BYGGFORSK
NBI: A552.312

Retrofit Insulation in Concrete and Masonry Walls

ALASKA BUILDING RESEARCH SERIES
HCM-01553

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." It is hoped that Alaska builders will be able to glean useful ideas from these publications with the understanding that differences exist between how they and we build. 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 describes techniques for retrofitting insulation on outer walls of concrete or masonry, concrete blocks or bricks. It can help contractors and homeowners select a suitable method of retrofitting insulation. Techniques for external insulation focus on frame walls ventilated to the outside. New methods of retrofit insulation are also included, as are K-values of the alternative insulation thicknesses.

02 Retrofit insulation on concrete and masonry walls will provide a more comfortable climate indoors. A retrofitted building will be warmer and more comfortable with lower heating costs.

03 When dealing with a building that has historical and architectural value, the use of retrofit insulation is often limited. When retrofitting is possible, external insulation should be used since it has many technical and architectural advantages. Conditions are especially well suited for external retrofit insulation when the external wall is in need of repair or the existing wall material no longer resists climatic demands such as rain and frost. External retrofit insulation can be placed continuously on the wall surface so that cold bridges at the floor separations and on adjoining inside walls will be eliminated. The existing wall will then stay at a higher temperature and will not be vulnerable to humidity or moisture accumulation. External retrofit insulation can also be done without significant bother to the inhabitants of the building and without loss of internal living space.

04 Internal retrofit insulation can be used where external retrofit insulation cannot, or where it is desirable to insulate only certain walls. Be aware of the disadvantages, however, such as increased cold bridge problems and the loss of useful interior space. The heating system (radiators or convectors) and main electrical penetrations can also cause complications with internal retrofit insulation. Internal insulation can cause the original wall to become colder, limiting its ability to dry. Do not use internal retrofit insulation on block or masonry walls without investigating potential frost damage and its effects on bricks or masonry.

05 Retrofitting insulation in walls should be planned in connection with other energy saving options. Attention should be given to sealing air leaks around windows. Improving or replacing inferior windows and insulation in other areas of the building (attics) should also be considered. To obtain full advantage, it is often necessary to readjust the heating and ventilation systems after the insulation and sealing work has been completed.

06 Retrofit insulation and cladding or paneling should be done in compliance with building codes that pertain to new buildings. Also take into account the number of floors, floor space, and usable area, so that the retrofit does not reduce the buildings' fire worthiness. Since there are no specific fire protection rules governing the improvement of existing buildings, review fire codes established by your local government regarding material use and constructions methods.

1 MATERIALS

11 Wooden materials

Use quality wood according to local code or standard practice. Wood that is likely to be wet should be pressure treated. A framework of lumber can be used for external retrofit insulation in buildings up to eight stories high.

12 Steel profiles

Use thin walled Z shaped profiles of steel for framework and support for the wall covering. The profiles must be corrosion protected with a zinc layer of 20 μm, which is considered sufficient.

13 Thermal insulation

131 Mineral wool

For thermal insulation in the wood frame or steel profile, use mineral wool type A with a thermal conductivity of 0.040 W/mK (watts per meter °Kelvin).

Boards or batts

Boards come in 2 x 8 foot sheets, and the center to center distance must be considered. Batts are available to fit 16- or 24-inch centers. Mineral wool can be either fiberglass or rockwool. Standard thickness are 3.5, 6, 8, and 9 inches.

132 Expanded polystyrene

Boards should be protected while stored to avoid later creep. Expanded polystyrene has an R-value of 4 per inch.

If flammable insulation is used, see that the local building code allows its use.

14 Wind barrier

141 Nonflammable wind barrier

External retrofit insulation in walls requires a fireproof wind barrier. In Norway, however, a special 9 mm sheetrock has been designed for this purpose.

142 Burnable wind barrier

In buildings where exterior fireproofing may not be required, an external wind barrier of windproof building cardboard or 12 mm asphalt-impregnated porous wood fiber with wind protective covering can be used. New products, such as spun olefin sheeting, are also available.

15 Vapor barrier

With internal retrofit insulation, use polyethylene sheeting, a minimum of 6 mils thick, as an internal vapor barrier. The polyethylene must cover the whole wall height and be carefully installed and sealed.

