NZTA B10: 2023

Specification for Hi-Lab Pavement Design, Production and Construction

WAKA KOTAHI
NZ TRANSPORT AGENCY

Te Kāwanatanga o Aotearoa
New Zealand Government

General

Scope

This specification describes the materials quality and construction methodology for a new heavy duty pavement design and construction method, referred to as **Hi**gh strength **L**ow fines **A**ggregate **B**ase (Hi-Lab). The pavement structure consists of a very densely packed and interlocked, mainly single sized large aggregate skeleton, combined with a low cement and fines void filler. Hi-Lab can be used for new construction or rehabilitation overlays.

This specification covers the following elements in the production and construction of a Hi-Lab pavement layer:

(a) Materials
(b) Plant and equipment
(c) Production plan
(d) Supply of aggregate to site
(e) Initial placement of aggregate
(f) Spreading of cement
(g) Mixing process (stabilisation)
(h) Compaction and finishing
(i) Post construction testing

Definitions

Hi-Lab 65

Cement-bound layer consisting of good quality crushed stone with a specified particle size distribution of nominal maximum stone size of 63mm. It is intended to be used as a base and/or subbase layer in a rigid pavement application with a 200mm – 250mm layer thickness.

Hi-Lab 40

Cement-bound layer consisting of good quality crushed stone with a specified particle size distribution of nominal maximum stone size of 37.5mm. It is intended to be used as basecourse in a rigid pavement application with a 150mm - 200mm layer thickness.

Referenced Documents

Waka Kotahi NZ Transport Agency

(a) NZTA B02 Specification for Construction of Unbound Granular Pavement Layers
(b) NZTA B05 Specification for In-Situ Stabilisation of Modified pavement Layers
(c) NZTA B06 Specification for In-Situ Stabilisation of Bound Sub-Base Layers
(d) NZTA M04 Specification for Basecourse Aggregate
(e) NZTA M10 Specification for Dense Graded Asphaltic Concrete
(f) NZTA M27 Specification for Stone Mastic Asphalt
(g) NZTA P11 Specification for Open-Graded Porous Asphalt
(h) NZTA T01 Standard test Procedure for Benkelman Beam Deflection Measurements
(i) NZTA T15 Specification for Repeated Load Triaxial Testing for Pavement Materials
(j) NZTA T19 Procedure for Design and Indirect Tensile Strength Testing of Modified and Bound Pavement Materials
(k) NZTA T20 Ethylene Glycol Accelerated Weathering Test
(l) NZTA Technical Memorandum TM 7003 v1 Roughness requirements for Finished Pavement Construction
(m) NZTA Research Report 463, Development of Tensile Fatigue Criteria for Bound Materials
(n) NZTA Z08 Standard for Inspection, Sampling and testing

Standards New Zealand

(a) NZS 3111 Methods of Test for water and Aggregate for Concrete
(b) NZS 3121 Water and Aggregate for Concrete
(c) NZS 3122, Specification for Portland and Blended Cements (General and Special Purpose)
(d) NZS 4402 Methods of Testing Soils for Civil Engineering Purposes
(e) NZS 4407 Methods of Sampling and Testing Road Aggregates
(f) NZS ISO/IEC 17025, General requirements for the Competence of Testing and Calibration Laboratories.

Other

(a) ASTM D3665 Standard Practice for Random Sampling of Construction Materials
(b) Austroads Test Method AG:AM/T001 Pavement Roughness Measurement with an Inertial Profilometer
(c) Civil Contractors New Zealand CCNZ BPG05 “Quality Assurance of Aggregates for Roads”
(d) Standards Australia AS 1141.15, Methods for Sampling and Testing Aggregates. Method 15 Flakiness Index.

Materials

General

All sampling and testing shall be carried out by a laboratory accredited to NZS ISO/IEC 17025.

Aggregate Source Rock Properties

Source Properties

The Hi-Lab aggregate shall be crushed from quarried rock and consist of hard, sound material of uniform quality, free from soft or disintegrated stone or other deleterious material. Source property testing shall be performed at a rate of at least one test for every 10,000m³ of source material for use on site unless stated otherwise in the contract document.

The aggregate components used to produce the Hi-Lab aggregate blend shall have the following properties:

Table 0.1 Aggregate Source Rock Quality Requirements

Test Property	Test Method	Requirements
Crushing Resistance	NZS 4407 Test 3.10	< 10% Fines @ 160kN
Weathering Quality Index	NZS 4407 Test 3.11	AA, AB, AC, BA, BB or CA
Ethylene Glycol Accelerated Weathering Index (see Note below)	NZTA T20	Proportional change < 30%

Note: If the result for the source rock exceeds 30%, further testing to detect the presence of smectite clays shall be carried out using X-ray diffraction. If the aggregate is shown contain trace amounts only of smectite clays (i.e. XRD <100 counts) then the source rock may be considered compliant with this criterion

Solid Density Testing

The solid density of the Hi-Lab aggregates shall be determined in accordance with NZS 4407 Test 3.7 The Solid Density of Aggregate Particles. Two tests per aggregate source shall be performed prior to construction and repeated at a rate of one test every 5,000m³ of source material used.

