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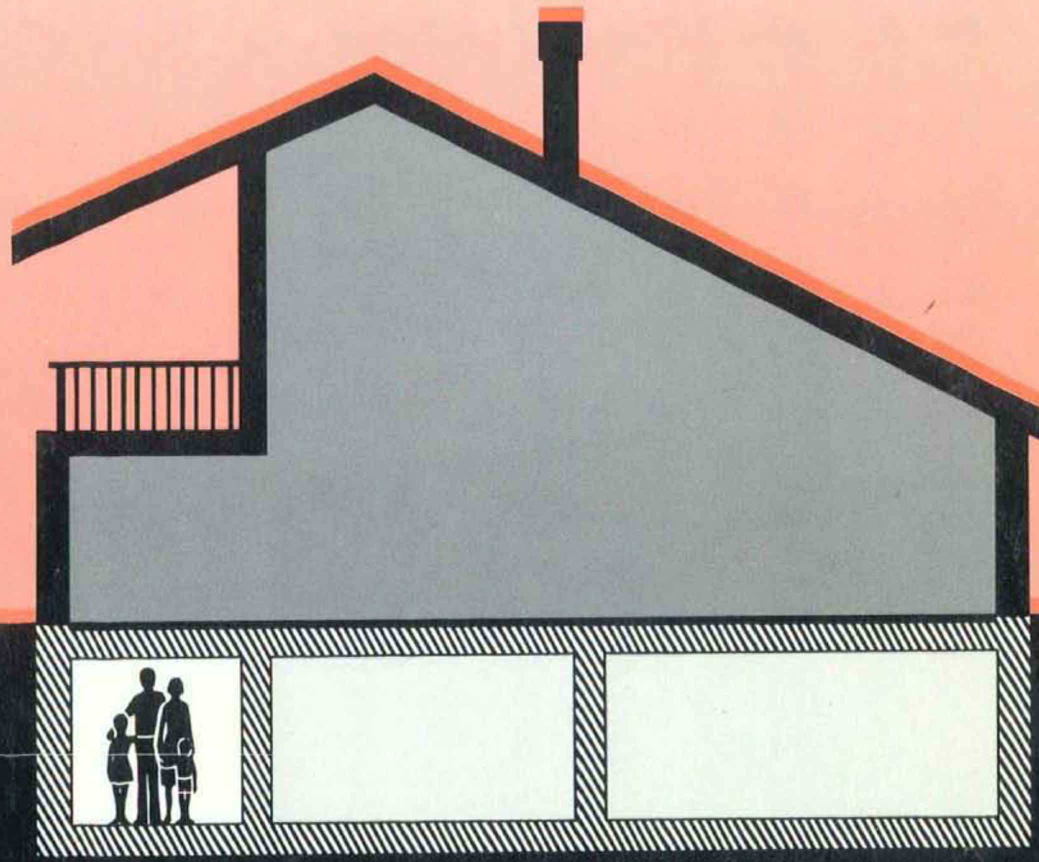
Home Fallout Protection



Canada

Home Fallout Protection

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Home Fallout Protection

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Foreword

Over the past few years we have seen a revival of interest in the likely effects of a nuclear attack on North America and what can be done by average people to help ensure their personal survival.

There has also been a great deal written on how to survive a nuclear attack, some of it useful, much of it questionable. The time has certainly arrived for an authoritative and reliable book discussing this most fundamental and practical subject in the Canadian context: fallout radiation and how to build a fallout shelter.

In 1974 Public Works Canada assumed responsibility for the Canadian government's planning for the protection of its citizens against fallout in the event of a war. Among its many duties, the Directorate of Emergency Preparedness at Public Works sets out the standards for fallout shelter design and qualifies practising graduate engineers and architects as Fallout Shielding Analysts, capable of analysing and designing fallout protection. Ken Farrell and Frank Jewsbury are in fact, the only two people in Canada who can certify a Fallout Shielding Analyst.

Any qualified shielding analyst will willingly show you his certification. If it is not offered, ask to see it, or check with the Directorate of Emergency Preparedness, Public Works Canada, or with the Public Information Branch of Emergency Planning Canada.

Ken Farrell, Frank Jewsbury and Larry Coyne have written a book that brings together in one volume practical and authoritative information on fallout shelters for private homeowners. Whether you decide to do it yourself or get a builder to do it for you, or whether you simply want to know what fallout, radiation and shelters are all about, we urge you to read this book. It is sensible, practical and clear. It is written by people in Canada uniquely qualified to talk about fallout protection for Canadians.

All in all, this book makes a strong contribution to emergency preparedness in case of war. We are pleased to have been able to help speed its publication and to recommend it to your attention.

D.W. Hall
Director General, Operations

M.E. Logan
Public Information

Emergency Planning Canada (Ottawa)

Preface

In the early Sixties a number of booklets were published informing people of the hazards of radioactive fallout and suggesting how they might protect themselves against it, should it ever become necessary.

In recent years, with the proliferation of nuclear weapons and the continuing unrest in many areas of the world, there has been an increasing demand for solid information on how to protect oneself from nuclear fallout radiation. Home Fallout Protection has been written to answer this demand, bringing together in one document the ideas, knowledge and experience accumulated over the past twenty years.

We have tried to make this book complete enough in itself that readers need not consult a wide variety of publications at different technical levels to obtain information. For those who want more detail on specific subjects, we have included a short reading list.

Acknowledgements

The authors wish to acknowledge the significant contribution by Edmond D. Koch in the early work in developing this book.

We also wish to thank Emergency Planning Canada, and particularly Don Hall, Director General, Operations for the work of his Public Information Branch in preparing this manuscript for publication and for defraying at his organization's expense the costs involved in illustrations, design, typesetting and layout of this book. Without that substantial material help, this book might still be only an idea.

Introduction

The threat of a nuclear war involving North America has been with us since the early sixties. Its implications are somewhat different for Canada than for the United States. Canada has no retaliatory weapons systems and the major population centres in Canada have no particular significance as strategic or military targets. Therefore, it is most uncertain which areas in Canada, if any, might be targets. What **is** certain is that under any type of nuclear attack on North America, Canada would be subjected to radioactive fallout from weapons that explode on missile sites in the United States. Even if some parts of Canada were to suffer direct attack, the greatest threat to most Canadians would still be from radioactive fallout.

In Canada, all levels of government deal with plans and preparations to enable the population to survive during an emergency that may arise from war or a peacetime disaster. This function is called civil defence. In the nuclear war context, civil defence will include arrangements for public information, warning, physical protection, radiological prediction and monitoring, essential services, and long-term survival. However, a person's last line of defence against radioactive fallout is his home. Conventional Canadian houses already afford some protection. That protection can be greatly enhanced by a room specifically planned and built as a sheltered area.

Preparing for emergencies is a healthy and normal activity. We take out insurance, install a burglar alarm in our home . . . both examples of how we protect ourselves against possible emergencies. The possibility of a nuclear war is a fact of 20th century life. Planning for the protection of yourself and your family in case such a catastrophe happens is not morbid, it is prudent. The better your preparation, the greater your chances of survival.

This book will guide the homeowner in the design and construction of a home fallout shelter, either in an existing house or in the plans of a future home. Such a shelter will protect you and your family from the most likely lethal hazard — radioactive fallout.

How to Use This Book

This book is divided into three parts.

Part 1 explains fallout and its effects and outlines the main points to consider in deciding what kind of shelter you want to build in your home and where to build it.

Part 2 describes how to design and build a fallout shelter and contains the technical information you or your builder will need to construct the shelter you choose.

Part 3 gives you step-by-step instructions for building a simple basement shelter and an expedient outdoor shelter.

We suggest you read this book completely before making any decisions. Then:

1. Decide how large or complete you wish your shelter to be.
2. Choose that part of your home that is most suitable as a shelter.
3. Sit down with a builder and work out your shelter design, using the technical drawings provided.
4. Hire a Certified Fallout Shelter Analyst to check your plan if you are in doubt about the protection it will give you.
5. Obtain construction costs.
6. If you are building the shelter yourself, obtain a building permit, if it is required, and follow the plans carefully.
7. If a contractor is doing the work for you, make sure he does not skimp on materials. Supervise the work or have someone who knows the principles in this book do so.

For readers who have the skills and equipment, we have included a step-by-step guide to building a basement shelter. Be sure to respect the technical specifications to ensure proper protection.

Finally, we include several ideas for improvising shelters when time is at a premium. Obviously, these will not be as comfortable as a shelter that has been planned in advance, but they will afford adequate fallout protection.

Part 1: Deciding What You Need

Basic Concepts

What is Nuclear Radiation?

Nuclear radiation is made up of high-energy rays sent out from the nuclei of radioactive atoms. The rays pass through air, liquids, and solids like streams of tiny bullets but at much greater speeds. They are invisible, silent, and cannot be felt. There are three kinds of dangerous radiation in fallout from nuclear weapons:

alpha;
beta; and
gamma radiation.

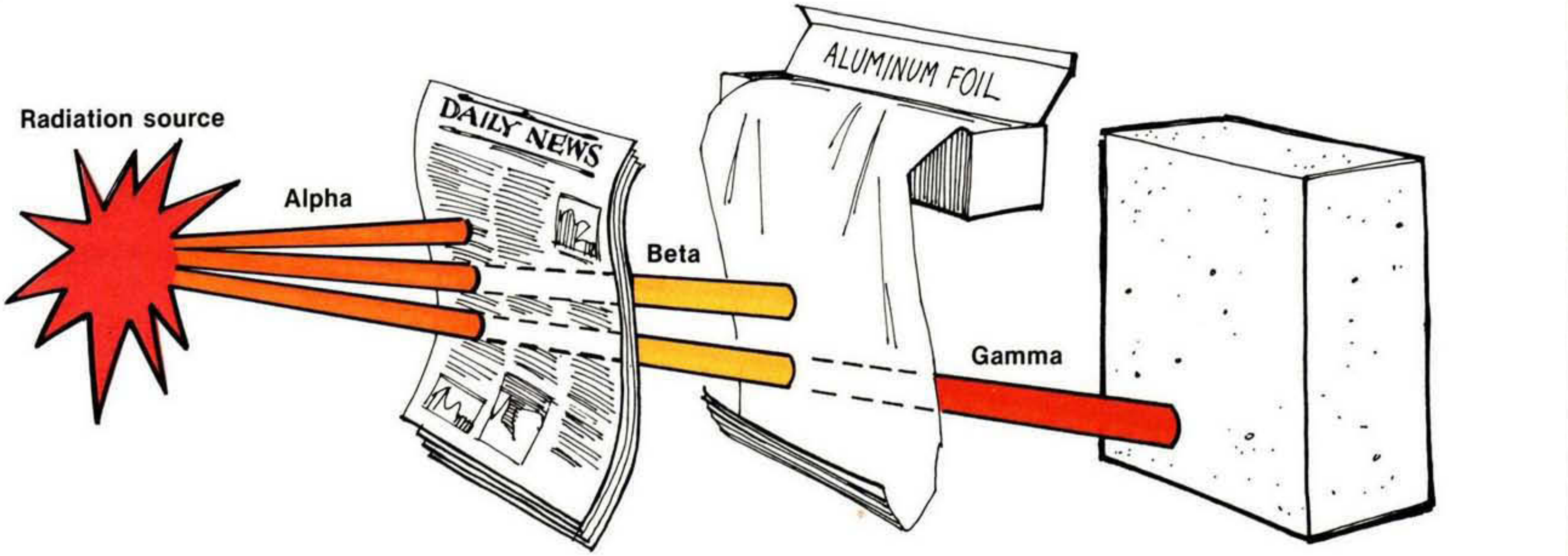
Alpha and beta particles are, in a way, like streams of large, slow bullets. The much smaller and more penetrating bullets of gamma rays travel at the speed of light. Gamma rays are identical to X-rays, except that X-rays are produced without using radioactive materials.

While all three kinds of radiation are dangerous, gamma radiation poses the greatest threat to human life. It is also the most difficult to defend against.

How Fallout Radiation is Produced

When a nuclear weapon explodes near the ground it makes a big crater. Earth from the crater is instantly changed from solids into hot gas and fine dust by the tremendous heat of the explosion. This hot gas and dust, together with vapourized materials from the bomb itself, form a giant fireball that rises rapidly high in the air. This becomes the top part of the mushroom cloud of a nuclear explosion (Figure 2). Pulverized earth is sucked up with the fireball as it rises. Dust and the heavier particles of earth make up the

Figure 1: ***Penetration of different types of radiation***



stem of the mushroom cloud. The dust and earth in the stem and in the mushroom cloud becomes radioactive mainly because radioactive materials created in the nuclear explosion stick to some of the dust and earth particles.

The air around the radioactive material does not become radioactive, neither do roofs or streets, on which it settles.

As the top of the "mushroom" spreads out and cools, it forms a cloud of fine particles of earth and debris. This cloud is carried for long distances by the wind and the particles gradually drift down to earth as fallout. The heavier, large particles settle closer to the point of explosion, but the wind can carry small particles several hundred kilometres. Very small particles come down very slowly and may spread over large areas of the earth's surface, over periods of many days, even weeks. This delayed fallout is sometimes called "worldwide" fallout, although most of the fallout comes down in the hemisphere in which it is produced (Northern or Southern). By the time it comes to earth, "worldwide" fallout has lost a good deal of its lethal radioactivity.

Most of the fallout that we are concerned with in this book will settle within 24 hours.

Figure 2

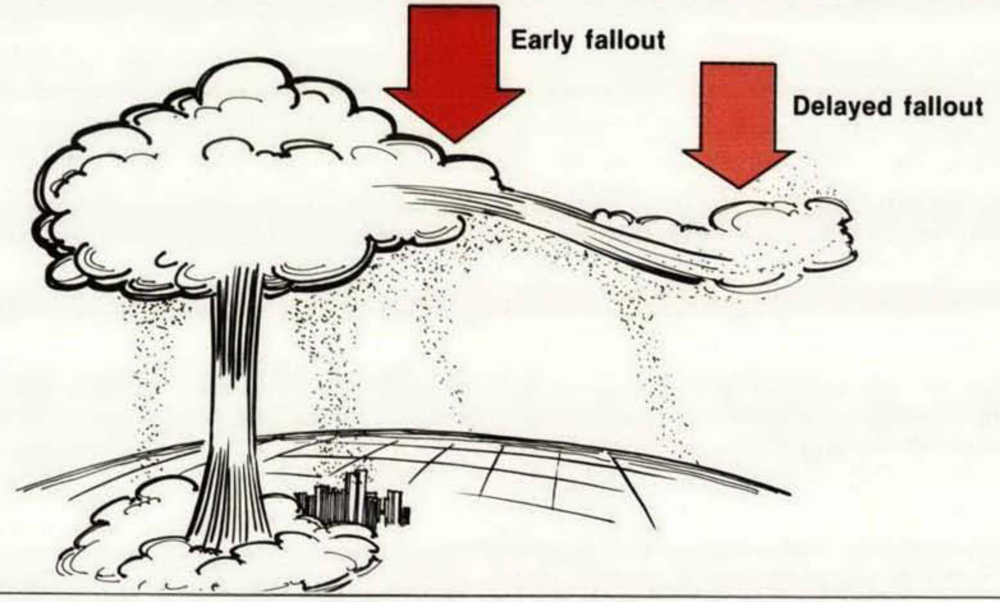
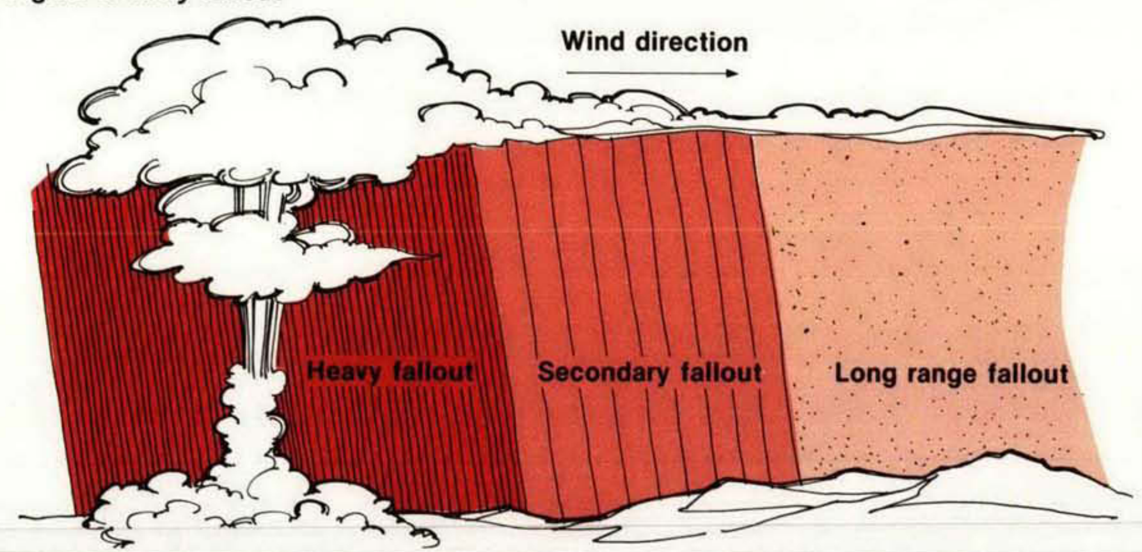


Figure 3: *Early fallout*



How Much Nuclear Radiation is Harmful?

Natural Background Levels

Everyone absorbs minute quantities of radiation in normal activities such as sunbathing.

Low levels of nuclear radiation are a natural part of our surroundings. They have been present since the earth was formed. Radioactive elements in our own flesh and blood give off nuclear radiation, as they do in the foods we eat, the buildings we live in, and some of the water we drink. Nuclear radiation also comes from the sky and is called cosmic radiation.

Symptoms of Radiation Injury

Although nuclear radiation from the natural background can damage or destroy cells, this damage is minimal and unnoticed. Billions of body cells die naturally every hour and are replaced by normal growth and repair. We feel no injury or sickness from exposure to nuclear radiation at the levels that exist in our natural surroundings.

However, if the body is exposed to gamma radiation from fallout many thousands of times higher than the natural background nuclear radiation, many cells will be damaged or destroyed. This will result in illness and even death. Symptoms may appear within the first three days after exposure. They include:

nausea
vomiting
diarrhea
fever
irritability
a lack of energy
a feeling of being tired

The symptoms may disappear and then come back after a week to three weeks, sometimes with diarrhea, sore throat, loss of hair, and a tendency to bleed easily.

The greater the dose, the earlier the symptoms will appear. They will also be more severe and last longer. Chances of infections are greater among those who receive larger doses because the higher dose damages the body's immune system that helps fight diseases. Small children will show symptoms of radiation injury at lower doses than will adults.

Contamination of Food and Water

If food containers, fruits, vegetables, and grains become contaminated by surface radioactive fallout particles, they need not be thrown away.

If the particles can be removed by washing, scrubbing, brushing, or peeling, the food is safe to eat.

Water from underground sources or stored in covered containers will be safe. Water into which fallout particles have fallen may be unsafe to drink for a while, because some fission products, such as radioactive iodine, will dissolve in water. Radioisotopes dissolved in water cannot be removed by boiling or settling, although the water can be purified by special filtering or chemical processes. Filtering water through soil will remove radioactive iodine, and in any case, it will almost completely disappear from any water in a few weeks owing to natural radioactive decay. Water in large, deep lakes and rivers contaminated by fallout may still be safe to drink because the radioiodine is diluted in large volumes of water. It could, of course, be unsafe because of other types of pollution.

How to Shield Yourself from Gamma Radiation

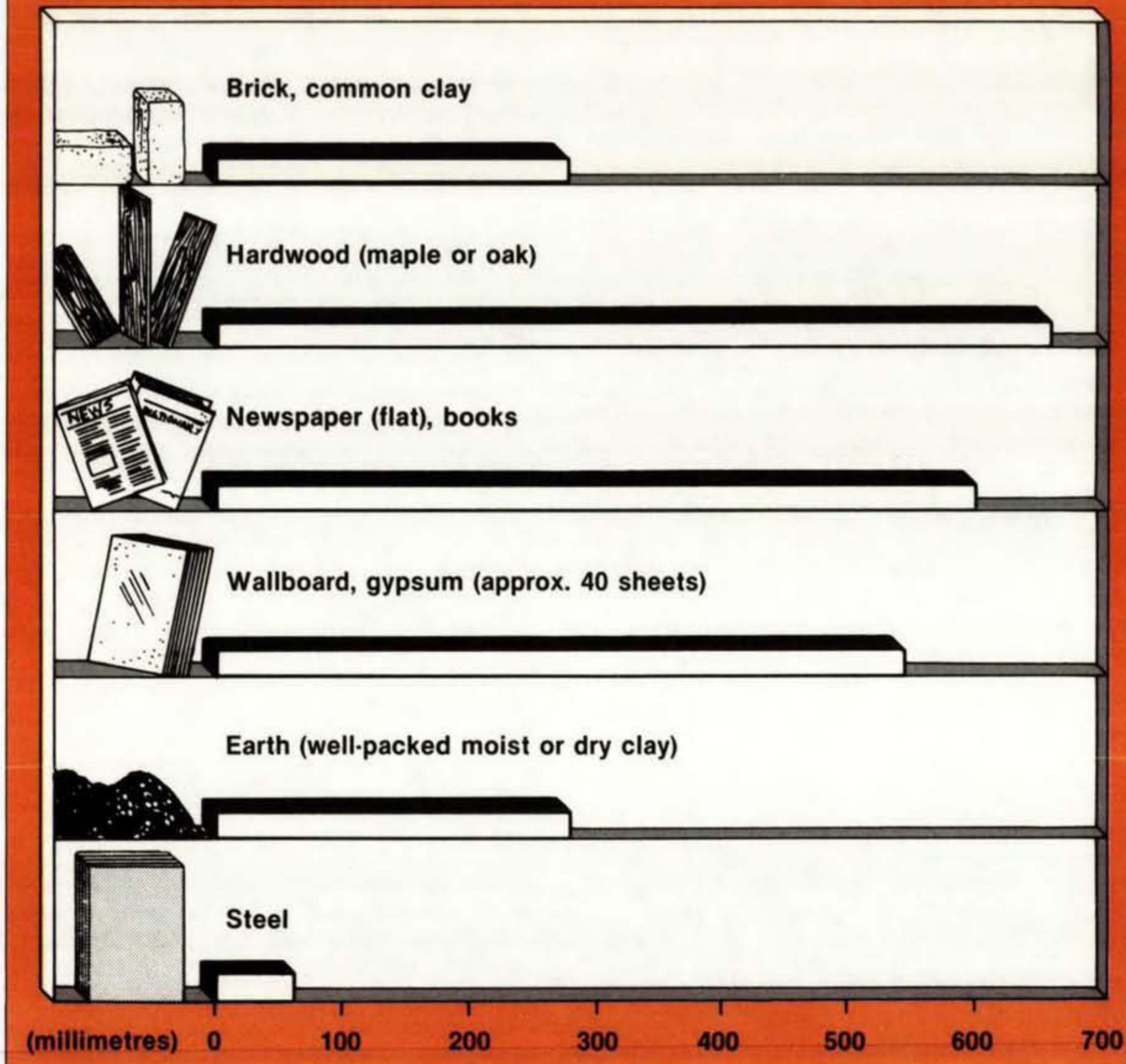
You can protect yourself from bullets by surrounding yourself with armour plate. You can shield yourself from gamma radiation by surrounding yourself with dense material. We know that a heavy enough wall will stop a bullet of certain size and speed. For gamma rays, a wall only cuts down the chances of the gamma "bullets" getting through.

Anything between you and the source of gamma radiation will cut down the number of rays that reach you. The heavier or more massive the barrier between you and the source, the less radiation will get through.

Two hundred millimetres of concrete will block out about 90% of the gamma radiation from fallout. Other materials will reduce the radiation more or less effectively, depending on whether they are more or less dense than concrete.

Figure 4: ***Thickness of various materials required (in millimetres) to achieve 90% reduction in radiation.***

Equally effective shielding



There are several important areas to consider in all fallout shelters. These are:

1. Shielding
2. Windows and entrances
3. Efficient use of space
4. Ventilation
5. Water Supply
6. Sanitation
7. Lighting
8. Heating
9. Cooking

Shielding

Gamma radiation penetrates your house directly and indirectly through the roof and walls. Therefore you build your shelter with dense materials in the walls and roof to block the radiation before it can enter.

Windows and Entrances

Windows. If you were planning to build a shelter from scratch, of course you would not install any windows. However, there may be a window in the only possible shelter location in your basement. In this case you will have to cover the window by one of the methods shown below.

The idea is to make the window area as dense as the rest of the shelter walls and roof.

Figure 5: ***How Radiation Enters Your Home***

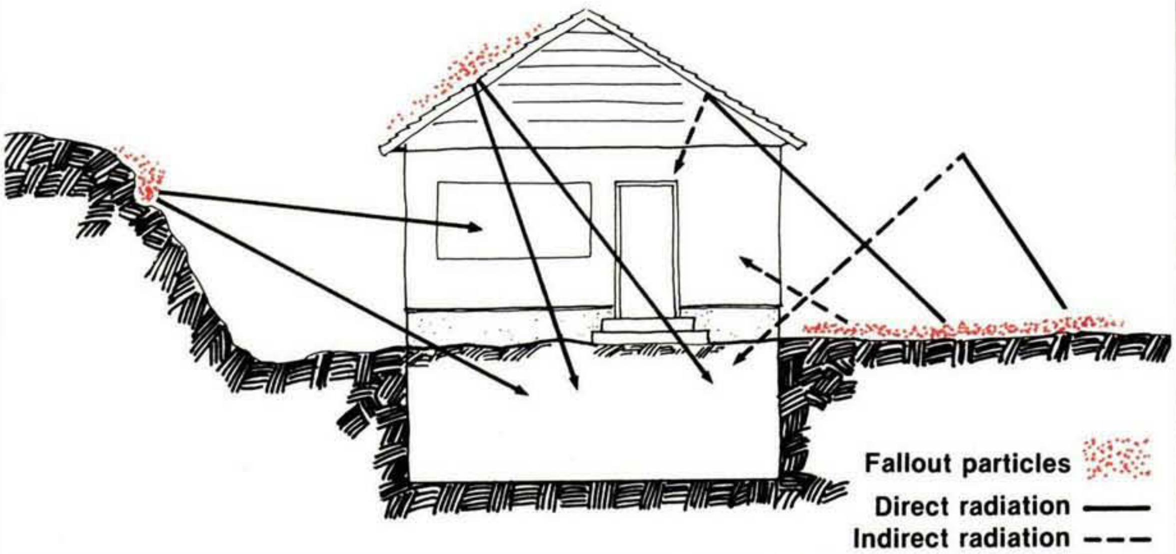
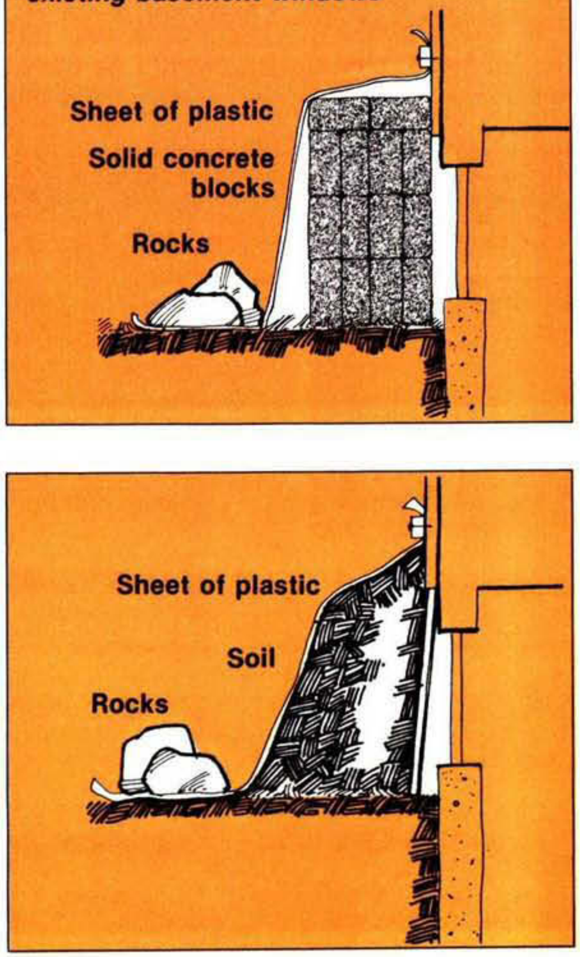


Figure 6: ***Two methods of shielding existing basement windows***



Entrance. The entrance has to provide the same protection as the rest of the shelter.

The baffle arrangement, shown below, is the best arrangement. It affords easy passage and ventilation, blocks radiation from entering, and provides a convenient area for waste storage and toilet during the early occupation period.

Efficient Use of Space

For a family of four, the minimum floor area is 6.0 square metres.

For each additional person add 1.4 square metres. A typical layout is shown here.

