

Design of a Counterfort Retaining Wall

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Abstract: The design of a counterfort retaining wall is similar in many respects to that of a cantilever retaining wall as far as computing overturning and sliding stability, bearing capacity, and soil pressure beneath the base slab are concerned. The retaining-wall computer program in the Appendix can be used to obtain the wall stability, bearing capacity, soil pressure, and toe shear and moments for a counterfort wall.

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Introduction:

Divide the stem into several horizontal zones and obtain longitudinal bending moments. About three strips-top, midheight, and at base--should be sufficient. Use these moments to find required horizontal reinforcing steel and run the required amount the full length on front and back face.

Divide the stem into several vertical strips, compute the vertical bending moments and shear at the base of the stem (junction with base slab), and check stem thickness for shear adequacy. for this analysis. Consider using cutoff points for the vertical steel. Divide the heel slab into several longitudinal strips, and use the pressure diagrams and the moment equations to obtain the longitudinal bending moments. Use these moments to find the longitudinal reinforcing steel in the base slab. Treat the base slab as a cantilever similar to the cantilever retaining wall, and find the shear at the back face of the stem and bending moment at this location. Revise the base thickness if necessary for shear requirements. Use the bending moment to compute required perpendicular heel-slab reinforcing steel.

Review of study:

Treat the toe of the, base slab identical to a cantilever retaining wall. Analyze the counterforts. They carry a shear of Q_c computed as follows:

$Q_{total} = 0.5qLH$ for each full counterfort spacing

$Q' = 0.2qLH =$ shear carried along base of wall

$Q_c = 0.5(0.5qLH - 0.2qLH) = 0.15qLH$

= lateral wall shear carried by counterfort

Assume a linear increase of shear (based on shape of pressure diagram) with depth to obtain tension steel to tie the counterfort to the wall. Using this same linear increase find the location of the shear resultant and compute the moment the counterfort must carry into the base slab. Use bent reinforcing

bars so that embedment depth is not critical.

Method of design

The alternative method of designing a counterfort retaining wall is to treat the system (wall and heel slab) as plates fixed on three edges with the appropriate pressure diagrams--hydrostatic in form for the wall and the combination of soil pressure and soil overlying the heel slab as in cantilever-retaining-wall analysis. It will be necessary to establish boundary conditions for this problem. It will be necessary also to solve half the plate to minimize the size of the matrix to be reduced. Since the plate is approximately symmetrical with respect to the vertical axis, one would set the Y rotations = 0.0 at the centerline; at the fixed edges all three displacements= 0.0 (X and Y rotations and Z translation). A similar situation is used to describe the heel slab. A typical grid for this problem. Note the use of closer grid spacing near the fixed edges. It is possible to account for varying thickness of the wall by dividing the wall height into several zones and using a constant (but different for each zone) thickness in the zone. The use of a varying thickness instead of a constant thickness may vary the computed bending moments 20 percent or more [see also Jofriet (1975)].

Basement or Foundation Walls;

Walls for Residential Construction

Walls for building foundations, and basement walls for both residential construction and larger structures require the same design considerations. Normally these walls are backfilled with any material available at the site and in a very limited backfill zone[1]. The tops of these walls are usually restrained from lateral movement so that active-pressure conditions are not very likely to be obtained. If active pressure conditions are obtained and especially if the backfill is cohesive, the lateral-

wall deformations would be likely to be noticeable. For this reason the lateral-pressure coefficient should be taken for a K_0 condition. The structural design would proceed as for other types of retaining walls. Backfill for residential basement walls should be carefully placed and of good quality and preferably granular. The wall should be provided with a perimeter drain placed on the wall footing. This type of construction will ensure a dry basement and is more economical than later having to dry the basement by digging out and replacing the fill and/or installing a perimeter drain. For much residential construction, however, the backfill for walls consists in any material available-usually material excavated from the basement and including large quantities of wood fragments from cutting the framing and other materials to proper size. The backfill is seldom compacted; however, since many basement walls are not designed and consist in concrete blocks and mortar, the lateral earth pressure they can sustain is rather low. It is not uncommon to observe walls propped into place in subdivisions under construction after heavy rains have densified and saturated the cohesive backfill. It is never possible to push the walls back into place; thus many basement walls remain permanently bulged.

Reinforced-Earth Retaining Structures

Reinforcing the earth with strips of metal or geotextiles is a means of providing a retaining wall. Illustrates the general concept of reinforced earth. The strips introduce cohesion into the soil via friction between the earth and the reinforcement strips, and the front plates are to prevent loss of earth. This concept has been much studied in recent years [Vidal (1969), Lee et al. (1973), Schlosser and Long (1974), Tumay et al. (1979) among others] both for a better understanding of the mechanism of reinforced earth and to determine what alternative reinforcing may be used.

The design of a reinforced earth wall consists in evaluating the active earth pressure at the various levels H_i from top where reinforcement strips are to be used. The pressure acting over the area ($h \times s$) centered on the strip produces the tension force $T_i = \gamma H_i K_a (h \times s) - T_{i-1}$ to be resisted by the reinforcement strip. The strip area is based on the allowable material stress f , and a suitable factor of safety F such that $b \times t \times f_a = F \times T_i$

The strip length beyond the active zone L_R (at depth H_i) is based on the friction resistance developed by the soil weight on the strip at that level as $2\gamma H_i b (L - L_R) \tan \delta = F \times T_i$

We note the 2 is for both sides of the strip and δ is the friction angle between soil and strip material. The ρ angle is used to obtain

$L_R = H \cot \rho$ The weight term γH and ρ should be suitably adjusted if the backfill is sloping or carries a surcharge.[2] The following factors tend to make this analysis somewhat approximate:

1. The strips alter the upper part of the "active" zone to a much lesser value somewhat analogous to the tension crack effect when backfill soil contains both cohesion and friction. This reduction of active zone may not be relied upon to reduce the strip length with any confidence. In the model tests of Tumay et al. (1979), wall failures occurred when the reinforcement strips were slightly larger than the active zone defined by $H \cot \rho$.
2. The strip tension builds up from the wall face to some peak value and then may decrease somewhat. It is usual to assume a uniform distribution of tension; however, alternatives have been proposed of using both a linear increase and a parabolic increase. With a reasonable safety factor the uniform tension assumption should be adequate. Variation of strip tension with distance into backfill has been addressed theoretically by Broms (1478).
3. Friction is developed on both faces of the reinforcement strip. There is evidence that the bottom face carries a larger friction resistance; however, a single average value is usually used for design.)

Conclusion

1. The wall surface, or "skin," can be almost any material which is weather/corrosion-resistant and reasonably flexible so that the skin deforms to fit the soil deformation.
2. The soil backfill should be a granular material for free-draining and angle-of internal-friction characteristics).

Reference

1. Bond, D. (1961), Influence of Foundation on Size of Settlement, *Geotechnique*, vol. 11, no. 2, June, pp. 121-143.
2. Borowicka, H. (1943), *Über ausmittig belaste starre Platten auf elastischisotropem Untergrund*, *Ingenieur-Archiv*, Berlin, vol. 1, pp.1-8.

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