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Temperature-Based Detection of Initial Yielding Point in Loading of Tensile Specimens Made of Structural Steel

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Abstract : The yield point represents the upper limit of forces which can be applied to a specimen without causing any permanent deformation. After yielding, the behavior of the specimen suddenly changes, including the possibility of cracking or buckling. So, the accumulation of damage or type of fracture changes depending on this condition. As it is difficult to accurately detect yield points of the several stress concentration points in structural steel specimens, an effort has been made in this research work to develop a convenient technique using thermography (temperature-based detection) during tensile tests for the precise detection of yield point initiation. To verify the applicability of thermography camera, tests were conducted under different loading conditions and measuring the deformation by installing various strain gauges and monitoring the surface temperature with the help of a thermography camera. The yield point of specimens was estimated with the help of temperature dip, which occurs due to the thermoelastic effect during the plastic deformation. The scattering of the data has been checked by performing a repeatability analysis. The effects of temperature imperfection and light source have been checked by carrying out the tests at daytime as well as midnight and by calculating the signal to noise ratio (SNR) of the noised data from the infrared thermography camera, it can be concluded that the camera is independent of testing time and the presence of a visible light source. Furthermore, a fully coupled thermal-stress analysis has been performed by using Abaqus/Standard exact implementation technique to validate the temperature profiles obtained from the thermography camera and to check the feasibility of numerical simulation for the prediction of results extracted with the help of the thermographic technique.

Keywords : signal to noise ratio, thermoelastic effect, thermography, yield point
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