

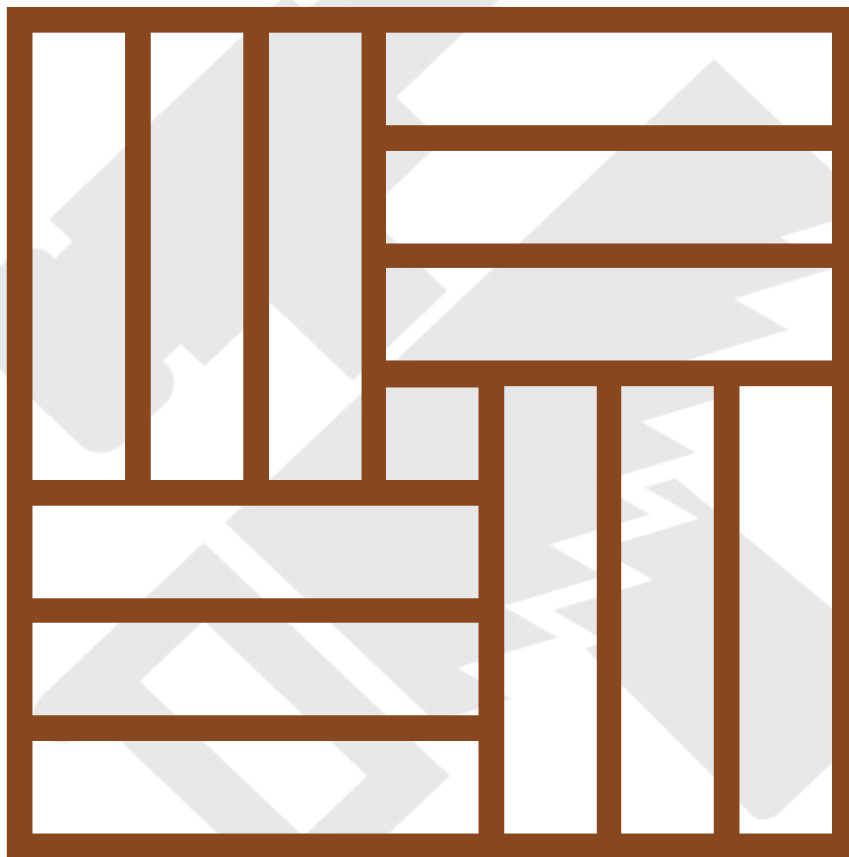


**BCATS**

BUILDING, CONSTRUCTION  
AND ALLIED TRADE SKILLS

# Paving

---



**Unit Standard 12938 (v5), Level 2**

---

Lay paving blocks  
as a BCATS project

**4** CREDITS

**BCITO**  
buildingpeople

**Building and Construction Industry Training Organisation  
(BCITO)**

---

**Level 5, 234 Wakefield Street  
PO Box 2615  
Wellington 6140  
0800 422 486  
[www.bcito.org.nz](http://www.bcito.org.nz)  
© 2020 BCITO**

All rights reserved.

No part of this work may be reproduced, adapted, modified, copied or transmitted in any form or by any means, including by way of example only, written, graphic, electronic, mechanical, reprographic, photocopying, recording, taping or information retrieval systems, without the written permission of the publisher.

# Table of contents

	Page
<b>Introduction</b>	<b>4</b>
<b>How you will be assessed</b>	<b>5</b>
<b>Glossary of terms</b>	<b>6</b>
<b>Health and safety</b>	<b>7</b>
<b>Paving overview</b>	<b>8</b>
<b>Paving project overview</b>	<b>9</b>
<b>Common resources</b>	<b>10</b>
<b>Calculating quantities</b>	<b>11</b>
<b>Preparing an order for materials</b>	<b>13</b>
<b>Excavating</b>	<b>14</b>
<b>Laying paving</b>	<b>16</b>
<b>Project 1 - Outdoor teaching area</b>	<b>19</b>
<b>Project 2 - Paved curved paths</b>	<b>23</b>

# Introduction

This handbook uses two projects as examples of common processes and techniques for laying paving areas. The examples are:

- an outdoor teaching area
- paved curved paths.

