

TRANSPORT FOR NSW (TfNSW)

QA SPECIFICATION B61

DRIVEN COMPOSITE PILES

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REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 0		First issue.	GM, RNIC (W Ho)	11.09.97
Ed 1/Rev 1	12 15	Extending reinforcement included in Pay Item 15(h) New Pay Item (h) added.	GM, RNIC	28.08.98
Ed 1/Rev 2	1.2, 2.3.2, 11, 11.1, 12	For welding, AS 1554 is replaced by RTA B204	GM, RNIC (J Woodward)	30.09.98
Ed 1/Rev 3	Annex B61/1 Annex B61/2	New schedule listing Identified Records Golder Associates & Ground Engineering added to 1(a).	GM, RNIC	28.02.00
Ed 1/Rev 4	1.2, Annex B61/2	Minor changes.	GM, RNIC	26.07.00
Ed 1/Rev 5	15 (a) & (f)	References to Conditions of Contract changed to suit C1.	GM, RNIC	30.05.01
Ed 1/Rev 6	Annexure B61/2 Item 1(a) Item 1(b)	Testing organisations (vi) and (vii) added. Testing organisation (iii) added.	GM, RNIC	02.08.01
Ed 2/Rev 0	All	Clauses & annexures rearranged. Text revised to direct imperative style. "Superintendent" replaced by "Principal". "Contractor" replaced by "you". "shall" replaced by "must". Reformatting and editing including font changes. Revised to align with RTA B50 Ed 3/Rev 1.	GM, IC	23.10.08

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 2/Rev 0 (cont'd)	Foreword	New clause after the Table of Contents.		
	Annexures	Renumbered and revised.		
Ed 2/Rev 1	1.3 8.1 8.3 Annex M	Definitions of “you” and “your” added. Added: NPER registration as equivalent to CPEng, Engrs Aust, for certification purposes Referenced documents updated	GM, IC Bernie Chellingworth	15.01.10
	Ed 3/Rev 0	Global 1.2.4 1.3 2.1 2.2 2.3.3 2.3.5 2.4 4 5.3.1 6.1, 7 6.1 8.1 8.2	Minor editing and rewording to improve clarity. “Driving Supervisor” changed to “Piling Supervisor”. Reference to spec Q on frequency of testing added. Clarification added that “Dynamic Testing” is same as “High-Strain Dynamic Testing”. Heading title changed to “Pile Lengths for Manufacture”. Requirement for submission of crack maps and proposals for repair to Principal added. Clause reworded to harmonise with corresponding clause in spec B200. New sub-clause on welding requirements, moved here from clause 11. Subsequent sub-clause renumbered. New clause on marking of piles. Where bottom level of pilecap is more than 2 m below existing surface level, requirements for excavation clarified. Clause on pile resistance reworded to improve clarity. Minimum period before restrike test increased to 24 hrs to accord with AS 2159. Statement on piling hammer mass and height of drop moved to clause 8.2. Heading title changed to “General”. Statement on piling hammer mass and height of drop moved here from clause 6.1.	

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 3/Rev 0 (cont'd)	8.4	Previously clause 8.3.1. Responsibility for cost of preboring under various situations clarified. Details of proposed preboring equipment and methods to be included in PQP. Preboring to nominated depths clarified.		
	9	Minimum age of piles before driving of 14 days added.		
	10.1	New heading "General" added to form clause 10.1. Subsequent clauses renumbered.		
	12	Requirement for lap length of reinforcement and prestressing strands to conform to AS 5100.5 amended.		
	13	Hold Point on cutting off and stripping of pile moved here from clause 10.4. Requirements for development lengths of reinforcing bars amended.		
	14.1	Reference to list of approved Dynamic Testing systems in Annex F deleted and replaced by url reference for list of approved bridge components on internet.		
	Annex B	Jetting removed from costs of pile driving to be included in Item (f).		
	Annex F	Previous lists of approved Dynamic Testing systems in Annex F deleted.		
	Annex M	Reference documents updated.		
Ed 3/Rev 1	2.3.2, 2.3.5, Annex L	Reference to "B204" replaced by "B201".	DCS	27.10.17
	12	Reference to "B204" replaced by "B203".		
	Annex M	Referenced documents updated.		
Ed 3/Rev 2	Global	References to "Roads and Maritime Services" or "RMS" changed to "Transport for NSW" or "TfNSW".	DCS	22.06.20



DRIVEN COMPOSITE PILES

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VERSION FOR: DATE:

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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW B61 Edition 3 Revision 1.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Any project specific changes are indicated in the following manner:

- (a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. ***Additional Text***.
- (b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. ~~Deleted Text~~.

TfNSW QA SPECIFICATION B61

DRIVEN COMPOSITE PILES

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for the manufacture and driving of composite piles. The Specification covers only composite piles comprising a precast prestressed concrete upper segment spliced onto an H-section steel lower segment.

1.2 STRUCTURE OF THE SPECIFICATION

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

1.2.1 Payment

The method of measurement and payment must comply with Annexure B61/B.

1.2.2 Schedules of HOLD POINTS, WITNESS POINTS and Identified Records

The schedules in Annexure B61/C list the **HOLD POINTS** and **WITNESS POINTS** that must be observed. Refer to Specification TfNSW Q for the definitions of **HOLD POINTS** and **WITNESS POINTS**.

The records listed in Annexure B61/C are **Identified Records** for the purposes of TfNSW Q Annexure Q/E.

1.2.3 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure B61/D and must be implemented.

1.2.4 Frequency of Testing

The 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 B61/L. Where a minimum frequency is not specified, nominate an appropriate frequency. Frequency of testing must conform to the requirements of TfNSW Q.

