NZS 3116:1991 INTERLOCKING CONCRETE BLOCK PAVING

SANZ

NZS 3116:1991

NEW ZEALAND STANDARD

INTERLOCKING CONCRETE BLOCK PAVING

Part 1 – GENERAL

Part 2 – Specification for
INTERLOCKING CONCRETE PAVING BLOCKS

Part 3 – Code of practice for
DESIGN AND CONSTRUCTION
OF INTERLOCKING CONCRETE BLOCK PAVING

Superseding NZS 3116:1981

NZS 3116: 1991
Part 2 of this standard has been superseded by AS/NZS 4455:1997

The price code for NZS 3116 is reduced to Pr FF.

UDC 691.327-431:625.821

Pr GG

Standards Association of New Zealand

Single User PDF Terms & Conditions

You have material which is subject to strict conditions of use. Copyright in this material is owned by the New Zealand Standards Executive. Please read these terms and conditions carefully, as in addition to the usual range of civil remedies available to Standards New Zealand on behalf of the New Zealand Standards Executive for infringement of copyright, under New Zealand law every person who infringes copyright may be liable to a fine of up to $10,000 for every infringing copy or imprisonment of up to 5 years, or a fine of up to $150,000 or imprisonment not exceeding 5 years.

You have access to a single-user licence to read this non-revisable Adobe Acrobat PDF file and print out and retain ONE printed copy only.

We retain title and ownership of the copyright in this PDF file and the corresponding permitted printed copy at all times.

Under this license use of both the PDF file and the single permitted printed copy of this PDF file you may make are restricted to you. Under no circumstances are you permitted to save, sell, transfer, or copy this PDF file, the one permitted printed copy of this PDF file, or any part of either of them.

You undertake that you will not modify, adapt, translate, reverse engineer, decompile, disassemble or create derivative works based on any of the downloaded PDF file, nor will you merge it with any other software or document, even for internal use within your organization.

Under no circumstances may this PDF file be placed on a network of any sort without our express permission.

You are solely responsible for the selection of this PDF file and any advice or recommendation given by us about any aspect of this PDF file is intended for guidance only and is followed or acted upon entirely at your own risk.

We are not aware of any inherent risk of viruses in this PDF file at the time that it is accessed. We have exercised due diligence to ensure, so far as practicable, that this file does not contain such viruses.

No warranty of any form is given by us or by any party associated with us with regard to this PDF file, and you accept and acknowledge that we will not be liable in any way to you or any to other person in respect of any loss or damage however caused which may be suffered or incurred or which may arise directly or indirectly through any use of this PDF file.

Regardless of where you were when you received this PDF file you accept and acknowledge that to the fullest extent possible you submit to New Zealand law with regard to this licence and to your use of this PDF file.

COMMITTEE REPRESENTATION

This Standard was prepared under the supervision of the Building and Civil Engineering Board (30/-) for the Standards Council, established under the Standards Act 1988. The Interlocking Concrete Block Paving Committee (P 3116) was responsible for the preparation of this Standard, and consisted of representatives of the following organizations:

Cement and Concrete Association of New Zealand
New Zealand Concrete Masonry Association
New Zealand Contractor's Association
New Zealand Local Government Association
Tonkin and Taylor
Transit New Zealand

ACKNOWLEDGEMENT

The financial contribution made by the New Zealand Concrete Masonry Association towards the preparation of this Standard is gratefully acknowledged.

STANDARDS ASSOCIATION OF NEW ZEALAND
6th FLOOR, WELLINGTON TRADE CENTRE,
181-187 VICTORIA STREET, WELLINGTON 1.
(Private Bag, Wellington) Telephone: (04)384-2108 Fax: (04)384-3938

	AMENDMENTS
Date of issue	*Description*

CONTENTS **PAGE**

Committee representation ..... IFC
Acknowledgement ..... IFC
Related documents 3
Foreword 5

PART 1 GENERAL

Section

101 Scope 7
102 Interpretation 7
103 Definitions 7

PART 2 SPECIFICATION FOR INTERLOCKING CONCRETE PAVING BLOCKS

Section

201 Intended use 10
202 Materials 10
203 Design shape and dimensions 10
204 Skid resistance 11
205 Colour 11
206 Physical condition 11
207 Compressive strength 12
208 Abrasion resistance 12
209 Tensile strength 13
210 Availability of results 14
211 Sampling and testing 14
212 Acceptance and rejection 15

PART 3 CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF INTERLOCKING BLOCK PAVING

Section

301 Scope 18
302 Pavement thickness design 18
303 Laying patterns 19
304 Drainage 19
305 Kerbs and abutments 21
306 Subgrade preparation 21
307 Basecourse 21
308 Bedding course 22
309 Surface course 23
310 Joint filling 25
311 Final surface tolerances 26

Appendix

A Method of measurement of dimensions and plan area 27
B Method for the determination of compressive strength 29
C Method for the determination of tensile splitting strength 31
D Method for the determination of flexural tensile strength 34

Contents continued overleaf

Table

1 Pavement thickness 18
2 Grading limits for bedding sand 22
3 Grading limits for joint sand 25

Figure

1 Basic components of interlocking block paving 8
2 Paving block laying patterns 20
C1 Positioning of paving block in testing machine for the tensile splitting test 32
D1 Positioning of paving block in testing machine for the flexural tensile test 36

RELATED DOCUMENTS

Reference is made in this document to the following:

NEW ZEALAND STANDARDS

NZS 3111:1986	Methods of test for water and aggregate for concrete
NZS 3112:- - - - Part 2:1986	Methods of test for concrete – Tests relating to the determination of strength of concrete
NZS 3113:1979	Chemical admixtures for concrete
NZS 3117:1980	Pigments for Portland cement, and Portland cement products
NZS 3121:1986	Water and aggregate for concrete
NZS 3122:1990	Portland cement (ordinary, rapid hardening, moderate heat and sulphate resisting)
NZS 3123:1974	Portland pozzolan cement
NZS 3125:1991	Portland-limestone filler cement
NZS 4402:- - - -	Methods of testing soils for civil engineering purposes –
Section 6.1:1986	Determination of the California Bearing Ratio (CBR)
Test 2.8.2:1986	Determination of the particle-size distribution. Subsidiary method by dry sieving
NZS 4404:1981	Urban land subdivision

BRITISH STANDARDS

BS 410:1986*	Test sieves
BS 939:1977*	Engineers' squares
BS 2564:1955	Control chart technique when manufacturing to a specification, with special reference to articles machined to dimensional tolerances

TRANSIT NEW ZEALAND
(Formerly National Roads Board)

TNZ B/2:1987	Construction of unbound granular pavement layers
TNZ F/1:1986	Earthworks construction
TNZ F/2:1984	Subsoil drainage construction
TNZ F/6:1985	Fabric wrapped aggregate subsoil drain construction

TNZ M/3 Notes:1986 Sub-base aggregate

*Endorsed as suitable for use in New Zealand.

ROAD RESEARCH UNIT TECHNICAL RECOMMENDATIONS

RRU TR1	Brickell, R.G, Geomechanics for New Zealand roads
RRU TR2	Dunlop, R.J, Lime stabilisation for New Zealand roads
RRU TR5	Tait, J.B, Cement stabilisation for New Zealand roads
RRU TR1O	Tait, J.B, Interlocking concrete block paving 1987

The users of this Standard should ensure that their copies of the above mentioned New Zealand Standards or of overseas standards endorsed as suitable for use in New Zealand are the latest revisions or include the latest amendments. Such amendments are listed in the annual SANZ *Catalogue* which is supplemented by lists contained in the monthly magazine *Standards* issued free of charge to committee and subscribing members of SANZ.

FOREWORD

This Standard is a revision of NZS 3116:1981. It sets out the requirements for the manufacture of precast interlocking concrete paving blocks. It also contains a code of practice for the design and construction of pavements using interlocking concrete blocks.

The many applications for interlocking concrete block pavements flow directly from the advantages inherent in this form of construction, as opposed to more conventional pavements. These advantages include:

(a) Access to underground services without destruction of the concrete blocks, and opportunity of reinstatement without leaving unsightly and poorly finished patches;

(b) Ease of reinstatement of areas of localized settlement without destruction of the pavement or use of road-breaking equipment;

(c) Simple construction methods suited to unskilled labour but with skilled supervision;

(d) Low construction plant cost;

(e) Low maintenance costs and long service life;

(f) Ability to withstand repeated pavement flexing under traffic loads;

(g) Suitable for many types of pavements from light duty through to heavy duty with high wheel loads or (with appropriate block specification) with tracked vehicles;

(h) Suitability for re-use after lifting for service access, maintenance, or to change layouts;

(j) Excellent durability and abrasion resistance;

(k) Design flexibility;

(m) Suitability for paving both large and small complex areas;

(n) Aesthetic appeal;

(o) Wide range of colours;

(p) Specific areas can be delineated by the use of blocks of contrasting colour.

The minimum thickness of paving block provided for in this Standard is 60 mm. Blocks of a lesser thickness are manufactured and may be quite suitable for strictly non-vehicular traffic such as for domestic patios and garden paths. However, it is considered that such blocks are outside the scope of this Standard because the test for compressive strength is not applicable to thin blocks and it is doubtful whether interlock as defined can be achieved. Blocks of materials other than concrete are not covered by the Standard.

