Q The 1960s house I'm working on has Romex wiring with a thin 16-gauge ground wire. We are doing a gut remodel of the kitchen and bath, including a new electrical panel. My electrician said that with the new panel, the 16-gauge ground wire in the rest of the house is completely fine. But I've had other people suggest that we should rewire the whole house with heavier gauge ground wire. Who is right?

A Cliff Popejoy, a licensed electrician in Sacramento, Calif., replies:

I agree with your electrician. The smaller-gauge grounding wire that was installed in your house should serve just fine to clear a short or a fault. But to do so, the wiring needs to have been correctly installed, and it needs to be in good condition.

I infer from his comments about the new panel that your electrician is installing arc-fault circuit interrupter (AFCI) breakers for most circuits. AFCI breakers, which are required by the National Electrical Code for new construction, will trip under the same three conditions as regular breakers:

■ If there's a short circuit (unintentional contact between an energized or "hot" wire or part and the return "neutral" conductor);

■ If there's a ground fault (contact between something that's hot and something that's grounded); and

■ If there's an overload (more current flowing than the breaker and wire are rated to safely carry).

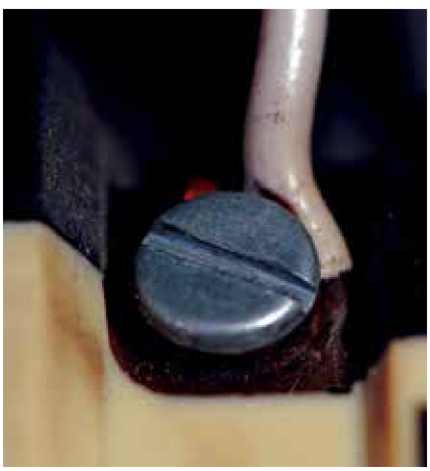
But an AFCI breaker will also trip in two other situations: 1) With ground fault current of 30 milliamps or more; and 2) with certain current patterns indicative of an arcing fault. An arcing fault can create a lot of heat (think arc welding on a smaller scale), but the current flows in spikes of such short duration that it usually won't trip a standard breaker. With AFCI breakers, the 16-gauge ground wire should be adequate.

In a conventional circuit equipped with a ground wire, if there's a problem with something connected to the circuit where the hot wire is touching an exposed metal part, the ground wire is there to carry a fault current back to the panel. In doing so, it keeps the metal parts of the tool, table lamp, or appliance at zero volts, and therefore safe. If enough ground fault current flows, the circuit breaker will trip.

Even without AFCI breakers, the 16-gauge ground wire should be adequate in most instances to clear a short, a fault, or an overload. The 16-gauge wire is more fragile than 14-gauge wire and is more apt to break either while making connections, or later, from being flexed over time as things are plugged and unplugged in an outlet that is loose. So there is some advantage to replacing all of the wiring, but the advantage of having a more robust ground wire has to be weighed against the cost of rewiring the house.

What I'd be more concerned about with the 16-gauge ground wire is whether the connections ("splices," in electrician-speak) in the ground wire are all good. Every circuit that serves receptacles and lights is made up of segments of wire (inside cable in most houses) that run from box to box. And in each box the grounds are spliced together (as are the hot and the neutral wires).

With a hot wire or a neutral wire, a bad splice can give users some warning before it fails by causing flickering lights, a buzzing noise, or a burning smell. But the ground wire is different because it only carries current when there's a ground fault. A bad splice in the ground



This electrical meter (photo, left) measures voltage drop that can occur from bad connections or splices such as having wire insulation caught under a connection screw (photo, right).

wire keeps it from carrying the fault current adequately, so the breaker won't trip as quickly as it is designed to, which can lead to a fire.

To check the condition of the circuit, you need a specialized tester that measures voltage drop in the circuit when a controlled load is applied. Running a voltage-drop test will tell you the condition of the wiring and the integrity of the splices without having to open every box in the house to check the connections. Plus, the tester can tell you if there are bad splices that you can't see, such as in a hidden junction box, or worse, not in any box at all. These testers are expensive, but a good service electrician who does troubleshooting and repair work should have one and should also have enough experience to interpret the results of the test.

Q If you have two identical-length floor joist spans, from an exterior foundation wall to a center beam and then on to the opposite exterior foundation wall, is there a significant difference between framing this as two simple spans with the joists lapped over the center beam (the most common arrangement), or using one continuous joist?

A Mark McKenzie, an engineer from Brewster, Mass., responds:

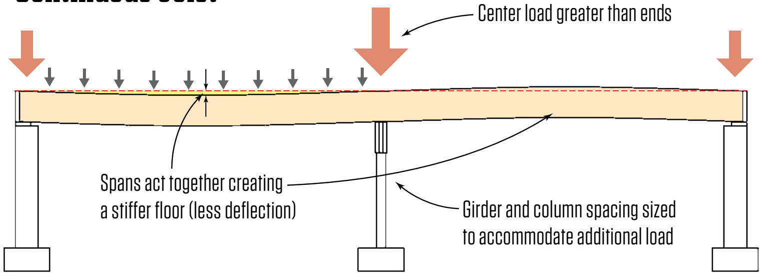
There is a significant difference between the two framing methods. In engineering terms it would be considered a simple-span beam versus multiple-span continuous beam analysis. When you have multiple-span continuous joists, the design moments (bending forces) are reduced and the deflection (sag) of the joists decreases. In other words, with regard to deflection and vibration, continuous joists are stiffer than two simple spans because the two coupled spans act together.

But it is also true that with multiple-span continuous joists, the reactions (loads at supports) concentrate at the center span and decrease at the ends. With simple single-span joists that are overlapped at the center beam or girder, the reactions are equal at each end of the joists. The result is that you can use smaller-sized stock (be it conventional lumber or I-joists) for multiple-span continuous joists than with simple single-span joists. But with the continuous joists, the center beam has more load on it, so you may be required to upsize that beam from the standard tables in the code. In other words, with continuous joists the size of the center beam might have to go from three 2x10s to three 2x12s, or the lally columns might need to be spaced closer together to support the added load.

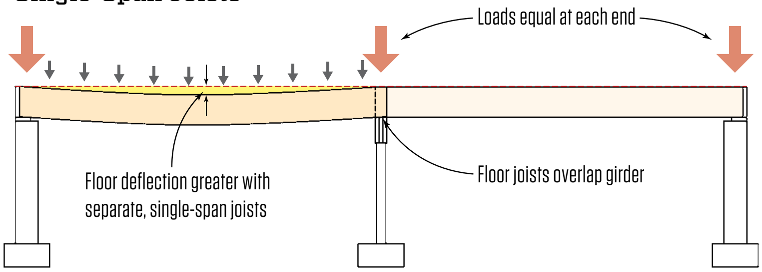
These days you really only see this

problem with engineered joists because it is difficult to find conventional lumber in lengths greater than 24 feet, which is pretty much the minimum width of a standard, modern-day house. Engineered joists come in lengths of up to 40 feet, so they are often used when you want to run full-span joists over a main carrying beam. By the way, this is only an issue with low girders (beams that are below the joists). Obviously, if joists are installed flush framed with the center beam, those joists would be considered simple single-span joists.

Continuous Joist



Single-Span Joists



Continuous joists over a center beam give you the advantage of creating a stiffer floor. But with that arrangement, you may need to install a larger center beam or increase the number of support columns, negating any advantage.