#3387

# Flair Homes Project
# REPORT NO. 2
# Incremental Costs of Energy Conservation Systems

Report of the Flair Homes
EnerdemoCanada/CHBA Mark XIV Project

Cat. No. M91-11/2-2-1989E
ISBN 0-662-16643-4

January 1989

Published by the authority of the Minister of Energy, Mines and Resources Canada, Goverment of Canada

This report summarizes a research project carried out under contract to Energy, Mines and Resources Canada. It has been published in accordance with our policy of making information available to all interested groups. Publication by Energy, Mines and Resources Canada does not signify that the contents necessarily reflect the views of the department, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. Furthermore, no warranty or representation is made with respect to the accuracy or completeness of the information contained in this report. This report is reproduced here from camera ready copy prepared by the contractor.

For more information on this report or to obtain additional copies write to:

Energy, Mines and Resources Canada
Residential Energy Management Division
Ottawa, Ontario
KIA OE4

This report was prepared by:

G. Proskiw, P.Eng., and
J. Beckman
Unies Limited
1666 Dublin Avenue
Winnipeg, Manitoba
R3H OH1

Printed in Canada

# INCREMENTAL COSTS

# OF

# ENERGY CONSERVATION SYSTEMS

PART OF THE

FLAIR HOMES ENERGY DEMO/CHBA FLAIR MARK XIV PROJECT

BY

G. PROSKIW, P.ENG.

UNIES Ltd.

JUNE, 1988

SUMMARY

The incremental costs of various residential energy conservation systems were analyzed and documented based on data obtained from the construction of 20 houses in the Flair Homes Energy Demo/Canadian Home Builders' Association Flair Mark XIV Project in Winnipeg. The energy conservation systems included building envelope and mechanical system components including many commonly used in R-2000 construction. Cost estimates were developed using a conventional 97 m² (1040 ft²) bungalow with a full basement as a reference structure. The builder was assumed to be a tract builder experienced in energy efficient construction. Incremental costs were defined as direct costs which the builder would incur beyond those normally encountered using conventional practices. No provisions were made for overhead, profit or learning time.

Three types of wall systems were studied: single stud framing, single stud framing with exterior insulated sheathing, and double wall construction. Insulation values ranged from RSI 3.43 to RSI 7.04 (R-19.5 to R-40.0). Incremental costs were determined for each wall system relative to both 38x89 (2x4) and 38x140 (2x6) framed walls. Thirteen basement insulation systems were studied including interior, exterior and sub-slab insulation techniques. Eight ceiling insulation levels were costed, ranging from RSI 7.93 to RSI 10.57 (R-45.0 to R-60.0).

Airtightness sealing costs were determined by defining 22 "airtightness components" for specific building envelope elements. These were assembled in different combinations to form complete "airtightness systems" ranging from a well-sealed polyethylene air/vapour barrier to the Airtight Drywall Approach.

Eleven "ventilation system components" were defined ranging from a simple fresh air intake to Heat Recovery Ventilators. Individual components were combined into eight "ventilation systems" and their incremental costs estimated. Costs of heating systems were calculated relative to a conventional naturally aspirated gas furnace with a seasonal efficiency of 60%. Five systems using either natural gas or electricity were analyzed plus ductwork and air conditioning options. Two integrated heating, ventilation and hot water heating systems were also studied.

Based on the results of the study, recommendations were developed for priorizing energy conservation system options in R-2000 housing using their relative cost effectiveness to rank the options.

## RÉSUMÉ

Les coûts supplémentaires de différents systèmes d'économie d'énergie ont été analysés et documentés à partir de mesures prises dans 20 maisons construites à Winnipeg dans le cadre du projet Flair Mark XIV de Flair Homes Energy Demo et de l'Association canadienne des constructeurs d'habitations. Les systèmes d'économie d'énergie comprenaient des installations mécaniques et des enveloppes de bâtiment, y compris de nombreuses constructions de type R-2000, très courantes. Les coûts ont été estimés pour un bungalow traditionnel type de 97 $m^2$ (1 040 $pi^2$) avec un sous-sol complet. On a posé comme hypothèse que le constructeur était un entrepreneur expérimenté dans la construction à haut rendement énergétique. Les coûts supplémentaires ont été définis comme étant les coûts directs encourus par l'entrepreneur en plus de ceux associés à des pratiques de construction traditionnelles. Aucun montant n'a été alloué pour les frais généraux, les profits ni pour le temps d'apprentissage.

Trois types de constructions de murs ont été analysés : à ossature de poteaux simple, à ossature de poteaux simple avec revêtement extérieur isolé et la construction à doubles murs. Les valeurs d'isolation se situaient entre RSI 3.43 et RSI 7.04 (R-19.5 et R-40.0). Les coûts supplémentaires ont été déterminés pour chaque système de construction de mur avec une ossature de poteaux de 38 x 89 (2 x 4) et avec des poteaux de 38 x 140 (2 x 6). Treize méthodes d'isolation du sous-sol ont été analysées, y compris l'isolation à l'intérieur, à l'extérieur et sous la dalle. On a déterminé les coûts correspondant à huit niveaux d'isolation de plafond, de RSI 7.93 à RSI 10.57 (de R-45.0 à R-60.0).

Le coût de l'étanchéité à l'air a été évalué grâce à la définition de 22 "éléments d'étanchéité à l'air" correspondant à des éléments précis de l'enveloppe des bâtiments. Ces éléments ont été rassemblés en différentes combinaisons pour former des "systèmes d'étanchéité à l'air" complets allant du pare-air-vapeur de polyéthylène bien scellé jusqu'à la cloison sèche étanche à l'air.

Onze "éléments de système de ventilation", allant de la simple prise d'air frais jusqu'aux ventilateurs récupérateurs de chaleur, ont été définis. Ces différents éléments ont été combinés en huit "systèmes de ventilation", dont les coûts supplémentaires ont été évalués. Les coûts des systèmes de chauffage ont été calculés comparativement à ceux d'un générateur d'air chaud

conventionnel, à tirage naturel, ayant un rendement saisonnier de 60%. Cinq systèmes utilisant soit le gaz naturel soit l'électricité ont été analysés ainsi que leurs conduits et les possibilités de climatisation. Deux systèmes intégrant le chauffage, la ventilation et le chauffage de l'eau sanitaire ont aussi été étudiés.

D'après les résultats de cette analyse, des recommandations ont été faites dans le but d'établir un classement parmi les systèmes d'économie d'énergie des maisons R-2000 en fonction de leur rentabilité relative.

ACKNOWLEDGEMENTS

The author(s) wish to express their appreciation and thanks to the members of the project's National Steering Committee, Technical Advisory Committee and resource individuals, who provided invaluable direction, review and advice in the design of the project and the preparation of this report.

National Steering Committee

Mr. W. Bryant of Energy, Mines and Resources Canada (Chairman)
Dr. J. Kenward of the Canadian Home Builders Association
Mr. W. McDonald of Manitoba Energy and Mines

Technical Advisory Committee

Mr. M. Riley of Energy, Mines and Resources Canada (Chairman)
Mr. T. Akerstream of Manitoba Energy and Mines
Mr. G. Barthels of the R-2000 Program of Manitoba (to 1988)
Mr. R. Cardinal of Dow Chemical Inc.
Mr. J. Dewil of Fiberglas Canada Inc.
Mr. D. Figley of the National Research Council
Mr. D. Geddes of the Heating, Refrigerating and Air Conditioning Institute (to 1987)
Mr. D. Goodman of Greentree Homes Ltd.
Mr. W. Heeley of the Heating, Refrigerating and Air Conditioning Institute
Mr. T. Mayo of Energy, Mines and Resources Canada
Mr. J. Méranger of Health and Welfare Canada
Mr. L. Nakatsui of the Residential Construction Group Inc.
Mr. P. Piersol of Ortech International
Mr. T. Robinson of Canada Mortgage and Housing Corporation
Dr. J. Timusk of the University of Toronto

Resource Individuals

Mr. O. Drerup of the Canadian Home Builders Association
Mr. T. Hamlin of Energy, Mines and Resources Canada
Mr. B. Maybank of Flair Homes (Manitoba) Ltd.
Mr. N. Shymko of Today Homes (East) Ltd.
Mr. R. Slasor of Energy, Mines and Resources Canada
Mr. B. Sloat of the Canadian Home Builders Association
Mr. D. Verville of Today Homes (East) Ltd.

TABLE OF CONTENTS

TABLE OF CONTENTS (con't)

TABLE OF CONTENTS (con't)

## SECTION 1

## INTRODUCTION

### 1.1 BACKGROUND

The Canadian home building industry's trend toward improved standards for energy conservation has produced an abundance of design options for new construction. Until a few years ago, builders had little doubt how to design the non-architectural components of a house; today numerous alternatives are available for each component. For example, virtually all exterior walls used to be constructed with 38x89 (2x4) framing and RSI 2.11 (R-12.0) insulation plus any one of several exterior cladding systems. Today, the basic wall design is still employed although, in many areas, it uses 38x140 (2x6) construction with RSI 3.52 (R-20.0) insulation. Other systems also becoming common include frame walls with exterior insulated sheathing, interior strapped walls and double walls. Mechanical system options have also increased, particularly those dealing with ventilation. A "ventilation system" was once assumed to mean a simple bathroom (and perhaps kitchen) exhaust fan, whereas now there are central exhaust systems, Heat Recovery Ventilators and integrated systems in which the ventilation, hot water and space heating functions are performed by one appliance. What, then, are the implications to the builder?

On the positive side, increased numbers of options mean increased flexibility in design and an enhanced ability to tailor the house to the marketplace. On the negative side, more options mean more decisions have to be made in the design phase, and new construction techniques have to be learned and applied on the job site.

Although factors such as marketability and availability of products and services play an obvious role in the selection of energy conservation options, the two major technical factors are cost and performance. The first issue, cost, is the subject of this report.

## 1.2 THE FLAIR HOMES ENERGY DEMO/CHBA FLAIR MARK XIV PROJECT

The Flair Homes Energy Demo/CHBA Flair Mark XIV Project is a demonstration with three objectives:

1. To demonstrate and evaluate the performance of various low energy building envelope systems.
2. To demonstrate and evaluate the performance of various residential mechanical systems with particular emphasis on ventilation systems.
3. To transfer the knowledge gained in the project to the Canadian home building industry.

In addition, the project is structured to support the R-2000 Home Program funded by Energy, Mines and Resources Canada and administered by the Canadian Home Builders Association. The project acquired the Mark XIV designation when a substantial portion of the research priorities identified by the Technical Research Committee of the CHBA in 1983/84 was incorporated into the project.

Support for the project has been provided by Energy, Mines and Resources Canada under the Energy Demo Program and by Manitoba Energy & Mines under the Manitoba/Canada Conservation and Renewable Energy Demonstration Agreement (CREDA). Project management is the responsibility of Flair Homes (Manitoba) Ltd. Monitoring of the project houses is the responsibility of UNIES Ltd. and will continue until the spring of 1989.

To meet the project objectives, 20 houses employing various envelope and mechanical systems were constructed in 1985 and 1986 in the Genstar Development Co. Lakeside Meadows subdivision of Winnipeg. The houses were built by Flair Homes (Manitoba) Ltd. using two of their standard floor plans. The houses are divided into 10 pairs, with each pair having a different combination of envelope and mechanical systems. Conservation levels range from those of conventional houses to those which meet or exceed the R-2000 Standard. A summary description of the project houses is shown in Table 1.

## 1.3 OBJECTIVE

This report was prepared to document, on a consistent, comparative basis, the incremental costs of the various energy conservation systems demonstrated in the Flair Homes Energy Demo/CHBA Flair Mark XIV Project.

TABLE 1
SUMMARY OF PROJECT HOUSES

| HOUSE NO. | BUILDING ENVELOPE: WALL CONSTRUCTION | BUILDING ENVELOPE: AIR/VAPOUR BARRIER | BUILDING ENVELOPE: BASEMENT INSULATION | BUILDING ENVELOPE: ATTIC INSULATION | MECHANICAL SYSTEMS: SPACE HEATING | MECHANICAL SYSTEMS: DHW HEATING | MECHANICAL SYSTEMS: VENTILATION SYSTEM | MECHANICAL SYSTEMS: VENT. DIST-RIBUTION SYSTEM |
|---|---|---|---|---|---|---|---|---|
| 1,2 | 38x140 (2x6), 38 mm (1½") Glasclad Insulated Sheathing c/w Tyvek Air Retarder (Reversed) | ADA, Paint Vapour Barrier | Interior Batts/Framing | Cellulose Fibre | Forced Air Electric Furnace | Electric Tank | HRV | Indirect Connection to Forced Air Heating System |
| 3,4 | 38x140 (2x6), 38 mm (1½") Glasclad Insulated Sheathing c/w Tyvek Air Retarder (Reversed) | ADA, Paint Vapour Barrier | Interior Batts/Framing | Cellulose Fibre | Forced Air Electric Furnace | Electric Tank | HRV | Indirect Connection to Forced Air Heating System |
| 5,6 | 38x140 (2x6), 38 mm (1½") Glasclad Insulated Sheathing c/w Tyvek Air Retarder (Reversed) | ADA, Paint Vapour Barrier | Interior Batts/Framing | Cellulose Fibre | Forced Air Electric Furnace | Electric Tank | HRV | Indirect Connection to Forced Air Heating System |
| 7,8 | 38x140 (2x6) | ADA, Paint Vapour Barrier | Interior Batts/Framing | Cellulose Fibre | Forced Air Electric Furnace | Electric Tank | Central Exhaust | Fresh Air Intake to Return Air Plenum of Furnace |
| 9,10 | 38x140 (2x6) | 6 mil Poly | Interior Batts/Framing | Cellulose Fibre | Forced Air Naturally Aspirated, Gas Furnace | Gas Tank | Bathroom Exhaust Fan | None |
| 11,12 | 38x140 (2x6), 51 mm (2") Glasclad Insulated Sheating c/w Tyvek Air Retarder (Taped) | ADA Limited Gaskets, Paint Vapour Barrier | 76mm (3") Exterior Baseclad and 25mm (1") Glasclad Underslab | Blown Fiberglass | Electric Baseboards and Heat Pump | Heat Pump, Int. with Vent. System | Exhaust-only Heat Pump Int. with Space and DHW Systems | Envelope Leakage and Exhaust Vent. Heat Recovery |
| 13,14 | 38x140 (2x6), 51 mm (2") Glasclad Insulated Sheating c/w Tyvek Air Retarder (Taped) | ADA Limited Gaskets, Paint Vapour Barrier | Interior Batts/Framing | Blown Fiberglass | Forced Air Electric Furnace | Electric Tank | HRV | Envelope Leakage and Unbalanced Heat Recovery Ventilator |
| 15,16 | Double Wall | 6 mil Poly | Interior Batts/Framing | Cellulose Fibre | Air-to-Air Heat Pump Int. with Vent. and DHW Systems | 2 Tank System Int. with Space Heating and Vent. Systems | A/A Heat Pump Int. with Forced Air Heating System | Combined Forced Air Heating and Ventilation System |
| 17,18 | Double Wall | 6 mil Poly | Interior Batts/Framing | Cellulose Fibre | Electric Baseboards | Electric Tank | A/A Heat Pump HRV and Duct Heater | Dedicated Supply-only Ventilation System |
| 19,20 | 38x89 (2x4), 51 mm (2") SM Insulated Sheathing | ADA, Paint Vapour Barrier | 51mm (2") Exterior SM and Interior Batts/Framing | Cellulose Fibre | Electric Baseboards | Electric Tank | HRV | Dedicated Supply-only Ventilation System |

LEGEND

| | | | | | |
|---|---|---|---|---|---|
| Int. | - Integrated | Vent. | - Ventilation | HRV | - Heat Recovery Ventilator |
| c/w | - Complete With | DHW | - Domestic Hot Water | | |
| ADA | - Airtight Drywall Approach | A/A | - Air to Air | | |

## SECTION 2

## REVIEW OF PREVIOUS COSTING STUDIES

### 2.1 PREVIOUS STUDIES

Several studies have addressed the issue of incremental costs of residential energy conservation systems. To be useful to this report, it was recognized that such studies must a) have been relatively recent so that cost data was current and b) have considered the types of systems demonstrated in the Flair Homes Energy Demo/CHBA Flair Mark XIV Project. Although no previous works precisely met these requirements, four did provide useful background information:

Ref. 1 - Draft "Incremental Construction Cost Analysis of R-2000 Homes Built in 1983", M. Lubun & Associates, 1986.
This study documented the incremental energy conservation costs of 266 R-2000 houses constructed in 1983. Data was drawn from reports which each builder submitted after the house had been completed.

Ref. 2 - Draft "Cost Effectiveness Study of R-2000 Homes Built in 1983", M. Lubun & Associates, 1986.
This study used the results of Ref. 1 to derive average cost figures which were in turn applied using a discounted payback analysis and a principal, interest, taxes and energy (PITE) analysis to assess the cost effectiveness of the various conservation options.

Ref. 3 - "Incremental Cost Analysis of R-2000 Homes", Bureau of Management Consulting, 1986.
This report summarized a study conducted in late 1986 in which 22 R-2000 builders from across Canada were interviewed to determine their incremental costs to build two standard houses to the R-2000 energy target versus their conventional style of construction and the 1983 "Measures for Energy Conservation".

Ref. 4 - "The True Cost of Energy Conservation", Progressive Builder, August 1986.
A study which looked at incremental costs in the U.S. Pacific Northwest, this investigation provided some useful information, particularly since it was aimed at a builder audience.

## 2.2 REVIEW

The four documents offered some useful insights in the development of a methodology for this study:

1. Wide variations in the reported incremental costs of various systems suggested that builder experience with the systems was a major factor in their estimation of costs. For example, Ref. 3 asked builders to estimate the cost of upgrading envelope airtightness for a standard, defined house design. Builders responded with a range of $156 to $1050 for a simple bungalow and $0 to $2075 for a 2 storey design. Such results suggest that builders may have been more influenced by their own experience with a system than its actual cost. While experience plays a role in determining costs, it became evident that this study had to assume a common experience level.

2. It is difficult to assess incremental costs with the same confidence that one can establish when, for example, measuring energy consumption. A construction site is a dynamic environment and unlike that of even a factory, it is often difficult to assess the cost of a small design change. In particular, labour costs are often difficult to determine accurately if changes affect more than one subtrade.

3. The inclusion of "overhead" costs tends to confuse reported results since builders appear to have different opinions as to what constitutes overhead. Administration, taxes, rent, profit, supervision, insurance, interest charges, learning costs, etc. are all possible components.

4. Most houses, including those constructed by R-2000 builders, are not optimized with respect to the R-2000 energy target or other energy standards. Therefore, by reporting total package costs rather than component costs, one may include unnecessary expenses due to "over-design".

5. Finally, one must admit that the "complete" cost study will never exist. Differences in cost caused by variations in house design, local material and labour charges, inflation, quality of construction, size of business, experience, and market preferences will make any study incomplete and, in time, dated.

# SECTION 3

# DEVELOPMENT OF COST DATA

## 3.1 PROCEDURE

Following review of the background studies, a procedure was developed for reporting costing data generated from this project. After construction of the 20 project houses, a list was assembled of the various energy conservation systems which had been demonstrated. To this total, several more were added which, it was felt, could be costed with reasonable confidence because they represented modifications of demonstrated systems or were supplied by a single subtrade willing to provide estimates.

Costs were developed and reported on a "system" basis with a system defined as a single conservation measure applicable to one part of the house. Typical systems included: an upgraded wall, underslab insulation and a high efficiency heating system. Each system was then analyzed by breaking it into component steps which described the additional and (any) deleted material and labour requirements relative to a conventional house. For example, a main wall system which used 38x140 (2x6) framing with 25 mm (1") rigid exterior, insulated sheathing required: additional studs, corner bracing, insulated sheathing, tape and longer fasteners. However, the system eliminated the need for the conventional fibreboard sheathing and building paper.

Material costs were determined using supplier prices with allowances for wastage. Labour costs were estimated in discussion with the builder and sub-trades.

A typical project house, #12, was then selected and each of the systems costed with respect to this structure. House #12 is shown in Figure 1.

## 3.2 FACTORS AFFECTING COSTS

Several factors affect system costs and these will, of course, vary. To give the reader an overview of the assumptions used to calculate costs in this study, the following description is provided.

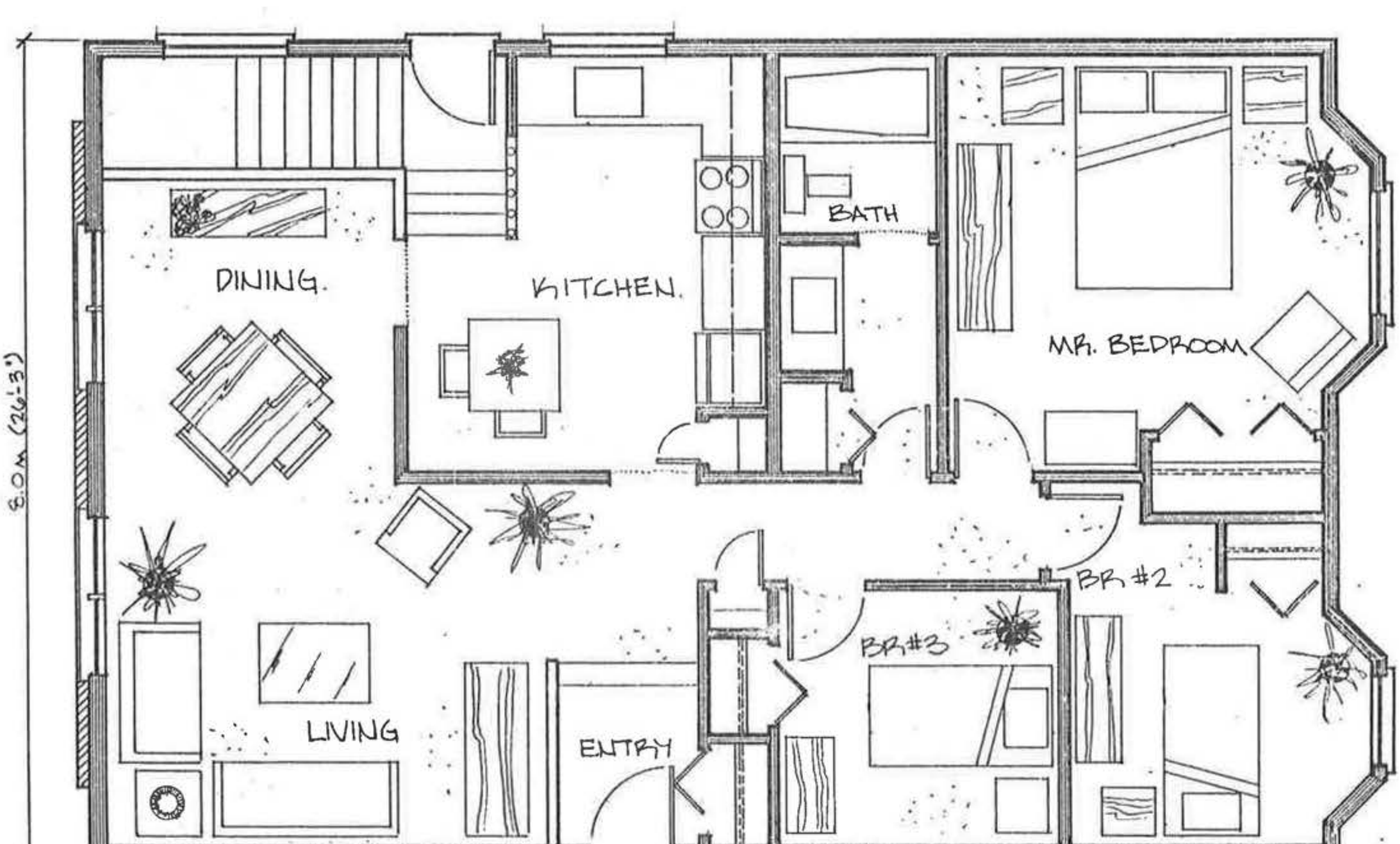

DINING.
KITCHEN.
BATH
MR. BEDROOM
BR #2
BR#3
LIVING
ENTRY
8.0 M (26'-3")
12.27 m (40'-3")

FIGURE 1

Builder Profile - Flair Homes (Manitoba) Ltd. is a large tract builder which produces 500 to 600 houses per year in the Winnipeg market. Their size of operation provides them with purchasing power for goods and services. They have been marketing energy efficient houses since 1980 and were the first tract builder in Canada to offer a well-sealed double wall house as an option. One of their most successful markets has been in the construction of affordable housing. All work is supplied by subtrades with the builder responsible for site supervision.

Experience and Productivity - For this study, all costs were calculated with no allowance for learning time. Each system was costed assuming that subtrades and supervisors were familiar with the system. Worker productivity was assumed to be equivalent to normal levels for a tract builder.

House Type - All systems were costed for Project House #12. This was a 97 $m^2$ (1040 $ft^2$) bungalow with a full-depth cast-in-place concrete foundation.

House Location - Winnipeg

Material Costs - Material costs were provided by Flair's normal suppliers and were effective as of the spring of 1987. Material costs were defined as those charged to the builder. Sample material prices are shown in Table 2.

Labour Costs - Labour costs were estimated in consultation with the builder's Site Supervisor and subtrades. Note that subtrades often bid on a task basis without breakdowns between labour and materials and no disclosure of hourly rates. In these cases, estimates were made of the effective, average labour rates for the various subtrades. These are also summarized in Table 2.

Provincial Sales Tax - None included.

Overhead and Profit - None included.

In summary, all incremental system costs shown in this report were determined for a 97$m^2$ (1040$ft^2$) bungalow constructed in Winnipeg by a tract builder using experienced and efficient subtrades and supervisors with minimal disruption between subtrades and with no provision for builder overhead or profit. Incremental system costs were defined as those which the builder would pay. Costs to the consumer would be increased by a factor for overhead and profit.

Data from this report can be applied to other house types and sizes, locations, builders, etc. with appropriate modification to reflect local conditions.

TABLE 2

SAMPLE MATERIAL COSTS AND LABOUR RATES

MATERIALS

| | |
|---|---|
| o 38x140 (2x6) #2 or better kiln-dried spruce | \$348.00/1000 board feet |
| o 16 mm (5/8") fibreboard sheathing | \$2.84/m² (26.4 ¢/ft²) |
| o Batt insulation | \$1.22/m² RSI (2.00 ¢/ft²·R) |
| o 51 mm (2") Glasclad insulated sheathing c/w Tyvek air barrier | \$7.51/m² (69.8 ¢/ft²) |
| o 51 mm (2") SM insulated sheathing | \$9.29/m² (86.3 ¢/ft²) |
| o 6 mil polyethylene | \$26.4 ¢/m² (2.45 ¢/ft²) |
| o Acoustical sealant (900 ml tube) | \$4.98/tube |

LABOUR RATES

| | |
|---|---|
| Framers | \$15.00/hour |
| Drywallers/Insulators | \$12.00/hour |
| Painters | \$15.00/hour |
| Electricians | \$17.50/hour |
| Sheet Metal Installers | \$15.00/hour |

## 3.3 SYSTEM DATA SHEETS

Each system analyzed was summarized on an individual Data Sheet, the set of which are contained in the Appendix. Each provides the following information:

| | |
|---|---|
| Gross Cost: | The total estimated incremental system cost resulting from the additional steps required by the system. |
| Savings: | The savings resulting from any deleted steps. |
| Net Cost: | The estimated incremental cost of the system to the builder relative to conventional practice (gross cost minus savings). |
| Net Unit Incremental Cost: | Net cost divided by the area of the component which has been upgraded (building envelope components only). |
| Cost Performance Index (CPI): | A benefit/cost parameter used to express and rank the cost effectiveness of envelope systems relative to conventional practice, as described below. |

Values for the thermal resistance of envelope components were calculated using nominal RSI-values to be consistent with the practice of the R-2000 Home Program.

## 3.4 COST PERFORMANCE INDEX

The CPI (Cost Performance Index) is a benefit/cost parameter developed for this study which describes the cost effectiveness of insulation systems. The larger the CPI, the greater the cost effectiveness. It is not applicable to airtightness or mechanical systems.

The "benefit" due to adding insulation, beyond that normally used in a conventional design, can be expressed as . . .

$$K\left(\frac{1}{RSI_{conv.}} - \frac{1}{RSI_{upgraded}}\right)$$

where "K" is a constant which accounts for the area of the component, climate, fuel cost and heating plant efficiency. For a given house in a given location, K will not change and can therefore be removed from the definition since the CPI is intended to be a comparative indicator with no physical significance. The "cost" of the system is simply the Net Unit

Incremental Cost for the component under consideration, as defined in this study. For convenience, the dividend shown above is multipled by 1000. Thus the CPI is defined as . . .

$$\text{CPI} = \frac{1000\left(\frac{1}{\text{RSI}_{\text{conv.}}} - \frac{1}{\text{RSI}_{\text{upgraded}}}\right)}{\text{Net Unit Incremental Cost}}$$

Example: Calculate the CPI of upgrading a conventional 38x89 (2x4) wall to a 38x140 wall (2x6) @ 400 mm (16") with 51 mm (2") of extruded polystyrene sheathing (this is wall system W-2(1)).

From the System Data Sheet for W-2(1), the Net Unit Incremental Cost is $14.96 per square meter of wall area and the nominal RSI values for the conventional and upgraded walls are 2.11 and 5.28 respectively. The CPI is thus . . .

$$= \frac{1000\left(\frac{1}{2.11} - \frac{1}{5.28}\right)}{14.96}$$

$$= 19$$

Since the heat loss from below-grade components will be affected by the surrounding soil (which is not accounted for in calculation of the CPI), comparisons of CPI values for different envelope components should be restricted to those with the same heat transfer characteristics. Thus, CPI values for above grade walls and ceilings can be compared directly while values for basement walls can only be compared to those of other basement walls. Similarly, CPI values for different basement slab insulation systems should only be compared to other slab systems.

## 3.5 CONTROLLING THE COST OF DESIGN CHANGES

All of the costs were calculated assuming ideal circumstances to provide a better assessment of the capabilities of each system. No allowances were made for learning time, errors, design changes or any of the many other inevitable factors which crop up when a new system is first tried. Therefore, it is worthwhile to add a few notes on controlling the cost of design changes.

### 3.5.1 The Cost of Learning

The additional time required to learn a new system will obviously vary with the complexity of the system, worker experience and the magnitude of the changes from conventional practice. To provide an example of the "learning curve", the Head Framer for several of the Project Houses was asked to assess the additional time requirements . . .

Additional time requirements (beyond the incremental production time):

First house - 25% to 35%
Second house - 10% to 20%
Third house - approaching zero

Thus, if a new system, once fully learned, took an additional 10 hours beyond conventional practice, the first house would require an incremental time of 12.5 to 13.5 hours to incorporate the system while the second house would have required 11 to 12 hours.

### 3.5.2 The Cost of Change

"Change" is in itself an added cost. The study estimated incremental costs for a number of energy conservation systems on the assumption of high worker productivity with insignificant learning time requirements. Tract builders typically operate in this manner provided no substantial changes are made from house to house. Changes which are incorporated often prove difficult and expensive to implement because of the scale of operation and the degree of specialization. Changes have to be transmitted from the design office to the Area Manager to the Site Supervisor to the appropriate subtrade(s) and suppliers and then subsequently inspected by the Site Supervisor to verify compliance. One comment was ruefully made that the effect of eliminating a single minor component (say the building paper on exterior walls) would increase the construction cost since the additional time to transmit the change and supervise its implementation would cost more than the savings resulting from the reduced labour and material requirements. For a tract builder, the most efficient way to operate is to minimize the variations from house to house. Once a "package" has been designed (incorporating any number of the systems discussed herein), it is desirable to hold it as constant as possible.

The situation is somewhat different for custom builders. Since the Designer, Area Manager and Site Supervisor may well be the same individual and fewer crews are used for a given subtrade, changes can be implemented somewhat easier.

Changes represent major disruptions to the normal process of designing and building a house. In particular, major costs can result if significant re-scheduling between subtrades is required (which drives up both direct and overhead costs) or if significant changes from normal materials orders are required (which may result in mistakes and higher overhead costs).

### 3.5.3 The Cost of Maintaining Efficiency

Another factor found to impact costs was the availability of experienced subtrades able to maintain their proficiency with a new system(s). Once a new system has been learned, the subtrade can operate on a production basis, that is, at minimal incremental cost. Unfortunately, the system may be offered as an option and only occasionally selected by homebuyers. As a result the subtrade may have few opportunities to "build" the system and therefore may be constantly relearning it. Conversely, larger subtrade firms may use one or two experienced crews for all orders for the system but be forced to move the crew over a large geographic area rather than the one subdivision in which they normally work. This is particularly relevant to some mechanical components, such as integrated systems, which require specially trained installers.

SECTION 4

# WALLS

## 4.1 CONVENTIONAL PRACTICE

The majority of detached and semi-detached Canadian housing uses wood frame construction. In eastern Canada and the west coast, 38x89 (2x4) framing with RSI 2.11 (R-12.0) insulation is the most common system while in Manitoba, Saskatchewan, Alberta and the north, 38x140 (2x6) construction with RSI 3.52 (R-20.0) insulation has become the norm in recent years.

## 4.2 SYSTEM OPTIONS ANALYZED

Three types of wall systems with several subtypes were analyzed. These are summarized along with their nominal thermal resistance values in Table 3. System W-1 represents the wide stud wall using 38x140 (2x6) framing. Systems W-2(a) to W-2(o) use rigid glass fibre insulated sheathing (Fibreglas Canada "Glasclad") or extruded polystyrene sheathing (Dow "SM"), with 400mm (16") or 600mm (24") stud spacing and 38x89 (2x4) or 38x140 (2x6) studs. System W-3 represents a 300mm (12") double wall.

## 4.3 CHANGES FROM CONVENTIONAL PRACTICE

Since there are effectively two "conventional" wall systems used in Canada, comparisons were made between both of these and each of the wall systems analyzed. The list of required changes for each conventional system is summarized on its data sheet.

4.3.1 Thicker Stud - The 38x89 (2x4) studs are replaced with 38x140 (2x6) studs, the RSI 2.11 (R-12.0) glass fibre batts are replaced with RSI 3.52 (R-20.0) batts and jamb extensions are added to doors and windows.