Tensile strength requirements, as an alternative to the compressive strength requirements, are specified for cases where a purchaser wishes to exercise this option.

In the absence of a proven abrasion resistance test, provision has been made in the revision for a high compressive strength to be specified where a purchaser requires high abrasion resistance.

REVIEW OF STANDARDS

Suggestions for improvement of this Standard will be welcomed. They should be sent to the Chief Executive, Standards Association of New Zealand, Private Bag, Wellington.

NEW ZEALAND STANDARD

INTERLOCKING CONCRETE BLOCK PAVING

PART 1 GENERAL

101 SCOPE

101.1
This Standard is in three parts. General clauses are contained in Part 1. The manufacture, testing, acceptance and supply of interlocking concrete paving blocks is contained in Part 2. The design and construction of the interlocking concrete block paving is covered in Part 3.

101.2
Pavement loadings described in this Standard range from heavy special purpose traffic to light vehicular traffic.

101.3
The interlocking blocks and bedding are alternatives to part or all of the surfacing and basecourse in conventional flexible pavement construction.

101.4
Pavements constructed in accordance with this Standard are suited to traffic speeds of up to 50 km/h with respect to ride characteristics, noise level and skid resistance.

101.5
Paving blocks of a thickness less than 60 mm and blocks of "cobblestone" shape (i.e. rectangular blocks with length to breadth ratios typically less than 1.4:1) are not covered in this Standard.

NOTE – Paving blocks less than 60 mm thick may be quite suitable for non-vehicular traffic. "Cobblestone" shape blocks of thickness 60 mm or more may be used for light vehicular traffic. However the design rules and application limitations are such that they can best be covered in a separate document.

102 INTERPRETATION

102.1
In this Standard, the word "shall" or the imperative mood indicates a requirement that is to be adopted in order to comply with the Standard. The word "should" indicates a recommended practice.

102.2
The full titles of reference documents cited in this Standard are given in the list of Related Documents immediately preceding the Foreword.

103 DEFINITIONS

103.1
For the purpose of this Standard, the following definitions shall apply:

BASECOURSE means the upper part of the structural pavement, bounded by the overlying surfacing and underlying sub-base.

BEDDING COURSE means the sand layer into which the surface course is bedded.

EDGE RESTRAINT means kerbing, abutments or other rigid structure along the perimeter of the paved area, or internally dividing large areas providing lateral support to the block paving.

INTERLOCK means the horizontal and vertical shear resistance developed by: the keying action of the dentated sides of paving blocks,the frictional forces developed between blocks,the laying pattern or a combination of the three.

INTERLOCKING CONCRETE BLOCK PAVING means a pavement structure comprising a surface course of interlocked concrete paving blocks with sand filling in joints between blocks, a sand bedding course, a base-course, a sub-base (depending on subgrade and traffic loading conditions), the subgrade and edge restraint (see figure 1).

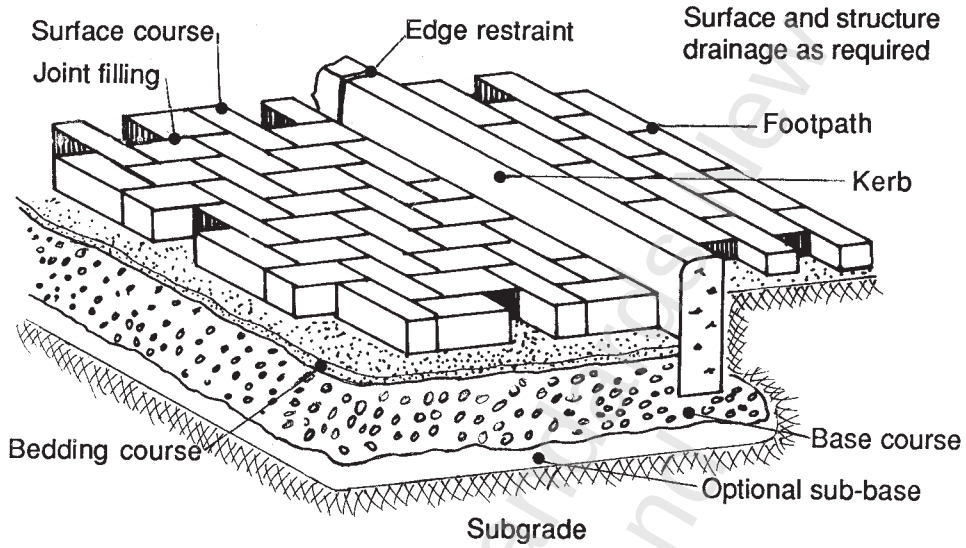


Figure 1 – Basic components of interlocking block paving

PAVING BLOCK means a rectangular or shaped solid unit manufactured to close tolerances, with plane or dentated sides, top and bottom faces parallel, preferably with arrises of the top surface chamfered, and of a size that can be hand placed.

SUB-BASE means the portion of the pavement between the basecourse and the subgrade.

SUBGRADE means the earthworks on which the block paving is constructed. This may comprise the natural ground, or may be selected imported material.

SURFACE COURSE means paving blocks laid together in a specific pattern with joints between blocks filled by sand which is densified by vibration.

TRAFFIC LOADING CLASSIFICATION means a broad grouping of severity of traffic loading as follows:

(a) Heavy duty: Areas such as:

(1) Container terminals, freight forwarders' yards, wharf areas, log yards and similar areas, where the handling equipment, such as fork lift trucks or straddle carriers, have high wheel loads (in excess of 300 kN in some circumstances) and where the materials stored or stacked can also apply high point loads on the pavement (for example, from the corner castings of ISO containers);

(2) Where solid rubber tyred vehicles or steel wheel or tracked vehicles operate frequently, for example, loading docks, loading ramps, industrial floors, factory floors;

(3) Where other high loadings can occur, such as at airports, plant repair bays;

(b) Normal highways: Areas such as city streets, intersections, petrol stations, bus stops, railway crossings;

(c) Light vehicular: Areas such as parking lots, shopping malls, footpaths, lightly trafficked residential streets, driveways.

NOTE – The two elements of traffic load are:

(a) The magnitude of the heaviest axle which regularly traverses the pavement;

(b) The number of passages across the pavement of the heavier loads.

Because highway axle weights are limited by regulation, highway loads depend on the volume of truck traffic. The design of footpaths depends on whether or not they can be used by vehicles. The design of carparks and driveways depends on whether or not they can be used by heavy trucks.

PART 2
SPECIFICATION FOR INTERLOCKING CONCRETE PAVING BLOCKS

201 INTENDED USE

201.1
This specification applies to concrete paving blocks for use in interlocking block paving designed for pedestrian traffic or to carry rubber tyred vehicles and constructed in accordance with the code of practice given in Part 3 of this Standard.

NOTE – Where the pavement is subject to heavy abrasion or where deep penetration of frost can occur repeatedly, special high strength units should be used. Clause 208 sets out provisions for high strength blocks where such are required for abrasion resistance.

202 MATERIALS

202.1
Cement shall comply with NZS 3122, NZS 3123, or NZS 3125.

202.2
Water and aggregates shall comply with NZS 3121.

202.3
Chemical admixtures shall comply with NZS 3113.

202.4
Colour pigments shall comply with NZS 3117.

203 DESIGN SHAPE AND DIMENSIONS

203.1
Regardless of any chamfer or radius at the top, all sides of the blocks shall be normal to their top and bottom faces. The design shape of the blocks shall be such that they can nest together with gaps between blocks of nominal 3 mm.

203.2
Blocks shall have a mean length to mean width ratio of 2:1 nominal. The width shall be not less than 75 mm at any section and the length shall not exceed 250 mm. The thickness shall be at least 60 mm. Chamfers shall be not greater than 7 mm in plan and elevation.

NOTE –

(1) Cobblestones are concrete paving units which do not comply with these limits and consequently are not covered by this Standard. Typically, cobblestones have a length to breadth ratio of less than 1.4:1.

(2) The edges of the top surfaces of blocks are normally chamfered to prevent spalling of the edges, to allow easier placing of joint sand by means of the funnelling effect and to reduce the likelihood of joint sand being sucked out by the action of passing tyres.

(3) For pedestrian areas, chamfers can cause discomfort to persons wearing high heel shoes. For such areas, blocks with a smaller chamfer may be specified by the purchaser. Greater care may be needed in laying the blocks.

203.3 Raised spacer nibs

203.3.1
Blocks may be manufactured with or without raised spacer nibs. Where spacer nibs are incorporated, this fact shall be stated by the manufacturer.

203.3.2
The manufacturer's work sizes shall not include raised spacer nibs.

203.3.3
Raised spacer nibs shall not cover more than 10 % of any side of any block, and shall not protrude more than 2.0 mm from the adjacent surface of the block. They shall be located such that nibs on adjacent blocks cannot touch.

NOTE – It is considered that blocks with spacer nibs will be less prone to spalling than blocks with no nibs. The risk of spalling may be further reduced by keeping the top of the nibs some 10 mm below the chamfers, however full height nibs may be necessary to facilitate mechanical laying. (See also 309.1.2)

203.4 Tolerances

NOTE – The economics of manufacture necessitate the use of moulds until reasonably worn. The manufacturer's "stated work size" or "specification" may vary between consignments.

