Footblock design

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THE SCIENCE OF sheeted earth support systems has developed slowly during the past fifty years. The original Subway type lagging method was patented in the late 1920's and the contact sheeting method was patented in the 1960's. Recent Rapid Transit construction in California, Washington, Boston and New York, and highway and anti-pollution projects throughout the United States and Canada is providing incentive for further advancement in construction and design of earth support systems. But many factors operate to discourage enterprising contractors and knowledgable engineers.

One of these factors is the present state of the science of soil mechanics. Another is the penalty suffered by engineers resulting from alleged or proven faulty design. Criteria for design has, generally, evolved from field and laboratory testing and observation of construction methods. Lack of adequate information has forced engineers to prepare their plans with safety factors related to the value of the work and the penalties resulting from errors and omissions. The size and arrangement of foot-blocks has, until quite recently, been determined by contractors (with few exceptions). Engineers were not willing to accept contractors' experience which had no accepted theoretical design criteria.

Applying accepted principles of foundation design or utilizing modified presumptive bearing capacities (as in building codes) results in uneconomical and sometimes harmful designs.

The following empirical criteria, developed and applied with complete success to foot-block design on hundreds of projects, might be an aid to engineers on present designs and provide a starting point for theoretical analysis and future design refinements.

The decision to use foot-blocks should be made only after a thorough investigation of subsurface conditions and an understanding of construction methods and requirements. In soils in which silt is the principal component, knowledgeable handling of surface runoff and ground water is mandatory to maintain its shearing strength (and hence the integrity of the foot-block support).

Criteria: See Fig. 1

1. Rakers: inclined 1 vertical to 1½ (Max.) Horizontal.
2. Center line of raker at face of footblock: 1'-0 (Min.) below top of footblock.
3. Soil: Class eleven or better (NYC Bldg. Code) or Firm to Stiff (non plastic to low plasticity) clays and/or inorganic granular soils.
4. Allowable bearing pressure on *Critical Section = 1 kip/s.f. (over full area of Critical Plane).
5. Horizontal surface of soil behind footblock 4 in. (min.) above top of footblock.
6. Critical section areas of adjacent footblocks do not overlap.
7. Surface and subsurface water handled in a proper manner to avoid a "quick" condition.
8. Footblocks protected from influence of excavations and equipment.
9. Contact sheeting (horizontal sheeting) maintained by packing to minimize voids.
10. Footblock materials designed in accordance with applicable codes and poured or installed against undisturbed soil. Rakers wedged tightly.

* Critical Section (plane): The top of the plane is located at a horizontal distance (measured from bottom bearing face of footblock) at ground surface behind the footblock equal to twice the depth of the footblock. The plane is perpendicular to the line of the raker.

Area of Critical Section is bounded by: Planes cutting the critical section at 45°, extending from bottom bearing edge and sides of footblock, and the ground surface intersected by the critical plane (see Fig. 2).

1. 4 ft × 5 ft × 6 ft (1.2x1.5x1.8m) concrete Footblock Area of critical section: D = 5 ft; L = 6 ft; W = 4 ft
   A_c = 16 ft × 17 ft (4.8x5.2m) =272 SF
   $P_{allowable}$ = ±272^k
2. 3 ft × 4 ft × 5 ft (0.9x1.2x1.5m) concrete Footblock: D = 4 ft; L = 5 ft; A_c = 12 ft × 13.5 ft (3.6x4.1m) = 162 SF
   $P_{allowable}$ = ±162^k
3. timber footblock: D = 3 ft; L = 4 ft; A = 9 ft × 10 ft 6 in. (2.7x3.2m) = 94.5 SF
   $P_{allowable}$ = ±94^k

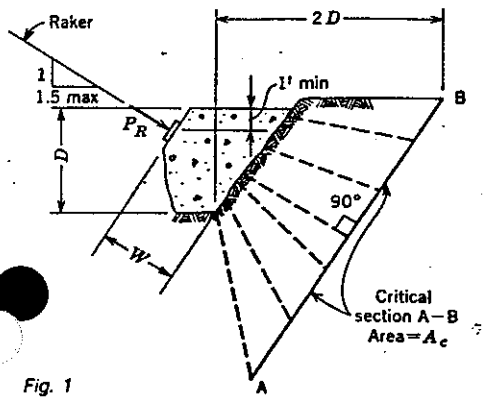

Fig. 1

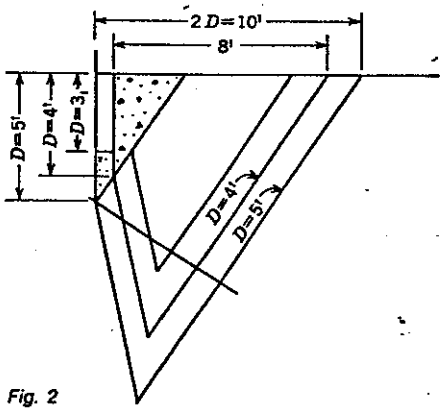

Fig. 2

Weldon S. Booth has worked in underpinning, cofferdams and unusual foundation projects since 1935.