CARES Model Specification Australia

2nd Edition

For Bonded Post-Tensioned Floors in Non-highway Structures

Guidance

For organisations for the use and installation of bonded post-tensioned floor slabs, transfer slabs and beams containing monostrand or flat / profiled multistrand tendons

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Model Specification for Bonded Post-Tensioned Floors in Non-Highway Structures

2nd Edition
July 2023

This model specification offers guidance to organisations for the use / installation of bonded post-tensioned floor slabs, transfer slabs and beams containing monostrand or flat / profiled multistrand tendons.
Notes for Designers are given (where appropriate) in italics and do not form part of the specification.

It is the specifier's responsibility to ensure that the contract specification is suitable for and meets the requirements of the contract.

The images throughout this Model Specification are courtesy of Interspan, SRG Global, Crosbe and Silva Global.

Contents

Standards and Design Guides

Design shall be in accordance with: AS3600:2018: Concrete structures.

All relevant post-tensioning design documentation should cross reference to this CARES Model Specification 2nd edition for Australia and in particular to the requirements of Clause 1(a).

1 Post-tensioning Contractors

a) Post-tensioning systems shall only be installed by specialist post-tensioning Specialist Builders that have the necessary experience, knowledge, resources, materials and equipment. Post-tensioned Specialist Builders shall have CARES certification for the installation of post-tensioning systems in concrete structures against CARES Appendix APT04 or equivalent accredited product certification.

b) Access to the works shall be granted to CARES for the purpose of quality auditing and maintenance of certification by arrangement with the post-tensioning Specialist Builder, Main Contractor and Client as appropriate.

c) The Main Contractor or Client may nevertheless request an additional surveillance audit on a CARES approved post-tensioning Specialist Builder by CARES (at their own cost). If such an audit is required by the Main Contractor or Client during the contract then this shall be clearly stated in the project specification.

d) All post-tensioning operations shall be carried out by operatives with appropriate knowledge, training and proven experience in carrying out similar operations. Supervisors and operators shall be trained and certified to meet the requirements as detailed in CARES Appendix APT05.

e) Trainee post-tensioning personnel shall be adequately supervised when performing post-tensioning activities.

Note: *The number of trainees should be limited and the ratio of trainees to experienced trained staff should be balanced according to circumstances and normally not exceed 25% of the post-tensioning personnel.*

f) All site post-tensioning duct fixing, tendon installation, stressing and grouting shall be undertaken by suitably trained and experienced staff under the direct supervision of the post-tensioning Contractor. Site operatives employed by other Contractors on the site shall not be used for post-tensioning work.

g) Where required by the Main Contractor or Client the names of all post-tensioning operatives to be employed on the site shall be submitted, with their training records before commencement of the subcontract works.

2 Quality plan

The post-tensioning Specialist Contractor shall provide the Main Contractor or Client with a quality plan giving details of all the proposed materials, equipment and method statements relating to site activities, including work instructions quality procedures, records inspection and test arrangements and work acceptance procedures.

Note: *The quality plan may comprise a single document or series of linked documents.*

3 Health and safety

All post-tensioning Contractors should submit full risk assessments, method statements and safe systems of work to cover the full scope of works prior to starting work on site.