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.

1.2.5 Referenced Documents

Unless specified otherwise or is specifically supplied by the Principal, the applicable issue of a referenced document must be the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure B61/M.

1.3 DEFINITIONS

The terms “you” and “your” mean “the Contractor” and “the Contractor’s” respectively

The following definitions apply to this Specification:

Calculated Set: The calculated average Set from 10 consecutive blows to achieve the required pile resistance with the Net Driving Energy stated on the Drawings.

Concrete Pile Segment: Upper precast prestressed concrete segment of the composite pile, which includes an H-section steel stub.

Contract Level: Reduced level (RL) of the pile toe shown on the Drawings.

Dynamic Analysis: A Wave Equation Analysis of a specific blow using force and velocity measured in Dynamic Testing together with measured pile/soil parameters, to replicate the measured traces of force and velocity and subsequently determine pile resistance, distribution of resistance and pile integrity (e.g. CAPWAP, TNOWAVE).

Dynamic Data: The force and velocity near the head of the pile and estimates of pile resistance, Net Driving Energy, pile integrity and stresses in the pile, determined immediately using electronic equipment (e.g. PDA) during pile driving.

Dynamic Testing: The measuring and recording of Dynamic Data for each blow of the hammer and subsequent Dynamic Analysis of specific blows. The term is the same as the High-Strain Dynamic Testing of AS 2159.

Maximum Net Driving Energy: Net driving energy which must not be exceeded at any time during driving, to prevent damage to the pile.

Minimum Penetration Depth: Minimum length of pile below existing surface level or other specified surface level at pile location shown on the Drawings.

Net Driving Energy: Driving energy at the top of the pile i.e. after hammer, helmet and cushion losses are accounted for.

Nominal Driving Energy: Driving energy nominally imparted by the hammer i.e. before hammer, helmet and cushion losses are accounted for; calculated by multiplying the hammer weight and nominal drop.

Nominal Refusal: A penetration of not more than 13 mm from 10 consecutive blows with the Net Driving Energy stated on the Drawings or derived after the driving of Representative Piles.

Penetration: Length of pile embedded in the ground.

Pile Design Load: The design ultimate axial load shown on the Drawings for the pile.

Piling Supervisor: Your employee responsible for supervision and control of the piling operations.

Representative Pile: A pile nominated on the Drawings or by the Principal that represents a number of piles that are driven to a resistance, for the purpose of determining driving parameters using

Dynamic Testing. Representative Piles which are driven prior to the manufacture of the piles represented are also Test Piles.

Set: Permanent pile displacement after each drop of the hammer.

Steel Pile Segment: Lower H-section steel segment of the composite pile.

Temporary Compression: Elastic deformation of the pile and soil when the hammer strikes the pile.

Test Piles: Piles manufactured and driven to enable the Principal to confirm or alter as necessary the pile lengths shown on the Drawings. Test Piles which represent piles driven to a resistance are also Representative Piles. Test Piles are nominated on the Drawings, and are usually dimensioned 2 (two) metres longer than required by the design Contract Levels.

Wave Equation Analysis: A predictive computer analysis of pile driving, which can use hammer, pile and soil characteristics measured during Dynamic Testing for the determination of resistance versus Set of a pile (bearing graph) or pile driveability (e.g. GRLWEAP).

2 MATERIALS AND MANUFACTURE OF PILES

2.1 PILE LENGTHS FOR MANUFACTURE

Manufacture Test Piles to the lengths shown on the Drawings.

Do not manufacture any piles, other than Test Piles, until driving of the Test Piles is completed. Following submission of the driving records and Dynamic Testing reports of the Test Piles, the Principal will instruct the lengths to be manufactured for the remainder of the piles, in accordance with Clause 6.2.

If you propose to the Principal, and the Principal has accepted your proposal, to manufacture all of the piles prior to completion of the Test Piles to lengths other than those instructed, any costs or delays arising out of the length of piles instructed after completion of the driving of the Test Piles being different to those manufactured by you, must be borne by you. Acceptance of such a proposal is at the absolute discretion of the Principal.

2.2 CONCRETE PILE SEGMENT

Manufacture the concrete pile segments in accordance with Specifications TfNSW B80 and B110 and to the details, including lengths, shown on the Drawings. Variations to pile lengths can be taken up by varying the length of the steel pile segments.

Concrete pile segments with permanent cracks of width of greater than 0.1 mm are considered to be nonconforming. Measure and map any such cracks and submit the crack maps together with your proposals for repair of the cracks, or other disposition, for the Principal's approval. Concrete pile segments with such cracks that are repaired to the Principal's satisfaction may be incorporated in the Works.

2.3 STEEL STUBS AND STEEL PILE SEGMENTS

2.3.1 Ferrous Materials

Supply the steel stubs, steel pile segments, and reinforcing plates in accordance with the Drawings and this Specification. Steel used for piling and for reinforcing plates for pile toes must conform to AS/NZS 3678, AS/NZS 3679.1 and AS/NZS 3679.2, as applicable.

Where shown on the Drawings, supply and fix steel reinforcing plates to the pile toes prior to driving.

2.3.2 Stud Shear Connectors

Supply, weld and inspect stud shear connectors in accordance with Specification TfNSW B201 and the requirements of this Specification.

2.3.3 Testing of Materials

All structural steel supplied must be manufactured under quality management systems certified to AS/NZS ISO 9001 by a third party accredited by the Joint Accreditation System of Australia and New Zealand.

Provide evidence that the materials used comply with the relevant Australian Standards and TfNSW specifications. A mill certificate with appropriate NATA registration from the material supplier will constitute documentary evidence of compliance.

Do not use any material or part in the Works until it has been identified with the tests prior to its use.

