

NEW ZEALAND ADDENDUM

ICE SPECIFICATION FOR PILING AND EMBEDDED RETAINING WALLS (THIRD EDITION)

A COLLABORATIVE INDUSTRY REFERENCE DOCUMENT THAT HAS BEEN
COMPILED AND PUBLISHED BY THE STRUCTURAL ENGINEERING SOCIETY
NEW ZEALAND (INC) AND THE NEW ZEALAND GEOTECHNICAL SOCIETY



This Document must be read in conjunction
with the Institution of Civil Engineers publication
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THE CONTENTS OF THIS DOCUMENT ARE INTENDED TO MODIFY
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PART A

A INTRODUCTION

The following amendments modify the Introduction in SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

Introduction	
Paragraph 7	<p><i>Delete and replace with:</i></p> <p>“The SPERWall New Zealand Addendum (SPERWall NZA) document sets out amendments to the SPERWall Third Edition to make such document relevant and applicable for use in the New Zealand construction industry. The SPERWall NZA must be read in conjunction with SPERWall. All users of the SPERWall NZA must purchase a legal copy of the SPERWall document from the Institution of Civil Engineers (ICE) at www.icevirtuallibrary.com. It is intended that SPERWall in conjunction with SPERWall NZA is used in the New Zealand construction industry for the specification of piling and embedded retaining walls for medium to large sized civil engineering and building projects. Specifiers should refer to SPERWall and SPERWall NZA so that their standard clauses need not be reproduced for every contract. Specifiers can make specific amendments to SPERWall and/or SPERWall NZA via the use of a project specification containing the relevant amendment details.</p> <p>Herein the use of the term SPERWall NZA shall mean both the SPERWall and SPERWall NZA documents.”</p>
Paragraph 8	<p><i>Delete:</i></p> <p>“SPERWall”</p> <p><i>Replace with:</i></p> <p>“SPERWall NZA”</p> <p><i>Delete second sentence and replace with:</i></p> <p>“Every reasonable effort has been made to avoid conflict between SPERWall NZA and common contract forms such as NZS 3910, NZS 3916 and the NEC.”</p>
Paragraph 9	<p><i>Delete first sentence and replace with:</i></p> <p>“There are many New Zealand, Australian, United States and European standards, both design and execution codes, that work in parallel with SPERWall NZA.”</p>
Paragraph 10	<p><i>Delete first sentence and replace with:</i></p> <p>“SPERWall NZA document has been designed for use with common practices, but is not intended to inhibit innovation.”</p>
Table 1.1	<p><i>Delete and replace with:</i></p>

Table 1.1 Some Standards relevant for piling and embedded wall works in New Zealand

Type of Standard	Standard Reference No.	Title
Design, Execution and Testing	AS 2159	Piling – Design and installation
Execution	BS 1536	Execution of special geotechnical work – bored piles
Execution	BS 1537	Execution of special geotechnical work – ground anchors
Execution	BS 1538	Execution of special geotechnical work – diaphragm walls
Execution	EN 12063	Execution of special geotechnical work – sheet piles
Execution	EN 12699	Execution of special geotechnical work – displacement piles
Execution	EN 12715	Execution of special geotechnical work – grouting
Execution	EN 12716	Execution of special geotechnical work – jet grouting
Execution	EN 14199	Execution of special geotechnical work – micropiles
Execution	EN 14475	Execution of special geotechnical work – reinforced fill
Execution	EN 14490	Execution of special geotechnical work – soil nailing
Execution	EN 14679	Execution of special geotechnical work – deep mixing
Execution	EN 14731	Execution of special geotechnical work – ground treatment deep vibro
Execution	EN 15237	Execution of special geotechnical work – vertical drainage
Testing ISO (various parts)	EN 22477	Testing of piles – various types of pile testing
Manufacture	12794	Precast concrete products – foundation piles
Execution	ISO 18674-1 to 9	Geotechnical Investigation and Testing – Various
Execution	SESOC/NZGS	Construction Specification – Bored and Driven Piles

Note that the above standards, codes or guidance documents have not been reviewed for compatibility with New Zealand practice and are provided for informational purposes only. Any standards or codes or guidance documents that are specifically referenced within a Part B or Part C document shall take precedence over the documents listed in Table 1.1.

A01 GENERAL REQUIREMENTS

The following amendments modify General requirements in Part A of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

General requirements	
A1 Introduction	<p><i>Delete:</i> “SPERWall”</p> <p><i>Replace with:</i> “SPERWall NZA”</p> <p><i>Add:</i> Herein the use of the term SPERWall NZA shall mean both the SPERWall and SPERWall NZA documents.</p>
A1.1 Ground conditions	<p><i>Delete second paragraph and replace with:</i> “The SI comprises a desk study and ground investigation (GI). A comprehensive GI comprising appropriate geotechnical and geoenvironmental fieldwork and laboratory testing should be carried out and reported in accordance with NZ Ground Investigation Specification (https://www.nzgs.org/libraries/nz-ground-investigation-specification/) or AS 1726 -Geotechnical site investigations.”</p>
A2 Contractual considerations	<p><i>Delete second paragraph and replace with:</i> “The evolution from an effective design to a finished scheme requires a contract which reflects the objectives of the parties and meets the needs of the scheme. There are a number of standard contractual options available, such as NZS 3910, NZS 3916, New Engineering Contract (NEC3) or the International Federation of Consulting Engineers (FIDIC). Bespoke contracts are also common in New Zealand for larger projects or frameworks.”</p> <p><i>Delete third paragraph and replace with:</i> “Further information can be found at relevant websites such as</p> <p>https://www.standards.govt.nz/</p> <p>www.neccontract.com</p> <p>http://fidic.org”</p>
A2.1 Specification roles	<p><i>Delete first paragraph and replace with:</i> “Within this document reference is made to the roles of the ‘employer’, ‘contract administrator’, ‘designer’ and the ‘contractor’ as this document is to cover various contractual forms. The ‘contract administrator’ is assumed here to have full delegated powers to control the contract and is acting on behalf of the ‘employer’ (under NZS 3910, NZS 3916 and FIDIC this would be the ‘engineer’, and under NEC3 this would be the project manager). The two main parties to the contract are the ‘employer’ and the ‘contractor’.”</p> <p><i>Delete sixth paragraph and replace with:</i> “Where piling or embedded walling works are executed under a contract which is not governed by either NZS 3910, NZS 3916, NEC3 or FIDIC conditions, the project specification should state which entities are to be nominated for the roles above.”</p>
A2.2 Competency	<p><i>Delete first paragraph and replace with:</i> “Under NZS 3910 and NZS 3916, it is a requirement that key representatives who are involved with the contract are competent.”</p> <p><i>Delete third paragraph and replace with:</i> “For piling and embedded walling works it is crucial that the employer appoints lead professionals with appropriate knowledge, understanding and experience. One source, among others, for such people is the Engineering New Zealand register for Chartered Professionals (https://www.engineeringnz.org/public-tools/find-engineer/).”</p>

General requirements	
A2.3 Temporary and permanent works	<p><i>Delete fifth paragraph and replace with:</i> “Further New Zealand specific guidance on temporary works can be found on found on the Temporary Works Forum NZ website (see www.engineeringnz.org/join-us/groups/temporary-works-forum-nz/);”</p>
A3 Health and safety	<p><i>Delete first paragraph and replace with:</i> “Piling is potentially a dangerous activity and employers, designers and contractors must work to reduce the risks so far as is reasonably practicable, in compliance with New Zealand law. Equal consideration should be given to appropriately eliminate or mitigate short and long-term health and safety risks.”</p>
A3.1 Legislation	<p><i>Delete first paragraph and replace with:</i> “The design and construction of the works shall be carried out in accordance with the current requirements of New Zealand law. Of particular relevance is the Health and Safety at Work Act, which places specific requirements on employers, designers and contractors.”</p> <p><i>Delete second paragraph and replace with:</i> “One of the primary aims of the Health and Safety at Work Act is to ensure designers consider the health and safety implications of their designs throughout the lifetime of the works from construction, through operation and maintenance, to demolition. This aim is as relevant to the design of piles and embedded retaining walls as any other part of construction.”</p> <p><i>Delete third paragraph and replace with:</i> “There is a significant body of legislation that is applicable to the health and safety of persons involved with or affected by the execution of the contract, which is typically more specific in nature. Examples include:</p> <ul style="list-style-type: none"> • Safety in Design • Temporary Works • Working at Heights • Crane ACOP • Load Lifting and Rigging ACOP • Excavation Safety”
A3.2 Risk management	<p><i>Delete first paragraph and replace with:</i> “Risk is the combination of the probability of a hazard event and its consequences.”</p> <p><i>Delete fifth paragraph and replace with:</i> “Some sectors have prescribed risk assessment methodology for which there is specific industry guidance that must be followed.”</p>
A3.2.1 Risk identification and assessment	<p><i>Delete second paragraph and replace with:</i> “There are many ways to undertake risk assessment (e.g. AS/NZS ISO 3100: 2009 Risk Management Principles and Guidelines) and each project shall identify the most appropriate method. As a minimum, a qualitative assessment of risk shall be undertaken in order to gain an appreciation of the relative importance of the various issues and to inform the risk management strategy.”</p>
A3.2.2 Risk communication	<p><i>Delete first paragraph and replace with:</i> “It is important that risk is clearly understood, and the terms defined in AS/NZS ISO 3100 are recommended.”</p>
A3.3 Health and safety plan	<p><i>As per SPERWall</i></p>

General requirements	
A3.4.4 Working platforms	<p><i>Delete second paragraph and replace with:</i> “The design, installation, use, maintenance and removal of working platforms is expected to be managed, just as any other temporary works, in accordance with the recommendations of Temporary Works forum NZ (see www.engineeringnz.org/join-us/groups/temporary-works-forum-nz/). Given the specialist nature of the works, the following specific considerations should be made.”</p> <p><i>Delete fourth paragraph and replace with:</i> “The working platform shall be designed by a competent person with appropriate geotechnical expertise, taking account of the specific site conditions and piling plant that is to be used. A Working Platform Certificate (see www.engineeringnz.org/join-us/groups/temporary-works-forum-nz/), or similar, should be used to identify responsibilities and confirm that the working platform has been properly designed, constructed in accordance with this design, and will be adequately maintained and repaired to ensure the integrity of the platform throughout its working life.”</p> <p><i>Delete sixth paragraph and replace with:</i> “Designs should be in line with best practice as per the recommendations of Temporary Works forum NZ (see www.engineeringnz.org/join-us/groups/temporary-works-forum-nz/).”</p> <p><i>Delete seventh paragraph.</i></p>
A4.1 Overall quality management framework	<p><i>Delete first paragraph and replace with:</i> “As a means of ensuring a basic level of record-keeping and auditability, the employer should require both the designer and contractor to work within an appropriate quality management system. In NZ, on larger projects, a quality management system is usually established in accordance with AS/NZSISO 9001. The employer should ensure that details of both the designer’s and the contractor’s systems are provided prior to commencement of work.”</p>
A4.2 Project records	<p><i>Delete first paragraph and replace with:</i> Specifiers should be aware of the Building Information Modelling (BIM) process. In NZ, ‘BIMinNZ’ are the ‘driving force’ of this emerging technology. All stakeholders are encouraged to consider the recommendations of BIMinNZ as outlined in their website https://www.biminnz.co.nz/.</p>
A5.3 Embodied carbon	<p><i>Add new third paragraph:</i> “In NZ the Project emissions estimation tool (PEET) (NZ Transport Agency Waka Kotahi) may function as an acceptable alternate to the above.”</p>
A5.4 Geothermal	<p><i>Delete first paragraph and replace with:</i> “In order to improve the sustainability of a project, technologies may be incorporated that minimise operational emissions of GHGs. The use of geothermal piles as a part of this process is now an established solution overseas, noting due consideration of Resource Management Act requirements in New Zealand.”</p>
A6.2.2 Methods of procurement of contractors	<p><i>Delete first bullet item and replace with:</i></p> <ul style="list-style-type: none"> • employ a specialist contractor directly in the absence of other contractors on the site. The specialist contractor will therefore have full responsibility for this site, and will be nominated as principal contractor.”
A6.5.2 Tender health and safety plan	<p><i>Delete first sentence and replace with the following:</i> “The contractor shall submit a health and safety plan with the tender if required by the Conditions of Tendering. This will be detailed in the Conditions of Tendering and may include:”</p>

PART B

B1 SPECIFICATION REQUIREMENTS FOR PILING AND EMBEDDED RETAINING WALLS

The following amendments modify Section B1 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

B1 Specification requirements	SPERWall Page No.	
B1.1 Standards	21	<i>Delete first paragraph and replace with:</i> “All materials and workmanship shall be in accordance with the relevant standards, codes of practice, guidelines and all other relevant documents which are specified in this addendum. All such documents shall be the current publication at the date of tender submission.”
B1.2 Project specification	21	<i>As per SPERWall.</i>
B1.3 Submission of information	21	<i>As per SPERWall.</i>
B1.4 Design	22	<i>As per SPERWall.</i>
B1.5 Materials	28	<i>As per SPERWall.</i>
B1.6 Safety	28	<i>As per SPERWall.</i>
B1.6.1 Standards	28	<i>As per SPERWall.</i>
B1.6.2 Working platform	28	<i>As per SPERWall.</i>
Table B1.2	28	Delete Table B1.2 and replace with Table B1.2 provided at end of this amendment.
B1.7 Ground conditions	30	<i>As per SPERWall.</i>
B1.8 Installation tolerances	30	<i>Delete paragraph and replace with the following:</i> “Table B1.4 provides the minimum installation tolerances for piles and embedded retaining walls and achievable tolerances for construction using special techniques. Unless specified elsewhere, the vertical elevation of the pile top following any trimming and preparation to pile cut-off level shall be constructed to within plus 25 mm or minus 25 mm from the vertical elevation shown on the drawings. The minimum tolerances shall be adopted unless otherwise required by the project specification.”
B1.8.1 Setting out	30	<i>As per SPERWall.</i>
B1.8.2 Forcible corrections to piles	30	<i>As per SPERWall.</i>
B1.9 Waterproofing of embedded walls	30	<i>As per SPERWall.</i>
B1.9.1 Inspections	30	<i>As per SPERWall.</i>
B1.9.2 Repair	32	<i>As per SPERWall.</i>
B1.10 Construction method	32	<i>As per SPERWall.</i>
B1.10.1 Obstructions and voids	32	<i>As per SPERWall.</i>
B1.10.2 Dimensions of piles and wall elements	33	<i>As per SPERWall.</i>
B1.10.3 Concrete casting level tolerances	33	<i>As per SPERWall.</i>

B1 SPECIFICATION REQUIREMENTS FOR PILING AND EMBEDDED RETAINING WALLS

B1 Specification requirements	SPERWall Page No.	
B1.10.3.1 Concrete piles or walls constructed in accordance with sections B3, B6 or B10	33	<i>Add the following footnotes to Table B1.5 as they are missing from SPERWall: * Beyond $H = 10\text{m}$, the casting tolerance applying to $H = 10\text{m}$ shall apply. ** In cases where a pile is cast so that the cut-off level is within a permanent lining tube, or for a wall, the appropriate tolerance is given by deleting the casing term $C/8$.</i>
B1.10.3.2 Concrete piles or walls constructed in accordance with sections B4, B5 or B6	33	<i>As per SPERWall.</i>
B1.11 Construction programme	34	<i>As per SPERWall.</i>
B1.12 Records	34	<i>As per SPERWall.</i>
B1.12.1 Records of the works		
B1.12.2 Piling and/or embedded wall as-built records	34	<i>Add: "All information reported with respect to depth shall include the reduced level of the referenced datum to allow conversion to the reduced level in the project vertical datum."</i>
B1.13 Nuisance and damage	34	<i>As per SPERWall.</i>
B1.13.1 Noise and disturbance	34	<i>As per SPERWall.</i>
B1.13.2 Damage to adjacent structure	34	<i>As per SPERWall.</i>
B1.13.3 Damage to completed piles or embedded wall elements	40	<i>As per SPERWall.</i>
B1.13.4 Temporary support to piles	40	<i>As per SPERWall.</i>
B1.14 Driving piles	41	<i>As per SPERWall.</i>
B1.14.1 Driving procedures and re-drive checks	41	<i>As per SPERWall.</i>
B1.14.2 Performance of driving equipment	41	<i>As per SPERWall.</i>
B1.14.3 Set	41	<i>Delete last paragraph and replace with: "The set shall be recorded as the penetration in millimetres per blow averaged over ten blows dropped from a constant drop height."</i>
B1.14.4 Driving sequence and risen piles	42	<i>As per SPERWall.</i>
B1.14.5 Pre-boring	42	<i>As per SPERWall.</i>
B1.15 Supervision and control of the works	42	<i>As per SPERWall.</i>
B1.16 Non-conformances	42	<i>As per SPERWall.</i>
B1.17 Trimming and cutting off piles and wall elements	42	<i>As per SPERWall.</i>

B1 Specification requirements	SPERWall Page No.	
<p>B1.18 Definitions</p>	<p>42</p>	<p><i>Delete definition of Downdrag and replace with the following:</i> “produces a time-dependent change in loading conditions, and is caused by the settlement of soils relative to the completed pile shaft. It can result from a number of factors including:</p> <ul style="list-style-type: none"> • significant depths of recently placed fill causing ongoing settlements of the underlying soils or the fill itself. The SI should, if possible, identify the age of any fill since this affects the prediction of any likely future settlements • floor loads from the proposed structure causing settlement of the underlying deposits • ongoing secondary consolidation of soft alluvial deposits and organic soils • reductions in water table resulting in consolidation settlement, although this may also improve the bearing capacity of piles in cohesionless soils • seismic-induced settlement. <p><i>Delete definition of Geotechnical design report and replace with the following:</i> “a report, as defined in BS EN 1997-1. In New Zealand, the use of the terms Geotechnical Factual Report (GFR) and Geotechnical Interpretive Report (GIR) are also used.”</p> <p><i>Delete definition of Geotechnical investigation report and replace with the following:</i> “a report, as defined in BS EN 1997-1. In New Zealand, the use of the terms Geotechnical Factual Report (GFR) and Geotechnical Interpretive Report (GIR) are also used.”</p> <p><i>Delete definition of Load and replace with the following:</i> “a force applied to a pile under test or in service. For SPERWall purposes, equivalent to an action as defined in BS EN 1990, BS EN 1991, BS EN 1997-1 and BS EN 1997-2. For SPERWall NZA purposes, equivalent to an action as defined in AS 2159-2009.”</p> <p><i>Delete definition of Partial resistance factors and replace with the following:</i> “for SPERWall purposes, the factors applied to actions or resistances as defined in BS EN 1997-1. For SPERWall NZA purposes, the factors applied to actions or resistances as defined in NZS 1170, AS 2159-2009 and the NZTA/Waka Kotahi Bridge Manual.”</p> <p><i>Delete Preliminary pile</i></p> <p><i>Delete definition of Representative action and replace with the following:</i> “for SPERWall purposes, is defined by BS EN 1990 as the value of the action used for the verification of a limit state. For SPERWall NZA purposes, is defined by AS 2159-2009 as the value of the design action effect used for the verification of a limit state.”</p> <p><i>Delete Safe pile capacity</i></p> <p><i>Delete definition of Specified representative action and replace with the following:</i> “for SPERWall purposes, the representative action is defined in BS EN 1990 clause 6.3.1 and the specified representative action is $F_{rep} = G_k + Q_{rep}$. For SPERWall NZA purposes, the representative action is defined in AS 2159-2009 clause 1.3.5 and the specified representative action is the SLS and ULS design loads as defined in Table B1.2.”</p> <p><i>Delete Specified working load (SWL)</i></p> <p><i>Add:</i> “Design SLS load: the axial design load under serviceability limit state actions that is associated with an allowable pile head settlement so that the structure can perform its intended function.</p> <p><i>Add:</i> “Design settlement under SLS load: the allowable pile head settlement under a specified SLS load so that the structure can perform its intended function.</p> <p><i>Add:</i> “Design ULS load: the axial design load under ultimate limit state actions that must not result in geotechnical failure of the pile nor excessive settlement leading to partial or full structural collapse.</p> <p><i>Add:</i> “Design settlement under ULS load: the pile head settlement that can be accommodated with acceptable structural performance at the ultimate limit state.</p>

Table B 1.2 Performance specification criteria for piles

Pile ref.	Permitted type(s) – performance specification Section no.	Pile designation	Design SLS load ¹	Design settlement under SLS load ²	Design ULS load ³	Design settlement under ULS load ²	Geotechnical strength reduction factor ⁴	Design verification load DVL ⁵	Minimum pile length from cut-off level to toe ⁶	Minimum or maximum pile diameter or dimensions of cross-section
			kN	mm	kN	mm			m	mm

Notes:

- ¹ Equal to the design load under serviceability limit state actions (also called design serviceability load), Eds per AS 2159–2009, or equivalent if adopting another standard.
- ² Refers to tolerable settlement providing acceptable structural performance that will be project specific.
- ³ Equal to the design load under ultimate limit state actions, E_g per AS 2159-2009, or equivalent if adopting another standard.
- ⁴ Calculate per AS 2159-2009 to account for the nature of the site, the available site information, the pile design and installation procedures, and pile testing if undertaken.
- ⁵ DVL should be test loads to verify SLS and ULS load-settlement performance (denoted as P_s and P_g respectively in AS 2159-2009), or to measure the ultimate geotechnical strength (denoted as P_u in AS 2159-2009) if this is the purpose of the test. Maximum settlement (deflection) at P_s and P_g shall be in accordance with Table 8.4.3.1 in AS 2159-2009, noting that for helical steel piles (screw piles), maximum deflection at P_g shall be $\frac{P_g L}{AE} + 10 + 0.1d_i$ (where L = pile length; A = Area of pile cross-section, E = Young's modulus of pile; d_i = helix diameter) to account for greater deflection (relative to other pile types) when loading screw piles attributed to deflection of the helix plate to develop resistance (as discussed in Practice Note 28 – Screw Piles: Guidelines for Design, Construction & Installation by IPENZ dated 2015).
- ⁶ In New Zealand, seismic loading often features when considering design requirements, particularly the connection between the pile and the substructure. Due consideration of sufficient pile embedment length to resist significant lateral (inertial and kinematic) seismic loading can also apply. Examples of seismic-derived loads for pile design in New Zealand are:
 - a. Tensile axial load (ULS or overstrength)
 - b. Compressive axial load (ULS or overstrength)
 - c. Lateral inertial load (and the proportion of it to be applied in conjunction with kinematic loads)
 - d. Kinematic loads derived from lateral soil displacement (cyclic and lateral spreading soil displacement).