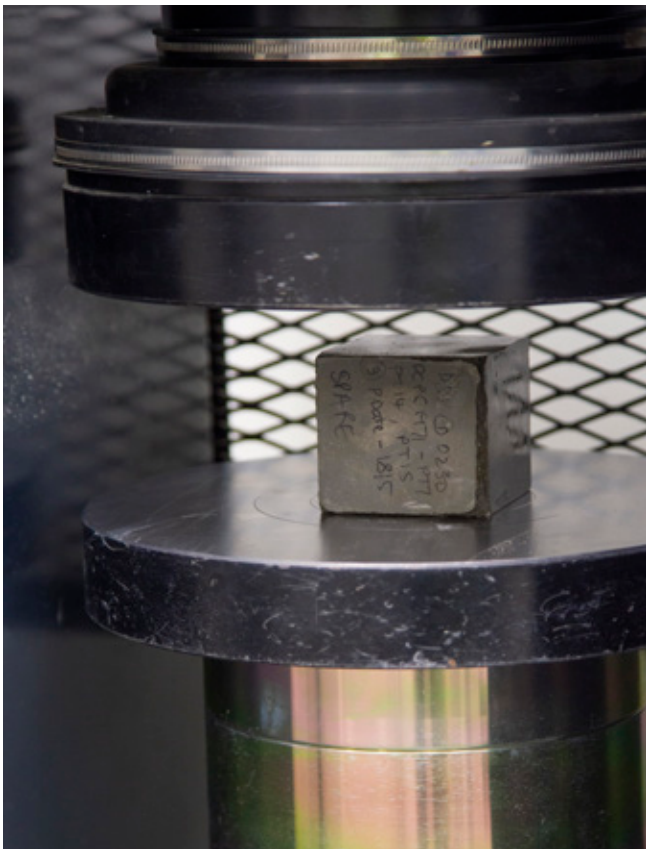
All post-tensioning Contractors should operate health and safety management systems to ISO45001, AS/NZS 4801 or an equivalent system.

4 Materials and products

4.1 Tensile element

a) Strand shall comply with AS/NZS 4672. The grade and diameter shall be specified by the post-tensioning Designer and shall be obtained from firm(s) holding a valid product conformity certificate of approval supplied by the Australasian Certification Authority for Reinforcing and Structural Steels (ACRS) and shall be of a type that is compatible with the anchorage tested and approved in line with the manufacturer installation instructions.

b) Tensioned bar shall comply with AS/NZS 4672.
The grade and diameter shall be specified and shall be obtained from firm(s) holding a valid ACRS certificate of approval.



Note: *Confirmation of the strand or bar supplier's approval status can be obtained from the ACRS Certification Body's website* ***(www.steelcertification.com)***

4.2 Anchorages

Anchorages for post-tensioning systems shall be adequately identified to ensure traceability and comply with the minimum performance requirements as defined in CARES Appendix APT01 and in accordance with AS/NZS 1314: 2003. The post tensioning kit may also hold a European Technical Assessment (ETA) against ETAG 013 or EAD 160004 but evidence shall be presented which shows that the appropriate tests have been undertaken using strand conforming to AS/NZS 4672. Documentary evidence of product conformity shall be provided if requested on site.

Evidence of compliance with the above post-tensioning kit/post-tensioning anchorage installation qualification for personnel should be obtained at tender stage if possible.

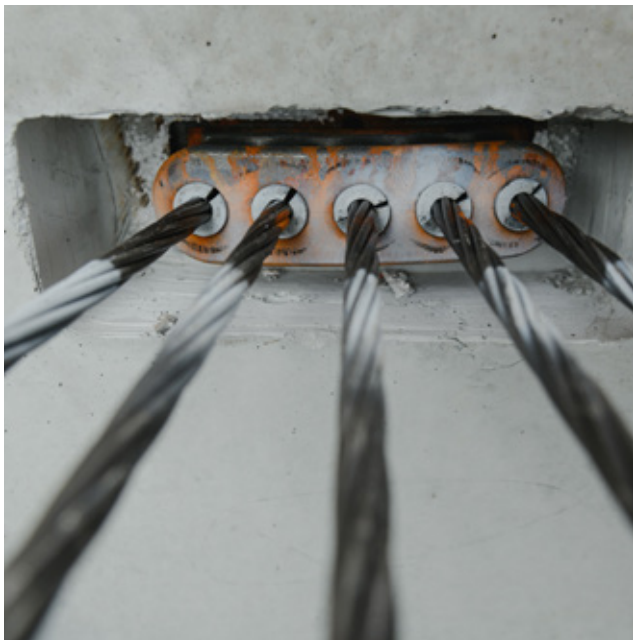
4.3 Ducts and vents

Duct, vent and connection material shall be robust enough to resist damage during construction; for example smooth galvanised steel with a minimum wall thickness of 0.35mm, corrugated galvanised steel with a minimum wall thickness of 0.30mm or high density polyethylene or polypropylene with a minimum wall thickness of 2.0mm. Plastic ducting should conform to the requirements of *fib (International Federation for Structural Concrete)* bulletin 75.

