Frost Proof Shallow Footings or Piers and Method Therefor

Fig. 4

Freezing line

Fig. 5

Temperature below 1/2" of plastic foam

Temperature above 1/2" layer of plastic foam

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This invention relates generally to buildings and building foundations and, more particularly, relates to novel procedures for economically constructing buildings and building foundations having shallow footings or piers which are above the normal frost line and yet provide full frost barriers. It is applicable to locales having frost penetrable soil and a surface exposed to an alfresco environment experiencing below freezing temperatures.

Present methods of construction generally require that frost penetrable soil be excavated for a foundation, footing, pier, etc. to be constructed, that good drainage be accommodated and/or that the depth of the base of the structure be placed below the frost depth. All these factors remove the possibility of frost heave by removing the source of water or the possibility of a freezing temperature.

Advantageously, our invention eliminates the freezing temperature at the foundation level by keeping the ground heat in, thus creating a frost-free zone below the footing or pier and thereby allowing the base to be raised essentially back to the grade level, provided sufficient bearing strength is available.

It is a principal object of this invention to provide a footing or pier for a building foundation that is above the normal frost line for a climate than conventional building practice permits. It is a related object of this invention to provide such a shallow footing or pier which nevertheless affords better insulative properties to the building and at the same time effects a great savings of concrete material and reinforcing steel for bearing walls or risers from the footings, a savings in the forms required for the smaller amount of concrete, and a savings in the labor by digging a shallow footing rather than a deep and relatively narrow excavation. It is yet another object of the present invention to provide a method for making a novel shallow footing or pier that is nonsusceptible to the detrimental effects of freezing temperatures. Still another object of the present invention is the provision of a novel footing or pier construction for buildings wherein an insulating layer, preferably of expanded plastic, retains the heat in the soil below such footings or piers and prevents the soil from freezing and heaving. Other objects and advantages of this invention will be apparent to one skilled in the art upon reading the following description and claims, reference being had to the accompanying drawings forming a part of the specification wherein:

FIG. 1 is a cross section view in elevation of a typical building construction showing in part the slab floor, bearing wall and concrete footing extending down to the frost depth line.

FIG. 2 is a cross section view in elevation showing the same building construction, but with a shallow frost proof footing utilizing the present invention on a heated building.

FIG. 3 is a cross section view in elevation of a slab floor in combination with a shallow frost proof footing utilizing the present invention in an unheated building.

FIG. 4 is a cross section view in elevation of yet another building construction utilizing the present invention.

FIG. 5 is a chart showing the thermal performance of a concrete footing that has been insulated in accordance with the present invention.

Looking now with more particularity at the drawings, FIG. 1 shows the conventional construction wherein slab 1 is attached to bearing wall 2 which extended downward to footing 3. Footing 4 is down to the frost depth level for the particular climate, the frost depth level being shown by the arrowed line starting at grade level 5. As can be seen, the foundation is designed to place the footing below the known frost depth for the geographic area in which the structure is located. This depth is well known and set by local code authorities. The intent is to prevent heaving of the soil under the footing which would in turn damage the structure.

Looking now at FIG. 2 wherein the construction shown utilizes the present invention, slab 5 is supported by bearing wall 6 and footing 7. The frost depth line is shown as extending downward from grade 8. As can be seen footing 9 extends only just below the slab 5 but the ground below footing 10 remains unfrozen due to positioning of insulation layers 9 extending horizontally away from the exterior of the building and also vertically along the exterior of bearing wall 7 just above footing 8. The construction shown in FIG. 2 is for that of a heated building whereby the heat loss to the ground through slab 5 is retained and freezing and heaving is prevented. Thus through practice of the present invention insulation is used in place of the masonry that would be required from grade level to the footing. FIG. 2 graphically illustrates how the frost depth and freezing line are altered away from the footing by keeping the soil below the insulation and below the heated structure above freezing.

The type of construction shown in FIG. 2 is effective as long as the building is heated. However, if the building were abandoned throughout a winter season the frost line would penetrate below the footing through the interior of the building, thus causing frost damage. This is prevented by a building construction such as is shown in FIG. 3. In this case, insulation 11 is placed symmetrically inside along slab 12 and outside along bearing wall 13 and extending horizontally outward, thereby protecting the footing 11 from freezing temperatures because of the insulative qualities of insulation 14 regardless if the building is heated or not. The frost depth shown extending downward from grade 15 does not impinge upon the footing as shown by the freezing lines.
A variation of the previously shown construction is that of FIG. 4, wherein the insulation 19 is laid horizontally underneath the footing 18 thereby acting as a bearing surface for the footing while it provides a continuous layer of insulation below and beside the footing to protect the soil underneath it from freezing regardless of the occupancy of the building. Insulation 19 extends symmetrically under slab 15 and outwardly to the exterior. As indicated, the insulation 19 must have a load carrying capability as well as insulative capability in order to carry bearing wall 17 and footing 18. The frost depth extending from grade 16 downward along with the freezing lines again shows that the ground underneath the footing will not freeze and no heaving of the construction will occur.

The data in FIG. 5 was obtained by testing an experimental construction similar to one shown in FIG. 4 in that the insulation was laid horizontally underneath the construction, thereby acting as a bearing surface while it provided a continuous layer of insulation below the footing to protect the soil underneath it from freezing. The insulation comprised a 1½ inch layer thick expanded polyurethane produced by The Lear Corporation under the trademark “Styrofoam.” A temperature couple was placed in the construction just above the insulating layer and another was placed in the soil just beneath the insulating layer. The chart of the temperatures taken from the two thermocouples illustrates the ability of the plastic foam to prevent the occurrence of freezing temperatures in the frost susceptible subgrades. These figures show the temperature above and below the insulation throughout the winter in a locale where the Air Freezing Index was 1302 degree-days. Since there was no freezing in the frost susceptible subgrade, no frost action occurred. Soil freezing depends to a great extent upon the duration of depressed air temperatures. It is customary to measure time and temperature by degree days. One degree-day represents one day with a mean air temperature 1° below freezing. Thus, 10 degree-days may result when the air temperature is 31° F. for 10 days or when the air temperature is 22° F. for one day. Degree-day data is cumulative and may be plotted for any period of time starting at any convenient date. The difference between the maximum and minimum points on a cumulative degree day plot is termed the freezing index.