Figure 7: *Entrance arrangements*

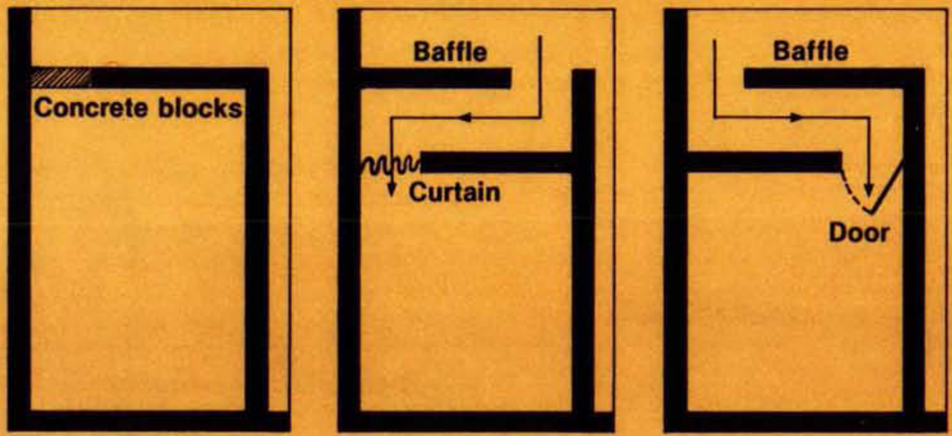
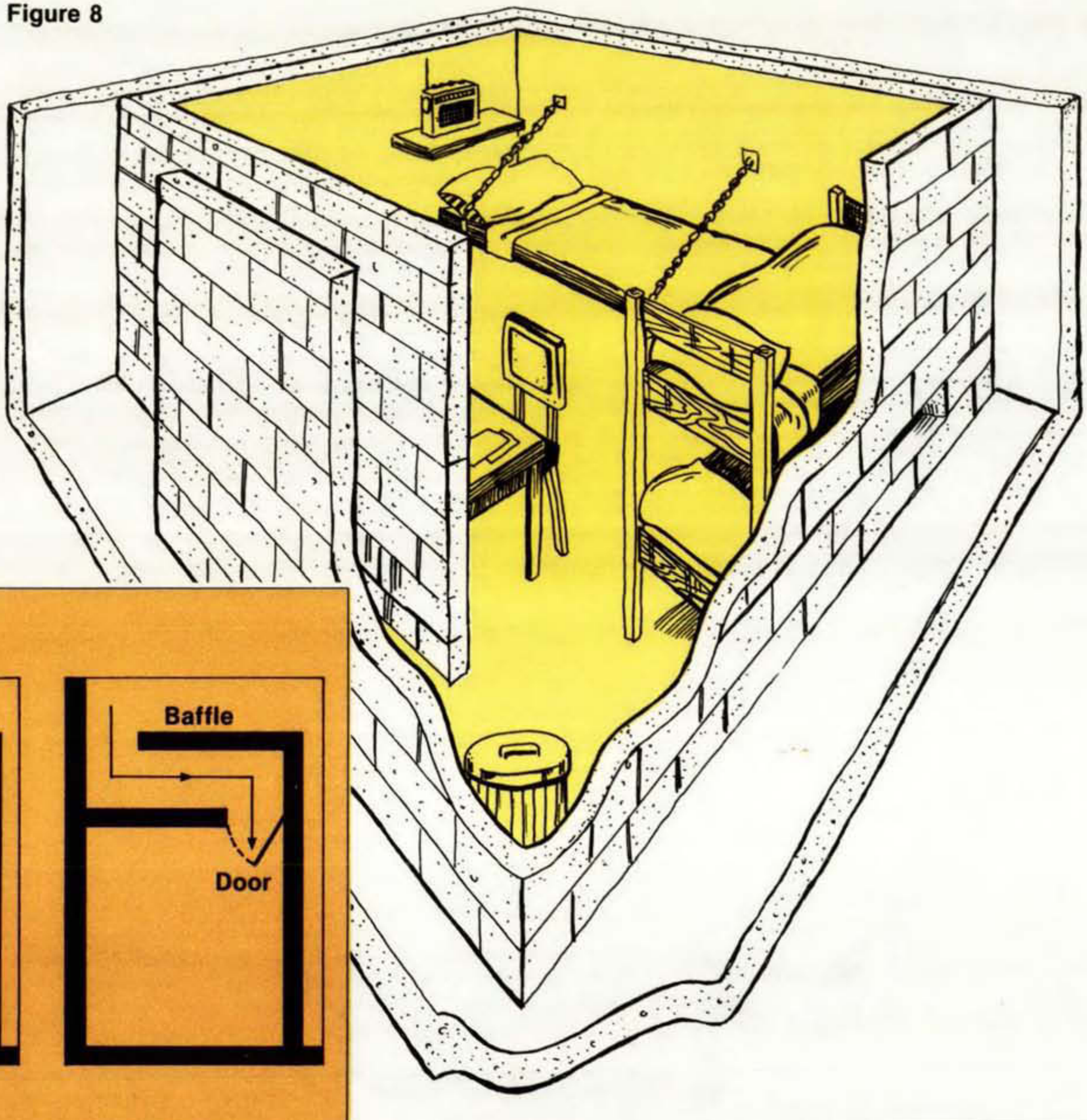


Figure 8



Ventilation

The minimum ventilation rate is 2.5 litres per second per person.

Ventilation methods for two types of shelters are shown here.

Figure 9: ***Air supply to a basement shelter***

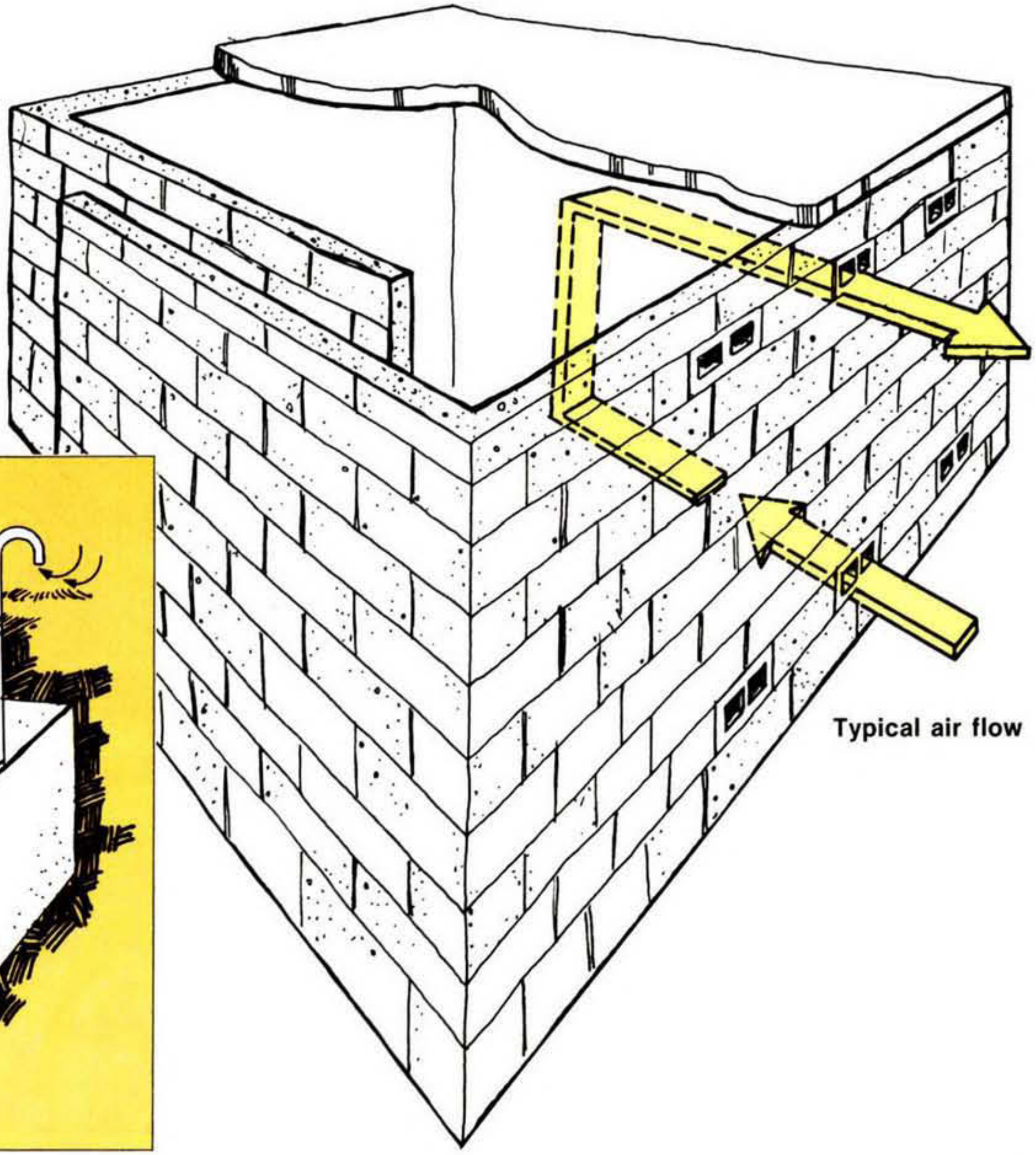
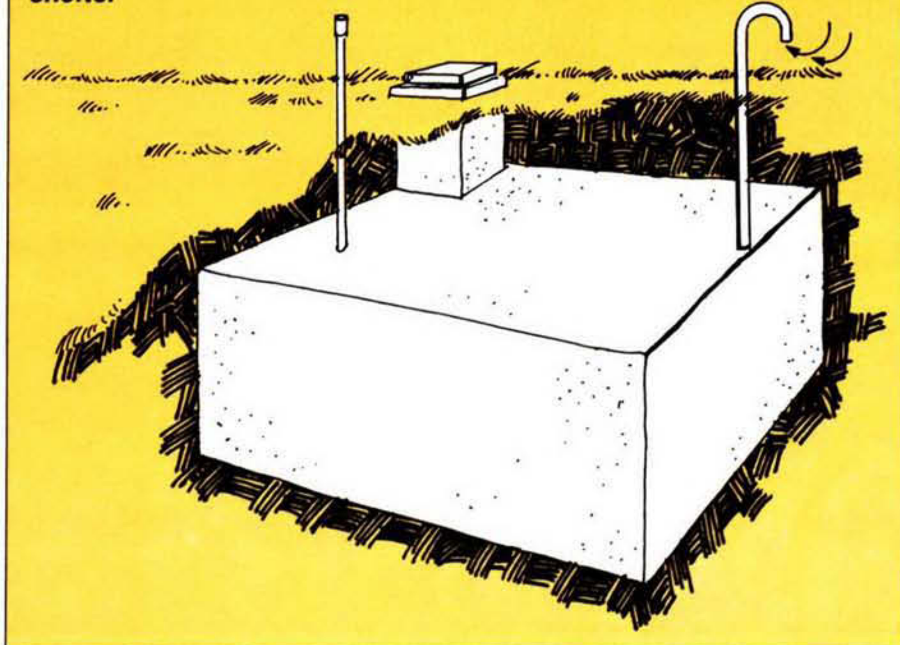


Figure 10: ***Air supply to an underground shelter***



Water Supply

The total amount of water required is 4.5 litres per person per day.

This will cover both washing and drinking. For the first three days, the total water required should be stored in the shelter. The remaining water supply necessary for the fourteen-day stay may be stored within easy access of the shelter.

Lighting

If your shelter is in the basement, you will have local wiring available which can be easily extended to provide shelter lighting. Even if you build a shelter separate from your house, you ought to include electrical lighting, because it is not necessarily true that a power failure will occur during the nuclear attack, and power failures that do occur may be temporary and local.

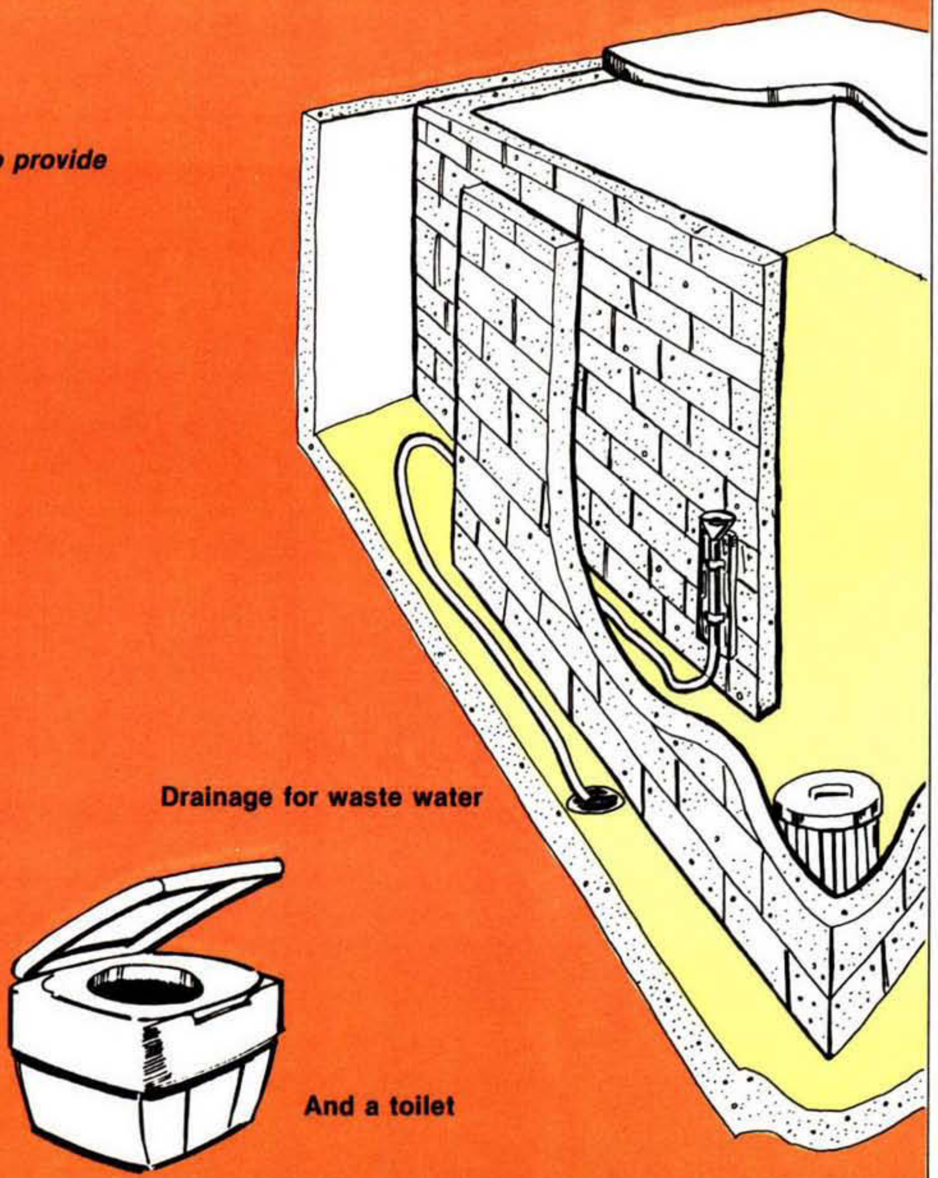
However, candles, flashlights and kerosene lanterns as standby supplies are also needed.
DO NOT USE PRESSURIZED LANTERNS!

Figure 11: ***Water containers already in your home***

Figure 12

Sanitation

You will have to provide



Heating

An independent source of heat is required to cover periods of electricity outage. In most parts of Canada a 6-square-metre shelter will require a heat source of 1200 to 1500 watts. This can be provided by one or more kerosene burners.
DO NOT USE PRESSURIZED BURNERS!

Cooking

Emergency cooking can be done on a kerosene burner if other heat sources are not available.

WARNING. Charcoal burning stoves and burners can be operated safely ONLY outdoors. They CANNOT be used inside the basement.

Figure 13

Fallout Shelter Designs For New Homes

Fallout shelters, especially basement fallout shelters, are easier and less expensive to build into a new house than to add to an existing one.

When including a basement shelter in the plans of your new home . . .

- **Determine basement corner with highest outside ground level**
- **Choose wood-frame or cement block wall construction**
- **Consult Chapter 8 when choosing wall and ceiling materials**
- **Check with local building authorities regarding building permit**

Figure 14: ***Thickening of outside wall above grade by adding poured concrete***

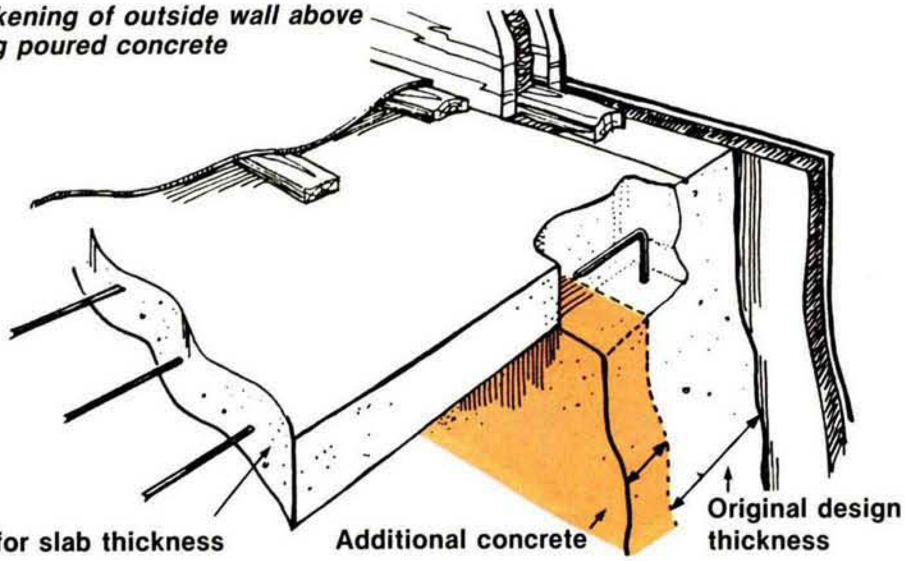
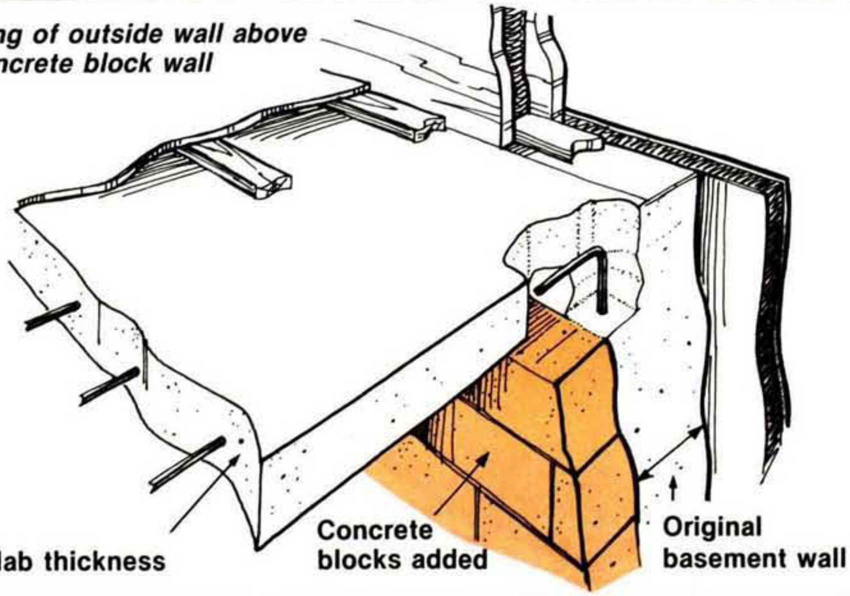


Figure 15: ***Thickening of outside wall above grade by adding concrete block wall***



This chapter illustrates some of the basic features of shelter construction. For details refer to Chapter 8.

Any basement walls that form part of the shelter must be thickened above grade.

Examples of Basement Shelters

Shelter With Wood Frame Walls

As shown in the illustrations on these two pages, wood frame construction affords a lot of versatility in the choice of shielding materials in the walls and ceiling. Generally, any combination of wall and ceiling materials can be used.

Figure 16: ***Composite drawing of different shielding materials you may use with wood frame construction***

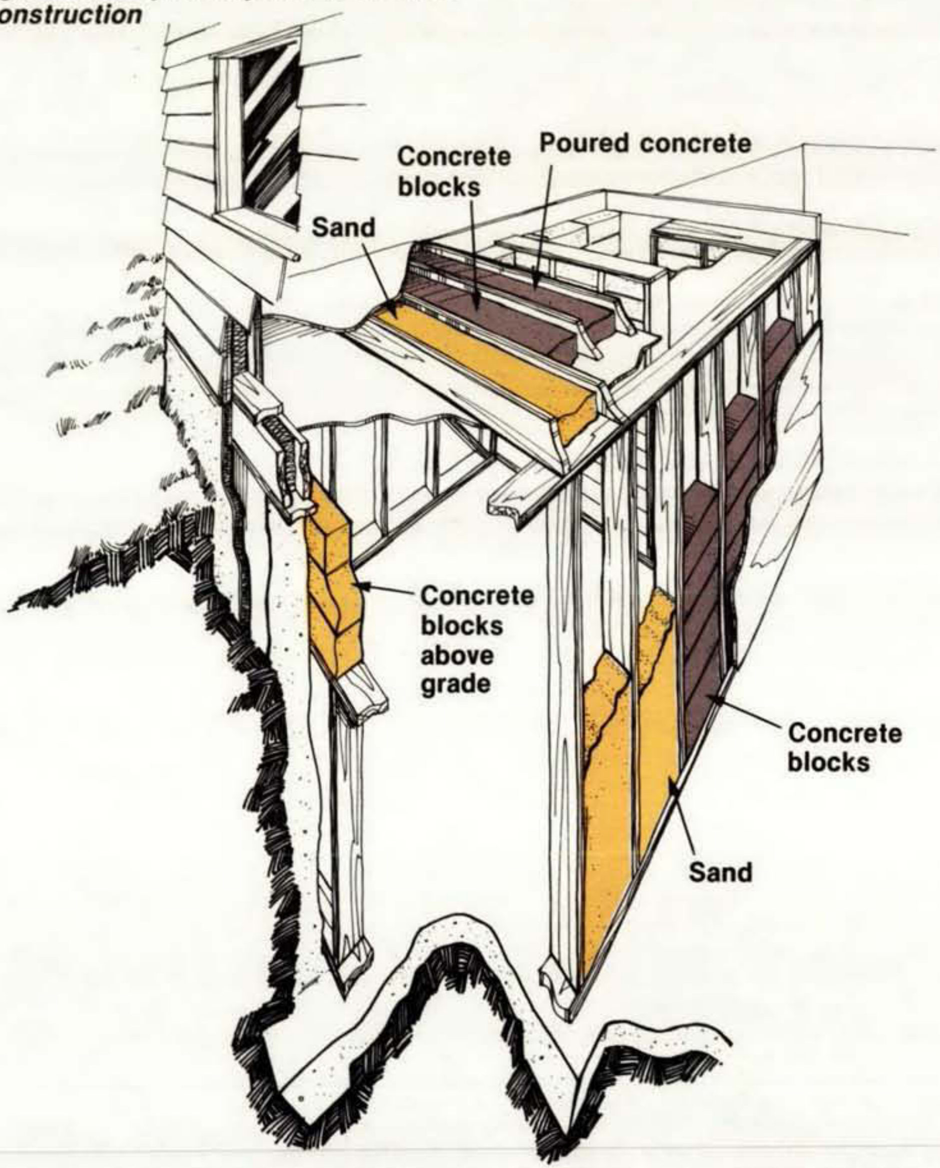


Figure 17: *Examples of wall/ceiling junctions in wood frame shelter*

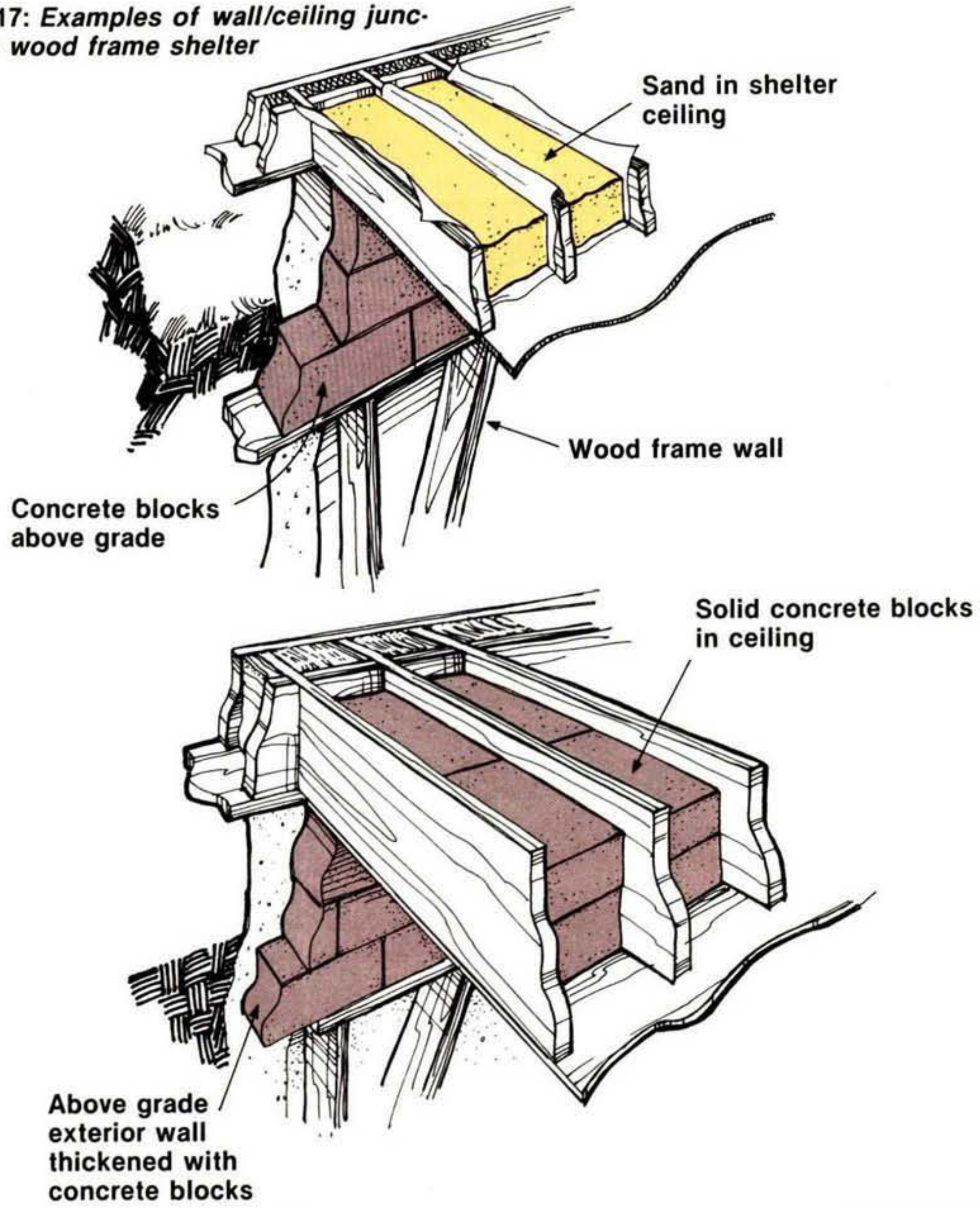
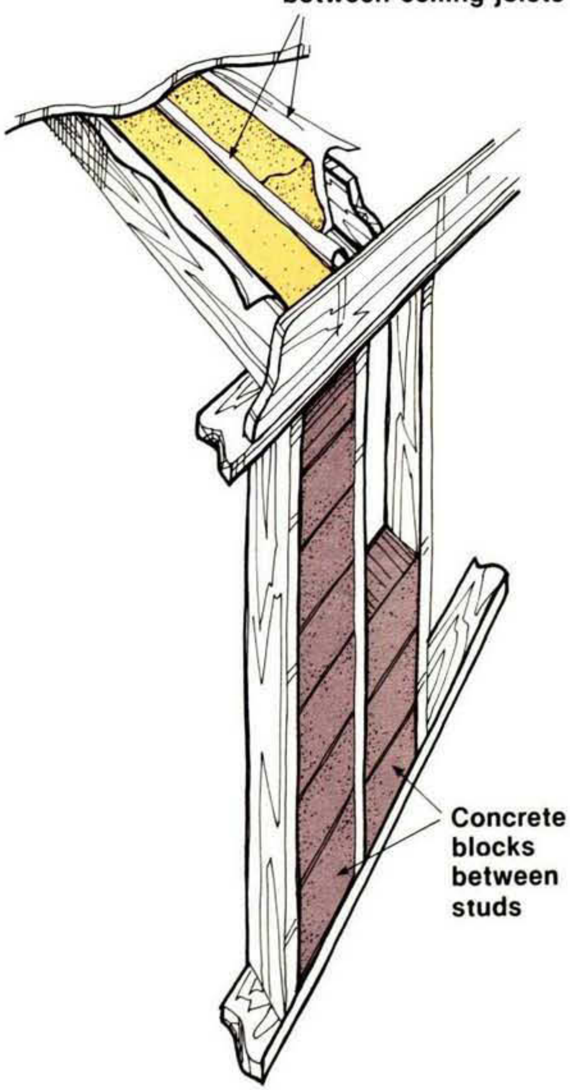


Figure 18: *Examples of shielding materials in ceiling and walls of a wood-frame shelter*



Shelter With Concrete Block Walls

As shown in Figure 19, the interior walls of your basement shelter can be built entirely with concrete blocks.