203.4.1
At any cross section the maximum dimensional deviations from the manufacturer's stated work sizes or specification for paving blocks sampled to 211.2.3 and measured in accordance with A2 of Appendix A shall be as follows:

length	± 2 mm
width	± 2 mm
thickness	± 3 mm

203.4.2
For paving blocks assessed for squareness in accordance with A3 of Appendix A, each side shall not vary from the perpendicular to the wearing surface and the opposite face by more than 2 mm.

204 SKID RESISTANCE

204.1
The top surface of the block shall be free from laitance and shall have a uniform coarse texture where required for skid resistance.

204.2
Materials subject to polishing under traffic shall be precluded from use in fine or coarse aggregate for interlocking concrete paving blocks.

NOTE – For road pavement applications, minimum quantifiable skid resistance values may be required by the purchaser.

205 COLOUR

205.1
Colour and colour variation shall be a matter of agreement between manufacturer and purchaser.

NOTE – Loss of colour may occur with time.

206 PHYSICAL CONDITION

206.1
At the point of sale, concrete paving blocks shall be sound and free of defects that could interfere with the proper laying of the blocks, or impair the strength, appearance or permanence of the paving.

206.2
The condition 'sound' shall include the physical condition of the concrete on the top surface of the block, especially the bond of aggregate.

206.3
Packaging and handling methods shall be a matter for agreement between the purchaser and manufacturer.

NOTE – Generally, supply on pallets will be advantageous for protection against damage and convenience of handling for laying.

207 COMPRESSIVE STRENGTH

207.1
At the time of delivery, concrete paving blocks shall have a characteristic compressive strength of at least 40 MPa when tested in accordance with Appendix B.

207.2
A manufacturer claiming to be producing paving blocks to this Standard shall consistently carry out production control testing for compressive strength as required by 211.2 to demonstrate compliance with 207.1.

NOTE – Compressive strength is an arbitrary measure of block quality. The method of test set out in Appendix B will give a higher apparent result than would be obtained if the same concrete were tested by the standard methods specified in NZS 3112 Part 2.

207.3
The manufacturer shall keep testing records which set out, for every sample of paving blocks tested for compressive strength the following:

(a) Date of manufacture and lot number;

(b) Date of test;

(c) Type of block tested;

(d) Compressive strength of each block;

(e) Mean compressive strength of the sample;

(f) The sample range as defined in 212.3.1;

(g) Characteristic compressive strength for the sample expressed to the nearest 0.1 MPa;

(h) The consignment number, where appropriate.

208 ABRASION RESISTANCE

208.1
Where a purchaser specifies a requirement for abrasion resistance, the paving blocks at the time of delivery shall have a characteristic compressive strength of at least 55 MPa when tested in accordance with Appendix B.

NOTE –

(1) This optional requirement is recommended for in-service situations where high volumes of pedestrian traffic are likely to prevail, such as footpaths and shopping malls.

(2) Direct measurement of abrasion is not specified as to date there is no universally accepted test method

to demonstrate the in-service abrasion performance. The direct test methods that are currently available tend to have higher than desirable in-test variations. While compressive strength does not directly measure a blocks ability to resist abrasion it will generally offer reasonable confidence.

(3) Compression testing is not an appropriate means to control block abrasion performance for blocks manufactured with a thin topping layer on the in-service wearing surface.

(4) If the purchaser wishes to have a high degree of confidence in the ability of a block to perform well in a high abrasion situation the purchaser may ask the manufacturer to provide additional evidence. The form of this evidence should be a matter for agreement between the manufacturer and the purchaser and could include demonstration of satisfactory in-service performance of similar blocks in similar situations, or a suitable abrasion test.

208.2
The data from testing required in terms of 208.1 shall be appended to the testing record referred to in 207.3.

209 TENSILE STRENGTH

209.1 General
For rectangular paving blocks 80 mm or thicker, where a purchaser so specifies, the blocks shall comply with tensile strength requirements. These shall be either tensile splitting strength requirements in accordance with 209.2, or flexural tensile strength requirements in accordance with 209.3, which ever is required by the purchaser. When either of these requirements is specified the requirement of 207.1 shall not apply.

NOTE – It is considered that a tensile strength property more truly represents the likely block distress modes than does compressive strength; particularly for heavy duty uses.

209.2 Tensile splitting strength
At the time of delivery concrete paving blocks shall have a characteristic tensile splitting strength of at least 4.5 MPa when tested in accordance with Appendix C.

209.3 Flexural tensile strength
At the time of delivery concrete paving blocks shall have a characteristic flexural tensile strength of at least 6.0 MPa when tested in accordance with Appendix D.

209.4 Testing records
The manufacturer shall keep testing records which set out for every sample of paving blocks tested for tensile strength the following:

(a) Date of manufacture and lot number;

(b) Date of test;

(c) Type of block tested;

(d) Whether tested for splitting or flexural strength;

(e) Tensile strength of each block;

(f) Mean tensile strength of the sample;

(g) The sample range;

(h) Characteristic tensile strength for the sample expressed to the nearest 0.1 MPa;

(j) The consignment number where appropriate.

210 AVAILABILITY OF RESULTS

210.1 General

The manufacturer shall make readily available to purchasers or potential purchasers for each type of block the testing records for the immediately preceding 12 months defined in 207.3 and where appropriate, 209.4. Alternatively at the manufacturer's discretion a summary of all these test records shall be made readily available. As a minimum this summary shall show:

(a) Block type;

(b) Date of test;

(c) Age at test;

(d) Characteristic compressive strength and range of each sample tested in terms of 207;

(e) Characteristic tensile splitting strength or characteristic flexural tensile strength and range of each sample for each sample tested in terms of 209.

211 SAMPLING AND TESTING

211.1 Production lots

For the purposes of subsequent identification, production runs of any one type of paving block produced during a single day shall be divided into lots of not more than 10 000 blocks. Each stack of blocks stockpiled on the premises of the manufacturer or his selling agent shall be marked with its appropriate lot number.

211.2 Sampling for production control tests

211.2.1

Dimensional testing and compression testing shall be carried out on the same sample.

211.2.2

The manufacturer shall take a sample for testing from each production lot. At least one sample shall be taken on every day that blocks are produced.

211.2.3

A sample of blocks for testing shall consist of five blocks taken from a single production lot. Both the lot from which the sample is taken and the blocks comprising the sample shall be selected at random. The blocks so selected shall be taken before or during the process of stacking after manufacture. Each shall be indelibly marked so that it can be identified at any time with the lot it represents and the date of manufacture. Marking shall not cover more than 5 % of the surface area.

NOTE – The most important aspect of sampling is to ensure that blocks are selected at random. The sample must comprise blocks that are distributed throughout the lot. A convenient sampling plan may be established in respect of either time or place using a set of random whole numbers between 1 and 100, or some other convenient number obtained from tables or by drawing lots of numbered marbles. For example, the length of time required for stacking may be divided into 100 equal intervals. The randomly selected numbers can then be used to designate the number of those intervals after starting time at which a specimen should be selected.

211.3 Sampling for consignment testing

211.3.1

A purchaser, after inspection of the manufacturer's production test records, may require additional tests to be carried out on representative blocks from a particular consignment. If this option is exercised, then the blocks shall be selected as required by either 211.3.2 or 211.3.3.

211.3.2
If, at the time of order, the consignment has not yet been manufactured, then sampling shall be carried out in the manner prescribed in 211.2 and the purchaser or his representative shall be given the opportunity to inspect the method of selection of specimens, reasonable notice having been given by the manufacturer.

211.3.3
If, at the time of order, the blocks which will comprise the consignment have already been manufactured, then five specimens comprising a sample to be tested shall be selected on a random basis from the manufacturer's stock piles, the method of random selection having been previously agreed between the purchaser and the manufacturer before inspection of the stock piles. The purchaser, if he should so wish, shall be permitted to make the selection in the agreed manner in the presence of the manufacturer or his representative. The purchaser may require samples to be taken from one or more lots comprising a consignment, but all the blocks comprising one sample shall be selected from the same lot. The sampling shall comply with the method prescribed in 211.2. Each block selected shall be indelibly marked so that it can be identified at any time with the lot it represents. Marking shall not cover more than 5 % of the surface area.

NOTE – In order for the selection of blocks for testing to be random each block should have an equal chance of being selected regardless of the stack in which it is contained and of its position within a stack.

211.4 Storage of paving blocks selected for testing

211.4.1
Before being transferred to a water bath prior to testing, selected paving blocks shall be stored at ambient temperature and humidity, protected from sun and rain and not in contact with the ground. Storage time shall not be longer than:

(a) For blocks selected as set out in 211.2 ..... 28 days

(b) For blocks selected as set out in 211.3 ..... 7 days

211.5 Testing facilities

211.5.1
The manufacturer shall supply all facilities for, or arrange for testing of blocks for compressive strength or tensile strength in accordance with Appendices B, C and D respectively. He shall bear the expense of carrying out all tests except that, where the purchaser elects to select blocks for testing as set out in 211.3.3, the costs of testing shall be borne as agreed between the parties at the time of order.

211.5.2
If consignment testing is being used, the manufacturer shall notify the purchaser of his intention to carry out such tests at stated times, allowing sufficient notice for the purchaser or his representative to be present during testing.

212 ACCEPTANCE AND REJECTION

212.1 General

212.1.1
Any paving block which does not comply with the provisions of 202, 203, 204 or 206, and 205 if applicable may be rejected by the purchaser in which case it shall be replaced by the manufacturer free of charge.

