

construction workers laid off in the winter took seasonal work in the lumbering industry etc. or lived on the premium wage-rates they had earned as construction workers. Work in our lumber camps, however, has also tended to become year-round and specialized and winter jobs are not available as in the past. Many construction workers needed income in the winter months and even those that were not to anxious in this regard were eligible for unemployment insurance benefits if construction employment was not available to them).

Finally, new materials and equipment greatly facilitated working in the wintertime, compared to a generation ago. The combination of these three main factors—aided by incentives and publicity—has lead to a steady and significant increase in the application of wintertime construction techniques to the point where more work is actually put in place during the winter months than during the whole year a decade or two ago.

The two main principles for wintertime construction are *pre-planning* and *protection*. Careful pre-planning is of course necessary for efficient construction at any time of the year but it is vital for winter operations. If the construction of a building can be scheduled so that it is "closed in" before the really extreme weather is experienced, most of the problem has been solved. Failing that, it is necessary to provide protection from the elements in the form of a temporary enclosure. This enables the builder to create his own climate.

Initially enclosures were made with canvas tarpaulins or plywood but more recently polyethylene has been widely used because of its low cost and ability to transmit solar radiation, thus reducing both lighting and heating charges. Enclosures are designed to fit the job and range in size from a small lean-to around a house to huge structures such as the one used this past winter at a power project on the Nelson River in northern Manitoba. This shelter encloses an area 580 feet by 120 feet to a height of 140 feet. Within this enclosure 750 men work in their shirtsleeves constructing a generating station while temperatures outside drop to -40° F or lower.

Among the new materials and equipment facilitating winter work (in addition to polyethylene mentioned above) are rippers and other excavating equipment and attachments which make short work of frozen ground; portable space heaters; heated ready-mix concrete and pre-cast concrete; and the wide range of pre-fabricated components which reduce on-site assembly and construction time.

Montreal received many visitors last year in connection with Expo '67. Many of the pavilions there were built in whole or in part during winter conditions. All of the skyscrapers along Dorchester Blvd. were built without let up during the winter and this included the foundation work in some instances. (Incidentally, the enclosures used to protect workmen in the winter months from snow and cold temperatures were used throughout the year on one skyscraper to protect the men from high winds and rain). Similarly, much of the overpass and cloverleaf work on the new highways leading to Expo was done during the 1966-67 winter and so were some of the related paving operations.

One can also see the start of the St. Lawrence Seaway in Montreal. It will be recalled that major hydroelectric installations were also built as part of the overall development along the St. Lawrence and Great Lakes. The international power dam at Barnhardt Island provided an interesting comparison on dam-building techniques on a grand scale inasmuch as half of it was built by U.S. contractors and engineers and the other half by Canadians. On the Canadian side the placing of concrete in high lifts made possible uninterrupted construction in spite of temperatures as low as 40° below zero. On the U.S. side concrete was placed in shorter lifts and the job was closed down during the winter. I should add that the American crews caught up during the summertime, but the point that is relevant here is that the requirements for manpower and materials were more stable year-round on the Canadian half due to the wintertime building.

The comments made so far may leave the impression that winter construction in Canada presents no problems at all. This is, of course, not true. Building in winter does have some peculiar hazards. The frost heave of soils under foundations or basement floor slabs is a particularly serious one. High concentrations of carbon dioxide from unvented oil or gas fired heaters will damage the surface of freshly placed concrete floor slabs. Air leakage through partially completed walls can saturate porous materials that are subsequently displaced due to frost action. All of these hazards can, however, be prevented provided the proper procedures are followed. The problems are no more serious than those encountered in summer and in many cases are more easily controlled. The penalty for inadequate execution or supervision of the work is sometimes greater than in sum-