Figure 19: ***Although this illustration shows reinforced concrete in the ceiling, other materials may be substituted***

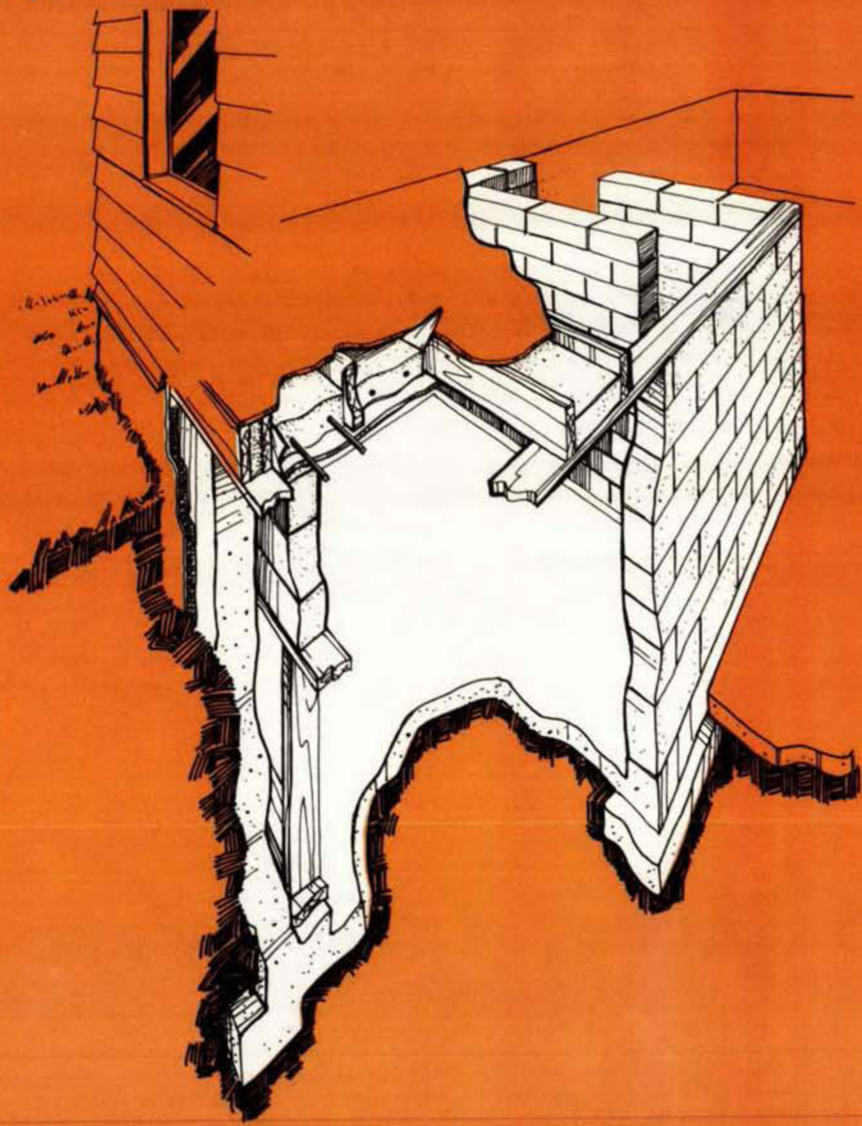
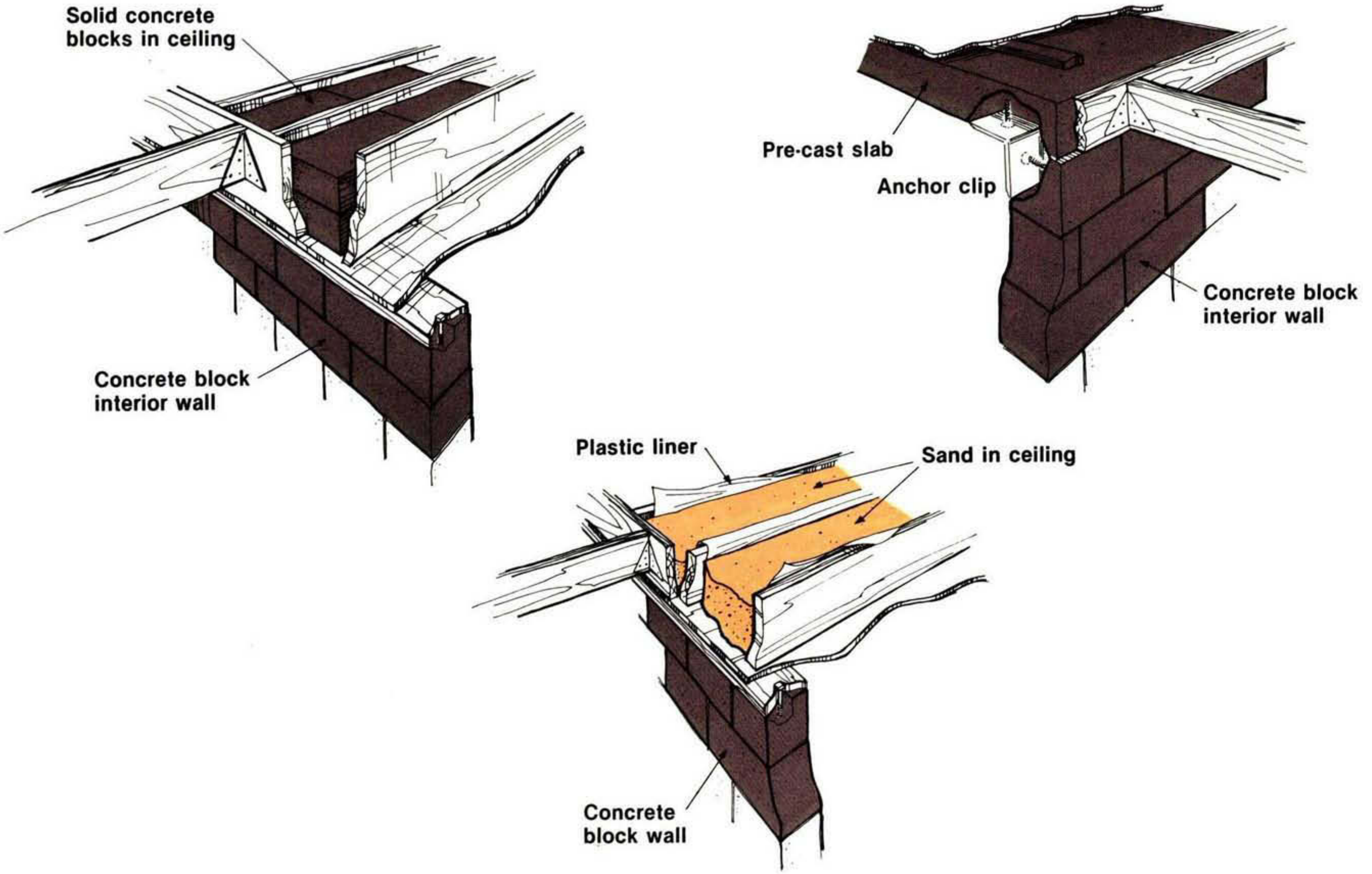


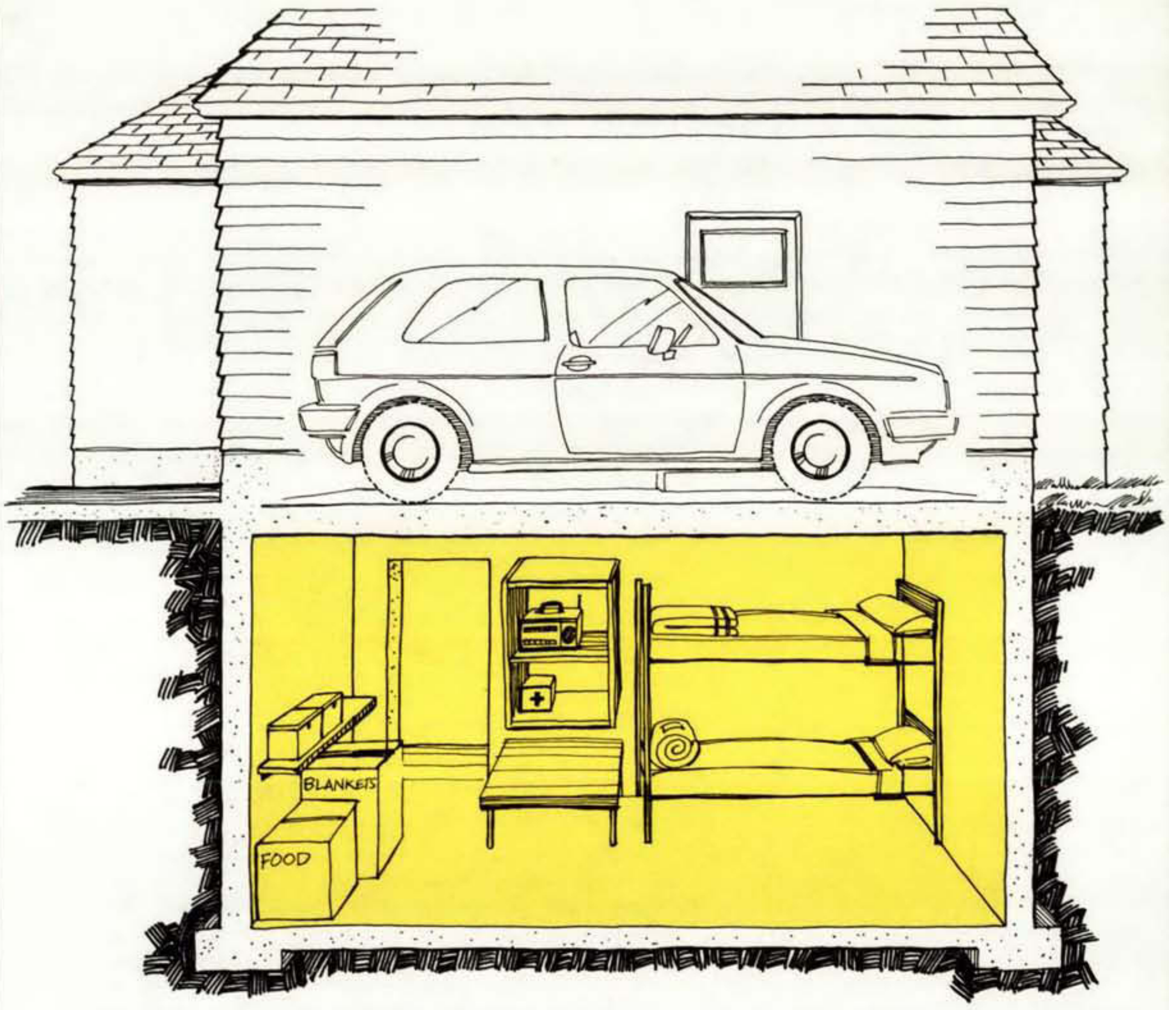
Figure 20: *Details of junctions of interior walls/ceilings*



Shelter Under Garage or Carport

An excellent low-cost shelter can be built under a garage or carport. The only additional costs are the increased depth of the foundation in the shelter area and the thicker floor slab in the garage over the shelter. See Chapter 8 for details.

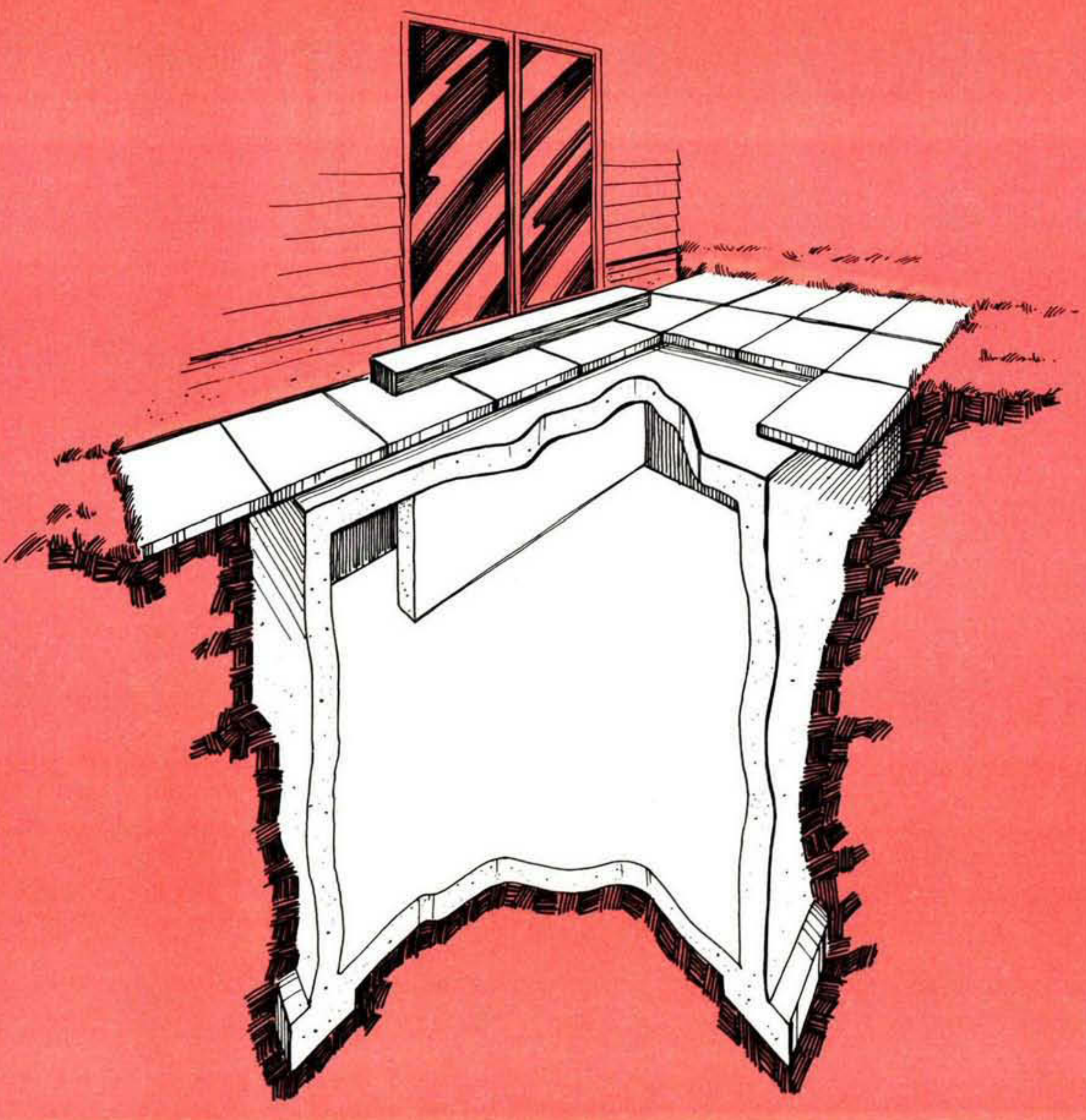
Figure 21



Shelter Under Patio

An effective fallout shelter can be built under a patio. A similar idea is to build the shelter under a porch. These designs could also be incorporated into an existing house. See Chapter 8 for details.

Figure 22



Fallout Shelters in Existing Homes

Many things can be done to improve the fallout protection of an existing home. The more complex and costly of the examples presented will provide comfortable conditions close to those of normal dwellings. The simpler ideas illustrate how some planning and preparation now will provide you and your family with an adequate fallout shelter during a nuclear war.

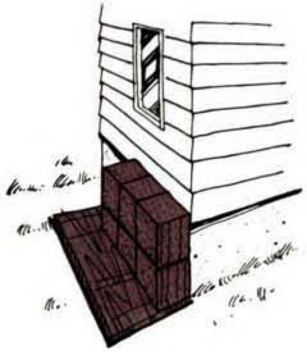
Shelter Design

Whether you intend to install a permanent shelter in your house or decide to make preparation now to complete a shelter in a time of emergency, you should design the shelter according to the information in Chapter 2. You must build the shelter with adequate shielding, water, sanitation and ventilation in mind.

If you are adding a basement shelter to your current home, you may encounter difficulties in finding a suitably shielded location in the layout you have at present. However, with a little ingenuity and planning you will be able to overcome most obstacles. A typical problem of this sort, with some suggested solutions, is illustrated here.

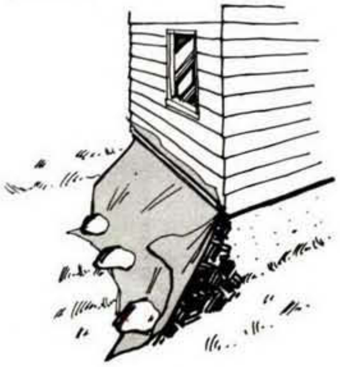
Figure 23

Improvised solutions



Concrete blocks stacked on a board

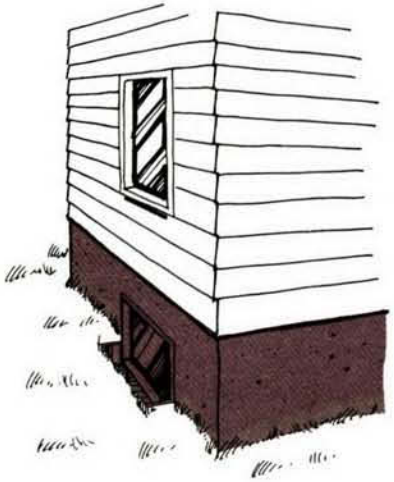
Strip of board holds plastic



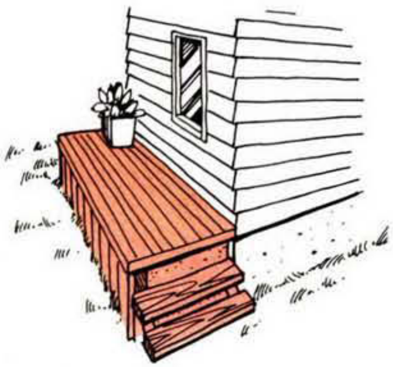
Earth piled and covered with plastic sheet

The problem:

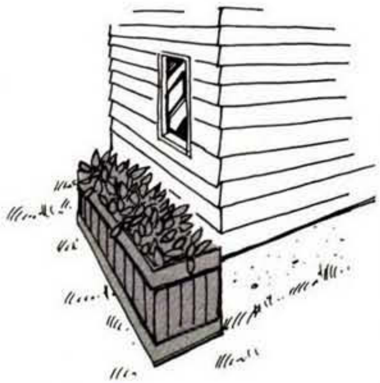
Your only possible shelter location has an above-grade wall, with or without a window



Permanent solutions

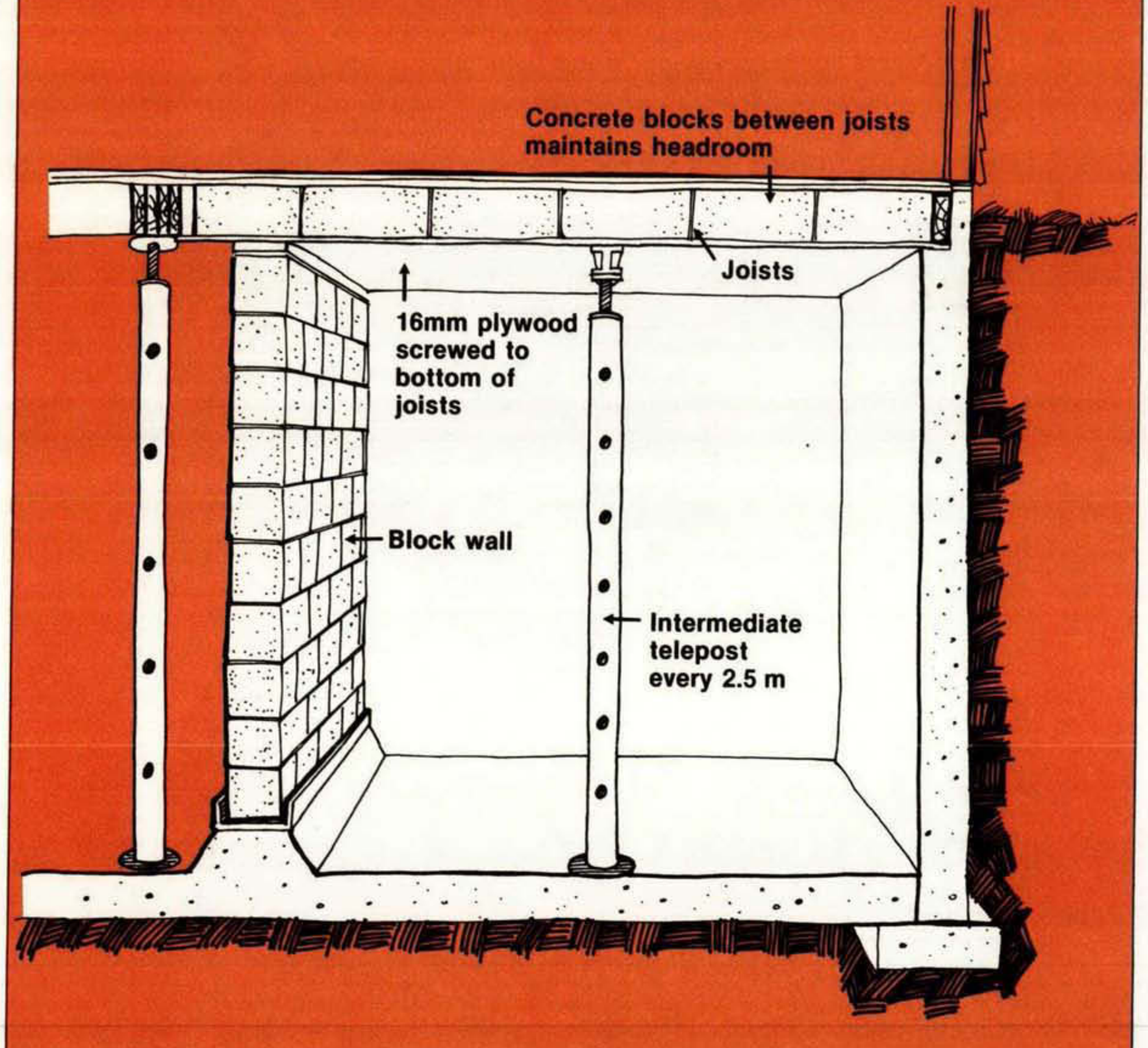


Deck over concrete



Flower box

Figure 24: This is one method of providing overhead protection. The walls can be built using one of the construction techniques shown in Chapter 3. See Chapter 9 for recommended material and thickness of both walls and ceilings.



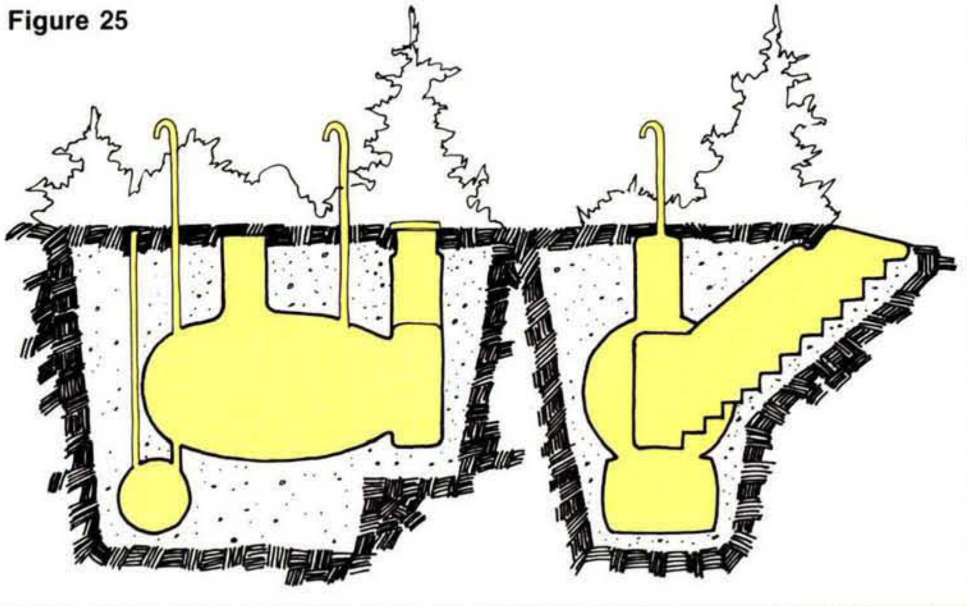
When building a basement shelter in an existing home . . .

- **Obtain a building permit**
- **Add concrete footings if necessary**
- **Use the illustrations here as guidelines.**

Below-Ground Fallout Shelters

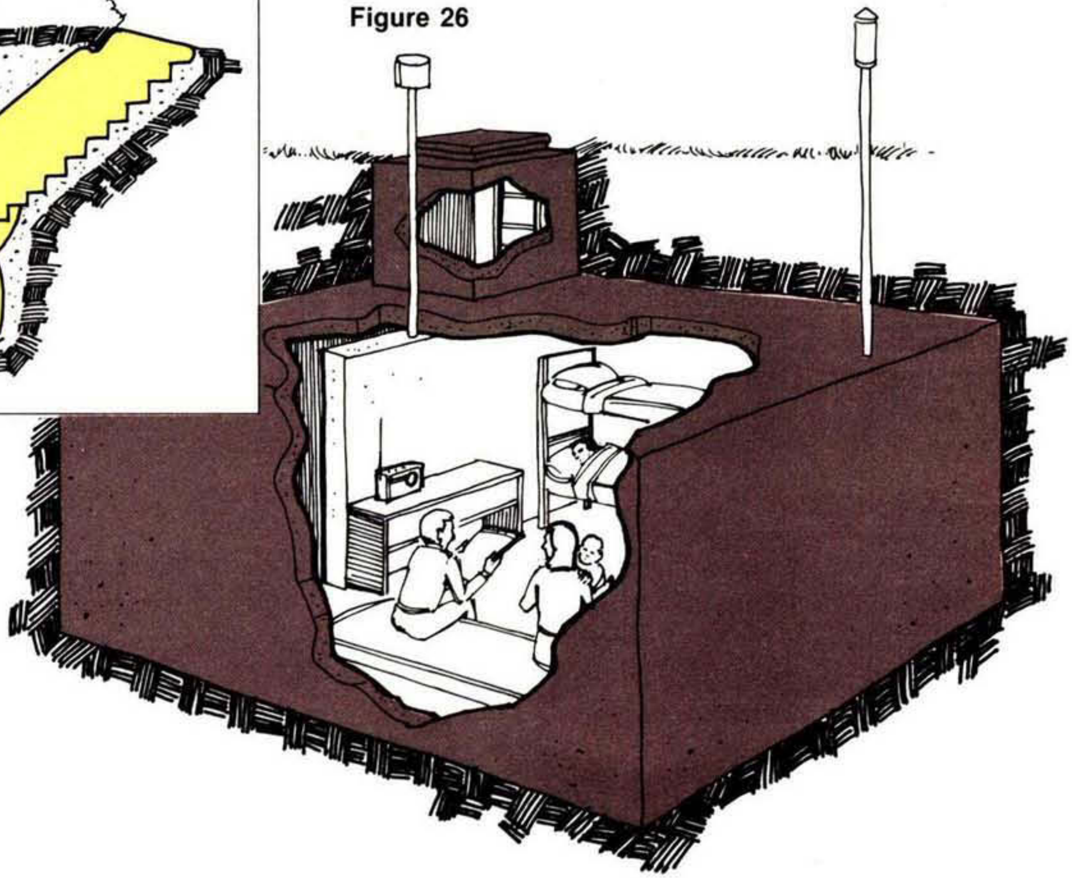
Below-ground shelters provide the best possible protection. They are also the easiest to conceal. Alternative designs are shown here.

Figure 25



The underground shelter is the most expensive. Separate water supply and drainage are required.

Figure 26



Improvised Shelter

If you do not have a prepared shelter in your home you can improvise a fallout shelter that may save your life. In an emergency, radio broadcasts will tell you whether you have time to improvise a shelter or whether you should take cover immediately.

The basic principles are the same as the ones described in the previous chapters, namely:

- **Choose the most protected area of your home.**
- **Increase the overhead and wall shielding as much as you can.**

Improvised Basement Shelter

The best location for a shelter is in a basement, in the corner where the outside ground level is highest.

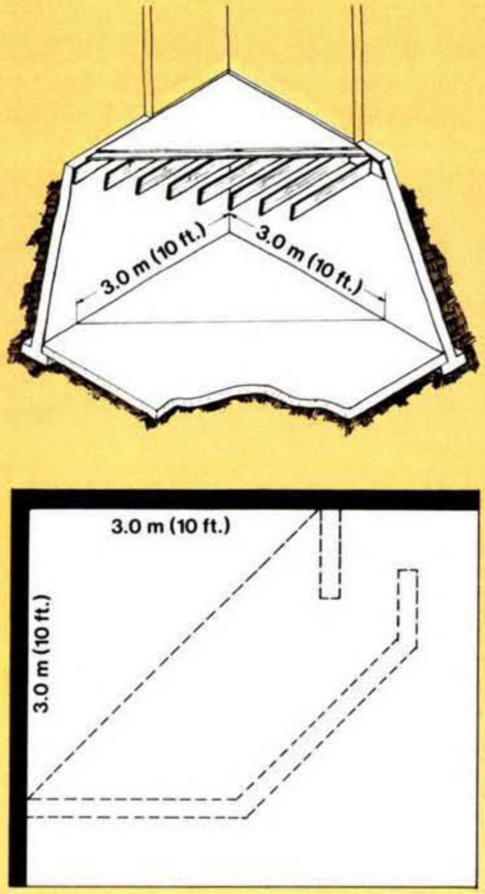
Measure a point 3 metres away from the corner on each wall. The line joining these two points will determine a triangle which is the best protected area and measures about 5 square metres.

Depending on the number of persons in your family you may have to increase the size of the shelter beyond this triangle.

The closer the shelter fits the triangle, however, the better the protection.

Should the corners not be usable, the next best location is along a wall, or, finally, in the centre of the basement.

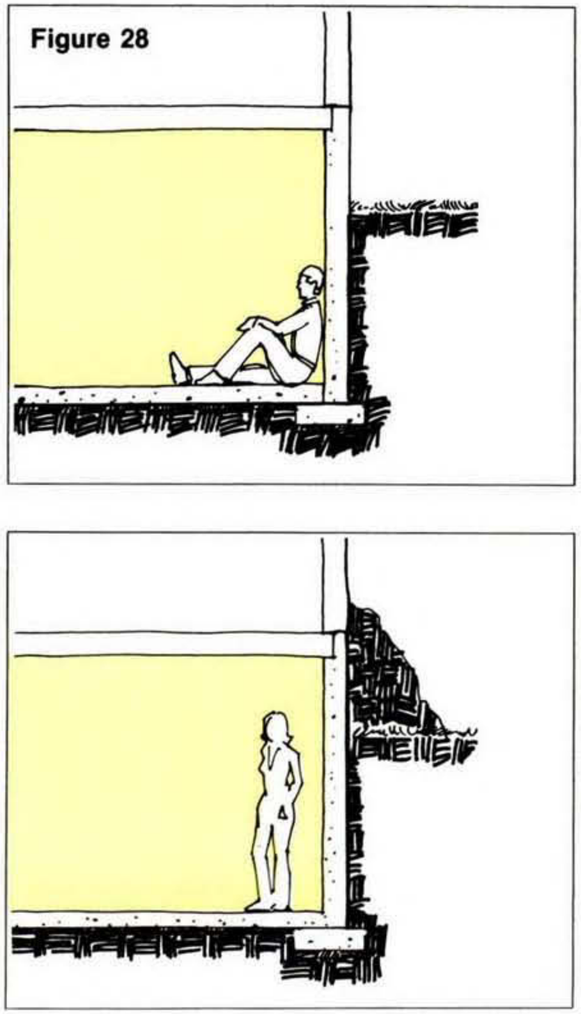
Figure 27



Remember that radiation will come from two main sources: the ground outside your basement wall and the roof.

To protect yourself from the lateral contribution on the outside walls you should ensure that you remain well below the exterior ground level. You could also improve this, as shown below, by adding to the mass thickness of the foundation wall projecting above ground level.

Figure 28



If you have not made advance preparations for your shelter, such as building concrete block walls, you can still build a complete improvised shelter. Shelters similar in protection value to those described in Chapter 4 could be erected quite rapidly in a crisis situation, provided certain materials had been stored and the necessary planning carried out ahead of time.

To protect yourself from the lateral contribution on the outside walls you should ensure that you can remain well below the exterior ground level. You could also improve this, as shown below, by adding to the mass thickness of the foundation wall projecting above ground level.

To protect yourself from the overhead contribution, pile shielding materials over the shelter area, either on the existing floor or on a make-shift horizontal support made out of a workbench, a heavy table, or some solid doors laid across strong supports.

