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Thermal comfort: Temperature and relative humidity of a habitable cell in foamed concrete in Burkina Faso

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Context and issues

- Intense use of cement in the construction of buildings in Burkina Faso.
- Excessive energy consumption in buildings.

Aim of the study

- Influence of temperature and mean relative humidity of the internal air of a building of different materials (foamed concrete (FC), hollow cinder block, Compressed Earth Block (CEB), adobe and Carved Laterite Block (CLB) for the months of January, April and August.

Study methodology

- 3D numerical resolution of heat transfer and relative humidity equations, using comsol multiphysics 5.3a and Matlab.

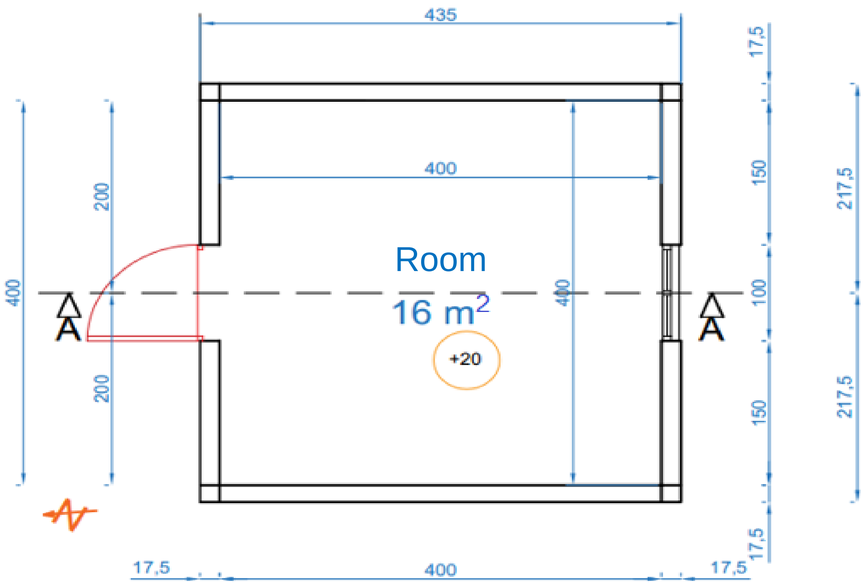


Figure 1 : Building plan

Heat transfer in buildings

- The heat transfer equation used is as follows :

$$(\rho C_p)\frac{\partial T}{\partial t} + \rho C_p \mathrm{u}.(\nabla \mathrm{T}) = \nabla.(\lambda \nabla \mathrm{T}) + \mathrm{Q} \qquad (1)$$

With $\boldsymbol{\rho}$: Fluid density (kg/m³), $\boldsymbol{C_p}$: Specific heat capacity at constant fluid pressure (J/kg.K), $\boldsymbol{\rho C_p}$: Volumetric heat capacity at constant pressure (J/m³.K), $\boldsymbol{T}$: Ambient temperature (K), $\boldsymbol{\lambda}$: Equivalent thermal conductivity of the medium, $\mathbf{u}$: Fluid velocity field (m/s), $\mathbf{Q}$: Heat source (W/m³)

When the fluid velocity is zero and the medium is isotropic, the equation becomes :

$$\rho C_p \frac{\partial \mathrm{T}}{\partial \mathrm{t}} - \lambda \nabla^2 \mathrm{T} = \mathrm{Q} \qquad (2)$$

- Saturation vapor pressure P_{vs}

❖ Bertrand's formula

$$P_{vs} = P_0 \times 10^{\left(17{,}443 - \frac{2795}{T(K)} - 3{,}868 \times log10(T(K))\right)} \qquad (3)$$

- Relative humidity equation

The general thermodynamic relationship for humid air is given by the following equation :

