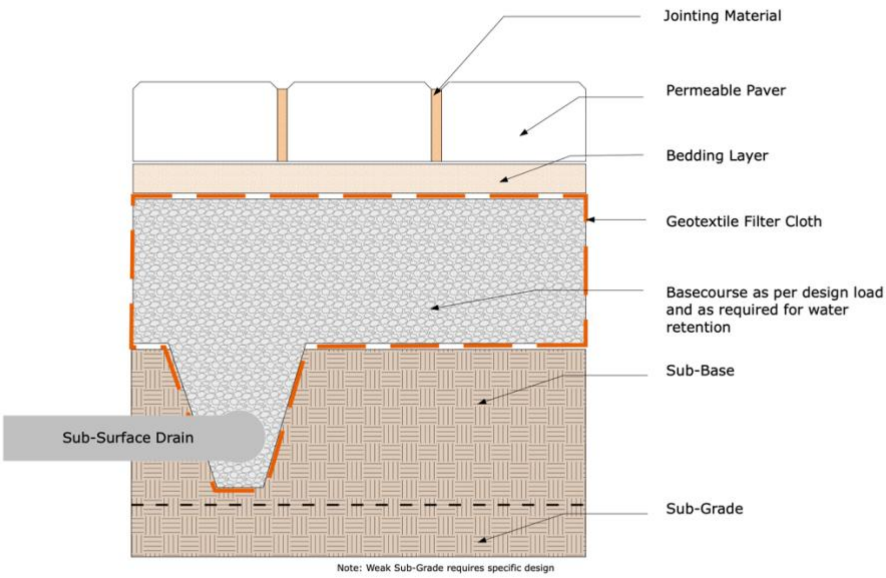
Installation Guide for Permeable Pavers

It is crucial that the installation process be undertaken in consultation with a professional—be it an engineer, architect, or landscape architect—to ensure adherence to local council requirements and project-specific conditions. The design of the pavements should be conducted under the guidance of a qualified civil engineer according to the NZS 3116:2002 standards, taking into account the sub-grade's moisture sensitivity and the necessity for appropriate filter fabrics. It is important to note that using normal GAP-type aggregates as a base course material is unsuitable and can lead to premature pavement failure.

Cross Section of Typical Permeable Pavement



Jointing Material The jointing material can either be a sand or an aggregate chip

Bedding Layer - Permeable pavers are bedded on a

30mm layer of either sand or chip

Basecourse The structural drainage layer underneath the bedding layer that serves as "storage medium". It can be either drainage aggregate or a no-fines concrete.

Sub-Base GAP40 or GAP65 to create a stable base

If the sub-grade is too weak

Sub-Grade The undisturbed soil at the bottom.

The strength of this influences the thickness of the basecourse

Sub-surface drain – A drainage system which allows water to drain out of the basecourse

Filter cloth – Normally a non-woven geotextile which is allows water to pass through, prevents the bedding sand from migrating into the basecourse, as well as protecting the basecourse from clay soils.

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Product Specifications

Urban Paving Permeable Pavers are meticulously crafted to enhance both the functionality and aesthetic appeal of outdoor spaces while promoting sustainable water management. Ideal for residential and commercial landscaping projects such as patios, walkways, driveways, and parking areas, these pavers feature a permeable design that allows water to flow through, reducing runoff and supporting groundwater recharge. Made from high-quality inorganic materials and sintered at 1200°C, they boast exceptional strength with a compressive strength exceeding 5MPa, and superior weather resistance, including frost durability. Available in various sizes and typically square or rectangular in shape, these 55mm thick pavers are designed for stability and can handle diverse traffic loads. Their range of colours and surface finishes allows them to seamlessly integrate into both traditional and modern outdoor designs, creating a cohesive and visually pleasing environment.

1. Sizes and Textures Available

	Size (mm)	Thickness (mm)	Number per m²
Residential pedestrian only	600 x 600	55	2.56
	600 x 300	55	5.03
	600 x 200	55	7.45
	600 x 150	55	9.83
	500 x 500	55	3.79
	400 x 400	55	6.25
	300 x 300	55	11.11
	450 x 300	55	7.13
Residential pedestrian, residential driveway, public footpaths*	400 x 200	55	12.13
	300 x 150	55	21.95
	200 x 200	55	25.64
	200 x 100	55	49.36

*applicable for typical load requirements under Table 1 and 1A, Section 302 NZS3116:2002

2. Performance Metrics

Compliance

	Test Standard	Result
Breaking Load KN (200 x150)	AS/NZS 4456.5:2003	**8.9**
Breaking Load per 100mm KN		**5.4**
Modulus of Rupture (min)		**5.3**
Coefficient of friction (COF)	AS 4586:2013	**0.6 V**
Slip Resistance Classification of New Pedestrian Surfaces		**60**
		P5