Your teacher/tutor will decide what paving project you will be doing. Because paving projects are ideal for group work, you may have the opportunity to brainstorm as a class to come up with ideas and opportunities for your school or community environment.

**Remember:**

The projects, materials, and construction methods detailed in this handbook are examples only. Your teacher/tutor will provide you with guidance specific to your paving project.

# How you will be assessed

You need to show your teacher/tutor that you can follow or adapt designs to construct a paved area of no less than one square metre.

Your teacher/tutor might give you a work diary to help you record how you did your project. If you can, take photos at different stages of the paving process and of the completed project.

You need to:

- calculate the quantities of materials needed
- prepare an order for materials
- excavate the area to be paved as per the project documentation
- lay and compact base course and sand as per the project documentation
- lay, compact and finish paving as per the project documentation and manufacturer's instructions
- complete all tasks safely
- keep your work area clean and tidy
- clean and store tools and equipment correctly.

# Glossary of terms

Term	Meaning
Aggregate	A combination of sand and gravel or crushed rock used to make concrete.
Base course	A compacted layer which provides a solid foundation for paving.
Bedding layer	A sand/crusher dust bedding course providing a base for pavers.
Bulking factor	The volume increase of excavated material in relation to the excavation volume from which it came.
Edge restraints	Term used for the material support to prevent sideways movement e.g. timber formwork, proprietary edging products, PVC strip (concealed below ground), etc.
Geotextile fabric	A cloth which filters out fine particles of backfill when laid over the drainage preventing blockage of the system.
Haunching	A layer of mortar or concrete placed against the outside row.
Joint sand	Fine sand – swept into paving joints to ‘lock up’ all paving into one solid mass.
Screed	A straight edge used to level concrete, sand/crusher dust, plaster etc.



Ara Trades Academy students laying out their tukutuku-inspired paving design.

# 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
- 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 can 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.



Your teacher/tutor will give you all the operating and safety knowledge you will need to use all the new tools and equipment you will be using



**Do not use any tools or equipment until your teacher/tutor tells you are safe to do so.**

# Paving overview

Pavers are used for paths, patios, courtyards and driveways. One of the many advantages of pavers over poured concrete is that they can be laid in stages and lifted if drains, cables or pipes underneath need servicing.

## Materials

Pavers are manufactured in clay and concrete, in a range of shapes, sizes and strengths. Shape and size should suit the area being paved. Strength should suit the weight of traffic, from pedestrian use, to light vehicle traffic, to heavy vehicles.

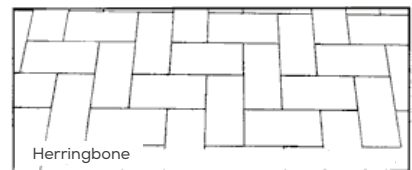
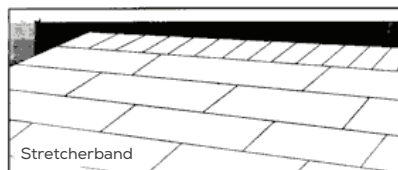
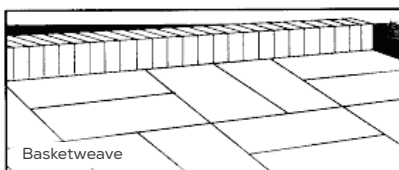
Base course material should be crushed rock with particles of different sizes. It should not contain any soil or plant material. No particles should be more than one third of the thickness of the required base course layer. For example, if the base course layer is 75mm, no particles should be bigger than 25mm across.

If the sub-grade is very soft (such as clay), lay geotextile fabric first to prevent the sub-grade pushing through the base course material. Bedding sand can be crusher dust or coarse river sand (not beach sand), which should be damp but not wet.

Jointing sand should be fine dry plaster sand with angular particles that lock well together. Some types incorporate a weed preventative. It is also sold as paving sand and pave lock.

Special sealers are also available to protect paving.

## Laying patterns



The laying pattern should suit the type of paver chosen and the area being paved. Options include 45° herringbone, stretcher bond, basket weave and soldier courses along the edges.



# Paving projects overview

The examples in this handbook were constructed by Kaiapoi High School Level 2 BCATS students with the support of their teacher, School Principal, Board of Trustees, and community. These projects show the possibilities of how impressive many square meters of individual paving projects can look when everyone works together to bring a big paving project to life.

