Fisica Ambiente Costruito

Building Physics

DII research group

Physics of Indoor Environment

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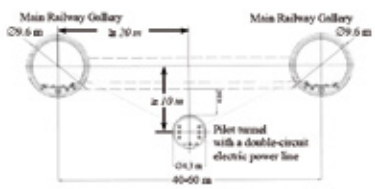
This research activity is carried out in collaboration with Prof. Roberto Benato of Power System Group of the Department of Industrial Engineering.

Main research topics:

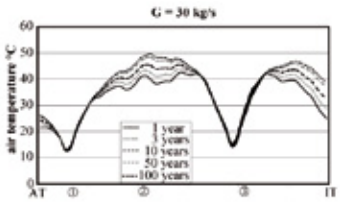
- Thermal behavior of buildings and building components
- Heating ventilating and air-conditioning systems
- Indoor climatic conditions and comfort levels
- Fire safety
- Indoor and outdoor acoustics: analyses, laboratory and field measurements.

Thermal Behaviour of Alpine Base Tunnels

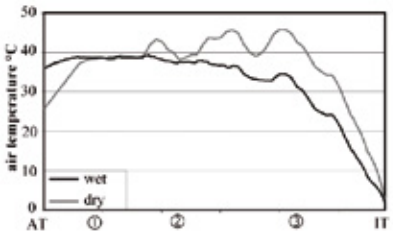
Remarkable overheating is often experienced in underground structures as a consequence of their internal heat gains, which may be not extremely high but are lasting for a long time. Quite typical is the case of many railway tunnels (e. g. the London Tube or the subway in Rome), but similar phenomena may also occur in other underground cavities. This research deals with the thermal behavior of Alpine base tunnels in presence of heat generation due to possible power lines installed inside the tunnel itself. Two meaningful cases have been investigated. First, a double-circuit power line inside the pilot tunnel of the high-speed railway tunnel under construction between Italy and Austria (Brenner Basis Tunnel, BBT) has been considered. Since the active power losses generated by a possible power transmission line may likely be about 7 MW, the thermal behaviour of BBT pilot tunnel and its ventilation requirements have been evaluated by resorting to a suitable computer model. This model is based on a "control volume" approach: a discretization of the space and time domains leads to a network of thermal capacities and resistances to be solved time after time by means of a linear algebraic system. In a similar way, also the possible installation of a power line inside LTF tunnel ("Lyon-Turin Ferroviaire") is certainly of some concern for the designers, since the heat generatied by the conductors is added to the thermal power due to the movement of the trains. On the other side, the main countermeasure to overheating (i.e. mechanical ventilation of the tunnel) is quite difficult for LTF project and, at least in principle, the tunnel should be ventilated by piston effect only. Therefore, the thermal behaviour of the tunnel has been assessed, once again, by resorting to a suitable computer model and some results are reported hereafter. As well known, this project has not been realized yet but it has been a forerunner of the HVDC-VSC cable line between Italy and France along the highways and inside the service tunnel of Frejus .



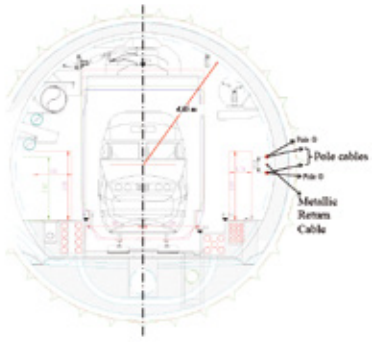
Brenner pass railway galleries and pilot tunnel



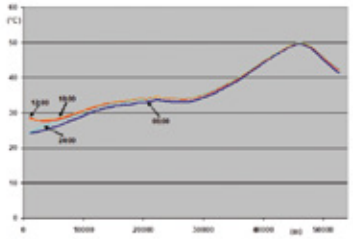
Air temperature along the Brenner pilot tunnel at different times of operation (air-flow rate 30 kg/s)



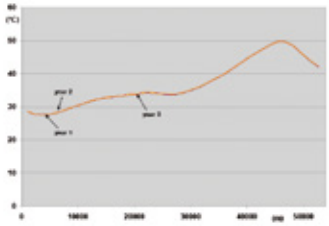
Air temperature profile along the Brenner pilot tunnel after 1 year with and without



Cross-section of LTF tunnel with DC cables



Conductor temperature along the LTF tunnel at different times of the day on June 30th of the first year with ventilated air gap at 5 m/s



Conductor temperature along the tunnel on June 30th, 12:00, for different years of operation, ventilated air gap at 5 m/s