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VISIT TO THE CONSTRUCTION SITE OF A HOUSING PROJECT IN PANGNIRTUNG, BAFFIN ISLAND, N.W.T.

by

R.L. Quirouette

PREFACE

The Division of Building Research was pleased to participate in a visit (in November 1978) to a 16-unit housing project being constructed in Pangnirtung, Baffin Island, by Poole Construction Limited (now PCL), of Edmonton, Alberta. Mr. J.C. Perreault of PCL had arranged to present a seminar on the principles of design and construction to the project staff and wished to have a member of DBR accompany him on this site investigation visit. Mr. R.L. Quirouette, an architect with the Division's Design and Use Section, was the DBR member of the visiting team.

This report is a record of some of the observations and subsequent discussions of the design and construction problems concerned with providing housing in Canada's North.

Ottawa
January 1980

C.B. Crawford
Director, DBR/NRC

NATIONAL RESEARCH COUNCIL OF CANADA

DIVISION OF BUILDING RESEARCH

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Checked by: G.O.H. **Approved by:** C.B.C. **Date:** January 1980

Prepared for: record purposes

Pangnirtung is located on a small plateau just above sea level at the mouth of a large fjord on Baffin Island. The plateau, surrounded by mountain ranges of moderate height, has little vegetation or wildlife, but retains a unique and bizarre beauty. The community has several hundred inhabitants, mostly Inuit (Eskimo) with a small proportion of whites.

As Pangnirtung lies less than 80 km south of the Arctic Circle (Fig. 1), its hours of daylight become few as the winter solstice approaches. At this time of year the sun rises at about 9:00 and sets by 14:00. Dusk may linger for some time thereafter, but the community is in total darkness by about 15:30.

Temperatures during our visit varied from -20°C to -30°C. There was, however, almost no wind. At other periods, particularly during January and February, Pangnirtung may experience winds up to 160 km/h. The size and strength of the anchor cables holding down buildings are clear evidence of this (Fig. 2A).

Sixteen housing units are being constructed in Pangnirtung for the government of the Northwest Territories. These new units constitute eight separate buildings of two dwelling units each. Units have either two or four bedrooms, built in 38 × 140 mm (2 × 6) wood-frame construction. They sit just above grade on light steel piles placed in slurry backfilled augered holes in the bedrock. The buildings appear to be sited in a loop with almost all buildings facing an inner court, itself the site of two buildings (Fig. 2B).

The builder is PCL, Edmonton, Alberta. Design consultants and contract managers are Beauchemin-Beaton-Lapointe, Inc., Montreal, P.Q. The project was begun in the fall of 1978; expected completion date is late spring, 1979.

Personnel on this field trip, which began in Montreal on 29 November 1978, were Mr. Michael Turner, Northwest Territories Housing Corporation; Mr. Claude Perreault, PCL (Edmonton); Mr. Don Briggs, PCL (Yellowknife); Mr. Pierre DeCourval, Beauchemin-Beaton-Lapointe, Inc.; and the author. When we arrived in Frobisher Bay at 16:00, three hours out of Montreal, it was already dark. It was cold, clear and windless. This community, on the south side of Baffin Island, has several thousand inhabitants, primarily Inuit. Our group stayed at the hotel, part of a complex incorporating government offices and a medium-size Hudson's Bay store.

During our stay in Frobisher Bay I visited two other construction projects being built by the Northwest Territories Housing Corporation. Our guide was Mr. Michael Turner, Construction Supervisor for the Corporation. Two schools recently built and of original design were also visited. Their unique features are the exterior walls which are constructed of prefabricated glass fibre panels. Discussion with the other members of the party revealed that the application or the use of glass fibre panels and this type of construction has proved to be quite successful in Frobisher Bay. Both of these schools, Nakasuk Elementary School (Fig. 3A) and Gordon Robertson Learning Centre (Fig. 3B) have already been reported on in Canadian Architectural magazines.