212.2 Compliance with shape and dimensional requirements

212.2.1
The lot represented by a sample selected as set out in 211 shall be deemed to comply with shape and dimensional requirements of this Standard if all five blocks comprising the sample comply with 203 when tested in accordance with Appendix A.

212.2.2
If the shape and dimensional requirements of any block of the sample does not comply with 203, then the lot represented by that sample shall be deemed not to comply and may be rejected. Such lots shall not be sold as complying with this Standard.

212.3 Compliance with compressive strength requirements

212.3.1
The characteristic compressive strength shall be calculated as the mean value of the compressive strength of the sample minus 0.35 times the sample range (difference between the largest and smallest value obtained from the sample).

212.3.2
The lot represented by a sample selected as set out in 211 shall be deemed to comply with the compressive strength requirement of this Standard if the characteristic compressive strength is not less than 40 MPa when tested in accordance with Appendix B.

212.3.3
If the characteristic compressive strength of a sample is less than 40 MPa, then the lot represented by that sample shall be deemed not to comply and may be rejected. Such lots shall not be sold as complying with this Standard.

NOTE – In order to have a 95 % probability that random lots are accepted by the above scheme, the manufacturer should ensure that the compressive strength of no more than 4.3 % of blocks manufactured fall below 40 MPa. A summary of the test records required by 207.3 should be kept, preferably in the form of control charts (see BS 2564).

212.4 Compliance with tensile splitting strength requirements

212.4.1
The tensile splitting strength shall be determined by the method set out in Appendix C. The characteristic tensile splitting test shall be calculated as the mean value of the tensile splitting strengths of the sample minus 0.35 times the sample range.

212.4.2
The lot represented by a sample selected as set out in 211 shall be deemed to comply with the optional tensile splitting strength requirements of this Standard if the characteristic tensile splitting strength for the sample at the time of delivery is not less than 4.5 MPa when tested in accordance with Appendix C.

212.4.3
Where the characteristic tensile splitting strength for the sample is less than 4.5 MPa the lot represented by that sample may still qualify for compliance with this Standard providing the purchaser has not specified that 209.2 shall apply.

212.5 Compliance with flexural tensile strength requirements

212.5.1
The flexural tensile strength shall be determined by the method set out in Appendix D. The

characteristic flexural tensile strength shall be calculated as the mean value of the flexural tensile strengths of the sample minus 0.35 times the sample range.

212.5.2
The lot represented by a sample selected as set out in 211 shall be deemed to comply with the optional flexural tensile strength requirements of this Standard if the characteristic flexural tensile strength for the sample at the time of delivery is not less than 6.0 MPa when tested in accordance with Appendix D.

212.5.3
Where the characteristic flexural tensile strength for the sample is less than 6.0 MPa the lot represented by that sample may still qualify for compliance with this Standard providing the purchaser has not specified that 209.3 shall apply.

PART 3
CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF INTERLOCKING CONCRETE BLOCK PAVING

301 SCOPE

301.1
This Code of practice sets out the requirements for the design and construction of interlocking block paving for a range of blocks used under New Zealand conditions, using interlocking paving blocks complying with Part 2 of this Standard.

NOTE – This Code of practice could be used for paving with other forms of paving blocks. However, the full advantage of interlock can be obtained when paving blocks comply with Part 1 of this Standard. This is essential for important pavements and those with a heavy density of traffic.

302 PAVEMENT THICKNESS DESIGN

302.1
The structure of the pavement shall be designed in accordance with recognized pavement design practice, using a pavement thickness appropriate to the subgrade strength and traffic loading.

302.2
For small projects basecourse and block thicknesses may be determined from table 1; other applications may warrant specific design. Subgrade strength classifications in table 1 are as follows:

Classification	Typical materials	Minimum CBR*
Weak	Clay and silt	4
Medium	Silty or 'clayey' gravel or sand	7
Strong	Dense sand or gravel or old pavement	15

* California Bearing Ratio in accordance with section 6.1 of NZS 4402.

Table 1 – Pavement thickness

Traffic loading classification	Basecourse thickness (mm)			Minimum paving block thickness (mm)
	Weak subgrade	Medium subgrade	Strong subgrade	
Light vehicular †	180	100	NIL	60
Normal highways	300	200	100	80
Heavy duty	Should be subject to specific design			80 or 100

† Assumes occasional heavy trucks.

NOTES to table 1

(1) In some applications a paving block thickness of 100 mm may be desirable for heavy duty traffic.

(2) Many areas that are nominally non-vehicular can be subjected to occasional heavy loadings, for

example, most pedestrian malls provide access for fire appliances, which often have high wheel loadings. Goods service vehicles often park on footpaths to unload. It is therefore recommended that most non-vehicular areas be designed for light vehicular use.

(3) Thicknesses assume good construction practices.

303 LAYING PATTERNS

303.1
The shape of paving block and laying patterns shall be suitable for the traffic loading classification. For heavy duty and normal highway use, the laying pattern shall be herringbone. Any of the three basic patterns illustrated in figure 2 may be used for lighter loading unless specified otherwise.

NOTE – The possible laying patterns are a function of the shape of the paving block. Most blocks can be laid in any of the three basic patterns – herringbone, stretcher bond and basketweave (or parquet). The herringbone pattern is the most satisfactory as it resists movements of the blocks in both plan directions. A herringbone pattern laid at 45° to the traffic direction has been found to be most successful in resisting loads, including braking forces in heavy industrial applications.

304 DRAINAGE

304.1 Surface grades

304.1.1
The following minimum surface grades shall be provided unless specified otherwise:

(a) Roads – 3 % crossfall;

(b) Other paved areas – $2^1/_2$ % crossfall.

NOTE – Architectural considerations may dictate flatter slopes e.g. 2 %. In these circumstances extra care will be needed in construction to avoid ponding.

304.2 Drainage channels

304.2.1
Side channels, gully drains and central drain channels shall be provided as required for the removal of surface water. The form of these drainage channels shall meet the requirements of the local authority.

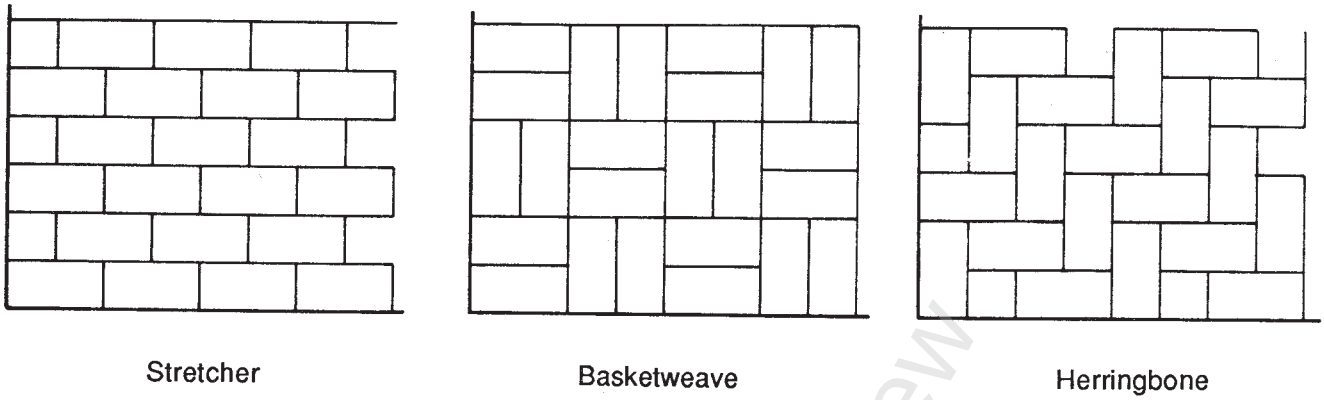
NOTE – Details of drainage channels are set out in local authority codes of practice for urban subdivision works (see NZS 4404). Where central drains are required in large areas, these can often form the abutments required by 305.2.

304.3 Pavement structure drainage

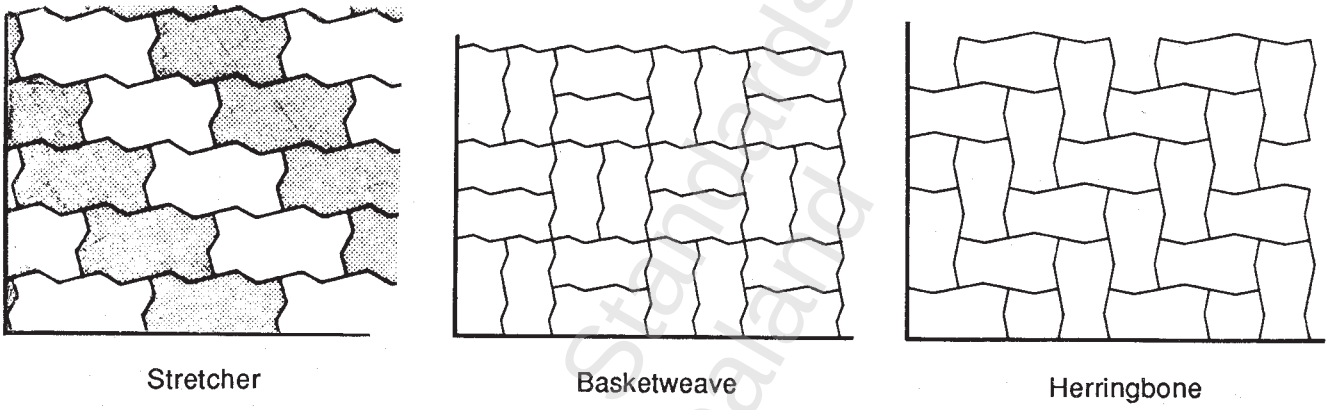
304.3.1
The pavement structure shall be designed so that drainage of the pavement layers is provided by adequate material permeability and internal flow gradients. Pavement layers shall either discharge to a feather edge, or to pavement drains. Pavement drains shall be located so that internal flow paths are not longer than 5 m. They shall also be located at all low points in large paved areas.

