CHAPTER 5

DESIGN FOR WELDING

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INTRODUCTION

A weldment is an assembly of component parts joined by welding. It may be a bridge, a building frame, an automobile, a truck body, a trailer hitch, a piece of machinery, or an offshore oil drilling structure. In the field of weldment design,[1] the primary objectives are to produce an assembly that (1) performs its intended functions, (2) has the required reliability and safety, and (3) can be fabricated, inspected, transported, and placed in service at a minimum total cost. The total cost includes the cost of design, materials, fabrication, erection, inspection, operation, repair, and product maintenance.

The designers of weldments must have an understanding of basic design principles and concepts. They must have some knowledge of and experience in cutting and shaping metals; assembling components; preparing and fabricating welded joints; evaluating welds in compliance with established acceptance criteria; and performing nondestructive examination and mechanical testing.[2] Designers routinely apply knowledge of the following areas when evaluating the effects these may have on the design of weldments:[3]

1. Mechanical and physical properties of metals and weldments;
2. Weldability of metals;
3. Welding processes, costs, and variations in welding procedures;
4. Filler metals and properties of weld metals;
5. Thermal effects of welding;
6. Effects of restraint and stress concentrations;
7. Control of distortion;
8. Efficient use of steel, aluminum, and other metals in weldments;
9. Design for appropriate stiffness or flexibility in welded beams and other structural members;
10. Design for torsional resistance;
11. Effects of thermal strains induced by welding in the presence of restraints;
12. Effects of stress induced by welding in combination with design stresses;
13. Practical considerations of welding and the selection of proper joint designs for the application.
14. Communication of weldment design to the shop, including the use of welding symbols; and
15. Applicable welding codes and safety standards.

As several of these topics involve highly specialized areas of science and technology, designers should refrain from relying entirely upon their own knowledge and experience, which may be may generalized. They are encouraged to consult with welding experts whenever appropriate.

PROPERTIES OF METALS

The properties of metals can be divided into five general groups: (1) mechanical, (2) physical, (3) corrosion, (4) optical, and (5) nuclear. The typical characteristics of each group are presented in Table 5.1. These are further categorized as structure-insensitive or structure-sensitive, as this distinction is made in most textbooks

1. Of necessity, the topics discussed in this chapter have not been developed exhaustively. For more information, the reader should refer to available textbooks, manuals, and handbooks, several of which are listed in the Bibliography and the Supplementary Reading List at the end of this chapter.
2. A great deal of similarity exists between the designs of weldments and brazements, with the exception of joint designs and the joining processes. Consequently, much of the information presented in this chapter can also be applied to brazement design. For more information, refer to O'Brien, R. L., ed., *Welding Processes*, 1991, Vol. 2 of *Welding Handbook,* 8th ed., Miami: American Welding Society.
3. The topics listed here are covered in this volume as well as in O'Brien, R. L., ed., *Welding Processes*, 1991, Vol. 2 of *Welding Handbook,* 8th ed., Miami: American Welding Society; Oates, W. R., ed., 1996, *Materials and Applications—Part 1*, Vol. 3 of *Welding Handbook,* Miami: American Welding Society; and Oates, W. R., and A. M. Saitta, eds., 1998, *Materials and Applications—Part 2,* Vol. 4 of the *Welding Handbook,* 8th edition: Miami: American Welding Society.