Your paving project will no doubt look quite different from the examples but the principles of laying quality paving remain the same.

To produce good workmanship, follow the plans and instructions carefully at every stage of your project.

1. Make sure you understand the drawings and specifications. If you aren't sure, ask your teacher/tutor.
2. From the drawings and specifications, identify and select the correct materials.
3. Calculate the depth required to allow for the compacted hardfill, bedding material and the paver thickness.
4. Excavate the area required. (Handy tip: it is always good to excavate before ordering compacted hardfill in case the excavation depth changes for unforeseen reasons.)
5. Calculate quantities of materials required and make up an order.
6. Lay hardfill, bedding material and pavers.
7. Apply grouting material and sealer coat if required.

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

- choose and use appropriate personal protective equipment (PPE)
- use tools correctly and safely
- keep the work area clean and dispose of waste
- clean, store and maintain tools, plant and equipment correctly.

# Common resources

## Getting started

The first step is to get the job specifications and a drawing from your teacher/tutor. These will include the size and design of the paving project/s and the materials to be used. Alternatively, your teacher/tutor may give you the opportunity to develop or help develop these drawings and specifications.

## What tools and equipment will I need?

You will need to use a wide range of hand tools, portable power, and fixed machinery. The actual range will depend on the approach taken as well as the resources available.

### A LIST OF TOOLS AND EQUIPMENT USED IN THE OUTDOOR TEACHING SPACE EXAMPLE

Hand tools	Portable power tools	Machinery
→ tool belt	→ tools: saber saw	→ concrete mixer
→ builder's ruler	→ jig saw	→ plate compactor
→ tape measure	→ battery drill	→ compound saw
→ carpenter's pencil	→ impact driver	
→ claw hammer	→ electric planer	
→ combination set	→ wet skill saw	
→ square	→ angle grinder with	
→ roofing square	→ diamond dry wheel	
→ cross cut saw		
→ sledge hammer		
→ spirit level		
→ string line		
→ spade		
→ shovel		
→ crow bar		
→ rake		
→ timber screed *		
→ a stiff broom.		

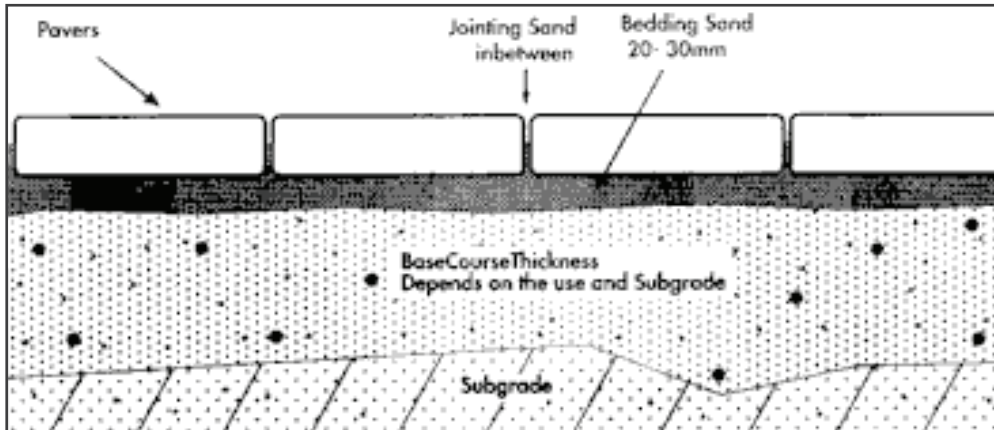
\* (notched to tile thickness less 3mm for compaction allowance)

**Depending on your school's policy, you might not be able to use some machinery and portable power tools on your own, such as the wet skill saw. If this is the case, you must still set up the machine for your teacher/tutor to use and be on hand to talk the tutor/teacher through how to use it as though you were using it yourself.**

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

# Calculating quantities

Draw a scaled plan of the area you want to pave. You can calculate the quantities of the various materials you need from this plan.



Quantities of base course material and bedding sand are calculated in volume of cubic metres ( $m^3$  – i.e. length x width x depth). You will need to allow a bulking factor for bedding sand and base course material so that you achieve correct depth once they are compacted. The supplier can tell you what percentage to allow.