NOTE –

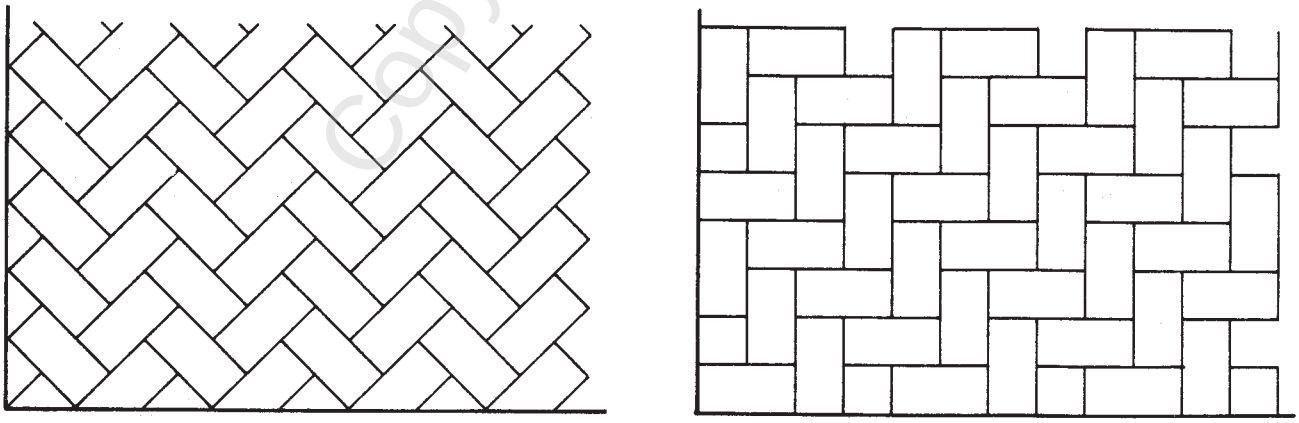
(1) Pavement structure drainage needs careful consideration because block paving is subject to high infiltration for the first few months after laying. If adequate drainage is not provided, the resulting saturation of the basecourse and subgrade will lead to a reduction of support strength and possibly pavement distress. The rate of infiltration gradually falls off with time, as the joints between the blocks tend to become sealed. Pavements with larger crossfalls will have better internal drainage than those



(a) Block laying patterns (plain blocks)



(b) Block laying patterns (dentated blocks)



(c) Use of herringbone pattern of laying (45° and 90°)

Figure 2 – Paving block laying patterns

with lower crossfalls, and therefore pavement structure drainage should be a consideration when deciding on surface grades.

(2) Methods for construction of subsoil drains are given in TNZ F/2 and TNZ F/6.

305 KERBS AND ABUTMENTS

305.1
Edge restraint shall be provided at the perimeter of the paved area to confine the paving blocks. Edge restraint may be in the form of a kerb, kerb and channel, rigid abutment, or established structure. Kerbs and abutments shall extend at least 50 mm below the bedding sand, and other details shall meet the requirements of the local authority.

305.2
When the slope of the pavement exceeds 1 in 8, intermediate abutments shall be provided at a maximum spacing of 30 m and finished at pavement surface level.

NOTE – Edge restraint is necessary to prevent the outward migration of paving blocks, resulting in the opening of joints and loss of interlock.

306 SUBGRADE PREPARATION

306.1 General

306.1.1
The subgrade shall be shaped and trimmed to the specified profile and levels and compacted to provide uniform support for the pavement. The compacted subgrade shall be checked for strength and uniformity and any weak areas excavated and replaced with suitable material.

NOTE – Compaction of the subgrade is desirable to minimize future settlement under traffic loading and to improve the shear strength of the soil. All subgrades should be given at least a light rolling, with more compaction for the heavier loadings. It is important that the subgrade be uniform in strength otherwise uneven settlement may occur leading to possible ponding or uneven riding. Methods of subgrade preparation, compaction and testing are outlined in RRU TR1. Improvement of the subgrade by stabilisation with lime or cement or other stabilising materials should be considered for weak soils. Geotextiles can also offer worthwhile benefits when placed over weak subgrades. Detailed methods are set out in RRU TR2 and TR5.

306.2 Tolerances

306.2.1
Subject to 306.2.2 the tolerances for surface finish for the subgrade shall be +0, –20 mm for level at a point and 15 mm departure from a 3 m straightedge or template in any direction. In addition the subgrade shall not pond water.

306.2.2
Where the bedding layer is to be laid directly on the subgrade, the requirements of 307.3 shall apply to the subgrade instead of those of 306.2.1.

307 BASECOURSE

307.1 Material
The basecourse, and sub-base where used, shall consist of graded granular material with hard durable particles free from organic material, or equivalent stabilized material.

NOTE – The principles of selection of material suitable for a basecourse are given in TNZ M/3 Notes. The lower part of the basecourse may need to act as a transition layer between a clay subgrade and the granular basecourse to prevent intrusion of clay. Alternatives to a transition layer include stabilization of the subgrade and use of a geotextile.

307.2 Compaction

The basecourse, and sub-base where used, shall be constructed in layers not exceeding 150 mm compacted thickness. Each layer shall be compacted to a uniform dense condition especially at manholes, kerbs and abutments.

NOTE – For the heavier traffic loadings, basecourse construction should be in accordance with TNZ B/2. Particular attention is necessary to the compaction and surface texture of the material to prevent migration of the bedding sand.

307.3 Tolerances

The tolerances for surface finish for the basecourse, and sub-base where used, shall be ±10 mm for level at a point, and 8 mm departure from a 3 m straightedge or template in any direction. In addition the surface shall not pond water.

308 BEDDING COURSE

308.1 Bedding sand

308.1.1

When tested by the method described in Test 2.8.2 of NZS 4402, a bedding sand shall be well graded within the limits given in table 2.

Table 2 – Grading limits for bedding sand

Sieve size	Percent passing
9.52 mm	100
4.75 mm	95–100
2.36 mm	80–100
1.18 mm	50–95
600 µm	25–60
300 µm	10–30
150 µm	0–15
75 µm	0–10

308.1.2

The sand may have rounded or angular grains and shall be permeable after compaction. The percentage passing a 75 µm sieve shall be non-plastic. The sand shall be hard and durable and shall have not more than 2.5 % by weight of lightweight particles as determined by NZS 3111, section 9. Where the aesthetic appearance of the pavement is important, the sand shall be free of deleterious soluble salts or other contaminants.

NOTE – Angular grains are preferred because they give a more stable material. However they require more careful water content control and compaction. Sand from a single source is desirable to minimize problems with different compaction characteristics. Well graded sands are preferred.

308.2 Storage

308.2.1

Bedding sand shall be stored in such a manner that it can be reclaimed without contamination. The storage area shall be free draining and the sand shall be protected against the rain when stockpiled, so that the water content is uniform.

308.3 Laying the bedding sand

308.3.1 *Method 1. Sand surcharge*

308.3.1.1
Bedding sand shall be laid loose with the aid of screeds over the prepared sub-base or subgrade to a depth, dependent on the grading characteristics of the sand and its water content, that will give a nominal compacted thickness of 30 mm. The surcharge required shall be checked by initial compaction of the first few metres of paving and checking the surface levels so obtained. If the levels are not correct, the paving blocks shall be lifted and the sand raked and rescreeded at an adjusted surcharge. The required surcharge shall continue to be checked throughout the paving. Temporary screed boards shall be used where screed widths exceed 5 m.

NOTE – The bedding sand on which the paving blocks are laid must have a uniform density and thickness so that settlement under compaction is even. The loose layer will generally be 5 to 15 mm thicker than the required compacted thickness. The loose density of sand in a damp condition is reasonably stable over a range of water contents but for sand approaching the dry condition or the saturated condition, loose density is very sensitive to water content change.

308.3.1.2
During laying, the bedding sand in each area of paving shall be at a uniform water content. The sand shall be protected against any form of compaction or passage of traffic until the paving blocks are laid and have been given initial compaction. Any sand accidentally compacted shall be raked and rescreeded in a loose condition.

308.3.1.3
A minimum extent only of bedding sand shall be placed ahead of the block laying to avoid compaction problems and under no circumstances shall bedding sand be placed so that it cannot be covered with paving on the same day.

308.3.2 *Method 2. Sand precompaction*
The sand bedding shall be spread and fully compacted by several passes of a motorised vibratory compactor. The top surface of the fully compacted sand shall then be screeded back to a compacted thickness of 15 mm – 25 mm. Any depressions exceeding 5 mm shall be overfilled with sand and recompacted and the area then rescreeded. Upon completing these screeding operations a 5 mm layer of uniformly loose sand shall be screeded or loosely scattered on top of the precompacted sand bed.

