BYGGFORSK
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SMALL HOUSE CONSTRUCTION in MUSKEG & BOGS

ALASKA BUILDING RESEARCH SERIES
HCM-01556

Introduction
This publication is one of nine that has been translated from Norwegian. They are taken from a series of publications produced by the Norwegian Building Research Institute (NBI) series, "Byggdetaljer," which literally translated means "building details." The translations were done by Dr. Nils Johanson and Richard D. Seifert of the University of Alaska Fairbanks with the cooperation and permission of NBI, Oslo, Norway. The financial support for the translations and printing came through the Alaska Department of Community and Regional Affairs, from USDOE Grant DE-FG06-80CS6908. The publications use the original index code of the Norwegian "Byggdetaljer" series so that specific translations can be directly cited. All questions on these translations should be directed to Richard D. Seifert, Cooperative Extension Service, P.O. Box 756180, University of Alaska Fairbanks, Fairbanks, Alaska 99775-6180. Phone: 907-474-7201

0 GENERAL

01 This bulletin discusses some principles of foundation design for small houses on muskeg and bogs, placement of pipes, and construction of roads and parking areas. Construction solutions and details must be adjusted to fit the great variations which characterize the geotechnical properties of this soil condition.

02 Because there is still too little experience to determine which method is best for building on bogs, this bulletin will describe general principles without explaining detailed solutions.

03 Before construction on a bog begins it is necessary to consider very carefully where the houses will be located and how many roads are necessary for vehicular traffic. A thorough geotechnical investigation establishing the depth to bearing ground must be done before building plans are developed. Care during the preconstruction phase is essential.

04 Bulletin A511-101 describes the soil types that are commonly encountered as foundation materials. Bogs are so different from most soils that they are considered in another bulletin, A511-102, *Foundation Conditions. Muskeg/bog: Geotechnical Properties*. The same bulletin also treats drainage, mass replacement, corrosion potential, and so on.

1 METHODS

11 When building a foundation on bogs or muskeg, the following principles apply:

1. Excavate through the bog/muskeg layer. Construct the bearing walls or piles down to solid bearing soil capable of carrying the load below the bog material.
2. Set pilings to a bearing layer.
3. Excavate down to (bearing ground) and pour piles (concrete).
4. Place the foundation in the bog/muskeg itself.
5. Replace the bog/muskeg with material that has an adequate bearing capacity and less compressibility than the bog material.

These methods are intended for houses without basements. If the house will have a basement, method 1, 2, or 5 may be used but construction will be relatively expensive.

See in addition Points 111, 113 and 115 and Figures 113b and 115.

111 Bearing walls and pilings support construction on the bearing layer below the bog. The simplest design for a foundation is to dig down through the bog/muskeg layer and use piles as a load transfer mechanism to the bearing layer. This method, however, should be used only for bog/muskeg depths under 2 meters (6 feet). If the house is to have a basement the foundation supports should be integral to the outer walls of the basement. Sidewall support of the excavation may be needed. However, it is usually better to avoid this and instead excavate with slopes that will stand by themselves. The excess material from the excavation can often be placed elsewhere on the property. A peat bog will not change much in volume when it has been dried out.

112 If piling will be driven to a bearing layer of soil, they can be made of several common materials, such as wood, steel profiles, or concrete. *Wooden piles must always be below groundwater level*. Steel piles, especially the portions that are above the groundwater table, may be exposed to damaging corrosion, and should be protected (for example, with asphalt). However, the corrosion danger is insignificant if the steel piles stand in the undisturbed bog material below the groundwater table. If steel piles are used, they should have at least an 8 mm webb and flange thickness. Concrete piles do not cause any particular problems if the concrete is at least *class C25*, if the surface is tight and free from scratches and nested stones, and if the reinforcing has a cover according to Norwegian Standard NS 3473.

(Regarding foundations with piles of concrete, see building details in group A 521.)