Aggregate Production Properties

General

Hi-Lab aggregates sampled during production shall comply with the production properties listed below. Production property testing shall be performed at a rate of at least one test for every 1,000 tonnes of material produced or part thereof unless stated otherwise below.

Broken Faces and Fines Quality Requirements

The Hi-Lab aggregate shall comply with the requirements of Table 0.2 below:

Table 0.2 Aggregate Rock Quality Requirements

Test Property	Test Method	Requirements
Two Broken Faces	NZS 4407 Test 3.14	100%
Clay Index (<0.075mm)	NZS 4407 Test 3.5	5 maximum
Plasticity Index	NZS 4407 Test	8 maximum

Note: Hi-Lab aggregate produced from a hard rock quarry source using angular and broken feedstock need not be tested for Broken Faces Content which may be assumed to be 100%.

Aggregate Particle Size Distribution

The particle size distribution during production of the blended Hi-Lab products shall comply with the limits in Table 0.3 or Table 0.4 as appropriate when tested in accordance with NZS 4407 Test 3.8.2. A minimum sample of 90kg of aggregate shall be used for each test.

Test samples shall be drawn and tested for every 1,000 tonnes produced. A minimum of 5 production test samples shall be drawn and tested for any one production lot. Test results shall be evaluated as follows:

(a) The rolling average results of five consecutive test samples shall be within the upper and lower limits for each test sieve
(b) No individual test result shall be outside the envelope formed by the lower buffer zone and the upper limit.

Note: Experience has shown that a blending plant with a minimum of three component feed bins is required to produce a consistently compliant Hi-Lab aggregate product.

Table 0.3 Hi-Lab 65 Particle Size Distribution Limits

Sieve Size (mm)	Percentage Passing Sieve		
	Lower Buffer	Lower Limit	Upper Limit
63.0	-	95	100
37.5	35	40	50
19	15	20	30
9.5	10	12	16
4.75	9	10	14
2.36	6	7	12
1.18	4	5	10
0.075	-	0	6

Table 0.4 Hi-Lab 40 Particle Size Distribution Limits

Sieve Size	Percentage Passing Sieve

(mm)	Lower Buffer	Lower Limit	Upper Limit
37.5	-	90	100
19.0	20	25	35
9.5	13	15	20
4.75	9	10	15
2.36	6	7	12
1.18	3	4	10
0.075	-	0	6

Aggregate Flakiness Value

Flakiness Value testing shall be carried out using the method of AS 1141.15. The percentage of flaky particles for each of the aggregate test fractions coarser than 9.50mm specified by AS 1141.15 Table 1 shall be determined and reported, and the Flakiness Value for each size fraction comply with the minimum requirement of Table 0.5:

Table 0.5 Aggregate Flakiness Value Requirement for Each Fraction

Aggregate Grade	Test Method	Requirement
Hi-Lab 65 Hi-Lab 40	AS 1141.15	< 30%

Choking Aggregate

The choking aggregate, such as 7mm crusher dust (AP 7), is normally a by-product of the Hi-Lab crushing or sealing chip production with all passing the 9.50mm sieve. The aggregate source properties (crushing resistance and quality of fines) shall be equal to or better than the required source properties for Hi-Lab aggregate. The AP 7 aggregate shall be sufficiently dry to allow uniform distribution without blocking spreading equipment.

Other Materials

Portland Cement Stabilising Agent

Cement shall comply with NZS 3122 Specification for Portland and blended cements (general and special purpose) for:

(a) General purpose Portland cement: Type GP; or
(b) General purpose blended cement: Type GB; or
(c) Special purpose low heat cement: Type LH.

General purpose Portland cement, type GP, shall be used unless otherwise specified in the Contract Documents. Note that high-early strength cement, type HE, shall not be used as a stabilising agent.

Cement shall be stored and handled to provide protection against deterioration or contamination.

Type GP cement with a loss of ignition test result greater than 3.0% shall not be used. Types GB and LH cement with a loss of ignition test result greater than that determined by the cement manufacturer shall not be used.

Cement shall be transported in clean tankers.

Water

Water used for stabilisation, construction and curing of stabilised layers shall be free from impurities that may deleteriously affect the setting, hardening or strength of the stabilised material. Water from sources other than public supply shall comply with the requirements of NZS 3121.

Plant and Equipment

Plant for Supply of Cement

For areas greater than 500m², cement shall be delivered to the site in purpose built bulk tankers unless otherwise approved by the Principal. Each bulk tanker shall be issued a Certificate of Loading that contains the following information which shall form part of the project quality plan:

(a) Tanker's identification details including certification number
(b) Product identification
(c) Name of the supplier
(d) If available, the batch number and date of manufacture
(e) Date, time and place of loading
(f) Details of any chemical or other substance added to the product before, during or after the loading procedure, if any.