Duct shall conform to the requirements of CARES Appendix APT02.

Ducting shall prevent the entrance of paste from the concrete, and shall not cause harmful electrolytic action or any deterioration of the tendon or tendon components. The internal cross-sectional area of the duct shall be at least twice the net area of the tendon's prestressing steel or as specified in the tested PT kit manufacturers installation instructions. Ducting shall be capable of transmitting forces from grout to the surrounding concrete.

A water-resistant, adhesive tape should effectively seal any ducts. It should be suitable for application to wet galvanised steel / plastic ducts and to be inert and non-reactive to anything in the concrete, grout or the steel (duct or strand).



Note: *The Designer should clearly specify the type of duct required to meet the required bond and durability requirements.*

Ducts are usually steel with a folded seam and are not leaktight. Where a higher level of protection is required such as in car parks, plastic duct systems should be considered.

The use of PVC is not recommended since it is known that chloride ions can be released in certain conditions.

4.4 Grout

Grout suitability tests shall be carried out by competent personnel with materials and plant proposed for use on site at the commencement of the project, to verify the properties are as per the criteria in 5.5.4.

Where the Specialist Builder operates in sites adjacent to a project, then any grout suitability test data may be used in accordance with the restrictions as detailed in CARES Appendix APT04.

The tests shall be sufficiently in advance of grouting operations to enable adjustments to be made to the materials, plant or personnel.

Such tests shall be repeated at least every 3 months or when a significant change in conditions occurs (examples include, but not limited to change in grout supplier, water supply, significant climate change)

Grout shall consist of pre-bagged material requiring only the addition of a measured amount of water and shall be CARES approved to Appendix APT03.

Grout shall be stored in accordance with the manufacturer's instructions.

Note: *Bagged grout materials have a specified shelf life and the bags are normally date marked. The material must be used by the specified date.*

Bleed water is excess water in the grout that is not chemically bound and can lead to low density grout, grout cracking, grout shrinkage and porosity, therefore the w/c ratio must be kept as low as possible. The necessary grout properties can be achieved with properly formulated grout materials and the addition of specified quantities of water.

4.5 Storage and handling of materials

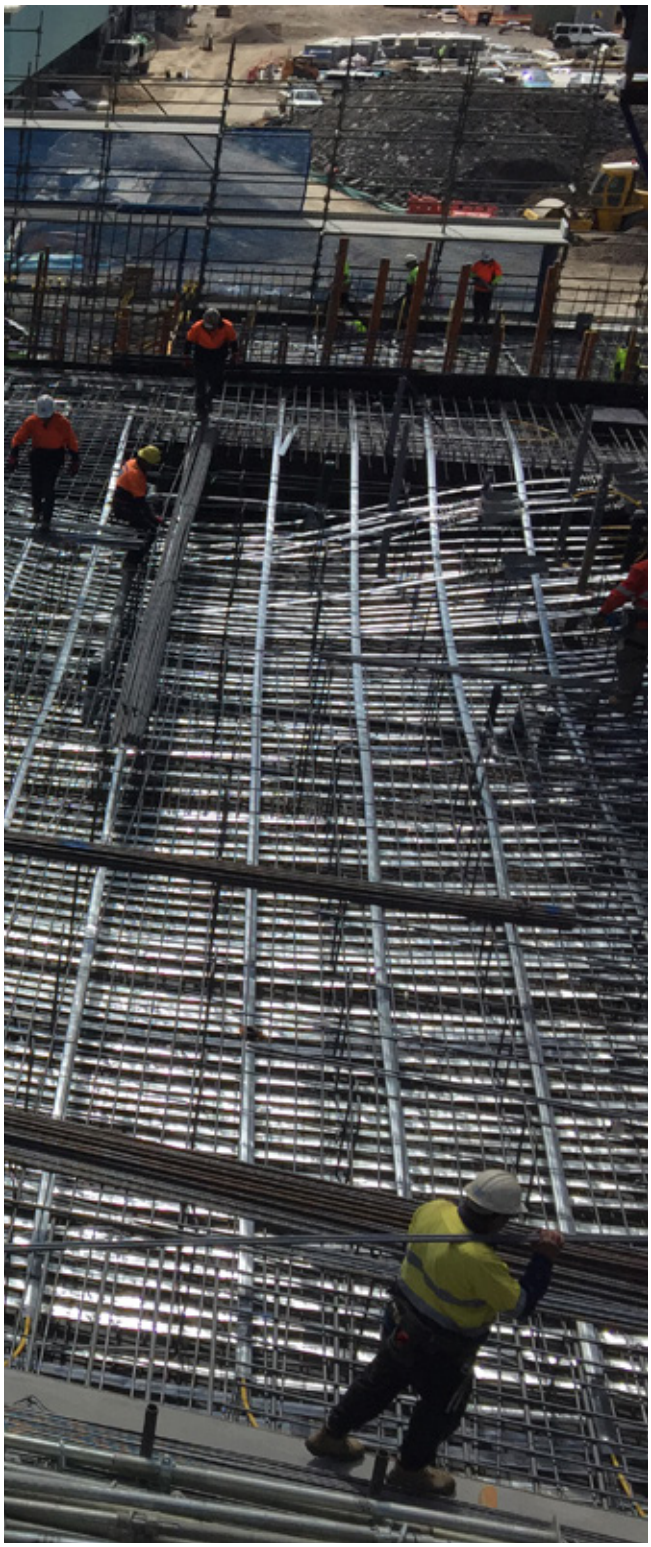
All materials and components are to be stored in a safe and careful manner to ensure no damage occurs to the wires or anchors. Strand is to be stored in large diameter coils prior to installation and kept away from welding and other dangerous operations and protected from extreme changes in temperature.