Because a pile foundation has little to assure the lateral stability of the house, (inclined piles or other lateral bracing), a continuous ring wall of reinforced concrete poured over the top of the piles and placed below the depth of frost penetration will give this lateral stability. The ring wall is also a necessary finishing element between the top of the piles and the house itself when the piles are below the groundwater table (Figures 112 a and b).

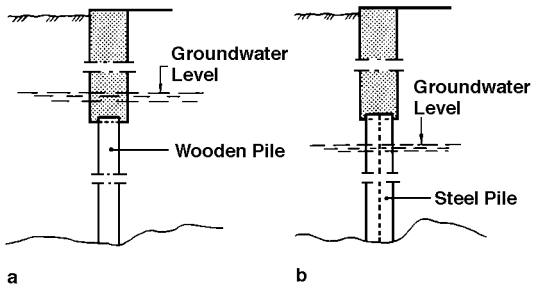

Figure 112
Piling to bearing ground. The ring wall must be down to frost-free depth.
A. Wooden piles—also pressure treated ones—must be below groundwater level.
B. Steel piles can protrude above groundwater level. The part that is above the water must be corrosion protected, with a coating such as asphalt.

113 Excavated shafts for piers or large piles down to solid ground are often used for large structures, and they can also be used for smaller buildings. When excavating the shaft, the walls must be braced, for example, with empty steel drums. The construction of the shaft is labor intensive and it pays to put the shaft down for a few piles and then pour bearing load beams or braces on top (Figure 113a). These beams can act as the finished ring wall but they must be sized (and reinforced) to carry a specific load. The material above the piles may be excavated to basement depth so that the completed ring wall will be the outer wall of the basement (Figure 113b).

Because excavated shafts are for large diameter piles, reinforcing is not usually necessary.

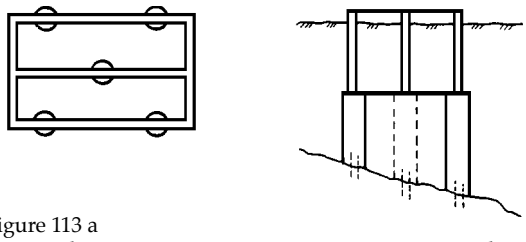

Figure 113 a
Piles in shafts excavated down to a bearing layer with bearing beams of concrete above.

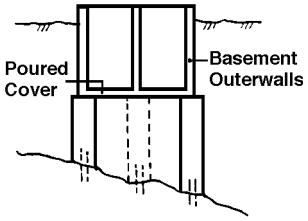

Figure 113 b
Piles excavated down to bearing material with a poured pad as basement floor, and the outer walls of basements above the floor.

114 If the bog/muskeg layer is particularly deep, a house can be founded without penetrating all the way down to a solid bearing layer (Figure 114). This method will, however, result in some settlement. Neverless if settlement has been anticipated and the necessary precautions taken with regard to utility connections, the resulting problems will usually be minimal. Because of variations in bog/muskeg depth, this method should be used only for small, freestanding houses. It must not be used for row houses or townhouses, because of the likelihood of damage as a result of unacceptably large differential settlement. The best way to avoid this is to pour a box foundation (this penetrates below the depth of frost penetration) under the house.

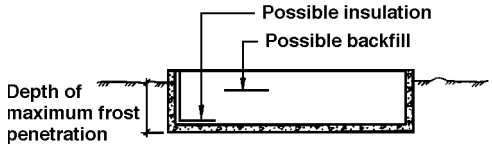

Figure 114
Poured "box" as foundation under the house.
The box must be insulated or be backfilled to prevent frost penetration below the bottom slab.

A box foundation must be internally insulated and, if advisable, backfilled to prevent frost penetration below the bottom slab. A ring wall and piles with

pile plates can also be used, but this system may increase the possibility of uneven, unsightly, and even damaging settlement.

Foundations in the bog/muskeg itself must not be installed without careful geotechnical investigations and engineering calculations showing that the method can be utilized at a specific site.

