



TECHNICAL MANUAL

HYDROPAVER® Ceramic Pervious Paving



Descriptions and Application Details

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NOTE: Checklists are to be scanned and emailed to Jagas at info@jagas.co.nz where they will be retained for quality control and audit purposes.

REVISIONS TABLE

No.	Date	Changes made	Authorised by
1	25/5/2016	Version 1 issued	Robert Sweet
2	5/8/2016	DRAFT Version 2 issued	Robert Sweet
3	20/12/2017	DRAFT Version 3 updated for name HYDROPAVER® and revised Engineer's O&M Manual; installers training clarified	Robert Sweet
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1 GENERAL DESCRIPTION



1.1 HYDROPAVER® CERAMIC PERVIOUS PAVERS

The HYDROPAVER® Pervious Paving system consists of ceramic pervious pavers, which, when correctly designed and installed, meet WSD (Water Sensitive Design) criteria, such as that described in the Auckland Proposed Unitary Plan stormwater management provisions, for permeable paving. Auckland Council Technical Report 2013/35 states that permeable paving, when installed in accordance with accepted standards, provides 10 mm retention of total rainfall depth and detention of events up to and including the 95th percentile storm. Each HYDROPAVER® will *itself* be able to store 11 mm of rainfall (adopting a 20% void space as tested). These permeable pavers installed with the required bedding material and base course will be able to store a total rainfall depth between 30 mm – 65 mm of rainfall depending on the thickness of the basecourse.

HYDROPAVER® pavers are made from recycled porcelain and clay, pressed into moulds at 1600 Tonnes pressure and baked at 1200°C. Heating the material to just below its melting point (sintering) forms strong bonds between individual grains and creates tiny pores. Thus the paver is able to absorb water as well as allowing water to pass through.

HYDROPAVER® contrasts markedly with concrete pavers such as Permeable Interlocking Concrete Pavement (PICP) which are *impervious* and designed to allow water to escape only through gaps between the pavers. HYDROPAVER® is “pervious”, that is, the water penetrates the paver itself, so (A) The paver acts like a sponge to retain and transpire water to the atmosphere, giving important environmental advantages; and (B) water infiltrates the paver at a very high rate.

The **HYDROPAVER®** paver itself has a Curve Number (CN) of close to the base number of 30, so when it is installed properly, runoff is significantly mitigated, outperforming grassed areas. Whether **HYDROPAVER®** is installed on the ground or as part of a deck in a building, foot traffic enjoys a water-free non-slip surface even in wet weather.

The paving bricks are very robust *in situ* and are even re-useable where re-laying becomes necessary for any reason or when a change to a different finish or colour makes the pavers available for laying in another location.

The most common sizes for **HYDROPAVER®** pavers are 300x300x55mm and 100x200x55mm. 600x300x55 was added to the range in 2016. These sizes make up over 80% of production. Other sizes and thicknesses are also available but are not manufactured as frequently. The pavers are available in a range of colours including black, white, grey, brown and yellow.

1.2 PROPERTIES*

Compressive Strength (Mean)	40 MPa
Breaking Load (M.O.R)	8 MPa
Water Absorption (Average Mass of Water)	20% by volume
Infiltration Rate (through paver to base)	1800mm per hour
Slip Resistance (Coefficient of Friction)	0.7 (wet)
Slip Resistance (Classification of pedestrian surface material)	V

*Based on testing carried out by Opus Consultants.



2 USES OF THE PRODUCT

Common uses for the product include:

- Public footpaths;
- Public pedestrian areas
- Public and private carparks;
- Hard surfaces around buildings, particularly where hard surfaces would normally be disqualified by impermeability factors.
- Hard surfaces as part of buildings, principally on decks and on patios in multi-storey buildings.

The 200x100x55 sized product (laid in a locking pattern, e.g. herringbone) is suitable for access roadways (such as through parks) and driveways. NOTE: This option should always be used when heavy traffic will have access to the laid surface.

Although very much less prone to clogging than concrete pavers, a proper maintenance regime is required for maximum water infiltration. See 7. MAINTENANCE below

In common with segmented and interlocking concrete pavers, Hydropavers are NOT designed for surfacing highways where an un-segmented surface is required.

