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Lumber Defects and Roof Frame Failures

Wood used in roof framing is not a homogeneous material. Various defects are present depending on the grade and method of cutting: plain sawn, quarter sawn and rift sawn.

Plain sawn (also known as flat sawn) is the type of cut most commonly found in lumber and the least expensive way to turn logs into lumber. The rings comprise 30 degrees or less of the board face. In quarter sawn wood, the rings in the wood intersect at a 60 to 90-degree angle, creating an intersecting design in the wood. Rift sawn wood is the most expensive type of wood, is milled perpendicular to the rings and has a unique linear design, but is extremely stable.

There are a number of defects such as knots, checks, pitch pockets and shakes that can be found in wood, which can affect its resilience.

Knot

A knot in a piece of framing lumber is a circular discontinuity caused by a tree branch. Small knots usually are not a problem since they adhere well to the wood board. Large knots cause a problem with strength in that they often become detached, leaving a large hole in the board and a significant reduction in strength.

Check

A check is a crack in a board brought on by shrinkage. Shrinkage can occur naturally, but typically it is a result of the drying process. Wood moisture content must be reduced to approximately 15 percent for maximum strength and longevity. Kiln drying often results in surface checks in thick pieces of wood. Surface cracks can coalesce and form larger, more damaging cracks.

Pitch pocket

This is a cavity in a piece of wood caused by insects or some impact to the tree. Sap fills the void and results in a resin-filled pocket that may appear solid, but can severely reduce the strength of a board.

Shake

A shake is a crack that forms along the growth rings from bacteriological growth. This is typically a result of high moisture content in the wood.

The following photos illustrate how these defects can impact wood's ability to handle the stress from roofs. When inspecting a roof failure, it is important to consider the contributing role of any wood defects.

Figure 1 shows a roof rafter failure brought on by a large knot that encompassed about half of the cross section of the board. The knot extended from the center all the way to the lower edge or tension side of the joist. The knot had not adhered well to the surrounding wood and a crack developed along the circumference of the knot. Since the crack entered the tension side of the joist, it propagated from the lower edge, resulting in severe reduction in strength. This left half of the cross section of the board supporting the load.

Figure 2 shows a roof rafter with a large knot at the upper or compression end of a roof rafter. The knot has reduced the bearing strength of the board and deflection is noted at the location of the knot.

Figure 3 shows a pitch pocket at the

FIGURE 1

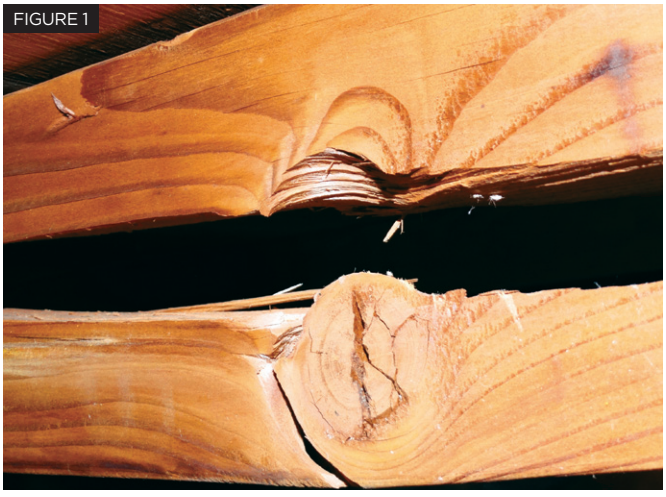

FIGURE 2

FIGURE 3

FIGURE 4

end of a roof rafter. This location on the rafter is not subjected to as much bearing stress as the middle of the rafter, but could still result in a failure from compression stresses.

In Figure 4, checks have developed into larger cracks that are following the grain. Unfortunately, the grain is not parallel to the long axis of the board and angles inward toward the neutral axis of the joist. The bending stress at the lower part of the joist will eventually drive the crack through the board, causing failure.

Failures of framed roofing systems occur from a variety of causes including the existence of defects in wood. Many roof framing failures have occurred under normal loading because of the reduced strength in wood framing from the defects mentioned above. Inspection of the failed framing will help determine the role of defects in the cause of the loss.