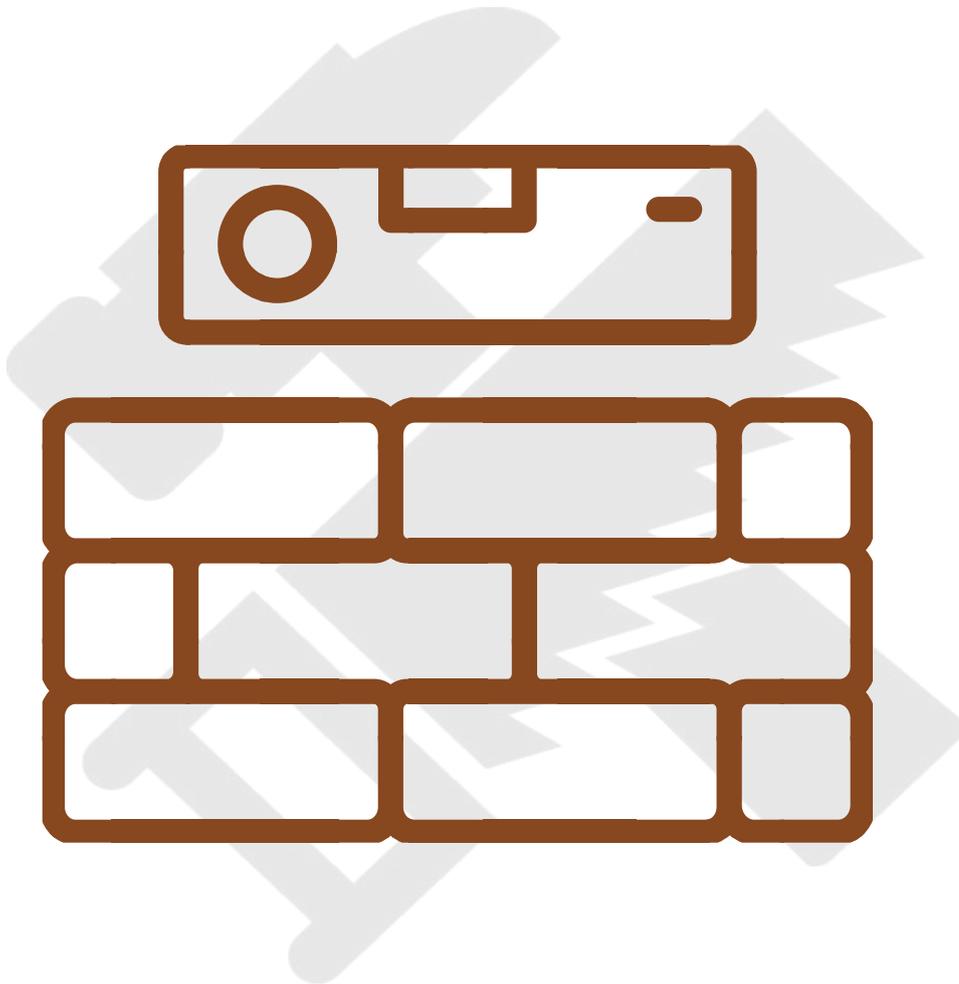


BCATS

BUILDING, CONSTRUCTION
AND ALLIED TRADE SKILLS

Retaining wall



Unit Standard 12939 (v5), Level 2

Construct a basic retaining wall
as a BCATS project. 4 CREDITS

BCITO
buildingpeople

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(BCITO)**

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Introduction

This handbook is an introduction to different types of retaining walls and their construction methods.

There are a number of ways to construct retaining walls. The type of material being used largely determines which way is best. Materials often used in retaining walls include:

- precast concrete block
- timber post and rail
- timber or concrete crib
- mortared stone
- poured concrete or concrete block.

Your teacher/tutor will decide what type you will construct and provide you with more detailed information if needed.

Remember:

The construction methods detailed in this handbook are an example only. There are different processes, equipment, machinery, and tools that could achieve the same or similar outcome. Your teacher/tutor will provide you with guidance on these for your particular retaining wall.

How you will be assessed

You need to construct a retaining wall between 350mm and 1m high, with a total length of not less than 1.2 metres.

Your teacher might give you a work diary to help you record how you make it. If you can, take photos of your project, including a photo of it completed.

