TRANSPORT FOR NSW (TfNSW)

SPECIFICATION D&C R225

CONCRETE INJECTED COLUMNS

REVISION REGISTER

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GUIDE NOTES

(Not Part of Contract Document)

GN1 General

Concrete injected columns (CIC) are sometimes termed controlled modulus columns (CMC) or controlled stiffness columns (CSC) used in ground improvement works.

CIC are constructed using the screwed cast-in-place displacement piling technique, which results in little or no spoil from the drilling.

The CIC are formed by augering down to the founding material before extracting the auger and pumping concrete through the hollow stem of the auger, allowing the concrete to flow into the excavation to form a monolithic concrete shaft.

If required by the Design Documentation drawings, a single reinforcing bar or a steel reinforcement cage is then placed into the completed concrete shaft to the nominated depth while the concrete is still plastic.

GN2 Ground Improvement Areas (GIA)

The Works should be divided into separate GIA for which exposure classifications to AS 2159 are determined by the Designer. Using the design information, the Designer must enter, for each GIA, its identification code and the corresponding exposure classification in Annexure R225/A1.

Where exposure classification cannot be determined with confidence before awarding the contract, this information will not be entered in Annexure R225/A1, but during construction, the Contractor will be required to determine the exposure classifications and submit them to the Designer for concurrence.

GN3 Trial Columns

To ensure that production columns constructed will be conforming and achieve the tolerances specified in Clause 8, the Contractor must first construct a sufficient number of trial columns (refer Clause 5) to confirm the installation parameters and CIC construction sequence to be used during the construction of the production columns.

The Designer must enter in Annexure R225/A1 the minimum number of trial columns required. The actual number of trial columns, which must not be less than this minimum, is best determined by the Contractor based on his drilling equipment, procedures and the site conditions.

GN4 Construction Sequence

The CIC construction sequence is likely to be dependent on the site geology, installation parameters and type of rig used.

Typically, the sequence may involve construction of columns in a “hit and miss” pattern, i.e. constructing every alternate column along a single row at a time in one direction only, such that the distance between each successive constructed column is spaced at double the centre to centre design column spacing.

The constructed columns, i.e. “hit” columns, should have gained sufficient strength before constructing the in-between columns, i.e. “miss” columns.

Transport for NSW

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FOREWORD

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BASE SPECIFICATION

This document is based on Specification TfNSW R225 Edition 2 Revision 0.

TfNSW SPECIFICATION D&C R225

CONCRETE INJECTED COLUMNS

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for ground improvement through construction of concrete injected columns (CIC) using the screwed cast-in-place displacement piling method.

This Specification does not cover ground improvement through construction of cast-in-place piles by a non-displacement method (e.g. using a continuous flight auger).

1.2 STRUCTURE OF THE SPECIFICATION

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

1.2.1 Project Specific Requirements

Project specific details of work are shown in Annexure R225/A.

1.2.2 (Not Used)

1.2.3 Schedules of HOLD POINTS, WITNESS POINTS and Identified Records

The schedules in Annexure R225/C list the **HOLD POINTS** and **WITNESS POINTS** that must be observed. Refer to Specification TfNSW D&C Q6 for definitions of **HOLD POINTS** and **WITNESS POINTS**.

The records listed in Annexure R225/C are **Identified Records** for the purposes of TfNSW D&C Q6.

1.2.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure R225/D and must be implemented.

1.2.5 Frequency of Testing

Your Inspection and Test Plan must nominate the proposed testing frequency to verify conformity of the item, which must not be less than the frequency specified in Annexure R225/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 a 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 R225/M.

1.3 DEFINITIONS AND ACRONYMS

1.3.1 Definitions

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

The term "column" used in this Specification refers to "concrete injected column" or "CIC".

The following definitions apply to this Specification:

Auger	A hollow stemmed drilling head attached to a steel tube for forming the displacement concrete injected columns.
Column design depth	Depth to the base level of the production column as shown on the Design Documentation drawings. Where columns designated as "full depth columns" (or "full length columns") are shown on the Design Documentation drawings as terminating at the top of the founding layer, such columns must be constructed with an additional 0.5 metre of penetration into the founding material beyond the base level shown on the Design Documentation drawings (refer Clause 3.4.3).
Cut-off level	Level of top of the concrete injected column. This level is usually the same as the level of the working platform.
Ground Improvement Area	A site defined area to be treated which is not greater than 50 m in length as measured along the road alignment (see also Annexure R225/A1).
Production columns	Concrete injected columns constructed within the Ground Improvement Area and forming the permanent works shown on the Design Documentation drawings.
Trial columns	Concrete injected columns constructed within or in the vicinity of the Ground Improvement Area prior to commencement of production column construction, to determine production column construction sequence and other parameters.

