Q A client asked me to build a garage that will also house the furnace. I need to install a bollard that would prevent a car from rolling into the furnace. What are the engineering requirements for such a structure, and do you have any suggestions for ways of making one?

A Bill Palmer Jr., an engineer and the editor-in-chief of Concrete Construction, a sister publication of *JLC*, responds: Interestingly, much of today's bollard design comes from military applications, such as stopping a large truck from running through a blockade—that's when you get into some serious design! But whether you're stopping a military truck that's careening into a blockade at 30 mph or preventing your Prius from rolling into the furnace at the back of the garage, calculating the size and configuration of bollards uses the same factors, including the speed and weight of the vehicle you're trying to stop, the amount that a vehicle "crushes" to absorb the impact, and the flexibility of the barrier itself.

In September 2010, *Structure* magazine ran an article, "A Rational Method to Design Vehicular Barriers," that included an involved formula for measuring the force that a bollard needs to stop based on those factors. The most astonishing aspect is that the amount of force increases exponentially with both the speed and weight of the vehicle.

In configuring bollards, both the IBC and ASCE-7 set a design force for bollards that assumes a 6,500-pound vehicle traveling at 5 mph. Using a chart in the *Structure* article (Figure 5), we can approximate an impact load of around 10,000 pounds at 5 mph. But that speed might be conservative if, for example, the driveway in front of the garage is inclined. A vehicle rolling down an incline could accelerate and reach a speed much greater than 5 mph, resulting in a much greater force that the bollard needs to stop.

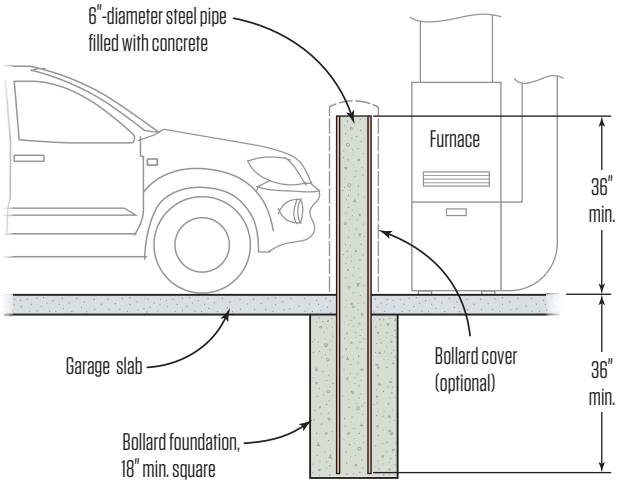
The *Structure* article shows a bollard made from 8-inch concrete-filled steel pipe embedded 4 feet into a concrete foundation. That may be overkill because that bollard is designed to stop a 4,500-pound car going 30 mph. On the other hand, you wouldn't want the car taking out the furnace. For the application you're asking about, I would recommend a 6-inch-diameter steel pipe filled with concrete.

According to the recommendations of the ***Military Field Manual***, the pipe needs to be at least 3 feet high to match the bumper height of most cars. For 6-inch-diameter steel pipe, I would recommend that the bollard foundation be 3 feet deep and at least 18 inches square. That works out to a bit less than 7 cubic feet of concrete (about ¼ yard)—not really that much, but still a fair amount to mix by hand.

Note that a concrete post by itself—even at 8 inches in diameter—has little to no bending strength. In other words, a car running into it would easily break through it. That means an effective bollard must be steel—ideally a steel pipe filled with concrete. Even though the concrete adds no strength in resisting impact, it helps the pipe itself resist collapsing at the point of impact.

If preventing scratches to a car bumper that might accidentally hit the bollard is an issue, there are some good plastic bollard covers available, including a large selection from Uline, to go over pipes of different diameters. These covers come in several colors; but I would go with something highly visible, such as yellow or red, to make the bollards easy to see.

Bollard Detail



Q My client has a sewer ejection tank in his basement for a laundry and a half-bath. When the washer drains and the tank pumps out, the liquid overwhelms the vent's ability to supply enough makeup air, causing a "pull" on nearby traps (mainly the first-floor toilet). What is the proper way to vent this system, and can I add venting to remedy this situation?

A Mike Casey, a licensed plumbing contractor and ICC Certified Combination Inspector in San Diego responds: Clothes washers pump out a lot of water quickly, which can put a load on the sewage ejector pump. But that shouldn't affect the traps connected to the sewage ejector tank if it's properly vented.

The ejector tank should be vented by a connection to the top cover that's at least 1½ inches in diameter, although 2-inch vent pipe is common in this application. The tank vent should be a dry vent that either terminates at the exterior of the house or connects to another dry vent that terminates at the exterior. In addition to the sewage ejector tank being vented, each of the plumbing fixtures connected to the tank must be properly vented, and all the plumbing fixtures in the remainder of the house must be correctly vented as well.

In your situation, I suspect that there is inadequate or even a total lack of venting at the ejector tank and possibly at the first-floor toilet as well. Determining the scope of the repair will require some investigation to ascertain the existence and adequacy of venting at all fixtures. I would also be sure to check the vent terminals (stack pipes) on the roof to establish that they are free from any obstructions.

If your jurisdiction allows it, you may be able to add an air admittance valve (AAV) to any plumbing fixtures that need venting. When properly installed, AAVs can be an inexpensive way to add venting in many places. However, be aware that an AAV cannot be used for venting a sewage ejector tank.

The principles and requirements for plumbing vents can be very technical, so I'd recommend having a licensed plumber inspect and evaluate the system to determine the best and most cost-effective method to correct your specific problem.