Building in winter with the aid of enclosures

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BUILDING IN WINTER WITH THE AID OF ENCLOSURES

BY

A. W. SMITH

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SUMMER BUILDING ALSO HAS ITS HAZARDS. Here time was lost and extra costs were incurred in this apartment summer-building project in Ottawa when the flooded excavation had to be pumped out after rain. (Illustration 1).

How to build in wintertime with the aid of enclosures

In recent years, extensive studies have been made by the Division of Building Research, National Research Council, into the applications, cost and performance of various types of enclosures when used in winter for different kinds of building construction.

This month, Mr. A. W. Smith of the DBR staff, who was co-author of the Armstrong report, begins an exclusive series of four articles in NB dealing with the use of enclosures for different types of building construction in winter.

A. W. SMITH

By A. W. SMITH

There are still many in the construction industry who believe that building in winter automatically implies extra costs and low quality.

Those who compare winter work with work done in the summer months often forget the days lost because of rain, slowdowns because of high temperatures, delays in the delivery of materials, the pumping out of an excavation, or the moving of vehicles stuck in the mud. (See illustrations 1 and 2.)

All of these summer problems represent added costs which are not nearly so apparent as the direct cost of heating materials and providing for fresh concrete in wintertime. Time lost in warming up, clearing up, and sitting out winter storms appears to be much more significant than time lost due to heat, rain and slow deliveries in summer.

Only within a complete enclosure can work continue entirely independently of weather under conditions which encourage the maximum output from labour. Increased productivity will cut construction costs and in many parts of Canada will often more than pay for the direct costs of winter construction.

Builders operating on a year-round basis have the opportunity of building up efficient crews of experienced workmen, and can greatly reduce overhead expenses and operating costs in general. They can take advantage of the seasonal fluctuation of material costs and can often avoid the labour and material price increases which occur every spring. It should be possible for subcontractors to reduce their winter prices knowing they can be assured of work for the duration of the winter.

By heating an enclosure which surrounds the work, the need for giving additional protection to the work itself is eliminated. It is also a simple matter to avoid the costly protection of building materials stored on the site by placing them inside the enclosure and close to their final position.

Heating of sun enclosures is one of the direct costs of winter construction. This can very often be reduced by utilizing solar energy.

The plastic films that are now widely used on such structures have the ability to trap solar heat so that the temperature inside such shelters may be as much

ANOTHER SUMMER BUILDING HAZARD. This also happened in Ottawa after rain in summer when transport became bogged down around a job-site. It could seldom happen in winter when the ground would be frozen. (Illustration 2).

as 45 F. above outside air temperatures during sunny weather. This alone will often provide all the heat required during the day.

At night, however, and during periods of cold, windy and cloudy weather, additional heat is required. (See charts—illustration 3.)

Sometimes a double layer of plastic can improve the insulating value of such a film by isolating an inch or so of air between each layer.

Savings can also be made by providing controls which will set a limit on the temperature within the enclosure.

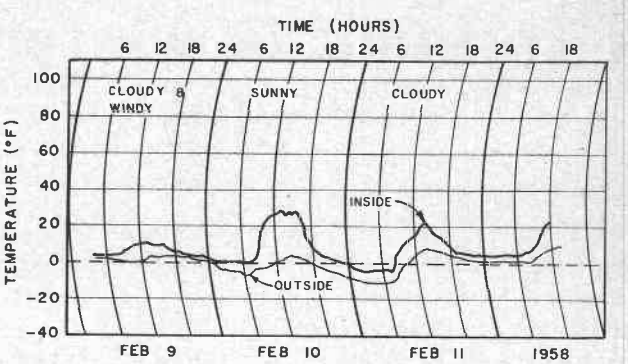
In many cases, where control is not exercised, the temperature may rise to a very high level. This not only increases the heating costs but may also have an adverse effect on the quality of the work.

Different types of building construction are affected in different ways during wintertime.

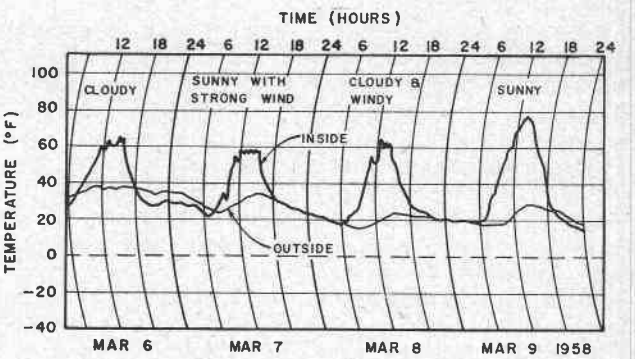
Prefabricated frameworks of steel or precast concrete are least affected since they can be erected without difficulty in all but the most severe weather conditions. Cast-in-place reinforced concrete frames and buildings with load-bearing walls present greater problems.

In all cases, best results are achieved when it becomes possible to use the enclosed building for support and maybe even as part of the enclosure itself.

In the ensuing articles in this series in National Builder, each type of construction will be considered separately and the various methods of enclosing each type will be discussed in some detail.