4.3.2 Single Stud Walls with Exterior Insulated Sheathing - The major change is the use of the insulated sheathing, generally in place of the conventional structural sheathing. To provide the necessary lateral support to the wall, corner bracing is also added. Framing at corners has

TABLE 3
WALL SYSTEMS

| SYSTEM | NOMINAL THERMAL RESISTANCE (RSI) | (R) | CONVENTIONAL: 38x89 (2x4) NUIC ($/m²) | ($/ft²) | CPI | CONVENTIONAL: 38x140 (2x6) NUIC ($/m²) | ($/ft²) | CPI |
|---|---|---|---|---|---|---|---|---|
| W-1 38x140 (2x6) @ 600mm (24") with 16mm (5/8") fibreboard sheathing | 3.52 | 20.0 | 4.01 | 0.37 | 47 | | | |
| W-2(a) 38x140 (2x6) @ 400mm (16") with 25mm (1") exterior Glasclad insulated sheathing c/w taped Tyvek air barrier, corner bracing | 4.30 | 24.4 | 8.39 | 0.78 | 29 | 4.73 | 0.44 | 11 |
| W-2(b) 38x140 (2x6) @ 400mm (16") with 38mm (1 1/2") exterior Glasclad insulated sheathing c/w taped Tyvek air barrier, corner bracing | 4.70 | 26.7 | 11.62 | 1.08 | 22 | 7.96 | 0.74 | 9 |
| W-2(c) 38x140 (2x6) @ 400mm (16") with 51mm (2") exterior Glasclad insulated sheathing c/w taped Tyvek air barrier, corner bracing | 5.07 | 28.8 | 13.88 | 1.29 | 20 | 10.22 | 0.95 | 8 |
| W-2(d) 38x140 (2x6) @ 400mm (16") with 25mm (1") exterior Glasclad insulated sheathing c/w Tyvek air barrier (reversed, joints not taped), corner bracing | 4.30 | 24.4 | 7.75 | 0.72 | 31 | 4.09 | 0.38 | 13 |
| W-2(e) 38x140 (2x6) @ 400mm (16") with 38mm (1 1/2") exterior Glasclad insulated sheathing c/w Tyvek air barrier (reversed, joints not taped), corner bracing | 4.70 | 26.7 | 11.19 | 1.04 | 23 | 7.42 | 0.69 | 10 |
| W-2(f) 38x140 (2x6) @ 400mm (16") with 51mm (2") exterior Glasclad insulated sheathing c/w Tyvek air barrier (reversed, joints not taped) | 5.07 | 28.8 | 13.45 | 1.25 | 21 | 9.79 | 0.91 | 9 |
| W-2(g) 38x89 (2x4) @ 400mm (16") with 38mm (1 1/2") exterior SM insulated sheathing, corner bracing | 3.43 | 19.5 | 8.39 | 0.78 | 22 | 4.73 | 0.44 | -2 |
| W-2(h) 38x89 (2x4) @ 400mm (16") with 51mm (2") exterior SM insulated sheathing, corner bracing | 3.87 | 22.0 | 10.65 | 0.99 | 20 | 6.89 | 0.64 | 4 |

TABLE 3 (con't)

| SYSTEM | NOMINAL THERMAL RESISTANCE (RSI) | (R) | CONVENTIONAL: 38x89 (2x4) NUIC ($/m²) | ($/ft²) | CPI | CONVENTIONAL: 38x140 (2x6) NUIC ($/m²) | ($/ft²) | CPI |
|---|---|---|---|---|---|---|---|---|
| W-2(i) 38x89 (2x4) @ 600mm (24") with 38mm (1 1/2") exterior SM insulated sheathing, corner bracing | 3.43 | 19.5 | 7.42 | 0.69 | 25 | 3.77 | 0.35 | -2 |
| W-2(j) 38x89 (2x4) @ 600mm (24") with 51mm (2") exterior SM insulated sheathing, corner bracing | 3.87 | 22.0 | 9.68 | 0.90 | 22 | 5.92 | 0.55 | 4 |
| W-2(k) 38x140 (2x6) @ 400mm (16") with 38mm (1 1/2") exterior SM insulated sheathing, corner bracing | 4.84 | 27.5 | 12.16 | 1.13 | 22 | 8.50 | 0.79 | 9 |
| W-2(l) 38x140 (2x6) @ 400mm (16") with 51mm (2") exterior SM insulated sheathing, corner bracing | 5.28 | 30.0 | 14.96 | 1.39 | 19 | 11.19 | 1.04 | 8 |
| W-2(m) 38x140 (2x6) @ 600mm (24") with 38mm (1 1/2") exterior SM insulated sheathing, corner bracing | 4.84 | 27.5 | 10.65 | 0.99 | 25 | 6.99 | 0.65 | 11 |
| W-2(n) 38x140 (2x6) @ 600mm (24") with 51mm (2") exterior SM insulated sheathing, corner bracing | 5.28 | 30.0 | 13.45 | 1.25 | 21 | 9.79 | 0.91 | 10 |
| W-2(o) 38x89 (2x4) @ 400mm (16") with 51mm (2") exterior SM insulated sheathing, fibreboard sheathing | 3.87 | 22.0 | 13.77 | 1.28 | 16 | 10.11 | 0.94 | 3 |
| W-3 Double wall | 7.04 | 40.0 | 38.52 | 3.58 | 9 | 34.54 | 3.21 | 4 |

<u>Notes</u>

1. NUIC = Net Unit Incremental Cost per unit wall area
2. CPI = Cost Performance Index

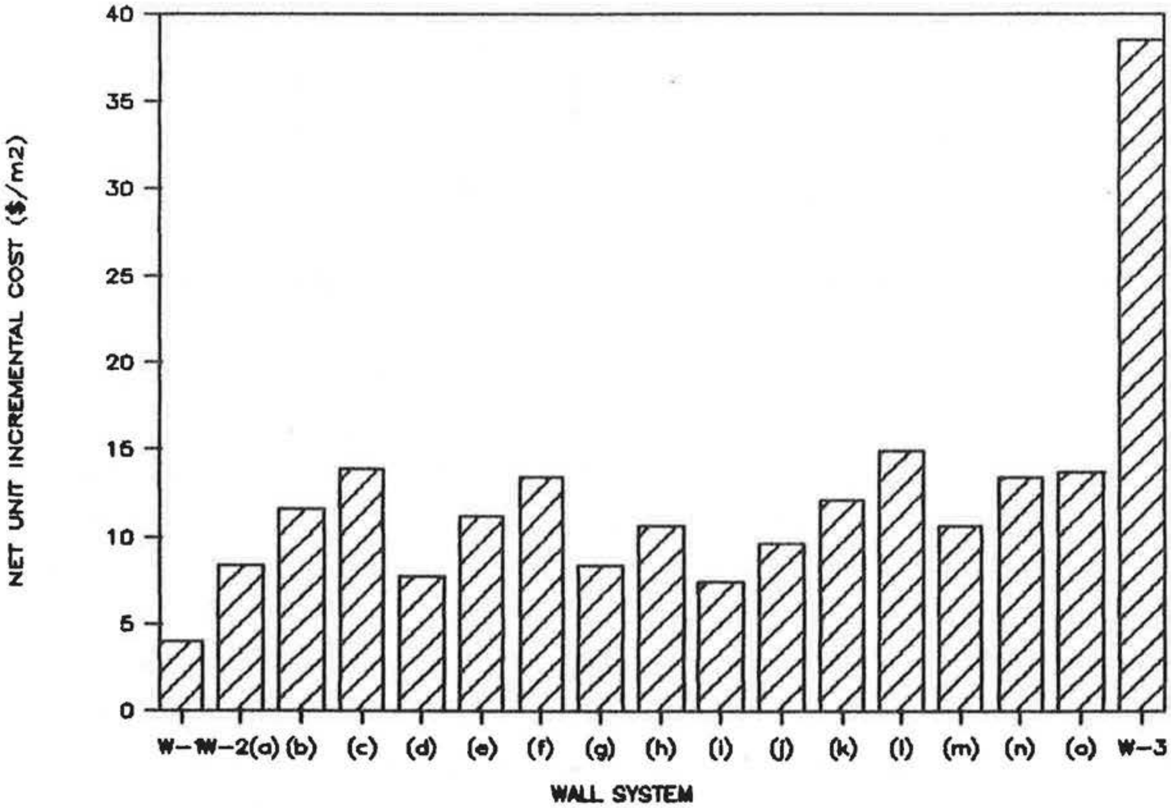
to be built out to provide a solid nailing base for the exterior cladding or stucco, and the rough openings for doors and windows have to be built out to permit secure fastening. If Glasclad is used as the exterior sheathing, stud spacing should be reduced to 400mm (16") O.C. or a rigid exterior cladding employed. Taping of the exterior spun-bonded polyolefin ("Tyvek") air barrier will be necessary at joints between sheets and around penetrations. The presence of Tyvek allows elimination of the building paper. If the Glasclad is reversed to eliminate taping of the Tyvek joints (since they would occur over framing members), building paper will be required under the stucco or siding. The flexibility of Glasclad requires additional material and labour to apply the stucco scratchcoat. If SM sheathing is used, either 400mm (16") or 600mm (24") stud spacing can be used. Building paper is still required to meet the National Building Code. With either type of insulated sheathing, door and window jamb extensions or exterior returns will be necessary. Interior drywall returns can also be used although these were not costed. With either system, gable end roof trusses may have to be cantilevered to provide a continuous vertical surface for the exterior cladding.

4.3.3 Double Wall - Representing the most radical departure from conventional construction, the double wall requires two complete walls to be framed and spaced apart using top and bottom plywood plates. All cavity spaces are filled with batt insulation and the air/vapour barrier is "built into" the wall during construction. Returns are required for all doors and windows. Due to the thickness of the finished wall, the exterior dimensions of the house are usually extended by 300mm (12") in each direction to prevent excessive loss of interior floor area. This requires additional material for the foundation, floor system, roof and exterior cladding and may increase property taxes which are based on exterior dimensions.

## 4.4 INCREMENTAL COSTS

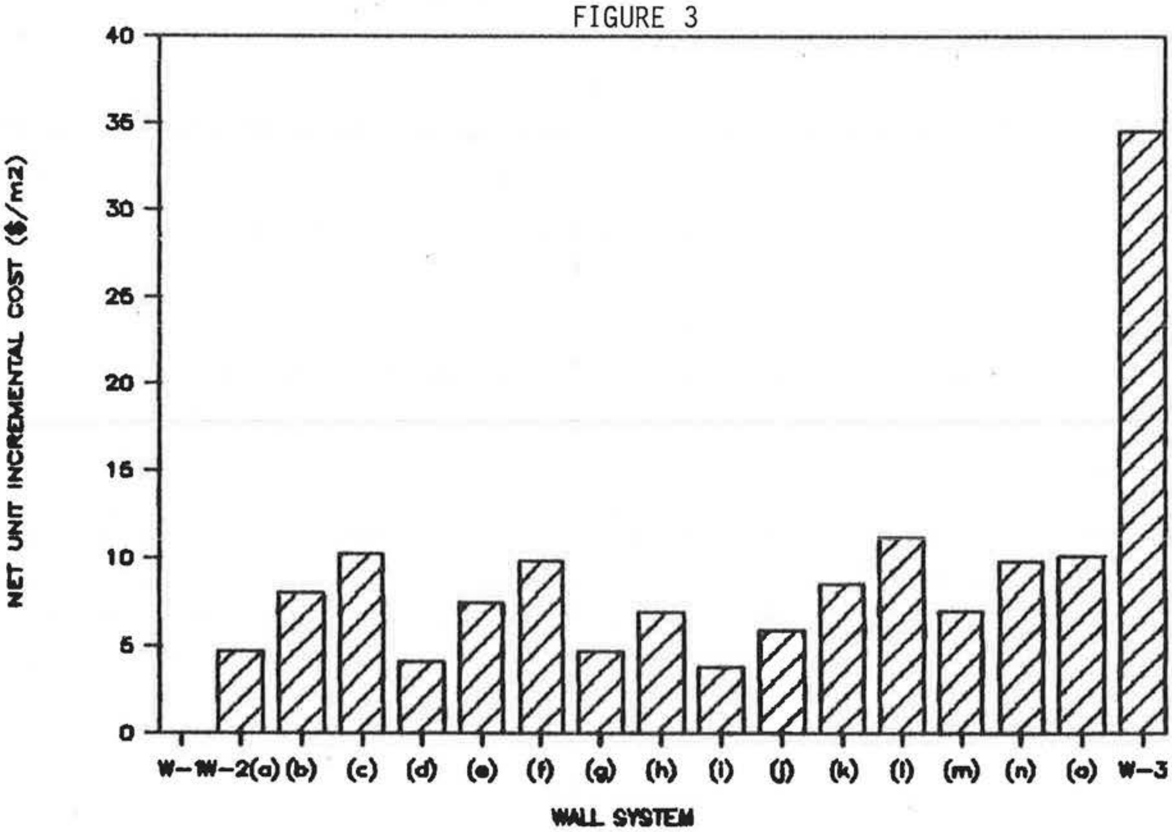
Incremental costs, expressed as the net cost per square metre of wall area (exclusive of door and window area) are shown in Table 3 and Figures 2 and 3.

FIGURE 2




Walls: Net Unit Incremental Cost, Conventional Practice 38x89 (2x4)

FIGURE 3




Walls: Net Unit Incremental Cost, Conventional Practice 38x140 (2x6)

4.4.1 Conventional: 38x89 (2x4) Walls - The incremental cost to upgrade to a 38x140 (2x6) wall was $\$4.01/m^2$ ($\$0.37/ft^2$)(W-1) and was the least expensive wall option in this category. The single stud walls with exterior insulated sheathing had incremental costs ranging from $\$7.42/m^2$ to $\$14.96/m^2$ ($\$0.69/ft^2$ to $\$1.39/ft^2$) while the double wall reached $\$38.52/m^2$ ($\$3.58/ft^2$).

4.4.2 Conventional: 38x140 (2x6) Walls - The incremental cost to upgrade from a 38x140 (2x6) wall to the equivalent wall with exterior insulated sheathing ranged from $\$3.77/m^2$ to $\$11.19/m^2$ ($\$0.35/ft^2$ to $\$1.04/ft^2$). The incremental cost for the double wall was $\$34.54/m^2$ ($\$3.21/ft^2$).

## 4.5 COST PERFORMANCE INDEX

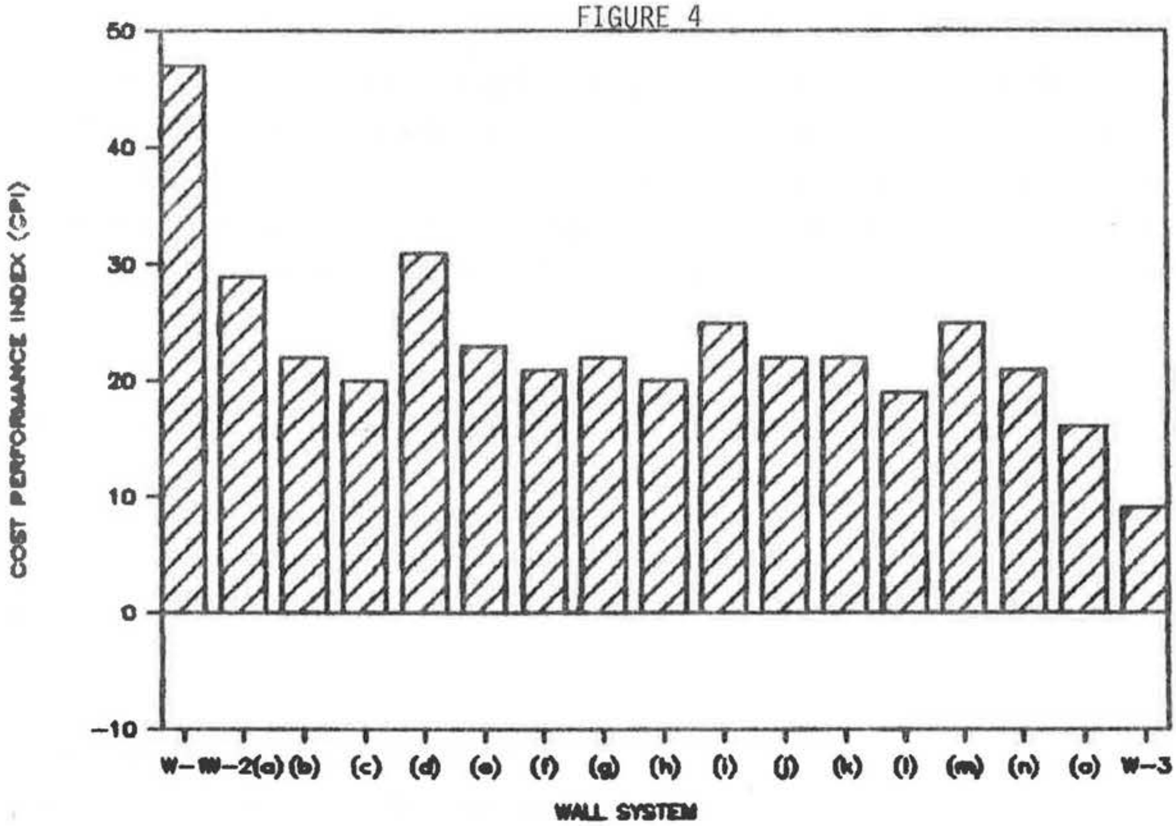
4.5.1 Conventional: 38x89 (2x4) Walls - The CPI reached 47 for upgrading this system to a 38x140 (2x6) wall as shown in Table 3 and Figures 4 and 5. For single stud walls with exterior insulated sheathing, the index was lower, ranging from 16 to 29 while for the double wall the CPI was 9.

4.5.2 Conventional: 38x140 (2x6) Walls - As expected, the CPI was lower for walls upgraded from 38x140 (2x6) construction. For systems with exterior insulated sheathing it ranged from -2 to 13. Two systems had indices less than zero because the values for their thermal resistances were less than that of the conventional wall. The index for the double wall was 4.

## 4.6 OBSERVATIONS

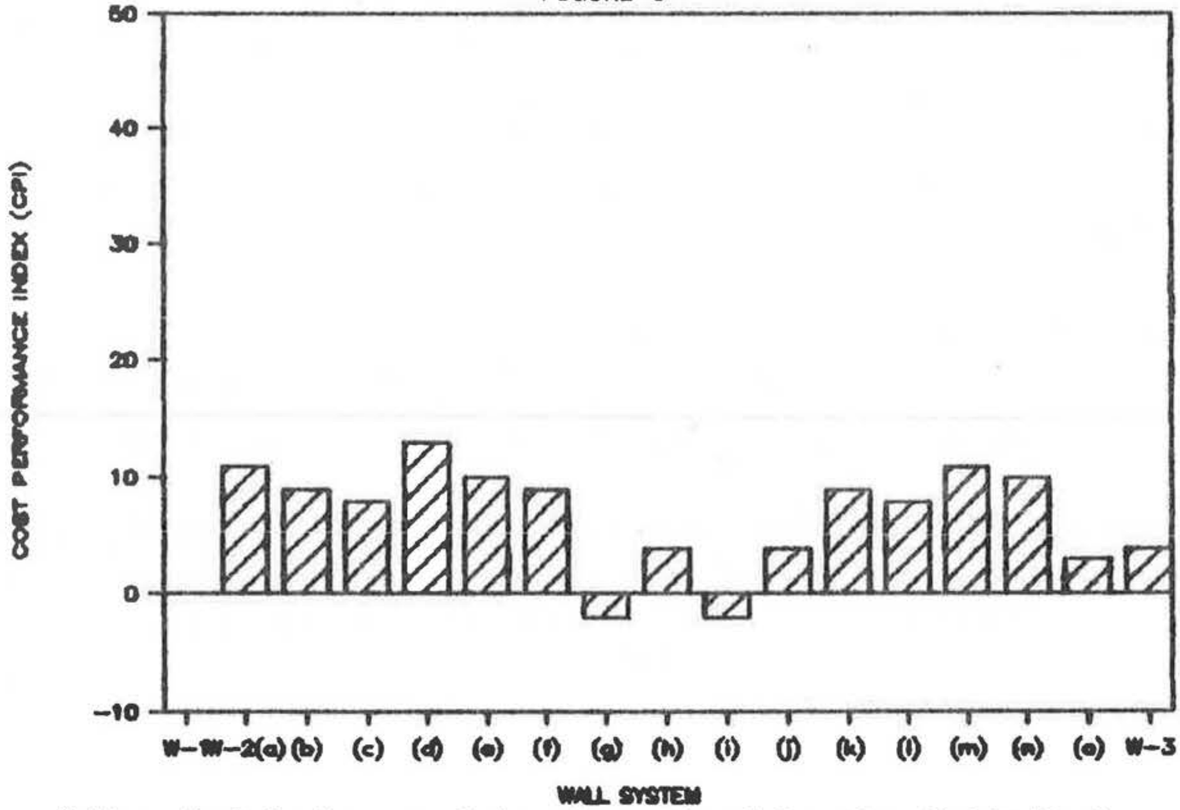
1. The highest CPI was achieved by the 38x140 (2x6) upgrade from a 38x89 (2x4) system. Although not surprising, the fact that the CPI was approaching twice that of the next highest system should be noted.
2. Single stud walls with exterior insulated sheathing which had the highest CPI values were those with 25 mm (1") of insulated sheathing. The CPI values for the two types of insulated sheathing materials studied were similar for equivalent thicknesses and stud spacings.

FIGURE 4




Walls: Cost Performance Index, Conventional Practice 38x89 (2x4)

FIGURE 5




Walls: Cost Performance Index, Conventional Practice 38x140 (2x6)

3. The CPI values for the double wall were low relative to the other systems, indicative of the significant labour and materials required to construct the system.

4. A significant cost for many of the wall systems was the jamb extensions for doors and windows required to accommodate the extra wall thickness.

5. Based on the systems studied, the following recommendation can be offered: for a builder currently using 38x89 (2x4) construction, the most cost-effective wall upgrade would be to switch to 38x140 (2x6) construction. For a builder currently using 38x140 (2x6) construction, the most cost-effective wall upgrade would be to add 25 mm (1") of exterior insulated sheathing. Note however, that some types of wall systems such as strapped, blown cellulose and manufactured walls were not included in the current study.

## SECTION 5

## BASEMENTS

### 5.1 CONVENTIONAL PRACTICE

Interior glass fibre batt insulation in 38x64 (2x3) or 38x89 (2x4) framing is the most common basement insulation system. For this study, RSI 1.76 (R-10.0) insulation from the bottom of the floor joists to the slab, with no underslab insulation, was assumed as conventional practice.

### 5.2 SYSTEM OPTIONS ANALYZED

Thirteen basement systems (10 wall and 3 slab) were costed, as shown in Table 4.

### 5.3 CHANGES FROM CONVENTIONAL PRACTICE

5.3.1 Walls - Systems B-1 to B-3 are upgrades with extra interior insulation. Systems B-4 to B-8 are exterior insulation schemes. These typically require that a pressure-treated nailer to be cast into the foundation at grade to serve as a nailing base or that an equivalent mechanical fastening system be used. Door and window rough openings also have to be roughed out to provide a solid nailing base. The insulation is added down to footing level in vertical sheets. Both rigid glass fibre (Fibreglas Canada "Baseclad") and extruded polystyrene (Dow "SM") were considered. The insulation is covered or parged for protection. With exterior insulation systems, the interior framing, insulation and poly as well as the dampproofing can be omitted. Systems B-9 and B-10 are combinations of interior and exterior insulation.

5.3.2 Slab - Systems B-11 and B-12 use small amounts of rigid insulation under the slab. B-13 shows the cost of slab crack control measures.

### 5.4 INCREMENTAL COSTS

Incremental costs were expressed as the net unit cost per square metre

TABLE 4
BASEMENT SYSTEMS

| SYSTEM | NOMINAL THERMAL RESISTANCE RSI | NOMINAL THERMAL RESISTANCE R | NET UNIT INCREMENTAL COST $/m² | NET UNIT INCREMENTAL COST $/ft² | COST PERFORMANCE INDEX |
|---|---|---|---|---|---|
| B-1 RSI 2.11 (R-12.0) interior G/F batts, 38x64 (2x3) framing | 2.11 | 12.0 | 0.43 | 0.04 | 219 |
| B-2 RSI 3.52 (R-20.0) interior G/F batts, 38x64 (2x3) framing | 3.52 | 20.0 | 2.29 | 0.21 | 124 |
| B-3 RSI 4.23 (R-24.0) interior G/F batts, 38x64 (2x3) framing | 4.23 | 24.0 | 3.43 | 0.32 | 97 |
| B-4 51mm (2") exterior Baseclad insulation, interior unfinished | 1.50 | 8.5 | 8.98 | 0.83 | -11 |
| B-5 76mm (3") exterior Baseclad insulation, interior unfinished | 2.38 | 13.5 | 12.90 | 1.20 | 11 |
| B-6 51mm (2") exterior SM insulation, interior unfinished | 1.76 | 10.0 | 10.19 | 0.95 | 0 |
| B-7 76mm (3") exterior SM insulation, interior unfinished | 2.64 | 15.0 | 15.45 | 1.44 | 12 |
| B-8 102mm (4") exterior SM insulation, interior unfinished | 3.52 | 20.0 | 16.99 | 1.58 | 17 |
| B-9 RSI 1.76 (R-10.0) interior G/F batts, 51mm (2") exterior Baseclad insulation | 3.26 | 18.5 | 14.00 | 1.30 | 19 |
| B-10 RSI 1.76 (R-10.0) interior G/F batts, 51mm (2") exterior SM insulation | 3.52 | 20.0 | 15.21 | 1.41 | 19 |
| B-11 Slab; 25mm (1") Glasclad insulation under slab | 0.97 | 5.5 | 4.69 | 0.44 | 881 |
| B-12 Slab; 25mm (1") SM under slab | 1.07 | 6.1 | 5.55 | 0.52 | 762 |
| B-13 Slab; crack initiators and isolators | N/A | N/A | 0.84 | 0.08 | N/A |

NOTES
1. NUIC values per unit of component area.
2. G/F = glass fibre

of wall or slab area based on interior dimensions, as shown in Figure 6.

5.4.1 Walls - Incremental costs ranged from \$0.43/m² to \$16.99/m² (\$0.04/ft² to \$1.58/ft²). The lower value representing a basic upgrade of using a thicker batt of insulation while the higher values represent a change to the exterior systems.

5.4.2 Slab - The two underslab insulation systems cost \$4.69/m² and \$5.55/m² (\$0.44/ft² and \$0.52/ft²) respectively while the slab crack control measures averaged \$0.84/m² (\$0.08/ft²).

## 5.5 COST PERFORMANCE INDEX

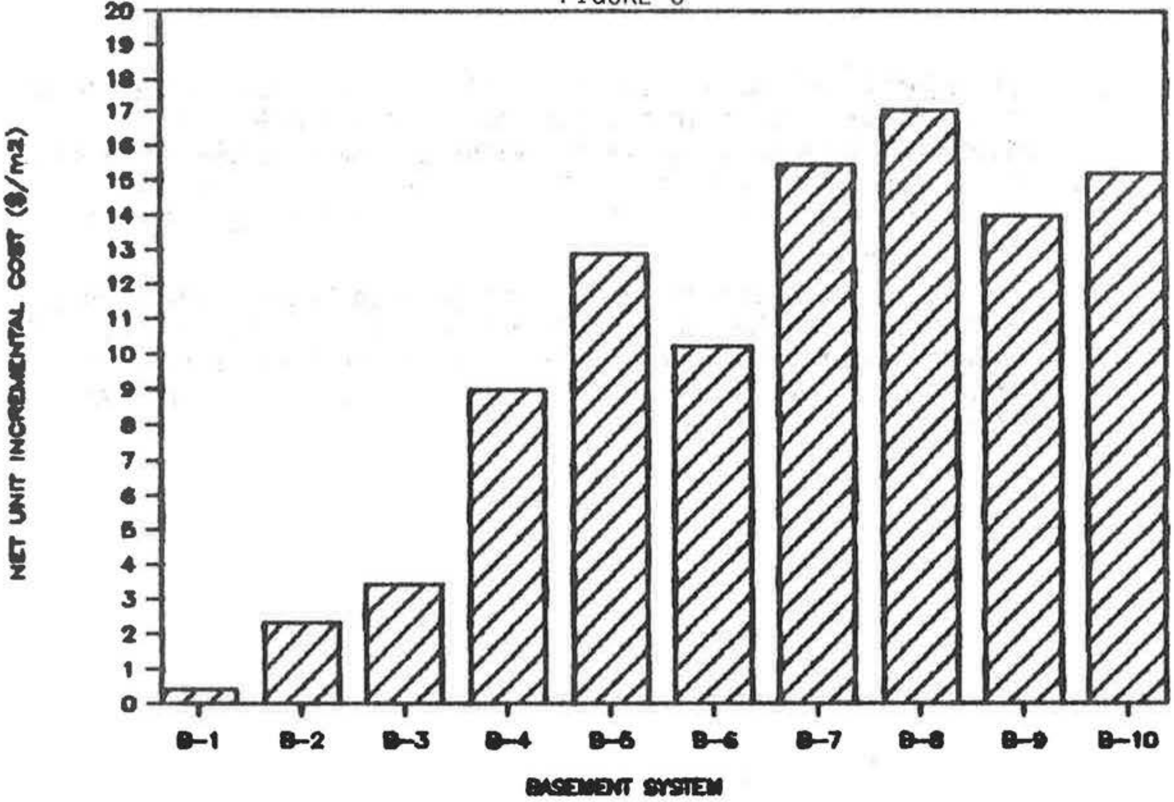
5.5.1 Walls - As shown in Figure 7, the high CPI values for the interior schemes reflect the minimal cost of upgrading from conventional practice and the relatively low RSI value of the conventional system, RSI 1.76 (R-10.0). The exterior or combined exterior/interior schemes had lower CPI values. The reader is also reminded that no credit is given for other possible performance benefits of exterior insulation schemes such as improved resistance to moisture penetration and improved concrete curing.

5.5.2 Slab - The high indices of the two underslab systems are noted but it must be recalled that the effects of the soil are ignored and thus only the RSI value of the concrete and air film contributed to the original RSI value. This would inflate the indices.

## 5.6 OBSERVATIONS

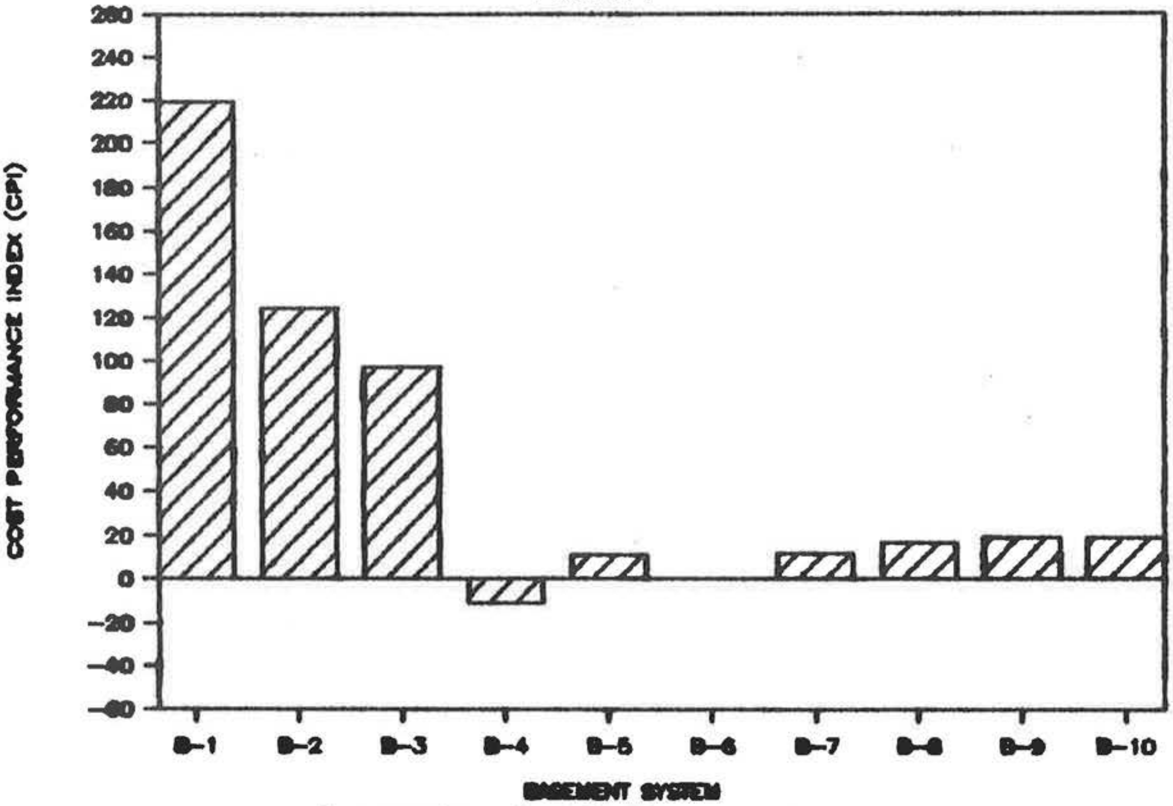
1. The CPI values for the interior insulation schemes were quite high. As a result, they should be given primary consideration for upgrading basement wall insulation levels.
2. The most cost-effective applications of exterior insulation were those systems which used the maximum insulation thickness available. This occurred because the fixed costs of applying the insulation represented a significant percentage of the total cost. The CPI values for the two types of exterior insulation systems were similar for equivalent material thicknesses.

FIGURE 6




Basements: Net Unit Incremental Cost

FIGURE 7




Basements: Cost Performance Index

3. The majority of the incremental cost for the basement systems was for materials. With interior systems, it was mainly for the additional insulation while for exterior systems, the extra costs were largely attributable to the protective cladding, pressure-treated nailer and built-out rough openings for the doors and windows.

4. Although direct comparisons can not be made between CPI values for sub-slab insulation and other components of the envelope, the extremely high values nonetheless suggest that builders give serious consideration to underslab insulation when upgrading designs.

# SECTION 6

# CEILINGS

## 6.1 CONVENTIONAL PRACTICE

The most common ceiling system is the truss roof with blown-in insulation although cathedral ceilings are also popular. For this study, conventional practice was assumed to be a truss roof with RSI 7.04 (R-40.0) insulation. Some variation of insulation levels exist, particularly in other parts of the country. Conventional, non-raised-heel trusses were assumed. Incremental costs for the systems using cellulose fibre were calculated assuming cellulose fibre had been used in conventional practice. Likewise, glass fibre blowing wool was assumed as conventional practice for systems costed using glass fibre.

## 6.2 SYSTEM OPTIONS ANALYZED

Eight ceiling systems were analyzed as shown in Table 5. These used either type of insulation in incremental amounts, from RSI 7.93 (R-45.0) to RSI 10.57 (R-60.0).

## 6.3 CHANGES FROM CONVENTIONAL PRACTICE

When calculating changes from conventional practice, only the cost of the added insulation was assumed with no provision for raised heel truss. This should be noted when reviewing ceiling system incremental costs since raised heel trusses, if used, could have an impact on cost.

## 6.4 INCREMENTAL COSTS

Incremental costs were quoted by the installer on the basis of area and insulation level for each type of material. These are summarized in Table 5 on the basis of the incremental costs per unit area of ceiling using interior dimensions.

6.4.1 Conventional: RSI 7.04 (R-40.0) Blown-in Cellulose - An installed cost of $\$0.824/m^2 \cdot RSI$ was quoted resulting in incremental costs ranging

TABLE 5

CEILING SYSTEMS

| SYSTEM | NOMINAL THERMAL RESISTANCE RSI | R | NET UNIT INCREMENTAL COST $/m² | $/ft² | COST PERFORMANCE INDEX |
|---|---|---|---|---|---|
| C-1 RSI 7.93 (R-45.0) blown-in cellulose | 7.93 | 45.0 | 0.73 | 0.07 | 22 |
| C-2 RSI 8.81 (R-50.0) blown-in cellulose | 8.81 | 50.0 | 1.45 | 0.13 | 20 |
| C-3 RSI 9.69 (R-55.0) blown-in cellulose | 9.69 | 55.0 | 2.18 | 0.20 | 18 |
| C-4 RSI 10.57 (R-60.0) blown-in cellulose | 10.57 | 60.0 | 2.91 | 0.27 | 16 |
| C-5 RSI 7.93 (R-45.0) G/F blowing wool | 7.93 | 45.0 | 0.86 | 0.08 | 19 |
| C-6 RSI 8.81 (R-50.0) G/F blowing wool | 8.81 | 50.0 | 1.72 | 0.16 | 17 |
| C-7 RSI 9.69 (R-55.0) G/F blowing wool | 9.69 | 55.0 | 2.57 | 0.24 | 15 |
| C-8 RSI 10.57 (R-60.0) G/F blowing wool | 10.57 | 60.0 | 3.43 | 0.32 | 14 |

Notes

1. Values shown for the Net Unit Incremental Cost and the Cost Performance Index are calculated assuming the same type of insulation material is used in conventional practice as employed in the costed system.
2. NUIC values are per unit ceiling area.
3. G/F = glass fibre

from \$0.73/m² to \$2.91/m² (\$0.07/ft² to \$0.27/ft²) for Systems C-1 through C-4.

6.4.2 Conventional: RSI 7.04 (R-40.0) Glass Fibre Blowing Wool - An installed cost of \$0.974/m²·RSI was quoted resulting in incremental costs ranging from \$0.86/m² to \$3.43/m² (\$0.08/ft² to \$0.32/ft²) for Systems C-5 through C-8.

## 6.5 COST PERFORMANCE INDEX

6.5.1 Conventional: RSI 7.04 (R-40.0) Blown-in Cellulose - CPI values ranged from 16 to 22.

6.5.2 Conventional: RSI 7.04 (R-40.0) Glass Fibre Blowing Wool - CPI values ranged from 14 to 19.

## 6.6 OBSERVATIONS

1. The ceiling CPI values were relatively high, despite the assumption of a high level of insulation, RSI 7.04 (R-40.0), for the conventional case. For example, all of the ceiling systems investigated were found to have higher CPI values than wall systems which used 38x140 (2x6) construction for conventional practice and were being considered for upgrading.

# SECTION 7

# AIRTIGHTNESS

## 7.1 ACHIEVING AIRTIGHTNESS

For many builders, airtightness is the most difficult conservation system to cost since it consists of a number of small measures which can be used in different combinations with varying degrees of effectiveness. For this study, 22 airtightness sealing "components" were defined, each relating to a specific part of the envelope. The airtightness components were then assembled in various combinations to form four airtightness "systems". The incremental costs are summarized in Table 6. Conventional practice was assumed to be 4 mil poly stapled in place but not sealed, with insulation jammed into major holes.

Data Sheets A-1 through A-22 summarize the costing information on the system components while A-23 to A-26 analyze the four complete systems. Each Data Sheet also contains a description of conventional practice and an estimate of the incremental time (hours:minutes) requirement for the system, broken down by subtrade.

Unlike the other building envelope components whose energy performance can be quantified by their RSI value, no comparable indicator exists to describe the performance of an airtightness system. Although the airtightness test using the blower door technique is in widespread use, it characterizes the behaviour of the entire envelope and provides no information on individual components. Inspections of the envelope can of course be carried out to identify leakage areas but these are only general indicators of a component's performance. As a result, no equivalent of the Cost Performance Index is available to describe airtightness. However, it is important to recognize that performance differences do exist between competing systems and should be considered when designing the building envelope.

TABLE 6
AIRTIGHTNESS COMPONENTS AND SYSTEMS

| | AIRTIGHTNESS COMPONENTS | INCREMENTAL COST PER HOUSE |
|---|---|---|
| A-1 | Material; Main Floor, 6 mil Poly Air/Vapour Barrier | $ 17.48 |
| A-2 | Material; Basement, 6 mil Poly Air/Vapour Barrier | 8.03 |
| A-3 | Main Floor Walls; Continuous, Sealed Poly Air/Vapour Barrier | 29.37 |
| A-4 | Basement Walls; Continuous, Sealed Poly Air/Vapour Barrier | 46.84 |
| A-5 | Wall/Header; Exterior Air Barrier | 123.11 |
| A-6 | Doors and Windows; Ethafoam Rod | 30.86 |
| A-7 | Doors and Windows; Poly-Wrap | 84.10 |
| A-8 | Wall/Floor/Foundation; Poly Air/Vapour Barrier | 48.98 |
| A-9 | Wall/Floor/Foundation; Tyvek Air Barrier | 59.04 |
| A-10(a) | Wall/Floor/Cast-In-Place Foundation; Gasket Sealing | 78.37 |
| A-10(b) | Wall/Floor/Sill Plate Foundation; Gasket Sealing | 118.57 |
| A-11 | Ceiling; Poly Air/Vapour Barrier Sealed to Partition Walls | 41.42 |
| A-12 | Ceiling; Continuous Sealed Poly Air/Vapour Barrier | -11.81 |
| A-13 | Ceiling; Continuous Taped Drywall Air Barrier (ADA) | -20.29 |
| A-14 | Ceiling; Continuous Taped Drywall Air Barrier (ADA), Poly Vapour Barrier | -20.29 |
| A-15 | Headers; Interior Rigid Air/Vapour Barrier | 167.61 |
| A-16(a) | Headers; Header Insulation Poly Bags with RSI 2.11 (R-12.0) | -36.66 |
| A-16(b) | Headers; Header Insulation Poly Bags with RSI 3.52 (R-20.0) | -18.06 |
| A-17 | Electrical Outlets, Main Floor; Rigid Poly Pans | 11.36 |
| A-18 | Service Penetrations | 16.25 |
| A-19 | Exterior Attic Hatch | 0 |
| A-20 | Sealed Floor Drain Cover | 19.95 |
| A-21 | Paint Vapour Barrier, Main Walls and Ceiling | 60.45 |
| A-22 | Paint Vapour Barrier, Basement Walls | 24.16 |
| | **AIRTIGHTNESS SYSTEMS** | |
| A-23 | Sealed Poly Air/Vapour Barrier | |
| | (a) Main floor only | $213.82 |
| | (b) Main floor and basement | 260.66 |
| | (c) Main floor only but with ethafoam rods (A-6) to seal door and window penetrations | 160.58 |
| | (d) Main floor and basement but with ethafoam rods (A-6) to seal door and window penetrations | 207.42 |
| A-24 | Airtight Drywall Approach, Paint Vapour Barrier | |
| | (a) Main floor only | 177.00 |
| | (b) Main floor and basement | 201.16 |
| A-25 | Airtight Drywall Approach, Poly Vapour Barrier (finished or unfinished basement) | 116.55 |
| A-26 | Fiberglas Canada Inc. Low Energy House System | |
| | (a) Finished basement | 81.92 |
| | (b) Unfinished basement | 106.08 |

7.2 SYSTEM COMPONENTS

Individual airtightness system components are discussed below. In addition, Table 7 summarizes the material costs for various types of joint sealant systems employing gaskets and caulking.