1.3.2 Acronyms

CIC	Concrete injected column
GIA	Ground Improvement Area
LTP	Load transfer platform

2 MATERIALS

2.1 GENERAL

All materials used in the Works must conform to the relevant standards, except that where the requirements in the standards conflict with those in this Specification, the requirements in this Specification take precedence.

2.2 CONCRETE AND STEEL REINFORCEMENT

2.2.1 Concrete - General

Unless otherwise specified, concrete used for CIC, and the associated testing requirements, must comply with Specification TfNSW D&C R53.

In addition to consideration of the exposure classification, the concrete mix design must also satisfy other durability requirements such as the potential corrosion of steel reinforcement, and sulphate or chloride attack of concrete (if relevant).

Submit details of your nominated concrete mix to the Designer for acceptance prior to commencement of any concrete works.

2.2.2 Exposure Classification

The exposure classifications of the various GIA are stated in Annexure R225/A1.

Where the exposure classifications are not stated in Annexure R225/A1, assess the ground conditions and determine the exposure classification in accordance with AS 2159. Submit your determined exposure classifications to the Designer for concurrence and include it in your method statement (refer Clause 3.3).

2.2.3 Concrete Strength

Unless shown otherwise on the Design Documentation drawings, concrete strength must comply with Table R225.1 for the relevant exposure classifications.

Table R225.1 – Concrete Strength in Relation to Exposure Classification

Exposure Classification (1)	**Minimum Concrete Strength** (2) **(MPa)**
Non-aggressive, mild or moderate environment	32
Severe or very severe environment	40

Notes:

(1) Exposure classification determined in accordance with AS 2159 for 100 years design life.

(2) 28 day unconfined compressive strength, in accordance with AS 1012.8.1 and AS 1012.9.

2.2.4 Supplementary Cementitious Material

Where used, fly ash must be between 20 to 25% by weight of the total binder content.

2.2.5 Steel Reinforcement

Steel reinforcement, where required, must be in accordance with Specification TfNSW D&C R53.

3 CONSTRUCTION – GENERAL

3.1 PROGRAM, SAFETY AND WORKING PLATFORM

3.1.1 Program

Provide a program showing the trial column construction (refer Clause 5) and production column construction (refer Clause 6), including their sequence and timing.

3.1.2 Safety

Prior to commencement of work on the CIC each day, carry out a safety inspection of the entire concreting line and associated equipment to ensure safe working conditions. Examine all lines for wear, joints for correct coupling and coupling clamps for tightness.

This safety inspection is additional to all other WHS requirements that are applicable to the site and associated construction activities.

3.1.3 Working Platform

Construct working platforms as required to suit your CIC construction plant. Maintain the working platforms for the safe movement and working of your plant, including repairing any damage caused by your works, flooding or other causes.

Unless otherwise approved by the Designer, use granular material for construction of the working platforms.

3.2 EQUIPMENT

3.2.1 General

Carry out the augering using only soil displacement methods that will not result in spoil rising to the surface. Use cutting heads suitable for boring into the founding material to achieve the specified embedment length or founding level.

The piling rig for construction of the CIC must have sufficient torque and downward force (or "crowd force") capable of penetrating the ground at a rate sufficient to avoid drawing surrounding soils laterally into the bore, i.e. side loading.

3.2.2 Auger Extensions

If extensions are required to achieve the required depths, preassemble the extensions into one length of auger prior to commencing the drilling, to avoid any interruption during augering. The auger stem must be dry prior to joining the extensions.

3.2.3 Monitoring

The piling rigs used for CIC construction must be equipped with on-board computers that can monitor and record the drilling and concrete injection parameters specified in Clause 4.4 over the full depth of the CIC shaft.

3.2.4 Concrete Supply Line

Keep the length of concrete hose to a workable minimum to facilitate easy pumping.

Inspect and clean all joints regularly to ensure that the concrete supply line, and auger stem, are watertight to avoid any leakage during concreting (refer Clause 4.2).