V ≥ 54 high slip resistance **X** 35-44 low slip resistance **Z** ≤25 Extremely low slip resistance

W 45-54 moderate slip resistance **Y** 25-34 very low slip resistance

Technical Parameters

	Test Standard	Standard	Notes
Compressive Strength	AS/NZS 4456.4:2003	>4MPa	5.4 MPa tested to GBT25995-2010
Water Absorption:	AS/NZS 4456.14:2003	N/A	Not tested, 11l /m^2
Density	AS/NZS 4456.8:2003		Estimated 2930kg/m^3
Frost Resistance	ASTM C1262		Based on product as being sintered at 1200°C and having passed 50 cycles of frost resistance testing at ±25°C, it is reasonable to expect that the pavers would meet or exceed the ASTM C1262 requirements for frost resistance.
Dimensional Tolerance	AS/NZS 4456.2:2003	+/- 2mm	+/- 2mm
Infiltration rate	GB/T 25993-2010 *	N/A	600mm/h per m2 of paver area

*This test method is more comprehensive and considers the dynamic viscosity of water at different temperatures, making it more suitable for conditions where temperature fluctuations are expected compared to NZS

Site Preparation

1. Sub-Grade

The subgrade's surface finish should be +0, -20 mm for level at a point, and should not deviate more than 15 mm from a 3-meter straightedge or template in any direction. It's important that the subgrade doesn't pond water.

For smaller residential projects, a uniform, well-compacted subgrade will usually be sufficient. Just make sure to follow the guidelines for compaction and strength checks. If you're laying the bedding layer directly on the subgrade, the tolerances are the same as for the basecourse.
For sub-grade load checks refer to Table 4.1.

2. Sub-Base

For very weak soils, or low graded CBR's the use of AP40 can help create a stable sub-base layer.

3. Geotextile

TNZ F/7:2003 specifies the requirements for geotextiles used in road construction and maintenance. The standard classifies geotextiles into different classes based on their physical and mechanical properties, such as tensile strength, puncture resistance, and permeability.

Table 3.1 Geotextile Classifications

Geotextile Class	Recommended Use	Typical Applications
Class A	Strong soil conditions (CBR15) with minimal load.	Light pedestrian areas, pathways, and patios.
Class B	Medium-strength soils (CBR7) under moderate load.	Residential driveways, light traffic roads.
Class C	Weak soils (CBR4) under light pedestrian or vehicle traffic.	Sidewalks, residential pathways, and garden areas.
Class D	Very weak soils (CBR4) or high load conditions.	Residential driveways with weak subgrades, areas with heavy traffic.
Specific Design	When subgrades are particularly weak or complex.	Custom applications requiring special reinforcement or mixed classes.

4. Basecourse

Basecourse Material

The basecourse shall comply with NZS3116:2002 Section 308.

The base course material shall be a drainage aggregate, such as AP40, or AP20, providing a suitable void ratio to allow for water retention of the system.

Typical GAP Aggregates are not suitable. GAP aggregates are designed for traditional pavement systems where water needs to be directed away from the surface, typically through surface runoff or subgrade drainage systems. These aggregates have a mix of fine and coarse particles, which result in low permeability once compacted, effectively limiting water infiltration.

Basecourse indicative thickness

Base course thicknesses are indicative only and are provided to give an example of typical construction. This table does not replace the use of engineering advice.

Table 4.1	**Subgrade Classification** CBR (California Bearing Ratio)		**Basecourse Thickness**	**Recommended Geotextile Class (TNZ F/7:2003)**
Residential Pedestrian Patio/Pathway	Weak Soil	CBR 4	100mm	Class C
	Medium Soil	CBR7	100mm	Class B
	Strong Soil	CBR15	100mm	Class A
Residential Light Traffic Single Unit Residential Driveways	Weak Soil	CBR 4	150mm	Class D
	Medium Soil	CBR7	125mm	Class C
	Strong Soil	CBR15	100mm	Class B
Residential Light to Medium Traffic Multi-Unit Residential Driveways	Weak Soil	CBR 4	Specific Design	Specific Design**
	Medium Soil	CBR7	150mm	Class D
	Strong Soil	CBR15	125mm	Class C
Public Footpath High and Low Impact	Weak Soil	CBR 4	100mm	Class D
	Medium Soil	CBR7	100mm	Class C
	Strong Soil	CBR15	100mm	Class B

There are three types of soil classifications called weak, medium and strong. These are also classified using the California Bearing Ratio, or CBR (Section6.1, NZS4402)

For small residential projects you can check these on site by walking on dampened or wetted ground. Your foot imprint is going to tell you what you need to know: weak – leaves strong imprint, medium – heel pressure leaves an imprint, strong - no imprint. For larger projects determine the on-site sub-grade CBR value use the Scala Penetrometer Test as per NZS 4402:1986

Slopes greater than 12% require specific design

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5. Bedding Layer

Permeable pavers are bedded on a 20mm layer of either sand or chip.