2.3.4 Defects in Ferrous Materials

Defects in the steel H-section and other components arising from their manufacturing which become evident at any stage are considered to be nonconformities.

Submit your proposals for repair or replacement of the defective materials in your PROJECT QUALITY PLAN.

2.3.5 Welding

All welding procedures, welder qualifications and welding must conform to Specification TfNSW B201 for Weld Category SP.

2.3.6 Protective Treatment and Cleaning

Where protective treatment is required, submit details of the proposed method of applying the treatment.

Thoroughly clean off all mud, grease, loose rust, loose mill scale, weld spatter, etc. from the portions of the piles which are to be embedded or encased in concrete, prior to the embedment or encasement.

2.4 MARKING OF PILES

Clearly and indelibly mark all Test Piles at one metre intervals commencing from the toe to show penetration depths attained during driving. All other piles must be marked for traceability.

3 HANDLING AND STACKING OF PILE SEGMENTS AND PILES

Verify, by engineering calculations, that your method of lifting and stacking of pile segments and piles do not cause any damage to the pile segments and piles.

Determine the sizes of bearers placed on foundation material, accounting for the site conditions, to keep pile segments and piles clear of each other and the ground.

Bearers must support the pile segments and piles over their full width and, where the pile segments and piles are stacked in more than one layer, be in line vertically to avoid additional bending in any pile segment and pile in the stack.

Damaged pile segments and piles are considered to be nonconforming.

4 SITE PREPARATION

Carry out any excavation or backfilling in the vicinity of the piles in accordance with Specification TfNSW B30.

Where the ground level is to be permanently lowered, such as for an excavated channel, do not drive piles located in the area to be excavated until such excavation is complete.

Where the level of the bottom of the pile cap is more than two metres below the existing natural surface level, prior to the driving of the piles, carry out excavation for the pile cap to a level which is not more than two metres higher than the level of the bottom of the pile cap, to reduce any temporary contribution of the ground above to the pile resistance measured during driving.

Where piles are shown on the Drawings as penetrating through a new embankment, place and compact the new embankment prior to driving the piles, unless specified otherwise.

5 ACCEPTANCE CRITERIA FOR PILE DRIVING

5.1 GENERAL

Drawings prepared to AS 5100 show ultimate loads. Ultimate loads are used as the basis for this Specification.

5.2 PILES DRIVEN TO NOMINAL REFUSAL IN ROCK

Apply this Clause where piles are shown on the Drawings as being driven to Nominal Refusal in rock.

5.2.1 Pile Resistance

Drive piles to achieve Nominal Refusal in rock, or to the required pile resistance as demonstrated by Dynamic Testing in accordance with Clause 5.3.1, at the end of driving.

5.2.2 Dynamic Testing

Carry out Dynamic Testing in accordance with Clause 14 to verify the Net Driving Energy delivered by the driving equipment and the distribution of resistance along the pile to confirm that the pile is

founded in rock, on at least one pile for each different pile rake and each different piling equipment set-up. This must include the first Test Pile driven, if Test Piles are nominated on the Drawings.

5.3 PILES DRIVEN TO A RESISTANCE

Apply this Clause where piles are not shown on the Drawings as being driven to Nominal Refusal in rock.

Unless specified otherwise or instructed by the Principal, if the driving record indicates that some piles of a footing have founded in rock or in another hard layer, then drive all piles of the footing to found in that same layer.

5.3.1 Pile Resistance

After achieving the Minimum Penetration Depth shown on the Drawings, drive the piles further to achieve the required pile resistance, given as follows:

- (a) For Representative Piles, the required pile resistance is at least the Pile Design Load divided by the applicable geotechnical strength reduction factor, both of which are shown on the Drawings, and demonstrated by Dynamic Testing.
- (b) For piles represented by a Representative Pile, the required pile resistance is the same as in item (a) above but demonstrated by the driving parameters established during the driving of that Representative Pile to achieve the same pile resistance.
- (c) For an individual pile not representative by a Representative Pile, the required pile resistance is at least the Pile Design Load divided by the applicable geotechnical strength reduction factor for individual pile testing, both of which are shown on the Drawings, and demonstrated by Dynamic Testing of that individual pile.

The acceptance of a proposal for Dynamic Testing of an individual pile will be at the absolute discretion of the Principal. Payment for such testing when accepted by the Principal must be in accordance with Item (1) in Annexure B61/B.

5.4 MINIMUM PENETRATION DEPTH

Apply driving methods that ensure all piles attain the Minimum Penetration Depth shown on the Drawings. Where the Minimum Penetration Depth cannot be achieved, notify the Principal. The Principal will determine whether a pile that does not reach Minimum Penetration Depth is acceptable.

5.5 POSITIONAL TOLERANCES

Drive piles with tolerances not exceeding the positional tolerance requirements specified in AS 2159.

5.6 DRIVING RECORDS

Prepare a driving record for each pile. The driving record must contain at least the following information:

- (a) Date of driving pile.
- (b) Design location, inclination and dimensions of pile.
- (c) Ground surface level at the time of driving, and pile toe level at end of driving.
- (d) Reports of Dynamic Testing, including restrike tests, when carried out.

- (e) Record of Sets and Temporary Compressions for Test Piles and Representative Piles including restrrike test results and, for other piles, at the end of driving.
- (f) Type and size of hammer and its stroke, or for double acting hammers the number of blows per minute.
- (g) Type and condition of packing on the pile head, and of the dolly or follower.
- (h) Sequence of driving in pile groups.
- (i) Actual location and any apparent deviation from design location and inclination.
- (j) Any other relevant information.