7.2.1 Materials - In conventional construction, 4 mil polyethylene is the most commonly used material for air/vapour barriers. For R-2000 style housing, 6 mil is generally used to provide extra durability. Incremental costs for 6 mil poly on the main floor (walls and ceiling) and basement (walls) were $17.48 and $8.03 respectively. These are material costs only with no provision for any additional sealing.

7.2.2 Walls - Polyethylene is usually secured in place on the main wall and basement framing by stapling. To seal the poly and allow it to function as an air/vapour barrier, continuous beads of acoustical sealant are applied along the top and bottom plates and between lap joints. In addition, a sill plate gasket was assumed to be installed under the bottom plate of the interior basement wall framing to account for any unevenness in the slab. Sealing of doors, windows, electrical outlets, headers and the ceiling were costed separately. The poly was assumed to be installed prior to partition wall framing. Based on these assumptions, costs to seal the air/vapour barrier on the main walls and basement walls were $29.37 and $46.84 respectively. The higher cost for the basement reflected the addition of the gasket under the bottom plate.

7.2.3 Wall/Header - A single option was costed for providing an exterior air barrier over the main walls and headers using Tyvek. This system eliminates the requirement for building paper but necessitates taping of all joints, edges and penetrations. The material is available in either sheet roll form or pre-attached to sheets of Glasclad insulated sheathing. The stand-alone sheet roll system was costed at $123.11 which included caulking of the joint between the header or sill plate and the foundation.

7.2.4 Doors and Windows - The most common method of reducing air

TABLE 7

JOINT SEALANT SYSTEMS

MATERIAL COSTS

o Acoustical sealant, 6 mm (1/4") bead - 18.0 ¢/m (5.5 ¢/ft.)

| | | |
|---|---|---|
| o Ethafoam rod: | 6 mm (1/4") | - 7.9 ¢/m (2.40 ¢/ft.) |
| | 10 mm (3/8") | - 10.3 ¢/m (3.15 ¢/ft.) |
| | 13 mm (1/2") | - 14.4 ¢/m (4.40 ¢/ft.) |
| | 16 mm (5/8") | - 22.2 ¢/m (6.76 ¢/ft.) |
| | 19 mm (3/4") | - 29.3 ¢/m (8.92 ¢/ft.) |
| | 25 mm (1") | - 47.6 ¢/m (14.5 ¢/ft.) |
| | 32 mm (1 1/4") | - 80.4 ¢/m (24.5 ¢/ft.) |
| | 38 mm (1 1/2") | - 118.1 ¢/m (36.0 ¢/ft.) |

o Closed cell neoprene sponge, self adhesive, 6 mm thick x 10 mm wide (1/4" x 3/8") - 32.5 ¢/m (9.9¢/ft.)

o Open cell neoprene sponge, self adhesive, 6 mm thick x 10 mm wide (1/4" x 3/8") - 48.9 ¢/m (14.9 ¢/ft.)

o 89 mm (3 1/2") polyethylene sill plate gasket, 6 mm (1/4") thick - 31.8 ¢/m (9.7 ¢/ft.)

o 140 mm (5 1/2") polyethylene sill plate gasket, 6 mm (1/4") thick - 48.9 ¢/m (14.9 ¢/ft.)

infiltration between the rough openings and jambs of doors and windows is to stuff shreds of glass fibre batts into the spaces. The conventional poly vapour barrier is usually stapled to the rough opening. Two alternatives were costed, an ethafoam rod system in which appropriately sized ethafoam rods are jammed into the space and a full "poly-wrap" system in which a strip of poly is caulked and sealed to the door or window frame and then sealed to the main wall air/vapour barrier. Costs of these two systems were estimated at $30.86 and $84.10 respectively.

7.2.5 Wall/Floor/Foundation - The wall/floor/foundation intersection is usually unsealed and relies upon the exterior cladding to provide airtightness. If stucco is used, particularly with a cast-in-place floor system, this can result in a very effective barrier to air leakage provided of course the stucco remains intact. With other cladding systems, this can be the most significant leakage area in the house. Three systems to control air movement were costed using poly, Tyvek and gaskets as the sealing methods. Details are provided on Data Sheets A-8 through A-10. Costs ranged from $48.98 to $118.57. It should be noted that System A-10 evaluated gasket sealing techniques for both cast-in-place and sill plate foundations with the latter costing approximately 50% more.

7.2.6 Ceiling - The ceiling is conventionally handled by stapling poly across the ceiling area and mating it to narrow strips of poly set between the double top plates of partition walls and to the poly of the main walls. Since no sealant is used, air leakage, particularly up partition walls, is frequently a problem. The first ceiling system, A-11, had an incremental cost of $41.42 to seal the ceiling poly to the partition wall poly. Sealing to the main walls poly was included under the "Main Floor Walls" airtightness components. Systems A-12 thorgh A-14 looked at continuous sealed poly as the air/vapour barrier, taped drywall as the air barrier (with the paint serving as the vapour barrier - costed separately) and continuous drywall as the air barrier but with the conventional 4 mil poly serving as the vapour barrier. All three of these systems produced cost savings over conventional practice (ranging from $11.81 to $20.29) provided the ceiling drywall (and poly if included) were installed prior to the partition walls and that there was no additional charge for any subtrade rescheduling. Note that Systems A-13 and A-14 show the same incremental cost saving (relative to conventional practice) because the credit for the eliminated poly in System A-13 appears in System A-21.

7.2.7 Headers - Two alternative header sealing systems were costed: the first comprising individual pieces of extruded polystyrene cut, fitted and sealed into place in the header spaces to serve as an air/vapour barrier. The second was a new product consisting of glass fibre batt-filled poly bags (Fiberglas Canada "Header Insulation") which are jammed but not sealed into the header space. Conventional practice is to staple, but not seal, poly into the header space. The first option, A-15, costed at $167.61, indicative of the labour involved. The second, A-16, produced cost savings relative to conventional practice ($36.66 and $18.06, depending on insulation level) because of the rapid installation time. This system would function as a vapour barrier, however it is unknown if it could sustain significant pressure differentials and thus be capable of functioning as an air barrier in the absence of any other air barrier system (such as A-5 or A-9).

7.2.8 Service Penetrations - The total cost to seal the service penetrations was determined. Conventionally these are usually poorly sealed or totally ignored. Interestingly, the incremental costs were relatively modest.

7.2.9 Paint Vapour Barrier - If a structural air barrier system is employed without a sufficiently low permeability to water vapour, a separate vapour barrier (or more accurately a vapour retarder) has to be employed. Two alternatives are to use either the conventional 4 mil, stapled poly, or to use the painted surface (of the drywall) as the vapour barrier. Systems A-21 and A-22 describe the paint vapour barrier approach for the main walls and ceiling and the basement walls respectively. Costs for each were $60.45 and $24.16. In each case an additional oil base primer was applied between the latex primer and the finish coat since oil base primers may raise the nap of paper-coated drywall. If an oil base finish coat was acceptable, then only 2 coats would be required (latex primer and oil base finish coat). Costs for the main walls were developed on the assumption that partition walls were painted as per conventional practice. There does not appear to be any difference in appearance where the partition and main walls intersect.

## 7.3 COMPLETE AIRTIGHTNESS SYSTEMS

7.3.1 Sealed Poly Air/Vapour Barrier Envelope (A-23) - This system consists of nine of the components discussed above and basically represents the "poly approach" to achieving airtightness. It is suitable for conventional framed walls, walls with exterior insulated sheathing or walls with interior strapping. Total estimated incremental system cost was \$213.82 for a house with an unfinished, conventionally sealed basement. If a well-sealed basement were included, the cost would increase to \$260.66. This system is known to be capable of achieving high levels of airtightness and can, if properly applied, easily meet the R-2000 Home Program's requirements for airtightness. Reviewing costs of the individual elements, it is interesting to note that almost 40% of the total cost is attributable to sealing the doors and windows. Considering the otherwise tight envelope, it might be reasonable to substitute system A-6 using ethafoam rods to seal door and window penetrations which would reduce the incremental system costs to \$160.58 and \$207.42 respectively, as shown in Table 6.

7.3.2 Airtight Drywall Approach, Paint Vapour Barrier (A-24) - This system utilizes the ADA approach with a painted vapour barrier and is comprised of seven of the component systems. Total incremental system cost was estimated at \$177.00 with the two major cost items being the wall/floor/foundation gasket systems (\$78.37) and the paint vapour barrier for the main walls and ceiling (\$60.45). The basement was assumed to be unfinished. If the basement was finished, the cost of the ADA house with paint vapour barrier would increase to $201.16.

7.3.3 Airtight Drywall Approach, Poly Vapour Barrier (A-25) - This system is in many respects similar to conventional construction in that 4 mil poly is used as the vapour barrier for the main walls and ceiling. It is basically identical to System A-24 except that the painted vapour barrier is eliminated. Total incremental system cost was estimated at $116.55 for a finished or unfinished basement since the conventional 4 mil poly on the basement walls is left intact.

7.3.4 Fiberglas Canada Inc. Low Energy House System (A-26) - The FCI LEHS is a modified ADA system designed to provide reasonable airtightness at minimal cost and is intended to be operated in conjunction with the Habitair energy system which operates the home under a slight negative pressure differential so that uncontrolled air movement is always inward across the envelope. It also assumes that Glasclad insulated sheathing with an attached Tyvek air barrier is used. Total estimated incremental cost was $81.92 with an unfinished basement or $106.08 with a finished basement.

## 7.4 OBSERVATIONS

1. The poly approach was the most expensive of the complete airtightness systems costed. However, with relatively minor modifications, such as changing the door and window sealing system, the incremental cost was reduced significantly to a level equal to the ADA system with a paint vapour barrier. It is doubtful that such modifications would have a major impact on performance.
2. The cost effectiveness of the ADA system was significantly improved by the use of 4 mil poly rather than paint as the vapour barrier. The use of poly also requires less change from conventional practice.
3. The Fiberglas Canada Inc. Low Energy House System had the lowest incremental cost. This could be further reduced by the use of poly instead of paint as the vapour barrier. Note that this system is intended to be incorporated with a modified wall and mechanical system which were not included in the airtightness cost.

4. The complete airtightness systems costed should not be regarded as fixed in their component make-up. All could be optimized to reduce cost, likely without significantly degrading performance.

5. There is a need for empirical data on the performance of airtightness components. At present, there is little if any quantitative information available on the performance of competing systems. For example, it would be useful to have air leakage measurements of the relative performance of the different door and window sealing systems, considering that their costs vary by a factor of 3:1.

# SECTION 8

# VENTILATION SYSTEMS

## 8.1 INTRODUCTION

The purpose of the ventilation system is twofold: to remove contaminated air from the house and to supply outdoor air, preferably in a well-distributed manner. In conventional, leaky houses, a portion of the ventilation requirements is met by natural infiltration. In houses with tighter envelopes, a mechanical ventilation system becomes increasingly important. In an R-2000 house, it is a requirement. In this study, 11 different components of typical mechanical ventilation systems were costed. These components were then assembled into a further eight complete ventilation systems. All 19 of these systems are summarized on Data Sheets V-1 to V-19 with costs broken down by subtrade.

## 8.2 CONVENTIONAL PRACTICE

The "conventional" ventilation system tends to vary with geographic location, house size and type and with builder. For this study the system was assumed to consist of:

- o fresh air intake,
- o kitchen exhaust fan, and
- o bathroom exhaust fan.

Incremental costs for the complete ventilation systems (V-12 to V-19) were determined with respect to this conventional system. Although the conventional ventilation system is shown as an alternative, it would not have the same capabilities or performance as the complete systems.

## 8.3 SYSTEM COMPONENTS

Table 8 summarizes the gross costs to the builder of the 11 ventilation system components analyzed. Systems V-5 and V-6, Heat Recovery Ventilators, are typical of the units being used in R-2000 homes with the small capacity unit suitable for homes up to approximately 139m² (1500ft²) and the medium capacity unit applicable for homes up to roughly 279m² (3000ft²).

TABLE 8

VENTILATION SYSTEM COMPONENTS

| SYSTEM COMPONENT | | DESCRIPTION | GROSS COST (INSTALLED) |
|---|---|---|---|
| V-1 | Fresh air intake | 127mm (5") fresh air intake from outdoors to return air plenum | $ 45.00 |
| V-2 | Kitchen exhaust fan | 61 l/s (130 CFM) free stream capacity kitchen exhaust fan | $ 126.00 |
| V-3 | Bathroom exhaust fan | 24 l/s (50 CFM) free stream capacity bathroom exhaust fan | $ 86.00 |
| V-4 | Central exhaust | 113 l/s (240 CFM) free stream capacity central exhaust drawing from kitchen and bathroom | $ 439.00 |
| V-5 | Heat Recovery Ventilator, small capacity | 47 l/s (100 CFM) HRV exhausting from kitchen and bathroom and supplying to return air plenum or dedicated ventilation-only supply system | $1,442.00 |
| V-6 | Heat Recovery Ventilator, medium capacity | 102 l/s (216 CFM) HRV exhausting from kitchen and bathroom and supplying to return air plenum or dedicated ventilation-only supply system | $1,742.00 |
| V-7 | Heat Pump Heat Recovery Ventilator | 125 l/s (265 CFM) heat pump HRV exhausting from kitchen and bathroom and supplying to return air plenum or dedicated ventilation-only supply system | $2,698.00 |
| V-8 | Dedicated Ventilation-Only Supply System | Ventilation-only duct system with 152mm (6") main and and 102mm (4") branch ducts from HRV (or supply fan) to 5 main floor and 2 basement registers. High sidewall supplies on main floor. | $ 475.00 |
| V-9 | Dehumidistat | 110 VAC dehumidistat installed in hallway to operate HRV or exhaust fan | $ 81.00 |
| V-10 | Duct heater | 2 kW duct heater in 152mm (6") fresh air duct | $ 370.00 |
| V-11 | Automatic damper | Automatic air controlled damper in 152mm (6") duct c/w switch | $ 121.00 |

System V-7 is also an HRV but uses a heat pump instead of a heat exchanger, to transfer heat between the exhaust and supply air streams. In terms of ventilation capacity, it is comparable to a medium capacity HRV (V-6). Also worthy of note is V-8, a dedicated ventilation-only supply air system. This provides supply air to all rooms in the house which do not have an exhaust outlet. It could be used to meet the R-2000 Program ventilation requirements in a house with a baseboard heating system.

## 8.4 COMPLETE VENTILATION SYSTEMS

As shown in Table 9, System V-12 represents the conventional ventilation systems while V-13 to V-19 use the three HRV's coupled with either forced air or baseboard heating systems. Strictly speaking, Systems V-16 to V-19 would not be used in a house the size used in this study because they provide excessive air flow capacity. They were included to document incremental costs.

## 8.5 OBSERVATIONS

1. The cost of the ventilation system was largely determined by the type of system and not house size. Since a large percentage of a house's total heating load will be attributable to ventilation, assuming proper air change rates are provided, the builder should ensure that a system with a high heat recovery performance is used. In larger houses with higher ventilation loads, HRV's with higher efficiencies should be used.
2. Although the HRV systems provide superior ventilation in terms of air delivery, distribution and energy savings, there was a significant cost gap between them and the conventional system. While perhaps unavoidable, this suggests that greater effort be directed at reducing installed HRV system costs, particularly if other methods of controlling indoor air quality (such as pollutant source removal or containment) can be used to permit reduced ventilation rates and lower ventilation energy costs.

TABLE 9

COMPLETE VENTILATION SYSTEMS

| SYSTEM | | DESCRIPTION | GROSS COST (INSTALLED) | LESS SAVINGS (INSTALLED) | NET COST (INSTALLED) |
|---|---|---|---|---|---|
| V-12 | Conventional ventilation system | o Fresh air intake (V-1)<br>o Kitchen exhaust fan (V-2)<br>o Bathroom exhaust fan (V-3) | $ 257.00 | $ 0 | $ 257.00 |
| V-13 | Central exhaust system | o Fresh air intake (V-1)<br>o Central exhaust (V-4)<br>o Dehumidistat (V-9) | $ 565.00 | $257.00 | $ 308.00 |
| V-14 | HRV system, small capacity, for forced air heating system | o HRV, small capacity (V-5)<br>o Dehumidistat (V-9) | $1,523.00 | $257.00 | $1,266.00 |
| V-15 | HRV system, small capacity, for baseboard heating system | o HRV, small capacity (V-5)<br>o Dedicated ventilation-only supply system (V-8)<br>o Dehumidistat (V-9) | $1,998.00 | $257.00 | $1,741.00 |
| V-16 | HRV system, medium capacity, for forced air heating | o HRV, medium capacity (V-6)<br>o Dehumidistat (V-9) | $1,823.00 | $257.00 | $1,566.00 |
| V-17 | HRV system, medium capacity, for baseboard heating system | o HRV, medium capacity (V-6)<br>o Dedicated ventilation-only supply system (V-8)<br>o Dehumidistat (V-9) | $2,298.00 | $257.00 | $2,041.00 |
| V-18 | Heat pump HRV system for forced air heating system | o Heat pump HRV (V-7) | $2,698.00 | $257.00 | $2,441.00 |
| V-19 | Heat pump HRV system for baseboard heating system | o Heat pump HRV (V-7)<br>o Dedicated ventilation-only supply system (V-8) | $3,173.00 | $257.00 | $2,916.00 |

# SECTION 9

# HEATING SYSTEMS

## 9.1 CONVENTIONAL PRACTICE

Like other mechanical system components, conventional practice for heating systems tends to vary by location and with utility rates. For this study the conventional heating system was assumed to be a naturally aspirated, forced-air, gas furnace with a nominal seasonal efficiency of 60%. Conventional, floor-mounted registers, located under windows, were used on the main floor with ceiling-mounted registers in the basement. Two return registers were also used - one in the main hallway and one in the basement. This system would not be permitted in the R-2000 Home Program since it uses a naturally aspirated appliance.

## 9.2 SYSTEMS ANALYZED

Table 10 summarizes the options analyzed. Six complete systems using gas or electric heat were costed. System H-7, high sidewall supply registers for a forced air heating system, would be used to minimize drafts from the supply registers with a continuous circulation furnace blower. Note that conventional, as opposed to "high-throw", grilles were assumed for this option and thus the supply air plume throw may be limited. System H-8, individual room air returns for a forced air system, would be used to provide better air circulation throughout the house. Doors will normally restrict air flow into a closed room in a conventional system if the undercut is small (which is usually necessary to restrict noise transfer and maintain privacy). Two air conditioning options are shown in H-9 and H-10. All costs on Data Sheets H-1 to H-10 are broken down by subtrade.

## 9.3 OBSERVATIONS

1. As a general recommendation, higher efficiency furnaces are most cost effective in houses with larger gross heating loads since the cost of the furnace is largely independent of house size and the extra cost of the unit can be applied against the larger load. For small and medium sized houses, an induced draft unit would likely be the most appropriate upgrade from a naturally

TABLE 10

HEATING SYSTEMS

| | SYSTEM DESCRIPTION | GROSS COST (INSTALLED) | LESS SAVINGS (INSTALLED) | NET COST (INSTALLED) |
|---|---|---|---|---|
| H-1 | Conventional naturally aspirated gas furnace c/w ductwork, nominal seasonal efficiency 60% | $1,458.00 | $ 0 | $1,458.00 |
| H-2 | Naturally aspirated gas furnace with spark ignition and vent damper c/w ductwork, nominal seasonal efficiency 69% | $1,833.00 | $1,458.00 | $ 375.00 |
| H-3 | Induced draft gas furnace c/w ductwork, nominal seasonal efficiency 80% | $2,028.00 | $1,458.00 | $ 570.00 |
| H-4 | Condensing gas furnace c/w ductwork, nominal seasonal efficiency 95% | $3,058.00 | $1,458.00 | $1,600.00 |
| H-5 | 10 kW electric furnace c/w ductwork | $1,530.00 | $1,458.00 | $ 72.00 |
| H-6 | 8.00 kW electric baseboard heating system | $ 756.00 | $1,458.00 | $ -702.00 |
| | | | | NET COST (INSTALLED) |
| H-7 | High sidewall supply registers on main floor (assume 6 registers) | | | $ 95.00 |
| H-8 | Individual room returns (assume 3 additional registers) | | | $ 115.00 |
| H-9 | 0.8 ton window air conditioner | | | $ 613.00 |
| H-10 | 2 ton central air conditioner | | | $2,115.00 |

aspirated gas furnace while in a large structure, a condensing unit would be more cost effective.

2. The incremental cost of high sidewall supplies was $95 or approximately $16 per register which may be viewed as a reasonable cost for the improved comfort. The incremental cost of the individual room returns was $115 or approximately $38 per register. Some opportunities may exist for optimization with both systems.

# SECTION 10

## DOMESTIC HOT WATER HEATING

### 10.1 CONVENTIONAL PRACTICE

Conventional practice also tends to vary with location, but for this study, was assumed to be a natural gas 114 l (25 I.G.) domestic hot water (DHW) tank.

10.2 SYSTEMS ANALYZED - Three systems, one gas and two electric, were analyzed as shown in Table 11. None have any energy conservation features, other than those adopted industry-wide, but they are included here for use when costing other system packages. Note that System D-1, the naturally aspirated gas DHW tank would not be permitted in the R-2000 Home Program. All costs on Data Sheets D-1 to D-3 are also broken down by sub-trade.

TABLE 11

DOMESTIC HOT WATER HEATING SYSTEMS

| SYSTEM DESCRIPTION | | GROSS COST (INSTALLED) | LESS SAVINGS (INSTALLED) | NET COST (INSTALLED) |
|---|---|---|---|---|
| D-1 | Conventional 114 l (25 I.G.) naturally aspirated gas DHW tank | $355.00 | $ 0 | $355.00 |
| D-2 | Electric 182 l (40 I.G.) DHW tank | $425.00 | $355.00 | $ 70.00 |
| D-3 | Electric 273 l (60 I.G.) DHW tank | $547.00 | $355.00 | $192.00 |

# SECTION 11

# INTEGRATED SYSTEMS

## 11.1 INTRODUCTION

Integrated systems combine the functions normally performed by two or more individual mechanical system components. In so doing, they attempt to maximize the overall efficiency of the mechanical system. Two early-generation integrated systems were costed in this study and are discussed separately below. It should be stressed that, in both cases, the cost analysis should be treated as approximate since the systems are departures from conventional practice and few have been manufactured and installed to date, so that it is difficult to factor out the learning curve costs. There is also a problem in determining incremental costs for integrated systems since they combine the functions of several systems, in whole or in part. Therefore several scenarios were developed for each system.

## 11.2 HABITAIR

This system, produced by Fiberglas Canada Inc., combines the house ventilation and DHW heating functions and provides degrees of supplemental space heating in winter and air-conditoning in summer. The Habitair consists of an exhaust-only ventilation system complete with an integral heat pump which recovers energy from the exhaust air and uses it to heat the DHW. In winter, once this load is met, the additional energy is made available for space heating. Conventional electric baseboard heaters or a forced air heating system, sized to the design heating load of the house, are also required. In summer, the system provides approx. 2.3 kW (8,000 Btu/hr) of air conditioning, with the energy extracted from the house air used for DHW heating. The Habitair includes an integral 273 l (60 I.G.) DHW tank with 1,500 W of supplemental resistance heaters. The system is intended to be integrated with the Fiberglas Canada Low Energy House System.

11.2.1 Costs - Total installed costs were estimated at $4,417.00. As noted, incremental costs were dependent on the assumed conventional system. For this study, four cases were explored as shown on Table 12. The first (case 1) represents the Habitair replacing the conventional DHW and ventilation system in a non R-2000 house with baseboard heating. Cases 2 through 4 represent the unit installed in an R-2000 house in which a higher quality ventilation system is required and the Habitair is able to also replace an HRV. Since the system also provides some cooling, the argument can be made that the Habitair will replace an air-conditioner, either a window unit (case 3) or a central unit (case 4). Note that due to its limited cooling capacity the Habitair will not provide the same degree of cooling as some window units or a central air conditioner. Nonetheless, by careful envelope design to minimize solar gain in summer, it may be possible for the builder to forego installing air conditioning. This significantly reduces the incremental costs attributable to the system.

11.3 PEACH

This system is produced by Cambridge Manufacturing Ltd. and is offered in various configurations. The example costed combines the space heating, DHW heating, ventilator and air-conditioning functions in one package and includes an outdoor air source heat pump. The integral heat pump provides energy for the heating loads, preheats the ventilation air and serves as the summer air conditioner. Two DHW tanks are required, a 182 l (40 I.G.) unit for preheating and a 114 l (25 I.G.) tank as a final booster. An integral 16 kW electric furnace supplies any additional space heating. Since the system only provides single-speed ventilation, supplemental exhaust capacity is required (in this instance bathroom and kitchen fans).

11.3.1 Costs - Total installed costs, were estimated at $6,325.00, which includes the two DHW tanks and two exhaust fans. Again, incremental system costs are dependent on which conventional components are being replaced. In this study, five cases were explored as shown in Table 13. The first, case 1, represents the complete Peach system being used in place of a conventional gas furnace and DHW tank and a conventional ventilation system

## TABLE 12

## HABITAIR INCREMENTAL COSTS

| CASE | TYPE OF INSTALLATION | GROSS COST (INSTALLED) | LESS SAVINGS (INSTALLED) | NET COST (INSTALLED) |
|---|---|---|---|---|
| 1 | Habitair replaces: o conventional 114 l (25 I.G.) gas DHW tank (D-1), o conventional ventilation system (V-12) | $4,417.00 | $ 612.00 | $3,805.00 |
| 2 | Habitair replaces: o 273 l (60 I.G.) electric DHW tank (D-3), o HRV system, medium capacity, for baseboard heating (V-17) | $4,417.00 | $2,845.00 | $1,572.00 |
| 3 | Habitair replaces: o 273 l (60 I.G.) electric DHW tank (D-3), o HRV system, medium capacity, for baseboard heating (V-17), window air conditioner (H-9) | $4,417.00 | $3,458.00 | $ 959.00 |
| 4 | Habitair replaces: o 273 l (60 I.G.) electric DHW tank (D-3), o HRV system, medium capacity, for baseboard heating (V-17), central air conditioner (H-10) | $4,417.00 | $4,960.00 | -$ 543.00 |

TABLE 13

PEACH INCREMENTAL COSTS

| CASE | TYPE OF INSTALLATION | GROSS COST (INSTALLED) | LESS SAVINGS (INSTALLED) | NET COST (INSTALLED) |
|---|---|---|---|---|
| 1 | Peach replaces: o conventional gas furnace, 60% efficient (H-1),<br>o conventional 114 l (25 I.G.) gas DHW tank (D-1),<br>o conventional ventilation system (V-12) | $6,325.00 | $2,070.00 | $4,255.00 |
| 2 | Peach replaces: o 10 kW electric furnace c/w ductwork (H-5),<br>o 273 l (60 I.G.) electric DHW tank (D-3),<br>o HRV system, medium capacity, for forced air heating (V-16) | $6,325.00 | $3,900.00 | $2,425.00 |
| 3 | Peach replaces: o 10 kW electric furnace c/w ductwork (H-5),<br>o 273 l (60 I.G.) electric DHW tank (D-3),<br>o HRV system, medium capacity, for forced air heating (V-16),<br>o central air conditioning (H-10) | $6,325.00 | $6,015.00 | $ 310.00 |
| 4 | Peach replaces: o Induced draft gas furnace, 80% efficient (H-3),<br>o 273 l (60 I.G.) electric DHW tank (D-3),<br>o HRV system, medium capacity, for forced air heating (V-16) | $6,325.00 | $4,398.00 | $1,927.00 |
| 5 | Peach replaces: o Induced draft gas furnace, 80% efficient (H-3),<br>o 273 l (60 I.G.) electric DHW tank (D-3),<br>o HRV system, medium capacity, for forced air heating (V-16),<br>o central air conditioning (H-10) | $6,325.00 | $6,513.00 | -$ 188.00 |

in a non R-2000 house. Cases 2 through 5 represent the unit installed in an R-2000 house which would normally require an HRV. Cases 2 and 3 show it replacing an all-electric system while cases 4 and 5 show the Peach displacing an induced draft gas furnace with electric DHW heating. Cases 3 and 5 include central air-conditioning. Once again, the incremental system costs were reduced significantly as more conventional components are replaced.

## 11.4 OBSERVATIONS

1. The integrated systems were most cost effective when they were able to completely replace, rather than augment, systems normally used in conventional practice. The cost effectiveness of both systems improved significantly when they eliminated an air-conditioning system.
2. Determination of the incremental costs for integrated mechanical systems is more difficult than other components of the home. The case examples discussed in this report should be regarded as illustrative rather than exhaustive. Further, the builder should exercise care when considering such systems to ensure that the most cost-effective application has been found.

# SECTION 12

# IMPLEMENTING THE STUDY RESULTS

## 12.1 RECOMMENDATIONS

The costing information developed in this study has been derived for a specific house type and a given builder in a single location. Applying this information in other situations will require modification to reflect individual circumstances. This can and should be done by those builders wishing to develop an accurate costing base for designing their own energy conservation packages. However, it is also possible to provide some guidance with respect to the order with which different systems should be considered.

This section contains basic recommendations on suggested energy conservation packages to upgrade a conventional house design to the R-2000 Standard. Recommendations are presented in Tables 14, 15 and 16 for three house types and can be applied regardless of climate or energy costs. Those measures listed as "Basic Requirements" are specified either to meet the Technical Requirements of the R-2000 Program or because they will generally prove necessary to meet the Program's Energy Budget or prescriptive standards. In some cases, these measures alone will prove adequate.

In other cases, additional measures will be required to meet the standard due to the severity of the climate or because of the high cost of energy. In these instances, the systems described under "Upgrade Options" should be considered. The upgrade options are subdivided into blocks which contain one or more options. Each of the options within a block are roughly of equivalent cost effectiveness and should be considered equally for inclusion in the total package. Once all the options in a given block have been considered, items in the following blocks can be investigated. In severe climates, or where energy costs are high, it may prove necessary to utilize all of the options listed.

Since these are general guidelines, the builder should recognize that individual circumstances will require some modification to the suggested

TABLE 14

SUGGESTED CONSERVATION PACKAGE

BUNGALOWS

BASIC REQUIREMENTS

| | |
|---|---|
| Walls | RSI 3.52 (R-20.0) |
| Basement Walls | RSI 3.52 (R-20.0) |
| Ceiling | RSI 7.04 (R-40.0) |
| Airtightness System | Poly or ADA |
| Heating System | Induced draft gas (80%) or electric |
| DHW | Induced draft gas or electric |
| Ventilation System | Medium efficiency HRV (~ 65%) |

UPGRADE OPTIONS

Increase basement wall insulation
Increase ceiling insulation
Use high efficiency HRV (~ 80%)

---

Add basement slab perimeter insulation

---

Add basement slab centre insulation

---

Use condensing gas furnace (90%)
Increase wall insulation

NOTES

1. If air-conditioning is planned, consider an integrated mechanical system capable of providing cooling and DHW heating.

2. Insulation levels for cathedral ceilings may be reduced if deeper roof joists are required.

TABLE 15

SUGGESTED CONSERVATION PACKAGE

SPLIT LEVELS, RAISED BUNGALOWS

BASIC REQUIREMENTS

| | |
|---|---|
| Walls | RSI 3.52 (R-20.0) |
| Basement Walls | RSI 4.23 (R-24.0) |
| Ceiling | RSI 7.04 (R-40.0) |
| Airtightness System | Poly or ADA |
| Heating System | Induced draft gas (80%) or electric |
| DHW | Induced draft gas or electric |
| Ventilation System | Medium efficiency HRV (∿ 65%) |

UPGRADE OPTIONS

Increase basement wall insulation
Add basement slab perimeter insulation
Use high efficiency HRV (∿ 80%)

---

Increase ceiling insulation

---

Add basement slab centre insulation
Use condensing gas furnace (90%)

---

Increase wall insulation

NOTES

1. If air-conditioning is planned, consider an integrated mechanical system capable of providing cooling and DHW heating.

2. Insulation levels for cathedral ceilings may be reduced if deeper roof joists are required.

## TABLE 16

## SUGGESTED CONSERVATION PACKAGE

## 1½, 2 STOREY

### BASIC REQUIREMENTS

| | |
|---|---|
| Walls | RSI 3.52 (R-20.0) |
| Basement Walls | RSI 3.52 (R-20.0) |
| Ceiling | RSI 7.04 (R-40.0) |
| Airtightness System | Poly or ADA |
| Heating System | Induced draft gas (80%) or electric |
| DHW | Induced draft gas or electric |
| Ventilation System | High efficiency HRV (∿ 80%) |

### UPGRADE OPTIONS

Increase basement wall insulation
Increase celing insulation

---

Use condensing gas furnace (90%)
Add basement slab perimeter insulation

---

Add basement slab centre insulation
Increase wall insulation

### NOTES

1. If air-conditioning is planned, consider an integrated mechanical system capable of providing cooling and DHW heating.

2. Insulation levels for cathedral ceilings may be reduced if deeper roof joists are required.

# APPENDIX

conservation packages. In addition, these guidelines were developed solely on the basis of energy cost efectiveness with no regard for factors such as comfort, moisture protection of the envelope, marketability, property taxes or impact on the living space. These will obviously have a major bearing on the final design and should be carefully considered based on individual circumstances. In addition, it should be remembered that this study has not considered all potential conservation options. Superwindow technology, strapped and manufactured wall systems, etc. were not included in the analysis and therefore no comments are provided regarding them.

## 12.2 CLOSING COMMENTS

The incremental costs presented in this study are indicative of actual costs to the builder under ideal circumstances with no unusual construction, supervision or supplier problems. To achieve this condition, and thus minimize costs, the builder should minimize variations between houses. Ideally, one envelope system and one mechanical system should be used. If an energy conservation package is required as an option, the builder should experiment with several systems, select a package which is best suited to him, his capabilities and his marketplace and then stick with the design. Only slight variations should be allowed, and these should preferably be within the scope of a single subtrade.