Strand is to be delivered to site clean and free from permanent bends, kinks, pitting, scale or other damage and to be stored in such a way as to protect it in this condition until it is installed.

If the strand is shown to have excessive corrosion it should not be used. For clarification, unacceptable corrosion is regarded as that which cannot easily be removed by hand and permanently marks the surface of the part (such as surface pitting).

4.6 Traceability

Traceability is key for all elements of the PT installation and traceable quality records shall be made available either in paper form or by electronic means. New state-of-the-art cloud-based technologies provide a digital tracking system as well as quick and easy access to data from the material's supply chain, right through to the construction site. With better visibility from manufacturer, there is also the opportunity to use advanced digital record-keeping, using QR-coded labels on the product packaging. The technological advances are moving towards delivering consistency and standardisation in the traceability of safety-critical materials. CARES Cloud App and ACRS Cloud App provides instant authentication of a supplier's CARES or ACRS certification and traceability to the origin of the materials.



5 Workmanship

5.1 Tendon installation

a) Vertical accuracy shall be +/- 5mm or greater at the discretion of the PT slab Designer.

b) Horizontal accuracy shall be 50mm in beams or 150mm in floor slabs.

c) Tendons may be deviated to avoid obstructions such as openings and columns with the agreement of the Main Contractor or Client. The change of direction of the tendon should occur away from the opening and trimmer bars should be provided to avoid any possible cracking at the corners. Such proposed changes to the design shall be checked by the PT Designer and if released, signed and dated with records readily available.

Note: *Tendon profiles which require a curve in plan may be provided by faceting straight lengths of flat duct down to a minimum radius of 50m and a 7 degree maximum facet angle. The length of each straight facet of duct shall not be less than 6m. For tighter radii, circular ducts should be used.*

Consideration shall be given to any restrictions or installation instructions supplied by the duct manufacturer.

Alterations to PT Designers drawings should be authorised by the PT Designer prior to pouring concrete, with records of such changes signed, dated and available for subsequent review.

d) Tendons shall be fixed and supported at centres not exceeding 1m and shall be securely fixed to prevent movement and flotation during the construction process.

Note: *Flat ducts are quite flexible in the vertical direction and it is common to install the strand within the duct and then profile the tendon, which increases the stiffness and aids the achievement of a smooth tendon.*

e) Vents shall be fixed at injection and exit points and, where tendon drape exceeds 500mm, intermediate vents shall be fixed at tendon high points. Vents must extend at least 500mm above the slab surface to ensure effective head of grout.