You will need to:

- calculate the quantities of materials needed correctly
- prepare an order for materials
- set out and excavate the retaining wall foundation
- construct and finish the retaining wall to an acceptable standard
- complete everything safely
- keep your work area clean and tidy
- clean and store tools, plant and equipment correctly.

Glossary of terms

Term	Meaning
Batter	The angle that a retaining wall makes with the vertical in order to resist the weight of the retained material – generally in a ratio of 1:4.
Course	A row of bricks or blocks.
Field drain	A system to collect and redirect water away from the base of a retaining wall.
Filter fabric	A cloth which filters out fine particles of backfill when laid over the drainage, preventing blockage of the system.
Footing	The bottom section of a retaining wall.
Granular fill	Clean gravel fill which is placed behind a retaining wall, allowing the water to flow down into the drainage system.
Hydrostatic pressure	The force applied by water behind a retaining wall. The pressure is reduced by using granular fill and drainage.
Low retaining wall	Any wall which provides stability and holds earth, rock etc. (up to 1.5m above ground level).
Plant	Equipment.
Weep holes	Holes through the bottom of a retaining wall to provide drainage.

Health and safety

The Health and Safety at Work Act 2015 is designed to:

- prevent harm to employees at work
- promote good practices in health and safety management.

The Act puts responsibilities on everyone to take all practical steps to ensure your own safety and the safety of others.

One way you can help ensure your own safety is to use personal protection equipment (PPE). For this project you will likely need to use:

- hearing protection
- safety boots or covered shoes
- gloves
- dust masks
- safety glasses (even if you wear prescription glasses, you must still use safety glasses)
- apron or overalls.

The machinery and other equipment you use could cause serious injuries. You **must** use appropriate guards and safety devices. You **must not** use any machine without the safety guards fitted correctly. You **must** receive training in the use of machines and equipment and apply it when you use them.

Before using a machine or portable power tool, check to see if all cords are in good condition. Also check that the compliance tags are current. When working outside always ensure a residual current device (RCD) is used, no matter what the weather conditions are.



RCD being used for outside work

Retaining walls overview

Retaining walls perform heavy and important work. As well as holding up unstable banks, retaining walls can terrace a sloping section to provide a level garden, lawn or paving area.

It is unlikely the retaining wall your teacher decides you'll make will require a building consent. It is good to know when one is needed, though. The following retaining walls require a building consent, and may also require an engineer's design:

- walls over 1.5m high
- walls lower than 1.5m but carrying extra loading on top, such as a driveway, a building or a steeply sloping bank.

For any construction job you carry out, it's important to:

- select and use appropriate personal protective equipment
- use tools correctly and safely
- clean the work area and dispose of waste
- clean, store and maintain tools correctly.

For any product or tool you use, make sure you read and understand any manufacturer's instructions that come with it before you start using it.

Vertical or sloping walls?

An important consideration when designing a retaining wall is to slope the posts towards the top of the bank. This is shown in the image to the right. In building terms, this is referred to as the 'batter', which should be no less than a 1:4 ratio

This ratio is preferred because the pressure from the soil behind will be attempting to push the top of the wall towards a vertical position. If the retaining wall is already vertical, the pressure can force the wall to bend outwards. This force can cause the wall to collapse, which is often referred to as a 'blowout'.

There is not as much of a risk of this happening when the walls are lower. Most of the photos in this handbook show lower vertical retaining walls. However, even low ones could be designed to the batter ratio – the extra work at the build stage will keep it upright for longer.



Good preparation

The area where you are building the retaining wall needs to be cleared of plant material and rubbish before excavation. If you are planning a thick wall construction, such as precast concrete block, crib or mortared stone, you will need to clear and excavate more than if it is a timber wall.

Good foundations

While the whole wall has to be strong enough to support the load pressing against it, it is the part below the ground that anchors it. No matter how sturdy the upper part of a wall is, there is nothing stopping the wall from collapsing if the footings or foundations are weak.

Good drainage

When an inclined area of soil or clay becomes waterlogged, it can become unstable. Retaining walls therefore need a way to drain water out of the bank behind. If a retaining wall does not drain effectively, it will eventually collapse. The build-up of water is known as hydrostatic pressure. The pressure is able to be reduced by using granular fill and drainage.

Drainage on any type of retaining wall should use slotted drain coil or weep holes at the base of the wall. Free draining gravel is then placed on top to within 300mm of the top of the wall.



