# TRANSPORT FOR NSW (TfNSW)

# SPECIFICATION D&C R81

# NO FINES CONCRETE SUBBASE



## REVISION REGISTER

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Transport for NSW

SPECIFICATION D&C R81

# NO FINES CONCRETE SUBBASE


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# FOREWORD

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## BASE SPECIFICATION

This document is based on Specification TfNSW R81 Edition 2 Revision 2.

# TfNSW SPECIFICATION D&C R81

# NO FINES CONCRETE SUBBASE

## 1 GENERAL

### 1.1 SCOPE

This Specification sets out the requirements for the construction of no fines concrete (NFC) subbase. It includes the requirements for:

- constituent materials;
- concrete mix design;
- production and transport of NFC;
- NFC subbase paving;
- survey;
- sampling and testing:
- conformity criteria.

This Specification is not applicable to NFC used as structural subbase layer in an asphalt composite pavement.

This Specification is also not applicable to NFC for subsurface drainage. For supply of NFC for subsurface drainage, refer to Specification TfNSW D&C 3222.

### 1.2 STRUCTURE OF THE SPECIFICATION

This Specification includes a series of annexures that detail additional requirements.

#### 1.2.1 (Not Used)

#### 1.2.2 (Not Used)

#### 1.2.3 Schedules of HOLD POINTS and Identified Records

The schedules in Annexure R81/C list the **HOLD POINTS** that must be observed. Refer to Specification TfNSW D&C Q6 for the definition of **HOLD POINTS**.

The records listed in Annexure R81/C are **Identified Records** for the purposes of TfNSW D&C Q6 Annexure Q/E.

#### 1.2.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure R81/D and must be implemented.

In all cases where this Specification refers to the manufacturer's recommendations, these must be included in the PROJECT QUALITY PLAN.

### 1.2.5 Frequency of Testing

The Inspection and Test Plan must nominate the proposed frequency of testing to verify conformity of the item, which must not be less than the frequency specified in Annexure R81/L. Where a minimum frequency is not specified, nominate an appropriate frequency. Frequency of testing must conform to the requirements of TfNSW D&C Q6.

You may propose to the Principal a reduced minimum frequency of testing. The proposal must be supported by statistical analysis verifying consistent process capability and product characteristics. The Principal may vary or restore the specified minimum frequency of testing, either provisionally or permanently, at any time.

### 1.2.6 Referenced Documents

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure R81/M.

## 1.3 DEFINITIONS, ACRONYMS AND SYMBOLS

### 1.3.1 Definitions

The terms "you" and "your" mean "the Contractor" and "the Contractor's" respectively.

The following definitions apply to this Specification:

**Agitator** An item of plant or equipment which maintains the plastic concrete in the mixed state. Consistent with common usage, this term is also used (for convenience) in lieu of "mobile mixer".

**Authorised nominated mix** A mix design which has been authorised by the Principal.

**Batch** A quantity of concrete containing a fixed amount of ingredients and produced in a discrete operation.

**Batching** The process of combining the concrete ingredients in fixed proportions by mass or by volume, including charging and mixing.

**Completion of batching**

(a) For a stationary batch mixer discharging into a storage bin or tipper truck, this will be the time at which discharge from the mixer commences.

(b) For a stationary batch mixer discharging into a mobile mixer, this will be the time at which mixing ceases at the batching plant, or 10 minutes after the completion of charging of the stationary mixer, whichever occurs first.

(c) For direct charging of a mobile mixer, this will be the time at which mixing ceases at the batching plant, or 10 minutes after the completion of charging, whichever occurs first.

(d) For a continuous mixer discharging into a tipper truck, this will be the time at which discharge into the truck commences.

(e) For a continuous mixer discharging into a storage bin, this will be the time of earliest discharge (from the mixer) of that concrete within the bin.

| | |
|---|---|
| **Edge, outer (of subbase)** | An edge against which material other than subbase concrete is to be placed (such as granular backfill). |
| **Fixed-form paving** | Also referred to as "manual paving" and "hand paving". Paving between fixed formwork using manually operated equipment such as plate vibrators and vibrating bull-floats. |
| **Formed joint** | All joints except for induced joints. This includes mechanical paving and fixed-formed joints. |
| **Forming time** | The elapsed time measured from the completion of batching to the incorporation of the concrete into the Works, including compaction and hand finishing. |
| **Load** | A single truckload of concrete comprising one or more batches. |
| **Lot** | As defined in TfNSW D&C Q6. See also "sub-Lot" and "transition sub-Lot". |
| **Mixers** | (a) **Stationary mixer**: a mixer in a fixed location adjacent to the batching equipment. This category includes stationary batch mixers and stationary continuous mixers:<br><br>**Stationary batch mixer**: a mixer which produces a fixed amount of concrete produced in a discrete operation.<br><br>**Stationary continuous mixer** or **through mixer**: a mixer where ingredients are continuously added to one end of the chamber while mixed concrete is continuously discharged from the other end.<br><br>(b) **Mobile mixer** (or **agitator**): a truck-mounted drum mixer which is used for mixing and delivery. Mobile mixer can be used as a mixer or as an agitator.<br><br>See AS 1379 Clauses 4.2 and 4.3 for further information. |
| **Mixing time** | As defined in Clause 4.3.1. |
| **Retemper** | The addition of water to a batch after "completion of batching" to restore consistence. See also "temper".<br><br>The addition of an admixture (such as a high range water reducer) is not considered to constitute retempering. |
| **Sub-Lot** | A sub-Lot is defined as a continuous pour of area:<br>• up to 500 $m^2$ for machine paved subbase;<br>• up to 300 $m^2$ for fixed-formed subbase.<br><br>In transition zones, generate separate sub-Lots in accordance with Clause 7.1.1. |
| **Temper** | The addition of water, and mixing of concrete (or mortar), to bring it initially to the required consistence. See also "retemper". |
| **Test result** | The result from a single test specimen or sample. |

| | |
|---|---|
| **Test value** | The value calculated from single test results to represent the Lot (in accordance with relevant clauses of this specification). For example, single cylinder compressive strength results are averaged (after application of correction factors) to derive a test value. |
| **Transition zone** | Area of machine paved concrete of 3 m length, at each side of a transverse construction joint. |
| **Transition sub-Lot** | A sub-Lot which falls within a transition zone (as defined). |
| **Yielded cubic metre** | As per the determination of mass per unit volume in accordance with AS 1012.5. |

### 1.3.2 Acronyms

The following acronyms apply to this Specification:

| | |
|---|---|
| **ATIC** | Australian Technical Infrastructure Committee |
| **NATA** | National Association of Testing Authorities, Australia |
| **NFC** | No fines concrete |
| **SCM** | Supplementary cementitious material |
| **SF** | Shape correction factor for cores (refer Clause 7.1.5) |

### 1.3.3 Symbols

| | |
|---|---|
| $\mathbf{F_{28}}$ | Actual 28-day (cylinder) compressive strength in the nominated mix |
| $\mathbf{F_{28Min}}$ | The specified minimum 28-day (cylinder) compressive strength in the nominated mix |
| $\mathbf{f_{cMin}}$ | The specified minimum 28-day (core) compressive strength in the pavement |

**Note:**

(1) The symbol for concrete strength shown with the leading uppercase "F" refers to test results on moulded cylinders from the nominated mix, while that shown with the leading lowercase "f" refers to test results on cores taken from the constructed work.

# 2 MATERIALS

## 2.1 COARSE AGGREGATE

### 2.1.1 General

Coarse aggregates for NFC must consist of clean, durable materials sourced from natural gravel, crushed stone or air-cooled iron blast furnace slag. Basic oxygen and electric arc furnace steel slag aggregates are not acceptable.

During the Contract, all aggregate testing must be on samples taken either from dedicated stockpiles or from materials delivered to Site.

Coarse aggregate must conform to AS 2758.1 and the supplementary requirements in Clause 2.1.2.

### 2.1.2 Requirements

The properties of the coarse aggregate must comply with Table R81.1.

**Table R81.1 – Coarse Aggregate Property Requirements**

| Property | Test Method | Requirement (1) |
|---|---|---|
| Bulk density (compacted) | AS 1141.4 Clause 7.2 | Minimum 1200 kg/m$^3$ |
| Particle density | AS 1141.6.1 or AS 1141.6.2 | Minimum 2100 kg/m$^3$ |
| Water absorption | AS 1141.6.1 or AS 1141.6.2 | Maximum 2.5% |
| Wet strength (2) | TfNSW T215 | Minimum 50 kN |
| Wet/Dry Strength variation | TfNSW T215 | Maximum 35% |
| Particle Size Distribution | AS 1141.11.1 | Nominated by the Contractor (refer Clause 3.6.2) |
| Particle shape:<br>2:1 ratio<br>3:1 ratio | AS 1141.14 | <br>Maximum 35%<br>Maximum 10% |
| Fractured faces: two or more (3) | TfNSW T239 | Minimum 80% |
| Alkali-aggregate reactivity (AAR) | TfNSW T363 and T364 | As per Clause 2.2 |

**Notes:**

(1) If two or more coarse aggregates are to be blended, the aggregate from each source must comply with these requirements.

(2) The fraction to be tested is the particle size distribution interval in Table 1 of AS 1141.22 which represents at least 50% of the aggregate by mass.

(3) Testing can be waived for aggregate which has been extracted from mineral rock quarries by drilling and blasting.

## 2.2 ALKALI-AGGREGATE REACTIVITY

Testing of aggregates for alkali-aggregate reactivity is not required if the SCM content in the concrete mix complies with TfNSW 3211 Annexure 3211/E3. Otherwise, carry out testing on aggregates from each proposed individual supply source for potential alkali-aggregate reactivity in accordance with Test Method TfNSW T363, within 18 months prior to the commencement of paving.

From the classification obtained by the testing, deal with the aggregates as follows:

(a) Where the aggregate is classified as "non-reactive": no further action is required.

