Determination under the Building Act 1991

No. 94/007: Soil stabilisation measures associated with a retaining wall

1. The matter to be determined

1.1 The matter before the Authority was whether proposed soil stabilisation measures were adequate to ensure that the loads likely to be experienced by a proposed retaining wall did not exceed those that the wall was capable of withstanding.

1.2 The Authority takes the view that it is being asked to determine whether, as required by clause B1.3.1, B1.3.6, and B1.3.7 of the New Zealand Building Code (the First Schedule to the Building Regulations 1992), proposed soil stabilisation measures are sufficient to ensure that the retaining wall concerned will have a low probability of becoming unstable or collapsing.

1.3 In making its determination the Authority has not considered whether the plans and specifications of the proposed building work comply with any other provisions of the New Zealand Building Code.

1.4 The owner of the property below the retaining wall was the applicant, the other party was the territorial authority. As it happened, the territorial authority was also the owner of the land above the retaining wall.

1.5 The Authority prepared a draft determination which was sent to the parties, who were asked whether they accepted the draft or wished to make further submissions at a hearing under section 19 of the Building Act. Such a hearing was held on 12 December 1994, at which the applicant appeared through its solicitor and its geotechnical consulting engineer. The territorial authority chose not to appear. This determination is based on the draft but has been amended as a result of the hearing and subsequent events (see 4.3 and 4.4 below).

2. The building work

2.1 General

2.1.1 The proposed retaining wall and associated soil stability measures are to replace a section of an existing crib wall that runs along the foot of a steep bank at the rear of a commercial property development. The existing wall was constructed in 1988, when a building platform was formed by excavating the toe of the bank, and retains approximately 3 m depth of ground. The natural slope above the retaining wall excavation was also excavated to form a steep bank. The section of retaining wall to be replaced collapsed after a period of heavy rain, whereupon the bank above that section slipped as a result of the loss of support.

2.1.2 There appears to be an unresolved disagreement between the applicant and the territorial authority, in its capacity as owner of the neighbouring land, as to the extent, if any, to which each of them should pay for the soil stabilisation work. The Authority is not concerned with that question and offers no opinion on it.

2.1.3 The applicant commissioned a subsoil investigation which involved the drilling of five boreholes. A report ("the EQWDC report") on the slip failure had been prepared by consulting engineers engaged by the Earthquake and War Damage Commission, and that report referred to boreholes commissioned by the territorial authority. Those appear to be the only available sources of specific information on the soils in the slip area.

2.1.4 The applicant's consultant described the soil to be retained as:

> "residual soils overlaying the interbedded sandstone/siltstone of the Waitemata Group with little or no Pliestocene cover".

The EQWDC report said that:

> "The drill holes include 2 holes close to the section of the wall failure and identify soft clay up to 1 m thick overlying firm/stiff clays and silts which contain remnant kernels of Parnell grit [which] forms part of the Waitemata Group Series and are derived from andesitic volcanic mud flows which occurred at the time the Waitemata series sediments were being deposited. There was no evidence from the bore holes of the more recent volcanic soils which are commonly found [in the vicinity of the bank concerned]."

2.1.5 The EQWDC report describes the entire bank as showing signs of instability, with evidence of creep. It observes:

> "The shallow surface instability indicates that the strength is marginal at the slope angle and that creep loadings may increase loads on the wall to significantly exceed active pressures (general used design assumptions)."

2.2 The course of events

2.2.1 Originally, the applicant took the view that it was not responsible for soil stabilisation work on the territorial authority's land, and applied for a building consent in respect of a crib wall only, noting on the application that soil stabilisation works "by others" would be necessary. However, after discussions with the territorial authority the applicant submitted a revised application including certain soil stabilisation works, including "sheet 1" referred to below. There were then further discussions, during which the territorial authority suggested certain amendments to sheet 1.

2.2.2 As a result of the discussions, the applicant submitted a further revision, including "sheet 1A" referred to below, which adopted all of the territorial authority's suggestions. A building consent was issued on the basis of that revision, but the applicant now contends that its provisions go beyond what is necessary for compliance with the New Zealand Building Code.

3. Discussion

3.1 General

3.1.1 The dispute is essentially as to the soil stabilisation measures that are to be provided behind the replacement wall. The consulting engineer engaged by the applicant to design the remedial works ("the applicant's consultant") has prepared two drawings, "sheet 1" and "sheet 1A", showing respectively the measures that he recommends and the more extensive measures suggested by the territorial authority. The applicant has invited the Authority to decide "what soil stabilisation measures are necessary to ensure that the loads likely to be experienced by the crib wall [as detailed] will be such that the wall will achieve the performances required by clause B1 of the New Zealand Building Code; specifically, whether any changes to the slope stabilisation measures proposed in [sheet 1] are necessary".