TEST ENCLOSURE COVERED WITH BUILDING PAPER AND POLYETHYLENE IN RATIO 3:2 (ILLUSTRATION 3)



TEST ENCLOSURE COVERED WITH POLYETHYLENE. (ILLUSTRATION 3)

THESE CHARTS SHOW how important can be the solar heating of an arch enclosure. They compare the daily variation of the air temperature inside the enclosures with the natural variation of the air temperature outside them.

HERE'S A GOOD EXAMPLE showing that building under a winter enclosure can be carried out in all sizes of projects. This is the new Survey and Mapping Building in Ottawa using an upper floor enclosure of timber forms and hanging tarps. Top surface of the roof slabs is covered with an insulating blanket. (Illustration 10)

How to solve winter's problems in multi-story construction

In the second of his series of articles on building in winter with the aid of enclosures, Mr. Smith of the Division of Building Research, N.R.C., deals here with multi-story frames. The prefabricated framework of steel or precast concrete, he says, is least affected since it can be erected without difficulty in all but the most severe weather conditions. Cast-in-place reinforced concrete frames and buildings with load-bearing walls, however, present greater problems. In all cases, best results are achieved when it becomes possible to use the enclosed building for support and maybe even as part of the enclosure itself.

By A. W. SMITH

Prefabricated frames

Prefabricated frames of steel or precast concrete can be erected without difficulty in all but the most severe weather conditions and then closed in simply and effectively by using a permanent floor construction above and below, and a temporary, lightweight wall enclosure supported by the frame itself.

There are two principal methods of enclosing the building skeleton.

The first and best method for taller buildings uses a covered-in suspended scaffold as an external working platform. (Illustration 5.)

This scaffold is suspended from outriggers at roof level and raised from one story to another as work progresses. (Illustration 6.) It provides the walls of a story-height enclosure. The roof and floor of this enclosure are best formed by precast concrete slabs but could just as well be formed by metal pans on bar joists or even timber floor forms.

The metal pans and timber formwork imply a cast-in-place concrete floor slab which will require additional protection on the uppermost outside surface.

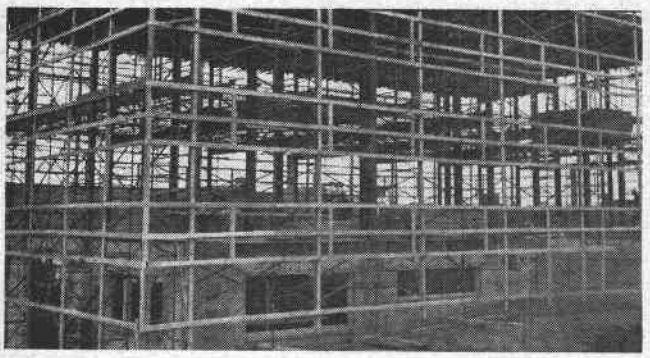
The second method of enclosing the skeleton makes use of standard sections of tubular scaffolding and is generally most economical for buildings under four or five stories. The scaffold is braced against the prefabricated frame and covered in by placing plywood, tarpaulins, or plastic over a light timber framework wired to the outside members. (Illustration 7.)

Prefabricated wall panels whether of metal, concrete or plastic can eliminate the need for an outside scaffolding of any kind and provide in themselves an immediate enclosure of permanent materials. (Illustration 8.)

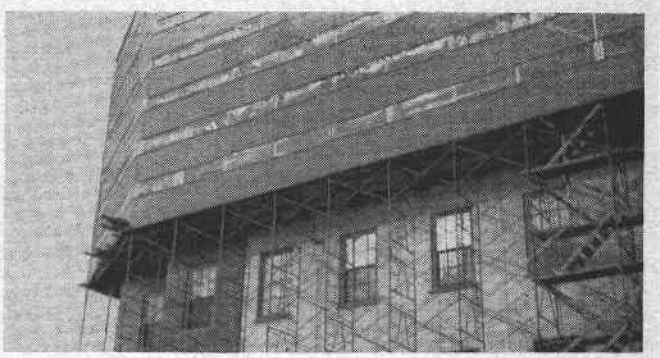
When used in conjunction with a pre-

COVERED-IN SUSPENDED SCAFFOLD. This covered scaffold, enclosing a story-high stage of construction, was used in Toronto. It is raised as the work proceeds. (Illustration 6.)

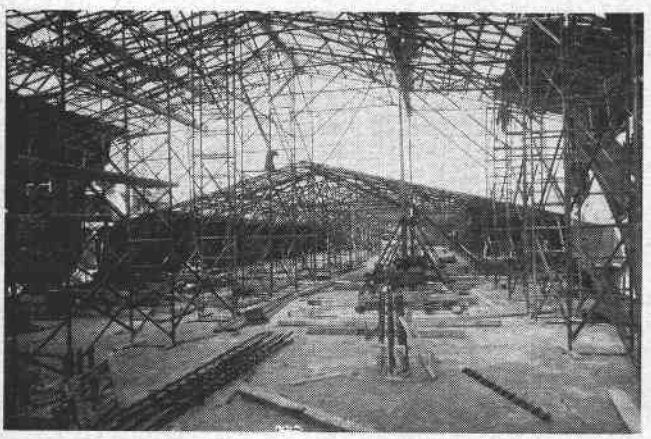
. . . **AND HERE'S WHAT** it looked like inside. Brickwork is going ahead many stories up with the men operating under near-ideal conditions despite severe weather outside. (Illustration 6.)