SYSTEM: 38x140 (2x6) @ 600 mm (24") with 16 mm (5/8") fibreboard sheathing

CHANGES FROM CONVENTIONAL PRACTICE:

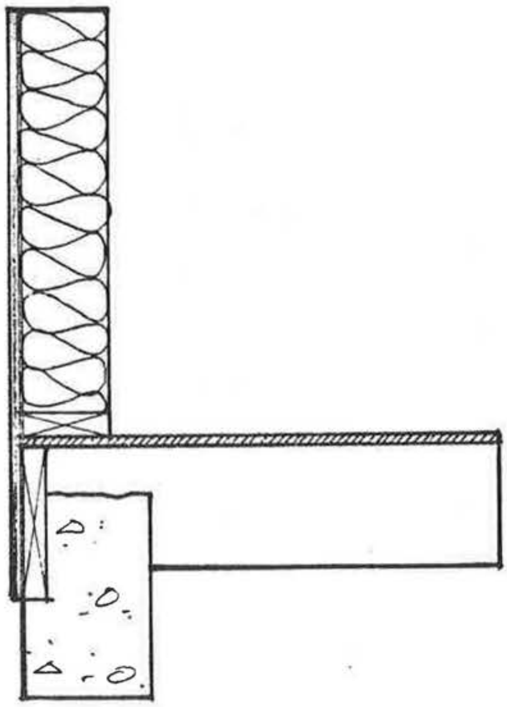
CONVENTIONAL - 38x89 (2x4)

- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs

CONVENTIONAL - 38x140 (2x6)

N/A

| | CONVENTIONAL WALL RSI 2.11 (R-12) | RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $341.48 | | m |
| | 15.00 | | l |
| | $356.48 | N/A | |
| LESS SAVINGS: | $ 0 | | m |
| | 0 | | l |
| | $ 0 | N/A | |
| NET COST: | $341.48 | | m |
| | 15.00 | | l |
| | $356.48 | N/A | |



| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 4.01 | $/m² |
| | 0.37 | $/ft² |
| COST PERFORMANCE INDEX: | 47 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.52 (R-20.0) | |

NOTES:

1. Insulated area does not include headers.

SYSTEM: 38x140 (2x6) @ 400 mm (16") with 25 mm (1") exterior rigid glass fibre insulated sheathing c/w taped exterior air barrier, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

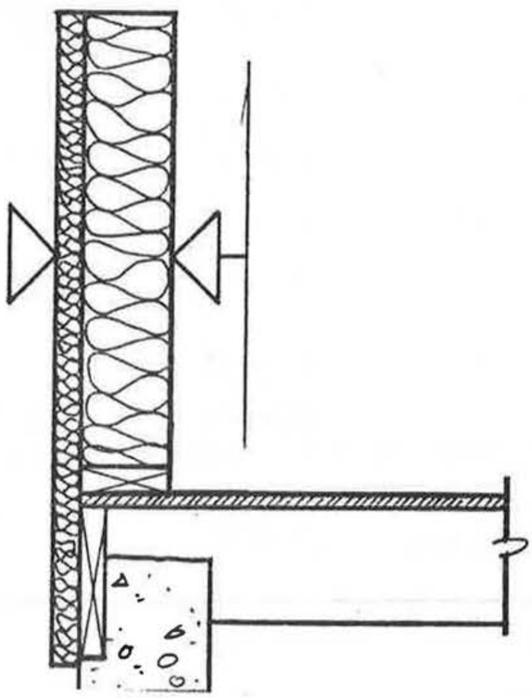
CONVENTIONAL - 38x89 (2x4)

- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier
- o Tape all joints with sheathing tape
- o Delete 16 mm (5/8") fibreboard sheathing
- o Delete building paper

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $ 974.51 | $633.03 | m |
| | 165.00 | 150.00 | l |
| | $1139.51 | $783.03 | |
| LESS SAVINGS: | $ 307.65 | $307.65 | m |
| | 20.00 | 20.00 | l |
| | $ 327.65 | $327.65 | |
| NET COST: | $ 666.86 | $325.38 | m |
| | 145.00 | 130.00 | l |
| | $ 811.86 | $455.38 | |
| NET UNIT INCREMENTAL COST: | 8.39 | 4.73 | $/m² |
| | 0.78 | 0.44 | $/ft² |
| COST PERFORMANCE INDEX: | 29 | 11 | |
| UPGRADED THERMAL RESISTANCE: | RSI 4.30 (R-24.4) | | |



NOTES:

1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

SYSTEM: 38x140 (2x6) @ 400 mm (16") with 38 mm (1½") exterior rigid glass fibre insulated sheathing c/w taped exterior air barrier, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)

- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

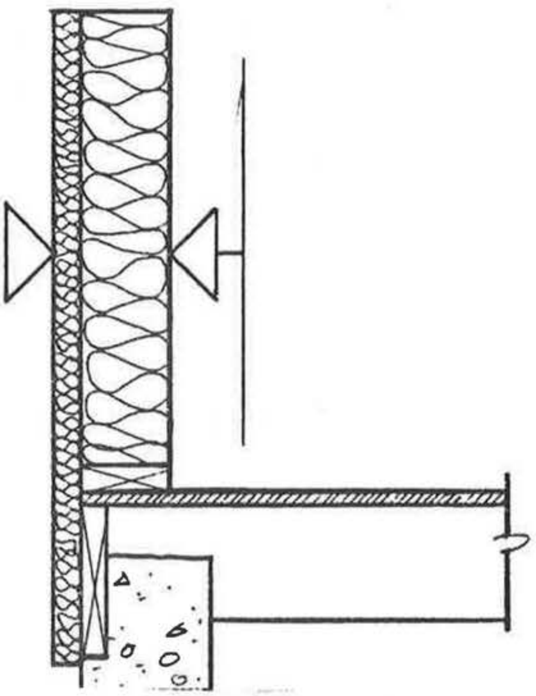
CONVENTIONAL - 38x140 (2x6)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier
- o Tape all joints with sheathing tape
- o Add exterior returns to windows
- o Add 25 mm (1") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Delete building paper

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1231.47 | $ 889.99 | m |
| | 217.50 | 202.50 | l |
| | $1448.97 | $1092.49 | |
| LESS SAVINGS: | $ 307.65 | $ 307.65 | m |
| | 20.00 | 20.00 | l |
| | $ 327.65 | $ 327.65 | |
| NET COST: | $ 923.82 | $ 582.34 | m |
| | 197.50 | 182.50 | l |
| | $1121.32 | $ 764.84 | |

| | | | |
|---|---|---|---|
| NET UNIT INCREMENTAL COST: | 11.62 | 7.96 | $/m² |
| | 1.08 | 0.74 | $/ft² |
| COST PERFORMANCE INDEX: | 22 | 9 | |

UPGRADED THERMAL RESISTANCE: RSI 4.70 (R-26.7)



NOTES:

1. Alternate: use 189 mm (7 7/16") window jambs instead of exterior returns, net additional cost $48.77.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

SYSTEM: 38x140 (2x6) @ 400 mm (16") with 51 mm (2") exterior rigid glass fibre insulated sheathing c/w taped exterior air barrier, corner bracing

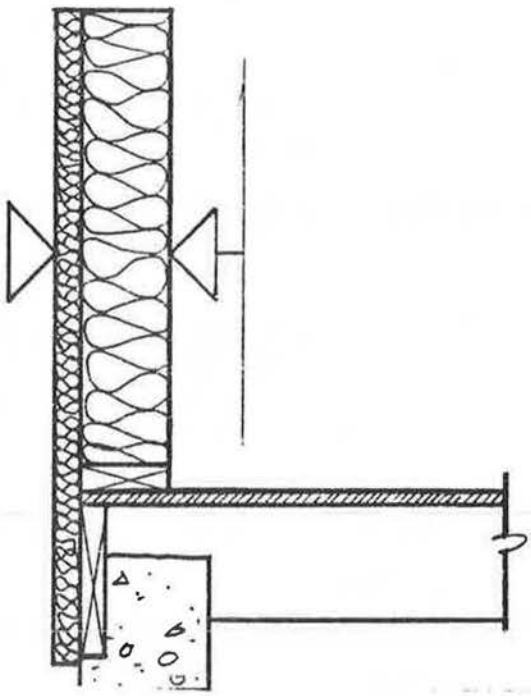
CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier
- o Tape all joints with sheathing tape
- o Add exterior returns to windows
- o Add 38 mm (1½") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Delete building paper

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1440.29 | $1098.81 | m |
| | 232.50 | 217.50 | l |
| | $1672.79 | $1316.31 | |
| LESS SAVINGS: | $ 307.65 | $ 307.65 | m |
| | 20.00 | 20.00 | l |
| | $ 327.65 | $ 327.65 | |
| NET COST: | $1132.64 | $ 791.16 | m |
| | 212.50 | 197.50 | l |
| | $1345.14 | $ 988.66 | |
| NET UNIT INCREMENTAL COST: | 13.88 | 10.22 | $/m² |
| | 1.29 | 0.95 | $/ft² |
| COST PERFORMANCE INDEX: | 20 | 8 | |

UPGRADED THERMAL RESISTANCE: RSI 5.07 (R-28.8)



NOTES:
1. Alternate: use 202 mm (7 15/16") window jambs instead of exterior returns, net additional cost $173.94.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

SYSTEM: 38x140 (2x6) @ 400 mm (16") with 25 mm (1") exterior rigid glass fibre insulated sheathing c/w exterior air barrier (reversed, joints not taped), corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)

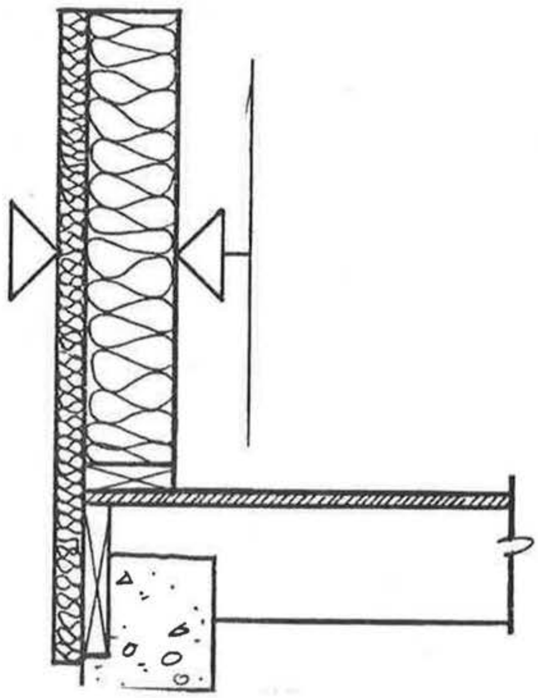
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier (reversed)
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $ 934.11 | $ 592.63 | m |
| | 105.00 | 90.00 | l |
| | $1039.11 | $ 682.63 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $ 646.10 | $ 304.62 | m |
| | 105.00 | 90.00 | l |
| | $ 751.10 | $ 394.62 | |
| NET UNIT INCREMENTAL COST: | 7.75 | 4.09 | $/m² |
| | 0.72 | 0.38 | $/ft² |
| COST PERFORMANCE INDEX: | 31 | 13 | |

UPGRADED THERMAL RESISTANCE: RSI 4.30 (R-24.4)



NOTES:

1. Alternate: use 163 mm (6 7/16") jambs for doors and windows without exterior returns.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

SYSTEM: 38x140 (2x6) @ 400 mm (16") with 38 mm (1½") exterior rigid glass fibre insulated sheathing c/w exterior air barrier (reversed, joints not taped), corner bracing

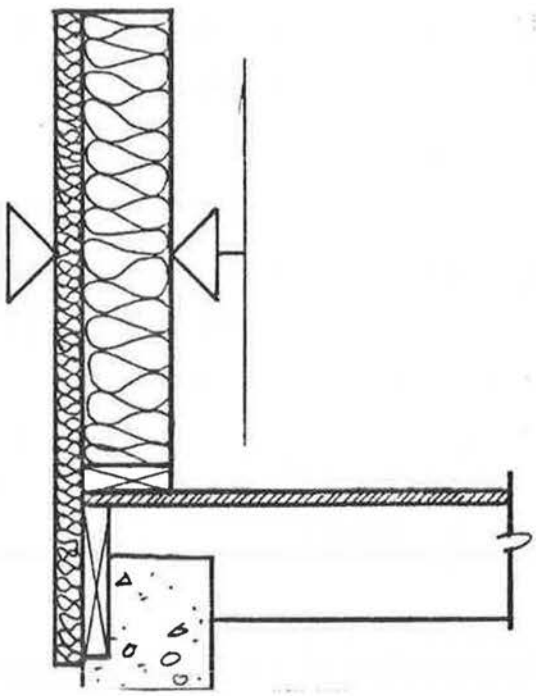
CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier (reversed)
- o Add exterior returns to windows
- o Add 25 mm (1") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1191.07 | $ 849.59 | m |
| | 172.50 | 157.50 | l |
| | $1363.57 | $1007.09 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $ 903.06 | $ 561.58 | m |
| | 172.50 | 157.50 | l |
| | $1075.56 | $ 719.08 | |
| NET UNIT INCREMENTAL COST: | 11.19 | 7.42 | $/m² |
| | 1.04 | 0.69 | $/ft² |
| COST PERFORMANCE INDEX: | 23 | 10 | |

UPGRADED THERMAL RESISTANCE: RSI 4.70 (R-26.7)



NOTES:
1. Alternate: use 189 mm (7 7/16") window jambs instead of exterior returns, net additional cost $48.77.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

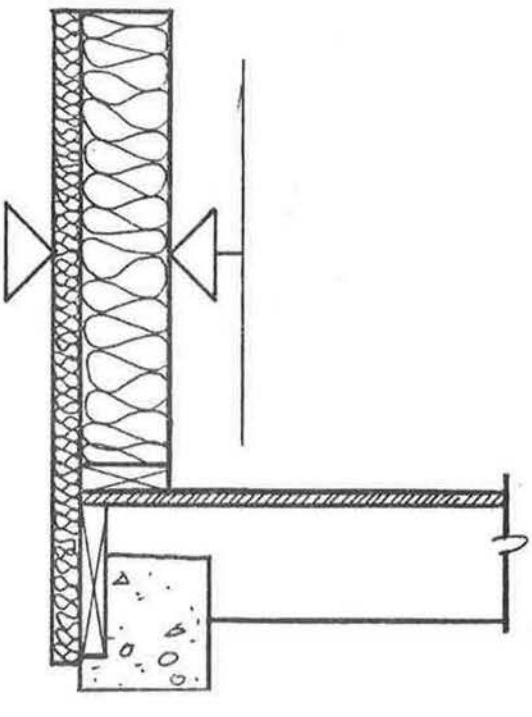
SYSTEM: 38x140 (2x6) @ 400 mm (16") with 51 mm (2") exterior rigid glass fibre insulated sheathing c/w exterior air barrier (reversed, joints not taped)

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 28x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier (reversed)
- o Add exterior returns to windows
- o Add 38 mm (1½") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1399.89 | $1058.41 | m |
| | 187.50 | 172.50 | l |
| | $1587.39 | $1230.91 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $1111.88 | $ 770.40 | m |
| | 187.50 | 172.50 | l |
| | $1299.38 | $ 942.90 | |
| NET UNIT INCREMENTAL COST: | 13.45 | 9.79 | $/m² |
| | 1.25 | 0.91 | $/ft² |
| COST PERFORMANCE INDEX: | 21 | 9 | |
| UPGRADED THERMAL RESISTANCE: | RSI 5.07 (R-28.8) | | |



NOTES:
1. Alternate: use 202 mm (7 15/16") window jambs instead of exterior returns, net additional cost $173.94.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

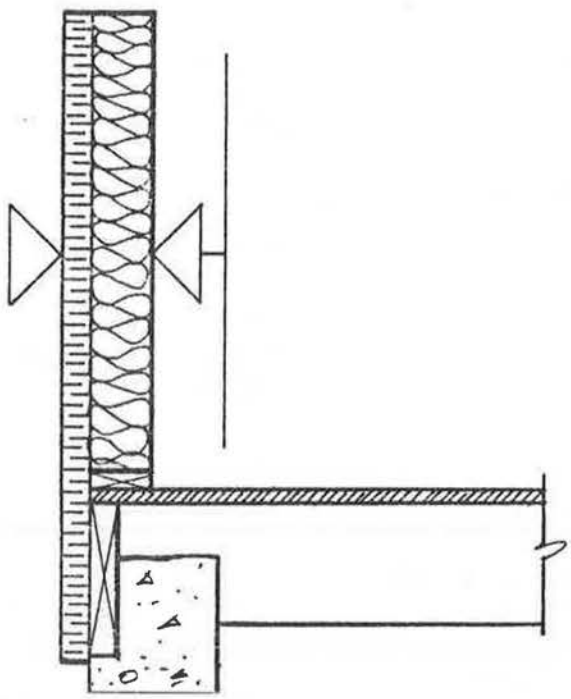
SYSTEM: 38x89 (2x4) @ 400 mm (16") with 38 mm (1½") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings
- o Use 163 mm (6 7/16") door and window jambs
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings (see note 1)
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1272.64 | $ 931.16 | m |
| | 138.75 | 123.75 | l |
| | $1411.39 | $1054.91 | |
| LESS SAVINGS: | $ 590.64 | $ 590.64 | m |
| | 6.00 | 6.00 | l |
| | $ 596.64 | $ 596.64 | |
| NET COST: | $ 682.00 | $ 340.52 | m |
| | 132.75 | 117.75 | l |
| | $ 814.75 | $ 458.27 | |
| NET UNIT INCREMENTAL COST: | 8.39 | 4.73 | $/m² |
| | 0.78 | 0.44 | $/ft² |
| COST PERFORMANCE INDEX: | 22 | -2 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.43 (R-19.5) | | |



NOTES:
1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.

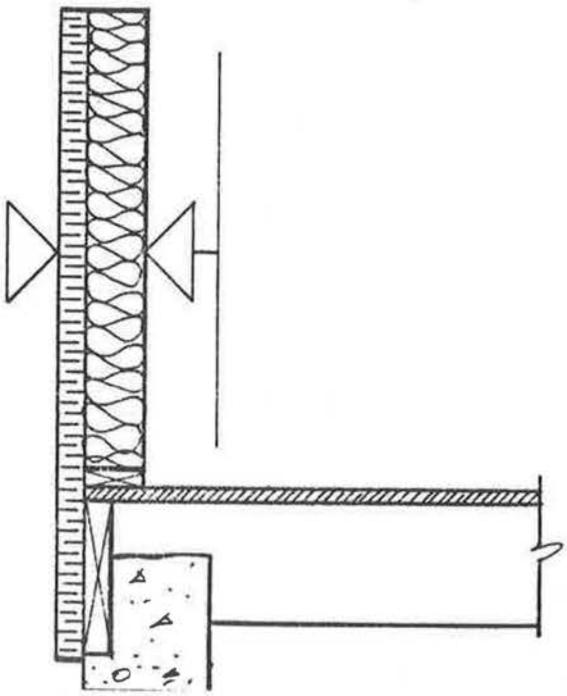
SYSTEM: 38x89 (2x4) @ 400 mm (16") with 51 mm (2") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings
- o Use 163 mm (6 7/16") door and window jambs
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings (see note 1)
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1495.46 | $1153.98 | m |
| | 127.50 | 112.50 | l |
| | $1622.96 | $1266.48 | |
| LESS SAVINGS: | $ 590.64 | $ 590.64 | m |
| | 6.00 | 6.00 | l |
| | $ 596.64 | $ 596.64 | |
| NET COST: | $ 904.82 | $ 563.34 | m |
| | 121.50 | 106.50 | l |
| | $1026.32 | $ 669.84 | |
| NET UNIT INCREMENTAL COST: | 10.65 | 6.89 | $/m² |
| | 0.99 | 0.64 | $/ft² |
| COST PERFORMANCE INDEX: | 20 | 4 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.87 (R-22.0) | | |



NOTES:
1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.

SYSTEM: 38x89 (2x4) @ 600 mm (24") with 38 mm (1½") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)

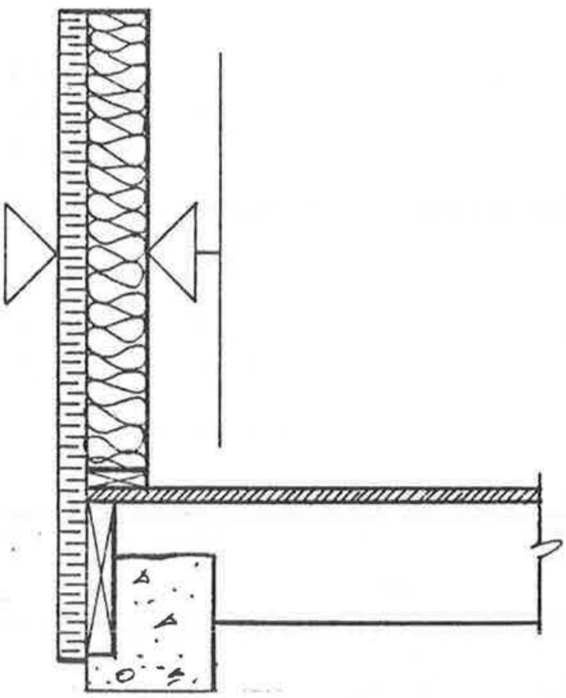
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings
- o Use 163 mm (6 7/16") door and window jambs
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

CONVENTIONAL - 38x140 (2x6)

- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings (see note 1)
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1155.36 | $ 813.88 | m |
| | 116.25 | 101.25 | l |
| | $1271.61 | $ 915.13 | |
| LESS SAVINGS: | $ 545.18 | $ 545.18 | m |
| | 6.00 | 6.00 | l |
| | $ 551.18 | $ 551.18 | |
| NET COST: | $ 610.18 | $ 268.70 | m |
| | 110.25 | 95.25 | l |
| | $ 720.43 | $ 363.95 | |
| NET UNIT INCREMENTAL COST: | 7.42 | 3.77 | $/m² |
| | 0.69 | 0.35 | $/ft² |
| COST PERFORMANCE INDEX: | 25 | -2 | |

UPGRADED THERMAL RESISTANCE: RSI 3.43 (R-19.5)



NOTES:

1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.

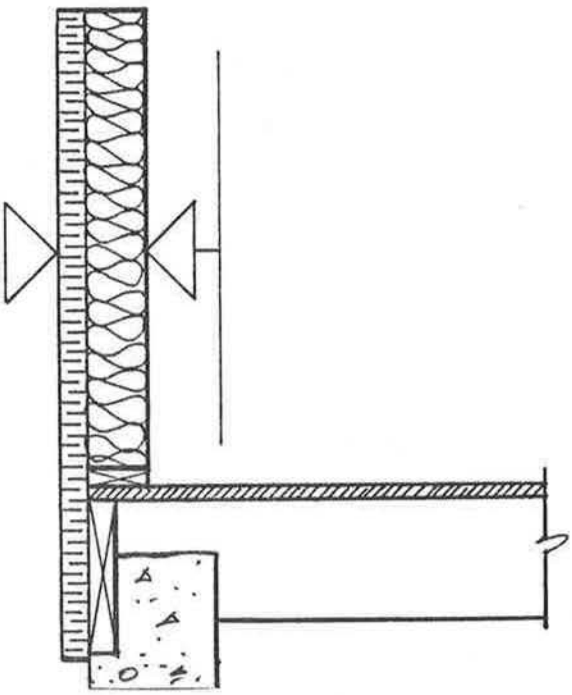
SYSTEM: 38x89 (2x4) @ 600 mm (24") with 51 mm (2") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings
- o Use 163 mm (6 7/16") door and window jambs
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

CONVENTIONAL - 38x140 (2x6)
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings (see note 1)
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)

| | CONVENTIONAL WALL RSI 2.11 (R-12) | RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1378.18 | $1036.70 | m |
| | 105.00 | 90.00 | l |
| | $1483.18 | $1126.70 | |
| LESS SAVINGS: | $ 545.18 | $ 545.18 | m |
| | 6.00 | 6.00 | l |
| | $ 551.18 | $ 551.18 | |
| NET COST: | $ 833.00 | $ 491.52 | m |
| | 99.00 | 84.00 | l |
| | $ 932.00 | $ 575.52 | |
| NET UNIT INCREMENTAL COST: | 9.68 | 5.92 | $/m² |
| | 0.90 | 0.55 | $/ft² |
| COST PERFORMANCE INDEX: | 22 | 4 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.87 (R-22.0) | | |



NOTES:
1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.

SYSTEM: 38x140 (2x6) @ 400 mm (16") with 38 mm (1½") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)

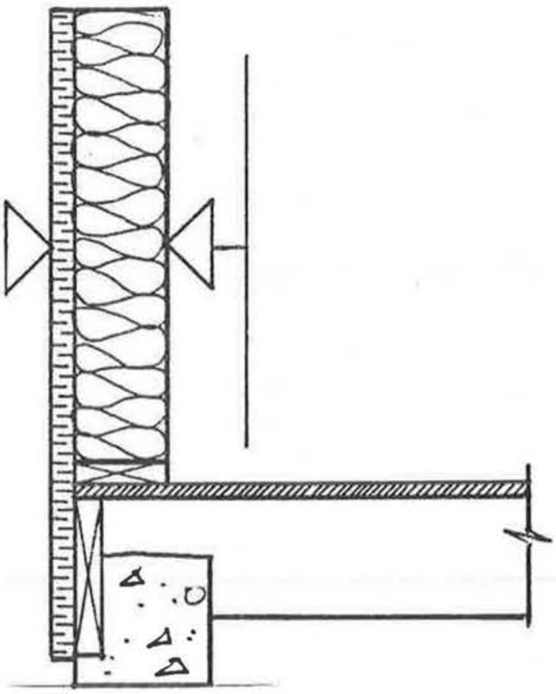
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing
- o Add exterior returns to windows
- o Add 25 mm (1") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1296.34 | $ 954.86 | m |
| | 165.00 | 150.00 | l |
| | $1461.34 | $1104.86 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $1008.33 | $ 666.85 | m |
| | 165.00 | 150.00 | l |
| | $1173.33 | $ 816.85 | |
| NET UNIT INCREMENTAL COST: | 12.16 | 8.50 | $/m² |
| | 1.13 | 0.79 | $/ft² |
| COST PERFORMANCE INDEX: | 22 | 9 | |

UPGRADED THERMAL RESISTANCE: RSI 4.84 (R-27.5)



NOTES:

1. Alternate: use 189 mm (7 7/16") window jambs instead of exterior returns, net additional cost $48.77.
2. Insulated area includes headers.

SYSTEM: 38x140 (2x6) @ 400 mm (16") with 51 mm (2") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

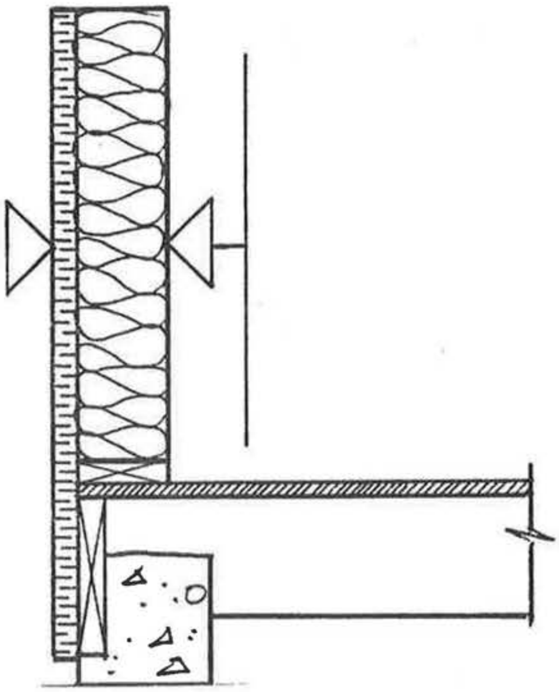
CONVENTIONAL - 38x89 (2x4)

- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing
- o Add exterior returns to windows
- o Add 38 mm (1½") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1549.90 | $1208.42 | m |
| | 180.00 | 165.00 | l |
| | $1729.90 | $1373.42 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $1261.89 | $ 920.41 | m |
| | 180.00 | 165.00 | l |
| | $1441.89 | $1085.41 | |
| NET UNIT INCREMENTAL COST: | 14.96 | 11.19 | $/m² |
| | 1.39 | 1.04 | $/ft² |
| COST PERFORMANCE INDEX: | 19 | 8 | |
| UPGRADED THERMAL RESISTANCE: | RSI 5.28 (R-30.0) | | |



NOTES:

1. Alternate: use 202 mm (7 15/16") window jambs instead of exterior returns, net additional cost $173.94.
2. Insulated area includes headers.

SYSTEM: 38x140 (2x6) @ 600 mm (24") with 38 mm (1½") exterior extruded polystyrene insulated sheathing, corner bracing

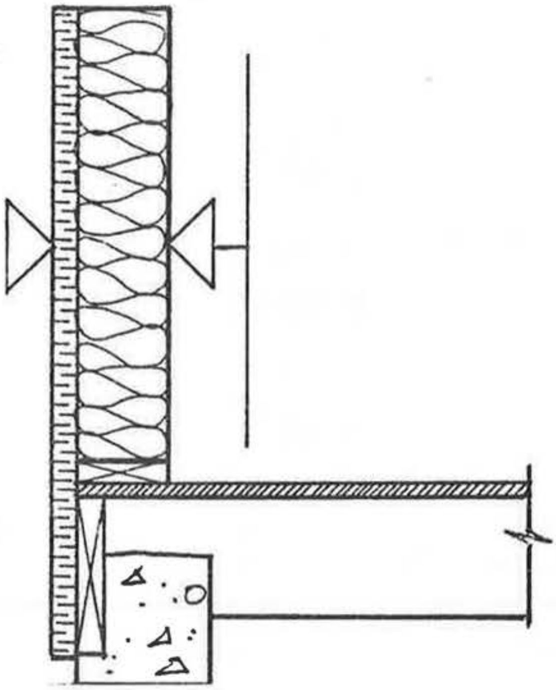
CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing
- o Add exterior returns to windows
- o Add 25 mm (1") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1179.06 | $ 837.58 | m |
| | 142.50 | 127.50 | l |
| | $1321.56 | $ 965.08 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $ 891.05 | $ 549.57 | m |
| | 142.50 | 127.50 | l |
| | $1033.55 | $ 677.07 | |
| NET UNIT INCREMENTAL COST: | 10.65 | 6.99 | $/m² |
| | 0.99 | 0.65 | $/ft² |
| COST PERFORMANCE INDEX: | 25 | 11 | |

UPGRADED THERMAL RESISTANCE: RSI 4.84 (R-27.5)



NOTES:
1. Alternate: use 189 mm (7 7/16") window jambs instead of exterior returns, net additional cost $48.77.
2. Insulated area includes headers.

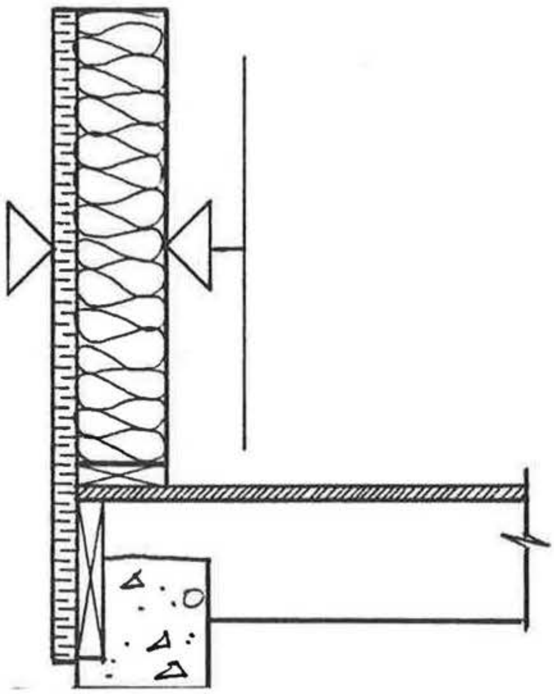
SYSTEM: 38x140 (2x6) @ 600 mm (24") with 51 mm (2") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing
- o Add exterior returns to windows
- o Add 38 mm (1½") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | \$1432.62 | \$1091.14 | m |
| | 157.50 | 142.50 | l |
| | \$1590.12 | \$1233.64 | |
| LESS SAVINGS: | \$ 288.01 | \$ 288.01 | m |
| | 0 | 0 | l |
| | \$ 288.01 | \$ 288.01 | |
| NET COST: | \$1144.61 | \$ 803.13 | m |
| | 157.50 | 142.50 | l |
| | \$1302.11 | \$ 945.63 | |
| NET UNIT INCREMENTAL COST: | 13.45 | 9.79 | \$/m² |
| | 1.25 | 0.91 | \$/ft² |
| COST PERFORMANCE INDEX: | 21 | 10 | |
| UPGRADED THERMAL RESISTANCE: | RSI 5.28 (R-30.0) | | |



NOTES:
1. Alternate: use 202 mm (7 15/16") window jambs instead of exterior returns, net additional cost \$173.94.
2. Insulated area includes headers.

WALLS W-2(o)

SYSTEM: 38x89 (2x4) @ 400 mm (16") with 51 mm (2") exterior extruded polystyrene insulated sheathing, fibreboard sheathing

CHANGES FROM CONVENTIONAL PRACTICE:

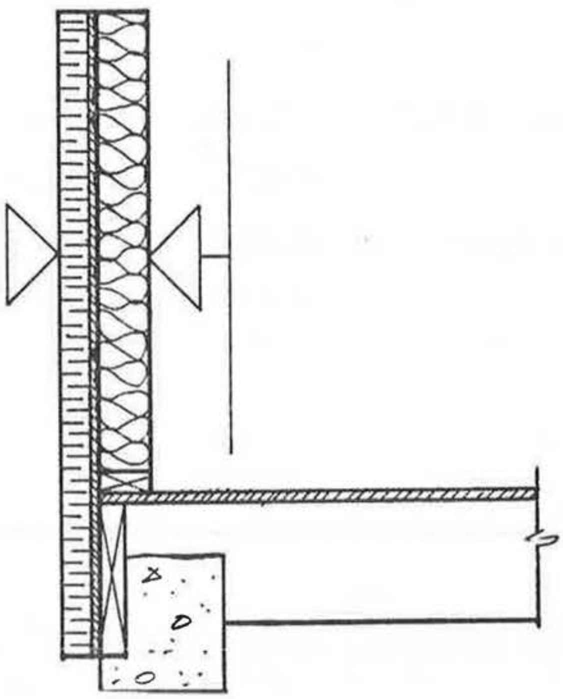
CONVENTIONAL - 38x89 (2x4)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings
- o Use 163 mm (6 7/16") door and window jambs
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

CONVENTIONAL - 38x140 (2x6)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings (see note 1)
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1482.26 | $1140.78 | m |
| | 157.50 | 142.50 | l |
| | $1639.76 | $1283.28 | |
| LESS SAVINGS: | $ 309.26 | $ 309.26 | m |
| | 0 | 0 | l |
| | $ 309.26 | $ 309.26 | |
| NET COST: | $1173.00 | $ 831.52 | m |
| | 157.50 | 142.50 | l |
| | $1330.50 | $ 974.02 | |
| NET UNIT INCREMENTAL COST: | 13.77 | 10.11 | $/m² |
| | 1.28 | 0.94 | $/ft² |
| COST PERFORMANCE INDEX: | 16 | 3 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.87 (R-22.0) | | |



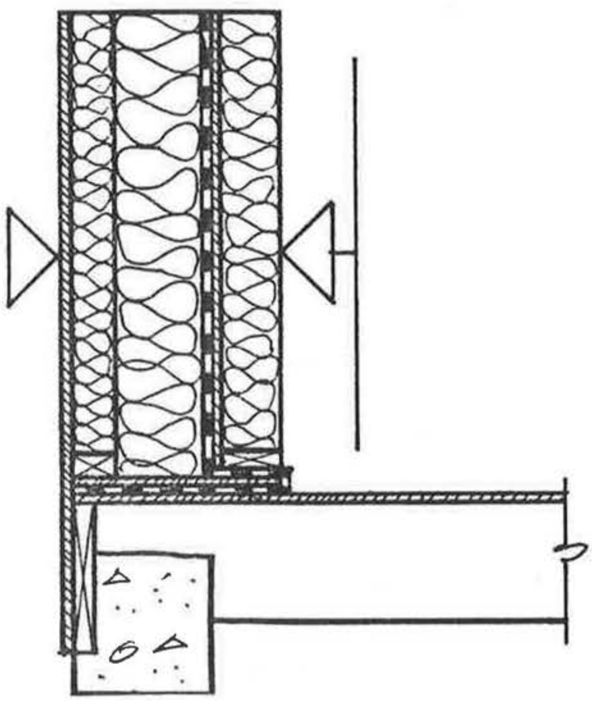
NOTES:
1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.

SYSTEM: Double wall

CHANGES FROM CONVENTIONAL PRACTICE,
FOR BOTH CONVENTIONAL WALL SYSTEMS:

- o Add outer 38x64 (2x3) wall c/w 11 mm (7/16") fibreboard sheathing
- o Add RSI 3.52 (R-20) batt insulation between inner and outer walls
- o Replace 4 mil poly with well sealed 6 mil
- o Add 16 mm (5/8") aspenite top and bottom plates
- o Use interior wood returns on all doors and windows
- o Extend trusses and roof 300 mm (1') in each dimension
- o Extend foundation by 300 mm (1') in each dimension
- o Extend floor joists and beam by 300 mm (1')
- o Additional stucco/siding to each dimension
- o Replace studs with 38x89 (2x4) @ 400 mm (16") O.C. to form inner wall

| | CONVENTIONAL WALL RSI 2.11 (R-12) | RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $2478.92 | $2137.44 | m |
| | 985.00 | 970.00 | l |
| | $3463.92 | $3107.44 | |
| LESS SAVINGS: | $ 37.21 | $ 37.21 | m |
| | 0 | 0 | l |
| | $ 37.21 | $ 37.21 | |
| NET COST: | $2441.71 | $2100.23 | m |
| | 985.00 | 970.00 | l |
| | $3426.71 | $3020.23 | |
| NET UNIT INCREMENTAL COST: | 38.52 | 34.54 | $/m² |
| | 3.58 | 3.21 | $/ft² |
| COST PERFORMANCE INDEX: | 9 | 4 | |
| UPGRADED THERMAL RESISTANCE: | RSI 7.04 (R-40.0) | | |



NOTES:
1. Insulated area does not include headers.
2. Cost includes airtightness sealing of main walls, windows and doors.
3. Requires additional manpower or mechanical aids to raise walls.