Plant for Spreading Stabilising Agent

The spreading equipment shall be capable of varying the spread width to cater for different road widths. The spread rate should be consistent along the spread width of the equipment. Where the chemical stabilising agent is applied directly to the surface of the pavement layer before stabilising, the spreader unit shall be a purpose-built calibrated belt or pneumatic rotary spreader incorporating adjustable spreader curtains.

Transfer of all stabilising agents into the spreading equipment shall be undertaken in such a manner to ensure that no contamination of the environment occurs. Where cement powder is transferred pneumatically, release filters shall be utilised to contain dust.

Plant for Stabilisation Process

The plant used for the mixing shall be a purpose-built recycling machine. It shall be from a reputable manufacturer having a demonstrable track record and manufacturing history for the equipment. As a minimum, the recycling machine shall have the following features:

(a) The ability to adjust the volume of water injection and rotor speed during the stabilising/mixing process.
(b) A capacity that is adequate for maintaining a constant rotor and forward speed, in addition to a capability for stabilising to the specified depth. The recycler speed shall be determined through trials and typically will be between 10 – 12 m/minute.
(c) The cutting tips on the drum shall be oriented in a straight-line configuration at a slight angle and not orientated in a "v" shape.
(d) The hood of the rotor drum shall be adjustable for height (i.e. to increase or decrease the volume) and pitch to lift or drop the front and back of the hood.
(e) A level control system that maintains a depth of stabilising within a tolerance of -5mm and +15mm of the required depth during continuous operation.
(f) The rotor of the recycler shall be capable of maintaining a constant drum speed of approximately 120 revolutions per minute under full load as demanded by the depth of stabilisation. A recycler drum that rotates upwards into the direction of advance, located between the axles shall achieve at least 2.0m of cut width in a single pass.
(g) Where the milling depth exceeds 150mm, the mixing chamber shall have an effective volume that can increase in relation to the depth of the cut, to accommodate additional material generated by increasing the depth of cut. This may be achieved by the recycler mixing drum being independent of the mixing chamber housing.
(h) An adjustable exit gate.

The mixing equipment shall include the following features to mix the milled material with water:

(i) A controlled pumping and metering system to regulate the application of water in relation to travel speed and mass of material being stabilised. The pumping systems shall be calibrated to deliver within a tolerance of ±5% by volume.
(j) A system of nozzles that evenly distributes an application of water across the full width of treatment.
(k) The application systems shall be capable of water adjustments for varying widths of stabilisation.

(l) A controlled uniform mixing and distribution of materials and water across the full stabilised width of the drum, providing a flat smooth surface behind the stabiliser showing no V-shaped deformation on the edges of the drum. This shall be proven during the Hi-Lab trials in clause **Error! Reference source not found.** to the satisfaction of the Principal.

Compaction Equipment

Primary Compaction

A steel drum roller (i.e. having a smooth drum) is required for the initial placement of aggregate. The roller shall have a gross weight of at least 12 tonnes.

The following compaction plant is required for primary compaction:

(a) At least one vibrating pad foot roller with gross weight of at least 14 tonnes, and
(b) At least one smooth drum vibrating roller with gross weight of at least 12 tonnes.

For primary compaction, the Contractor shall use GPS or other means approved by the Principal to demonstrate that all areas of the pavement receive the required number of passes with each type of roller.

Secondary Compaction

The following compaction plant is required for secondary compaction:

(a) A vibratory pneumatic tyre roller loaded to at least 1.3 tonnes per wheel, or
(b) A static pneumatic tyre roller loaded to at least 2.0 tonnes per wheel. At least two pneumatic rollers shall be used.
(c) A three wheeled steel drum roller loaded to at least 10 tonnes gross weight.
(d) A 12 tonne single drum steel wheel roller.

Note: More than one roller of each type may be required to achieve the minimum amount of rolling time for secondary compaction specified in 0 below for large areas of Hi-Lab.

Pavement Trial

A pavement trial is required for new projects. The trial section shall have at least two longitudinal joints and at least one transverse joint. The joints shall be constructed and compacted to the satisfaction of the Principal.

The Contractor shall construct a test trial of Hi-Lab sub-base and basecourse pavement using the materials and processes specified by clause 0 below to verify design assumptions, material properties and construction methodology. The trial shall be undertaken in the presence of the Principal using the construction procedures, equipment and operating personnel proposed for the work in the placing, stabilising, compaction and finishing of the individual layers.

The trial section shall be a minimum of 4,000m^2 and be subject to material testing and Benkelman Beam deflection testing to NZTA T01 of each individual layer including the subgrade improvement layers. This testing shall be used to validate (or amend) the specified Benkelman Beam deflection criteria of clause 0.

Material testing shall be particle size distribution of Hi-Lab material sampled post-stabilisation, in-situ density, core and beam specimen testing. The sampling and testing rate shall be three times the rates otherwise required for non-trial pavements

The beam and core specimens from the Hi-Lab layers shall be cut from the pavement trial section no less than 21 days after placement. The beam and core samples shall be tested for modulus and fatigue relationships at no less than 28 days after placement of the Hi-Lab.