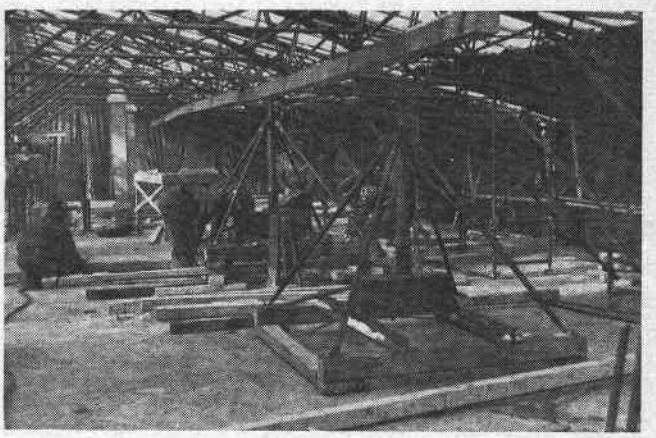
HERE'S AN EXAMPLE from the Maritimes of how standard scaffolding can be enclosed by wiring a light timber framework to the outside members and covering it with hardboard and plastic. This is the Maritime Auto Parts Building, Halifax. (Illustration 7.)



. . . **AND HERE IS ANOTHER** method for enclosing multi-story buildings, also from Halifax. It is the Maritime Telephone and Telegraph Building where standard scaffolding was braced against the building frame. (Illustration 7.)



JACKED-UP ROOF STRUCTURE. During construction of an 11-story apartment building in Ottawa, this temporary roof structure was jacked up story by story in sections. As the whole enclosure was raised, each floor was constructed within it. (Illustration 11.)



. . . **THE SAME JOB IN CLOSE-UP.** The mechanical jacking system raised the temporary enclosure in sections as work proceeded. Note how the jacks are positioned and that the men are working in comfort despite sub-zero temperatures outside. (Illustration 11.)

cast concrete frame they can eliminate the need for temporary enclosures of any kind and reduce the closing-in time to an absolute minimum. (Illustration 9.)

Cast-in-place frames

The problem of enclosing cast-in-place construction is basically the same in that it revolves around the enclosure of a story-height section of the building but the whole operation is generally much slower and more complicated.

Time is lost while waiting for the concrete frame to gain sufficient strength to support the next "layer" of construction and it is generally necessary to enclose two or even three stories at one time. This means that temporary heating costs are increased and additional materials are required.

The walls of the enclosure are usually formed by hanging tarpaulins and covered scaffolding as previously described. The roof is provided by the floor form, whether of permanent steel sheeting or temporary plywood, and is supported by column forms and telescopic jacks which rest on the roughly finished floor which has just been completed. (Illustration 10.)

This method still requires additional protection for the outside surface of the "roof" slab and this is usually provided by some kind of insulating blanket.

Some contractors have developed temporary roof coverings which can be jacked from floor to floor as the work progresses. This method of totally enclosing the working area provides full protection for the workmen, who are then able to form and place each floor in ideal conditions. The temporary roof, usually in the form of a steel or timber truss, is supported on steel columns which pass through the floor being constructed and rest on the completed floor underneath. (Illustration 11.)

This temporary roof may also be supported on temporary columns located outside the walls of the building under construction. This arrangement has the advantage that the supports for the enclosure do not interfere with construction operations.

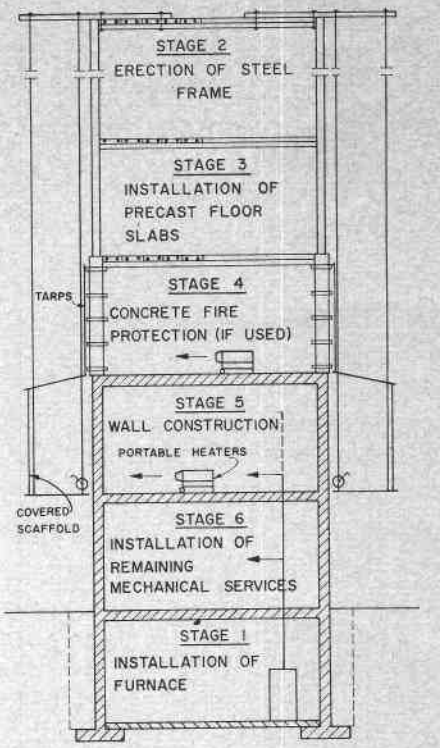
The lift slab method is particularly well suited to wintertime construction. The only enclosure required is a very simple one at ground level. (Illustration 13.)

All the floor slabs are placed within this small enclosure, one on top of the other, and then raised into position by hydraulic jacks on top of steel columns.

Hanging tarpaulins or prefabricated wall panels can be used to close in the entire structure after the precast floor slabs are finally positioned. The original enclosure used for the concreting operation might be a laminated timber arch structure covered with plastic.