16 Internal wall materials

161 Fire resistant surfaces

Internal surfaces in the building should be fire safe. Use a minimum of 5/8 inch sheetrock in most applications and defer to local fire codes.

Polystyrene insulation must always be covered by a material that is difficult to ignite and must be installed without an air gap between the insulation and the cover. The insulation must, in addition, be placed directly up against a noncombustible foundation.

162 Other kinds of coverings

Internal covering in other buildings other than those specified in .161 (e.g., small houses or cabins) may include wood panels, fiberboards or other suitable materials.

17 External coverings and claddings

171 Noncombustible covering

In a building which must be fire safe, use noncombustible covering when the building has more than four stories, when the front of the building is not accessible with the ladders that

the local fire department has, or when the ladders of the fire department are considered as one of the two demanded fire exits (building with one stairwell).

There must be a fire barrier for every fourth floor. A nonflammable covering can be plates of steel or aluminum.

172 Burnable claddings

Burnable claddings are acceptable for a fire safe building that does not meet the requirements set forth in point 171. Such claddings must be difficult to ignite.

Fire blocking must be arranged for each floor. The sectioning and construction of the facade with regard to fire blocking must be discussed with the local building authorities. Examples of claddings that are burnable but difficult to ignite and can be used in a fire safe building include artificial plates with polyester as a glue, fiberglass reinforced polyester plates, and some other plastic plates. The plates or panels must be approved.

2 EXTERNAL RETROFIT INSULATION

Table 2 shows the K values of various wall types with and without retrofit insulation.

21 Insulated framework with cladding

211 Fastening the framework to the existing wall

Fasten with expansion bolts of steel or expanding plugs of plastic or nylon. In lightweight concrete use special plugs designed for this material. Since fasteners made from different materials will have different load capabilities, the data for dimensioning should be acquired from the manufacturers. The framework must be fastened securely to prevent damage or failure. The sizing should be supplemented with simple pull tests on the actual wall.

212 Thermal insulation

Use mineral wool. It is important that the mineral wool fill the whole hollow space between the frames so it does not bulge out but is pressed against the back wall, and placed and fitted carefully.

213 Wind sealing

A wind barrier for plywood demands good framing. Recommended stud space is 2 feet (600 mm) on center. All joints must have support underneath. Plywood should be fastened to a framework of wood with 25-35 slate nails, nailed 6 inches on center (C/C150 mm). For a framework of steel profiles use self threading screws, 8 inches on center (C/C200 mm). Plates or coverings which are exposed to direct rain during construction can curl, so it is important to place the plates solidly against the nailing boards before installing the outer covering. A wind barrier of building cardboard is fastened to a framework of wood with cardboard nails or staples. For a framework of steel, the cardboard is fastened with lap boards or to the framework itself.

214 External claddings

Examples of coverings and their uses are given in point 17. For construction details, refer to the manufacturer's brochures. External covering plates should be vented to the outside.

215 Examples of construction. Figures 215 a through f show some types of insulated framework with wind barrier and supports for wall cladding.

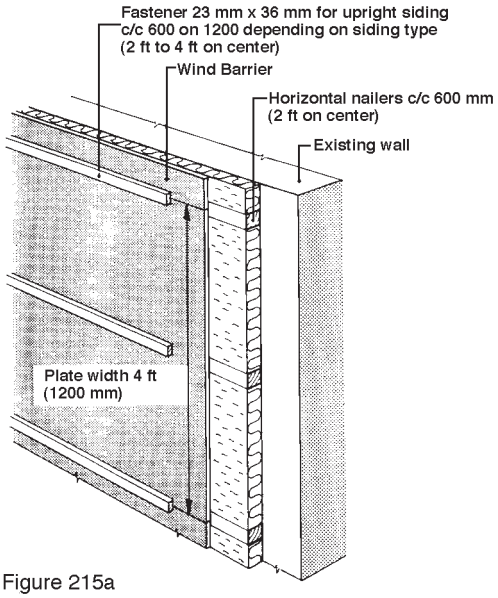

Figure 215a
External retrofit insulation with mineral wool in the space, using upright corrugated siding and wind barrier.