3 REQUIREMENTS

3.1 DESIGN

In every case where water run-off mitigation is an objective of the installation (most cases), the installation must be designed correctly, factoring in:

- the condition of the ground,
- the slope of the final surface, and
- any requirements of the Resource Management Act 1991.

The design will require the ground condition and the CBR results to be known, so CBR testing (see 6.2 below) should be carried out before the design. If drainage is required to dispose of storm water during high rainfall events, a separate drainage design will be required.

Where **HYDROPAVER®** is to be used on decks, apartment patios etc, the building plans will need to specify suitable paver support having regard to the choice of membrane. Engineering will need to allow for the additional weight of water retained within the paver following a rain event. Use of **HYDROPAVER®** may allow a reduction in step-down, improving so-called “indoor-outdoor flow”.

For footpaths etc, it is the designer’s responsibility to take into account closeness to building foundations, boundaries, retaining walls, basements, groundwater table, overall stability of land etc. Where the pavers are to be placed within 1000mm of a building foundation, the suitability of the ground (including cut or filled ground) for installation of **HYDROPAVER®** pavers is the responsibility of the designer.

The water retention abilities of **HYDROPAVER®** pavers are affected by slope. The water in the paver at the top of the slope will pass to the paver downhill of it and so on down. Slopes should not exceed 5% (1:20).

Sites in regions with significantly greater rainfall events than average require site specific design.

3.2 CONSIDERATIONS

HYDROPAVER® pavers must be installed by **Jagas Accredited Installers** in accordance with this manual to ensure the quality of the system. Accredited Installers are listed on the Jagas website.

When cutting, drilling or grinding bricks do so in an open air environment or areas that are well ventilated and wear approved safety glasses and dust mask. All aspects of cutting, drilling or grinding must comply with the latest regulations of the Occupational Safety and Health division of the Ministry Of Business, Innovation & Employment.

The paving bricks should be stored on site on the pallets which they were delivered on and kept covered & free of dampness until required. [HANDLING NOTE: The bricks freely absorb water and will increase in weight if allowed to get wet.] Care should be taken to limit damage to edges or corners when handling.

HYDROPAVER® paving bricks must be maintained annually, to ensure the integrity of the whole system. See 7. MAINTENANCE below.

4 COMPLIANCE WITH THE BUILDING CODE

4.1 COMPLIANCE OF SCOPE

HYDROPAVER® paving bricks comply with the following clauses of the New Zealand Building Code:

B1(part)- Structure

B2 - Durability

D1– Access Routes

E1–Surface Water

F2 - Hazardous Building Materials



4.2 B1 STRUCTURE

Specifically B1.3.1; B1.3.2 and B1.3.3(b). **HYDROPAVER®** paving bricks are able to withstand weathering effects of wind, rain and snow experienced in New Zealand. The bricks are tested to be of sufficient strength to allow vehicular traffic to pass over, and to manoeuvre on, correctly installed paving bricks.

4.3 B2 DURABILITY

HYDROPAVER® paving bricks will meet the requirements of B2.3.1(a): a life of not less than 50 years with normal maintenance. The maintenance regime for **HYDROPAVER®** is set out under 7. (below).

The paving bricks will not generally form part of the structure of a building but may be used in conjunction with a building to provide pedestrian and vehicular access. The bricks are made with materials (kiln fired recycled porcelain and clay) which typically last a very long time and certainly in excess of 50 years. They may be compared favourably with common building bricks which typically last hundreds of years.

4.4 D1 ACCESS ROUTES

Applicable codes are D1.3.3 (d) and D1/AS1 2.1 and D1/VM1 1.0.1. Access routes must enable people to safely and easily approach the main entrance of buildings from the apron or construction edge of a building. Slip resistance testing carried out independently by Opus Consultants confirms that the **HYDROPAVER®** paving brick has a mean coefficient of friction of 0.7, and meets classification “V” of AS/NZS 4586 Wet Pendulum Test. This classification indicates that the contribution of the floor surface to the risk of slipping is “Very Low” and suitable for external ramps.

