

(1) Concrete. Guidance for concrete materials and mixture proportioning is given in EM 1110-2-2000. Typically, a compressive strength of 25 MPa (3,000 psi) at 28 days is used. Higher strengths may sometimes be justified for retaining walls, I-walls, or U-frame structures. Air-entrained concrete should be used when freeze-thaw conditions are anticipated. Microsilica, fly ash, aggregate hardness, etc., should be considered as improvements in resistance to abrasion, when required. Type II cement should be used when sulfates are present in moderate concentration.

(2) Reinforcement. Steel bars shall be American Society for Testing and Materials (ASTM) Grade 60, deformed, cut lengths, or fabricated mats. Steel welded wire fabric shall be deformed wire produced from rods or bars that have been hot rolled. Consideration should be given to the use of a lower-permeability concrete and epoxy coated or galvanized reinforcement steel in areas where channel linings will be subjected to highly corrosive constituents such as saltwater or sanitary and industrial wastes.

(3) Joint filler. Joint filler shall be preformed sponge rubber.

(4) Joint sealant. Joint sealant shall be cold applied, multicomponent, and elastomeric. The sealant is installed in joints to prevent weathering of joint filler and is subjected to cyclic tension and compression loading as the temperature changes.

(5) Waterstops. Waterstops should be installed in joints of concrete sections when watertightness is desired. Guidance for use of waterstops is given in EM 1110-2-2102 and EM 1110-2-2502. Waterstops in joints which may experience appreciable movements should be rubber or polyvinyl chloride.

*b. Structural design loadings.* The forces acting on the structures and the weight of structures should be defined to perform the stability analyses and the design of the reinforced concrete sections of the structures. Some of the applied forces may be indeterminate in nature, and the designer must assume their location, direction, and magnitude. Assumptions should be based on available criteria, loading conditions, and the application of engineering expertise and judgment. Unsymmetrical loading, resisted by sliding friction or passive pressure, should be analyzed.

(1) Earth pressures. Earth pressures on walls of rectangular channels should be determined by using the

criteria given in EM 1110-2-2502 and ETL 1110-2-322 for T-type retaining walls and EM 1110-2-2504 for I-walls. Free-draining granular materials should be used for backfill behind walls to reduce the lateral earth pressure, decrease pressures due to frost action, minimize pressure increases from in situ materials having expansive characteristics, and increase the effectiveness of the drainage system.

(2) Hydrostatic pressures. Hydrostatic horizontal pressure behind walls and uplift pressure under paving slabs should be determined. Uplift pressures should be determined for the steady-state seepage and drawdown conditions. The magnitude of hydrostatic pressures may be reduced by installing drainage systems as discussed in paragraphs 2-4, 3-3, 4-5, and 5-4.

(3) Earthquake forces. Seismic forces for vertical walls of rectangular channels may be significant and should be determined using criteria given in ER 1110-2-1806 and EM 1110-2-2502. Seismic forces cause only small increases in earth and hydrostatic pressures on paving slabs and should be ignored.

(4) Wind. Reference should be made to EM 1110-2-2502 for wind loads on walls but these are usually negligible. Wind loads on paving slabs should be ignored.

(5) Surcharge. Surcharge loads from construction, operations and maintenance equipment, and highway or street vehicles should be included as appropriate. Criteria for determining surcharge loads are given in EM 1110-2-2502.

*c. Constructibility.* The dimensions of the concrete structures of flood control channels should be such that the reinforcement, embedded metal, and concrete can be properly placed. The thickness of the top of walls greater than 8 ft in height and footings supporting such walls shall not be less than 12 in. to facilitate concrete placement. The thickness of the top of walls less than 8 ft in height and containing only one layer of reinforcement may be decreased to 8 in. Walls should be designed for construction simplicity and maximum reuse of concrete forms. Dimensions of monoliths, independently stable units of concrete structures, should be selected to allow practical volumes of concrete placements.

*d. Joints in concrete.* Joints are provided in the reinforced concrete structures of flood control channels to divide them into convenient working units and to allow for expansion and contraction. The number of joints