115 If the muskeg is excavated and replaced with bearing materials, and if the work is done correctly, the foundation will probably be adequate. The fill mass must be compacted and must extend beyond the planned ring foundation. This prevents pile wall failure and a mixture of fill material with the overlying bog/muskeg (Figure 115a). If this method is used in deep bog/muskeg, a basement can be constructed under the house (Figures 115b and c). If the fill mass is not frost susceptible (for instance, coarse gravel, fractured rock, etc.) the foundation can be laid down to a level even with the upper part of the bog instead of below the active layer.

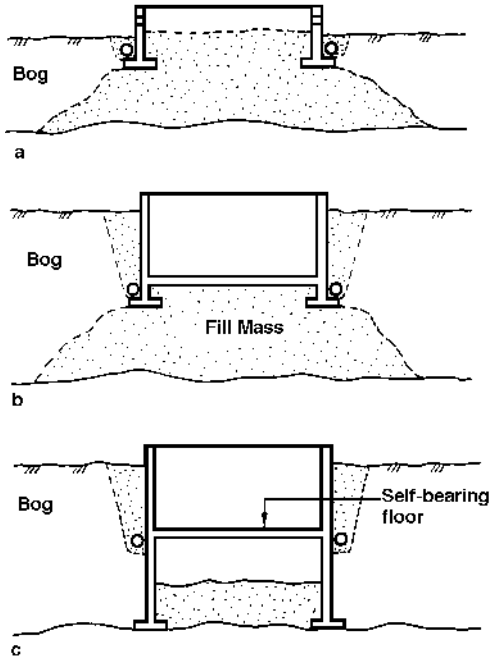

Figure 115
a. Ring wall poured on replaced, compacted fill.
b. The basement outer walls constructed on fill with appropriate bearing capacity.
c. If the bog is deep and there is limited availability of bearing materials, it may be impossible to place the foundation on bearing ground. The upper part can then be used as a basement with self supporting slab as a floor. This is a relatively expensive and undesirable method.

12 FOUNDATION WORK

121 When installing utilities, follow the same principles as for the foundation of the house (Figures 121a, b, c and d).

Surface water drains and wastewater pipes must be constructed with sufficient drop. Even small settlement may give the pipes a drop in the opposite direction, and breakage can occur if they are constructed of rigid materials. Pipes of plastic and other more elastic material are less susceptible to breakage.

Waterpipes present fewer problems because vertical bends and negative gradients are not really damaging. If plastic pipe is used, the danger of breakage is relatively small. Water pipes of plastic can be placed directly in the bog layer, however the best results are obtained if the pipes are set into bearing ground (Figure 121A).

When the bog depth is shallow, an especially good technical solution is to replace the bog with a less compressible bearing material and place the pipes on this fill (Figure 121B).

The pipes can also be placed on wooden supports that are constructed on solid ground (Figure 121C).