(b) Where any of the aggregates in the mix is classified as "slowly reactive", limit total alkali content in the mix to 2.1 kg/m$^3$. (Total alkali content is the available alkali content of cement and other sources expressed as $Na_2O$ equivalent, calculated as the sum of $Na_2O$ and 0.658 $K_2O$.)

(c) Where any of the aggregates in the mix is classified as" reactive":

either:

(i) use a different aggregate and repeat the test;

or

(ii) re-test using blended cement conforming to TfNSW 3211 and re-assess the alkali-aggregate reactivity potential using Test Method TfNSW T364.

Do not use aggregates that are classified "reactive" by TfNSW T364.

## 2.3 CEMENTITIOUS MATERIALS

Cementitious materials must comply with TfNSW D&C 3211.

## 2.4 WATER

Water used in the production of concrete must be free from materials harmful to concrete, and be neither salty nor brackish. The water must conform to AS 1379 Clause 2.4 and Table 2.2, and the following:

(a) chloride ion: maximum 500 mg/L determined by AS 1478.1 Appendix C;

(b) sulfate ion: maximum 400 mg/L determined by AS 1289.4.2.1.

Water which is drawn solely from a reticulated drinking water supply is deemed to conform to the above.

If the water contains a component from a source other than reticulated drinking water supply, the combined mixing water must conform to the requirements of this Clause.

## 2.5 ADMIXTURES

### 2.5.1 General

Chemical admixtures and their use must conform to AS 1478.1.

Admixtures must not contain calcium chloride.

For combinations of two or more admixtures, their compatibility with each other must be certified in writing by their manufacturers.

### 2.5.2 Total Alkali Contribution

For mixes with less than 50 kg/m$^3$ fly ash, the total alkali contribution (measured as $Na_2O$ equivalent in accordance with AS 1478.1) from all admixtures used in any mix must not exceed 0.20 kg/m$^3$.

### 2.5.3 Seasonal Dosage Variation

Provide details in the PROJECT QUALITY PLAN of the criteria for initiating changes in admixture type with changes in season. If the same admixture is proposed for use across all seasons, provide also dosage rate charts for various temperature ranges. Additional testing in the mix design process is not required if admixture dosage rate changes are based solely on ambient temperature.

## 2.6 CURING MEMBRANE

Curing membrane must consist of 0.2 mm minimum thickness opaque polyethylene sheets at minimum width of 1.2 m.

# 3 DESIGN OF CONCRETE MIXES

## 3.1 GENERAL

Design the concrete mix in accordance with this Specification, taking into consideration the anticipated conditions that will be prevailing on site so that, under those conditions, the concrete in the constructed subbase meets all the requirements of this Specification.

## 3.2 WATER TO CEMENTITIOUS MATERIAL RATIO

The water to cementitious material ratio must provide for complete cementitious paste coverage of the aggregate and must be in the range of 0.30 to 0.45 by mass. The paste content must not be such as to cause the paste to flow during mixing, handling or placing.

## 3.3 COMPRESSIVE STRENGTH

Concrete compressive strength must comply with the requirements listed in Table R81.2.

**Table R81.2 – Concrete Strength**

| Description | Nominated Mix (1) | Insitu Pavement Concrete (2) |
|---|---|---|
| Test specimen | Cylinder (150 mm diameter) | Core (refer Clause 7.1) |
| Test method | Moulding: TfNSW T376<br>Testing: AS 1012.9 | AS 1012.14, as amended by Clause 7.1.4 |
| Compressive Strength | at 28 days:<br>minimum 6.0 MPa ($F_{28Min}$) | at 28 days:<br>minimum 5.0 MPa ($f_{cMin}$) |

**Notes:**

(1) Each sample must have a minimum air void content of 25% for the concrete strength to be valid. Determine air void content using Test Method TfNSW T378.

(2) Insitu pavement core concrete strength requirements are provided in this Clause for comparison with the cylinder strength requirements of the nominated mix.

To determine the compressive strength $F_{28}$ for each batch of the nominated mix, test a minimum of 3 specimens at age 28 days. $F_{28}$ is taken as the mean of all individual results from all batches which are not more than 2.0 MPa from the median value of all individual results.

## 3.4 PERMEABILITY

Mould a nominal 150 mm diameter cylinder and cure the specimens in accordance with Test Method TfNSW T376.

Test the permeability in accordance with Test Method TfNSW T377.

Permeability must not be less than 0.015 m/s.

## 3.5 SULFATE CONTENT

### 3.5.1 General

Sulfate ion contents must comply with Table R81.3.

**Table R81.3 – Sulfate Ion Content Requirements**

| Attribute | Test Method | Requirement |
|---|---|---|
| Sulfate ion content | Clause 3.5.2 | maximum 5% relative to cement mass (1) |

**Note:**

(1) Calculate the sulfate ion content relative to the cement mass (i.e. excluding supplementary cementitious materials such as fly ash and slag).

### 3.5.2 Sulfate Content Testing

Carry out testing for sulfate ion contents by either:

(a) testing of concrete constituents, or

(b) testing of hardened concrete.

**(a) Testing of Concrete Constituents**

Determine the sulfate content of the mix by testing in accordance with:

(i) AS 1012.20.1 for aggregates;

(ii) AS 1289.4.2.1 for water and admixtures dissolved in water;

(iii) AS 2350.2 for cementitious materials,

and calculating the total sulfate content and percentage in the mix.

For water, test samples taken from the source proposed for the Works. If the mixing water is drawn solely from a reticulated drinking water supply, test values provided by the supply authority may be used.

For admixtures, the sulfate contents may be taken as the values certified in writing by the manufacturer.

**(b) Testing of Hardened Concrete**

Determine the sulfate content of the hardened concrete in accordance with AS 1012.20.1.

## 3.6 TRIAL MIXING FOR MIX DESIGN

Conduct trial mixing in the laboratory to demonstrate that the proposed mix designs conform to this Specification.

The trial mixing must conform to your proposals under Clause 4 for batching and mixing, including the dilution and incorporation of admixtures, and the sequence of addition of the constituent materials.

The date of testing of both the laboratory trial mix and all constituent materials must not be older than 18 months from the date on which the nominated mix is proposed to be used.

If sufficient production mix test results are available within this period in accordance with AS 1379, the Principal may reduce the scope of the laboratory mix or may waive it altogether.

## 3.7 SUBMISSION OF NOMINATED MIXES

### 3.7.1 General

Prior to commencing production of each subbase concrete mix, submit to the Principal the following:

(a) details of each nominated mix in accordance with Clauses 3.7.2 to 3.7.4;

(b) NATA endorsed test results for all specified tests;

(c) a copy of a verification checklist covering the items listed in Clauses 3.7.2 to 3.7.4;

(d) a statement signed by you certifying that each nominated mix and its constituents meet the requirements of this Specification.

Alternatively, you may propose a mix which is currently listed as conforming to this Specification in the TfNSW Register of Concrete Mixes, available at:
http://www.rms.nsw.gov.au/business-industry/partners-suppliers/register-of-materials/concrete-mix/conform-conc-mix.pdf

**HOLD POINT**

| | |
|---|---|
| Process Held: | Production of each concrete mix. |
| Submission Details: | At least 5 working days before production, submit one of the following:<br>(a) For **new mixes**: details and attachments as specified in Clause 3.7.1;<br>or<br>(b) For nominated **mixes from the TfNSW Register of Concrete Mixes**: a statement stating that the mix conforms to this Specification and is suitable for its intended use. |
| Release of Hold Point: | The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point. |

### 3.7.2 Constituent Materials

Provide the following details:

(a) Cement: supplier, product name, ATIC registration number and source.

(b) SCM: supplier, product name, ATIC registration number and source (for each).

(c) Water: source.

(d) Admixtures: proprietary source, type, name and dosage recommended by manufacturer.

(e) Aggregates: source, geological type, moisture condition on which mix design is based (oven dry, saturated surface dry or nominated moisture content).

(f) Relevant test results for all constituents.

(g) Test results for sulfate content, in accordance with Clause 3.5.

### 3.7.3 Mix Design

Provide the following details:

(a) Constituent quantities, including cementitious material content, per yielded cubic metre of concrete, and maximum allowable water to cementitious material ratio.

(b) Nominated particle size distribution of aggregates.

### 3.7.4 Test Results of Nominated Mix

For each nominated mix, submit details and demonstrate conformity for the following:

(a) Water to cementitious material ratio.

(b) Compressive strength ($F_{28}$) and air void content at age 28 days.

(c) Permeability.

Mould all test specimens from the same homogeneous batch. Certify that the specimens were moulded in accordance with the requirements of this Specification.

## 3.8 VARIATIONS TO AUTHORISED NOMINATED MIX

After the nominated mix has been accepted for production, it becomes the authorised nominated mix for use.

You may vary the authorised nominated mix without resubmitting a new nominated mix, unless the proposed variations from the current authorised nominated mix exceed the following amounts:

(a) Cement: –10 kg/m$^3$, +20 kg/m$^3$.

(b) Other cementitious material: 20 kg/m$^3$.

(c) Other solid constituents: 5% by mass.

(d) Admixture dosages in accordance with Clause 2.5.

(e) Water: not specified.

Notify the Principal of such variations to an authorised nominated mix before commencing production with the varied quantities.

If you intend to vary the quantities of the constituents in excess of the above amounts, or to change the type of admixture or the source of supply of any constituent, submit a new nominated mix in accordance with Clause 3.7.

# 4 PRODUCTION AND TRANSPORT OF CONCRETE

## 4.1 GENERAL

### 4.1.1 Concrete Characteristics

Concrete produced for the Works must be homogeneous, without segregation or loss of materials during transport. The concrete must have workability, at the time of incorporation, which is compatible with the capacity of the paving equipment to achieve the required compaction uniformly, and a surface finish requiring only minimal manual finishing.