Prior to augering the first CIC of the day, prime the line with a cement/water mix or equivalent, and pump concrete through the full length of the line.

3.3 METHOD STATEMENT

Prior to commencement of any column construction, submit a method statement as part of your PROJECT QUALITY PLAN incorporating, as a minimum, the following:

(a) plan(s) showing each GIA and trial columns within or in the vicinity of each GIA (refer Clause 5.1), and proposed sequence of column construction (refer Clause 3.5);

(b) concrete mix design details for the CIC construction (refer Clause 2.2);

(c) plant and equipment details, including monitoring systems (refer Clause 3.2);

(d) methods for CIC construction, including that to achieve the specified founding depth such as pre-boring if necessary (refer Clause 4);

(e) instrumentation and monitoring plan to protect adjacent structures or previously constructed columns against ground heave (refer Clauses 3.5.2 and 3.5.3) and lateral movement arising from the CIC construction;

(f) procedures for handling possible interruptions during the CIC construction (refer Clause 4);

(g) method for placing steel reinforcement (where required) (refer Clause 4.3);

(h) method for constructing working platform and load transfer platform, including materials required (refer Clauses 3.1.3 and 9.3);

(i) construction accuracy, and methods to verify compliance with the specified tolerances (refer Clause 8.1);

(j) procedures for identification and control of nonconformities;

(k) spoil management;

(l) details of construction records and their submission (refer Clause 4.4);

(m) safety and environment risk assessment;

(n) calibration record of all instruments used.

3.4 COLUMN POSITION AND DIMENSIONS

3.4.1 Set Out

Set out the columns to the positions and spacing(s) shown on the Design Documentation drawings.

3.4.2 Check Position and Verticality

Check the position and verticality of the auger stem prior to commencement of drilling of each CIC.

3.4.3 Column Diameter and Length

Construct the columns to the diameter and length(s) shown on the Design Documentation drawings.

Where columns designated as "full depth columns" (or "full length columns") are shown on the Design Documentation drawings as terminating at the top of the founding layer, construct the columns with an additional 0.5 metre of penetration into the founding material beyond the base level shown on the Design Documentation drawings.

Where the "column length to diameter" (L-D) ratio, after taking into consideration the additional 0.5 metre mentioned above, exceeds the maximum L-D ratio for the applicable soil type and consistency shown in Table R225.2, notify the Designer promptly and request the Designer for a direction.

3.5 COLUMN CONSTRUCTION SEQUENCE

3.5.1 General

Based on the findings of the trial column construction (refer Clause 5), construct the CIC in such sequence as to minimise any ground and/or column heave and lateral movement, and avoid potential damage to adjacent structures and previously constructed columns.

3.5.2 Construction Adjacent to Existing Structures

Where columns are to be constructed adjacent to an existing structure, commence the construction for the columns closest to that structure and work away from it.

Install sufficient monitoring instrumentation near and/or at the existing structure to monitor its response to the construction of the CIC, in accordance with the instrumentation and monitoring plan which form part of the method statement in Clause 3.3.

The plan must provide details of the proposed instrumentation, monitoring location(s), frequency and duration, movement trigger levels and proposed remedial actions. The movement trigger levels and movement limits of the existing structures must be approved by the Designer.

3.5.3 Construction Adjacent to Constructed Columns

Unless otherwise approved by the Designer, do not construct columns within a centre to centre distance of less than double the design column spacing from adjacent columns cast within the previous 24 hours. You may propose to change this minimum distance based on the findings of the trial column construction (refer Clause 5).

3.5.4 Ground or Column Heave

The maximum allowable ground or column heave from the CIC construction is 25 mm, provided that at this amount of heave, no damage occurs to the adjacent structures or previously constructed columns. Reduce this limit if there are signs of damage to adjacent structures or columns.

If the 25 mm limit (or a reduced limit) is exceeded, revise your proposed column construction sequence or method, including the installation parameters.

Submit a revised work method statement incorporating the changes to the construction sequence or method to the Project Verifier.

4 DRILLING, CONCRETING AND REINFORCEMENT INSTALLATION

4.1 AUGERING

4.1.1 General

During augering, keep the rate of penetration as uniform as possible. Monitor and record the installation parameters specified in Clause 4.4.

Do not lift the auger stem at any stage during augering, to ensure that the toe sealing device does not become detached and the auger stem remains watertight.