B2 DRIVEN PRECAST CONCRETE PILES

The following amendments modify Section B2 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

B2 Specification requirements	SPERWall Page No.	
B2.1 General	62	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “This section applies to piles which are installed in the ground without excavation or removal of material from the ground except for limiting heave and/or limiting vibration as well as removal of obstructions or to assist penetration. Piles are driven into the ground using impact, vibration, pressing, screwing or a combination of these methods. All material and work shall be in accordance with sections B1, B2, and B21 of this specification.”</p>
B2.2 Project specification	62	<i>As per SPERWall.</i>
B2.3 Materials	62	
B2.3.1 Compliance with standard	62	<p><i>Delete:</i> “BS EN 12794”</p> <p><i>Replace with:</i> “NZS 3101”</p>
B2.3.2 Pile Joints	62	<p><i>Delete:</i> “BS EN 12794”</p> <p><i>Replace with:</i> “AS2159 Clause 5.2.4”</p>
B2.3.3 Pile Shoes	62	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “The Engineer shall confirm the project specific pile shoe requirements.”</p>
B2.3.4 Pile Head Reinforcement	62	<p><i>Delete:</i> “BS EN 12794”</p> <p><i>Replace with:</i> “AS2159 Clause 5.3”</p>

B2 Specification requirements	SPERWall Page No.	
B2.3.5 Pile Quality	62	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “A certificate of quality shall be provided by the manufacturer. As a minimum, this shall include the following information:</p> <ul style="list-style-type: none"> (a) Name and registered address of the producer. (b) Identification number of the unit or date of casting of the lot (to ensure traceability). (c) The year in which the pile has been produced. (d) The Precast NZ certification number for the production facility. (e) The joint type for segmental piles. (f) Compressive strength of the concrete. (g) Ultimate yield strength of the reinforcing steel. (h) Tensile yield strength of the reinforcing steel. (i) Certified mill test report for the reinforcing steel. (j) Ultimate tensile strength of the prestressing steel. (k) Tensile 0.1 proof stress of the prestressing steel. (l) Critical dimensions. (m) Layout of reinforcement: central bar/ radial reinforcing. (n) Confirmation of the mix design and cover as specified. (o) Reference to technical information for relevant proprietary systems. (p) PS1 producer statement, where required. (q) PS2 producer statement, where required. (r) PS3 producer statement, where required. (s) PS4 producer statement, where required.”
B2.3.6 Marking of piles	62	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “Each foundation pile or pile segment shall be marked with the following:</p> <ul style="list-style-type: none"> (a) Markings indicating points of support during storage and transportation (b) Markings indicating hoisting points (c) Markings identifying the head and toe of the pile element (d) Markings indicating the pile joint type for segmental piles <p>Each foundation pile or segment shall also be labelled near the head with its identification number to ensure traceability and to refer to the supporting information provided in the certificate of quality.</p> <p>A manual shall also be provided by the manufacturer describing the meaning of the markings in addition to instructions on handling of the pile (or pile segments) during transportation, storage and handling on site.”</p>
B2.4 Construction Processes	62	
B2.4.1 Ordering of piles	62	<i>As per SPERWall.</i>
B2.4.2 Handling, transportation and storage of piles	62	<i>As per SPERWall.</i>

B2 DRIVEN PRECAST CONCRETE PILES

B2 Specification requirements	SPERWall Page No.	
B2.4.3 Driving of piles	62	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “Pile installation and procedures shall be in accordance with clause B1.14 and AS2159 Clause 7.3.3.</p> <p>The pile shall be fitted with a helmet during driving so as to uniformly distribute the hammer impact to the top of the pile. This shall include suitable hammer cushion placed between the hammer and the helmet to protect the hammer and a pile cushion placed between the helmet and the top of a precast concrete pile to protect the pile head from destructive direct impact.”</p>
B2.4.4 Strength of piles	62	<p><i>Delete:</i> “BS EN 12794”</p> <p><i>Replace with:</i> “AS2159 Clause 7.3.3.1”</p>
B2.4.5 Pile installation system	62	<i>As per SPERWall.</i>
B2.4.6 Performance of driving equipment	62	<i>As per SPERWall.</i>
B2.4.7 Length of piles	63	<i>As per SPERWall.</i>
B2.4.8 Repair and lengthening of piles	63	<i>As per SPERWall.</i>
B2.4.8.1 Repair of damaged pile heads	63	<i>As per SPERWall.</i>
B2.4.8.2 Lengthening of precast reinforced and pre-stressed concrete piles	63	<i>As per SPERWall.</i>
B2.4.8.3 Driving repaired or lengthened piles	63	<i>As per SPERWall.</i>
B2.4.9 Cutting off Pile Heads	63	<i>As per SPERWall.</i>
B2.5 Testing	63	<i>As per SPERWall.</i>
B2.6 Records	63	<i>As per SPERWall.</i>

B3 BORED CAST-IN-PLACE PILES

The following amendments modify Section B3 in Part B of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

B3 Specification requirements	SPERWall Page No.	
B3.1 General	65	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “This section applies to bored cast-in-place piles which are constructed with or without casing and support fluid if required.</p> <p>All material and work shall be in accordance with sections B1, B3, B20 and B21 of this specification and with reference to AS 2159 as the general standard adopted for piling design and installation that includes bored cast in-situ piles.”</p>
B3.2 Project specification	65	<p><i>Delete:</i> “(f) ribbed piles”</p> <p><i>Replace with:</i> “(f) grooved piles”</p> <p><i>Add:</i> “(i) Details of precast driven plugs”</p>
B3.3 Materials	65	
B3.3.1 Support Fluid	65	<i>As per SPERWall.</i>
B3.3.2 Casing	65	<i>Delete the first sentence of the first paragraph and replace with:</i> “Temporary casings shall be of a quality of material, length and thickness adequate for the purpose of preventing water and unstable soil from entering the pile excavations and of sufficient strength to enable its installation and full extraction.”
B3.4 Construction tolerances	66	
B3.4.1 Steel Reinforcement	66	<p><i>Add:</i> “Cages are to be fabricated in accordance with NZS3109 clause 3.9 tolerances.</p> <p>Where cross-hole sonic logging tubes are specified, to achieve reliable data collection care shall be taken to ensure the tubes are installed and adequately secured to the reinforcing cage to remain equidistant from one another over their length.”</p>
B3.4.2 Plunge columns	66	<i>As per SPERWall.</i>
B3.5 Construction Processes	66	
B3.5.1 Placing casing	66	<i>As per SPERWall.</i>
B3.5.2 Placing concrete	66	<i>As per SPERWall.</i>
B3.5.2.1 General	66	<i>As per SPERWall.</i>
B3.5.2.2 Consistency of concrete	66	<i>As per SPERWall.</i>

B3 Specification requirements	SPERWall Page No.	
B3.5.2.3 Placing concrete in dry bores	66	<p><i>Delete first paragraph and replace with:</i></p> <p>“A dry bore shall be defined as a bore with all of the following:</p> <ul style="list-style-type: none"> • the depth of water at the base of the pile at commencement of concrete placement less than 75 mm; • the inflow of water is less than 200mm of bore depth per hour, <p>unless a project-specific definition that considers the geotechnical, structural and durability design of the pile is agreed by the contract administrator prior to the commencement of the works.”</p> <p><i>Add new final paragraph:</i></p> <p>“Where a rigid delivery tube is not proposed then specific approval is required by the contract administrator.”</p>
B3.5.2.4 Placing concrete under water or support fluid	66	<p><i>Delete the second paragraph and replace with the following:</i></p> <p>Concrete to be placed under water or support fluid shall be placed by a full depth tremie in one continuous operation and shall not be discharged freely into the water or support fluid. The bottom end of the tremie shall be square to the axis of the tremie and its circumference shall be continuous.</p> <p><i>Insert new third and fourth paragraphs:</i></p> <p>“The tremie shall be equipped with a large enough hopper at its upper end to receive fresh concrete at sufficient discharge rate from the truck and to prevent spillage of concrete into the pile. For the placement of the first concrete, it is essential that the tremie pipe is continuously flowing full until at least 1.5 m of the pile bore is filled. Where concrete is pumped to the tremie, the hopper shall hold a minimum capacity of concrete to fill not less than 1.5 m of bore depth and should have a means of holding this concrete until ready for the initial discharge.”</p> <p>“A flexible tremie pipe of any type shall not be used down the pile. All pile concrete shall flow under gravity within the tremie from the hopper to the point of discharge within the pile. Under no circumstances shall concrete be pumped down any pile.”</p>
B3.5.3 Stability of pile bore	67	<i>As per SPERWall.</i>
B3.5.4 Pumping from pile bores	67	<i>As per SPERWall.</i>
B3.5.5 Continuity of construction	67	<p><i>Add:</i></p> <p>“Where appropriate the Designer shall include any specific limitations on the casing length and the time the bore is open prior to placement of concrete.”</p>
B3.5.6 Underreams	68	<i>As per SPERWall</i>
B3.5.7 Cleanliness of pile bases	68	<i>As per SPERWall.</i>
B3.5.7.1 General	68	<i>As per SPERWall.</i>
B3.5.7.2 Underreams	68	<i>As per SPERWall.</i>
B3.5.8 Inspection	68	<i>As per SPERWall.</i>
B3.5.8.1 General	68	<p><i>Delete:</i></p> <p>“Each pile bore which does not contain support fluid shall be inspected from the ground surface”</p> <p><i>Replace with:</i></p> <p>“Each pile bore which does not contain water or support fluid shall be inspected from the ground surface”</p>
B3.5.8.2 Underreams	68	<i>As per SPERWall.</i>
B3.5.9 Extraction of casing	69	<i>As per SPERWall.</i>

B3 BORED CAST-IN-PLACE PILES

B3 Specification requirements	SPERWall Page No.	
B3.5.9.1 General	69	<i>As per SPERWall.</i>
B3.5.9.2 Concrete level	69	<i>As per SPERWall.</i>
B3.5.10 Protection to pile bores	70	<i>As per SPERWall.</i>
B3.5.11 Shaft or base grouting	70	<i>As per SPERWall.</i>
B3.5.11.1 Grouting of piles	70	<i>As per SPERWall.</i>
B3.5.11.2 Method of grouting	70	<i>As per SPERWall.</i>
B3.5.11.3 Grout system	70	<i>As per SPERWall.</i>
B3.5.11.4 Pile uplift	71	<i>As per SPERWall..</i>
B3.5.11.5 Grout testing	71	<i>As per SPERWall..</i>
B3.5.11.6 Grout tube decommissioning	71	<i>As per SPERWall.</i>
B3.5.12 Placing of plunge columns	71	<i>As per SPERWall.</i>
B3.5.13 Driven Precast Plugs	71	<p><i>Add new section:</i></p> <p>“Where a pile is to be constructed of a steel casing driven to full depth and excavated dry or under water followed by the use of a permanent steel encased precast plug driven into the in-situ soil through the base, the following shall apply:</p> <ul style="list-style-type: none"> • Excavation shall only be carried out to the level identified on the project drawings • Base cleaning shall be in accordance with B3.5.7. • Plug installation including lifting, handling, transporting and storing of plugs shall be such as to ensure that plugs are not damaged. The plug shall be carefully lowered into the casing. The lowering method shall ensure that no components protrude above the surface of the top plate once in position. • Plug driving procedures shall be in accordance with B1.14 • Plug driving in submerged conditions shall be carried using a suitable wet driving hammer or long tubular mandrel hammer with consideration given to drag and hydraulic cushioning effects. The driving method shall be submitted to the contract administrator for approval 5 days before commencement of plug driving. • The plug shall be driven out of the base of the casing until the specified resistance is achieved or the plug position has reached its specified minimum engagement inside the casing. Where the plug has reached its minimum engagement length and the specified resistance has not been achieved, driving of the plug shall cease and the contractor shall advise the contract administrator. <p>Where driven precast plugs are to be used, the following requirements shall be provided in the project specification as appropriate:</p> <ul style="list-style-type: none"> • Dimensions of the precast driving plug • Minimum steel thickness and grade for plug casing and top plate • Minimum concrete strength • Minimum engagement length • Design ultimate geotechnical resistance • Excavation depth relative to the casing toe level <p>When plug driving is carried out with the full height of the hammer stroke in air, the Hiley formula included in Appendix C of the SESOC/NZGS Piling Specification shall be used to assess ultimate plug resistance.</p>

B3 BORED CAST-IN-PLACE PILES

B3 Specification requirements	SPERWall Page No.	
B3.5.13 Driven Precast Plugs (continued)	71	<p>When plug driving is carried with the full height of the hammer stroke below water level inside the casing (submerged driving), a modified wet driving Hiley formula shall be used to assess ultimate plug resistance (see C3.5.13).</p> <p>The maximum drop for submerged methods should be as below unless otherwise agreed with the contract administrator:</p> <ul style="list-style-type: none"> • Wet driving hammer - 3m • Tubular hammer - 4.5m • Static mandrel - 2m (top driven)/ 2.5m (bottom driven) <p>To verify the variables associated with using drop hammers for submerged driving, the contractor shall, by means of high-speed video monitoring of the above ground portion of the hammer or a follower, measure the velocity of the hammer at impact. The measurement of velocity at impact shall be used to produce calculated value of effective free fall height for their selected drop hammer. An alternative approved method of measurement may be used. The methodology for the measurement and calculation shall be submitted to the contract administrator for approval 5 days before commencement of plug driving.</p> <p>This shall be carried out on the first pile for each combination of hammer and pile size unless otherwise agreed with the contract administrator. Results shall be provided to the contract administrator within 2 working days. The contract administrator may request this to be carried out where they consider the proposed hammer may not be achieving the calculated drop efficiency.”</p> <p>On completion of plug driving, base cleanliness shall be in accordance with B3.5.7.</p>
B3.6 Records	71	
B3.6.1 Records of piling	71	<i>As per SPERWall.</i>
B3.6.2 Grouting records	71	<i>As per SPERWall.</i>

B4 PILES CONSTRUCTED USING CONTINUOUS FLIGHT AUGERS OR DISPLACEMENT AUGERS

The following amendments modify Section B4 in Part B of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

B4 Specification requirements	SPERWall Page No.	
B4.1 General	80	<p><i>Delete:</i> "All materials and work shall be in accordance with Sections B1, B4 and B21 of this specification and BS EN 1536."</p> <p><i>Replace with:</i> "All material and work shall be in accordance with sections B1, B2, and B21 of this specification and with reference to AS 2159 as the general standard adopted for piling design and installation that includes CFA bored piles."</p>
B4.2 Project specification	80	<p><i>As per SPERWall.</i></p> <p><i>Add:</i> (g) detailed method statement</p>
B4.3 Materials	80	
B4.3.1 Steel Reinforcement	80	<i>As per SPERWall.</i>
<i>Insert</i> B4.3.2 Concrete	80	Refer B21.
B4.4 Construction Processes	80	
B4.4.1 Boring	80	<i>As per SPERWall.</i>
B4.4.2 Sealing the base of the auger	81	<i>As per SPERWall.</i>
B4.4.3 Removal of augers from the ground	81	<i>As per SPERWall.</i>
B4.4.4 Use of air during boring	81	<i>As per SPERWall.</i>
B4.4.5 Depth of piles	81	<i>As per SPERWall.</i>
B4.4.6 Placing Concrete	81	<i>As per SPERWall.</i>
B4.4.6.1 General		
B4.4.6.2 Commencement of concrete supply to each pile	81	<i>Add:</i> For a bottom discharge auger there is no requirement to re-insert the auger back to the base of the pile.
B4.4.6.3 Rate of supply of Concrete	82	<i>As per SPERWall.</i>
B4.4.6.4 Interruption in concrete supply	82	<i>As per SPERWall.</i>
B4.4.7 Splitting of Augers	82	<i>As per SPERWall.</i>

B4 PILES CONSTRUCTED USING CONTINUOUS FLIGHT AUGERS

B4 Specification requirements	SPERWall Page No.	
B4.4.8 Placing of reinforcement	82	<p><i>Delete and replace with the following:</i></p> <p>"Spoil on top of the concrete pile shall be suitably cleaned off and removed to expose fresh, clean concrete at ground surface for cage to be inserted.</p> <p>All reinforcement shall be placed with the minimum delay after the completion of the concreting operation.</p> <p>Reinforcement shall be placed and maintained in position at the specified level with a tolerance of +150mm/-50mm (i.e. a maximum of 150mm high) or, if agreed, at the commencing surface level.</p> <p>Where reinforcement is made up into cages, they shall be sufficiently rigid to enable them to be handled and plunged vertically into the pile without damage/distortion. Suitable spacers shall be used to ensure minimum concrete cover is maintained along the full length of the cage while it is plunged. These shall be spaced at quarter points around the perimeter of the cage and there shall be no more than 3m vertical spacing between spacer sets.</p> <p>To assist insertion of cage to the design depth the use of a small vibratory drive head, or other mechanical means of a consistent force to result in a steady penetration into the concrete may be used in agreement with the contract administrator.</p> <p>If the reinforcement cage cannot be placed to the specified depth, the cage must be removed and the pile re-augered and re-concreted unless agreed with the contract administrator.</p> <p>Where self-compacting concrete is used, cage vibrators are not permitted. If standard pumpable concrete is used, cage vibrators may be used."</p>
B4.4.9 Continuity of construction	83	<i>As per SPERWall.</i>
B4.4.10 Monitoring system for pile construction B4.4.10.1 Automated Monitoring System	83	<p><i>Delete:</i></p> <p>"the mast of the piling rig shall have increments marked at 0.5m intervals over its full height and the metre measurements shall be marked numerically".</p> <p><i>Add:</i></p> <p>Pile number as shown on the Drawings; and</p> <p>Vertical height telemetry should be calibrated every time the machine is rigged up before starting.</p>
B4.4.10.2 Manual monitoring system	84	<i>As per SPERWall.</i>
B4.4.10.3 Target boring and concreting parameters	84	<i>As per SPERWall.</i>
B4.4.10.4 Calibration	84	<p><i>Delete:</i></p> <p>"Equipment used for monitoring shall be calibrated at the start of the works and calibration certificates issued to the contract administrator prior to commencement of the piling."</p> <p><i>Delete:</i></p> <p>"The calibration certificate shall be available for inspection by the contract administrator at the commencement of the works."</p> <p><i>Add:</i></p> <p>Calibration certificates for the transducer that is used to pick up the concrete pump strokes is not required. If warranted, the engineer can be present during the pouring of the first pile to witness the calibration of the system.</p>
B4.5 Records	84	
B4.5.1 Records of Piling	84	<p><i>Delete:</i></p> <p>(l) depth of auger versus time.</p> <p><i>Add:</i></p> <p>(m) Reinforcing checks</p> <p>(n) Concrete delivery records</p>

B5 CAST-IN-SITU DISPLACEMENT PILES

The following amendments modify Section B5 in Part B of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

B5 Specification amendments	SPERWall Page No.	
B5.1 General	91	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “This applies to piles which are installed in the ground without excavation or removal of material from the ground except for limiting heave and/or limiting vibration as well as removal of obstructions or to assist penetration. Piles are driven into the ground using impact, vibration, pressing, screwing or a combination of these methods.</p> <p>All material and work shall be in accordance with sections B1, B5, and B21 of this specification.”</p>
B5.2 Project specification	91	<p><i>Insert:</i> “The specification of any driving plugs.”</p>
B5.3 Materials	91	<p><i>As per SPERWall.</i></p>
B5.3.1 Concrete general	91	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “Concrete shall comply with NZS 3109 and section B21. Mortar and grouts shall comply with section B21”</p>
B5.3.2 Pile Shoes	91	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> Pile shoes shall comply with AS 2159 clause 7.4.2</p>
B5.3.3 Concrete for use with base driving or for an enlarged base	91	<p><i>Delete:</i> “For a plug consisting of semi-dry concrete which is tamped during the installation of cast-in-place displacement piles, the cement content shall be specified with a minimum of 350 kg/m³ and the strength class shall be at least C25/30.”</p> <p><i>Replace with:</i> “For a plug consisting of semi-dry concrete which is tamped during the installation of cast-in-place displacement piles, the cement content shall be specified with a minimum of 350 kg/m³ and the with a minimum cylinder strength of 20MPa.”</p>
B5.3.4 Reinforcement	91	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “Reinforcement shall comply with NZS 3109”</p>
B5.4 Construction Processes	91	<p><i>As per SPERWall.</i></p>
B5.4.1 Temporary casing	91	<p>Delete the second sentence of the first paragraph and replace with: “They shall be of uniform cross-section throughout each continuous length and shall be of sufficient strength to withstand driving and ground forces and full extraction.”</p>
B5.4.2 Length of Piles	91	<p><i>As per SPERWall.</i></p>
B5.4.3 Driving Piles	91	<p><i>Delete and replace with:</i> “Pile installation and procedures shall be in accordance with the requirements of clause B1.14 and AS 2159.”</p>

B5 CAST-IN-SITU DISPLACEMENT PILES

B5 Specification amendments	SPERWall Page No.																
B5.4.4 Base Driving	91	<p><i>Add:</i></p> <p>“Where an aggregate plug is used it shall be a minimum depth of 1.5 times the diameter of the pile. The aggregate shall be a hard durable screened and washed aggregate with the following properties:</p> <table border="1"> <thead> <tr> <th>Gradation</th> <th>Sieve Size</th> <th>Percent Passing</th> </tr> </thead> <tbody> <tr> <td></td> <td>19 mm</td> <td>100</td> </tr> <tr> <td></td> <td>13.2 mm</td> <td>0 - 5</td> </tr> <tr> <td>Crushing Resistance</td> <td colspan="2">Less than 10% fines at 230 kN as per NZS4407 Test 3.10</td> </tr> <tr> <td>Solid Density</td> <td colspan="2">At least 2.60 as per NZS4407 Test 3.71</td> </tr> </tbody> </table> <p>The length of the driving plug shall not be greater than 4 m without the prior approval of the contract administrator.</p> <p>Where a precast concrete plug is driven at the base of the pile the end bearing capacity of the plug shall be demonstrated by dynamic testing in accordance with AS2159.”</p>	Gradation	Sieve Size	Percent Passing		19 mm	100		13.2 mm	0 - 5	Crushing Resistance	Less than 10% fines at 230 kN as per NZS4407 Test 3.10		Solid Density	At least 2.60 as per NZS4407 Test 3.71	
Gradation	Sieve Size	Percent Passing															
	19 mm	100															
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Crushing Resistance	Less than 10% fines at 230 kN as per NZS4407 Test 3.10																
Solid Density	At least 2.60 as per NZS4407 Test 3.71																
B5.4.5 Enlarged pile bases	91	<i>As per SPERWall.</i>															
B5.4.6 Repair of Damaged Pile Heads and Extension of Piles	91	<i>As per SPERWall.</i>															
B5.4.7 Inspection and Remedial Work	92	<p><i>Delete second paragraph and replace with the following:</i></p> <p>“Upon completion of driving, the interior of the pile shaft shall be inspected to verify its integrity prior to concrete placement. Unless agreed prior in writing with the contract administrator, in the event of water or foreign matter having entered the casing, the casing shall be withdrawn, repaired if necessary and re-driven or other action taken to continue the construction of the pile to meet the requirements of the project specification.”</p>															
B5.4.8 Placing concrete	92																
B5.4.9 Extraction of Casing	92	<i>As per SPERWall.</i>															
B5.4.10 Vibrating Extractors	92	<i>As per SPERWall.</i>															
B5.4.11 Concrete casting Tolerances	92	<i>As per SPERWall.</i>															
B5.4.12 Cutting off Pile Heads	92	<i>As per SPERWall.</i>															
B5.5 Records	92	<i>As per SPERWall.</i>															
B5.5.1 Record of Piling		<i>As per SPERWall.</i>															

B6 MICROPILES

The following amendments modify Section B6 in Part B of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

B6 Specification amendments	SPERWall Page No.	
B6.1 General	94	<i>Delete:</i> “BS EN 14199 and parts of BS EN 1536 where relevant.” <i>Replace with:</i> “AS2159 where relevant.”
B6.2 Project specification	94	<i>As per SPERWall.</i>
B6.3 Definitions and uses and types	94	<i>Add:</i> “Micropiles shall be generally designed for compressive and tensile load cases, with or without lateral loads. When the tensile load is greater than 65% of the compressive load, micropiles shall be designed as ground anchor elements.”
B6.4 Materials	94	
B6.4.1 Grout/mortar/concrete	94	<i>As per SPERWall.</i>
B6.4.2 Reinforcement	94	<i>As per SPERWall.</i>
B6.5 Construction processes	95	<i>As per SPERWall.</i>
B6.5.1 General		
B6.5.2 Installation of self-drilling hollow bar	95	<i>As per SPERWall.</i>
B6.5.3 Installation of rotary bored micropiles	95	<i>As per SPERWall.</i>
B6.5.4 Installation of SFA micropiles	95	<i>As per SPERWall.</i>
B6.6 Testing	95	<i>As per SPERWall.</i>
B6.7 Trimming	95	<i>As per SPERWall.</i>
B6.8 Records	96	<i>As per SPERWall.</i>

B7 HELICAL STEEL PILES

The following amendments modify Section B7 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

B7 Specification requirements	SPERWall Page No.	
B7.1 General	100	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “This section applies to Helical Steel Piles. For the purposes of this document, a ‘helical steel pile’ (or ‘screw pile’) is defined as a steel pile with one or more steel helix at the base, with the helices conforming to clause B7.3.3 of this specification. Piles using flat plates or ‘multi-turn’ helices are not included in this document.</p> <p>All materials and work shall be in accordance with sections B1 and B7 of this specification, AS 2159, NZS 3404 and NZS 3101.”</p>
B7.2 Project specification	100	<i>As per SPERWall.</i>
B7.3 Materials and fabrication	100	
B7.3.1 Compliance with standards	100	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “The materials of helical steel piles shall as a minimum comply with API5L, AS 1163, NZS 3678, NZS 3404 and NZS 3101 (if applicable).”</p>
B7.3.2 Inspection and test certificates	100	<i>As per SPERWall.</i>
B7.3.3 Manufacturing tolerances	100	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “Helices are to be mechanically pressed by suitable means to ensure a true helix is formed to meet the following criteria:</p> <ul style="list-style-type: none"> a) The pitch at the inside and outside of the helix must be equal ($\pm 4\%$ of flange width but no greater than 10mm). b) The gradient of the spiral should be constant. c) Any radial measurement across the helix should be perpendicular to the shaft ($\pm 4\%$ of flange width but no greater than 10mm). <p>When multiple helices are welded to a shaft, the plates shall be spaced at a multiple of the helix pitch.</p> <p>Permitted dimensional deviations shall comply with NZS 1163.”</p>
B7.4 Construction processes	100	
B7.4.1 Ordering of piles	100	<i>As per SPERWall.</i>
B7.4.2 Marking of piles	100	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “Each pile shall be labelled or marked to enable traceability in accordance with NZS 5131.”</p>
B7.4.3 Handling and storage of piles	100	<i>As per SPERWall.</i>

B7 Specification requirements	SPERWall Page No.	
B7.4.4 Installation of piles	100	<p><i>Delete and replace with:</i> "Pile installation and procedures shall generally comply with AS 2159.</p> <p>The installation procedure shall be such as to avoid damage to the piles. The installation of each pile shall be continuous until the required depth or defining torque requirement has been reached. In the event of unavoidable interruption to installation, pile installation may continue provided it can subsequently be installed to design depth and/or resistance without damage.</p> <p>Installation records shall be made for every pile using a data-logging system. This record shall contain:</p> <ul style="list-style-type: none"> (a) the type and torque rating of the torque motor used for installation (b) the recorded installation torque (c) the penetration rate (depth of penetration per revolution of pile). <p>The contractor shall inform the contract administrator immediately if an unexpected change in the driving characteristics is noted.</p> <p>The rotation speed during installation should not exceed 20 revolutions per minute. The rotation speed should be appropriate for the expected ground conditions and responsiveness of the installation equipment, and should be reduced where unacceptable penetration rates are observed.</p> <p>If pre-drilling is used to assist installation, the diameter of the pre-drill auger shall not exceed the pile shaft diameter. No material is to be removed within a distance of 4 times the helix diameter of the helix founding depth unless the methodology is replicated and proven by pile load testing and approved by the contract administrator and/or designer as appropriate.</p> <p>The diameter of any shaft extensions or oversized connections shall be constant or decrease with depth unless a collar splice connection applies in which case the collar diameter shall be no greater than the shaft diameter plus 25mm."</p>
B7.4.4.1 Installation Torque	101	<i>As per SPERWall.</i>
B7.4.4.2 Minimum torque	101	<i>As per SPERWall.</i>
B7.4.4.3 Maximum torque	101	<i>As per SPERWall.</i>
B7.4.4.4 Penetration rate	101	<p><i>Delete the first paragraph and replace with the following:</i> " The designer shall be informed should the rate of penetration fall outside of one helix pitch $\pm 15\%$ per revolution. In this event the pile capacity shall be reassessed by the designer. If the penetration rate falls below half the helix pitch per revolution, installation should cease, and the designer shall be informed immediately. Further advancement of an off-pitch pile should only proceed on instruction from the designer."</p>
B7.4.5 Extraction	101	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> "Piles should be extracted by unscrewing, in a similar manner to their installation.</p> <p>A pile shall not be re-used following extraction without confirmation by inspection that the pile condition is suitable to continue to provide the required strength and durability. The results of this inspection shall be noted on the piling record.</p> <p>"Where a removed pile is to be replaced, or a pile reduced in depth from its maximum penetration, the design engineer should assess the effect of the disturbed ground on the shaft friction, uplift capacity and end bearing of the new pile."</p>
B7.5 Protection against corrosion	101	<p><i>Delete and replace with:</i> "Hot dip galvanising shall conform to AS/NZS 4680."</p>

B7 HELICAL STEEL PILES

B7 Specification requirements	SPERWall Page No.	
B7.5.1 Hot dip galvanising for protection against corrosion	101	<i>Delete and replace with:</i> “ The renewal of any surfaces with damaged galvanising shall conform to AS/NZS 4680.”
B7.5.2 Coating helical piles for protection against corrosion	101	<i>As per SPERWall.</i>
B7.6 Welding procedures	101	<i>Delete and replace with:</i> “All welding, testing and inspection of welds shall be in accordance with NZS 1554.”
B7.6.1 Site welding	102	<i>Delete and replace with:</i> “All welding shall be in accordance with NZS 1554.”
B7.6.2 Non-destructive testing of welds	102	<i>Delete and replace with:</i> “Non-destructive testing of welds shall be in accordance with NZS1554.”
B7.7 Static load testing of helical piles	102	
B7.7.1 General	102	<i>As per SPERWall.</i>
B7.7.2 Lateral load testing	102	<i>As per SPERWall.</i>
B7.7.3 Test pile removal	102	<i>As per SPERWall.</i>
B7.8 Records	102	<i>Delete and replace with the following:</i> “All records shall be in accordance with clause B1.12, the project specification and AS 2159 Section 7.7. Records should include: (a) Date of installation of the pile. (b) Location and dimensions of the pile. (c) Depth installed. (d) Pile inclination. (e) The type and torque rating of the torque motor used for installation. (f) The recorded installation torque, at maximum 0.5m intervals. (g) Rate of penetration (distance travelled per revolution). (h) Details of any pile flighting / augering. (i) Depth and diameter of any pre-drilling. (j) Concrete infill docket. (k) Material certificates. (l) Welding quality. (m) Results of any onsite pile load testing.”
B7.9 Concrete Placement	102	<i>Add:</i> “Concrete shall be in accordance with section B21. Prior to concrete being poured, the base of the pile shall be checked for debris or water. If present, these shall be removed prior to placing concrete. The Contractor shall notify the Engineer if water has entered the pile during construction.”

