NZ TRANSPORT AGENCY
WAKA KOTAHI

SPECIFICATION FOR IN-SITU STABILISATION OF BOUND SUB-BASE LAYERS

1. SCOPE

This Specification shall apply to the in-situ stabilisation of granular pavement layers to produce a bound sub-base layer using cement or a blend of cement and lime.

The pavement layer shall be constructed in accordance with the levels, grades and cross-sections shown in the drawings of the Project Specifications.

Where design expectation is that tensile strength will be retained in the bound layer the specification requires the layer receives a significant curing period before the construction of subsequent layers or trafficking of the pavement. Where tensile strength is not expected to be retained in the bound pavement layer (pre-cracked), there is no significant curing period. For either approach vibratory compaction for the construction of any subsequent pavement layer should be done with caution as specified in the project specification.

The Contractor shall ensure that road users' vehicles are protected from deleterious effects of the binders used in construction at all times

2. TERMINOLOGY

Descriptions of the Terminology that is used in this specification are described in the Notes to this Specification.

3. MATERIALS

Imported aggregates, if any, shall comply with the Project Specifications.

4. STABILISING AGENT

4.1 Chemical Stabilising Agents

Stabilising agents shall consist of either cement or a blend of cement and lime. The components of the cement and lime blend shall meet the requirements of 4.1.1 and 4.1.2 and shall achieve the strength requirements of the Project Specifications when mixed with the aggregates.

4.1.1 Lime

Lime shall comply with NZTA M/15.

4.1.2 Cement

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

- General purpose Portland cement – Type GP;
- General purpose blended cement – Type GB; or
- Special purpose low heat cement – Type LH.

General purpose Portland cement, type GP, shall be used unless otherwise specified in the Contract documents.

Cement shall be stored and handled to provide protection against deterioration or contamination. Cement that is more than 3 months old, or is suspected of not being stored in a way that protects it from deterioration, shall be tested for loss of ignition in accordance with Appendix B of NZS 3122.

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.

5. WATER

The Contractor shall be responsible for ensuring that the water for stabilisation, construction and curing of stabilised layers is free from impurities that may deleteriously affect the setting, hardening, strength or durability of the bound aggregate layer.

Water from sources other than public supply may have its suitability established to the satisfaction of the Engineer by repeating the final approved laboratory-based mix design tests with the water now being considered for use. The results of these subsequent mix verification tests shall be greater than 90% of the final results from the previously verified mix design. In addition, work shall be stopped if any discolouration or residue is observed when adding or sprinkling water into or onto the material.

6. PLANT AND EQUIPMENT

All plant shall be supplied and operated so that it will uniformly spread, or add, the stabilising agent and thoroughly mix it to the specified depth with the in-situ material.

Stabilising and spreading plant shall be purpose-built by a manufacturer having a demonstrable track record and manufacturing history for the equipment used. Plant and equipment not meeting this requirement shall not be allowed on site.

6.1 Plant for Supply of Stabilising Agent

The stabilising agent shall, for areas greater than 500 m^2, be delivered to the site in bulk tankers or trucks unless otherwise approved by the Engineer. Each bulk tanker or truck shall be issued a *Certificate of Loading* that contains the following information:

- Tanker's identification details including certification number;
- Product identification: Name of the supplier;
- Batch number and date of manufacture ;
- Date, time and place of loading;
- Comments on the state of the tanker at the time of loading in terms of cleanliness, details of the previous load carried, and whether any residual product from the previous load remains;
- Details of any chemical or other substance added to the product

  before, during or after the loading procedure, if any; and
- Net weight of product before and after discharge into the mechanical spreaders.

The Certificate of Loading shall form part of the project quality plan

6.2 Plant for Spreading the Stabilising Agent

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

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

6.3 Plant for Stabilisation (mixing process)

Mixing using graders, profilers, or asphalt milling machines and agricultural type implements, shall not be permitted.

As a minimum, the stabilising machine shall have the following features:

- **A capacity that has adequate rating for maintaining a constant rotor and forward speed, in addition to a capability for stabilising to the specified depth.**
- **A stabilising drum that rotates upwards into the direction of advance and is located between the axles. The drum shall achieve at least 2.0 m of cut width in a single pass and shall have a level control system that maintains a depth of stabilising within a tolerance of +/- 10 mm of the required depth during continuous operation.**
- **Where the stabilised depth exceeds 200 mm, the mixing chamber shall have an effective volume that can increase in relation to the depth of the cut, in order to accommodate additional material generated by increasing the depth of cut. This is achieved by the stabilising mixing drum being independent of the mixing chamber housing.**
- **An adjustable exit gate.**

To mix the material to be stabilised with water (if required) and stabilising agent, the mixing equipment shall include the following features:

- **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.**
- **A system of nozzles that promotes a uniform application of water across the full width of treatment. The application systems shall be capable of adjustments for varying widths of treatments.**

7. CONSTRUCTION

7.1 Limitations

7.1.1 Weather limitations

Temperature
Work shall not be started if the ambient air temperature is below 5 °C or above 30 ºC.
If, during construction, the ambient air temperature drops below 5 °C, then no further work, other than compaction and finishing, shall be permitted.

Dryness, wind
Spreading of the stabilising agent on the road ahead of the stabilising machine shall not continue when the stabilising agent generates a dust problem or when the wind speed exceeds 25 km/hr, except if the mixing and spreading is carried out in one unit that effectively contains the stabilising agent.

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

7.1.2 Time limitations

The maximum time period, from mixing of the materials to completion of primary compaction of the stabilised layer, shall be two (2) hours.

Final trimming and compaction shall be within four (4) hours of mixing.

Where the time limit is exceeded, details of the remedial actions taken by the Contractor shall be submitted to the Engineer for approval.

7.2 Before Stabilisation Commences

7.2.1 Initial Laboratory Testing

In the event that the contractor's proposed material(s) and stabilising agent(s) vary from the project specifications or there is no project specific mix design, the contractor shall be responsible for determining the optimum binder content(s) in accordance with NZTA T/19 to meet the designer's intent.

7.2.2 Surface preparation

Before any work commences, the surface of the area to be stabilised shall be prepared by:

- **Cleaning all vegetation, detritus and other foreign matter;**
- **Removing any standing water;**
- **Pre-hoeing or pre-milling where high spots are to be removed**
  (as directed by the Engineer);
- **Accurately pre-marking the proposed longitudinal cut lines on**
  the existing road surface; and

- Installing lift pegs or other survey controls if required by the Project Specifications.

In addition, if not detailed in the project drawings, the Contractor shall record the location of all road markings that will be destroyed in the stabilising process.

Scarification of the existing seal layer(s), if specified by the Project Specification, shall be carried out in such a way to end up with a particle size ≤50 mm.

The area to be stabilised shall be formed to final longitudinal and transverse shape, at an appropriate level so that the nominal compacted thickness of stabilised material is achieved to the tolerances as specified in clause 8.2. The aggregate to be stabilised shall be compacted to prevent visible displacement while the spreading and mixing operations take place. The stabilising process and materials shall not be used to make good deficiencies in shape or thickness; such improvements shall be achieved before commencing stabilising operations.

7.2.3 Production plan

Before start of work every day, the Contractor shall prepare a production plan detailing their proposals for the forthcoming day's work. This plan shall indicate:

- The overall layout of the length and width of road intended for stabilising during the day, provided in a sketch, broken into number of parallel cuts required to achieve the stated width, and the overlap dimensions at each joint between cuts;
- The sequence and length of each cut to be stabilised before starting on the adjacent or following cut;
- An estimate of the time required for spreading the stabilising agent, mixing and compacting each cut. The layout sketch shall also show the time when the completion of each cut is expected;
- The location where samples have been taken to determine the in-situ moisture contents, together with the results of the tests;
- Proposed water addition for each cut, and the location at which any change is to be made within that sequence;
- The source and quantity of material to be imported;
- The amount and type of stabilising agent to be applied to each cut;
- The proposed quality control testing programme;
- The proposed locations/timings of joints which, where possible, shall avoid joints on wheel paths;
- The number of passes to achieve sufficient mixing of the binder;
- Locations of existing services and mitigation/contingency plan to avoid conflict with the stabilising operation;
- Other information as requested by the Engineer.

The Contractor's site representative shall keep the daily production plan on site at all times.

7.2.4 Supply of aggregate to site

The supply of aggregate to the site and any stockpiling or other movement of aggregate before its placement on the road shall be controlled to avoid contamination and segregation. Contaminated or segregated aggregate shall be removed from site.

Where an existing basecourse is being utilised as a subbase the following also applies:

- Where the Project Specification calls for material to be imported for the purpose of shape correction, the material shall be spread, compacted and shaped to the design levels before stabilising.

- Where the Project Specification calls for material to be imported for the purpose of altering the particle size distribution of the stabilised material, or effecting mechanical modification, the material shall be spread evenly on the existing road surface as a layer of uniform thickness before stabilising.

7.3 Spreading the Stabilising Agent

The stabilising agent shall be uniformly spread at the specified application rate across the pavement to the two tolerances set out in Table 1:

Table 1: Tolerance for spreading stabilising agent

Test	Frequency	Tolerance
Mat test: (1 m^2 canvas)	Every 400 m^2	Within $\pm$0.5 kg/m^2 of the specified rate
Average usage test: Compare tonnes used (from delivery docket) with measured area	Upon emptying the spreader and bulk tanker	Within $\pm$2.5 % of the specified rate

The type of stabilising agent and application rate shall be specified in the Project Specifications.

The Contractor shall record and keep records of the tonnage of stabilising agent used per area, including the Mat results.

During the operation the utmost care shall be exercised to ensure that all run-off is contained on the road. In the event of any stabilising agent entering any waterways the Engineer and the environmental authority for the region shall be notified immediately.

7.4 Addition of Water

Sufficient water shall be added during the stabilising process. A system that controls water addition in relation to the forward speed of the stabilising machine shall be used. Particular care shall be taken to prevent any portion of the work from excessive wetting.

The optimum water content (OWC) of the stabilised materials shall be determined by NZS 4402, test 4.1.3, *New Zealand vibrating hammer compaction test*.

The water content during compaction shall be in the range of 90% to 100% of the material's optimum water content. The water content tests taken prior to stabilising and the water consumed per cut shall be recorded in the production plan records. (refer section 7.2.3)

7.5 In-situ Mixing

The stabilising equipment shall be set up and operated to ensure that the following key requirements are met:

7.5.1 Control of cut depth

The project specifications shall specify the thickness of stabilised layer required. The actual depth of the cut shall be physically measured at both ends of the stabilising drum at least once every 200 m along the cut length. Maximum variation from the specified depth of cut is –0 mm and +20 mm. Unless specifically allowed in the project specification, the depth of cut shall not intrude into a subgrade layer.

7.5.2 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 200 mm or half the layer thickness, whichever is the greater.

Unless stated to the contrary in the Project Specifications and where practical, longitudinal joints shall be planned to coincide with each change in crossfall across the road width. The overlap width shall be marked out before starting each cut sequence. Water and the stabilising agent shall only be applied to the overlap during the last cut to the overlap.

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.

The location of longitudinal joints must also consider prior and subsequent layers while avoiding future wheelpaths. The longitudinal joint where possible should be at least two times the layer thickness away from the longitudinal joints (if any) of prior and subsequent layers.

7.5.3 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 the stabilising agent ceased. To ensure continuity of the stabilised layer, the next successive cut shall be started 1 m behind this mark.

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.

The stabilised area shall be squared off at the end of the day's production, and the location shall be recorded on the production plan for that day.

The location of transverse joints must also consider prior and subsequent layers. The transverse joint must at be at least 5m from the transverse joints (if any) of prior and subsequent layers.

7.5.6 Particle size distribution of stabilised material

The forward speed of the stabilising machine, rate of rotation of the stabilising drum, and the positioning of the gradation control beam, shall all be adjusted to ensure that the in-situ material is broken down to a particle size distribution as specified in the Contract documents, and thoroughly mixed with the stabilising agent. Excessive breakdown of aggregate shall be controlled and, if possible, prevented.

To ensure that design requirements are met, the freshly hoed material shall be visually assessed within the first 20m run of each section, and then at an ongoing frequency as required, based on the variability of in-situ materials. The freshly hoed aggregate particle size distribution shall be assessed for uniformity and degree of aggregate breakdown. Where breakdown is considered excessive and stabilising speed and/or drum configuration cannot be adjusted to achieve a satisfactory particle size distribution, the works shall be suspended immediately and the Engineer notified.

7.5.7 Mixed material testing

Testing of the mixed material shall be carried out in lots to allow confirmation of the design parameters. A lot is defined as a continuous batch for a specific pavement layer on a particular project. The area of a lot shall not exceed 5000 m^2 or 250 linear metres of roadway whichever is the least.

During mixing, the contractor shall take a pair of representative samples behind the mixing plant per lot or at a minimum of 2 pairs of representative samples per day. These samples shall be placed in a sealed plastic bag and cured for 1 hour before compacting into a mould and testing the indirect tensile strength (ITS) of the mixed material according to NZTA T/19.

7.5.8. Particle size distribution behind stabilizer

Testing of the stabilised aggregate particle size distribution shall be carried out on site in lots taken behind the stabilizer to ensure the post stabilised particle size distribution achieves the specified parameters. A lot is defined as a continuous batch for a specific pavement layer on a particular project. The area of a lot shall not exceed 5000 m^2 or 250 linear metres of roadway whichever is the least.

Wet sieve analysis will be completed within 4 hours after stabilizing, and consist of a minimum of 3 sample bags per lot.

The Engineer should then confirm whether any further modification to the stabilised material is required. If the required changes are beyond the Contractor's control any future changes will be a variation.

7.6 Compaction

Compaction shall be achieved by the minimum necessary number of passes of compaction plant, not by traffic. Details of plant shall be given in the Quality Plan.

At the outset of compaction the contractor shall undertake plateau density tests for the purpose of determining the practicality of both the OWC and the MDD mix design targets, the minimum, and possibly the maximum, number and type of roller passes required to achieve the MDD for the proposed compaction plant and stiffness of lower pavement 'anvil' beneath the layer to be compacted. The plateau tests shall be undertaken with compaction plant that is to be used for construction – which shall be appropriate for the depth and type of materials to be compacted. The plateau tests shall be undertaken to confirm the optimum pattern of static and vibratory passes for the unique site settings and shall be undertaken in an area where lower pavement stiffness is representative. Repeated plateau density tests shall be undertaken when the material to be compacted or lower pavement parameters change visibly.

Compaction plant shall include type (i) for primary compaction, and type (ii) for the final consolidation of the top portion of the layer, as defined below:

Type (i) Padfoot vibratory rollers with single vibrating drum

Type (ii) Smooth double drum roller

Type (ii) rollers may be replaced with a combination roller, which has one smooth drum at the one axle and rubber-tyred pneumatic wheels across the full width at the second axle of the roller.

The rolling operation shall not extend beyond the width of the stabilised cut unless the adjacent stabilised material is within the time limitations of clause 7.1.2. Rolling beyond the stabilised cut onto longitudinal adjacent cuts that have already partly cured may fracture especially where there is a change of cross fall such as along the crown of the road.

The contractor shall test each layer immediately after primary compaction and provide the results of the water content and achieved density to the engineer. Frequency of testing and lot sizes shall be as defined in clause 8.1.

7.7 Pre-cracking

The requirement and timing for pre-cracking shall be as described in the project specification. Pre-cracking of the cement-bound sub-base layer, if specified, shall be done between 24 and 48 hours after stabilisation is completed. It shall be achieved with 2 to 3 passes with

the single drum vibratory roller, which was used for primary compaction, at maximum amplitude and travelling at a slow walking speed of about 3 kph. The rolling pattern shall be carefully planned, recorded in the production plan (7.2.3) and documented in the project quality plan.

7.8 Protection, Curing and Maintenance before Overlaying

The Contractor shall protect, maintain and cure the completed cement-bound sub-base until the next layer is applied. Curing of the layer shall be achieved by either light watering (to maintain a damp surface) or covering with impermeable sheeting or placing the basecourse aggregate or spraying with a curing compound / bituminous medium as approved by the Engineer. Besides construction traffic required for the above curing no other construction traffic shall be permitted onto the layer within 7 days of stabilisation, unless otherwise approved by the engineer. Maintenance shall include the immediate repair of any damage to or defects in the layer, and shall be repeated as often as it is necessary. Any remedial grading after the time limitations set out in clause 7.1.2, shall be cut to waste. Any significant defects or damage occurring during the construction or maintenance of the pavement layer before the next layer is applied shall be made good immediately by the Contractor as directed by the Engineer.

8. ACCEPTANCE CRITERIA OF THE CONSTRUCTED LAYER

8.1 Compaction

The stabilised pavement layer shall be compacted to a uniform, dense, stable condition.

Compaction testing during construction of the stabilised pavement layers shall be carried out in lots. A lot is defined as a section where the pavement layer appears homogeneous and evenly compacted. The area of a lot shall not exceed 1000 m^2.

The degree of compaction for each lot shall be determined by testing at least five randomly selected areas. The compaction requirements shall be met if the mean and minimum compaction values of the tests taken comply with the values in Table 2. In preference to random selection the Engineer may carry out any testing for uniformity to determine the location of density tests.

The Contractor shall be responsible for carrying out laboratory tests according to NZS 4402:1986, Test 4.1.3 to determine the maximum dry density (MDD) at the OWC of the modified material. The tests shall be undertaken on modified material that is taken from behind the Stabiliser.

The Maximum Dry Density of the stabilised material shall be determined for each layer at a minimum frequency of one Maximum Dry Density per 5,000 m^2 of material laid. If the aggregate source, processing method, or stabilised materials are expected to change then a new OWC and target MDD shall be determined.

Table 2: Mean and minimum degree of compaction for pavement layers as a percentage of agreed Maximum Dry Density

Degree of Compaction	Cement Treated Subbase
Mean	≥ 95 %
Minimum	≥ 92 %

Where the Acceptance Criteria are based on laboratory results and cannot be met, the Engineer shall nominate an independent laboratory to repeat the laboratory tests and supervise a repeat of the Plateau Density test. Should the Criteria still appear unachievable the Engineer may accept the Plateau Density tests as a means of determining the agreed target Maximum Dry Density on site. This process may be repeated for each target MDD determined at the Engineer's discretion. Should the additional testing agree with the Contractors testing, the additional testing shall be at the Principal's cost.

8.2 Construction Tolerances

8.2.1 Width

The maximum variation from the specified width shall be:

Unconstrained : -20 mm and + 100 mm

Constrained : Zero

8.2.2 Vertical

The maximum variation from the specified vertical surface of the completed pavement layer shall be such that, when all loose aggregate is removed, it conforms to the vertical variations specified in Table 3.

Table 3: Maximum vertical variations

Pavement layer	Between pavement centre line and pavement edge (mm)	
	with unbound granular base	with asphalt bound base
Sub-basecourse surface level	- 5 mm + 10 mm	- 15 mm + 0 mm
Sub-basecourse layer thickness	- 0mm + 20mm	- 0mm + 20mm

8.2.3 Crossfall

The crossfall between two points more than 2m apart, transverse to the centre line, shall not depart from the specified crossfall shown by more than 0.5%. Where the crossfall is not explicitly defined it shall not be less than the existing crossfall at start of construction.

No area of completed surface shall have any depression that will allow excess water to pond.

9. QUALITY PLAN

Compliance with the requirements of clauses listed in Table 4 shall be checked by the Contractor, included in the project's Quality Plan, and records made available for inspection by the Engineer.

Table 4: Summary of stabilisation compliance requirements

Construction / Stabilisation activity	Clause reference
Temperature	7.1.1
Time limitations	7.1.2
Addition of stabilising agent	7.3 – Table 1
Addition of water	7.4
Stabilisation depth	7.5.1
Strength testing (ITS)	7.5.7
Particle size distribution behind stabilizer	7.5.8.
Compaction	8.1 – Table 2
Construction tolerances	8.2

Measurements of crossfall should not be necessary unless indications are that the requirements of this specification have not been met. If the surface subsequently deteriorates so that finished surface levels may be affected, then the Contractor shall carry out further measurement of the construction dimensions to confirm compliance.

10. BASIS OF PAYMENT

If not included in the contract documents, the basis of payment shall be as follows:

All miscellaneous items, lodgings, supervision, setting out, contingencies, conveyance of plant, and other incidental work, general overhead administration and maintenance shall be incorporated in the unit rates listed in the schedule.

10.1 Preparation of surface (cubic metres/square metres)

If any special treatment is required to the existing pavement other than those described in this Specification, it shall be specified in the Project Specifications.

Payment will be made on the solid volume measured in cubic metres of inferior pavement removed and/or the area measured in square metres cleared to the satisfaction of the Engineer.

10.2 Supply and placing of imported aggregate (cubic metres)

Payment for each section of the works specified in the contract documents shall be made on the total compacted volume in cubic metres (m^3) of material measured. Measurement shall be calculated from the difference between the surveyed profile of the existing road and the finished levels or imported quantity specified.

The scheduled rate shall include allowance for supply, cartage, placing, watering, pre-compaction, and obtaining a finish so that the stabilisation can meet the thickness tolerances as specified.

10.3 Pre-treatment (square metres)

Payment for each section of the works specified in the Contract documents will be made on the specified area pre-treated by the stabilizer (m^2) to a specified depth (mm). Measurement shall be in area (m^2) of the finished dimensions of the pre-treated area as shown on the drawings or those directed and marked on site by the Engineer. In the case of the latter, the dimensions shall be agreed before stabilisation commences.

10.4 Stabilising (square metres)

Payment for each section of the works specified in the Contract documents will be made on the specified area stabilised (m^2) to a specified depth (mm) at a specified stabilising agent application rate (kg/m^2). Measurement shall be in area (m^2) of the finished dimensions of the stabilised layer shown on the drawings or those directed and marked on site by the Engineer. In the case of the latter, the dimensions shall be agreed before stabilisation commences.

The scheduled rate shall include allowance for the supply and spreading of the specified stabilising agent, injecting the water, mixing, compacting, trimming, finishing, pre-cracking and curing as specified.

10.5 Extra over or under clause 10.4 for the supply and spreading of stabilising agent (tonnes)

Extra or lesser payment for any section of the works specified in the Contract documents where the Engineer requires a variation to the amount of the stabilising agent that would have been used in clause 10.4 above, as specified in the original Project Specifications. Measurement shall be in tonnes (t) of stabilising agent.

The scheduled rate shall include allowance for supply and cartage of the stabilising agent.