Take measures to avoid any delay during augering. Do not leave columns partially bored.

The founding level and length of each CIC must conform to the requirements of the CIC design (including any additional 0.5 metre depth as required under Clause 3.4.3), as guided by the installation parameters (e.g. penetration rate, drilling rate, drilling torque, etc) registered by the on-board computers.

4.1.2 Pre-boring

Notify the Designer where obstructions are encountered below the ground surface which cannot be penetrated using normal augering methods.

Where appropriate, you may use pre-boring to clear obstructions and facilitate the construction of the CIC. Where used, the depth of pre-boring must not extend more than 300 mm past the obstructions into the underlying compressible soil.

Cover any pre-bored holes to prevent surface water ingress and ensure safety to personnel traversing the site.

HOLD POINT

Process Held	Pre-boring for trial or production columns (where required).
Submission Details	Details of method and depth of pre-boring, including methods to remove spoil material from GIA to prevent contamination of the holes, prevent surface water ingress, and ensure safety to site personnel, at least five working days prior to commencement.
Release of Hold Point	The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point.

4.2 CONCRETING/AUGER EXTRACTION

4.2.1 General

Commence concrete placing as soon as practicable after completion of augering.

Verify from the concrete delivery docket that the concrete delivered is that specified, prior to discharge of any concrete. Visually check the mix, and carry out slump tests in accordance with and at the frequency stated in TfNSW D&C R53.

Take moulded cylinder samples for compressive strength testing at 28 days at the frequency stated in Annexure R225/L.

4.2.2 Process

Concrete placing must be continuous to form a monolithic column shaft, of the full cross section shown on the Design Documentation drawings, and free from soil and other debris, or segregated concrete.

During concreting, keep the auger rotating and use the rate of extraction as determined from trial columns, to ensure that the CIC conforms to the specified requirements over its entire concreted length.

Extraction of the auger must be smooth without jerks, whilst maintaining a positive concrete oversupply of not less than 5%, in accordance with the requirements of AS 2159.

During auger extraction, if the concrete oversupply drops to zero or below, note the depth at which this occurred, stop the extraction and immediately re-auger to 500 mm below that depth and then recommence extraction and concreting.

Continue pumping concrete until the auger tip rises to 300 mm above the ground level, to ensure that contamination of concrete, such as inclusions of soil or other debris within the concrete mass, does not occur.

4.3 STEEL REINFORCEMENT PLACEMENT

4.3.1 General

Where steel reinforcement are shown on the Design Documentation drawings to be required, place the reinforcing bar(s) or cage in the CIC within one hour from completion of its concreting.

Check reinforcement bars/cages prior to placement, to ensure that they are clean and straight.

4.3.2 Spacers

Attach suitable spacers to the reinforcement cage at locations and intervals not exceeding 3 m, to maintain the specified minimum concrete cover.

Where the steel reinforcement comprises only a single central steel bar, the installed bar must not deviate by more than 75 mm from the centre of the column.

4.3.3 Installation

Remove all spoil from around the newly concreted column before inserting reinforcement into the newly concreted column.

You may insert bars into the concrete by hand or mechanical means, supplemented by the use of vibrators where required. Keep the bars vertical during insertion.

Place reinforcement as shown on the Design Documentation drawings, and secure the reinforcement in position until the concrete hardens. Cut off or otherwise remove any projection of the steel reinforcement above the specified cut-off level, unless approved otherwise by the Principal.

4.4 CONSTRUCTION RECORDS

For each trial and production column, take construction records containing the following details as a minimum:

Before commencement of each CIC

(a) date and start/finish time of construction;

(b) column reference number and diameter;

(c) working platform and ground levels (Australian Height Datum);

(d) operator and supervisor details;

(e) plant details;

(f) mix identification of concrete used;

During augering

(g) continuous log of penetration rate (m/sec);

(h) continuous log of drilling rate (mm/rev);

(i) continuous log of drilling torque (% of maximum available);

(j) continuous log of downward force ("crowd force") (kN);

During concreting/auger extraction

(k) continuous log of auger extraction rate (m/sec);

(l) continuous log of concreting pressure (bar);

(m) log of concrete oversupply levels at 0.1 m intervals (%);

(n) log of volume of concrete injected at 0.1 m intervals (m^3);

On completion of concreting

(o) total concrete volume used and theoretical volume (m^3);

(p) details of steel reinforcement installed if any, including length and depth;

(q) column verticality, positional and dimensional values (i.e. log of column diameter with depth) achieved;

(r) toe level;

(s) any other records, such as records of any incidents during construction of the CIC.