Paver quantities are calculated in area of square metres ( $m^2$  – i.e. length x width). Divide the total area by the area of a single paver to work out the number of pavers you need. If any pavers need to be cut because of the laying pattern, allow for some wastage and order a few extra pavers.

Jointing sand is generally sold pre-packed. Follow the manufacturer's instructions on the bag to calculate how much is required.

## Example

Calculate the volume of materials required for the following:

Area to be paved measures 5.4 metres x 2.1 metres

Base course laid to depth of 150mm

Bedding sand laid to depth of 30mm

Pavers measure 150 x 150 x 40mm

Total depth of excavation = combined height of bedding sand, base course and paver (150 + 30 + 40mm) = 220mm.

## Calculating quantities

### Calculations

---

<b>Base course (m<sup>3</sup>)</b>	= (l x w x d) + bulking factor = (5.400 x 2.100 x 0.150) + 15% = 1.701 + 0.255 = 1.956m <sup>3</sup>
<b>Bedding sand (m<sup>3</sup>)</b>	= (l x w x d) + bulking factor = (5.400 x 2.100 x 0.030) + 5% = 0.340 + 0.017 = 0.357m <sup>3</sup>
<b>Pavers (total needed)</b>	= total area ÷ paver area = (5.400 x 2.100) ÷ 0.150 x 0.150 = 11.340 ÷ 0.0225 = 504

---

When ordering materials, you also need to consider that some materials may only be available in particular amounts. In the example above, you may need to round the quantities up to order 2m<sup>3</sup> of base course material and 0.4m<sup>3</sup> of bedding sand.



# Preparing an order for materials

Buy all your pavers from one outlet, and from the same batch if possible. This avoids differences in colour that can result from different batches. If you have to buy from more than one batch, mix the pavers up before laying.

Storage of all the paving materials can be a problem, particularly if the site is small. It may be a good idea to excavate first, then re-check the amount to order and lay base course material, then order and lay the paving sand and pavers.

You need to provide the following information when placing an order with a supply merchant for building materials. The order should be clearly written or typed, and include the following information:

- date of order
- customer's name and billing address
- customer account number
- 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 with enough time for them to prepare and deliver it. Keep a copy of the order for your records. It's a good idea to call them if you don't receive confirmation that the order has been received.

**Your teacher/tutor will give you a template of an order form for you to complete once you have calculated what quantities of materials are needed for your project.**

# Excavating

The area must be excavated to the correct level before you start paving.

## Calculating the amount of excavated material

Depending on the area being paved, the amount of material excavated can be significant. It then needs to be removed from the site either by wheelbarrow to another area close by or by filling a skip or bin which is then taken away by truck.

As with all compact material that is loosened, the actual volume can increase by varying amounts, depending on:

- the method used to excavate
- the type of material being excavated
- the moisture content of the material.

This is called the bulking factor. Soil has a bulking factor of between 10 to 30%.

## Example

Calculate the volume of excavated material, plus a bulking factor of 20%, for an area measuring 5.4 metres x 2.1 metres with a total depth of excavation of 220mm.

### Calculation

---

<b>Volume</b>	= length x width x height = 5.400 x 2.100 x 0.220 = 2.494m <sup>3</sup>
<b>Bulking factor</b>	= 2.494 x 20% = 0.498
<b>Excavated material (volume)</b>	= 2.494 + 0.498 = 2.992m <sup>3</sup> Approximately 3m <sup>3</sup> to be excavated.

---

## Testing the sub-grade

The sub-grade is the underlying ground. Test the firmness of the sub-grade to determine how thick the base course should be. Soft sub-grade needs a thicker base course than hard sub-grade and so has to be dug out deeper.