The mean coefficient of friction of 0.7 equates to a slope of 25% (1:4) or well above normal.

4.5 E1.SURFACE WATER

Applicable codes are E1.3.1 and E1.3.3 (a) and (e). Except as otherwise required under the Resource Management Act 1991 for the protection of other property, surface water, resulting from an event having a 10% probability of occurring annually and which is collected or concentrated by buildings or sitework, shall be disposed of in a way that avoids the likelihood of damage or nuisance to other property.

The **HYDROPAVER®** paving brick is specifically designed to mitigate surface water accumulating on the exposed surface or from running on to neighbouring properties.

The paving brick achieves this by allowing water to first enter the brick for later transpiration to the atmosphere and secondly (when saturated) to pass through to the sand and other materials on which the paver is laid.

In heavy rain events, surface run-off can occur and design of the installation needs to ensure that surface run-off is prevented from entering buildings. In this regard, areas paved with **HYDROPAVER®** should be treated the same way as grassed areas, using standard stormwater surface drainage practices.

Correct installation is essential and this is covered under 6. INSTALLATION below.

4.6 F2 HAZARDOUS BUILDING MATERIALS

Applicable codes are F2.3.1. **HYDROPAVER®** paving bricks are intrinsically non-hazardous. See also 4.4 above where the paving bricks also provide a safe walking surface for pedestrians in wet weather.

5 LIST OF COMPONENTS

The **HYDROPAVER®** product is a single unit product which comes in a number of sizes, principally 300x300x55mm and 200x100x55mm. It also comes in a range of colours; the colours are baked in during the firing process so are resistant to fading.

Installation also requires accessories (supplied by others), in particular base course, bedding materials and jointing sand. Refer to next section for details.

6 INSTALLATION

SEE ALSO APPENDIX A: **HYDROPAVER®** PAVING SYSTEM STANDARD DETAILS

6.1 DESIGN

As stated in LIMITATIONS above, where water run-off mitigation is an objective of the installation, the installation must be designed correctly, factoring in the condition of the ground and the slope of the final surface. The design will first require the strength of the ground to be known. If drainage is required to dispose of storm water during high rainfall events, a separate drainage design will be required. The following paragraphs are for the guidance of both the designer and the installer. As noted in USES above, brick shaped pavers (200x100) must be specified for heavy traffic areas, using a locking pattern such as herring-bone.

6.2 EXCAVATION AND GROUND PREPARATION

Remove all top soil and any non-engineered fill material. Prepare sub-grade in accordance with NZS 3116:2002 section 307

Test the strength of the subgrade. For all but Residential and Single Driveway applications, have a geotechnical engineer determine the strength; typically this will involve measuring the California Bearing Ratio (CBR). A minimum CBR of 4 is required for all applications. If necessary undercut, roll and compact the subgrade so as to achieve the required strength.

For Residential Pedestrian and Single Residential Driveway applications the following subgrade assessment tests may be sufficient. Weather conditions can significantly influence the test. The test should be carried out under damp or wet conditions:

- (a) Weak (CBR 4-7) – walking leaves a strong foot imprint;
- (b) Medium (CBR >7) – heel pressure leaves an imprint;
- (c) Strong (CBR >10) – no imprints.

A punched geotextile filter cloth meeting filtration classes 1-4 for TNZ F/7:2003 specification is to be installed on top of the prepared subgrade.

1.5 m separation is required from the seasonal high water table where there is vehicle loading.

6.3 BASE COURSE

Install a base course of TNZ40 to appropriate thickness as described in Table 1.

Compact base course in accordance with NZS 3116:2002 section 308.2.

Table 1

Type	Base course Thickness. <i>Use TNZ40 base course.</i>	
	Weak Sub-grade CBR 4-7	Medium Sub-grade CBR >7
Residential Pedestrian	100 mm	100 mm
Residential Driveway Single	150 mm	125 mm
Residential Driveway Multiple	200 mm	150 mm
Public Footpath	100 mm	100 mm
<i>Parking Lots Require Specific Engineering Design</i>		

6.4 BEDDING MATERIAL

Place 20 mm of bedding material meeting NZS3116:2002 309 1.1 and 1.2 on top of the base course. Bedding material shall comply with NZS 3116:2002 Grading Curve for Bedding Sand. Single sized, gap graded, or other sands containing an excessive amount of fines shall not be used.

