

# Building Insulation Materials: Technical Assessment

## Learning Objectives

- Calculate and analyze thermal resistance values for different insulation materials
- Identify and compare various insulation materials used in construction
- Apply theoretical knowledge to practical construction scenarios
- Understand thermal bridging and its implications
- Perform cost-benefit analysis for different insulation solutions

## Part 1: Thermal Conductivity Calculations

Using your calculator and the provided formulas, solve the following problems:

### Problem Set 1:

Calculate the thermal resistance (R-value) for each material layer:

Material	Thickness (d)	Thermal Conductivity ( $\lambda$ )	Calculations	R-Value
Mineral Wool	15 cm	0.036 W/mK		
EPS	10 cm	0.040 W/mK		

## Material Properties Analysis

Complete the matching exercise and explain your reasoning:

Draw lines connecting materials with their correct thermal conductivity values:

### Materials:

- Mineral Wool
- Expanded Polystyrene (EPS)
- Extruded Polystyrene (XPS)
- Polyurethane Foam

### Values (W/mK):

- 0.032-0.036
- 0.035-0.040
- 0.030-0.035
- 0.022-0.028

Explain your matching choices:

Using the provided material samples, complete the detailed analysis table:

Material Sample	Visual Characteristics	Density Range	Fire Class	Applications
Sample A				
Sample B				
Sample C				

### Key Differences Between EPS and XPS:

1. Manufacturing Process:

2. Physical Properties:

3. Performance Characteristics:

## Practical Application: Wall Assembly Design

Using Romanian norm C107/2005, complete the following exercises:

### Climate Zone III Analysis:

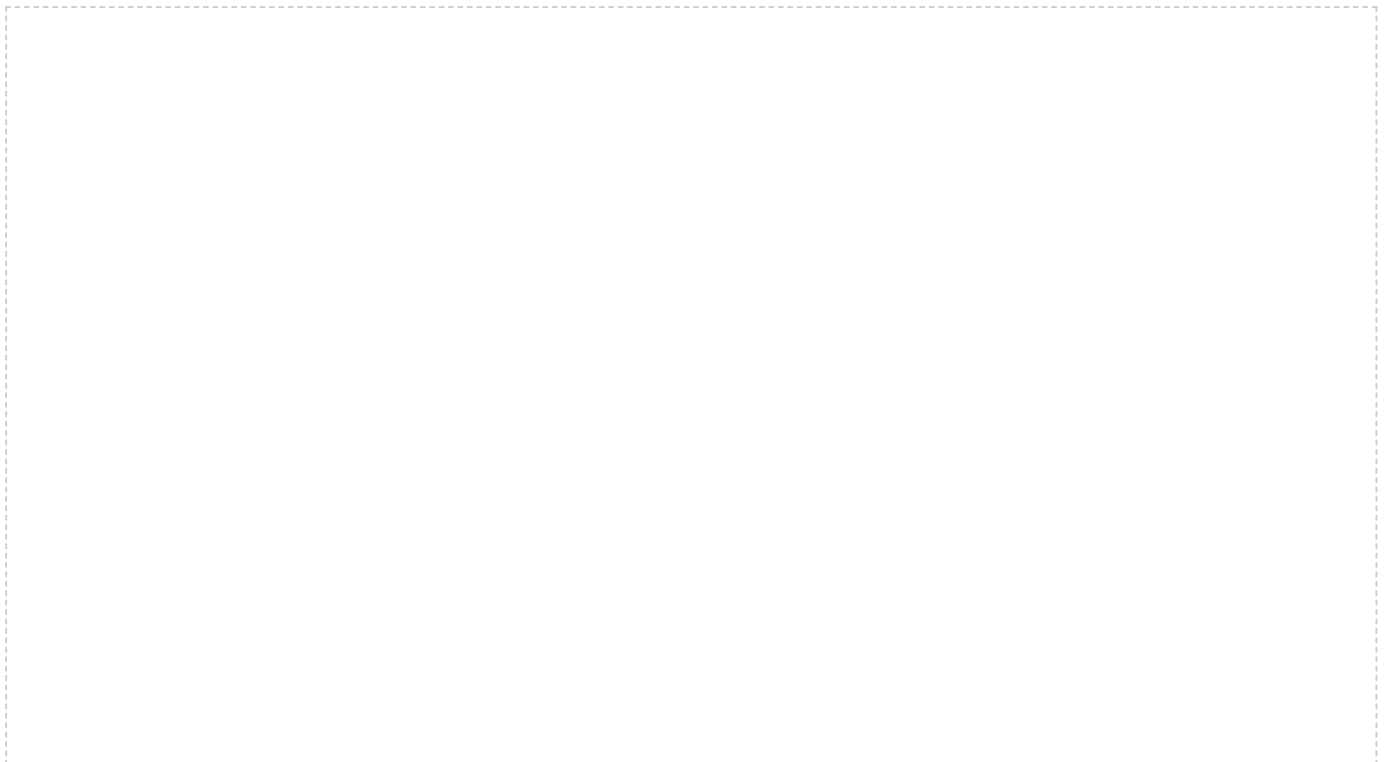
1. Minimum required R-value according to standards:

2. Calculate required mineral wool thickness:

3. Alternative EPS solution (show calculations):

### Technical Drawing Exercise:

Draw and label a complete external wall assembly below



#### Legend:

1. Structural elements
2. Insulation layers
3. Vapor barriers
4. Air gaps

## Thermal Bridge Analysis

Analyze common thermal bridges in building construction:

### Case 1: Balcony Connection

Calculate heat loss through thermal bridge:

1. Linear thermal transmittance ( $\psi$ -value):
  
2. Temperature factor (fRsi):
  
3. Proposed solution:

### Case 2: Window Reveal

Identify critical points and solutions:

1. Critical areas:
  
2. Heat loss calculation:
  
3. Improvement measures:

## Cost-Benefit Analysis

Complete a comprehensive cost analysis for different insulation solutions:

Insulation Type	Initial Cost (€/m <sup>2</sup> )	Installation Cost (€/m <sup>2</sup> )	Lifespan (years)	Annual Energy Savings (€/m <sup>2</sup> )	ROI Period
Mineral Wool					
EPS					
XPS					

### ROI Calculations:

ROI Period = (Initial Cost + Installation Cost) ÷ Annual Energy Savings

## Environmental Impact Assessment

Analyze the environmental aspects of different insulation materials:

Criteria	Mineral Wool	EPS	XPS
Embodied Carbon (kgCO <sub>2</sub> /kg)			
Recyclability			
Production Energy (MJ/kg)			

### Life Cycle Assessment

#### Production Phase

#### Use Phase

#### End-of-Life Phase

#### Transportation Impact

## Final Project: Comprehensive Building Envelope Design

*Design a complete building envelope system for a residential building:*

### Project Parameters:

- Building Location: Climate Zone III
- Total Wall Area: 450 m<sup>2</sup>
- Window Area: 15% of wall area
- Required U-value: 0.20 W/m<sup>2</sup>K
- Budget Constraint: €45,000

### Design Tasks:

1. Material Selection and Justification:

2. Thermal Performance Calculations:

3. Cost Analysis:

4. Installation Details:

### Technical Details:

## Assessment Criteria

Criteria	Points Available	Points Earned
Calculations Accuracy	30	
Material Analysis	25	
Technical Drawing	25	
Overall Presentation	20	
<b>Total</b>	<b>100</b>	

**Teacher's Comments:**

**Signature:** \_\_\_\_\_

**Date:** \_\_\_\_\_