## Excavating

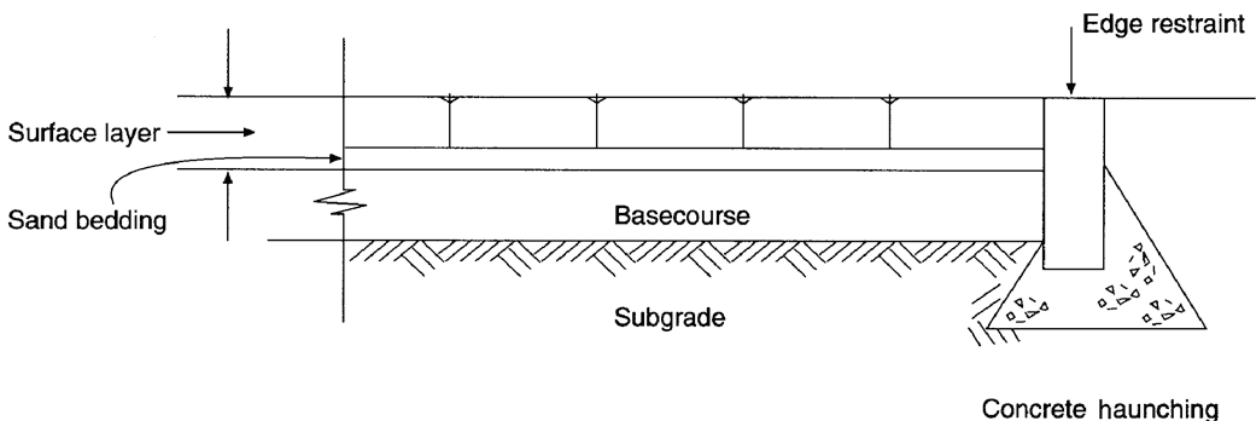
To test the sub-grade:

1. Dig down to about 200mm in several places within the planned paved area.
2. Walk on the sub-grade and stamp your heel into it.
  - On a weak sub-grade, walking leaves distinct footprints. You will need 75mm base course for pedestrian use, and 175mm for driveways (light vehicle traffic).
  - On a moderate weak sub-grade, your heel leaves an impression. You will need 50mm base course for pedestrian use, and 125mm for driveways.
  - On a strong sub-grade, no impression is left. This requires no base course for pedestrian use, and 75mm for driveways.

## Excavation

Determine the finished level of the highest part of your paving. Against buildings, that should be at least 150mm below the level of concrete floors, or below the ground level under timber floors. Your paving should slope away from the building, at a rate of between 15 to 30mm per metre, to prevent water ponding or running under buildings.

Mark and dig out the area to be paved to the combined depth of the three layers of: pavers, bedding sand and base course. Paver thickness depends on the expected weight of traffic, bedding sand is laid between 20-30mm thick, and base course thickness depends on the firmness of the sub-grade.



Paving installation

# Laying paving

## Preparing the sub-grade

The finished sub-grade level should match the contour of the finished paving within 20mm. After excavating, the sub-grade may have holes that need to be filled to even out the surface or match the contour. Fill these gaps with base course material no more than 100mm thick and then compact with a plate compactor or rammer in layers.

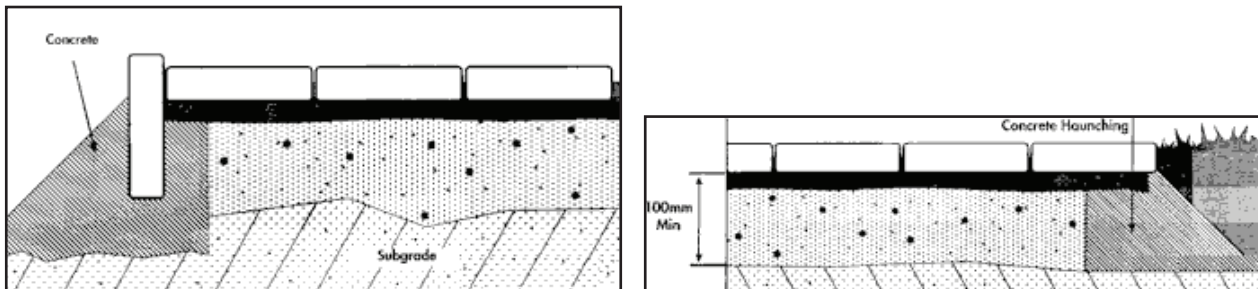
## Preparing the base course

Lay the base course in layers, no thicker than 100mm, and compact evenly. Be especially careful around manholes and curbs. If the base course is relatively dry you will need to give it a spray with water to help with the compaction process. The finished texture of the base course should not allow bedding sand to filter through.

