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Temperature and Relative Humidity Distribution in a Heritage Church Attic During Summer

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INTRODUCTION

Attic spaces represent a unique yet often overlooked part of historical buildings in microclimatic analysis. However, it is the historical timber roof trusses that are an important part of the architectural heritage in listed buildings, and their preservation necessitates a thorough understanding of the indoor microclimatic conditions.

Attic Microclimate Factors

- Roof Structural Design
- Roof Ventilation Method
- External Weather Conditions
- Orientation Relative to Cardinal Directions
- Solar Radiation Absorption by Roof Covering
- Permeability and Tightness of Roof Covering
- Storage Capacity of Walls and Ceilings
- Building Occupancy and Function

Fig. 1 Main factors affecting microclimatic conditions in historical attic spaces

METHODOLOGY

Site Location & Heritage Status

- located near the heavy-traffic first-class road No. 64 (I/64) in Zilina-Bytcica
- listed in the Register of Immovable National Cultural Monuments of Slovak Republic

Fig. 2 St. Emeric Church in Zilina-Bytcica (left: exterior view; right: view into the attic space)

Microclimatic Monitoring & Data Collection

- hourly measurements:
  - air temperature and air relative humidity
  - external climate data
- specific-day measurements:
  - air velocity
  - airflow visualisation

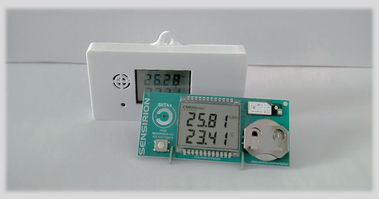

Fig. 3 Measuring equipment (left: wireless T/RH sensors; right: fog machine)

Data Analysis & Spatial Assessment

- focused on a typical summer week
- cross-section A-A is closer to the tower on the west side of the church
- cross-section B-B is closer to the sanctuary on the east side of the church

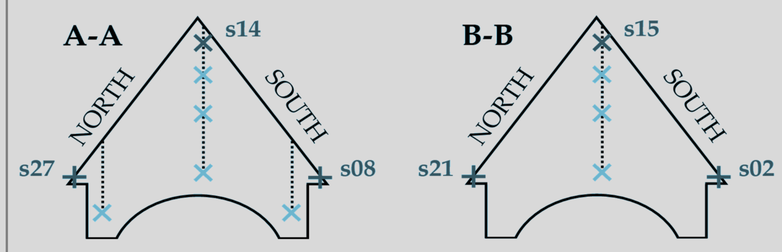

Fig. 4 Location scheme of the selected sensors in the analysed attic cross-sections

RESULTS & DISCUSSION

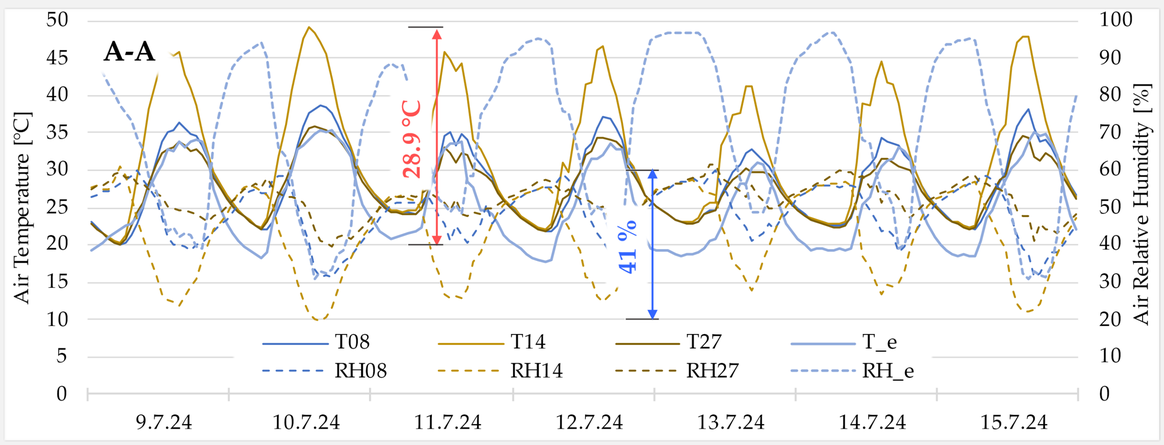

Fig. 5 Temperature and relative humidity trends in cross-section A-A during a typical summer week

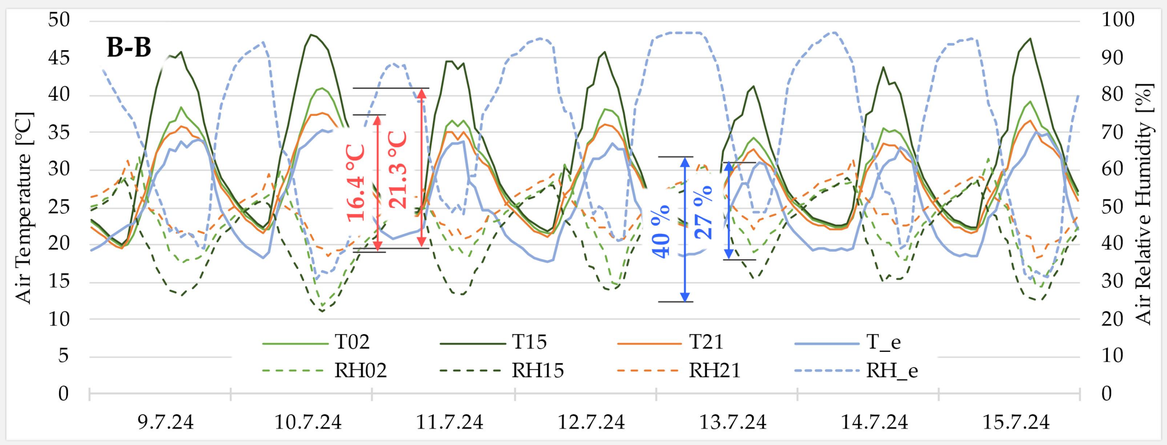

Fig. 6 Temperature and relative humidity trends in cross-section B-B during a typical summer week

CONCLUSION

- **Air Temperature and Air Relative Humidity** – The results revealed significant gradients of temperature and relative humidity in the attic space of St. Emeric Church during a typical summer week, with daily cycles with maxima and minima influenced by the sun exposure time of roof planes and the position of analysed cross-sections. The highest temperatures and lowest relative humidities were recorded at the roof ridge, where the temperature increased to 49.1 °C and the relative humidity decreased to 20 % in the afternoon. Comparing the northern and southern parts of the roof, temperatures were higher and relative humidities lower at the south eaves by approximately 2.5 °C and 9 %, respectively.
- **Microclimatic Monitoring** – The study highlights the importance of microclimatic monitoring for understanding hygrothermal dynamics in attic spaces of historical buildings. Long-term monitoring, including analysis of seasonal variations, can provide deeper insights and thus contribute to tangible cultural heritage protection. The measurement results are also invaluable for calibrating dynamic simulation models that will allow testing different attic ventilation alternatives in a virtual world. High-quality input data is, therefore, crucial to achieve accurate simulation results.

ACKNOWLEDGEMENT

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