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Experimental Study on Infrared Radiation Temperature Field of Concrete under Uniaxial Compression

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Highlights:

(1) Distribution of IRTs follows Gaussian distribution.
(2) Surface topography of IRT field is similar to hyperbolic paraboloid due to the stress field of sample.
(3) R^2 of Gaussian and hyperbolic paraboloid fitting was proposed as the quantitative index.
(4) Normalization images of IRT field were proposed as an auxiliary mean for analysis of IRT field.

Abstract: Infrared thermography, as a nondestructive, non-contact and real-time monitoring method, has great significance in assessing the stability of concrete structure and monitoring its failure. It is necessary to conduct in depth study on the mechanism and application of infrared radiation (IR) of concrete failure under loading. In this paper, the concrete specimens with size of 100×100×100 mm were adopted to carry out the uniaxial compressions for the IR tests. The distribution of IR temperatures (IRTs), surface topography of IRT field and the reconstructed IR images were studied. The results show that the IRT distribution follows the Gaussian distribution, and the R^2 of Gaussian fitting changes along with the loading time. The abnormities of R^2 and AE counts display the opposite variation trends. The surface topography of IRT field is similar to the hyperbolic paraboloid, which is related to the stress distribution in the sample. The R^2 of hyperbolic paraboloid fitting presents an upward trend prior to the fracture which enables to change the IRT field significantly. This R^2 has a sharp drop in response to this larger destruction. The normalization images of IRT field, including the row and column normalization images, were proposed as auxiliary means to analyze the IRT field. The row and column normalization images respectively show the transverse and longitudinal distribution of the IRT field, and they have clear responses to the destruction occurring on the sample surface. In this paper, the new methods and quantitative index were proposed for the analysis of IRT field, which have some theoretical and instructive significance for the analysis of the characteristics of IRT field, as well as the monitoring of instability and failure for concrete structure.

Key words: Infrared radiation field, Gaussian fitting, Hyperbolic paraboloid fitting, R square,