The bedding sand shall comply with NZS3116:2002 Table 4 Sand category III residential, residential driveways and public footpaths.

BS sieve size	Percentage by mass passing		
	Sand category I	**Sand category II**	**Sand category III**
5.00 mm	90 to 100	89 to 100	89 to 100
2.36 mm	75 to 100	65 to 100	65 to 100
1.18 mm	55 to 90	45 to 100	45 to 100
600 µm	35 to 65	25 to 80	25 to 80
300 µm	10 to 45	5 to 48	5 to 48
150 µm	0 to 10	0 to 15	0 to 15
75 µm	0 to 1.5	0 to 5	0 to 5 [1]

[1] For residential pedestrian applications, a 0-10% range can be used.

6. Jointing Material

The jointing material can either be a sand or an aggregate chip.

The joint sand shall conform to NZS 3116:2002 Table 5 Other.

Sieve size	Roads and Industrial Pavements	Other
2.36 mm	100%	100%
1.18 mm	75 – 90%	75 – 100%
600 µm	55 – 80%	55 – 100%
300 µm	20 – 40%	15 – 60%
150 µm	5 – 15%	3 – 30%
75 µm	0 – 5%	0 – 5%

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Installation Steps

7. Site Clearing and Excavation Techniques

Remove all existing vegetation, debris, and topsoil. Ensure the site is clear and level before excavation. Excavate to the required depth based on your load calculations, ensuring a uniform surface. Account for the total thickness of all layers, including the paver.

8. Base Preparation

Use open-graded crushed stone (e.g., ASTM No. 57) for the base layer. This material should provide both structural support and water storage. Ensure that the aggregate is clean, with minimal fines to maintain permeability.

Spread the base material evenly, ensuring a consistent depth. Compact the base layer using a plate compactor to achieve a firm and stable base. Aim for a compaction level that ensures stability without reducing permeability. Multiple passes with the compactor may be necessary.

Create a slight slope in the base layer to facilitate drainage. The slope should direct water towards natural drainage points or a subsurface drainage system. If necessary, install a subsurface drainage system using perforated pipes to manage excess water.

9. Installation of Geotextiles and Geogrids

Use non-woven geotextiles to separate the base material from the subgrade. This prevents soil migration and maintains the integrity of the base layer. For areas with heavy loads or poor subgrade, geogrids can provide additional reinforcement, improving load distribution and preventing rutting.

Lay the geotextile or geogrid directly over the prepared subgrade. Overlap edges by at least 300mm to prevent gaps. Secure the geotextile or geogrid in place using stakes or pins to prevent movement during base material installation.

10. Laying the Pavers

Ensure that the base is fully compacted and stable. Check for any soft spots or uneven areas. Plan the paver layout to ensure minimal cutting and optimal visual appeal. Mark reference lines using string and stakes.

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Begin laying pavers at a corner or edge, working outward. Use a straight edge or string line to maintain alignment. Place pavers with a small gap (as specified in your jointing material instructions) to allow for jointing material. Ensure each paver is level with the adjacent ones, using a rubber mallet to tap them into place as needed.

Frequently check the alignment of rows and adjust as needed to maintain straight lines. For consistent joint spacing, use spacers or a consistent measuring tool.

11. Jointing Techniques

Use a fine aggregate that allows water to pass through easily.

Spread the jointing material over the pavers and sweep it into the joints, ensuring they are fully filled. Use a plate compactor with a protective mat to compact the pavers and jointing material, ensuring the joints are tightly packed. Sweep away any excess material from the surface before activating with water if using polymeric sand.

12. Finishing Touches

Use a wet saw or masonry saw to cut pavers to fit around edges or obstacles. Wear appropriate safety gear. Install edge restraints along the perimeter to prevent paver movement. Ensure that the edges are secure and level.

13. Cleaning and Initial Maintenance Tips

Sweep the surface to remove any debris or loose sand. For polymeric sand, ensure the surface is clean before wetting. Apply a sealant if desired, following the manufacturer’s instructions to enhance colour and protect the surface.

14. Advanced Installation Tips

For slopes, ensure that the base and pavers are installed in layers that follow the slope, using geogrids for added stability.