### 4.1.2 Handling, Storing and Batching

The handling, storing and batching of materials and the mixing, transport and consistence of concrete, including any retempering, must comply with AS 1379, Sections 3 and 4 (using control of water by control of water to cementitious material ratio) and AS1379 Appendix A (except for determination of slump, air content and mass per unit volume of the air-free mortar), modified by the requirements of Clauses 4.2 to 4.6.

Detail in the PROJECT QUALITY PLAN the proposed methods of handling, storing and batching materials, and the method of charging the mixer, including the proposed sequence of addition of ingredients. The method and sequence of charging must be consistent with the recommendations of the suppliers of mix additives.

### 4.1.3 Production and Transport Capacity

For machine paving, the production and transport equipment must have an operational capacity which allows continuous paving at your target paving speed. The capacity must not be less than that required to maintain a continuous paving speed, with adequate allowance for mixer efficiency and control testing.

Do not use pumping to transfer NFC.

## 4.2 PRODUCTION MIXES

### 4.2.1 General

For production mixes, always target the authorised nominated mix. Table R81.4 lists the tolerances for constituents in individual batches from the authorised nominal mix.

**Table R81.4 – Production Tolerances**

| Description | Tolerance (% by mass) |
|---|---|
| **Aggregate Particle Size Distribution: (AS sieve)** | |
| 26.50 mm sieve | ± 2 |
| 19.00 mm sieve | ± 5 |
| 9.5 mm sieve | ± 2 |
| 0.075 mm sieve | ± 1 |
| **Each Cementitious Material:** | ± 3.0 |

Notwithstanding these tolerances, the water to cementitious material ratio must comply with Clause 3.7.4.

### 4.2.2 Production Monitoring

#### (a) Aggregates

Do not use aggregates in the Works which have become intermixed or contaminated with foreign matter.

**(b) Cementitious material**

For all batches within a Lot, monitor the mean content of each cementitious material. The mean content must be not less than that of the authorised nominated mix or as varied in accordance with Clause 3.8.

Weigh each cementitious material separately.

**(c) Water**

For volumetric batching of water, use a measuring device calibrated in one litre increments to an accuracy of ± 2% of the value shown on the indicating device.

**(d) Admixtures**

For liquid admixtures, the metering equipment must measure the volume, or mass, of liquid to an accuracy of ± 5% of the value shown on the indicating device.

### 4.2.3 Batching Record

Maintain a Batching Record which records the actual masses of each constituent in every batch, together with departures beyond the allowable tolerances. Do not incorporate nonconforming batches or loads into the Works.

## 4.3 MIXING OF CONCRETE

### 4.3.1 Measurement of Mixing Time

The term "mixing time" is applicable to batch mixers only, and comprises only that mixing carried out at the specified mixing rate (i.e. excluding agitation). It is measured as follows:

(a) For **stationary batch mixers**, the mixing time is measured from the time when at least 90% of the total water content and all other ingredients are in the mixing drum, until mixing ceases, or after the completion of specified revolutions.

(b) For **mobile mixers**, the mixing time is measured from the time all the ingredients, including the total added water content, are in the mixing drum until mixing ceases or after specified revolutions.

### 4.3.2 Minimum Mixing Time

For **stationary batch mixers**, the minimum mixing time $MT_{min}$ must be the greater of that determined from mixer uniformity testing in accordance with Annexure R81/E and the following:

(a) **stationary twin-shaft mixers**: not be less than 30 seconds plus 5 seconds for each cubic metre (or part thereof);

(b) **all other stationary batch mixers**: not be less than 54 seconds plus 6 seconds for each cubic metre (or part thereof).

Up to 10% of the remaining total water content for the authorised nominated mix may be added after the defined mixing time, and the mixing time increased as follows:

(i) **stationary twin-shaft mixers**: a minimum of 15 seconds of mixing must be provided after the final addition of water.

(ii) **all other stationary batch mixers**: a minimum of 30 seconds of mixing must be provided after the final addition of water;

For **mobile mixers**, the minimum mixing time $MT_{min}$ after charging must be greater of that shown on the mixer identification plate and 3.0 minutes.

Provide the full period of mixing at either the testing station or the point of placement. Ignore all other mixing and agitation for the purpose of assessing the actual mixing time for a specific batch.

### 4.3.3 Maximum Mixing Time

The maximum mixing time is 5 minutes for split-drum and twin-shaft mixers, and 10 minutes for all other mixer types.

### 4.3.4 Admixture Addition

Detail in the PROJECT QUALITY PLAN how admixtures will be incorporated in the mix in accordance with the requirements of this Specification.

Incorporate the admixtures in accordance with the manufacturer's instructions, and by a method which ensures that no adverse interaction occurs.

Dilute admixtures separately and thoroughly in the mixing water prior to their introduction to other materials.

### 4.3.5 Discharge

For batch mixers, after the completion of batching, discharge the entire batch of concrete from the mixer before any further charging takes place, with the exception of conforming retempering.

### 4.3.6 Hold Point

| **HOLD POINT** | |
|---|---|
| Process Held: | Production of concrete for paving of NFC subbase (including paving trial). |
| Submission Details: | Results demonstrating conformity of mixer uniformity as per Annexure R81/E. |
| Release of Hold Point: | The Nominated Authority will consider the submitted results, within 2 working days of receipt of the results, prior to authorising the release of the Hold Point. |

## 4.4 TRANSPORT OF CONCRETE

### 4.4.1 Batch Delivery Docket

Provide with each batch of concrete an identification certificate (delivery docket), which is pre-numbered and issued sequentially in accordance with the order of batching. This certificate must record the details required to establish the time of completion of batching as defined in Clause 1.3.1.

Show on the identification certificate the quantity of water in the batch, and the total allowable quantity of water.

Depending on the mixer and transport types, this may require the recording of times for charging, and/or mixer discharge.

Detail in the PROJECT QUALITY PLAN how the identification certificate will be monitored for compliance with the batching requirements of this Specification.

### 4.4.2 Transport of Mixes for Manual Paving

Use agitators to deliver concrete which will be placed manually, except that material transfer placers and tipper trucks may be used where haul lengths are such that segregation does not occur, and compaction and finishing of the mix is not compromised.

## 4.5 RETEMPERING

For concrete which is delivered by other than agitators, do not add water or any other ingredient to the mixed batch.

Concrete which is delivered by agitators may be retempered in accordance with the following conditions:

(a) Retempering is allowed only within 40 minutes of the completion of batching, except for mixes containing hydration control admixture. For such mixes, the time nominated for retempering in the mix design is applicable.

(b) Retemper only in the presence of your representative who has been previously nominated to the Principal for this purpose.

(c) Retemper only at the batch plant, the testing station, or the point of placement.

(d) Immediately after retempering, re-mix the batch at the designated mixing speed for not fewer than 30 revolutions, or for such additional time as may be necessary to re-establish uniformity of the mix.

(e) Record the quantity of added water during retempering on the identification certificate for that batch. If water is added after the commencement of discharge, record the estimated remaining quantity of concrete at that time.

(f) During retempering, ensure that the maximum water cement ratio nominated in the mix design is not exceeded.

(g) Mould test cylinders for compressive strength from the retempered mix, in accordance with this Specification. These cylinders are additional to the routine testing requirements.

Detail in the PROJECT QUALITY PLAN how concrete supply will be monitored for conformity with these retempering provisions.

## 4.6 FORMING TIME

### 4.6.1 Maximum Forming Time

Determine the maximum forming time (refer Clause 1.3.1 for the definition of “forming time”) for each authorised nominated mix, with consideration of the prevailing weather conditions and concrete temperature.

Detail in the PROJECT QUALITY PLAN the procedure to determine the maximum forming time.

### 4.6.2 Actual Forming Time

Monitor the actual forming time, and record the actual forming time for any load exceeding:

(a) 90 minutes for air temperatures less than 30°C;

(b) 60 minutes for air temperatures greater than or equal to 30°C;

(c) the nominated forming time for mixes with hydration control admixtures, based on the laboratory trials for their mix designs.

NFC subbase constructed from such loads may be accepted if the compressive strength of cores taken from the section of subbase constructed with the specific load is conforming. Record the specific location of the load placed in the Works.

# 5 NO FINES CONCRETE SUBBASE PAVING

## 5.1 GENERAL

| **HOLD POINT** | |
|---|---|
| Process Held: | Paving of NFC subbase (including paving trial). |
| Submission Details: | Schedule of underlying surface levels and relevant nonconformity report together with any proposed redesign of pavement levels. |
| Release of Hold Point: | The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point. |

Place, pave and finish concrete in such a manner as to:

(a) avoid segregation or loss of materials;

(b) avoid premature stiffening;

(c) produce a homogeneous product throughout the subbase layer;

(d) meet strength and permeability requirements;

(e) provide the minimum specified thickness and surface finish. Notwithstanding this, the thickness of NFC subbase must not exceed 300 mm.

Where the NFC subbase extends over subsurface drains with NFC, the placing of NFC in the drains may occur in the same shift as the NFC subbase layer.

### 5.1.1 Concrete Paving Crew Training

Provide staff training in paving techniques for no fines concrete in accordance with TfNSW D&C Q6.

Submit details of such training as part of the PROJECT QUALITY PLAN.

### 5.1.2 Traceability

Maintain records showing the location of each load of concrete in the finished work, in accordance with TfNSW D&C Q6. The method of traceability must be sufficiently accurate to enable subsequent identification of specific loads for examination and/or testing.

Detail in the PROJECT QUALITY PLAN the method of traceability.

## 5.2 SURFACE PREPARATION USING DENTAL CONCRETE

Where the underlying surface is uneven with a risk of ponding of water under the NFC subbase layer, use dental concrete to produce a smooth even surface.

Dental concrete may be either:

(a) lean mix concrete complying with Specification TfNSW D&C R82, or

(b) concrete of minimum strength Grade N20 complying with Annexure R53/E of Specification TfNSW D&C R53.