Note: *Consideration should be given to the use of intermediate vents on tendons over 100m in length, typically about 30 to 70m.*

f) All inlets and outlets shall be suitably marked to identify the tendon and their location along the tendon.

g) Pressure rating for inlets, outlets and vents must not be less than 1.0MPa, all tubing to be plastic and 20mm minimum inside diameter. Smaller ID tubing at 12mm minimum may be used for small grout quantities.

5.1.1 Tendon position

Where the tendon position is not accurately and authoritatively documented, reinforcement detection equipment should be utilised to locate tendon positions prior to any cutting or drilling work on the slab.

5.1.2 Tendon installation records

Tendon installation shall be recorded. Records shall include:

a. Date of installation.
b. Strand source.
c. Coil number.
d. Heat number (or Cast number)
e. Anchorage batch number.
f. Wedge batch number.
g. Duct batch number.
h. Supervisor.
i. Operatives.
j. Location of the products within the structure.
k. Drawing number and revision status.

5.2 Pour Watch

Each concrete pour shall be watched by experienced competent PT personnel and any issues which could significantly affect the original installation or disrupt subsequent installation operations shall be recorded and rectified. Records shall be made of any rectification carried out.

5.3 Stressing

a) The post-tensioning Designer shall calculate the theoretical tendon extension. All relevant system data shall be stated e.g. μ, k, strand E value and area, wedge draw-in on lock off and any assumed movement of dead end etc.

b) The PT Contractor shall make the actual extensions available for review by the designated structural engineer of the Main Contractor or Client. Stressing shall not commence before the concrete has achieved the transfer strength specified by the PT Designer and / or the PT kit installation instructions and receipt of written confirmation to proceed by the designated competent engineer.

c) The concrete transfer strength shall be based on site cured cubes taken at the point of concrete placement or at the pumping source.

Note: *There can be significant differences in concrete strength between the first and last loads to be poured, therefore the slab's concrete transfer strength should be based on cubes taken from the last 25% of the concrete load on the final pour.*

Site curing of cubes requires the cubes to be cured at the same temperature as the concrete element from which the cubes were taken, to ensure the tested cubes are representative of the concrete, in line with the requirements of AS3600.

d) The Designer shall specify any restrictions on stressing sequence and increments.

e) The jacking force should not exceed those given in the appropriate design standard and should be provided by the PT Designer.

f) Tendons shall be stressed in the specified sequence and load increments.

g) For routine stressing, extensions shall be measured prior to commencement of stressing, and after stressing and locking off to an accuracy of 3% or 2mm whichever is greater. Measurements shall take into consideration the possible strand movement at the dead end anchor.

h) The actual extensions shall be within the limits specified in AS3600 and investigations undertaken if in excess of 10% of the theoretical extension.

i) Tendons are not to be cut and sealed, until the PT Designer has checked and signed off the actual extensions.

Note: *Theoretical extensions are used as an indication that tendons have the correct load applied during stressing. The accuracy of extension calculations will depend on the accuracy of inter alia: the tendon profile and the assumptions made for movement at the anchorages, friction and wobble coefficients.*

j) In the event that any failures occur during stressing (system components or concrete) the cause shall be thoroughly investigated and a formal report presented to the Main Contractor or Client. No further stressing on that element shall be undertaken until the proposed corrective action has been approved by the Main Contractor or Client.

5.3.1 Stressing equipment

Stressing jacks and their load measuring system should have an appropriate and current calibration certificate, which is traceable to AS1349, and no more than 6 months old at the time of stressing.
The calibration shall be undertaken by a NATA accredited company. The stressing equipment shall be capable of establishing a tendon load to a maximum tolerance of +/- 3%.

Tendons shall be cropped using mechanical means.