Figure 29

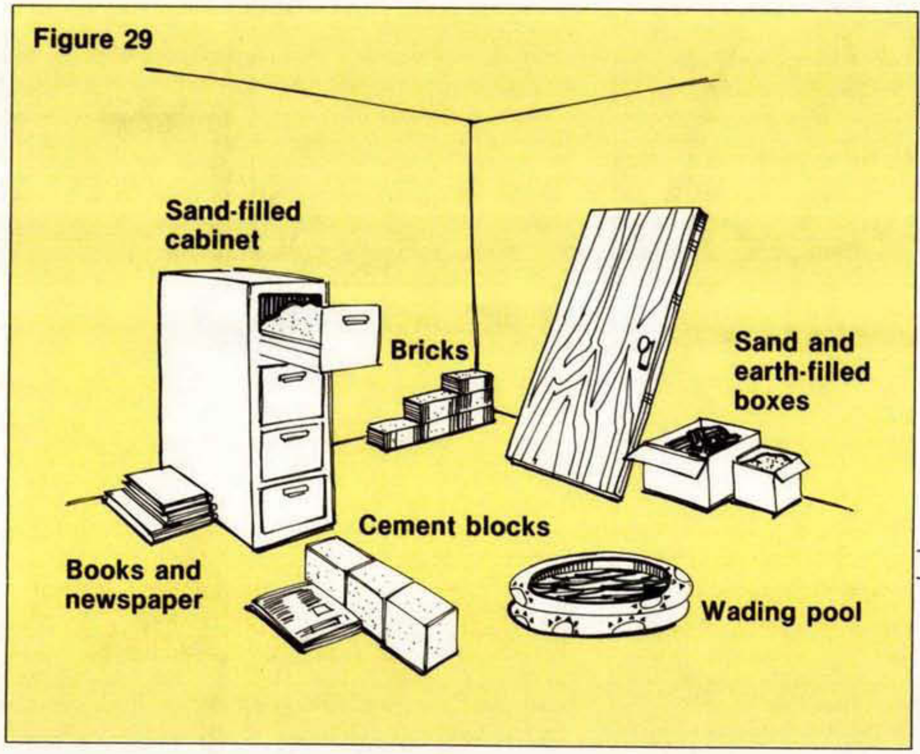
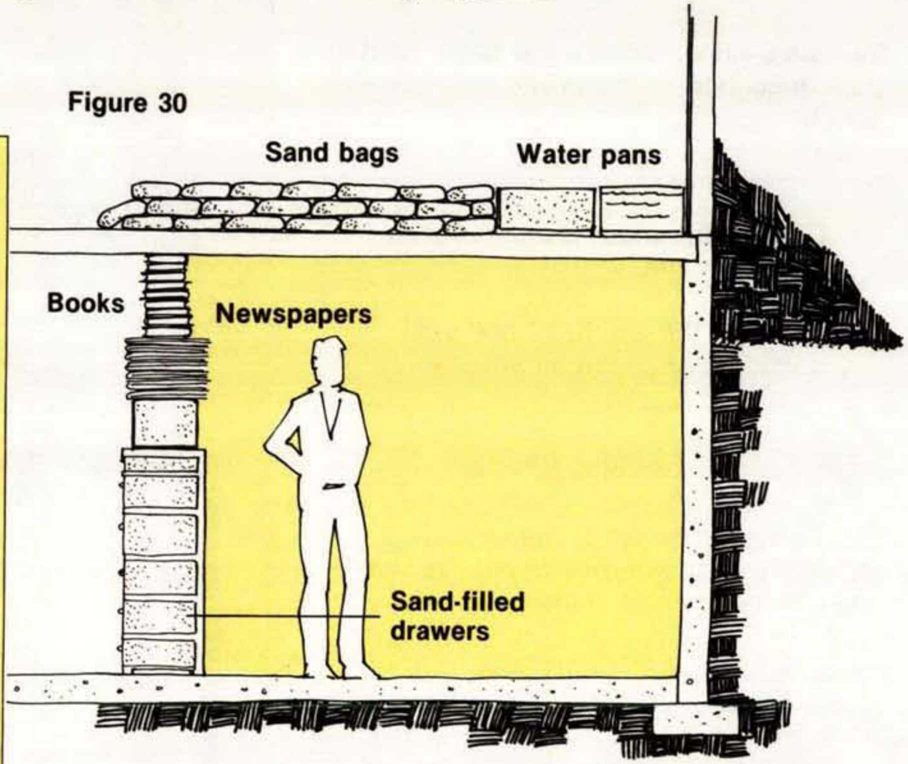


Figure 30



The various shielding objects can be arranged to form a shelter as shown here, preferably now, well before any nuclear alert.

Exterior Walls

The two exterior foundation walls can be protected as shown above. Soil, blocks or sandbags could be used to increase protection where the walls are exposed.

Overhead (Ceiling) Protection

In case of emergency, the floor area over the shelter can be covered with sandbags or water pans giving a mass thickness of 500 kilograms per square metre. See Chapter 8 for other alternatives. If the floor joists span more than 2.5 metres you will have to add a support at mid-span to ensure that the roof of your shelter is strong enough to carry the added load.

Other Walls

The interior walls of the shelter may be put in place ahead of time. They can be built with solid concrete blocks or they could be made of sandbags.

Empty sandbags and water pans have the advantage of being easy to store and inexpensive to purchase. Sandbags are already available in areas of frequent flooding. They could, however, be a problem to fill if the crisis occurred in winter when the soil is frozen. You may have to make the necessary arrangements to ensure a supply of sand for the purpose.

Place water pans in their proper location tightly set one against the other. Fill them using a hose or other means. Then cover them with a sheet of plastic to avoid excessive evaporation.

The pans can also double as water storage for the latter part of the stay in the shelter. In fact, you could use a waterbed or wading pool laid above the shelter area to ensure proper protection.

Remember that it is important to distribute the mass evenly and not allow gaps or unprotected areas. Also remember not to overload the shelter area.

Materials for Shielding

To provide the required overhead and lateral protection, use any heavy material. This includes concrete blocks, sandbags and water pans as previously described. It could also include:

- Dressers and Chests: Fill the drawers with sand or earth after they have been placed in position.
- Trunks, Boxes, Cartons: Fill them with sand or earth after they have been placed in position.
- Tables, bookcases.
- Books, magazines and stacks of firewood or lumber.
- Flagstones or concrete patio blocks, etc.
- Waterbeds or water in any type of container.
- Loose sand or soil.

House doors taken off their hinges (especially solid core doors) could be used as a shelter ceiling on which to stack the heavy shielding materials. A heavy work bench could also be used for the same purpose. In these cases, the shelter area will, of course, be cramped but it should offer a reasonable level of protection.

Other Improvised Shelters

If your house does not have a basement, try and find refuge in a public shelter or with friends who have proper protection. If this is not possible, choose an area in the centre of your house on the ground floor or in the crawl space and surround yourself on all four sides and on the top with as much shielding material as you can find.

Again, take care that your shelter is structurally stable and ensure that the shielding material is distributed as evenly as possible, leaving no gaps.

Improvised Outdoor Shelters

Alternatively, you may want to use an improvised backyard shelter as described in Chapter 12.

Boat Shelter

If no better fallout protection is available, a boat with an enclosed cabin could be used as a shelter. In addition to emergency supplies such as food, drinking water and battery-powered radio, you should have aboard the items you would need (a broom, a bucket, or pump-and-hose) to sweep off or flush off any fall-out particles that might collect on the boat.

The boat should be anchored or cruised slowly at least 60 metres offshore, where the water is at least 1.5 metres deep. This distance from shore would protect you from radioactive fallout particles that had fallen on nearby land. A 1.5-metre depth of water would absorb the radiation from particles falling into the water and settling on the bottom.

If particles drift down on the boat, stay inside the cabin most of the time. Go outside now and then, and sweep or flush off any particles that have collected on the boat.

Shelter Living

Although shelter living is not easy, this chapter will deal with factors that can make conditions safer and more comfortable.

Shelter Layout

Arrange your shelter as compactly and neatly as possible. Properly arranged, bunk beds can serve as chairs and tables. Folding furniture and hammocks will also provide more shelter space. Painted walls and small personal touches will make the shelter more tolerable for a two-week stay.

Food

Have a minimum two-day supply of food and water inside the shelter. The remaining twelve-day supply may be stored outside but near the shelter.

Water

Water is much more crucial to survival than solid food. While a person can survive 2 to 3 weeks without food, a few days without water could be fatal. It is essential to drink one litre of fluids per day. In total, each person will require 4.5 litres of water daily for drinking and washing.

Before occupying the shelter, turn off the normal water supply to your home at the main shut-off valve. This valve should not be re-opened until authorities have advised that the water is safe to use.

The illustration on page 10 of Chapter 2 shows some safe sources of water available in the home.

Heating and Cooking

Electrical power failures are likely. You must, therefore, provide standby means of cooking and heating that do not rely on electricity.

The quantity of fuel required is quite small. Even in winter, 4 litres of liquid fuel per day will be adequate for all heating, lighting, and cooking purposes within a shelter. In summer, you should keep cooking to a minimum.

Lighting

Battery-powered lamps, candles or kerosene lanterns or lamps can be used.

Sanitation

Your main concern will be the disposal of human waste. You should purchase a sanitary toilet with a two-week supply of large-size polyethylene bags. When filled, the bags should be tied at the neck and temporarily stored in a metal garbage can. For at least the first 48 hours, the toilet and garbage can should be placed in the entrance passageway of the shelter. Later, when it is safe to leave periodically, the toilet can be removed to a more distant spot. Washing of hands is extremely important. Use ordinary soap and water. Drainage for waste water will have been provided in the shelter construction. Refer to illustration on page 11 of Chapter 2.

Hygiene

To prevent skin diseases, follow these precautions:

- **Wear shoes or sandals to prevent fungus infections**
- **Keep as cool as possible to keep skin dry**
- **Use household bleach to disinfect toilet seat. Rinse well afterwards**
- **Have several changes of socks and underwear for each occupant**

Equipment and Supplies

A list of necessary items is included at the end of Chapter 13. After all essentials have been stored, you should consider additional personal items which might make shelter life more pleasant, provided there is still room.

Daily Routine

You can greatly reduce the stress caused by confinement if you follow a daily routine.

In planning a daily routine, you should break up the day into various periods for rest, individual and group activity, cooking and eating, shelter chores, and so on.

Leaving the Shelter

Generally, it is likely that you will have to remain inside your shelter continuously for 48 hours. After that, your trips outside the shelter will be in accordance with instructions broadcasted at the time. It will be extremely important that you follow these instructions carefully.

Safety

Follow these precautions:

- **Keep all medical supplies in a locked cabinet**
- **Keep taps, fuel, matches, etc. out of the reach of children**
- **Carefully refuel appliances with a funnel after the appliance has cooled**
- **DO NOT use gasoline or other volatile fuels in the shelter. Kerosene is recommended and must be stored in leakproof containers**

Part 2 — Construction Details and Design Tables

Introduction

Chapter 8, of Part 2 contains construction details for the following shelters:

1. Shelter with concrete filled ceiling and concrete block walls
2. Shelter with reinforced concrete ceiling and concrete block walls
3. Shelter with concrete block filled wood frame ceiling and walls
4. Shelter with sand filled wood frame ceiling and walls
5. Shelter under a garage or carport
6. Shelter under a porch slab or patio

Chapter 9 consists of a worked example of a basement shelter design and three tables, as follows:

- Mass Thickness Design Tables for Shelters
- Mass Thicknesses of Common Building Materials
- Reinforced Concrete Slab Design Table

Finally, Chapter 10 contains detailed construction drawings for an underground fallout shelter.

Examples of Fallout Shelter Designs

We show here some examples of fallout shelter designs to illustrate the variety and construction methods that can be used. These designs are offered as a guide to the builder.

The designs illustrate only ceiling and wall construction. In most parts of Canada, separate footings will be required for the interior walls. In some jurisdictions some of the construction methods suggested here may not be acceptable. The builder will have to get a building permit from the local authority and may be required to modify some construction details.

As long as the mass thickness of the shelter ceiling and walls are not reduced, the shelters will provide the desired protection level.

Where an exterior basement wall also forms the exterior shelter wall, the mass thickness of the above-grade part of the shelter wall must be equal to that of the basement wall plus that of the other walls of the shelter.

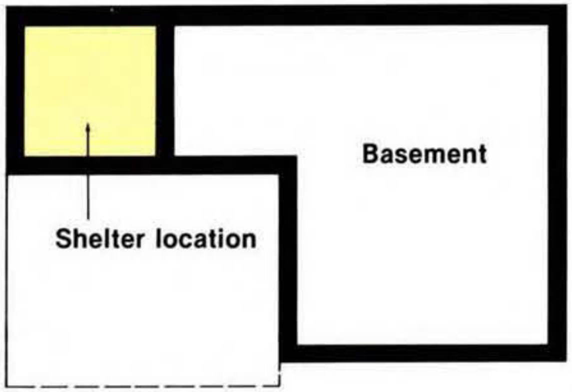
For example, if the basement wall is a heavy wall of 200 millimetres of poured concrete with a mass thickness of 490 kilograms per square metre and the shelter wall for this particular design is 195 kilograms per square metre, then in the shelter area the above-grade part of the exterior wall will have to have a mass thickness of 685 kilograms per square metre. (490 + 195 = 685)

1. Shelter with Concrete Filled Ceiling and Concrete Block Walls

The shelter in this plan is located to take advantage of three foundation walls. This plan will reduce the additional costs for including a fallout shelter in a new house that uses it.

The location shown on the plan would be classed as a **corner location** when you look in Chapter 9 for the required mass thicknesses for the shelter ceiling and shelter walls.

Figure 31



In this shelter, the ceiling mass is provided by filling the space between the floor joists with concrete. The wall mass is provided by hollow concrete blocks. The cores are filled with sand or mortar when required.

The mass thickness of the ceiling and walls is determined from Chapter 9 and a suitable wall is selected. The concrete depth in the ceiling is determined from Table 1.

Table 1

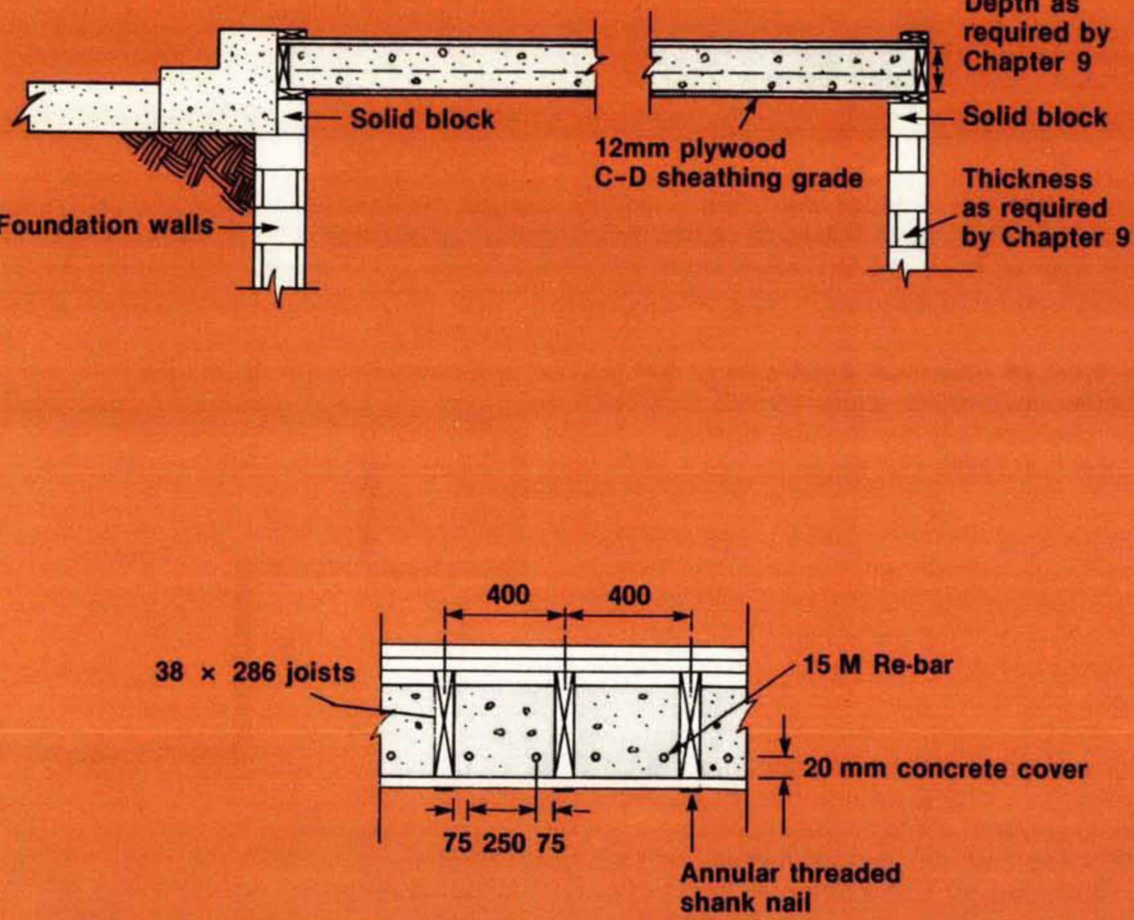
Ceiling Mass Thickness (kg/m²)	Concrete Depth (mm)
295	135
365	165
490	220
540	250
585	265

This construction is not practical for mass thicknesses greater than 585 kilograms per square metre.

The floor joists must be selected from lumber that has a minimum allowable bending stress of 7.2 MPa. Use 38 by 286 joists for all spans up to 5 metres. Spans over 2.5 metres must be supported at mid-span until the concrete cures.

The joists may be notched to make the floor level with the remainder of the house. If they are notched, a 38 by 89 ledger plate anchored to the wall with 20-millimetre diameter bolts at 400 millimetres spacing must be provided.

Figure 32



2. Shelter with Reinforced Concrete Ceiling and Concrete Block Walls

The shelter shown in this plan again benefits from three foundation walls, thus reducing the additional cost of including a shelter in the new house.

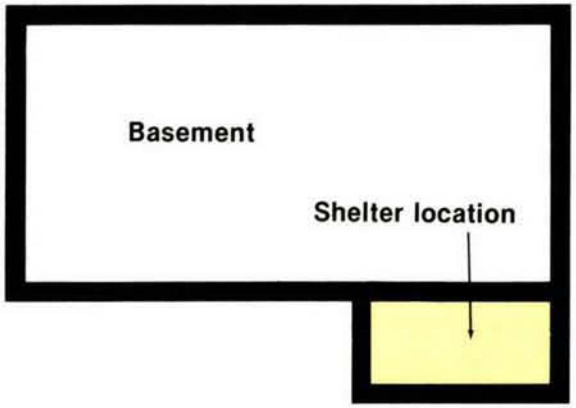
The location shown would be classed as a **corner location** when you look in Chapter 9 for the required mass thicknesses for the shelter ceiling and shelter walls.

Once the mass thicknesses are determined, a suitable wall is selected. The depth and reinforcing for the concrete slab is found from the design table in Chapter 9.

This type of shelter could be built anywhere in a basement as long as the proper mass thicknesses are provided. The concrete block wall could be replaced by a solid concrete wall if desired.

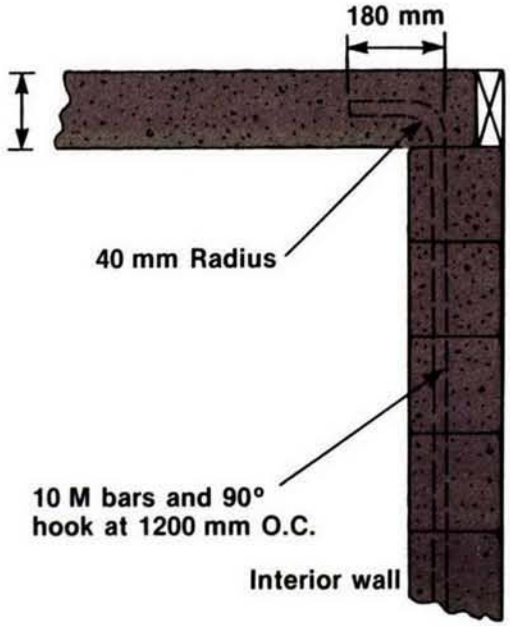
The shelter ceiling could serve as the floor of a mudroom or entrance. Otherwise a sub-floor and finish floor supported on sleepers will be laid on top of the concrete.

Figure 33



See Chapter 3 for illustrations of ceiling details.

Figure 34



3. Shelter with Concrete Block Filled Wood Frame Ceiling and Walls

The shelter has been located to take advantage of the existing fireplace foundation wall in order to reduce the overall cost of the shelter.

The location shown would be classed as a **side location** when you look in Chapter 9 for the required mass thicknesses for the shelter ceiling and shelter walls.

Typical ceiling construction for various mass thicknesses is shown in Table 2. Floor joists are 235 millimetres O.C.

This construction is not practical for a mass thickness greater than 635 kilograms per square metre. Joists should be lumber with a minimum allowable bending stress of 7.7 MPa.

Typical wall construction for various mass thicknesses are shown in Table 3.

Figure 35

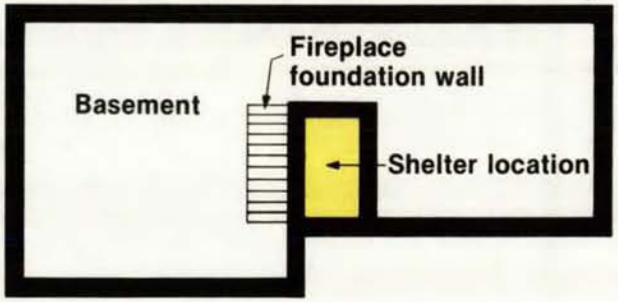


Table 2

Mass Thicknesses	Total Depth of Stacked Concrete Blocks	Floor joists @ 235 mm O.C. for various spans (metres)				
		2.0	2.5	3.0	3.5	4.0
295	150 mm	38 × 235	38 × 235	38 × 235	38 × 286	38 × 286
365	185 mm	38 × 235	38 × 235	38 × 235	38 × 286	38 × 286
490	250 mm	38 × 286	38 × 286	38 × 286	38 × 337	
540	270 mm	38 × 286	38 × 286	38 × 286	38 × 337	
585	295 mm	38 × 337	38 × 337	38 × 337		
635	320 mm	38 × 337	38 × 337			

Table 3

Mass Thicknesses	Total Thickness of Stacked Concrete Blocks	Typical Combinations of Concrete Blocks	Studs at 435 mm O.C.
150	65 mm	1-390 × 65 × 190 on edge	38 × 89
220	100 mm	1-390 × 40 × 190 on edge 1-390 × 65 × 190 on edge	38 × 140
295	135 mm	1-390 × 140 × 190 flat	38 × 140
320	145 mm	1-390 × 65 × 190 on edge 1-390 × 90 × 190 on edge	38 × 184
390	175 mm	2-390 × 90 × 190 on edge	38 × 184
490	225 mm	1-390 × 40 × 190 on edge 1-390 × 190 × 90 flat	38 × 235

Figure 36

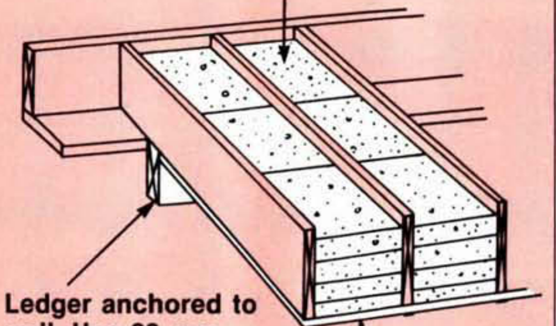
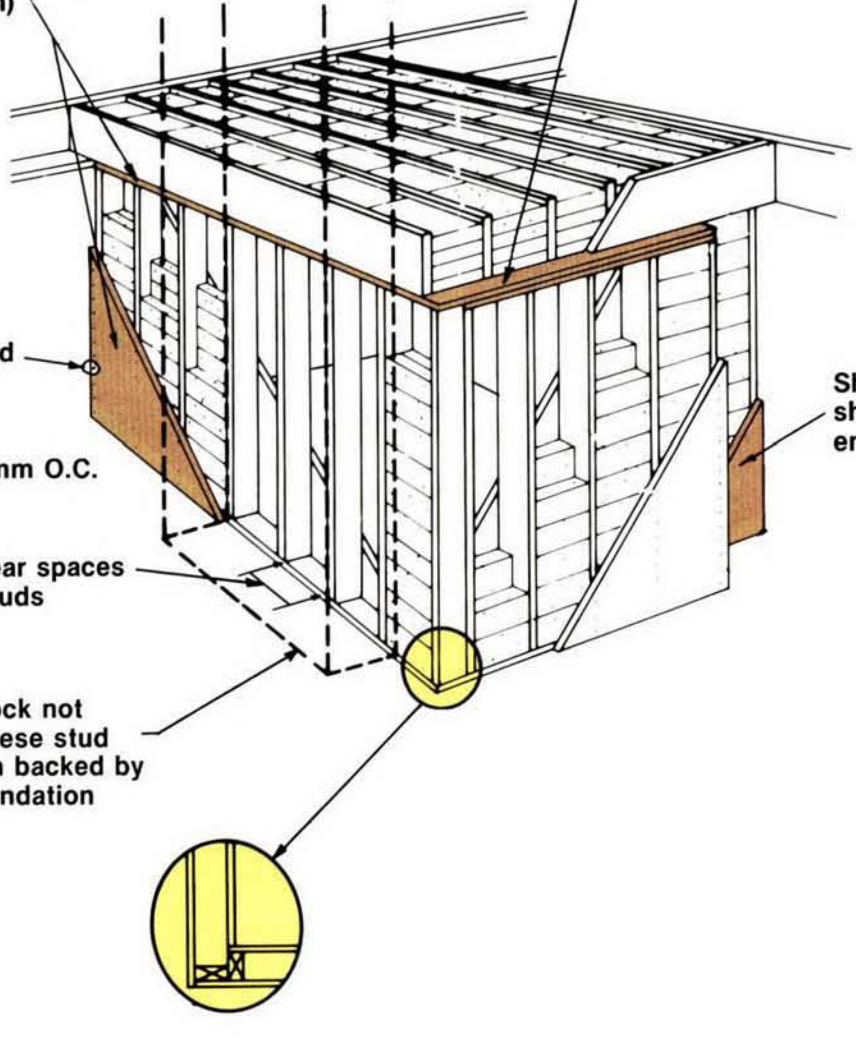


Figure 37



4. Shelter with Sand-Filled Wood Frame Ceiling and Walls

The location shown would be classed as a **centre location** when you consult Chapter 9 for the required mass thicknesses for the shelter ceiling and shelter walls. The shelter ceiling is extended across the hallway to the foundation wall to protect the shelter entrance.

Typical ceiling construction for various mass thicknesses is shown in Table 4.

This construction is not practical for a mass thickness greater than 540 kilograms per square metre. Joists should be lumber with a minimum allowable bending stress of 7.7 MPa.

Typical wall construction for various mass thicknesses are shown in Table 5.

Table 4

Mass Thicknesses	Depth "D" mm		Floor Joists @ 300 mm O.C. for Various Spans (metres)				
	Sand	Pea Gravel	2.0	2.5	3.0	3.5	4.0
295	225	180	38 × 235	38 × 235	38 × 235	38 × 286	38 × 337
365	280	230	38 × 286	38 × 286	38 × 337	38 × 337	
490		310	38 × 337	38 × 337	38 × 337		
540		335	38 × 337	38 × 337	38 × 337		

Table 5

Mass Thicknesses	Wall Width "S" mm		Studs @ 400 mm O.C.
	Sand	Pea Gravel	
150	110	90	38 × 89
195	145	120	38 × 140
245	180	150	38 × 64 spaced
295	215	180	38 × 64 spaced
345	250	210	38 × 64 spaced
390	285	240	38 × 64 spaced
440	325	270	38 × 64 spaced
490	360	300	38 × 64 spaced
730	540	450	38 × 64 spaced

A suggested construction sequence is to install the room partitions before installing the floor above. Temporarily install the top plate and the plywood to hold the studs in place, being careful not to nail to the top plate. When the partitions are in place, remove the top plate and finish nailing the plywood to the studs. Fill the wall cavity with sand or gravel. Then replace the top plate and complete all nailing.