Two stage-by-stage plans for winter building

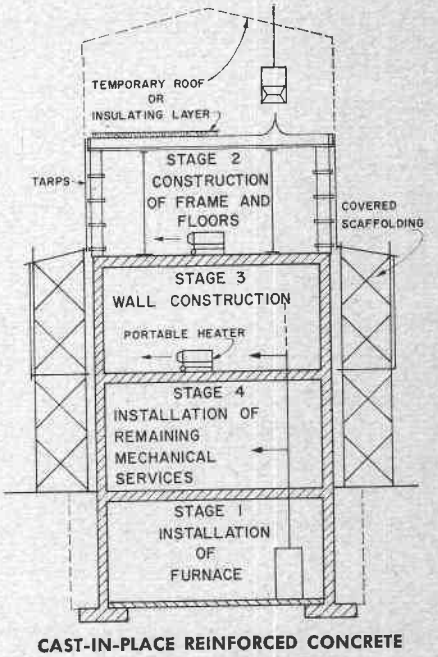
Prefabricated frames of steel or precast concrete can be erected without difficulty in all but the most severe weather conditions. They can then be closed in simply and effectively by using a permanent floor construction, above and below, and a temporary, lightweight wall enclosure supported by the frame itself. (Illustration 5)



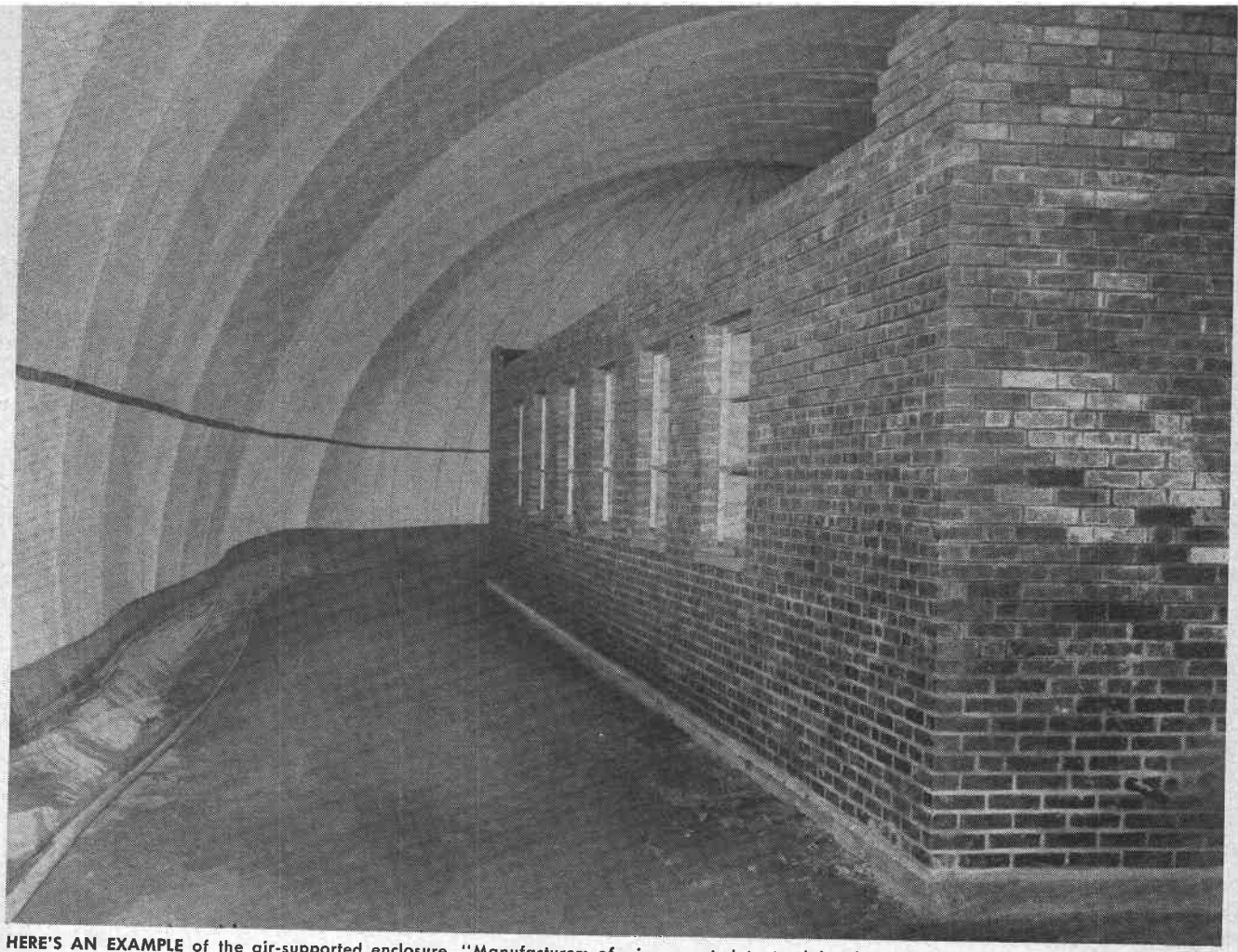
STEEL FRAME BUILDING

These illustrate a method of enclosing the working areas and suggest a sequence of operations which can reduce the direct costs of a temporary enclosure.