Completion of the pavement trial and testing shall constitute a mandatory hold point. If the acceptance criteria of Table 0.1 are not achieved, then the Principal in conjunction with the Contractor shall assess the results and determine subsequent actions.

The Contractor shall develop a testing regime for the test trial in conjunction with the Principal, which will include the type and number of tests required. All pre- and post- stabilisation test results shall be made available to the Principal for review.

The following additional testing shall be undertaken on the trial pavement:

Table 0.1 Additional testing on Hi-Lab Basecourse and Sub-basecourse materials

Test Criterion	Test Method	Acceptance Criteria
Indirect Tensile Strength Test (see note)	NZTA T19	700kPa min (Core samples)
Flexural Beam breaking test (see note)	NZTA Report 463	average >1400kPa

Notes: Flexural beam test shall be carried out in accordance with the test method set forth in Appendix A of NZTA Research Report No. 463, Development of Tensile Fatigue Criteria for Bound Materials.

All test results shall be submitted to the Principal and demonstrate compliance with this specification. This shall constitute a hold point.

Construction

Production Quality Plan

The Contractor shall prepare a Production Plan for approval by the Principal prior to commencement of delivery of Hi-Lab aggregate to site, detailing all aspects of its Hi-Lab production process, how it will achieve compliance with this specification, and procedures in the event of non-compliance or plant breakdown. The Production Plan shall include detailed methodology for:

(a) Manufacture of the Hi-Lab aggregate and stockpiling in the quarry.
(b) Quarry stockpile management.
(c) Loading from quarry stockpile and transport to site.
(d) Spreading, shaping and compaction ahead of cement spreading.
(e) Cement spreading.
(f) Stabilisation.
(g) Compaction, choking with fines and finishing.
(h) Sampling, testing and reinstatement of sample locations.
(i) Ensuring compliance with clause 0.

The Production Plan shall break down each task in detail. This shall include but not be limited to:

(j) Plant type and operating procedures.
(k) Expected rates of production.
(l) Timing of operations.

The production plan shall include contingency plans in the event of malfunction of items of plant or to mitigate other risk factors critical to the Hi-Lab production and construction process.

Daily production sketches shall also be produced for approval by the Principal ahead of each forthcoming day's work including details such as:

(m) The overall layout of the length and width of road intended for stabilising during the day, broken into number of parallel cuts required to achieve the stated width, and the overlap dimensions at each joint between cuts.
(n) The sequence and length of each cut to be stabilised before starting on the adjacent or following cut.
(o) An estimate of the time required for cement spreading, mixing and compacting each cut.
(p) The time when the completion of each cut is expected.
(q) The number and location of samples and tests.

The Contractor shall comply with their Production Plan at all stages of implementation. Deviations from the Production Plan shall immediately be brought to the attention of the Principal, who may require the plan to be revised and re-approved prior to the next repeat of the work stage.

Approval of the Production Plan and/or Daily Production Drawings by the Principal does not remove the obligation of the Contractor to meet the specification requirements.

Personnel Training and Experience

The Contractor shall nominate a list of appropriately trained and experienced staff to manage the construction of the Hi-Lab pavement. The list shall be submitted to the Principal.

The nominated staff shall control the operations throughout the project. Where such staff are unavailable then works shall cease until approved replacements are identified.

Supply of Aggregate to Site

Transportation

Aggregate shall be loaded from the stockpile at the quarry or from the blending plant, directly into the trucks which will deliver and spread the aggregate on site. When loading trucks from quarry stockpiles, the material shall be turned over and rendered homogeneous by mixing with the loader operated by an operator skilled in this procedure. Aggregate shall be loaded and transported with sufficient moisture so that the fines are retained, and they bind and coat the larger aggregate stone, thereby limiting segregation.

Aggregate which arrives on site in a contaminated condition shall be rejected and removed from site.

Initial Placement of Aggregate

The Contractor is responsible for ensuring the surface level after spreading and compaction prior to stabilisation will result in final layer thickness and finished levels after stabilisation that are within the required tolerances.

To minimise aggregate break down and segregation the following methodology shall apply:

(a) Aggregate shall be spread directly where it is required for construction of the Hi-Lab layer.
(b) Aggregate shall be placed wet to improve workability.
(c) No stationary dumping shall be allowed except where any alternatives are impractical.
(d) Aggregate shall be placed in two layers of approximately equal thickness by directing truck and trailer or bottom dumper trucks to pre-defined start and end points. Layer thickness shall be carefully determined to minimise additional grading to obtain final levels
(e) Spreading with truck and trailers shall be undertaken by skilled operators to minimise the amount of grading required to achieve finished levels. Bottom dumpers shall be used if truck and trailers are incapable of properly spreading the aggregate.
(f) The layer shall be trimmed with the minimum number of grader passes to ensure sufficient material has been placed for stabilising.
(g) A maximum of three passes per layer with a smooth steel drum vibrating roller on low amplitude vibration or static shall be applied. Care shall be taken not to break any stones during this process.
(h) Layer thickness shall be carefully determined so that the Contractors' pre-determined levels for layer thickness prior to stabilisation are achieved following this rolling.
(i) When constructing Hi-Lab against kerb and channel the Contractor shall place a nominally 300mm width of NZTA M04 basecourse aggregate against the vertical face to provide a compactable material against the concrete kerb where the stabiliser can't reach.