Make suitable provision in the records for the names and signatures of your personnel responsible for driving and testing the piles and for verifying its conformity with the specification requirements.

6 TEST PILES

6.1 GENERAL

Drive Test Piles at locations nominated on the Drawings as "Test Piles".

For each pile group, drive all Test Piles BEFORE making up any of the remaining steel pile segments in that group.

For Test Piles which are also Representative Piles, comply also with the requirements of Clause 7.

HOLD POINT

Process Held:	Driving of each Test Pile.
Submission Details:	Notification of the time and location of the driving of each Test Pile at least one working day prior to commencing.
Release of Hold Point:	The Principal will attend the site of each Test Pile and may inspect arrangements for monitoring prior to authorising the release of the Hold Point.

Record the number of blows per metre for Test Piles over the whole driven length. For the last ten blows, record the final Set in mm and the average Temporary Compression per blow.

Perform Dynamic Testing over the whole driven length and record data for analysis from the start to the end of driving.

Unless specified otherwise, carry out a restrrike test in accordance with Clause 14.3 after a minimum period of 24 hours. Where restriking a pile is carried out, the driving parameters achieved must be equal to or better than those measured at the end of driving and the distribution of resistance along the pile must be effectively unchanged. Where these criteria are not met, submit the driving records to the Principal and take such action as directed by the Principal.

Notwithstanding that a Test Pile may have achieved the required pile resistance and the required Minimum Penetration Depth, the Principal may require further driving of the Test Pile.

6.2 CONFIRMATION OR ALTERATION OF PILE LENGTHS

On completion of driving of the Test Piles, submit to the Principal the driving records and Dynamic Testing reports of the Test Piles.

Allow three working days for the Principal to consider your submission and instruct the lengths of piles to be made up. Refer also to Clause 10.2.

7 REPRESENTATIVE PILES

Drive Representative Piles at locations nominated on the Drawings as "Representative Piles".

HOLD POINT

Process Held:	Driving of each Representative Pile.
Submission Details:	Notification of the time and location of the driving of each Representative Pile at least one working day prior to commencing.
Release of Hold Point:	The Principal will attend the site of each Representative Pile and may inspect arrangements for monitoring prior to authorising the release of the Hold Point.

Record the number of blows per metre for Representative Piles over the whole driven length. For the last ten blows, record the final Set in mm and the average Temporary Compression per blow.

Perform Dynamic Testing over the whole driven length and record data for analysis from the start to the end of driving.

Unless specified otherwise or accepted by the Principal, the Set must be in the range of 3 mm to 10 mm per blow at the end of the driving so that the full pile resistance is mobilised and can be measured using Dynamic Testing equipment.

Unless specified otherwise, carry out a restrike test in accordance with Clause 14.3 after a minimum period of 24 hours. Where restriking a pile is carried out, the driving parameters achieved must be equal to or better than those measured at the end of driving and the distribution of resistance along the pile must be effectively unchanged. Where these criteria are not met, submit the driving records to the Principal and take such action as directed by the Principal.

The driving energy and Set corresponding to the required pile resistance must be the driving parameters for the driving of piles represented by the Representative Pile.

Where Calculated Set and the basis for its calculation are shown on the Drawings, these are indicative only and are not to be used as the driving parameters.

The required pile resistance is deemed to be achieved if Nominal Refusal is reached prior to the required resistance, as measured by Dynamic Testing, and subsequent Wave Equation Analysis indicates that the required pile resistance has in fact been achieved.

Notwithstanding that a Representative Pile may have achieved the required pile resistance and the required Minimum Penetration Depth, the Principal may require further driving of the Representative Pile.

Where more than one Representative Pile is used to represent a pile, the required Set may be obtained by linear interpolation between the resistance versus Set curves.

Where there is any reason to believe that the geotechnical conditions are not essentially uniform, the Principal may nominate additional piles to be Representative Piles and determine which piles are represented by those piles.

8 DRIVING EQUIPMENT AND METHOD

8.1 GENERAL

Without limiting the requirements of Specification TfNSW G22, prior to bringing any piling equipment or plant to the site, provide drawings and calculations certified by a Chartered Professional Engineer with membership of Engineers Australia practising in the field of geotechnical engineering (or equivalent) of any working platforms or supports required to keep the piling rig stable and safe during piling operations at the site.

An equivalent to membership of Engineers Australia would be an Engineer registered on the National Engineering Register (NER) in the general area of practice of Civil Engineering and experienced in the geotechnical assessment of the stability and safety of working platforms or supports for piling rig during piling operations.

8.2 DRIVING EQUIPMENT

Piles may be driven with diesel, steam, compressed air or drop hammers or a combination of these. Clutch operated drop hammers must not be used.

The piling hammer must be capable of achieving the specified Net Driving Energy. Drop hammers must be of sufficient mass to achieve the Net Driving Energy with a drop of not more than two metres.

The driving equipment must be capable of producing a consistent driving energy with a variation of less than 10% between piles at equivalent stages of driving.

Maintain the equipment including packing so that whenever measurements are made to determine the driving resistance including restriking, the Net Driving Energy will not differ by more than 10% from that used to establish the driving parameters.

Replace the packing regularly to maintain efficient cushioning of the driving force.

8.3 DRIVING METHOD

Unless specified otherwise or approved otherwise by the Principal, the method of driving must be in accordance with AS 2159 and the requirements of this Specification.

Prior to commencing piling operations on site, submit to the Principal certification, including calculations, by a Chartered Professional Engineer with membership of Engineers Australia practising in the field of Civil or Structural Engineering (or equivalent), verifying that under the proposed setting-up and site conditions, the equipment nominated will be used within its safe working capacities.

