, including their load-bearing characteristics and their effects on design requirements. This knowledge is successfully incorporated into the design process, leading to the creation of multi-storey timber buildings with outstanding architectural quality.

Applied during: O2 intensive course in Vienna, Austria (September 2021, Host University: FHCW)

2.2. CONSTRUCTION SOLUTIONS FOR A GIVEN PROJECT

Task formulation:

The students continue to work on the projects from the first intensive course in Vienna, going deeper into the structural systems and Eurocodes, timber technology, connections, detailing of different building elements, solutions for fire protection, acoustics, durability, sustainability, and thermal insulation.

The initial phase of the workshop assignment involves conducting a comprehensive static analysis of the projects. This analysis encompasses various aspects such as explaining the structural grid, understanding the transmission of vertical and horizontal loads through primary and secondary constructions, considering the bracing concept, examining the foundation and roof system, and evaluating the spanning capabilities. Based on the findings of this assessment, the chosen timber technology was reassessed, leading, if necessary, to adjustments in architectural plans and building element dimensions.

Following this, informed decisions should be made concerning the building systems. This includes selecting roof systems (warm roof vs. cold roof) and wall systems (bar-shaped, flat components, and mixed forms). The utilization of prefabricated elements and modules, as well as constructive moisture protection, should also be considered. These decisions are to be guided by a sustainability concept that prioritizes temporary approaches, combinability, and the potential for future dismantling of the building.

The final subtask of the assignment is to develop a superstructure catalogue (details). It should outline the connections between exterior wall-roof, exterior wall-ceiling, interior wall-ceiling, plinth (exterior wall), interior wall-roof, and cantilever components. These details are to be created at a scale of 1:10 or 1:5, taking into consideration important factors such as thermal insulation (u-value) and thermal envelope, seals and thermal breaks, impact, and airborne sound insulation (Rw, Lnw), and moisture protection.

The students should elaborate the following task components:

2.2.1. Load bearing structures

Components of the analysis

- Plans with the structural grid (static system)
- Explanation of the vertical and horizontal load transfer (primary and secondary constructions, bracing concept, spanning (e.g., which roof system), foundation
- Timber technology, connections (adjustment of architectural concept, if needed)

2.2.2. Construction system

Components of the analysis

- Assembly, joining technology, prefabrication, modularity
- Assembly sequence from the foundation to the roof in chronological order
- Sustainability concept: temporary approach, combinability, recyclability, and deconstructability (dismantling)

- **Components:** construction system from foundation to roof
  - Roof system explanation: Warm roof vs. cold roof/ventilated structures
  - Wall system explanation: bar-shaped or flat components, mixed forms, bracing, prefabricated elements and modules, constructive moisture protection
  - Facade design with energy aspects
  - Cantilevers (construction system)

2.2.3. Building Physics

- **Superstructure catalogue (Details):**
  - **Exterior wall-roof:** detail 1:5, 1:10 (material selection, thermal envelope, constructive moisture protection, noise protection concept)
  - **Exterior wall-ceiling:** detail 1:5, 1:10 (material selection, impact sound insulation and airborne sound insulation, wet/dry screed)
  - **Interior wall-ceiling:** detail 1:5, 1:10 (material selection, wet/dry screed, impact sound insulation and airborne sound insulation)
  - **Plinth (exterior wall):** detail 1:5, 1:10 (material selection, constructive moisture protection)
  - **Interior wall-roof:** detail 1:5, 1:10 (material selection,
  - **Cantilevers:** detail 1:5, 1:10 (material selection, sealing, waterproofing and thermal separation)

Aspects to be considered:

- Thermal insulation (u-value) - thermal envelope, seals, and thermal break
- Sound insulation (Rw, Lnw) - noise control concept (impact sound insulation):
  - Interior wall-ceiling
  - Interior wall-roof
  - Exterior wall-ceiling
  - Plinth (exterior wall)

   - Exterior wall-roof
- Constructive moisture protection
- Concept node/connection details (sound insulation / structural engineering)
- Separating components between utilization units

Type of assessment: Group work (international teams, group of 6 students)

Number of hours: 50h

Learning Outcome: The learning outcome of the assignment is the students' in-depth understanding of the physical and constructive properties of timber. They deepen their competency by effectively incorporating concepts related to sound, heat, fire, and moisture protection into their projects and successfully integrating these aspects into the detailed construction plans.

Applied during: O4 intensive course in Cracow, Poland (Mai 2022, Host University: CUT)

2.3. ELABORATION OF A BUILDING SITE MANAGEMENT CONCEPT

Task formulation:

The students continue to work on the projects from the intensive courses in Vienna and Cracow and develop rough building site management concepts for the buildings. The goal of the assignment is to adapt the plans considering different parameters such as costs, logistics, transportation, dimensions, and prefabrication. At the end of the workshop, students should be able to estimate the advantages and disadvantages of different structural systems and building components, understand the consequences of changes, and make informed decisions.

Submission:

Students are required to submit a **report** covering the following topics and including the effects of selected variants in terms of advantages and disadvantages:

1. Construction Process: Students should outline the level of prefabrication, modularity, and dimensions of building components during transportation, joining technology, and digital processes. They should also select production companies based on sustainable aspects.
2. Logistics: This section should cover transport, montage, timeline, management of relevant disciplines, and management of the building site.
3. Assembly sequence (visualisation): Students should provide a visualization of the chronological order of the assembly sequence from the foundation to the roof.
4. Rough cost estimation
5. Sustainability concept: This section should cover the temporary approach, combinability, recyclability, and deconstructability (dismantling) of the building.

6. Lessons learned: In this section, students should reflect on what they have learned about all phases of the workshop. They should also highlight the problems they encountered and how they were resolved.

The report should be well-structured and clearly written, with each section addressing the relevant topic. Students should provide evidence to support their arguments and include references where necessary. The report should be submitted on the last day of the workshop and meet the required formatting and citation standards.

Students should prepare a **presentation** and explain the outcomes of their projects to the july.

Type of assessment: Group work (international teams, group of 5 students)

Number of hours: 30h

Learning Outcome: Tangible understanding of the process of erecting a building; ability to elaborate a rough building site management concept.

Applied during: O6 intensive course in Riga, Latvia (March 2023, Host University: RBC)

2.4. BUILDING A PHYSICAL MODEL

Task formulation:
Students are expected to select one of the projects and construct a **physical model** in 1:20 scale, representing all storeys of the building, from the foundation to the roof, including the individual layers of the building elements. The model should be capable of being disassembled into individual components, visualizing the chronological order of erection, building element dimensions by the transportation, prefabrication level, assembly process, and dismantling concept.

Type of assessment: Group work (international teams, group of 5 students)

Number of hours: 20h

Learning Outcome: Tangible understanding of the construction of timber building and its components; and of the assembly chronology

Applied during: O6 intensive course in Riga, Latvia (March 2023, Host University: RBC)