The problem of enclosing cast-in-place construction is basically the same in that it revolves around the enclosure of a story-height section but the whole operation is generally much slower and more complicated. (Illustration 10)



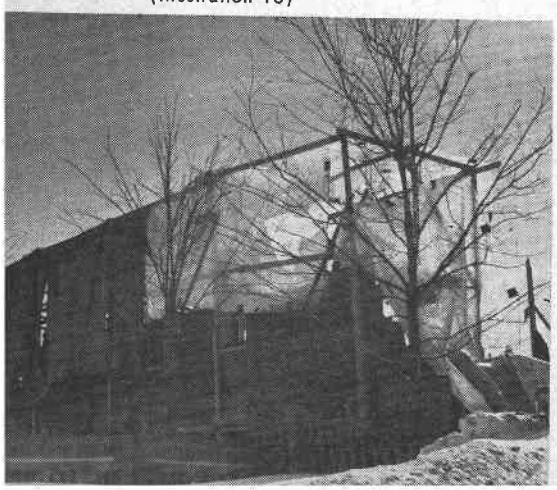
CAST-IN-PLACE REINFORCED CONCRETE



HERE'S AN EXAMPLE of the air-supported enclosure. "Manufacturers of air-supported tents claim that they can 'roof' an area the size of a football field" says Mr. Smith, author of this series. (Illustration 15)

Here's when total enclosure pays off for one-storey winter building

THIS SIMPLE ENCLOSURE was used on a three-story office building in Ottawa to protect the construction of a load-bearing wall. (Illustration 16)



By A. W. SMITH

. Methods of enclosing load-bearing walls and single-story construction for winter building is the theme of this month's article on the use of enclosures by Mr. A. W. Smith of the Division of Building Research, NRC. In this, the third of his series for National Builder, Mr. Smith says: "Repeated use of standard sections makes it possible to think in terms of geodesic domes and other forms of aluminum space frames capable of covering the largest of construction sites."

The slip-form method of construction, in which a working platform covering the whole building area is raised on jackrods imbedded in the cast-in-place load-bearing walls, is easily enclosed.

A temporary roof can be erected on top of the working platform and consequently carried up to roof level as an integral part of this platform.

Other methods of bearing-wall construction present much greater difficulties unless the building is low enough or narrow enough to be completely enclosed, roof construction and all.

Total enclosure is much more expensive in both materials and in heating requirements but repeated use of standard sections makes it possible to think

in terms of geodesic domes and other forms of aluminum space frames capable of covering the largest of construction sites. Such enclosures can be easily moved as a complete package from one site to another by crane or helicopter and may be light enough to position manually.

A rented framework of standard scaffolding may prove more economical than a temporary timber structure when salvage value and capital outlay are taken into account. In most cases, it is possible to use the scaffolding for its normal purpose — that of a working platform for wall construction.

The most efficient way of enclosing a given ground area is probably by means of a laminated arch structure. For larger spans, however, headroom at the edges becomes a limiting factor and for this reason arch enclosures have proved most successful for foundation work and basement construction (Illustrations 14).

Generally column footings and strip footings require a relatively small amount of concrete in localized areas and so total enclosure of the whole working site is not necessary until the frame itself is erected. An insulating layer of straw, for example, placed on top of these footings immediately after the concrete has hardened is usually all that is required.

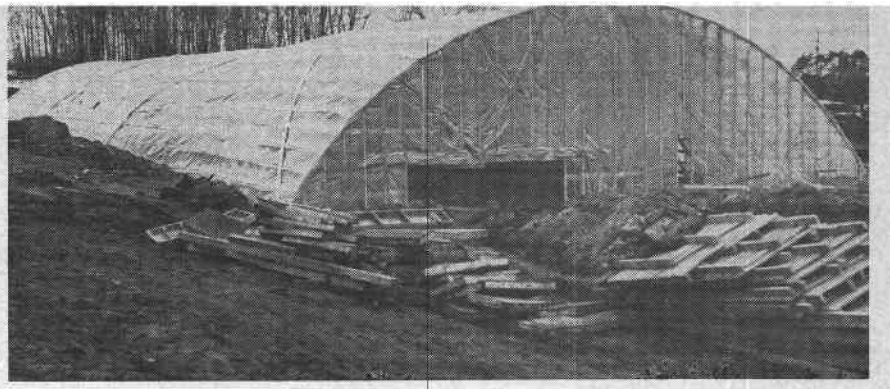
Manufacturers of air-supported tents claim that they can "roof" an area the size of a football field and they have developed a heating system to go with the air blower that maintains the pressure differential necessary to support the whole structure.

At present, these air-supported tents are made of lightweight plastic - coated fabric and the initial cost is in the region of $6,000 for a structure large enough to enclose a house.

