Civil Engineering Project Documentation - Dataset 5

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1. Project Overview

1.1 Building Specifications

1.1.1 Dimensions

- Width (b) = 7.2m
- Length 1 (L1) = 6.6m
- Length 2 (L2) = 10.8m
- Height 1 (h1) = 2.5m
- Height 2 (h2) = 2.65m
- Roof angle = 16°
- Purlin spacing = 1.1m
- Ground level = -1.4 m.a.s.l

1.1.2 Materials

- Walls: Max 220 block
- Insulation: Mineral wool
- Roofing: Steel tile 0.6mm
- Structure: C27 timber class

1.2 Drawing Set

1.2.1 Main Views (Scale 1:50)

- Vertical projection (front elevation) The vertical projection provides a comprehensive front view of the building structure, illustrating the key height dimensions and structural relationships. This drawing is essential for understanding the vertical spatial organization and the integration of different building components. It clearly demonstrates the relationship between wall heights, roof angle, and foundation level, which are critical for construction planning.

- Horizontal projection (top view) The horizontal projection presents the building's layout from above, showing the spatial arrangement and dimensional relationships of all major components. This drawing is crucial for understanding the building's footprint, structural grid, and the distribution of load-bearing elements. It provides essential information for material quantity estimation and construction sequencing.

1.2.2 Detail Drawings (Scale 1:10)

1. Foundation-column connection This critical structural detail illustrates the interface between the timber column and concrete foundation, ensuring proper load transfer

and stability. The drawing shows the precise dimensioning of the 150×150mm column section and its 400mm embedment into the foundation, along with all necessary connection hardware and waterproofing measures.

2. Roof-column connection The roof-column connection detail demonstrates the structural integration of C27 timber elements at this crucial junction. This detail is essential for understanding load paths and ensuring proper force transfer between vertical and horizontal structural members, while maintaining the building's structural integrity.
3. Wall-roof junction This detail focuses on the critical interface between wall and roof assemblies, highlighting proper insulation continuity and moisture management. The drawing demonstrates the integration of vapor barriers, flashing, and thermal insulation to prevent thermal bridges and ensure weather-tight construction.
4. Insulation installation The insulation detail provides comprehensive information about the thermal envelope construction, showing the proper installation of mineral wool insulation and associated air barriers. This detail is crucial for achieving the specified thermal performance and preventing condensation issues within the building envelope.

2. Structural Analysis

2.1 Material Properties

2.1.1 C27 Timber (EN 338)

- Characteristic bending strength (fm,k) = 27 N/mm²
- Characteristic compression parallel to grain (fc,0,k) = 22 N/mm²
- Mean modulus of elasticity (E0,mean) = 11.5 kN/mm²
- Characteristic density (ρk) = 370 kg/m³
- Partial safety factor (γ_M) = 1.3
- Modification factor (k_{mod}) = 0.8 (Service Class 2)

2.2 Load Calculations

2.2.1 Dead Loads

1. Steel tile roofing (0.6mm): 0.047 kN/m²
2. Timber structure:
   - Rafters: 0.15 kN/m²
   - Purlins: 0.10 kN/m² Total dead load (gk) = 0.297 kN/m²

2.2.2 Snow Load (EN 1991-1-3)

For Warsaw, Poland: - Ground snow load (sk) = 0.7 kN/m² - Roof shape coefficient (μ_1) = 0.8 ($\alpha = 16°$) - Exposure coefficient (Ce) = 1.0 - Thermal coefficient (Ct) = 1.0

Snow load on roof: $s = \mu_1 \cdot C_e \cdot C_t \cdot s_k = 0.8 \times 1.0 \times 1.0 \times 0.7 = 0.56$ kN/m²

2.2.3 Wind Load (EN 1991-1-4)

Basic parameters for Warsaw: - Basic wind velocity (vb,0) = 22 m/s - Terrain category III - Reference height (ze) = 2.65 m

Wind pressure calculation: qp(z) = ce(z) × qb where: - ce(z) = 1.6 (exposure factor) - $q_b = 0.5 \cdot \rho \cdot v_{b,0}^2 = 0.302$ kN/m²

Peak velocity pressure: $q_p(z) = 1.6 \cdot 0.302 = 0.483$ kN/m²

2.3 Structural Design

2.3.1 Purlin Design

Load transfer: - Design load (Ed) = 1.401 kN/m² - Purlin spacing = 1.1 m - Load per purlin = 1.541 kN/m

Section properties (80mm × 160mm): - Maximum span = 1.8m - Design moment = 0.623 kNm - Section modulus = 341,333 mm³ - Design stress = 1.83 N/mm² < 16.62 N/mm² ✓

2.3.2 Rafter Design

Load combination (ULS): $E_d = 1.35 \cdot g_k + 1.5 \cdot q_k + 1.5 \cdot \psi_0 \cdot q_w = 1.401$ kN/m²

Section properties (100mm × 200mm): - Maximum span = 5.62m - Design moment = 6.12 kNm - Section modulus = 666,667 mm³ - Design stress = 9.18 N/mm² < 16.62 N/mm² ✓

2.3.3 Column Design

Load calculation: - Tributary area = 5.94 m² - Design load (Ned) = 8.32 kN

Section properties (150mm × 150mm): - Area = 22,500 mm² - Compressive stress = 0.37 N/mm² - Design strength = 13.54 N/mm² ✓

3. Thermal Analysis

3.1 Wall Assembly

3.1.1 Components

1. Max 220 block:
   - Thickness = 220 mm
   - $\lambda = 0.33$ W/(m·K)
   - $R_1 = 0.667$ m²K/W
2. Mineral wool:
   - Thickness = 150 mm
   - $\lambda = 0.035$ W/(m·K)
   - $R_2 = 4.286$ m²K/W
3. Surface resistances (EN ISO 6946):
   - $R_{si} = 0.13$ m²K/W (internal)
   - $R_{se} = 0.04$ m²K/W (external)

Total thermal resistance: $R_T = 5.123$ m²K/W U-value = 0.195 W/(m²K) < 0.20 W/(m²K) ✓

3.2 Roof Assembly

3.2.1 Components

1. Steel tile:
   - Thickness = 0.6 mm
   - $\lambda = 50$ W/(m·K)
   - $R_1 = 0.000012$ m²K/W
2. Air gap:
   - R2 = 0.16 m²K/W (ventilated)
3. Mineral wool:
   - Thickness = 200 mm
   - $\lambda = 0.035$ W/(m·K)
   - $R_3 = 5.714$ m²K/W
4. Surface resistances:
   - $R_{si} = 0.10$ m²K/W

- $R_{se} = 0.04$ m²K/W

Total thermal resistance: $R_T = 6.014$ m²K/W U-value = 0.166 W/(m²K) < 0.18 W/(m²K) ✓

4. References

1. EN 338:2016 - Structural timber - Strength classes
2. EN 1990:2002 - Basis of structural design
3. EN 1991-1-3:2003 - Snow loads
4. EN 1991-1-4:2005 - Wind actions
5. EN 1995-1-1:2004 - Design of timber structures
6. EN ISO 6946:2017 - Thermal resistance calculation