New Life

FOR ROTTEN TIMBERS

Repair in-place with steel and epoxy is sometimes the best treatment for decayed wooden beams.

by Paul Stumes

Routing with a chainsaw is noisy but effective for slotting the timber from end to end to receive the steel insert.

Temporary jacks downstairs hold the sagging beam true while the epoxy cures to permanently hold it in place. Interruption to the existing ceiling was minimal.

A shot of epoxy precedes the insertion of the steel plate to the right of the beam. More epoxy will cover the steel.

Wood is the most common building material in North America. The majority of single-family homes are built of wood and even some of the largest and most complex buildings contain load-bearing wooden timbers.

But since wood is an organic substance, it is also popular with all types of living organisms—as food. Rodents, insects, and fungi consume thousands of tons of wood annually. One of the most common and damaging problems is the decay of beam ends that rest on masonry. Many floor joists, roof rafters, and other structural elements must be replaced at great expense because of this problem.

Although fairly simple steps can prevent such problems in new construction, curing existing damage is tricky. The two most common methods of repairing beams with rotten ends are replacing the decayed beam with a new one and splicing in new pieces.

Replacement can be very costly for two reasons. First, lumber is expensive, especially in large cross sections and finer species. Sometimes, the particular sire or species is not available. Second, removing and replacing a joist or rafter requires the tedious work of separating the piece from all the connecting boards or other members. In some cases, removing the beam will require temporary shoring as well.

Splicing can be a simple alternative in some cases. On exposed or finely finished beams, however, the splices always create visual problems.

Another alternative has been developed that avoids these problems. This new system uses epoxy resins combined with reinforcing inserts. Historically, this system can be traced back to the 1950s when the U.S. Army Corp of Engineers used epoxies to extend the life of some WW II temporary buildings. Based on this experience, various systems were developed. One, called the WER-system, has been used successfully in many buildings in the U.S. and Canada—and a similar process has been used extensively in Europe.

WER is not a trade name, only a convenient abbreviation of the system's main ingredients: W = wood; E = epoxy; R = reinforcement.

Unlike many similar systems, WER is not patented and can be freely used by anyone to rehabilitate deteriorated timbers. The engineering for the system is based on extensive testing funded by the Canadian government. For the rehab of typical light-frame structures, easy rules of thumb will do. For more complex structures, some simple calculations will result in dependable designs.

Figure 1. *The reinforcing plate of steel, fiberglass or plywood, is placed in a deep slot cut along the length of the beam and filled with epoxy.*

Figure 2. *(A) Mark location of groove. (B) Cut guide line with circular saw. (C) Cut groove with wide blade (chain saw), Note use of G clamp to provide depth gauge. (D) Pour some epoxy into the groove. (E) Place plate in groove. (F) Fill up groove with epoxy.*