Submit to the Project Verifier construction records taken for each column, no later than two working days after construction of the column, in the form of a signed paper copy, and an electronic copy.

5 TRIAL COLUMNS

5.1 GENERAL

Determine the number of trial columns required for each GIA, which must not be less than the number shown in Annexure R225/A1, taking into consideration your equipment type, methods and the site conditions.

In consultation with the Designer, select those columns to be constructed as trial columns. The trial columns selected must be in group(s) of 16 columns arranged inside a square as a 4 x 4 matrix.

5.2 CONSTRUCTION OF TRIAL COLUMNS

Construct the trial columns using the concrete mix and installation parameters proposed in your method statement (refer Clause 3.3), to determine and confirm:

(a) appropriate method of construction, including use of pre-boring where necessary;

(b) adequacy of your construction methods to comply with this Specification;

(c) installation parameters;

(d) construction sequence of the production columns.

HOLD POINT

Process Held:	Construction of the first trial column in each GIA.
Submission Details:	Method statement (refer Clause 3.3), proposed concrete mix details, installation parameters and location of the trial column, at least 10 working days prior to commencement.
Release of Hold Point:	The Nominated Authority will consider the submitted documents and may inspect arrangements for monitoring of columns prior to release of the Hold Point.

WITNESS POINT

Process Witnessed:	Construction of subsequent trial columns, after the first trial column in each GIA.
Submission Details:	Notification of the time and location of the trial column construction, at least one working day prior to commencement.

Verify that all constructed trial columns satisfy the heave and position/verticality tolerances requirements specified in Clauses 3.5.4 and 8.1 respectively.

5.3 TESTING OF TRIAL COLUMNS

5.3.1 Frequency of Testing

Carry out the tests and at the frequencies specified in Annexure R225/L on the constructed trial columns.

5.3.2 Testing Methods

Carry out the testing in accordance with the testing methods specified in Clause 7.

5.3.3 Trial Column Test Report

Following completion of testing for each GIA, prepare and submit a trial column test report containing the following details as a minimum:

(a) installation parameters and sequence used in the construction of the trial columns;

(b) monitoring records taken during construction for each of the trial columns;

(c) results of the trial columns testing, and analysis and discussion of the results;

(d) recommended installation parameters and construction sequence for production columns;

(e) certification that the recommended installation parameters, equipment and procedures for construction of the production columns will be suitable to meet the specified design requirements.

5.4 ACCEPTANCE OF TRIAL COLUMNS

Trial columns satisfying the conformity requirements of Clause 8 will be accepted as production columns.

6 PRODUCTION COLUMNS

6.1 CONSTRUCTION OF PRODUCTION COLUMNS

Following testing (refer Clause 5.3) and acceptance (refer Clause 5.4) of the trial columns, finalise the installation parameters and sequence for the production columns using the same material, equipment and plant used for the trial columns.

Notify the Designer immediately of any variations in diameter, spacing or depth of the columns arising from site conditions which have not been anticipated in the design, and take corrective actions as required.

HOLD POINT	
Process Held:	Construction of the first production column in each GIA.
Submission Details:	Trial column test report (refer Clause 5.3.3) and construction program (refer Clause 3.1.1), at least seven working days prior to commencement.
Release of Hold Point:	The Nominated Authority will consider the submitted documents and assess the recommended installation parameters and sequence, prior to authorising the release of the Hold Point.

WITNESS POINT	
Process Witnessed:	Construction of subsequent production columns, after the first column in each GIA.
Submission Details:	Notification of the time and location of the column construction, at least one working day prior to commencing.

6.2 TESTING OF PRODUCTION COLUMNS

6.2.1 Frequency of Testing

Carry out the tests and at the frequencies specified in Annexure R225/L on the constructed production columns.

The Project Verifier will nominate the columns and core samples to be tested under this Clause.

6.2.2 Testing Methods

Carry out the testing in accordance with the testing methods specified in Clause 7.

6.2.3 Submission of Test Results

Submit all test results within 48 hours of testing to the Project Verifier for review.