The slotted drain coil should be so the collected water can drain away effectively.

Both ends should go beyond the end of the wall to allow the tube to be flushed out with a garden hose occasionally.

Preparing an order for materials

You will need to use the drawings and specifications your teacher gives you to calculate the quantity of materials needed for the wall you're building. The types and quantities of materials will depend on:

- the construction method being used;
- the design drawings and specifications;
- the finished height and length of the wall; and
- any allowance for wastage, for example, if a material is only available in a fixed length.

When placing an order with a supply merchant for building materials, the following information is needed. This will ensure that the right materials are supplied to the right place at the right time, and the correct information is supplied for budget and accounting purposes.

The order should be clearly written or typed, and include the following information:

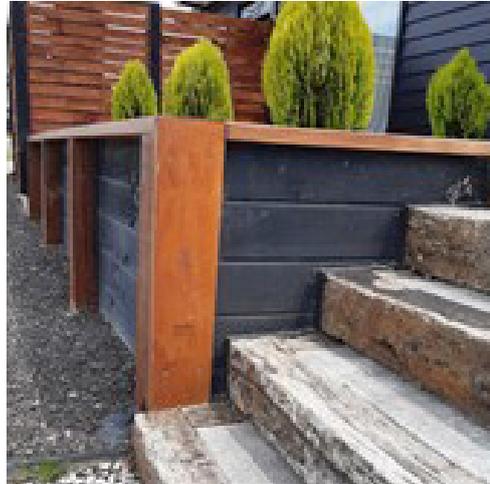
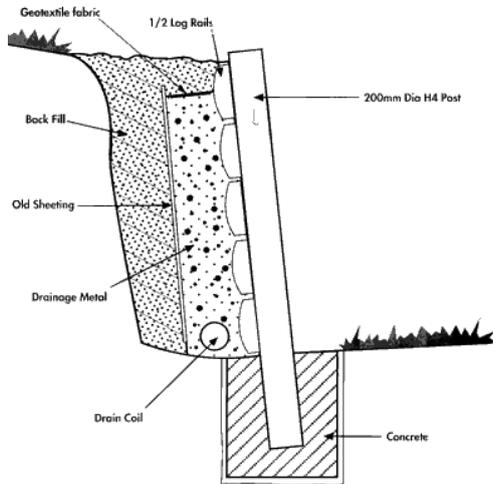
- date of order
- customer's name account number and billing address
- job identification or number
- order number
- supply merchant's name
- description of goods required and quantity
- address where the order should be delivered
- date and time required
- any other delivery details
- authorised purchaser's signature.

Send the order to the supplier allowing enough time for them to prepare and deliver it. (You should also keep a copy of the order for your records.) It's a good idea to follow up with a phone call if you don't receive confirmation that the order has been received.

Note:

A template for an order form is available in the resources for your use. Your teacher will ask you to use this or another one.

Timber post and rail



Timber post and rail is probably the most common type of retaining wall construction. Poles or posts are embedded in the ground to act as a cantilever and provide stability to prevent overturning, Horizontal rails are then fixed to the inside of the posts.

What tools and equipment will I need?

What tools you will need to use will depend on the type of retaining wall you're constructing. This timber post and rail example used the following.

LIST OF TOOLS AND EQUIPMENT USED FOR SHOWN EXAMPLE

Hand tools	Portable power tools	Equipment
→ measuring tape	→ circular saw	→ sledgehammer
→ square		→ concrete mixer or wheelbarrow
→ pencil		
→ string line		
→ spade or post hole borer		
→ shovel		
→ hammer		
→ spirit level		

Depending on your school's policy, you might not be able to use the circular saw. If this is the case, pay careful attention to your teacher using it. Hand saws are a handy alternative when circular saws aren't available.

Remember that the processes and machinery you use may be different from the ones used in these example projects.

Timber post and rail

Materials

Materials commonly used in timber post and rail walls include:

- H5 posts
- H4 rails
- Concrete
- Nails – 100/125mm and 150mm galvanised or, if close to the ocean, stainless steel
- Plastic drain coil
- Drainage gravel
- Geotextile fabric
- Bracing timber, pegs, and nails.

Construction overview

The vertical posts are treated to H5, and normally have concrete compacted around them. The depth and spacing of the posts must be to the manufacturer's design details, and depend on:

- soil type being retained
- wall height
- wall loadings.

