Winter construction practice in Canada

At a meeting of the Institution of Civil Engineers on Thursday, 18 February, 1965, a lecture entitled 'Winter construction practice in Canada' was given by Dr Robert F. Legget, B.Eng., M.Eng., LL.D., D.Sc., M.I.C.E., Director of the Division of Building Research, National Research Council, Ottawa, and the Institution's Canadian Member of Council.

Dr Legget gave an interesting review of the attitude adopted by the Canadian construction industry towards winter construction, which they now accept as part of their normal working conditions, despite temperatures that are usually slightly worse than those experienced in Britain during the winter of 1962–63 and with snowfalls that have exceeded 30 in. in one storm. The following are some of the salient points made by Dr Legget in his lecture and in his replies to numerous questions.

Discussing the historical background of winter construction in Canada, Dr Legget stated that the earliest record he could find related to one of the most notable overseas projects ever undertaken by the Royal Engineers. In 1826 they began the construction of a military waterway joining the Ottawa River with the fortress of Kingston on Lake Ontario, and now known as the Rideau Canal. The Clerk of Works, John McTaggart, left a vivid first-hand account of the winter construction of a 60 ft span masonry arch which formed part of the first bridge across the Ottawa River, long famous as the 'Union Bridge'. The record spoke of daily snowfalls and immense floats of ice coming down the Rapids. There were only two days in the whole winter when they could not work for absolute cold—when the mercury froze in the thermometer in many parts of the country. All this in 1826; and the arch still stands today!

Typical of the early ingenuity of individual Canadian builders was the use by a Montreal contractor in the winter of 1927–28 of a complete enclosure for a five-storey apartment building. The framework was made up of light steel trusses carried on steel columns, being jacked up by a reciprocating steel cylinder working through a ratchet device. The five concrete floors were placed in two weeks of mid-winter Montreal weather, and all the interior finish was completed within 7 weeks.

One of western Canada's justly famous structures, the five-span arched reinforced concrete Broadway Bridge, across the South Saskatchewan River at Saskatoon was essentially a winter job, carried out in 1932 as an unemployment relief measure. Hand labour was therefore used as much as possible, concrete being wheeled in buggies distances as much as 1000 ft regardless of air temperatures, which ranged as low as $-45°C$. The concrete of the bridge is still in splendid condition, despite the very severe winter conditions in which it was placed.

A diligent search through the records of the Institution revealed only one paper on various winter construction, although two series of short papers (with discussions) on winter conditions in Great Britain were published in 1947 and in 1963. The paper, on a Canadian job, was one of the Selected Engineering Papers (No. 117)* issued by the Institution in the thirties. It

* R. F. Legget. Winter construction of an automatic low-head hydro-electric plant in Canada. *Instn civ. Engrs Selected Engng Papers*, 1934. Paper No. 117.

described the construction of the Upper Notch automatic hydro-electric plant on the Montreal River in northern Ontario. About 75% of the total concrete was placed in sub-freezing temperatures (some at −45°C) but the estimated extra cost for all winter protection measures was no more than 1% of the total cost, this extra being more than repaid by the savings that the unusual schedule effected. This finding was an interesting indicator of what is today's common experience in Canadian construction. The concrete placed at −45°C is as good today as when it was originally under its temporary winter protection.

In 1955 the Canadian Government instituted a broad scale attack on seasonal unemployment, amounting to as many as 250 000 Canadians each winter and of whom at least one-third would be construction workers, so that the volume of federal construction could be evened out over the year. At the same time, organizations representing all sides of the construction industry launched an intensive campaign to promote winter construction.

Discussing the costs involved in winter construction, Dr Legget quoted the survey carried out by the Canadian Construction Association in 1962 on 106 Canadian jobs. The jobs ranged in size from about $20 000 to $3 million, the total value being nearly $50 million. The extra costs for winter construction included the extra heating arrangements and the provision, erection, and dismantling of the winter protective shelters. On the jobs valued at over $660 000 the extra cost averaged 0·79% of the total cost: for smaller jobs the average extra cost was 1·31%. The overall average extra was 0·97%, or just about 1%. Given good management, good planning, and experience in winter construction, Dr Legget thought that the 1% was a reasonable figure.