B8 STEEL BEARING PILES

The following amendments modify Section B8 in Part B of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

B8 Specification requirements	SPERWall Page No.	
B8.1 General	106	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “This section applies to steel piles which are installed in the ground without excavation or removal of material from the ground except for limiting heave and/or limiting vibration as well as removal of obstructions or to assist penetration. Piles are driven into the ground using impact, vibration, pressing, screwing or a combination of these methods. This excludes bottom driven steel tubes (concrete filled) and tube piles (bored) with driven precast concrete plugs which are covered in Clause B5.</p> <p>All material and work shall be in accordance with sections B1, B2, and B21 of this specification.”</p>
B8.2 Project specification	106	<i>As per SPERWall.</i>
B8.3 Materials	106	
B8.3.1 Compliance with standards	106	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “The materials of steel piles shall as a minimum comply with the requirement of NZS 3404. Certified mill test reports, test certificates issued by the mill or independent test agencies shall be provided as evidence of compliance with the material supply standards referenced in NZS3404.</p> <p>Fabrication of steel piles shall comply with NZS 5131.”</p>
B8.3.2 Inspection and test certificates	106	<i>As per SPERWall.</i>
B8.3.3 Piles shoes	106	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “Pile shoes (if specified) shall be manufactured from durable material capable of withstanding the stresses caused by the installation method and ground conditions without damage.”</p>
B8.3.4 Manufacturing tolerances	106	<p><i>As per SPERWall.</i></p> <p><i>Add:</i> The rolling or manufacturing tolerances for steel casings or pipe piles shall be such that the actual weight of section does not differ from the theoretical weight by more than ±5%. The external diameter at any section, measured using a steel tape on the circumference, shall not differ from the theoretical diameter by more than ±1%.</p>
B8.3.5 Straightness of sections	106	<p><i>As per SPERWall.</i></p> <p><i>Add:</i> The deviation from straightness on any longitudinal face shall not exceed 1/600 of the length of the pile, nor 5 mm in any 3000 mm length.</p>

B8 Specification requirements	SPERWall Page No.	
B8.3.6 Fabrication of piles	106	<i>As per SPERWall.</i> <i>Add:</i> Steel casings and pipe piles shall be Engineer approved longitudinally or spirally welded steel or an approved substitute. Where steel casings or pipe piles are used as structural elements in a finished structure, they shall comply with the steel grade and other requirements as specified on the Drawings or Project Specific Requirements. The casing and pipe pile walls shall not have holes or weld discontinuities.
B8.4 Construction processes	107	
B8.4.1 Ordering of piles	107	<i>As per SPERWall.</i>
B8.4.2 Marking of piles	107	<i>As per SPERWall.</i>
B8.4.3 Handling of piles	107	<i>As per SPERWall.</i>
B8.4.4 Installation	107	<i>Delete:</i> This entire Clause shall be deleted. <i>Replace with:</i> “Pile installation and procedures shall be in accordance with AS2159 and Clause B1.14.”
B8.4.5 Pile strengthening	107	<i>As per SPERWall.</i>
B8.4.6 Pile installation system	107	<i>As per SPERWall.</i>
B8.4.7 Length of piles	107	<i>As per SPERWall.</i>
B8.4.8 Matching of tubular pile lengths	107	<i>As per SPERWall.</i>
B8.4.9 Matching of proprietary sections	107	<i>As per SPERWall.</i>
B8.4.10 Preparation of pile heads	108	<i>As per SPERWall.</i>
B8.4.11 Extraction	108	<i>As per SPERWall.</i>
B8.5 Coating piles for protection against corrosion	108	<i>As per SPERWall.</i>
B8.5.1 Definition	108	<i>As per SPERWall</i>
B8.5.2 Specialist labour	108	<i>As per SPERWall</i>
B8.5.3 Protection during coating	108	<i>Add:</i> “...unless otherwise approved by the Contract Administrator where outside conditions meet the requirements of the coating system.”
B8.5.4 Surface preparation	108	<i>Delete:</i> This entire Clause shall be deleted. <i>Replace with:</i> “(b) All surfaces to be coated shall be clean and dry and prepared in accordance with AS/NZS 2312 CI 4.2.2 and/or 4.2.3”
B8.5.5 Application of primer	108	<i>Delete:</i> “within four hours” <i>Replace with:</i> “as soon as reasonably practicable”
B8.5.6 Control of humidity during coating	108	<i>As per SPERWall.</i>
B8.5.7 Parts to be welded	108	<i>As per SPERWall.</i>
B8.5.8 Thickness, number and colour of coats	108	<i>Delete:</i> “BS EN ISO 12944” <i>Replace with:</i> “AS/NZS 2312”

B8 Specification requirements	SPERWall Page No.	
B8.5.9 Inspection of coatings	109	<p><i>Delete:</i> "BS EN ISO 12944"</p> <p><i>Replace with:</i> "AS/NZS 2312"</p> <p><i>Delete:</i> "BS EN ISO 2409"</p> <p><i>Replace with:</i> "AS/NZS 2312 Clause 9.8.10"</p>
B8.6 Welding procedures	109	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> "All welding, testing and inspection of welds shall be in accordance with NZS 1554"</p>
B8.6.1 Site Welding	109	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> "All welding, testing and inspection of welds shall be in accordance with NZS 1554. Welders shall be certified in accordance with the requirements of NZS 1554 and NZS 5131."</p>
B8.6.2 Offsite welding	109	<i>As per SPERWall.</i>
B8.6.2.1 Welded tubular piles	109	<i>As per SPERWall.</i>
B8.6.2.2 Welded box piles and proprietary sections	109	<i>As per SPERWall.</i>
B8.6.3 Non-destructive testing of welds	109	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> "All welding, testing and inspection of welds shall be in accordance with NZS 1554"</p>
B8.6.4 Standards for welds	110	<i>As per SPERWall.</i>
B8.6.4.1 Longitudinal welds in tubular piles	110	<p><i>Delete:</i> "Specification for Line Pipe 5L"</p> <p><i>Replace with:</i> "NZS 1554"</p>
B8.6.4.2 Longitudinal welds in proprietary box piles and proprietary sections	110	<i>As per SPERWall.</i>
B8.6.4.3 Circumferential welds	110	<p><i>Delete:</i>"Specification for Line Pipe 5L"</p> <p><i>Replace with:</i> "NZS 1554"</p>
B8.6.5 Site welded butt splices	110	
B8.6.5.1 Support and alignment of sections	110	<i>As per SPERWall.</i>
B8.6.5.2 Standards for site welds	110	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> "All welding, testing and inspection of welds shall be in accordance with NZS 1554"</p>
B8.6.5.3 Weld tests	110	<p><i>Delete:</i> "BS EN 5817"</p> <p><i>Replace with:</i> "NZS 1554"</p>
B8.6.5.4 Protection during welding	110	<i>As per SPERWall.</i>
B8.7 Records	110	<i>As per SPERWall.</i>

B9 DRIVEN TIMBER PILES

The following amendments modify Section B9 in Part B of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

B9 Specification requirements	SPERWall Page No.	
B9.1 General	113	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “This section applies to timber piles which are installed in the ground without excavation or removal of material from the ground except for limiting heave and/or limiting vibration as well as removal of obstructions or to assist penetration. Piles are driven into the ground using impact, vibration, pressing, jetting or a combination of these methods.</p> <p>All material and work shall be in accordance with sections B1, B9, and B21 of this specification.”</p>
B9.2 Project specification	113	<p><i>Add:</i> “(n) Number, location and requirements of trial piles (o) Type and number of pile tests (p) Timber hazard class in terms of NZS 3640”</p>
B9.3 Materials	113	
B9.3.1 Species /grade of timber	113	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “The species of timber shall be as stated in the project specification.</p> <p>The grade of timber shall be in accordance with NZS 3605 (for soft woods including medium and high-density Pinus Radiata) and AS1720 (for hardwoods).</p> <p>The timber shall be new and free from defects, decay, large loose or dead knots, undue shake, excessive sap, rot, pests, fungal or pest attack which may affect the strength or durability of piles.”</p>
B9.3.2 Sapwood	113	<i>As per SPERWall.</i>
B9.3.3 Tolerance in timber dimensions	113	<i>As per SPERWall.</i>
B9.3.4 Preservatives	113	<p><i>Add:</i> “All preservatives shall also comply with NZS 3605 and NZS 3640”</p>
B9.3.5 Certification of timber	113	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Add:</i> “Certificates of treatment shall be submitted to the Engineer for all treated timber prior to delivery to site.”</p>
B9.3.6 Pile shoes	113	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “The material and dimensions of the pile shoes, where required, shall be as specified.</p> <p>Where a pile shoe is used, it should be manufactured from durable material capable of withstanding the stresses caused by the installation method and ground conditions without damage.</p>
B9.4 Construction processes	114	

B9 Specification requirements	SPERWall Page No.	
B9.4.1 Inspection and stacking	114	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Add:</i> “The contractor shall notify the contract administrator of the delivery of the timber piles to the Site, and provide all labour and equipment to enable the Engineer to inspect each piece of timber on all faces, and to measure it, all at the time of delivery and prior to driving.</p> <p>Each timber pile shall be clearly marked prior to installation, with its number and overall length.</p> <p>All timber piles shall be safely stacked in lengths clear of the ground and to ensure no deformation occurs.</p> <p>All operations such as handling, transporting and pitching of piles shall be carried out in such a manner as to prevent damage to piles.”</p>
B9.4.2 Treatment with preservative	114	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “Unless specified otherwise in the Project Specific Requirements timber piles shall be treated to TPC Brand H6 in accordance with NZS3640.</p> <p>Cutting and boring of timber shall be done as far as practicable before preservative treatment, but where this is impracticable, any piles that are cut or notched after pressure treatment shall be well dried and brush treated with a suitable preservative, in accordance with NZS3605.</p> <p>Certificates of treatment shall be submitted to the contract administrator for all treated timber. The type and method of treatment shall be compatible with the type of timber and the use to which the timber so treated is to be put.”</p>
B9.4.3 Pile shoes	114	<p><i>Add:</i> “The pile shoe dimensions shall not exceed the pile end dimensions.”</p>
B9.4.4 Pile heads	114	<p><i>Delete the first sentence and replace with:</i> “The pile head shall be flat and at right angles to the axis of the pile. When timber piles are installed by driving, the heads shall be cut off square to expose sound timber and to within ± 20 mm of the levels specified on the drawings.”</p> <p><i>Add:</i> “Unless noted otherwise in the Project Specific Requirements, all portions of cut off pile heads shall become the property of the Contractor and shall be removed from the site.”</p>

B9 Specification requirements	SPERWall Page No.	
B9.4.5 Splicing	114	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “Piles shall be provided in one piece unless specified otherwise or agreed prior in writing by the Engineer.</p> <p>If the piles are to be spliced, the splice shall be capable of resisting any stresses which may develop during lifting, pitching, driving or under the action of the design loads in the completed structure. The position and details of the splice shall be reviewed and approved in writing by the Engineer prior to driving of piles.</p> <p>Splices shall be made using two timbers of the same cross-sectional dimensions, each cut at right angles to its axis, to make contact over the whole of the cross section when the two pile sections are aligned. All splice details shall be approved by the Engineer and if appropriate may consist of a steel spike or a steel tube for round piles or steel box section for rectangular piles. The steel connectors shall be bolted, screwed, or spiked to the timbers to ensure that the ends of the timbers are kept in close contact. The axial alignment of the two timber sections shall not vary by than 10 mm from a 1000 mm straightedge. The requirements for corrosion protection of steel joining elements are detailed in the Project Specific Requirements.</p> <p>Alternative splice details (e.g. pinned or mitred connection) may be adopted provided they comply with Clause 5.6.2 of AS2159.</p>
B9.4.6 Length of piles	115	<i>As per SPERWall.</i>
B9.4.7 Spliced piles	115	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “Spliced piles shall be observed continuously during driving to detect any departure from true alignment. If any such departure occurs, driving shall be suspended, and the contract administrator shall be notified.”</p>
B9.4.8 Preparation of pile heads	115	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “All pile heads shall be flat and perpendicular to the axis of the pile. No timber pile head shall be cut off without the approval of the Engineer.</p> <p>Unless noted otherwise in the Project Specific Requirements, all portions of cut off pile heads shall become the property of the Contractor and shall be removed from the site.</p> <p>After driving, the piles shall be cut off square to within 20mm of the levels shown on the drawings and the cut surfaces shall be treated in accordance with NZS 3605.”</p>
B9.4.9 Driving piles	115	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “Pile installation and procedures shall be in accordance with AS 2159 and clause B1.14.”</p>
B9.5 Records	115	<i>As per SPERWall.</i>

B10 DIAPHRAGM WALLS AND BARRETTES

The following amendments modify section B10 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

B10 Specification amendments	SPERWall Page No.	
B10.1 General	118	<p><i>Delete:</i> The entire clause shall be deleted.</p> <p><i>Replace with:</i> “For diaphragm walls and barrettes which are typically between 500mm and 1200mm thick</p> <p>All material and work shall be in accordance with sections B1, B3, B4, B6, B11, B20 and B21 of this specification and EFFC / DFI Guide to Tremie Concrete for Deep Foundations”</p>
B10.2 Project specification	118	<i>As per SPERWall.</i>
B10.3 Materials	118	<i>As per SPERWall.</i>
B10.3.1 Support fluid	118	<i>As per SPERWall.</i>
B10.3.2 Permanent stop-ends in diaphragm wall panels	118	<i>As per SPERWall.</i>
B.10.3.3 Grout	118	<i>As per SPERWall.</i>
B10.3.4 Alternative to steel reinforcement	118	<i>As per SPERWall.</i>
B10.4 Construction tolerances	118	<i>As per SPERWall.</i>
B10.4.1 Guide wall	118	<i>As per SPERWall.</i>
B10.4.2 Diaphragm wall and barrettes	118	<i>As per SPERWall.</i>
B10.4.3 Recesses	119	<i>As per SPERWall.</i>
B10.4.4 Reinforcement	119	<p><i>Add:</i> “Positional tolerances for coupler / connection reinforcement to be +- 50mm for single cage with addition allowance for extra splices of 20mm”</p>
B10.4.5 Concrete casting level	119	<i>As per SPERWall.</i>
B10.4.6 Dimensions of panels	119	<i>As per SPERWall.</i>
B10.4.7 Water retention	119	<i>As per SPERWall.</i>
B10.5 Construction processes	119	<i>As per SPERWall.</i>
B10.5.1 Drawings	119	<i>As per SPERWall.</i>
B10.5.2 Guide walls	119	<i>As per SPERWall.</i>
B10.5.3 Stability of the excavation	119	<i>As per SPERWall.</i>
B10.5.4 Cleanliness of the base	119	<i>As per SPERWall.</i>
B10.5.5 Condition of support fluid prior to concreting	119	<i>As per SPERWall.</i>
B10.5.6 Stop-ends in diaphragm wall panels	120	<i>As per SPERWall.</i>

B10 DIAPHRAGM WALLS AND BARRETTES

B10 Specification amendments	SPERWall Page No.	
B10.5.7 Placing concrete	120	<i>As per SPERWall.</i>
B10.5.8 Temporary backfilling above panel casting level	120	<i>As per SPERWall.</i>
B10.5.9 Excavation near recently cast panels	121	<i>As per SPERWall.</i>
B10.5.10 Breaking down of concrete	121	<i>As per SPERWall.</i>
B10.5.11 Base or shaft grouting	121	<i>As per SPERWall.</i>
B10.6 Records	121	<i>As per SPERWall.</i>
B10.6.1 Placing concrete	121	<i>As per SPERWall.</i>
B10.6.2 Records of special control measures during excavation	121	<i>As per SPERWall.</i>
B10.7 Trial panels	121	<i>As per SPERWall.</i>

B11 SECANT PILE WALLS

The following amendments modify Section B11 in Part B of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

B11 Specification amendments	SPERWall Page No.	
B11.1 General	130	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “As per SPERWall this applies to primary and secondary piles that are interlocking to form a retaining wall; typically, only secondary piles are reinforced.</p> <p>All material and work shall be in accordance with sections B1, B3, B4, B6, B11, B20 and B21 of this specification and with reference to AS 2159 as the general standard adopted for piling design and installation that includes cast in-situ piles.”</p>
B11.2 Project specification	130	<i>As per SPERWall.</i>
B11.3 Materials	130	<i>As per SPERWall.</i>
B11.3.1 Self-hardening slurry mixes and low-strength concrete	130	<i>As per SPERWall.</i>
B11.3.2 Support fluid	130	<i>As per SPERWall.</i>
B11.3.3 Alternative to steel reinforcement	130	<i>As per SPERWall.</i>
B11.4 Construction tolerances	130	<i>As per SPERWall.</i>
B11.4.1 Guide wall	130	<i>As per SPERWall.</i>
B11.4.2 Secant piles	130	<i>As per SPERWall.</i>
B11.4.3 Recesses	131	<i>As per SPERWall.</i>
B11.4.4 Reinforcement	131	<p><i>Add:</i> “Cages are to be fabricated in accordance with NZS3109 clause 3.9 tolerances” Positional tolerances for coupler / connection reinforcement to be +/- 50mm for single cage with additional allowance for extra splices of 20mm”</p>
B11.4.5 Water retention	131	<i>As per SPERWall.</i>
B11.4 Construction processes	131	<i>As per SPERWall.</i>
B11.5.1 Guide walls	131	<i>As per SPERWall.</i>
B11.5.2 Bored cast-in-place piles	131	<i>As per SPERWall.</i>
B11.5.3 Continuous flight auger piles	131	<i>As per SPERWall.</i>
B11.5.4 Micropiles	131	<i>As per SPERWall.</i>
B11.5.5 Boring into recently cast piles	131	<i>As per SPERWall.</i>
B11.5.6 Placing concrete, low-strength concrete and self-hardening slurry mixes	131	<i>As per SPERWall.</i>
B11.5.7 Breaking down of concrete	131	<i>As per SPERWall.</i>
B11.6 Records	131	<i>As per SPERWall.</i>

B12 CONTIGUOUS PILE WALLS

The following amendments modify Section B12 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

B12 Specification amendments	SPERWall Page No.	
B12.1 General	136	<i>Delete:</i> This entire Clause shall be deleted. <i>Replace with:</i> “All material and work shall be in accordance with sections B1, B3, B4, B6, B11, B20 and B21 of this specification and with reference to AS 2159 as the general standard adopted for piling design and installation that includes cast in-situ piles.”
B12.2 Project specification	136	<i>As per SPERWall.</i>
B12.3 Materials	136	<i>As per SPERWall.</i>
B12.3.1 Support fluid	136	<i>As per SPERWall.</i>
B12.3.2 Alternative to steel reinforcement	136	<i>As per SPERWall.</i>
B12.4 Construction tolerances	136	<i>As per SPERWall.</i>
B12.4.1 Guide wall	136	<i>As per SPERWall.</i>
B12.4.2 Contiguous piles	136	<i>As per SPERWall.</i>
B12.4.3 Recesses	136	<i>Replace:</i> “the vertical tolerance shall be in accordance with clause 12.4.3” <i>With:</i> “the vertical tolerance shall be in accordance with clause 12.4.4”
B12.4.4 Reinforcement	136	<i>Add:</i> “Cages are to be fabricated in accordance with NZS3109 clause 3.9 tolerances” <i>Add:</i> “Positional tolerances for coupler / connection reinforcement to be +- 50mm for single cage with addition allowance for extra splices of 20mm”
B12.5 Construction processes	136	<i>As per SPERWall.</i>
B12.5.1 Guide walls	136	<i>As per SPERWall.</i>
B12.5.2 Bored cast-in-place piles	136	<i>As per SPERWall.</i>
B12.5.3 Continuous flight auger piles	137	<i>As per SPERWall.</i>
B12.5.4 Micropiles	137	<i>As per SPERWall.</i>
B12.5.5 Placing concrete	137	<i>As per SPERWall.</i>
B12.5.6 Breaking down of concrete	137	<i>As per SPERWall.</i>
B12.6 Records	137	<i>As per SPERWall.</i>

B13 KING POST WALLS

The following amendments modify Section B13 in Part B SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

B13 Specification requirements	SPERWall Page No.	
B13.1 General	140	<i>Delete:</i> This entire Clause shall be deleted. <i>Replace with:</i> All material and work shall be in accordance with sections B1, B3, B4, B6, B8, B9, B13, B20 and B21 of this specification, as appropriate, and with reference to AS 2159 as the general standard adopted for piling design and installation.”
B13.2 Project specification	140	<i>As per SPERWall.</i>
B13.3 Materials	140	
B13.3.1 King Post	140	<i>Delete:</i> This entire clause shall be deleted. <i>Replace with:</i> “Unless specified otherwise in the project specifications, (a) the materials for the king post structural steel sections shall comply with B8 and B21 (b) the material for the king post timber poles shall comply with B9 (c) the material for reinforced concrete piles shall comply with B3, B4 and B21.”
B13.3.2 Support fluid	140	<i>As per SPERWall.</i>
B13.3.3 Lagging	140	<i>Add new clause:</i> “Lagging may comprise timber, steel, precast concrete or sprayed concrete. All materials shall comply with B13.3 and B21.”
B13.3.4 Backfill and Drainage Materials	140	<i>Add new clause:</i> “Drainage and backfill materials behind the wall shall be as per the Project Specification and Drawings.”
B13.3.5 Inspection and test certificates	140	<i>Add new clause:</i> “Where required to prove compliance with clause B13.3, the contractor shall provide the contract administrator with test certificates for all piles, lagging and backfill to be incorporated into the works, prior to installation.”
B13.3.6 Manufacturing and tolerances	140	<i>Add new clause:</i> “The dimensional, length and weight tolerances shall comply with the relevant standard for the type of pile specified and to be used.”
B13.4 Construction tolerances	140	<i>As per SPERWall.</i>
B13.4.1 Piles	140	<i>As per SPERWall.</i>
B13.4.2 King posts	140	<i>As per SPERWall.</i>
B13.5 Construction processes	140	<i>As per SPERWall.</i>
B13.5.1 Bored cast-in-place piles	140	<i>As per SPERWall.</i>
B13.5.2 Continuous flight auger piles	140	<i>As per SPERWall.</i>
B13.5.3 Micropiles	140	<i>As per SPERWall.</i>
B13.5.4 Placing king posts	140	<i>As per SPERWall.</i>
B13.5.5 Placing concrete	140	<i>As per SPERWall.</i>
B13.5.6 Backfilling	141	<i>As per SPERWall.</i>
B13.6 Records	141	<i>As per SPERWall.</i>

