THE BASICS OF PROPER DESIGN FOR RESIDENTIAL BASEMENTS IN ALASKA

by Richard D. Seifert

Basement, crawlspaces, and pads are all used in residential design in Alaska. Materials for basements and floors vary substantially in cost and availability throughout the state and include: masonry (block and/or concrete) for full basements, All-Weather Wood (a chemically- and pressure-treated plywood system), piles used with open crawlspaces, and wood framing and metal sheathing for crawlspaces.

WHY BOTHER WITH A BASEMENT?

Residences built on permafrost should *not* include normal basements, of course. Buildings on permafrost soils should have open crawlspaces to minimize heating of the permafrost and possible thawing. Thawing of the permafrost might cause uneven settlement of the soil and foundation, and could cause failure of the building. If permafrost is suspected at the building site, have a soil core drilled by a testing company or excavate the site to investigate the soil conditions. Several valuable publications on the subject are available, including "Permafrost—A Problem of Building in Alaska."[1]

If soil conditions at the construction site are found suitable for a basement, the builder will need to decide which type of basement to construct. How do the choices compare? A ranch-style home with a living area of 1,536 sq ft (24' x 64') with a warm plenum crawlspace cost $67,458 in 1980, or $43.92 per sq ft. In the same study, a 24' x 32' two-story house with an insulated masonry basement (one inch of polystyrene) was found to cost $42,158. This is a difference of $25,300 for the same useful living space. Also important is the fact that the house with a basement provided a substantial savings in fuel oil costs over the ranch-style house (~30%).[2] This striking difference in cost for the same useful floor space shows why basements are a very effective building component: they are less expensive while providing more space, with lower fuel costs. This is certainly an incentive to consider a basement when building. This article focuses on the cost evaluation for both constructing and heating different types of basements in Alaska. It is assumed that the builder will use all appropriate caution to ensure the basement is not installed in a permafrost soil area, and that proper construction, sealing, and backfilling techniques are employed. These will be described later.

COMPARISON OF BASEMENT/ FOUNDATIONS

The basement types considered here are variations of the All-Weather Wood (plywood and studs) system for building below ground, and the standard masonry (concrete and cement block) basement and foundation systems commonly used in Alaska construction. Each basement's annual heating requirement was obtained using a computer program known as F-Load,[3] which enables a detailed accounting of the annual energy use of each type of basement. In the comparison, each basement option was modeled as underlying identical first floors. The basement was the only part of the "model" residence that was changed. Therefore, the basement heating costs and thermal losses are directly comparable among the examples.

For each of the basement types, a detailed bill of materials was prepared in order to determine the cost of each basement option fairly accurately. Fairbanks labor and material costs were used. The labor costs were obtained from the Winter 1981 issue of the Community Research Quarterly of the Fairbanks North Star Borough Information Center.[4] The wage rates are based on the journeyman scale for carpenters ($24.86) and cement-masons ($19.98) and include fringe benefits. Materials costs are averaged from three Fairbanks commercial building supply companies in April, 1982.

The purpose of this comparison of basement/foundation options is to determine the most cost-effective combination of material, labor and heating costs for the homeowner/residential builder.

WHICH BASEMENT IS BEST?

This study indicates that the most energy-efficient and cost-effective basement option is the All-Weather Wood, daylight basement, with 12-inch walls of double-stud construction. This is described as basement type 06, the "base case" in Table 1. The second option listed, type 07, is also All-Weather Wood and has a larger amount of insulation than the base case: 18 inches of fiberglass in an 18-inch wall cavity. This option has a construction cost