We left Frobisher Bay at 14:00, 30 November 1978, by charter flight and arrived in Pangnirtung in a little more than an hour. Although daylight was falling rapidly, the view was spectacular as the aircraft descended into the fjord valley. Messrs. Briggs and Perreault and I flew on this charter; Messrs. Turner and DeCourval followed on the cargo flight which was carrying materials for the Pangnirtung housing project. All of us were accommodated in a pleasant medium-size workmen's lodge, within walking distance of the project, and overlooking the fjord waters (then frozen).

Although night had fallen, Mr. Briggs took us on a tour of the project. I then spent an hour examining the architectural and construction drawings provided for the project, while Mr. Perreault went on an on-site inspection tour. He and I met afterwards to discuss several potential problems, particularly the potential for air leakage.

Building Design

Each double dwelling is rectangular, about 18 × 7.6 m, and two storeys high. The two-bedroom units have a second floor slightly smaller than their ground floor, an effect achieved by reducing floor width and introducing a roof element at the front of the building (Fig. 4). Under each unit is a small room housing a potable water tank, and a sewage holding tank. The clearance between the grade and the underside of the service room floor is approximately 1½ to 2 feet. The buildings are heated by oil-fired forced warm air systems. The oil tanks are installed outside the units on a structurally strengthened balcony floor. As the first floor is well above grade, each dwelling has steps leading to a verandah and the front door.

The windows in the units are triple-glazed; some are fixed and others are a combination of a fixed panel and a hopper sash. Thermal resistance values of the elements that constitute the building enclosure are walls 3.5 RSI and ceilings 7.0 RSI. The first floor is constructed of 38 × 235 mm joists completely filled with glass fibre insulation (Fig. 5). The heating system ducts for the ground floor are routed through the false floor constructed over the insulation-filled joist space. While warm air is forced directly to each room, small holes drilled in the duct work pressurize the false floor to achieve a uniform floor temperature.

Wall studs are 38 × 140 mm, 610 mm on centre; wall cavities are filled with 3.5 RSI glass fibre friction-fit batts. On the inside surface of the insulation a 0.10 mm polyethylene sheet is held in place by 17 × 64 mm strapping spaced 406 mm on centre (note: these values indicate soft conversion; design was in imperial units). Gypsum board is placed directly over the strapping, creating a cavity 19 mm deep for exterior-wall wiring and outlet boxes. The outside of the exterior walls is 9 mm plywood, covered with a 15-lb building paper shiplap fashion, and further secured by vertical strapping. This creates another cavity between the outside finish and the plywood sheathing. The exterior finish is cedar siding, applied diagonally on the end walls and horizontally elsewhere. Second floor ceilings comprise high-lift roof trusses 610 mm on centre, (Fig. 6A) insulated between as well as above their lower cords with 7.0 RSI friction-fit insulation. On the lower side of the insulation an air and vapour barrier of 0.10 mm polyethylene is stapled to the ceiling and lapped at the walls with the wall polyethylene. Furring, 305 mm on centre, creates the cavity between the gypsum board and the polyethylene film.

The first floor above grade, is multi-layered as follows, starting from the underside: a 9 mm plywood undersheathing; 38 × 235 mm wood joists with inter-joist cavities filled with glass fibre insulation; 0.10 mm polyethylene film: a sheathing of 9 mm plywood. A second cavity is then created between the inner sheathing and the first floor proper by 38 × 53 mm wooden blocks 250 mm long, set on the 38 mm edge over the entire floor area (Fig. 5). A continuous 38 × 53 mm ribbon was also nailed on edge around the perimeter. Joists, 38 × 64 mm (2 × 4) were then installed over top at right angles to the blocks, on edge and continuous on 406 mm centres thus forming a cavity 117 mm deep. Left unfilled and covered with 16 mm tongue-and-groove plywood, the cavity holds first-floor warm air ducts which lead to the individual rooms. Small holes purposely punched in these ducts pressurize the floor.

Sound insulation is provided by a continuous wall separating adjacent units, vertically. Studs in this party wall are 38 × 140 mm. Interstices are partially filled with insulation and covered with gypsum board, mounted on resilient channels on both sides. Numerous holes created for the electrical systems may undermine the rated ability of this partition with respect to fire and sound resistance.