## 5.3 TEMPERATURE, WEATHER CONDITION AND TUNNEL LEAKAGE

### 5.3.1 Concrete Temperature

Measure and record concrete temperature at the point of discharge in accordance with ASTM C1064M.

Do not place concrete in the Works if its temperature at the point of discharge from transport vehicles is less than 10ºC or more than 32ºC.

### 5.3.2 Air Temperature

When placing concrete in areas outside tunnels or within 100 m from the tunnel portals inside tunnels, measure and record the air temperature outdoors in the shade at the paving site, but remote from artificial influences such as machinery exhaust outlets.

Monitor the air temperature at intervals not exceeding 30 minutes. Stop concrete batching when the air temperature reaches 32°C and is rising.

Do not place concrete in the Works when the air temperature is below 5°C or above 35°C.

### 5.3.3 Rain and Tunnel Leakage

Do not place concrete in the Works:

(a) during rain or when rain appears imminent, for areas outside tunnels or within 20 m from the tunnel portal inside tunnels;

(b) when water is continually leaking in drops or streams from the roof of the tunnel onto the paved area, unless such water is temporarily diverted from above the area being paved;

(c) the surface has water ponding.

## 5.4 MACHINE (MECHANICAL) PAVING

### 5.4.1 General

Where practicable, carry out paving by the machine paving method.

The unsupported longitudinal edge produced must maintain its shape and must not sag or tear.

Plan the work, and coordinate the concrete delivery, spreading and paving activities to optimise the continuous and uniform progress of the paver and to minimise discontinuities in the work. Record details of any interruptions to the progress of the paver, including the reason, location, and duration.

### 5.4.2 Paving Equipment

The mechanical paver must spread, compact, screed and finish the freshly placed concrete so as to produce a homogeneous layer with uniform aggregate to aggregate contact, and with a uniform finish requiring minimum hand finishing.

The mechanical paver must be a self-propelled machine and must include the following features:

(a) an automatic control system with a sensing device to control line and level to the specified tolerances;

(b) means of spreading the mix uniformly and regulating the flow of mix to the paver and conforming plate without segregation of the components;

(c) a tamping device as part of the paver for compaction of concrete. Roller compaction is not permitted;

(d) capability of paving to the widths and depths shown on the Design Documentation drawings.

Detail in the PROJECT QUALITY PLAN the equipment and methods to be used for placing, spreading and finishing the NFC subbase.

For each of the proposed machine paving configurations, nominate the following parameters in the PROJECT QUALITY PLAN:

(i) maximum paving speed (i.e. instantaneous, not average);

(ii) target (optimum) paving speed;

(iii) gross operating mass per linear metre of paving width.

## 5.5 FIXED-FORM (MANUAL) PAVING

### 5.5.1 General

Detail in the PROJECT QUALITY PLAN the equipment and methods to be used for placing, spreading and finishing the concrete.

### 5.5.2 Formwork

Design and construct the formwork such that it is braced in a substantial and unyielding manner.

Debond the formwork so that it can be removed without damaging the concrete.

Set the formwork up such that the screeding surface will be within the tolerances of the specified levels of the finished NFC subbase surface.

### 5.5.3 Placing and Compacting

Deposit and spread the concrete uniformly and without segregation within the formwork by means other than vibration.

Compact the concrete by at least two passes of a hand-guided vibratory screed traversing the full width of the paving run on each pass. The screed's length must be consistent with the width of the paving run under construction.

## 5.6 PAVING IN TRANSITION ZONES

For transition zones, use methods of placing which will ensure adequate compaction of the concrete.

Provide the following details in the PROJECT QUALITY PLAN:

(a) proposed technique for paving at transverse construction joints, for both machine and fixed form paving, at both the start and finish of paving runs;

(b) length of paving run between a transverse construction joint and the point of effective paver tamping, at both the start and finish of paving runs;

(c) details of vibratory screed devices for manual paving;

(d) method of side forming to prevent edge slump.

## 5.7 JOINTS AND EDGES

### 5.7.1 General

The first-placed face must be compacted and visually homogenous.

Where a joint is nonconforming or its edge is damaged, it must first be reinstated or repaired and allowed to set before new concrete for the adjoining section is placed.

Unless shown otherwise on the Design Documentation drawings, slabs formed by the joints (both transverse and longitudinal) must not have dimensions or corner angles less than that shown in Table R81.5.

**Table R81.5 – Minimum Dimensions or Corner Angles**

| Description | Minimum Value |
|---|---|
| Length (m) | 1.5 (1) |
| Width (m) | 1.0 (2) |
| Corner angle (°) | 70 (3) |

**Notes:**

(1) measured parallel to the control line

(2) measured orthogonal to the control line

(3) measured in plan view

### 5.7.2 Transverse Construction Joints

Provide transverse construction joints at discontinuities in the placement of concrete as determined by your paving operations.

Transverse joints must be:

(a) continuous over the full paving width, without steps or offsets in any axis, so that along the line of the joint, it does not deviate by more than 50 mm from a 3 m straightedge nor by more than 10 mm from a 0.3 m straightedge;

(b) constructed with a butt (flat) joint face which is orthogonal (± 5°) to the finished top surface of the NFC subbase.

### 5.7.3 Longitudinal Construction Joints

Where longitudinal joints are required by your placing methods, their location must be at minimum 300 mm (nominal) offset from a planned longitudinal joint in the base. The joint location must not deviate from the planned or nominated position at any point by more than 100 mm; i.e. the joint location of the NFC subbase must not be less than 200 mm offset from a planned longitudinal joint in the base.

Longitudinal joints must, along the line of joint, not deviate horizontally by more than 20 mm from a 3 m straightedge placed along the joint, after due allowances for any planned curvature, nor by more than 10 mm from a 0.3 m straightedge.

The face profile of the longitudinal joint must be either one of the following:

(a) the face of the joint is orthogonal to the finished top surface of the NFC subbase, with the top 50 mm at a tolerance of 10° and below this top 50 mm, at a tolerance of 45° (see Figure R81.1 (a) below); or

(b) the entire face of the joint is orthogonal to the finished top surface of the NFC subbase, with a tolerance of 22.5° (see Figure R81.1 (b) below).

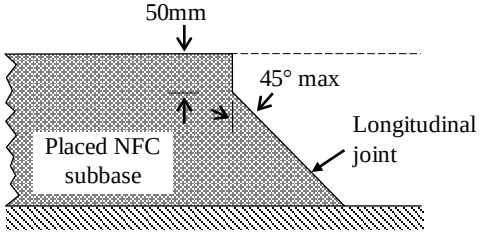



**Figure R81.1 (a)**

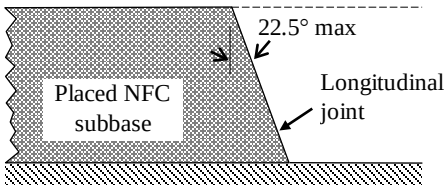



**Figure R81.1 (b)**

### 5.7.4 Outer Edges

Unless shown otherwise on the Design Documentation drawings, the NFC subbase must be constructed wider than the plan position of the overlying base by 50 mm (with a tolerance of ± 25 mm).

The face profile of outer edges must conform to that for longitudinal joints in Clause 5.7.3.

Outer edges must be compacted and visually homogenous.

Where the paved edge is to form a longitudinal construction joint with adjoining subbase concrete, the horizontal alignment tolerances must comply with Clause 5.7.3.

### 5.7.5 Inspection

Inspect each joint and edge within 24 hours of its construction, and again before paving of the next adjoining section of the NFC subbase. If nonconformity is detected, implement Corrective Action before proceeding with the paving of the adjoining section.

## 5.8 PREVENTION OF MOISTURE LOSS

### 5.8.1 Meteorological Data

Detail in the PROJECT QUALITY PLAN what meteorological or other data will be collected, how such data will be used and what measures will be taken to restrict the evaporation of water from the concrete surface and to limit the incidence of plastic shrinkage cracking or rapid drying of the surface leading to aggregates being dislodged from the concrete.

### 5.8.2 No Evaporation Retarders

The use of evaporation retarders to restrict the evaporation of water is not permitted.

### 5.8.3 Inspection

Inspect the plastic concrete regularly to monitor the effectiveness of the adopted procedures.

## 5.9 SURFACE FINISH

The paved surface of the NFC subbase must be uniform and without distinct ridges or recesses.

## 5.10 CURING

Provide curing to the NFC subbase by covering with polyethylene sheets complying with Clause 2.5.

Apply the sheeting immediately after finishing of the surface and continue curing for a continuous period of 7 days, or until insitu concrete strength of 4 MPa is achieved, whichever occurs first. A minimum of 200 mm overlap must occur at edges of the sheeting. Restrain edges to prevent exposed areas.

## 5.11 CONCRETE PAVING TRIAL

### 5.11.1 General

Prior to full scale NFC subbase paving, construct a trial section of NFC subbase, using the authorised nominated concrete mix, equipment and methods, and in accordance with the dimension and volume limits stated in Table R81.6.

**Table R81.6 – Dimension and Volume Limits for Paving Trial Section**

| Parameter | | Requirements | |
|---|---|---|---|
| | | **Machine paving** | **Fixed-form paving** |
| Length of paving trial [1, 2] | Minimum | 50 m | 15 m |
| | Maximum | 100 m | 50 m |
| Concrete volume in paving trial | Minimum | Not applicable | 20 $m^3$ |

**Notes:**

(1) The Project Verifier may accept an extension of the paving trial to a full day of paving if the Contractor has demonstrated satisfactory paving performance in recent past projects.

(2) Construct the trial section(s) in a continuous operation without intermediate construction joints.

Give the Project Verifier at least 5 working days written notice of your intention to commence the paving trial.

If a paving trial is conducted at a paving width of less than 70% of the maximum paving width proposed, the Project Verifier may call for a new trial section prior to paving of sections with widths equal to or greater than 70% of the maximum width proposed.