Spreading of Cement

Spreading Rate

The cement spread rate shall be 3% by dry mass of the aggregate, or as otherwise specified by the specific contract requirements. Calculate the mass of aggregate per unit area using an assumed compacted density of 82% of the aggregate solid density.

Spreading of cement shall only take place after quality checks have confirmed that correct levels have been achieved during initial placement of the aggregate. The cement shall be uniformly spread at the specified application rate across the pavement to the two tolerances set out in the following table:

Table 0.1: Stabilising Agent Spreading Testing Requirements

Test	Frequency	Tolerance
Mat test: 1m² canvas	Every 250m²	Within ± 0.5kg/m² of the specified rate

Average usage test: compare tonnes used (from delivery docket) with measured area	Upon emptying the spreader and bulk tanker	Within ± 2.5% of the specified rate

The utmost care shall be exercised to ensure that any runoff is contained on the road. In the event of any cement agents entering any waterways the Principal and the environmental authority for the region shall be notified immediately.

Weather Limitations

Spreading of cement on the road ahead of stabilisation shall not continue when the cement becomes a dust problem due to dryness or when the wind speed exceeds 25km/hr.

No spreading of cement shall commence if it is raining. If rain is likely to start before the cement can be mixed into the aggregate, then spreading shall not take place.

Time Limitations

The maximum time period, from mixing of the materials to completion of primary compaction shall be 2.0 hours.

Unless specifically justified in the approved Production Plan, stabilisation shall commence no later than 10:00 am and the area to be stabilised shall not exceed 4,000m² per day, unless agreed otherwise by the Principal, to ensure sufficient time to complete the full stabilisation process.

Stabilisation

Stabilisation/Addition of Water

Water shall be added and controlled through direct injection within the recycler hood.

The Contractor shall continuously monitor the moisture content of the material behind the recycler and in consultation with the Principal adjust the rate of water injection as necessary. The Contractor shall also monitor continuously for blocked nozzles or any other risk to the consistency of the mixture.

The rate of water injection per metre for each layer shall be determined during Hi-Lab production trials (refer to contract requirements). This shall be used as guidance during full production.

The Contractor's plant and personnel shall be well organised and consistent in the timing of this phase of the work so that the estimate of additional water required is accurate. Additional water shall be applied to ensure the mixture remains damp as gross changes in water content can occur because of the drying effects of wind and sun. The stabilisation area shall not exceed 4000m² per day, with a maximum single stabilisation run length of 225m, unless agreed otherwise by the Principal.

Control of Mixing Depth

The Contractor shall determine the mixing depth so that the final stabilised layer thickness after compaction meets the contract requirements. During stabilisation the depth of the cut shall be physically measured at both ends of the mixing drum at least once every 50m. The measured stabilisation depth shall confirm full mixture of the placed Hi-Lab layer at full depth with no untreated materials present at the bottom of the test hole.

Overlap on Longitudinal Joints

To ensure complete stabilisation across the full width of the road, longitudinal joints between successive cuts shall overlap by a minimum of 200mm or half the layer thickness, whichever is greater. Overlap width shall be increased if any dry material is noticed between runs.

The locations of longitudinal joints shall be agreed between the Contractor and Principal and recorded in the production plan, and shall take into account:

(a) the overall dimensions of the stabilised pavement
(b) the width of the stabilising plant

(c) locations of heavy vehicle wheel paths on the finished pavement
(d) changes in crossfall
(e) performance risks associated with double stabilising of the overlaps
(f) any other factors deemed relevant by the Principal.

All joints, including joints to existing unstabilised sections of pavement, shall be mixed, compacted and finished satisfactorily so that the final surface does not have permeable or loose patches.

Continuity of Stabilised Layer

The exact location of the end of the cut shall be carefully marked. This mark shall coincide with the position of the centre of the mixing drum at the point at which the supply of cement ceased. To ensure continuity of the stabilised layer, the next successive cut shall be started 3m behind this mark. This tie-in length shall be reduced to 1m for stabilised layers older than 7 days. Cement shall be spread on the overlap for the next run.

All joints, including joints to existing unstabilised sections of pavement, shall be mixed, compacted and finished so that the final surface does not have unbound or loose patches.

The stabilised area shall be squared off at the end of the day's production, and the location shall be recorded on the Daily Production Drawings.

Particle Size Distribution of Stabilised Material

The Contractor shall ensure a person with appropriate experience with stabilisation works walks behind the recycling machine and continuously visually monitors the material behind the stabiliser for consistency and uniformity. Where inconsistent or non-uniform areas are observed the stabilisation operation shall cease and appropriate corrective actions taken.

