10.7 SPECIFYING COLLATERAL LOAD

10.7.1 Challenges

As described in Chap. 3, collateral load is a subset of dead load that includes the weight of any materials other than permanent construction. These materials can include pipes, sprinklers, mechanical ducts, electrical conduits, ceilings, and finishes. Some typical weights of these components are listed in Chap. 3, where we conclude that a commercial or industrial building with sprinklers, lights, and mechanical ducts—but without ceiling—could in many cases be designed for a collateral load of 5 psf.

It is easy to demonstrate that a uniformly distributed 5-psf load applied to a simply supported purlin spanning 25 ft (the typical purlin span) and spaced 5 ft on centers produces a slightly larger bending moment than a 300-lb concentrated load applied in the middle of the span. Thus the 5-psf level of design loading seems substantial enough to allow for the weight of many hung items and even small roof fans.

However, the 5-psf collateral load allowance may not be sufficient to account for the weight of some common building elements, such as the sprinkler mains, typically 8-in or larger pipes. An 8-in water-filled pipe weighs about 50 lb per linear ft. These pipes are commonly hung from purlins every 10 ft on centers by sprinkler installers, while the purlins are typically spaced 5 ft on centers. Therefore, every other purlin would probably carry a 500-lb design hanging load, while its neighbors would carry none. While the average collateral loading on the roof is theoretically not exceeded, the purlins supporting the sprinkler main pipes will carry more than their share of the collateral load; these purlins may become overstressed under the full design snow or roof live load.

10.7.2 Two Ways of Accounting for Heavy Pipes

There are two ways of solving the problem: (*a*) add a purlin directly above each heavy pipe and support the sprinkler mains at each purlin rather than on every other purlin, or (*b*) increase the level of collateral loading on all the purlins.

The first solution—adding purlins exactly at the right locations over the pipes or dictating where the sprinkler mains must be supported—is probably the most economical, but it is not the most practical. It requires an uncommon level of coordination among the metal building manufacturer, the building erector, the sprinkler system designer, and the sprinkler installer. Far from such coordination being the norm, sometimes the owner chooses to do the fire-protection design and installation *after* the building is erected. Regrettably, the opportunity to involve the metal building designer is then lost, and the pipes might end up being installed in less than desirable ways. Figure 10.15 illustrates a sprinkler pipe (not the main, thankfully), hung from a light-gage pre-engineered truss diagonal.

The second solution—increasing the level of collateral loading on all the purlins—has a better chance of success, but it obviously drives up the cost. If we accept the fact that the structural effect of a 300-lb concentrated load is roughly equivalent to that of a 5-psf uniform collateral load, a 500-lb concentrated load would require a uniform allowance of about 8 psf.

So what amount of collateral load should be specified? The author's practice is to specify at least a 5-psf uniform collateral load, increasing it to 8 psf or even higher when sprinkler mains or other heavy hanging loads are expected. Other sources suggest similar levels of collateral loading. For example, Westervelt[9] advises using 8 psf for "a moderate amount of mechanical and electrical items." Miller and Evers[7] state that 5 or 10 psf is a typical value specified for collateral load.

Increasing collateral load above 10 psf is not recommended, because this level of loading suggests a presence of some heavy supported items. In general, it is very difficult to support heavy loads from light-gage steel members, and this situation is best avoided in favor of providing dedicated support framing.

Some manufacturers use lower levels of collateral load for the design of primary frames than for purlins. On the surface, this is approach seems to make sense, but one should keep in mind that the building codes do not provide any criteria for such load reduction.

FIGURE 10.15 This is not a good way of supporting collateral load. The pipe should have been hung from a truss panel point.

10.7.3 Complaints about High Levels of Collateral Loading

The high levels of collateral loads sometimes elicit controversy and complaints. Pre-engineered building manufacturers tend to compete on price with the purveyors of conventional structural systems and with one another, and there is pressure to use the least amount of collateral load—the only type of structural loading not firmly fixed by the codes. Indeed, relatively minor changes in collateral loading can translate into substantial price changes for the metal roof framing. An added superimposed dead load of 5 psf adds relatively little to the total load on a building framed with concrete or structural steel, but it is significant in metal building systems where roofs typically weigh only 2–3 psf.

Also, as discussed in Chap. 9, the task of specifying design loads is generally the responsibility of the owner, who may or may not be technically sophisticated or might be influenced by sharpen-the-pencil advice from a builder trying to meet a tight budget. As a result, on some projects the specified value of design collateral loading has been insufficient, or not used at all—a situation fraught with danger.

Another argument against using high levels of collateral load is this: Why must all the purlins be overdesigned to compensate for a single line or a few lines of purlins that actually carry the heavy load? In the author's opinion, the real-world behavior of metal building systems under heavy loading is not perfectly understood. A few extra pounds of design collateral loading might spell the difference between survival and collapse of a structure nearing its load-carrying limit. As we discuss below, failure of a single line of purlins can bring down the whole metal building.