A Series of Studies on Role of Plastic Flow in Plastic Buckling of Steel Plates

Plasticity in steel is characterized by an appreciable amount of plastic flow which precedes strain hardening. This study is devoted to analytical evaluations of the effective plastic shear modulus and bending stiffness of fully yielded steel plates at the instant of buckling. First, these stiffness are calculated by incremental stress-strain theory. It is shown that the steel plate has the finite magnitude of bending stiffness in the plastic flow range. These values give too higher solutions than experimental results. Secondly, it is assumed that yielding of steel is to follow the Tresca yield criterion and that plastic deformation of a steel plate is to be caused by slips. A new theory is proposed that assumes a non-uniform distribution of slips. The twisting of the plate is then accompanied by distortion of its sectional shape, and this mode provides a considerable reduction in the effective plastic shear modulus. These evaluations lead to a lower bifurcation strength, which provides much better correlations with experimental results than previous predictions.

Furthermore, the elephant foot buckling behavior of circular section steel stub-columns is clarified. In this case, a non-uniform distribution of slips may not occur because of their geometrical symmetry. It is made clear that buckling strength by the deformation theory perfectly coincides with test results in spite of the length of yield plateau of the material.