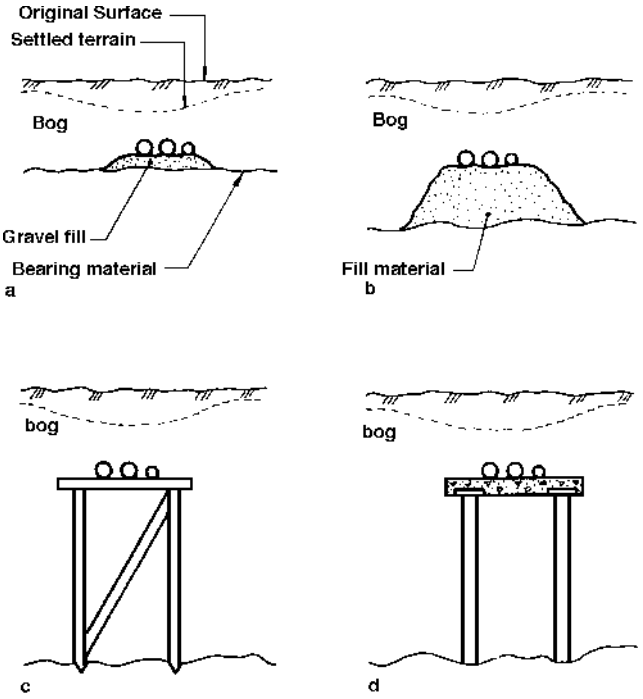

Figure 121
Supports for surface water drains and wastewater pipes.
Shallow bog depth
a. The pipes are placed on graded ground of suitable bearing capacity.
b. The pipes are placed on fill with adequate bearing capacity and low compressibility.
With greater bog depth
c. The pipes are placed on supports that are carried down to solid ground and braced lengthwise and sidewise.
This method presupposes a light load from the material above and short spans between the supports.
d. The pipes are placed on a reinforced concrete strip poured on piles which penetrate down to solid ground. Lateral stability must be assured. This method is suitable where there is vehicle traffic above.

If the swamp later settles, however, the overlying mass will be a load on the pipes. The distance between the supports must, therefore, not be greater than the free span, so that the pipes can safely carry their own weight without being broken or deformed. The support must be braced both lengthwise and sidewise. If there is vehicular traffic over the pipes, the supports must be replaced by a reinforced concrete strip poured on piles which penetrate down to bearing ground (Figure 121D).

122 Where the bog depth is relatively shallow, (up to about 2 m), the simplest method is to replace the bog with a suitable material. If settlement is expected in the bog., it is best if the upper surface of the road is lower than the surrounding bog surface. Otherwise there may be too much of an elevation differential between the road and the bog when the primary settlement has ended (Figure 122A). This construction method is also desirable with regard to utilities in the road.

If the bog depth is greater than 2 to 3 m it may still be best to replace the mass if the bog material can be easily excavated and if fill material is readily available.

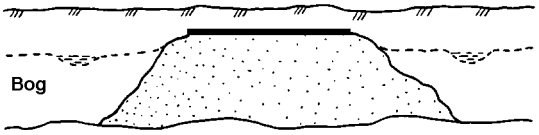

Figure 122a
Road constructed on a fill mass of suitable bearing capacity. Replacement of the muskeg can pay off at shallow bog depth and where the conditions otherwise are appropriate. If settlement in the muskeg is expected, the surface of the road should be somewhat lower than the surrounding terrain.

If the bog depth is very great, so that the road must be built on the bog itself, the construction method will depend on the bearing capacity of the bog. Corduroys or construction with *bakhon as support for the road can yield good results (Figure 122b). The bearing layer can also be placed directly on the bog. In these cases assume that the bearing layer will settle and that new material will have to be added. In most instances this operation will be repeated numerous times before the whole system will stabilize. There is a risk of bog failure, causing the bearing layer to sink down to solid ground (exceeding the bearing capacity of the bog). The bog and the road subgrade should be separated as much as possible. This can be done by installing a filter cloth made from a synthetic fabric (usually called a geotextile).

Piles can also be used as foundations for low lying bridges and similar construction, but is an expensive solution and must be evaluated in each individual case.

Figure 122b
A road constructed on supports of corduroy with deep muskeg.

For a deep bog carrying small loads, this is a possible solution. However, it is possible that the bearing layer will sink and that new fill mass will have to be added. [The use of styrofoam fill for construction under these circumstances is discussed in a bulletin by the Norwegian Road Research Laboratory and has possible application here — Editor]

2 REFERENCES

21 This bulletin was developed by Jarle R. Herje and edited by Molfrid Enge and Ivar Storseth. It replaces NBI(16). 021. The editorial work completed September 1979. Translated into English version July, 1988, University of Alaska, Dr. Nils Johanson and Richard D. Seifert.

22 Literature

221 Herje, Jarle R. Experiences on building on bog, Oslo 1978. Norwegian Building Research Institute. Working report #12.

Bakhon are large round timbers similar to corduroy road design. Bakhon is the Norwegian term for this wood underlayment method of road building.

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