Misreading Rail Flaw Size

The use of ultrasonic testing techniques to locate internal rail defects such as detail fractures, transverse fissures, and compound fissures is a standard method employed by most operating railroads. By monitoring the approximate defect size, usually in terms of percent cross-sectional area of the rail head, those faults that are potentially dangerous are located and removed from track. By 'dangerous' we mean that they significantly reduce the beam or bending strength of the rail. Such defects can thus increase the probability that the rail will break under traffic.

As the defects approach or exceed predetermined size limits, either the railroad's own or those set by FRA, remedial action is taken. It is based on the measured size of the defect. Thus knowledge of defect size, and the corresponding accuracy of the measurement is of great importance in any decision about the proper course of action necessary when a defect is found in track. The denser the track and the heavier the axle loading, the more important it is to have accurate information regarding defect size and rail strength.

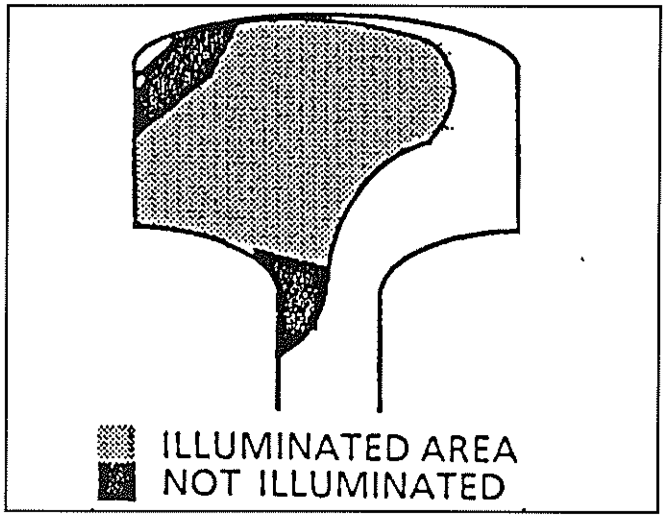

Figure 1 — UT View of Large Flaw

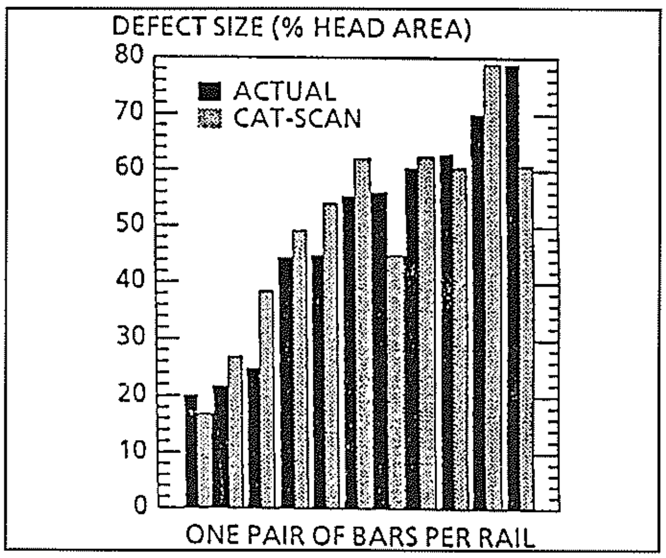

Figure 2 — CAT Scan Error vs. Flaw Size

Sources for error

Recent test work[1] carried out at FAST and on operating railroads by the Transportation Systems Center (TSC), has been directed at the estimation of the size of the internal defects in the rail head. These programs have identified three sources of potential measurement error. While the investigators employed a hand-held, single 70-degree angle and pulse-echo detector as well as a rail-mounted UT probe using CAT-scan technology, the general observations and several of the specific errors reported upon have direct applicability to most, if not all, ultrasonic measuring equipment. It is of importance that railroads be aware of these sources of potential error.

The first source of error can be due to the inability of the ultrasonic beam to illuminate the parts of the crack surface near the gage corner and in the head-web fillet area. This is shown in Figure 1, and occurs usually with flaws larger than 65 percent of the head area.

A related error for small flaws can be caused by a partial transmission of the ultrasonic beam across the crack surface. It is a phenomenon which results in an underestimation of the flaw size, or because of a finite beam width can result in an overestimation of the flaw size. Typical errors of the kind are presented in Figure 2.

It compares defect size from CAT-scan readings against actual size obtained by breaking and examining the rail.

Human errors

The second source for errors — one that is most familiar to railroad and contractor personnel — is of direct human origin. Such errors can stem from improper probe positioning, inadequate use of couplant fluid for hand-held types of probes, or improper reading of the analog output signal for vehicle-mounted probes. Measurement accuracy, of course, can vary significantly with the skill of the operator. Thus, while an expert operator is generally quite accurate, the "average" track inspector—as noted in the evaluation—tends to produce the least reliable results when measuring flaw size using the techniques mentioned.

A third source of error, discovered through laboratory testing, originates from changes in rail temperature. Thus, it was found that flaw size decreased as the temperature increased and the rail was put into compression. These results, which were observed both in the laboratory and in the field, are presented in Figure 3. It illustrates the variation in flaw size with rail temperature. The differences are quite significant, and could be of real importance in the monitoring of internal rail defects for ultrasonic or possibly other inspection techniques. While temperature is not a variable that can be controlled in the field, knowledge of this error phenomenon is useful in compensating for it under field measurement conditions.

Not all these errors may occur in normal railroad inspection practices. But the potential occurrence for at least some does exist. As such, the railroads and contractors should be aware of their possible extent and effects.

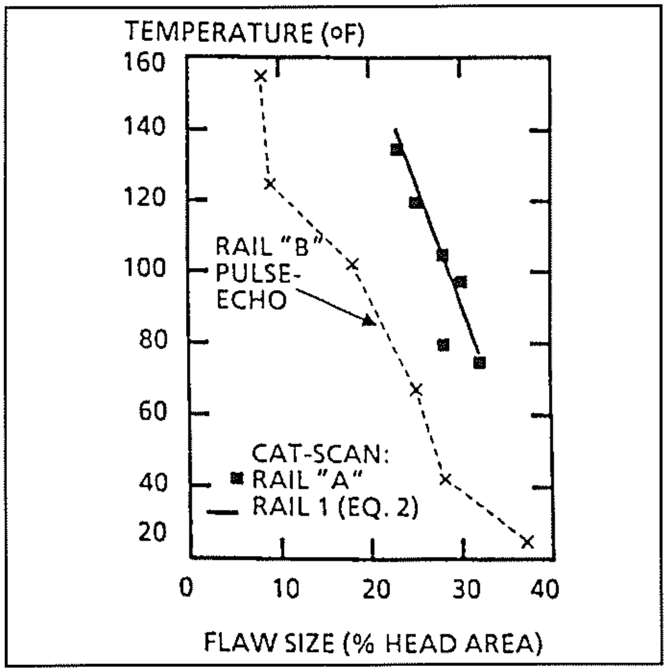

Figure 3 — Apparent Flaw Size vs. Rail Temperature

Reference:

1. Orringer, O., et al., "Detail Fracture Growth in Rails: Test Results"; Theoretical and Applied Fracture Mechanics; Volume 5, No. 2, 1986.