Fig. 1

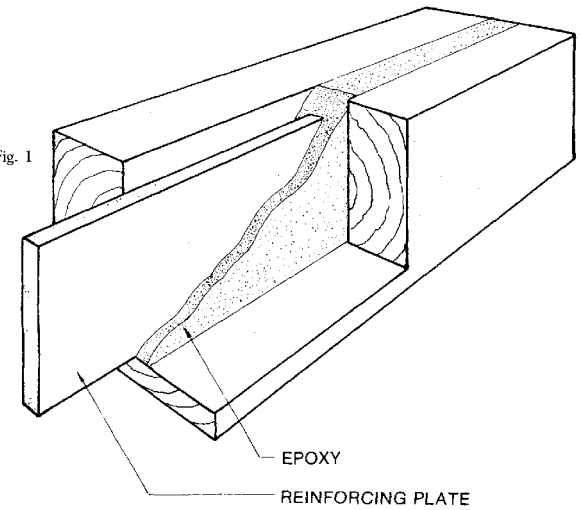


Fig. 2

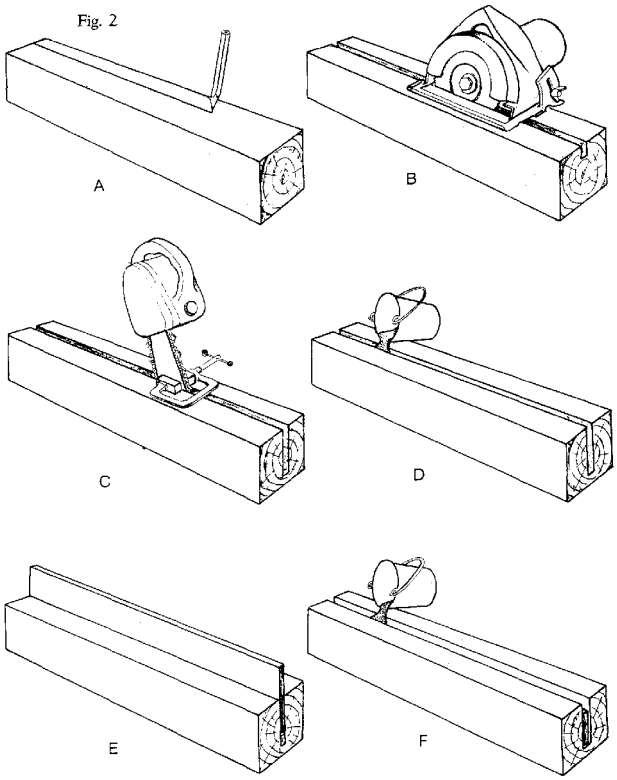


Figure 3. *The steel plate transfers the load from the bearing surface to the sound part of the beam. For engineering purposes, it is divided into three lengths: the bearing surface (La), the decayed or missing part of the beam (Lb), and the section of sound wood (Lc). A bearing plate is often used to spread the load, and wooden blocking is recommended to cover any exposed steel.*

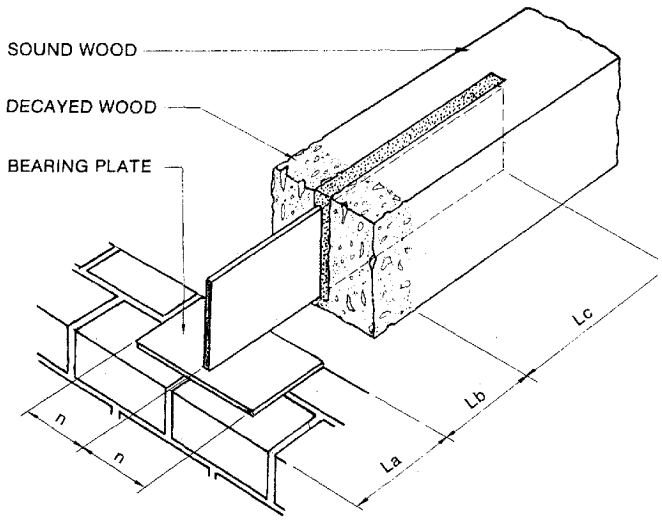
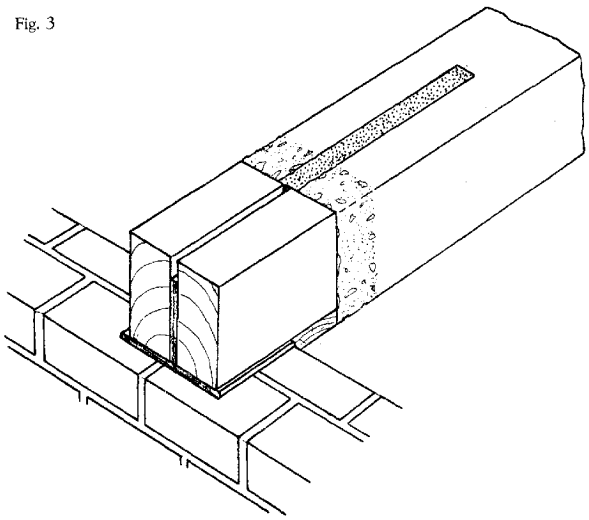


Fig. 3



The WER system is designed to reinforce deteriorated timbers. It is not a wood preservative. Therefore, after the wood is reinforced, you must brush it generously with a preservative to prevent further decay.

Groove With A Chain-Saw

The basic system is very simple. The beam is left in place and strengthened with a steel plate inserted in a groove cut down the length of the beam. The groove is then filled with epoxy, which strongly bonds the wood to the reinforcing plate (see Figure 1).

The groove does not go completely through the beam. About 1 inch of wood is left at the bottom to prevent the epoxy from dripping out (see Figure 2). The actual work sequence, once the beam is exposed is as follows:

1. Mark the location of the groove.
2. Make a small cut with a circular saw to serve as a guide.
3. Cut groove with wide-blade chain saw. Note the use of a G-clamp to provide a depth gauge.
4. Pour some epoxy into the groove.
5. Place reinforcing plate in the groove.
6. Fill the groove with epoxy.

It's important to understand that a strong bond forms only between the reinforcement and the wood in the *sound part* of the beam. The reinforcing plate will bridge the decayed part of the beam and transfer the load to the bearing surface. This principle is illustrated in Figure 3.