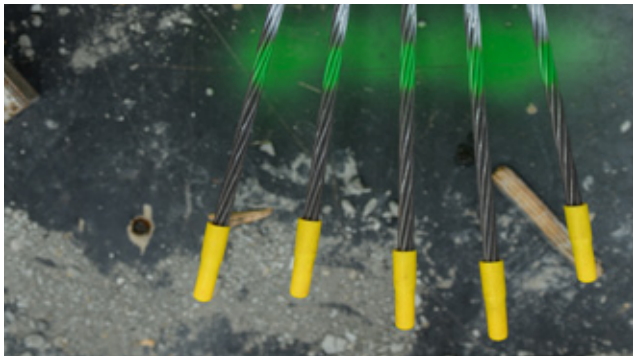
Note: *Flame cutting is not acceptable for cutting strand, as heat will adversely affect the properties of the strand.*

5.3.2 Stressing records

Stressing operations shall record:

a. Date of stressing.
b. Strength and age of concrete cubes.
c. The minimum age of concrete at transfer.
d. Stressing equipment.
e. Calibration date.
f. Supervisor and operators.
g. Serial numbers of gauges and jacks.
h. Tendon identification.
i. Theoretical extension, actual extensions and corresponding, loads (where required), initial and final jacking loads.
j. Drawing number and revision status.

Completed stressing records shall be made available to the Main Contractor or Client not more than one week after stressing.



5.4 Sealing of anchorage components

Anchorage components shall be sealed against the ingress of water or aggressive agents likely to cause corrosion of the steel or anchorage. The method of anchorage sealing shall be stated in the project specification.

The chosen method of sealing shall be capable of resisting the specified grout pressure.

Note: *Proprietary non-shrink mortars and bonding agents are recommended for sealing the anchor pockets.*

Anchors are usually cast into pockets in edge beams and the pockets sealed with mortar/ render. The detailing of this area requires some attention, as mortar / render can be permeable and / or subject to shrinkage which may allow for corrosion of the embedded tension end.

For exposed anchors and where the anchor design allows, a higher levels of protection should be considered such as end caps.

Data sheets and method statements for anchorage sealing shall be submitted to the CA.

5.5 Grouting

a) Grouting of the ducts shall normally be shown to leave no void which has a radial dimension greater than 5% of the maximum duct sectional dimension or which poses a risk to the integrity of the tendon. Particular attention shall be given to avoiding bleed collection or void formation at high points in the ducts or anchorages.

b) Grouting trials are typically not considered unless tendons are longer than 50m or have particularly severe profiles. (For example on transfer slabs less than 350mm or a profile range with a high point to low point of more than 300mm).

c) “Grout trials should be considered for structures in Exposure Classifications B1, B2, C1, C2 & U as detailed in AS3600 Table 4.3.

5.5.1 Preparation of ducts

Where necessary, all grouting and venting points shall be suitably marked to enable identification of the duct to which they are connected.

Note: *In many slabs the duct layout is simple and repetitive and vent labelling may not be necessary. However with more complex duct/ vent configurations where it is possible to confuse vents from different ducts, it is important to mark and identify the vents.*

The ducts shall be kept free from contamination at all stages from storage to installation and shall be thoroughly clean before grouting.

Ducts should be blown through with oil free compressed air prior to grouting (not water). Blowing through of tendons should be recorded for each tendon individually. No grout shall be placed if the temperature of the structure adjacent to the tendons is expected to be outside of the recommended working range of the pre-bagged grout to be used. Grouting shall not be performed below 5°C or above 35°C unless suitable documented precautions / procedures are followed.

5.5.2 Grouting equipment

Pumps and grout inlets must be fitted with pressure gauges capable of reading grout pressures up to 1.0 MPa. Pressure gauges must have a full scale reading less than 1.5 MPa and must be maintained in calibration.

5.5.3 Grouting procedure

Grout injection shall be continuous and shall be slow enough to avoid segregation of the grout. The grout should fill the duct at a rate of no greater than between 10 to 15m of duct per minute. Filling rates for vertical ducts must not be more than 5m per minute.

There shall be a procedure for corrective action in the event of blockage or breakdown such as backup equipment or flushing out of ducts.

All vents shall be closed one after another in the direction of the flow. The injection tubes shall then be sealed off under positive pressure of not greater than 100kPa.

The filled ducts shall be protected to the satisfaction of the Main Contractor to ensure that there is no damage to the grout due to shock or vibration for 24 hours after injection of the grout and that the temperature in the ducts does not fall below 5°C or exceed 35°C for 24 hours after injection of the grout.

