Quantitive Evaluation Technology for Delamination of Composite Laminate Panel using Statistical Analysis of Infrared Thermal Image

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Composites materials have recently witnessed a rapid expansion of their applications across various structure of transportation. This is primarily attributed to their superior mechanical, thermal, and electrical properties when compared to traditional metal materials. In the realm of railway transportation, the initial utilization of composite materials centered on replacing conventional metal components such as bearings, body frames, and front panels. However, a noteworthy trend has emerged, emphasizing the integration of nanomaterials for functional enhancements. For instance, within the domain of railway vehicles, there has been prior research focusing on enhancing the functionality of composite laminate panels extensively used for interior elements like train cabins and compartments. This involved the integration of a carbon fiber heating element into glass fiber composite materials during the molding process. The outcome was a unified panel capable of generating heat when external power is supplied. Nonetheless, it is important to note that exposure to thermal loads can result in various forms of damage within composite materials, including thermal strain and thermal residual stress. Among these, delamination damage, stemming from the multi-layer stacking structure of composite materials, holds significant importance in the context of composite material integrity. Even if it occurs over a wide area between layers, delamination cannot be visually identified from the exterior. This study introduces a novel non-destructive inspection method, enabling the quantitative discrimination of delamination areas through statistical analysis of temperature data extracted from thermal images. Test specimens of heating-capable composite laminate panels, deliberately containing internal delamination, were fabricated and subjected to heating tests. Subsequently, statistical analysis was applied to the temperature data obtained from thermal images. The study presents a statistical analysis method demonstrating a linear correlation with changes in the internal delamination area within the composite panel.