Saleh Alogla - Effect of transient creep on response of RC columns under fire

Summary

Concrete columns experience significant transient creep deformations in later stages of fire exposure, and are susceptible to failure due to transient creep effects. However, in current practice transient creep deformations are not fully accounted for in evaluating fire resistance of RC columns. This is in part due to the limited studies on the subject, and availability of data in the literature. As part of my PhD research, experiments are carried out to quantify transient creep in different concrete mixtures including; normal strength concrete, steel fiber reinforced normal strength concrete, and polypropylene fiber reinforced high strength concrete. A costume built test set-up is designed and built to conduct experiments aimed at quantifying transient creep strain in concrete at different stress levels, temperature ranges, and rates of heating. The results of these experiments clearly indicate that transient creep constitute a significant part of total strain of concrete at high temperature. Thus, transient creep shall not be neglected in fire resistance analysis of concrete members, particularly columns. Previous studies have shown transient creep to be more dominant in concrete columns than concrete beams or slabs. In columns most of the concrete cross section is under compression and exposure to fire can be from more than one face, whereas in beams and slabs exposure to fire is often from the bottom side where concrete is under tension.

In addition to experiments, a three-dimensional finite element based numerical model is built in ABAQUS to trace the behavior of RC columns under fire. Temperature induced transient creep strains in concrete and reinforcing steel are explicitly accounted for in the analysis. The model also accounts for temperature induced degradation in concrete and reinforcing steel, and material and geometrical nonlinearities. The model is applied to evaluate the effect of high-temperature creep on the response of fire exposed RC columns. Since concrete columns are prone to exposure to various fire scenarios from different sides depending on the location of the column within a building, the developed model is extended to study different parameters effect on the extent of transient creep influence in reinforced concrete columns under fire conditions. These parameters include; severe fire exposure, fire exposure from 2, 3, or 4 faces of the column, different stress levels, and exposure to natural fires with cooling phase.