For curved areas, cut pavers as needed and lay them in a radial pattern, ensuring tight joints and consistent spacing.

When installing near tree roots, allow space for root growth. Use flexible edging to accommodate movement. Mark and avoid utility lines. If necessary, reroute them before installation to prevent damage.

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Maintenance and Care

To keep your permeable pavers functioning properly, regular maintenance is key. Here's a simple guide to help you out

Regular Sweeping: Sweep the surface often, especially after storms, to remove dirt, debris, and leaves before they can clog the gaps between pavers.

Vacuuming: Use a wet-dry shop vac or a commercial vacuum to pull out any dirt that has settled in the voids, ideally once a year or more in busy areas.

Pressure Washing: Give your pavers a good wash with a pressure washer (set between 1500-2000 PSI) to clear out accumulated sediments. Be gentle to avoid damage, and do this at least once or twice a year.

Joint Maintenance: After cleaning, you may need to top up the joint filler material (sand or gravel) to ensure proper drainage. Keep an eye out for any signs of erosion.

Prevent Organic Build-Up: Clear away leaves, mulch, and other organic matter promptly, as they can promote weeds and clogging. Also, make sure landscaping runoff doesn't wash onto the pavers.

Weed Control: Check for weeds regularly and remove them to prevent soil accumulation. You can also use eco-friendly herbicides or landscape barriers for prevention.

Professional Cleaning: If DIY maintenance isn't enough, professional cleaning services can help restore your pavers. Some use specialized vacuum systems that clean without disturbing the base.

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Tools and Materials

Tools

- Measuring tape
- String line and stakes
- Rubber mallet
- Plate compactor
- Level
- Trowel and rake

Materials

- Permeable porcelain pavers (sizes as specified in our range)
- Permeable jointing material (polymeric sand or aggregate)
- Bedding sand or fine gravel
- Crushed aggregate for base and sub-base layers
- Geotextile fabric (optional)
- Edge restraints (e.g., plastic, metal, or concrete)

Water Retention

1. Mortar base

Where a mortar base is used only the water retention of the pavement is limited to the water retention of the individual paver and will store approximately 11l per m^2.

2. Installation to NZS3116;2002

Where a drainage aggregate is used, the water retention of the system can be calculated using the void ratio of the compacted basecourse materials. Typical void ratios of compacted basecourse aggregates are:

AP20: The typical void ratio for AP20 (20mm Aggregate) is approximately 30-35%. This means that 30-35% of the volume of the compacted aggregate is void space that can retain water.
AP40: The typical void ratio for AP40 (40mm Aggregate) is slightly lower, around 25-30%. This reflects the larger particle size and reduced surface area, leading to less void space overall.

These values are indicative and may vary depending on the source and specific composition of the aggregates. It's important to account for these variations when calculating water retention capacity in your design.

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Example Calculation for a Residential Footpath;

Basecourse thickness = 100mm (0.1 meters)
Area = 1m²
Void ratio for AP20 aggregate = 30% (0.30)

Step 1: Calculate the Volume of the Basecourse Layer

- Volume = Area × Thickness
- Volume = $1m^2 \times 0.1m = 0.1$ cubic meters (m^3)

Step 2: Calculate the Volume of Void Space

- Void Volume = Volume of Basecourse × Void Ratio
- Void Volume = $0.1m^3 \times 0.30 = 0.03$ cubic meters (m^3)

Step 3: Convert to Liters

- Since 1 cubic meter equals 1,000 litres:
- Void Volume in Liters = $0.03m^3 \times 1{,}000 = 30$ litres

Result:
For a $1m^2$ area with a 100mm thick AP20 basecourse layer, the system can retain approximately **30 litres** of water within the void spaces.

Notes:

- This calculation assumes the void ratio of 30% for AP20. If AP40 (with a void ratio of 25%) were used, the result would be slightly lower.
- This is a simplified calculation, and actual retention may vary based on compaction and other factors.

Subsoil Drainage Considerations:

When installing a permeable paving system, it is essential to ensure that the subsoil drainage is adequately designed to handle the water collected within the basecourse layer. This may involve the installation of drainage pipes, a sloped base, or a connection to an existing stormwater management system. The design should also consider the soil permeability and the local climate, as these factors will influence the design of the drainage system. Proper drainage ensures that the water is removed at a rate that prevents saturation of the subgrade, maintaining the load-bearing capacity of the system over time.

Reference Documents

NZS 4404:2010 - Land Development and Subdivision Infrastructure
Auckland Council Stormwater Management Devices: Design Guidelines Manual (GD01)
E1 Surface Water - New Zealand Building Code:

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