To keep the reinforcing plate from cutting into the masonry bearing wall, we usually place a flat metal plate under the reinforcing plate (Figure 3). It's also advisable to cover the exposed ends of the reinforcing plate with wood, as shown, both to conceal and to protect it.

In most cases, the beam being repaired is covered with floor boards. Typically, we remove these to cut the groove and install the reinforcement, then replace them once the epoxy hardens.

Getting the Right Glue

The epoxy that is used for the WER system is not the same as the thick paste commonly called "epoxy glue." For the WER system, we recommend using an epoxy that has the consistency of thick motor oil. (One we use is Colma Dur LV from Sika Corp., P.O. Box 297, Lyndhurst, NJ 07071; 201/933-8800.)

Why Beam-Ends Rot

While various types of fungi can thrive on any part of a wood timber, why do the ends suffer most?

To understand this, we must examine the relationship between the moisture content of wood and the virulence of fungus. The vast majority of wood-destroying fungi are active when the moisture content of the wood is relatively high, usually over 20 percent. This is one reason why timber is seasoned below 16 percent water content for use in construction. Why, then, does otherwise dry timber get wet at the ends, creating ideal conditions for rotting?

Water is always present in the environment, dispersed as vapor. The higher the temperature of the air, the more water vapor it can hold. When air at a given temperature holds all the vapor it can, the condition is called "saturation." For example 1 cubic yard of air at 68° Fahrenheit can hold 0.5 ounces of water in vapor form. If the temperature drops to 40° Fahrenheit the air can support only 0.1 ounce of water vapor: the remaining 0.4 ounces will precipitate out as liquid water.

Because of its contact with the ground and its thermal mass, a masonry wall is usually cooler than the temperature inside a building. When warm air in a building contacts the cool surface of masonry, the layer of air touching the masonry will cool down radically and deposit condensation (water) on the masonry. This phenomenon is easily observed on single-pane windows in winter.

Where the end of a dry wood beam rests on masonry, it readily soaks up the condensed water, elevating its moisture content, and promoting fungal growth. In simple terms, this is why wood will eventually rot when it contacts brick, stone, concrete or any masonry material.

How can we avoid this? Simply by placing a layer of thin material between the wood and the masonry that acts as insulation and a capillary break, One or two sheets of impregnated felt paper will do the job. Once the damage is done, though, it is costly to reverse it.

Such epoxies are used in boat building and, sometimes, in heavy construction. They are readily available from better hardware stores, building-supply houses, and plastic businesses. The epoxy comes in two parts, which must be mixed according to the manufacturer's instructions.

For various reasons, we strongly recommend mixing 20 to 35 percent by volume of diatomaceous earth into the epoxy. This filler improves the structural characteristics of the hardened epoxy. Also, because diatomaceous earth is inexpensive, it makes the epoxy mixture more economical. Diatomaceous earth is commonly used as a filter media for swimming-pool filters. So if it is not available from your building-supply house, you can buy it cheaply from swimming-pool suppliers.

Do not confuse epoxy with polyester resin, a similar product that is used for building fiberglass boats. We strongly advise *not* to use the polyester resin, because it is not adequate for the job.

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The Reinforcement

The most efficient material to use as reinforcement is usually medium-grade structural steel plate. Occasionally, we have used aluminum, fiberglass, or plywood plates instead.

The following table shows the dimensions of steel reinforcements we have used to repair decayed beam ends. While these dimensions have worked well for us, we cannot guarantee that they will work equally well in other circumstances.

Table 1. Dimensions of Reinforcement (in inches)

A	B	T	H	L
2	4	3/8	3	8
2	6	3/8	5	12
2	8	3/8	7	20
3	6	7/16	5	14
3	9	7/16	7.5	20
4	6	1/2	5	14
4	12	9/16	10	28

A = thickness of timber
B = depth of timber
T = thickness of steel-reinforcing plate
H = depth of reinforcing plate
Lc = length of reinforcing plate in sound wood. (See Lc in Figure 3.)

Other Uses

We only use the WER system where it is prudent to retain the old timber for economic or aesthetic reasons. Otherwise, we replace decayed beams with new timbers, or repair the rotten joist ends with splices.

The WER system can have many applications besides the repair of beams with decayed ends. In our practice, we frequently find beams with the inside completely deteriorated by "heart-rot." We often leave such a beam in place but reinforce it along its entire length with WER. This technique has been especially useful in churches and public buildings where ceiling beams are exposed and richly decorated.

For More Information

If you wish to use the WER system, you should obtain a copy of the *WER Manual* which gives thorough and easy-to-follow instructions. The manual costs $5.75 from: Association for Preservation Technology, BOX 2487, Station D, Ottawa, Ontario K1P 5W6. ■

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