INSTALLATION GUIDE

VERSION 3.0 FEBRUARY 2023

STOPDIGGING!
THE GROUND SCREW FOR SOLID FOUNDATIONS

CODEMARK
CMNZ70132

Ground Screw System

Contents

Purpose

Installation of a STOPDIGGING! ground screw foundation system (the system) involves three stages:

- first stage is to
  - confirm soil suitability
- second stage is to
  - determine pile design loads, and
  - complete a static pile test.
- third stage is
  - installation of the STOPDIGGING! ground screw foundation system.

This guide describes completion of all stages.

Important documents

Installation of the system relies on the following documents:

- building consent plans and specifications or the system design
- STOPDIGGING! ground screw foundation system static ground screw test report (online app)
- STOPDIGGING! ground screw foundation system record of installation (online app).

Skills required

This document is intended for use by accredited STOPDIGGING! approved installers only.

Description

The STOPDIGGING! ground screw foundation system is a proprietary system that can be used as an alternative to traditional foundation and strip footings as defined in NZS 3604:2011. However, their use is not limited to the scope of NZS 3604:2011.

The ground screws are mechanically installed into soil to a depth at which the required load bearing capacities are achieved. They can be installed without disturbance or damage to the ground.

STOPDIGGING! ground screws are made of steel that complies with ISO 630 – Fe -360A – High Tensile Steel for Structural Purposes and are manufactured with a hot-dipped galvanised coating that achieves an average of 125 µm zinc cover. They are classified as category HDG900 (900 g/m^2).

STOPDIGGING! ground screws are supplied in various screw diameters with extensions, adapters and connection brackets. Diameter, adapter and connection brackets are determined by soil conditions, applicable loads and fixing requirements. The screws are reusable and recyclable.

Installation

HEALTH AND SAFETY

Take all necessary steps to ensure your safety and the safety of others:

- wear appropriate safety equipment, clothing and footwear
- use all tools in accordance with relevant instruction manuals
- clear the work area of any obstruction before work starts.

For further information refer to:

- WorkSafe. [July 2018] *Small Construction Sites, the Absolutely Essential Health and Safety Toolkit.*
- WorkSafe. [December 2016] *Health and Safety at Work, Quick Reference Guide.*

These documents are available at www.worksafe.govt.nz.

HANDLING AND STORAGE

Handle ground screws with care to ensure screws are not damaged when transporting, unloading and storing.

SOIL SUITABILITY

Confirm soil suitability. Soil type may be used to confirm soil suitability.

Table 1: Suitability of ground screws based on soil type

Major soil type	Suitability[1]	Rationale
Silt	Yes	Silt can generally be predrilled with a suitable soil auger, allowing for installation of the ground screws.
Sand	Yes	Ground screws can generally displace sands during installation.
Fine gravel	Yes	Fine gravels are expected to behave in a similar way to sands.
Medium gravel	Requires on-site confirmation	Medium gravels may become disturbed during installation, diminishing the bond strength between the ground screw and the soil. As such the suitability of the soils will need to be confirmed with on-site testing.
Coarse gravel	Requires on-site confirmation	Coarse gravels may become disturbed during installation, diminishing the bond strength between the ground screw and the soil. As such the suitability of the soils will need to be confirmed with on-site testing.
Cobbles	No	Cobbles are expected to become disturbed during installation or prevent installation altogether due to penetration resistance. Disturbed cobbles would have a greatly diminished bond strength to the installed ground screw.
Boulders	No	It is unlikely that the predrilling process or the ground screw installation will be able to penetrate through soil medium comprising boulders as the main constituent.
Clay	Yes	Clays can generally be augured, allowing the predrilling process to be completed successfully and in most cases shall allow for the successful installation of the ground screws.
Peat	No	Peat is an organically dominated material that is unsuitable for most shallow foundation types.
Topsoil	No	Topsoil is an organically dominated material that is unsuitable for most shallow foundation types.
Rock	No	Predrilling is generally unsuccessful into bedrock and ground screws are unable to displace rock during installation.
Non-engineered fill	No	Non-engineered fills are inconsistent material with unpredictable characteristics. Uncontrolled fill lacks the horizontal stratification that is common in naturally deposited materials. As such, localised soil and load testing cannot be used to infer the performance or the load carrying characteristics of the soil across an entire site.

1 Assuming soil is sufficiently dense.

Where 'good ground' (as defined in NZS3604:2011) conditions are known to exist geotechnical testing is not required.

Where 'good ground' cannot be confirmed but the soil type is considered suitable and confirmation of the use of STOPDIGGING! ground screw foundation system is established by the static pile test, a geotechnical report is not required.

In all other circumstances an independent geotechnical report is required.

DESIGN LOADS

For structures within the design scope of NZ3604, whether or not building consent is required, Appendix 1 identifies individual pile design loads for a given floor load that are to be used for static pile test targets. Test loads designated in the table allow a geotechnical safety factor.

A static pile test should be provided to 100% of the 'Test Load' in the table.

For structures outside the design scope of NZ3604 and requiring Specific Engineered Design, design loads need to be provided by the project structural engineer.

Confirm that the engineer has included a geotechnical safety factor in the supplier design loads. If a standard ULS load has been provided without a safety factor, provide a static pile test to 150% of this ULS design load.

STATIC GROUND SCREW TEST

Purpose

The static ground screw test measures the response of a ground screw under an applied load. It provides an accurate method for determining ground screw capacities and the ability to support load without excessive or continuous displacement.

In addition, it provides confirmation or signals the need for a change in respect of the size of the ground screw and/or screw depth necessary to meet the foundation design.

Methodology

Two tests are required, one that establishes the compressive load capacity and the other the lateral load capacity.

Table 2: Load testing apparatus

Component	Description
1	Bolted plate and shackle with 56 kN minimum capacity in tension.
2	Digital display for load cell with current calibration certificate 0.5 kN minimum display resolution.
3	50 kN load cell with current calibration certificate 0.5 kN minimum read accuracy.
4	Tripod constructed with 50 mm SHS 5 mm thick steel sections.
5	Hydraulic pullback ram with 50 kN minimum capacity.
6	Mechanical strain gauge with current calibration certificate and 0.01 mm minimum resolution.
7	Stain gauge support – Steel Y post (Waratah) or similar. Support to be isolated from testing apparatus by placement at a distance of 0.5 m minimum from any loaded ground screw or tripod load distribution pad.
8	Bolted plate and shackle with 56 kN minimum capacity in tension.
9	The ground screw installed as per this document undergoing load proof-testing for either tensile, compressive or lateral demands.
10	0.3 x 0.3 load distribution pads to limit vertical settlement of the tripod during tension testing.
11	Hydraulic pump compatible with chosen hydraulic pull-back ram. Shall be rated to cope with hydraulic pressures when ram-loaded to 50 kN.
12	Ground screws installed to provide a reaction force during compressive testing of the test screw. These screws shall be installed as deeply as the on-site conditions allow to minimise the risk of a tension failure during the test.

Component	Description
13	Hydraulic jack with 50 kN minimum capacity.
14	Bolted plate and shackle with 20 kN minimum capacity in shear.
15	Tension tendon with 20 kN minimum capacity in tension. This tendon shall be regularly checked for any defects or fraying that may affect its capacity.
16	Reaction system for tension tendon. Shall be stable under loads of up to 20 kN without undergoing significant displacement that could affect test results.

ESTABLISHING COMPRESSIVE LOAD CAPACITY

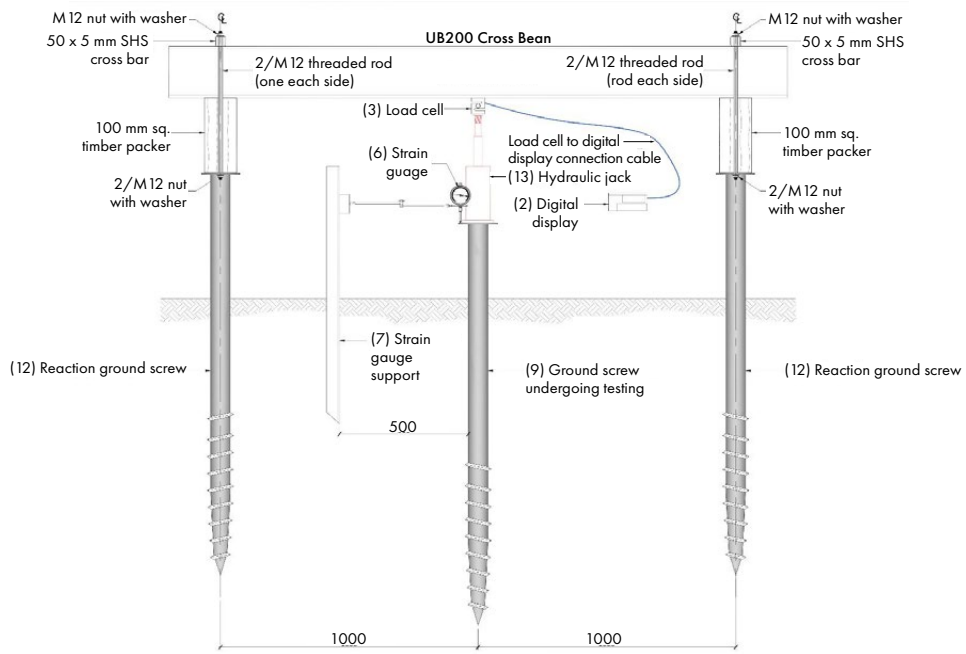
Either a Compression or Tension testing methodology may be used.

Compression test (Maintained load)

Installation of test rig

Install test screw vertically and in one drive within the footprint of the proposed structure or within close proximity to the footprint. Record distance of the screw from the footprint (if being tested outside the footprint).

Figure 01 – Compression Test testing rig



The height of the screw above ground shall be carefully monitored, as this shall replicate the installed conditions while in-service.

Ensure the reaction screws are installed in line with the test screw and are spaced 1.0 m from the test screw as shown in Figure 01. The reaction screws are to be installed as deeply as on-site conditions allow. This minimises the risk of tension failure during the test. The reaction screws must have a combined tensile capacity of 1.2 times the maximum compressive test load.

Install timber packers and cross-beam as shown in Figure 01. Confirm that all bolted connections are tightly fastened.

Install the strain gauge support 0.5 m from the test and reaction screws. The purpose of the strain gauge support is to prevent undue movement of the support during testing that may affect recorded measurements. Ensure installation will achieve this, including loosening the support after being driven to reposition the strain gauge.

Install loading and measuring apparatus as per Figure 01. Confirm that the strain gauge is aligned with the test screw, so that only vertical displacement in the direction of loading is measured.

Install the hydraulic jack vertically and fix directly to the top of the test screw. Check full contact through the load cell is made with the cross-beam.

Testing

Test in accordance with the Design and Test Load Tables, (Appendix 1) or where specifically engineered test to 150% of the design load if a geotechnical safety factor has not been included.

Ensure each of the target loads is maintained as accurately as possible for the time periods of 1–15 minutes. Minor ongoing adjustment of the hydraulic pump will be necessary while monitoring the digital display to ensure the target load is maintained.

Timing begins once the target load has been achieved. The target load shall not vary by more than 5 % at each loading increment. Ensure that the target load is not significantly exceeded, even momentarily, while loading the screw. Overshooting the target load will skew the results, causing a failed result.

Record results

After each test, record the results.

When the testing is finished, complete the Static Ground screw Test Report and supply to the engineer if required.

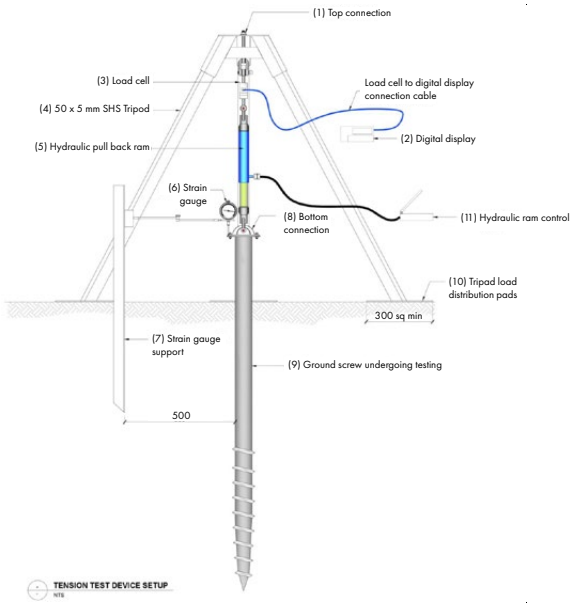
Tension test (Maintained load)

Installation of test rig

Install test screw vertically and in one drive within the footprint of the proposed structure or within close proximity to the footprint. Record distance of the screw from the footprint (if being tested outside the footprint).

The height of the screw above ground shall be carefully monitored, as this shall replicate the installed conditions while in-service.

Figure 02 Tension Test testing rig



Install the tripod as shown in Figure 02 over the installed test screw. Position the top connection directly above the test screw to eliminate other forces from interfering with the recorded results.

Fasten bottom connection of the tripod to the top of the test screw ensuring all bolts are securely tightened.

Install the strain gauge support 0.5 m from the test and reaction screws. The purpose of the strain gauge support is to prevent undue movement of the support during testing that may affect recorded measurements. Ensure installation will achieve this, including loosening the support after being driven to reposition the strain gauge.

Install loading and measuring apparatus as indicated in Figure 02. The strain gauge must be accurately aligned with the test screw so that only vertical displacement is measured.

The hydraulic pull-back ram must be installed vertically and directly above the bottom support so that only a vertical force is applied and any undue lateral forces are avoided.

Testing

Test in accordance with the Design and Test Load Tables, (Appendix 1) or where specifically engineered test to 150% of the design load if a geotechnical safety factor has not been included. Ensure each of the target loads is maintained as accurately as possible for the time periods of 1–5 minutes. Minor ongoing adjustment of the hydraulic pump will be necessary while monitoring the digital display to ensure the target load is maintained.

Timing begins once the target load has been achieved. The target load shall not vary by more than 5 % at each loading increment. Ensure that the target load is not significantly exceeded, even momentarily, while loading the screw. Overshooting the target load will skew the results, causing a failed result.

Record results

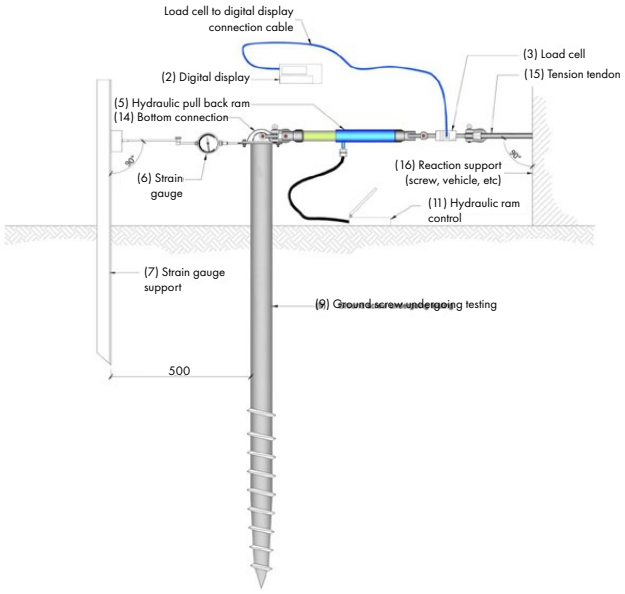
After each test, record the results. Displacements shall be recorded in millimetres and micrometres. Measurements shall be taken as close to the end of the load increment as possible. If displacement at a certain load increment is not stable and has begun to creep, then the load inducing this displacement shall be noted as resulting in failure.

ESTABLISHING LATERAL LOAD CAPACITY

Installation of test rig

Install test screw vertically and in one drive within the footprint of the proposed structure or within close proximity to the footprint. Record distance of the screw from the footprint (if being tested outside the footprint).

Figure 03 Lateral load capacity test rig



The height of the screw above ground shall be carefully monitored as this shall replicate the installed conditions while in-service.

Install a reaction system at least 1.0 m away from the test screw. This reaction system may be another test screw, a heavy vehicle, arbitrary kentledge or any other mass capable of providing the required reaction force.

Fasten the bolted connection to the top of the test screw and secure the tension tendon to the reaction system as shown in Figure 03.

Install the strain gauge support 0.5 m from the test and reaction screws. The purpose of the strain gauge support is to prevent undue movement of the support during testing that may affect recorded measurements. Ensure installation will achieve this, including loosening the support after being driven to reposition the strain gauge.

Install loading and measuring apparatus as indicated in Figure 03. Ensure the strain gauge is accurately aligned with the tension tendon so that only horizontal displacement in the direction of loading is measured.

The hydraulic pull-back ram and tension tendon must be installed at 90° from the top of the test screw. Any variation from 90° in the tension tendon/hydraulic pull-back ram during loading and measurement will cause inaccurate measurements.

Testing

Test in accordance with the Design and Test Load Tables, (Appendix 1) or where specifically engineered test to 150% of the design load if a geotechnical safety factor has not been included. Ensure each of the target loads is maintained as accurately as possible for the time periods of 1–5 minutes. Minor ongoing adjustment of the hydraulic pump will be necessary while monitoring the digital display to ensure the target load is maintained.

Timing begins once the target load has been achieved. The target load shall not vary by more than 5 % at each loading increment. Ensure that the target load is not significantly exceeded, even momentarily, while loading the screw. Overshooting the target load will skew the results, causing a failed result.

Record results

After each test, record the results. Displacements shall be recorded in millimetres and micrometres. Measurements shall be taken as close to the end of the load increment as possible. If displacement at a certain load increment is not stable and has begun to creep, then the load inducing this displacement shall be noted as resulting in failure.

FAILED TEST RESULTS

Where 100 % of the compression load capacity is not achieved, establish a new test rig with a larger diameter test screw or where the test screw is longer.

Where lateral load capacity testing fails, consider the introduction of above ground diagonal bracing. Specification of this bracing must be carried out in consultation with the design engineer.

GROUND SCREW FOUNDATION INSTALLATION

Predrilling

Predrilling holes prior to the installation of STOPDIGGING! ground screws enables installation in one drive.

Ensure that the drill bit is suitable for the specific soil conditions. For gravel soils, use a masonry style drill bit and for fine-grained soils, such as silts and clays, use an auger-style drill bit.

Predrill to a depth of 100 mm less than the final installation depth for the ground screw.

Do not over-drill, this will decrease the compressive capacity of the installed ground screw.

Installation of Ground Screw

Ground screws must be installed vertically and in one drive.

The heads of all ground screws that are to be installed as part of a foundation system must finish at the same level after installation. Establish finished height with a laser level and a fixed datum.

Diagonal Bracing

Install bracing units in accordance with engineer's design.

Use 48.3 x 3.2 CHS Grade 250 tube, maximum length 3.2 m installed at a brace angle between 10° and 45° to the horizontal.

Connect the bracing unit with a swivel clamp that has an established capacity of greater than 6kN. The bracing unit must be fixed at least 100 mm above ground level.

Completion

When all ground screws have been installed in accordance with the building consent plans and specifications or the system design, complete the STOPDIGGING! Installation Declaration and provide to the project manager.

Appendix 1

TABLE 3: 1.5 kPa AND 2 kPa FLOOR LOADS

SPAN* OF		DESIGN & TEST LOADS FOR GROUND SCREWS							
BEARER (M)	JOISTS (M)	FLOOR AND NON-LOADBEARING WALLS ONLY		1 STOREY		2 STOREY		3 STOREY	
		DESIGN LOAD	TEST LOAD	DESIGN LOAD	TEST LOAD	DESIGN LOAD	TEST LOAD	DESIGN LOAD	TEST LOAD
1.30	2.0	6kN	10kN	11kN	20kN	16kN	25kN	18kN	30kN
	3.5	8kN	15kN	18kN	30kN	27kN	40kN	34kN	50kN†
	5.0	11kN	20kN	27kN	40kN	40kN	60kN†	45kN	70kN†
	6.0	14kN	25kN	30kN	45kN†	45kN	70kN†	55kN	85kN†
1.65	2.0	6kN	10kN	14kN	25kN	21kN	35kN	24kN	40kN
	3.5	9kN	15kN	27kN	40kN	33kN	50kN†	40kN	60kN†
	5.0	14kN	25kN	30kN	45kN†	50kN	75kN†	55kN	85kN†
2.00	2.0	6kN	10kN	16kN	25kN	27kN	40kN	30kN	45kN†
	3.5	11kN	20kN	27kN	40kN	41kN	60kN†	55kN	85kN†

TABLE 4: 3 kPa FLOOR LOADS

MAXIMUM SPANS* OF		DESIGN & TEST LOADS FOR GROUND SCREWS					
BEARERS (M)	JOISTS (M)	FLOOR ONLY		FLOOR AND WALLS OF:			
				1 STOREY		2 STOREYS	
		DESIGN LOAD	TEST LOAD	DESIGN LOAD	TEST LOAD	DESIGN LOAD	TEST LOAD
1.30	2.0	4kN	10kN	7kN	15kN	11kN	20kN
	3.5	7kN	15kN	24kN	40kN	38kN	60kN†
	5.0	8kN	15kN	30kN	45kN†	50kN	75kN†
	6.0	9kN	15kN	38kN	60kN†	59kN	90kN†
1.65	2.0	7kN	15kN	9kN	15kN	27kN	40kN
	3.5	8kN	15kN	27kN	40kN	50kN	75kN†
	5.0	11kN	20kN	38kN	60kN†	63kN	95kN†
2.00	2.0	6kN	10kN	11kN	20kN	34kN	50kN†
	3.5	11kN	20kN	34kN	50kN†	59kN	90kN†

*Span is the average of the bearer or joist spans on either side of the pile under consideration.

†Special consideration is required for these loads, please check with STOPDIGGING! to confirm the availability of the larger capacity testing and installation equipment.

Note: the above tables relied on the following assumptions

ULS bearing capacity = 150 kPa

ULS vertical capacity of pad = 150 kPa x 0.275m x 0.275 m = 11 kN

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See www.stopdigging.co.nz for current version.

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