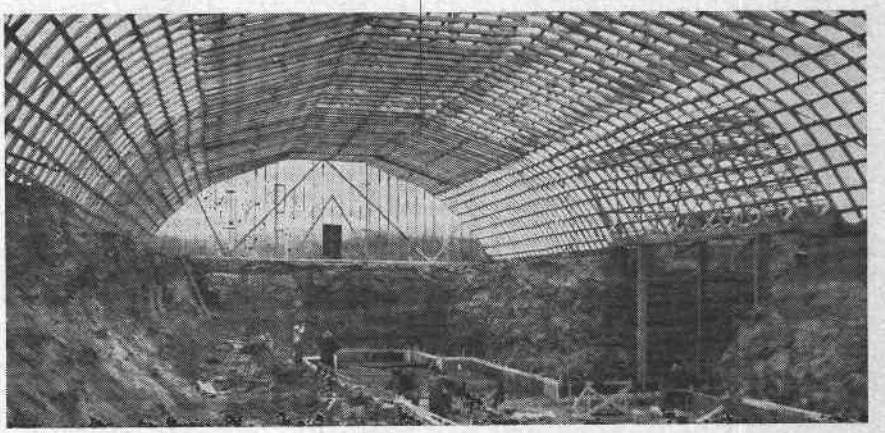
However, the manufacturers of polyethylene are developing a similar structure of this material which should sell for approximately $1,000. The covering is removed from the completed building by unzipping standard segments and the whole enclosure can be moved from one site to another in a light truck or station wagon.

If the working area is too large to cover with a single enclosure or if the roof system is prefabricated and requires little in the way of winter protection, it may be more economical to enclose the bearing-wall construction by itself. Sometimes a windbreak is all that is necessary although it is easy enough to enclose a short length of scaffolding which can be moved from one position to another along the line of the wall (Illustration 16).

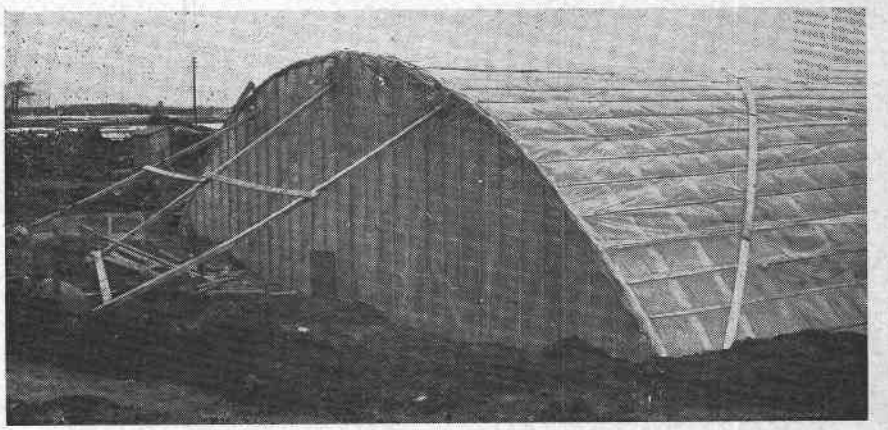
Insulated forms can be used to maintain the temperature of heated concrete long enough to prevent frost damage when these forms are finally removed.



1 This is an exterior view of the huge laminated arch enclosure—250' long, 70' wide, 20' high—used to protect foundation work of a supersonic wind tunnel at Uplands, Ottawa. (Illustration 14)