The final surface of the base course should match the contour of the finished paving with no bumps and no holes deeper than 10mm.

## Placing the edging

Edging prevents sideways movement of pavers and stops bedding sand leaking out.



Existing pathways, or other permanent structures (such as house foundations), can be used to retain both the bedding sand and pavers on one or more edges. For the remaining edges and for other projects, different methods of edge restraint are used to ensure the paved area remains level.

There are several options for edge restraints. These include:

- soldier course of either standing or flat pavers
- paving kerb – segmented raised kerbing
- paving edge – concealed, underground PVC strip
- haunching – concealed concrete strip
- a timber form-work type restraint
- proprietary edging products.



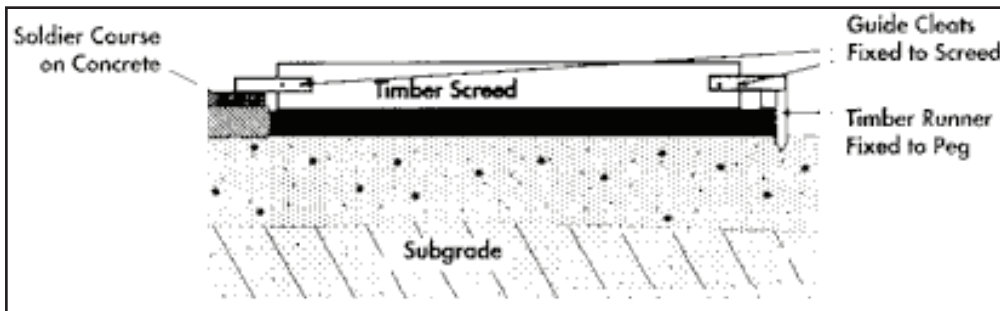
## Laying paving

### Preparing the bedding sand base

Bedding sand supports your pavers and will hide small irregularities in the base course.

To test how much the thickness of the sand will reduce, spread some sand over a small area. Lay a paver on top, and hit it with a rubber hammer. The reduction in sand thickness will indicate how much the sand compacts. (Do not compact the bedding sand directly. It compacts under the pavers.)

Only one area of bedding sand is put down at a time. Pavers are then laid on top before moving on to the next area. Spread sand only over an area that can be finished in one session. Spread the sand to slightly more than the depth the rubber hammer test indicated. (This will usually be 5-10mm.)



Screed the sand to a uniform level. When screeding, guides or runners are needed on each side to run the screed board on. If there is already a soldier or kerb course of pavers for edging in place, this can be used to support the runners. If not, drive pegs and fix runners to them, just like concrete boxing.

### Laying the pavers

It is best to lay the pavers from the lowest point first if the area is sloped.

Start from the straightest convenient edge, and lay the pavers with a space of 2mm to 4mm between them. (Some pavers have spacer nibs which do this automatically.) The space allows joint sand to penetrate around the pavers.

Lay all full pavers first, then cut and lay any pieces. Cut the pavers with a diamond toothed concrete saw blade, a paver splitter (both available from hire centres), or use a brick bolster for smaller areas. Always wear a dust mask when cutting pavers.

Do not put any weight on the paving area until it is completely finished. For example, do not allow vehicles on to the paving. Use heavy planks as running boards for pedestrian and wheelbarrow access.

## Laying paving

### Compacting the pavers

The pavers now need to be compacted evenly over the whole area. For a small area, use a rubber hammer on a short length of heavy timber such as a piece of 50 x 50mm. For larger areas, use a vibrating plate compactor from the local hire centre.

When the pavers are all compacted, sweep jointing sand over the whole area and compact again to drive the sand into the joints. Keep sweeping and compacting until all joints are filled.



# Project 1 - Outdoor teaching area

This paving project is an outdoor teaching area next to Kaiapoi High School's library. These students completed US 12933, *Complete minor concrete works as a BCATS project*, first. This provided most of the edge restraints needed for the paved areas.

