Optical fiber sensor monitoring system of composite structures for damage tolerance design

Nobuo Takeda

(The University of Tokyo, Graduate School of Frontier Sciences, Professor)

【Outline of survey】

Carbon fiber reinforced plastic (CFRP) composites have been used in primary structures, but complicated damages cannot be detected by conventional non-destructive evaluation techniques. Structural health monitoring (SHM) technologies have recently been proposed to monitor the structural integrity in real time with sensors installed in structures. The present study uses two kinds of optical fiber sensor based SHM technologies for aerospace composite structures. One is a piezo-electric actuator (PZT)/fiber Bragg grating (FBG) active sensing system. Lamb waves generated by PZT travel in CFRP laminated structures, and a high-speed FBG strain is measured to detect the damage in the wave path. The other is pre-pumped BOTDA technique to measure the strain distribution along an optical fiber installed in the structure, with length resolution of 10 cm and strain resolution of 25 με. Small-diameter optical fiber is used to be embedded in CFRP laminates without inducing any damage. The combined local-global monitoring system is developed to measure quantitatively the critical damage in bonded CFRP structures and CFRP repair patches.

【Expected results】

Reliability and safety will be significantly improved by establishing the above combined local-global optical fiber sensor based SHM system. Periodical maintenance is also drastically improved in quality and in cost. A new damage-tolerant design method may be established using the reliable SHM system. The Japanese composite structure design and manufacturing technology will obtain more advantage over that in other countries.

【References by the principal researcher】

• N. Takeda et al., “Development of Smart Composite Structures with Small-Diameter Fiber Bragg Grating Sensors for Damage Detection: Quantitative Evaluation of Delamination Length in CFRP Laminates Using Lamb Wave Sensing,” *Compos. Sci. Tech.*, Vol. 65, 2005,. pp. 2575-2587.

• N. Takeda et al., “Estimation of the Damage Patterns in Notched Laminates with Embedded FBG Sensors,” *Compos. Sci. Tech.*, Vol. 66, 2006, pp. 684-693.

【Term of project】 FY2006－2010

【Budget allocation】22,700,000 yen

【Homepage address】 http://www.smart.k.u-tokyo.ac.jp/