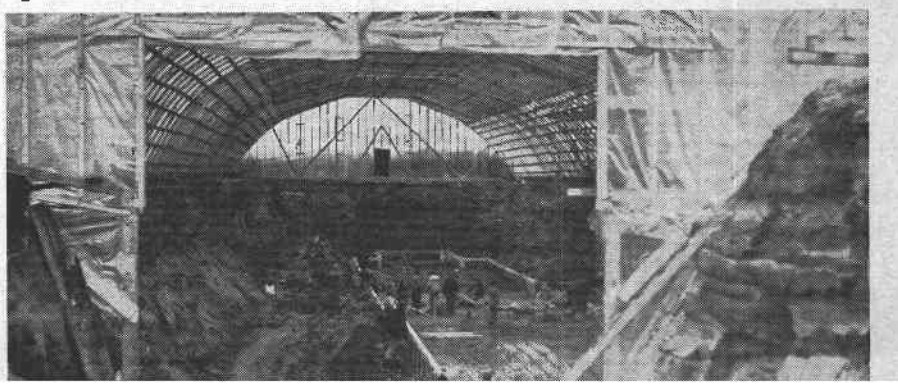


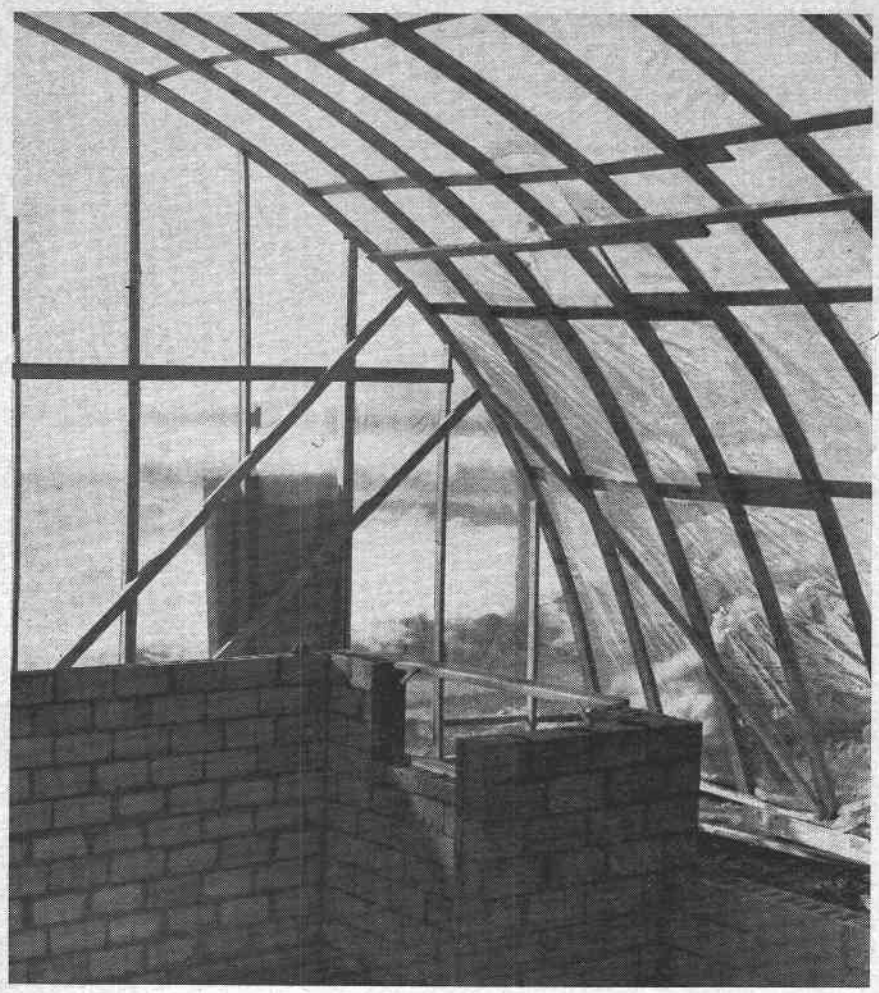
2 And this is how it looked on the inside with the men working normally in good light and comfortable temperatures despite frost outside.



3 Note the longitudinal bracing used during construction of the enclosure until the arch structure had been covered and additional diagonal bracing placed.

4 To permit the easy entry and exit of ready-mix trucks, etc., this vehicular access was available as required. It was about 15' square.





HERE IS AN EXAMPLE of a plastic-covered laminated arch structure which was used to protect the construction during winter of a 24' by 40' bungalow. When the replacement value of such a structure was spread over five houses, it showed that the saving in the builder's labor exactly equalled the operational cost of the enclosure — $400 per house. (Illustration 18.)

How winter housebuilding can score by using standard enclosures

A. W. SMITH

In the last of his series of four articles for National Builder on building in winter with the aid of enclosures, Mr. A. W. Smith of the Division of Building Research, NRC, deals specifically with housebuilding. And he emphasizes that the type of enclosure used for house building depends on the size and type of the builder's own operation.

By A. W. SMITH
Division of Building Research, NRC

The number of houses you build in a winter season will have a direct bearing on the type of enclosure most suitable to your operation.

When a building is a standard form (like a single family house) which is repeated many times, it becomes possible to think in terms of a standard form of enclosure to shelter it.

The emphasis shifts from material costs and heating costs to erection and transportation costs. There is a balance between low cost, expendable materials and more expensive, longer lasting ones that can be re-used. Labor costs become a greater percentage of the unit cost charged to each job and may warrant the use of mechanical erection equipment.

A laminated timber arch structure whose replacement value was spread over five houses showed that the saving in the builders' labor exactly equaled the operational cost of the enclosure itself — $400 per house (See illustration 18).

The cost of erecting and dismantling this enclosure was 60% of the unit cost and could have been greatly reduced by slight modification. (This was described in Mr. Smith's article on the DBR study of a bungalow built under a plastic

shelter which appeared in the November and December issues, 1958, of National Builder.)

You will be able to rent these house enclosures

A number of scaffolding distributors and aluminum fabricators are at present developing standard enclosures specifically for house construction. These should be available on a rental basis shortly.

The type of enclosure used for house building depends on the builder's own operation.

Those builders who build only four or five houses in a winter season may prefer to enclose the whole house and do everything, including the painting, within the enclosure.

The larger project builder will usually prefabricate most of his work and may prefer to use the enclosure for the basement and subfloor construction only. Once the furnace is installed in the finished basement, it can be used to heat the prefabricated shell. (See illustration 19.) The larger operator is not so concerned about getting his final payments and can often leave the painting and brickwork till spring. Some of these builders believe they could use a single enclosure ten times during one winter.

