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Please note

Winter construction is now an accepted fact in all parts of Canada. There are still, of course, some who believe that it is costly and produces low quality buildings, in spite of the many examples to the contrary which can be found in every part of our country. Winter construction is not new in Canada and much valuable experience has been accumulated over the years by contractors and sub-contractors. This experience, combined with new techniques and new materials which have come on the market in the past few years, has led to a marked change in the attitude of engineers, architects and owners toward winter building.

Larger building projects continue during winter months without interruption, and although it is still considered desirable to be "closed in" before the cold weather there are more and more cases where major projects are initiated during the winter. Most projects which are held over until spring are smaller ones which can be substantially completed in 6 to 8 months. It is here that one finds the greatest resistance to winter construction, due to the belief that although the extra direct cost of winter construction can be absorbed on a large job, it is just not feasible to provide the equipment necessary for quality construction and remain competitive on small jobs. In this note conditions under which winter work is carried on in Canada are examined, and the problems which arise and how they may be overcome are discussed.

It must be realized that winter construction is carried on under conditions that vary over a very wide range in different parts of the country. In the Atlantic Provinces, for example, the mean daily minimum temperature in January is +10°F. Storms with heavy snow or rain and high winds are common. In southern Quebec and Ontario, minimum temperatures vary from O°F in Quebec, Montreal and Ottawa to +15°F around Lake Erie. Storms are less frequent than along the coast, and although some areas near the Great Lakes receive heavy snowfall, precipitation is generally less and wind speeds lower than on the Atlantic Coast.

In the Prairie Provinces, the mean daily minimum temperature is -10°F in January and the average winter snowfall amounts to 40 inches. Although blizzards accompanied by high winds, low temperatures, and snow or drifting snow occur at intervals during the winter, there are only three days in January when precipitation amounts to 0.1 inch or more, and the hours of sunshine in the same period are the highest in Canada. Long periods of below-zero weather are not uncommon. In British Columbia, minimum temperatures vary from 10 degrees inland to 30 degrees along the coast. Precipitation is heavy, occurring mainly as snow in the mountains and as rain on the lower mainland and Vancouver Island. There is little sunshine, and precipitation amounting to 0.1 inch or more occurs, on the average, for more than 15 days along the Pacific Coast in January.

Winter, if defined as that period requiring special precautions to prevent damage by frost action or excess precipitation, varies from more than five months on the prairies to less than three months on the lower British Columbia mainland. Under average winter conditions, construction continues at a high level in all parts of Canada, but severe weather in any region will cause a stoppage of work unless adequate winter construction equipment is used. The effect of winter weather on various phases of construction is not always that which would be expected.

Excavation in deeply frozen ground is expensive. In most regions outside the Prairie Provinces and North Western Ontario, however, frost penetration under snow cover is seldom more than 1 foot. Where this is the case, excavation is not difficult and, in fact, is usually carried out with greater ease than in spring and fall because of the firm footing for equipment and trucks. Ground water levels are lower in winter except in coastal areas, and the sides of frozen cuts do not slump into the excavation. Where it is known in advance that excavation work will be carried out the depth of frost can be kept to a minimum by leaving the snow undisturbed or by covering the site with a layer of straw as insulation. As soon as an excavation is made, of course, steps must be taken to prevent frost getting into the ground. Again, straw is often used and can be re-used to protect footings after they are placed.

Protection for concrete is essential during placing and curing in any region where temperatures below freezing are expected. Good practice requires that the concrete be warm when placed and that it be kept above freezing until it bas gained sufficient strength to prevent damage when frozen. Concrete which has attained a strength of 500 psi is considered past the danger stage, although it is still not capable of withstanding repeated cycles of freezing and thawing. Further gain in strength will depend on temperature and humidity conditions, but care must be taken to see that temperatures do not rise to a high level. Every effort should be made to keep the temperature of the concrete during the initial curing period as close as possible to the minimum curing temperatures. As given in the American Concrete Institute's "Recommended Practice for Winter Concreting", these temperatures are 70 degrees for three days or 50 degrees for five days.

