

Excavation adjacent to RMS infrastructure

Background

The number and size of ground excavations in close proximity to Roads and Maritime Services (hereafter referred to as “RMS”) infrastructure have increased steadily in recent years. It is imperative that the design and construction of the supporting structures to these excavations are adequate to provide security to the road infrastructure and its operations.

Purpose

The purpose of this document is to provide a technical direction for all proposed excavations by private and commercial developments with their influence zones, and/or any temporary structures extending onto the road reserve and RMS easements. It sets out the requirements for RMS concurrence upon referral of a Development Application involving excavation adjacent to classified roads affecting the road infrastructure.

This technical direction is an integral policy document for the management of excavation related geotechnical risks within the Work Authorised Development (WAD) Approval framework.

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

Scope

This document applies to retaining structures (typically embedded cantilever and propped/anchored retaining structures) constructed to support the sides of excavations which are within close proximity to the roadway. It also outlines the requirements for installing ground anchors and instrumentation as part of these excavations. Proponents must contact the RMS Project Manager for areas that are not covered by this Technical Direction.

It should be noted that the RMS review relates to the impact on its road assets and does not relieve the wall designers and property developers of their obligations with respect to any other statutory requirements as part of the development.

For:	Engineers, Works Supervisors, Surveillance Officers and Councils		
Enquiries:	Supervising Geotechnical Engineer (Standards)	Phone:	8837-0248
Amendment / Addition to:	Ref File: GEO 4364		xxxxxxxx

Referral from Consent Authority

Where the consent authority refers a development application to RMS for comment and an excavation is proposed as described above then the consent authority is to be advised that the developer needs to comply with this Technical Direction.

Submission to RMS

The following documents are to be submitted for RMS concurrence at least six weeks prior to commencement of construction:

Dilapidation Survey: RMS may require a dilapidation survey for sensitive assets where there is a potential risk of damage caused by the proposed development. The dilapidation survey must cover RMS 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.

Design documentation: The design documentation must be presented in a format that is readily understood by engineers. The structural engineering report must detail an accurate geometry of the retention scheme, load and design assumptions, load cases, structural section properties / material parameters including analysis output (such as moment and shear envelopes and deflections). Cross sections at critical sections of the proposed excavation showing the geotechnical model used for design must be clearly indicated. The geotechnical report on which the design is based must be provided with the design documentation. The design report must include both temporary and permanent structures where applicable.

Drawings: The Drawings must show the layout of the proposed structure(s) relative to RMS assets including but not limited to roads, tunnels, bridges, embankments, walls, noise walls and traffic signals. Longitudinal and cross sections showing the proposed structures and RMS assets must be drawn at critical locations. The construction sequence must be shown on the Drawings.

Specifications : Copies of the specifications are to be included where necessary to interpret the design and Drawings.

Instrumentation and Monitoring:

The instrumentation layout proposed for the monitoring of movement as a result of the excavation must be included in the Drawings together with the frequency of monitoring, trigger levels and action to be taken when trigger levels are exceeded.

Construction

Following RMS concurrence, construction is to be carried out in accordance with the Drawings, and specifications accepted by the RMS. Any modifications to the design, following acceptance, must be referred to RMS for concurrence.

Work-As-Executed (WAE) Drawings: Upon completion of construction the WAE Drawings of the retaining structures supporting the RMS infrastructure, including stabilisation measures in the case of excavation in rock must be submitted to RMS for record purposes.

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Technical Requirements

Design Standards

Retaining structures must be designed in accordance with the relevant RMS documents and the current edition of the following Standards as appropriate, unless otherwise specified in this document. Where conflicting information occurs, the RMS document is to take precedence.

AS 1726 Geotechnical Site Investigations

AS 1170 Structural design actions – General principles

AS 5100 Bridge design – Scope and general principles

AS 3600 Concrete structures

AS 2159 Piling – Design and installation

The design of the proposed structures must be in accordance with AS 5100 unless otherwise specified in this document. The design life of permanent retaining wall structures is 100 years and the design of these walls and associated elements is to include both short term and long term effects. In particular, the unplanned excavation as detailed in Section 13.3.1 of AS 5100.3 for stability design must be considered.

Geotechnical Investigations

As a minimum, geotechnical investigations are to be undertaken in accordance with AS 1726 to develop surface/subsurface 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 to a minimum of 3 metres 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 mechanisms (joints, fault zones, volcanic intrusions, weak zones etc) which may have an adverse impact on the development and adjacent RMS Infrastructure. Where excavations are in excess of 10 metres depth in rock, an assessment of the rock stress state and its effects on the excavation is required.

Utilities

The nature of any utilities located within the zone affected by the proposed excavation must be established. The effect of the excavation on these utilities must be analysed and reported. The requirements of utility owners and the sensitivity of these utilities to ground movements must be taken into account in the design and construction.

Where the utility owner requirements are not established, the design must consider either the effect of ruptured utilities or the underpinning of such utilities.

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Types of Acceptable Ground Support

Whilst most types of ground support structures can be considered, 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 Class III sandstone (Pells Classification System) or where the rock has adverse defects.

Design Loads and 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 must take into account construction loads, loads from neighbouring structures and other surcharge loads as required by the relevant design standards. A minimum UDL of 10 kPa must 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 impacting on RMS infrastructure, and the developer must inform themselves 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. Possible damming effects leading to elevated water pressures should be considered.

Where drainage measures are proposed to relieve water pressures behind the structure these 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.

Design groundwater levels and drainage details must be shown on the Drawings.

Ground Anchors

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

- Only temporary ground anchors will be permitted;
- Ground anchors are to be designed and tested in accordance with AS 5100;

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- Temporary ground anchors must have a minimum design life of 2 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 must be stressed to greater than 75% of the tendon UTS under either working load or test load;
- No part of any ground anchor must be less than 2 metres below the surface within the State road reserve and RMS easement.
- Once the anchors are no longer required to carry load, all structural connection between the anchors and the proposed development must be removed.

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

Ground Deformation and Wall Deflection

The prediction of vertical and horizontal deflections of the proposed retaining structure for each stage of construction and in the long term must be provided in the design documentation. These deflections must be presented in graphical form at critical sections for the full height of the retaining structure.

Retaining wall structural deflections must not result in any damage to RMS assets. Ground deformation estimates must 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 deflection of the retention elements.
- Groundwater drawdown.
- Consolidation of soils.
- Other site specific work or processes affecting ground deformation

Permissible deflections will be determined by RMS on a case by case basis, taking into account the sensitivity of RMS assets to movements, the proximity of the structure to such assets and the ground movements that will occur within RMS property or the road reserve. However, total serviceability deflection of the wall in any one direction acceptable for non-sensitive RMS assets is to be limited to 0.5% of the excavated height or 30 mm, whichever is the lesser. Generally, the permissible movements on infrastructure assets should be clarified with RMS prior to the design.

Instrumentation and Monitoring

RMS 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 metres
- Propped or anchored walls with a retained height exceeding 6 metres

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Where required, instrumentation will generally include a minimum of two inclinometers installed to at least 3 metres below the toe level of the walls. Where the groundwater level is above the final excavation level a number of piezometers must 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 RMS assets affected by the development.

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

- Before commencement of construction of retaining structures where appropriate to determine baseline readings. Two independent sets of measurements must be taken confirming measurement consistency.
- After construction of the retaining structures, but before commencement of excavation.
- After excavation to the first row of supports or anchors, but prior to installation of these supports or anchors.
- After excavation to any subsequent rows of supports or anchors, but prior to 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 must be carried out by a competent person experienced in the equipment used. The results of each monitoring stage must be reported to the design engineer. Before work proceeds to the next stage the design engineer 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. Verification by the design engineer must constitute a 'Hold Point' for each stage of construction.

RMS must 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 program or 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 agreed value, excavation could be continued.
- ☐ **Action:** If lateral displacements are greater than 80% but less than 100% of the agreed value, RMS should be notified and the monitoring data be reviewed. The frequency of monitoring should be increased.

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- **Alarm:** If lateral displacements are greater than the agreed value, the RMS Project Manager must be advised immediately in which case the excavation works is to be terminated. A comprehensive Risk Management / Contingency Action Plan is to be implemented with measures taken to safeguard the road infrastructure.

Hold Points

Construction must be carried out in accordance with the Council approved plans and work method statements agreed by the RMS. Construction must not proceed to the next stage until preceding 'Hold Points' have been released.

Completion of the 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 commencement 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 RMS 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 RMS 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.

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Access to Site

Access to the site by RMS Engineers must be allowed for the purpose of reviewing compliance to the requirements of this document and the Work Authorised Development documents agreed with RMS.

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