Posts for a low retaining wall must go into the ground 100mm for every 100mm above ground, up to a wall 1.2m high. The spacing of the posts can vary from 0.900m to 1.800m depending on the size of the horizontal rails.

Horizontal rails are treated to H4, and can be half rounds, 50mm timber plank, tongue and groove, or a combination of these.

Construction process

The process used for most timber post and rail retaining walls is below. Your teacher/tutor may have slightly different ways of doing things.

1. Decide where the wall is to be located. Check that there is enough space behind the wall to attach the rails and for drainage – at least 250 to 350mm. The bank may need to be cut back to provide enough room.
Make sure the ground at the base of the wall slopes towards the end where the water is to be drained.
2. Set out the line of the wall.
3. Set out the post spacing as required by the specific design.
4. Excavate the post holes to the depth required by the specific design.
5. Place 100mm of concrete in the two end holes and set the posts on top.
Make sure only uncut post ends go into the holes. Cut post ends do not have the same protection from moisture as uncut ends and will rot. Use a timber preservative to restore protection to cut ends if you have timber with two cut ends.
6. Brace posts in position.
7. Fill the two end post holes with concrete. Tamp concrete down during placing to ensure it is well compacted.
8. Run string lines top and bottom between the two end posts.
9. Place the intermediate posts and position to the string lines. Plumb from the front and brace the posts.
10. Concrete the intermediate posts in the same way as the end posts.
Allow at least 48 hours for the concrete to gain strength. (The concrete must have enough time to set before any pressure is placed on the wall.)

Timber post and rail

11. Starting at the bottom of the wall, nail the horizontal rails to the back of the posts.

Any joins in the rails should be made on the posts.

Check, with a spirit or laser level, that the bottom rail is level before nailing the horizontal rail in position. This will give you confidence the string line was set correctly.



12. Construct the wall to the required height and trim the post tops. Often a circular saw is used to cut mid-way through the post before finishing with a hand-saw before fitting the horizontal capping rail. Do not use the circular saw yourself if this is against school policy. Handsaws are a bit slower but do the job.



13. Place a 50mm layer of clean free-draining gravel along the bottom at the back of the wall.
14. Lay drain coil on top of the gravel. Remember to extend the drain coil past both ends of the wall so it can be flushed with a garden hose from time to time.
15. Place clean, free-draining gravel to within 300mm of the ground surface at the top of the wall. (In some situations, it may be easier or necessary to place the gravel as the wall is being constructed).
16. Place the geotextile fabric over the gravel to prevent the topsoil filtering down into the gravel and drainage system.
17. Place topsoil as required.

Precast concrete block

Precast concrete block walls are constructed on a compacted base course or a concrete foundation. The blocks are laid in interlocking courses, with each course stepped back.

Precast blocks are manufactured in a range of shapes, textures and colours. Some types are hollow and can be filled with soil as the wall is constructed. Other types allow the wall to be built in concave or convex curves.

Because each type of block is different, it is very important to read and follow the manufacturer's instructions. These instructions should include:

- foundation type
- instructions for constructing the wall
- maximum height
- amount each course needs to be stepped back.



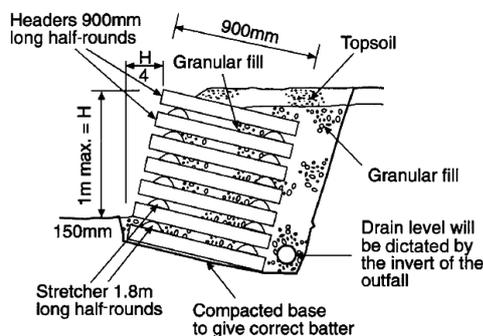
Keystone wall with internal fibreglass rods to keep individual stones in position.

Timber or concrete crib

Crib walls are a type of gravity wall that can be used for low and high retaining walls. They usually use a proprietary system that consists of header and stretcher units locked together to retain granular fill. This provides weight to the system and prevents the wall overturning. They can be constructed on foundations of concrete, compacted fill, or sleepers.

Timber

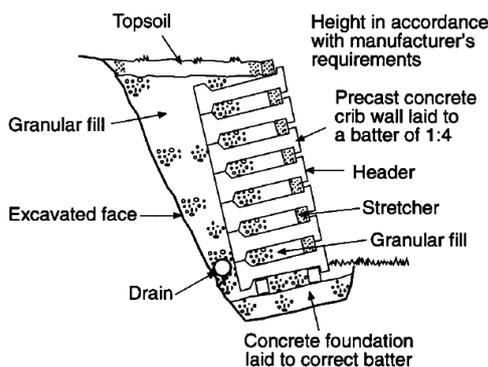
Timber crib walls up to 1m high can also be constructed in H5 half-round posts.