308.4 Herbicides
In light traffic areas, herbicidal treatment should be applied to the bedding sand prior to block laying to prevent weed growth.

309 SURFACE COURSE

309.1 Layout

309.1.1
Paving blocks shall be laid together to the specified pattern on the screeded bedding layer. String lines shall be set up in two directions at not more than 5 m centres to ensure joint lines are straight and square.

309.1.2
Joint widths between blocks shall comply with the following:

90 % of joint widths shall be within the range 2–4 mm.
The minimum width shall be 1 mm.
The maximum width shall be 5 mm.

Where blocks with raised spacer nibs are used, the above joint widths shall apply to the portions of blocks that are not raised.

NOTE – Raised spacer nibs ensure an adequate minimum joint width for jointing sand penetration, which in turn inhibits block spalling and encourages lock-up. It is acceptable for the raised spacer nibs to touch the adjacent blocks after laying.

309.2 Placing order and infills

309.2.1
All full units shall be laid first then closures to perimeter areas and around drainage and other structures filled subsequently with part blocks having plan dimensions in two perpendicular directions not less than 50 mm.

309.2.2
Remaining spaces shall be infilled after initial compaction using concrete of strength not less than 25 MPa.

309.2.3
Where there are slopes, laying shall proceed uphill.

309.3 Block thickness
The maximum variation in block thickness between any two paving blocks that will be adjacent when laid shall be 2 mm.

309.4 Initial compaction

309.4.1
The compactor used for initial compaction of the paving shall be a mechanical flat plate vibrator having characteristics as follows:

Block pavement usage	Minimum plate compaction characteristics
Pedestrian only areas Private driveways	Standard plate compactor(s): 60–120 kg static weight 10–24 kN centrifugal force
All other uses, especially: Pedestrian areas subject to heavy vehicles, Industrial collector streets, Industrial areas, Residential collector streets	Heavy duty plate compactor(s) 300–600 kg static weight 30–65 kN centrifugal force

NOTE –

(1) The purpose of vibratory compaction on the newly laid concrete blocks is to compact the damp bedding sand for shear strength and so that it will not further compact under heavy traffic when fully saturated, to eliminate “lipping” of adjacent blocks, and to force bedding sand particles into the bottom of the joints between blocks to encourage “lock-up”. Compaction reduces the likelihood of loss of pavement shape, hence it is particularly important on flatter pavements.

(2) The use of heavy duty plate compaction is recommended for all pavements that will be exposed to trucks or other heavy vehicles. It is also recommended for all pavements where the bedding sand has been laid by the sand precompaction method of 308.3.2.

(3) Static weight and centrifugal force is used as a quick reference means of defining vibratory compactors. It is recognized that centrifugal force is not a technically correct means of defining compactability.

309.4.2
The paving blocks shall be settled into the bedding layer and the bedding compacted by not less than two passes at right angles to each other of the plate compactor. Compaction shall follow as closely as possible after laying but shall not come within 1 m of the laying face.

NOTE –

(1) An alternative to heavy duty plate compactors is to give at least 2 passes of a standard plate compactor over the blocks, followed by 2 to 6 passes of a vibrating roller or pneumatic tyred roller. The roller passes should be after construction of the jointing sand. To limit the risk of damage to the blocks yet still provide compaction, suitable rollers would include 7 to 14 tonne pneumatic tyred rollers, or vibratory rollers with rubber coated drums, or ride-on vibratory rollers of both static weight less than 4 tonnes and nominal amplitude less than 0.6 mm.

(2) It is important that the bedding sand is compacted as soon as practicable after block laying to avoid migration of sand in the loose condition due to the displacement of the poorly supported blocks, or the ingress of water.

309.4.3
All paving shall be left compacted at the completion of each day's laying to within 1 m of the laying face.

309.4.4
All blocks damaged during compaction shall be immediately removed and replaced with sound blocks.

309.4.5
Pedestrian traffic may use the paving after initial compaction but heavier loads shall not be applied until the joints have been filled.

310 JOINT FILLING

310.1 Joint sand

310.1.1
The sand used for filling joints between paving blocks shall consist of hard durable particles and shall be broadly graded within the limits given in table 3.

Table 3 – Grading limits for joint sand

Sieve size	Percent passing
2.36 mm	100
1.18 mm	90 – 100
600 µm	55 – 100
300 µm	15 – 60
150 µm	3 – 30
75 µm	0 – 5

310.1.2
Joint sand shall be free of all soluble deleterious salts and other contaminants. The percentage passing a 75 mm sieve shall be non-plastic. The sand shall have not more than 2.5 % by weight of lightweight particles as determined by NZS 3111, section 9.

NOTE –

(1) For more heavily trafficked pavements a well (broadly) graded sand is preferred. For lightly trafficked pavements a more uniformly graded (near single sized) sand can be used.

(2) Soluble salts can contribute to efflorescence.

(3) For pavements on steep slopes a well graded jointing sand will resist water induced scour better than a near single sized sand.

310.1.3
At the time of joint filling, the sand shall be dry enough to be free running.

310.2 Placing sand

310.2.1
As soon as practicable after the initial compaction of the blocks and infilling of closures, joint sand shall be swept across the paving blocks and introduced into the joints by further passes of a compactor. Joints shall be completely filled with dense sand. Compactors other than plate vibrators may be used at this stage.

NOTE –

(1) Once joints are filled it is very difficult to adjust the pavement profile. Final joint filling cannot be completed until all closures (including cast *in situ* concrete and mortar closures) to kerbs and other boundaries have been done. If construction traffic must use the pavement before closures have been completed, then joint filling short of the closures but significantly beyond the wheel tracks may be used.

(2) Traffic is beneficial to the development of interlocking strength of the block paving as the flexing action densifies the joint filling to an extent which is not possible by vibration. The best performing pavements will be obtained from areas which have been alternatively used by traffic and resanded and revibrated to ensure a regular even surface and densely filled joints.

310.2.2
Joints shall be inspected between 1 and 3 days after sanding and after trafficking, and resanded and revibrated as necessary. Reinspection and topping up shall continue at intervals between 1 and 2 weeks until two such inspections show no loss or settlement of joint sand.

310.2.3
Excess sand shall be removed from the pavement following the final inspection.

311 FINAL SURFACE TOLERANCES

311.1
The final surface of the paving shall be within ±10 mm of the design level provided that the surface level is at least 5 mm above drainage channels or gully entries and continuously graded towards them. The surface shall not pond water. The deviation from a 3 m straightedge or template shall not exceed 8 mm and the difference in level between adjacent paving blocks shall not exceed 2 mm.

NOTE – For pedestrian areas, surface levels of the paving adjacent to any fittings or edges may require tighter tolerances.

APPENDIX A
METHOD OF MEASUREMENT OF DIMENSIONS AND PLAN AREA

A1 Scope

This Appendix sets out test procedures for the determination of the following parameters of interlocking paving blocks:

(a) Thickness, length and width (see A2);

(b) Squareness (see A3);

(c) Net plan area (see A4).

A2 Determination of thickness, length and width

A2.1 *Apparatus*

Means of measuring blocks to an accuracy of 0.1 mm such as vernier callipers.

A2.2 *Procedure*

A2.2.1

General. Sets of measurements on blocks of any particular type shall be made in the same relative positions. Record all measurements to the nearest 1 mm.

A2.2.2

Thickness. Measure the thickness of blocks at three positions, one measurement to be at the middle and one near to each end.

A2.2.3

Length. Measure the length of blocks at two positions, one measurement to be at the middle and one near to one side.

A2.2.4

Width. Measure the width of blocks at three positions, one measurement to be at the middle and one near to each end.

A3 Determination of squareness

A3.1 *Apparatus*

(a) A profiled template or an engineer's square complying with BS 939,

(b) Feeler gauges capable of measuring to an accuracy of 0.1 mm.

A3.2 *Procedure*

With the stock of the square or the profiled template in contact with the top or bottom face of the block, bring the blade into contact with the side of the block. Measure with the feeler gauges the clearance, if any, between the square or profiled template and the side of the block at 10 mm from the top and bottom edge. Take measurements at 6 different points spaced approximately equally around the block. Record the measurements at each point to the nearest 0.5 mm.

A4 Determination of net plan area

A4.1 *Apparatus*

(a) Means of measuring blocks to an accuracy of 0.1 mm such as vernier callipers;

(b) Graph paper having square size 1 mm or 2 mm (Method 2 only);

(c) Planimeter (Method 3 only)

A4.2 *Method 1: Rectangular paving blocks only*
Take two measurements of the length and three measurements of the width of the top surface excluding chamfers to the nearest 0.5 mm and record the average values. Record the net area to the nearest 10 mm^2.

A4.3 *Method 2: Blocks of any shape*
Place the block with top surface uppermost on a sheet of graph paper and trace around the block with a sharp pencil. Remove the block and measure the width of chamfer on each side of the top face using the vernier callipers. Draw a second line inside the first and at a distance equal to the measured width of the chamfers. Count the number of squares on the graph paper inside the smaller area. Record the net area to the nearest 10 mm^2.

A4.4 *Method 3: Blocks of any shape*
Use the same procedure as Method 2 but using plain paper instead of graph paper. Measure the small area with a planimeter and record to the nearest 10 mm^2.

APPENDIX B
METHOD FOR THE DETERMINATION OF COMPRESSIVE STRENGTH

B1 Scope

This Appendix sets out the test procedure for the determination of compressive strength of concrete interlocking paving blocks.