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TABLE 1

Basic Description (all are 28' x 48')	*Materials Description*	*1982 Costs* Materials (%)	Labor (%)	Total Cost	*Above Base*	*Basement Heat Loss Avg./Yr. (Millions of BTUs)*	*First-Year Heating Cost @ $1.25/Gal 65% Efficiency*
TYPE 06 Base Case Treated All-Weather Wood 4 Feet Below Grade	½" All-Weather plywood walls with double 2" x 4" studs, 16" O.C., 12" wall cavity, fiberglass insulation to R-36, poured concrete pad with 2" Styrofoam insulation.	$8,902 (59%)	$6,215 (41%)	$15,117	---	32.2	$151.66
TYPE 07 Treated All-Weather Wood 4 Feet Below Grade	Same as above except 18" wall cavity with R-56 insulation, poured concrete pad with 2" Styrofoam insulation.	9,382 (59%)	6,418 (41%)	15,800	$683	28.7	135.18
TYPE 08 Full Masonry Basement 4 Feet Below Grade	Concrete block construction with 2" Styrofoam insulation on walls (exterior), poured concrete pad with 2" Styrofoam insulation.	11,141 (61%)	6,985 (39%)	18,126	3,110	43.1	203.00
TYPE 09 Full Basement; Half All-Weather Wood (4 Feet Above Grade) and Half Masonry	Top half is All-Weather Wood with 12" fiberglass insulation (R-38). Lower half is concrete block with 2" Styrofoam insulation (R-15).	12,532 (57%)	9,281 (42.5%)	21,814	6,696	34.0	160.14
TYPE 10 Full Basement; Same as Type 09 Except All Walls Are All-Weather Wood	Same as above except All-Weather Wood Wall is 6" with R-19 insulation.	12,003 (57.1%)	9,015 (42.9%)	21,019	5,902	40.0	235.01
TYPE 11 Full Masonry Basement 4 Feet Below Grade	Concrete block walls with poured concrete slab, 2" Styrofoam under pad, no insulation on walls.	8,370 (55%)	6,960 (45%)	15,330	213	90.5	426.00

$686 above the base case, but only achieves a $16.48 first-year saving in heating costs. The long payback of this option makes it less economical to build the thicker wall (18 inch versus 12 inch).

Types 08, 09 and 11 all include large amounts of concrete block masonry. In the insulated all-masonry basement, type 08, the material cost of concrete block construction is a disadvantage. The ratio of materials cost to labor cost for this concrete basement is 61% materials and 39% labor, compared to 59% materials and 41% labor for the base-case All-Weather Wood system. The concrete masonry basement, with 2 inches of Styrofoam™ insulation, costs $3,110 more than the base case, and the first-year heating cost is 34% more ($203 compared to $151, Table 1).

The type 09 basement, which is essentially half All-Weather Wood and half concrete block, with a 12-inch wall cavity and 2 inches of Styrofoam on the concrete wall below-grade, performs well from a heating cost standpoint. The first-year heating cost is only $8.48 above the base case, but the building costs are much higher: $6,696.

Type 11 is a full concrete-block masonry basement. It has uninsulated walls, and is included in this analysis to demonstrate the value of insulation. Although the building cost is only $213 above the All-Weather Wood base case, the increased heating costs are dramatic. This uninsulated basement costs more than twice as much to heat as the base case ($426 compared to $151). These high heating costs would only increase with inflation during the life of the building. Insulating a basement with as much as R-38 equivalent insulation above-grade (and also using that much insulation below-grade with All-Weather Wood) and with at least 2 inches of polystyrene foam, or its equivalent, in the case of a masonry basement below-grade, is in the economic best interest of the homeowner or commercial developer.

KEEPING BASEMENTS DRY

All basement types mentioned here, and virtually all conceivable basements, require extra care with respect to sealing against water penetration. This problem is universal and must not be overlooked. It is becoming ever more important, as more people recognize the economic value of basement space, and some even consider underground homes.

All-Weather Wood Construction

In the case of All-Weather Wood construction, the *All-Weather Wood Foundation System Manual* provides an excellent description of the proper building and sealing techniques to use in this type of construction.[5] Included here are elements of the recommended steps to ensure dryness in below-ground (grade) construction:

- Adjacent ground surface should be sloped away from the structure with a gradient of at least ½-inch per foot for a distance of 6 feet or more. Provisions should be made for drainage of accumulated surface water (see Figure 1).