The Contractor shall sample the material behind the stabiliser for particle size distribution analysis using NZS 4407 test 3.8.1 (wet sieving) and advise the Principal of the result as soon as practicable. The sample frequency shall be a minimum of 5 samples per 4000m^2. The samples shall be representative of the full stabilised area.

Hi-Lab sampling method:

(a) Randomly select a sample location from behind the stabiliser
(b) Excavate all stabilised aggregate within a 400mm diameter, to the full depth of the stabilised layer. Make sure a minimum of 90kg aggregate sample is obtained
(c) Place excavated material directly into a sample container and seal it
(d) Ensure the sample does not get contaminated by material from a previous layer
(e) Avoid sampling material from the stabiliser overlap/edges
(f) Avoid sampling material that collapses into the hole during sampling

The Principal shall have the right to sample and analyse the particle size distribution behind the stabiliser at any time.

Particle size analysis shall be carried out on samples of the Hi-Lab aggregate from behind the recycling machine and the results reported to the Principal. Samples drawn from behind the stabiliser should have a particle size distribution within the limits shown in Table 0.2.

If the particle size distributions are outside the specified envelope the Contractor shall investigate the cause of the change in particle size distribution and report the outcome to the Principal. One of the following actions shall then occur:

(a) The Contractor shall remove any material that has not met the requirements of this specification or any specific contractual requirements and replace this with compliant material.
(b) If the Contractor's methodology has been in accordance with the specified requirements, the Principal shall bear the risk associated with any non-compliant material retained in the pavement and direct the Contractor how to proceed. The Contractor shall also work with the Principal to agree adjustments to the methodology to increase the probability that subsequent Hi-Lab construction has aggregate particle size distribution within the limits of Table 0.2.

Table 0.2: Hi-Lab Placement Particle Size Distribution Limits

Sieve Size (mm)	Aggregate Grade	
	Hi-Lab 65	Hi-Lab 40
75.0	100	-
63.0	95 – 100	-
53.0	-	100
37.5	45 – 55	90 – 100
19.0	20 – 30	30 – 40
9.5	12 – 16	15 – 22
4.75	10 – 14	10 – 15
2.36	8 – 12	7 – 12
1.18	6 – 10	5 – 10
0.075	0 - 6	0 – 6

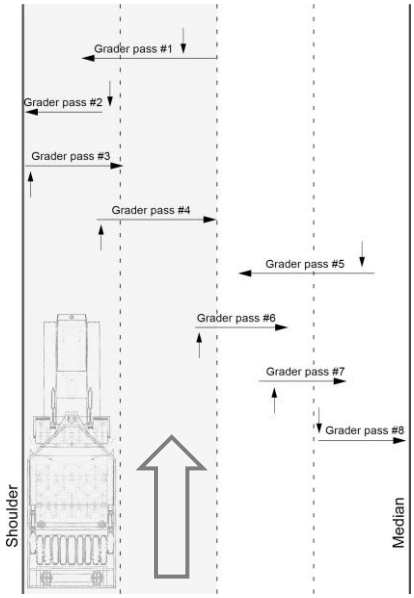
Compaction and Finishing

1 Primary Compaction

Primary compaction shall be undertaken as follows. The number of roller passes shall be recorded and verified using the GPS equipment or agreed equivalent on the roller:

(a) Six passes of the vibrating padfoot roller shall be completed followed by one grader pass to remove indentations and smooth the surface out.
(b) A second pass with the grader (if required) shall be carried out, with the grader blade not cutting and moving material, the grader moving at a slow speed, “sweeping” from side to side with one third of the blade overlapping, followed by six passes with the vibrating smooth drum roller (the diagram below is a typical example of the grader movements)
(c) The above grading and rolling shall be completed within a maximum of two hours of commencement of stabilisation and no further grading will be allowed.
(d) All roller speeds shall be set at a maximum speed of 4.5km/h.
(e) All rolling shall be carried out with vibration amplitude set on high.

Figure 1: Hi-Lab Construction Sequencing



Secondary Compaction and Choking

Following primary compaction, both basecourse and sub-base layers shall be choked with a thin layer of dry AP 7 crusher dust aggregate. The AP 7 shall be applied with a chip seal spreader to fill any surface cavities

and “choke” the surface. The AP 7 shall be placed within 3 hours of stabilisation to ensure the cement will react with the fines from the AP 7 and lock the surface in place. The AP 7 shall be placed in multiple layers, spread thinly to ensure the fines penetrate the surface cavities without resulting in a dry thick barrier layer preventing the fines from washing into the cavities. A water cart shall be used to ensure sufficient water is made available to maintain the Hi-Lab water content and for the fines to penetrate the cavities.

Note: Where weather conditions are such that rapid drying is experienced, additional water carts may be required to ensure that the water content of the Hi-Lab layer is maintained.