Figure 38

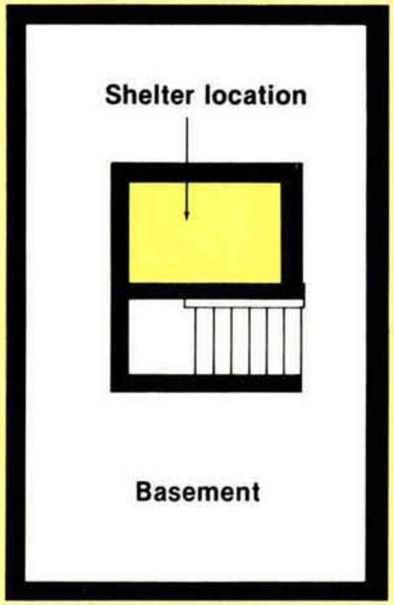
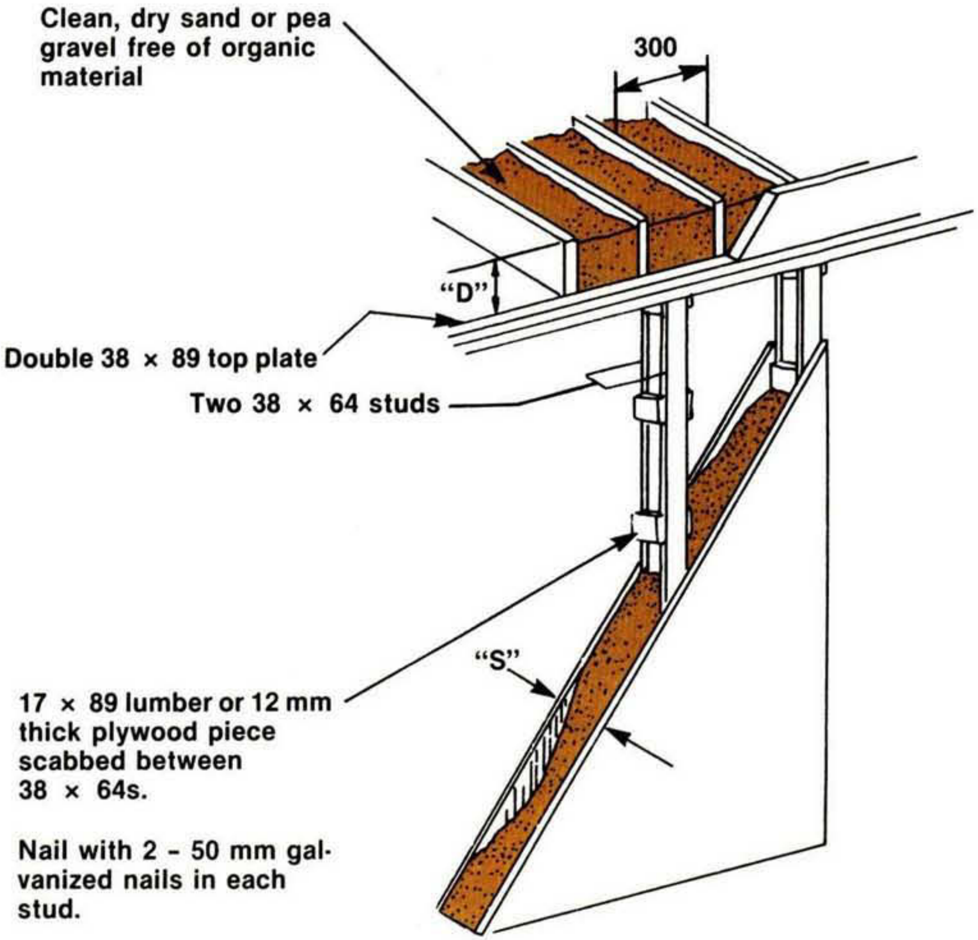


Figure 39



5. Shelter Under a Garage or Carport

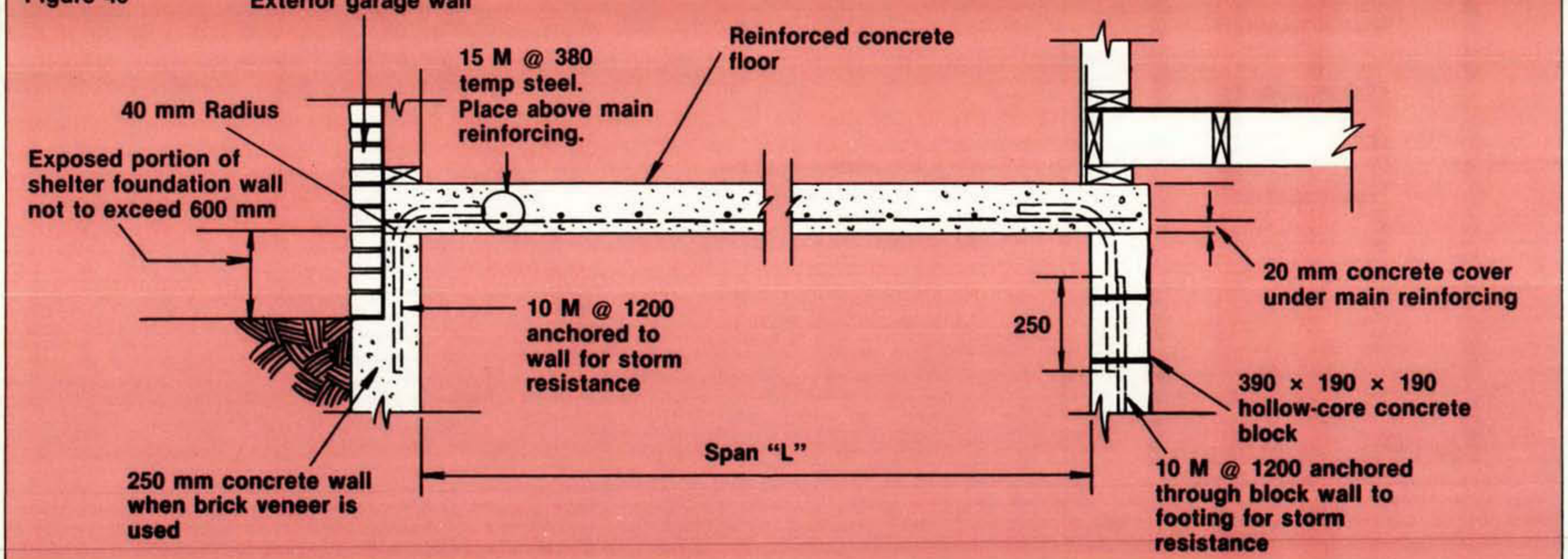
An excellent low-cost fallout shelter can be built under a garage or carport. The only additional costs are the increased depth of the foundation in the shelter area and the thicker floor slab in the garage over the shelter.

The location will normally be in one corner of the house. Use the **corner location** when checking in Chapter 9 for the proper mass thicknesses. However, the minimum mass thickness for the shelter ceiling must be 365 kilograms per square metre.

Because the ceiling slab must carry the weight of a car, only those slabs noted with * in the design table in Chapter 9 should be used.

Fallout can drift onto the concrete slab in a carport. Therefore, the ceiling slab of a shelter built under a carport should have a minimum mass thickness of 730 kilograms per square metre for the enhanced protection level, and 490 kilograms per square metre for the standard protection level.

Figure 40



6. Shelter Under a Porch Slab or Patio

Because fallout can land directly on the porch or patio, the shelter ceiling slab must be a minimum of 730 kilograms per square metre for enhanced protection and 490 kilograms per square metre for standard protection. The shelter walls in both cases must not be less than 295 kilograms per square metre for enhanced protection and 195 kilograms per square metre for standard protection.

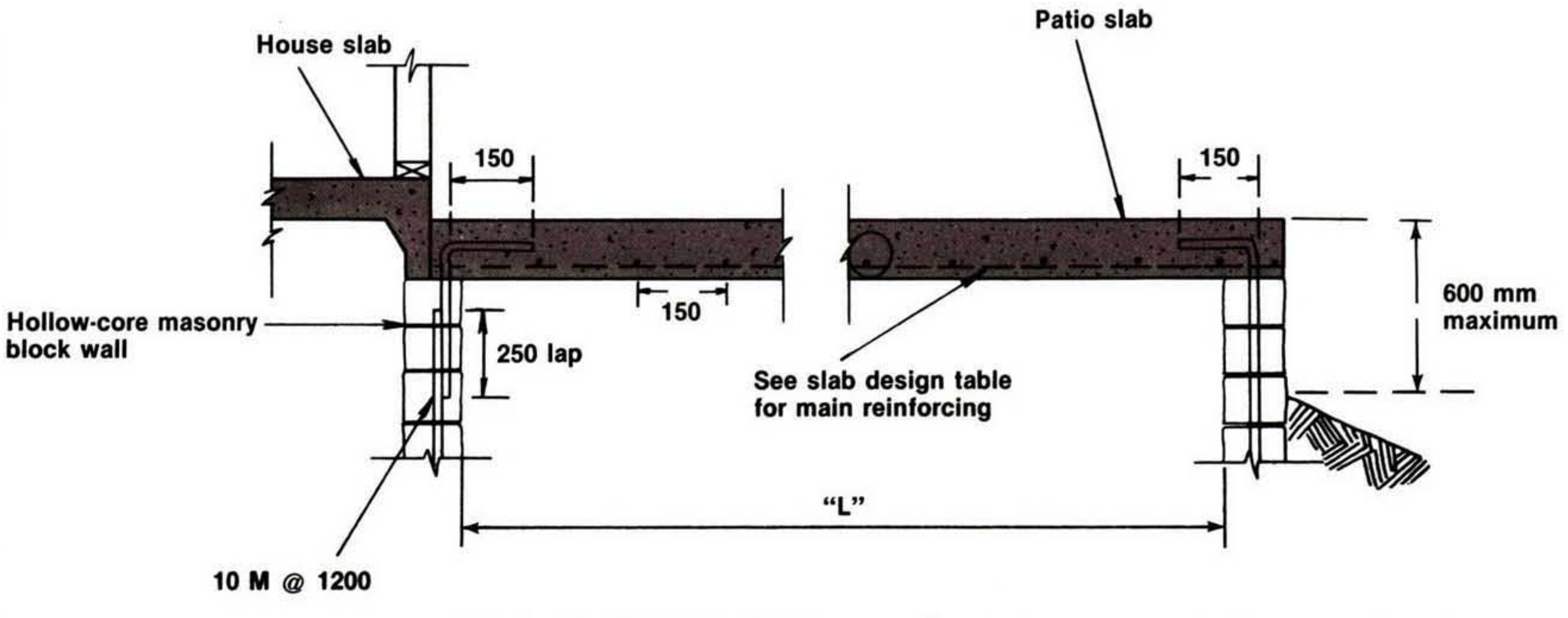
Details of the reinforcing steel for these slabs are given in Chapter 9.

If there is no entrance from the house basement to the shelter, access can be provided by a bulkhead entrance. Walls common to the basement and bulkhead entrance should be 390 kilograms per square metre for enhanced protection and 295 kilograms per square metre for standard protection.

Ventilation must be provided, either through openings in the basement wall or by separate pipes to the atmosphere, as in an underground shelter.

The above-ground portion of the exterior wall can be increased to the required mass thickness by installing concrete steps or planters.

Figure 41



The effectiveness of building materials in reducing gamma radiation depends on their density, configuration and thickness. Therefore, to determine the amount and type of material you use in the construction of your shelter, take into account the current protection afforded by your house. This is determined by the type of house, its size, its foundation and where you locate the shelter.

Table 6 lists the shelter ceiling and wall masses for all combinations of the above factors. Radiation from the ceiling will be much more intense and direct than radiation from the walls, since ceiling radiation originates from fallout resting on the roof which is only a short distance from the shelter, whereas radiation from the walls originates from fallout on the ground at varying distances from the house. This is why the values for ceiling masses in Table 6 are much higher than the wall masses. By building your shelter using the ceiling and wall mass values in the appropriate pair of adjacent columns, you can achieve either the standard level or an enhanced level of protection in your shelter. See Table 7 for mass thicknesses of common building materials.

Example

Given: - Two-storey house 120 m^2 total floor area
- Solid concrete foundation, exposed 800 mm above ground.

Required: Design shelter in a basement corner.

Solution: In Table 6, for a two-storey house of 60 m^2/floor (small), heavy foundation, 800 mm exposed (between 0.5 m and 1.0 m) corner location

READ:

Ceiling masses 365 kg/m^2 and 490 kg/m^2
Wall masses 150 kg/m^2 and 295 kg/m^2
In all cases the lower values provide standard protection and the higher values provide enhanced protection.

From Table 7 we can select a variety of materials, which provide the required masses, such as concrete block walls and a reinforced concrete roof.

If the shelter is built for enhanced protection, the walls could be 140-millimetre hollow concrete blocks filled with mortar or sand and the ceiling could be layers of solid concrete block stacked 200 millimetres or more deep. Finally, note that where a foundation wall is part of the shelter, the mass thickness of the above-grade portion of this wall must be increased.

The foundation wall, which is 200 millimetres thick, will have to be increased by the 140 millimetres for the above-grade portion. Alternatively, the foundation wall could be increased in thickness by 125 millimetres of concrete poured in place. Of course, the wall could be made thicker for its entire height if this is simpler and cheaper.

Table 6
Mass Thickness Design Tables for Basement Fallout Shelters

House Type and Area per Floor	Foundation Type	Foundation Wall Exposure Above Grade	Shelter Location in Basement	Standard Protection: Shelter Ceiling Mass kg/m²	Standard Protection: Shelter Wall Mass kg/m²	Enhanced Protection: Shelter Ceiling Mass kg/m²	Enhanced Protection: Shelter Wall Mass kg/m²
Small one storey under 110 m²	Light	To 0.5 m	Corner	490	195	540	345
			Side	490	245	585	390
			Centre	585	245	635	390
		0.5 m to 1.0 m	Corner	490	320	540	490
			Side	585	295	585	490
			Centre	585	340	635	490
	Heavy	To 0.5 m	Corner	490	150	540	295
			Side	490	150	585	345
			Centre	585	195	635	340
		0.5 m to 1.0 m	Corner	490	195	540	345
			Side	490	245	585	390
			Centre	585	245	635	390
Large one storey over 110 m²	Light	To 0.5 m	Corner	490	245	585	340
			Side	490	245	585	390
			Centre	585	295	635	440
		0.5 m to 1.0 m	Corner	490	340	585	490
			Side	585	340	685	490
			Centre	585	365	685	490
	Heavy	To 0.5 m	Corner	490	150	585	295
			Side	490	195	635	340
			Centre	585	220	635	390
		0.5 m to 1.0 m	Corner	490	245	585	340
			Side	490	245	585	390
			Centre	585	295	635	440

Table 6 (continued)
Mass Thickness Design Tables for Basement Fallout Shelters

House Type and Area per Floor	Foundation Type	Foundation Wall Exposure Above Grade	Shelter Location in Basement	Standard Protection: Shelter Ceiling Mass kg/m²	Standard Protection: Shelter Wall Mass kg/m²	Enhanced Protection: Shelter Ceiling Mass kg/m²	Enhanced Protection: Shelter Wall Mass kg/m²
Small two storey under 70 m²	Light	To 0.5 m	Corner	365	150	490	295
			Side	365	195	490	340
			Centre	365	245	490	390
		0.5 m to 1.0 m	Corner	365	315	540	440
			Side	365	315	490	490
			Centre	365	340	490	490
	Heavy	To 0.5 m	Corner	295	150	540	195
			Side	365	150	490	245
			Centre	365	195	635	295
		0.5 m to 1.0 m	Corner	365	150	490	295
			Side	365	195	490	340
			Centre	365	245	490	390
Large two storey over 70 m²	Light	To 0.5 m	Corner	365	195	540	295
			Side	365	220	490	340
			Centre	365	295	540	390
		0.5 m to 1.0 m	Corner	365	315	540	440
			Side	365	315	490	490
			Centre	365	365	540	490
	Heavy	To 0.5 m	Corner	295	150	585	195
			Side	365	150	490	295
			Centre	365	195	490	340
		0.5 m to 1.0 m	Corner	295	150	540	295
			Side	365	220	490	340
			Centre	365	295	540	390

Table 7
Mass Thickness Table
1 in = 25 mm
1 lb/sq.ft. = 4.9 kg/m²

Material	Metric		Imperial	
	Thickness	Approximate Mass Thickness	Thickness	Approximate Mass Thickness
	mm	kg/m²	inches	lbs/sq. ft.
Concrete:	100	245	4	50
	200	490	8	100
	300	730	12	150
	400	980	16	200
Standard Hollow Concrete Blocks:	90	150	4	30
	140	200	6	42
	190	250	8	55
	240	325	10	68
	290	400	12	80
Standard Hollow Concrete Blocks Filled with Mortar or Sand:	90	210	4	42
	140	310	6	65
	190	450	8	92
	240	525	10	108
	290	600	12	125
Bricks	100	175	4	35
Earth (Dry Packed):	100	140	12	100
Sand (Dry Packed):	100	150	12	95
Gravel:	100	180	12	115
Water:	100	100	12	62
Wood:	100	40	4	10
Drywall:	13	10	½	2
Lead Sheet:	10	113	½	30
Steel Plate:	10	77	½	20

Figure 42: ***Arrangement of reinforcement single span, simply supported***

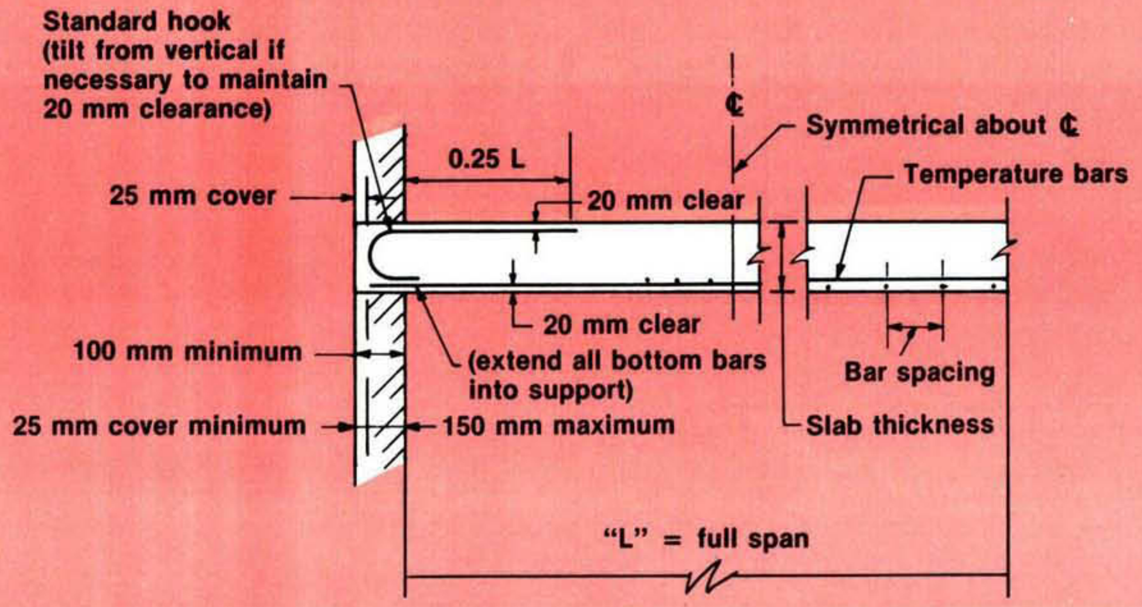


Table 8
Reinforced Concrete Slab Design Table
Concrete design strength = 20 MPa **Steel yield strength = 400 MPa**

All slabs are designed to carry normal residential floor loads. Slabs designated by a * are also designed to carry a residential garage floor load.

Mass Thickness (kg/m^2)	Slab Thickness (mm)	Reinforcing Steel		Span (metres)						
				2.0	2.5	3.0	3.5	4.0	4.5	5.0
295	125	Bottom Bar	Size	10	10	10	10	10	15	15
			Spacing	370	370	370	200	200	250	250
		Top Bar	Size	10	10	10	10	10	10	10
			Spacing	440	440	440	440	440	440	440
		Temp. Bar	Size	10	10	10	10	10	10	10
			Spacing	440	440	440	440	440	440	440
365	150	Bottom Bar	Size	10	10	10	10	15	15	15
			Spacing	370	370	370	320	300	300	300
		Top Bar	Size	10	10	10	10	10	10	10
			Spacing	370	370	370	370	370	370	370
		Temp. Bar	Size	10	10	10	10	10	10	10
			Spacing	370	370	370	370	370	370	370
490*	200	Bottom Bar	Size	10	10	10	10	10	10	15
			Spacing	260	260	260	260	260	220	350
		Top Bar	Size	10	10	10	10	10	10	10
			Spacing	280	280	280	280	280	280	280
		Temp. Bar	Size	10	10	10	10	10	10	10
			Spacing	280	280	280	280	280	280	280
540*	220	Bottom Bar	Size	10	10	10	10	10	10	15
			Spacing	240	240	240	240	240	240	350
		Top Bar	Size	10	10	10	10	10	10	10
			Spacing	250	250	250	250	250	250	250
		Temp. Bar	Size	10	10	10	10	10	10	10
			Spacing	250	250	250	250	250	250	250

Table 8 (continued)
Reinforced Concrete Slab Design Table
Concrete design strength = 20 MPa   Steel yield strength = 400 MPa

Mass Thickness (kg/m^2)	Slab Thickness (mm)	Reinforcing Steel		Span (metres)						
				2.0	2.5	3.0	3.5	4.0	4.5	5.0
585*	240	Bottom Bar	Size	15	15	15	15	15	15	15
			Spacing	460	460	460	460	460	460	350
		Top Bar	Size	15	15	15	15	15	15	15
			Spacing	460	460	460	460	460	460	460
		Temp. Bar	Size	15	15	15	15	15	15	15
			Spacing	460	460	460	460	460	460	460
635*	260	Bottom Bar	Size	15	15	15	15	15	15	15
			Spacing	420	420	420	420	420	420	420
		Top Bar	Size	15	15	15	15	15	15	15
			Spacing	420	420	420	420	420	420	420
		Temp. Bar	Size	15	15	15	15	15	15	15
			Spacing	420	420	420	420	420	420	420
685	280	Bottom Bar	Size	15	15	15	15	15	15	15
			Spacing	390	390	390	390	390	390	390
		Top Bar	Size	15	15	15	15	15	15	15
			Spacing	390	390	390	390	390	390	390
		Temp. Bar	Size	15	15	15	15	15	15	15
			Spacing	390	390	390	390	390	390	390
730*	300	Bottom Bar	Size	15	15	15	15	15	15	15
			Spacing	370	370	370	370	370	370	370
		Top Bar	Size	15	15	15	15	15	15	15
			Spacing	370	370	370	370	370	370	370
		Temp. Bar	Size	15	15	15	15	15	15	15
			Spacing	370	370	370	370	370	370	370

An Underground Fallout Shelter

Introduction

The drawings in this chapter give you the construction details your builder will need for a below-ground shelter, independent of a house.

Figure 43: *Below ground shelter: Plan view*

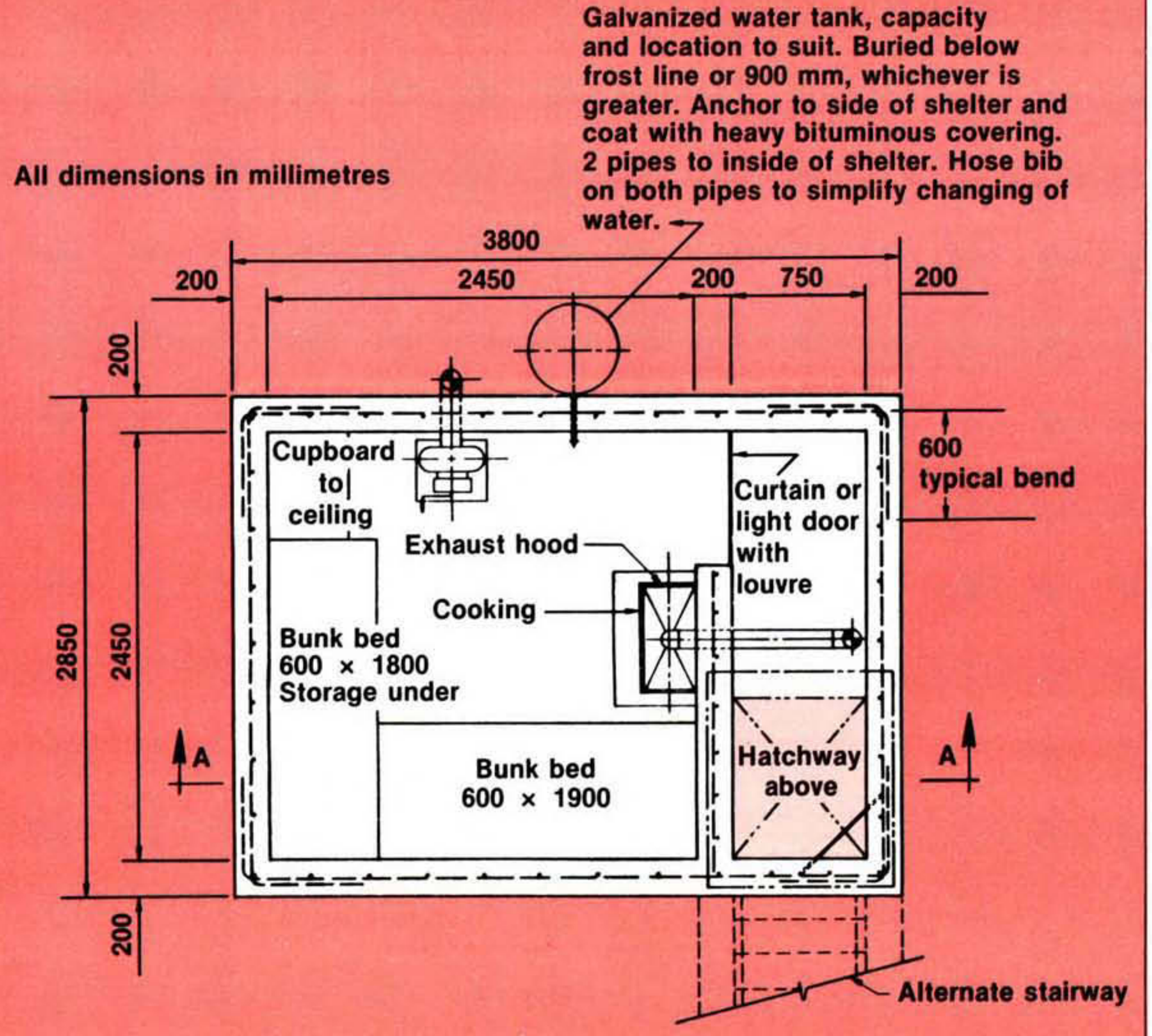


Figure 44: ***Below-ground shelter: Section "A" - "A"***

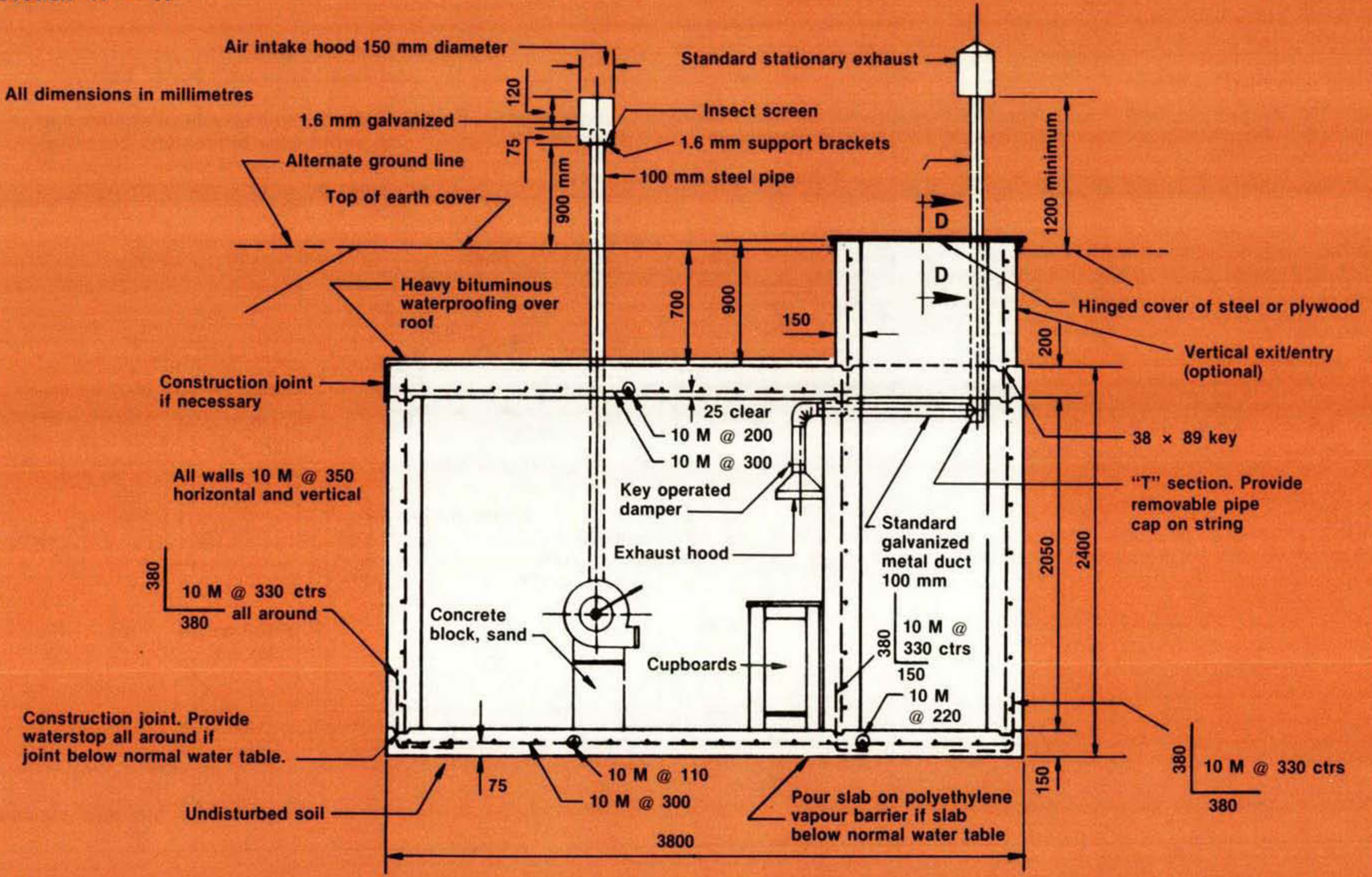


Figure 45: ***Below-ground shelter: Alternate stairway details***

All dimensions in millimetres

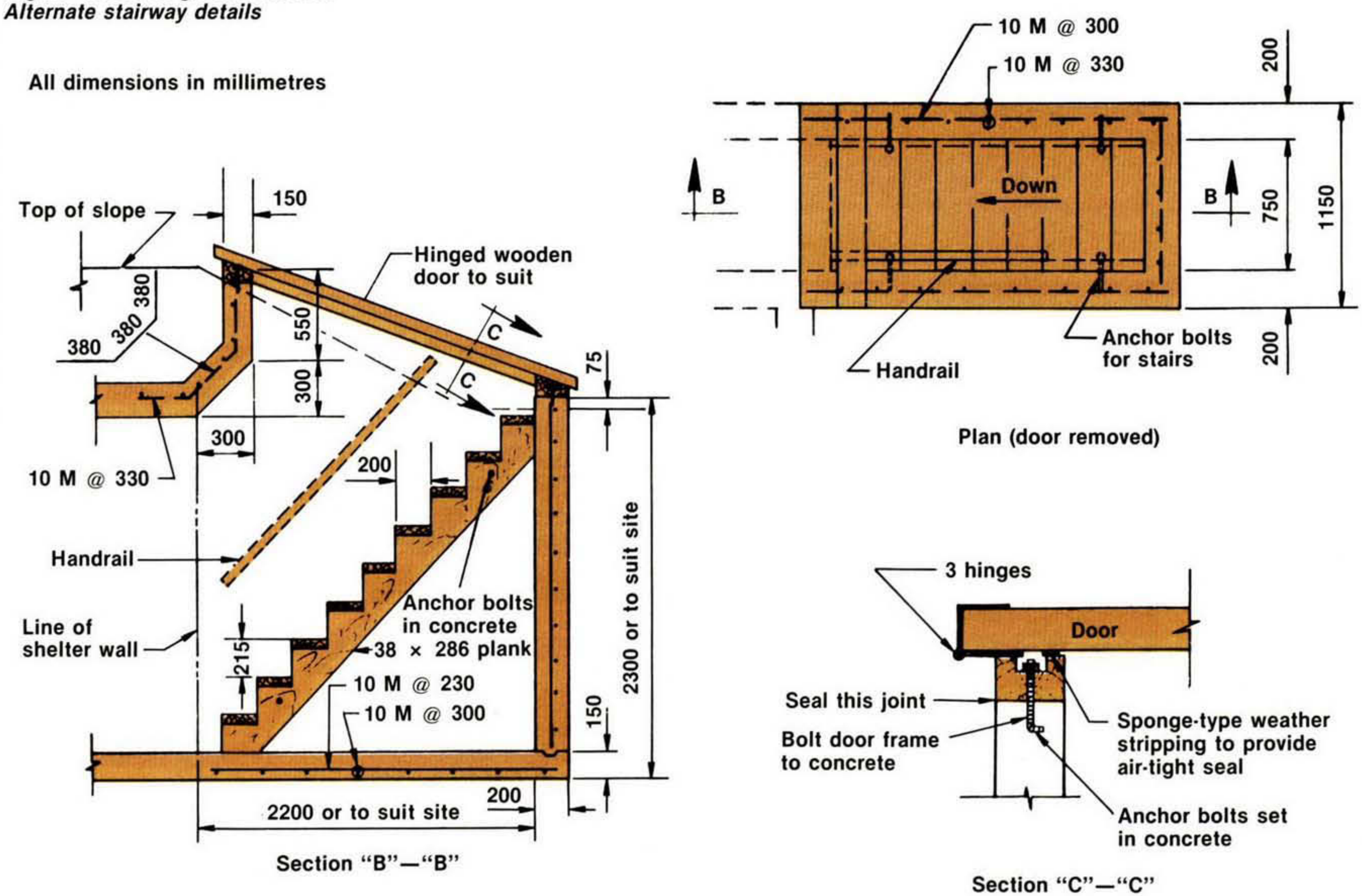
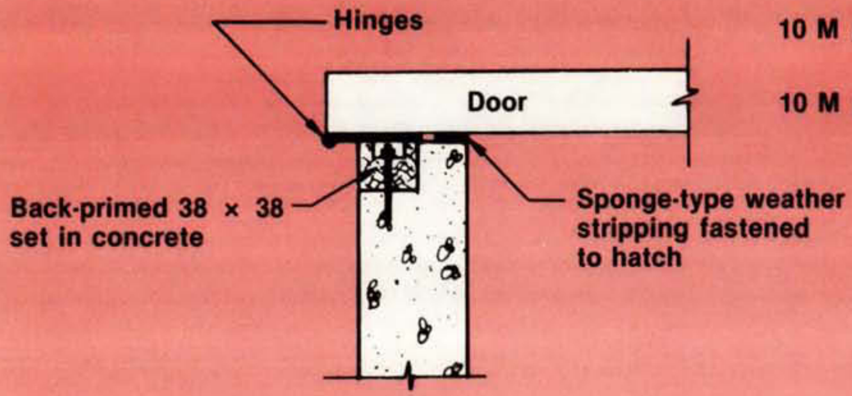