- A porous layer of gravel, crushed stone or sand should be placed to a minimum thickness of 4 inches under the basement floor slab and all wall footings. Provisions should be made for automatic draining of this pad.

- A 6-mil thick polyethylene moisture barrier should be applied over the porous layer and a 4-inch thick (thicker if required by local code) concrete slab poured over the film.

- Where there is habitable space below grade, a sump should be installed to assure proper drainage. It should be 24-inch diameter or 20-inch square, and extend 30 inches below the basement slab. The sump should have positive drainage to remove any accumulated water. Drainage may be by gravity to a sewer or to daylight (unless winter freeze-up precludes gravity drain to daylight), or a sump pump may be provided.

- In basement construction, plywood panel joints in the foundation walls should be sealed full length with appropriate caulking compound.

- A 6-mil thick polyethylene film should be applied over the below-grade portion of exterior basement walls prior to backfilling. Joints in the polyethylene film should lap 6 inches and be sealed with adhesive. The top edge of the polyethylene film should be bonded to the sheathing to form a seal. Protect film areas at grade level from mechanical damage and exposure by a treated lumber or plywood strip attached to the wall several inches above finish grade level and extending approximately 9 inches below grade. The joint between the strip and the wall should be caulked full length prior to fastening the strips to the wall. Asbestos cement board, brick, stucco or other covering appropriate to the architectural treatment may also be used. The polyethylene film should extend down to the bottom of the wood footing plate but should not overlap or extend into the gravel footing.

- The space between the excavation and the plywood wall should be backfilled with the same material used for footings, up to a height of one foot above the footing for well-drained sites, or half the total backfill height for poorly-drained sites. This porous fill should be covered with strips of 30-pound asphalt paper or 6-mil polyethylene, to permit water seepage while avoiding infiltration of fine soils.

- If a continuous concrete footing rather than a composite wood and gravel footing is used with the All-Weather Wood Foundation, the concrete should be placed over a 4-inch thick layer of gravel, crushed stone or sand to allow drainage of water from outside the footing to the sump under the basement slab. Alternately, drainage across the footing may be provided by pipes or drain tiles embedded in the concrete every 6 feet around the foundation.