Construction

Fourteen of the 16 units were constructed by a 14-man crew and one field supervisor. One two-unit building was constructed by local inhabitants under the guidance of a PCL supervisor as part of a training program. Construction is said to be on schedule, but it should be noted that this schedule is probably longer than one for identical units built further south. Mr. Briggs believed that construction under conditions like those at Pangnirtung requires an average of about 30 per cent more man hours per project. It is a very hard environment in which to work: workers must be heavily clothed and must wear gloves at all times; materials such as polyethylene, building paper and caulkings, although in theory unchanged by the cold, must often be warmed up to apply or even to unwrap.

Examination of Buildings

On the morning of 1 December 1978, Mr. Perreault and I continued our examination of the buildings, especially those whose constructions were most advanced. We discussed the pressurized base and the problems it could lead to, the 19 mm cavity behind all drywall, the use of plywood as exterior sheathing and the multitude of holes created by chimneys, plumbing and wiring. We concluded that pressurizing the floor cavity could lead to serious condensation problems, either in the insulation of the floor or in the wall cavity defining the perimeter of the building. In addition, it was discovered that three of the 16 units had 38 × 53 × 250 mm spacer blocks instead of a continuous 38 × 53 mm ribbon around the perimeter, thereby creating gaps at least 25 × 250 mm leading directly into the outside wall cavity behind the polyethylene sheathing (Fig. 5). The harshness and long duration of the winter can make even a minor air leak a serious problem; openings of this size might well cause the exterior walls to fill with condensation in a matter of weeks. To avert this potential problem, Mr. Perreault and the field superintendent decided to insert 38 × 140 mm wood blocks between the studs and complete the seal by caulking. To reduce further the risk of air leaking into the wall, it was recommended that additional outlet grilles be installed in the floor to relieve cavity pressure. Further discussion of this problem with Mr. Pierre DeCourval revealed that such pressure relief had been intended and was specified but the necessary hardware was not available. The intent was to install specially designed grilles in which forced warm air from the duct outlet would draw floor space air by venturi action. This would have assured a continuous flow of air in the false floor, thereby maintaining the intended uniform floor temperature at a minimum air pressure difference.

In principle, the object of constructing a service cavity between drywall surfaces and the structure is commended, but in practice it may lead to far more air leakage than if the drywall had been applied directly over the structural elements. Since the cavity between the drywall and the structural elements is continuous between the walls and roof surfaces, any openings on the interior are now connected to any other opening on the exterior regardless of the location of each one. Therefore, the probability of air leakage through the building is very high in comparison with a construction technique which would cellularize or compartmentalize the building envelope as occurs when the drywall is applied directly over the structural elements.

Another area of construction detailing which seemed to deserve more attention was the openings formed by the plumbing and electrical services. Although there was no way to seal off all possible penetrations through all walls, it was suggested that, where several of these service pipes punched through in a cluster in a chase space, a wire mesh be used to span the opening, attached to all service pipes, and filled with a plaster or cement. This would minimize the area of openings while providing necessary fire protection around pipes such as chimney flues. Smaller holes, cracks and crevices, such as those created by wiring and intersections of sheathing materials and structural components where shrinkage could occur should be sealed with caulking.

Snow can be fine and powdery, especially when driven by high winds. In the North, this type of snow will often be driven up into attic spaces, in some cases to completely cover the insulation. But even though this powdery snow is light, it is still heavier than air, and it must obey laws of gravity and inertia. To reduce the problem of snow accumulation in attics, a baffle has been incorporated into the soffit vents. This makes incoming air follow a special route; as it does so it loses the snow it carries. This baffle principle is reported to have been successful in a Frobisher Bay housing project.

Plans for the Pangnirtung project specified polystyrene insulation in two layers on the inside of header joists at certain areas. Inspection of this detail, however, revealed large gaps between the insulation and the header, a practical difficulty when rigid insulation is used for this purpose (Fig. 6B). Air circulating in this space will probably negate the intended effect of the insulation. Even if the insulation had been nailed or glued to the joist surface, its application would still be questionable.