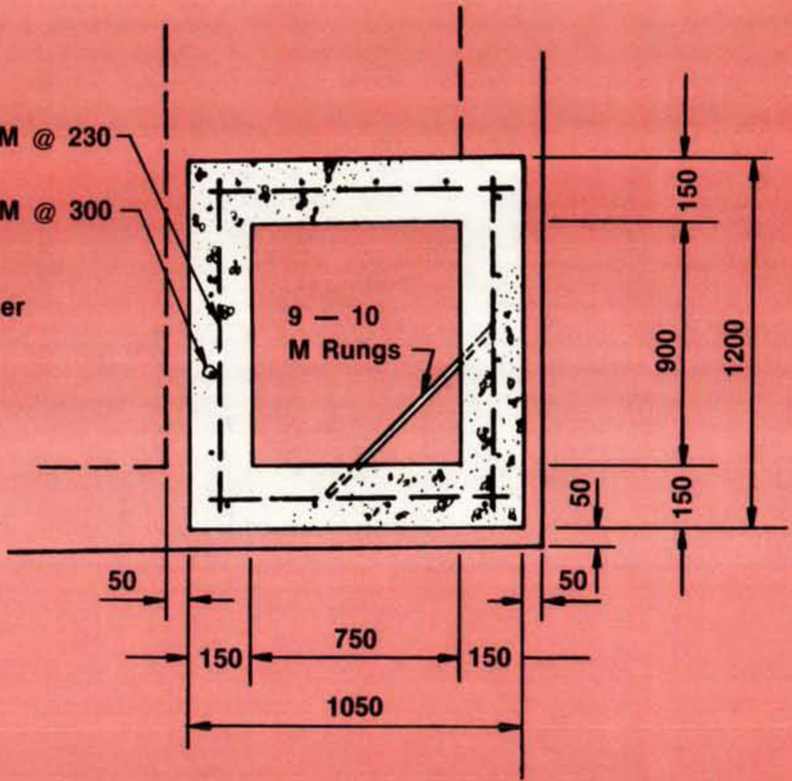
Figure 46: ***Below-ground shelter: Detail of hatchway***

All dimensions in millimetres



Provide sash cord or light chain to stop hatch from springing hinges

Section "D"—"D"



Note: Provide hooks and eyes to secure door or hatch tightly from inside. Provide simple locking device to lock shelter when empty.

Part 3: Doing it Yourself

Introduction

Chapter 11 contains detailed step-by-step instructions and drawings for building a simple, effective fallout shelter in your basement. This shelter takes time to build. It is a major project, even for a home handyman.

Chapter 12 contains detailed instructions for building an expedient outdoor shelter.

Chapter 13 gives you a series of checklists:

- Precautions to take now
- What to do if an attack occurs
- Inventory of shelter supplies

A Simple Basement Fallout Shelter

Selection of Site

The corner of the basement with the highest outside ground level is the best place to build a shelter. This site offers maximum protection and will also simplify construction. If, however, the ground is level with the basement floor or varies only slightly, you should place the shelter below a room that contains a considerable amount of heavy equipment, such as a kitchen. In this way you increase overhead protection. You can improve this further, after a fallout warning has been received, with more furniture, books, magazines, etc.

The corner you select should have no basement windows inside the shelter. If it does, the windows and wood frame must be removed and the opening filled with brick or solid concrete blocks at least 190 millimetres thick. (See Figure 23 in Chapter 4, Page 21.)

About This Shelter

The basement fallout shelter described here has been designed as a "do-it-yourself" project. An able-bodied person should be able to build it by following the instructions and the plans in this Chapter.

The shelter is a small, protected room built on the concrete basement floor. The walls are made of heavy concrete blocks, except against the part of the cellar wall that is below the level of the ground outside. Here there is no danger from radiation and the wall of the shelter is simply a framework of lumber to hold the concrete blocks above it. The roof of the shelter consists of two layers of loose concrete blocks, laid on planks or plywood strips which are supported by strong wooden joists resting on the two sides of the shelter. The entrance is a short passageway built of concrete blocks to prevent direct radiation coming in the doorway.

Page 70 shows an outline plan of such a shelter located in the corner of a house basement.

Size

This shelter has been designed so that the shortest wall is at least 2 metres long inside. This width provides for a full-length bed along the end wall furthest from the shelter entrance.

Most houses have a maximum distance of 3,000 millimetres clear between the external wall and the beam supporting the floor joists. Thus, this shelter will fit into most houses without interfering with the existing structural framework. The height from the underside of the floor joists to the basement floor in an average Canadian home is approximately 2,200 millimetres. This should still give adequate headroom in the shelter after its roof has been put in place. If the height of your basement is less, the height of the shelter must be reduced. We describe how later in this Chapter.

Page 70 shows the dimensions of a typical shelter to accommodate five people, using a width of 2,000 millimetres between the inside walls. **The size of the shelter should not be reduced even for families with fewer than five persons. A smaller shelter is likely to be much less comfortable and may create ventilation problems.**

Changes in length required to accommodate additional persons are shown in Table 9.

Table 9

No. of People	Clear Inside Width (mm)	Clear Inside Length (mm)	Overall Length (mm)
5	2,000	2,800	4,200
6	2,000	3,200	4,600
7	2,000	4,000	5,400
8	2,000	4,400	5,800

Plan Your Work

Now that you have selected the best location for your shelter, draw to scale a sketch of the wall and roof construction. Use the measured dimensions of the material (not the nominal ones in the drawings). Use the high point of the basement floor as a base elevation and the floor-to-ceiling joist measurement at that point as your basic headroom. Remember to add 10 millimetres to the block heights when calculating the height at any given course, to allow for the thickness of the mortar.

Consider carefully how many rows of blocks you can get into the height of your wall. The top row of blocks must be at least 400 millimetres below the existing floor joists or you will not have room for your roof. You may not be able to use the nine rows of blocks needed to give you 1,800 millimetres of clearance within the shelter. (The shelter described here is, of necessity, calculated on the basis that the average Canadian house has 2,200 millimetres of clearance between floor joists and basement floor.)

You will, however, want to make use of every millimetre of headroom your basement offers. If a wall of nine courses (or rows) of blocks is too high and one of eight courses not high enough, the difference can be made up by increasing the height of the footing you make for the wall and, if necessary, by combining this with a top course of 90-millimetre blocks on the wall.

Table 10 will show you how to do this.

Table 10

If your basement headroom is: (mm)	You will need this number of courses of 190-mm blocks	and this increase in height to your level wall footing (mm).
2,200	9	Nil
2,175	8½*	75
2,150	8½*	50
2,125	8½*	25
2,100	8½*	Nil
2,075	8	75
2,050	8	50
2,025	8	25
2,000	8	Nil

*The half course consists of 90 mm blocks.

If the basement headroom is less than 2,000 millimetres, which means a shelter headroom of 1,625 millimetres, build the next larger size of shelter to be sure of having the correct volume of air space inside.

Tools, Material and Techniques

Figures 51, 52 and 53 (Sections A, B, C) at the end of this Chapter show various construction details. The materials required to construct the shelter include:

1. concrete blocks of several sizes for the walls and roof (solid blocks are suggested but you may use hollow blocks provided their hollows are completely filled with sand or mortar as work proceeds);
2. heavy lumber to support the roof and construct the framework against the basement wall;
3. hydrated lime cement and sand to make mortar;
4. nails, lag screws, bars and washers to be used as described in Figures 54 and 56.

The detailed amounts required for the four sizes of shelters noted above are listed on Pages 68 and 69, Building Materials.

Tools required for the project include:

- mortar mixing board
- shovel and pail
- bricklayer's trowel
- level and bricklayer's line
- long straightedge
- saw
- hammer
- drill with masonry bit
- wrench

The mortar mix recommended for shelter construction is one part of cementing material to three parts of clean sand. The cementing material may be masonry cement, Portland cement plus hydrated lime in equal proportion, or Portland cement alone. The usual cement used in construction, Portland cement, produces a mix that is more difficult to work with when used alone as the masonry cement. Prehydrated lime, purchased in bags, gives a workable mix when added to Portland cement, but means that an extra ingredient must be purchased.

A ready mortar mix in bags containing both cement and sand and requiring only mixing with water, is available in some localities.

Mix the cementing material and sand while dry, then add water and mix again thoroughly. Do your mixing in a shallow box, on a metal or plywood sheet or on a board platform. You may even use the basement floor for mixing, if you do not object to its discoloration by the cement, but a box or plywood sheet will be more convenient. Mortar sets quickly. Mix only as much at one time as you can use conveniently in 15 or 20 minutes.

Footings and Levelling Course

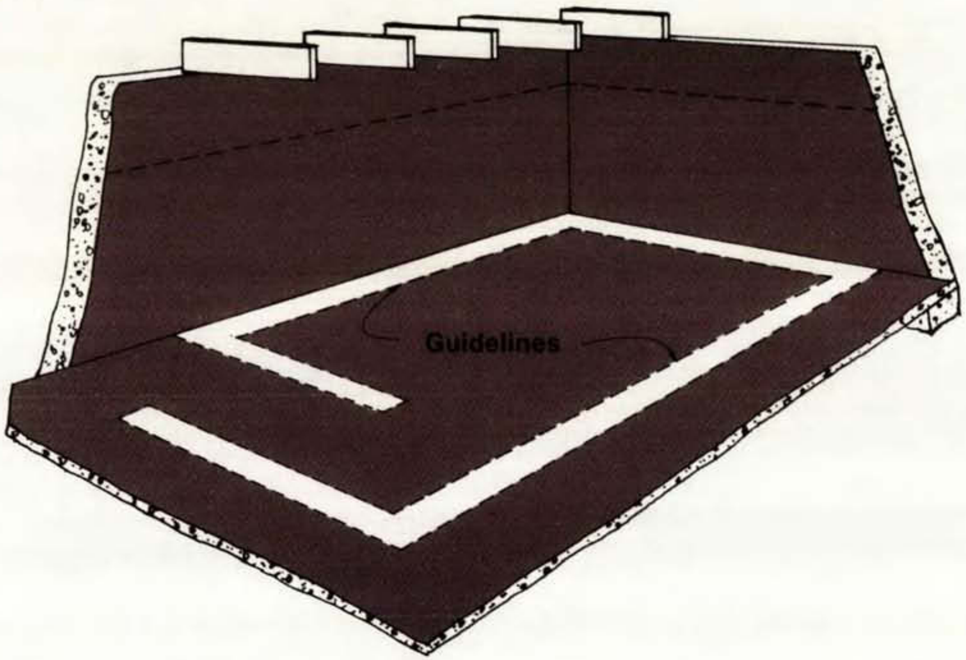
Having decided the size of shelter you need for your family, the first step is to mark out "Guidelines" on the basement floor as illustrated in Figure 48.

If the local building codes require a footing, the basement floor should be broken out along the guidelines and a level footing poured, as shown in Figure 57. One extra row of concrete blocks would be required.

After marking out your "Guidelines":

1. Check that the floor surface is free of paint, tar or other substances, to provide a good bond for the concrete.
2. Using 19- by 140-millimetre boards with straight edges on the top, construct the forms for the foundation pad. Take the dimension at each joist crossover to obtain the proper height of the boards.
3. Cut the bottom of the board to match the slope of the floor and use it as a guide to determine the thickness of the final pad.
4. Nail strips 19 millimetres by 38 millimetres along the lower edges for better support and strength, and across the top of the form every 600 to 900 millimetres.
5. Do a final check with a 2,400-millimetre (or longer if necessary) straightedge and carpenter's level to ensure that the top of the form is perfectly level around all five walls.

Figure 48



Framing

The blocks that are built against the existing basement walls of the house, above the ground level, rest on 38-millimetre by 184-millimetre timber framing, which itself must be supported on a levelling course of concrete. (See Figures 52 and 53, Sections B and C.) The framing reduces the number of concrete blocks required and provides storage space.

Below outside ground level and immediately adjacent to the shelter, the existing concrete wall of the house and the existing ground will provide adequate protection. Therefore, the height of the framing and the number of courses of blocks on top will depend on the level of the ground outside the basement wall.

Example: If it is 1,370 mm from ground level to basement floor, then the top 38 mm by 184 mm board on which blocks are laid must not be more than 1,370 mm from the floor. If the grade outside is lower, the height of the framing must also be lower. If the ground level is higher than the top side of the shelter roof, you do not need concrete blocks on these walls at all. However, timber framing must be built on these walls to support the ends of the roof joists. The timber framing must be properly braced with diagonal pieces and all pieces well "spiked" together, using 100 mm nails. (See Figure 51: Section A).

The framing must be anchored to the existing basement wall as shown in Figure 54 on Page 74 and Figure 56 on Page 75.

It is important to remember that the height of your framing and the blocks on top of it must always correspond to the height of the rows of blocks on the opposite walls so that your shelter will end up at the same height on all sides.

The surfaces of the framing that are to be placed in contact with concrete or masonry should first be treated with some suitable timber preservative such as copper naphthanate. You just paint it on; you will get the necessary instructions on its use when you buy it.

Walls

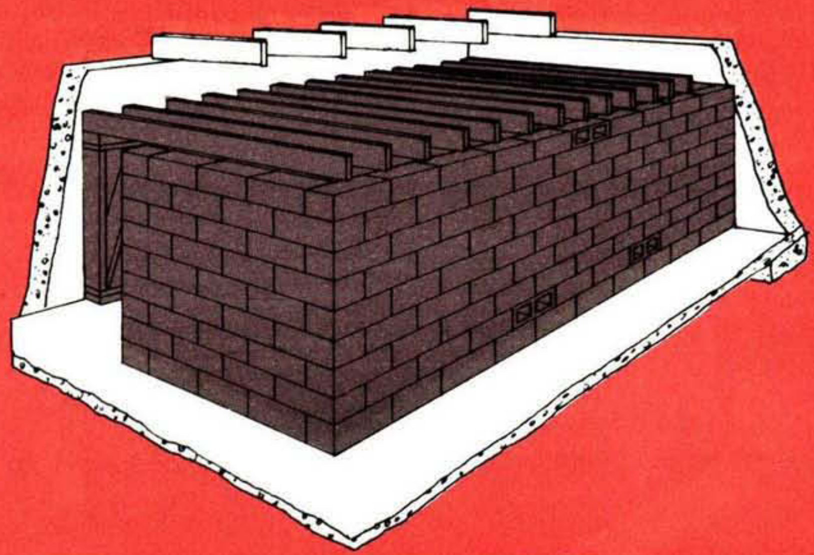
Having set the timber framing in position, build the corner of the shelter on top of the framing using concrete blocks 390 millimetres × 190 millimetres. Build the remainder of these two walls to the same height. (See Figure 58.) Continue building the wall in this way to the required height.

The blocks that form the 90-degree angles at the corners must be "toothed" together (as shown in Figure 58) in order to achieve proper bonding and rigidity. This means that corner blocks must alternate and be fitted together; you must therefore keep the corresponding mortar joints at the same heights on all walls. Use a long, wooden straightedge, a level and a bricklayer's line to check your work. Do not forget that the cores of hollow blocks must be filled as work progresses in order to give the desired degree of protection.

These blocks must support the heavy roof of the shelter. Therefore the wall must be anchored to the existing basement walls. This is done by embedding a metal bar at every other block between the two top courses of blocks and securing it to the basement wall by means of a lag screw (Figure 54). Do not forget to drill the holes in the basement wall and secure the bars in place (bent as shown in Figure 54) before laying the top course.

The first row, or base course, of blocks that form the other walls is set in about 10 millimetres of wet mortar along the levelling course you have built on the floor. Next, move to the corner nearest

Figure 49



the centre of the basement, build that corner about four blocks high and continue with the remaining walls in the same manner as described above.

Do not forget to insert the vent or air-circulating blocks as shown in Figure 49. Hollow blocks laid on edge will form suitable openings.

Block designs differ, but most blocks will provide about the same area of opening — .025 square metres per block. Use four blocks for vents, two at the top and two at the bottom of the shelter, providing up to 0.05 square metres of opening at each level. You may, if you wish, arrange to provide the equivalent area of opening in some other way, such as by leaving out half a block. (If you plan to use solid blocks in your construction, it would be an idea to buy four hollow blocks for the vents.)

Before the construction of the outer wall has gone too far, all bulky fittings and furniture such as cots, bunks or tables should be placed inside the shelter. Even when these have been put in place, do not build the walls all the way to the basement ceiling since you need a clear space of at least 400 millimetres overhead to allow you to build the shelter roof. The baffle wall protecting the shelter entrance from direct radiation must be the same height as the shelter walls.

Roof

When the mortar in the block wall has dried for a period of at least 48 hours, you can install the roof joists. Because the inside width of the shelter is 2,000 millimetres, position joists 38 millimetres by 140 millimetres by 2,340 millimetres (the length equal to the overall shelter width less the thickness of the header) on 300-millimetre centres. Nail a blocking piece between each pair of joists, flush with the inside face of the shelter wall. Nail a header across the end of the joist, flush with the outside face of the shelter wall.

The space between the joists where they rest on the wall must be filled with mortar. (See Figures 51, 52 and 53.)

Note in Figure 51: Section A that the joists carrying the roof over the entrance are supported on two 89-millimetre by 89-millimetre posts and a beam placed there for that purpose.

After the spaces between the joists on the house foundation wall side of the shelter have been filled with mortar, begin laying the 19-millimetre roof boards or plywood strips at that side of the shelter. The first one or two boards or the first strip should be placed in position across the roof joists. Nail these boards to the joists by reaching up through the open space between the joists. Then pass 90-millimetre solid concrete blocks between the joists and place them on the roof. (There is no need to mortar them together.) These roof blocks are in two layers to form a total thickness of 180 millimetres as shown in Figure 52.

Continue work on the roof in a similar manner until you reach the inside of the opposite wall. Again, the space between the joists where the blocks rest on the wall must be filled with mortar. When this has been done, continue with the remaining courses of 90-millimetre blocks to complete the roof.

Building Sequence

In summary, the steps which you should follow in constructing the shelter are:

1. **Plan your work well. Use the instructions in conjunction with the diagrams.**
2. **Mark out guidelines on the basement floor.**
3. **Form and pour the levelling course.**
4. **For additional bracing use concrete blocks along the side of the forms.**
5. **At this stage mix mortar and pour inside the forms.**
6. **After this, remove the wooden top strip braces one by one to allow the surface to be screeded and trowelled level with the top of the form.**
7. **Periodically moisten the surface to cure the concrete properly.**
8. **After approximately 60 hours the concrete block bracing and wooden form can be removed.**
9. **Erect timber framing against the outer basement walls and fasten it to them.**
10. **Build the concrete block wall on top of the framing to the required height and anchor it to the basement walls.**
11. **Build the remaining walls to the required height, remembering to move larger objects inside before the walls have been raised too high.**
12. **Place the joists or rafters into position, inserting the necessary blocking pieces between them and filling the spaces between joists and blocks with mortar.**
13. **Construct the overhead projection by nailing on roof boards and placing 90 mm concrete blocks in position, working from the outside wall on the house inwards towards the centre of the basement.**

See Figure 51 for construction details.

Table 11: Building Materials

Item	Size	Quantity in Shelter for:			
		5 People	6 People	7 People	8 People
Concrete blocks (preferably solid but can be hollow (a))					
Walls	190 × 190 × 390 190 × 190 × 190	220 20	240 20	260 20	300 20
Roof	90 × 190 × 390	210	250	300	340
Inner Layer Shielding (b)	190 × 190 × 390 - allow for each course	13	14	16	17
	90 × 190 × 390 - one course only	7	8	10	11
Mortar					
Hydrated Lime		90 kg	115 kg	140 kg	160 kg
Cement		715 kg	835 kg	1070 kg	1280 kg
Mortar Sand		2 m^3	2.5 m^3	3 m^3	3.5 m^3
Lumber (c)					
Posts and Beam	89 × 89 × 3000	2 pcs.	2 pcs.	2 pcs.	2 pcs.
Stud Wall Plates (short)	38 × 184 × 2400	3	3	3	3
Stud Wall Plates (long)	38 × 184 × 3000	3	-	-	-
	38 × 184 × 3650	-	3	-	-
	38 × 184 × 4260	-	-	3	-
	38 × 184 × 4870	-	-	-	3
Studs	38 × 184 × (d)				
Rafters	38 × 140 × 2400	14	16	19	20
Blocking Pieces	38 × 140 × 3000	5	5	6	6
Curtain Frame	38 × 89 × 2400	2	2	2	2

(a) If solid blocks are used, add four hollow blocks to the list for ventilation purposes.
(b) Height depends upon height of shelter above ground level.
(c) Commercial lengths are listed. See diagram dimensions for lengths you cut.
(d) Lengths depends upon height of shelter above ground level.

Table 11: Building Materials (continued)

Item	Size	Quantity in Shelter for:			
		5 People	6 People	7 People	8 People
Lumber (c)					
Roof Boards	19 × 140 × 4200	17	-	-	-
or	19 × 140 × 4700	-	17	-	-
	19 × 140 × 5500	-	-	17	-
	19 × 140 × 5900	-	-	-	17
Plywood Roofing	18.5 × 1200 × 2400	3.5	4	5	5
	18.5 × 600 × 2400	7	8	9	10
Shelving	17 × 184 × 3000	4	3	6	7
Hardware					
Nails	150	0.5 kg	0.5 kg	0.5 kg	0.5 kg
	100	3 kg	3 kg	3.5 kg	4 kg
	50	1.5 kg	1.5 kg	1.5 kg	2 kg
Copper Naphthanate		AS REQUIRED			
Framing Anchor					
Lag Screw & Plugs	9 mm	4	4	4	4
Washers		4	4	4	4
Lumber	38 × 89 × 184	2	2	2	2
Wall Anchor					
Lag Screw & Plugs	6 mm	5	5	6	7
6 mm Bar	*300 mm long	5	5	6	7
Washers		5	5	6	7

(a) If solid blocks are used, add four hollow blocks to the list for ventilation purposes.
(b) Height depends upon height of shelter above ground level.
(c) Commercial lengths are listed. See diagram dimensions for lengths you cut.
(d) Lengths depends upon height of shelter above ground level.
*Bent as shown in Diagram 1