The bedding material shall be free of deleterious materials, soluble salts and other contaminants.

The particles shall preferably be sharp. The sand shall have moisture content in the range 4-8%. Fine washed river known as No. 1 or No. 2 sand & Washed PAP7 meet the NZS 3116:2002 Grading Curve.

Bedding materials should have less than 10% clay particles commercial installations less than 5%.

6.5 PAVER INSTALLATION

Install pavers with edges not greater than 2 mm difference in height. Pavers are required to be installed on the same day bedding material has been laid down.

Compact the base course and the bedding layer (together) with a 65 kg vibrating plate compactor. Where there is to be vehicular loading, compaction is to be done with a roller.

Where there is to be vehicular loading, 100 mm x 200 mm x 55 mm pavers are to be laid in a herringbone pattern as shown in APPENDIX A



Sweep a layer of jointing sand over the pavers to fill in the joints. Do NOT leave sand residue on the paver (top) surface.

6.6 JOINTING SAND

Jointing sand shall comply with 6.7 & 7.1 NZS3103. Firth PaveSand will comply. Do NOT use PaveLock or other cement enhanced materials as these will block the pores within the pavers.

Re-sand joints for 2 weeks following installation in accordance with NZS 3116:202 311.2.4

6.7 EDGE RESTRAINTS

Edge restraints should be installed along the perimeter of the paving extending a minimum of 50 mm below the bedding material.

Intermittent edge restraints are required every 30 m where vehicle loading will occur.

6.8 SURFACE DRAINAGE

For large areas of permeable paving or where a site is sloped towards a building or structure surface drainage design may be required.

NOTE: The installation material in this section of the manual is based on work carried out for **HYDROPAVER®** by ACH Consulting Engineers, Auckland, whose report is available on request.

7 MAINTENANCE

7.1 MAINTENANCE SCHEDULE

Correctly installed, the **HYDROPAVER®** paving system requires normal maintenance only. Over time, dirt, vegetation, and other debris can collect in the voids and joints affecting both the aesthetics of the system and its porosity.

To maintain the design standard of the system as well as the aesthetic value, periodic maintenance will be needed to remove surface debris and restore infiltration capacity.

We recommend a minimum maintenance frequency of once yearly. Two effective maintenance methods are water blasting and vacuuming.

Maintenance should be conducted as per the following schedule.

MAINTENANCE FREQUENCY SCHEDULE HYDROPAVER®		
Item	As Needed	Annually (Autumn)
Water blasting or Vacuuming		X
Weed Control	X	
Outlet Inspection		X
Surface Inspection	X	X
Jointing Sand top-up		X

7.2 SPECIFIC MAINTENANCE/ INSPECTION REQUIREMENTS

The general maintenance/inspection items are items conducted on a frequent basis. A maintenance checklist has been included in Appendix B. A summary of requirements is as follows:

7.2.1 WATER BLASTING OR VACUUMING

The dust and pollen produced in spring and summer can settle onto the surface of the stone acting to reduce stormwater infiltration through the paver surface. Water blasting or vacuuming of the surface should take place annually, preferably in the autumn before the start of the New Zealand rainy season. A small sweeper vacuum or standard water blaster can effectively remove this debris and will not damage properly laid pavers.

7.2.2 WEED CONTROL

Any vegetation is to be removed from the joints between individual pavers. Hand removal is preferable as chemical herbicides infiltrate into the surrounding environment.

7.2.3 OUTLETS

Outlet and silt trap should be inspected and the silt trap cleared of any silt.

7.2.4 SURFACE INSPECTION

Routine inspections (and after major storm events) are to be carried out as per the maintenance schedule to ensure the paving stones have remained in place and not become either recessed or lifted up out of the ground. The requirements of routine inspections are to check for movement of the paved and kerbed areas adjacent to the **HYDROPAVER®** installation. Additionally jointing sand may require to be topped up from time to time. Any items requiring attention are to be forwarded to the maintenance representative for action. A follow up visit should be made to ensure items have been attended to. Evidence of severe settling should be inspected by a suitably qualified engineer.

