GEOTHERMAL SNOW MELTING AND DE-ICING

European Geothermal Energy Council

Current Situation

With the first days of winter approaching, the road users have normally not adapted yet to the changed traffic conditions. Bridges use to cool down earlier than the normal roads. Thus icy surface conditions can occur on bridges even when the normal roads don't give any hints for problems.

Diligent winter maintenance is a crucial factor to guarantee certain mobility on the roads. A first intervention of the winter maintenance vehicles is needed on bridges, on strong inclines, on important traffic intersections, on express ways in urban areas, etc. However, obstructions in traffic due to snow and ice may also constrain the use of maintenance and emergency vehicles. Consequently the number and the length of the hold-ups are increasing instead of decreasing. This may even lead to a complete breakdown of public and private traffic.

Different geothermal sources are suitable.

Freezing rain in particular can stop traffic within minutes – even in large urban areas. The traffic comes to a halt – for hours. The maintenance service is no longer able to clear the roads.

Also carports, ramps or car access ways to a building need special attention during the cold seasons. Snow and ice cause delays in professional work. Delayed flights due to snow and ice at airports or on runways are annoying and ex-pensive. Last but not least, sidewalks, public areas, waiting areas for pedestrians need to be cleared of snow and ice to prevent accidents during day and night time.

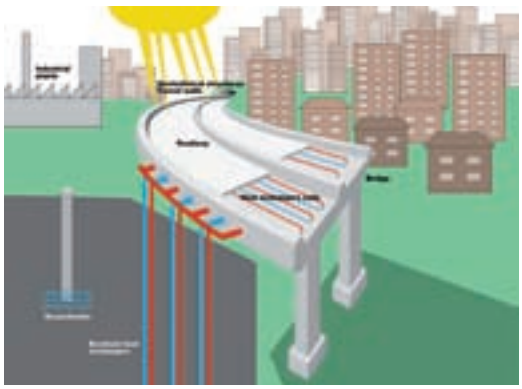
A winterly traffic situation leads to reduced speeds, traffic jams and therefore to losses of time. Every improvement in the status quo has a positive effect on the capacity and performance of roads, the traffic progresses and so our society.

Geothermal snow melting and de-icing is based on hydronic systems.

Geothermal Solution

Winter maintenance, snow melting and de-icing "from the bottom" using renewable and free geothermal heat is an obvious solution.

The safety of pedestrians, waiting or walking, as well as the security of the running traffic may be increased with a reliable, sustainable and environmentally-friendly method.



Geothermally heated outside surfaces are typically based on hydronic heat exchanger installations in the pavement. The installed heating capacity depends on the climatic conditions and the system specifications. Snow melting needs higher system temperatures than simple prevention of ice-formation. Low system temperatures implicate an anticipatory operation control.

Various system designs are suitable. Various sources may be used: Direct use with geothermal hot water (normally bound to special geothermal conditions); direct use of warm or cold groundwater; direct use of borehole heat exchangers or energy piles. A combination with a heat pump may be considered. Underground thermal energy storage (UTES) is suitable - in this case the heated area is also cooled in summer.

Other heat sources – like waste heat – may be taken into account if a reliable supply over the whole design lifetime is guaranteed.

The first step in system design consists of the definition of the plant specifications – as accurate as possible. The next step is an estimation of the annual operating time and the typical and maximum heat output of the heating system.

Examples

A number of pilot plants for geothermal snow melting and/or geothermal de-icing have been built all over the world.

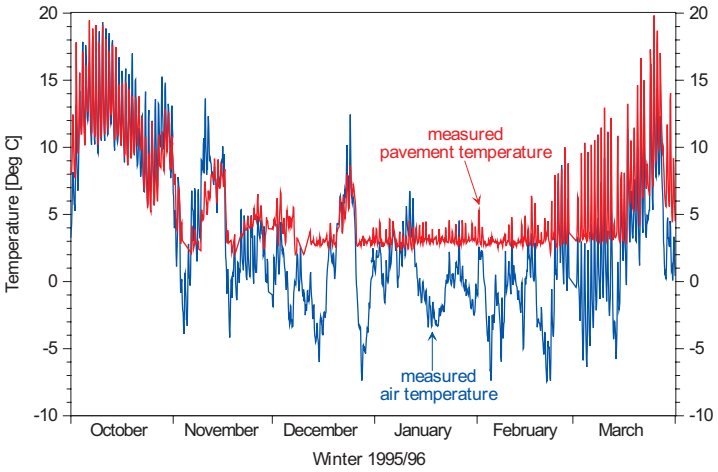
In the USA a few projects for geothermal road and bridge heating have been realized. Some of these are combined with heat pumps. Some others are using seasonal heat storage. The oldest documented geothermal snow melting installation was built in 1948 using natural hot geothermal water.