Figure 50: *Do-It-Yourself Shelter — Plan View*

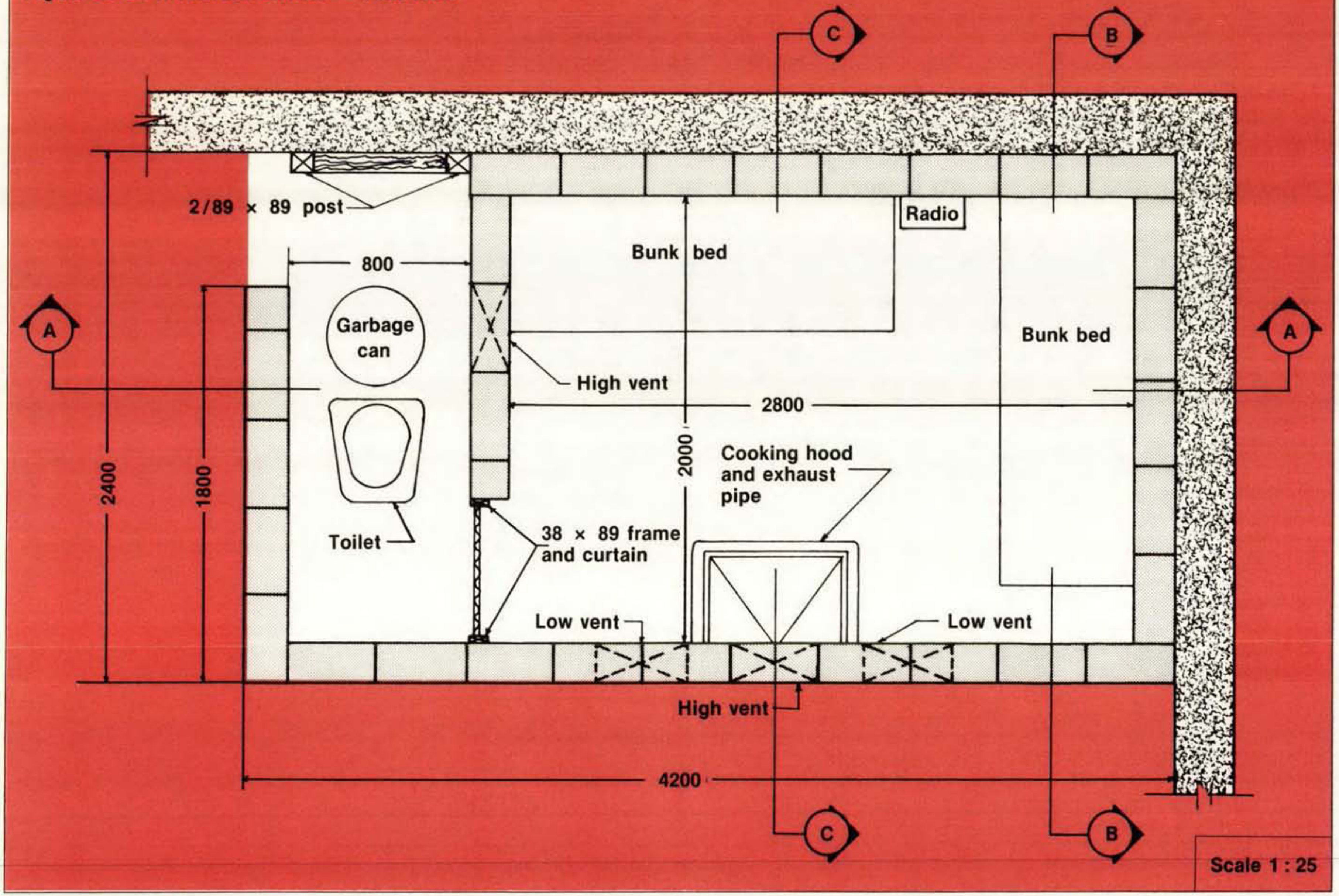


Figure 51: *Section A*

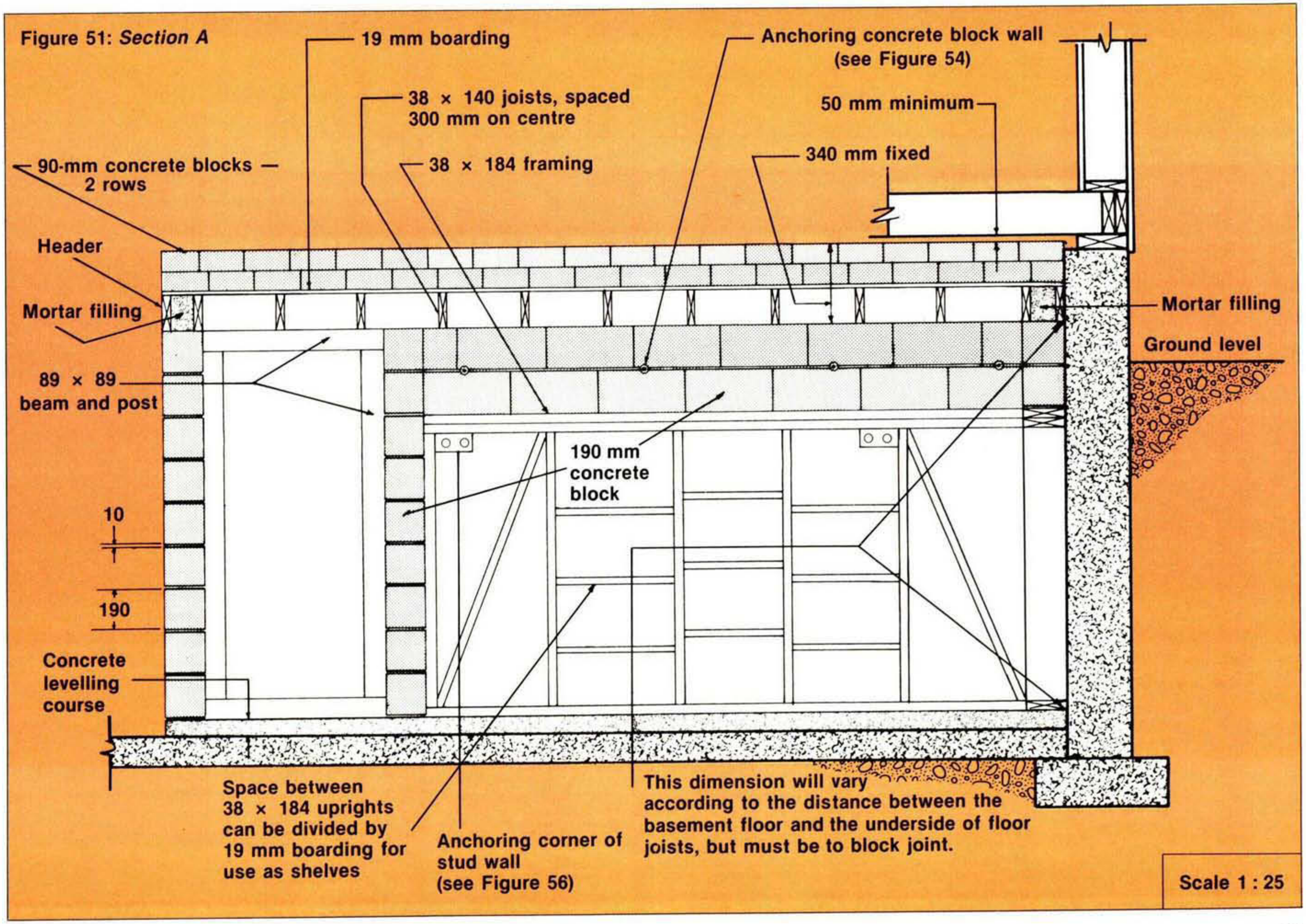
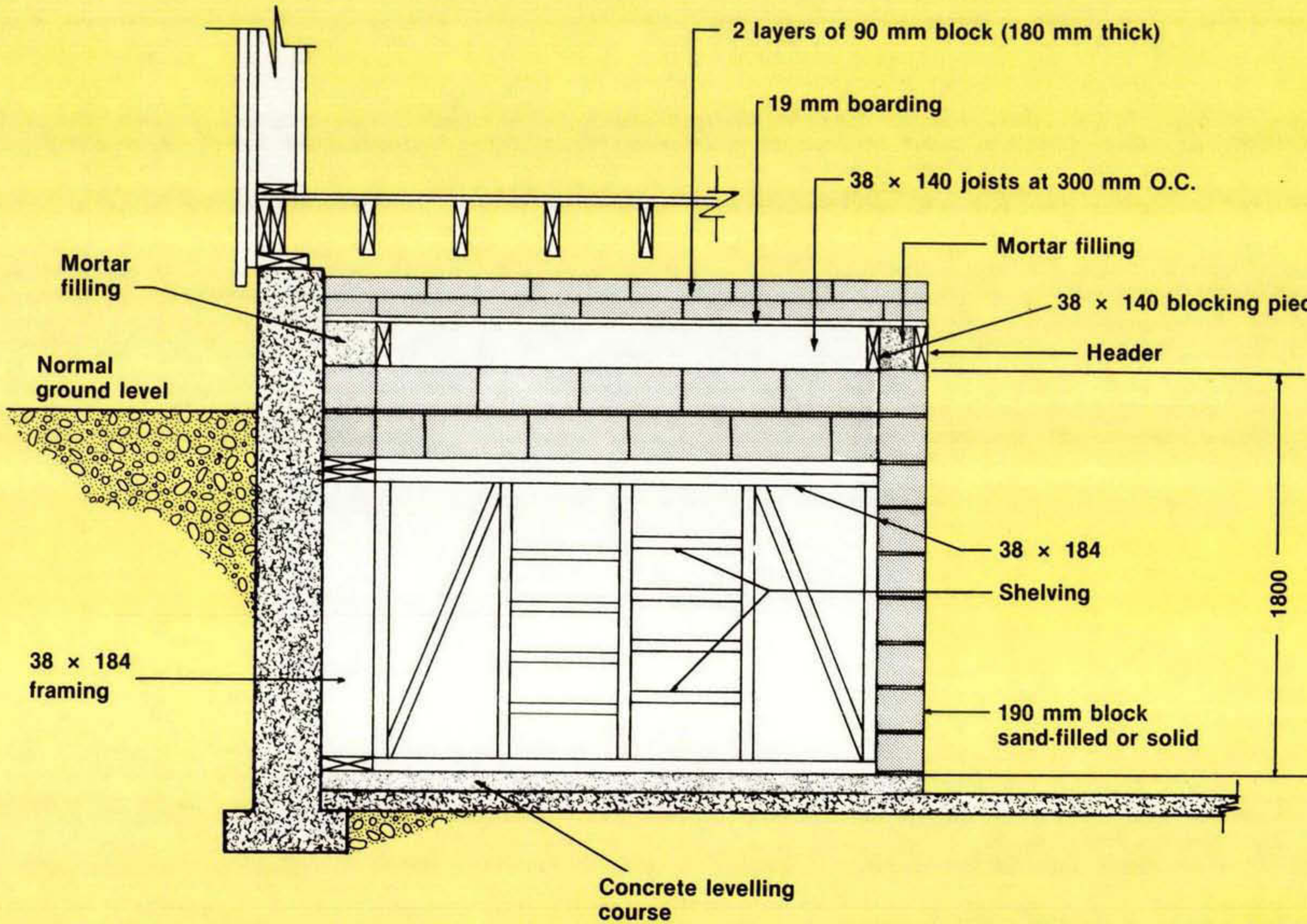


Figure 52: *Section B*



Scale 1 : 25

Figure 53: *Section C*

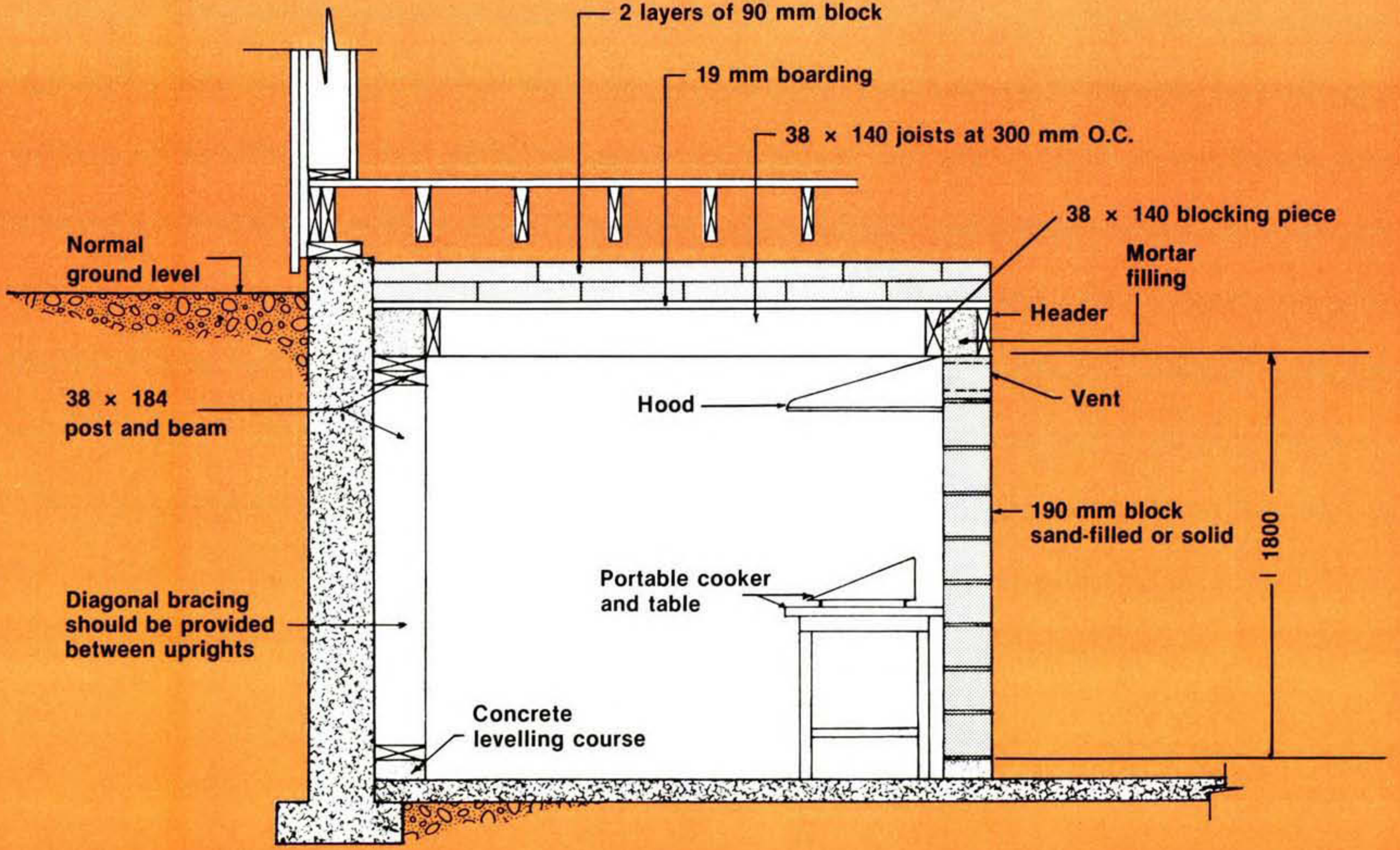


Figure 54: ***Diagram 1***

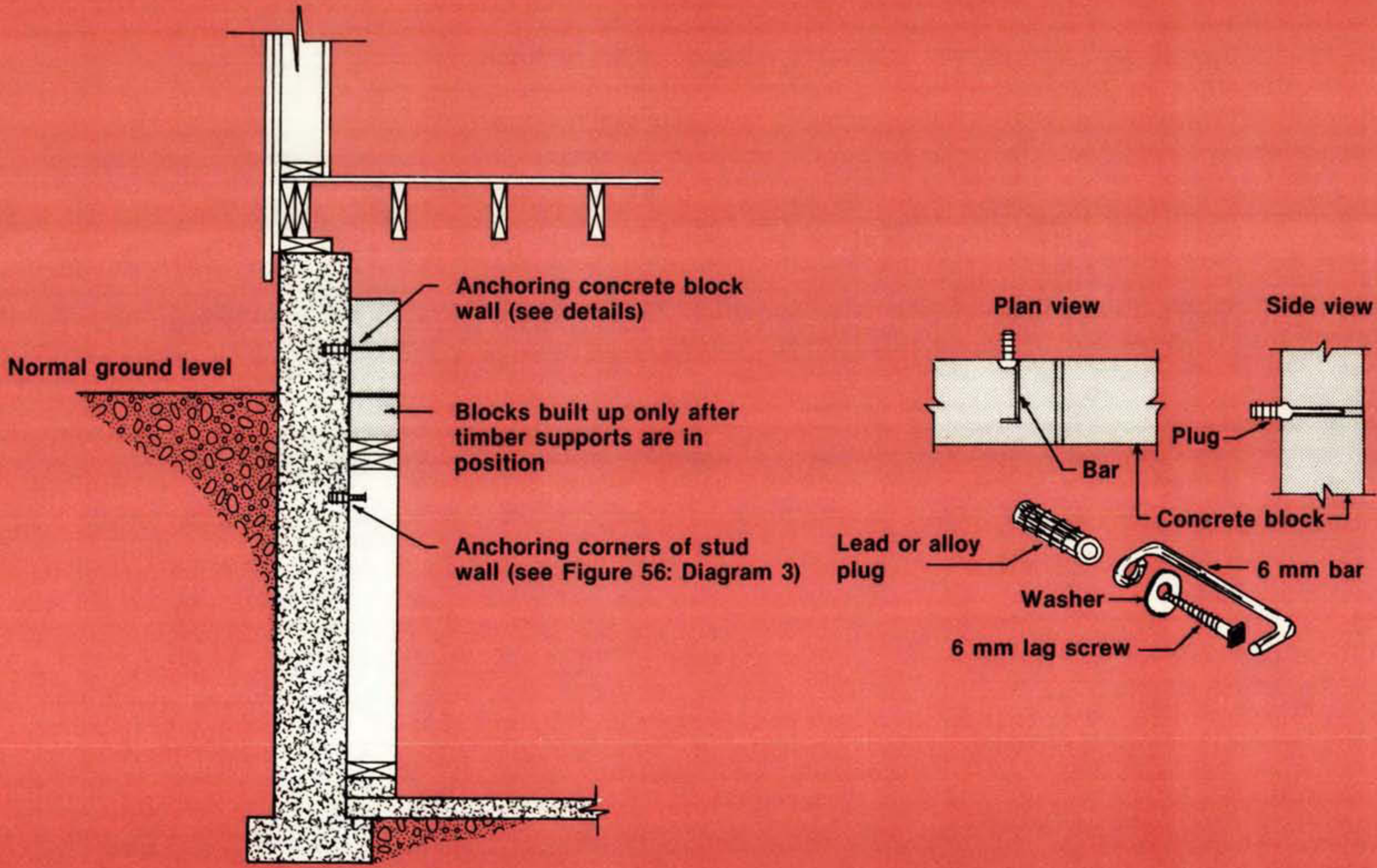


Figure 55: *Diagram 2*

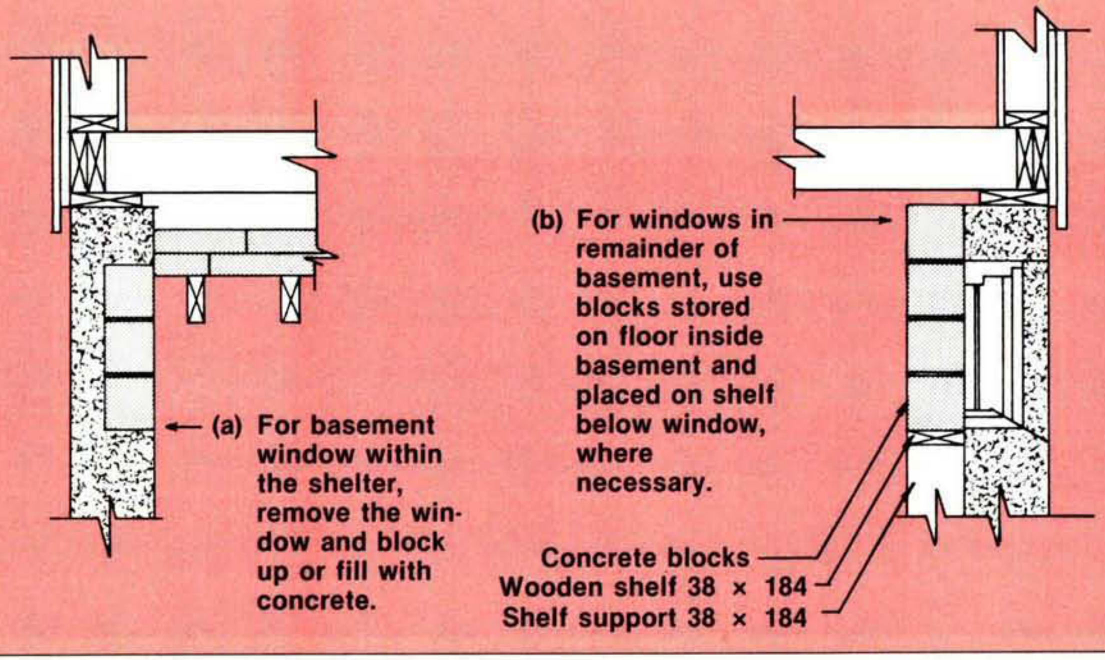


Figure 56: *Diagram 3*

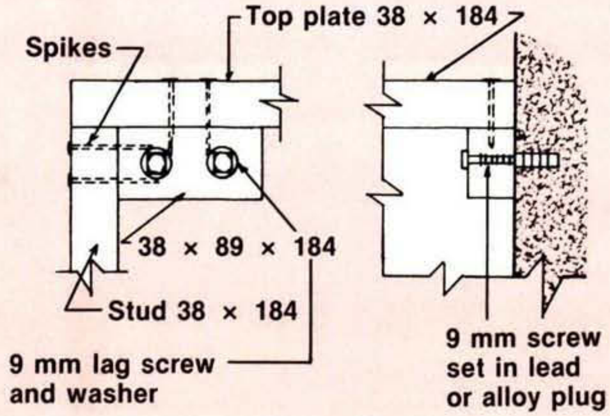


Figure 57: *Diagram 4 Constructed Foundation Pad*

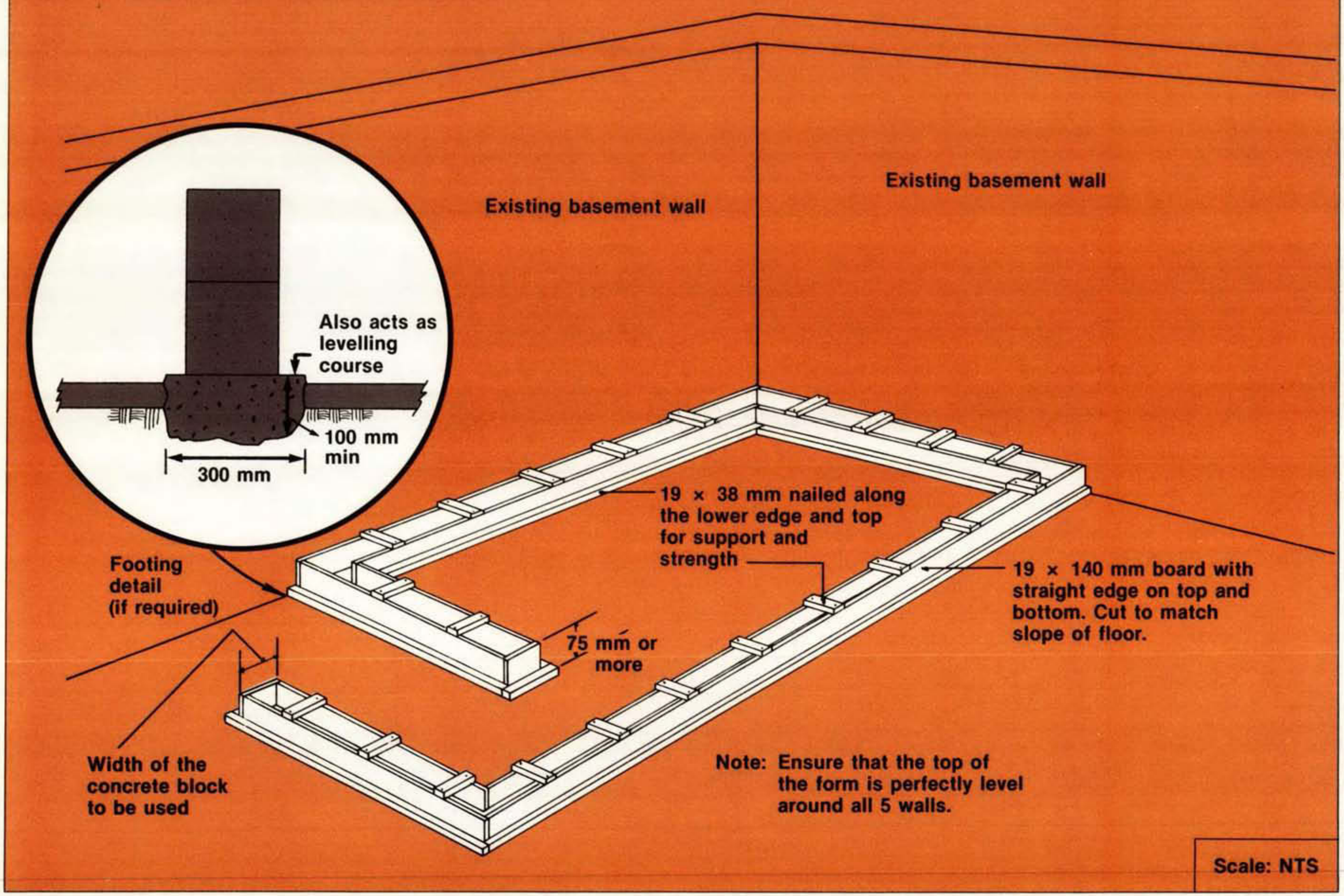
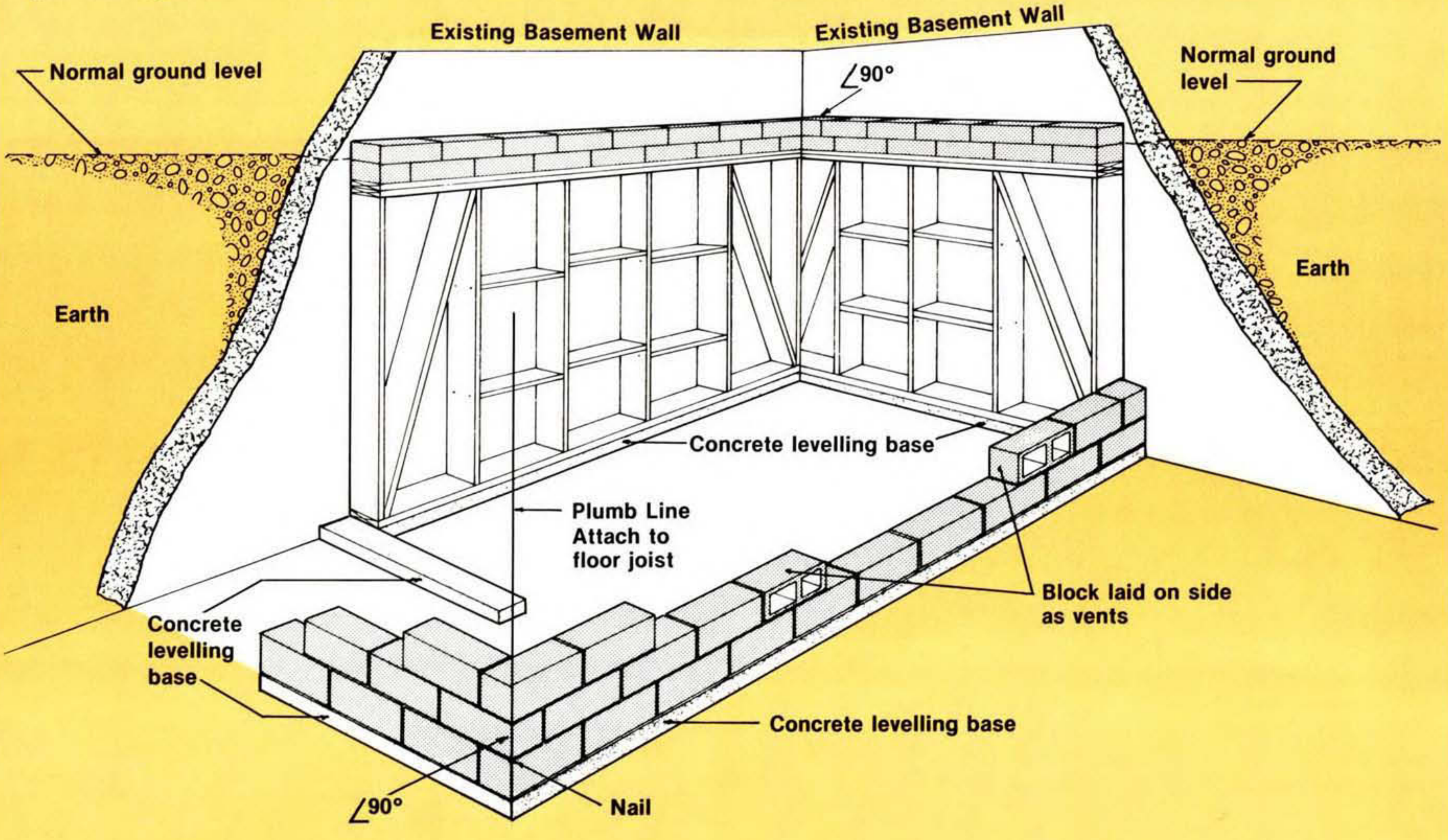


Figure 58: *Diagram 5*



Note: Concrete blocks that form 90° angle at the corners must be toothed together.

Scale: NTS

An Expedient Outdoor Shelter

Chapter 12

This shelter offers very high protection when it is covered with 750 millimetres of earth. It also provides fair protection against fire if the cloth in the entry is sufficiently covered with mud and your shelter is not near any fire producing toxic smoke. If you cannot dig deeper than 350 millimetres owing to rock or a high water table, this plan is very suitable. In addition, it can be constructed in 36 hours by groups of two or more hard-working people with very little building experience.

The shelter illustrated is designed for six people. One door width is required for each occupant and two extra doors are required for the entrance and exit. The minimum length for this type of shelter is six doors, adequate for four occupants. If there are to be more than seven occupants, we recommend building a second shelter.

To Make Your Job Easier . . .

1. **Plan your work and study all instructions and diagrams carefully.**
2. **Divide the different jobs among your work team and check off each job as it is completed.**
3. **Sharpen and maintain all tools.**
4. **Always wear gloves to prevent blisters and infections.**
5. **Construct the shelter away from buildings and trees to reduce the risk of fire and the work of digging through tree roots.**
6. **Remove all door knobs from doors.**

Materials and Tools

Essential

1. Eight doors (boards or plywood at least 15 millimetres thick can replace the doors if necessary).
2. Wood
   - Several pieces of timber at least 1,000 millimetres long for braces. Any timber or poles of a reasonable size can be used for this.
   - Approximately eight 17-millimetre by 140-millimetre planks to cover the shelter entrance and exit.
   - Floor boards approximately 1,200 millimetres long.
3. Wooden pegs and string to mark out trench and to tie sandbags.
4. At least four double-bed sheets for each of the first four persons and three double-bed sheets for each additional person to be sheltered, or the equivalent in other fabric or plastic sheeting.
5. Rainproofing materials (plastic film, shower curtains, etc.) 13 square metres for the first four persons and 2.5 square metres for each additional person.
6. Hammer and nails; 100 nails 50 millimetres long and 30 nails 100 millimetres long.
7. A shovel for each two workers and one pick or mattock if the ground is hard.
8. Saw.

Useful

1. Large cans, buckets or wheelbarrow to carry earth.
2. Axe or hatchet.
3. Tape measure, yardstick or ruler.
4. Additional cloth and waterproof material.
5. Pillowcases, plastic bags, etc., for use as sandbags.

Staking Out Your Shelter

Lay the doors on the ground in the same position they will be in when they are used for the roof. (Figure 59: Step One Page 81.) Use the two largest doors for the entrance and exit. Measure the doors to determine the exact size of your shelter.

After you have staked out your shelter, dig the trench at least 350 millimetres deep by 900 millimetres wide. (Figure 60: Step 2, Page 81.) The length will vary according to the number of people to be sheltered. Spread the excavated soil on both sides of the trench, at least 600 millimetres from the edge.

Temporary walls must be constructed against which to build earth rolls later. Six of the doors that will later be used for the roof are placed along the sides of the trench supported by temporary braces (Figure 61: Step 3, Page 82.) Only the upper braces need be nailed to the doors. Use the small nails for this. Allow an offset of approximately 600 millimetres for the entrance and exit.

Construction of Earth Rolls

The walls of the shelter are made of earth that is formed into rolls contained in bed sheets or similar fabric such as carpets or large plastic sheets.

First, place the sheeting material as shown in Figure 62: Step 4, Page 82. At least 600 millimetres of the sheeting material should be on the ground and the remainder folded up out of the way over the outsides of the door forms. These sheets should overlap approximately 300 millimetres for stability and to prevent leakage. The earth roll construction sequence is shown in Figure 63: Step 5, Page 83.

Shovel the earth onto the parts of the sheet on the ground to the height of the rolls you are making. A height of about 200 to 250 millimetres is recommended.

Note that one side of the shelter is 100 millimetres higher than the other side so that water drains off the roof.

Make a narrow trench in the earth that you have shoveled onto the sheeting material.

Fold down the upper part of each sheet while pulling on it to keep it tight and without wrinkles.

Pack earth onto the part of the folded-down sheet that is in the narrow trench and fold back the loose edge of the sheet over this small amount of packed earth to form a 'hook'. The hook keeps the weight of the earth inside the roll from pulling the cloth out of its proper position.

Make a roll first on one side and then the other so that the weight is distributed evenly against the temporary braces.

Before starting the next earth roll, level out the top of the previous roll by adding additional soil.

After the rolls have reached their finished height (600 millimetres on one side and 500 millimetres on the other side), carefully remove the braces and the door forms. The door forms of the side walls of the shelter can be removed before building the end walls. When smoothing the earth on top of the last earth roll, be sure the earth is slanted at an angle so that when the doors to be used for the roof are put in place, they will be slanted enough to allow rainwater run-off and will be fully supported over the width of the walls.

As shown in Step 7 on Page 84 and Step 8 on Page 85, use sandbags and the tucked-in ends of the earth-filled rolls to make the outer ends of each entryway. Make the two doorway frames as high as the wall on each side. Slope the top board of the frame so that it will be flat against the door to be supported. Build the end walls of earth rolls in the same way as the side walls were built.

After all temporary braces and doors are removed, be sure the earth is sloped evenly so that the doors will rest flat and without gaps.

Place the roof doors in their final position (Step 10, Page 85).

Next, position wooden planks (17 millimetres by 140 millimetres) to cover the shelter entrance and exit.

If you have enough waterproof material, cover all the roof doors and the tops of the walls to keep the doors from absorbing moisture from the earth. Fold the waterproof material under the high edges of the doors to keep the plastic from slipping down the sloping doors as the earth is being shoveled onto it.

Shovel the earth onto the plastic, being very careful not to puncture it with small rocks or pieces of roots. To make earth arching more effective in supporting most of the earth to be placed on the roof, first mound earth on or near the ends of the entrances and then fill in the centre. The roof and all corners must be covered with at least 500 millimetres of earth (750 millimetres is preferable).

Build mounds of packed earth 100 millimetres high just inside the entrance and exit to prevent surface water from running into the shelter. If any waterproof material remains, use it to cover the shelter floor. This will help to keep the shelter clean and make it more comfortable.