An equivalent to membership of Engineers Australia would be an Engineer registered on the National Engineering Register (NER) in the general area of practice of Civil or Structural Engineering.

HOLD POINT

Process Held:	Setting up of piling frame and driving of all piles, including Test Piles and Representative Piles.
Submission Details:	Details of the proposed driving equipment and method together with certification, including calculations, by a Chartered Professional Engineer with membership of Engineers Australia practising in the field of Civil or Structural Engineering (or equivalent), verifying that under the proposed setting-up and site conditions, the equipment nominated will be used within its safe working capacities.
Release of Hold Point:	The Principal will consider the details and certification submitted, prior to authorising the release of the Hold Point.

8.4 USE OF PRE-BORING

Pre-boring may be used to assist in attaining the Minimum Penetration Depth specified.

Where pre-boring to nominated depths is shown on the Drawings, the cost of pre-boring must be included in the rate for Item (f) in Annexure B61/B. Where pre-boring is not shown on the Drawings but is directed by the Principal, the costs of the pre-boring will be borne by the Principal.

Pre-boring may be carried out at your discretion in a manner not detrimental to the pile performance, in which case the costs of the pre-boring will be borne by you.

In all cases where pre-boring is used, submit details of your proposed pre-boring equipment and methods including pre-boring diameter in the PROJECT QUALITY PLAN. Notify the Principal if you require to change the pre-boring diameter.

The depth of pre-boring must not exceed the Minimum Penetration Depth specified.

Determine the depth of pre-boring by trial and error during the pre-boring of Test Piles/Representative Piles where such piles are specified. Otherwise, determine the depth of pre-boring by trial and error during the actual driving of piles.

Carry out pre-boring of the second and third Test Piles/Representative Piles using information derived from the driving and Dynamic Testing of the first and second Test Piles/Representative Piles respectively.

If the sides of the pre-bored hole are not self supporting, provide temporary support for the hole.

To ensure that the pile is properly supported laterally and will develop skin resistance in the pre-bored hole, before driving, backfill any space remaining between the pile and the sides of the pre-bored hole with a suitable granular material, and compact by flooding the granular material. Remove any temporary support after the pre-bored hole has been backfilled.

Record the diameter, use of any temporary support and reduced level (RL) of the bottom of all pre-bored holes as part of the pile driving record.

Extend as necessary, at your cost, any pile which, in the Principal's opinion, requires extending due to excessive pre-boring.

9 MINIMUM AGE OF PILES BEFORE DRIVING

Do not drive concrete pile segments, including segments extended in accordance with Clause 12, until:

- (i) at least 7 days after the specified 28 day structural strength of the concrete in the pile has been achieved; or
- (ii) the pile concrete maturity exceeds 4,750°C.hrs for normal temperature curing or 350°C.hrs for heat accelerated curing, plus 7 days,

but in either case, no earlier than 14 days after their casting.

10 DRIVING OPERATION

10.1 GENERAL

Your Piling Supervisor must supervise and control the driving at all times.

During all driving operations, the driving equipment, procedures and parameters must be in accordance with the procedures established during driving of the Test Pile/Representative Pile. At the end of driving and during restriking, the Net Driving Energy delivered to the pile must be within 10% of that used at the end of driving and restriking of the appropriate Test Pile/Representative Pile.

Confirm during driving using the records of the driving of the Test Pile/Representative Pile that the pile is being driven in the same manner, using the records of number of blows per metre, Penetration and Temporary Compressions.

If driving operations cease for any reason other than to perform a restrike test, then upon recommencement of driving, allow the striking of a minimum of 30 blows at the required Net Driving Energy before assessing whether the pile has met the required driving criteria.

At all times during the driving operation, adjust the driving equipment such that the blow of the hammer is directed centrally and axially on the pile head.

10.2 PILE LENGTHS

The lengths of the concrete pile segments must be as shown on the Drawings.

Make up any variations in overall pile lengths by varying the length of the steel pile segments.

At all times, make up not more than two steel pile segments in advance of the pile being driven, unless directed otherwise by the Principal.

HOLD POINT

Process Held:	Make up of the first three steel pile segments for piles represented by a Test Pile.
Submission Details:	Driving records of the Test Pile including restrike test results.
Release of Hold Point:	The Principal will consider the driving records of the Test Pile and will confirm or alter the pile lengths shown on the Drawings, prior to authorising the release of the Hold Point.

HOLD POINT

Process Held:	Making up of the fourth and each subsequent steel pile segment for piles represented by a Test Pile.
Submission Details:	Driving records of piles driven previously within the group of piles represented by a Test Pile.
Release of Hold Point:	The Principal will consider the driving records of the piles and will confirm or alter the pile length shown on the Drawings of the next pile, prior to authorising the release of the Hold Point.

10.3 RESTRICTION ON STRESSES AND NET DRIVING ENERGY DURING DRIVING

During driving, including testing and restriking of piles, ensure at all times that the driving stresses do not exceed those for installation specified in AS 2159, and that the Net Driving Energy does not exceed the Maximum Net Driving Energy shown on the Drawings, unless otherwise approved by the Principal.

Avoid damage to the pile caused by excessive stresses during driving. Initially limit the Net Driving Energy to no more than half of the required Net Driving Energy and the pile Set to no greater than 10 mm per blow. Then gradually increase the energy, ensuring at all times that the Set of the pile does not exceed 25 mm per blow when the driving is between one half and the full required Net Driving Energy.

Should damage to the pile be likely during driving, modify the driving procedure further so as to prevent damage from occurring.

In the case of a diesel hammer, the initial Net Driving Energy may need to be limited to the free fall of the hammer.