SYSTEM: RSI 2.11 (R-12.0) interior glass fibre batts, 38x64 (2x3) framing

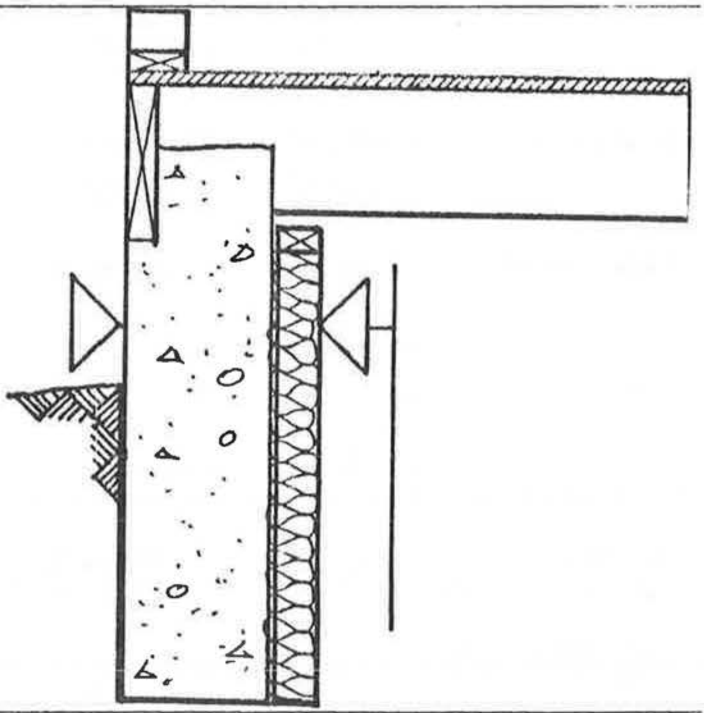
CHANGES FROM CONVENTIONAL PRACTICE:

- o Replace RSI 1.76 (R-10.0) batts with RSI 2.11 (R-12.0)

| | | |
|---|---|---|
| GROSS COST: | $37.28 | m |
| | 0 | l |
| | $37.28 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $37.28 | m |
| | 0 | l |
| | $37.28 | |

---

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 0.43 | $/m² |
| | 0.04 | $/ft² |
| COST PERFORMANCE INDEX: | 219 | |
| UPGRADED THERMAL RESISTANCE: | RSI 2.11 (R-12.0) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

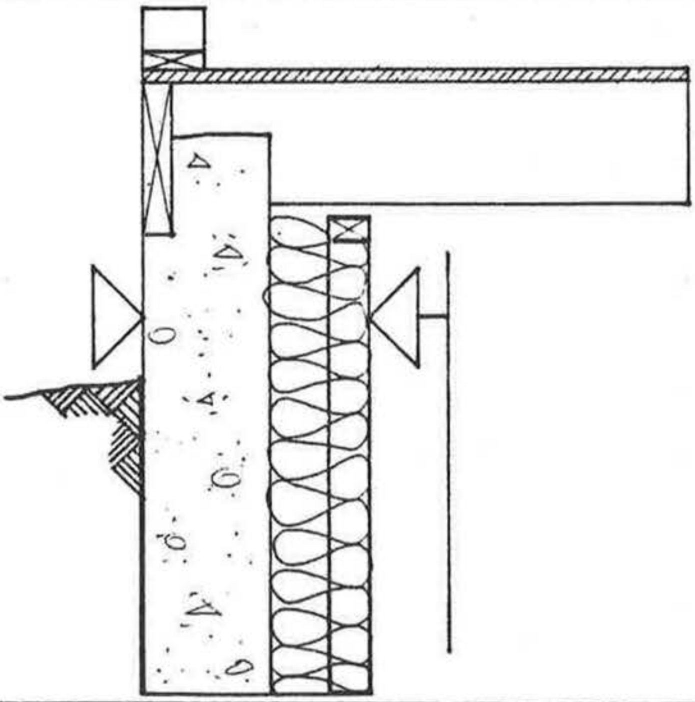
SYSTEM: RSI 3.52 (R-20.0) interior glass fibre batts, 38x64 (2x3) framing

CHANGES FROM CONVENTIONAL PRACTICE:

- o Replace RSI 1.76 (R-10.0) batts with RSI 3.52 (R-20.0)

| | | |
|---|---|---|
| GROSS COST: | $186.40 | m |
| | 12.00 | l |
| | $198.40 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $186.40 | m |
| | 12.00 | l |
| | $198.40 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 2.29 | $/m² |
| | 0.21 | $/ft² |
| COST PERFORMANCE INDEX: | 124 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.52 (R-20.0) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

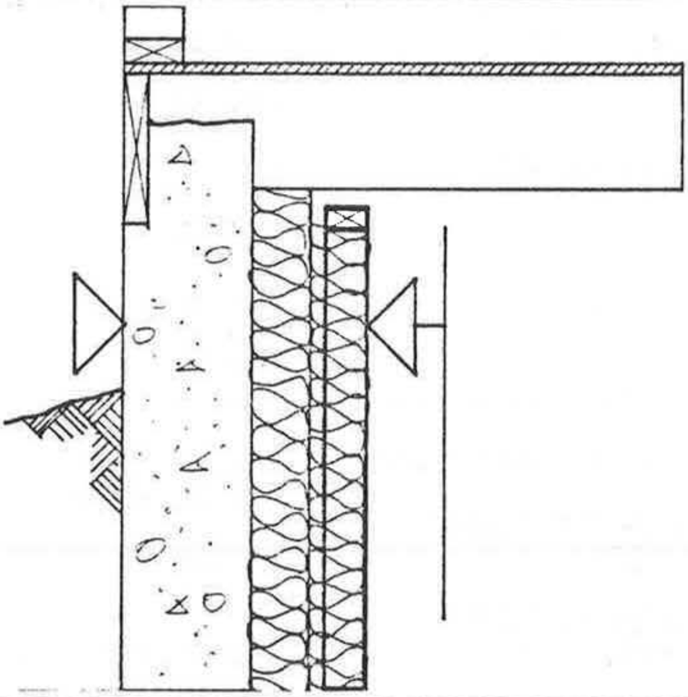
SYSTEM: RSI 4.23 (R-24.0) interior glass fibre batts, 38x64 (2x3) framing

CHANGES FROM CONVENTIONAL PRACTICE:

- o Replace RSI 1.76 (R-10.0) batts with RSI 2.11 (R-12.0) vertical and RSI 2.11 (R-12.0) horizontal

| | | |
|---|---|---|
| GROSS COST: | $260.96 | m |
| | 36.00 | l |
| | $296.96 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $260.96 | m |
| | 36.00 | l |
| | $296.96 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 3.43 | $\$/m^2$ |
| | 0.32 | $\$/ft^2$ |
| COST PERFORMANCE INDEX: | 97 | |
| UPGRADED THERMAL RESISTANCE: | RSI 4.23 (R-24.0) | |



NOTES:

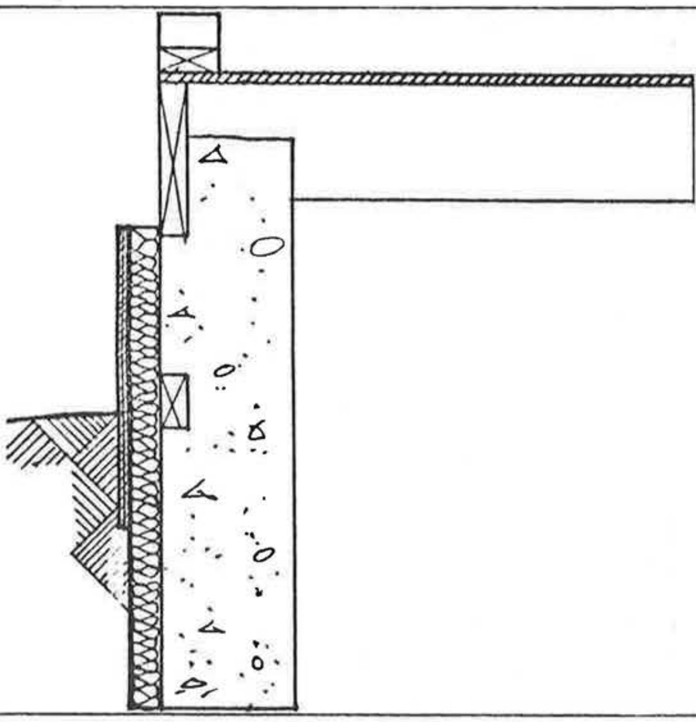
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

SYSTEM: 51 mm (2") exterior rigid glass fibre insulation, interior unfinished

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 51 mm (2") insulation to footing level
- o Cover insulation to 150 mm (6") B/G with 13 mm (½") P/T plywood
- o Delete interior insulation, framing, poly
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1115.06 | m |
| | 172.50 | l |
| | $1287.56 | |
| LESS SAVINGS: | $ 388.81 | m |
| | 121.00 | l |
| | $ 509.81 | |
| NET COST: | $ 726.25 | m |
| | 51.50 | l |
| | $ 777.75 | |



| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 8.98 | $/m² |
| | 0.83 | $/ft² |
| COST PERFORMANCE INDEX: | -11 | |
| UPGRADED THERMAL RESISTANCE: | RSI 1.50 (R-8.5) | |

NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

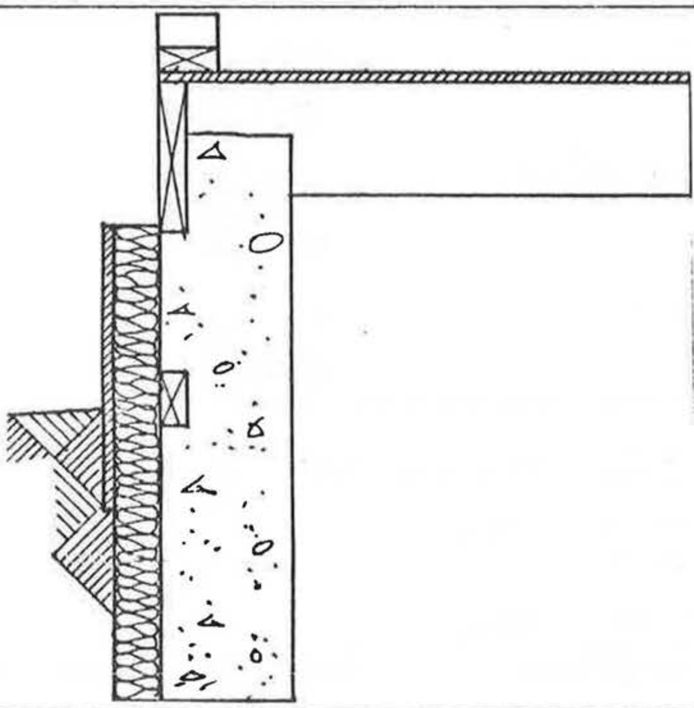
SYSTEM: 76 mm (3") exterior rigid glass fibre insulation, interior unfinished

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 76 mm (3") insulation to footing level
- o Cover insulation to 150 mm (6") B/G with 13 mm (½") P/T plywood
- o Delete interior insulation, framing, poly
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | \$1439.61 | m |
| | 187.50 | l |
| | \$1627.11 | |
| LESS SAVINGS: | \$ 388.81 | m |
| | 121.00 | l |
| | \$ 509.81 | |
| NET COST: | \$1050.80 | m |
| | 66.50 | l |
| | \$1117.30 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 12.90 | $\$/m^2$ |
| | 1.20 | $\$/ft^2$ |
| COST PERFORMANCE INDEX: | 11 | |
| UPGRADED THERMAL RESISTANCE: | RSI 2.38 (R-13.5) | |



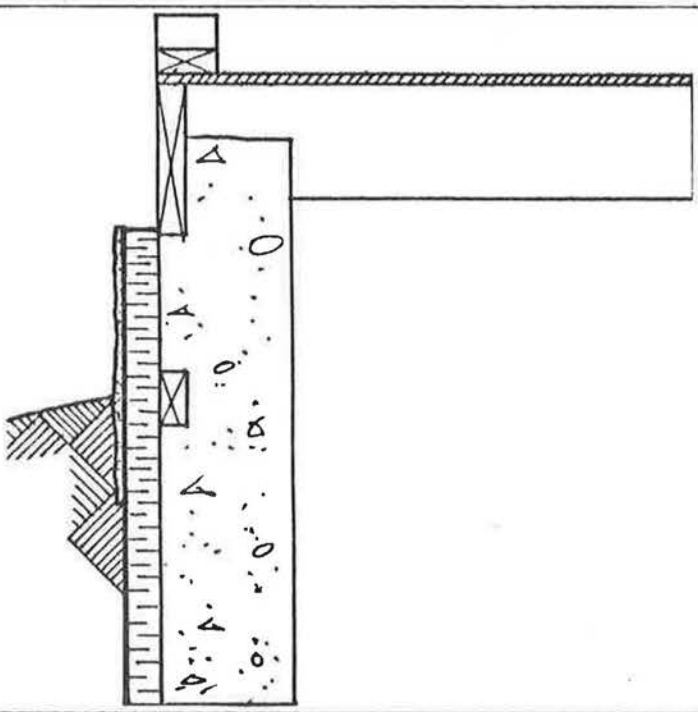
NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

SYSTEM: 51 mm (2") exterior extruded polystyrene insulation, basement unfinished

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 51 mm (2") insulation to footing level
- o Tape joints between sheets
- o Apply acrylic latex parging to 150 mm (6") B/G
- o Delete interior insulation, framing, poly
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1220.27 | m |
| | 172.50 | l |
| | $1392.77 | |
| LESS SAVINGS: | $ 388.81 | m |
| | 121.00 | l |
| | $ 509.81 | |
| NET COST: | $ 831.46 | m |
| | 51.50 | l |
| | $ 882.96 | |



| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 10.19 | $/m² |
| | 0.95 | $/ft² |
| COST PERFORMANCE INDEX: | 0 | |
| UPGRADED THERMAL RESISTANCE: | RSI 1.76 (R-10.0) | |

NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

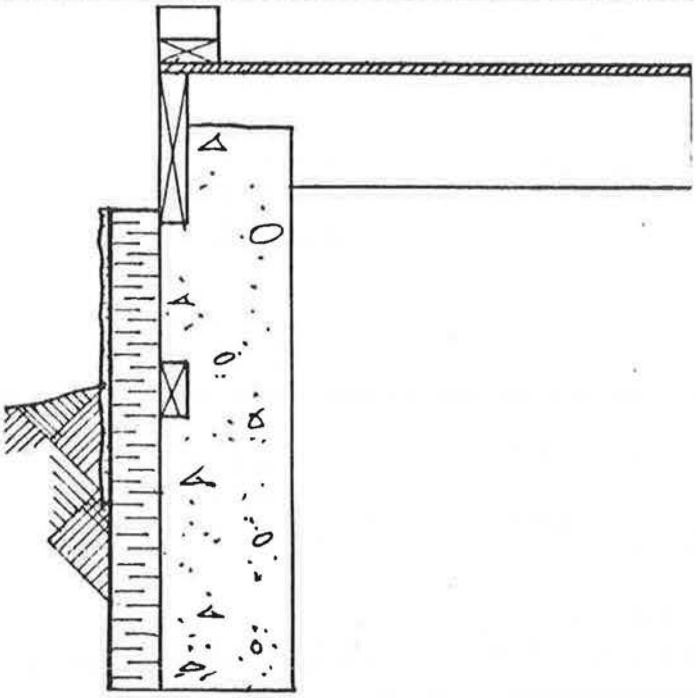
SYSTEM: 76 mm (3") exterior extruded polystyrene insulation, basement unfinished

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 76 mm (3") insulation to footing level
- o Tape joints between sheets
- o Apply acrylic latex parging to 150 mm (6") B/G
- o Delete interior insulation, framing, poly
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1660.15 | m |
| | 187.50 | l |
| | $1847.65 | |
| LESS SAVINGS: | $ 388.81 | m |
| | 121.00 | l |
| | $ 509.81 | |
| NET COST: | $1271.34 | m |
| | 66.50 | l |
| | $1337.84 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 15.45 | $/m² |
| | 1.44 | $/ft² |
| COST PERFORMANCE INDEX: | 12 | |
| UPGRADED THERMAL RESISTANCE: | RSI 2.64 (R-15.0) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

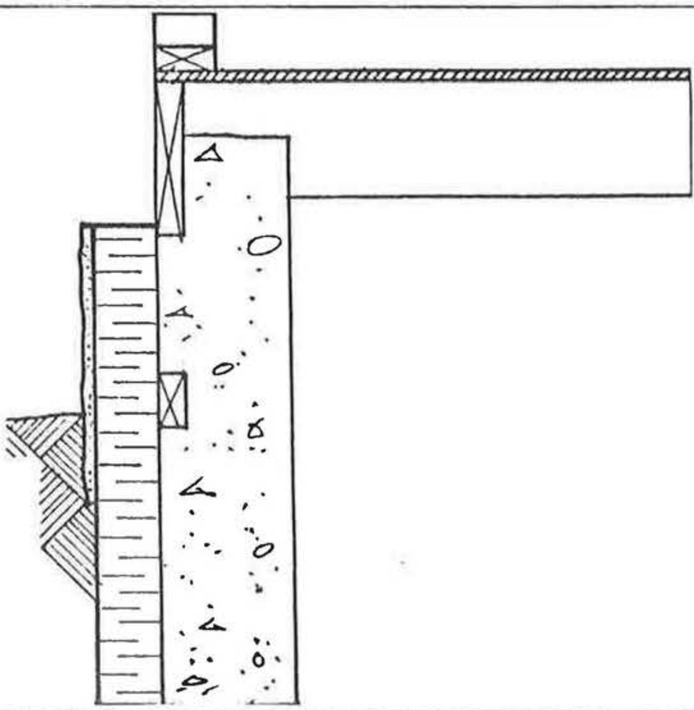
SYSTEM: 102 mm (4") exterior extruded polystyrene insulation, basement unfinished

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 102 mm (4") insulation to footing level
- o Tape joints between sheets
- o Apply acrylic latex parging to 150 mm (6") B/G
- o Delete interior insulation, framing, poly
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1764.25 | m |
| | 217.50 | l |
| | $1981.75 | |
| LESS SAVINGS: | $ 388.81 | m |
| | 121.00 | l |
| | $ 509.81 | |
| NET COST: | $1375.44 | m |
| | 96.50 | l |
| | $1471.94 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 16.99 | $/m² |
| | 1.58 | $/ft² |
| COST PERFORMANCE INDEX: | 17 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.52 (R-20.0) | |



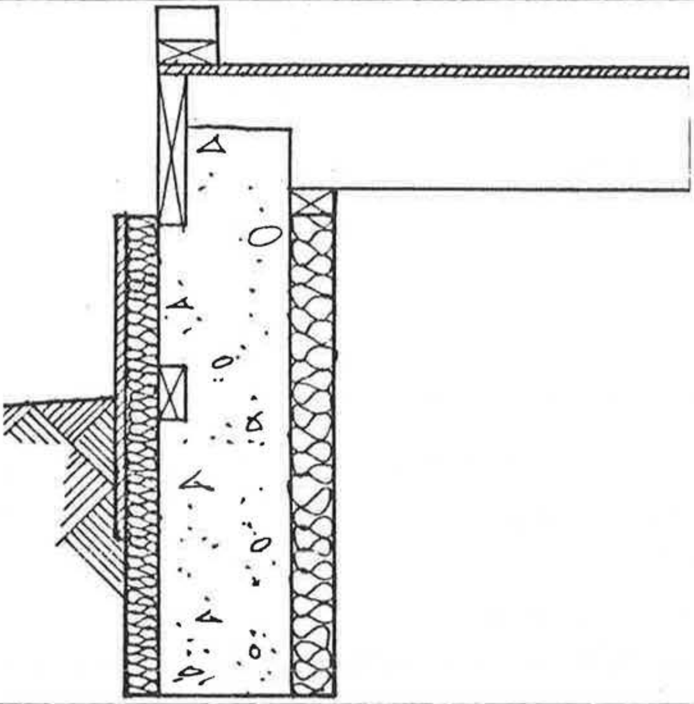
NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

SYSTEM: RSI 1.76 (R-10.0) interior glass fibre batts, 51 mm (2") exterior rigid glass fibre insulation

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 51 mm (2") insulation to footing level
- o Cover insulation to 150 mm (6") B/G with 13 mm (½") P/T plywood
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | \$1115.06 | m |
| | 172.50 | l |
| | \$1287.56 | |
| LESS SAVINGS: | \$ 50.00 | m |
| | 25.00 | l |
| | \$ 75.00 | |
| NET COST: | \$1065.00 | m |
| | 147.50 | l |
| | \$1212.56 | |



| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 14.00 | \$/m² |
| | 1.30 | \$/ft² |
| COST PERFORMANCE INDEX: | 19 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.26 (R-18.5) | |

NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

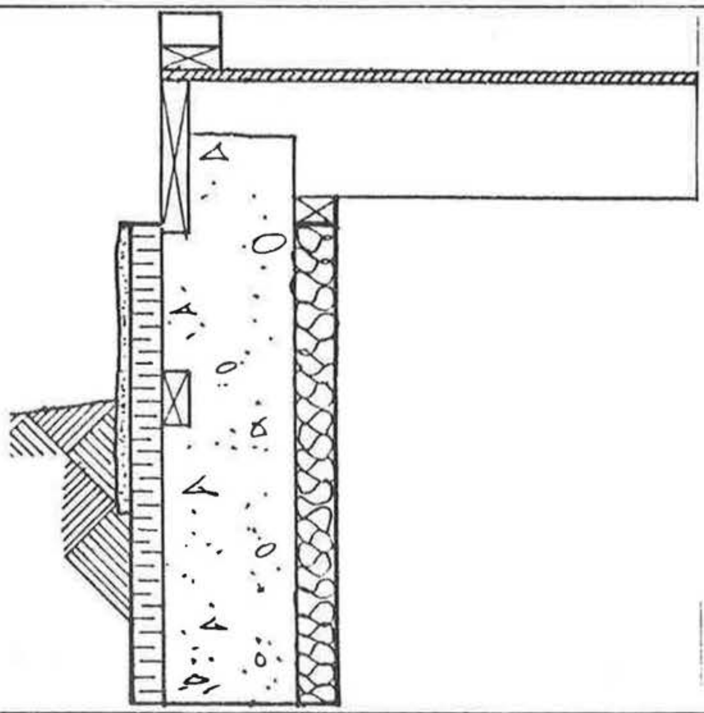
SYSTEM: RSI 1.76 (R-10.0) interior glass fibre batts, 51 mm (2") exterior extruded polystyrene insulation

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 51 mm (2") insulation to footing level
- o Tape joints between sheets
- o Apply acrylic latex parging to 150 mm (6") B/G
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1220.27 | m |
| | 172.50 | l |
| | $1392.77 | |
| LESS SAVINGS: | $ 50.00 | m |
| | 25.00 | l |
| | $ 75.00 | |
| NET COST: | $1170.27 | m |
| | 147.50 | l |
| | $1317.77 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 15.21 | $/m² |
| | 1.41 | $/ft² |
| COST PERFORMANCE INDEX: | 19 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.52 (R-20.0) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

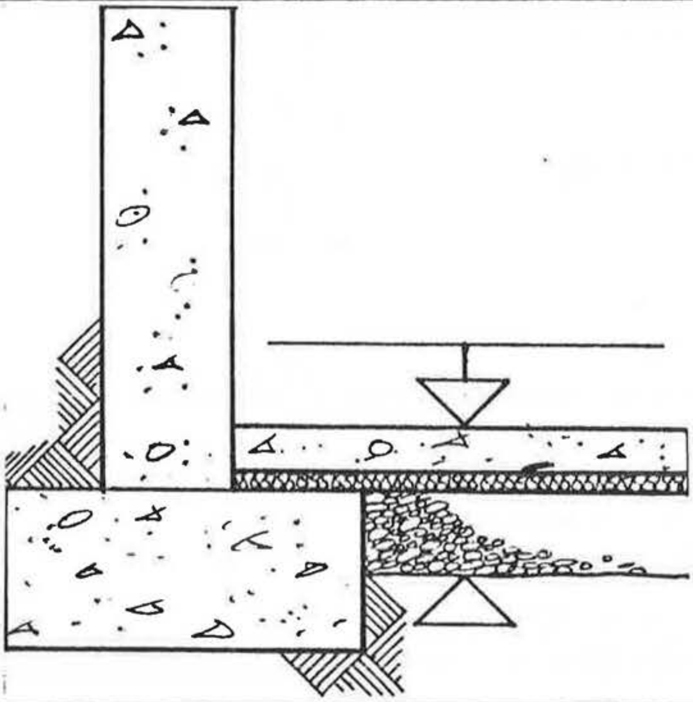
SYSTEM: Slab; 25 mm (1") rigid glass fibre insulation under slab

CHANGES FROM CONVENTIONAL PRACTICE:

- o Remove air barrier from insulation (see note 1)
- o Add 25 mm (1") insulation under slab

| | | |
|---|---|---|
| GROSS COST: | $ 353.23 | m |
| | 63.00 | l |
| | $ 416.23 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 353.23 | m |
| | 63.00 | l |
| | $ 416.23 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 4.69 | $/m² |
| | 0.44 | $/ft² |
| COST PERFORMANCE INDEX: | 881 | |
| UPGRADED THERMAL RESISTANCE: | RSI 0.97 (R-5.5) | |



NOTES:
1. Air barrier should be removed to prevent excessive cure time of concrete or water ponding within insulation.
2. Cost includes extra time to level small variations in pea gravel height.
3. RSI values include effect of concrete.
4. RSI values do not include effect of soil.

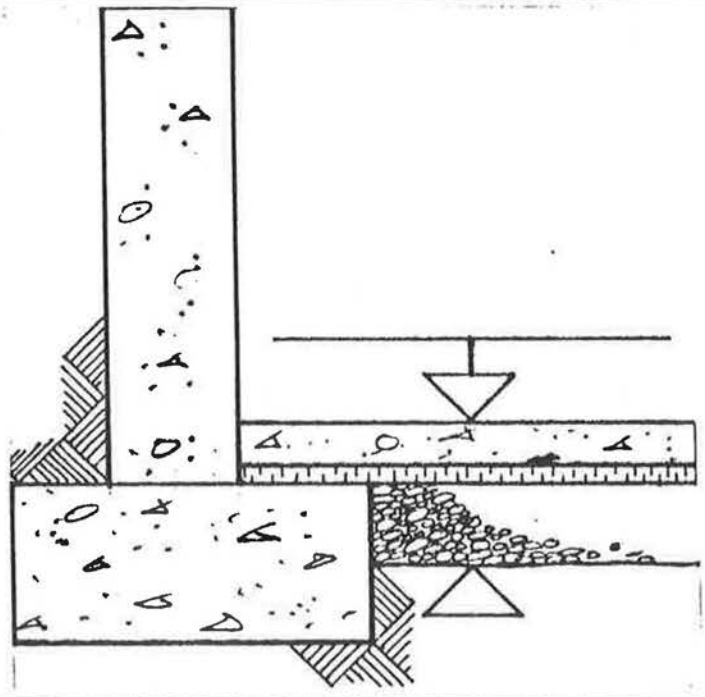
SYSTEM: Slab; 25 mm (1") extruded polystyrene under slab

CHANGES FROM CONVENTIONAL PRACTICE:

o Add 25 mm (1") insulation under slab

| | | |
|---|---|---|
| GROSS COST: | $ 419.40 | m |
| | 73.50 | l |
| | $ 492.50 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 419.40 | m |
| | 73.50 | l |
| | $ 492.50 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 5.55 | $/m² |
| | 0.52 | $/ft² |
| COST PERFORMANCE INDEX: | 762 | |
| UPGRADED THERMAL RESISTANCE: | RSI 1.07 (R-6.1) | |



NOTES:
1. Cost includes extra time to level small variations in pea gravel height.
2. RSI values include effect of concrete.
3. RSI values do not include effect of soil.

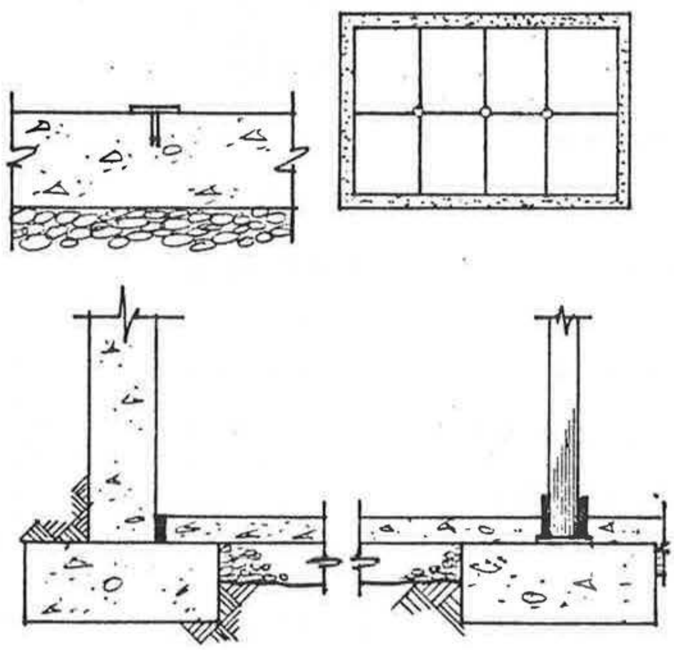
SYSTEM: Slab; crack initiators and isolators

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in crack initiators in approx. 3mx3m (10'x10') sections
- o Place 16 mm (5/8") fibreboard strip slip joint around perimeter of slab
- o Place slip joints around tele-posts

| | | | |
|---|---|---|---|
| GROSS COST: | $ | 45.97 | m |
| | | 28.88 | l |
| | $ | 74.85 | |
| LESS SAVINGS: | $ | 0 | m |
| | | 0 | l |
| | $ | 0 | |
| NET COST: | $ | 45.97 | m |
| | | 28.88 | l |
| | $ | 74.85 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 0.84 | $/m² |
| | 0.08 | $/ft² |
| COST PERFORMANCE INDEX: | N/A | |
| UPGRADED THERMAL RESISTANCE: | N/A | |



NOTES:

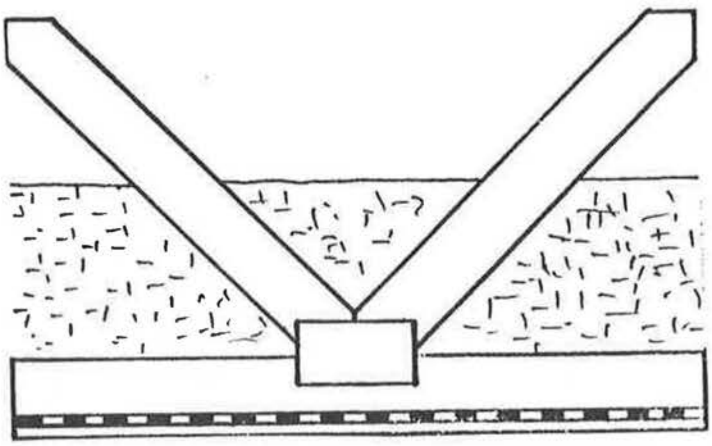
1. Assumes 2 man basement floor placer crew to install crack initiators.

SYSTEM: RSI 7.93 (R-45.0) blown-in cellulose

CHANGES FROM CONVENTIONAL PRACTICE:

o Blow-in additional RSI 0.88 (R-5.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $66.82 | m |
| | | l |
| | $66.82 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $66.82 | m |
| | | l |
| | $66.82 | |
| NET UNIT INCREMENTAL COST: | 0.73 | $/m² |
| | 0.07 | $/ft² |
| COST PERFORMANCE INDEX: | 22 | |



NOTES:

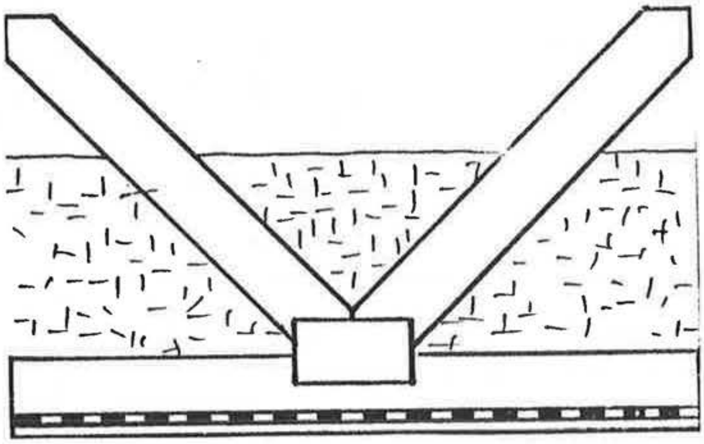
1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) blown-in cellulose.

SYSTEM: RSI 8.81 (R-50.0) blown-in cellulose

CHANGES FROM CONVENTIONAL PRACTICE:

- o Blow in additional RSI 1.76 (R-10.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $133.64 | m |
| | | l |
| | $133.64 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $133.64 | m |
| | | l |
| | $133.64 | |
| NET UNIT INCREMENTAL COST: | 1.45 | $/m² |
| | 0.13 | $/ft² |
| COST PERFORMANCE INDEX: | 20 | |



NOTES:

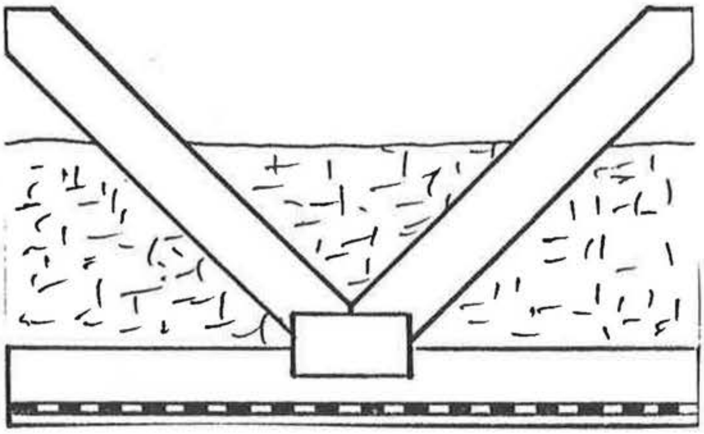
1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) blown-in cellulose.

SYSTEM: RSI 9.69 (R-55.0) blown-in cellulose

CHANGES FROM CONVENTIONAL PRACTICE:

o Blow in additional RSI 2.64 (R-15.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $200.46 | m |
| | | l |
| | $200.46 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $200.46 | m |
| | | l |
| | $200.46 | |
| NET UNIT INCREMENTAL COST: | 2.18 | $/m² |
| | 0.20 | $/ft² |
| COST PERFORMANCE INDEX: | 18 | |



NOTES:

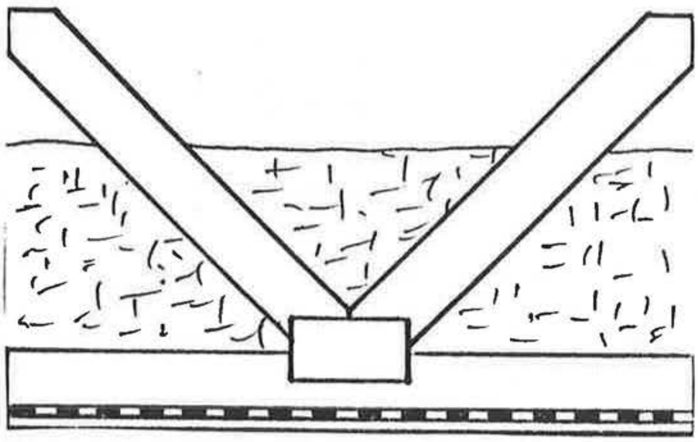
1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) blown-in cellulose.

SYSTEM: RSI 10.57 (R-60.0) blown-in cellulose

CHANGES FROM CONVENTIONAL PRACTICE:

o Blow in additional RSI 3.52 (R-20.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $267.28 | m |
| | | l |
| | $267.28 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $267.28 | m |
| | | l |
| | $267.28 | |
| NET UNIT INCREMENTAL COST: | 2.91 | $/m² |
| | 0.27 | $/ft² |
| COST PERFORMANCE INDEX: | 16 | |



NOTES:

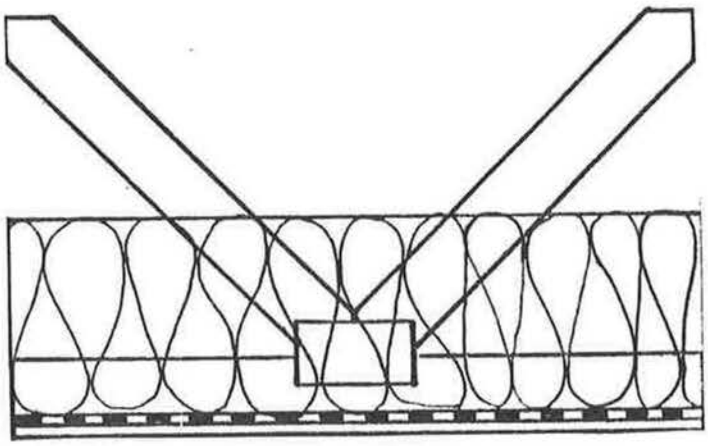
1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) blown-in cellulose.

SYSTEM: RSI 7.93 (R-45.0) glass fibre blowing wool

CHANGES FROM CONVENTIONAL PRACTICE:

o Blow in additional RSI 0.88 (R-5.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $ 78.99 | m |
| | | l |
| | $ 78.99 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 78.99 | m |
| | | l |
| | $ 78.99 | |
| NET UNIT INCREMENTAL COST: | 0.86 | $/m² |
| | 0.08 | $/ft² |
| COST PERFORMANCE INDEX: | 19 | |



NOTES:

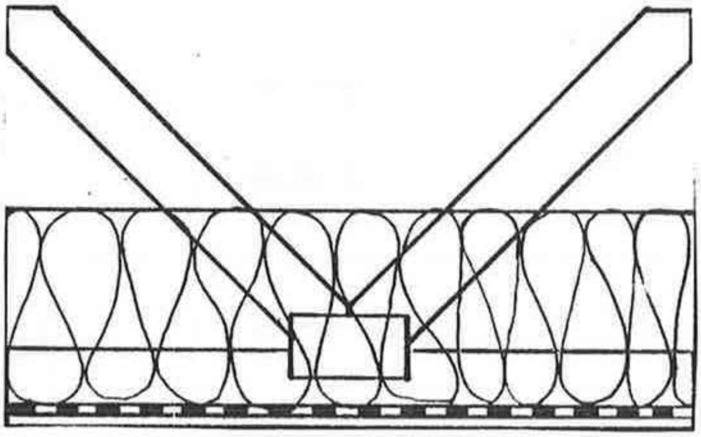
1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) glass fibre blowing wool.

SYSTEM: RSI 8.81 (R-50.0) glass fibre blowing wool

CHANGES FROM CONVENTIONAL PRACTICE:

o Blow in additional RSI 1.76 (R-10.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $157.98 | m |
| | | 1 |
| | $157.98 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | 1 |
| | $ 0 | |
| NET COST: | $157.98 | m |
| | | 1 |
| | $157.98 | |
| NET UNIT INCREMENTAL COST: | 1.72 | $/m² |
| | 0.16 | $/ft² |
| COST PERFORMANCE INDEX: | 17 | |



NOTES:

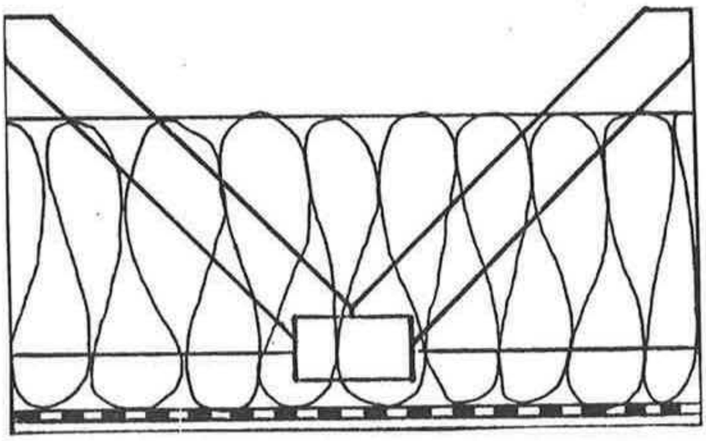
1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) glass fibre blowing wool.