B14 STEEL SHEET PILES

The following amendments modify Section B14 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall

B14 Specification requirements	SPERWall Page No.	
B14.1 General	143	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> “This section applies to sheet piles which are installed in the ground using impact, vibration, jetting, pressing or a combination of these methods. All material and work shall be in accordance with sections B1, B2, and B21 of this specification.”</p>
B14.2 Project specification	143	<p><i>Delete:</i> “Basement grade to BS 8102”</p>
B14.3 Materials and fabrication	143	
B14.3.1 Compliance with standards	143	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “Unless specified by the project specification, hot rolled sheet piles should be manufactured to BS EN 10248 and cold formed sheet piles to BS EN 10249. Unless otherwise specified by the project specification, all other structural steel components shall comply with the following codes: AS1163 – Structural steel hollow sections AS1594 – Hot-rolled steel flat products AS/NZS 3678 – Structural steel – Hot-rolled plates, floorplates and slabs AS/NZS 3679 – Structural steel Part 1 - Hot-rolled bars and sections Part 2 - Welded I-sections”</p>
B14.3.2 Fabricated sheet piles	143	<i>As per SPERWall.</i>
B14.3.3 Inspection and test certificates	143	<p><i>Add:</i> “For temporary works piles made from unidentified steel, unless a full test in accordance with BS EN 10002-1 is made, the yield stress of the steel used in design (fy) shall be taken as 170MPa, and the tensile strength used in design (fu) shall be taken as 300MPa.</p>
B14.3.4 Manufacturing tolerances	143	<i>As per SPERWall.</i>
B14.3.5 Clutch sealant and seal welding	143	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “Where required, sheet pile interlocks shall be sealed or welded in accordance with the project specification. Sealant materials shall be applied in accordance with the manufacturer’s specification. Where permeability requirements are very strict, it should be demonstrated by realistic tests on sealed interlocks that the proposed product satisfies the design specifications.”</p>
B14.4 Construction processes	144	
B14.4.1 Ordering of piles	144	<i>As per SPERWall.</i>
B14.4.2 Marking of piles	144	<i>As per SPERWall.</i>
B14.4.3 Handling and storage of piles	144	<i>As per SPERWall.</i>

B14 Specification requirements	SPERWall Page No.	
B14.4.4 Pile Installation	144	<p><i>Delete:</i> “Creep or shrinkage of the pile lines shall not exceed the manufacturer’s rolling tolerances.”</p> <p><i>Add to paragraph 11:</i> “Practical refusal of sheet piles by vibratory driving shall be defined as 50mm progression per minute or 250mm over a 5 minute period with suitable equipment.”</p> <p><i>Add to end of paragraph 8, sentence 2:</i> “unless otherwise approved by the contract administrator or temporary works designer.”</p> <p><i>Delete:</i> “and where hard driving is encountered this lead shall not exceed 1m.”</p> <p><i>Replace with:</i> “with particular care taken during hard driving.”</p>
B14.4.5 Pile extraction	145	<i>As per SPERWall.</i>
B14.4.6 Pile installation system	145	<i>As per SPERWall.</i>
B14.4.7 Performance of installation equipment	145	<i>As per SPERWall.</i>
B14.4.8 Length of piles	145	<i>As per SPERWall.</i>
B14.4.9 Methods of assisting pile installation	145	<i>As per SPERWall.</i>
B14.4.10 Preparation of pile heads	146	<i>As per SPERWall.</i>
B14.5 Corrosion rates	146	<p><i>Delete:</i> “The UK national annex to BS EN 1993-5 presents two tables giving the loss of thickness that should be allowed for on each face in soil and water.”</p> <p><i>Replace with:</i> “The loss of thickness that should be allowed for on each face in soil and water shall be calculated in accordance with SNZ TS 3404:2018”</p>
B14.5.1 Coating piles for protection against corrosion	146	<p><i>Delete:</i> “BS EN ISO 12944”</p> <p><i>Replace with:</i> “SNZ TS 3404:2018”</p>
B14.6 Welding procedures	146	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “Testing and inspection of welds shall be in accordance with AS/NZS 1554. All procedures shall be in accordance with AS/NZS 1554. The contractor shall submit full details of the welding procedures and electrodes, with drawings and schedules, in the method statement.”</p>
B14.6.1 Welding standards	146	<p><i>Delete:</i> “BS EN ISO 9606-1”</p> <p><i>Replace with:</i> “AS/NZS 1554.1”</p> <p><i>Delete:</i> “BS EN 1101-1 and BS1101-2”</p> <p><i>Replace with:</i> “AS/NZS 1554”</p>

B14 Specification requirements	SPERWall Page No.	
B14.6.2 Seal welds	146	<p><i>Delete:</i> “BS EN 12063 Category D acceptance level quality for the seal welds shall be required unless otherwise stated in the project specification. Visual examination and testing for at least 10% of the full length of seal welds shall be undertaken to prove that the welds are free from surface cracking and are watertight.”</p> <p><i>Replace with:</i> “Seal welds shall be in accordance with AS/NZS 1554.1”</p>
B14.6.3 Support and alignment	146	<i>As per SPERWall.</i>
B14.6.4 Weld tests	147	<p><i>Delete:</i> “BS EN 5817”</p> <p><i>Replace with:</i> “AS/NZS 1554.1”</p>
B14.6.5 Protection during welding	147	<i>As per SPERWall.</i>
B14.7 Records	147	<i>As per SPERWall.</i>

B15 INTEGRITY TESTING

The following amendments modify Section B15 in Part B of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

B15 Specification amendments	SPERWall Page No.	
B15.1 General	154	<i>As per SPERWall.</i>
B15.2 Methods of testing	154	<i>As per SPERWall.</i>
B15.3 Project specification	154	<i>As per SPERWall.</i>
B15.4 Measuring instruments	154	<i>As per SPERWall.</i>
B15.5 Age of test elements at time of testing	155	<i>As per SPERWall.</i>
B.15.6 Preparation of the element to be tested	155	<i>As per SPERWall.</i>
B15.7 Specialist integrity test organization	155	<i>As per SPERWall.</i>
B15.8 Interpretation of tests	155	<i>As per SPERWall.</i>
B15.9 Report	155	<i>Delete first paragraph and replace with: "Preliminary results of the tests shall be submitted to the contract administrator within two (2) working days of carrying out the tests."</i>
B15.10 Anomalous results	155	<i>As per SPERWall.</i>

B16 DYNAMIC AND RAPID LOAD TESTING OF PILES

The following amendments modify Section B16 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

B16 Specification requirements	SPERWall Page No.	
B16.1 General	159	<i>As per SPERWall.</i>
B16.2 Project specification	159	<i>Add:</i> (j) minimum number of piles for which waver equation analyses are required to be undertaken (k) Individual piles that are required to be tested (if applicable) (l) If the test piles are preliminary (sacrificial) or working piles
B16.3 Construction of a preliminary pile to be tested	159	<i>As per SPERWall.</i>
B16.3.1 Notice of construction		
B16.3.2 Method of construction	159	<i>As per SPERWall.</i>
B16.3.3 Boring or driving record	159	<i>As per SPERWall.</i>
B16.3.4 Concrete test cylinders	159	<i>Add to Last sentence of first paragraph:</i> The cylinders shall be made and tested in accordance with NZS3112.2. For cast in-situ concrete piles, four test cylinders shall be made from the concrete used in the preliminary test pile and from the concrete used for building up a working pile. If a concrete pile is extended or capped for the purpose of testing, a further four cylinders shall be made from the corresponding batch of concrete. The cylinders shall be made and tested in accordance with NZS 3112.2. The pile test shall not be started until the strength of the cylinders taken from any preliminary pile, pile extension or cap or representative of any working test pile is at least that specified in AS2159 Clause 7.3.3.1.
B16.4 Preparation of a working pile to be tested	159	<i>As per SPERWall.</i>
B16.4.1 Notice of construction		
B16.4.2 Method of construction	160	<i>As per SPERWall.</i>
B16.4.3 Preparation of the pile head	160	<i>As per SPERWall.</i>
B16.5 Safety	160	<i>As per SPERWall.</i>
B16.5.1 Supervision		
B16.5.2 Safety precautions	160	<i>As per SPERWall.</i>
B16.6 Measuring instruments	160	<i>As per SPERWall.</i>
B16.7 Hammer or propellant	160	<i>As per SPERWall.</i>
B16.8 Time of testing	160	<i>Replace second paragraph with</i> “The time between the completion of installation and testing for a concrete pile shall be at least ten days, or as stated in the project specification, and shall be such that the pile is not damaged under the stresses during testing.”
B16.9 Interpretation of tests	160	<i>As per SPERWall.</i>
B16.10 Results	160	<i>Add:</i> (n) location of possible damage and magnitude of damage
B16.10.1 Report		
B16.10.2 Additional information	161	<i>As per SPERWall.</i>
B16.10.3 Analysis	161	<i>As per SPERWall.</i>

B17 STATIC LOAD TESTING OF PILES

The following amendments modify Section B17 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

B17 Specification amendments	SPERWall Page No.	
B17.1 General	165	<i>Delete first sentence of second paragraph and replace with:</i> The design and full details of the proposed load application, measurement and reaction system shall be satisfactory for the required test and undertaken by experienced and competent person(s) conversant with the test equipment and test procedure.
B17.2 Project specification	165	<i>Delete:</i> “preliminary piles” from (c) and (f) <i>Replace with:</i> “representative piles”
B17.3 Construction of a representative pile to be tested	165	
B17.3.1 Notice of construction	165	<i>Delete:</i> “preliminary pile” <i>Replace with:</i> “representative pile”
B17.3.2 Method of construction	165	<i>Delete:</i> “preliminary pile” or “preliminary piles” <i>Replace with:</i> “representative pile” or “representative piles” respectively
B17.3.3 Boring or driving record	166	<i>Delete:</i> “preliminary pile” <i>Replace with:</i> “representative pile”
B17.4 Concrete test cubes	166	<i>Delete:</i> “preliminary piles” <i>Replace with:</i> “representative piles” <i>Delete:</i> “cubes” <i>Replace with:</i> “cylinders” <i>Delete:</i> “BS EN 12390” <i>Replace with:</i> “NZS 3112.2”
B17.5 Preparation of a working pile to be tested	166	<i>As per SPERWall.</i>
B17.6 Cut-off level	166	<i>As per SPERWall.</i>
B17.7 Supervision of test	166	<i>As per SPERWall.</i>
B17.8 Safety Precautions	166	

B17 STATIC LOAD TESTING OF PILES

B17 Specification amendments	SPERWall Page No.	
B17.8.1 General	166	<i>As per SPERWall.</i>
B17.8.2 Kentledge	166	<i>As per SPERWall.</i>
B17.8.3 Tension piles, reaction piles and ground anchorages	166	<i>As per SPERWall.</i>
B17.8.4 Testing equipment	167	<i>As per SPERWall.</i>
B17.9 Reaction systems	167	
B17.9.1 Pile head for compression test	167	<i>As per SPERWall.</i>
B17.9.2 Compression Tests	167	<p><i>Delete:</i> Paragraph 6</p> <p><i>Replace with:</i> “Unless otherwise specified by the project specification, all welding procedures shall be in accordance with AS/NZS 1554. The contractor shall submit full details of the welding procedures, consumables, with drawings and schedules, in the method statement.”</p>
B17.9.3 Tension Testing	167	<i>As per SPERWall.</i>
B17.9.4 Working Piles	168	<p><i>Delete:</i> Paragraph 2.</p> <p><i>Replace with:</i> “Where working piles are used as reaction piles their movement shall be measured and recorded to within an accuracy of 0.2mm.”</p>
B17.9.5 Spacing	168	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “Minimum distances from the test pile centre-line to anchorages, kentledge or reaction piles shall be in accordance with AS 2159 Appendix A2.2.”</p>
B17.10 Application of Load	168	
B17.10.1 Equipment for applying load	168	<i>As per SPERWall.</i>

B17 Specification amendments	SPERWall Page No.	
B17.10.2 Measurement of load	168	<p><i>Delete:</i> “The load measuring devices shall be calibrated at least every 12 months, whenever adjustments are made to the device or at intervals appropriate to the type of equipment. Certificates of calibration traceable to national standards shall be supplied to the contract administrator 48 hours before the commencement of testing if requested, and included as an appendix to the final report.”</p> <p><i>Replace with:</i> “The load measuring devices shall be calibrated at least every 6 months, whenever adjustments are made to the device or at intervals appropriate to the type of equipment. Certificates of calibration traceable to national standards shall be supplied to the contract administrator 48 hours before the commencement of testing if requested, and included as an appendix to the final report.”</p> <p><i>Delete:</i> “A record of the load being measured by the secondary load measuring device shall be made at loads of 100% DVL, 100% DVL + 50% F_{rep}, to check that the load being measured correlates with the load being measured by the primary load measuring device, within +5%.”</p> <p><i>Replace with:</i> “A record of the load being measured by the secondary load measuring device shall be made at loads of 100% P_s and 100% P_g for proof tests in accordance with AS 2159-2009 as well as 100% P_u for ultimate tests in accordance with AS 2159-2009, to check that the load being measured correlates with the load being measured by the primary load measuring device, within +5%.”</p>
B17.10.3 Control of loading	168	<i>As per SPERWall.</i>
B17.10.4 Remote Monitoring	169	<i>As per SPERWall.</i>
B17.11 Measuring pile head movement	169	<i>As per SPERWall.</i>
B17.11.1 Reference beams and electronic displacement transducers	169	<p><i>Delete:</i> “The transducers or gauges shall enable readings to be made to an accuracy of at least 0.025% of pile diameter” from paragraph 3.</p> <p><i>Replace with:</i> “The transducers or gauges shall enable readings to be made to an accuracy of at least 0.1% of pile diameter or 0.1mm in accordance with AS2159 Appendix A2.3.2”</p>
B17.11.2 Optical levelling method	170	<i>As per SPERWall.</i>
B17.12 Protection of testing equipment	170	
B17.12.1 Protection from weather	170	<i>As per SPERWall.</i>
B17.12.2 Prevention of disturbance	170	<i>As per SPERWall.</i>
B17.13 Test procedure for maintained load compression test	170	

B17 Specification amendments	SPERWall Page No.	
B17.13.1 General	170	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “The loading and unloading shall be carried out in stages as defined in AS 2159-2009 clause 8.4.2 and Appendix A3. The type of test, single or multi cycle, shall be in accordance with the project specification.</p> <p>The load shall be sustained at a constant magnitude until the rate of movement of the pile satisfies the limits as defined in AS 2159-2009 Appendix A3.2.”</p>
B17.13.2 Proof load test procedure for working compression piles	170	<p><i>Delete:</i> This entire clause shall be deleted.</p>
B17.13.3 Extended proof load test procedure for preliminary compression piles	170	<p><i>Delete:</i> This entire clause shall be deleted.</p>
B17.13.4 Testing of piles designed to carry load in tension	173	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “The testing of piles designed to carry load in tension shall follow the loading sequence of AS 2159-2009 Table A2.</p> <p>Alternatively, the test procedure for compression piles can be used for tension loading.”</p>
B17.14 Presentation of factual results	173	
B17.14.1 Results to be submitted	173	<i>As per SPERWall.</i>
B17.14.2 Schedule of recorded data	173	<p><i>Delete:</i> “representative action (F_{rep})”</p> <p><i>Replace with:</i> “design load under serviceability limit state actions (E_{ds} per AS 2159-2009)”</p>
B17.15 Presentation of test interpretation	174	
B17.15.1 Need for interpretation	174	<i>As per SPERWall.</i>
B17.15.2 Working load test interpretation	174	<i>As per SPERWall.</i>

B17 Specification amendments	SPERWall Page No.	
B17.15.3 Preliminary load test interpretation	174	<p><i>Delete:</i> Paragraph 1.</p> <p><i>Replace with:</i> “The contractor shall make a statement on the adherence of the results to the specified deflection limits for P_s and P_g (where P_s and P_g are test loads to verify SLS and ULS load-settlement performance in accordance with AS 2159-2009) and any deflection limits identified in the project specification. Unless otherwise specified in the project specification, the deflection limits shall be those identified in AS 2159-2009 clause 8.4.3.1. Where a limit has been exceeded, the contractor shall make an explanation of the likely reasons for the non-performance with a proposal to the contract administrator regarding the design and/or construction of the working piles and/or regarding the requirements of the project specification.”</p> <p><i>Delete:</i> “preliminary pile”</p> <p><i>Replace with:</i> “representative pile”</p>
B17.16 Completion of a test	175	
B17.16.1 Removal of test equipment	175	<i>As per SPERWall.</i>
B17.16.2 Representative Pile	175	<i>As per SPERWall.</i>
B17.16.3 Working pile test cap	175	<i>As per SPERWall.</i>

B18 PILES WITH PERMANENT CASING AND/OR COATINGS

The following amendments modify Section B18 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall

B18 Specification requirements & amendments	SPERWall Page No.	
B18.1 General	179	<i>As per SPERWall.</i>
B18.2 Project specification	179	<i>As per SPERWall.</i>
B18.3 Bituminous or other coating materials	179	
B18.3.1 General	179	<i>As per SPERWall.</i>
B18.3.2 Protection from damage	179	<i>As per SPERWall.</i>
B18.3.3 Installation	179	<i>As per SPERWall.</i>
B18.4 Permanent casing	179	
B18.4.1 General	179	<i>As per SPERWall.</i>

B19 INSTRUMENTATION FOR PILES AND EMBEDDED RETAINING WALLS

The following amendments modify Section B19 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

B19 Specification requirements	SPERWall Page No.	
B19.1 General	181	<i>As per SPERWall.</i>
B19.2 Project Specification	181	<p><i>Delete:</i> (q) other particular technical requirements.</p> <p><i>Add:</i> (q) purpose of the instrumentation and whether it will be permanent or temporary (r) the level of redundancy required for the instrumentation on the project (s) specific system requirements for uploading data and / or reports (t) specifications for accuracy and precision requirements of instrumentation, and (u) other particular technical requirements.</p>
B19.3 Type of instrumentation	18	<p><i>Delete:</i> (g) other special instrumentation not covered by the above.</p> <p><i>Replace with:</i> (g) fibre optic sensing (h) thermal instrumentation (j) other special instrumentation not covered by the above.</p>
B19.3.1 Extensometers B19.3.1.1 General	181	<i>As per SPERWall.</i>
B19.3.1.2 Rod Extensometers	182	<i>As per SPERWall.</i>
B19.3.1.3 Magnetic Extensometers	182	<i>As per SPERWall.</i>
B19.3.2 Inclinometers B19.3.2.1 General	182	<i>As per SPERWall.</i>
B19.3.2.2 Torpedo type	182	<i>As per SPERWall.</i>
B19.3.2.3 Non-Torpedo types	183	<i>As per SPERWall.</i>
B19.3.3 Load Cells	183	<i>As per SPERWall.</i>
B19.3.4 Pressure cells	184	<i>As per SPERWall.</i>
B19.3.5 Strain gauges B19.3.5.1 General	184	<i>As per SPERWall.</i>
B19.3.5.2 Strain gauges attached to steel or precast concrete piles	184	<i>As per SPERWall.</i>
B19.3.5.3 Strain gauges embedded in concrete	184	<i>As per SPERWall.</i>
B19.3.5.4 Fibre optic strain sensors	184	<i>As per SPERWall.</i>
B19.3.5.5 Fibre optic strain sensors – general	185	<i>As per SPERWall.</i>

B19 INSTRUMENTATION FOR PILES AND EMBEDDED RETAINING WALLS

B19 Specification requirements	SPERWall Page No.	
B19.3.5.6 Embedded fibre optic strain sensors – general	185	<i>As per SPERWall.</i>
B19.3.5.7 Surface attached fibre optic strain sensors	185	<i>As per SPERWall.</i>
B19.3.5.8 Specification requirements for fibre optic strain sensors	185	<i>As per SPERWall.</i>
B19.3.6 Surveying	185	
B19.3.6.1 Precise Levelling	186	<i>As per SPERWall.</i>
B19.3.6.2 Geodetic surveying	186	<p><i>Delete:</i> The spatial movement of the datums and the precision of the survey must be established and agreed before the project begins.</p> <p><i>Replace with:</i> The spatial movement of the datums, method of, accuracy and the precision of the survey must be established and agreed before the project begins with the contract administrator.</p>
B19.3.7 Other Special Instrumentation	186	<i>Add:</i> When other types of instrumentation are specified, the quality of the instruments shall be provided by the contractor and approved by the contract administrator.
B19.4 Installation	186	<i>As per SPERWall.</i>
B19.4.1 Personnel	186	<i>As per SPERWall.</i>
B19.4.2 Protection	186	<i>Add:</i> The level of protection for all instrumentation shall be agreed with the contract administrator.
B19.4.3 Surveying	186	<i>As per SPERWall.</i>
B19.5 Monitoring	186	<i>As per SPERWall.</i>
B19.5.1 Monitoring equipment	186	<p><i>Delete:</i> The monitoring equipment shall remain on site for the duration of the monitoring programme, except when necessary for it to be calibrated, after which it shall return to site.</p> <p><i>Add:</i> If instruments and/ or read out units other than the original equipment are used, calibration records for this equipment shall be provided and the use of the alternative instrument and/or read out units shall be agreed with the contract administrator.</p>
B19.5.2 Readings	187	<i>As per SPERWall.</i>
B19.5.3 Calibration and data checking	187	<p><i>Add to first sentence:</i> The contractor shall submit to the contract administrator details of proposed calibration(s) for each instrument and /or read out unit and the contract administrator shall agree the level of calibration required.</p> <p><i>Add:</i> The contractor shall closely collaborate with their installation supplier and rectify any issues with the data prior to submission to the contract administrator.</p>
B19.6 Report	187	<i>Add:</i> (j) an electronic format for data transfer be agreed and accepted prior to installation.