7 TESTING METHODS

7.1 GENERAL

Carry out testing of the trial and production columns in accordance with Clauses 7.2 to 7.6.

You may use alternative methods of sample recovery and in-situ testing of columns. Alternative sample recovery methods must be capable of obtaining an undisturbed sample of sufficient diameter and length for the proposed testing.

7.2 COMPRESSIVE STRENGTH – CYLINDERS

Prepare, cure and test the concrete cylinder samples in accordance with AS 1012.8.1 and AS 1012.9 at 28 days age.

Alternatively, you may prepare and test another pair at an earlier age.

7.3 COMPRESSIVE STRENGTH – CORES

7.3.1 Coring Method

Carry out full depth coring, unless approved otherwise by the Principal, of the columns in accordance with AS 1012.14 or other approved in-situ sampling method at between 7 and 14 days after the CIC construction.

Besides using the cores taken for compressive strength testing (refer Clause 7.3.2), use the coring to also check the quality of the placed concrete in the column (e.g. presence of voids/honeycombing), and to check that the column verticality is within the tolerance specified in Clause 8.1.2.

7.3.2 Core Sampling

From the recovered core, take 3 sets of samples, with each set comprising a pair of test cylinders, at locations within the core selected by the Project Verifier.

The number of sets of samples may be reduced in instances where the length of intact core samples retrieved is limited.

7.3.3 Storage and Curing

Prepare, store and cure the samples in accordance with AS 1012.14.

7.3.4 Testing

For all of the samples taken, test one set at 28 days age in accordance with AS 1012.14. You may use one of the remaining two sets to test at an earlier age.

Store the remaining set(s) of samples and the remainder of the core under the same humid environment as that specified in Clause 7.3.3 until conformity with the 28 days strength is verified, or use them for further testing if required. Hand any remaining samples over to the Project Verifier.

7.4 INTEGRITY TESTING

7.4.1 Pulse Echo Method

Carry out integrity testing using low strain pulse echo (PE) method in accordance with AS 2159 Annexure D3.

CIC to be tested using the PE method must not exceed the maximum “column length to diameter” (L-D) ratio shown in Table R225.2.

Table R225.2 – Maximum L-D Ratio for Integrity Testing Using PE Method

Soil Type and Consistency [1, 2]	Maximum L-D Ratio
Soft to very soft clayey soil, loose to very loose sandy soil	50
Firm clayey soil, medium dense sandy soil	40

Note:

(1) The specified values applies only if the soil material through which the column passes from cut-off level to toe level is uniform.

(2) For non-uniform material with interbedded stiff/very stiff/dense/very dense soil, the L-D ratio may be smaller than those values shown in the table. Consult the Designer and Principal to agree on a suitable L-D ratio, taking into account the relative stiffness of soil types at various layers.

7.4.2 Other Methods

You may also use high strain dynamic or static load test methods for integrity testing

Static load testing, including column top preparation, must be carried out in accordance with ASTM D1143.

Use the high strain dynamic test only for columns which are reinforced, and the column head has been suitably prepared for the test in accordance with AS 2159.

The methods adopted for integrity testing must be capable of testing the full length of the column, with the stress wave generated during the test capable of reaching the toe of the column.

7.4.3 Approved Testing Organisation

All integrity testing (whether low strain or high strain), and interpretation of the test results, must be carried out by an organisation which is listed in Section 9 “Dynamic Testing of Piles” in the “Lists of Transport for NSW (TfNSW) Approved Bridge Components and Systems”, notwithstanding that the list is only for high strain dynamic testing.

The list is available from:
http://www.rms.nsw.gov.au/business-industry/partners-suppliers/documents/tenders-contracts/listofapprovedbridgecomponentssystems.pdf.

7.5 VISUAL EXAMINATION

In the event that the integrity test results for a GIA fail to satisfy the acceptance criterion (refer Clause 8.2.4), expose 1% of the cracked columns, with a minimum of two, by excavating to a minimum depth of 4 m below surface of the working platform around the column for a visual inspection by the Project Verifier.

7.6 FURTHER TESTING

7.6.1 Further Integrity Testing

In the event that the integrity testing and subsequent visual examination fail to satisfy the acceptance criteria specified in Clauses 8.2.4 and 8.2.5, the Project Verifier may request that further integrity testing in accordance with Clause 7.4 be carried out on 10% of the untested columns in each GIA.