$$\mathrm{HR} = \frac{P.H_{ab}}{P_{vs}(H_{ab}+0{,}622)} \qquad (4)$$

P : Partial pressure of air humidity ; H_{ab}: Absolute humidity

Results

- Indoor air temperature and relative humidity in January, April and August

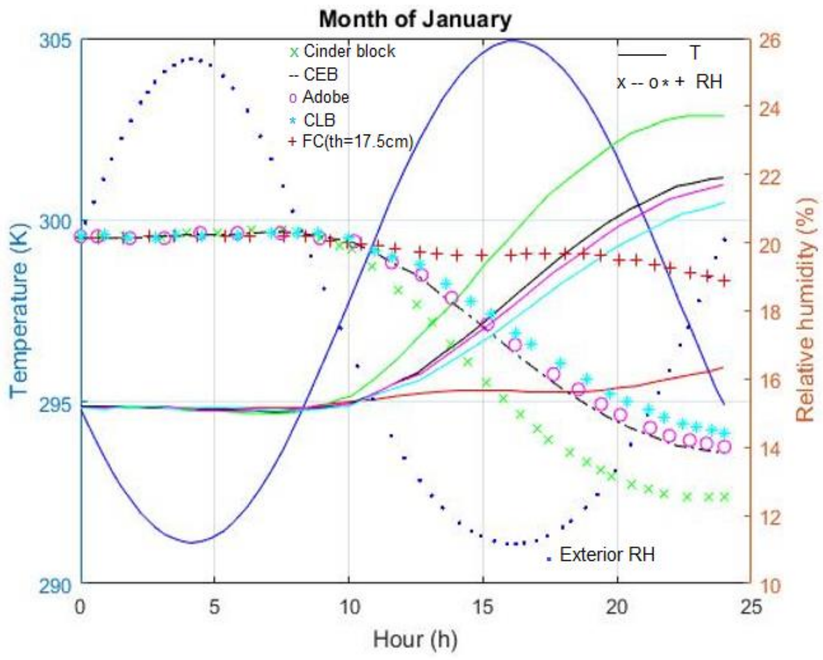


Figure 2 : Temperature and relative humidity of the internal air of the building in January

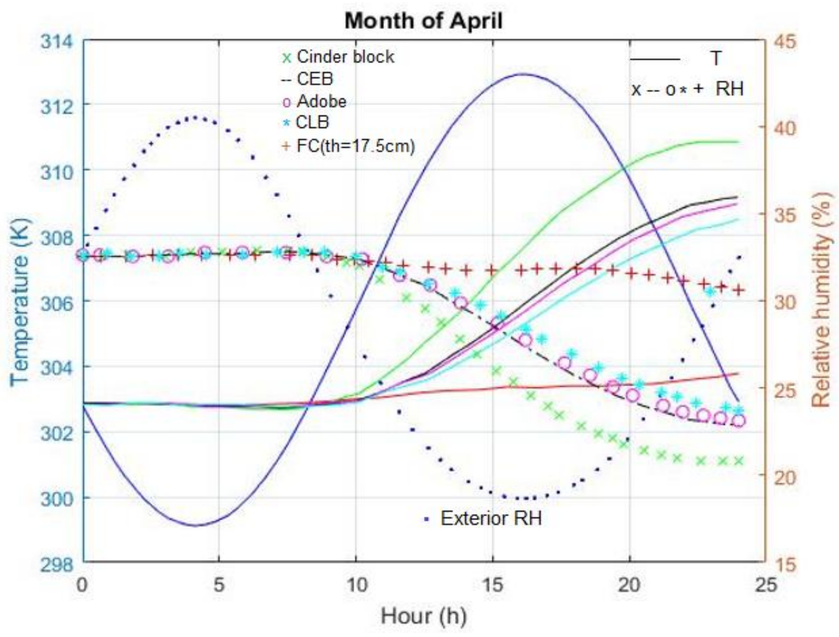
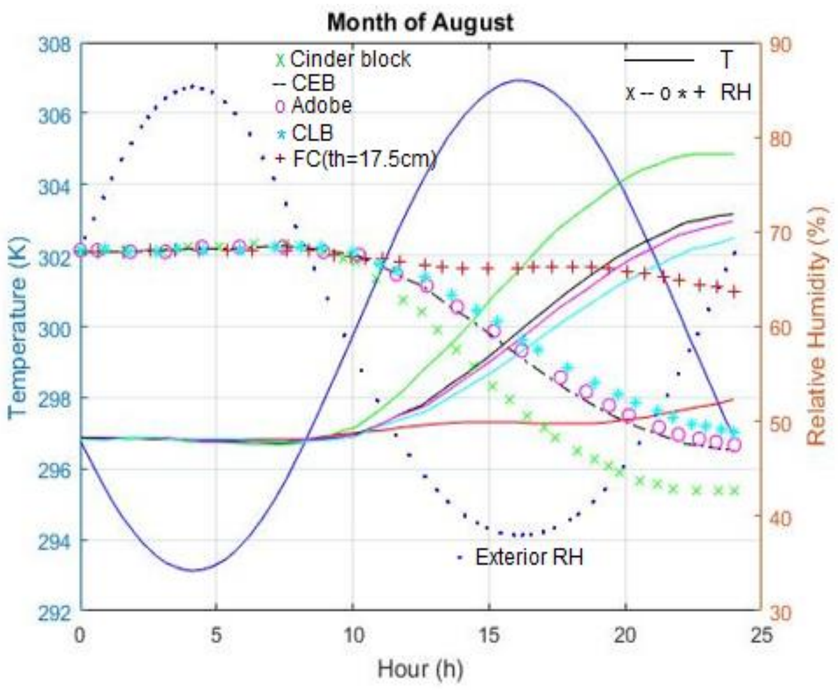


Figure 3 : Temperature and relative humidity of the internal air of the building in April



- Figure 4 : Temperature and relative humidity of the internal air of the building in August

Conclusion

- The temperature and the relative humidity of the internal air of the BM-930, e = 17.5 cm in the months of January, April and August respectively have values of 296 K, 19%; 304K, 31% and 298K, 63.7%.
- Foamed concrete is a building material that improves thermal comfort in buildings.