B20 SUPPORT FLUIDS

The following amendments modify Section B20 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

B20 Specification Requirements	SPERWall Page No.	
B20.1 General	192	<i>As per SPERWall.</i>
B20.2 Project specification	192	<i>As per SPERWall.</i>
B20.3 Evidence of suitability of Support Fluid	192	<i>As per SPERWall.</i>
B20.4 Materials	193	<i>As per SPERWall.</i>
B20.4.1 Water	193	<i>As per SPERWall.</i>
B20.4.2 Storage and Use of Additives to the Fluid	193	<i>As per SPERWall.</i>
B20.5 Mixing of Support Fluid	193	<i>As per SPERWall.</i>
B20.6 Compliance Testing of Support Fluid	193	<i>As per SPERWall.</i>
B20.7 Spillage and Disposal of Support Fluid	194	<i>As per SPERWall.</i>

B21 GENERAL REQUIREMENTS FOR CONCRETE, STEEL REINFORCEMENT, STRUCTURAL GROUT AND MORTAR AND STRUCTURAL STEEL

The following amendments modify Section B21 in Part B of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

B21 Specification requirements	SPERWall Page No.	
B21.1 General	201	<p><i>Delete</i></p> <p><i>Replace with:</i> “All materials and work shall be in accordance with sections B1 and B21 of this specification, AS 2159, NZS 3101, NZS 3109 and related standards and the project specification. Where there may be conflict of requirements, the project specification shall take precedence.</p> <p>Steel reinforcement shall be in accordance with AS/NZS 4671.</p> <p>Steel reinforcement shall be manufactured and supplied to a recognized third-party product certification scheme meeting the requirements of AS/NZS 4671 or shall be subject to testing to demonstrate product conformity in accordance with AS/NZS 4671, Clause 9.</p> <p>Structural steel shall be manufactured and supplied by a recognized third-party product certification scheme accredited supplier, with all supporting documentation meeting the traceability requirements of AS/NZS 5131.</p> <p>In this section the term ‘pile’ shall refer to piles, diaphragm wall panels and barrettes.</p> <p>Requirements for the project specification shall be stated in Table B21.1 provided at the end of this addendum.”</p>
B21.2 Concrete	201	
B21.2.1 Strength	201	<p><i>Delete</i></p> <p><i>Replace with:</i> “Concrete shall be in accordance with the requirements of NZS 3104 and NZS 3109, except where specified otherwise herein or instructed otherwise by the contract administrator. Copies of these standards shall be kept on the site and relevant parts read with the following clauses of this specification.</p> <p>The required strength(s) of concrete in the piles shall be as per the project specification.”</p>

B21 Specification requirements	SPERWall Page No.	
B21.2.2 Composition of concrete	201	<p><i>Delete</i></p> <p><i>Replace with:</i> “Concrete shall typically be NORMAL concrete (N) or SPECIAL concrete (S), defined in NZS 3104, Clause 2.10, as required by the project specifications.</p> <p>Concrete mix designs shall be developed to suit the contractor’s preferred method of placement to achieve the required performance criteria. Concrete to be placed into pile casings, underwater or under drilling support fluids shall be specifically designed to suit placement using tremie techniques.</p> <p>The maximum chloride and sulphate content of the concrete shall not exceed the limits given in NZS 3109, Clause 6.1.</p> <p>Admixtures containing chlorides shall not be added to concrete.</p> <p>Where the pile will be exposed to wet or saline conditions, aggressive soil or groundwater conditions, the concrete mix design shall meet the minimum cement contents, including use of supplementary cementitious materials, and water/ cementitious material ratios as per NZS 3101, Clause 3.5 or 3.7.</p> <p>Where concrete is to be placed under water or support fluid by tremie methods, the following shall apply, unless approved otherwise by the contract administrator before commencement of the works:</p> <ul style="list-style-type: none"> a) the cementitious content shall not be less than 400 kg/m³ b) total water content shall not be greater than 180 kg/m³ c) maximum aggregate size shall be 20 mm d) target concrete slump shall be 230 mm, ±40 mm or spread test diameter shall be 550 mm ± 50 mm e) minimum slump / spread retention of 2hrs (extended further as required) for slump retention in excess of 4 hours, hydration stabilizers should be used. <p>Details for the concrete mix design and other information in the project specification, if requested, shall be provided to the contract administrator before commencement of the works.</p>
B21.2.3 Special requirements for non-structural concrete	202	<p><i>As per SPERWall.</i></p>
B21.2.4 Properties of fresh concrete	202	<p><i>Delete</i></p> <p><i>Replace with:</i> “The concrete shall have sufficient workability (consistence) and stability to allow it to be placed and compacted under self-weight without excessive bleeding, filtration or segregation.”</p>
B21.2.5 Alkali-silica reaction	202	<p><i>Delete</i></p> <p><i>Replace with:</i> “Where concrete aggregates proposed to be used are potentially reactive with alkalis, the concrete shall comply with the requirements of NZS 3104, Clause 2.5.2 or precautions to minimize the risk of damage shall be taken in accordance with CCANZ TR3.”</p>

B21 Specification requirements	SPERWall Page No.	
B21.3 Ready-mixed concrete	202	<p><i>Delete</i></p> <p><i>Replace with:</i> “Ready-mixed concrete shall be specified, produced, and transported in accordance with NZS 3104. The general requirements in clause B21.1 shall apply.</p> <p>Ready-mixed concrete shall be produced at a plant with current Annual Certificate of Audit to the requirements of NZS 3104, Clause 2.16.</p> <p>Reasonable access shall be provided for the contract administrator to inspect the concrete batching plant(s) and/or quality records when requested.</p> <p>All materials and water for each concrete mix shall be added at the batching plant. Water or other material shall not be added to the concrete after it has left the plant, except when explicitly approved by the contract administrator.</p> <p>Each truck delivery shall be accompanied by a delivery docket including the concrete mix design code and time of mixing. Delivery dockets shall be retained by the contractor as part of construction quality assurance records.”</p>
B21.4 Site-batched concrete	202	<p><i>Delete</i></p> <p><i>Replace with:</i> “Site batched concrete shall be specified and produced in accordance with the requirements of NZS 3104. The requirements in clauses B21.1, B21.2 and B21.3 apply.”</p>
B21.5 Trial mixes	202	
B21.5.1 General	202	<p><i>Delete</i></p> <p><i>Replace with:</i> “Requirements for trial mixes shall be contained in the project specific requirements including any performance requirements for strength, workability, stability and durability. Trial mixes shall be designated SPECIAL concrete as per NZS 3104. The project specific requirements shall specify testing requirements and compliance tolerances, in accordance with NZS 3104.”</p>
B21.5.2 Preliminary trial mixes	202	<p><i>Delete</i></p> <p><i>Replace with:</i> “Where insufficient previous concrete production history for strength, workability and stability is available, trial mixes shall be prepared for each concrete mix design to be used in the piles for the project.</p> <p>When required in accordance with clause B21.5.1 the contractor shall, before the commencement of concreting, produce and have tested preliminary trial mixes, preferably under full-scale production conditions.</p> <p>Results from trial mixes shall be submitted to the contract administrator to demonstrate that the concrete mix performance requirements can be achieved.”</p>
B21.5.3 Trial mixes during the works	203	<p><i>As per SPERWall.</i></p>

B21 Specification requirements	SPERWall Page No.	
B21.5.4 Properties of fresh concrete	203	<p><i>Delete</i></p> <p><i>Replace with:</i></p> <p>“Where required by the project specification, the properties of fresh concrete shall be determined by the methods below.</p> <p>Workability parameters of each batch of the trial mixes shall be determined by the slump test or spread test as described in NZS 3112, Part 1, slump-flow test to AS1012.3.5 (or BS EN 12350-8) or flow table test to BS EN 12350-5, and as specified in the project specification.</p> <p>The project specification shall specify requirements for workability retention of the fresh concrete.</p> <p>L-box flow shall be determined by the L-box test to BS EN 12350-10 except that the time for the concrete to reach the end of the box, T_{end}, shall be recorded in addition to the passing ability ratio. The two-bar test shall be used except where the maximum aggregate size (D_{max}) is 10 mm or less.</p> <p>The stability of each batch of the trial mixes shall be determined by bleeding, segregation resistance and filtration resistance tests, and as specified in the project specification.</p> <ul style="list-style-type: none"> • The bleeding test shall be as described in ASTM C232 including determination of bleeding rate. • The segregation resistance shall be determined by observation of the flow or slump-flow test, and the visual stability index (VSI) rated as described in ASTM C1611. • Filtration resistance shall be measured by the Bauer filtration test described in CIA Z17 and EFFC/DFI Best Practice Guide to Tremie Concrete for Deep Foundations. <p>Trial mixes shall establish appropriate proportioning of concrete mix constituents and ensure that admixture and water interactions are stable designed water/cement ratio and chosen workability for each concrete mix design.”</p>
B21.5.5 Variations in composition	203	<p><i>Delete</i></p> <p><i>Replace with:</i></p> <p>“No changes to the agreed concrete trial mix design proportions or constituent materials shall be made without demonstrating conformance with the specification requirements.”</p>
B21.6 Transporting concrete	203	<p><i>Delete</i></p> <p><i>Replace with:</i></p> <p>“Concrete shall be transported in accordance with NZS 3104, Clause 2.9.”</p>
<p><i>Rename:</i></p> <p>B21.7 Cold weather precautions</p> <p><i>With:</i></p> <p>B21.7 Placing in unfavourable conditions</p>	203	<p><i>Delete</i></p> <p><i>Replace with:</i></p> <p>“Concrete shall not be placed in unfavourable conditions, as defined in NZS 3109, Clause 7.2, which may be detrimental to the quality and finish of the concrete in the completed piles.”</p>
B21.8 Testing of concrete	204	
B21.8.1 Sampling	204	<p><i>Delete</i></p> <p><i>Replace with:</i></p> <p>“Concrete for piles shall be sampled for completion and evaluation of control tests in accordance with NZS 3104, Clause 2.15. Samples shall be taken on site, at the point of placing concrete in the piles.”</p>

B21 Specification requirements	SPERWall Page No.	
B21.8.2 Consistence testing	204	<p><i>Delete</i></p> <p><i>Replace with:</i> “Slump tests shall be carried out in accordance with NZS 3112: Part 1. A slump test shall always be taken when a compression test is made. Where flowing concrete is specified, the flowing ability shall be measured in accordance with NZS 3112: Part 1, or as specified in the project specification.</p> <p>Other requirements for concrete mix workability properties shall be as per the project specifications.”</p>
B21.8.3 Sampling for compressive strength testing	204	<p><i>Delete</i></p> <p><i>Replace with:</i> “In addition to the control testing at the Ready-Mix plant required by NZS 3104, concrete control test samples shall also be taken on site by the contractor, at the time of the pour. A sample shall comprise a minimum of three test cylinders from each concrete pour, for compressive strength control tests in accordance with NZS 3104.</p> <p>Unless specified otherwise in the project specification, samples for compressive strength testing shall be taken as follows:</p> <p>a) one sample per concrete pour and b) for every 75 m³ of concrete cast during the same pour.”</p>
B21.8.4 Compressive strength testing	204	<p><i>Delete</i></p> <p><i>Replace with:</i> “Test cylinders shall be moulded, cured and tested in accordance with NZS 3112: Part 2.”</p>
B21.8.5 Acceptance criteria for compressive strength	204	<p><i>Delete</i></p> <p><i>Replace with:</i> “Acceptance criteria for compressive strength test results shall be in accordance with NZS 3104.”</p>
B21.8.6 Records of tests	204	<i>As per SPERWall.</i>
B21.9 Steel reinforcement	205	
B21.9.1 Condition of reinforcement	205	<i>As per SPERWall.</i>
B21.9.2 Bending of reinforcement	205	<p><i>Delete</i></p> <p><i>Replace with:</i> “Reinforcement shall be bent in accordance with NZS 3109 to the correct shape and bend radii before fixing and placing.”</p>
B21.9.3 Fabrication of reinforcement	205	<p><i>Delete</i></p> <p><i>Replace with:</i> “Reinforcement shall be fabricated and tied in accordance with NZS 3109. Reinforcement shall be assembled and securely tied with wire ties to form a rigid cage. Additional support, such as support or lacing bars, shall be provided to secure the cage against permanent distortion from lifting, handling and during concreting. Intersecting bars in the cage shall be fixed together by tie wire. Hoops or stirrup reinforcement shall fit closely around and be tied to the main longitudinal bars. The ends of all tie wire shall be turned away from the concrete face to maintain cover. Reinforcement shall be placed and maintained in position to provide the specified projection of reinforcement above the final cut-off.”</p>

B21 Specification requirements	SPERWall Page No.	
B21.9.4 Spacers	205	<i>Delete</i> <i>Replace with:</i> “Spacers, in accordance with NZS 3109, shall be provided to ensure the correct cover to and position of the reinforcement along the length of the cage and to all faces of the pile. Spacers shall be of durable material which will not lead to corrosion of the reinforcement or spalling of the concrete cover.”
B21.9.5 Welding of reinforcement	205	<i>Delete</i> <i>Replace with:</i> “Welding of reinforcement shall be in accordance with AS/NZS 1554.3 and the project specification. In-line quenched and tempered reinforcement shall not be welded.”
B21.9.6 Non-ferrous reinforcement	205	<i>As per SPERWall.</i>
B21.10 Structural grout and mortar	205	
B21.10.1 General	205	<i>Delete</i> <i>Replace with:</i> “The mix design for grout or mortar to be used in the formation of piles shall produce a grout which is suitable for pumping. Grout shall consist of ordinary Portland cement, clean water and may contain fine aggregates or approved additives. Approved additives may be used to reduce water content or improve workability but no additives containing chlorides, nitrates or sulphides shall be used. Proprietary grout or mortar mixes may be used, with the acceptance of the contract administrator. Structural grout or mortar shall have a minimum compressive strength of 30 MPa. The water/cement ratio of mortar or structural grout shall not exceed 0.50. Prior to grouting, the Contractor shall conduct volume change and bleed tests as specified in NZS 3109 to demonstrate compliance and present the results and grout mix design to the contract administrator for approval. The quantity of bleed water from the grout after being kept at rest for 3 hours shall be less than 1.0%. All bleed water shall be re-absorbed after 24 hours.”
B21.10.2 Batching	205	<i>As per SPERWall.</i>
B21.10.3 Mixing	206	<i>Delete</i> <i>Replace with:</i> “Grout shall not be used more than one hour after first mixing and shall be continuously mixed during that time. Grout shall be mixed in a continuous mixing machine capable of delivering the required volume of the grout at suitable delivery pressures.”
B21.10.4 Transporting	207	<i>As per SPERWall.</i>
B21.10.5 Compressive strength testing of structural grout or mortar	207	<i>Delete</i> <i>Replace with:</i> “Grout control test samples shall be taken on site by the contractor, at the time of the pour. A sample shall comprise a minimum of three test cylinders from each grout pour, for compressive strength control tests. Where grout or mortar is supplied ready mixed, sampling requirements shall be as in clause B21.8.3. For site-batched grout, one sample shall be taken from each 15 m ³ of grout or part thereof. Test cylinders shall be moulded, cured and tested in accordance with NZS 3112: Part 4. The contractor shall keep a detailed record of the results of all tests on grout and materials. Each test shall be clearly identified with the piles to which it relates.”

B21 Specification requirements	SPERWall Page No.	
B21.10.6 Acceptance criteria for compressive strength of grout and mortar	207	<p><i>Delete</i></p> <p><i>Replace with:</i> "Acceptance criteria for compressive strength test results shall be in accordance with NZS 3104."</p>
B21.10.7 Placing in unfavourable conditions	207	<p><i>Delete</i></p> <p><i>Replace with:</i> "Grout shall not be placed in unfavorable conditions, as defined in NZS 3109, Clause 7.2, which may be detrimental to the quality and finish of the grout in the completed piles."</p>
B21.11 Form for specification of designed concrete	207	<p><i>Delete</i></p>
<i>Add:</i> B21.12 Structural Steel	207	
<i>Add:</i> B21.12.1 Compliance with standards		<p>Structural steel shall be in accordance with sections B7, B8, B13 and B14 of this specification and the project specification. Where there may be conflict of requirements, the project specification shall take precedence.</p> <p>Fabrication of structural steelwork shall be in accordance with AS/NZS 5131 and the project specification.</p>
<i>Add:</i> B21.12.2 Inspection and test certificates		<p>Where required to demonstrate compliance with the structural steel supply standards, the contractor shall provide mill or test certificates for all structural steel, prior to installation and as required by the project specification.</p> <p>Local random verification testing of chemical and mechanical properties of the structural steel shall be carried out on a sample from every heat or batch by an IANZ (International Accreditation New Zealand) accredited testing laboratory in accordance with the relevant standard(s), where any of the following applies:</p> <ol style="list-style-type: none"> a) structural steel is not sourced from and certified by an ACRS, API, or JAS-ANZ accredited 3rd Party Certification Scheme accredited supplier b) supporting documentation does not meet the traceability requirements of AS/NZS 5131 c) mill or test certificates are not endorsed by an International Laboratory Accreditation Cooperation (ILAC) signatory holding accreditation for the correct scope of testing to the named steel standard of supply mill or test certificates are not able to be verified as genuine.

Table B21.1 Form for specification of concrete mix design properties

1	Concrete mix designation			
2	Specified compressive strength			
3	Maximum water/cementitious material ratio			
4	Minimum cement content (kg/m ³)			
5	Nominal maximum size of aggregate (mm)			
6	Exposure classification			
7	Special requirements for cement or combination			
8	Method of placing concrete			
9	Target slump/spread and test method			
10	Tolerance on target slump/spread			
11	Special requirements for slump/spread retention			
12	Rate of sampling for strength testing			
13	Acceptance criteria for segregation resistance (test method and limit)			
14	Acceptance limit for filtration resistance			
15	Acceptance limit for bleeding and/or bleeding rate			
16	Acceptance limit for L-box end time (T_{end}) and passing ability ratio			
17	Additional requirements			
18	Special requirements for strength development			
19	Special requirements for heat of hydration development			
20	Other special technical requirements e.g. Special requirements for aggregates Special requirements for temperature of fresh concrete			

PART C

C1 SPECIFICATION REQUIREMENTS FOR PILING AND EMBEDDED RETAINING WALLS

The following amendments modify Section C1 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C1 Guidance notes	SPERWall Page No.	
C1.1 Standards	46	<p><i>Delete and replace with:</i></p> <p>“This addendum to SPERWall intends to reflect the requirements of New Zealand/ Australia standards where available and other European, British or American standards have been referenced where this is not the case.</p> <p>Due consideration should be given to precedence in New Zealand practice, and the contractor can be asked to demonstrate precedence using previous projects of a similar foundation type in similar ground conditions.”</p>
C1.2 Project specification	46	<i>As per SPERWall.</i>
C1.4 Design	46	<i>As per SPERWall except for the following:</i>
Design: pile performance	49	<p><i>Delete and replace with:</i></p> <p>“The following notes should be followed when pile performance is being specified in Table B1.2.</p> <p>Each note corresponds to a column in the table, reading from left to right:</p> <ul style="list-style-type: none"> • each and every pile should be allocated a unique reference number or code • permitted types of pile are restricted to those specified in the corresponding section of the specification, for example insertion of ‘section B3’ will restrict permitted type(s) of pile to bored cast-in-place piles only. Further specification, for example ‘underreams not permitted’ may be necessary in particular circumstances • the pile designation relates to the size of the particular pile and possibly to the reinforcement cage. The number of different pile sizes for the project will then be listed separately • design SLS load is defined in B1.18 • design settlement under SLS load is defined in B1.18 • design ULS load is defined in B1.18 • design settlement under ULS load is defined in B1.18 • according to AS2159:2009, highest geotechnical strength reduction factor (SRF) values come from statically testing more than 3% of the piles or dynamic testing (incorporating pile driving analyser field measurements and subsequent Case Pile Wave Analysis Program (CAPWAP) signal matching analyses) at least 15% of the piles, however maximum SRF values may be governed by other design requirements • the design verification load (DVL) shall be specified where pile load testing is to be undertaken, with section 8 of AS 2159-2009 providing further guidance • the stratigraphy of the ground may make it imperative that piles have a minimum length, to ensure penetration into a particular stratum; alternatively, the minimum penetration into a particular stratum can be specified (the column heading will then require to be changed to ‘Minimum penetration into XYZ’) • minimum pile dimensions will normally be determined by the permitted stresses in the pile materials, taking into account axial loads, moments and transverse loads. Maximum pile dimensions may be determined from pile spacings.

C1 Guidance notes	SPERWall Page No.	
Design: pile performance (continued)	49	<p>To demonstrate that the piles are performing in line with design, in many cases it will be appropriate to take the maximum load of all contract piles of the same dimension and penetration into the load bearing layer; that is, the utilisation of the pile resistance should tend to 1. Provision of SLS and ULS pile performance criteria on which to assess the impact on structure performance is also essential to demonstrate the design. This is particularly the case with pile design for liquefied conditions where a displacement-based approach offers more flexibility in design compared with a force-based approach.</p> <p>The designer shall confirm the appropriate adjustment to be made to the representative action to confirm the DVL specific to the pile under test. In providing this they should consider:</p> <ul style="list-style-type: none"> • contribution of materials above the stratum relied upon for capacity and their impact on pile performance • ground water levels at the time of testing and their impact on pile performance • in selecting working piles for test, the contract administrator should consider how representative the pile under test is relative to other working piles, for example <ul style="list-style-type: none"> - pile diameter – coverage of the range of working pile diameters on a site - pile length (and stratum contributing to resistance) - construction difficulties experienced - safe working space to construct the temporary works for the test frame and to conduct the test.
C1.6 Safety	52	
C1.6.1 Standards	52	<i>Delete and replace with:</i> "The design and construction of the works must be carried out in accordance with the Health and Safety at Work Act, which places specific requirements on employers, designers and contractors."
C1.7 Ground conditions	52	<i>Delete first sentence of second paragraph and replace with:</i> "A comprehensive, accurate and clearly presented SI carried out in accordance with NZ Ground Investigation Specification or AS 1726 – Geotechnical site investigations is an essential prerequisite to the selection, design and construction of piles or embedded walls."
C1.8 Installation tolerances	53	
C1.8.1 Setting out	54	<i>As per SPERWall.</i>
C1.8.2 Forcible corrections to piles	54	<i>As per SPERWall.</i>
C1.9 Waterproofing of retaining walls	55	
C1.9.2 Repair		<i>As per SPERWall.</i>
C1.10 Construction method	56	
C1.10.1 Obstructions and voids	57	<i>As per SPERWall.</i>
C1.10.3 Concrete casting level tolerances	57	<i>As per SPERWall.</i>
C1.11 Construction programme	57	<i>As per SPERWall.</i>
C1.12 Records	57	<i>As per SPERWall.</i>
C1.13 Nuisance and damage	57	
C1.13.1 Noise and disturbance	57	<i>As per SPERWall.</i>
C1.13.2 Damage to adjacent structures	57	<i>As per SPERWall.</i>

C1 Guidance notes	SPERWall Page No.	
C1.13.3 Damage to completed piles or wall elements	58	<i>As per SPERWall.</i>
C1.14 Driving piles	59	
C1.14.1 Driving procedures and re-drive checks	59	<i>Add:</i> Driven piles may exhibit hydraulic characterizing characterized by no/ low set with high rebound and normally occurs in coarse silts to fine sands and peat. If this occurs, driving should be temporarily suspended to allow pore pressures to dissipate and then be attempted to be driven again. This should be repeated until hydraulic characterizing is no longer observed or the set at re-drive is achieved to the satisfaction of the contract administrator.”
C1.14.3 Set	59	<i>Add the following:</i> For driven piles in New Zealand that are often evaluated using the Hiley pile driving formula, reference should be made to the SESOC/NZGS Piling Specification.
C1.14.4 Driving sequence and risen piles	60	<i>As per SPERWall.</i>
C1.14.5 Pre-boring	60	<i>As per SPERWall.</i>
C1.15 Supervision and control of the works	60	<i>As per SPERWall.</i>
C1.18 Definition	61	<i>As per SPERWall.</i>

C2 DRIVEN PRECAST CONCRETE PILES

The following amendments modify Section C2 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C2 Guidance notes	SPERWall Page No.	
C2.1 General	64	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “AS2159 provides general guidance on the installation of driven precast displacement piles. It is preferable that the design is based on pile sizes that are commonly available.”</p>
C2.3 Materials	64	<p><i>Add to paragraph 2:</i> “Proprietary pile precast concrete pile systems are not commonly used in New Zealand, so the availability of and local experience of individual proprietary systems should be considered before specifying.”</p>
C2.4.2 Handling, transportation and storage of piles	64	<p><i>As per SPERWall.</i></p>
C2.4.3 Driving piles	64	<p><i>Add:</i> “Suitable pile cushions include, but are not limited to:</p> <ul style="list-style-type: none"> • Ply or softwood • Coiled hemp rope <p>The hammer cushion material should have enough stiffness to transmit hammer energy efficiently into the pile. Suitable hammer cushions include, but are not limited to:</p> <ul style="list-style-type: none"> • Hardwood • Nylon • Urethane • Supplied cushions provided by the hammer manufacturer”
C2.4.4 Strength of piles	64	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “Concrete cover for precast concrete driven concrete piles will be less than that used for other piling techniques but still sufficient for durability purposes as specified by AS2159 Clause 6.4.3. Cover will be minimalised - excessive cover may lead to spalling during pile driving.”</p>
C2.4.5 Pile installation system	64	<p><i>As per SPERWall.</i></p>
C2.4.9 Cutting off Pile Heads	64	<p><i>Add:</i> “With respect to the design of piles in New Zealand it should be noted that they are usually subjected to lateral loading, in particular during seismic loading, requiring connection between the pile head and substructure.</p> <p>The design should consider and enable the pile to be cut down to any point along its length to allow for variable founding levels.”</p>

C3 BORED CAST-IN-PLACE PILES

The following amendments modify Section 3 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C3 Guidance notes	SPERWall Page No.	
C3.1 General		<i>As per SPERWall.</i>
C3.2 Project specification	73	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> "It is preferable that the design is based on pile diameters that are commonly available. Construction of piles to special diameters requires the manufacture of new tools and casings and may increase the costs of the project. Early discussions between the designer and contractor will help to establish availability. The more commonly available diameters range from 300 to 1200 mm in 150 mm increments and from 1200 to 2400 mm in 300 mm increments.</p> <p>In practice, the as-built diameter of a completed bored pile can be difficult to determine, particularly at commencing surface or in variable and coarse grained soils. It is therefore normal to base the pile diameter on the diameter of the casing and auger which are more readily accessible."</p>
C3.2 (f) Grooved piles	73	<p><i>Delete:</i> This entire Clause shall be deleted.</p> <p><i>Replace with:</i> "In NZ piles with grooves are formed by introducing a reaming tool into the pile bore to create ridges down the pile shaft. These may be helical or could be formed at discrete depths. It is important to consider:</p> <ul style="list-style-type: none"> • geometry of grooves to prevent their shearing from the shaft • geometry of grooves to optimise shaft friction • spacing of grooves (or pitch) down the pile shaft • assumptions as to the design shaft friction adopted • construction methodology and time. <p>The process is only practical in stable cohesive soils or very weak rock (UCS < 5MPa). Discontinuities and fractures can result in overbreak in the pile bore and poorly formed grooves; the resulting roughness of the pile shaft walls and effect on shaft friction should be considered by the Designer.</p> <p>Typically, a 50 x 50 mm finger is withdrawn to achieve a pitch of 300 mm, over the minimum embedment length. If a temporary or permanent casing is used, the minimum length of embedment below the bottom of the casing should be specified on the drawings.</p> <p>A grooving trial to demonstrate the methodology adopted should be carried out on the first production pile to allow inspection of the grooved pile shaft by the Engineer in accordance with B3.5.8.1."</p>
C3.3.2 Casing	73	<p><i>Add the following paragraph to end of clause:</i> "Where the contribution of a permanent casing to the structural stiffness or flexural overstrength is considered to be significant, the designer shall coordinate with the contractor to establish a casing wall thickness and material properties suitable to resist the stresses during casing installation. Where the design is progressed prior to a contractor being engaged, the designer shall clearly communicate on the design drawings assumed casing wall thickness and material properties, noting that the contractor remains responsible for selecting a casing of sufficient strength to resist stresses during installation."</p>
C3.4 Construction tolerances	73	
C3.4.1 Steel Reinforcement	73	<i>As per SPERWall.</i>

