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**Conclusions to Seminar VIII**
**Snow and Ice Effects on Structures**

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Professor Allan Davenport presented the first paper, entitled "Snow and Wind Loads on Roofs" and which was co-authored by N. Isyumov and M. Mikitiuk, also of the University of Western Ontario, Boundary Layer Wind Tunnel.

The presentation introduced the need to reconcile the physical characteristics of snow with the meteorological characteristics of the site. Particular attention was drawn to the choice of appropriate "conversion factors" for use in establishing roof snow loadings based on measured, ground snow accumulations.

The speaker referred to the information provided by the National Building Code of Canada and the Division of Building Research of the National Research Council of Canada for determining the allowances for unbalanced snow loading caused by wind action. Also described, were the current laboratory techniques for the determination of qualitative and quantitative values for the variation in snow deposition on roofs. The uses of water flumes and wind tunnels for this purpose were noted.

The paper went on to suggest the choice of load combination factors for specific roof geometries, based on observed maximum combined wind and snow loads compared with maximum wind and snow loads acting independently. The proposed laboratory simulation for forecasting snow loads for specific roof structures in specific locations was described by the speaker as relatively crude at present but promising for the future.

The second paper "Damages due to Snow Loads", was presented by Dr. Bengt Johannesson.

The paper describes a comprehensive study of the structural damage and failures which occurred in Sweden during the relatively severe winter of 1976-77. Most of the structures were of timber or light weight steel construction.

The failures of a number of example structures were described in detail. The authors pointed out that a significant number of the failures were caused by "manufacturing faults", (fabrication/construction did not conform to design) and "underdesign" (mistakes or other deficiencies in the design calculations). "Excessive snow load" the third cause, resulted usually from improper consideration of snow drifting.

Of interest was the authors' reference to the difficulties experienced in obtaining reliable information concerning structural failures. For this reason, it was emphasized that caution must be used in accepting as fact, information not supported by proven evidence.

The speaker concluded with the observation that, in general, structures with high snow load to dead load ratios were most susceptible to failure. Such structures, typically of timber and light weight steel, require special care in their design and construction.

Professor Edo Hemerich presented the third paper entitled "Determination of Design Snow Loads".

This paper proved to be a logical follow-up to the second paper in that it recognized the tendency for light weight structures to have a lower degree of safety under snow loading. A means of establishing a formula which provides for a uniform degree of safety was described. The method is based on statistical data on snow fall for specific locations, dead load to snow load ratios, and data obtained from the analyses of the reliability index of existing structures. Also in the formula, the probabilistic characteristics of resistance must be determined from statistical data on the actual material being used.

The formula for calculating snow load, after values for all the required parameters are inserted, indicates the design snow load for a flat roof at a constant degree of safety.

The final paper was presented by Josef Grob, civil engineer of Basle Switzerland. His presentation described the extremely innovative design and construction of a cable suspended pipeline over a glacier in the Swiss Alps.

The suspension cables for the pipeline extend more than 857 m from a fixed low anchorage tripod at elevation 2700 m to the high anchor at 2981 m. Of particular interest is the intermediate support for the cables which is founded on the glacier itself at approximately elevation 2780 m. This support consists of a 35 m pylon, restrained by 4 guy cables which are anchored in the glacier. The design allows for the surface, downhill creep of the glacier (15-20 m per year). A total displacement of 50 m parallel to the suspension cables and 10 m transverse can be accommodated, after which the pylon may be removed and re-erected as necessary.

The presentation of these four papers made for a very interesting and informative seminar, as evidenced by the response of the audience during the question periods.