A minimum of 3 hours of continuous rolling per 2,000m² area with each of the rollers specified by clause 0 shall be applied to complete secondary compaction. The time of rolling for areas less than 2,000m² shall be reduced in proportion. Additional rollers shall be used for areas greater than 2,000m² to achieve three hours of rolling per 2,000m² within a three (3) hour time frame.

A thin slurry layer shall be produced by the secondary compaction to ensure all surface voids are choked by the AP 7 aggregate. A drag broom shall be used to move the slurry around during secondary compaction to fill surface voids and so that a slurry biscuit layer is not left on the surface to set like a crust.

Surface Prior to Placing Next Hi-Lab layer and/or Sealing

Fines shall be removed and broomed to produce a mosaic surface prior to placing the next Hi-Lab layer or sealing. The surface shall not have any loose fines and/or “caked” laminations of fines and shall be a mosaic stone surface free of fines.

Surface Shape

The surface shape of the completed pavement layer shall be tested every 20 lineal meters. When all loose aggregate is removed, it shall conform to the shape specified within the tolerances in Table 0.3:

Table 0.3 Maximum Vertical Variations from Design Level

Pavement Layer	Between pavement centreline and pavement edge (mm)	
	Without concrete channel	With concrete channel
Subbase	-5 to +20	-5 to -5
Base	-0 to +15	Varies, see Notes below
Final combined layers	-0 to +15	-0 to +15

Notes:

(a) Locations at or close to the lip of channel, including the basecourse aggregate strip between channel and Hi-Lab base: –0mm to +5mm
(b) Other locations on the pavement: –0mm to +15mm

The standard of smoothness shall be such that no point in the surface varies more than 10mm from a 3.0m straight edge placed on the road, and any deviation from the straight edge is gradual. No area of the completed surface shall have any depression that will allow water to pond where lateral or longitudinal fall is greater than 1%.

Crossfall

The crossfall between two points more than 2.0m apart, transverse to the centreline, shall not depart from the design crossfall by more than 0.5%.

Protection and Maintenance

No construction equipment shall be driven on any Hi-Lab aggregate layers until at least 48 hours have passed following completion of secondary compaction. At no time during the construction of the Hi-Lab pavement layers shall any haulage of earthworks and/or drainage construction activities e.g. the use or movement of excavators be allowed, only construction activities directly associated with the construction of the Hi-Lab layers, e.g. placement of aggregate.

For rehabilitation works, the Hi-Lab pavement may be trafficked after secondary compaction and prior to construction of the surfacing.

The Contractor shall protect and maintain the completed stabilised layer until the next layer or surfacing is applied. In addition to the curing of the stabilised layer by frequent light watering, maintenance shall include the immediate repair of any damage to or defects in the layer as approved by the Principal. The standard of sweeping shall be sufficient to remove all loose aggregate, dirt, dust, silt, and other deleterious matter to expose a clean stone mosaic surface prior to sealing or placing any further Hi-Lab layers.

No remedial grading shall be allowed. Any defects or damage of any nature, occurring during the construction or maintenance of the pavement layer before the seal is applied, shall be made good immediately by the Contractor as approved by the Principal.

For a minimum of 48 hours after stabilisation the Contractor shall:

(a) provide additional AP 7 running course, if required (using clause 10 of NZTA B02 as a guide)
(b) keep the surface damp but not wet to prevent drying and ravelling
(c) drag-broom the whole surface, keeping a balanced distribution of AP 7.

Compaction

Compaction testing of the pavement layers shall be carried out in lots. A lot is defined as a section that was stabilised and compacted using the same methodology and materials across the entire area.

The degree of compaction for each lot shall be determined by testing at least five (5) randomly selected areas per 4,000m² or part thereof. The method of ASTM D3665 or similar shall be used to identify random locations for testing. For lot sizes larger than 4,000m² additional testing shall be undertaken at a rate of 1 test per 1000m².

The degree of compaction for the Hi-Lab layer shall be determined by using the method of NZTA T23. A hole shall be drilled to accommodate the probe to the full depth of the Hi-Lab layer and/or layers. A 22mm drill bit has been found to be acceptable. The probe shall be set at increasing increments of 50mm and a measurement shall be recorded for each depth setting. This process shall be repeated with a 180 degree rotational off-set around the hole. A minimum of two 200mm diameter core samples per 4,000m² or lot size whichever is the lesser, shall be taken within 0.5m of the probe hole to be used for water correction and immediately sealed in plastic bags so that no water is lost by evaporation. Use the method of NZS 4407 test 3.1 to determine the water content. Calculate water correction for the nuclear density testing using the average core water content. Use the same core sample for ITS testing.

Note: Core specimens shall be drilled dry so that the core moisture contents are representative of the Hi-Lab pavement.

The degree of compaction as a percentage of solid density shall be calculated, reported and compared against the targets in Table 0.4:

Table 0.4 Density Requirements for Pavement Layers

Parameter	Degree of Compaction for Sub-base and Basecouse Pavement Layers
Average Value	83 %
Minimum Value	81 %

Coring, ITS Testing and Flexural Beam Testing

Coring

After a minimum of 7 days post stabilisation the Contractor shall take 200mm diameter core samples, using a dry coring technique from randomly identified locations in the stabilised layers for Indirect Tensile Strength (ITS) testing. The method of ASTM D3665 or similar shall be used to identify random locations for sampling. If the Hi-Lab basecourse is placed prior to 7 days after sub-base construction, both layers shall be cored together at least 7 days after basecourse construction.

Two cores are required per 4,000m² lot or part thereof for each stabilised layer. Cores which are not intact shall be rejected and the Contractor shall be responsible to extract an intact replacement core. If two intact

cores have not been obtained after five core attempts within a 4,000m² area, it shall be referred to the Principal for a decision whether to take further cores.

A suitable pre-mixed concrete (such as ≥ 20MPa lean mix concrete) or dense asphalt mix shall be used for core hole reinstatement for a Hi-Lab sub-base layer. Only pre-mixed concrete shall be used for the reinstatement of core holes in Hi-Lab basecourse layer. Asphalt mixes used for reinstatement shall be compacted in layers using a vibrating hammer.

Indirect Tensile Testing

The Contractor shall carry out Indirect Tensile Strength testing on the field cores in accordance with NZTA T19 test method as revised below:

(a) ITS testing should be undertaken after a minimum of 21 days after stabilisation. If field cores are taken before 21 days, the cores shall be cured as per NZTA T19 (3 days at 40°C in a plastic bag, cooled down for 24 hours and tested dry)
(b) field cores shall not be trimmed and shall be tested in dry condition
(c) a constant loading rate of 1mm/min shall be used
(d) the following shall be reported for each core: core diameter, length, weight, bulk density, load and ITS value. All results shall be submitted to the Principal.

Layer Depth

The minimum post construction layer depth shall comply with the project specified thickness, less the variations of Table 0.3, as measured from the field core holes.

Flexural Beam Testing

The Contractor may be instructed by the Principal to carry out flexural beam testing as detailed in NZTA Research Report 463. A masonry saw shall be used to cut and remove the beam specimen from the pavement. The flexural beam test results are for the information of the Principal only.

Deflection Testing

Benkelman beam testing shall be carried out on top of the Hi-Lab sub-base and basecourse layers in accordance with NZTA T01 specification at 10m intervals in alternating wheel paths for all lanes, within 7 days after stabilisation.

All measured deflection measurements from each construction lot shall meet the following criteria as validated or amended during the pavement trial:

(a) Hi-Lab Basecourse: 95^{th} percentile ≤0.3mm (maximum <0.4mm)
(b) Hi-Lab Sub-base: 95^{th} percentile ≤0.4mm (maximum <0.5mm)

Note: Falling Weight Deflectometer can be used instead of Benkelman beam testing with the agreement of the Principal. Appropriate acceptance limits shall be agreed by the Principal and the Contractor.

Pre-Seal Ride Quality Requirements

A smooth and even ride, free of bumps and undulations, is required over the finished Hi-Lab basecourse surface. The roughness over the Hi-Lab basecourse for final in-service chip seal surfacing shall be determined from the average of three replica runs for each traffic lane and be tested in accordance with the procedures given in the Austroads AG:AM/T001 and reported as NAASRA counts. The roughness measurements are to be made at 20m intervals and the results shall be assessed as described in the NZTA Network Operations Technical Memorandum No: TNZ TM 7003 v1, 2006. The results shall comply with the following:

(a) For in-service chip seal surfacing: the 100m rolling average lane roughness of Hi-Lab basecourse shall not exceed 75 NAASRA counts per km.
(b) For asphalt in-service surfacing: the roughness requirements on Stone Mastic Asphalt (to M27 specification) or Epoxy Modified Open-Graded Porous Asphalt (to P11 specification) final surfacing shall be less than 50 NAASRA counts per km (100m rolling average/km) and a maximum of 60 NAASRA counts per km.

Any pre-levelling for the Hi-Lab pavement shall be an approved asphalt mix compliant with NZTA M10 specification, such as dense graded AC 10 or DG 7, after chip sealing and prior to final surfacing. The Contractor shall submit the asphalt pre-levelling methodology to the Principal for review and approval prior to implementation.

Note: Any dense graded pre-levelling asphalt mixes shall comply with the deformation resistance criterion (Wheel Tracking) of NZTA M10 specification.

The basecourse surface finish, as distinct from the surface shape, shall present a tightly consolidated surface when swept in which:

(a) the large aggregate is held in place with a matrix of smaller aggregates
(b) the smaller aggregate is held firmly in place by cemented fine material; and
(c) the matrix does not displace under normal trafficking or sweeping.

The standard of sweeping shall be sufficient to remove all loose aggregate, cement laminations, dirt, dust, silt, and other deleterious matter.

Before sealing, the Contractor shall advise the Principal that the pavement surface has been prepared in accordance with this specification although final sweeping may not have been performed. The Principal shall be given the opportunity to inspect the swept pavement surface for approval.