SYSTEM: RSI 9.69 (R-55.0) glass fibre blowing wool

CHANGES FROM CONVENTIONAL PRACTICE:

o Blow in additional RSI 2.64 (R-15.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $236.96 | m |
| | | 1 |
| | $236.96 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | 1 |
| | $ 0 | |
| NET COST: | $236.96 | m |
| | | 1 |
| | $236.96 | |
| NET UNIT INCREMENTAL COST: | 2.57 | $/m² |
| | 0.24 | $/ft² |
| COST PERFORMANCE INDEX: | 15 | |



NOTES:

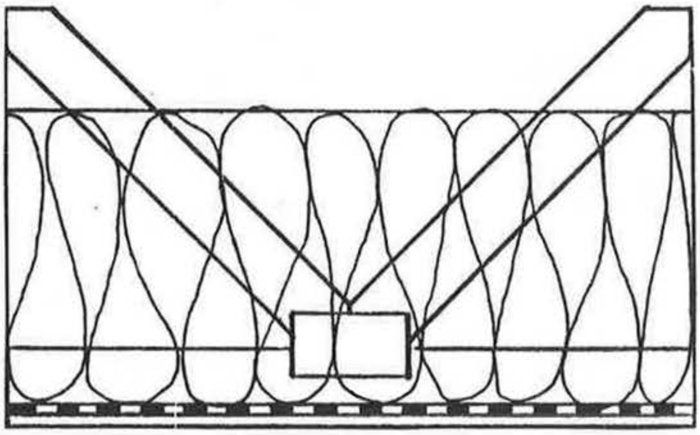
1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) glass fibre blowing wool.

SYSTEM: RSI 10.57 (R-60.0) glass fibre blowing wool

CHANGES FROM CONVENTIONAL PRACTICE:

o Blow in additional RSI 3.52 (R-20.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $315.95 | m |
| | | l |
| | $315.95 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $315.95 | m |
| | | l |
| | $315.95 | |
| NET UNIT INCREMENTAL COST: | 3.43 | $/m² |
| | 0.32 | $/ft² |
| COST PERFORMANCE INDEX: | 14 | |



NOTES:

1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) glass fibre blowing wool.

AIRTIGHTNESS A-1

SYSTEM COMPONENTS: Material; main floor, 6 mil poly air/vapour barrier

CONVENTIONAL PRACTICE: 4 mil poly

CHANGES FROM CONVENTIONAL PRACTICE:

o Replace 4 mil poly with 6 mil on main walls and ceiling

| | | |
|---|---|---|
| GROSS COST: | $ 52.22 | m |
| | 60.00 | l |
| | $112.22 | |
| LESS SAVINGS: | $ 34.74 | m |
| | 60.00 | l |
| | $ 94.74 | |
| NET COST: | $ 17.48 | m |
| | 0 | l |
| | $ 17.48 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Does not include any additional sealing, material change only.
2. Total wall and ceiling area 181 $m^2$ (1947 $ft^2$).

AIRTIGHTNESS A-2

SYSTEM COMPONENTS: Material; basement, 6 mil poly air/vapour barrier

CONVENTIONAL PRACTICE: 4 mil poly

CHANGES FROM CONVENTIONAL PRACTICE:

- Replace 4 mil poly with 6 mil on basement walls, excluding header areas

| | | |
|---|---|---|
| GROSS COST: | $23.98 | m |
| | 18.00 | l |
| | $41.98 | |
| LESS SAVINGS: | $15.95 | m |
| | 18.00 | l |
| | $33.95 | |
| NET COST: | $ 8.03 | m |
| | 0 | l |
| | $ 8.03 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Does not include any additional sealing, material change only.
2. Total wall and ceiling area 87 m² (932 ft²).

SYSTEM COMPONENT: Main floor walls; continuous, sealed poly air/vapour barrier

CONVENTIONAL PRACTICE: Poly, stapled, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply acoustical sealant to seal:
  - top plate
  - bottom plate
  - lap joints in poly
- o Approx. 3.9 tubes of caulking required

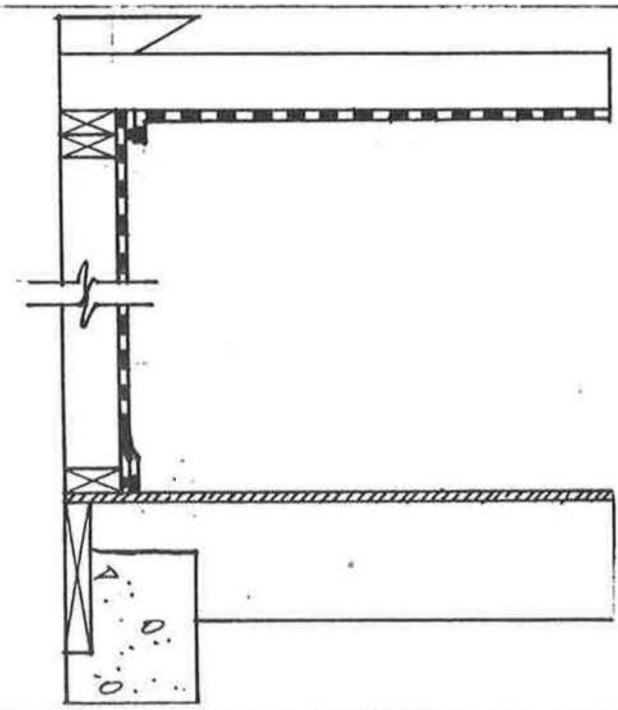
GROSS COST: $19.37 m
10.00 l
$29.37

LESS SAVINGS: $ 0 m
0 l
$ 0

NET COST: $19.37 m
10.00 l
$29.37

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:50 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Assumes poly installed prior to partition walls.
2. Does not include sealing of:
   - windows and doors
   - electrical outlets
   - ceiling
   - headers

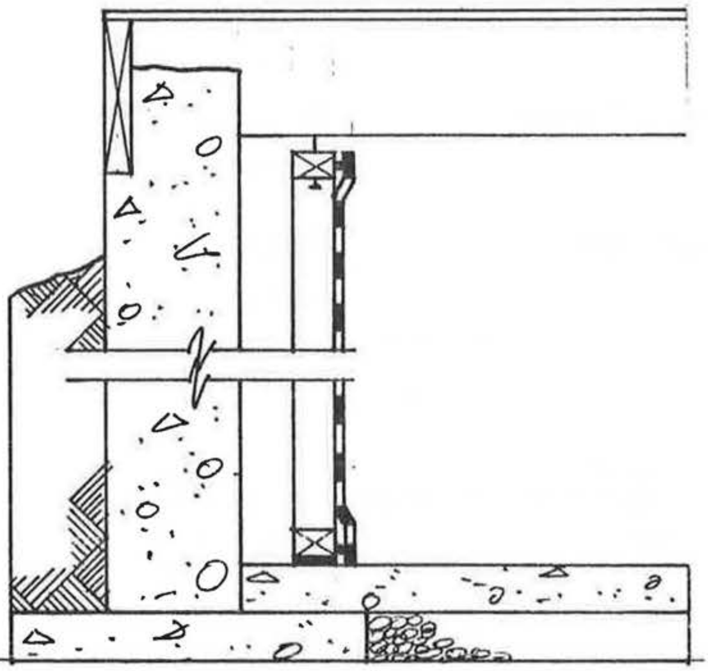
SYSTEM COMPONENT: Basement walls; continuous, sealed poly air/vapour barrier

CONVENTIONAL PRACTICE: Poly, stapled, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply acoustical sealant to seal:
  - top plate
  - bottom plate
  - lap joints in poly
- o Approx. 3.8 tubes of caulking required
- o Apply 89 mm (3½") sill plate gasket under bottom plate, approx. 40 m (130') required

| | | |
|---|---|---|
| GROSS COST: | $32.84 | m |
| | 14.00 | l |
| | $46.84 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $32.84 | m |
| | 14.00 | l |
| | $46.84 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 1:10 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Does not include sealing of:
   - basement windows
   - electrical outlets
   - headers

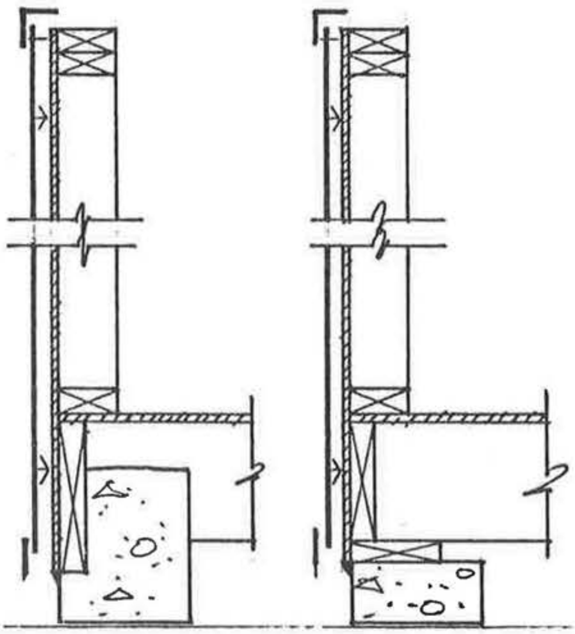
SYSTEM COMPONENT: Wall/header; exterior air barrier

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply polyolefin sheet to exterior of framed wall from top plate to bottom of header or sill plate to serve as air barrier
- o Tape all joints and penetrations with sheathing tape
- o Caulk joint between header and foundation or sill plate and foundation, approx. 4 tubes of caulking required
- o Polyolefin sheet replaces building paper

| | | |
|---|---|---|
| GROSS COST: | $134.83 | m |
| | 37.50 | l |
| | $172.33 | |
| LESS SAVINGS: | $ 19.22 | m |
| | 30.00 | l |
| | $ 49.22 | |
| NET COST: | $115.61 | m |
| | 7.50 | l |
| | $123.11 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Rigid exterior glass fibre insulated sheathing comes complete with polyolefin air barrier.

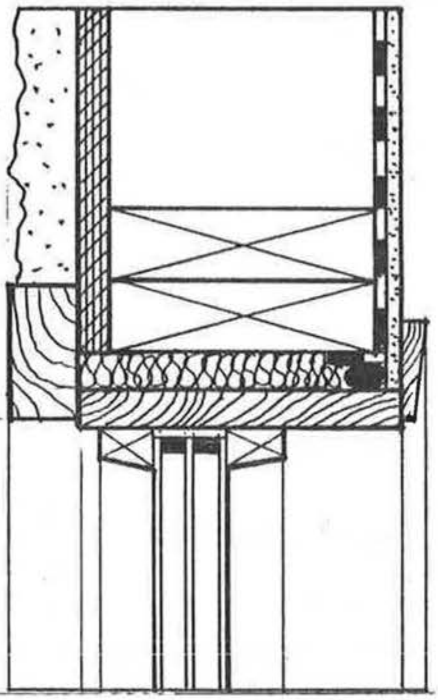
SYSTEM COMPONENT: Doors and windows; ethafoam rod

CONVENTIONAL PRACTICE: Glass fibre insulation stuffed into space between rough opening and jamb

CHANGES FROM CONVENTIONAL PRACTICE:

- o After glass fibre batts have been stuffed around jambs, force fit appropriate diameter ethafoam rod into space to sit against drywall
- o Approx. 53 m (175') of joints to be gasketed

| | | |
|---|---|---|
| GROSS COST: | $ 8.36 | m |
| | 22.50 | l |
| | $ 30.86 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 8.36 | m |
| | 22.50 | l |
| | $ 30.86 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Requires several different sizes of ethafoam rods to be kept on site. Available in at least 8 sizes between 6 mm (¼") and 38 mm (1½").
2. Glass fibre jammed into space between window and door frames and rough openings to provide insulating value.

SYSTEM COMPONENT: Doors and windows; poly-wrap

CONVENTIONAL PRACTICE: Glass fibre insulation stuffed into space between rough opening and jamb

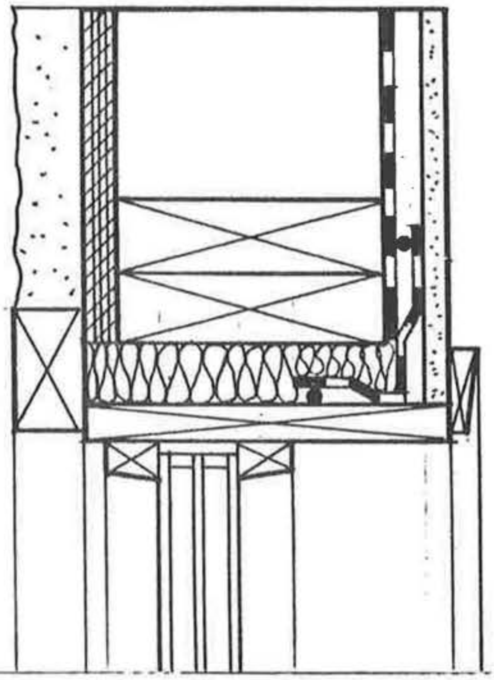
CHANGES FROM CONVENTIONAL PRACTICE:

- o Poly-wrap all doors and windows; caulk and staple poly to frames; seal window/door poly to main wall poly
- o Approx. ¼ tube (average) of caulking required per window or door
- o Seal 7 windows and 2 doors

| | | |
|---|---|---|
| GROSS COST: | $ 16.60 | m |
| | 67.50 | l |
| | $ 84.10 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 16.60 | m |
| | 67.50 | l |
| | $ 84.10 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 4:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Glass fibre jammed into space between window and door frames and rough openings to provide insulating value.

SYSTEM COMPONENT: Wall/floor/foundation; poly air/vapour barrier

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

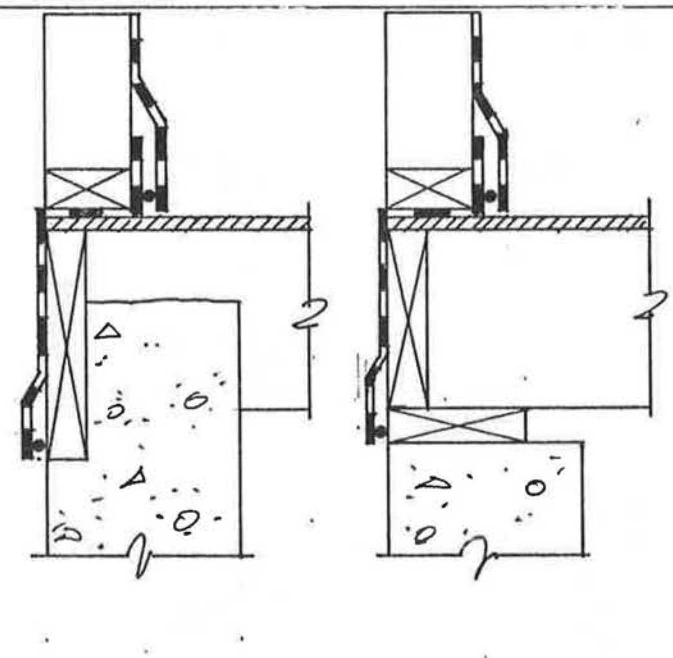
CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply poly strip around headers as shown, seal at points A and B with acoustical sealant
- o Apply strip of building paper on top of poly to provide protection when wall is raised
- o Approx. 4 tubes of caulking required

| | | |
|---|---|---|
| GROSS COST: | $ 26.48 | m |
| | 22.50 | l |
| | $ 48.98 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 26.48 | m |
| | 22.50 | l |
| | $ 48.98 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. This detail can only be used when exterior insulation is used which will prevent condensation in the header area (if no exterior insulation is used, see system A-9 or use a recessed header).
2. Caulking bead at point "B" should be wide enough to seal crack between the header/sill plate and the concrete and yet permit poly to be stapled to header/sill plate through the bead.

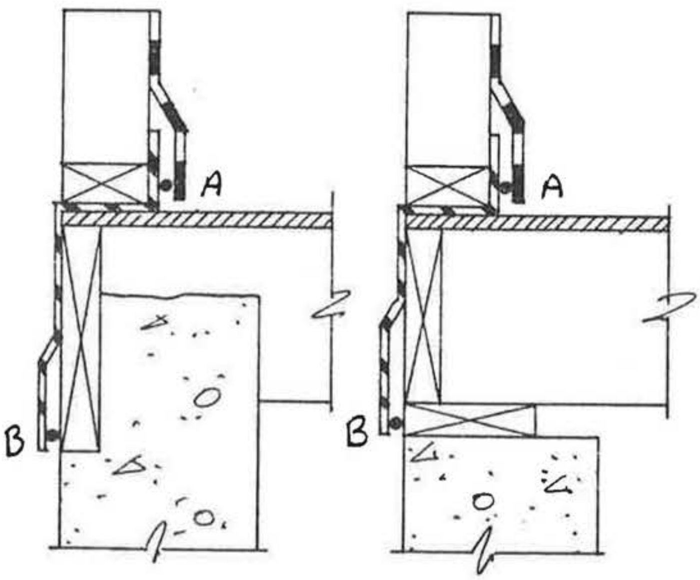
SYSTEM COMPONENT: Wall/floor/foundation; polyolefin air barrier

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply polyolefin strip around headers as shown. Seal at points A and B with acoustical sealant
- o Approx. 4 tubes of caulking required

| | | |
|---|---|---|
| GROSS COST: | $ 39.04 | m |
| | 20.00 | l |
| | $ 59.04 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 39.04 | m |
| | 20.00 | l |
| | $ 59.04 | |




ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:20 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Does not require exterior insulation to be applied over polyolefin sheet.
2. Caulking bead at point "B" should be wide enough to seal crack between the header/sill plate and the concrete and yet permit poly to be stapled to header/sill plate through the bead.

AIRTIGHTNESS A-10(a)

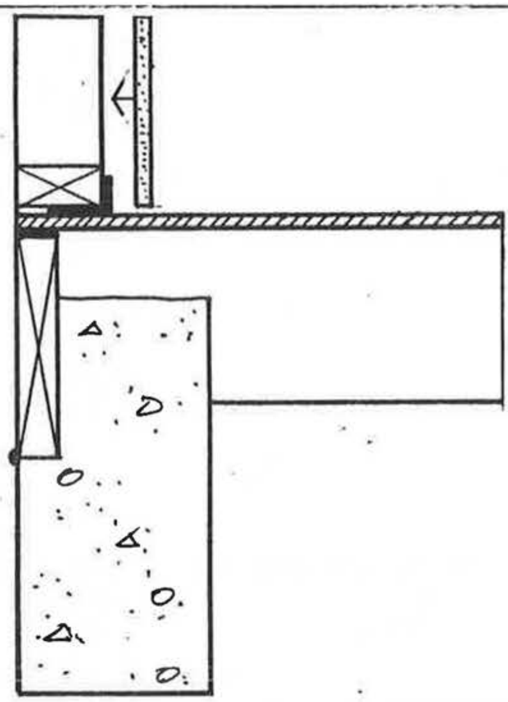
SYSTEM COMPONENT: Wall/floor/cast-in-place foundation; gasket sealing

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply 140 mm (5½") sill plate gasket under bottom plate, fold end up to seal face of plate against drywall
- o Apply 6mmx10mm (1/4"x3/8") open cell neoprene gasket to top of header
- o Caulk joint between header and foundation, approx. 2.2 tubes of caulking required

| | | |
|---|---|---|
| GROSS COST: | $ 53.37 | m |
| | 25.00 | l |
| | $ 78.37 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 53.37 | m |
| | 25.00 | l |
| | $ 78.37 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:40 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Single 140 mm (5½") sill plate gasket can be replaced by 2 soft, open cell gaskets.

SYSTEM COMPONENT: Wall/floor/sill plate foundation; gasket sealing

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

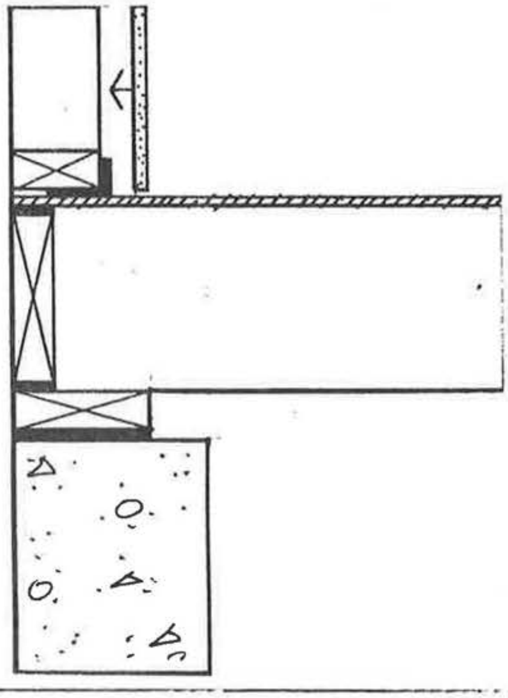
CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply 140 mm (5½") sill plate gasket under bottom plate, fold end up to seal face of plate against drywall
- o Apply 6mmx10mm (1/4"x3/8") open cell neoprene gasket to top and bottom of header
- o Apply 140 mm (5½") sill plate gasket between sill plate and foundation

| | | |
|---|---|---|
| GROSS COST: | $ 84.82 | m |
| | 33.75 | l |
| | $118.57 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 84.82 | m |
| | 33.75 | l |
| | $118.57 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 2:15 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Single 140 mm (5½") sill plate gasket under bottom plate can be replaced by 2 soft, open cell gaskets.

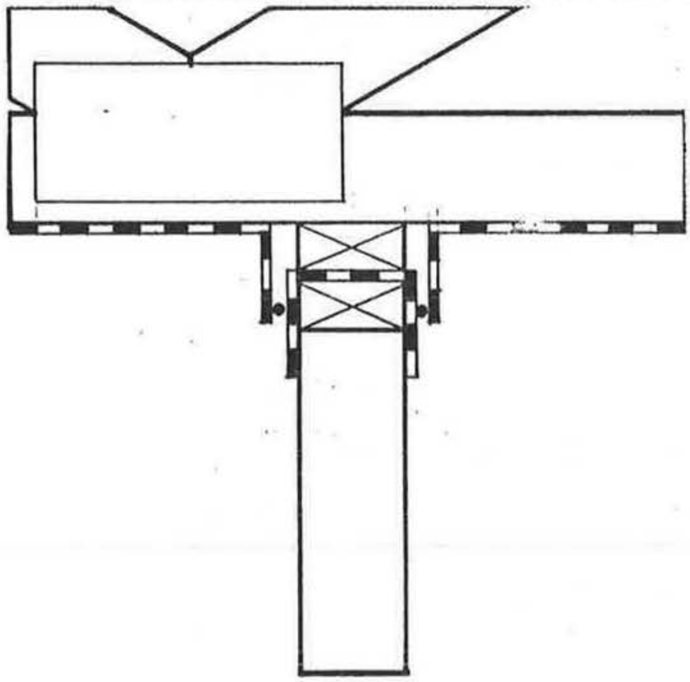
SYSTEM COMPONENT: Ceiling; poly air/vapour barrier sealed to partition walls

CONVENTIONAL PRACTICE: Poly stapled, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Install continuous sheets of poly, seal all joints
- o Install 300 mm (12") strips of poly along partition walls, seal to ceiling poly
- o Approx. 3.8 tubes of caulking required
- o Mate ceiling poly to main wall poly

| | | |
|---|---|---|
| GROSS COST: | $ 18.92 | m |
| | 22.50 | l |
| | $ 41.42 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 18.92 | m |
| | 22.50 | l |
| | $ 41.42 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Suitable for load-bearing partition walls where partition wall must be installed prior to trusses.
2. Assumes caulking of main wall/ceiling joint accounted for in main floor wall sealing.

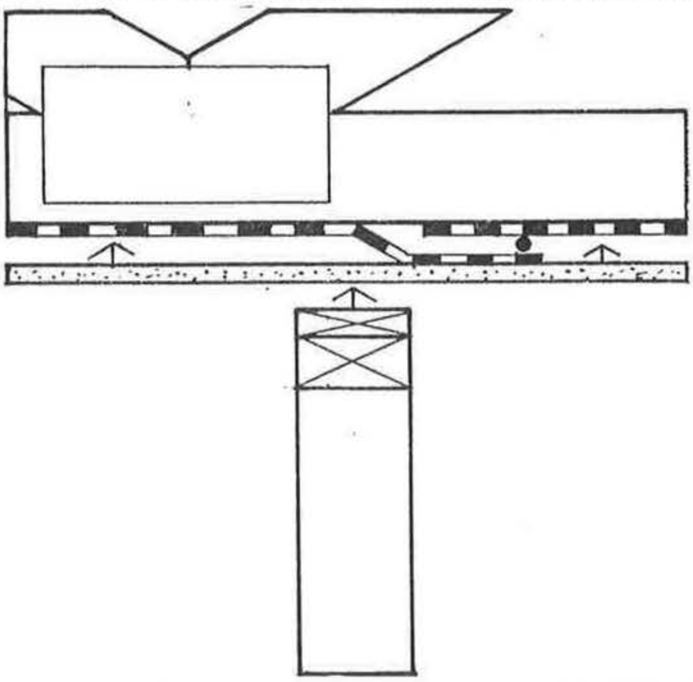
SYSTEM COMPONENT: Ceiling; continuous sealed poly air/vapour barrier

CONVENTIONAL PRACTICE: Poly stapled, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Install continuous sheets of poly, seal all joints, drywall and tape ceiling prior to framing partition walls
- o Approx. 1.1 tubes of caulking required
- o Mate ceiling poly to main wall poly
- o Use 19x89 (1x4) plate on top of partition walls instead of 38x89 (2x4) to provide clearance for drywall

| | | |
|---|---|---|
| GROSS COST: | $ 5.48 | m |
| | 3.00 | l |
| | $ 8.48 | |
| LESS SAVINGS: | $ 5.29 | m |
| | 15.00 | l |
| | $ 20.29 | |
| NET COST: | $ 0.19 | m |
| | -12.00 | l |
| | $-11.81 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | -0:45 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Assumes caulking of main wall/ceiling joint accounted for in main floor wall sealing.
2. May require re-scheduling between framers and drywallers since ceiling drywall has to be installed and taped before partitions are framed.

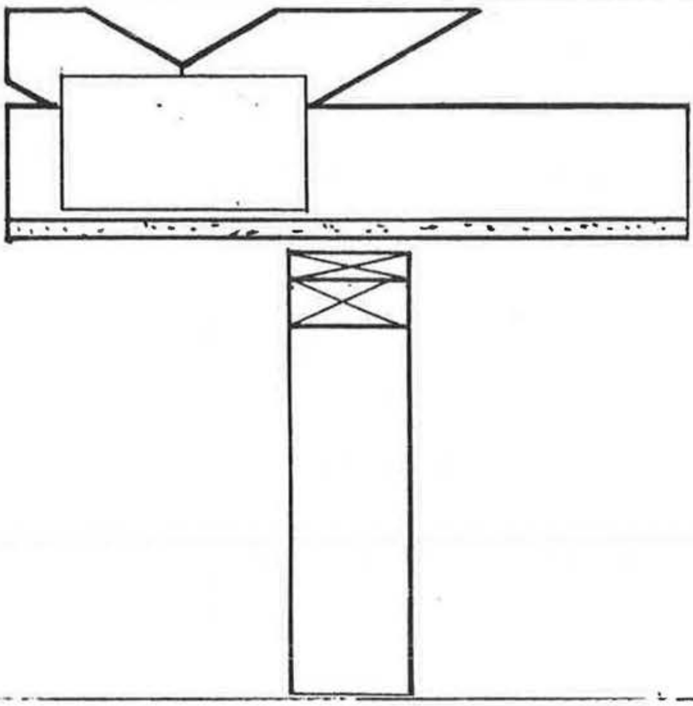
SYSTEM COMPONENT: Ceiling; continuous taped drywall air barrier (ADA)

CONVENTIONAL PRACTICE: Poly stapled, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Install and tape drywall prior to framing partition walls, no poly used
- o Use 19x89 (1x4) plate on top of partition walls instead of 38x89 (2x4) to provide clearance for drywall

| | | |
|---|---|---|
| GROSS COST: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| LESS SAVINGS: | $ 5.29 | m |
| | 15.00 | l |
| | $ 20.29 | |
| NET COST: | $ -5.29 | m |
| | -15.00 | l |
| | $-20.29 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | -1:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

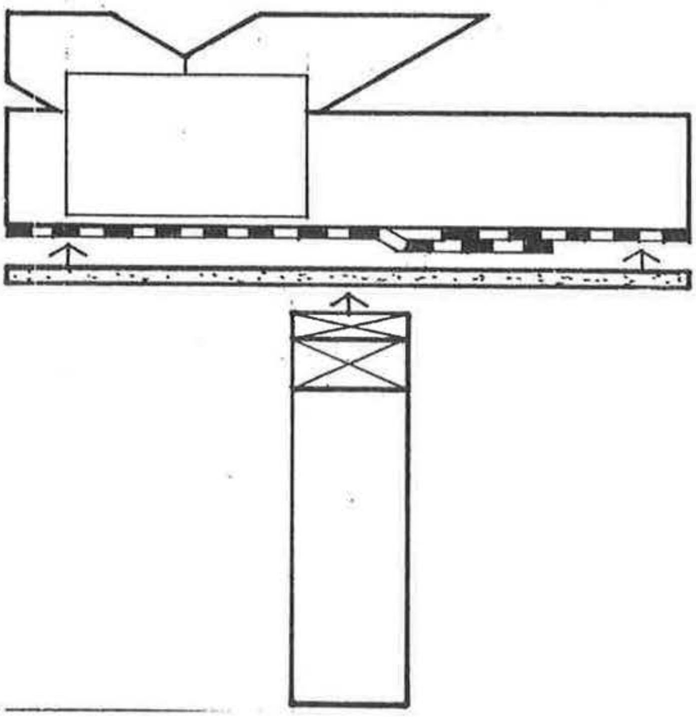
1. Requires ceiling paint to serve as vapour barrier see Sheet A-21.
2. May require re-scheduling between framers and drywallers since ceiling drywall has to be installed and taped before partitions are framed.

SYSTEM COMPONENT: Ceiling; continuous taped drywall air barrier (ADA), poly vapour barrier

CONVENTIONAL PRACTICE: Poly stapled, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Install stapled, 4 mil poly prior to partition wall (conventional practice)
- o Use 19x89 (1x4) plate on top of partition walls instead of 38x89 (2x4) to provide clearance for drywall



| | | |
|---|---|---|
| GROSS COST: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| LESS SAVINGS: | $ 5.29 | m |
| | 15.00 | l |
| | $ 20.29 | |
| NET COST: | $ -5.29 | m |
| | -15.00 | l |
| | $-20.29 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | -1:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Poly serves as vapour barrier.
2. May require re-scheduling between framers and drywallers since ceiling drywall has to be installed and taped before partitions are framed.

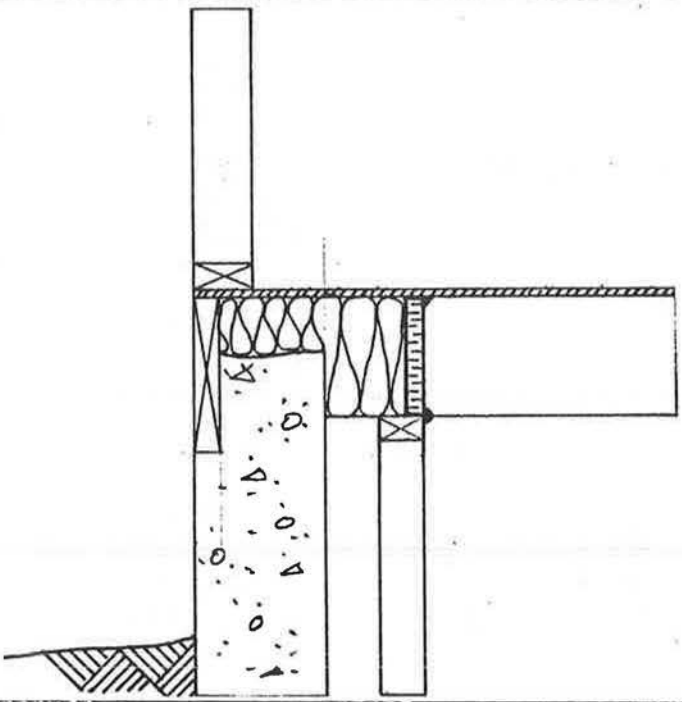
SYSTEM COMPONENT: Headers; interior rigid air/vapour barrier

CONVENTIONAL PRACTICE: Poly stapled in header spaces, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Install 25 mm (1") extruded polystyrene in each header space. Caulk in place, approx. 4.8 tubes required

| | | |
|---|---|---|
| GROSS COST: | $ 61.16 | m |
| | 144.00 | l |
| | $205.16 | |
| LESS SAVINGS: | $ 1.55 | m |
| | 36.00 | l |
| | $ 37.55 | |
| NET COST: | $ 59.61 | m |
| | 108.00 | l |
| | $167.61 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 9:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Can be difficult to install where headers run parallel to joists.

AIRTIGHTNESS A-16(a)

SYSTEM COMPONENT: Headers; insulation-filled poly bags with RSI 2.11 (R-12.0)

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

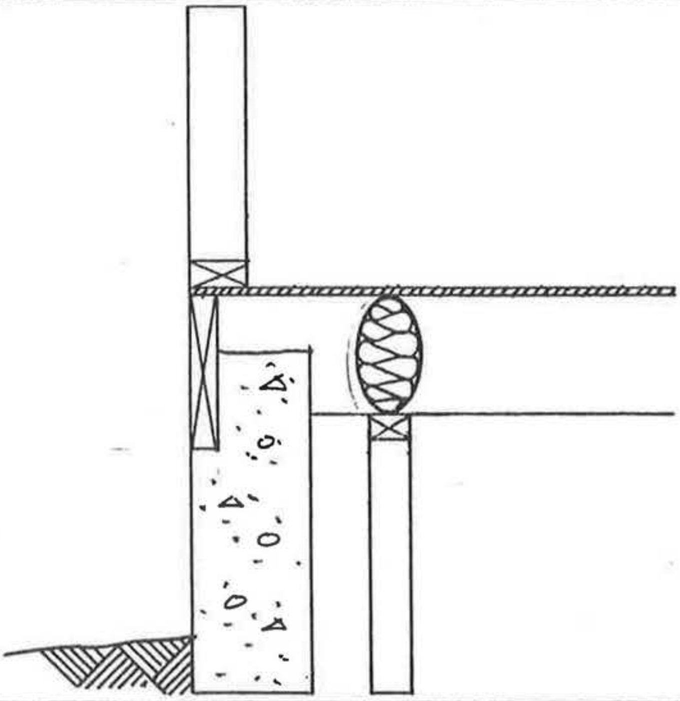
CHANGES FROM CONVENTIONAL PRACTICE:

- o Install insulation-filled poly bags with RSI 2.11 (R-12.0) into header spaces

| | |
|---|---|
| GROSS COST: | $ 28.59 m |
| | 12.00 l |
| | $ 40.59 |
| LESS SAVINGS: | $ 23.25 m |
| | 54.00 l |
| | $ 77.25 |
| NET COST: | $ 5.34 m |
| | -42.00 l |
| | $-36.66 |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | -3:30 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. "Less Savings" includes cost of the RSI 2.11 (R-12.0) insulation used in conventional practice.
2. May require separate air barrier or that the house be operated under a negative pressure differential.
3. Poly bags function as vapour barrier.

SYSTEM COMPONENT: Headers; insulation-filled poly bags with RSI 3.52 (R-20.0)

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

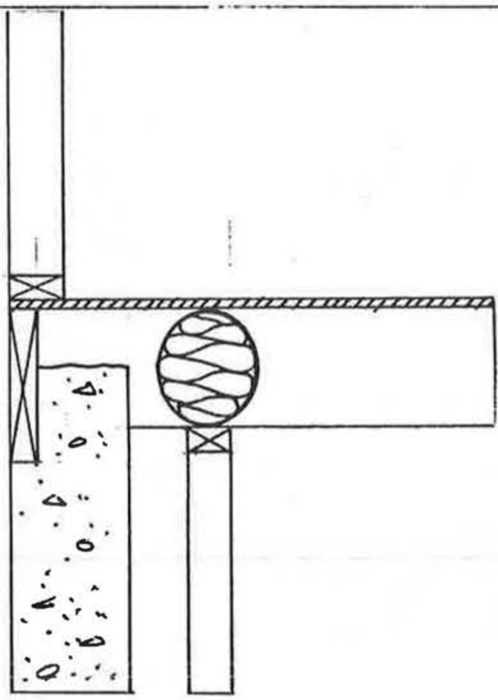
CHANGES FROM CONVENTIONAL PRACTICE:

- o Install insulation-filled poly bags with RSI 3.52 (R-20.0) into header spaces

| | | |
|---|---|---|
| GROSS COST: | $ 61.75 | m |
| | 12.00 | l |
| | $ 73.75 | |
| LESS SAVINGS: | $ 37.81 | m |
| | 54.00 | l |
| | $ 91.81 | |
| NET COST: | $ 23.94 | m |
| | -42.00 | l |
| | $-18.06 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | -3:30 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. "Less Savings" includes cost of the RSI 3.52 (R-20.0) insulation used in conventional practice.
2. May require separate air barrier or that the house be operated under a negative pressure differential.
3. Poly bags function as vapour barrier.