7.6.2 Further Dynamic or Static Load Testing

The Project Verifier may also request that high strain dynamic or static load testing be carried out on 10% of defective columns, as determined from integrity testing, with a minimum of four, to check the column capacity at serviceability limit state (i.e. P_s in Clause 8.3.3 of AS 2159).

7.6.3 (Not Used)

7.7 CORE HOLE REINSTATEMENT

Fill with cement grout with equivalent strength of concrete in all core holes at completion of testing.

8 CONFORMITY REQUIREMENTS

8.1 POSITION AND VERTICALITY TOLERANCES

8.1.1 Plan Position

The maximum deviation of the column centre from its design plan position is 75 mm in any horizontal direction, measured at the column cut-off level.

8.1.2 Verticality

The maximum deviation from the vertical at any level of CIC at any stage of the construction is 1:100 (H:V).

8.2 ACCEPTANCE CRITERIA

8.2.1 General

The compressive strength used in these acceptance criteria for trial and production columns, is based on the 28 day strength specified in Clause 2.2.

Where this strength is verified as achieved by testing at an earlier age, the Project Verifier can waive the 28 day testing requirement.

For the columns to be conforming, the acceptance criteria stated in Clauses 8.2.2 to 8.2.6 must be met.

8.2.2 Compressive Strength – Moulded Cylinders

Average of the test results from the pair of cylinders tested conforms to the specified strength.

8.2.3 Compressive Strength – Cores

Not more than 10% of the test results fall below the specified strength, provided that all test results are equal to or greater than 75% of the specified strength.

8.2.4 Integrity Testing

(a) Columns supporting embankments and flexible retaining walls

(Examples of flexible retaining walls include reinforced soil wall and gabion wall.)

At least 75% of the tested columns in each GIA are free from cracking or any other defects.

(b) Columns supporting rigid retaining walls

(Example of rigid retaining walls include L-shaped reinforced concrete retaining wall.)

At least 90% of the tested columns in each GIA are free from cracking or any other defects.

The above percentages are applicable only if the Contractor also provide evidence that such percentage of defective columns will not compromise the design intent.

8.2.5 Visual Examination

No diagonal cracks or discontinuities visible.

8.2.6 Load Testing

The geotechnical and structural capacities of the tested columns are greater than the design load at serviceability limit state shown on the Design Documentation drawings.

8.3 TREATMENT OF NONCONFORMITY

For columns which do not meet the acceptance criteria, you may propose further testing of the columns, including different types of tests on previously tested columns, and tests on untested columns, or demonstrate that the nonconformity will not compromise the design intent of the CIC or carry out remedial measures, acceptable by the Designer.

8.4 ACCEPTANCE OF CONSTRUCTED WORKS

Following completion of construction and testing of the production columns, filling of all core holes and rectification of all nonconformities to the satisfaction of the Project Verifier, submit all outstanding construction records and results of tests carried out on the production columns, together with a written certification that the constructed Works conform to the requirements of this Specification and the Design Documentation drawings.

You will not be given Completion until the above documents have been submitted and reviewed by the Principal, and the constructed Works have been accepted by the Principal.

9 LOAD TRANSFER PLATFORM

9.1 GENERAL

Construct a load transfer platform (LTP) in accordance with the Design Documentation drawings, to transfer the load from the embankment onto the columns, and to control bending of the columns due to excessive ground lateral movement.

Use appropriate high strength geosynthetic reinforcement and Selected Material complying with Specification TfNSW D&C R67 to construct the LTP.

9.2 DESIGN OF LTP

Where the LTP details are not shown on the Design Documentation drawings, in consultation with the Designer, carry out a design of the LTP in accordance with BS 8006 and Specification TfNSW D&C R67, whichever is more stringent, and submit it to the Designer for review and acceptance prior to its construction.

9.3 CONSTRUCTION OF LTP

Construction of the LTP must be in accordance with TfNSW D&C R67.

HOLD POINT	
Process Held:	Construction of load transfer platform.
Submission Details:	Certification of conformity of the production columns, including construction records and test results of production columns in accordance with Clause 8, and Contractor's LTP design if applicable.
Release of Hold Point:	The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point.

ANNEXURE R225/A – PROJECT SPECIFIC REQUIREMENTS

Refer to Clause 1.2.1.