Conduct concrete compressive strength testing for the trial in accordance with Clause 7.1.

| **HOLD POINT** | |
|---|---|
| Process Held: | Commencement of NFC subbase paving other than paving trial. |
| Submission Details: | Report of paving trial, including test results (but excluding results for 28-day compressive strength). |
| Release of Hold Point: | The Nominated Authority will inspect the constructed trial pavement and consider the submitted documents, within 2 working days of their receipt, prior to authorising the release of the Hold Point. |

### 5.11.2 Acceptance of Trial Section

The trial section will be accepted as part of the Works if it conforms to this Specification.

If the trial section is nonconforming, remove the paved concrete, carry out paving of a new trial section and repeat the evaluation detailed in this Clause.

### 5.11.3 New Trial Section

The Principal may call for a new trial section at any stage of the Works if:

(a) significant changes are made to the equipment, materials, plant or rate of paving;

(b) recurring nonconformities of the NFC subbase occur.

## 5.12 PROTECTION OF WORK

### 5.12.1 Temperature

If the temperature at the Site is forecast by the Bureau of Meteorology to fall below 10°C within 24 hours of paving, when placing concrete in areas outside tunnels or within 100 m from the tunnel portals inside tunnels, measure and record surface temperatures for the first 24 hours after paving, at two or more locations within each day's paving, using purpose-made surface thermometers.

Detail in the PROJECT QUALITY PLAN the procedures and equipment proposed for the protection of concrete from low air temperatures.

Failure to maintain the temperature of the concrete, at or above 5°C for the first 24 hours after paving, is a nonconformity.

### 5.12.2 Water Damage

Protect the Works from water damage. Keep the protective equipment on site ready for use by experienced personnel at short notice.

Detail in the PROJECT QUALITY PLAN the procedures and equipment proposed to protect the concrete from water damage.

Concrete is nonconforming if it is exposed to water within the period from tipping to application of the curing sheeting.

Beyond this time, assess water-exposed surfaces in accordance with the finished surface acceptance criteria.

## 5.13 ASPHALT INTERLAYER

### 5.13.1 General

Where shown on the Design Documentation drawings, place an asphalt interlayer over the top surface of the NFC subbase. The application of this asphalt interlayer is not considered to be a curing treatment.

Asphalt must be either AC7 or AC10, using C450 binder, conforming to TfNSW D&C R116.

### 5.13.2 Surface Preparation Prior to Placing Asphalt Interlayer

Clean the NFC subbase surface of all loose, foreign and deleterious material before applying the asphalt interlayer.

Square up and infill spalled areas with NFC.

Immediately prior to placing the asphalt, apply a light surface spray of bitumen uniformly over the top of the NFC subbase.

Detail in the PROJECT QUALITY PLAN the methods used to ensure loose, foreign and deleterious material does not get carried onto the NFC subbase by the vehicle wheels supplying asphalt to the paver.

### 5.13.3 Placing of Asphalt Interlayer

Do not place the asphalt interlayer until:

(a) the NFC subbase has achieved insitu compressive strength of 4.0 MPa;

(b) NFC subbase level schedules are submitted and disposition for nonconformity is completed (refer Clause 7.3.2).

Place the asphalt interlayer in accordance with TfNSW D&C R116, to the thickness and level tolerances shown in Table R81.7.

**Table R81.7 – Asphalt Interlayer Thickness and Level Tolerances**

| Asphalt Designation | Nominal Thickness (mm) | Tolerances | |
|---|---|---|---|
| | | Thickness [(1)] (mm) | Level (mm) |
| AC7 | 25 | ± 5 | – 20, + 0 |
| AC10 | 30 | ± 6 | – 20, + 0 |

**Note:**

[(1)] Conformity is based on the average thickness of the sub-Lot.

## 5.14 TRAFFICKING OF NFC SUBBASE AND ASPHALT INTERLAYER

### 5.14.1 Trafficking of NFC Subbase

Do not allow personnel or equipment, except for those associated with essential inspection and testing, to traffic the NFC subbase until an insitu compressive strength of 4.0 MPa has been reached.

**HOLD POINT**

| | |
|---|---|
| Process Held: | Trafficking of NFC subbase. |
| Submission Details: | Insitu compressive strength test results of the NFC subbase. |
| Release of Hold Point: | The Nominated Authority will consider the submitted results, within 2 working days of receipt of the results, prior to authorising the release of the Hold Point. |

Thereafter, only foot traffic, vehicles with a gross mass of less than 1.5 tonnes, and any construction equipment necessary for the following operations are permitted to travel over the NFC subbase:

(a) surface survey measurements;

(b) repair, removal or replacement of the curing sheeting;

(c) construction equipment required to place the asphalt interlayer (refer to Clause 5.13.1).

### 5.14.2 Trafficking of Asphalt Interlayer

After the asphalt interlayer has been placed, only the equipment required for the construction of the overlying continuously reinforced concrete pavement (CRCP) is permitted to traverse over it.

For all other traffic and where the insitu compressive strength of the NFC subbase exceeds 8 MPa, the following applies:

(a) All vehicles/equipment with axle loads within the legal limits may traffic the asphalt interlayer.

(b) Rubber tracked vehicles with a maximum pressure of 15 $t/m^2$ over the contact area may traverse over the asphalt interlayer, provided that the asphalt interlayer and NFC subbase is protected from damage.

(b) For vehicles/equipment with axle loads over the legal limit, provide calculations in accordance with the Hold Point for trafficking of asphalt interlayer.

## HOLD POINT

| | |
|---|---|
| Process Held: | Trafficking of asphalt interlayer by vehicles/equipment other than those required for CRCP paving. |
| Submission Details: | **(a) Axle loads within legal limits**<br>Insitu compressive strength test results of the NFC subbase and axle loads of proposed vehicles/equipment traversing over asphalt interlayer.<br>For rubber tracked vehicles with maximum track pressure of 15 t/m$^2$, details of measures to protect asphalt interlayer and NFC subbase.<br>**(b) Axle loads over legal limits**<br>In addition to the requirements under item (a) above, estimated number of repetitions of axle loadings and calculations verifying that the NFC subbase in the area to be trafficked can withstand the proposed loading. |
| Release of Hold Point: | The Nominated Authority will consider the submitted details prior to authorising the release of the Hold Point. |

### 5.14.3 Rectification of Damage

Rectify any damage caused to the NFC subbase and asphalt interlayer resulting from your operations in a way which produces a homogeneous subbase with the specified surface finish at your own cost.

# 6 SURVEY

Carry out survey in accordance with Specification TfNSW D&C G71 and this Specification. Conformity requirements for alignment, levels and surface profile are specified in Clause 7.3.

## 6.1 LEVELS

### 6.1.1 General

When determining the levels, use a survey staff (or reflector) with flat base of area between 300 mm$^2$ and 4,000 mm$^2$.

Report the levels obtained to the nearest millimetre.

During the progress of the Works, carry out surveys to determine the levels at the top of:

(a) underlying surface, over which the NFC subbase is to be placed;

(b) finished surface of NFC subbase;

(c) asphalt interlayer surface levels, where applicable.

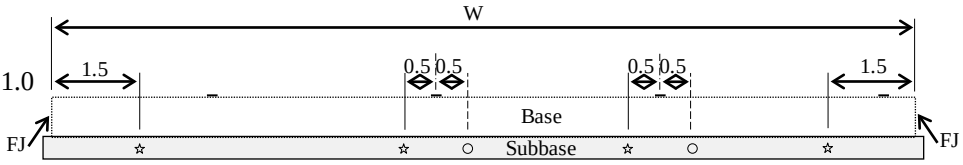
### 6.1.2 Survey Prior to NFC Subbase Paving

Carry out a survey of the underlying surface levels prior to the commencement of NFC subbase paving.

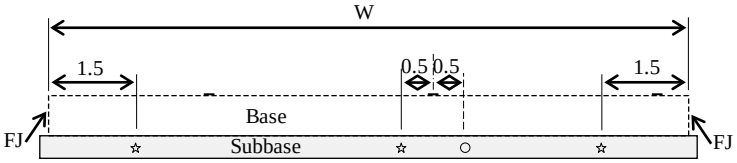
Take levels of the underlying surface at a spacing of 10.0 m longitudinally and at the transverse offsets shown in Figure R81.2, with a tolerance of 0.5 m.

Prior to NFC subbase paving and upon completion of placing dental concrete, submit a Survey Report highlighting all locations where the actual levels are outside of tolerance with respect to the design levels.

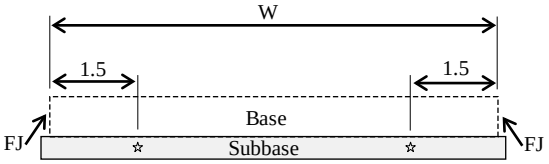
**Case 1**
Machine paved: $W \geq 11.0$



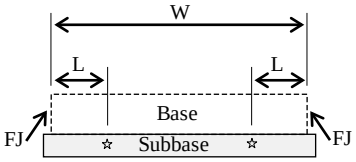

**Case 2**
Machine paved: $W \geq 8.0$
Fixed-formed: $W \geq 6.0$




**Case 3**
Machine paved: $4.5 \leq W < 8.0$
Fixed-formed: $4.5 \leq W < 6.0$




**Case 4**
$W \leq 4.5$
For $3.0 < W \leq 4.5$: $L = 1.0$
For $W \leq 3.0$: $L = 0.5$




**Case 5**
$W \leq 4.5$
For $3.0 < W \leq 4.5$: $L = 1.0$
For $W \leq 3.0$: $L = 0.5$

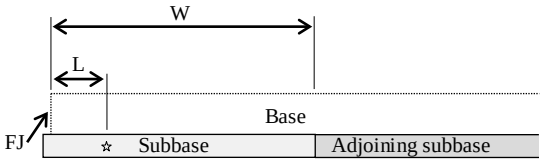



**Figure R81.2 - Survey Locations**

**Legend:**

- Location of lane line on base course
- ⭑ Location of survey point (see Note (2) below)
- ○ Alternative location of survey point at other side of lane line (see Note (2) below)
- FJ Formed joint or edge

**Notes:**

(1) All dimensions shown in the figure above are in metres (m).

