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# Study of an optimal heating duration indicator for square pulsed thermography applied to CFRP gluing quality control

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During previous works, square pulsed thermography was used to carry out non destructive testing of bonding quality of CFRP glued on civil engineering structures during reinforcement operations [1,2]. The use of such wave form excitation was motivated by "*on-site*" requirements, but also by measurements duration, number of composite layers to test, depth of possible faulting areas versus temperature elevation allowed at composite level according to inner heat diffusion.
Nevertheless, square pulsed excitation implies to choose an adapted heat duration. This duration is directly linked to the reliability of the parameter estimator [3]. In fact, after a certain duration the standard deviation of the estimation procedure stagnates.
According to these observations, an indicator able to predict the sufficient heating time when the reliability of the parameter estimator reached an asymptotic evolution behavior was studied. Based on the absolute thermal contrast, the proposed indicator $I_{ph}$ is defined with the maximum thermal contrast $\Delta T_{max}$ and the time delay ($t_{ph}$) between the heating time $t_c$ and the appearance of the maximum contrast, as shown in figure 1 (left). A typical evolution of the Iph indicator is proposed in figure 1 (right).
This indicator allows to take into acount the detectability as well as the induced flaw temporal effect on the thermal contrast shape evolution. It has been observed that the maximum of $I_{ph}$ is connected with the sufficient heating time when the standard deviation of the estimation procedure tends to be minimized.
This paper will present the establishment of this indicator for optimal square heating time and present an analysis of results obtained with numerical simulations and laboratory experiments.

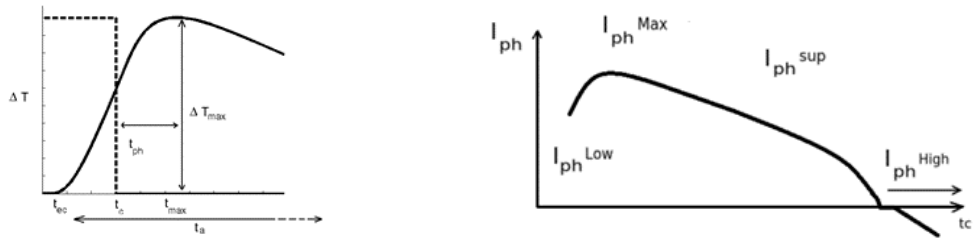


**Figure 1 Absolute thermal contrast characteristics (left) and indicator $I_{ph}$ evolution with heating time duration**

**Keywords**: NDT, Square pulse heating, Optimal Design, Civil engineering, Parameter estimation

## References

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