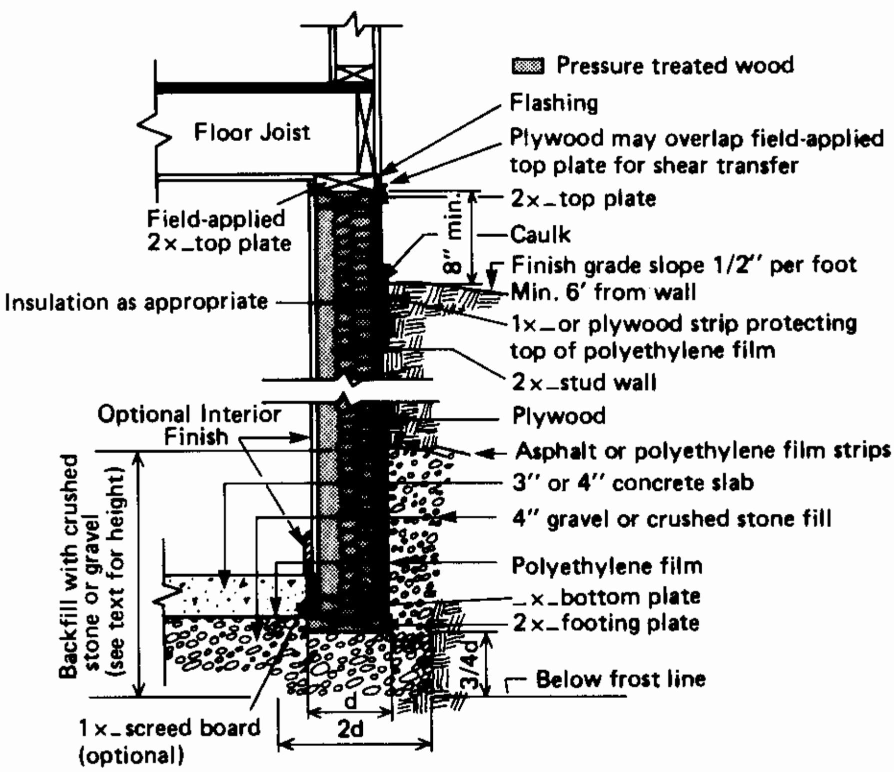

Figure 1. Basement wall with All-Weather Wood construction.[5]

Masonry Construction

Many of these same design features apply to masonry construction. Sealing the exterior of masonry construction with a waterproof, asphaltic sealant is the first step, assuming the basement floor has been sealed from below with a 4- or 6-mil polyethylene plastic vapor barrier (as in the All-Weather Wood foundation). This asphaltic sealant should be covered with 6-mil polyethylene on the exterior as an additional exterior sealant. The polyethylene should be taken to the ground level and sealed to the wall with waterproof caulking. The same precaution for drainage of accumulated surface water should be made as in point 1 of the above steps to ensure dryness.

If the concrete is still uncured (green), it may give off moisture in quantities large enough to cause water to accumulate behind the basement's interior vapor barrier. To avoid this, the basement can be left unfinished until curing is complete, or a moisture-breathing strip can be placed on top the foundation wall. This is a plywood strip that is saw-grooved every inch. Technically the best solution is to insulate the foundation wall on the outside (Fig. 2).[6]

There are three major advantages in insulating the basement wall on the outside: First, it avoids moisture problems just discussed. Second, the concrete is no longer exposed to severe temperature fluctuations and thus is less likely to sustain damage. Third, the concrete is inside the warm envelope of the house and thus acts as thermal storage; this tends to smooth out the daily temperature swings.[6]

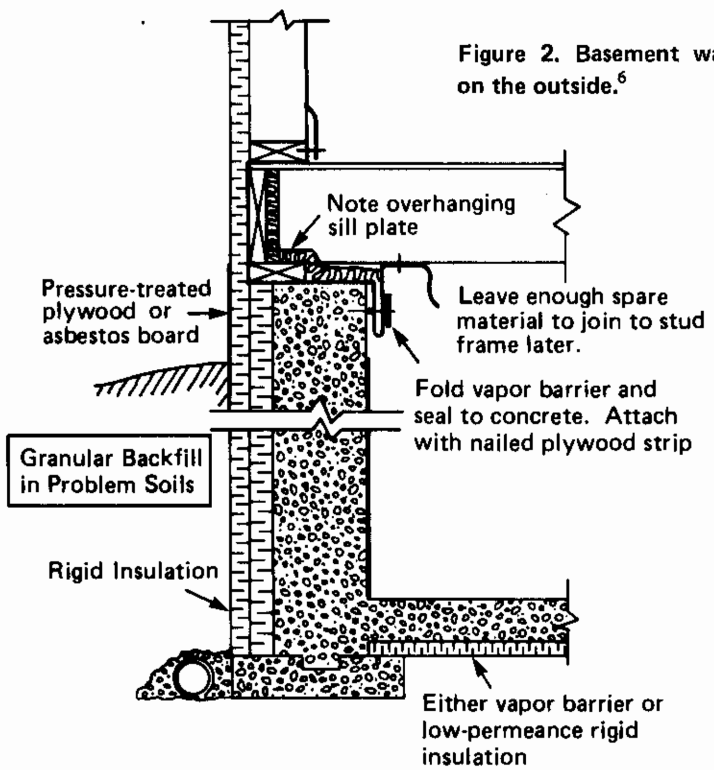

Figure 2. Basement wall insulated on the outside.[6]