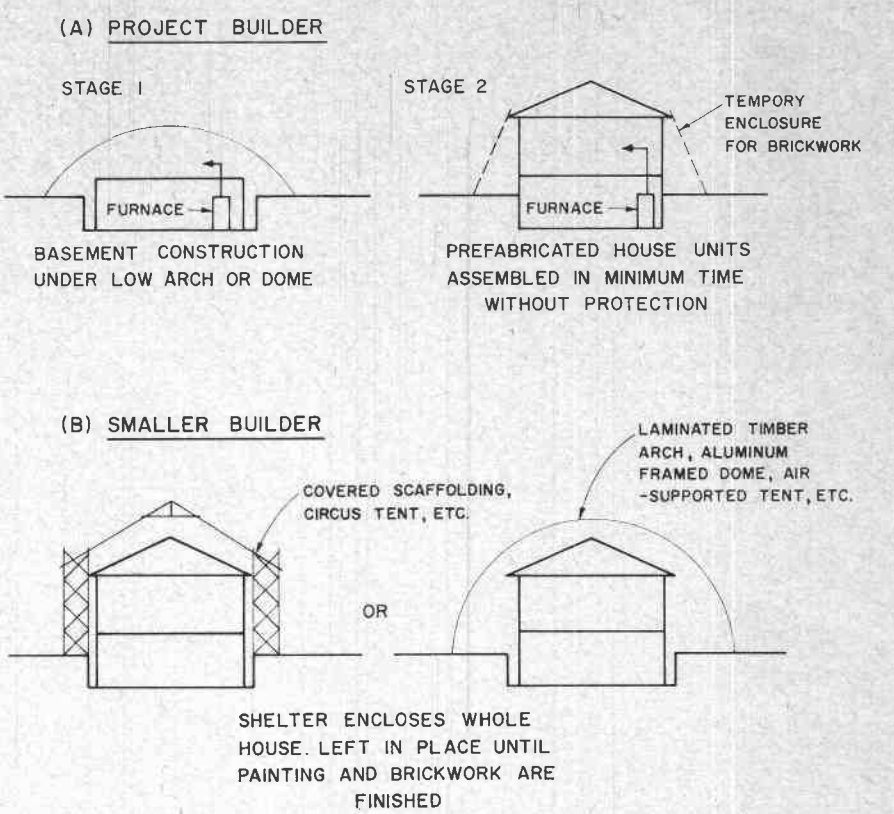
Keep design loads down to the needs of the job

As the enclosure is a temporary shelter, it would be impractical to use the design loads for snow and wind as they are set out in our building codes. The main purpose of the enclosure is to provide a simple shelter at the lowest possible cost and, although it would be easy to build a strong, heavy structure that could withstand any storm, the extra cost of labor and materials would not be warranted for such a temporary building, whose effectiveness is determined by its easy erection and dismantling.

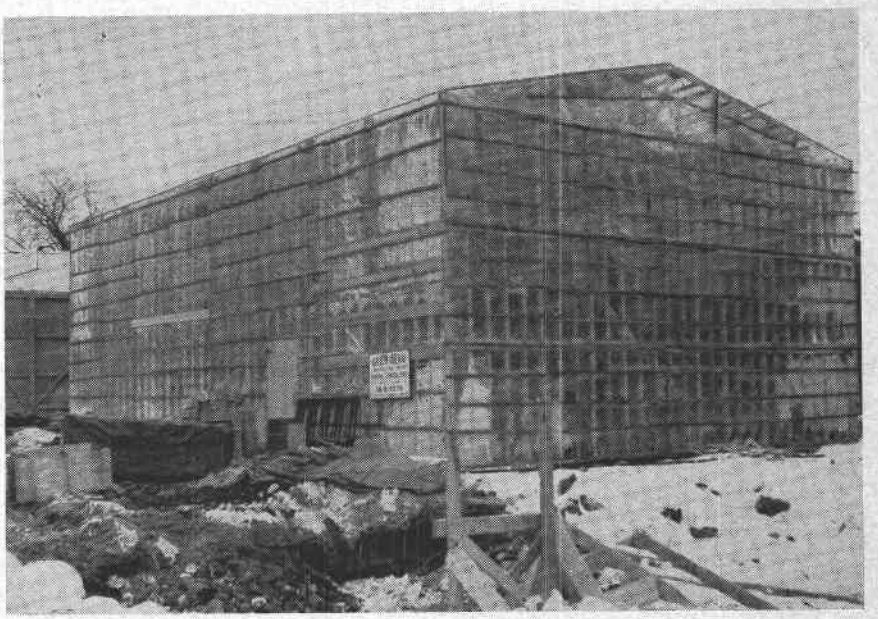
It should be possible to design the enclosure for a definite wind speed (say 40 mph) and a definite snow load (say 15 psf) and to make provision for extra bracing at higher wind speeds and for removing extra snow. The figure of 15 psf suggested as a snow load represents a 12-inch fall of wet snow.

During Canada's severe winter, it is not enough to protect the work alone. Such protection merely involves an extra cost for protective materials and has no effect on the workman's reduced efficiency. In any case, the workman himself has a definite limit and will find it impossible to work when exposed to extreme temperatures and high winds.

In these circumstances, total enclosure of the working site is essential and can often more than pay for itself with increased productivity which reaches maximum levels in a controlled climate.



THIS DIAGRAM DEMONSTRATES how the type of enclosure used for house building depends on the builder's own operation. The smaller builder may prefer to enclose the whole house and do everything within the enclosure. The project builder, prefabricating most work, may use the enclosure only for basement and subfloor construction. (Illustration 19)



"TOTAL ENCLOSURE of the working site can often more than pay for itself with increased productivity," says Mr. Smith, author of these articles. This is an example of total enclosure used to protect the construction of a two-bay service station on Cumberland Street, Ottawa.

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