C3 Guidance notes	SPERWall Page No.	
C3.4.2 Plunge columns	74	<p><i>Add the following paragraph to end of clause:</i></p> <p>“The plunge column verticality tolerance of 1 in 400 requires specific installation methods and higher standards of steel fabrication than typically achievable. The issue of construction tolerances between the plunge column and pile reinforcing cage must be carefully considered and the use of 1 in 200 verticality is advocated for design.</p> <p>For bored piles with plunge columns, it is important to check the pile construction tolerances and internal diameter of the reinforcement cage relative to the column tolerances to avoid the column clashing with either the reinforcement cage or pile shaft, noting that the tolerances of these two constructions are different. Increasing the diameter of the pile bore is generally used to increase reinforcement cage and column clearance to 150mm. In some situations, it is possible to connect the cage to the column, place them in an oversized bore and then concrete the pile but this must be considered in conjunction with the construction method and in particular concrete placement.”</p>
C3.5 Construction Processes	74	
C3.5.1 Placing casing	74	<i>As per SPERWall.</i>
C3.5.2.3 Placing concrete in dry bores	74	<p><i>Delete:</i></p> <p>“(the London District Surveyors’ Association (LDSA) guidance notes for the design of straight shafted piles in London Clay (2009) allows 20% of the shaft area to be subject to wetting, for example).”</p>
C3.5.2.4 Placing concrete under water or support fluid	75	<p><i>Delete:</i></p> <p>“BS EN 1536 gives recommendations regarding tremie dimensions.”</p> <p><i>Replace with:</i></p> <p>“The bore of the tremie should be smooth to allow the free flow of concrete and have a minimum uniform internal diameter greater than either six times the maximum size of aggregate or 100mm.</p> <p>The external shape and dimension of the tremie, including its joints, shall allow its free movement within the reinforcement cage. The maximum outside diameter of the tremie, including its joints, should be not more than:</p> <ul style="list-style-type: none"> • 0.35 times the pile diameter, or the inner diameter of a casing • 0.45 times the inner diameter of the reinforcing cage for circular piles.” <p><i>Add the following paragraph to end of clause:</i></p> <p>“It is strongly recommended that the relevant advice which is outlined in the following guidance documents is followed during the placement of concrete using the tremie method:</p> <ul style="list-style-type: none"> • Guide to Tremie Concrete for Deep Foundations (EFFC/DFI, 2024) • Recommended Practice Tremie Concrete for Deep Foundations (CIA, 2012).”
C3.5.3 Stability of pile bore	75	<i>As per SPERWall.</i>
C3.5.5 Continuity of construction	76	<p><i>Add:</i></p> <p>“It is considered best practice from a design and safety perspective to concrete the piles as soon as practical after the drilling is completed. Where piles are deep (>20m), large diameter (>1m) or use support fluid the pile construction duration can be several days when drilling, support fluid cleaning, cage installation / splicing and concrete programming is considered; the pile design needs to be aligned with the construction programme.</p>
C3.5.6 Underreams	76	<i>As per SPERWall.</i>
C3.5.7 Cleanliness of pile bases	76	<i>As per SPERWall.</i>
C3.5.7.1 General	76	<i>As per SPERWall.</i>

C3 BORED CAST-IN-PLACE PILES

C3 Guidance notes	SPERWall Page No.	
C3.5.7.2 Underreams	78	<p><i>Delete:</i> “underreams have rarely been constructed in the UK since the 1980’s, there remain only a few UK operators experienced in underream construction”</p> <p><i>Delete:</i> “Several UK specialist contractors”</p> <p><i>Replace with:</i> “Several international specialist contractors”</p>
<i>Add:</i> C3.5.8.1 General		<p><i>Add:</i> “Visual or CCTV inspection is not practical due to the lack of clarity in water or support fluid filled bores. Where groundwater seepages into a stable bore only results in a partially filled bore inspection of the empty upper portion of the shaft is possible. The use of pumping or flocculants is not recommended as this can cause degradation of the pile shaft affecting pile performance.”</p>
C3.5.8.2 Underreams	78	<p><i>Add:</i> “In some cases, underream are adopted to provided additional tension capacity in which case testing of the base may be unnecessary.”</p>
C3.5.9 Extraction of casing	78	<i>As per SPERWall.</i>
C3.5.9.2 Concrete level		<i>As per SPERWall.</i>
C3.5.11.1 Grouting of piles	78	<p><i>Delete:</i> “UK”</p> <p><i>Replace with:</i> “NZ”</p>
C3.5.11.2 Method of grouting	78	<p><i>Delete:</i> “UK”</p> <p><i>Replace with:</i> “NZ”</p>
C3.5.11.4 Pile uplift	79	<i>As per SPERWall.</i>
C3.5.11.5 Grout tube decommissioning	79	<i>As per SPERWall.</i>

C3 Guidance notes	SPERWall Page No.	
<p>Add: C3.5.13 Driven Precast Plugs</p>		<p><i>New section:</i> “The use of driven precast plugs to induce enhanced end bearing through densification of the toe of the pile is typically applied in New Zealand for pile diameters between 900mm and 1200mm.</p> <p>Plugs are constructed of a steel casing topped with a welded steel driving plate and mass filled with high strength concrete. Sufficient curing time is required before installation and driving. Plug lengths are typically between two and four times the pile diameter. The plug diameter should be sized to provide adequate clearance to the inside of the casing to prevent engagement during driving, typically 20-40mm.</p> <p>If the annulus is too great, material may migrate to the top of the plug affecting driving efficiency.</p> <p>Casings are driven open ended to the target depth and excavated to a specified distance above the toe, nominated on the project drawings. This soil left in the base of the pile provides additional compaction ahead of the precast plug, however if it is too deep, there is a risk of the plug engaging with the casing before it reaches the base and subsequently dragging the casing down with it. In some cases, this material may be removed and replaced with a gravel pack if the in-situ soil is not considered suitable. Care should be taken when specifying this initial plug driving condition. It should consider the dimensions and site-specific ground and groundwater conditions. It is recommended that this is developed based on the relevant experience of the designer and contractor.</p> <p>When driven in submerged conditions, a modified “wet driving” Hiley formula is often used to estimate the geotechnical ultimate bearing resistance achieved. These are based on the use of a suitably sized wet driving hammer or tubular hammer.</p> <p>The following modified Hiley formula may be used to assess ultimate plug resistance:</p> $R = \frac{Whn}{s+c/2}$ <p>R = ultimate driving resistance (kN) W = non buoyed weight of hammer (kN) S = final set or penetration per blow (mean of final ten blows) measured from the portion of the hammer or suitably attached follower which protrudes above the pile casing (mm) C = sum of estimated temporary compressions of pile dolly, packings, hammer elastic shortening and ground (mm) n = efficiency of blow (dimensionless) - calculated in accordance with the formulae in Appendix C of the SESOC/NZGS Piling Specification using the non-buoyed weights of the plug and hammer h = effective free-fall height of hammer (mm)</p> <p>The effective free fall height of a suitable wet driving/ tubular hammer shall be initially estimated as:</p> <p>For free fall trigger operated wet driving/ tubular drop hammers - 60% of the drop For winch operated wet driving drop/ tubular hammers - 50% of the drop For hydraulic impact hammers suitable for underwater driving - the equivalent drop specified by the manufacturer for underwater driving</p>

C3 Guidance notes	SPERWall Page No.	
		<p>Typical options for driving submerged plugs are:</p> <p>A suitably sized wet driving hammer – this consists of two parts; a driving hammer and a guide casing. The driving hammer should be fitted with guide vanes to allow it to fall inside the guide casing with a nominal 10mm clearance. The Guide casing should be a thin-walled tube with a diameter at least 40% greater than that of the hammer but no greater than 90% of the plug diameter to allow the flow of water in the annulus between the guide casing and the pile casing. This should in turn be fitted with guide vanes to centralise it in the pile casing with a nominal clearance of 10mm (consideration should be given to internal pile protrusions such as welding backing rings). The base of the guide casing shall have four symmetrically spaced vents cut in with a total area equal to the driving hammer base. This will allow trapped water to escape and prevent excess cushioning. The guide casing should protrude above the pile casing to allow sets to be measured. Where the hammer does not protrude sufficiently at the surface to allow video monitoring of the impact velocity, it shall be fitted with a follower.</p> <p>A suitably sized tubular hammer – This consists of a heavy wall (typically 30mm thick) steel casing. The tube hammer should be at least 50% of the plug diameter but no greater than 60% of the internal diameter of the pile casing. Guide vanes shall be fitted to the casing at 10m intervals providing 20mm nominal clearance to the pile casing (consideration should be given to internal pile protrusions such as welding backing rings). The lower 1.5m of the hammer shall be reinforced with a full height cruciform of 32mm thick plate which extends outside the tube hammer to provide 20mm clearance to the pile casing. This should be welded to the tube with at least 20mm SP fillet weld all round to NZS 1554.1. The tubular shape of this approach reduces drag and prevents energy loss through cushioning. The hammer must extend above the top of the pile casing, including when the plug is fully driven, to allow sets to be measured. At no point should the tube be closed off with plates or other obstructions which could cause cushioning. Temporary compression due to the elastic shortening of the tube hammer should be considered in this method.</p> <p>A suitable static mandrel – This consists of a tubular steel mandrel installed on top of the plug which is then top or bottom driven in the dry using a traditional drop hammer or hydraulic hammer. The mandrel must be suitably sized to overcome the buoyancy effects from displaced water. When top driven, the mandrel must have appropriate strength to resist the applied driving stresses. Driving stresses in the mandrel must not exceed 0.9fy. Temporary compression due to elastic shortening of the mandrel when top driving should be considered for this method. The principal advantage provided by top driving the mandrel in this method is the opportunity for the use of dynamic pile load testing in accordance with B16. This can be installed to the section of the mandrel above the pile casing.</p> <p>It is not generally considered reasonable to expect a piling contractor to have access to hammers to suit submerged driving for all pile diameters and lengths. The contractor may propose the use of a hammer which falls slightly outside the recommendations above. Where the contractor proposes the use of a suitably detailed drop hammer which does not meet the above criteria, acceptance should be based on the contract administrator's experience and the contractors demonstrated past performance with similar equipment. It is important in this case that dynamic measurement using high speed video capture is used to verify the true effective free fall height to confirm that the hammer can act efficiently. The criteria for the minimum hammer weight relative to the plug weight (using non buoyed weights) in Appendix C of SESOC/NZGS Piling Specification shall apply.</p> <p>The typical remedial for plugs which fail to achieve adequate resistance before reaching the minimum engagement inside the casing is for a second plug to be placed directly on top of the first and driving to continue. Consideration should be paid to efficiencies of driving equipment and the proven thickness of the founding strata.</p>

C4 PILES CONSTRUCTED USING CONTINUOUS FLIGHT AUGERS OR DISPLACEMENT AUGERS

The following amendments modify Section C4 in Part C of SPERWall.
 Any clause not amended by the following documents shall remain as written in SPERWall.

C4 Guidance notes amendments	SPERWall Page No.	
C4.1 General	85	<i>As per SPERWall.</i>
C4.2 Project Specification	85	<i>Add</i> (e) detailed method statement describing all proposed equipment and the construction sequence.
C4.3 Materials	85	<i>As per SPERWall.</i>
C4.3.1 Steel reinforcement	85	<i>As per SPERWall.</i>
C4.4 Construction Processes	85	<i>Add:</i> Tolerances are provided in SPERWall, Table B1.4. Engineer to amend as considered necessary in the Project Specification and/or with the Contractor.
C4.4.1 Boring	85	<i>Add:</i> Special care is required for the construction of continuous flight auger piles in cohesive soils with an undrained shear strength of less than 15 kPa and cohesionless (granular) soils below the ground water level with uniformity coefficients (D60/ D10) of less than 3.
C4.4.3 Removal of augers from the ground	86	<i>As per SPERWall.</i>
C4.4.4 Use of air during boring	87	<i>As per SPERWall.</i>
C4.4.5 Depth of piles	87	<i>As per SPERWall.</i>
C4.4.6 Placing concrete	87	<i>As per SPERWall.</i>
C4.4.6.1 General	87	<i>As per SPERWall.</i>
C4.4.6.2 Commencement of concrete supply to each pile	87	<i>Add:</i> For side discharge augers reborings after initiation is important.
C4.4.6.3 Rate of supply of concrete	88	<i>As per SPERWall.</i>
C4.4.6.4 Interruption in concrete supply	88	<i>As per SPERWall.</i>
C4.4.7 Splitting of augers	89	<i>As per SPERWall.</i>
C4.4.8 Placing of reinforcement	89	<i>Add:</i> SPERWall allows for reinforcement to be +150mm/-50mm, (i.e. be 150mm high). Contract administrator to recommend to specify project specific values if this is not suitable.
C4.4.10 Monitoring system for pile construction	89	<i>As per SPERWall.</i>

C4 PILES CONSTRUCTED USING CONTINUOUS FLIGHT AUGERS

C4.4.10.1 Automated monitoring system	89	<i>As per SPERWall.</i>
C4.4.10.2 Manual monitoring system	90	<i>As per SPERWall.</i>
C4.4.10.3 Target boring and concreting parameters	90	<i>As per SPERWall.</i>
C4.4.10.4 Calibration	90	<i>As per SPERWall.</i>
C4.5 Records	90	<i>As per SPERWall.</i>
C4.5.1 Records of piling	90	<i>As per SPERWall.</i>
C4.5.2 QC testing	90	<i>Add:</i> Contract administrator to consider requirement for integrity testing of piles and specify as required.

C5 CAST-IN-SITU DISPLACEMENT PILES

The following amendments modify Section C5 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C5 Guidance notes amendments	SPERWall Page No.	
C5.1 General	93	<p><i>Delete:</i> BS EN 12699.</p> <p><i>Replace with:</i> “AS 2159 as the general standard adopted for piling design and installation that includes cast in-situ displacement piles.”</p>
C5.3.2 Pile Shoes – watertightness	93	<p><i>Add:</i> “It should be noted that the standard pile shoe (traditionally referred to as a “penny”) is typically a contractor specified element.”</p>
C5.3.3 Concrete for use with base driving or for an enlarged base	93	<p><i>Add:</i> “Gravel plugs are typically use for bottom driven piles in NZ.”</p>
C5.4.1 Temporary casing	93	<p><i>As per SPERWall.</i></p>
C5.4.4 Base Driving	93	<p><i>Add:</i> “The gravel driving plug material should be recharged at maximum intervals of 40 minutes during continuous driving or when the plug becomes powdered resulting in a soft response indicating a loss of driving efficiency. The recharge plug length shall be between 450 mm and 600 mm long. A recharge plug shall have at least 20 blows and no more than 75 blows applied to it prior to measuring the set.</p> <p>Up to 60 kg of cement may be added to the initial gravel plug but recharging of the driving plug does not require cement to be added.”</p>
<i>Add:</i> C5.4.7 Inspection and remedial work	93	<p><i>Add:</i> “There have been instances in New Zealand of pile casings having collapsed during driving. It is therefore recommended that the interior of the pile casing is visually inspected to verify the integrity of the pile prior to concrete placement.”</p>
C5.4.8 Placing concrete	93	<p><i>As per SPERWall.</i></p>
C5.4.11 Concrete casting Tolerances	93	<p><i>As per SPERWall.</i></p>
C5.4.12 Cutting off Pile Heads	93	<p><i>As per SPERWall.</i></p>

C6 MICROPILES

The following commentary adds to Section C6 in Part C SPERWall to suit New Zealand good practice and conditions.

Any clause not amended shall remain as written in SPERWall.

C6 Guidance Notes	SPERWall Page No.	
C6.3 Definitions and uses and types	97	<p><i>Para 2, add:</i> “(e) kinematic soil displacements and/or lateral soil displacements.”</p> <p><i>Add new clauses:</i> “Differentiation in design approaches for micropiles designed to resist tensile loads and those required for ground anchors must be considered. For the design of ground anchors reference should be made to the NZGS Ground Anchor Guidelines or other appropriate, relevant design standards.</p> <p>When designing micropiles for lateral load and kinematic effects, reference should be made to MBIE/NZGS Module 4 Earthquake Resistant Foundation Design.”</p>
C6.4.1 Materials grout/mortar/concrete	97	<i>As per SPERWall.</i>
C6.4.2 Materials reinforcement	98	<i>As per SPERWall.</i>
C6.5 Construction processes	98	<i>As per SPERWall.</i>
C6.5.1 Installation of self-drilling hollow bar	98	<i>As per SPERWall.</i>
C6.5.2 Installation of rotary bored micropiles	98	<i>As per SPERWall.</i>
C6.5.3 Installation of SFA micropiles	99	<i>As per SPERWall.</i>
C6.6 Testing	99	<i>As per SPERWall.</i>

C7 HELICAL STEEL PILES

The following amendments modify Section C7 of Part C of SPERWall.

Any guidance clause not amended by the following documents remain as written in SPERWall.

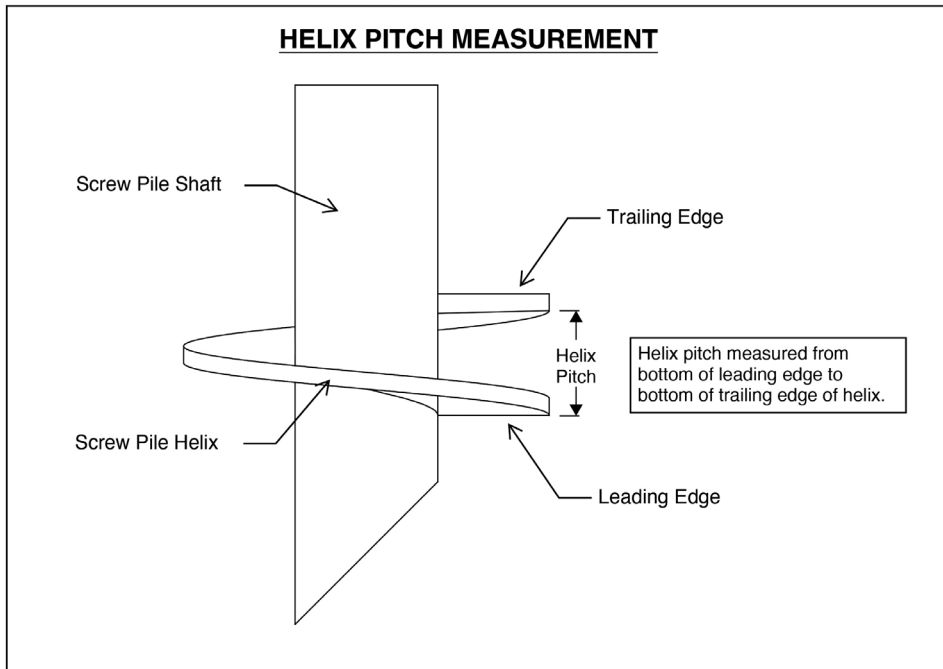
C7 Guidance notes	SPERWall Page No.	
C7.1 General	103	<p><i>Delete and replace with the following:</i></p> <p>“This section applies to the durability, material execution, construction, monitoring and load testing of helical (or screw) steel piles. The section gives non-contradictory, complimentary information for use with AS2159 and IPENZ Practice Note 28. Detailed guidance on helical steel piles can be obtained from IPENZ Practice Note 28 and sector/employer specific standards and specifications.</p> <p>Helical piles generally comprise a lead section (comprising individual helical plates attached to a central steel shaft) and extension sections.</p> <p>Flat plate screw in piles are not defined as ‘helical’ piles as their drive plates do not meet the requirements of clause B7.3.3 of this specification, fundamental to a helical pile. Whilst SPERWall B7 could be used as a reference for shaft and helix materials and manufacturing requirements, it is recommended that the user consider a product specific specification for flat plate screw in piles.</p> <p>The use of cast single or multi-turn helices are excluded from this specification. The quality risks of cast products subject to high strains and multi-directional loading are vast and are insufficiently covered in SPERWall. Single or multi-turn cast helices are a proprietary product, and the supplier should provide their own technical specification.”</p>
C7.2 Project specification	103	<p><i>Delete:</i></p> <p>“(d) Helical piles are normally manufactured to BS EN 10219, BS EN 10210 and BS EN 10025 in grades S275 and S355, but higher strength steel options are available.</p> <p>(e) Helical piles are usually hot dip galvanised to at least 2m below ground level, rather than over the full depth of the pile.”</p> <p><i>Replace with:</i></p> <p>“(d) Helical piles are normally manufactured using grade C350 steel circular hollow sections, but higher strength steel options are available.</p> <p>(e) Appropriate allowance should be made for corrosion. In New Zealand use of a sacrificial thickness of steel is commonly used due to the damage to coatings that will occur during installation.”</p>
C7.3 Materials and fabrication	103	<p><i>Delete:</i></p> <p>This entire Clause shall be deleted.</p> <p><i>Replace with:</i></p> <p>“Information on steel properties can be found in IPENZ Practice Note 28 Appendix C Clause SP7.0.”</p>
C7.3.2 Inspection and test certificates	103	<i>As per SPERWall guidance.</i>
C7.3.3 Manufacturing tolerances	103	<p><i>Delete:</i></p> <p>This entire Clause shall be deleted.</p> <p><i>Replace with:</i></p> <p>“Helical plate fabrication tolerances have been specified to ensure a ‘true’ helix is formed. Helices that do not conform with the outlined tolerances (including piles using flat plates, or similar).</p> <p>Further information on material tolerances can be found in IPENZ Practice Note 28 Appendix C Clause SP7.0.”</p>

C7 HELICAL STEEL PILES

C7 Guidance notes	SPERWall Page No.	
C7.4 Construction processes	103	
C7.4.4 Installation of piles	103	<i>As per SPERWall guidance.</i>
C7.4.4.1 Installation Torque	103	<i>Add the following paragraph to end of clause:</i> “Direct electronic torque measuring devices are the most accurate and preferable method of measuring torque. Appropriate calibration of such devices should be regularly maintained. If torque is to be inferred using the hydraulic pressure through the torque motor, then the system should be calibrated using direct electronic torque measuring equipment at a frequency of not less than 6 months, and due consideration should be given to any variation in the system such as oil temperature, influence of other hydraulic functions simultaneous with torque application, and any mechanical changes with the plant.”
<i>Add:</i> C7.4.4.4 Penetration rate	103	<i>Add:</i> “The helix pitch shall be defined as the distance from the bottom of the leading edge of the helix plate to the bottom of the trailing edge of the helix plate.” See helix pitch sketch provided at end of this amendment.
C7.5 Protection against corrosion	103	<i>Delete:</i> “BS EN 1993-1-1 and to BS EN 1993-5” <i>Replace with:</i> “AS 2159 Section 6.5 and SNZ TS 3404”.
C7.5.1 Considerations	103	
C7.6 Welding procedures	104	
C7.6.2 Non-destructive testing of welds	104	<i>Delete:</i> This entire Clause shall be deleted. <i>Replace with:</i> “All welding, testing and inspection of welds shall be in accordance with NZS 1554.”
C7.7 Static load testing of helical piles	104	
C7.7.1 General	104	<i>Add:</i> “When determining the testing requirements in accordance with AS 2159 Clause 8.2.4, allowance may be made for verification testing other than static load testing (e.g. installation torque to axial capacity correlations). Supporting evidence on the suitability / applicability of the correlation to the specific site shall be provided by the engineer.”
C7.8 Design	104	<i>Add:</i> Further guidance on the design of helical piles may be found within IPENZ Practice Note 28 Appendix C Clause SP6.0.
C7.8.1 Compliance with standards	104	<i>Delete:</i> “BS EN 1997-1, national annex to BS EN 1997-1” <i>Replace with:</i> “AS 2159, NZS 3404” <i>Delete:</i> “BS 8004” <i>Replace with:</i> “IPENZ Practice Note 28”
C7.8.2 Piles that do not achieve design depth or minimum installation torque	104	<i>Delete:</i> “BS 8004 annex A” <i>Replace with:</i> “IPENZ Practice Note 28”

C7 Guidance notes	SPERWall Page No.	
<p>Add: C7.9 Concrete Placement</p>		<p>Add: “Concrete infill to helical pile is not mandatory, but provides ductility, stiffness, internal corrosion protection, and strength improvements to the pile shaft. A concrete filled CHS is one of the most ductile sections available and can handle high curvatures without structural failure.</p> <p>The choice of concrete mix and aggregate size needs careful consideration. NZS3101 Clause 8.3.2 states “the nominal maximum size of the aggregate shall be equal to or less than three-quarters of the minimum clear spacing between individual reinforcing bars...” but this should also apply to the clear spacing between reinforcing bars and the inside wall of the pile shaft.</p> <p>Concrete can be placed by chute or pump and can be dropped from any height provided the concrete does not contact a reinforcing cage during placement causing segregation of concrete. For piles less than 100mm nominal bore a grout fill should be considered instead of concrete.”</p>