Discussion

This short but intensive learning experience made it clear that there are several major problems with providing housing in the North. Both the climate and lifestyles of the inhabitants (now and in the foreseeable future) are badly matched with the type of architecture now promoted in these areas. To have imported directly into the North an entire house building technology, evolved for moderate climates is evidence of an insensitivity to the forces that shaped that technology in the first place. In contrast with the more southerly zones of Canada, northern communities experience severe cold for much longer periods of time. They are often plagued by high winds and some areas experience extraordinary snow falls. The social conditions of the North are different from those that prevail in more temperate zones, and will continue to be shaped by forces beyond man's control. Daylight hours for example, are few at winter solstice, yet almost day-long during the summer. There is not the variety and abundance of energy, or even the raw materials from which energy is derived, that the south of Canada enjoys. Designers of buildings for the North must be encouraged not only to explore forms of architecture compatible with the indigenous conditions but to develop appropriate construction techniques as well.

In group discussions, it became apparent that of all materials available to the construction industry, wood and steel were the easiest to obtain, transport and erect on site. On the other hand, polyethylene, building papers, and various caulking compounds are difficult to work with in the North both during framing and at finishing. The use of masonry or masonry products seems out of the question, because of the constant low temperatures and the costs of transportation of these types of materials. Given the remoteness of northern building sites from sources of materials, the limited access to special equipment, and other inhibiting factors, both construction scheduling and the actual process of construction can be harassing. There are usually long delays in overcoming shortages or obtaining specialized skills, making it hard to maintain a planned schedule. Because of this, the northern work philosophy emphasizes making do with what you have. To avoid ad hoc improvisation which tends to destroy design intent, complicated design processes should be avoided. Simplicity of design and construction alike should become the goal.

In addition, special considerations are required in providing services which include potable water, heating fuels and sewage disposal. Because of the prevailing permafrost or rock conditions, most of these must be constructed above grade and enclosed within the building and have storage capacities sufficient to offset unpredictable pickups and deliveries.

Our group left Pangnirtung on 1 December 1978 at 13:00. We stopped in Frobisher Bay to transfer from a DC3 to Nordair's 737 jet. We were in Montreal by 20:00 where the group split up and I boarded the 22:30 Air Canada flight to Ottawa.

Acknowledgements

The author wishes to thank the following persons for their co-operation during his visit to Pangnirtung: Mr. Michael Turner of the Northwest Territories Housing Corporation, Mr. Pierre DeCourval of Beauchemin-Beaton-Lapointe, Inc., and Mr. Don Briggs, Site Superintendent of PCL.