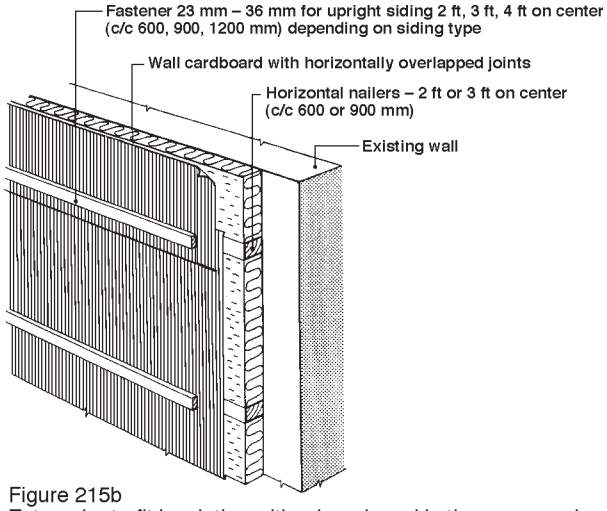

Figure 215b
External retrofit insulation with mineral wool in the space, using standing corrugated siding and cardboard wind barrier.

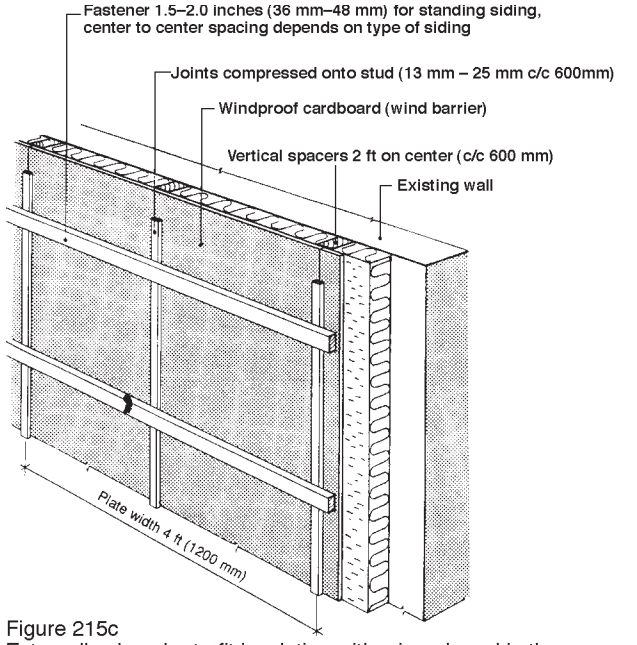

Figure 215c
Externally placed retrofit insulation with mineral wool in the space. Method used with upright plywood siding panels or where the climatic conditions place extra demands for vertical venting. Wind barrier is cardboard.

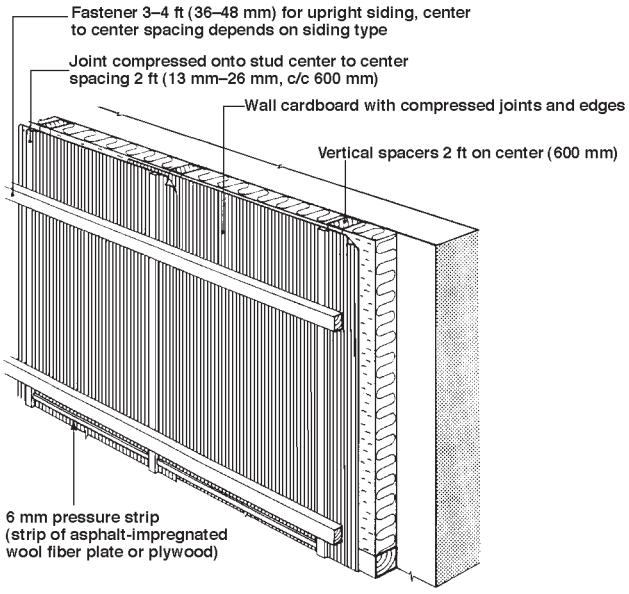

Figure 215d
External retrofit insulation with mineral wool in the space. Method used with upright plane board siding or where the climatic conditions place extra demands on vertical venting. Wind barrier is cardboard.

