Chapter 1
Introduction

1-1. Purpose

This manual prescribes guidance for (a) designing hydraulic steel structures (HSS) by load and resistance factor design (LRFD) and (b) fracture control. Allowable stress design (ASD) guidance is provided as an alternative design procedure or for those structure types where LRFD criteria have yet to be developed.

1-2. Applicability

This manual applies to HQUSACE/OCE elements, major subordinate commands, districts, laboratories, and field operating activities having responsibility for design of civil works projects.

1-3. References

References are listed in Appendix A.

1-4. Background

a. Types of HSS. Typical HSS are lock gates, tainter gates, tainter valves, bulkheads and stoplogs, vertical lift gates, components of hydroelectric and pumping plants, and miscellaneous structures such as lock wall accessories, local flood protection gates, and outlet works gates. HSS may be subject to submergence, wave action, hydraulic hammer, cavitation, impact, corrosion, and severe climatic conditions.

b. Types of steels. Structural grade steels used for design of HSS are as referred to in CW-05502 and American Institute of Steel Construction (AISC) (1986, 1989). High-strength structural steels may be considered where economy, simplicity of detail, or greater safety of design may result from their use. Instability, local buckling, and deflection of members shall be checked regardless of the type of steel used to fabricate the structure. However, these design limit states will generally be more critical for structures fabricated from high-strength steel.

c. Design policy. Previously, in accordance with EM 1110-1-2101, ASD criteria were specified for design of all HSS. LRFD is now the preferred method of design and should be used for those structure types for which LRFD guidance is provided (see Appendixes B through I). For HSS where LRFD has been developed, ASD may be used as an alternative design method only with prior approval of CECW-ED. Chapter 4 includes ASD criteria which are required for those HSS where LRFD has not yet been developed. For design of a structure, LRFD and ASD methods shall not be combined; however, use of LRFD and ASD methods for the design of separate structures on large construction projects is allowed.

d. Structures other than HSS. Designs for aluminum, timber, and masonry structures, service bridges and highway structures, building construction, cold-formed steel construction, railroad bridges and other railroad structures, and open-web steel joist construction shall conform to the respective industry standards and are not included in this manual.

1-5. Commentary on Paragraph 1-4, Background

Historically, the ASD method has yielded safe and reliable structures; however, the method does not recognize differing variability of different load effects (live load, dead load) and resistances (i.e. bending capacity, shear capacity, fracture, etc.). For this reason, LRFD is the preferred method of design. In the ASD method, an elastic analysis is performed for the structure of interest and the computed stress is compared with an allowable stress. The allowable stress is the yield stress, buckling stress, etc., divided by a single factor of safety (FS). In order to obtain structures with a more uniform reliability and to achieve economy, a limit states design (LSD) approach such as LRFD has been adopted by most specification writing committees. The Load and Resistance Factor Design (LRFD) approach (an LSD approach) recognizes that the loads applied to a structure and resistances of structural members are random quantities. The LRFD method has two main advantages over the ASD method. First, in a limit state analysis, one does not have to assume linearity between load and force, or force and stress. Second, multiple load factors can be used to reflect the degree of uncertainty for different loads (dead, live), while application of multiple resistance factors reflects differing uncertainties in a particular resistance (bending capacity, shear capacity, etc.). Due to these advantages of LRFD, more uniform reliability is attained in the design process and in many cases a more economical structure results.