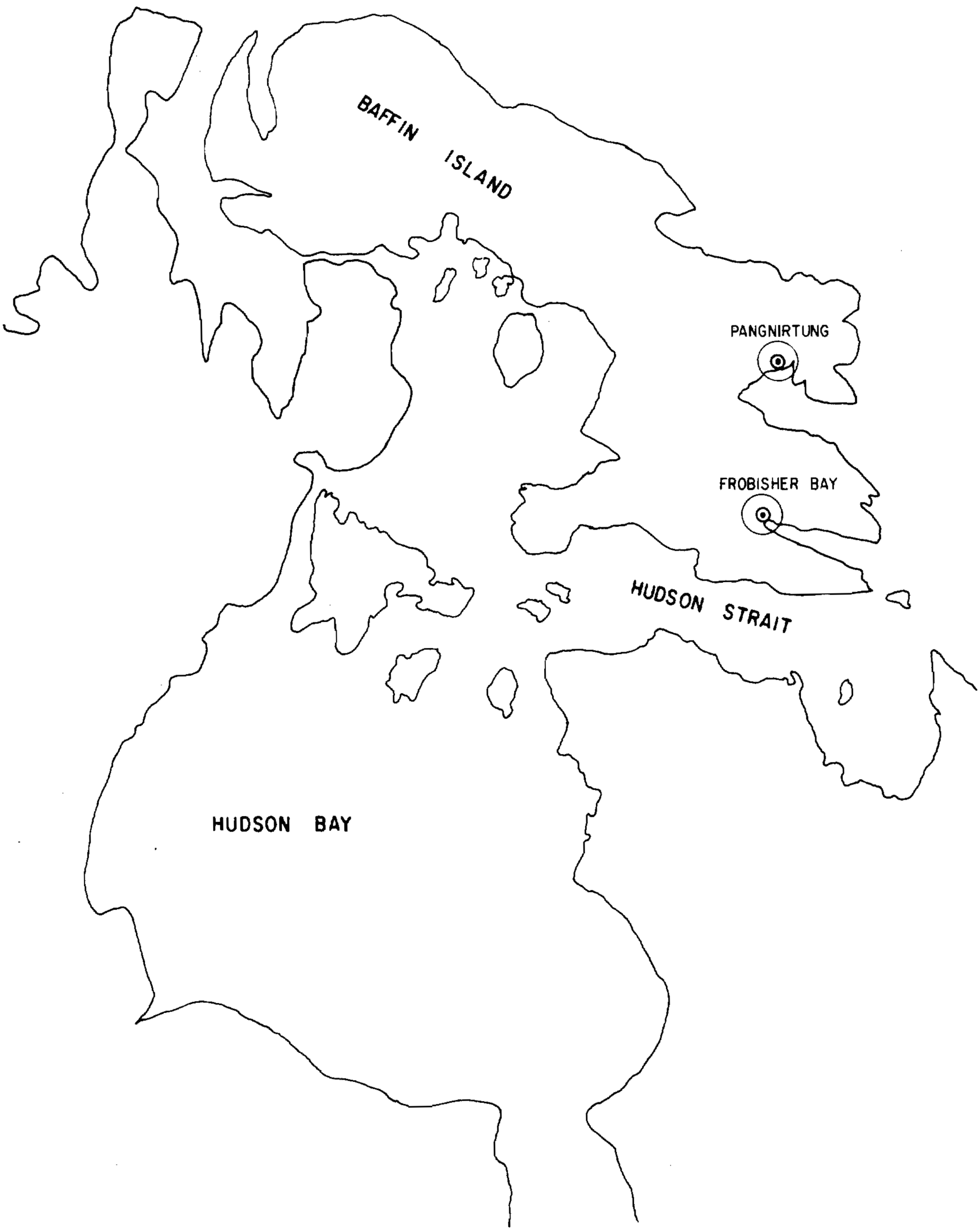
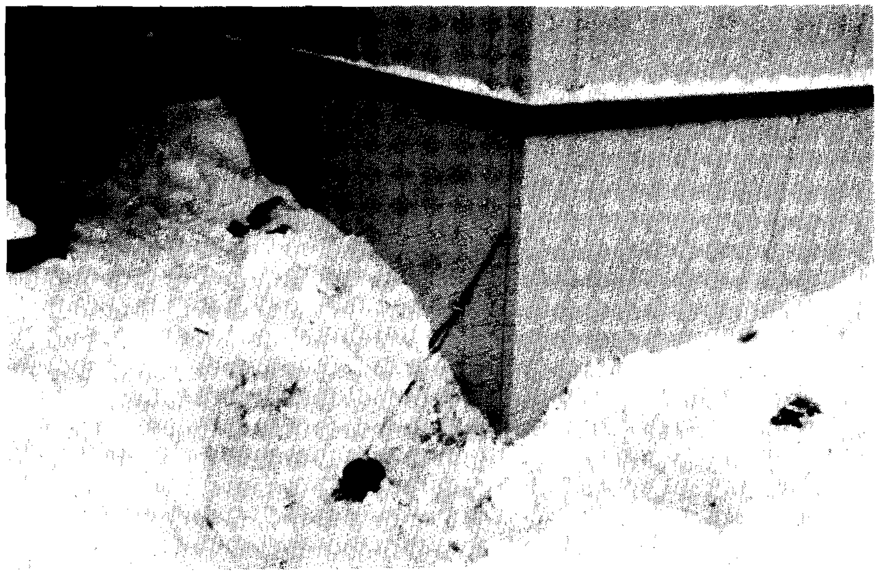
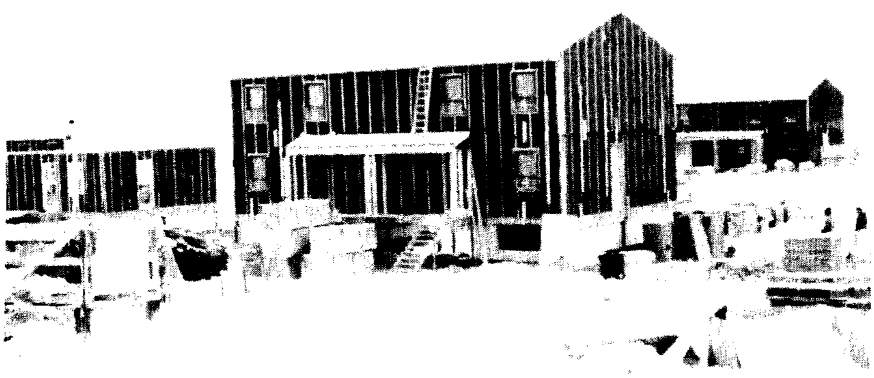