As a specific example, in accordance with the present invention, a building was erected in a locale where the frost line is 3½ feet below the ground and where the climate was rated at 750-1000 degree-days. A shallow trench was dug and the concrete footing was placed so that the top of it was just below ground level. Expanded polystyrene boards 1½ inches thick were then placed horizontally in the ground just above the concrete footing so that they formed a horizontal border on either side of the footing for a distance of 18 inches. The concrete slab of the building rested in part on the inner 18 inch border of the insulating board while the bearing wall on the side exposed to exterior cold was covered with the 1½ inch insulating board from the juncture of the wall with the outer horizontal insulating board up to grade. Such a construction altered the freezing line away from the footing and was adequate to protect such a shallow footing from frost heaving in the mentioned climate.

On the basis of known data which is well documented, the thickness of foam material as well as the horizontal distance it has to be extended for any given locale is easily calculated by those skilled in the art of soil mechanics, and the like, the primary benefit of such calculations being economic. That is to say, such calculations can indicate the minimum thickness and area of the foam material needed to alter the frost depth and freezing line away from the footing by keeping the soil below the insulation and below the heated structure above freezing.

With regard to the insulating barrier itself, it should be understood that other expanded plastic materials having similar insulating capability, imperviousness to vapor transmission, compressibility, strength and thermal conductivity as expanded polystyrene can also be used in constructions of the present invention. One of such other possible layer materials can be closed cell expanded urethane, for example. The present invention is especially effective in a cold climate which takes in most of the northern United States, the presence of a frost susceptible soil which is randomly distributed throughout a large area of the United States and the use of slab construction which is a high percentage of all the construction in the United States. Slab construction is utilized in approximately 16 percent of all residential structures and about 33 percent of non-residential structures. Further, appendages to residential construction such as carpots, garages and patios are beneficially served by the present invention as although these do not normally receive insulation for comfort, nevertheless, in the climates discussed above, they require foundations down to the frost line. Thus, the present invention should be comprehended in all of its alternative embodiments and should not be limited by the specific embodiments heretofore described. For example, the insulation used in the slab construction, although depicted herein to be concrete, may be of any material useful in such construction.

What is claimed is:
1. A shallow footing or pier construction for a building, said building comprising footings or piers, walls, and a foundation, such construction providing a frost-free zone below said footing or pier, said frost-free zone comprising generally frost penetrable material having a surface exposed to an alfresco environment experiencing below freezing temperatures, the footing or pier located above the normal frost line for the particular locale of said frost penetrable materials, said construction comprising said footing or pier and a substantially water impermeable thermally insulating plastic foam barrier material, said barrier material extending substantially horizontally under and beyond the peripheral extent of said footing or pier from the side thereof exposed to exterior cold.
2. The shallow footing or pier construction of claim 1 wherein said barrier material also extends substantially horizontally beyond inner extent of said footing or pier.
3. The shallow footing or pier construction of claim 1 wherein said plastic foam barrier material is expanded polystyrene.
4. A shallow footing or pier construction for a building, said building comprising footings or piers, walls, and a foundation, such construction providing a frost-free zone comprising generally frost penetrable material having a surface exposed to an alfresco environment experiencing below freezing temperatures, the footing or pier located above the normal frost line for the particular locale of said frost penetrable materials, said construction comprising said footing or pier and a substantially water impermeable thermally insulating plastic foam barrier material, said barrier material extending outwardly substantially from a juncture above the bottom of said footing or pier on the side exposed to exterior cold and substantially vertically upward from the juncture of said horizontally extended material with said exterior side up to grade, whereby said frost line is altered away from said footing or pier by creating said frost-free zone in said generally frost penetrable material below said footing or pier.
5. The shallow footing or pier construction as in claim 4 wherein said barrier material also extends outwardly and substantially horizontally from a juncture above said
footing or pier on the inside thereof and substantially vertically upward from the juncture.

6. A shallow footing or pier construction as in claim 4 wherein said plastic foam barrier material is expanded polystyrene.

7. A method of making a shallow frost-free footing or pier for buildings exposed to an alfresco environment experiencing below freezing temperatures comprising the steps of making a relatively shallow excavation in the soil where the footing or pier is to be placed, said footing or pier located above the normal frost line for the particular locale, placing the footing or pier in said excavation, placing sheets of high thermal insulating plastic foam barrier material substantially horizontally of said footing or pier on the side exposed to exterior cold at a juncture above the bottom of said footing or pier and substantially vertically upward from said juncture, and completing filling of said excavation.

8. The method of claim 7 wherein an additional step includes placing sheets of high thermal insulating plastic foam barrier material substantially horizontally of said footing or pier on the side thereof not exposed to exterior cold at a juncture above the bottom of said footing or pier and substantially vertically upward from said juncture.

References Cited

UNITED STATES PATENTS
2,050,798 8/1936 Kothe 52—169
2,743,602 5/1956 Dunn 52—169
2,968,130 1/1961 Bascom 52—169
3,250,188 5/1966 Leonards 52—408
3,135,097 6/1964 Scheinberg 52—294

OTHER REFERENCES
American Builder, March 1956, pp. 144-145.

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52—294, 309, 742; 61—50