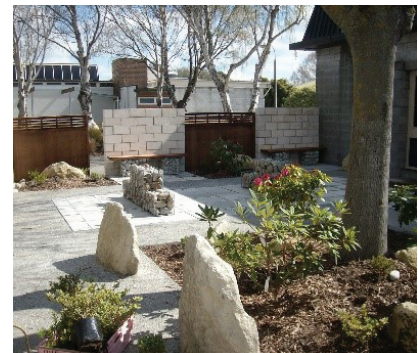
## Selecting pavers

You do not have to make your own pavers to achieve this unit standard but your teacher may give you the opportunity to if your project specifies concrete pavers. This example project used student-made pavers because it was more cost-efficient and they had to keep within budget. They had 500mm moulds and so drew their plans using multiples of 500mm for maximum efficiency of both time and materials. Only three of the pavers needed a side shortened.



Previous Governor-General and his wife watching the building class emptying the moulds and pouring a new batch of pavers for the library job. (left)

Five concrete blocks wide with four whole pavers. (right)



## Excavating

1. Calculate the depth needed to be excavated, allowing for the compacted hardfill, the bedding sand, and the pavers.

There was only going to be foot traffic on these pavers so it was decided to use 100mm of AP 20, 30mm of bedding sand, and 40mm thick pavers. This gave a total excavation depth of 170mm below the height of the concrete edge restraints. (AP 20 is an aggregate which compacts really well due to the clay content in with the crushed rock.)

2. Wear protective footwear. You will be working with shovels, spades, and rakes. Make sure you are aware of where your classmates are to avoid injuring them.
3. Excavate the areas to be paved to a depth of 170mm, or to the depth your project needs. Have people on rakes leveling off and others on string lines stretched across the edge restraints to check the dig out depth with rulers. You don't want to take out too much or you will have both done more digging than needed and have to pay for extra hardfill.

## Project 1

### Preparing the base course

4. Spread the hardfill, checking with the string method. This project needed 60mm left above the hardfill, to the string line, because the plate compactor will compress it approximately 10mm. This left 70mm for the bedding sand and the paver thickness.
5. Recheck the height once you have been over it with the plate compactor. If you have more than the required distance between the hardfill and the string line, add some hardfill, repeat the compaction, and height check again.

### Preparing the bedding sand base

6. You are now ready to place the bedding sand. Allow for it compressing under the weight of the pavers. The bedding sand chosen for this project was crusher dust, which compacts so much that an additional 5mm of bedding sand was added.



Using the screed

The edge restraints for this project were made of exposed aggregate ('exposed ag'), whose finish is too harsh for the screed board to operate on. This was overcome by placing a 2mm thick strip of acrylic on top of the exposed ag on each side to sit the notched part of the screed board on. This meant they only needed to notch out 37mm instead of the full 40mm (paver thickness). This gives us 35mm from the bottom edge of the screed to the surface of the exposed ag.

7. It is important to keep moving the screed forward at an even pace and to keep the face of it nice and vertical. It is best to always run the screed over each area at least twice to ensure the bedding sand has a nice smooth finish.
8. Once the finish is smooth, tidy up both edges where the notched part of the screed leaves an uneven surface. This is best done with a large steel float. Lay it flat on the smooth area of the bedding sand and then slide it flat to the edge of the concrete. Remove the extra material that has collected on top of the float.
9. Next, slide the steel float along the edge the same way you would float up a concrete surface, creating a great surface to lay your pavers.

## Project 1

### Laying the pavers

10. Pavers that have straight edges need gaps between them when laying to leave space for grout. The moulds for the pavers used in this example project were angled on the sides by 4 degrees (relief angle) to ensure the pavers come out of their moulds well. This angle provides the grout joint.
11. The largest area of this project was five whole pavers wide and so these were laid first. Pavers that need cutting are laid last. Remember to wear a dust mask when cutting them.
12. It is important when placing the pavers that you do not let the bottom edge of the paver dig into the bedding sand. It would otherwise create a build-up of dust between the edge of the paver and the edge of the concrete.
13. To avoid this build-up, keep about one third of the thickness of the paver above the bedding sand and pull it back hard against the surface. Then slowly lower the paver, using the edge of the paver closest to you as a hinge. Once the paver comes down flat you can let it go and it will give nice tight joints. Your teacher/tutor will show you how to do this.
14. Once the first row is laid, check them with a straight edge to make sure the grout joint is straight. If it is a little bit out, simply get the edge of the steel float in the joint and carefully lever and adjust the pavers. This step can be repeated for the other rows if needed.