10.4 DRIVING OF PILES

WITNESS POINT

Process to be Witnessed:	Driving of each pile.
Submission Details:	Notification of the time and location of the driving of each pile at least one working day prior to commencing.

During pitching, lift and support piles at the positions on the pile shown on the Drawings.

During the initial stages of driving, do not bend or spring piles into position but effectively hold and guide the pile.

At all stages of driving, ensure that the pile frame does not exert any undue lateral force on the pile using frequent checks. Do not use significant horizontal force to correct any tendency for the pile to run off line. At all times, ensure that the pile is not restrained against rotation about its longitudinal axis.

Any pile with a concrete pile segment that exhibits permanent cracks greater than 0.1 mm wide or splits during driving or becomes damaged in any way is considered to be nonconforming.

If, during driving, the steel pile segment is damaged to the extent that further driving is not possible, investigate the causes of the damage and prove that damage has not occurred elsewhere in the pile, and that the pile is still capable of performing its designed function. Otherwise, extract the pile immediately and replace it with a sound pile at your expense, unless the cause of the damage was outside your control.

If damage has not occurred elsewhere in the pile, the damaged length of the steel pile segment may be cut out and repaired using a spliced length of identical H-section steel pile in accordance with Clause 11 and driving continued. In these circumstances, cutting out and restoring the pile to its correct length will be at your own expense unless the cause of this was outside your control. You may use a suitable off-cut length of undamaged H-section steel pile for this purpose.

Where the pile driving equipment is altered, test the driving equipment to determine the relationship between the operation of the equipment and the Net Driving Energy at the head of the pile. Such a test will be at your own expense.

Where there is reason to believe that the Net Driving Energy differs by more than 10% from the Net Driving Energy measured during driving at equivalent stages of the Test Pile/Representative Pile, the Principal may direct that additional dynamic tests be carried out to re-establish driving criteria.

In this instance, if the test shows that the Net Driving Energy at the head of the pile differs by more than 10% from the Net Driving Energy measured during driving at equivalent stages of the Test Pile/Representative Pile, then you must bear the full cost of the test and of any retest, after modification of the driving equipment or system, and of any other costs. Otherwise, payment will be made in accordance with Item (k) in Annexure B61/B.

If the required pile resistance or Nominal Refusal is obtained before the Minimum Penetration Depth is reached and rock is not encountered, prior to driving any other piles, amend the driving method as necessary to reach the Minimum Penetration Depth without damaging the piles.

HOLD POINT

(For piles not founded in rock and if the Minimum Penetration Depth is not achieved)

Process Held: Driving of any further piles.

Submission Details: Details of the amended driving method, together with certification that the amended driving method is likely to result in achieving the Minimum Penetration Depth before the required pile resistance is obtained.

Release of Hold Point: The Principal will consider the submitted documents and may carry out further surveillance and audit, prior to authorising the release of the Hold Point.

Where it is uncertain that the piles have been driven in the same manner as the Test Piles/Representative Piles; where driving has been interrupted prematurely, or a check on pile resistance needs to be made, or for any other reason, the Principal may require a restrike test to be made in accordance with Clause 14, with payment in accordance with Item (k) in Annexure B61/B.

11 SPLICING OF STEEL PILE SECTIONS

A steel pile segment may be lengthened by splicing on an additional length of identical steel H-section.

Splice the steel stub in the concrete pile segment to the steel pile segment in accordance with the details shown on the Drawings.

Unless specified otherwise, the welded connection for the splices must be full penetration butt welds over the whole steel cross-section, carried out in accordance with Clause 2.3.5.

12 EXTENDING CONCRETE PILE SEGMENT

A concrete pile segment may be extended after completion of driving by casting a cast-in-place reinforced concrete extension to it. This extension must conform to Specification TfNSW B80.

The connection at the extension must be capable of developing the full structural and bending capacity of the pile.

Any welding of reinforcement carried out as part of the extension must be in accordance with TfNSW B203 and to the manufacturer's recommendations. Do not weld tendons.

The extension must be of the same cross-sectional dimensions as the connected section. Concrete used must have the same minimum 28 day compressive strength as that specified for the connecting section. The concrete durability exposure classification must be as shown on the Drawings.

Unless nominated otherwise by you and accepted by the Principal, the following applies:

- (a) The number and size of reinforcing bars in the extension must provide at least the same strength as the original concrete pile segment. The location of the reinforcing bars in the extension must be similar to the location of the bars in the original concrete pile segment.;
- (b) The lap length of reinforcement, and prestressing strands where required, must conform to AS 5100.5.

Provide certification from a Chartered Professional Engineer with membership of Engineers Australia practising in the field of civil or structural engineering (or equivalent), verifying that the cast-in-place extension and connection conform to the requirements of this Clause.

Where a pile is extended by extending the reinforcement/tendons only and does not require casting of a cast-in-place concrete extension, this must be paid in accordance with Item (h) in Annexure B61/B.

13 CUTTING OFF AND STRIPPING OF PILES

HOLD POINT	(On the completion of the driving of each pile)
Process Held:	Cutting off and stripping or extending a pile after completion of driving.
Submission Details:	Driving records and survey report showing the alignment and plan position of the pile. Certification by the Piling Supervisor that the pile has been driven in accordance with this Specification.
Release of Hold Point:	The Principal will consider the details submitted, prior to authorising the release of the Hold Point.

Do NOT use explosives for the cutting off and stripping operations. Use only hand held equipment.

The methods used to cut off and strip the pile must not result in spalling, cracking and/or scoring of the face of the pile below the cut-off level and damage to the reinforcement and stressing tendons along their full final length. The top of the pile after cutting must be undamaged, sound, free of laitance and any loose material and must have a profile with surface roughness not less than 3 mm.