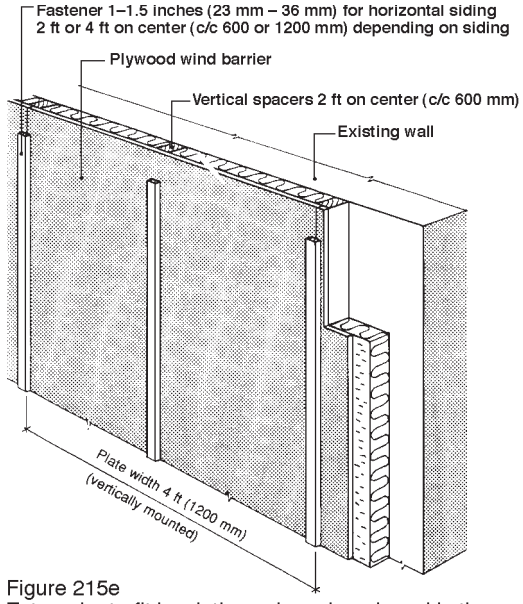

Figure 215e
External retrofit insulation using mineral wool in the space. Method used with horizontal siding or other siding that requires vertical nailers. Plywood wind barrier.

Table 2 shows K-values for various wall types with and without retrofit insulation.

22 Newer methods

Methods other than insulation with framework include brick backed mineral wool, externally plastered mineral wool, and externally plastered polystyrene.

These methods can be used when covering with panels is not aesthetically acceptable. Externally plastered installations are not as thick as other types for a given level of insulation. However, with plastered polystyrene the window frame can also, in many instances, be insulated because thicknesses down to .5 inch (20 mm) can be used. This is especially useful when the windows are being replaced. Applying plaster on the polystyrene insulation has been used in Alaska. However, the experience base is still small.

Table 2
Approximate k-values (W/m²K) for various wall types with and without add retrofit insulation.

Existing structure			Retrofit insulated structure (external or internal)						
Wall type			**Mineral wool in the space c/c 600 mm. thickness mm***			**Expanded polystyrene or mineral wool in homogeneous layer, thickness mm****			
			50	**75**	**100**	**20**	**40**	**60**	**80**
Concrete internal insulation with:									
cork	30 mm	0.93	0.45	0.36	0.30	0.63	0.48	0.39	0.33
	40 mm	0.75	0.40	0.33	0.28	0.55	0.43	0.35	0.30
	50 mm	0.63	0.36	0.31	0.26	0.48	0.39	0.33	0.28
cellulose wood concrete	50 mm	1.05	0.47	0.38	0.31	0.68	0.51	0.41	0.34
	75 mm	0.79	0.41	0.34	0.29	0.56	0.44	0.36	0.31
	100 mm	0.63	0.36	0.31	0.26	0.48	0.39	0.33	0.28
gas expanded concrete	100 mm	1.13	0.49	0.39	0.32	0.72	0.53	0.42	0.35
	125 mm	0.98	0.46	0.37	0.31	0.67	0.50	0.40	0.33
	150 mm	0.86	0.43	0.35	0.29	0.60	0.46	0.37	0.31
lightweight aggregate	100 mm	1.31	0.52	0.41	0.33	0.78	0.56	0.44	0.36
	150 mm	1.02	0.46	0.37	0.31	0.67	0.50	0.40	0.33
	200 mm	0.84	0.43	0.35	0.29	0.60	0.46	0.37	0.31
Concrete wall, externally insulated with									
gas expanded concrete	100 mm	1.23	0.51	0.40	0.33	0.76	0.55	0.43	0.36
	125 mm	1.06	0.47	0.38	0.31	0.68	0.51	0.41	0.34
	150 mm	0.93	0.45	0.36	0.30	0.63	0.48	0.39	0.33
lightweight aggregate	100 mm	1.41	0.53	0.41	0.34	0.82	0.58	0.45	0.37
	150 mm	1.10	0.48	0.38	0.32	0.70	0.52	0.41	0.34
	200 mm	0.89	0.44	0.36	0.30	0.61	0.47	0.38	0.32
Lightweight concrete made of									
gas expanded concrete	250 mm	0.64	0.37	0.31	0.27	0.48	0.39	0.33	0.28
lightweight aggregate	250 mm	0.80	0.41	0.34	0.29	0.56	0.44	0.36	0.31
Wall of concrete hollow blocks	250 mm	1.56	0.56	0.42	0.35	0.88	0.61	0.46	0.31
Masonry (brick) wall massive or with hollow spaces	1/2 brick	1.50	0.55	0.42	0.35	0.86	0.60	0.46	0.37
	1 3/4 brick	1.25	0.51	0.40	0.33	0.76	0.55	0.43	0.36
	2 brick	1.20	0.50	0.40	0.33	0.74	0.54	0.43	0.35
	2 1/4 brick	1.05	0.47	0.38	0.31	0.68	0.51	0.41	0.34
Brick wall (1 brick) inside insulation with									
gas expanded concrete	70 mm	1.10	0.48	0.38	0.32	0.70	0.52	0.41	0.34
	100 mm	0.94	0.45	0.36	0.30	0.63	0.48	0.39	0.33
	125 mm	0.83	0.43	0.35	0.29	0.58	0.45	0.37	0.31
	150 mm	0.75	0.40	0.33	0.28	0.55	0.43	0.35	0.30