7.2.5 BEDDING MATERIAL& PAVER REPLACEMENT

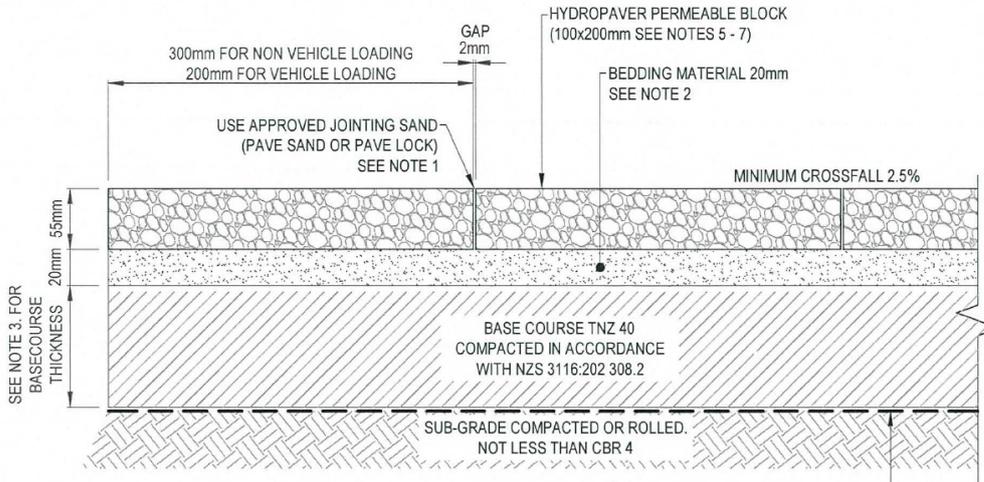
Bedding sand and paver replacement can be required in one of the following instances:

1. If spilling of a significant amount of petrochemicals or other environmental toxins occurs
 - a. Replace jointing sand, bedding sand and pavers in the affected area.
 - b. Dispose of old material in an appropriate land fill.

2. If surface ponding lasts for a period of time greater than 1.5 days following the end of a precipitation event sediments from runoff may have built up in the bedding sand (proper installation and adequate maintenance prevents sediment accumulation). If bedding sand requires replacement due to excessive ponding the following will be required:
 - a. Put in place erosion control to protect the area during maintenance.
 - b. Develop a staging area for materials to be disposed of.
 - c. Remove paving stones and waterblast.
 - d. Remove bedding sand and dispose of in an appropriate land fill.

NOTE: The maintenance requirements in this section of the manual are based on work carried out for **HYDROPAVER®** by ACH Consulting Engineers, Auckland, whose report is available on request.

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	ADDRESS:		TECHNICAL DRAWING
		JOB No: 150719	DATE: 01.11.17
		BY: LN	



SURFACE DRAINAGE BY OTHERS

**HYDROPAVER PERMEABLE PAVERS
TYPICAL SECTION HOUSING NEW ZEALAND**

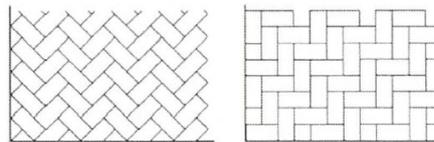
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NOTES:

1. **JOINTING SAND**
JOINTING SAND SHALL COMPLY WITH 6.7 & 7.1 NZS3103. SWEEP OVER COMPACTED PAVERS.
RE-SAND JOINTS FOR 2 WEEKS IN ACCORDANCE WITH NZS 3116:202 311.2.4
2. **BEDDING MATERIAL**
DEPTH 20mm
BEDDING MATERIAL SHALL COMPLY WITH NZS3116:2002 309 1.1 & 1.2
E.G. NO.3 RIVER SAND

BEDDING MATERIAL SHALL BE COVERED WITH PAVEMENT ON SAME DAY
3. **BASECOURSE NOTES**
MINIMUM SUBGRADE CBR = 4

4. **BASECOURSE NOTES**
GEOTEXTILE FILTER CLOTH MEETING FILTRATION CLASSES 1 - 4 FOR TNZ F/7:2003 SPECIFICATION FOR GEOTEXTILES
5. LAYED IN HERRING BONE PATTERN (REFER IMAGE BELOW).
6. EDGE RESTRAINTS AT PERIMETER TO EXTEND MIN 50mm BELOW BEDDING SAND.
7. INTERMITTENT EDGE RESTRAINT AT MAX 30m INTERVALS.