(2) Where an alternative location of survey point is shown (Cases 1 and 2), the Contractor can take survey levels at either side of the lane line (i.e. at either of the locations marked with "⭑" or with "○").

(3) Survey levels must be taken for both the underlying surface (refer Clause 6.1.2) and the NFC subbase and asphalt interlayer (where applicable) finished surface (refer Clause 6.1.3).

(4) At locations where the distance between a formed edge and the adjacent lane line is varying (i.e. is tapered in plan view), the survey point will be at a 0.5 m offset from that lane line.

### 6.1.3 Survey Prior to Asphalt Interlayer and Base Paving

Carry out a survey of the finished surface levels of both the NFC subbase and asphalt interlayer (where applicable) for conformity with levels and thickness within 4 days of placing, unless agreed otherwise with the Project Verifier.

Take levels at the following locations:

(a) at the same plan locations as those surveyed for the levels on the underlying layer under Clause 6.1.2, with a tolerance of 0.5 m;

(b) randomly selected locations at a minimum frequency of at least half the frequency required to comply with item (a) above.

Submit to the Project Verifier schedules of levels showing the measured actual levels and their corresponding design levels, and the difference between the two. Highlight those levels and differences that are out of tolerance, and those locations which were specially surveyed for apparent nonconformity.

Use the following convention for the difference between the actual and design levels:

(i) where actual levels are above design levels, show the difference as positive;

(ii) where actual levels are below design levels, show the difference as negative.

## 6.2 ALIGNMENT

### 6.2.1 Times

Carry out a survey for conformity of the alignment of the edges and joints within 4 days of placing a sub-Lot of NFC subbase.

### 6.2.2 Frequency

Survey each outer edge (refer Clause 5.7.4) for alignment conformity at random locations, commencing with the trial paving and thereafter independent of the boundaries to Lots, at a frequency not less than the following:

(a) one reading per 10 m of edge, until five conforming results are recorded; and thereafter

(b) one reading per 50 m of edge.

The survey frequency reverts to item (a) above if nonconformity is detected.

## 6.3 SURFACE PROFILE

### 6.3.1 Times

Carry out a survey of the surface profile within 4 days of placing a sub-Lot of NFC subbase, or at the times agreed with the Project Verifier.

### 6.3.2 Test Method

Determine the surface profile under a 3 m straightedge in accordance with Test Method TfNSW T183. Where the surface is convex, place the straightedge so that the cantilever length does not exceed 0.75 m.

### 6.3.3 Frequency

Survey for surface profile conformity at random locations, commencing with the paving trial and thereafter independent of the boundaries to sub-Lots, at a frequency of not less than the following:

(a) one reading of longitudinal and transverse surface profile per 10 m of paving run, until 5 conforming results are recorded, and thereafter

(b) one reading of longitudinal and transverse surface profile per 100 m of paving run.

The testing frequency reverts to (a) if nonconformity is detected.

# 7 CONFORMITY

## 7.1 CONCRETE COMPRESSIVE STRENGTH

### 7.1.1 Sub-Lot Delineation

Assess conformity of NFC subbase for compressive strength on the basis of sub-Lots (refer Clause 1.3.1 for definition of sub-Lots)

Treat Transition zones as separate sub-Lots.

### 7.1.2 Test Groups

A test group of cores is defined as a group comprising two cores taken from the NFC subbase within a distance of 0.3 m to 1.0 m apart from each other, except that:

(a) if either of the cores has compressive strength of less than 4.5 MPa; or

(b) the difference between the strengths is greater than 1.0 MPa,

then take a third core at a distance within 0.3 m to 1.0 m from the others and include this in the Test Group.

The insitu compressive strength of the sub-Lot is the mean (rounded to the nearest 0.1 MPa) of the corrected compressive strengths of all the cores in the particular test group.

Determine the void content of the cores using Test Method TfNSW T378 before strength testing and submit the results to the Project Verifier.

### 7.1.3 Location and Frequency of Coring

Select the locations for coring at random in accordance with TfNSW D&C Q6 Annexure Q/L Clause L3 and as set out below.

Take one test group of cores from:

(a) each sub-Lot of machine paved concrete.

(b) each sub-Lot of fixed-formed concrete.

(c) in Transition Zones, commencing with the trial section, the minimum frequency of coring is as follows:

  (i) one group from each sub-Lot until 3 consecutive conforming sub-Lots are obtained; and then

(ii) one group from each third sub-Lot, selected on the basis of time sequence, until 4 consecutive sub-Lots conform; and then

(iii) one group from each fifth sub-Lot, selected on the basis of time sequence.

If a nonconforming result in item (c) (ii) or (c) (iii) above is obtained, the frequency of testing, starting from the nonconforming Lot, reverts to that specified in item (c) (i) above.

Do not take additional cores for the purpose of core compressive strength testing without the prior approval of the Project Verifier.

In accordance with TfNSW D&C Q6, take further samples at specific (non-random) locations which are visually non-homogeneous and/or non-representative.

Backfill core holes in accordance with Clause 7.5.

### 7.1.4 Test Specimens

Prepare and test the core specimens in accordance with AS 1012.14, but with the following amendments:

(a) Cores must be 150 mm in diameter.

(b) Concrete in the NFC subbase must have hardened enough to permit removal of the cores without the coarse aggregate coming off.

(c) AS 1012.14 Clause 6.3.2 (b) is amended to read as follows:
"The diameter at any cross-section deviates from the mean diameter by more than 5 mm."

(d) AS 1012.14 Clause 6.4 (d) is amended to exclude dry conditioning. Instead, cores must be wet conditioned by submersion in water at a temperature of 23 ± 5°C for not less than 24 hours and not more than 72 hours immediately prior to testing.

(e) The individual core strengths must be corrected for shape (length/diameter ratio) in accordance with Clause 7.1.2 of this Specification.

(f) AS 1012.14 Clauses 9 (k), 9 (l), 10 (h) and 10 (i) are amended by the addition of the following words:
"… except where the strength is less than 10 MPa, in which case it must be calculated to the nearest 0.1 MPa."

Prior to testing, trim from the cores asphalt where found on the core.

### 7.1.5 Correction Factors

Do not apply age correction factors to core compressive strength results.

Apply the shape correction factor (SF) shown in Table R81.8 to the core compressive strengths by multiplying them with SF to obtain the "factored core strength". Apply the shape correction factor to the unrounded core strength.

**Table R81.8 – Shape Correction Factor**

| Length-Diameter Ratio of Core | Shape Correction Factor (SF) |
|---|---|
| 2.0 | 1.00 |
| 1.75 | 0.98 |
| 1.5 | 0.96 |
| 1.25 | 0.93 |
| 1.0 | 0.87 |

### 7.1.6 Conformity for Core Compressive Strength

NFC subbase must achieve insitu compressive strength of 5.0 MPa or greater within 28 days of placement.

Remove and replace any sub-Lot of NFC subbase which fails to achieve insitu compressive strength of 5.0 MPa within 28 days of placement.

## 7.2 THICKNESS

### 7.2.1 General

Assess the thickness of NFC subbase and asphalt interlayer (if applicable) within sub-Lots as defined in Clause 1.3.1, except that each transition zone must be combined with the adjacent sub-Lot. (Refer to Table R81.6 for thickness tolerance on asphalt interlayer.)

### 7.2.2 NFC Subbase and Asphalt Interlayer Thickness Determination from Survey

Calculate the NFC subbase and asphalt interlayer thickness at individual survey points selected as the difference between the finished surface level and the underlying surface level surveyed in accordance with Clause 6.1.

Adjust the calculated thickness to allow for the design surface longitudinal and transverse slopes between the two surveyed points.

Detail in the PROJECT QUALITY PLAN the method of determining the thickness, with adjustment.

### 7.2.3 NFC Subbase Thickness Determination from Cores

Measure the NFC subbase thickness on cores taken for compressive strength testing.

### 7.2.4 Discrepancy Between Thickness from Survey and Cores

Wherever a core thickness result is thinner by 5 mm or more than the thickness calculated from the survey result at a location within 1.5 m of the core, or thinner by 10 mm or more at a location between 1.5 m and 2.5 m from the core, the core result will be the accepted thickness and the particular survey result disregarded.

If the frequency of such occurrences is more than 3 in any group of 10 consecutive comparisons, the NFC subbase thickness calculated from the survey results for the entire area represented will be disregarded.

In areas where the NFC subbase thickness calculated from survey results is nonconforming, and no representative cores are available for comparison, the Project Verifier may authorise the drilling of 50 mm diameter cores.

Do not take additional cores for the purpose of thickness assessment without the prior approval of the Project Verifier.

### 7.2.5 Mean Thickness

Calculate the mean thickness for each sub-Lot using all results for the sub-Lot (to the nearest 1 mm) which have not been disregarded. Round off the calculated mean thickness to the nearest 5 mm.

### 7.2.6 Conformity for Thickness

A NFC subbase sub-Lot will be conforming in thickness if:

(a) the rounded mean thickness is not less than the design thickness; and

(b) no individual result is 15 mm or more below the design thickness.

### 7.2.7 Offsetting Subbase Thickness Deficiency With Increased Base Thickness

A reduced NFC subbase thickness may be offset by an increase in base thickness as shown in Table R81.9.

**Table R81.9 – Increased Concrete Base Thickness as Offset for NFC Subbase Thickness Deficiency**

| Deficiency in Mean NFC Subbase Thickness [(1)] (mm) | Increase in Specified Base Thickness (mm) |
|---|---|
| 10 | 5 |
| 15 | 10 |
| 20 | 15 |

**Note:**

(1) Thickness deficiency is the calculated difference between the rounded mean thickness and the design thickness.