A1 GIA AND TRIAL COLUMNS

NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure R225/A1)

Complete the table below by filling in the required details. Insert additional rows as necessary to include all GIA.

Under the column "Description of GIA Location", insert details of the GIA location, (e.g. "Shallow Creek Bridge Abutment B approach, General Embankment, Reinforced Soil Wall, L-Shaped Retaining Wall etc.)".

Determine the exposure classification in accordance with AS 2159. The possible exposure classifications are:

- *Non-aggressive;*
- *Mild;*
- *Moderate;*
- *Severe;*
- *Very severe.*

The number of trial columns specified must be at least 16 for each GIA.

GIA Identification	Description of GIA Location	Exposure Classification (1)	Number of Trial Columns (2, 3)

Notes:

(1) Exposure classification determined in accordance with AS 2159 for 100 years design life.

(2) For each GIA, the number of trial columns specified will be at least 16. Refer also Clause 5.1 on selection of the trial columns.

(3) The Contractor may increase the number of trial columns.

ANNEXURE R225/B – (NOT USED)

ANNEXURE R225/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.3.

C1 SCHEDULE OF HOLD AND WITNESS POINTS

Clause	Type	Description
4.1.2	Hold	Pre-boring, where required
5.2	Hold	Construction of first trial column in each GIA
5.2	Witness	Construction of subsequent trial columns
6.1	Hold	Construction of first production column in each GIA
6.1	Witness	Construction of subsequent production columns
9.3	Hold	Construction of load transfer platform

C2 SCHEDULE OF IDENTIFIED RECORDS

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

Clause	Description of Identified Record
4.4, 8.4	Certification of conformity, including construction records and reports of tests carried out on production columns
5.3.3	Trial column test report
9.2	Load transfer platform design

ANNEXURE R225/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
3.3	Method statement for CIC works

ANNEXURE R225/E TO R225/K – (NOT USED)

ANNEXURE R225/L – MINIMUM FREQUENCY OF TESTING

Carry out the tests and at the frequencies specified in Table R225/L.1 to verify conformity of both trial and production columns.

Table R225/L.1 – Testing Types and Frequencies

Type of Tests	Trial Columns	Production Columns [1]
Slump	In accordance with TfNSW D&C R53	
Compressive strength [2]		
Moulded cylinders [3]	2 pairs at start of concreting day; 2 pairs at end of concreting day	2 pairs at start of concreting day; 2 pairs at end of concreting day
Cores	N/A	1% of columns in each GIA, with a minimum of two [4]
Integrity testing [5]	100% of all trial columns in each GIA	Columns supporting embankment and flexible retaining walls: - 10% of columns in each GIA Columns supporting rigid retaining wall: - 20% of columns in each GIA
Visual examination [6]	N/A	1% of cracked columns, with a minimum of two in each GIA
Further testing [7]	N/A	Further integrity testing: - 10% of untested columns in each GIA Further dynamic or static load testing: - 10% of defective columns, with a minimum of four in each GIA

Notes:

(1) Tests carried out on trial columns which have subsequently been accepted as production columns do not count towards the percentage of production columns to be tested.

(2) Unconfined compressive strength, tested in accordance with AS 1012.8.1 and AS 1012.9 for moulded cylinders and AS 1012.14 for core cylinders.

(3) Each pair of moulded cylinders must be from a different batch.

(4) Refer Clause 7.3. Three sets of samples taken from each core, with one set tested at 28 days.

(5) Refer Clause 7.4 for various types of integrity tests.

(6) Only required when criterion for integrity testing is not satisfied.

(7) Refer Clause 7.6. Further testing required only where requested by the Project Verifier.

ANNEXURE R225/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.6.

TfNSW Specifications

TfNSW D&C Q6	Quality Management System (Type 6)
TfNSW D&C R53	Concrete for General Works
TfNSW D&C R67	High Strength Geosynthetic Reinforcement

Australian Standards

AS 1012	Methods of testing concrete
AS 1012.8.1	Method for making and curing concrete - Compressive and indirect tensile test specimens
AS 1012.9	Compressive strength tests - Concrete, mortar and grout specimens
AS 1012.14	Method of securing and testing cores from hardened concrete for compressive strength
AS 2159	Piling - Design and installation

Other Standards

ASTM D1143	Standard test methods for deep foundations under static axial compression load
BS 8006	Code of practice for strengthened/reinforced soils and other fills