

CHAPTER 4

SITE STRUCTURES

4-1. Drainage structures

a. Box culverts. Concrete box culverts will be designed for loadings defined in the AASHTO Standard Specifications for Highway Bridges in accordance with design requirements presented therein. Consideration will also be given to requirements set forth in ASTM C 789 and C 850 as applicable. Box culverts, if constructed of other materials, will be designed in accordance with the generally recognized codes and standards applicable to such materials.

b. Manholes and inlets. Manholes and inlets will be designed to resist earth, water, temperature, and other loads to which they will be subjected. Structural design of concrete structures will be in accordance with ACI 318. Design of other types of manhole construction will be in accordance with applicable codes covering that type of construction. Additional guidance for watertight construction and load distribution coefficients for these types of structures may be found in PCA IS003.02D and IS072.01D. Special consideration will be given to the effect of roof and wall openings, and proper allowance will be made for differential movement due to settlement, thermal expansion, etc., between manholes and interconnecting elements. To the extent practical, precast components for manhole construction will be used. Precast components will be furnished in accordance with ASTM C 478.

c. Miscellaneous drainage structures. Corrugated culvert pipes will be designed in accordance with American Iron and Steel Institute (AISI) SG-861. Concrete culvert pipe will be reinforced and furnished in accordance with ASTM C 76. Required three edge bearing strength will be determined in consideration of class of bedding and applicable load factor as set forth in Foundation Engineering by Leonards. Corrugated aluminum culvert pipe will be furnished in accordance with ASTM B 745. Other materials will be considered subject to acceptance by the appropriate headquarters provided any special requirements such as bedding, etc., are met.

d. Sewers. Criteria for structural design of the various components of sewer systems will be established from information presented in Water Pollution Control Federation (WPCF) MOP9CTG, TM 5-814-1/AFM 88-11, Volume 1, and TM 5-814-2/AFM 88-11, Volume 2.

4-2. Earth related structures

a. General. NAVFAC DM-7.1, DM-7.2, and DM-73 will be the basic references for design of earth related structures. Additional references including MIL-HDBK-1025/4, the Structural Engineering Handbook by Gaylord & Gaylord, Foundation Analysis and Design by Bowles, Principles of Foundation Engineering by Das, as well as

publications by the manufacturers of proprietary products and systems will be consulted as necessary.

b. Retaining structures. Retaining structures can be classified with respect to the manner in which forces are transmitted to the surrounding soil as either gravity, cantilever, or anchored types. Though numerous variations exist within each general type, only a few are identified in the following discussions.

(1) Gravity structures. Gravity structures are those which rely solely on their own weight to maintain stability. Among the types of construction which act as gravity structures are concrete gravity blocks, bin or cellular cofferdams, crib walls, bin walls, gabions, and reinforced earth type structures.

(2) Cantilever structures. Cantilever structures are those which interact with the surrounding earth through flexural bending in such a way that a portion of the earth mass is brought into play in resisting the forces imposed on the structure. Among the types of construction which act as cantilever structures are reinforced concrete "tee" walls, counterfort or buttress walls, cantilevered concrete or steel sheet piles, overlapping drilled piers, and reinforced concrete slurry walls.

(3) Anchored bulkheads. Anchored bulkhead type structures are structures which typically employ a flexural "wall" type element to retain the earth and an anchor system connected near the top of the wall to reduce the magnitude of the reactions at the base of the wall. Typical anchored bulkhead type structures are anchored bulkhead waterfront structures, soldier beam and lagging systems, braced walls, and slurry walls when anchored near their top. Depending on the characteristics of the earth materials, the stiffness of the wall, etc., the base of the wall of such structures may be considered to be rotationally fixed to some degree which results in a reduction in the required flexural strength for the wall. There are also a number of options available regarding the type of anchor structure which can be used including anchor wall, batter pile system, earth or rock anchors, etc.

c. Shore protection structures. Shore protection structures will be designed as described in the CERC Shore Protection Manual, Volumes I through III. Additional information available from manufacturers of specialized shore protection products, e.g., revetment mattresses, interlocking articulated blocks, etc., will be considered where the use of such systems is warranted. Care will be taken in selection of material for such systems and regard given to the possibility of reduced service life when artificial materials are used.

TM 5-809-6/AFM 88-3, Chap. 6

4-3. Other site structures

a. Canopies and shelters.

(1) *Open canopies.* Open canopies include unenclosed roofed areas and one-, two-, and three-sided enclosures. Design of such structures will be based on the specialized loading considerations set forth in TM 5-809-1/AFM 88-3, Chapter 1 or MIL-HDBK-1002/2 and American National Standards Institute (ANSI) A58.1.

(2) *Mobile.* Mobile canopies and shelters will be designed for the loads which would otherwise apply to stationary structures of that type with additional provisions

regarding impact factors appropriate for the speed at which the structures are to be moved. Additional consideration will be given to possible load increases which can result from irregularities in alignment of the support system over which the structures will be moved, e.g., enforced displacements or variable support conditions.

b. Light poles, flag poles, and sign supports. Design of light poles, flag poles, and sign supports will be in accordance with the special provisions for such structures set forth in ANSI A58.1.