B2 Apparatus

B2.1

A compression testing machine complying with section 6 of NZS 3112:Part 2. Where the bearing area of a platen is not sufficient to cover the bearing area of the block an auxiliary steel bearing plate meeting the requirements of B2.2 shall be placed between the platen and the block.

B2.2

Auxiliary bearing plates shall have a thickness equal to at least one-third of the distance from the edge of the platen to the most distant corner of the block, but in no case less than 10 mm. The surfaces of the steel platens and the auxiliary bearing plates shall not depart from a plane by more than 0.03 mm in any 150 mm dimensions.

B3 Procedure

(a) Immerse each paving block in water at 21 ± 5 °C for a period of at least 24 h but for not more than 72 h immediately prior to testing;

(b) Prior to testing, determine the gross dimensions of the paving block and the net area of the top surface excluding chamfers;

(c) Wipe the platens of the testing machine clean and remove any loose grit or other material from the top and bottom faces of the paving block;

(d) Place nominal 10 mm soft board packing sheets larger than the paving block by at least 5 mm at all points between the platens and the paving block. Use the packing once only;

(e) Place the paving block symmetrically between the platens of the testing machine with the top surface as laid uppermost;

(f) Apply the load without shock at a constant rate to apply stress within the range 10 to 20 MPa/min until no greater load can be sustained. Record the maximum load indicated by the testing machine at failure.

B4 Calculations

(a) Calculate the compressive strength of the paving block, f_c, from the following formula:

$$f_c = \frac{W.K}{A} \quad \text{..... MPa}$$

where

W is the failure load (N)
A is the net plan area of the block excluding chamfers (mm^2) obtained by method A4
K is a factor which is dependent on the thickness of the block as set out in the following table:

Nominal thickness mm	Factor, K
60	0.90
80	1.00
100	1.14
120	1.22

(b) Calculate the characteristic compressive strength, F_c of the sample of 5 paving blocks from the formula:

$$F_c = \overline{f_c} - 0.35\,R$$

where

$\overline{f_c}$ is the mean value of the compressive strength of the 5 blocks comprising the sample (MPa)

R is the sample range (difference between the largest and smallest value of strength) (MPa).

B5 Records

Record the following for each sample of paving blocks tested:

(a) Lot number;

(b) Date of manufacture;

(c) Date of test;

(d) The measured gross dimensions of each block to the nearest millimetre;

(e) The net area of the top surface of each block, excluding chamfers;

(f) The maximum applied load in kilonewtons for each block;

(g) The compressive strength of each block to the nearest 0.1 MPa;

(h) The mean compressive strength of the sample;

(j) The sample range;

(k) The characteristic compressive strength to the nearest 0.5 MPa.

APPENDIX C
METHOD FOR THE DETERMINATION OF TENSILE SPLITTING STRENGTH

C1 Scope

This Appendix sets out the test procedure for the determination of the tensile splitting strength of concrete interlocking paving blocks. The method is not suitable for other than rectangular blocks.

C2 Apparatus

(a) A compression testing machine complying with section 6 of NZS 3112:Part 2;

(b) Packing strips of plywood or hardboard, 15 ±2 mm wide, nominal 3 mm thick and length not less than the length of the line of contact of the test specimen;

(c) Two steel loading pieces of length not less than the length of the line of contact of the test specimen and with a cross section in the shape of a segment of a circle of radius 75 mm.

The positioning of the paving block in the testing machine is shown in figure C1.

C3 Procedure

(a) Immerse each paving block in water at 21 ±5 °C for a period of at least 24 h, but not more than 72 h immediately prior to testing;

(b) Unless a positioning device is used, mark the block with lines on the top and bottom faces with respect to the position as laid, and along which the load is to be applied. These lines shall be opposite to each other in a vertical plane and at a distance of half the thickness of the block ±1 mm from one end. Connect the extremities of the two lines across the sides of the block so as to clearly define the plane of loading (see figure C1).

(c) Measure the overall width of the block along the two lines of contact to the nearest millimetre and record the average of the two measurements (b). Measure the thickness of the block in the plane containing the marked lines, to the nearest millimetre, near the ends and at the middle of the lines, and record the average of the three measurements (d).

(d) Wipe clean the platens of the testing machine, the steel loading pieces and the packing strips, and remove any loose grit or other material from the surfaces of the block which are to be in contact with the packing strips;

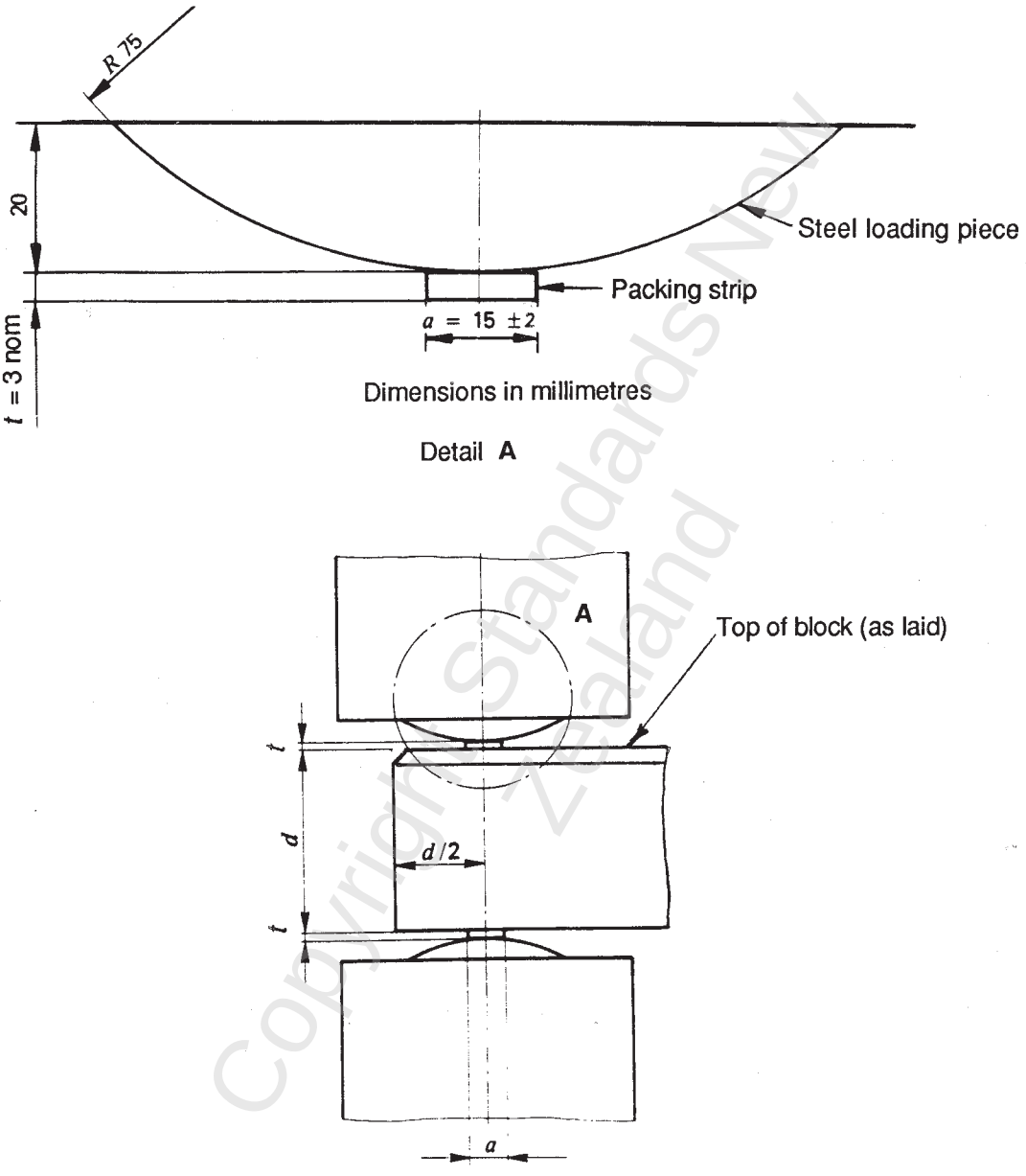
(e) Place the block in the testing machine upright with respect to its position as laid, with the plane of loading as marked on the block central on the axis of the machine, the packing strips and the steel loading pieces, as shown in figure C1. Make sure by blocking the spherical head of the machine and by supporting the unloaded end of the block that the block remains centred when the load is first applied. Remove the blocks and supports for the remainder of the test.

(f) Apply the load without shock at a constant rate to apply stress within the range 2 to 4 MPa/min until failure. The testing time shall be at least 30 s. Record the maximum load indicated by the testing machine at failure (W) to the nearest 100 N.

C4 Calculations

(a) Calculate the tensile splitting strength, f_{st} of each paving block from the formula:

$$f_{st} = \frac{2W}{\pi bd} \quad \text{..... MPa}$$



(k) The characteristic tensile splitting strength to the nearest 0.1 MPa.

where

W is the maximum load at failure (N)
b is the average of the overall width of the block measured along the lines of contact on the top and bottom faces (mm)
d is the average thickness of the block in the plane of loading (mm)

(b) Calculate the characteristic tensile splitting strength, F_{st} of the sample of 5 paving blocks from the formula:

$$F_{st} = f_{st} - 0.35\,R$$

where

f_{st} is the mean value of the tensile splitting strengths of the 5 blocks comprising the sample (MPa)
R is the sample range (difference between the largest and smallest value of strength) (MPa).

