Numerical and Experimental Study of Concrete Structures under Extreme Conditions: Impact and Fire

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ABSTRACT

During service life concrete structures may be exposed to extreme loading conditions, e.g. fire, explosion, impact, earthquake and their combination. It is well known that concrete behavior in case of high loading rates differs significantly from that observed under quasi-static loading. Moreover, high thermal exposure causes degradation of material properties and generates free and load induced thermal strains, which significantly influence their static and dynamic response.

In the presentation the behavior of concrete structures exposed to extreme conditions (impact and fire) is discussed. Experimental and numerical results performed on reinforced concrete (RC) slabs and frames are presented. RC slabs were first exposed to elevated temperature and then loaded by free falling hammer. The aim was to investigate the influence of thermally induced damage of concrete on the punching properties of RC slab in case of high impact velocity. Similar studies were carried out on a single storey RC frames, which were first damaged through fire and subsequently loaded by impacting pendulum.

The numerical simulations were performed by employing multi-body dynamic 3D FE code based on the rate sensitive thermo-mechanical microplane model for concrete and steel [1][2]. In order to calibrate and verify the numerical model, all experimental results were simulated. Subsequently, parametric study was carried out. The experimental and numerical results show significant influence of the thermally induced damage of concrete structures on their static and dynamic response. It is demonstrated that the effect of thermally induced damage for static and dynamic loading is different. The comparison between experimental and numerical results shows that the employed 3D FE code is able to realistically replicate structural behavior due to complex loading conditions.

REFERENCES

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