The K-value for a wall with added insulation is approximately the same whether the insulation is placed on the inside or outside. Insulation applied to the inside will give a greater total heat loss because of cold bridges.

* The space obtained using steel profiles instead of wood gives an increase in K-value of approximately. 6-8% (with wood siding about 15%) i.e., it is less energy efficient to use steel profiles.

** The K-values can be used for walls which are insulated on the inside with polystyrene, covered with flame retardant material or externally insulated using newer methods with plastered polystyrene or mineral wool.

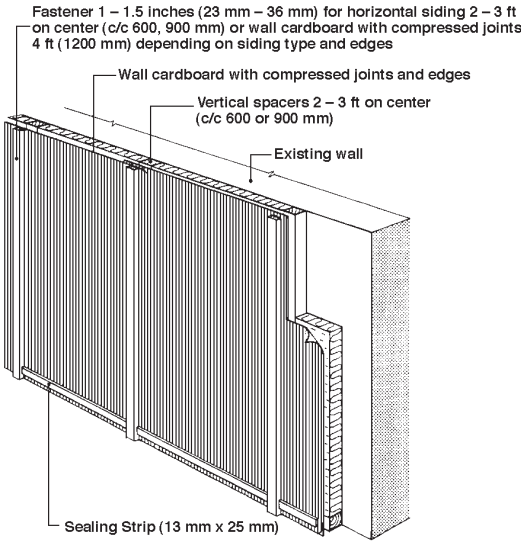

Figure 215f
External retrofit insulation using mineral wool in the space. Method used with horizontal siding or other siding that requires vertical nailers. Cardboard wind barrier.

221 Brick backed mineral wool

An external wall of mineral insulation, 2.5 inches (60 mm) thick, is constructed between the new outside wall and the existing wall (Figure 221). As a foundation for the new external wall, pour a small concrete beam against the existing foundation and anchor it to the existing foundation. It is also possible to bolt a steel beam in place as a foundation; there are special beams available for this purpose. The new brick wall must be fastened to the existing wall with anchors which are fastened with mortar in predrilled holes. Over the windows use the reinforced spans of brick or other methods for transmitting the load. Larger areas of the facade must be partitioned into vertical joints that are sealed with an elastic joint filler.

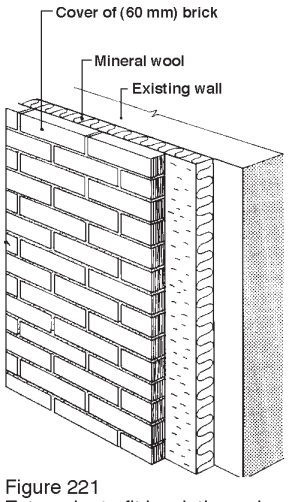

Figure 221
External retrofit insulation using mineral wool and brick siding.

222 Externally plastered mineral wool

Mineral wool boards (density 100 kg/m^3) are fastened to the existing wall. The boards are plastered with a special plaster (Figure 222a), and there are several patented systems in existence. Special fasteners are used to attach the boards to the existing wall. These fasteners are designed so that movement between the new plastering and the existing wall will not be transferred. The mineral wool boards are pushed against the existing wall so that the fasteners penetrate the board. A special plastering mesh is keyed to the fastening elements with a lock spline. A foundation is then sprayed on followed by coarse plaster, and finally a fine plaster. The total thickness is about .75 inch (20 mm).