Figure 59: *Step 1 Mark Out Trench*

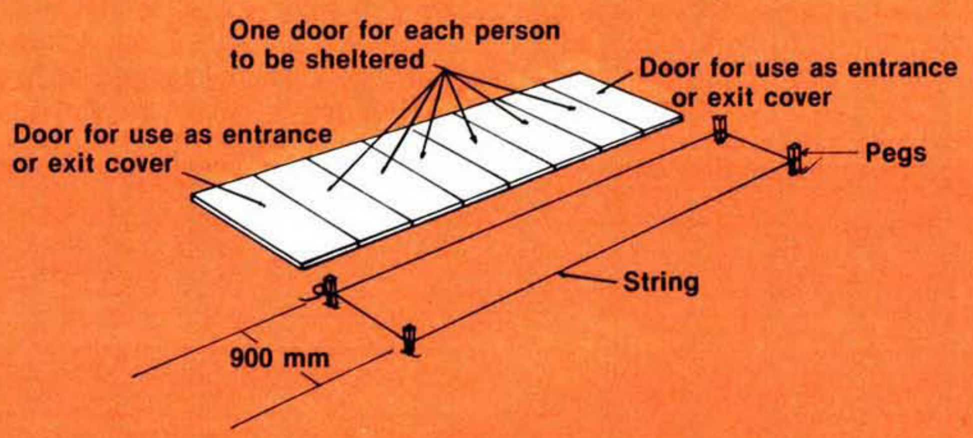


Figure 60: *Step 2 Excavate Trench*

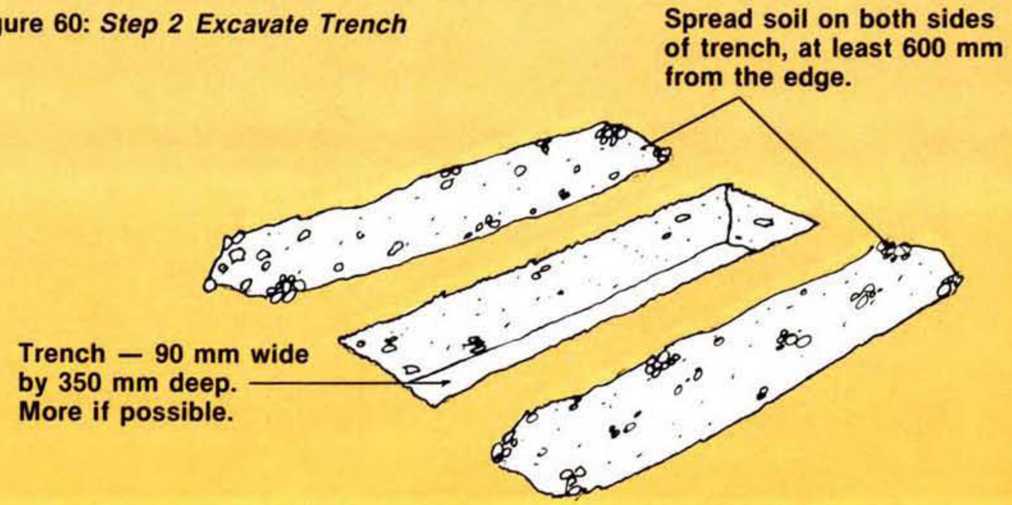


Figure 61: *Step 3 Construct Temporary Walls*

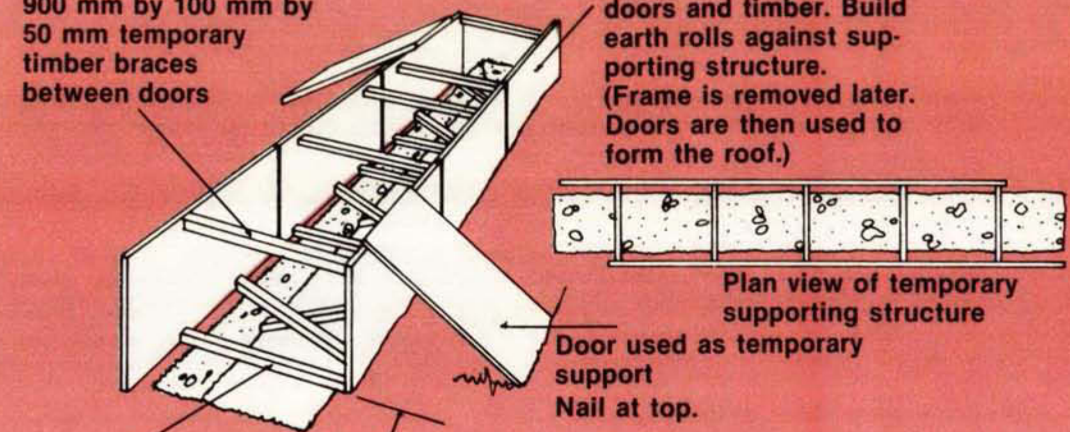


Figure 62: *Step 4 Position Sheeting Materials*

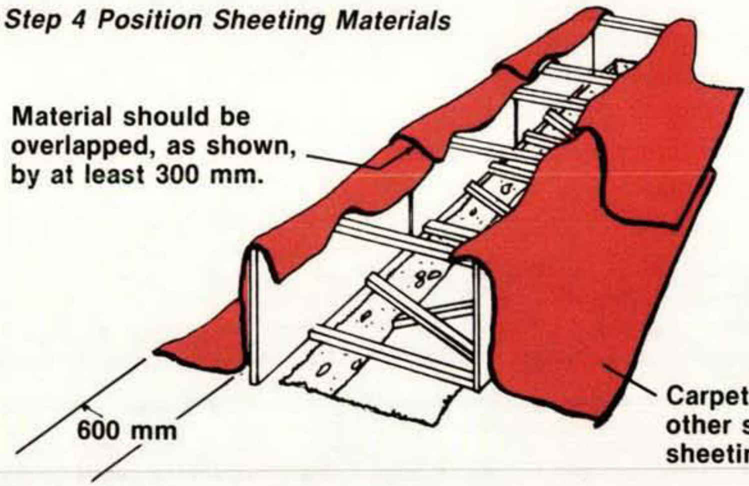


Figure 63: *Step 5*
Construction of Earth Rolls

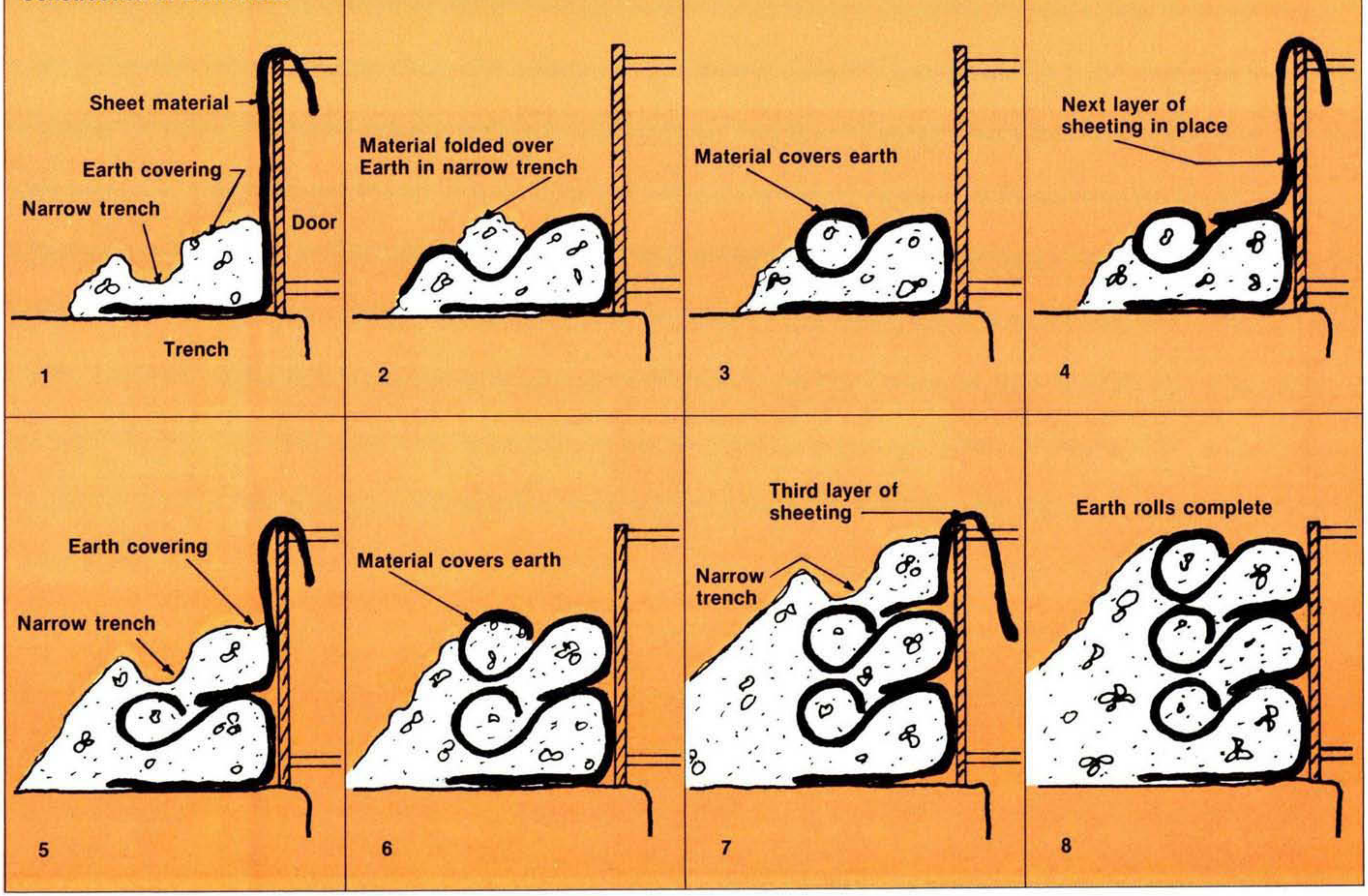


Figure 64: *Step 6 Remove Temporary Walls*

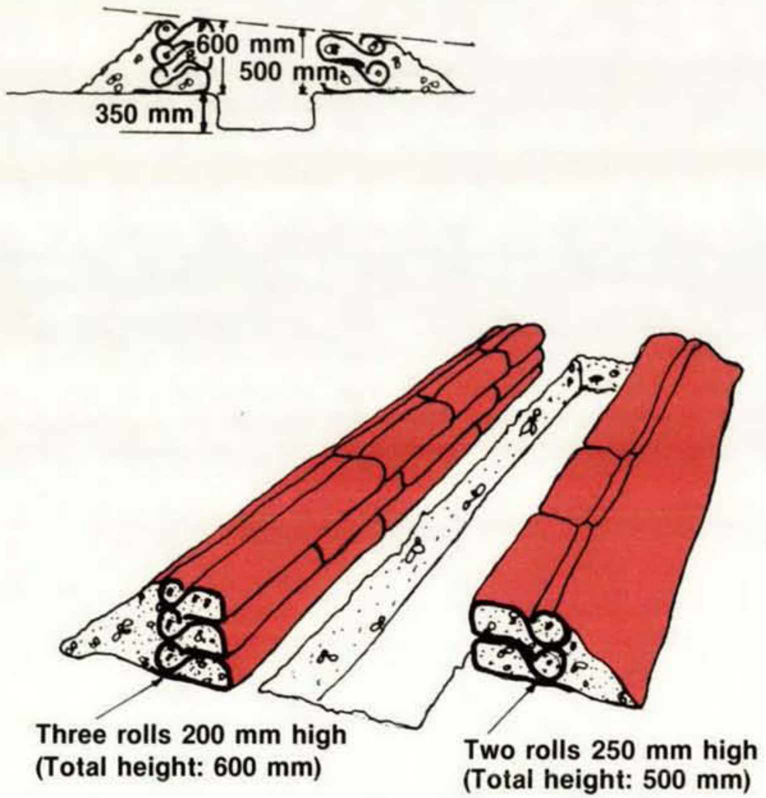


Figure 65: *Step 7 Build Entry/Exit Frames*

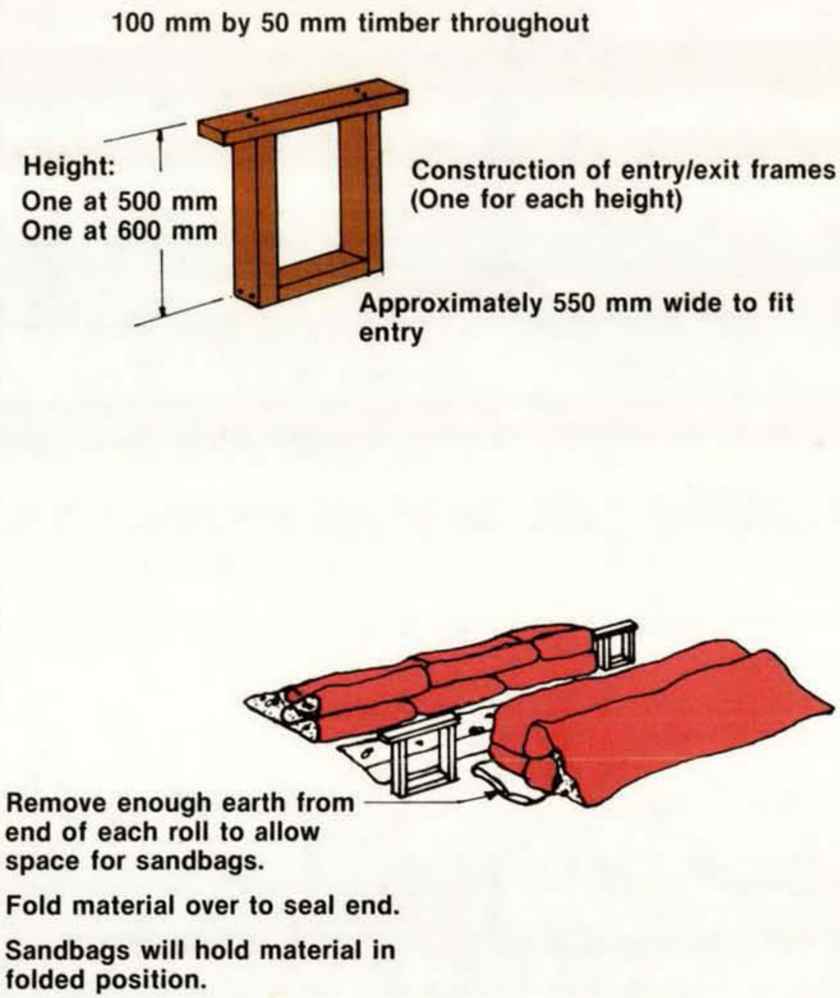


Figure 66: *Step 8 Build End Earth Rolls*

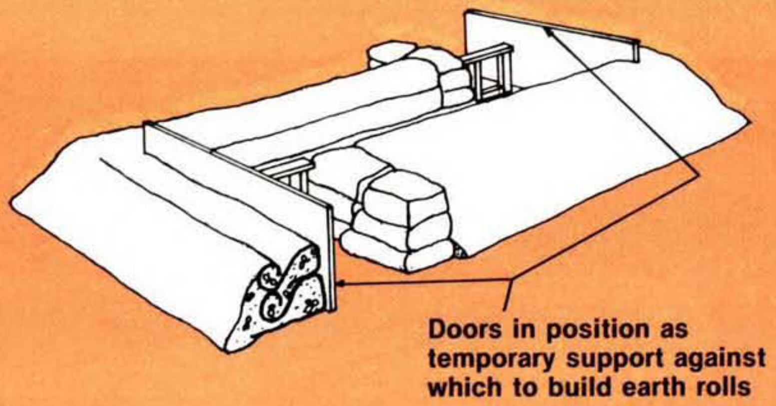


Figure 68: *Step 10 Position Doors and Waterproof Cover*

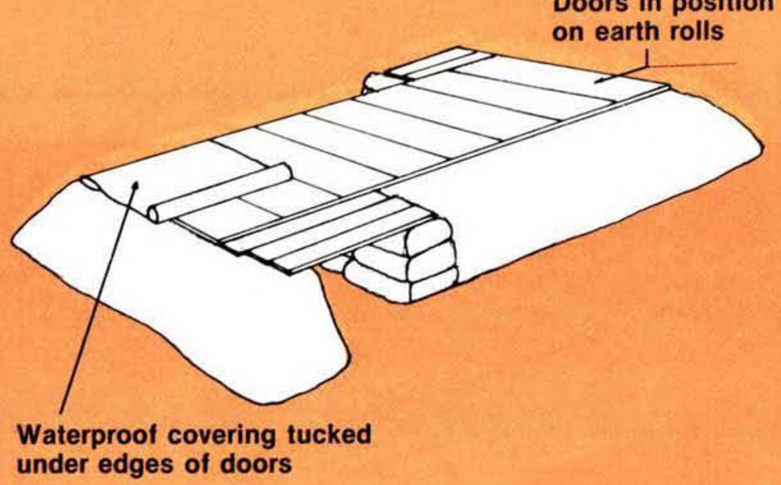


Figure 67: *Step 9 Assemble Entrance/Exit Covers*

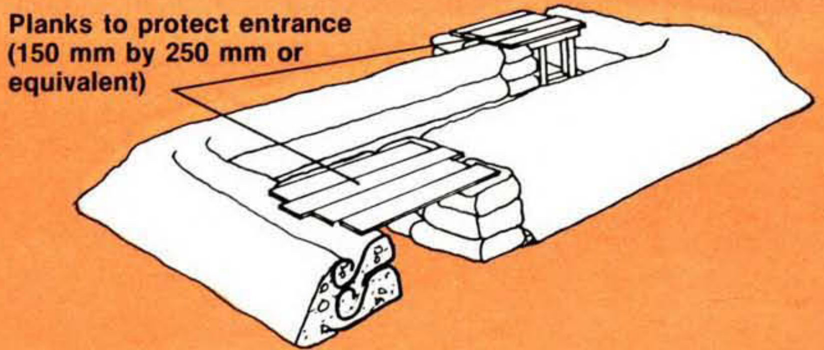
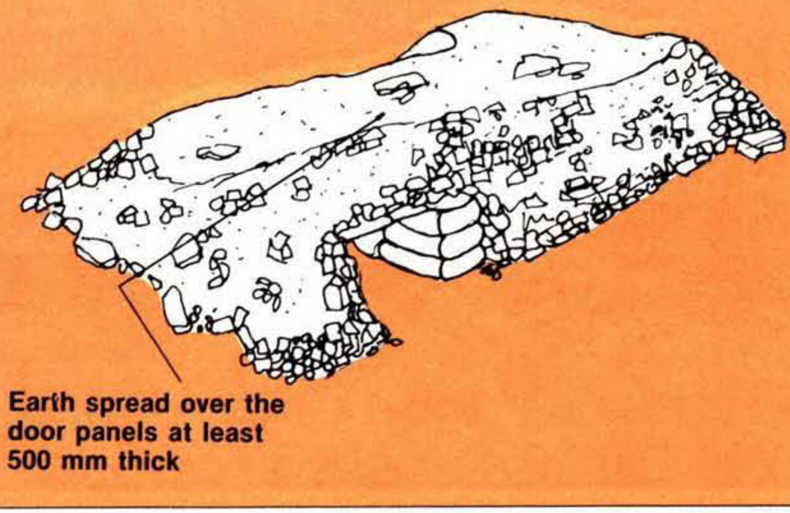


Figure 69: *Step 11 Finish Shelter With Earth Cover*



Action Guide

Now You Can

1. Build your shelter according to your plans.
2. Install the suggested items of equipment. Check them against the list at the end of this Chapter. Do you have all the essentials, particularly the shelter radio?
3. Store all the food, water, fuel, batteries, etc., that you will need. Arrange to use and replace them at the specified intervals.
4. Plan a family drill for occupying the shelter and practise it. (Remember, any adult or adolescent in your home may have to take charge of the situation at the time of an emergency.)
5. Plan a daily routine for shelter life.
6. Make preparations so that all basement windows can be quickly and effectively shielded in accordance with instructions in Chapter 2.
7. Keep the shelter warm and dry.

If Warning Comes

1. Turn on your home radio. Wait for instructions. You will be told when to go into your shelter.
2. If there is time — you will be told how much you have — do as many of the following tasks as you can, **in this order of priority:**
   a. Shield all basement windows;
   b. Move clothes and bedding, suitable for the season, into the shelter;
   c. Move as much furniture, books, magazines, papers, etc., as possible into the room above your shelter;
   d. Fill up any additional water containers that may be useful later on. These can be left outside the shelter for use when you are told it is safe to venture into the basement;
   e. Open an upstairs tap and turn off the water at the main shut-off valve.
   f. Take in any extra reading material, etc. you might need.

Go Into the Shelter

1. Last person in places toilet and garbage can in passageway.
2. Turn on the shelter radio. Listen for instructions.
3. Put daily shelter routine into effect.
4. Remain in the shelter until instructed to leave. (In most cases this will come via radio, but in some instances civil defence officials may notify you in person.)
5. Keep calm. Your family will look to you for leadership.

Shelter Supplies

*indicates desirable but not essential

Equipment

Beds (Bunks or folding)
*Table (Folding or other facility)
*Stools (Fold flat)
Cooking vessels
Cups and Plates (disposable)
Knives, forks, spoons
Can openers
Paper towels
Kerosene cooker
Kerosene Lamp
Electric Lamp and Batteries, spare bulbs
Flashlight
†40 L Kerosene (10 L in shelter; remainder in basement)
Matches
Garbage can (two if no waste water run-off is possible)
Garbage bags
Toilet
Polyethylene bags for toilet (two-week supply)
Shovel
Crowbar
Axe
Pocket knife
Whistle
*Saw
*Screwdriver
*Hammer
*Screws
*Nails
Pliers
Fire Extinguisher (non-carbon tetrachloride)
*12 mm Rope
String
Battery Radio
Clock
Spare Radio batteries
Hand basin
Candles
Duct tape (cloth)
Household bleach
*Small portable generator and exhaust hose

† Some home insurance policies specify a limit on volume of stored flammable liquids. CHECK YOUR INSURANCE POLICY.

Recreational

Calendar
*Books
Paper
Pencils
Playing cards
*Chess, checkers, other games
*Crossword, other puzzles
*Knitting, sewing, etc.
*Hobby materials

Toiletries

Soap, toothpaste, toothbrushes
Detergent
Nail brush/file
Razor, blades and soap
*Mirror
*Women's basic cosmetics
Tissues (face and toilet)
Face cloth
Towels
Brush and comb
*Shampoo

Personal

Bedding (blankets preferable)
Warm sweaters and socks
Change of underclothing and socks
Personal hygiene items for women
Baby clothes
Plastic bag for storing personal belongings
Baby feeding equipment
Disposable diapers (two-week supply)
Plastic sheeting
*Legal papers (if shelter is not at the residence)

Medical

A simple first aid box kept in your shelter or in your evacuation kit should contain:

1 bottle mild antiseptic solution
Use to clean cuts

2 - 5 m × 50 mm
gauze bandages

6 triangular bandages
Use for slings

12 - 72 mm × 72 mm
sterile gauze pads
Use to cover cuts, wounds and burns

4 - 200 mm × 200 mm
sterile gauze pads

12 assorted individual adhesive dressings
Use for minor cuts

2 large pressure pads (shell dressing type) 200 mm × 200 mm
(Available at minimal cost from St. John Ambulance Association)

5 m of 72 mm adhesive tape

12 assorted safety pins

1 small bottle toothache drops
For temporary treatment of toothache

1 tube of petroleum jelly

1 small bottle ASA (aspirin) tablets

1 thermometer

1 small scissors (blunt ended)

1 medicine glass

1 pair tweezers

115 g baking soda
Make a drinking solution by adding 15 mL. salt and 5 mL. baking soda to 1 L of water

1 first aid manual
St. John Ambulance Association

1 home nursing textbook
St. John Ambulance Association and/or Canadian Red Cross Society

1 box paper tissues

Note: Individuals requiring special medication, such as insulin, should maintain at least 100 days' supplies.

Food and Water

These are the requirements per person for 14 days. Canned foodstuffs should be used and replaced at least once a year. Check off the items as you stock them in the shelter.

Milk: 4 cans milk (454 g each, evaporated or dried skim milk)

Vegetables: 6 cans (426 mL or 568 mL cans - beans, peas, tomatoes)

Fruits: 6 cans (426 mL or 568 mL cans - peaches, pears)

Juices: 6 cans citrus juice (568 mL cans - apple, grapefruit, lemon, orange, tomato)

Cereals: 14 individual packages (sealed in wax bags inside or outside)

Biscuits: 2 packages crackers
2 packages plain biscuits (graham wafers, melba toast)

Main Dish Items:
2 cans meat (283 g - corned beef, luncheon meats)
2 cans beef and gravy
2 cans beans (426 mL or 568 mL cans - baked beans, pork and beans)
2 jars cheese
2 cans fish (240 g)

Canned and Dehydrated Soups:
2 cans (283 g - bean, pea, tomato, vegetable)
4 or 5 pouches dehydrated soups

Other Foods:
1 can honey
1 jar or can peanut butter
1 package tea bags
1 jar sugar
1 jar instant coffee
Salt and pepper
Jam, syrup, molasses, jelly
Chocolate powder
Chewing gum

The remaining fresh food in the house that requires minimum cooking such as fruits, vegetables and bread should be brought to the shelter at the last moment. Use this food during the first few days; it will spoil quickly without refrigeration.

Water

Requirement:	56 litres for each member of the family. Some water may be replaced by canned or bottled beverages.
Containers:	Store in clean, tightly covered containers such as large thermos jug, new fuel cans, large vinegar bottles, etc.
Change:	Change the stored water at least once a month.

Special Requirements for Children

- For each infant include 14 cans evaporated milk - 454 g each, and infant food for 14 days.
- For each child up to three years, include 8 extra cans of milk.

Glossary

Words set in Small Caps are defined elsewhere in the Glossary.

Air Burst. The explosion of a nuclear weapon at such a height that the fireball does not touch the earth. Such bursts do not create much fallout.

Alpha Particle. A relatively heavy, positively charged particle emitted by some radioactive elements. It is identical with the helium nucleus, having the same mass and electric charge.

Beta Particle. A relatively light, negatively charged particle emitted by some radioactive elements. It is identical with an electron moving at a high velocity.

Certified Fallout Shielding Analyst. A person, usually a professional engineer or an architect, certified by Public Works Canada as being capable of analysing the protection afforded by existing structures, and designing appropriate and reliable fallout shelters. Such people are required to participate in an authorized course of instruction and to pass an examination before being certified. A certified shielding analyst will willingly show you his certification. If he does not offer it, ask to see it.

The names and addresses of certified fallout shielding analysts are available from Public Works Canada, Directorate of Emergency Preparedness, Ottawa, Ontario K1A 0M2, or from Public Information, Emergency Planning Canada, Ottawa, Ontario, K1A 0W6.

Civil Defence. A function of government, and the activities of delegated agencies at all levels, dealing with plans, preparations, and organization for those emergency measures that are primarily related to the survival of the population during the period of an emergency arising from war or a peacetime disaster.

Enhanced Protection. A Protection Factor of 100

Fallout. Particles of earth and debris, which, contaminated by radioactive material during a nuclear explosion, rise in the air, are scattered, and eventually fall back to earth.

Gamma Radiation. Electromagnetic radiations of high energy emitted from the nuclei of certain unstable atoms. Physically, gamma rays are identical with x-rays of high energy.

Lateral Protection. Protection against the penetration of Gamma Radiation through walls

Mass Thickness. A measure of the capacity of a given thickness of material to reduce the penetration of Nuclear Radiation. It is expressed as mass per unit area.

Nuclear Radiation. Spontaneous particulate and electromagnetic radiation emitted from atomic nuclei of a radioactive element. The important nuclear radiations from a weapons standpoint are Alpha and Beta Particles, Gamma Rays, and neutrons.

Overhead Protection. Protection against penetration of Gamma Radiation through roofs and ceilings

Protection Factor. A number used to express the relative amount of protection afforded by a structure against Fallout Gamma Radiation.

Radioactive. Giving off, or capable of giving off, radiant energy in the form of particles or rays, as Alpha and Beta Particles and Gamma Rays, by the spontaneous disintegration of atomic nuclei.

RADIOACTIVITY. Process whereby certain nuclides undergo spontaneous disintegration in which energy is liberated, generally resulting in the formation of new nuclides. The process is accompanied by the emission of one or more types of radiations, such as ALPHA PARTICLES, BETA PARTICLES, and photons (electromagnetic radiation).

REGISTER OF CERTIFIED FALLOUT SHIELDING ANALYSTS. A list, maintained by Public Works Canada, of all certified fallout shielding analysts, together with their registration number and address. Section 1 of the register lists analysts in alphabetical order; Section 2 groups the list by Province. Information on shelter analysts in the Register may be obtained by writing to the Director Emergency Preparedness, Public Works Canada, Ottawa, K1A 0M2, or to Public Information, Emergency Planning Canada, Ottawa K1A 0W6.

SHIELDING. Any material or obstruction that absorbs nuclei or THERMAL RADIATION and tends to protect people or materials from the effects of a nuclear explosion

SHIELDING ANALYST. See CERTIFIED FALLOUT SHIELDING ANALYST, above.

STANDARD PROTECTION. A PROTECTION FACTOR of 50

SURFACE BURST. A nuclear burst in which the fireball touches the surface of the land or water

THERMAL RADIATION. The heat rays emitted by the fireball in a nuclear explosion

Bibliography

Glasstone, S., and Dolan, P.J. 1977. *The Effects of Nuclear Weapons.* Third edition. Washington: United States Department of Defence and United States Department of Energy.
This is the standard textbook on the effects of nuclear weapons. It is available in paperback from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Specify stock number 008-046-00093-0 when ordering.

Home Office. 1982. *Domestic Nuclear Shelters. Technical Guidance.* Second edition. London.
Available from the Government Bookshop, 49 High Holborn, London, WC1V 6HB, U.K.

Kearny, C.H. 1980. *Nuclear War Survival Skills.* Aurora: Caroline House Publishers Inc.
Available for $U.S. 12.95 prepaid by writing to the Publisher at 920 West Industrial Drive, Aurora, Illinois 60506.

Public Works Canada. 1978. *Manual of Shielding Analysis.* Ottawa.
A technical handbook prepared for practicing engineers and architects involved in the analysis and design of fallout protection. Available by writing to Public Works Canada, Sir Charles Tupper Building, Ottawa, Ontario K1A 0M2.

Spencer, L.V., Chilton, A.B., and Eisenhauer, C.M. 1980. *Structure Shielding Against Fallout Gamma Rays from Nuclear Detonations*. Washington: NBS Special Publication 570.
Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Specify stock number 80-600120, CODEN: XNBSAV when ordering.

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