Fig. 1. Location of sites visited



(A)



(B)

Fig. 2. Typical 2-unit, 4-bedroom house

(A) - anchor cable; (B) - front view of unit

(A)

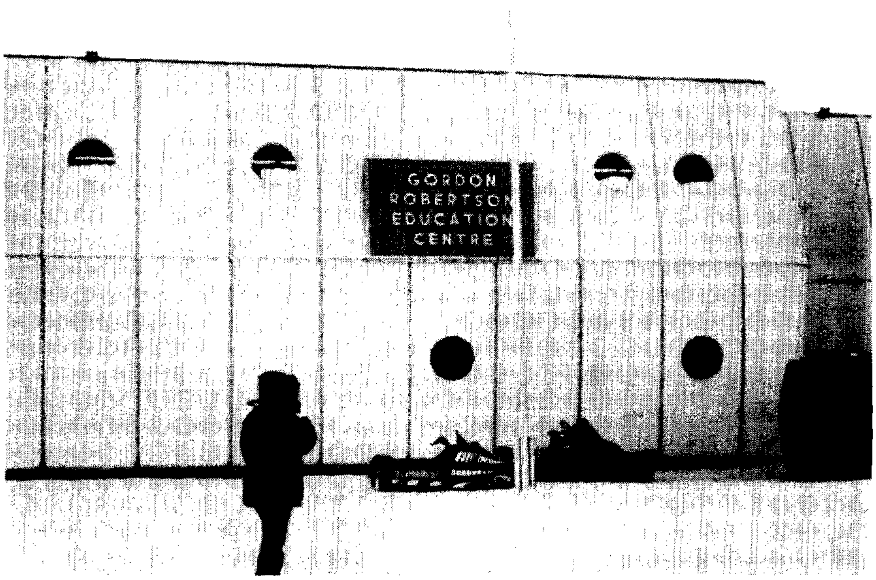


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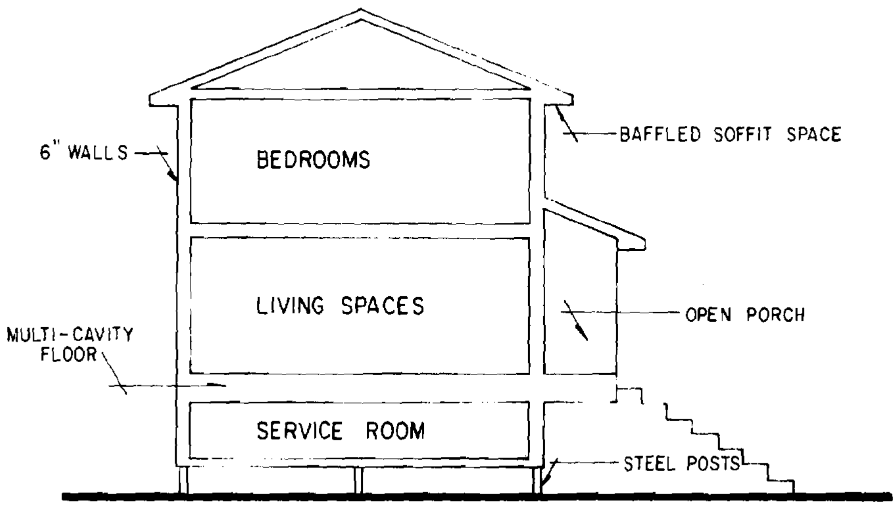
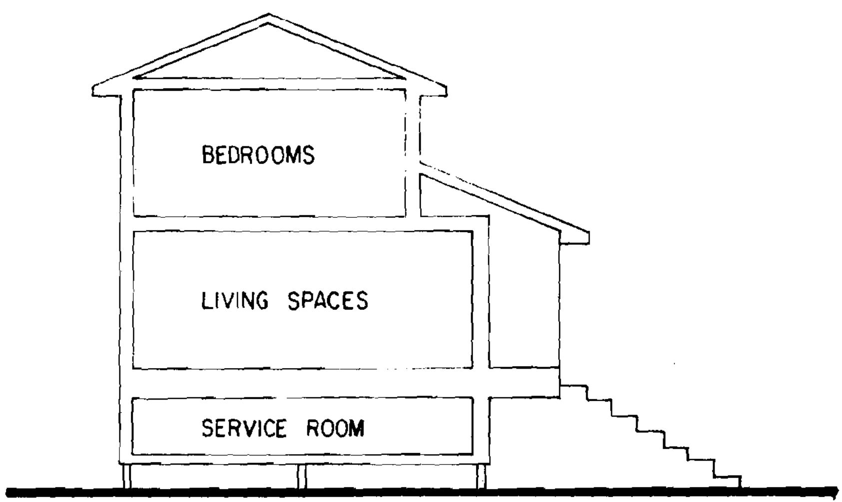
Fig. 3. Schools visited at Frobisher Bay:

(A) - Nakasuk Elementary School; (B) - Gordon Robertson Education Centre



SECTION- 4 BEDROOM UNIT



SECTION- 2 BEDROOM UNIT

Fig. 4. Cross-section of 4- and 2-bedroom units

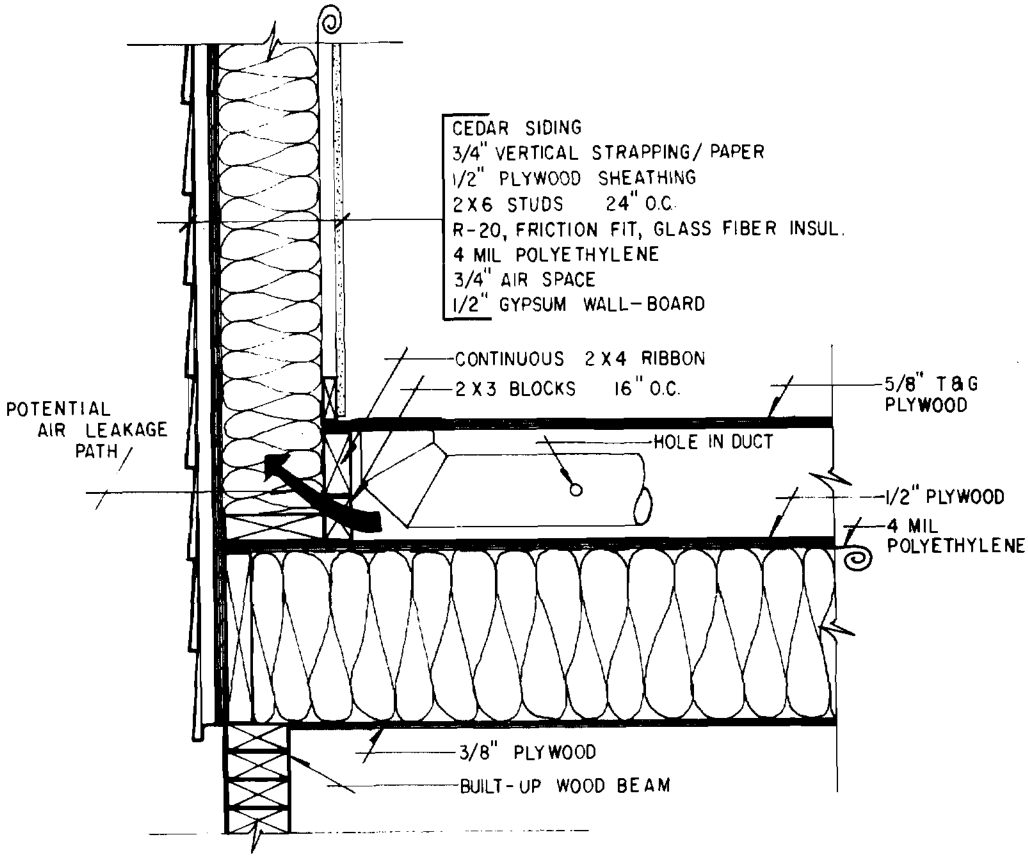
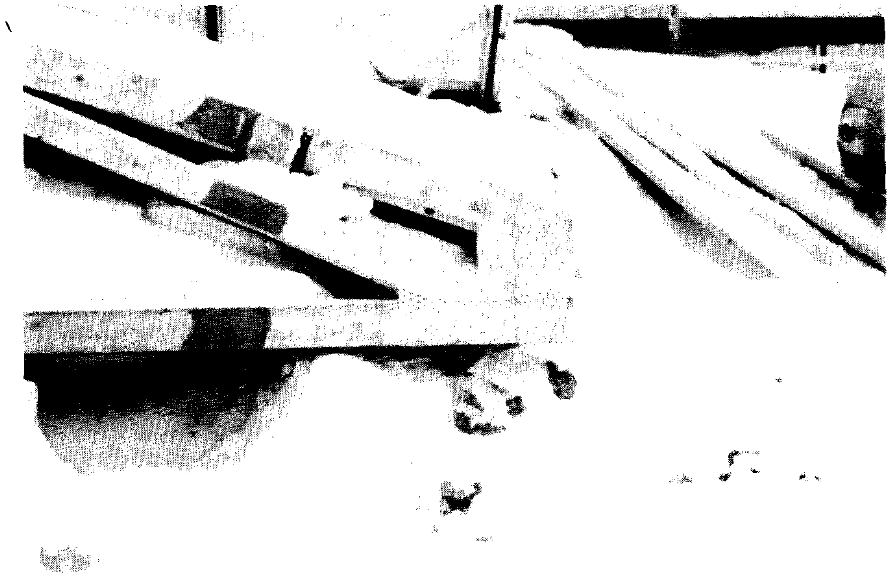
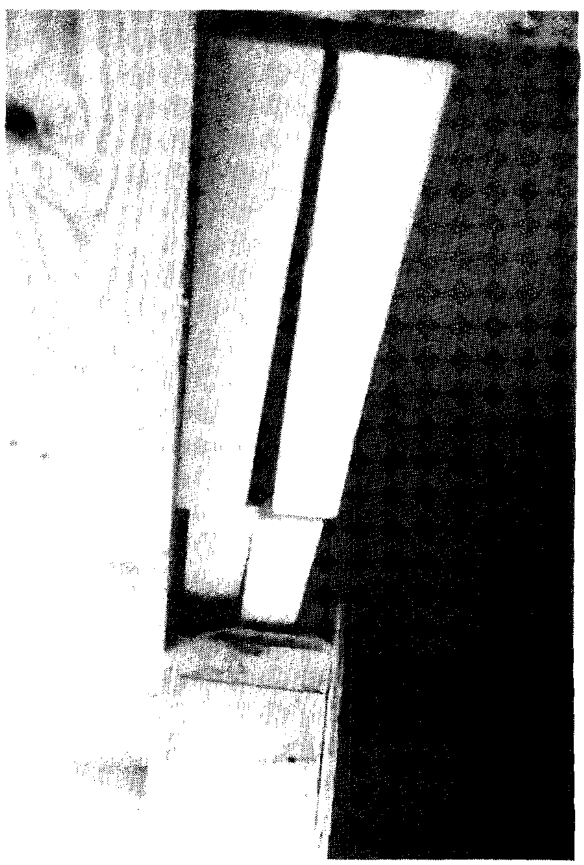


Fig. 5. Construction details of wall-floor section (taken from building drawings)



(A)



(B)

Fig. 6. Construction details:

(A) - high-lift prefabricated wood truss; (B) - insulation detail