## 7.3 SUBBASE ALIGNMENT, LEVELS AND SURFACE PROFILE

### 7.3.1 Alignment

Tolerances on horizontal alignment are given in Clause 5.7.4 for the outer edges of the NFC subbase and for joints.

### 7.3.2 NFC Subbase and Asphalt Interlayer Surface Levels

Assess the NFC subbase and asphalt interlayer (if applicable) surface levels for conformity on the basis of individual survey results.

The level at any point on the top of the NFC subbase must not vary by more than 0 mm above or 20 mm below the design level.

The level at any point on top of the asphalt interlayer must comply with the tolerances shown in Table R81.7.

**(a) Levels below the levels shown on the Design Documentation Drawings**

For such sub-Lots, after allowing for the specified tolerance, submit a nonconformity report and attach the survey report and the relevant assessment of thickness.

**(b) Levels above the levels shown on the Design Documentation Drawings**

For such **NFC subbase** sub-Lots, after allowing for the specified tolerance, submit a nonconformity report and grind the high spots down to the design levels. Remove grinding debris by suction. Re-survey the area and resubmit the survey report.

For such **asphalt interlayer** sub-Lots, mill and cover the area with a slurry seal, to provide a surface consistent with the adjacent asphalt and complying with specified level requirements. Re-survey the area and resubmit the survey report.

Alternatively, for NFC subbase and asphalt interface areas which are high by 20 mm or less, carry out a redesign of the finished levels in accordance with Clause 7.4.

## HOLD POINT

| | |
|---|---|
| Process Held: | Placing of overlying layer over area of NFC subbase surveyed. The overlying layer may be asphalt interlayer, or concrete base if asphalt interlayer is not required. |
| Submission Details: | Schedule of measured levels and any relevant nonconformity report, at least 5 working days prior. |
| Release of Hold Point: | The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point. |

## HOLD POINT

| | |
|---|---|
| Process Held: | Placing of overlying concrete base over area of asphalt interlayer surveyed (if asphalt interlayer is required). |
| Submission Details: | Schedule of measured levels and any relevant nonconformity report, at least 5 working days prior. |
| Release of Hold Point: | The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point. |

### 7.3.3 Surface Profile

Deviations under a 3 m straightedge, laid in any direction, must not exceed 10 mm where the NFC subbase is overlaid by asphalt, or 5 mm otherwise.

## 7.4 REDESIGN OF PAVEMENT LEVELS

Where the pavement levels are high and nonconforming, redesign the pavement levels in accordance with the following criteria:

(a) The rate of level change on any longitudinal profile string, calculated relative to the approved design, must not be greater than 0.1% (1.0 mm per metre).

(b) The revised crossfall (or superelevation) at any location must not vary from the approved value by more than ± 0.3% (expressed as actual values); hence a specified crossfall of 3.0% may be varied within the range 3.0% ± 0.3%.

(c) The transition from the redesigned pavement to abutting structures and pavements must be smooth.

(d) Vertical clearance requirements must be complied with.

The redesigned pavement must be such that:

(i) Water will not pond on the carriageway.

(ii) Drainage is not compromised in any aspect, including depth and rate of flow over the pavement, flow direction and capacity (both on the pavement and within the drainage network).

(iii) The risks and associated consequences (in terms of drainage) are not increased at locations such as superelevation transitions, taking into account the likely construction deviations (within the specified level tolerances) from the finished base levels.

Submit the redesign to the Principal for approval. The Principal will respond within 4 working days.

## 7.5 RESTORATION OF NFC SUBBASE AFTER CORING

Restore all core holes in NFC subbase prior to placing of asphalt interlayer.

Clean and backfill all core holes taken in the NFC subbase with NFC having compressive strength of not less than that in the NFC subbase. The approved NFC subbase mix may be used.

After backfilling, the finished surface of the NFC subbase at the core hole location must be flush with the surrounding surface of the NFC subbase.

## 7.6 REMOVAL AND REPLACEMENT OF NFC SUBBASE

### 7.6.1 Boundaries of Section for Removal

Where an area of the NFC subbase is nonconforming and have to be removed and replaced, the longitudinal boundaries of the section for removal must either coincide with existing longitudinal joints or edges, or be parallel to the control line. Transverse boundaries must be orthogonal to the longitudinal boundaries with a 6° tolerance.

The locations of the boundaries of the section for removal must be such that the dimensions of both the replacement slab and the residual slab (i.e. slab remaining after removal), and the corner angles, comply with Table R81.5.

The location of the longitudinal construction joints created by the removal and replacement of nonconforming concrete must also conform to Clause 5.7.3 with respect to the location of the longitudinal joint in the overlying base.

### 7.6.2 Sawcutting

| **HOLD POINT** | |
|---|---|
| Process Held: | Sawcutting for removal and replacement of NFC subbase. |
| Submission Details: | Nonconformity report for each section of nonconforming NFC subbase to be removed, at least 3 working days prior. |
| Release of Hold Point: | The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point. |

Sawcut to the full depth of the NFC subbase in straight lines which are continuous between opposing boundaries.

Manage waste from sawcutting operations in accordance with Specification TfNSW D&C G36. Remove detritus from the cut edges of the remaining NFC subbase by suction.

Do not extend sawcuts by more than 150 mm beyond the boundaries which define the limits of removal. Do not over-saw any internal sawcuts which are made to aid the removal of the NFC subbase.

### 7.6.3 Replacement

Replace the area of NFC removed with conforming NFC.

# ANNEXURES R81/A AND R81/B – (NOT USED)

# ANNEXURE R81/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.3.

## C1 SCHEDULE OF HOLD POINTS

| Clause | Description |
|---|---|
| 3.7.1 | Submission of nominated mix details and associated documents |
| 4.3.6 | Submission of evidence of conformity of mix uniformity |
| 5.1 | Submission of schedule of underlying surface levels and associated documents |
| 5.11.1 | Submission of paving trial report |
| 5.14.1 | Submission of insitu compressive strengths prior to trafficking of NFC subbase |
| 5.14.2 | Submission of vehicles/equipment details prior to trafficking of asphalt interlayer |
| 7.3.2 | Submission of measured levels and associated documents of NFC subbase area surveyed<br>Submission of measured levels and associated documents of asphalt interlayer area surveyed |
| 7.6.2 | Submission of nonconformity report for each section of nonconforming NFC subbase to be removed and replaced |

## C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW D&C Q6 Annexure Q/E.

| Clause | Description of Identified Record |
|---|---|
| 3.7.1 | Statement and attachments referred to in Clause 3.7 regarding the nominated mix |
| 3.8 | Details of variations to a nominated mix before commencing production with the varied quantities |
| 5.11 | Checklists and test results, excluding results for compressive strength, for paving trial |
| 6.1.2 | Schedule of levels on underlying layer below the NFC subbase and survey report |
| 6.1.3 | Schedule of levels on top of NFC subbase and any relevant nonconformity report |
| 6.1.3 | Schedule of levels on top of asphalt interlay and any relevant nonconformity report |
| 7.1.2 | Insitu strength test results of the NFC subbase |
| 7.6.2 | Nonconformity report for each location of NFC subbase to be removed |

# ANNEXURE R81/D – PLANNING DOCUMENTS

Refer to Clause 1.2.4.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. The requirements of this Specification and others included in the Contract must be reviewed to determine additional documentation requirements.

| Clause | Description of Document |
|---|---|
| 2.5.3 | Admixture selection |
| 4.1.2 | Method of handling, storing and batching of materials |
| 4.3.4 | Admixture incorporation method |
| 4.4.1 | Monitoring of identification certificate |
| 4.5 | Monitoring of concrete supply for compliance with the retempering provisions |
| 4.6.1 | Determination of maximum forming time |
| 5.1.1 | Details of staff training |
| 5.1.2 | Method of traceability of batches/loads of concrete placed |
| 5.4.2, 5.5.1, 5.6 | Equipment, methods, and parameters for placing, spreading and finishing concrete |
| 5.4.2 | Parameters for proposed machine paving configurations |
| 5.8.1 | Meteorological data and measures to restrict evaporation |
| 5.12.1, | Protection of work from low air temperatures |
| 5.12.2 | Protection of work from water damage |
| 5.13.2 | Method to ensure loose, foreign and deleterious material does not get carried onto the NFC subbase by the equipment wheels supplying asphalt |
| 7.2.2 | Method of calculating adjusted thickness from survey |

# ANNEXURE R81/E – MIXER UNIFORMITY TESTING

## E1 GENERAL

### E1.1 Charging Mixer

For the purpose of conducting the mixer uniformity test, charge the mixer:

(a) in accordance with the manufacturer's instructions;

(b) in the sequence proposed to be used in the Works;

(c) to the maximum volume (or throughput) proposed to be used in the Works.

Thereafter, use the same charging sequence and do not exceed the volume (or throughput) unless another uniformity test is conducted.

### E1.2 Use of Concrete from Uniformity Test

Concrete from the mixer uniformity test may be incorporated into any part of the Works on the condition that all concrete from the test conforms to the relevant specification and is placed in a discrete sub-Lot. The entire sub-Lot must be removed if the mixer fails to meet the criteria specified in Clause E2 or Clause E3.

## E2 STATIONARY MIXER

### E2.1 General

Where concrete is to be produced and mixed by a stationary mixer, conduct mixer uniformity tests before paving with that mix, and thereafter upon production of each 30,000 $m^3$ of concrete from that mixer (includes all mix types and customers), or as otherwise required in accordance with AS 1379 Clause 3.5.

Carry out tests on each NFC subbase mix to be placed in the Works.

For stationary batch mixers, conduct tests on 3 consecutive batches of the same mix which conform to the requirements of this Specification.