3.1.2 Both sheets 1 and 1A show a new crib wall along the base of the slip area, with seven horizontal slotted subsoil drains radiating from the apex of the slip area into the slope above. Water from those drains, and from a surface interceptor above the slip area, runs into a manhole and from there through a pipe feeding into another manhole behind the wall. Within the slip area are six slotted counterfort drains running at right angles to the wall and at specified depths below the restored surface of the bank. Water from the counterfort drains flows into an interceptor drain running behind the base of the wall and thence into the manhole behind the wall, which discharges into the existing drainage system outside the wall.

3.1.3 The differences between sheets 1 and 1A relate to the surface interceptor, the counterfort drains, the interceptor drain, and the general restoration of the surface of the bank over the slip area. Those differences are summarised in the table below.

3.1.4 In support of the application, the applicant submitted a report ("the peer review") from another consulting engineer which essentially endorsed the sheet 1 approach but suggested that surface water should feed to two cesspits, one at each end of the surface interceptor, instead of to one cesspit at the centre of the surface interceptor, and that a separate pipe should lead from each cesspit to the interceptor drain behind the retaining wall. The peer review also suggested that the spacing of the counterfort drains could be increased from 5 to 6 m.

Table of Differences between the Applicant's proposals ("Sheet 1") and the Building Consent ("Sheet 1A")

Item	*Sheet 1*	*Sheet 1A*
Surface interceptor	Concrete channel feeding to a central precast cesspit	Clay bund feeding to a central concrete inlet structure
Counterfort drains	Twin perforated drainage pipes	Twin perforated drainage pipes complying with Transit New Zealand specification F2.
	At specified depths varying from 3.5 to 4.0 m.	At specified depths varying from 3.5 to 6.0 m.
	All extending to the face of the slip.	The outer two extending significantly beyond the face of the slip.
	Lined with filter cloth and bedded in 20/7 scoria backfill below 1 m of compacted clay and 150 mm of topsoil	Bedded in 2 m of cement and AP20 scoria mix at the base of AP20 scoria backfill below 500 mm of compacted clay and 150 mm of topsoil
Interceptor drain	No access for maintenance	Vertical riser with rodding eye at each end of the interceptor drain
General restoration	Grade with bulldozer and leave	Reinstate with compacted clay to original profile, topsoil, and grass

3.2 Surface interceptor

3.2.1 In its submissions, the territorial authority contended that:

(a) A concrete interceptor channel would be difficult to construct because of the local topography,

(b) An inlet structure was more effective than a precast cesspit at collecting surface water on a steep slope and less likely to block, and

(c) The surface interceptor shown on sheet 1 “would not be effective given the steep slope of the land and the presence of [a] gully”.

3.2.2 Possible difficulties in construction are not reasons for refusing building consent. Owners must be free to adopt whatever construction methods they wish, but at the risk that if those methods are unsuccessful the territorial authority will issue a notice to rectify rather than a code compliance certificate.

3.2.3 However, the Authority considers that neither sheet 1 nor sheet 1A show technically acceptable surface water disposal systems, because they each combine subsoil and surface drainage systems, which in extreme situations of outlet blockage could lead to pressurising the slope. The Authority considers that an appropriate method of surface water disposal would be for the water collected by the surface interceptor channel (the profiles shown in sheet 1 and sheet 1A are equally acceptable) to go into a shallow lined trench running down the slope to the top of the wall to a collection sump with a screened inlet. If necessary to suit the slope and the expected volume of surface water, the trench should be stepped to reduce velocity. From the collection sump the water would be discharged through a pipe to the existing drainage system; alternatively, if acceptable to the applicant, that pipe could be "daylighted" by extending it through the wall to discharge on to the sealed area in front of the wall and so to the existing drainage system. The manhole shown at the rear of the wall in both sheet 1 and sheet 1A may be utilised for the collection sump provided that it is partitioned to ensure that surface water is kept separate from subsoil water.

3.3 Counterfort drains

3.3.1 The Authority understands that Transit New Zealand specification F2, as shown on sheet 1A, is appropriate for pipes at depths exceeding 3 m.

3.3.2 The Authority considers that the compacted clay backfill should be placed no deeper than 650 mm below the surface, as shown in sheet 1A, to minimise the potential for perched water tables. However, the other backfill details shown in sheet 1A, are less satisfactory than those shown in sheet 1 because if the fines content of the proposed backfilling material is too high that material will have low permeability and be an ineffective drainage material. The Authority does not consider that cement is required to prevent erosion provided the grading of the scoria is appropriate.

3.3.3 The Authority considers that the counterfort drains should be backfilled with drainage material to 650 mm below the surface. The drainage material, or at least the bottom 2 m of it, should be wrapped in an appropriate geotextile. The geotextile shown on sheet 1 is considered inadequate for that purpose and should be replaced by a filter fabric complying with Transit New Zealand specification F6. The drainage material shown on sheet 1 is more than adequate and may be replaced with 50/14 or GAP 65 scoria if desired.