Retainer wall max 1m high constructed with H5 treated half round timber

Concrete

Concrete crib walls are constructed from precast interlocking units with varying patterns and sizes.



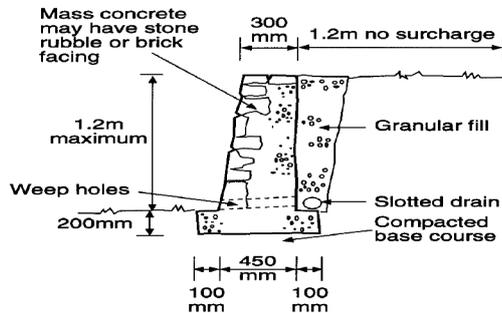
Proprietary concrete crib walling

The maximum height for a crib wall depends on several factors. These factors include:

- the type of ground that needs containing
- type of backfill used
- the efficiency of site drainage.

Manufacturers' recommendations for each situation and instructions for constructing the wall should always be read and followed.

Mortared stone

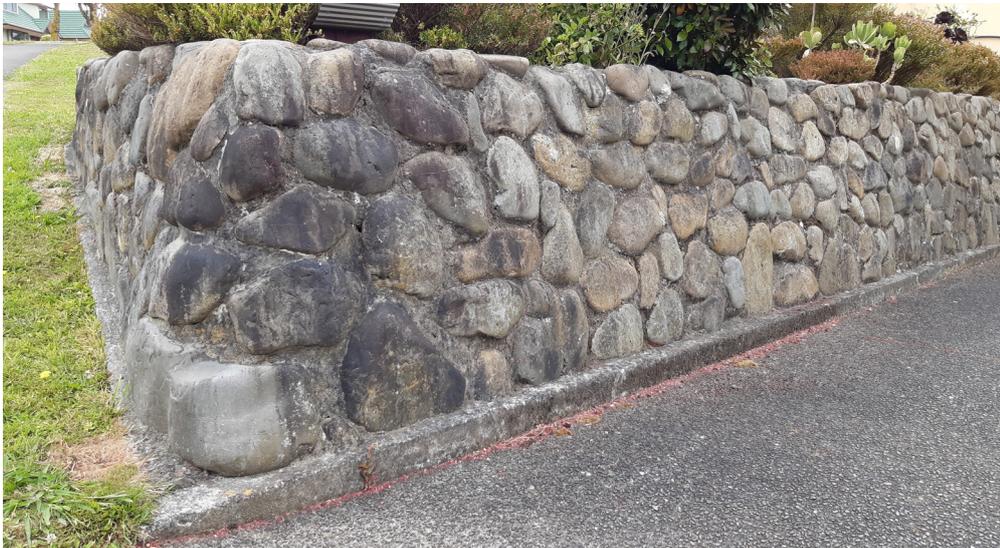


Mass concrete or rubble gravity retaining wall

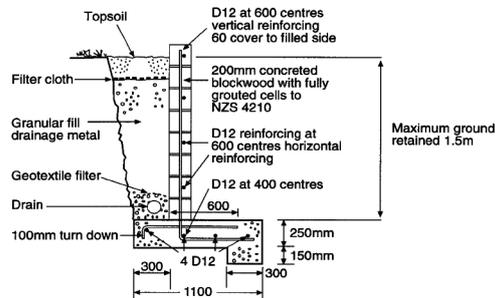
Mortared stone walls rely on their weight and a low height to width ratio for stability against overturning or horizontal slipping.

This type of wall can be constructed on a compacted base course in mass stonework, concrete or a combination of both.

Stone walls should be designed and built by experienced designers and contractors.



Poured Concrete or Precast Concrete Block



Concrete block retaining wall for clay soil

Poured concrete or precast concrete block retaining walls are stabilised by using a wide T or L shaped footing. The footings are crucial to the strength of the wall.

Poured concrete or precast concrete block retaining walls need steel reinforcing and must be built to Building Code standard, even if a building consent isn't required.

Both types of concrete retaining walls should be designed and built by experienced designers and contractors.



