TENSILE TESTS ON HIGH STRENGTH STEEL MATERIALS USING HIGH PRECISION MEASUREMENTS

Ho-Cheung Ho[1,2], Meng Xiao[1], Xiao Liu[1,2] and Kwok-Fai Chung[1,2]

[1] Department of Civil and Environmental Engineering,
[2] Chinese National Engineering Research Centre for Steel Construction (Hong Kong Branch),
the Hong Kong Polytechnic University, Hong Kong SAR, China

ABSTRACT

The mechanical properties of steel materials are commonly determined using standard tensile tests. Currently, there are two widely adopted tensile testing standards, namely ASTM E8/E8M-13 and EN ISO 6892-1, for tests of metallic materials under ambient temperature. For elastic design and analysis of structural elements, the two standardized methods are good enough to obtain basic mechanical properties. However, a transformation to true stress-strain curves is essential for plastic design and analysis of steel structures at large deformations. With high precision measurement method using Digital Image Correlation (DIC) technology, true stress-strain curves of steel materials may be directly measured in standard tensile tests.

This paper reports a total of 4 standard tensile tests on both Q345 and Q690 steel coupons. The existing transformation methods from engineering stress-strain curve to true stress strain curves were compared with experimental results. It is found that the material model based on Power Law tends to give a lower true stress-strain curve, while the material model based on Linear Law is found to give an upper true stress-strain curve. By direct adoption of measured true stress-strain curves into an advanced finite element model, numerical simulations with a high level of accuracy were obtained. Moreover, the ratios of surface tensile stress to the average tensile stress of both Q345 and Q690 steels were found to be about 0.875 at points of fracture respectively. Hence, corrected true stress-strain curves for Q345 and Q690 steels have been proposed, which are considered to be very important for numerical analyses of steel structures subjected to large plastic deformations.

Keywords: Tensile test, Plastic deformations, High strength steel, Digital Image Correlation, Finite element analysis.