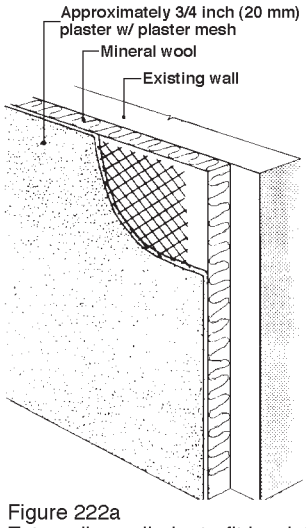

Figure 222a
Externally applied retrofit insulation with special plaster on mineral wool.

There must be vertical expansion joints on the finished surface, spaced about 15 meters apart. Special boards consisting of a layer of cellulose cement (20 mm) and a layer of mineral wool are fastened on the wall (the cellulose cement acts as a plaster reinforcement) with special fasteners and mesh using the same principle as mentioned for mineral wool boards. The boards are plastered in the traditional way. The total thickness of plaster will be about 20 - 25 mm (Figure 222b). Horizontal and vertical joints must be spaced 10 - 15 m apart.

223 Externally plastered polystyrene

This insulation system consists of a layer of fireproof expanded polystyrene which is glued onto the wall externally with a special glue cement. Necessary pretreatment of the

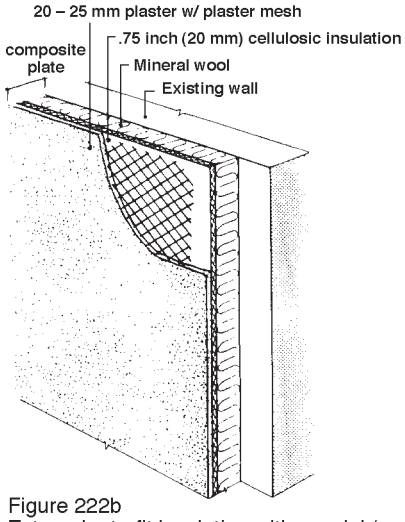

Figure 222b
External retrofit insulation with special (composite) siding plates of mineral wool and cellulose wool cement. Can be plastered in traditional manner.

wall before gluing must be determined by the provider of the insulation system. A reinforcing layer of fiberglass is glued on the other side of the boards A special plaster (akrylharts) is then applied in a layer of about 1/8 inch (3 mm) thick (Figure 223). A corresponding insulation system of extruded polystyrene, where the sheathing is mechanically fastened to the wall, is also available. This system makes it unnecessary to pretreat the original wall surface for gluing.

3 INTERNAL RETROFIT INSULATION
Table 2 shows K-values for the various wall types, with and without retrofit insulation.

31 Insulated paneling with cladding

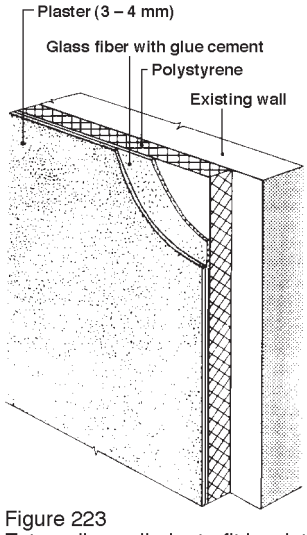

Figure 223
Externally applied retrofit insulation with boards of polystyrene and special plaster.

311 Framework
Retrofit insulation should form a smooth foundation for the cover without loosening. Use the fasteners mentioned in point 211. On a concrete wall, the framework for support can be fastened with ramset fasteners. The thickness of the frame must be the same as the thickness of the insulation. The distance between the studs must fit the dimensions of the mineral wool and the cover material which will be used.

312 Placement
The insulation must fill the whole space between the nailed studs. It should not bulge out, but be pressed against the back wall and placed with care.

313 Vapor barrier
A vapor barrier of polyethylene (visqueen), foil, or cardboard should cover the entire wall. It should be sealed against the top and bottom beams and be fastened to the studs of the internal covering. The vapor barrier must be continuous over window openings and should not be cut until the window frame pieces are installed. Vertical joints should be wrapped over the studs and sealed with "Tremco" acoustical sealant or equivalent.