The stripping must expose the longitudinal reinforcement (and/or strands) for the stress development lengths shown on the Drawings. If they are not shown on the Drawings, the stress development lengths must conform to AS 5100.5 for the development of the yield strength of bars in tension.

Where bars (or strands) of different diameters are used the stripped length must be equal to the longest of the individual requirements.

14 DYNAMIC TESTING

14.1 GENERAL

Carry out Dynamic Testing in accordance with this Clause and AS 2159 using an approved organisation with approved equipment using an approved dynamic testing system, with subsequent wave equation analysis or signal matching carried out using an approved computer program, all as listed in the “Lists of TfNSW Approved Bridge Components and Systems” at:

<http://www.rms.nsw.gov.au/business-industry/partners-suppliers/documents/tenders-contracts/listofapprovedbridgecomponentssystems.pdf>

14.2 PROCEDURE

Use the following testing procedure:

- (a) Attach four bolt-on transducers to the pile at a minimum of 1.5 times the maximum pile width, below the head of the pile in accordance with the requirements of the system supplier.
- (b) Following the connection of the transducers to the analyzer, strike the pile with sufficient energy to verify the required pile resistance.

To avoid pile damage, immediately report to the Piling Supervisor if the allowable driving stresses could be exceeded at any time during the driving.

Record the driving stresses, measured pile resistance, Nominal Driving Energy, measured Net Driving Energy and Set.

The relationship between Net Driving Energy and Set determined from a dynamic test is valid only for the specific combination of hammer, helmet, cushion, pile rake, pile size, pile material and founding material.

14.3 RESTRIKE TEST

When a restrike test is required, consider only the first 20 blows at the beginning of the driving to be part of the restrike test. Measure the driving parameters at the required Net Driving Energy on blow numbers 6 to 15 inclusive.

The acceptance criteria for a restrike test on a pile are that the driving parameters achieved must be equal to or better than those measured at the end of driving and the distribution of resistance along the pile must be effectively unchanged. Where these criteria are not met, submit the driving records to the Principal and take such action as directed by the Principal at the Principal's cost.

14.4 DYNAMIC ANALYSIS

Analyse the dynamic test results for each pile tested. Analyses must include full Dynamic Analysis using measured field parameters of the test data (e.g. CAPWAP) and resistance versus Set curves (e.g. GRLWEAP analysis), when requested by the Principal, showing a minimum of six (6) different resistances and the corresponding blowcounts.

14.5 REPORT

Provide to the Principal two copies of a report for each pile tested including:

- (a) Complete PDA (or approved equivalent) output for all blows, including driving stresses and Net Driving Energy;
- (b) CAPWAP (or approved equivalent) analyses for selected blows;
- (c) When requested by the Principal, GRLWEAP (or approved equivalent) output in the form of resistance versus set curves giving the true pile resistance for specific driving energies, using data measured during driving;
- (d) Certification that the tested pile has been driven in accordance with this Specification. If it is not possible for this certification to be provided due to nonconformities in the driving or the driven pile, provide instead an itemised nonconformity report together with the proposed disposition.

ANNEXURE B61/A – (NOT USED)

ANNEXURE B61/B – PAYMENT

Refer to Clause 1.2.1.

The Lump Sum covers all activities required to construct piling to the resistance shown on the Drawings, plus the value of work under the Provisional Quantity work included in the Schedule of Prices.

In the Schedule of Prices accompanying the Lump Sum Tender, the cost of piling, including Test Piles and Representative Piles, is divided into the following items (similar items must be separately provided for each size of pile):

(a) Supply of Steel Pile Sections

This item includes the cost of supply and delivery of steel pile sections in the stock lengths given on the Drawings or in the Specification. The unit is per metre. The quantity is the total length of the stock lengths of steel pile sections.

The “per metre of pile length” rate included in the Schedule of Prices may be used by the Principal in accordance with the Conditions of Contract for the purpose of valuing variations due to changes of the pile lengths instructed under Clause 6.2 which necessitate additional stock lengths of steel pile sections to those given on the Drawings or the Specification.

(b) Manufacture of Steel Pile Segments

This item includes the cost of manufacture of steel pile segments to the lengths given on the Drawings. The unit is per pile.

The rate includes:

- (i) the cost of any splices required to make up each full length of pile to suit the Contract Levels;
- (ii) the cost of splicing of the steel stub from the concrete pile segment onto the steel pile segment; and
- (iii) the cost of cutting off a stock length of steel pile section to give the length as shown on the Drawings or altered length authorised by the Principal as per Clause 10.2.

(c) Supply and Fitting of Reinforcing Plates for Pile Toes

This item applies only when reinforcing plates for pile toes are shown on the Drawings. The unit is per pile.

(d) Splicing of Steel Pile Segments - Provisional Quantity

Where this item is included in the Schedule of Prices, payment for splices, in accordance with Clause 11, between H-section steel pile lengths (including the supply of all materials but not including the H-section steel pile lengths) will be made at the tendered rate for this item. The unit of measurement is per splice.

This item is only applicable where the pile is lengthened by the Principal under Clause 6.2, and such lengthening necessarily requires an additional welded splice.

(e) Manufacture and Delivery of Concrete Pile Segments

This item includes the cost of supply, manufacture and delivery of concrete pile segments of the lengths shown on the Drawings. The unit is per metre. The quantity is the total length of concrete pile segments shown on the Drawings.

(f) Driving of Composite Piles

This item includes all costs associated with driving composite piles of the number and lengths shown on the Drawings. The units are per pile and per metre of pile length (Provisional Quantity). The quantities are the total number and total length of piles shown on the Drawings.

Payment for pre-boring will be in accordance with Clause 8.4.