It was possible to calculate accurately for two-thirds of these 106 projects the cash revenue accruing to the owners because of the earlier dates of completion. The total extra revenue amounted to well over twice the total extra winter cost, or more than 2% of the total job cost. In addition, there was the benefit of maintaining steady standards of workmanship as work proceeded at a fairly uniform temperature and with complete protection from the weather.

Dr Legget emphasized that the key to success in winter building lies in adequate preliminary planning, a truism which cannot be over-emphasized. After the overall job schedule has been worked out, it must be correlated with the corresponding extremes of weather that are expected to be encountered and the hours of daylight for the period involved. Necessary job services such as the provision of lighting, temporary heat, protection of exposed water lines, etc, can then be worked out fully in advance. The site itself must be planned before work starts so that access will not be interfered with no matter what the weather. Construction roads must be clearly marked; drainage facilities designed not only to take care of rainfall but also melting snow; access stairways made safe against icing. All quite obvious, but all too often even in Canada, it is decided to 'take a chance', with consequent inefficiency.

Dealing with the techniques used in Canada to cope with winter construction problems, Dr Legget stated that the wide availability of 6 mil polyethylene sheet had transformed the appearance of winter jobs. This material was used to completely enclose works constructed in winter. Stretched over light wooden frames, it gives complete weather protection and good light transmission. Although these lightweight shelters were first developed specifically to combat cold weather conditions, almost by accident contractors had found that the shelters were also valuable in keeping the rain out and making the

general conditions on the job much more satisfactory for the workers. Also it had a profound effect on the morale of the workers on the job because they knew that they would be working in conditions almost as convenient as those for workers in a factory.

Of significance for British conditions is the fact that some Atlantic Coast contractors now use plastic shelters for all their winter jobs even though their winter temperatures are not extreme and snowfall is variable, in order to give their men protection from the rain. They find that the extra costs are more than repaid by the increased productivity consequent upon comfortable and equitable working conditions.

To overcome the disadvantages of polyethylene sheeting, in particular its rather low tear resistance, Canadian plastic manufacturers were investigating and developing reinforced plastic film.

A variety of portable heaters are now available for use inside the shelters, but oil-fired space heaters are most commonly used. Their use introduces some hazards, especially in connexion with fire, but these hazards could be avoided by good preliminary planning and proper maintenance. It was essential that the placing of the heating units and the fuel supply should be properly planned and there should be adequate provision of fire fighting equipment in case of fire.

A less obvious danger is the effect that the products of combustion can have upon the properties of newly placed concrete. Chalking of concrete floors placed under enclosures had been traced to inadequate ventilation. Excessive humidity during concreting and plastering operations can also cause trouble, but this can be avoided by proper ventilation.

Since almost all jobs are totally enclosed during winter, it was the usual practice to use normal cement with normal mixes; the necessity for using high early strength cement did not usually arise. In Canada it was preferred to place concrete without the use of calcium chloride, but it was a regular practice to recommend calcium chloride when necessary. There had been a few special cases of a little trouble developing, but in each case there had been some departure from normal good practice.

For a long time, mass concrete had been placed during winter for the construction of dams. It was the standard practice to have special formwork which incorporated insulation. Another method was to have very high lifts. In the construction of one international power house, mass concrete had been placed in lifts 40 ft high. By means of continuous placing, sometimes for 48 hours without a break, and by the use of very high lifts, the problem of the surfaces was very largely eliminated.

The Canadians were now going in for winter construction on very large earth moving jobs. The South Saskatchewan Dam on the Saskatchewan River was being constructed right through the winter. There was also a steady increase in winter road building operations, although an attempt was made not to do the earth moving during the winter months.

Dr Legget illustrated the techniques that are now regularly used in Canada by means of a most interesting film: 'Winter building—it can be done'. This film had been produced by the N.R.C.'s Division of Building Research.

A vote of thanks to Dr Legget was proposed by the Chairman, Professor J. K. T. L. Nash, and carried by acclamation.