C5 Records

Record the following for each sample of paving blocks tested:

(a) Lot number;

(b) Date of manufacture;

(c) Date of test;

(d) The measured gross dimensions of each block to the nearest millimetre;

(e) The dimensions of each block in the plane of loading to the nearest millimetre;

(f) The maximum applied load in kilonewtons for each block;

(g) The tensile splitting strength of each block to the nearest 0.05 MPa;

(h) The mean tensile splitting strength of the sample;

(j) The sample range;

Figure C1 – Positioning of paving block in testing machine for the tensile splitting test

APPENDIX D
METHOD FOR THE DETERMINATION OF FLEXURAL TENSILE STRENGTH

D1 Scope

This Appendix sets out the test procedure for the determination of the flexural tensile strength of concrete interlocking paving blocks. The method is not suitable for other than rectangular blocks.

D2 Apparatus

(a) A compression testing machine complying with section 6 of NZS 3112:Part 2.

(b) Three steel rollers nominal 30 mm diameter and length not less than the width of the paving block.

(c) Packing strips of plywood or hardboard 15 ±2 mm wide, nominal 3 mm thick and length not less than the width of the paving block.

(d) Where the contact surfaces of the steel rollers extend beyond the bearing areas of the upper or lower plattens of the testing machine, an auxiliary bearing plate of dimensions sufficient to fully support the rollers without distortion under load.

The positioning of the paving block in the testing machine is shown in figure D1.

D3 Procedure

(a) Immerse each paving block in water at 21 ±5 °C for a period of at least 24 h, but not more than 72 h immediately prior to testing;

(b) Unless a positioning device is used, mark the top surface of the block with respect to its position as laid with a line perpendicular to the length and at mid length of the block. Mark the bottom surface with two lines perpendicular to the length, 150 mm apart and equidistant from the centre line marked on the top surface.

(c) Measure the width of the block across the bottom surface directly below the centre line marked on the top surface to the nearest millimetre and record (b). Measure the depth of the block on the centre line near each side and at the middle to the nearest millimetre and record the average of the measurements (d).

(d) Wipe clean the platens of the testing machine, the steel rollers and the packing strips, and remove any loose grit or other material from the surfaces of the block which are to be in contact with the packing strips.

(e) Place the block in the testing machine as shown in figure D1 with the top surface with respect to its position as laid uppermost. Ensure that the block, rollers and packing are positioned symmetrically with respect to the axis of the machine. By blocking the spherical head of the machine and by wedging the block, ensure that the latter remains centred when the load is first applied. Remove the blocks and wedges for the remainder of the test to ensure that the rollers are free to rotate.

(f) Apply the load without shock at a constant rate to apply stress within the range 2 to 4 MPa/min until failure. The testing time shall be at least 30 s. Record the maximum load indicated by the testing machine at failure (W) to the nearest 100 N.

D4 Calculations

(a) Calculate the flexural tensile strength, f_{bt} of each paving block from the formula:

$$f_{bt} = C \frac{W}{bd^2} \quad \text{..... MPa}$$

where

W is the maximum load at failure (N)
b is the width across the bottom of the block directly below the line of application of the load (mm)
d is the average depth of block below the line of application of the load (mm)
C = 225 mm, being 3/2 x the distance between the centres of the support rollers.

(b) Calculate the characteristic flexural tensile strength, F_{bt} of the sample of 5 paving blocks from the formula:

$$F_{bt} = f_{bt} - 0.35\,R$$

where

f_{bt} is the mean value of flexural tensile strengths of the 5 blocks comprising the sample (MPa)
R is the sample range (difference between the largest and smallest value of strength) (MPa).

D5 Records

Record the following for each sample of paving blocks tested:

(a) Lot number;

(b) Date of manufacture;

(c) Date of test;

(d) The measured gross dimensions of each block to the nearest millimetre;

(e) The width across the bottom of each block and the average depth of each block, below the line of loading;

(f) The maximum applied load in kilonewtons for each block;

(g) The flexural tensile strength of each block to the nearest 0.05 MPa;

(h) The mean flexural tensile strength of the sample;

(j) The sample range;

(k) The characteristic flexural tensile strength to the nearest 0.1 MPa.

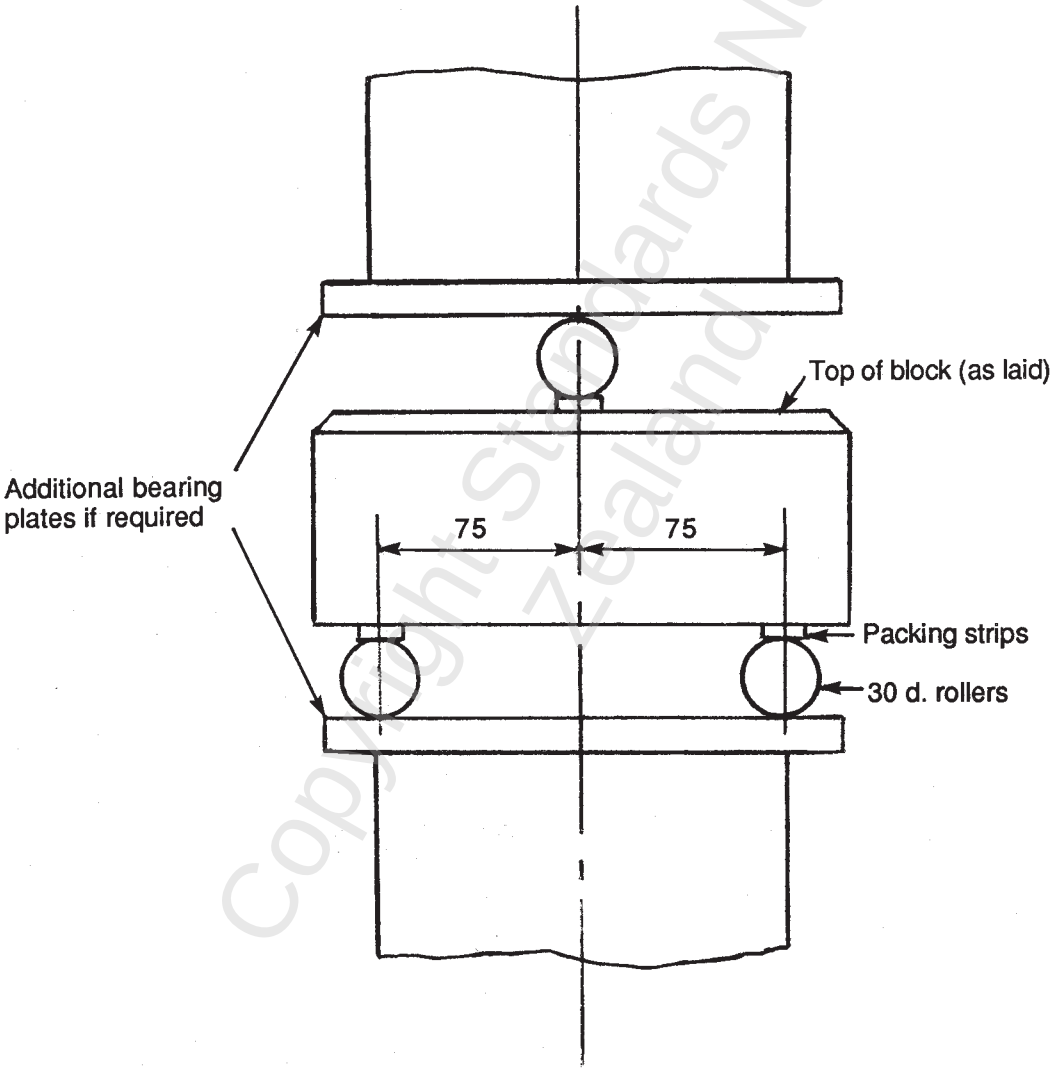


Figure D1 – Positioning of paving block in testing machine for the flexural tensile test

THE NEW ZEALAND STANDARD CERTIFICATION MARK SCHEME

The 'S' Mark appearing on a product, container or label is an assurance that the goods are manufactured under a system of supervision, control, and testing (including periodical inspection at the manufacturer's works by SANZ Certification Officers) designed to ensure compliance of the commodity, process, or practice with the relevant New Zealand Standard. The New Zealand Standard Certification Mark, registered as a certification trade mark under the Trade Marks Act 1953, may be used only in terms of a licence issued by SANZ, and must be accompanied by the licence number and the NZS number.

Used correctly in conjunction with advertising the 'S' Mark can provide a strong assurance of product quality for a manufacturer when selling his goods and thus becomes a powerful marketing tool.

Manufacturers may obtain particulars of the conditions of licensing from the Quality Services Manager, Standards Association of New Zealand, Private Bag, Wellington.

Approved by the Standards Council on 2 August 1991 to be a New Zealand Standard pursuant to the provisions of section 10 of the Standards Act 1988.

First published: 18 September 1991

The following SANZ references relate to this Standard.

Project No. P 3116
Draft for comment No. DZ 3116
CPT ref: KMcI 20
Printing code: 500-1991/7010/2248
Typeset by: SANZ
Printed by: Wright & Carman Ltd.

NZS 3116:1991