C7.4.4.4 Helix Pitch sketch.jpg



C8 STEEL BEARING PILES

The following amendments modify Section C8 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C8 Guidance notes	SPERWall Page No.	
C8.1 General	111	<i>As per SPERWall.</i>
C8.2 Project Specification	111	<i>Delete:</i> "BS EN 10025 in grades S235, S275 and S355" <i>Replace with:</i> "NZS 3404 in grades 300 and 350"
C8.3 Materials	111	<i>Delete:</i> This entire Clause shall be deleted <i>Replace with:</i> "Information on steel properties can be obtained from NZS 3404 and NZS 3679"
C8.3.1 Compliance with standards	111	<i>Add:</i> "Local random verification testing is recommended to be carried out where any one of the following applies: <ul style="list-style-type: none"> • Steel traceability requirements to AS/NZS 5131 cannot be met. • Structural steel materials are not sourced from and certified by an ACRS, API, or JAS-ANZ accredited 3rd Party Certification Scheme accredited supplier. (ACRS = Australasian Certification Authority for Reinforcing and Structural Steels, API = American Petroleum Institute and JAS-ANZ = Joint Accreditation System of Australia and New Zealand). • Mill or test certificates are not endorsed by an ILAC signatory holding accreditation for the correct scope of testing to the named steel Standard of supply. (ILAC = International Laboratory Accreditation Cooperation). • Mill or test certificates are not able to be verified as genuine. • When steel materials do not perform as expected during fabrication or erection. Further guidance is available here: https://www.nzta.govt.nz/resources/17-09-verification-testing-of-steel-materials "
C8.3.2 Inspection and test certificates	111	<i>Delete:</i> Second Paragraph <i>Add:</i> "In the case of second life and re-used materials, these shall as a minimum comply with the requirements concerning geometrical and material properties specified in the design and shall be free from damage and deleterious matters that would affect strength and durability. Justification and supporting information for these materials shall be made available to the contract administrator at least one week before work commences. Further guidance on the reused materials in New Zealand can be found in Structural Steel Reuse Protocol (SCNZ, 2009)."
C8.3.3 Pile Shoes	111	<i>Add:</i> "The following types of pile shoes have previously been used in New Zealand where piles have been driven on moderately strong to extremely strong rock: <ul style="list-style-type: none"> • With universal columns, a section of the same size, but heavier section; e.g. a 2 metre length of 310UC137 welded to the bottom of a 310UC97 • With universal columns - two steel plates parallel with the web at ¼ points along the flanges • With steel tubes a section of the same size, but heavier wall section; e.g. a 2 metre length of 610x15.8 tube welded to the bottom of a 610x12.7 tube"
C8.4.1 Ordering of piles	111	<i>As per SPERWall.</i>
C8.4.3 Handling and storage of piles	111	<i>As per SPERWall.</i>

C8 Guidance notes	SPERWall Page No.	
C8.4.4 Installation	111	<i>As per SPERWall.</i>
C8.4.8 Matching of tubular pile lengths	111	<i>Add:</i> "Alignment of piles with seams offset less than 100mm may be carried out subject to the engineer's approval."
C8.4.11 Extraction	112	<i>As per SPERWall.</i>
C8.5 Coating piles for protection against corrosion	112	<i>As per SPERWall.</i>
C8.5.8 Thickness, number and colour of coats	112	<i>Delete:</i> "Part 7 of BS EN ISO 12944" <i>Replace with:</i> "AS/NZS 2312"
C8.6.1 Site welding	112	<i>As per SPERWall.</i>
C8.6.2.1 Welded tubular piles	112	<i>As per SPERWall.</i>

C9 DRIVEN TIMBER PILES

The following amendments modify Section C9 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C9 Guidance notes	SPERWall Page No.	
C9.1 General	116	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “Timber piles for permanent structures should only be used below the lowest anticipated groundwater table or free water level during the lifetime of the structure unless adequate protection is provided.</p> <p>Further guidance on the design and installation of timber piles is given in AS 2159. Further guidance on design, suitable species and treatment is given in NZS 3603, NZS 3605 and AS 1720.”</p>
C9.2 Project specification	116	<i>As per SPERWall.</i>
C9.3 Materials	116	<i>As per SPERWall.</i>
C9.3.1 Species /grade of timber	116	<p><i>Add:</i> “The species listed are available in the UK. Alternative common species are available in New Zealand e.g. Ironbark. Reference should be made to NZS 3603 and AS 1720 Part 2: Timber Properties”</p>
C9.3.4 Preservatives	116	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “The natural durability class of timber heartwood varies between species, while the sapwood of all species is effectively non-durable. Four durability classes are defined in AS1720 Part 2 in accordance with the classification system established in AS 5604. These range from 1 (very durable) to 4 (not durable).</p> <p>The durability classes should not be used as stand-alone criteria for determining the suitability of timber species for particular projects. Other factors can have significant influence on the performance and life expectancy of timber in specific applications and environments including:</p> <ul style="list-style-type: none"> - Preservative treatment - Supplementary protection and maintenance - Climate - Environmental conditions - Human influence - Member sizing and detailing - Manufacturing process <p>In particular attention should be paid to the negative influence of salt water on the life expectancy of timber piles, when selecting an appropriately durable species.</p> <p>As most hardwoods are resistant to preservative treatment, the most suitable timber selection for piling is often either hardwoods with a high durability class or softwoods with appropriate preservative treatment.</p> <p>Consideration should be given to using the timber in the round (i.e. not sawn). The band of sapwood on the outside of round timber is normally more permeable than heartwood and can be penetrated with a high loading of preservative. This can provide a better degree of protection than that to be expected from the limited preservative penetration often obtained in the heartwood of timber classed as resistant or extremely resistant.</p> <p>NZS 3640 and should be used to select appropriate treatments to suit all likely exposure conditions throughout New Zealand, based on the six hazard classes established in the standard.</p> <p>Treatment specified to NZS 3640 should also be designed to provide protection for the timber against insect attack as appropriate.”</p>

C9 DRIVEN TIMBER PILES

C9 Guidance notes	SPERWall Page No.	
C9.3.5 Certification of timber	117	<p><i>Delete:</i> This entire clause shall be deleted.</p> <p><i>Replace with:</i> “Timber certification schemes exist to demonstrate that a timber product has been sourced from a responsibly and sustainably managed forest. The largest international forest certification schemes are:</p> <ul style="list-style-type: none"> • Forest Stewardship Council (FSC) • Programme for the Endorsement of Forest Certification (PEFC) <p>These are the main schemes within New Zealand and Australia, however others are in operation and further schemes are more prevalent internationally.</p> <p>It is important than any specification requirement for the certification of timber is appropriate and not overly restrictive or unachievable. Enquiries should be made with suppliers regarding the availability of the selected timber species under various schemes. It may be necessary to balance the importance of certification with the selection of specific timber species for specification in a project.”</p>
C9.3.6 Pile shoes	117	<p><i>Add:</i> “The driving of timber piles may cause high toe stress and splitting depending on ground conditions, installation method and pile details. A combination of analysis and/or past experience should be used to decide whether pile shoes are required. Consideration should be made of lateral constraint and support of the pile provided by overlying strata.</p> <p>A fitted cone fabricated from plate may be used to form the driving shoe.”</p>
C9.4 Construction processes	117	<i>As per SPERWall.</i>

C10 DIAPHRAGM WALLS AND BARRETTES

The following amendments modify section C10 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C10 Specification amendments	SPERWall Page No.	
C10.1 General	122	<i>As per SPERWall.</i>
C10.2 Project specification	122	<i>Add:</i> “The use of the basement space should be carefully considered but typically an internal lining wall is not required where a diaphragm wall is constructed with a waterbar at each panel joint. It is good practice to provide an accessible drainage channel at each basement floor level to confine and manage any seepages that are present.”
C10.3 Materials	122	<i>As per SPERWall.</i>
C10.3.1 Support fluid	122	<i>Delete:</i> The entire clause shall be deleted. <i>Replace with:</i> “Whilst Section 20 provides detailed information on support fluids the ground conditions and nature of the bentonite used e.g., sodium bentonite, sodium-activated and bentonite – polymer blends can be specified more narrowly.”
C10.3.4 Alternative to steel reinforcement	122	<i>Add:</i> “The use of stainless steel or galvanized steel should not be used with bentonite as an adverse reaction can cause the build-up of bentonite affecting the quality of the diaphragm wall.”
C10.4 Construction tolerances	122	<i>As per SPERWall.</i>
C10.4.1 Guide wall	122	<i>As per SPERWall.</i>
C10.4.2 Diaphragm wall and barrettes	122	<i>As per SPERWall.</i>
C10.4.3 Recesses	123	<i>Delete:</i> Bullet point (a) as re-bending of structural steel reinforcement is not generally permitted in New Zealand.
C10.4.4 Reinforcement	123	<i>Add:</i> “The clearance between vertical and horizontal reinforcement should allow for the actual bar diameter of deformed / ribbed bars and consider steel reinforcement fabrication tolerances particularly where paired or groups of bars are used.” Cages are typically fabricated off-site and transported to site in sections and spliced so there is continuity over the full depth / elevation. In a multi-bite, corner and tee panels multiple cages are required in plan; the use of additional horizontal bars to create the vertical splice between these cages is not recommended given the associated safety and quality issues. For horizontal couplers within the reinforcement cage to facilitate connection to structural slabs or beams positional tolerances to be +/- 50mm where a single reinforcement cage lifted into the panel. An additional allowance of 20mm per splice should be allowed for couplers located below reinforcement cage splices”
C10.4.5 Concrete casting level	126	<i>As per SPERWall.</i>
C10.4.6 Dimensions of panels	126	<i>As per SPERWall.</i>

C10 DIAPHRAGM WALLS AND BARRETTES

C10 Specification amendments	SPERWall Page No.	
C10.4.7 Water retention	126	<p><i>Add:</i></p> <p>“The use of box-outs and couplers is recommended for base slab connections to minimise breaking out or drilling of concrete that can cause cracking that permit groundwater seepages.</p> <p>The use of anchors can be achieved using reservation tubes fixed to the reinforcement cage. The use of a steel tube with a waterstop detail and an anchor head that allows grouting after stressing is recommended to minimise potential leakage.</p> <p>It is noted that the stressing sequence of the anchors must be in accordance with the design to ensure stresses and associated concrete crack widths are not exceeded as these can cause groundwater seepage”</p>
C10.5 Construction processes	127	<i>As per SPERWall.</i>
C10.5.1 Drawings	127	<p><i>Add:</i></p> <p>“The panel layout drawing is important from construction perspective and must be developed jointly by the Designer and Contractor.”</p>
C10.5.2 Guide walls	127	<i>As per SPERWall.</i>
C10.5.3 Stability of the excavation	127	<i>As per SPERWall.</i>
C10.5.4 Cleanliness of the base	128	<p><i>Add:</i></p> <p>“The methodology for testing base hardness may be similar to that used for a bored pile (B3) where significant end bearing capacity is required. A method statement for testing the base should be submitted for approval.”</p>
C10.5.6 Stop-ends in diaphragm wall panels	128	<i>As per SPERWall.</i>
C10.5.7 Placing concrete	128	<p><i>Add:</i></p> <p>“The EFFC/ DFI Guide to Tremie Concrete for Deep Foundations is considered best practice.”</p>
C10.6 Records	128	<i>As per SPERWall.</i>
C10.6.1 Placing concrete	128	<p><i>Add:</i></p> <p>“An example tremie pour record is provided in Appendix B of the SESOC/NZGS Piling Specification.</p>
C10.6.2 Records of special control measures during excavation	129	<i>As per SPERWall.</i>
C10.7 Trial panels	129	<i>As per SPERWall.</i>

C11 SECANT PILES

The following amendments modify Section C11 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C11 Guidance notes amendments	SPERWall Page No.																						
C11.1 General	132	<i>As per SPERWall.</i>																					
C11.2 Project specification	132	<i>As per SPERWall.</i>																					
C11.3 Materials	132	<i>As per SPERWall.</i>																					
C11.3.1 Self-hardening slurry mixes and low-strength concrete	132	<p><i>Add:</i></p> <p>“Low strength concrete mixes are generally 5 - 10MPa at 28 days to facilitate drilling at an age of 2 - 5 days. These mixes do not comply with current New Zealand or other international standards for concrete primarily from a durability perspective. Also, suitable replacement cementitious materials that are commonly used internationally in low-strength concretes may not be readily available locally.</p> <p>The maximum strength or strength gain is more important for construction quality and buildability than the minimum 28 day strength that is normally targeted by concrete specifiers and suppliers; specific trials, quality control measures and early age strength testing are essential as high early strength gain of the concrete can result in pile construction and tolerance issues with loss of pile interlock.</p> <p>It is generally understood that these mixes are predominantly temporary works with internal liner walls to provide the necessary long-term groundwater retention. Some relevant references are Gannon (2015) and Quillin et al. (2005).</p> <p>Gannon, J. (2015). Primary firm secant pile concrete specification. Proceedings of the Institution of Civil Engineers, Geotechnical Engineering, Vol. 169, Issue 2, pp. 110-120. Published online: https://doi.org/10.1680/jggen.15.00038</p> <p>Quillin, K., Nixon, P.J., Matthews, J.D. and Longworth, T.I. (2005). Concretes with high ggbs contents for use in hard/firm secant piling. BRE Information paper IP 17/05. ISBN 186081 894 3.”</p>																					
C11.4 Construction tolerances	132	<i>As per SPERWall</i>																					
C11.4.2 Secant piles	132	<p><i>Add:</i></p> <p>“The necessary overlap of the secant piles relies upon the plan and verticality tolerances adopted in the design being aligned with the pile construction methodology as tabulated below:</p> <table border="1" data-bbox="564 1496 1230 1872"> <thead> <tr> <th>Pile installation Methodology</th> <th>Verticality Tolerance</th> <th>Maximum Pile Interlock Depth</th> </tr> </thead> <tbody> <tr> <td>Bored pile with standard tooling</td> <td>1 : 75</td> <td>5 m</td> </tr> <tr> <td>CFA pile:</td> <td>1 : 75</td> <td>5 m</td> </tr> <tr> <td>• Standard tooling</td> <td></td> <td></td> </tr> <tr> <td>• Extra heavy-duty augers</td> <td>1 : 125</td> <td>7 m</td> </tr> <tr> <td>• Cased CFA</td> <td>1 : 150</td> <td>15 m</td> </tr> <tr> <td>Bored pile with stiffened casing and cutting teeth</td> <td>1 : 200</td> <td>20 m</td> </tr> </tbody> </table> <p>The above tolerances are only achievable if the adjacent low strength concrete piles are of similar age and strength which requires careful pile construction sequencing.</p>	Pile installation Methodology	Verticality Tolerance	Maximum Pile Interlock Depth	Bored pile with standard tooling	1 : 75	5 m	CFA pile:	1 : 75	5 m	• Standard tooling			• Extra heavy-duty augers	1 : 125	7 m	• Cased CFA	1 : 150	15 m	Bored pile with stiffened casing and cutting teeth	1 : 200	20 m
Pile installation Methodology	Verticality Tolerance	Maximum Pile Interlock Depth																					
Bored pile with standard tooling	1 : 75	5 m																					
CFA pile:	1 : 75	5 m																					
• Standard tooling																							
• Extra heavy-duty augers	1 : 125	7 m																					
• Cased CFA	1 : 150	15 m																					
Bored pile with stiffened casing and cutting teeth	1 : 200	20 m																					
C11.4.3 Recesses	133	<i>As per SPERWall</i>																					

C11 Guidance notes amendments	SPERWall Page No.	
C11.4.4 Reinforcement	133	<p><i>Delete paragraph 5 and replace with:</i></p> <p>“To avoid lifting of reinforcement during casing removal on bored piles, or to assist plunging reinforcement into continuous flight auger piles, it may be necessary to increase cover above that specified in the project specification. Where full-length casing is required, a minimum clear distance of 50 mm between the inside of the temporary casing and outer cage diameter should be maintained.”</p> <p><i>Add the following to end of clause:</i></p> <p>“The clearance between vertical and horizontal reinforcement should allow for the actual bar diameter of deformed / ribbed bars and consider steel reinforcement fabrication tolerances particularly where paired or groups of bars are used.</p> <p>The final cover may need to be increased beyond 75mm due to temporary casing thickness particularly where segmental casing is required.</p> <p>For horizontal couplers within the reinforcement cage to facilitate connection to structural slabs or beams positional tolerances to be +- 50mm where a single reinforcement cage lifted into the pile. An additional allowance of 20mm per splice should be allowed for couplers located below reinforcement cage splices.</p> <p>In a pile cage, twist and orientation must be controlled to achieve +/- 15° rotational accuracy at coupler level.”</p>
C11.4.5 Water retention	133	<p><i>Add:</i></p> <p>“The cold joint between each pile and low strength concrete durability generally means an internal lining wall designed for the water pressures is required.”</p>
C11.4 Construction processes	134	<p><i>As per SPERWall.</i></p>
C11.5.1 Guide walls	134	<p><i>As per SPERWall.</i></p>
C11.5.2 Bored cast-in-place piles	134	<p><i>As per SPERWall.</i></p>
C11.5.5 Boring into recently cast piles	134	<p><i>As per SPERWall.</i></p>

C12 CONTIGUOUS PILE WALLS

The following amendments modify Section C12 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C12 Guidance notes amendments	SPERWall Page No.	
C12.1 General	138	<i>As per SPERWall.</i>
C12.2 Project specification	138	<i>As per SPERWall.</i>
C12.3 Materials	138	<i>As per SPERWall.</i>
C12.3.1 Support fluid	138	<i>As per SPERWall.</i>
C12.4 Construction tolerances	138	<i>As per SPERWall.</i>
C12.4.1 Guide wall	138	<i>As per SPERWall.</i>
C12.4.2 Contiguous piles	138	<p><i>Add:</i></p> <p>“The layout of contiguous piles should consider the overall construction methodology, in particular:</p> <ul style="list-style-type: none"> • The use of a guidewall to improve tolerance in plan from 75mm to 25mm, • The drilling method and associated verticality tolerance achievable, • The actual diameter of the pile allowing for the outside diameter of any temporary casing used. <p>Based upon the above and pile depth, the spacing must ensure piles do not clash affecting the verticality, productivity and the overall quality of the wall.”</p>
C12.4.3 Recesses	138	<i>As per SPERWall.</i>
C12.4.4 Reinforcement	138	<p><i>Delete paragraph 4 and replace with:</i></p> <p>“To avoid lifting of reinforcement during casing removal on bored piles, or to assist plunging reinforcement into continuous flight auger piles, it may be necessary to increase cover above that specified in the project specification. Where full-length casing is required, a minimum clear distance of 50 mm between the inside of the temporary casing and outer cage diameter should be maintained.”</p> <p><i>Add the following paragraph to end of clause:</i></p> <p>“For horizontal couplers within the reinforcement cage, to facilitate connection to structural slabs or beams, positional tolerances should be +/- 50mm where a single reinforcement cage is lifted into a pile. An additional allowance of 20mm per splice should be allowed for couplers located below reinforcement cage splices.</p> <p>In a pile cage, twist and orientation must be controlled to achieve +/- 15° rotational accuracy at the coupler level.”</p>
C12.5 Construction processes	139	<i>As per SPERWall.</i>
C12.5.1 Guide walls	139	<i>As per SPERWall.</i>
C12.5.6 General	139	<i>As per SPERWall.</i>

C13 KING POST WALLS

The following amendments modify Section C13 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C13 Guidance Notes	SPERWall Page No.	
C13.1 General	142	SPERWall refers to a contractor supplied design for king post elements. In New Zealand, it is considered more typical that permanent king post retaining wall designs are usually provided by the Designer.
C13.3 Materials	142	
C13.3.2 Support Fluid	142	<i>As per SPERWall.</i>
C13.4 Construction Tolerances	142	
C13.4.2 King Posts	142	<i>As per SPERWall.</i>
C13.4 Construction Tolerances	142	
C13.5.4 Placing king posts	142	<i>As per SPERWall.</i>

C14 STEEL SHEET PILES

The following amendments modify Section C14 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C14 Guidance notes	SPERWall Page No.	
C14.1 General	148	<p><i>Delete:</i> “, in accordance with the UN National Annex NAD to BS EN 1993-5”</p> <p><i>Add:</i> “For installation of vinyl sheet piles refer to US Corps of Army Engineers ECB2017-4 Interim Polyvinyl PVC Sheet Pile Guidance.”</p> <p><i>Add:</i> “The requirements for temporary works sheet piles may vary from permanent works, including:</p> <ul style="list-style-type: none"> • Installation tolerances • Installation controls • Deflections • Factor of safety for overall stability • Corrosion • Coatings”
C 14.3 Materials and fabrication	148	<i>As per SPERWall.</i>
C14.3.2 Fabricated sheet piles	148	<i>As per SPERWall.</i>
C14.3.5 Clutch sealant and seal welding	148	<i>As per SPERWall.</i>
C14.4.1 Ordering of piles	149	<i>As per SPERWall.</i>
C14.4.3 Handling and storage of piles	149	<i>As per SPERWall.</i>
C14.4.4 Pile Installation	149	<i>As per SPERWall.</i>
C14.4.9 Methods of assisting pile installation	150	<p><i>Delete:</i> “14.7.3”</p> <p><i>Replace with</i> “14.8.3”</p>
C14.5 Corrosion rates	151	<p><i>Delete:</i> “BS EN 1993-5”</p> <p><i>Replace with:</i> “SNZ TS 3404:2018”</p>
C14.5.1 Coating piles for protection against corrosion	151	<i>As per SPERWall.</i>
C14.6 Welding procedures	151	<p><i>Delete:</i> “Figure C14.1”</p> <p><i>Replace with:</i> “AS/NZS 1554.1”</p>

C14 Guidance notes	SPERWall Page No.	
C14.6.1 Welding standards	151	<p><i>Delete:</i> This entire clause shall be deleted</p> <p><i>Replace with:</i> “Information regarding welding is given in BS EN 12063. Welder approval to AS/NZS 1554.1 is necessary to demonstrate competence in general welding techniques for both butt and fillet welds. If a range of approval is required, it should be clearly stated in the project specification.</p> <p>AS/NZS 1554.1 is also appropriate for any associated steelwork such as bracing and strutting to the sheet piling.”</p>
C14.6.2 Seal welds	151	<p><i>Delete:</i> Paragraph 2</p> <p><i>Delete:</i> Figure C14.1</p>
C14.8 Specialised systems	151	
C14.8.1 Combi-Walls	151	<i>As per SPERWall.</i>
C14.8.2 Toe pinning	153	<i>As per SPERWall.</i>
C14.8.3 Crush piling	153	<i>As per SPERWall.</i>
Figure C14.1	152	<p><i>Delete:</i> This entire figure shall be deleted</p>

C15 INTEGRITY TESTING

The following amendments modify Section C15 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C15 Guidance note amendments	SPERWall Page No.	
C15.1 General	156	<p><i>Add:</i></p> <p>“The need for integrity testing shall be evaluated using a risk-based approach, considering relevant project-specific factors including but not limited to:</p> <ul style="list-style-type: none"> • Pile installation method and associated potential for otherwise undetectable defects. • Prior experience of contractor with the specific method of construction. • Limitations and applicability of integrity test methods to the construction methodology. • Ground conditions, depth of excavation, level of water table. • Need for tremie placement of concrete. • Whether the pile bore will be dry at placement of concrete. • Structure importance level. • Structural redundancy. • Consequence of failure, and potential impact to adjacent property. • Alternative means of verifying integrity (e.g. ability to visually examine exposed face of secant or contiguous pile walls during excavation). • Available means and effectiveness of undertaking integrity testing after pile installation in the event that issues are encountered during construction, noting most methods require prior installation of instrumentation or access tubes. <p>Integrity testing has traditionally been considered to be within the purview of the geotechnical engineer. However, it should be appreciated that integrity testing is undertaken primarily to identify defects that may affect the structural performance of the foundations, and structural input is therefore critical. Any assessment of the need for such testing shall therefore be made with due consideration of both structural and geotechnical factors, and the results of any such testing shall be considered by both the geotechnical and structural designers.”</p>
C15.2 Methods of testing	156	<p><i>Add following new paragraph after third paragraph:</i></p> <p>“The use of low strain integrity testing for piles with rock sockets should consider that the pile toe reflection may be disturbed and not clearly visible in the interpretation of the results. Rock socket characteristics like socket length and rock strength in terms of dynamic shear modulus were found to have remarkable effect on stress wave attenuation and the reflection of the pile toe within rock sockets.”</p> <p><i>Delete:</i></p> <p>“For piles, an access duct for every 0.25m to 0.35m of diameter should be provided, with a minimum of four access tubes for piles of 1m diameter or greater.”</p> <p><i>Replace with:</i></p> <p>“For piles, an access duct for every 0.25m to 0.35m of diameter should be provided, with a minimum of four access tubes for piles of 1m diameter or greater. It is recommended to install at least 3 pipes for cross hole sonic logging into circular piles. The minimum pile diameter for circular piles for the use of cross hole sonic logging should be 750 mm and the distance between access pipes should not exceed 835 mm centre to centre.”</p>
C15.5 Age of test elements at time of testing	157	<i>As per SPERWall.</i>
C15.6 Preparation of test elements to be tested	158	<i>As per SPERWall.</i>
C15.9 Report	158	<i>As per SPERWall.</i>

C16 DYNAMIC AND RAPID LOAD TESTING OF PILES

The following amendments modify Section C16 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C16 Guidance notes	SPERWall Page No.	
C16.1 General	162	<p><i>Add:</i> Specialists may also have obtained accreditation for testing and interpretation of dynamic testing from Pile Dynamics, refer: http://www.pdaproficiencetest.com/. It is recommended that the testing and interpretation be undertaken under the supervision of someone with an intermediate ranking or better.</p> <p>Delete BS EN 22477-4 and replace with AS2159.</p>
C16.3/16.4 Construction/ preparation of a pile to be tested	163	<p><i>Add:</i> Testing of a sacrificial rotary bored or CFA pile (rather than a production pile) may enable the tests be undertaken to the point of destruction of the pile, with potentially a greater mobilised resistance proven. It is recommended that the structural design of the preliminary piles be reviewed by the pile contractor and the specialist tester to confirm the pile in conjunction.</p>
C16.6 Measuring instruments	163	<p><i>Add:</i> "Measuring of the permanent set and temporary compression of the pile is an acceptable method of measurement, as described in Appendix C6 of the SESOC/ NZGS Piling Specification.</p>
C16.7 Hammer or propellant	163	<p><i>As per SPERWall.</i></p>
C16.8 Time of testing	163	<p><i>Add to the end of the second paragraph:</i> It is recommended that a DL test should be undertaken at least 12 hours after pile installation.</p>
C16.9 Interpretation of results	164	<p><i>As per SPERWall.</i></p>
C16.10.1 Report	164	<p><i>As per SPERWall.</i></p>
C16.10.2 Additional Information	164	<p><i>As per SPERWall.</i></p>
C16.10.3 Analysis	164	<p><i>As per SPERWall.</i></p>

C17 STATIC LOAD TESTING OF PILES

The following amendments modify Section C17 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C17 Specification amendments	SPERWall Page No.	
C17 Static load testing of piles	176	
C17.1 General	176	<p><i>Delete:</i> Paragraph 3</p> <p><i>Delete:</i> "Preliminary piles</p> <p>The purpose of preliminary piles is to validate the geotechnical design of the pile, achievable performance criteria and to prove that a contractor's method of construction can construct viable foundations in particular ground conditions. Where preliminary pile testing is considered necessary and the ground conditions show significant variation from one area to another, tests may be required in more than one location. Indeed, more than one test per location may be necessary to judge pile performance under compressive, tensile or lateral loads."</p> <p><i>Replace with:</i> "Representative piles</p> <p>Representative piles refer to test piles in advance of construction or installation following clause 8.2.1 of AS 2159-2009. The purpose of representative piles is to validate the geotechnical design of the pile, achievable performance criteria and to prove that a contractor's method of construction can construct viable foundations in particular ground conditions. Where representative pile testing is considered necessary and the ground conditions show significant variation from one area to another, tests may be required in more than one location. Indeed, more than one test per location may be necessary to judge pile performance under compressive, tensile or lateral loads.</p> <p>The extent of testing is usually determined on a risk based approach and is linked to the determination of a geotechnical reduction factor. Refer to AS2159-2009 Section 4 for risk assessment criteria and determination of geotechnical reduction factors."</p>
C17.2 Project Specification	176	
C17.3.2 Method of construction	177	<p><i>Delete:</i> 'Preliminary pile'</p> <p><i>Replace with:</i> 'Representative pile'.</p>
C17.4 Concrete test cubes	177	<p><i>Delete:</i> 'Concrete test cubes' in heading</p> <p><i>Replace with:</i> 'Concrete test cylinders'.</p> <p><i>Delete paragraph and replace with the following:</i></p> <p>'A calculation should be undertaken to calculate the design concrete strength needed for the test pile at the time of testing, and this should be verified by concrete cylinder strength tests prior to pile testing.'</p>

C17 Specification amendments	SPERWall Page No.	
C17.6 Cut-off level	177	<p><i>Delete:</i> The entire clause shall be deleted</p> <p><i>Replace with:</i> 'It is important that the test loads are appropriate to the situation of the test and the long-term loads for which the piles are being designed. If down-drag is expected on working piles, test loads should be in accordance with AS2159-2009 clause 8.3.3.3. Where piles are being installed and tested in advance of an excavation or fill, the test loads should take account of the support provided or excluded by the change in soil depth for production state.'</p>
Add: C17.8.1 General		<p><i>Add:</i> 'Static load testing typically involves the application of load through a series of beams and reaction systems. The application of load applies stresses to such beams and reaction systems. The systems of load and reactions form 'temporary works' and should be designed and erected in accordance with <i>Temporary Works Forum NZ: Temporary Works Procedural Control, Good Practice Guideline</i> document.</p> <p>Given the design complexity and consequence of failure of the static load test restraint systems, it is expected that temporary works associated with static load testing would typically be designed by a CPEng qualified engineer.'</p>
Add: C17.9.3 Tension Testing		<p><i>Add:</i> 'Please refer to clause A2.2 regarding competency.'</p>

C18 PILES WITH PERMANENT CASING AND/OR COATINGS

The following amendments modify Section C18 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall

C18 Guidance notes	SPERWall Page No.	
C18.1 General	180	<i>As per SPERWall.</i>
C18.3 Bituminous or other coating materials	180	
C18.3.2 Protection from damage	180	<i>As per SPERWall.</i>
C18.3.3 Installation	180	<i>Add:</i> Where a permanent casing and/or coating is used in a pile socket and/or anchorage zone, appropriate allowance must be made for likely reduced skin friction (side resistance).

C19 INSTRUMENTATION FOR PILES AND EMBEDDED RETAINING WALLS

The following amendments modify Section C19 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C19 Guidance notes	SPERWall Page No.	
C19.1 General	188	<i>Add:</i> “Care should be taken to select appropriate material types. For example, avoid galvanised steel when using bentonite support systems to avoid anomalous data due to build up of bentonite on galvanised steel.”
C19.2 Project Specification	188	<i>As per SPERWall.</i>
C19.3 Type of instrumentation	188	<i>As per SPERWall.</i>
C19.3.1 Extensometers	188	<i>As per SPERWall.</i>
C19.3.2 Inclinometers	188	<i>Add to the last sentence:</i> Consideration should be made to the access tube strength relative to the stiffness of the pile installation and the required expected deflections. An inclinometer requires the base of the access tube to be either anchored at the toe of the pile or extended through the base of the pile in to expected static ground.
C19.3.2.3 Non-torpedo types	188	<i>Add:</i> It is noted SAAs are now known as Shape Array’s. Other new instruments such as GeoFLex provide similar options to Shape Arrays and in-place inclinometers. These provide for remote and automated data capture.
C19.3.3 Load cells	189	<i>As per SPERWall.</i>
C19.3.4 Pressure cells	189	<i>Add:</i> “It is expected that diaphragm wall designs should consider the use of pressure cells if appropriate, however this is dependent on the design and installation access for the project.”
C19.3.5 Strain gauges	189	<i>As per SPERWall.</i>
C19.3.5.1 General		
C19.3.5.3 Fibre optic strain sensors	189	<i>As per SPERWall.</i>
C19.3.6 Surveying	190	<i>As per SPERWall.</i>
C19.3.7 Other special instrumentation	190	<i>As per SPERWall.</i>
C19.4.2 Protection	190	<i>Add:</i> “It is noted that most instruments are electronic and require consideration of protection from “Electrical Noise” or EMF issues. It is common for construction sites to have large and varying power supplies that can affect the performance of instruments and the data collected. Additional spectral analysis equipment may be required for vibrating wire sensors. Consideration shall be made for the potential of signal and data contamination.”
C19.5.1 Monitoring Equipment	190	<i>As per SPERWall.</i>
C19.5.2 Readings	191	<i>Add:</i> “The lifetime of the instrumentation will need to be considered and the potential for replacement as new technologies become available. It is noted that the performance of piles may be required for many years after construction. Possible reasons for this could include wind loading on turbines, post-event performance of piles in seismic zones and many other reasons.”

C19 Guidance notes	SPERWall Page No.	
<p><i>Add:</i> C19.5.3 Calibration and data checking</p>		<p><i>Add:</i> “The contractor will require close collaboration with their installation supplier and rectify any issues with the data prior to submission to the contract administrator.”</p>
<p><i>Add:</i> C19.6 Report</p>		<p><i>Add:</i> “It is encouraged that the contractor, designer and instrumentation specialist conduct collaborative discussions to better understand the installation, monitoring and provision of the data to the project. Contractual agreements can sometimes limit connectivity between these parties, potentially impacting on positive outcomes to achieve the purpose.”</p>

C20 SUPPORT FLUID

The following amendments modify Section C20 in Part C of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C20 Guidance notes	SPERWall Page No.	
C20.1 General	195	<p><i>Add the following paragraph after the second paragraph:</i></p> <p>“The experience in NZ of using bentonite and polymer support fluids is limited compared to the UK, but the experienced based guidance under Section C20 is relevant to NZ.”</p> <p><i>Paragraph 17 add:</i></p> <p>“Where there is concern that an excessive filter cake may have developed the digging tools used during excavation can be lowered into the excavation to confirm the dimensions. The use of brushes or other tools to remove the filter cake is not recommended as this can cause instability.”</p> <p><i>Paragraph 18 Delete:</i></p> <p>“CIRIA PG3”</p> <p><i>Replace with:</i></p> <p>“EFFC/DFI Guide to Support Fluids for Deep Foundations”</p> <p>Add the following sentence to the end of paragraph 21:</p> <p>“There is a significant body of successful experience with polymer fluids for bearing pile projects in the UK, but experience with diaphragm walling in the UK is limited.”</p> <p><i>Replace with:</i></p> <p>“In NZ the experience of using polymer fluids with diaphragm walling is even more limited compared to the UK.”</p>
C20.3 Evidence of suitability of Support Fluid	198	As per SPERWall
C20.4 Materials	198	As per SPERWall
C20.4.1 Water	198	As per SPERWall
C20.4.2 Additives to the support fluid	198	As per SPERWall
C20.6 Compliance testing of support fluid	199	<p><i>Delete first note beneath Table C20.1.</i></p> <p><i>Add the following sentence to the end of the notes beneath Table C20.2:</i></p> <p>“The minimum viscosity of 90 s indicated for polymer prior to concreting is considered higher than typically required to maintain stability; if appropriate experience exists, or the polymer supplier recommends otherwise, lower viscosity polymer is acceptable.”</p>

C21 GENERAL REQUIREMENTS FOR CONCRETE, STEEL REINFORCEMENT, STRUCTURAL GROUT AND MORTAR AND STRUCTURAL STEEL

The following amendments modify Section C21 in Part B of SPERWall.

Any clause not amended by the following documents shall remain as written in SPERWall.

C21 Guidance Notes	SPERWall Page No.	
C21.1 General	208	<p><i>Delete</i></p> <p><i>Replace with:</i></p> <p>“This specification takes account of the requirements of standards for concrete materials, specification, production and testing.</p> <p>The specification for concrete to be supplied to a project requires input from both the designer and the contractor. The designer should provide requirements for strength and other properties that may affect the design performance of the completed pile, for example strength requirements or concrete mix composition requirements related to durability. The contractor should provide input for requirements related to executing construction of the pile, as designed, for example workability, workability retention and stability based on their proposed methods of construction.</p> <p>The main factors affecting the successful performance of piling concrete are:</p> <ul style="list-style-type: none"> • materials and concrete mix composition • placement methods • workability, stability and compaction • strength • durability. <p>All of these factors should be given equal consideration when considering the specification requirements.</p> <p>It is recommended that the reinforcing steel be supplied to a recognised third-party product certification scheme, such as ACRS, or tested to meet the product conformity requirements of clause 9 of AS/NZS 4671.</p> <p>Similarly, it is recommended that structural steel material be supplied to a recognised third-party product certification scheme, such as ACRS.”</p>
C21.2 Concrete		
C21.2.1 Strength class	208	<p><i>Delete</i></p> <p><i>Replace with:</i></p> <p>“In accordance with the project specifications, taking into account minimum concrete compressive strengths and use of supplementary cementitious materials required to provide durable concrete.”</p>

C21 Guidance Notes	SPERWall Page No.	
C21.2.2 Composition of concrete	209	<p><i>Delete</i></p> <p><i>Replace with:</i> “Recent trends have favoured higher strength classes and lower water/cement ratios resulting in greater dependence on admixtures to compensate for reduced workability in fresh state and setting time. Problems observed in bored piles cast using tremie methods have identified that a significant contributing factor was the use of concrete mixes with inadequate workability, or insufficient stability or robustness. The consequences of these problems can be significant. Besides the selection of suitable concrete constituents and appropriate concrete placement methods, developing suitable and robust concrete mixes is essential, as well as appropriate testing methods to ensure compliance.</p> <p>Current standard practice is to specify compressive strength, minimum cement content, maximum water/cement ratio and slump. These parameters may be insufficient to fully describe the required fresh properties for tremie concrete, particularly in terms of consistence, consistence retention and stability.</p> <p>Refer to the EFFC/DFI Guide to Tremie Concrete for Deep Foundations for additional requirements for the tremie concrete target values and test methods.</p> <p>Supplementary cementitious materials are required to provide enhanced durability to concrete exposed to aggressive conditions. Addition of supplementary cementitious materials to concrete mixes can also be used to impart special properties and benefits such as improvement of self-compacting properties, lower heat of hydration and as cement replacements to lower embodied carbon content. Supplementary cementitious materials should be taken fully into account in the calculation of cement content and water/cement ratio.</p> <p>Concrete should be tested for stability, including its susceptibility to bleeding, as part of the trial mix procedure in clause B21.5.2; guidance is given in clause C21.2.4.”</p>
C21.2.3 Special requirements for non-structural concrete	209	<p><i>Delete</i></p>
C21.2.4 Properties of fresh concrete	210	<p><i>Delete</i></p> <p><i>Replace with:</i> “The term ‘consistence’ has been retained and used in this document, instead of the more familiar term ‘workability’, to maintain the terminology used in SPERWall and related guidance documents such as EFFC/DFI Guide to Tremie Concrete for Deep Foundations. Consistence describes a concrete’s ability to flow, be placed or to be worked. In the context of this document consistence and workability should be taken as having the same meaning.</p> <p>The term stability, as used in this document, is defined as the resistance of a concrete to segregation, bleeding and filtration.</p> <p>For a comparison of the terms used in SPERWall and EFFC/DFI, reference can be made to Table C21.2.</p> <p>Segregation is the separation of constituents in a mixture leading to an uneven distribution of materials that can affect strength and durability of concrete. Segregation may occur while it is being transported or placed (dynamic), or between the time of placement and initial concrete set (static). Segregation may not always be accompanied by bleeding.</p> <p>Filtration is the mechanism of the separation of fluids (mix water or cement paste) from the fresh concrete, under a hydrostatic pressure gradient.</p>

C21 Guidance Notes	SPERWall Page No.	
C21.2.4 Properties of fresh (concrete (continued))	210	<p>The consistence and stability of concrete are critical to the successful construction of cast in-situ concrete piles. As vibration of concrete in a pile is impractical and the concrete may need to flow past closely spaced reinforcement, the concrete should be designed as self-compacting.</p> <p>Segregation and excessive bleeding should be avoided by limiting the use of excessive water to provide high consistence.</p> <p>Certain combinations of concrete constituents, including, super-plasticising admixtures, may result in rheological properties such as low yield stress and plastic viscosity which may result in excessive segregation of aggregate, with long setting time after the concrete has been placed. This phenomenon is known as static segregation.</p> <p>Careful mix design is necessary to ensure stability, especially for large diameter piles and diaphragm wall panels.</p> <p>With the common use of admixtures, this has decoupled the relationship between consistence and compressive strength. Measurement of concrete consistence should only be used as an indicator of the suitability of the concrete for placing and compaction, and not as a possible indicator of concrete strength.</p> <p>Slump testing is not considered suitable for determining consistence of high flow concrete mixes where slumps in excess of 200 mm are expected. For high consistence concrete the use of other methods such as the spread test or slump-flow test should be considered. Use of the L-box flow test (see clause B21.5.2) can provide additional information on consistence of the concrete. The method of consistence measurement can be specified in the project specification.</p> <p>Recommended target consistence values and tolerances for flow and slump for various conditions are given in Table C21.1.</p> <p>Where retention of concrete consistence is specified for extended concrete pours, procedures for consistence retention testing should be specified in the project specification, including minimum target values and allowable tolerances to be met at the end of the desired retention period.</p> <p>It is recommended that testing be performed on trial mixes, to establish the suitability of the particular concrete mix (see section C21.5). Such testing is not generally suited to routine testing as part of concrete production but repeat tests should be conducted if there are any changes made to the materials or mix design that might affect stability. Guidance on test methods and limiting values for stability is given in section C21.5.</p> <p>Experience can be gained through testing or by trials of known suitable and unsuitable concrete mixes. Some guidance is given in Table C21.3. Careful mix design should provide a concrete of suitably high consistence but with sufficient cohesion and viscosity to prevent segregation, excessive bleeding or excessive susceptibility to filtration.</p> <p>Once suitable mix designs are established, it should not generally be necessary to perform testing for stability on a routine basis (i.e. more than once a week) although this may be required by the project specification in special cases.”</p>

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Table C21.1 Target consistence values and recommended tolerances

Spread/Slump-flow/Flow (mm)		Slump (mm)		Examples
Target	Tolerance	Target	Tolerance	
500	± 50 (initial discharge) ± 40 (composite sample)	150	± 30 (initial discharge and composite sample)	Placement in dry conditions
550	± 50 (initial discharge) ± 40 (composite sample)	n/a	n/a	Placement by pumping Placement by tremie in submerged conditions under water
600	± 50 (initial discharge) ± 40 (composite sample)	n/a	n/a	Placement by tremie in submerged conditions under support fluid

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C21.2.5 Alkali-silica reaction	211	<i>Delete</i> <i>Replace with:</i> "NZS 3104 requires materials used in the production of concrete, be non-reactive or additional precautions taken to minimise the risk of alkali—silica reaction causing damage to the hardened concrete in-situ."
C21.3 Ready-mixed concrete	212	<i>Delete</i> <i>Replace with:</i> "Concrete for piling activities is likely to be supplied from ready-mixed concrete suppliers. It is recommended that only ready-mixed concrete suppliers with a current certificate of audit are used so that ready mixed concrete with the required level of product conformity meeting the specifications is supplied to the project. Where ready-mixed concrete suppliers do not hold a current certificate of audit, the contractor, with their proposed ready-mixed concrete supplier, shall propose the necessary quality assurance measures to ensure compliance with concrete production standards and this specification. The supervised addition of water or additives at site, to control mix slump/spread properties, in accordance with NZS 3104 Clause 2.10.3.1, may be permitted with the approval of the contract administrator. Such addition of water or additives shall be at the written instruction of the ready-mixed concrete supplier."
C21.4 Site-batched concrete	212	<i>Delete</i> <i>Replace with:</i> "Where it may be practical for concrete to be supplied from an on-site batching plant, the quality requirements in NZS 3104, and guidance in clause C21.3, shall apply equally as they do to ready-mixed concrete. Where possible and practical, site batching plants should operate as a satellite plant to a main plant having a current certificate of audit, using the same materials and mix designs as the main batching plant."
C21.5 Trial mixes	212	

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C21 Guidance Notes	SPERWall Page No.	
C21.5.1 General	212	<p><i>Delete</i></p> <p><i>Replace with:</i> "In lieu of strength testing of trial mix designs, data available from the concrete producer of previous production of concrete using similar mix designs and materials can be taken into consideration. Consistence and stability testing can be performed readily and in a relatively short time.</p> <p>Consideration should be given to the strength conformity requirements of concrete due to the slower rate of strength gain for mixes utilising supplementary cementitious materials. Design and specification of lower 28-day concrete compressive strengths for use in piling may be more practical rather than specifying strength conformance for the concrete mix design at 56-days."</p>
C21.5.2 Preliminary trial mixes	212	<p><i>Delete</i></p> <p><i>Replace with:</i> "Information on early age strength development of concrete may be advantageous, for example, where adjacent construction activities, such as further pile installation would require resistance to effects of vibration. Additional samples required and testing should be specified in the project specifications or by the contractor."</p>
C21.5.4 Properties of fresh concrete	212	<p><i>Delete</i></p> <p><i>Replace with:</i> "Consistence, consistence retention and stability are important properties for fresh concrete used in piling. Table C21.2 lists suitable tests together with guidance on acceptance limits.</p> <p>The visual stability index (VSI) from ASTM C1611 is used to evaluate resistance of the mix to segregation in slump/slump-flow tests or the flow table tests. The test evaluates aggregate segregation and presence of a mortar halo around the concrete at the end of the test to provide a numerical rating.</p> <p>The Bauer filtration test is described in the CIA's guide (2012) Tremie Concrete for Deep Foundations recommended practice and in EFFC/DFI Best Practice Guide to Tremie Concrete for Deep Foundations, Appendix A. The test simulates the water retention ability of fresh concrete under hydrostatic pressure and determines the loss of water through a filter. A cylinder is filled with fresh concrete and is pressurised with compressed air. Water which separates from the concrete mix passes through a filter paper and is collected at the bottom of the cylinder. The recorded filter loss is a measure of the filter stability of the concrete.</p>

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Table C21.2 Test methods and recommended acceptability limits for properties of fresh concrete

Test	Standard	Acceptance limits	EFFC/DFI ¹ terminology for property measured
Consistence			Workability
Slump	NZS 3112 Part 2	See Table C21.1	Consistence
Slump-flow	AS 1012.3.5 (or BS EN 12350-8)	See Table C21.1	Consistence/(flowing ability)
Flow table	BS EN 12350-5	See Table C21.1	Consistence
L-box flow	Modified BS EN 12350-10 (to also measure time for concrete to reach end of box - see Clause C21.5.4)	$T_{end} < 12$ seconds	Flowing ability/passing ability/ (segregation resistance)
Consistence Retention	Refer project specifications	As specified	Consistence
Stability			Stability
Visual stability index (VSI)	ASTM C1611	VSI 0 (ASTM C1611)	Segregation resistance/water retention
Bleeding and bleeding rate	Modified ASTM C232 (to include determination of bleeding rate - see clause C21.5.3)	Bleeding rate recommended to be below 0.1ml/min after approx. 2 hours. Review if greater	Water retention
Bauer filtration	Tremie concrete for deep foundations. See clause C21.5.3.	Suggested rates: 15litres/m ³ or 22ml direct filtrate. Review in conjunction with stability and bleeding rate	Water retention/ (segregation resistance)

Note: ¹EFFC/DFI Table B2.

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		Full scale mixes can perform differently to laboratory scale mixes due to different admixture dosages and resulting effect on the mix consistence. A set of preliminary trial mix tests should be conducted on a full scale mix to take into account possible variability of trial mix batches. This also assesses the performance of the batching and mixing plant. Trial mixes should include potential effects of water content variations due to permissible batching tolerances on the range of tests results achieved.”
C21.8 Testing of concrete	214	
C21.8.1 Sampling	214	<i>Delete</i> Replace with: “The point of placing concrete in the piles should be considered as the point of discharge from the delivery vehicle or mixer, e.g. the point of discharge of concrete into a pump or a skip.”
C21.8.2 Consistence testing	214	<i>As per SPERWall.</i>

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C21.8.3 Sampling for compressive strength testing	214	<p><i>Delete</i></p> <p><i>Replace with:</i> “NZS 3104 places the responsibility on the concrete supplier to demonstrate the conformity of the concrete compressive strength results (amongst other control tests). Control tests and quality audits are required as part of this and records are expected to be retained by the concrete supplier and made available to the contractor and contract administrator, upon request, for concrete supplied to a project.</p> <p>The tradition of taking sample cylinders on site is continued in this specification, to cover for the rate of sampling, required for concrete production quality under NZS 3104, generally being insufficient to cover concrete volumes typically supplied to individual pile concrete pours. The concrete producer, contractor or an independent third party may take samples and prepare these for storage and testing provided the requirements of the specification and standards are met.</p> <p>Additional samples shall be taken, for additional tests, testing at earlier or later ages, as required by the project specification or the contractor. Early age strength results may be useful for contractors to allow for commencement of adjacent pile installation or other works that could adversely affect the strength of previously cast piles. Cylinders may also be held in reserve for testing at a later age should non-conforming results be indicated in the 28-day tests.”</p>
C21.9 Steel reinforcement	215	
C21.9.3 Fabrication of reinforcement	215	<p><i>Delete</i></p> <p><i>Replace with:</i> “Additional reinforcement may be required to be placed within the cage to limit distortion of the cage during fabrication and lifting. Additional measures to secure reinforcing cage sections in order to safely handle these, lift them for splicing into longer reinforcing cages may be required. Designers should consider the requirement for welding of hoops etc. to assist with stability and lifting of cages when selecting steel type and designing the cages.”</p>
C21.10 Structural grout and mortar	215	
C21.10.1 General		<p><i>Delete</i></p> <p><i>Replace with:</i> “Grout or mortar mix designs should consider flowability, resistance to bleeding and segregation (stability).</p> <p>Where aggregate or fine sand is incorporated, consideration shall be given to the avoidance of alkali—silica reaction.”</p>



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