

IN-SERVICE INSPECTION

An important part of regularly scheduled inspection of structural components is to detect incipient fatigue damage. This is clearly vital to the fail-safe design approach.

The highly localized nature of fatigue requires extremely careful examination for possible early detection. At present, there is no known certain way of finding evidence of damage prior to the development of cracks. Observations that are feasible include the detection of small cracks and the detection of aggravations, such as corrosion pitting or excessive fretting, that may lead to fatigue cracking. In many situations a load or pressure application is essential for good visual inspection. Both are strongly dependent on the experience, skill, and care of the inspector.

Table lists several methods of searching for fatigue cracks. The extreme difficulty and time-consuming nature of such searches require particular emphasis on locations judged to be critical and searching first for any suspicious indications and later analyzing each indication for positive crack identification. In such procedures, there is no present method superior to visual inspection.

Classification	Remarks
Nondestructive	
Commonly used:	
Visual	With such aids as dye penetrants. borescope, etc.
Electromagnetic	Magnaflux, eddy currents, etc.
Others:	
Ultrasonic	Inspection of special parts.
X-rays	Limited value for fatigue.
Destructive	
Metallographic:	
Surface	Primarily in failure analyses
Fractographic	

Visual inspection is frequently aided by the use of dye penetrants and "superpenetrants." These often afford a contrast enabling a crack to be spotted easily. A precaution in any sort of visual inspection is that various imperfections may be difficult to distinguish; a machine mark may look like a crack and conversely.

Electromagnetic inspection includes such diverse methods as use of magnetic particles and eddy-current probes. The latter may be particularly helpful around discontinuities such as bolt holes.

Other methods of nondestructive inspection have particular usefulness in special situations, but less general applicability in the field than visual and electromagnetic methods. Ultrasonics can be used to locate very small flaws, including cracks, in parts of suitable geometry and such that good coupling to the surface is feasible. This method is more useful for specific components and under laboratory conditions than for general use in the field. X-rays may be used for radiography of spots not directly accessible. In the laboratory, with expert care, radiography can show up small fatigue cracks, but positive identification may be difficult or impossible under field conditions. Other means of locating cracks (thermal detection, electrical-resistance discontinuities, etc.) are at present solely of academic interest.

Destructive means of inspecting for early fatigue are limited to situations which warrant "surgery" – failure investigations and critical investigation of locations highly suspect on the basis of experience and of previous nondestructive examination. These are, however, important. The "metallographic" list might include both surface examination (destructive if much etching or surface removal or any sectioning is involved) and studies of the edges exposed by fracture. For either surface, of the part or of the crack, magnifications from small optical (5X to 50X) to large electron-microscopes (5,000X to 40,000X) may be used, depending on facilities, experience, and total background.