Report on Renfrew Cold Storage Plant
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TECHNICAL NOTE

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PREPARED FOR Inquiry Reply | DATE June, 1953.

SUBJECT Report on Renfrew Cold Storage Plant

General

The Cold Storage Plant of the Upper Ottawa Valley Cooperative Poultry Products Limited is situated at the west edge of the town of Renfrew, Ontario. The plant is L-shaped, about 135 feet long and 64 feet wide. At the end of the long wing is a cold room, 38 feet by 50 feet. The plant was built in 1946 but damage has occurred only within the last 2 or 3 years.

The cold room rests on a perimeter footing 2 feet wide with 4 interior columns resting on footings 3 feet square. The footings are located nearly 7 feet below the finished floor in original ground. The original grade was about 3-1/2 feet above the footing elevation and the remaining 2 or 3 feet are filled with gravel.

The floor is of sandwich construction consisting of 6 inches of cork insulation over a 4-inch concrete slab with a 3-inch concrete surface above the insulation. The walls and ceiling are insulated with 6 inches of cork. Although no insulation is shown on the plans there is about 6 inches of insulation around the steel columns.

Observations

The exterior of the building is practically undamaged except for cracks at the northwest and northeast corners and two small cracks along the east wall. Level readings on the exterior of the perimeter footing indicate little, if any, differential movement around the building. A maximum variation of about 1/2 inch was found in the elevation of this footing.

Although the soil immediately surrounding the locker room is terraced, the general area appears to be poorly drained. At the north end of the building the terrace is about one foot below the top of the perimeter footing. A few feet away the level drops more than two feet.

A soil boring located north of building as shown in Drawing BR 440 revealed a crumbly, fissured silty clay to a depth of 3 feet. This type of soil may be expected to heave considerably with slowly penetrating frost. At the time of boring, March 26, 1953, the soil was frozen from about a depth of 6 inches to 2 feet.

Damage is most evident inside the cold room. Around the centre of the room, the floors are badly cracked and heaved. Along part of the northeast wall the ceiling and the wall have separated by about one inch vertically.

Frost Action Phenomena

The thermal regime beneath the centre of a cold storage room differs from that within normally exposed ground in that there is no seasonal warming effect. For this reason the frost line goes down into the soil until a balance is reached between the heat flowing from the frost line to the surface and the heat flowing to the frost line from the underlying soil. In order to reduce the penetration of frost, a layer of insulation is put into the floor of cold rooms. Insulation is also added to the walls to reduce heat flow through the walls and footings of the structure. The insulation does not prevent heat flow or frost penetration, it merely reduces the rate of heat flow and hence reduces the depth at which inflow of heat from below will balance loss of heat upward from the frost line. Insulation reduces the ultimate depth of frost penetration.

Toward the edge of a cold room the seasonal effect of climate can be noticed. With adequate insulation the depth of frost penetration at the perimeter of the structure may be little more than in naturally exposed ground.

When the subsoil freezes, the water in the voids of the soil turns into ice with an increase in volume. This increase in volume is small but in some soils additional water is drawn up from below by suction and the water freezes in layers which build up in thickness, sometimes to several inches. It is this phenomenon which causes detrimental frost heaving.

Discussion

In this structure the area of maximum heave is displaced from the centre of the structure to the northwest side. This is probably due to the particular solar orientation of the building. The southeast wall of the building would normally receive much more warmth from the sun than would the other walls. The northwest wall is actually shaded from the south by a wing of the building.

It appears reasonably certain that all relative movement of this building has been caused by frost heaving in certain areas. It is difficult to judge whether there has been any movement of the floor relative to the columns. In most cases there is a hairline crack at the floor-to-column joint but this could be a construction joint. At the northwest interior column the joint appears to be patched. Some relative movement between the floor and column could easily be concealed by distortion within the insulation.

No information was obtained on the depth of frost below the floor but very likely at the time of observation it was about 5 to 6 feet. Probably both the floor and the columns are heaving to a certain degree with greater heaving occurring under the floor. This interpretation appears reasonable in view of the nature of the contours. It is also consistent with the soil conditions beneath the building. The gravel fill would not be expected to heave but the original ground is likely to heave with a penetrating frost line. Since the thermal conductivity of concrete is greater than that of soil a deeper frost penetration around the columns may be expected. Further assistance for frost penetration is gained because the steel columns (of very great conductivity) rest on the concrete piers below the floor insulation. Although the columns are insulated, heat flow through the columns would be greater than through the floor.