SYSTEM COMPONENT: Electrical outlets, main floor; rigid poly pans

CONVENTIONAL PRACTICE: Loose poly wrap

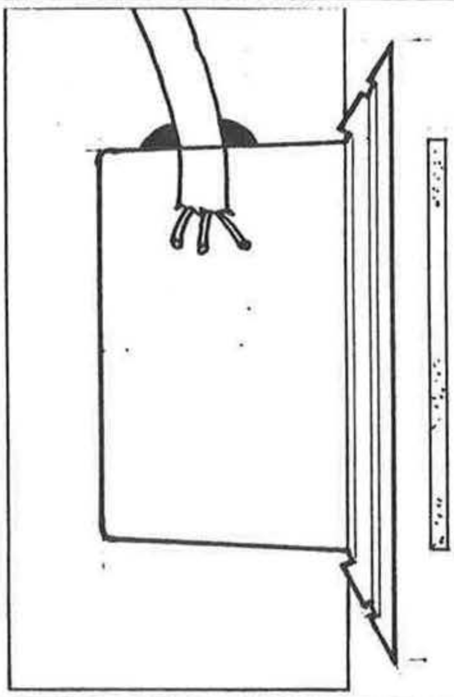
CHANGES FROM CONVENTIONAL PRACTICE:

- o Use manufactured rigid poly pans with face plate gaskets for electrical outlets on exterior walls, caulk poly pans to air barrier

| | | |
|---|---|---|
| GROSS COST: | $ 6.25 | m |
| | 10.21 | l |
| | $ 16.46 | |
| LESS SAVINGS: | $ 0 | m |
| | 5.10 | l |
| | $ 5.10 | |
| NET COST: | $ 6.25 | m |
| | 5.11 | l |
| | $ 11.36 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:17 M/H |



NOTES:

1. Assumes 7 duplex plugs or switches on exterior walls.
2. Some plugs and switches were initially relocated from exterior to interior walls.
3. Requires drywallers to caulk poly pans to drywall.

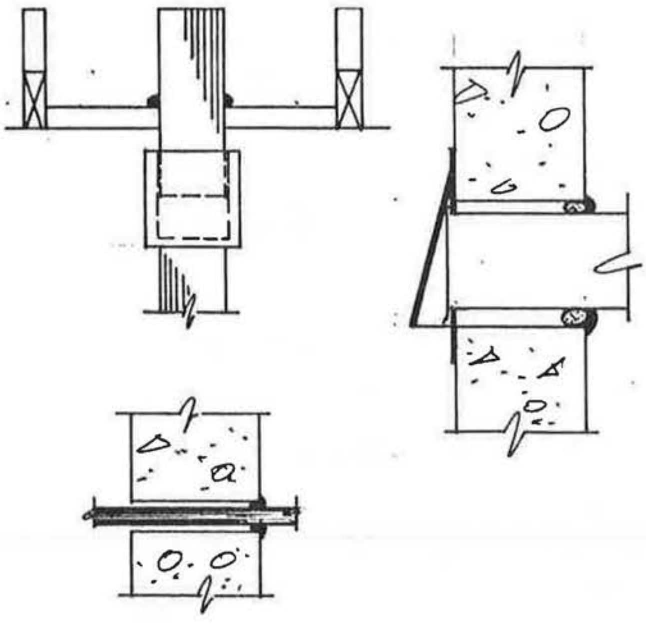
SYSTEM COMPONENT: Service penetrations

CONVENTIONAL PRACTICE: Unsealed

CHANGES FROM CONVENTIONAL PRACTICE:

- o Caulk and seal penetrations for:
  - plumbing stack
  - main electrical service
  - dryer vent
  - hose bib
  - exterior electrical outlet
  - outdoor light
- o For larger joints, apply ethafoam rod into joint to serve as a backer rod, then caulk
- o For smaller joints, apply caulking directly into joint

| | | |
|---|---|---|
| GROSS COST: | $ 5.00 | m |
| | 11.25 | l |
| | $ 16.25 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 5.00 | m |
| | 11.25 | l |
| | $ 16.25 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:45 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Sealing of HRV inlet and outlet duct penetrations not included.
2. Approx. 0.75 tubes of caulking and 2 m (6') of ethafoam rod required.

SYSTEM COMPONENT: Exterior attic hatch

CONVENTIONAL PRACTICE: See note below

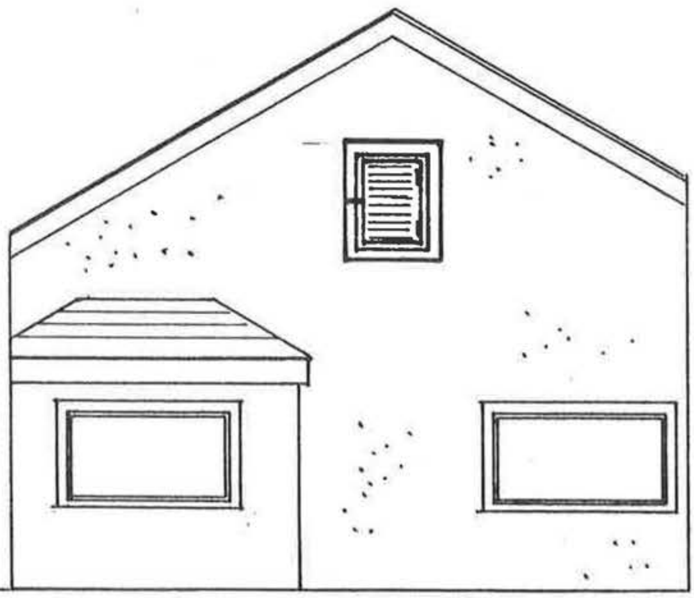
CHANGES FROM CONVENTIONAL PRACTICE:

- Replace interior attic hatch with exterior, gable hatch

| | | |
|---|---|---|
| GROSS COST: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 0 | m |
| | 0 | l |
| | $ 0 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Exterior attic hatches are becoming typical for conventional construction, however comparison is made to an interior hatch to note incremental cost.

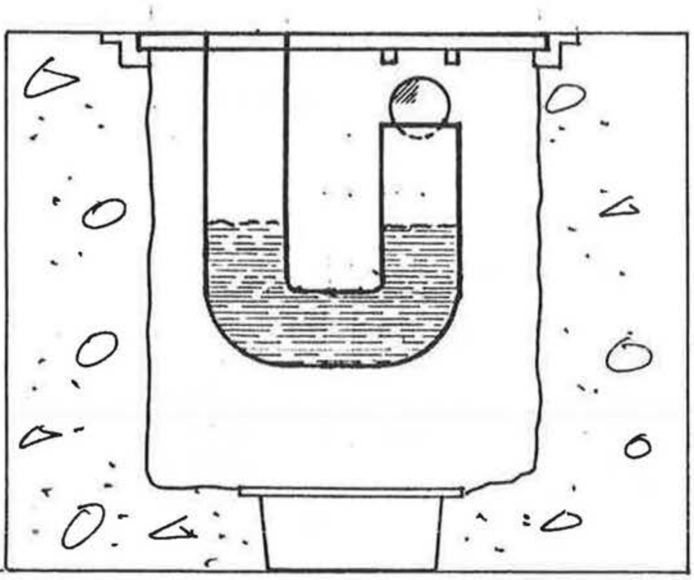
SYSTEM COMPONENT: Sealed floor drain cover

CONVENTIONAL PRACTICE: Open floor drain cover

CHANGES FROM CONVENTIONAL PRACTICE:

- o Use self-sealing floor drain cover c/w retaining ring in place of conventional drain

| | | |
|---|---|---|
| GROSS COST: | $ 29.95 | m |
| | 0 | l |
| | $ 29.95 | |
| LESS SAVINGS: | $ 10.00 | m |
| | 0 | l |
| | $ 10.00 | |
| NET COST: | $ 19.95 | m |
| | 0 | l |
| | $ 19.95 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Model also available for sumps.
2. System also reduces radon migration.

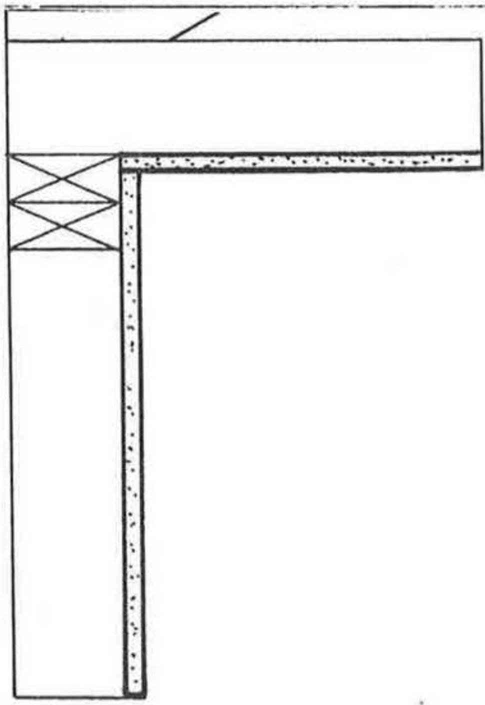
SYSTEM COMPONENT: Painted vapour barrier, main walls and ceiling

CONVENTIONAL PRACTICE: 4 mil poly stapled, no caulking with the following point schedule:
Walls - 1 coat latex sealer/primer
1 coat flat latex interior
Ceiling - 1 coat latex sealer/primer
texture finish coat

CHANGES FROM CONVENTIONAL PRACTICE:

- o Revise point schedule as follows:
  - Main walls - latex primer
    - oil base primer
    - latex finish coat
  - Ceilings - latex primer
    - oil base primer
    - texture finish coat
- o Omit poly vapour barrier

| | | |
|---|---|---|
| GROSS COST: | $ 70.00 | m |
| | 82.50 | l |
| | $152.50 | |
| LESS SAVINGS: | $ 32.05 | m |
| | 60.00 | l |
| | $ 92.05 | |
| NET COST: | $ 37.95 | m |
| | 22.50 | l |
| | $ 60.45 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | -5:00 M/H |
| PAINTERS | 5:30 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. "Gross Cost" covers application of oil base primers coat.
2. Painted drywall surface serves as the vapour barrier.
3. Latex primer is used to prevent the oil-based primer from raising the paper nap on drywall.
4. Assumes 89 m² (956 ft²) of wall area and 92 m² (991 ft²) of ceiling area painted.
5. Partition walls painted as per conventional schedule.

SYSTEM COMPONENT: Painted vapour barrier, basement walls

CONVENTIONAL PRACTICE: 4 mil poly stapled, no caulking with the following point schedule:
1 coat latex sealer/primer
1 coat flat latex interior

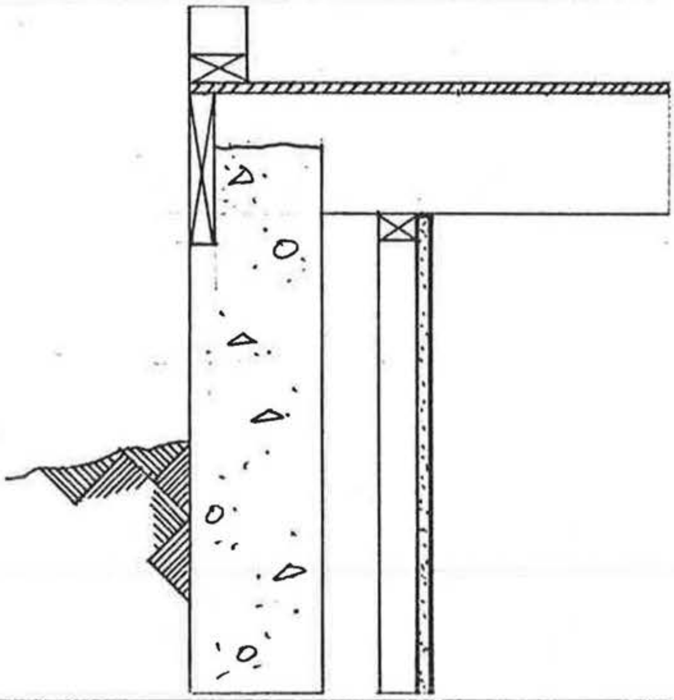
CHANGES FROM CONVENTIONAL PRACTICE:

- o Revise point schedule as follows:
  - Basement walls - latex primer
  - - oil base primer
  - - latex finish coat
- o Omit poly vapour barrier

| | | |
|---|---|---|
| GROSS COST: | $ 35.00 | m |
| | 22.50 | l |
| | $ 57.50 | |
| LESS SAVINGS: | $ 15.34 | m |
| | 18.00 | l |
| | $ 33.34 | |
| NET COST: | $ 19.66 | m |
| | 4.50 | l |
| | $ 24.16 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | -1:30 M/H |
| PAINTERS | 1:30 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Painted drywall surface serves as the vapour barrier.
2. Latex primer is used to prevent the oil-based primer from raising the paper nap on drywall.
3. Assumes 87 m² (932 ft²) of wall area.
4. Partition walls painted as per conventional schedule.

SYSTEM: Sealed poly air/vapour barrier envelope

CONVENTIONAL PRACTICE: See individual data sheets

CHANGES FROM CONVENTIONAL PRACTICE:

- o Material; main floor, 6 mil poly (A-1)
- o Material; basement 6 mil poly (A-2)
- o Main floor walls, continuous sealed poly (A-3)
- o Windows and door; poly-wrap (A-7)
- o Wall/floor/foundation; polyolefin (A-9)
- o Ceiling; continuous sealed poly (A-12)
- o Electrical outlets; main floor (A-17)
- o Service penetrations (A-18)
- o Exterior attic hatch (A-19)

| | | |
|---|---|---|
| GROSS COST: | $167.94 | m |
| | 199.96 | l |
| | $367.90 | |
| LESS SAVINGS: | $ 55.98 | m |
| | 98.10 | l |
| | $154.08 | |
| NET COST: | $111.96 | m |
| | 101.86 | l |
| | $213.82 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 6:40 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:17 M/H |

NOTES:

1. This is a well sealed "poly approach" house suitable for conventional framed walls, walls with exterior insulated sheathing or walls with interior strapping.
2. System shown is for a conventionally-sealed unfinished basement, for low leakage sealing, add System A-4.

SYSTEM: Airtight Drywall Approach (painted vapour barrier)

CONVENTIONAL PRACTICE: See individual data sheets

CHANGES FROM CONVENTIONAL PRACTICE:

- o Windows and doors; ethafoam rod (A-6)
- o Wall/floor/foundation; gaskets (A-10(a))
- o Ceiling; continuous taped drywall (A-13)
- o Electrical outlets; main floor (A-17)
- o Service penetrations (A-18)
- o Exterior attic hatch (A-19)
- o Painted vapour barrier; main walls, ceiling (A-21)

| | | |
|---|---|---|
| GROSS COST: | $142.98 | m |
| | 151.46 | l |
| | $294.44 | |
| LESS SAVINGS: | $ 37.34 | m |
| | 80.10 | l |
| | $117.44 | |
| NET COST: | $105.64 | m |
| | 71.36 | l |
| | $177.00 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 2:55 M/H |
| DRYWALLERS/INSULATORS | -5:00 M/H |
| PAINTERS | 5:30 M/H |
| ELECTRICIANS | 0:17 M/H |

NOTES:

1. System shown is for an unfinished basement; for a finished basement, add System A-22.

SYSTEM: Airtight Drywall Approach (poly vapour barrier)

CONVENTIONAL PRACTICE: See individual data sheets

CHANGES FROM CONVENTIONAL PRACTICE:

- o Windows and doors; ethafoam rod (A-6)
- o Wall/floor/foundation; gaskets (A-10(a))
- o Ceiling; continuous taped drywall (A-14)
- o Electrical outlets; main floor (A-17)
- o Service penetrations (A-18)
- o Exterior attic hatch (A-19)
- o Install 4 mil stapled poly; main walls (as per conventional practice)

| | | |
|---|---|---|
| GROSS COST: | $ 72.98 | m |
| | 68.96 | l |
| | $141.94 | |
| LESS SAVINGS: | $ 5.29 | m |
| | 20.10 | l |
| | $ 25.39 | |
| NET COST: | $ 67.69 | m |
| | 48.86 | l |
| | $116.55 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 2:55 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:17 M/H |

NOTES:

1. System shown is for a finished or unfinished basement.

SYSTEM: Fiberglas Canada Inc. Low Energy House System

CONVENTIONAL PRACTICE: See individual data sheets

CHANGES FROM CONVENTIONAL PRACTICE:

- o Windows and doors; ethafoam rod (A-6)
- o Ceiling; continuous taped drywall (A-13)
- o Headers; polyethylene bags (A-16(a))
- o Electrical outlets; main floor (A-17)
- o Service penetrations (A-18)
- o Exterior attic hatch (A-19)
- o Sealed floor drain cover (A-20)
- o Painted vapour barrier; main walls, ceiling (A-21)

| | | |
|---|---|---|
| GROSS COST: | $148.15 | m |
| | 138.46 | l |
| | $286.61 | |
| LESS SAVINGS: | $ 70.59 | m |
| | 134.10 | l |
| | $204.69 | |
| NET COST: | $ 77.56 | m |
| | 4.36 | l |
| | $ 81.92 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:15 M/H |
| DRYWALLERS/INSULATORS | -8:30 M/H |
| PAINTERS | 5:30 M/H |
| ELECTRICIANS | 0:17 M/H |

NOTES:

1. Intended to be operated with the house under a slight negative pressure differential as supplied by the Habitair System (I-1).
2. Assumes exterior rigid glass fibre insulation on main and basement walls.

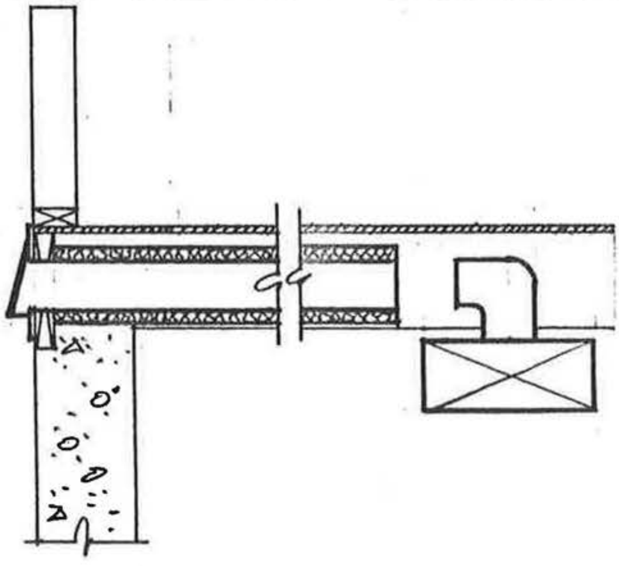
SYSTEM COMPONENT: Fresh air intake

SYSTEM COMPONENT DESCRIPTION:

- o Intall 127mm (5") fresh air intake to return air plenum of furnace c/w insulation, vapour barrier, hood and screen and balancing damper. Assume 2.4m (8') duct run.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $45.00 |
| ELECTRICAL | 0 |
| PLUMBING | 0 |
| | $45.00 |



NOTES:

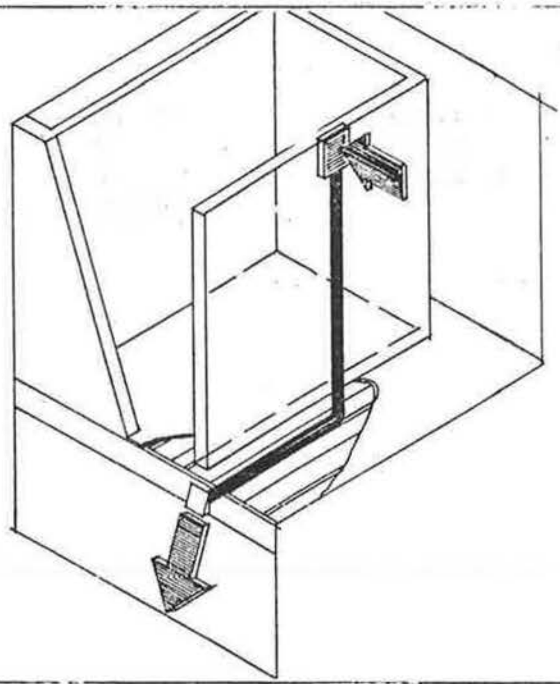
SYSTEM COMPONENT: Kitchen exhaust fan

SYSTEM COMPONENT DESCRIPTION:

- o Install exhaust fan in kitchen, duct down partition wall into basement and out header c/w exhaust hood, backdraft damper and wall-mounted switch. Assume 4.9m (16') of duct run.
- o Exhaust fan capacity (free stream) 61 l/s (130 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $100.00 |
| ELECTRICAL | 26.00 |
| PLUMBING | 0 |
| | $126.00 |



NOTES:

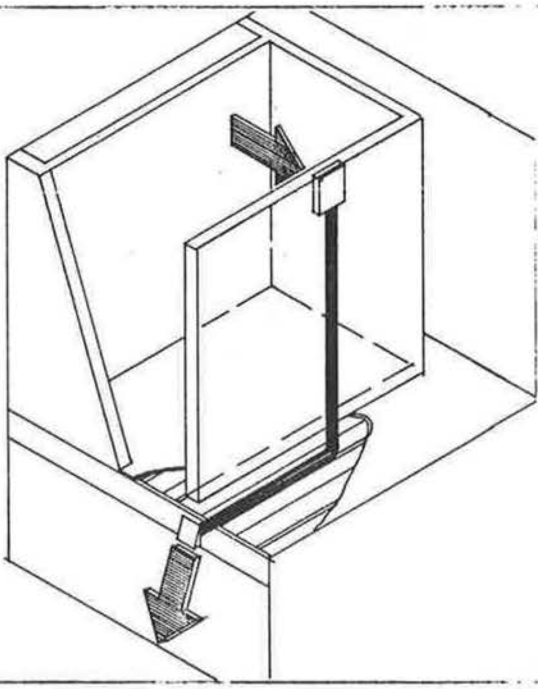
SYSTEM COMPONENT: Bathroom exhaust fan

SYSTEM COMPONENT DESCRIPTION:

- o Install exhaust fan in bathroom, duct down partition wall into basement and out header c/w exhaust hood, backdraft damper and wall-mounted switch. Assume 4.9m (16') of duct run.
- o Exhaust fan capacity (free stream) 24 l/s (50 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $60.00 |
| ELECTRICAL | 26.00 |
| PLUMBING | 0 |
| | $86.00 |



NOTES:

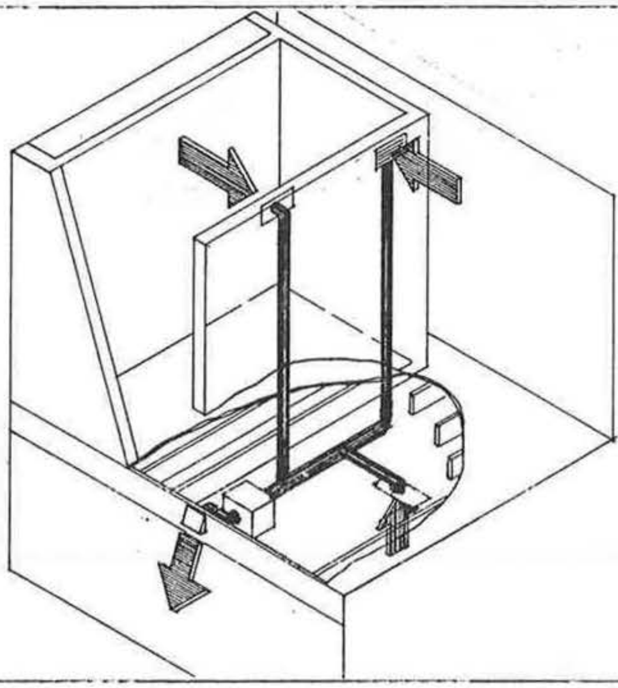
SYSTEM COMPONENT: Central exhaust

SYSTEM COMPONENT DESCRIPTION:

- o Install central exhaust in basement, drawing from bathroom and kitchen and exhausting out through header c/w 2 grilles, exhaust hood, backdraft damper and 2 switches (bathroom and kitchen).
- o Exhaust fan capacity free stream 113 l/s (240 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $400.00 |
| ELECTRICAL | 39.00 |
| PLUMBING | 0 |
| | $439.00 |



NOTES:

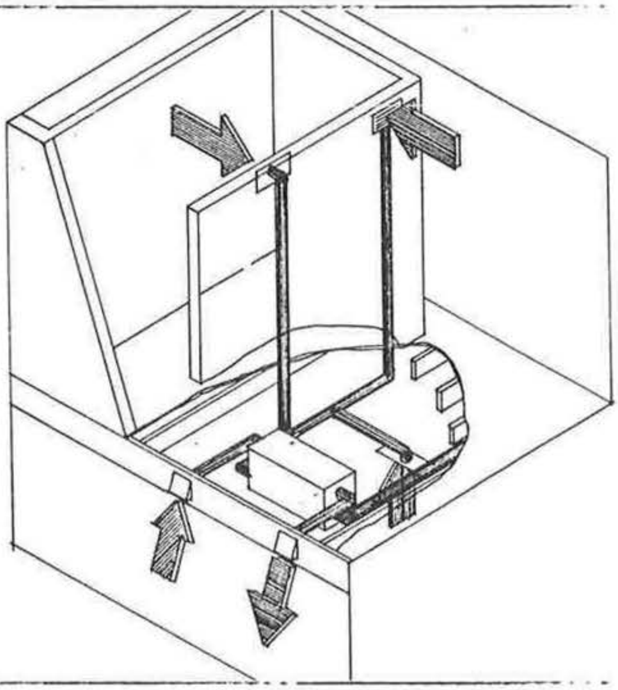
SYSTEM COMPONENT: Heat recovery ventilator, small capacity

SYSTEM COMPONENT DESCRIPTION:

- o Install small capacity HRV c/w insulated ductwork and vapour barrier between unit and outdoors, intake and exhaust hood, dehumidistat in hallway and switches in bathroom and kitchen. Capacity 47 l/s (100 CFM) @ 87 Pa and 50 Pa (0.35" and 0.20" $H_2O$) exhaust and supply static pressures.
- o HRV to exhaust from bathroom and kitchen (ductwork included).
- o HRV to supply air to return air plenum of heating system or dedicated ventilation-only duct system.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,300.00 |
| ELECTRICAL | 112.00 |
| PLUMBING | 30.00 |
| | $1,442.00 |



NOTES:

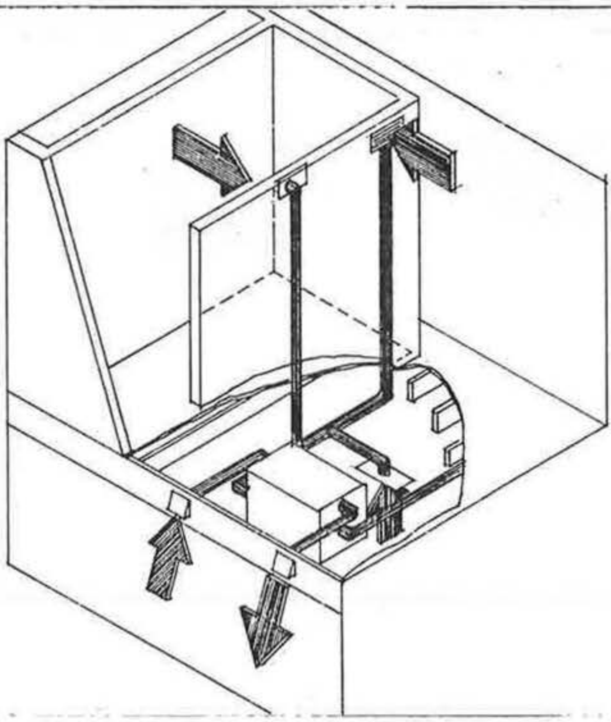
SYSTEM COMPONENT: Heat recovery ventilator, medium capacity

SYSTEM COMPONENT DESCRIPTION:

- o Install medium capacity HRV c/w insulated ductwork and vapour barrier between unit and outdoors, intake and exhaust hood, dehumidistat in hallway and switches in bathroom and kitchen. Capacity 102 l/s (216 CFM) @ 75 Pa (0.30" $H_2O$) static pressure.
- o HRV to exhaust from bathroom and kitchen (ductwork included).
- o HRV to supply air to return air plenum of heating system or dedicated ventilation-only duct system.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,600.00 |
| ELECTRICAL | 112.00 |
| PLUMBING | 30.00 |
| | $1,742.00 |



NOTES:

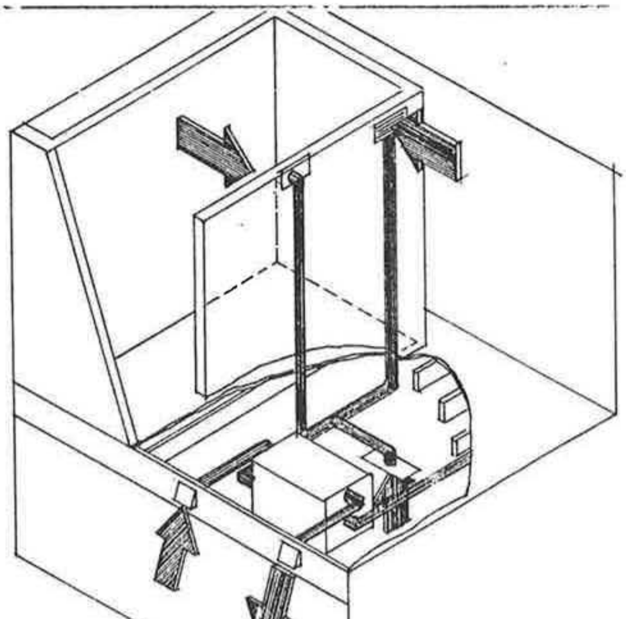
SYSTEM COMPONENT: Heat pump heat recovery ventilator

SYSTEM COMPONENT DESCRIPTION:

- o Install a heat pump HRV c/w insulated ductwork and vapour barrier between unit and outdoors, intake and exhaust hood, dehumidistat in hallway and switches in bathroom and kitchen. Capacity 125 l/s (265 CFM).
- o HRV to exhaust from bathroom and kitchen (ductwork included).
- o HRV to supply air to return air plenum of heating system or dedicated ventilation-only duct system.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $2,400.00 |
| ELECTRICAL | 268.00 |
| PLUMBING | 30.00 |
| | $2,698.00 |



NOTES:

1. This unit is similar in configuration and layout to more conventional HRV's but uses an air-to-air heat pump rather than a heat exchanger core to transfer heat between the exhaust and supply air streams.

SYSTEM COMPONENT: Dedicated ventilation-only supply system

SYSTEM COMPONENT DESCRIPTION:

- o Install duct system with 152 mm (6") main and 102 mm (4") branch ducts c/w 5 registers on main floor and 2 in basement.
- o Tape all ductwork.
- o Main floor registers to be mounted on partition walls within 0.3 m (1') of ceiling. Basement registers to be ceiling-mounted.
- o Duct system to start at HRV or supply air fan.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $475.00 |
| ELECTRICAL | 0 |
| PLUMBING | 0 |
| | $475.00 |

see Figure V-8

NOTES:

1. Costs do not include HRV supply fan, or exhaust ductwork.
2. If 38x64 (2"x3") partition walls are used, branch ducts, 102 mm (4") will have to be compressed or equivalent rectangular ducting used.

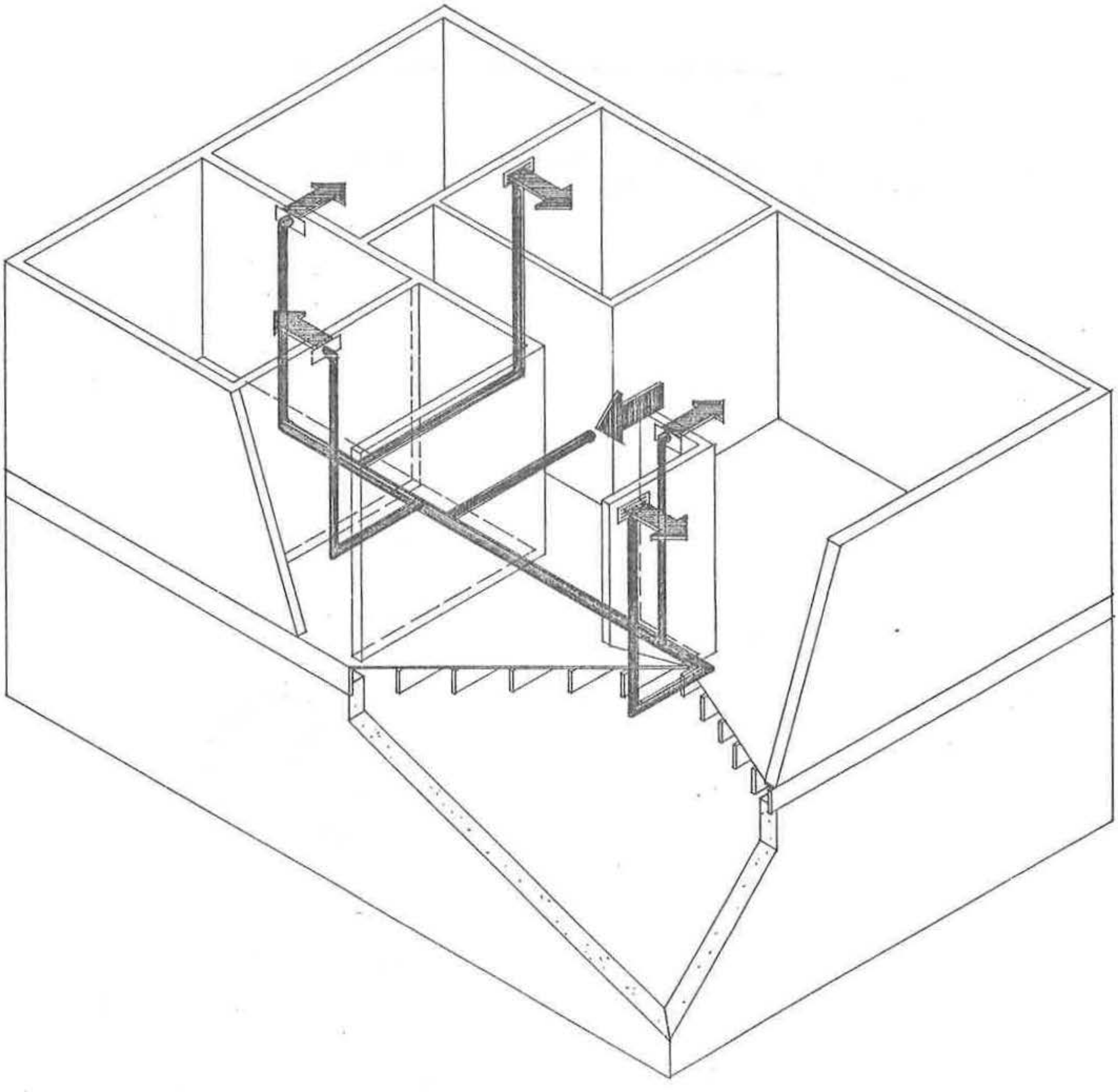


FIGURE V-8

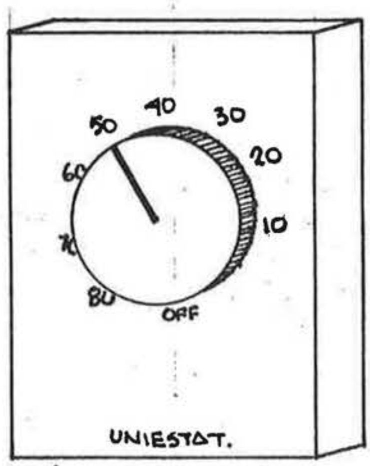
SYSTEM COMPONENT: Dehumidistat

SYSTEM COMPONENT DESCRIPTION:

- o Install 110 VAC dehumidistat in living room to provide automatic control of exhaust-only ventilation systems.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $55.00 |
| ELECTRICAL | 26.00 |
| PLUMBING | 0 |
| | $81.00 |




NOTES:

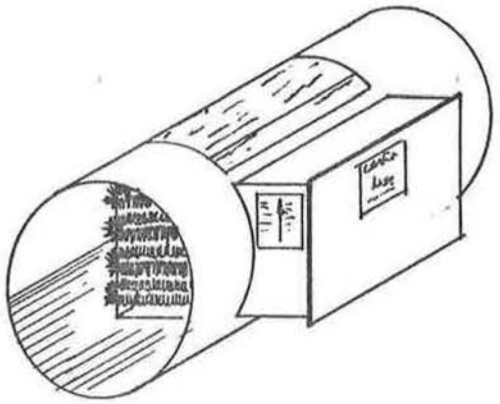
SYSTEM COMPONENT: Duct heater

SYSTEM COMPONENT DESCRIPTION:

o Install 2 kW heater in fresh air duct to preheat in-coming air.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $280.00 |
| ELECTRICAL | 90.00 |
| PLUMBING | 0 |
| | $370.00 |



NOTES:

1. Typically not required when an HRV or high side-wall supplies are used. Also, not recommended for a fresh air duct unless a supply air fan is used to provide adequate flow through heater.