3.3.4 The most important difference between the parties is as to the depth of the counterfort drains. The parties agree that the mode of failure to be guarded against is a "planar" failure in which a block of soil slides on a planar surface parallel to the ground surface. However, the applicant's consultant (supported by the peer review) is of the opinion that only the upper 2 to 3 m of soil is at risk, whereas the territorial authority is of the opinion that the soil down to the sandstone/siltstone interface some 6 or 7 m below the surface is at risk.

3.3.5 The Authority notes that the EQWDC report indicates that deeper planar failures should be considered.

3.3.6 The Authority considers that the calculations submitted by the applicant's consultant do not adequately address the overall stability of the slope, and in particular do not address the possibility of deep seated planar failures. There is therefore no information available to the Authority that justifies the depths shown in sheet 1 for the counterfort drains, and on that basis the Authority considers that the more conservative approach represented by sheet 1A must be preferred.

3.3.7 The Authority considers that the counterfort drains should be extended as shown in sheet 1A to isolate the slip area from adjacent areas.

3.4 Interceptor drain

3.4.1 The Authority considers that the vertical risers shown in sheet 1A are a sensible maintenance provision justified for compliance with the New Zealand Building Code.

3.4.2 As an alternative, however, the Authority would accept "daylighting" of the counterfort drains by extending them through the wall. If that is practicable and acceptable to the applicant, there would be no need for the interceptor drain, and a single perforated drainage pipe could be used for each counterfort drain instead of the twin pipes shown in sheet 1A.

3.5 General restoration

3.5.1 The documents submitted to the Authority do not record any discussion on the general restoration of the ground surface. The applicant's consultant, in a letter to the territorial authority, said that "The slope needs . . . recontouring to remove scarp faces, tension cracks etc . . . topsoil and re-grassing". It is not clear who was responsible for the description "Grade with bulldozer and leave", used in a letter from the applicant's legal representatives and adopted in the table above. It is not clear from sheet 1 whether all backfill over the slip area is to be compacted, but on sheet 1A there is an additional cross section of the bank annotated "Reinstate slipped area with compacted clay to original ground profile topsoil & grass". The Authority considers that backfill in the slip area should be compacted to ensure that the surface contours are maintained.

4. Conclusion

4.1 The Authority concludes that the applicant's consultant prepared a design to guard against the comparatively shallow type of failure that had already occurred, but did not take adequate account of the deeper type of failure that must be regarded as possible unless that possibility is precluded by geotechnical investigations or specific design consideration.

4.2 Other matters in dispute are of a comparatively minor nature, in some cases the Authority supports the opinion of the territorial authority, in other cases it does not, as detailed above.

4.3 At the hearing, the applicant, through its solicitor, undertook to prepare a “contingency” retaining wall design on the assumption that there was a deeper weak soil layer than had been assumed in the original design. That design has now been submitted to the Authority and is approved as complying with the building code for the assumed soil conditions. A copy of the approved contingency design signed on behalf of the Authority will accompany the copies of this determination that are given to the parties in accordance with section 20(b) of the Building Act

4.4 The applicant also undertook to engage its geotechnical consulting engineer to make geotechnical investigations, by way of appropriate localised investigations to approximately 6 m depth, to discover whether or not there is a weak soil layer as assumed for the contingency design. If a weak layer is discovered then the "contingency" design shall be followed and the counterfort drain depths shall be increased to correspond to the depth of the weak layer.

4.5 Those undertakings are reflected in the Authority's decision.

5. The Authority's decision

5.1 In accordance with section 20(a) of the Building Act, the Authority hereby determines that the territorial authority's decision to issue a building consent in terms of sheet 1A is hereby modified as follows:

(a) The plans and specifications referred to in the building consent shall be amended such that:

(i) The surface water disposal system is to be as described in 3.2.3 above,

(ii) The depths of the counterfort drains and their bedding and backfilling details are to be as shown in sheet 1 but modified as described in 3.3.3 above, and

(iii) If the applicant so wishes, the counterfort drains may be carried through the wall and the interceptor drain omitted as described in 3.4.2 above.

(b) The following conditions shall be added to the building consent:

(i) The applicant's geotechnical consulting engineer shall make additional investigations, by way of appropriate localised deepening of the excavations for the counterfort drains to approximately 6 m depth, to discover whether there is a weak soil layer not allowed for in the design for which the building consent was issued, and

(ii) If it is established that such a layer is present then the depths of the counterfort drains shall be increased to correspond to the depth of the weak layer and the retaining wall shall be constructed in accordance with the contingency design approved by the Authority, but

(iii) If it is established that such a layer is not present the investigatory excavations shall be appropriately backfilled and compacted.

Signed for and on behalf of the Building Industry Authority on this 22nd day of December 1994

J H Hunt
Chief Executive.