314 Internal covering or paneling
Examples of coverings and their uses are given in point 16.

32 Internal insulation of expanded polystyrene
Polystyrene must only be used against a non-burnable foundation and (in Norway) is limited to certain thicknesses with a maximum thickness of 2 inches (50 mm). The polystyrene is covered directly with sheetrock and without an air space. Polystyrene is not permitted as a framing material.

4 WINDOWS

41 External retrofit insulation
Details concerning windows are shown in Figure 41a. New windows can be installed as shown in Figure 41b. See separate building details about installation of windows.

42 Internal retrofit insulation
Be careful to make sure that the vapor barrier is tightly sealed around the windows (Figure 42).

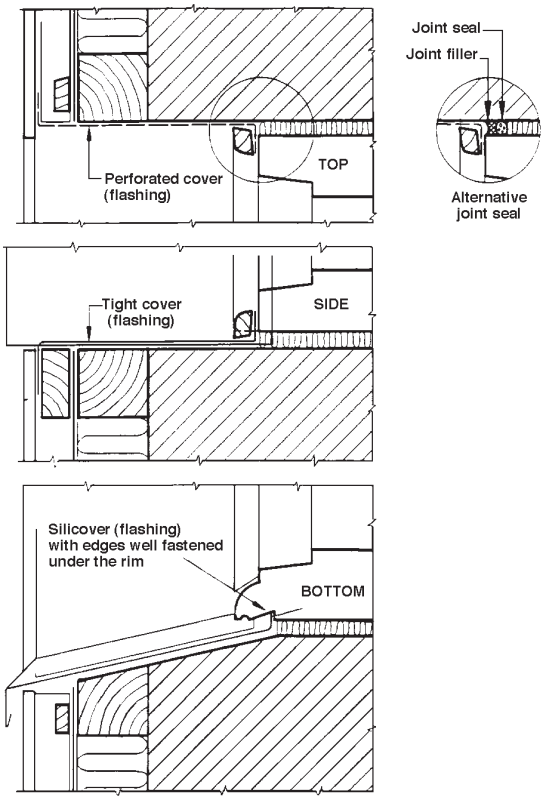

Figure 41a
Example of window details around existing window with externally applied retrofit insulation.

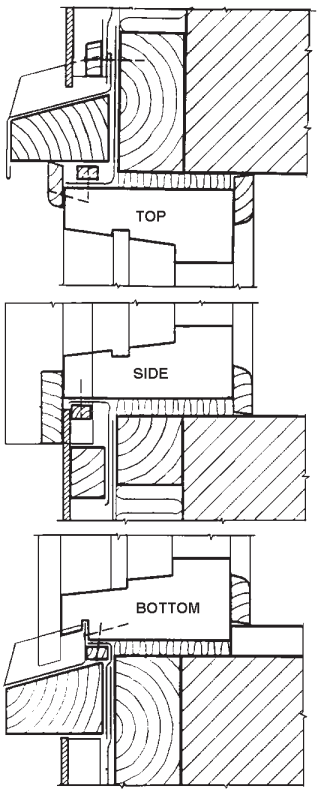

Figure 41b
Example of window details around a new window with externally applied retrofit insulation.

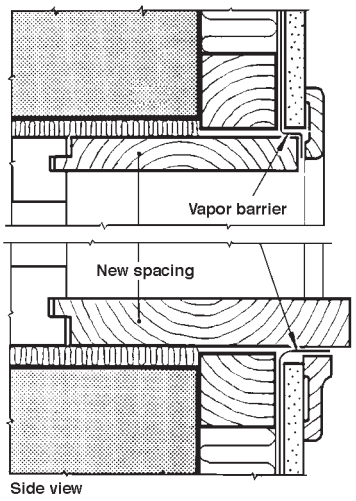

Figure 42
Example of sealing around a window with retrofit insulation applied on the inside.

5 REFERENCES

51 This bulletin was developed by Svein Erik Torgersen and edited by Knut I. Edvardsen. It replaces the bulletin with the same number published in Fall 1977. Editorial process completed August 1982.

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