

Technical Direction

Geotechnology

GTD 2020/001 | Version No. 01 – 2 July 2020

Excavation adjacent to Transport for NSW Infrastructure

Summary:	Audience:
<p>The number and size of excavations in close proximity to Transport for NSW (TfNSW) infrastructure have increased steadily in recent years. It is imperative that the design and construction of these excavations including the supporting structures are adequate to provide security to the infrastructures and their operations.</p>	<ul style="list-style-type: none"> • Engineers/designers • Development proponents • Contractors • Project managers • Asset managers

Purpose

This document provides technical direction for all proposed excavations by private and commercial developments with their influence zones, or temporary structures extending onto the road reserve and TfNSW easements. It sets out the requirements for TfNSW concurrence, including referrals of development applications involving excavation adjacent to TfNSW roads and associated infrastructure.

This technical direction is also an integral policy document for the management of excavation related geotechnical risks within the Work Authorisation Deed (WAD) approval framework.

The document lists the contents of submission required for TfNSW review and it also details technical requirements for the design and construction of retaining walls for these excavations.

This technical direction supersedes GTD 2012/001.

Approvals:

Owner:	Director Pavements & Geotechnical	Review Date:	2 July 2022
Authorised by:	Director of Engineering	Effective Date:	2 July 2020

Scope

This document applies to retaining structures (including embedded cantilever and propped/anchored retaining structures) constructed to support the sides of excavations which could be within close proximity to roadway and railway. It also outlines the requirements for installing ground anchors and instrumentation as part of these excavations. Proponents must contact TfNSW for areas that are not explicitly covered by this technical direction.

The TfNSW review relates to the impact on its assets and it does not relieve the designers and property developers of their obligations with respect to statutory requirements as part of their development.

Technical requirements

This technical direction contains requirements for the following:

- Design standards
- Geotechnical investigations
- Utilities
- Types of acceptable ground support
- Design loads and load combinations
- Groundwater levels
- Ground anchors
- Ground movement
- Instrumentation and monitoring
- Thresholds
- Hold points

Design standards

Retaining structures shall be designed in accordance with the relevant TfNSW documents and the following Australian Standards as appropriate, unless otherwise specified in this document. Where conflicting information occurs, the TfNSW document is to take precedence.

- AS 1726 Geotechnical Site Investigations
- AS 1170 Structural design actions
- AS 5100 Bridge design
- AS 2159 Piling – Design and installation

The design life of permanent retaining wall structures should not be less than 100 years and the design of these walls and associated elements must include both short term and long term effects. In particular, the unplanned excavation must be considered for stability design as detailed in Section 13.3.1 of AS5100.3 *Bridge design - Foundation and soil-supporting structures*.

Geotechnical investigations

Geotechnical investigations are to be undertaken in accordance with AS1726 to develop geological models and groundwater conditions, and to determine the properties of the soil and rock units. The geotechnical field investigations and laboratory testing must be comprehensively carried out to determine the site conditions and geotechnical material parameters for the detailed design and construction of the retaining

structure. These investigations must be carried out at least one borehole per 30 m intervals of wall length and 3 m into the competent material below the final excavation level. Investigation by test pits is generally not considered acceptable. Non-core and rock core drilling using triple tube sampling is the preferred technique. Where proposed excavations are predominantly in rock, the geotechnical investigations must define adverse defect systems (joints, fault zones, volcanic intrusions, weak zones etc.) which may have an adverse impact on the development and adjacent TfNSW Infrastructure.

Where excavations are in excess of 10 m depth in rock, geological mapping of the rock cutting for every 2 m of excavation by a suitably qualified engineering geologist or geotechnical engineer is required. The results must be reviewed for the design conformance before progressing further.

Utilities

The proponent shall detail the nature and extent of any utilities located within the zone affected by the proposed excavation.

The proponent shall analyse and report the effect of the excavation on these utilities. The design and construction shall take into account the requirements of utility owners and the sensitivity of these utilities to ground movements.

Types of acceptable ground support

Most types of ground support structures may be considered, however the following types are not generally considered acceptable as permanent retention structures:

- Use of steel sheet pile walls below the groundwater table
- Wall toes founded above the final excavation levels on unsupported rock ledges with rock quality inferior to medium strength rock (e.g. Class III based on Sydney Shale and Sandstone Classification System, Pells *et al* 1998), or where the rock has adverse defects.

Design loads and load combinations

Design loads and load combinations must be in accordance with AS 5100, but with a minimum uniformly distributed live traffic load (UDL) of 20 kPa for the serviceability limit state. This minimum UDL must be applied on the road which represents the most adverse loading condition for the retaining structure. The accompanying lane factors given in AS 5100 may be applied to the UDL for multiple lanes.

The design shall take into account construction loads, loads from adjacent structures and other surcharge loads as required by the relevant design standards. A minimum UDL of 10 kPa shall be applied for the serviceability limit state for loads other than traffic loads.

Particular loads or load cases may need to be considered for design of the retaining structures affecting TfNSW infrastructure, and the developer shall clarify of any special requirements before commencing design.

Groundwater levels

Design groundwater levels must take into account both short term, long term and accidental groundwater levels in the vicinity of the retaining structure. Where drainage measures are proposed to relieve water pressures behind the structure, the drainage measures must be readily accessible for inspection and maintenance. This requirement may apply either during the construction phase or the in-service phase of the structure.

Where dewatering is required for the proposed excavation, a dewatering management plan shall be included in the submission for review. Groundwater shall be monitored during construction and the monitoring results shall be submitted to the designer for review.

Ground anchors

Where proposed ground anchors are located in whole or in part within the road reserve and TfNSW easements, the following requirements applies:

- Only temporary ground anchors will be permitted
- Ground anchors shall be designed and tested in accordance with AS5100.3 *Bridge design - Foundation and soil-supporting structures*
- Temporary ground anchors shall have a minimum design life of two years. Where ground anchors are required for more than 18 months they must be designed as permanent anchors
- No anchor forming part of the works shall be stressed to greater than 75% of the tendon ultimate tensile strength under either working load or test load
- No part of any ground anchor shall be less than 1.5 m below the surface within the State road reserve and TfNSW easement
- Once the anchors are no longer required to carry load, all structural connection between the anchors and the proposed development must be removed. Temporary anchors must be safely de-stressed

'Nails and Bolts' used as structural support elements are treated the same as ground anchors.

Ground movement

The prediction of ground movement including vertical and horizontal movements of the proposed retaining structure at each construction stage shall be provided. These movements shall be presented in graphical form at critical sections for the full height of the retaining structure.

The movements of retaining wall structures shall not result in any damage to TfNSW assets. Ground movement estimates shall consider the full zone of influence of the proposed excavation and include the following:

- Demolition of existing retaining or support structures
- Construction of the retention elements
- Excavation and movement of the support system
- Groundwater drawdown
- Consolidation of soils
- Other site specific work or processes affecting ground movement

TfNSW will determine permissible ground movements on a case by case basis, taking into account the sensitivity of TfNSW assets to movements, the proximity of the structure to such assets, and the ground movements that will occur within TfNSW property or the road reserve. The total serviceability horizontal movement of the wall in any one direction acceptable for non-sensitive TfNSW assets is to be limited to 0.5% of the excavated height, or 30 mm, or the structural serviceability requirements of the retaining wall, whichever is the lesser. Generally, the permissible movements on infrastructure assets should be clarified with TfNSW before the design.

Instrumentation and monitoring

TfNSW requires geotechnical instrumentation and monitoring where infrastructure assets may be affected by the proposed excavation. These include bridge structures, associated foundations, existing wall structures etc. adjacent to the proposed excavation. Instrumentation and monitoring may be required for the following retaining wall types:

- Cantilever retaining walls with a retained height exceeding 3 m

- Propped or anchored walls with a retained height exceeding 6 m

Where required, instrumentation will generally include a minimum of two inclinometers installed to at least 3 m below the toe level of the walls. Where the groundwater level is above the final excavation level, a number of piezometers shall also be installed. Other monitoring systems such as a total station survey system (using remote data capture or other technology) may also be required depending on the nature of the development and TfNSW assets affected by the development.

Where monitoring is required, it is to be carried out at the following stages:

- Before the start of significant site work to determine baseline readings. Two independent sets of measurements shall be taken confirming measurement consistency
- After construction of the retaining structures, but before the start of excavation
- After excavation to the first row of supports or anchors, but before installation of these supports or anchors
- After excavation to any subsequent rows of supports or anchors, but before installation of these supports or anchors
- After excavation to the base of the excavation
- After de-stressing and removal of any row of supports or anchors
- One month after completion of the permanent retaining structure or after three consecutive measurements not less than a week apart showing no further movements, whichever is the later

Instrumentation and monitoring shall be carried out by a suitably qualified geotechnical professional. The results of each monitoring stage shall be reviewed by the geotechnical professional before hold point release. Before work proceeds to the next stage the geotechnical professional must verify that, based on the monitoring results and the inspections carried out, the structure is performing in accordance with the design intent and that where trigger levels have been exceeded, action has been taken in accordance with the monitoring plan. This verification shall constitute a 'hold point' for each stage of construction.

TfNSW shall be informed immediately when the trigger levels are exceeded.

The monitoring detailed above does not override any monitoring scheduled by the design engineer or required for any other reason. However, the monitoring detailed above may be included in monitoring programs prescribed by others provided all the requirements described in this document are incorporated into the monitoring plan.

Thresholds

It is recommended that the following trigger threshold criteria be adopted and shown on the drawings:

- **Alert:** If lateral displacements are less than 80% of the agreed values, excavation could be continued.
- **Action:** If the ground movements are greater than 80% but less than 100% of the agreed values, TfNSW must be notified within 24 hours and the monitoring data be reviewed. The frequency of monitoring should be increased. A copy of the trigger action response plan, with agreement by TfNSW, is to be available for implementation.
- **Alarm:** If the ground movements are greater than the agreed values, TfNSW must be notified immediately and all excavation works are to be suspended. The trigger action response plan is to be implemented with measures taken to safeguard the road and/or rail infrastructure.

Hold points

Construction shall be carried out in accordance with the Council approved plans and work method statements agreed by TfNSW. Construction shall not proceed to the next stage until preceding 'hold points' have been released.

Completion of each stage of construction listed below constitutes a 'hold point'. At each 'hold point', certification must be provided by a chartered professional engineer that the conditions listed after each stage of construction below have been met before releasing each 'hold point'.

1. After construction of the retaining structures, but before start of excavation:
 - a. Certify that the structures have been constructed in accordance with the approved drawings.
2. After excavation to and installation of the first row of supports or anchors:
 - a. Certify that the geotechnical conditions are in accordance with those described in the geotechnical report. If not, specify actions required and confirm that these actions have been carried out.
 - b. Certify that the anchors/supports have been constructed in accordance with the approved drawings.
 - c. Certify that the anchors have been tested and passed in accordance with TfNSW requirements.
3. After excavation to and installation of any subsequent rows of supports or anchors:
 - a. Certify that the geotechnical conditions are in accordance with those described in the geotechnical report. If not, specify actions required and confirm that these actions have been carried out.
 - b. Certify that the anchors/supports have been constructed in accordance with the approved drawings.
 - c. Certify that the anchors have been tested and passed in accordance with TfNSW requirements.
4. After excavation to and construction of the base of the excavation:
 - a. Certify that the geotechnical conditions are in accordance with those described in the geotechnical report. If not, specify actions required and confirm that these actions have been carried out.
 - b. Certify that the excavation base conditions have been constructed in accordance with the approved Drawings.
5. After de-stressing and removal of any row of supports or anchors:
 - a. Certify that all temporary anchors have been de-stressed, removed or disconnected from the permanent retaining structure.

Submission requirements

The following shall be submitted to TfNSW for review and concurrence:

- Design documentation
- Drawings
- Specifications
- Dilapidation survey

Design documentation

The design submission shall include all geotechnical information, and supporting designs and calculations.

The submission shall include an accurate geometry of the support system, design loading, geotechnical parameters adopted for design, design assumptions, load cases, structural section properties, material parameters, analysis output (such as moment and shear envelopes, deflections and ground movements) and assessment of effects on the TfNSW infrastructure.

Cross sections at critical locations shall be considered in the design.

The results of predicted ground movements due to the proposed development such as demolition of existing structure, bulk excavation and associated dewatering works shall be presented.

The results of impact study for the existing TfNSW infrastructure during excavation and in the long term shall be presented.

Both temporary and permanent structures, where applicable, shall be included in the report.

The geotechnical report on which the design is based must be provided with the design documentation.

An instrumentation and monitoring plan shall be submitted. A trigger action response plan shall be submitted when the trigger threshold of Action is activated.

Drawings

Details and proximity of significant TfNSW infrastructure to the excavations shall be included in plans and sections in the drawings for clarity. Such assets may include but not limited to roads, tunnels, bridges, embankments, walls, noise barriers, traffic signals and drainage elements. The proposed instrumentation, trigger value thresholds and actions to be taken and the construction sequence shall be shown in the drawings.

Specifications

Copies of the specifications shall be included where necessary to interpret the design and drawings.

Dilapidation survey

TfNSW may require a dilapidation survey for sensitive assets where there is a potential risk of damage caused by the proposed development. The dilapidation survey shall cover TfNSW assets within the influence zone of the excavation. Where applicable, these may include the road pavement, associated subsurface drainage structures, bridges, traffic signal structures and other road assets.

Construction

Construction shall be carried out in accordance with the DA approved drawings, and specifications accepted by TfNSW. Any amendments to the design shall be re-submitted for TfNSW concurrence before implementation.

Post-construction

Upon completion of construction an electronic copy of the work-as-executed (WAE) drawings of the development shall be submitted to TfNSW for record purposes.

Contact Us:

If you have any questions or would like more information on this document please contact Transport for NSW:



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