The design of a building has considerable bearing on the ease with which it may be constructed in winter. Steel-frame buildings have advantage in that the structural steel may be erected in all but the most severe weather. Enclosures may then be attached to this framework to permit other phases of the work to proceed. Reinforced concrete frame buildings require more care in that provision must be made to protect the concrete columns and beams until they have attained the desired strength.

Precast concrete is being used to overcome some of these difficulties. In fact, the growth of this industry is quite remarkable. One form of site precasting that lends itself to winter work is the lift-slab method of construction. Since all the floor and roof slabs are cast at ground level, enclosures are small and easy to heat. Wood-frame construction, widely used in residential buildings, is not affected by cold weather. In fact, the quality of such work is often better in winter since the frame is not subjected to wetting by rain as so often occurs in summer.

Regulations in general use in Canada and the United States which deal with cold weather masonry construction are based on the results of experiments carried out in the late thirties to determine the effect of low temperature on concrete. It was considered, apparently, that the mortar used in masonry construction would act in the same way as concrete. That this is not the case is shown by the many examples of fine brick masonry structures constructed during periods of violent weather with little or no protection. There are still cases being reported, however, where masonry has suffered damage and this damage has been blamed, rightly or wrongly, on the exposure conditions during winter construction. Until, therefore, more is known on this subject, it is advisable to require that bricks and mortar be warm when laid and masonry be protected from freezing for 48 hours.

Plastering often causes difficulties in winter because of condensation on cold surfaces such as windows, or even on exterior walls. High humidity conditions, particularly at temperatures of 40 to 50 degrees may prevent drying of the plaster; this greatly weakens the bond of the plaster to the base. After plaster has hydrated, which will be within 24 hours, ventilation must be provided to permit drying. If outside temperatures are below 40 degrees heat must be introduced to supplement ventilation. The temperature should be controlled, however, to prevent too rapid drying of the plaster which may result in the formation of shrinkage cracks. A temperature of 65 degrees could be considered a desirable maximum level. Ventilation should be so arranged that air currents do not impinge on a freshly plastered surface. In very cold weather it is desirable to introduce air for ventilation at some point away from the area to be dried.

Painting should not be carried out at a temperature below 50 degrees. Ventilation is desirable not only to assist in the drying of the paint but also to remove the solvents which are sometimes toxic.

Shelters

Since winter in Canada is severe, winter construction is a risky business if the contractor does not have the equipment to ensure good working conditions. Perhaps most important is shelter material, which should be of a type to permit repeated use.

Enclosures are not new in Canada. Over 30 years ago a shelter was developed which even by today's standards would be considered quite remarkable. This shelter, used in Montreal, was formed of light steel trusses in 8-foot sections bolted together to give a clear span of up to 80 feet. The trusses were carried on columns located outside the building line and, as work progressed, were jacked up the columns by a reciprocating steam cylinder working through a ratchet device. The framework was covered with tarpaulins and the enclosure heated. Under this shelter, the excavation for a five-story apartment building was started late in January 1928. Five concrete floors were placed in two weeks and within seven weeks the interior trim and painting were being completed. Although not as elaborate, many similar types of enclosures were used during this period. With the great drop in private construction during the depression, however, shelters of this type were forgotten; and only in recent years, mainly as a result of developments in the Prairie Provinces, have enclosures once again been seen on more and more construction sites. But in spite of the great advances in the development of new materials and construction equipment in the last thirty years, no shelters of the type used in Montreal in 1928 are to be found in Canada. They may be found, however, in Sweden and possibly in other Scandinavian countries where they are now used through the winter months and, in fact, long before winter sets in.

The great advantage of using a shelter to enclose all or a portion of the work is that it permits the contractor to carry on without interruption under conditions selected to ensure maximum quality and productivity. He can in effect control the weather. The value of this is well illustrated with concrete construction.