The per metre of pile length (Provisional Quantity) rate included in the Schedule of Prices may be used by the Principal in accordance with the Conditions of Contract for the purpose of valuing adjustments to the Contract Price due to changes of the pile lengths instructed under Clause 6.2.

(g) Cutting Off and Stripping of Piles

This item includes all costs associated with the cutting off and stripping of piles in accordance with Clause 13, including disposal of cut off pile lengths and stripped materials. The unit is per pile.

(h) Extending Steel Reinforcement into Pile Cap - Provisional Quantity

This item applies to extending the steel reinforcement into pile caps or abutment headstocks by butt welding or other approved method, when the projecting reinforcement after stripping is shorter than the specified development length. The unit of measurement is per pile.

(i) Extending of Concrete Pile Segments - Provisional Quantity

Where this item is included in the Schedule of Estimated Quantities, payment for all activities under Clause 12, including supply of all materials, will be made at the tendered rates for this item (except where pile is extended as a result of excessive pre-boring). The units of measurement and payment are:

- (i) per pile extended; and
- (ii) per metre of extended pile length.

(j) Dynamic Testing of Test Piles/Representative Piles for Resistance

This item includes mobilisation and Dynamic Testing in accordance with Clause 14 for each Test Pile/Representative Pile to determine the Net Driving Energy and Set at the required resistance. The unit of measurement is per pile tested.

(k) Dynamic Testing of Piles to Verify Dynamic Data - Provisional Quantity

This item includes Dynamic Testing or restrrike testing in accordance with Clause 14 when testing is instructed by the Principal to verify the Net Driving Energy delivered by the driving equipment or other Dynamic Data in accordance with Clauses 5.2, 7 or 10.4. The unit of measurement is per pile tested.

Payment is subject to the provisions of Clause 10.4.

(l) Dynamic Testing of Individual Piles for Resistance - Provisional Quantity

This item includes the cost of Dynamic Testing in accordance with Clause 14 of individual piles in accordance with Clause 5.3.1 (c), the cost of which will be borne by you if pile lengths supplied differ from those instructed under Clause 6.2, but otherwise this testing will be paid for at the tendered rate for this item.

ANNEXURE B61/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.2.

C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS

Clause	Type	Description
6.1	Hold	Driving of each Test Pile
7	Hold	Driving of each Representative Pile
8.3	Hold	Setting up of driving frame and driving of all piles, including Test Piles and Representative Piles
10.2	Hold	Making up of the first three steel pile segments for the piles represented by a Test Pile.
10.2	Hold	Making up of the fourth and each subsequent steel pile segment for piles represented by a Test Pile.
10.4	Witness	Driving of each pile
10.4	Hold	Driving of any further piles (for piles not founded in rock and Minimum Penetration Depth is not achieved)
13	Hold	Cutting off and stripping or extending a pile after completion of driving

C2 SCHEDULE OF IDENTIFIED RECORDS

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

Clause	Description of Identified Record
2.3.3	Materials test reports
2.3.5	Details of H-pile steel pile splices, welding procedures and welder qualifications
6.2	Driving records of each Test Pile
7	Driving records for each Representative Pile
10.4	Driving records and survey report for each pile
12	Engineer's certification of conformity of pile extension and connection
14.5	Dynamic Testing report for each tested pile

ANNEXURE B61/D – PLANNING DOCUMENTS

Refer to Clause 1.2.3.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. Review the requirements of this Specification and other contract documents to determine any additional documentation requirements.

- (a) repair and replacement procedures for defective steel pile materials (refer to Clause 2.3.4);
- (b) welding procedures and welder qualifications (refer to Clause 2.3.5);
- (c) application of protective treatment, if required (refer to Clause 2.3.6);
- (d) pile driving record sheets (refer to Clause 5.6);
- (e) driving equipment including the pile hammer, pile helmet, cushion assembly, pile driving rig, crane, leaders and/or other equipment proposed for lifting and driving the piles and for positioning and supporting the piles during driving (refer to Clause 8.2);
- (f) pile driving method (refer to Clauses 8.3 and 10);
- (g) proposed pre-boring diameter, and details of the equipment and methods to be used for pre-boring (refer to Clause 8.4);
- (h) pile lifting method (refer to Clause 10.4); and
- (i) Dynamic Testing organisation and system, and field testing personnel (refer to Clause 14).

ANNEXURES B61/E TO B61/K – (NOT USED)**ANNEXURE B61/L – FREQUENCY OF TESTING**

Refer to Clause 1.2.4.

Clause	Characteristic analysed	Use Test Method in	Minimum Frequency of Testing
2.2	Concrete for piles	TfNSW B80	TfNSW B80
5.5	Pile position	TfNSW Q Annexure Q/K	Each pile
6, 7	Pile resistance by Dynamic Testing	Clause 14	Each Test Pile or Representative Pile
11	Weld quality	TfNSW B201	Each welded splice

ANNEXURE B61/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.5.

TfNSW Specifications

TfNSW G22	Work Health and Safety (Construction Work)
TfNSW Q	Quality Management System
TfNSW B30	Excavation and Backfill for Bridgeworks
TfNSW B80	Concrete Work for Bridges
TfNSW B110	Pretensioned Precast Concrete Members
TfNSW B201	Steelwork for Bridges
TfNSW B203	Welding of Steel Reinforcement

Australian Standards

AS 2159	Piling - Design and installation
AS/NZS 3678	Structural steel – Hot-rolled plates, floorplates and slabs
AS/NZS 3679	Structural steel
AS/NZS 3679.1	Hot-rolled bars and sections
AS/NZS 3679.2	Welded I sections
AS 5100	Bridge design
AS 5100.5	Part 5: Concrete