the span. Torsional-flexural buckling can be prevented by keeping the compressive stresses very low or by plenty of bracing, as discussed later in this chapter.

The complexities of light-gage member design do not stop at flexural and compression calculations. Tedious shear calculations are often accompanied by even more cumbersome web crippling checks. To be sure, web crippling failures occur in hot-rolled steel members too, but light-gage sections are incomparably more susceptible. Web crippling failures such as that shown in Fig. 5.5 are most likely to occur at supports, where shear stresses are at their maximum. Web crippling stresses are additive to bending stresses, and a combination of both needs to be investigated.

Whenever web crippling stresses are excessive, bearing stiffeners are required at supports, in which case it is common to assume that the total reaction force is transferred directly through the stiffener into the primary framing, neglecting any structural contribution of the member's web. A small gap might even be left under the flange of a girt or purlin. The stiffeners are usually made of clip angles, plates, or channel pieces. In Fig. 5.6, the load is transmitted from the web of a Z purlin via screws or bolts to the clip-angle stiffener and then from the stiffener to the rafter. Some other clip designs, which not only help the purlin resist web crippling stresses but also stabilize it laterally, are described later in the chapter (Sec. 5.5.5).

The Specification recognizes the fact that analytical methods of establishing load-carrying capacities of some cold-formed structural framing may not always be available or practical and allows determination of structural performance by load testing for such cases. The testing procedure is

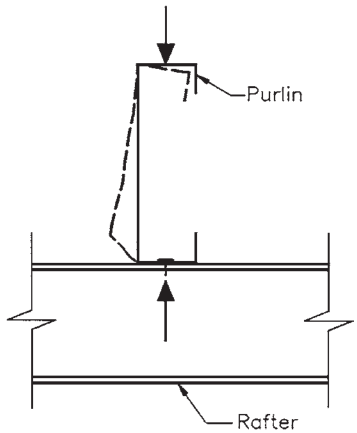

FIGURE 5.5 Web crippling.

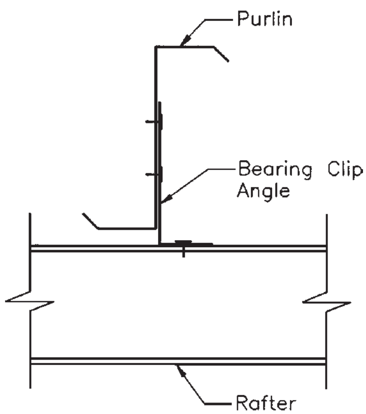

FIGURE 5.6 Bearing clip angle acting as web stiffener.

described in the Specification section entitled "Tests for Special Cases." In the 1986 edition, the test criteria were relatively clear. Specifically, the member or assembly being tested should have been able to carry twice the live load plus 1.5 times the dead load (the strength test) *and* not to distort excessively under 1.5 times the live load plus 1.0 dead load (the deflection test). The values of the effective section modulus and moment of inertia were established based on the measurements of strains and deflections. The test results applied only to the specimen being tested. If the testing was intended to apply to the whole class of sections, as it usually was, the material properties such as yield strength were measured and the test results adjusted by the ratio of the nominal to actual strength of the steel. For example, if the nominal yield strength of the steel was 55 ksi but the actual was measured at 60 ksi, the test results were reduced by the ratio of 55/60 = 0.917. Otherwise, they would overstate the capacity of similar members made from steel with a yield strength lower than 60 ksi.

The 1996 and later editions derive the allowable design strength of the member or assembly as the average value of all the test results divided by a factor of safety. The latter is equal to 1.6 divided by the resistance factor, which requires some computations to be determined.

5.3 COLD-FORMED STEEL PURLINS

5.3.1 Available Sizes and Shapes

Cold-formed C and Z purlins are the workhorses of the industry. Configurations of these members have originated at the bending press—they represent the two basic ways to bend a sheet of metal into a section with a web and two flanges. Light-gage purlins of 8 to 12 in in depth can span 25 to 30 ft, and even more, depending on the loading, material thickness, and deflection criteria. Purlin spacing is dictated by the load-carrying capacity of the roof panels; a 5-ft spacing is common. Appendix B includes section properties for purlin sizes offered by some manufacturers.

Cold-formed purlins are normally made of high-strength steel. Uncoated cold-formed members, still in the majority, usually conform to ASTM A 570 or A 607. Occasionally, galvanized purlins are provided. The old designation for galvanized members, ASTM A 446, has been replaced with a new ASTM Standard Specification A 653.[7] The new standard includes the designations of zinc coating, G60 and G90, which used to be a part of a separate standard, ASTM A 525. (The latter has been replaced by ASTM A 924, which now covers all kinds of metal coatings applied by a hot-dip process.) For the products of structural quality (SQ), three grades—33, 40, and 80—are available, corresponding to the old grades A, C, and E of ASTM A 446. For example, ASTM A 653 SQ grade 40 with coating designation G60 takes the place of the old ASTM A 446 grade C with G60 coating.

The minimum yield strength for steel sections 16 gage and heavier is normally specified as 55,000 psi, although the Light Gage Structural Institute (LGSI) bases its load tables[8] on a minimum yield strength of 57,000 psi.

How is it possible that LGSI can use a higher strength of steel than most manufacturers for the same material specification? The ASTM specifications define the *minimum* yield strength of steel, but the actual strength is often higher. It may be possible to justify using the 57 ksi, rather than 55 ksi, yield strength, if a credible program of inspection and material testing is maintained, and only the steel with a minimum actual strength of 57 ksi is allowed for use. This is what LGSI does, although this practice is not followed in structural steel design.

Similarly, LGSI member companies have adopted slightly different section properties for their cold-formed sections than those of most metal building systems manufacturers (Fig. 5.7). LGSI products try to optimize flange and lip sizes.

Cold-formed purlins can be designed as simple-span or continuous members. The beneficial effects, as well as the disadvantages, of continuous framing are explained in Chap. 3. The concept of continuous Z purlins was introduced in 1961 by Stran-Steel Corp., already mentioned in Chap. 1 as a pioneer of pre-engineered buildings. (Prior to that invention, manufacturers used simple-span cold-formed sections or bar joists.) Cold-formed purlins can be made continuous by overlapping and