Correction of Frost Heaving

It is of course good insurance to provide protection against frost damage in the design and construction of a cold storage plant on soil which is subject to frost heaving. This is often done by insulating the floor and by providing a heat source between the floor and the subsoil. The heat source may be artificial or it may be merely a provision for natural ventilation.

The correction of frost trouble is a much more difficult and costly proposition. The obvious method is to close down the plant, install the necessary insulation and heating and rebuild the floor. This is generally undesirable, however, in cold storage operations. If operation of the plant is to be continuous during repairs it is essential that the thawing of the subsoil be a slow process occurring from the bottom of the frozen layer. Otherwise, water released from ice lenses may supersaturate the soil creating an unstable condition.

Two general methods may be used in order to thaw the subsoil. The first and simplest is to install perimeter heat at a depth of several feet around the outside of the building. The heating may be obtained by circulating steam or hot water through a pipe system. The second method is to get under the building and supply heat by natural air circulation or by artificial means. One successful application of this method was to construct a tunnel 6 feet high and 4 feet wide under the building and to control the subsidence of the structure as it occurred. In another case low consumption electrical heating wires were installed.

In the case of the Renfrew Storage Plant the perimeter heating method may be sufficient. The tunnel method would undoubtedly remove the frost from its immediate vicinity but there is no information on the extent of its effect. It would be practically impossible to insert any type of heating unit into the gravel fill from outside the building.

It may, however, be possible to work in the clay below the gravel fill by jet-driving a casing at an angle from outside. If frost is encountered a warm jet may be necessary.

It is good practice to make periodic checks on the rate of movement of the structure during the thawing process. Rate of movement can then be controlled by variation in the heating arrangement. In the case of the construction of a full-scale tunnel, movement can be controlled by jacks or shims.

No matter what system is used to thaw the ground, a permanent heating or ventilation arrangement is necessary to prevent the recurrence of the frost heaving.