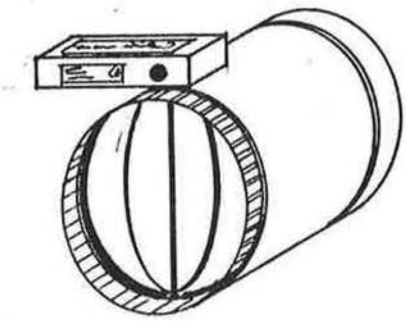
SYSTEM COMPONENT: Air control dampers

SYSTEM COMPONENT DESCRIPTION:

o Install automatic 152 mm (6") air control damper c/w wall-mounted switch, in exhaust duct from laundry room.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $ 95.00 |
| ELECTRICAL | 26.00 |
| PLUMBING | 0 |
| | $121.00 |



NOTES:

1. For control of air flows within zoned systems or for seldom-ventilated rooms.

SYSTEM: Conventional ventilation system

SYSTEM DESCRIPTION:

- o Fresh air intake (V-1)
- o Kitchen exhaust fan (V-2)
- o Bathroom exhaust fan (V-3)

| | |
|---|---|
| GROSS COST: | $257.00 |
| LESS SAVINGS: | 0 |
| NET COST: | $257.00 |

NOTES:

SYSTEM: Central exhaust system

SYSTEM DESCRIPTION:

- o Fresh air intake (V-1)
- o Central exhaust (V-4)
- o Dehumidistat (V-9)

| | |
|---|---|
| GROSS COST: | $565.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $308.00 |

NOTES:

SYSTEM: HRV system, small capacity for forced air heating system

SYSTEM DESCRIPTION:

- o HRV, small capacity (V-5)
- o Dehumidistat (V-9)

| | |
|---|---|
| GROSS COST: | $1,523.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $1,266.00 |

NOTES:

SYSTEM: HRV system, small capacity, for baseboard heating system

SYSTEM DESCRIPTION:

- o HRV, small capacity (V-5)
- o Dedicated ventilation-only duct system (V-8)
- o Dehumidistat (V-9)

| | |
|---|---|
| GROSS COST: | $1,998.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $1,741.00 |

NOTES:

SYSTEM: HRV system, medium capacity, for forced air heating system

SYSTEM DESCRIPTION:

- o HRV, medium capacity (V-6)
- o Dehumidistat (V-9)

| | |
|---|---|
| GROSS COST: | $1,823.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $1,566.00 |

NOTES:

SYSTEM: HRV system, medium capacity, for baseboard heating system

SYSTEM DESCRIPTION:

- o HRV, medium capacity (V-6)
- o Dedicated ventilation-only supply system (V-8)
- o Dehumidistat (V-9)

| | |
|---|---|
| GROSS COST: | $2,298.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $2,041.00 |

NOTES:

SYSTEM: Heat pump HRV system for forced air heating system

SYSTEM DESCRIPTION:

o Heat pump HRV (V-7)

| | |
|---|---|
| GROSS COST: | $2,698.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $2,441.00 |

NOTES:

SYSTEM: Heat pump HRV system for baseboard heating system

SYSTEM DESCRIPTION:

- o Heat pump HRV (V-7)
- o Dedicated ventilation-only supply system (V-8)

| | |
|---|---|
| GROSS COST: | $3,173.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $2,916.00 |

NOTES:

SYSTEM: Conventional gas furnace, 60% efficient

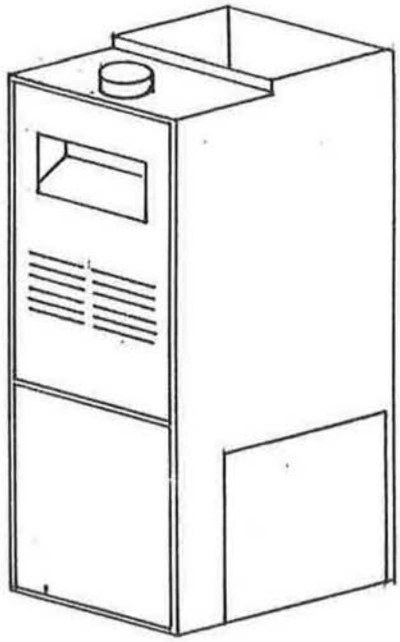
SYSTEM DESCRIPTION:

- o Install 18 kW input (60,000 Btu/Hr), naturally aspirated gas furnace c/w vent and ductwork.
- o Install ductwork system with 7 supply and 1 return air registers on main floor and 4 supply and 1 return registers in basement. Supply registers to be floor-mounted near exterior walls. System capacity: 241 l/s (510 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,425.00 |
| ELECTRICAL | 33.00 |
| PLUMBING | 0 |
| | $1,458.00 |

| | |
|---|---|
| GROSS COST: | $1,458.00 |
| LESS SAVINGS: | 0 |
| NET COST: | $1,458.00 |



NOTES:

1. Ductwork illustrated in Figure H-1.

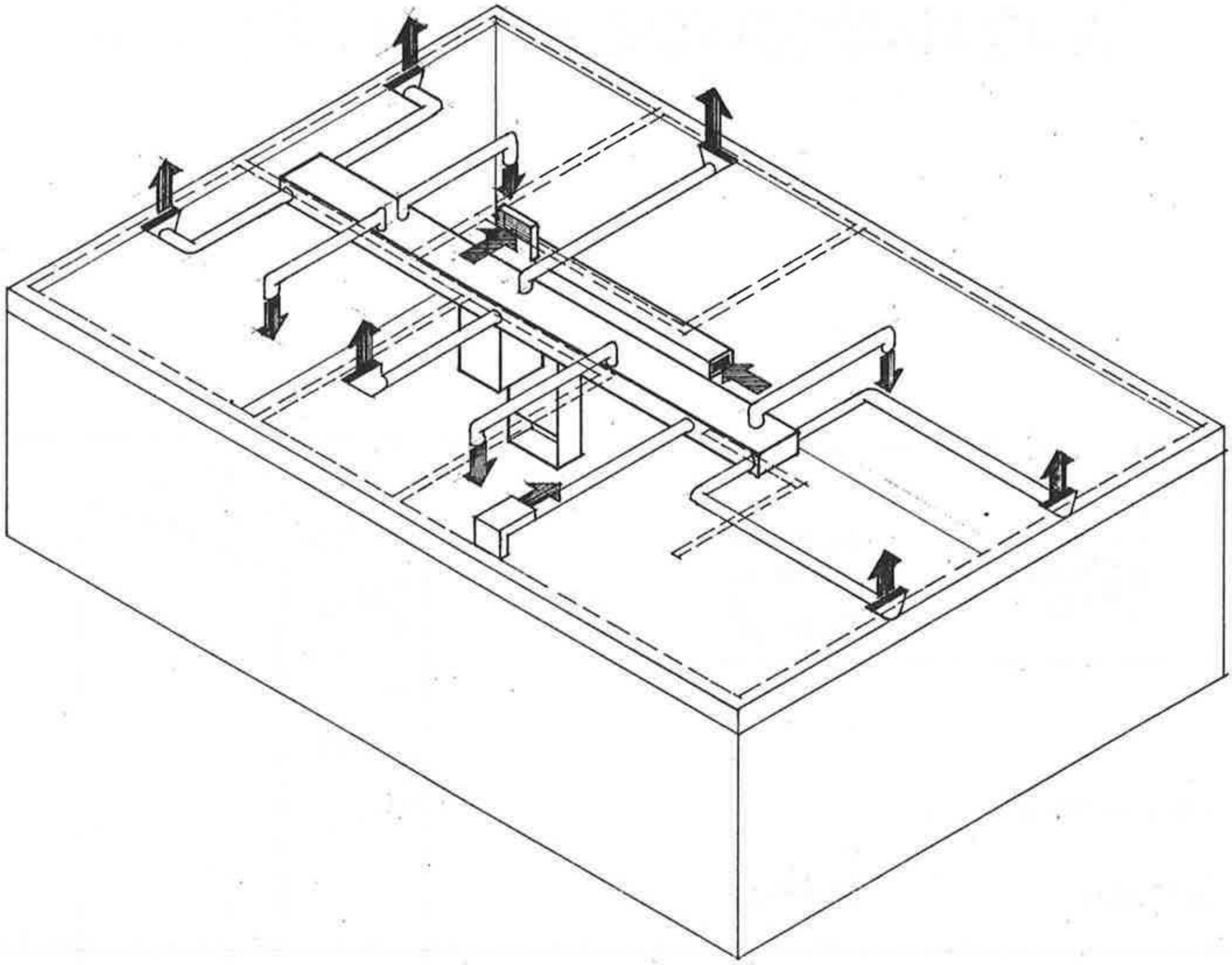


FIGURE H-1

SYSTEM: Naturally-aspirated gas furnace with spark ignition and vent damper, 69% efficient

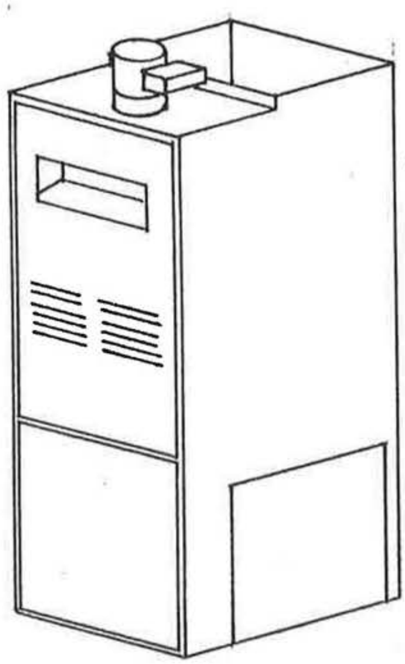
SYSTEM DESCRIPTION:

- o Install gas furnace c/w spark ignition, flue draft damper, continuous circulation blower and ductwork.
- o Install ductwork system with 7 supply and 1 return air registers on main floor and 4 supply and 1 return registers in basement. Supply registers to be floor-mounted near exterior walls. System capacity: 241 l/s (510 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,800.00 |
| ELECTRICAL | 33.00 |
| PLUMBING | 0 |
| | $1,833.00 |

| | |
|---|---|
| GROSS COST: | $1,833.00 |
| LESS SAVINGS: | 1,458.00 |
| NET COST: | $ 375.00 |



NOTES:

1. Ductwork illustrated in Figure H-1.

SYSTEM: Induced draft gas furnace, 80% efficient

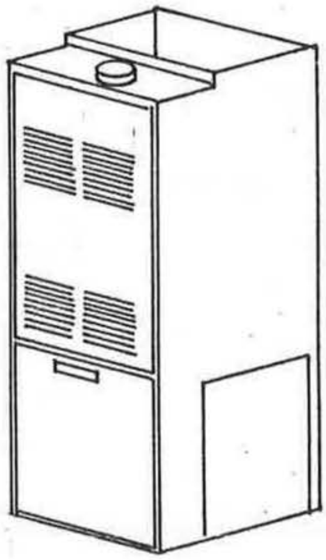
SYSTEM DESCRIPTION:

- o Install induced draft gas furnace and ductwork.
- o Install ductwork system with 7 supply and 1 return air registers on main floor and 4 supply and 1 return registers in basement. Supply registers to be floor-mounted near exterior walls. System capacity: 241 l/s (510 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,995.00 |
| ELECTRICAL | 33.00 |
| PLUMBING | 0 |
| | $2,028.00 |

| | |
|---|---|
| GROSS COST: | $2,028.00 |
| LESS SAVINGS: | 1,458.00 |
| NET COST: | $ 570.00 |



NOTES:

1. Ductwork illustrated in Figure H-1.

SYSTEM: Condensing gas furnace, 95% efficient

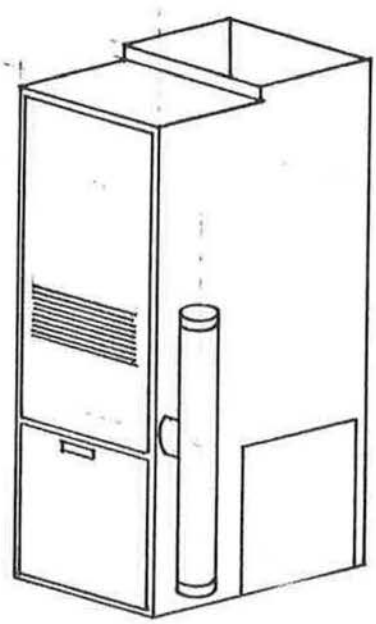
SYSTEM DESCRIPTION:

- o Install condensing gas furnace c/w continuous circulation blower and ductwork.
- o Install ductwork system with 7 supply and 1 return air registers on main floor and 4 supply and 1 return registers in basement. Supply registers to be floor-mounted near exterior walls. System capacity: 241 l/s (510 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $2,995.00 |
| ELECTRICAL | 33.00 |
| PLUMBING | 30.00 |
| | $3,058.00 |

| | |
|---|---|
| GROSS COST: | $3,058.00 |
| LESS SAVINGS: | 1,458.00 |
| NET COST: | $1,600.00 |



NOTES:

1. Ductwork illustrated in Figure H-1.

SYSTEM: 10 kW electric furnace

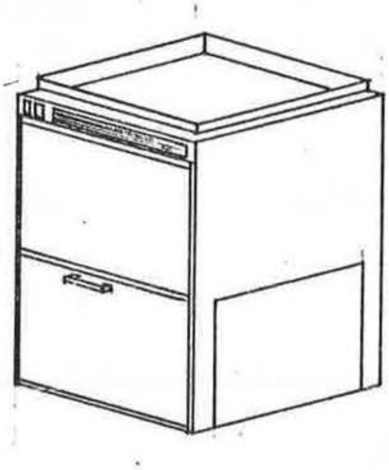
SYSTEM DESCRIPTION:

- o Install 10 kW electric furnace c/w continuous circulation blower and ductwork.
- o Install ductwork system with 7 supply and 1 return air registers on main floor and 4 supply and 1 return registers in basement. Supply registers to be floor-mounted near exterior walls. System capacity: 241 l/s (510 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,350.00 |
| ELECTRICAL | 180.00 |
| PLUMBING | 0 |
| | $1,530.00 |

| | |
|---|---|
| GROSS COST: | $1,530.00 |
| LESS SAVINGS: | 1,458.00 |
| NET COST: | $ 72.00 |



NOTES:

1. The gas and electric furnaces are not of equivalent capacity but this is the smallest electric unit normally available.

2. Ductwork illustrated in Figure H-1.

SYSTEM: 8.00 kW electric baseboard heating system

SYSTEM DESCRIPTION:

- Install electric baseboard heating system:

| | |
|---|---|
| master bedroom | - 1000 W c/w wall-mounted thermostat |
| bedroom #2 | - 750 W c/w wall-mounted thermostat |
| bedroom #3 | - 750 W c/w wall-mounted thermostat |
| bathroom | - 500 W c/w integral thermostat |
| living/dining/kitchen | - 2500 W c/w wall-mounted thermostat |
| basement | - 2500 W ganged to one integral thermostat |
| Total Capacity | 8.00 kW |

GROSS COST:

| | |
|---|---|
| MECHANICAL | $ 0 |
| ELECTRICAL | 756.00 |
| PLUMBING | 0 |
| | $ 756.00 |

| | |
|---|---|
| GROSS COST: | $ 756.00 |
| LESS SAVINGS: | 1,458.00 |
| NET COST: | $- 702.00 |

see Figure H-6

NOTES:

1. Assumes 200 Amp service installed to meter and 100 Amp between meter and panel.

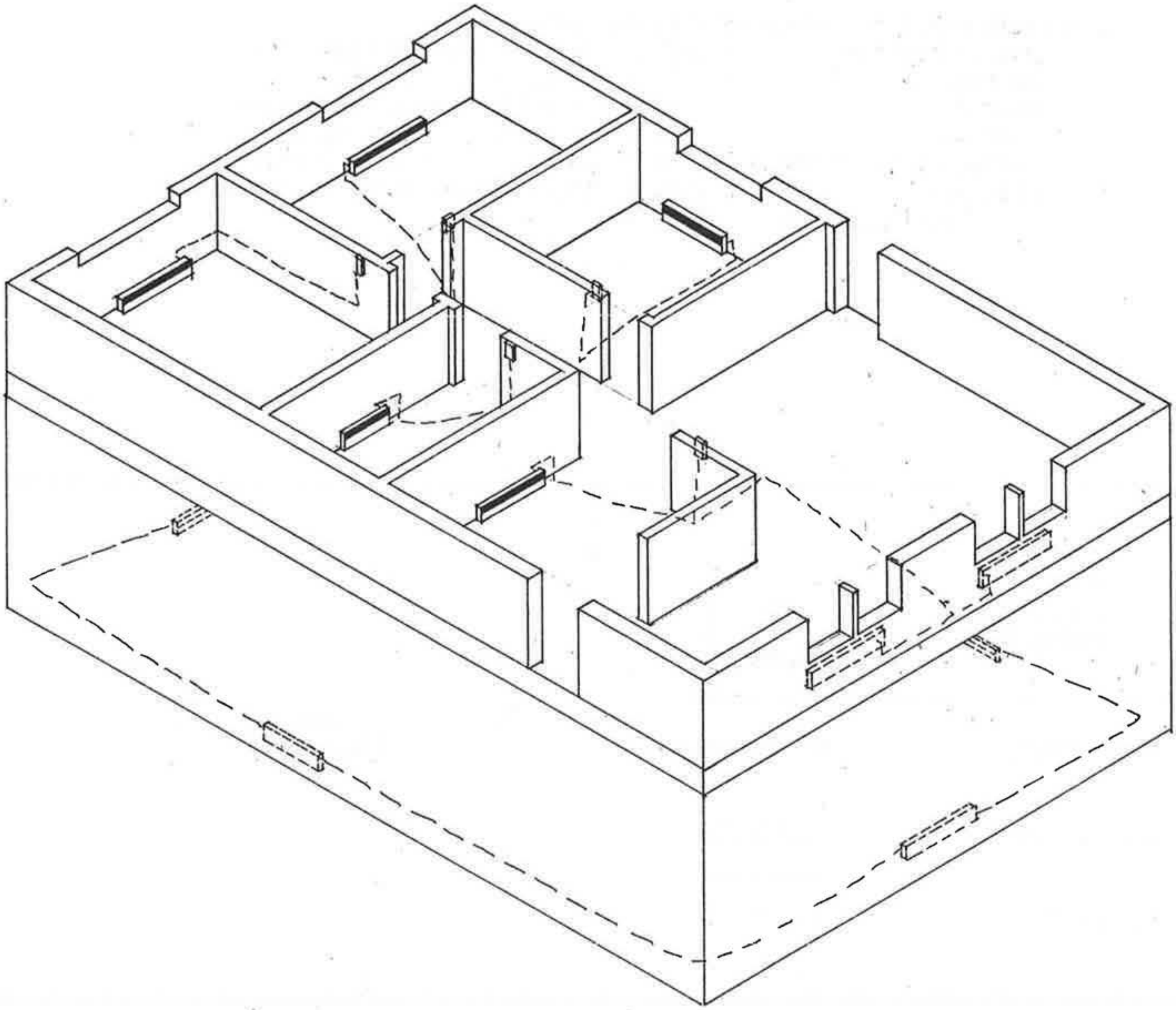


FIGURE H-6

SYSTEM: High sidewall supply registers, main floor

SYSTEM DESCRIPTION:

o Install 6 high sidewall supply registers in place of floor-mounted registers in:

| | |
|---|---|
| master bedroom | - 21 l/s (45 CFM) |
| bedroom #2 | - 19 l/s (40 CFM) |
| bedroom #3 | - 19 l/s (40 CFM) |
| bathroom | - 14 l/s (30 CFM) |
| living/dining/kitchen (see note 1) | - 47 l/s (100 CFM) |

GROSS COST:

| | |
|---|---|
| MECHANICAL | $95.00 |
| ELECTRICAL | 0 |
| PLUMBING | 0 |
| | $95.00 |

see Figure H-7

NOTES:

1. Additional 26 l/s (55 CFM) is supplied to the living room through a floor-mounted register which architecturally could not be relocated into a partition wall.
2. Assumes no change to basement air supply.

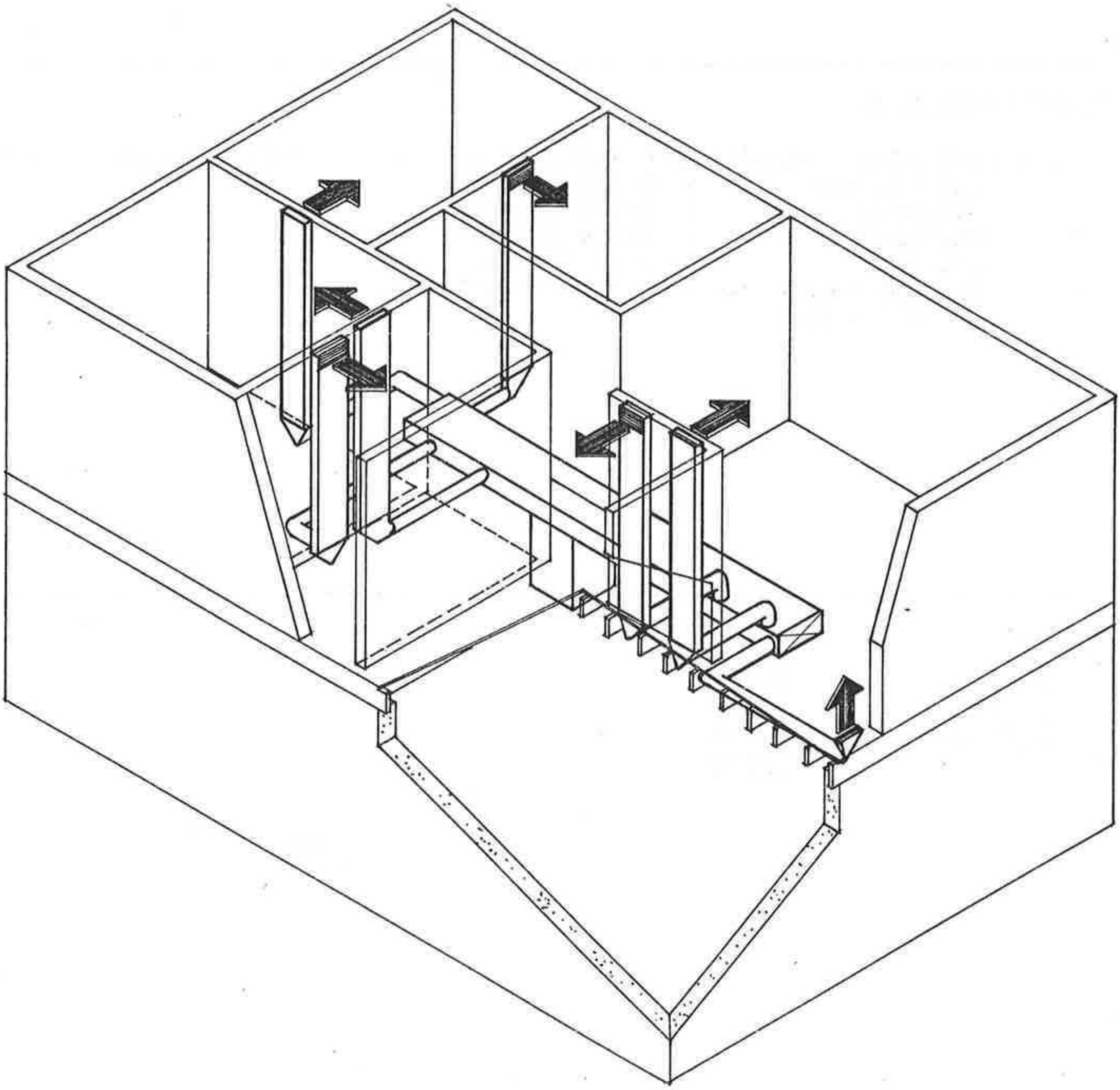


FIGURE H-7

SYSTEM: Individual room returns

SYSTEM DESCRIPTION:

- o Install additional room return air registers in:
  - master bedroom
  - bedroom #2
  - bedroom #3
- o Conventional system would use one return in hallway and one in basement.
- o Locate close to return air plenum (down centre line of house) to minimize costs.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $115.00 |
| ELECTRICAL | 0 |
| PLUMBING | 0 |
| | $115.00 |

see
Figure H-8

NOTES:

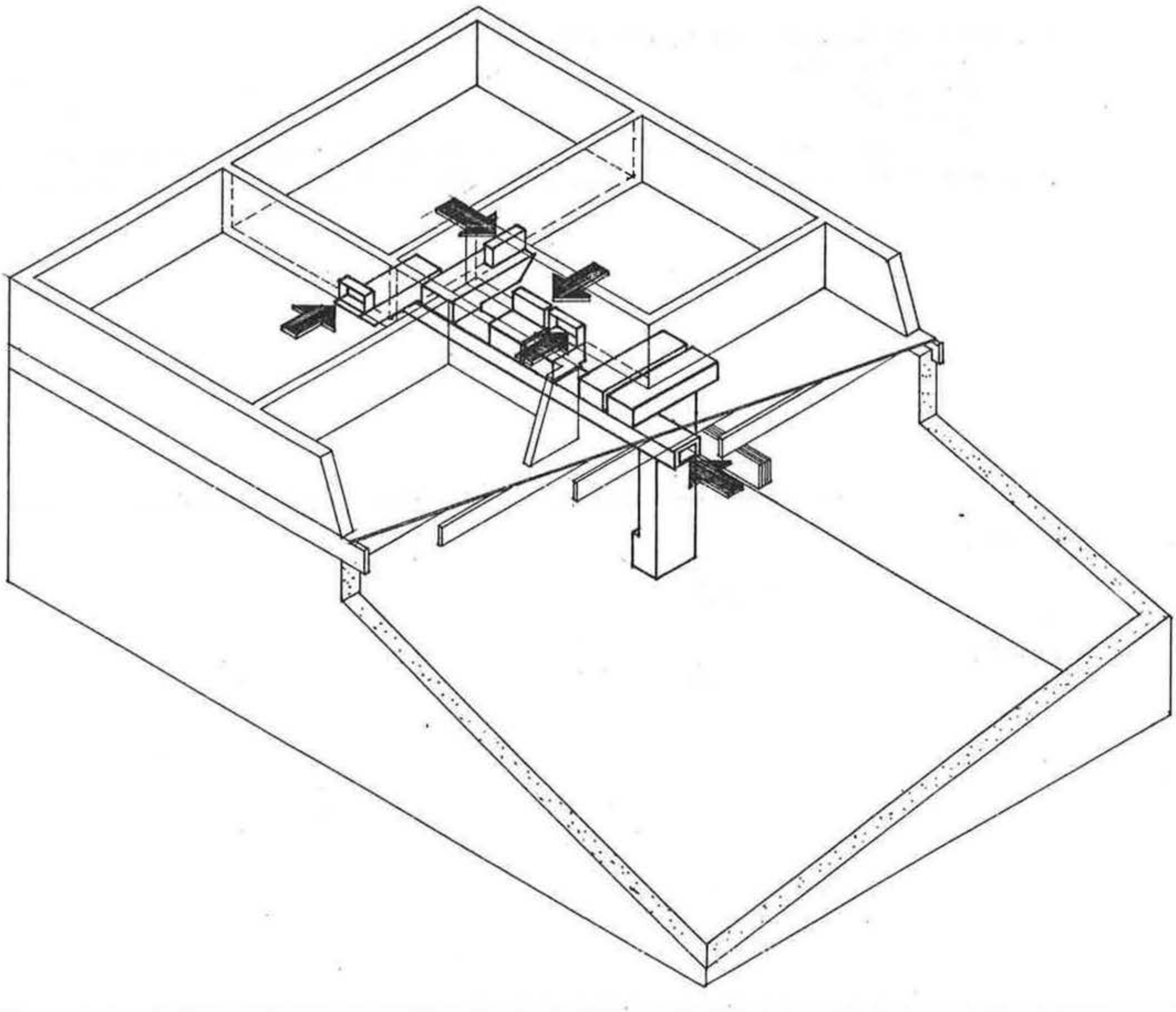


FIGURE H-8

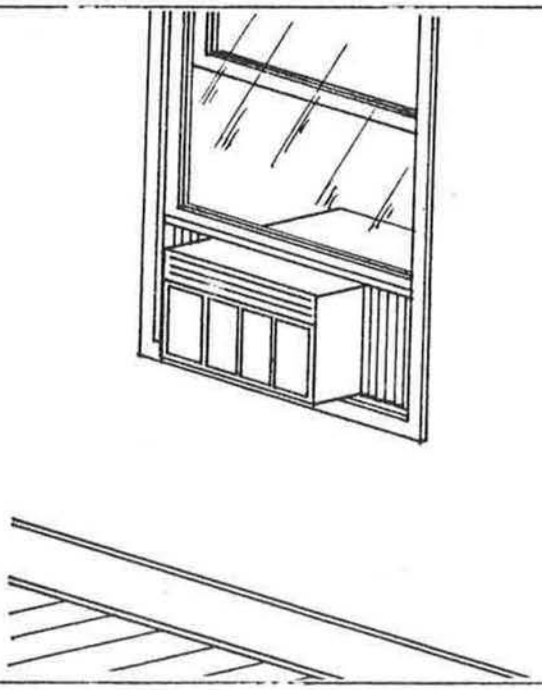
SYSTEM: Room air conditioner

SYSTEM DESCRIPTION:

o Install 0.8 ton window room air conditioner.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $600.00 |
| ELECTRICAL | 13.00 |
| PLUMBING | 0 |
| | $613.00 |



NOTES:

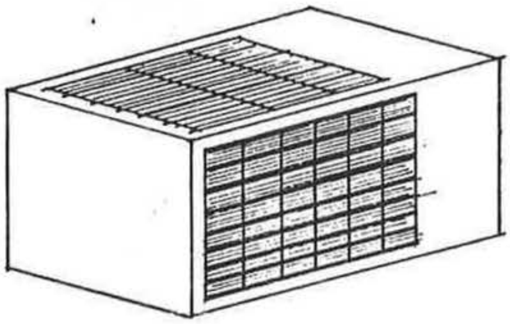
SYSTEM: 2 ton central air conditioning

SYSTEM DESCRIPTION:

- o Install 2 ton central air conditioner.
- o Ducting not included.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,900.00 |
| ELECTRICAL | 185.00 |
| PLUMBING | 30.00 |
| | $2,115.00 |



NOTES:

1. Includes $200.00 to increase capacity of ductwork to 378 l/s (800 CFM).

DOMESTIC HOT WATER HEATING D-1

SYSTEM: Conventional 114 l (25 I.G.) gas DHW tank

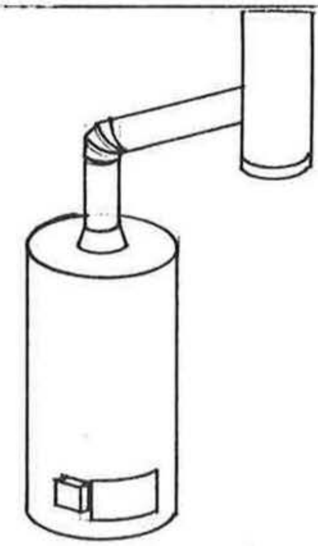
SYSTEM DESCRIPTION:

- o Install 114 l (25 I.G.), 9 kW input (32,000 Btu/Hr) naturally-aspirated gas domestic hot water tank. Connect to existing vent.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $ 320.00 |
| ELECTRICAL | 0 |
| PLUMBING | 35.00 |
| | $ 355.00 |

| | |
|---|---|
| GROSS COST: | $ 355.00 |
| LESS SAVINGS: | 0 |
| NET COST: | $ 355.00 |



NOTES:

SYSTEM: Electric 182 l (40 I.G.) DHW tank

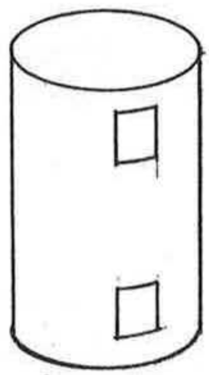
SYSTEM DESCRIPTION:

- Install 182 l (40 I.G.), 3000 W electric domestic hot water tank.

GROSS COST:

| | | |
|---|---|---|
| MECHANICAL | $ | 300.00 |
| ELECTRICAL | | 90.00 |
| PLUMBING | | 35.00 |
| | $ | 425.00 |

| | | |
|---|---|---|
| GROSS COST: | $ | 425.00 |
| LESS SAVINGS: | | 355.00 |
| NET COST: | $ | 70.00 |



NOTES:

SYSTEM: Electric 273 l (60 I.G.) DHW tank

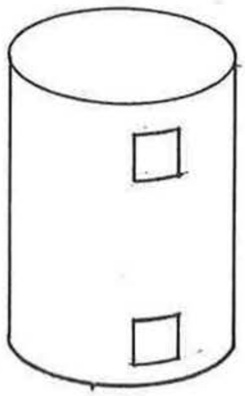
SYSTEM DESCRIPTION:

o Install 273 l (60 I.G.), 4500 W electric domestic hot water tank.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $ 400.00 |
| ELECTRICAL | 112.00 |
| PLUMBING | 35.00 |
| | $ 547.00 |

| | |
|---|---|
| GROSS COST: | $ 547.00 |
| LESS SAVINGS: | 355.00 |
| NET COST: | $ 192.00 |



NOTES:

SYSTEM: Habitair

SYSTEM DESCRIPTION:

o Install Habitair integrated system which provides ventilation and DHW heating and degrees of supplemental space heating in winter and air-conditioning in summer. Unit consists of an exhaust-only ventilation system c/w integral heat pump to recover energy from the exhaust air which is used for DHW and space heating. In summer, heat is extracted from interior air to preheat DHW and provide a degree of air-conditioning. Heat pump cooling capacity is approx. 2.3 kW (8,000 Btu/hr) and DHW tank capacity is 273 l (60 I.G.) c/w 1,500 W of supplemental electric resistance heaters.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $5,000.00 |
| ELECTRICAL | 255.00 |
| PLUMBING | 100.00 |
| | $5,355.00 |

see
Figure I-1

NOTES:

1. Habitair is intended by its manufacturer to ideally be integrated with the Fiberglas Canada Inc. Low Energy Home system which permits a leakier house envelope to be constructed.

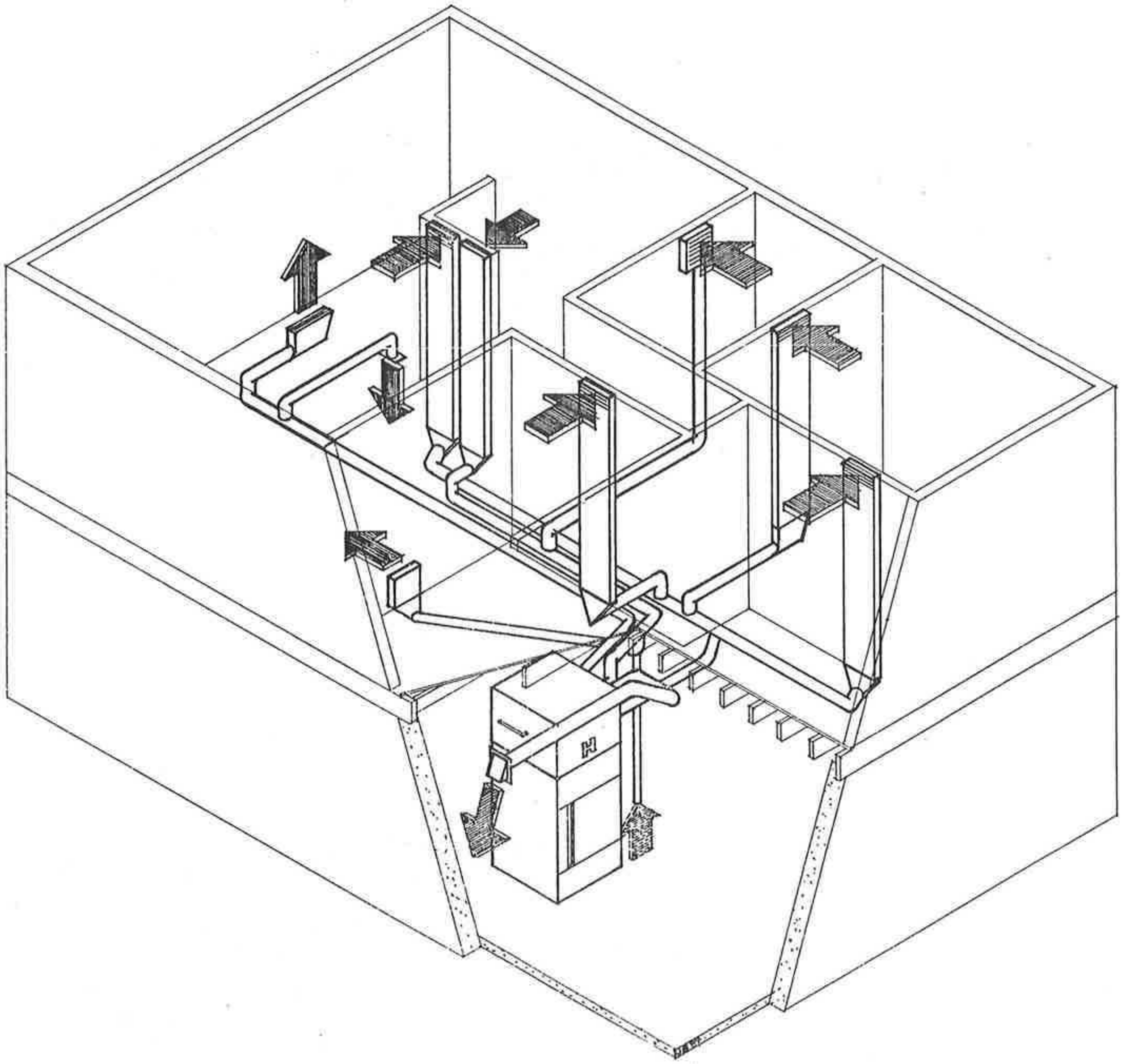


FIGURE I-1

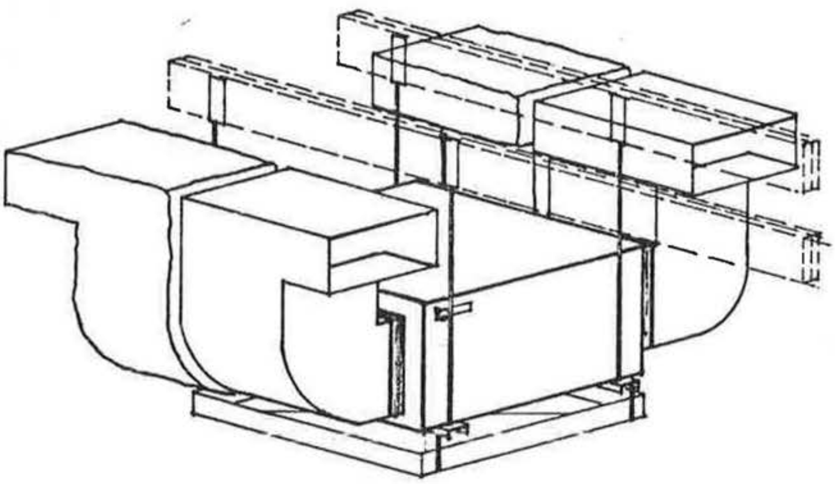
SYSTEM: Peach

SYSTEM DESCRIPTION:

- o Install Peach integrated system which provides space heating, DHW heating, ventilation and air conditioning. System consists of an integral 8 kW electric furnace, two electric DHW tanks 182 l (40 I.G.) and 114 l (25 I.G.), an integral air-to-air pump which recovers heat from outdoor and exhaust and a simple exhaust and supply ventilation system. Costs include all ductwork.
- o For cold climate applications, system requires supplemental exhaust system capacity from bathroom and kitchen fans.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $5,460.00 |
| ELECTRICAL | 545.00 |
| PLUMBING | 220.00 |
| FRAMING | 100.00 |
| | $6,325.00 |



NOTES: