

SPECIFICATION FOR THE MANUFACTURE AND CONSTRUCTION OF PLANT MIXED BOUND SUB-BASE PAVEMENT LAYERS

1. SCOPE

This specification shall apply to the manufacture and construction of plant-mixed aggregates to produce grader or paver laid bound sub-base layers using cement.

The pavement layer shall be constructed in accordance with the levels, grades and cross-sections as shown on the contract drawings.

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 these specifications are provided in the Notes to these Specifications.

3. MATERIALS

Aggregates to be treated shall comply with the Project Specifications.

4. STABILISING AGENTS

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 AS 2350.2 or 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 laboratory-based mix design tests with the water considered for use. The results of these mix design tests shall be greater than 90% of the final results from the 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 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 used.

6.1. Plant for Supply of Cement

Cement shall be delivered to the mixing plant site in bulk tankers unless otherwise approved by the Engineer. Each bulk tanker 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 cement storage vessel at the mixing plant.

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

6.2. Plant for Transferring Cement

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

6.3. Plant for Batching and Mixing

The batching and mixing 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 used.

The batching plant shall be calibrated as per the manufacturer's procedures every time it is moved and monthly thereafter.

The mixing plant shall be capable of consistently producing a uniform mixture to the proportions and tolerances given in clause 7.3.

As a minimum, the batching and mixing plant shall have the following features:

- A plant capacity that has adequate rating for maintaining a continuous mixing process and able to introduce the cement to produce a final mix that is consistent with the specified proportions.
- A mechanical mixer of sufficient length, rotation and paddle design that ensures thorough mixing without segregation of the treated material.
- A system of nozzles that promotes a uniform application of water across or along the flow of aggregate passing through the mixing process.

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 °C.

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 and rain

After mixing, plant mixed material shall be protected from the influence of weather. During stockpiling (if any) and transportation the material shall be covered to avoid drying below optimum moisture content or wetting from rainfall. Laying of plant mixed material shall not be undertaken during weather conditions that result in excessive drying or wetting of the material prior to compaction at the specified moisture content..

If, during construction, rain starts, no further work shall be permitted other than compaction and finishing

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 Laying 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 on which the stabilised material is placed (the substrate) shall be prepared by:

- Cleaning all vegetation, detritus and other foreign matter;
- Removing any standing water;
- Repairing or replacing any damaged substrate sections or sections which do not comply with the specified requirements;
- Ensuring that the substrate layer is dry enough to prevent damage by the construction of the new stabilised layer;
- Accurately pre-marking the proposed longitudinal joint lines on the existing surface;
- Recording the location of all road hardware such as service covers, road marking and the like.
- Installing lift pegs if required by the Project Specifications;

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

The stabilised layer covered by these specifications shall not be used to make good deficiencies in shape or thickness; such improvements shall be achieved before commencing these operations. The level tolerance of TNZ F/1 shall apply to the substrate surface. Any high spots that need to be removed (as directed by the engineer) shall be pre-milled. The substrate shall be formed to final longitudinal and transverse shape, at an appropriate level so that the nominal compacted thickness of stabilised layer is achieved to the tolerances as specified in clauses 8.2.

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 pavement intended to be constructed during the day, provided in a sketch, broken into number of parallel joints in the optimum position required to achieve the stated width;
- An estimate of the time required for plant mixing the binder, transporting, spreading for grader shaping, or delivering to paver and compacting each fresh section. The layout sketch shall also show the time when the completion of each run is expected;
- The location where samples will be taken to determine the target maximum dry density and optimum water content;
- Proposed water addition for the specified process, and the location at which any change is to be made within that sequence;

- The source and quantity of material to be supplied or recycled;
- The amount and type of cement to be applied, to the respective materials;
- 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 primary compaction of the layer;
- Locations of existing services and mitigation/contingency plan to avoid conflict with the construction of the pavement operation;
- Other information as requested by the Engineer.

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

7.3. Plant Batching and Mixing

7.3.1. 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.

7.3.2. Handling and addition of aggregate

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

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, this material shall be kept strictly in a separate stockpile and introduced to the mixing plant by way of separate bins.

Aggregates shall be batched within 95-105% of the proportions approved by the Engineer.

7.3.3. Addition of cement

The cement shall be fed uniformly and measured by mass on a continuous basis to the specified application rate and tolerance set out in Table 1:

Table 1: Tolerance for Cement addition

Test	Frequency	Tolerance
Continuous weigh auger and plant display reading	Continuous by plant operator	Within $\pm 5\%$ of the specified rate

Average usage test: Compare tonnes used (from delivery docket) with measured mixed quantity	Upon emptying the bulk tanker	Within $\pm 5\%$ of the specified rate
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The type of cement and application rate shall be specified in the Project Specifications.

The Contractor shall record and keep records of the tonnage of cement used per mixed quantity of material stabilised.

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

7.3.4. Addition of water

Sufficient water shall be added during the mixing process to ensure that the stabilised material is within 90 to 100 % of the material's optimum water content (OWC) during primary compaction. A system that continuously controls the water addition in relation to the aggregate(s) weight shall be used. Particular care shall be taken to prevent excessive wetting of the stabilised material.

The optimum water content (OWC) of the bound 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 stabilised material's optimum water content (OWC).

7.3.5. 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 volume of a lot shall not exceed 1000 m³ or 250 linear metres of roadway whichever is the least.

During mixing, the contractor shall take a pair of representative samples at the mixing plant per lot or at a minimum of 2 pair 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 TNZ T/19.

7.3.6. Grading of plant mix

Testing of the plant mixed material grading shall be carried out on site after placement, 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 volume of a lot shall not exceed 1000 m³ 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.

7.4. Loading, Transportation and Discharge

The mixed material shall be protected from the weather to maintain its moisture content during loading, transporting and whilst waiting discharge.

Segregation or contamination shall be prevented during all stages of loading, transport and discharge. Contaminated or segregated material shall not be used.

Stockpiling shall not be permitted.

7.5. Construction of Cement Bound Sub-base Pavement Layers

7.5.1. Placement of mixed material

Immediately prior to placing the cement stabilised material the underlying substrate shall be moistened and kept moist but not excessively wet.

The cement stabilised material shall be spread by mechanical paver or grader to achieve the width and layer thickness as specified or shown on the Project Drawings after final compaction to the requirements of clause 8.2 of this Specification.

The method used to place the stabilised material, either by mechanical paver or grader, shall avoid segregation and be detailed in the projects Quality Plan. The projects Quality Plan shall specifically detail the steps that will be taken, including further testing, if segregation does occur.

The Engineer may require additional sampling and testing. Should the additional samples comply the additional testing will be at the Principal's cost. These samples may be taken without the use of a sampling mat. The sample shall include all material within at least 50% of the layer thickness over an area of at least 0.7 m² and be of sufficient mass for the specified testing.

7.5.2. Layer Thickness

The project specifications shall specify the thickness of the cement stabilised layer required.

The depth of the layer shall be controlled by either lift stakes or electronic guided levelling guidance equipment. Maximum variation from the specified depth shall follow the requirements of clause 8.2.2.

The average compacted thickness of the cement stabilised layer shall be:

- (a) not less than 150 mm or 3 times the maximum stone size, whichever is the greater; or
- (b) not more than 250 mm

7.5.3. Joints

Unless stated to the contrary in the Project Specifications, and where practical longitudinal joints shall be planned to coincide with each and every change in crossfall across the road width. All joints, including joints to existing sections of pavement, shall be placed, compacted and finished satisfactorily so that the final surface does not have permeable or loose patches.

Between paver runs a construction joint with an inclined rough face at less than 45 degrees from the vertical shall be made and kept moist. At the end of each day's work, and when operations are delayed or stopped for more than one hour, an inclined rough face at less than 45 degrees from the vertical shall be made in thoroughly compacted material.

The constructed 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.

All joints shall be 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. The longitudinal joint must at least be two times the layer thickness away from the longitudinal joints (if any) of prior and subsequent layers.

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.

7.6. 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 measure 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 specified 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 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 cement treated pavement layer shall be compacted to a uniform, dense, stable condition.

Compaction testing of the modified 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 m².

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 Maximum Dry Density of the stabilised material shall be determined for each layer at a minimum frequency of one Maximum Dry Density per 5,000m² 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 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 the Maximum Dry Density. This process may be repeated for each MDD determined at the Engineer's discretion. Should the additional testing find the same as 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 crossfall shown in the documents 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 water to pond where the lateral or longitudinal fall is greater than 1%.

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 tolerances

Construction / Stabilisation activity	Clause reference
Addition of aggregates	7.3.2
Addition of Cement	7.3.3 — Table 1
Addition of water	7.3.4
Strength testing (ITS)	7.3.5
Grading of plant mix	7.3.6.
Compaction	7.6 & 8.1
Width	8.2.1
Vertical	8.2.2
Crossfall	8.2.3

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 substrate 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 substrate removed and/or the area measured in square metres cleared to the satisfaction of the Engineer.

10.2. Supply and placing plant mix stabilised material

The unit of measurement shall be square metre of completed cement-bound sub-base, the quantity of which shall be calculated in accordance with the specified dimensions shown on the contract drawings.

The proportions and type of aggregate and cement together with the nominal layer thickness, shall be specifically described in the payment item.

The scheduled rate shall include allowance for the supply and addition of all specified materials, cement and water, in addition to the mixing, transporting, placing, compacting, trimming and finishing, to all the specified tolerances including pre-cracking and curing of the layer as specified.

10.3. Extra over or under clause 10.2 for the supply and mixing of cement (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 cementitious stabilising agent that would have been used in clause 10.2 above, as specified in the original Project Specifications. Measurement shall be in tonnes (t) of agent.

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