Figure 2 shows a basement insulated on the outside with two layers of rigid insulation. Note that the vapor barrier has to end in such a way that the airtightness of the house is maintained. The procedure shown creates a permanent airtight seal around the top of the foundation wall, and it allows continuity of the vapor barrier when the basement is finished at a later stage. This procedure should be used whenever the basement is left undeveloped.[6]

Waterproofing

Many products are available which claim to be suitable for below-grade (ground) applications. An appropriate coating should perform the following waterproofing functions:[7]

- It must be *waterproof*—not *vapor* proof or *damp* proof or any other euphemism.
- It must retain its flexibility, its ability to expand and contract without cracking.
- It must be either very tough or self-sealing in order to counteract the likelihood of the occasional puncture.
- It must be chemically or mechanically resistant to acids and salts in the soil.
- It must be capable of forming a monolithic, contiguous, uninterrupted envelope around the building.
- If it should fail for some reason, it should be simple to repair and should *not* complicate the identification of the point of failure.

BUYING A BETTER BASEMENT

The prospective homebuyer should inspect a home with a basement for signs of inadequate waterproofing or sealing. The following are good indicator items to check:

- Try to determine the presence of exterior below-grade polyethylene sheeting.
- Inspect the basement for dark "damp" spots, especially at the edge of the floor. These may indicate lack of a vapor barrier below the concrete floor pad. Pull up any carpeting, if it is present, in an inobtrusive location near a wall.
- Look for direct signs of water seepage damage. These include stained framing or paneling, warped or buckled paneling or sheetrock, floor stains, warped floor coverings, or a damp mildew odor which may indicate moisture accumulation in walls where it may not yet have become visible on the wall surface.

A FEW CONCLUSIONS

Basements are worth whole books in themselves; this brief article has touched only a few important points. Essentially, a good basement for Alaska, like good boots for the north, should be warm and dry—and help keep everything from there on up comfortable.

A basement makes fiscal sense everywhere but on sites underlain by permafrost. If carefully installed and properly insulated and waterproofed, All-Weather Wood basements are competitive with standard masonry construction in thermal performance and are less costly. It is possible to overinsulate a basement so that the savings on heating costs will not reasonably pay back the initial expense, but it is also possible to use too little insulation and suffer unnecessarily high fuel bills for the life of the structure.

REFERENCES

[1]Permafrost—A Problem of Building in Alaska. 1978. Cooperative Extension Service Publication No. 754. University of Alaska, Fairbanks, AK 99707.

[2]Figures listed here are updated from A. Carlson's 1979 publication P-1157, Design of Floors for Arctic Shelters, Cooperative Extension Service, University of Alaska, Fairbanks (out of print). The author revised figures, accounting for inflation, to reflect 1980 costs.

[3]*F-Load*, A building heating loads calculation computer program, version 3.4, October, 1981. Beckman, Duffie and Associates. 4406 Fox Bluff Rd., Middleton, WI 53562.

[4]Fairbanks North Star Borough Community Information Center Quarterly Report . 1981. Vol. IV, No. 4, Winter. 105 pp.

[5]National Forest Products Association. 1982. All-Weather Wood Foundation System, Design Fabrication Installation Manual. 1619 Massachusetts Ave., N.W., Washington, DC, 94 pp. ($10.00.)

[6]Eyre, D. and D. Jennings. 1981. Air-Vapour Barriers. SRC Publication #E-825-2-E-81, Saskatchewan Research Council, Saskatoon, Saskatchewan, Canada.

[7]Metz, D. 1982. "Keeping Dry Underground," *Solar Age*, pp. 24–31, May. Available in libraries or on request from Energy Specialist, Cooperative Extension Service, University of Alaska, Fairbanks, AK 99707. ♦