HERRINGBONE PATTERN
EXAMPLE

TYPE	BASE COURSE THICKNESS	
	SUBGRADE CBR 4 - 7	SUBGRADE > 7
	TNZ40	TNZ40
RESIDENTIAL PEDESTRIAN	100mm	100mm
RESIDENTIAL DRIVEWAY SINGLE	150mm	150mm
RESIDENTIAL DRIVEWAY MULTIPLE	200mm	150mm
PUBLIC FOOTPATH	100mm	100mm
PARKING LOTS	REQUIRES SPECIFIC ENGINEERING DESIGN	

* WHERE PUBLIC FOOTPATHS WILL EXPERIENCE LIGHT SERVICE VEHICLE LOADING, INCREASE THE BASE COURSE THICKNESS TO 'RESIDENTIAL DRIVEWAY SINGLE' DEPTH.

*** CBR 5 MINIMUM FOR HN72 OR GREATER TRAFFIC LOADING.

^ PARKING LOTS REQUIRE SPECIFIC ENGINEERING DESIGN.

HYDROPAVER® DESIGN CHECKLIST

APPENDIX B

Name of Client _____ Job No. _____

GEOGRAPHIC LOCATION	<i>Name:</i>
– Mean annual rain fall (mm)	
– One in Ten Year Event (mm/hour)	
SITE LOCATION	<i>Name:</i>
– Ground Strength / California Bearing Ratio value	
– Soil infiltration rate (mm/hour)	
– Site topography	
– Stormwater run-off evaluation done	<i>Comment:</i>
– Stormwater discharge assessment done	<i>Comment:</i>
– Under drainage required (Y/N)	
– Surface drainage required (Y/N)	
– Closeness to foundations <1000mm may not be suitable	<i>Comment:</i>
– Closeness to, boundaries, retaining walls, basements checked for suitability (Y/N/Comment)	
– Level of water table and stability of land checked for suitability (Y/N/Comment)	
PROPOSED USE per Client Classify Use as: 1. Residential Pedestrian 2. Residential Driveway Single 3. Residential Driveway Double 4. Public Footpath; 5. Car Parking (public)	<u>Classification Number:</u>
LOCAL COUNCIL REGULATIONS AND STIPULATIONS relevant to this installation	<i>Comment:</i>

Signed _____ Position _____ Date _____

To be retained with Job records and scanned and emailed to Jagas at QA@jagas.co.nz for quality control and audit purposes.

APPENDIX C

HYDROPAVER® CONSTRUCTION CHECKLIST

SITE ADDRESS _____

Pre-Construction				Construction			
Yes	No	NA/ Comment		Yes	No	NA	
Materials used			Description				
QA/QC							
Yes	No	NA/ Comment					

Tick all items that are satisfactory. Others comment as required.

COMMENTS:

Signed _____ Date _____

Position _____

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MAINTENANCE checklist

Annually	Yes	No	Method
Surface Cleaned			
Weed Control			
Outlet Inspected			
Silt trap cleaned			
Surface Inspection	Yes	No	Action taken
Hydropavers appear to have moved			
Jointing sand needs to be replenished			
As Required	Yes	No	Method
Removed weeds from joints			
Bedding material and Hydropavers Replacement (Only as needed)	Yes	No	Comment
Has an accidental chemical or petro-chemical spill occurred on the Hydropaving?			If yes replace affected Hydropaving and bedding material.
Does the surface pond for more than 1.5 days following the cessation of rain?			If yes replace bedding material.
Name of landfill where used bedding material and or stones have been takes to. (Please attach docket for council records)			

COMMENTS: _____

Signed _____ Date _____ Position _____