Deliverable D2.2
Prototyping best performing new eco-friendly insulating façade insulation panels

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InnoWEE D2.2 “Prototyping best performing new eco-friendly insulating façade insulation panels”

Document History

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Publishable summary

Deliverable D2.2 “Prototyping best performing new eco-friendly insulating façade insulation panels” presented the numerous steps that led to the laboratory assessment of real scale panels, starting from the assessment of geopolymer mixtures.

The prototyping phases required an extensive work that allowed identifying the main issues related to the manufacture of real scale panels, and addressing them to the maximum extent feasible in a laboratory production.

Suitable sizes and geometry of both ETICS-like and ventilated-façade panels were selected, aimed at optimizing their production and installation.

Geopolymer mixtures were further tuned to meet the needs of the pilot-plant production, especially in terms of fluidity and open time, and to improve the behaviour against issues highlighted by real scale prototypes, mainly due to shrinkage cracking.

Various casting options were tested to determine the most suitable for serving as a base for the scaled-up production, which finally was that labelled as “bottom cast + stamping”.

The assessment of panels was carried out by testing their main physico-mechanical properties and by analytical calculation of their thermal properties, which were particularly of interest only for ETICS-like panels.

For both ETICS-like and ventilated-façade panels, a suitable fastening method was selected and designed, in order to prove their potential compliance with building regulations in force.

Moreover, preliminary installation tests were carried out on a sacrificial wall to demonstrate their applicability in real cases.

Finally, proper insulating materials, appearance (textures and colours) and dedicated requirements for historical buildings were discussed.
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<tr>
<td>CDW</td>
<td>Construction and Demolition Waste</td>
</tr>
<tr>
<td>EoL</td>
<td>End-of-Life</td>
</tr>
<tr>
<td>EPS</td>
<td>Expanded PolyStyrene</td>
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<tr>
<td>ETICS</td>
<td>External Thermal Insulation Composite System</td>
</tr>
<tr>
<td>FA</td>
<td>Fly-Ash</td>
</tr>
<tr>
<td>GPS</td>
<td>Graphite PolyStyrene</td>
</tr>
<tr>
<td>HDG</td>
<td>High Density Geopolymer</td>
</tr>
<tr>
<td>HDPE</td>
<td>High Density PolyEthylene</td>
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<td>InnoWEE</td>
<td>Innovative pre-fabricated components including different Waste construction materials reducing building Energy and minimising Environmental impacts</td>
</tr>
<tr>
<td>K-sil</td>
<td>Potassium (K) silicate</td>
</tr>
<tr>
<td>LoW</td>
<td>List of Waste</td>
</tr>
<tr>
<td>MIP</td>
<td>Mercury Intrusion Porosimetry</td>
</tr>
<tr>
<td>MK</td>
<td>Metakaolin</td>
</tr>
<tr>
<td>MR</td>
<td>Molar Ratio SiO₂/M₂O (M = K or Na)</td>
</tr>
<tr>
<td>Na-Sil</td>
<td>Sodium (Na) silicate</td>
</tr>
<tr>
<td>NIR</td>
<td>Near-InfraRed</td>
</tr>
<tr>
<td>NMR</td>
<td>Nuclear Magnetic Resonance</td>
</tr>
<tr>
<td>OPC</td>
<td>Ordinary Portland Cement</td>
</tr>
<tr>
<td>PAH</td>
<td>Polycyclic Aromatic Hydrocarbons</td>
</tr>
<tr>
<td>PAN</td>
<td>PolyAcryloNitrile</td>
</tr>
<tr>
<td>PCB</td>
<td>Polyc-Chlorinated Biphenyls</td>
</tr>
<tr>
<td>PSD</td>
<td>Particle Size Distribution</td>
</tr>
<tr>
<td>RH</td>
<td>Relative Humidity</td>
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<tr>
<td>RHM</td>
<td>Random Heterogeneous Material</td>
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<tr>
<td>SEM</td>
<td>Scanning Electron Microscopy</td>
</tr>
<tr>
<td>SL</td>
<td>granulated blast furnace slag</td>
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<tr>
<td>SRM</td>
<td>Secondary Raw Material</td>
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<tr>
<td>TOC</td>
<td>Total Organic Carbon</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compounds</td>
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<tr>
<td>WG</td>
<td>Wood Geopolymer</td>
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<td>WGP</td>
<td>Wood Geopolymer Panel</td>
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<tr>
<td>WR</td>
<td>Weight Ratio SiO₂/M₂O (M = K or Na)</td>
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<td>XPS</td>
<td>Extruded PolyStyrene</td>
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### Symbols

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<tr>
<td>$\lambda$</td>
<td>thermal conductivity</td>
<td>$[W \cdot K^{-1}]$</td>
</tr>
<tr>
<td>$\rho$</td>
<td>density</td>
<td>$[kg \cdot m^{-3}]$</td>
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<tr>
<td>$\rho_b$</td>
<td>bulk density</td>
<td>$[kg \cdot m^{-3}]$</td>
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<tr>
<td>$\phi = \frac{V_i}{V_{tot}}$</td>
<td>volumetric fraction of the $i_{th}$ component</td>
<td>$[%]$</td>
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<tr>
<td>$C = \rho c_p$</td>
<td>volumetric heat capacity</td>
<td>$[J \cdot m^{-3} \cdot K^{-1}]$</td>
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<tr>
<td>$c_p$</td>
<td>specific heat</td>
<td>$[J \cdot kg^{-1} \cdot K^{-1}]$</td>
</tr>
<tr>
<td>$f_c$</td>
<td>compressive strength</td>
<td>$[MPa, \text{ i.e. } N/mm^2]$</td>
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<tr>
<td>$f_m$</td>
<td>bending strength</td>
<td>$[MPa, \text{ i.e. } N/mm^2]$</td>
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<tr>
<td>$f_{po}$</td>
<td>pull-off strength (adhesion strength)</td>
<td>$[MPa, \text{ i.e. } N/mm^2]$</td>
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<tr>
<td>$f_{sp}$</td>
<td>splitting strength</td>
<td>$[MPa, \text{ i.e. } N/mm^2]$</td>
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<tr>
<td>OP</td>
<td>open porosity</td>
<td>$[%]$</td>
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<tr>
<td>$R_c$</td>
<td>(cubic) compressive strength</td>
<td>$[MPa, \text{ i.e. } N/mm^2]$</td>
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<tr>
<td>$T_w$</td>
<td>density expressed in degrees $T_{\text{Wadell}}$</td>
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<tr>
<td>$V_i$</td>
<td>volume of the $i_{th}$ component</td>
<td>$[m^3]$</td>
</tr>
<tr>
<td>$V_{tot}$</td>
<td>volume of the compound</td>
<td>$[m^3]$</td>
</tr>
<tr>
<td>WA</td>
<td>water absorption</td>
<td>$[%]$</td>
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