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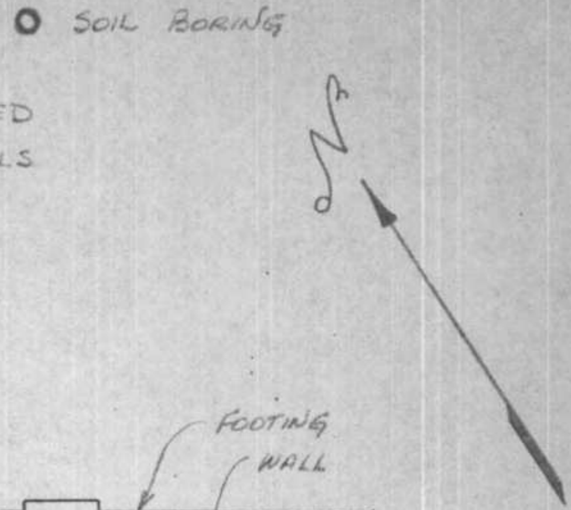
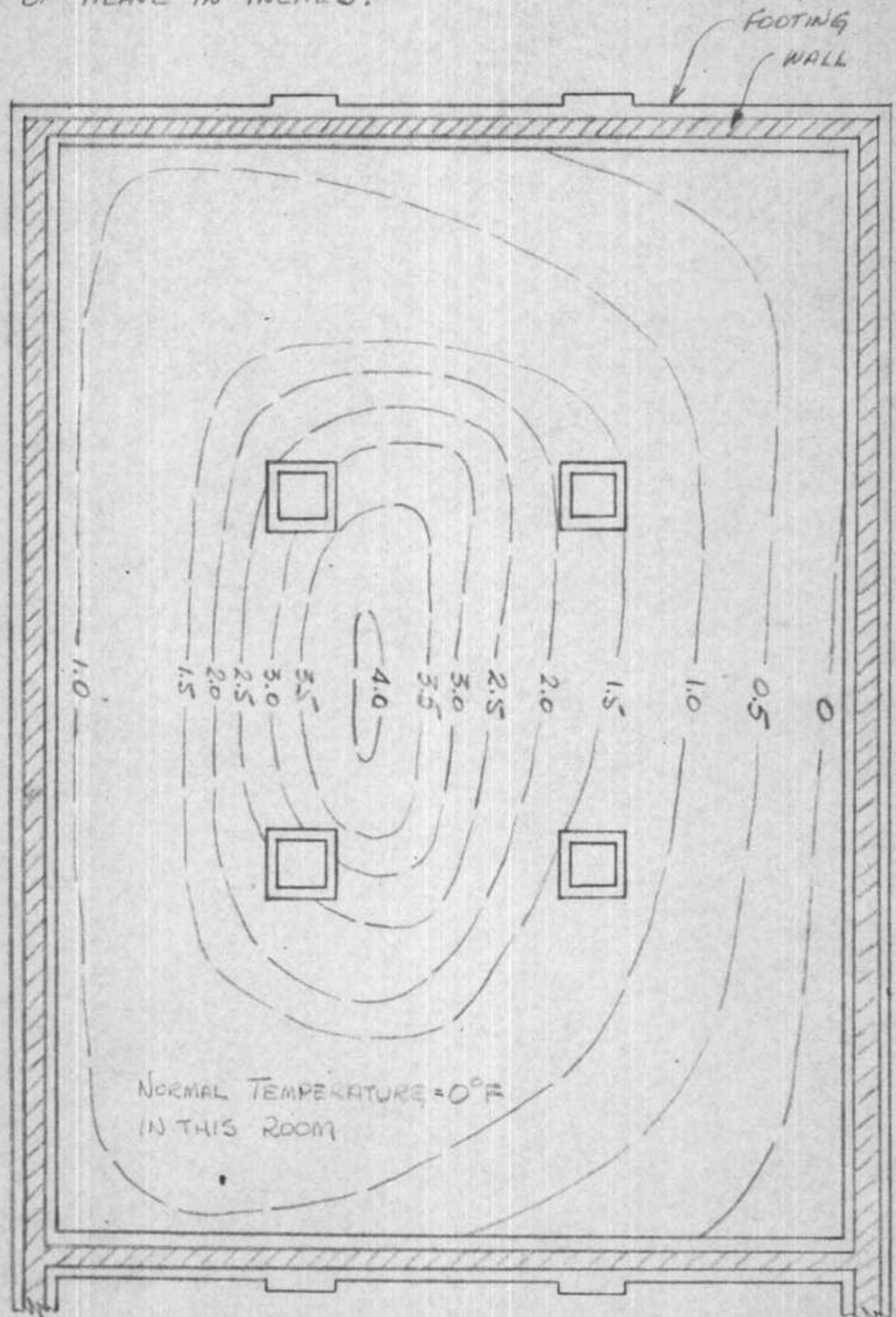
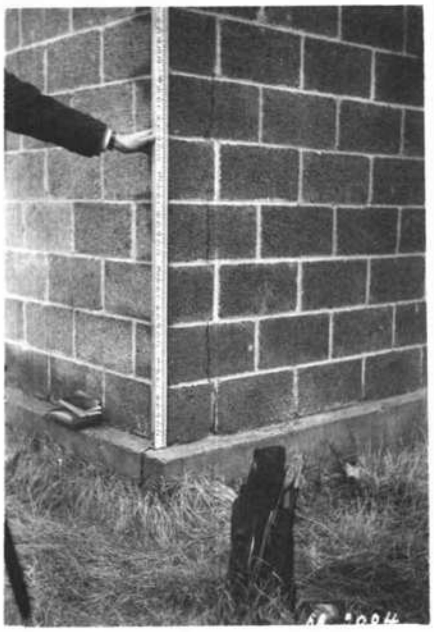


NOTE: FLOOR CONTOURS, SHOWN AS DASHED LINES ARE BASED ON A FEW SPOT LEVELS TAKEN ON MARCH 26, 1953. IT WAS ASSUMED THAT THE FLOOR NEXT TO THE EAST WALL HAD NOT MOVED. WITH THIS DATUM THE CONTOURS REPRESENT THE AMOUNT OF HEAVE IN INCHES.



TITLE: FOUNDATION PLAN OF COLD STORAGE PLANT, RENFREW				DRAWING No. BR 440
DRAWN: CRC	CHECKED: MB	APPROVED: RFL	DATE: 24.4.53	SCALE: 1/8" = 1'-0"

PHOTOGRAPHS TAKEN AT RENFREW COLD STORAGE PLANT



N.E. Corner Looking West

N.W. Corner Looking South

East Wall Looking West

Interior Floor Cracks
Looking South