Because of the volume of concrete used in construction in all parts of the world, a great deal of research has been undertaken to provide a greater knowledge of this remarkable construction material. The results of this work have been applied to winter concreting, and it is now known that concrete which is not allowed to freeze and which is placed and cured at low temperatures above freezing develops higher ultimate strength and greater durability than concrete placed at higher temperatures. It is only in the winter that the contractor can "control the weather" to ensure that the low temperatures required for top quality concrete are obtained.

Other materials also benefit by being put in place under controlled conditions. Uniform temperatures during construction reduce the possibility of cracking of masonry, plaster, and stucco; on the other hand many roofing failures can be traced to adverse weather conditions during the application of the roofing materials.

Most enclosures make use of transparent plastic film. Sometimes the plastic is used only as temporary hoarding for door and window openings or as window strips, but often the whole enclosure is covered with polyethylene. Other enclosures use panels of plywood or building board which are later recovered and used in construction. Tarpaulins are still widely used. Recently, plastic tarpaulins have been introduced which have the great advantage of remaining flexible at low temperatures. The transparent plastics also have the great advantage of trapping solar heat so that the temperature inside enclosures covered with polyethylene may be as much as 45 degrees above outside air temperatures during sunny weather. This often provides all the heat that is required during the daytime. In very cold areas, additional insulation may be obtained with two layers of plastic to provide an air space to reduce heat loss during cloudy, windy weather and at night.

Shelters can be grouped in two general classifications. There are those which are self-supporting such as the laminated-arch plastic-covered enclosures first used in Winnipeg and now in use from coast to coast. Manufacturers of plastic coated fabric have introduced air supported structures large enough to cover an area the size of a football field. They have also developed a heater which can be used with an air blower to provide comfortable working conditions. These air supported structures are expensive, but development work is being done by polythene manufacturers to produce a similar but low cost shelter.

The second type of shelter uses the existing frame of the building for support and is generally used with steel or precast concrete frames. The most common type is the enclosed scaffold suspended from outriggers on the roof. This external working platform is raised from one story to the next as work progresses. Another method of enclosing the skeleton makes use of standard sections of tubular scaffolding, and is generally most economical for buildings under four or five stories in height. The scaffold is braced against the frame and covered with plywood tarpaulins or plastic attached to a light frame wired to the outer members of the scaffold.

Any discussion of winter construction must consider cost, since in a great many cases the decision to build or not to build in winter is based on this factor. It is one of the most difficult questions to answer. There are many cases where bids on a building project which offered the alternative of a fall or spring start produced identical prices. Many contractors believe that winter cold creates fewer problems than summer heat and rain. Where surveys have been made, however, the average figure for extra cost is usually given as 5 to 10 per cent. It is computed from the extra direct cost of providing tarpaulins, heaters, fuel, snow removal and insulation. It can, however, be very convincingly argued that on a well-planned project the indirect savings resulting from higher productivity, uninterrupted schedules, and greater control of the "weather" on the job will more than offset the direct costs. Winter costs are also compared with those for the previous summer, and yet in labour costs alone a $100,000 project may cost anywhere from $3,000 to $4,000 more in the spring than during the previous fall. Winter weather in all parts of Canada requires careful planning, but with proper equipment and supervision any building programme can proceed on schedule. In the spring, it is assumed that the weather will cooperate, but all too often building projects are held up for weeks or carry on under adverse conditions because of "unseasonable" rain. Later, summer heat may so reduce productivity and the quality of workmanship that costs soar.

It is well in thinking of costs to consider the cost of not building in winter. The only alternative to winter construction is a complete shut-down as soon as cold weather arrives, and the effect of such action on an already full summer programme is not difficult to imagine. Canadians have, however, become so accustomed to winter construction activity that there is every indication that it will eventually equal in volume the work carried out in summer.