The Main Contractor or Client or their representative may be invited to witness a representative sample of the grouting operation and countersign the grouting record sheet prepared by the Post- tensioning Contractor.

Grouting to take place as soon as practicable after the tendons have been stressed, extensions approved and the strands cropped but no longer than 28 days from stressing without the approval of the Main Contractor or Client. In case of any delays, then suitable precautions shall be taken to ensure no water ingress. Details of such precautions taken and approval by the Main Contractor or Client shall be maintained. In moderate or severe corrosivity areas this shall be reduced to 14 days or 7 days respectively.

Note: *Bonded tendons cannot achieve their full ultimate design capacity until the grouting operations have been completed. The PT Designer may therefore need to consider the reduced slab capacity in the temporary condition.*

5.5.4 Grout testing

Grout shall comply with the performance requirements of Table 1 below:

Grout properties	
Fluidity[*1, 4]	Immediately after mixing t_0: Efflux time 10 - 25 s End of Grouting t_e or 45 minutes after mixing (whichever is sooner): Efflux time 10 - 25 s but no more than 3 secs deviation from t_0
Bleeding[*2, 4]	Final bleeding < 0.5%. (measured when two successive readings show no further bleed)
Early contraction/ expansion[*2, 4]	After 3 hrs. ≤ + 0.5%
Strength[*3, 4]	32MPa at 7 days
Sieve test[*1]	<2.4mm using a calibrated sieve
w/c ratio	≤ 0.40 by mass
Grout temperature	As specified by the grout manufacturer
Density	From cube tests

Table 1

Footnote

1. Tested in accordance with ASTM C939
2. Tested in accordance with ASTM C940, modified for wick test
3. Tested in accordance with AS1478-2
4. Reference to procedures in APT04, Appendix B

The frequency of grout testing shall be in accordance with Table 2 below.

Frequency of grout testing	
Test	**Frequency**
Fluidity	One set of tests per grout mix at t_0 and t_e (End of Grouting or 45 mins after t_0, whichever is sooner)
Bleeding/volume change	See clause 4.4 – Grout suitability trials
Strength	3 cubes per grouting session taken at mixer (per Appendix B of APT04)
Density	Recorded from cube tests above

Table 2

Grout shall be batched in accordance with the manufacturer's instructions.

The source of materials and procedures approved as a result of satisfactory trials shall not be departed from without the approval of the Main Contractor or Client.

5.5.5 Grout Records

Records of each grouting operation shall be kept detailing:

a. The materials used, including batch numbers.

b. The date, time and conditions under which the grouting operations were carried out.

c. Ambient and structure temperatures and weather conditions.

d. Grout properties including temperatures, bleed, volume change and fluidity.

e. Details of any interruptions and any problems encountered during the grouting process e.g. blockages, loss of grout or loss of grout pressure.

f. Supervisor and operatives undertaking the grouting operation.

g. Grout manufacturer's Technical and Safety data sheet.

5.5.6 Calibration

Calibration records shall be available and retained for all measuring equipment used on site during the PT installation. Such equipment includes:-

- Flowmeters and pressure gauges used during air testing or in the grouting operation
- Pressure gauges and associated jacks in the stressing operation
- Temperature probes.

In the case of the latter certificates of conformity/Manufacturer statements of accuracy are acceptable. These are typically supplied with the instrument on purchase.

Flowmeters and pressure gauges used NATA accredited calibration certificates issued within the last 100 operations for which the device was used or within the last six months, whichever is earlier.

In all cases the devices should have a clear identification which can be referenced against the calibration records and dates.

CARES Scheme Appendices referenced:

APT01: Quality and operations assessment schedule for the Production and Supply of Prestressing Anchorages for Post-Tensioning Systems

APT02: Quality and operations assessment schedule for the Production and Supply of galvanised ducting for use in Post-Tensioning Systems (NB. This Scheme was issued in January 2023)

APT03: Quality and operations assessment schedule for the Production and Supply of Pre-bagged Grout Material for use in Post-Tensioning Systems

APT04: Supply and Installation of Post-Tensioning Systems in Concrete Structures (excluding Highways Structures)

APT05: Certification Scheme for CARES Registration Scheme for Competent Post-Tensioning Personnel

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