25 papers were submitted, 19 of them were assigned for oral presentation in Technical Sessions, 6 to Poster Session.

They can be broken down to following themes:

A)

- Environmental effects of road salt and alternative de-icing agents on groundwater, aquifers, soil and roadside vegetation (7 papers)
- Minimizing use of de-icing agents (3 papers)
- Road dust control, dust particle materials (2 papers)

B)

- Snow melting and ice-control systems using natural energy (10 papers)
- Road heating using urban waste heat (2 papers)

C)

- Aspects of permafrost regions (1 paper)

Environment:

Twelve papers deal with environmental effects of countermeasures such as

- use of studded tires
- applying gritting abrasives
- spreading de-icing agents

to increase road safety on snow- and ice-covered roads and slippery surfaces and with efforts to minimize use of de-icing agents.

Investigation of negative environmental effects cover

- air pollution and their health aspects by dust of abrasives and particles loosened by pavement wear
- pollution of groundwater especially aquifers and natural water net works by chemical de-icing agents
- harms to roadside soils, vegetation and trees by road salt.

Reason for intensified research of environmental effects of de-icing agents meanwhile is the growing concern about their increasing use, but frequently also the consequence of the aim to avoid dustproblems.

Great anxiety reveal studies from areas in Scandinavia and Belgium about harmful impacts of road salt on groundwater and aquifers because large parts of the population depend on groundwater supply. Investigations deal with different behaviour of Na- and Cl-ions in various aquifer soils and minerals, with search for

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alternative, more sparing saltcombinations and with calculation methods to determine saltconcentration in groundwater, due to the use of road salts.

Research further covers effects to roadside vegetation trees, especially conifers and shrubs due to antifreezing agents splashed by vehicles and their absorption by roots, bark and leaves and thereby different behaviour of soils and Ca-, Na- and Cl-ions.

All recommendations, also what spreading techniques – prewetted salt, brine – are concerned, aim at minimizing salt quantities and following negative effects. But a new de-icing agent with less environmental impact and equal thawing qualities and costs as normal road salt is not yet discovered although quite often some "miracle" gritting materials are coming up.

To solve air quality problems in Scandinavia quality classifications and sieving methods for sanding materials are formulated to reduce dust quantities and health hazards. Thorough analysis of road pavement particles, related to wear by studded tires, and their effect to public health in urban areas it is aimed at gaining arguments to abandon the use of studded tires.

One paper deals with aspects in permafrost regions but mainly with road design and construction problems because in that region permafrost at present is in the state of deterioration.

Energy:

Eleven papers from Japan (one from Europe, Switzerland) indicate that Japanese people are very thoroughly pursuing the use of natural energy and urban waste heat for snow melting and ice control.

Roadheating systems however are not installed along full length of roads but because of high costs for construction and operation only along limited road-sections. These include mainly accident prone spots, such as steep slopes, crossings, bridges, sudden curves, entrances of tunnels and snow-sheds and others.

Natural energy sources utilized are of high diversity and include ground- or lake water heat, geothermal heat, solar heat and wind force. Moreover urban waste heat of sewage pipes and power- and incineration plants is used.

This variety of energies reveal that there is still a large potential acquiring ample and stable energy supply. Combining some of these energy sources with each other, brings along further advantages. Sprinkling groundwater from nozzles to distribute heat on the road surface, as originally done in the 1960's is obsolete; groundwater by that way is wasted. Meanwhile heat radiation pipes are installed underneath surface of roads, of side walks or parking lots and are recharged by using groundwater or water heated up by other energy sources. A large number of systems of this kind are in operation in Japan in snowy areas more than 600 000 m² e.g. about 75 km.

When utilization wind generated electricity – with large propellers as a energy source – for road heating, an electric heating wire system is installed in the pavement. Energy in summer is used for jetfan and lightening, surplus is sold to Electric Power Co. and partially bought back in wintertime.

Utilization of various energy-source ask for specific installations:

- Groundwater: Pumping groundwater out of well circulating through road radiation system in the roads and recharging it back into aquifers.

- Lakewater: Heat exchange system with spiral coils submerged lake water and pumping a heat collecting carrier fluid through road tubing system.

- Geothermal heat: Borehole heat exchange systems with tanks using water or a heat carrier fluid for distribution in a pavement radiating system.

- Solar energy: Road heating pipes buried under roads or in pavement structure to collect solar energy during summer, store it underground and recover it effectively during winter time attaining a positive heat balance

all over the year. All different thermal energy storage systems include vertical boreholes with heat exchange pipes for circulating water. To achieve high thermal conductivity, boreholes are excavated in rock underground or are backfilled with special heat transferfillers. Efficiency is often raised by combined utilization of solar and geothermal energy.

- Urban waste energy:

  Utilizing

  ?? hot waste water from powerplants
  ?? waste heat from incinerators and
  ?? processed or unprocessed sewage

  for snow melting in special snowmelting-tanks or pipes in urban areas by

  ?? heating the tanks from the inside through heat exchangers
  ?? in addition to that by sprinkling and discharging hot water and
  ?? heating the tanks by sewage pipes or even disposal of snow in processed sewage.

Quite a few snow melting facilities treating snow, hauled by snow-removal trucks are in operation in the city of Sapporo.

Research and development of systems using natural energies for snow melting and ice control are worth while to be promoted, because they offer unconventional solutions for special problems in urban areas and at critical road-sites.