The screed board in progress. (left)

The paver is about one third above concrete height and is in the lowering process. (right)

**Note:** all his pressure on the tile is towards himself to ensure a nice tight joint.



## Project 1

### Compacting and finishing the pavers

15. These pavers are 500mm square and it was overall a small area so hiring a vibrating plate compactor was not necessary. They were instead compacted by simply tapping the surface evenly with rubber mallets.

16. Apply grouting once the compacting is done.

It is very important that the pavers are completely dry before you do the grouting. If the pavers are damp, the jointing sand will become damp and start rolling up in balls as you work the broom instead of falling nicely into the joints.

The easiest and quickest way to grout the pavers is to tip a pile of jointing sand on their surface and then use a broom to sweep it at about 45 degrees across the joints.

17. Keep changing direction and continue until the joints are full.

18. Sweep the surface clean.

19. The final step is to get a hose with a fine spray nozzle and dampen (not flood) the surface. This activates the cement in the jointing sand and sets the grout.

As you can see, the broom is not parallel to the joints. Sweeping at an angle applies the grout better.

You can also see that this is one of the two areas that are six blocks long (2400mm) so the students are cutting 100mm off three pavers for the last row.





# Project 2 - Paved curved paths

This example project is one of paved curved paths leading to Kaiapoi High School's Cultural Learning Centre. The two curved paths are both created solely from 200mm x 100mm pavers and with concrete hunching for edge restraints.

Money was saved by using 14 pallets of 'seconds' pavers that were kindly donated by a local business. They were in a variety of colours, which meant working out how the pallets would be mixed up and which to lay for what area for attractive finished paths.

The focus of processes in this example is on how to make paving areas curved. All remaining processes are the same as those already described for paving projects with straight edges.



Compacting the bedding sand (left) and the finished paths (right).

## Creating curved paths

1. Work out how wide to dig out. This project needed to be wide enough for 12 rows of pavers (200mm x 100mm), two lots of boxing and pegs, and extra room for the concrete hunching to be poured as edge restraints.
2. Use the methods described in the 'Excavating' section to work out the depth of excavation required.
3. Mark out the two curved paths with spray paint.
4. Dig out and box up the first side of the curve for each path.  
75mm x 25mm boxing was used for this project to allow a nice even curve. Short pieces of 75mm x 12mm x 600mm were used to screw enough length together to complete each run.
5. Students held the curve even at different points while others pegged the outside. Once all the pegs are in place, set the height to attach the boxing to the pegs. Check that there is an even fall on the path from one end to the other.

## Project 2

6. Make a spacer board to place on the inside of the boxing already in place.

To get the spacer board the length required, add the width of the pavers and the thickness of the boxing for the second side. The calculation for this project included 50mm to ensure 12 rows of pavers could be fitted in comfortably even around the curves.  $100\text{mm} \times 12 + 25\text{mm} + 50\text{mm} = 1275\text{mm}$  is the length of this spacer.

7. Working along the path, put the spacer board across at each peg. Hammer in a peg at the end of the spacer to take the second side of boxing. Once all the pegs were in place, place a 1.8m spirit level on the top edge of the boxing at each peg and, holding it level, mark the new pegs to get the height to set the second side of boxing.

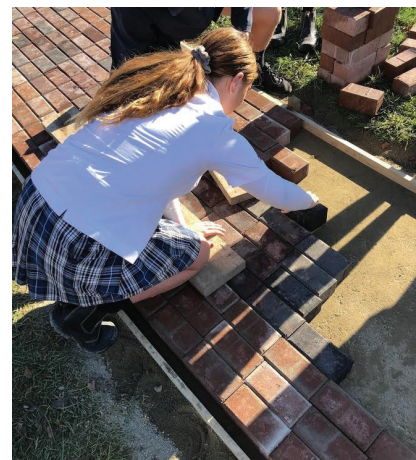
Attach the pegs and boxing with screws and an impact drill. This makes it easy to dismantle later. Using these instead of a hammer and nails also means the boxing doesn't move around.



Flattening off and tidying up the crusher dust at the sides with the steel trowel



Note the gap between the inside boxing and the edge of the paver. A 20mm spacer was used with the first row.



8. Compact and finish the pavers in the same way as for the first project.