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Development and testing of an innovative energy wall system in Torino (Italy)

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Shallow geothermal energy (SGE) is increasingly being regarded as a valuable solution for space heating and conditioning because of high efficiency, diffuse availability and low environmental impact. Significant growth in the number of installations is envisaged as a result of energy policies and European Directives. Indeed, the obligations in the construction sector about the share of energy supply from renewable sources is increasingly pushing the design of new and renovated buildings. On the one hand shallow geothermal energy is suitable as a sustainable and distributed energy source. On the other hand, significant installation costs related to drilling of traditional installations represent an hampering factor. Thermally activating geostructures such as piles, diaphragm wall, tunnels and anchors can allow to include these costs in the construction of the structural elements. Moreover, a large availability of operational surface is represented by new and/or existing building heritage in urban areas as most of them have underground levels that can be equipped with heat exchangers.

This contribution introduces a novel modular very shallow geothermal exchanger as part of a Heating, Ventilation and Air Conditioning (HVAC) system. The system concept allows its application not only to new structures and buildings but also to existing ones. While the low depths interested may penalize the heat exchange rates, on the contrary, extremely low installation costs make the cost-benefit ratio of this new technology extremely interesting and promising.

A first prototype consisting of three modules was designed by the authors and installed in an office building in Torino (Italy). External deployment of pipes to the basement wall in two different arrangements was realized in order to test system efficiency. Due to the experimental nature of the tests, a large number of sensors were placed to monitor the additional stresses and strains on the wall and the thermal regime of the partially saturated ground volume involved in heat exchange.

Preliminary thermal performance tests were performed together with numerical modelling re-interpretation. On the basis of the first tests and interpretation carried out, it was demonstrated that remarkable heat exchange rates of up to 20 and 27 W/m² could be injected/extracted from the ground in summer and winter respectively. Furthermore, the monitoring records suggest that extremely low affection of ground thermal status is operated by the system with respect to analogous non thermo-active walls. This evidence is extremely promising in the perspective of

wide and dense diffusion of this new shallow geothermal energy system in urban areas where thermal interferences should be limited or avoided.