In the 1990s several pilot plants for snow melting installations based on geothermal heat pumps were built in Japan, where active snow melting using non-renewable sources has a long tradition.

A well known and well documented geothermal installation is the SERSO pilot plant in central Switzerland, which went into operation in 1994 and is still running. Aim of the installation was to prevent ice-formation on a highway bridge surface.

SERSO is in a way the mother of the geothermal bridge or road heating systems. The SERSO system was developed and designed in the early 1990s and went into operation in 1994. SERSO is working since 1994 without interruption until today. Aim of the installation was to guarantee the same road surface conditions on the heated bridge as on the adjacent road sections.

SERSO is collecting heat in summer from the hot road surface and is storing the energy in a near-by rock storage, which consists of a concentric field of 91 bore-hole heat exchangers. In winter, heat is extracted from the heat storage and used to maintain a temperature of the bridge surface above 3 °C. SERSO provides a direct use of the geothermal heat. Electricity is only used for circulation pumps. The installation has shown that much more heat was collected in summer than needed in winter for de-icing. Experts agree that cooling in summer would also extend the lifetime of the pavement.



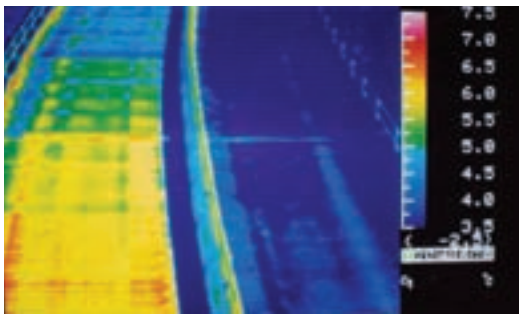
Prevention of ice-formation on a bridge surface (Swiss SERSO plant).

There are similar road and outside surface heating systems for snow melting and de-icing in other European countries (e.g. The Netherlands). These systems use mainly groundwater as heat and cool source and are combined with building services.

Geothermal snow melting installation at a bridge in Amarillo, TX (USA).

Another such installation was constructed in the Harz region in Germany in 2005. Aim of the geothermal heating system was snow melting on a platform of a local train stop. The platform has an extent of 200 m. The underground heat storage is tapped with 9 borehole heat exchangers with a length of 200 m each.

Geothermal snow melting and de-icing was a subject of different studies recently worked out in central Europe. The GeoVerSi study of Nordrhein-Westfalen's road construction and maintenance department (Germany) serves as a recent example.



Infrared picture of the Swiss SERSO plant when operating on the left lane.

Advantages

Geothermal road, bridge or outside surface heating is a feasible and approved possibility to increase traffic and public safety. Several examples have shown that geothermal road heating systems work without problems over years – completely renewable. A fully automatic operation allows reducing the number of night shifts of winter maintenance staff.

A geothermal snow melting or de-icing system is a smart and environmentally-friendly alternative to the common mechanical and/or chemical winter maintenance and is – as a big advantage – available in the day and at night without a costly stand-by emergency organisation.

At heavy snow fall, the geothermal heating prevents the freezing of the surface even with low system temperatures: mechanical clearing becomes very easy.

Geothermal snow melting systems applied to important traffic junctions or express ways increases mobility as well as traffic safety. It decreases the number of accidents and the total number of traffic hold-up hours and therefore lowers the overall economic costs.

Costs

Geothermal snow melting without heat pump is very cheap in operation, independent of the geothermal heat source used. The use of ground source heat pumps makes the system operation more expensive.

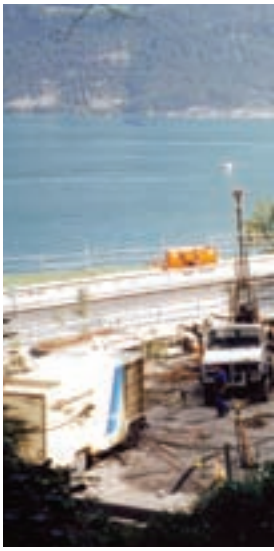
The installation of a hydronic geothermal heating system is rather cost intense - depending upon the geothermal heat source. The costs range from several hundred Euros to about 1'200 Euros/m^2.

A value benefit analysis is recommended and normally shows a reasonable result. Although the initial costs are high, such systems are not uneconomical. Social and macroeconomic benefits are given.

Geothermal snow melting on a small access road to a private parking area.

Basic data: Located in central Europe; heated area: 25 m^2; cooling in summer provided; no heat pump used; heat demand approx. 9 kW_{th} - depending on the local climatic conditions.

Geothermal snow melting system: 1 borehole heat exchanger (depth 260 m - depending on local geology). Costs of borehole heat exchanger, piping and heating installation in the pavement; control system and adjustment: 855 Euro/m^2. Electricity need per year (operating costs) approx. 350 kWh.



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