For stationary continuous mixers, conduct tests on 3 consecutive batches with each batch separated by an interval equivalent to at least 2 $m^3$ of throughput of the same mix which conform to the requirements of this Specification. Each batch must comprise not less than 5 $m^3$ of mix.

For each batch, report the following:

(a) mixing speed;

(b) batch volume;

(c) duration of charging;

(d) total mixing time or, for continuous mixers, the throughput rate;

(e) mixing time after the last addition of water.

### E2.2 Sampling

Discharge and sample the whole of a single batch by one of the following procedures:

(a) By discharge into a tipper truck with tray length not less than 8 m. Conduct sampling from the truck before tipping. Obtain the samples by using a shovel or scoop but exclude the top 100 mm of concrete.

(b) By discharge into a transport vehicle typical of that to be used in the Works, and then spread evenly over a length of between 6 m and 10 m onto ground which is either sealed or pre-dampened to prevent absorption of water from the mix. Conduct sampling from the ground.

In each case, sample the batch at three points approximately 15%, 50% and 85% along the discharged length of the mix, but not closer to either end than 10% of the length. Take a sample of approximately 50 litres from each point in accordance with AS 1012.1.

### E2.3 Testing

Carry out tests required for each property of the concrete in AS 1379 Table A1 on each of the 50 litre samples, in accordance with Appendix A of AS 1379, and as amended by this Specification.

### E2.4 Compliance

The mixer will be deemed to have passed the uniformity test if for each batch, the differences between the highest value and the lowest value for the corresponding properties of the three samples do not exceed the limiting values given in AS 1379 Table A1.

## E3 MOBILE MIXERS

### E3.1 Sampling and Testing

Over a period of 24 months, randomly test the number of mobile mixers listed in Table R81/E.1.

**Table R81/E.1 – Mobile Mixer Fleet Testing**

| Population Size | Sample Size |
|---|---|
| < 16 | All |
| 16-25 | 17 |
| 26-50 | 22 |
| 51-90 | 24 |
| 91-150 | 26 |
| 151-280 | 28 |
| 281-500 | 32 |

Take 3 samples each of approximately 50 litres at uniform interval from each of the randomly selected mobile mixers in accordance with AS 1012.1 Clause 7. Carry out tests for the properties in AS 1379 Table A1 on each sample, in accordance with Appendix A of AS 1379, and as amended by this Specification.

This sampling program is predicated on an 8% limiting quality value.

Because of the retempering provisions of the Specification, include mobile mixers which are used to transport centrally-mixed concrete in the fleet testing.

### E3.2 Compliance

The differences between the highest value and the lowest value for the corresponding properties of the three samples of each randomly selected mixer in accordance with Table R81/E.1 must be within the limiting values given in AS 1379 Table A1.

The fleet will be deemed to conform if all the randomly selected mixers satisfy the requirements of AS 1379 Appendix A.

Where a mixer fails to satisfy a mixer uniformity test, the entire fleet is deemed to have failed, until:

(a) the producer immediately stands down the mixer while reasons for the failure are investigated to determine whether the failed result is a true outlier. If it is found that the failure was due to extraordinary reasons, it may be treated as an one-off event;

(b) you immediately test another randomly selected mixer from the same fleet and that result will determine the continued compliance of the fleet, as follows:

  (i) if it passes, the fleet will carry provisional compliance until the failed mixer is either repaired and passed or is withdrawn from operational service;

  (ii) if it fails, proceed in accordance with item (a) above.

To satisfy the mixer uniformity and compliance program, regularly inspect all mixers to determine the extent of internal wear, internal build up and the ability to rotate at the required rate (revolutions/minute). Keep a progressive maintenance record for each mixer showing inspection frequency and details of any repair or rectification and make this available on request.

Carry out further testing:

(i) upon evidence of non-uniformity of mixing which appears to be associated with mixer wear, or

(ii) where the discharge time for that mixer is more than 25% longer than the typical time for other trucks using the same mix.

All mobile mixers must display an identification plate in accordance with AS 1379 to certify conformity with mixer uniformity criteria.

Where a mixer is one of the randomly tested mixers, show the date of the latest test on its identification plate.

## ANNEXURES R81/F TO R81/K– (NOT USED)

# ANNEXURE R81/L – MINIMUM FREQUENCY OF TESTING

| Clause | Characteristic Tested | Test Method | Minimum Frequency of Testing |
|---|---|---|---|
| **Constituent Material: Coarse aggregate** | | | |
| 2.1 | Wet strength | TfNSW T215 | One per 2,000 t (1) |
| 2.1 | Wet/dry strength variation | TfNSW T215 | One per 2,000 t (1) |
| 2.1 and 4.2.1 | Particle size distribution of combined aggregate - deviation from nominated:<br>- by calculation | <br>AS 1141.11.1 | One per 800 t of aggregate |
| **Constituent Material: Other Materials** | | | |
| 2.3 | Cementitious materials | TfNSW 3211 | As per TfNSW 3211 |
| 2.4 | Water | AS 1379,<br>AS 1478.1,<br>AS 1289.4.2.1 | One per 40,000 $m^3$ of concrete |
| 3.5 | Sulfate ion content | As per Clause 3.5 | One per 30,000 $m^3$ of concrete |
| **Concrete Mixer** | | | |
| Annexure R81/E | Mixer uniformity | AS 1379 and Annexure R81/E | As per Annexure R81/E |
| **Placed NFC Subbase** | | | |
| 5.7.2 | Geometric tolerance on transverse joints | As per Clause 5.7.2 | Two tests per joint |
| 5.7.3 | Geometric tolerance on longitudinal joints | As per Clause 5.7.3 | Initially, and after each nonconformity:<br>One per 10 lin m of joint until 5 conforming results are recorded, then one per 25 lin m |
| 5.14.1 | Insitu compressive strength (for trafficking purposes) | Cores as per Clause 7.1.2 | As per Clause 7.1.2 |
| 6.1 | Surface levels | As per Clause 6.1 | As per Clause 6.1 |
| 6.2 | Alignment | As per Clause 5.7.4 | As per Clause 5.7.4 |
| 6.3 | Surface profile | As per Clause 6.3 | As per Clause 6.3 |
| 7.1.2 | Compressive strength of concrete cores at 28 days | As per Clause 7.1.2 | As per Clause 7.1.2 |
| 7.1.2 | Void content of cores | TfNSW T378 | As per Clause 7.1.2 |
| 7.2 | Thickness | As per Clause 7.2 | As per Clause 7.2 |
| **Placed Asphalt Interlayer** | | | |
| 6.1 | Surface levels | As per Clause 6.1 | As per Clause 6.1 |

| Clause | Characteristic Tested | Test Method | Minimum Frequency of Testing |
|---|---|---|---|
| 7.2 | Thickness | As per Clause 7.2 | As per Clause 7.2 |

**Notes:**

(1) Provided that all of the 6 previous tests have met specified requirements for both wet strength and wet/dry strength variation, the following reduced frequency applies:

- where all wet/dry variation results are < 25%: 1 per 10,000 t
- where all wet/dry variation results are < 30%: 1 per 4,000 t

# ANNEXURE R81/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.6.

**TfNSW Specifications**

| | |
|---|---|
| TfNSW D&C Q6 | Quality Management System (Type 6) |
| TfNSW D&C G36 | Environmental Protection |
| TfNSW D&C G71 | Construction Surveys |
| TfNSW D&C R53 | Concrete for General Works |
| TfNSW D&C R82 | Lean-mix Concrete Subbase |
| TfNSW D&C R116 | Heavy Duty Dense Graded Asphalt |
| TfNSW D&C 3211 | Cementitious Materials, Binders and Fillers |

**TfNSW Test Methods**

| | |
|---|---|
| TfNSW T183 | Surface Deviation Using a Straightedge |
| TfNSW T215 | Wet/Dry Strength Variation |
| TfNSW T239 | Fractured Faces of Coarse Aggregate |
| TfNSW T363 | Accelerated Mortar Bar Test for the Assessment of Alkali-Reactivity of Aggregate |
| TfNSW T364 | Concrete Prism Test for AAR Assessment |
| TfNSW T376 | Moulding of No Fines Concrete Specimens |
| TfNSW T377 | Water Permeability of No Fines Concrete (Falling Head Laboratory Permeameter) |
| TfNSW T378 | Void Content of No Fines Concrete |

**Australian Standards**

| | |
|---|---|
| AS 1012 | Methods of testing concrete |
| AS 1012.1 | Sampling of concrete |
| AS 1012.5 | Determination of mass per unit volume of freshly mixed concrete |
| AS 1012.9 | Compressive strength tests – Concrete mortar and grout specimens |
| AS 1012.14 | Method for reading and testing cores from hardened concrete for compressive strength |
| AS 1012.20.1 | Determination of chloride and sulfate in hardened concrete and aggregates – Nitric acid extraction method |
| AS 1141 | Methods for sampling and testing aggregates |
| AS 1141.4 | Bulk density of aggregate |

| | |
|---|---|
| AS 1141.6.1 | Particle density and water absorption of coarse aggregate – Weighing-in-water method |
| AS 1141.6.2 | Particle density and water absorption of coarse aggregate – Pycnometer method |
| AS 1141.11.1 | Particle size distribution – Sieving method |
| AS 1141.14 | Particle shape by proportional calliper |
| AS 1141.22 | Wet/dry strength variation |
| AS 1289.4.2.1 | Soil chemical tests – Determination of the sulfate content of a natural soil and the sulfate content of the groundwater – Normal method |
| AS 1379 | Specification and supply of concrete |
| AS 1478.1 | Chemical admixtures for concrete, mortar and grout - Admixtures for concrete |
| AS 2350.2 | Method of testing Portland, blended and masonry cements – Chemical composition |
| AS 2758.1 | Aggregates and rock for engineering purposes – Concrete aggregates |

**Other Standards**

| | |
|---|---|
| ASTM C1064M | Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete |