TS 1170.5:2024 - (Geotechnical Considerations)

- Background for the need to include geotechnical considerations in TS 1170.5
- Philosophy / approach taken
- Summary of the new material in the TS and TS commentary

29 February 2024

Background for including geotechnical considerations in TS 1170.5

- The seismic performance of a building is fundamentally linked to the strength, stiffness and stability of the ground supporting the building foundations
  - The assumption of a fixed base condition in seismic structural analysis is true for only a few situations (e.g., shallow foundations on hard rock)
- Clause B1 (Performance) does infer consideration of geotechnical issues through the requirement to take into account *"…all physical conditions likely to affect the stability of buildings, building elements and sitework*" e.g.:
  - earth pressure
  - earthquake
  - differential movement
  - variation in the site characteristics

Background for the inclusion (introduction of) geotechnical considerations into TS 1170.5

- NZS 1170.5 does not address how the performance of the ground and the interaction of the ground with foundations are to be considered in seismic design.
- Does not require the performance of the foundation soils to be considered as part of the verification of limit state performance

No direct provision of seismic hazard parameters for use in geotechnical assessment / design

Approach taken for TS 1170.5:2024

- Not enough time to fully incorporate all geotechnical considerations
- The use of a prescriptive ‘deemed to satisfy’ approach (e.g., VM) was not considerable practical or desirable
- Completely new content – hence a ‘soft introduction’ of geotechnical considerations was deemed important

Key objectives:

- Succinct provision of minimum requirements in Section 2 (Verification)
- Provide commentary to highlight important issues and references to the NZGS modules and selected other guidance / standards that might be useful
- Set out the seismic hazard parameters / values to be used for geotechnical assessment / design

Overview of the new content - TS

Section 2 – Verification

Ultimate Limit State

- *Section 2.3.1 General (e)*: requirement that the deformation of the foundation soils *does not compromise the assumed behaviour of the structure*
- *Section 2.3.4 Deformation control*: deformation limits explicitly include *deformation of the foundation soils*

Serviceability Limit State

- *Section 2.4*: *requires explicit consideration of the deformation of foundation soils*

Appropriate consideration of ground deformation implicitly requires the consideration of several geotechnical issues

Overview of the new content - TS

Section 3 – Site Demand Parameters

Section 3.3 (new) – Hazard parameters for geotechnical assessment and design

- PGAs and earthquake magnitudes provided for a range of APEs (by specific location or grid point)
- Must know the site class or use a default site class

Refer to Misko's presentation

- Note that the provision to use a 'default' value of *PGA = max(PGA) for Site Classes II-VI* does not preclude the Section 2 requirements to confirm that foundation soil deformations are within acceptable limits – *(typically through appropriate geotechnical assessment)*
- PGA = $S_a(0)$ in elastic design spectra – consistency of loading parameters across design applications

Overview of the new content - TS

Section 5.3 – Design actions for geotechnical considerations

- Simply states that the PGA and M values for geotechnical assessment and informing structural design shall be determined as described in Section 3

Overview of the new content – TS commentary

C2 Verification – C2.1 General requirements – **Performance of foundations and supporting soils**

- The performance of the foundation soils *should be considered as part of the verification process*
- Lists typical ground behaviour / foundation performance issues that should be considered (e.g., liquefaction/lateral spreading, seismic settlement, lateral soil loads, pile down drag, seismic slope stability, buoyancy)
- Highlights the need to consider the effects of a potential step-change in soil behaviour

Overview of the new content – TS commentary

C2 Verification – C2.1 General requirements – **Performance of foundations and supporting soils**

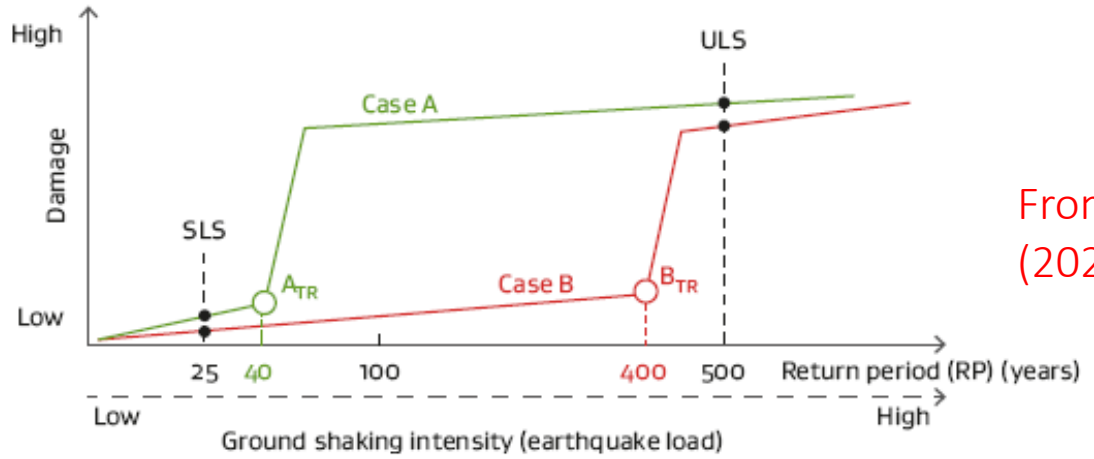
- Highlights important geotechnical considerations that can impact design and performance of foundations – e.g.:
  - both soil strength and soil stiffness need to be considered in foundation design
  - shallow liquefaction can have large effect on foundation performance
  - the importance of considering the uncertainty inherent in geotechnical assessment and accounting for it in analysis and design
- Lists the typical items that a geotechnical investigation / assessment might include along with suggested minimum report content

Overview of the new content – TS commentary

C2.3.1 Verification of ultimate limit state

- Recommends that tolerable limits for foundation deformation be agreed between the geotechnical and structural engineers and the building owner
- Highlights the need to consider the potential for step-change in soil behaviour
  - ➢ In the absence of specific guidance, recommends checking for step-change behaviour up to 150% of ULS shaking
  - ➢ Highlights the importance of considering potential step-change behaviour between SLS and ULS

Figure 2: Comparative evaluation of the seismic performances of two geotechnical systems



From NZGS Module 1 (2021)

Additional considerations for future TS revision and / or guidance

Issues identified as important to address

- Design load limits that account for nonlinear soil behaviour
- Treatment of step-change in soil behaviour
- Treatment of foundation settlement and bearing capacity in design
- Soil-structure interaction
- Liquefaction / lateral spreading considerations in design

Develop sections in the TS to support consideration of these issues in the design process, and / or develop guidance to help inform design

Updated NZGS MODULES

Module 1 (2024)

- Significant revisions to Section 5 – Estimating ground motion parameters

Module 2 (2024)

- Some revision of Section 3.7 – In situ seismic testing
  - In particular Section 3.7.3 – Non-invasive (surface wave) methods

- To be released with final version of TS1170.5:2024

Thank you