Simultaneous Strain and Temperature Field Measurements for Thermo-Structural Response during Fires

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Response of real structures to fires is controlled by non-uniform load paths, load redistribution, as well as variable temperatures of the structure. Point measurements of temperature, strain, and deflections may not be adequately positioned to capture this non-uniform behavior, thus missing important failure points in the structure. Imaging techniques have been developed to simultaneously quantify the three dimensional deflections and strains with the surface temperatures of structural elements exposed to fire conditions. Stereoscopic digital imaging correlation (DIC) was used to measure the three-dimensional displacements and strains, while an infrared (IR) camera was used to measure surface temperatures. These two techniques were fused so that IR temperature pixel temperatures were matched with the displacement and strain pixel measurements. This allowed thermal strains to be separated from the measurements so mechanical strains could be directly quantified. The DIC-IR system was used to measure thermo-structural response of various structural components exposed to fire conditions while under mechanical load up to failure. Samples included coupon size (0.1 m long) aluminum weld samples, coupon size sandwich composites, intermediate scale (0.5 m) aluminum plates with stiffeners, and intermediate scale sandwich composite plates. A system currently being acquired to measure large-scale samples (~10m) will be presented.