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Fire Resistance of Eccentrically Loaded Reinforced Concrete Columns

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Abstract. Fire resistance of reinforced concrete (RC) columns in design codes is based on concentric loading conditions. The effect of eccentric loads on spalling and fire resistance of RC columns is a matter of investigation. The present study, therefore, broadly aims to determine the influence of relative levels of spalling under eccentric loads on fire resistance of RC columns. Experimental investigation is done on 3.15 m long column specimens. The experimental results indicate that the increase in load eccentricity (from 20 mm to 40 mm) increases the amount of spalling leading to exponential decrease in fire resistance (by 43%). Spalling is restricted by increase in longitudinal bars, particularly mid-perimeter bars, contributing to increase in fire resistance by 100% with doubling of number of longitudinal bars. Even the decrease in spacing of transverse reinforcement (from 300 mm to 150 mm) for eccentric loads leads to 123% increase in fire resistance. However, this advantage is limited by greater amount of compression face spalling (400% more) under eccentric loads, which is seen to increase with the density of reinforcement. For explosively spalled high strength columns, further reduction in fire resistance occurs on account of local softening of longitudinal reinforcement due to early (10 min) and protracted (up to 58 min) deep spalling. The chances of global column element buckling become more dominant with increase in load eccentricity around 40 mm. It is concluded that spalling levels change with relative change in reinforcement detailing with other parameters under eccentric loads. From this study, it is concluded that the feasibility of existing methods of determination of fire resistance for eccentrically loaded columns are inadequate and need to be revised to as per the results of this study.

Keywords: Concrete, Column, Eccentricity, Fire resistance, Spalling

List of symbols

RC	Reinforced concrete
HSC	High strength concrete
NSC	Normal strength concrete
Phi(*l*)	Dia of longitudinal reinforcement
RH	Relative humidity
e(*x*)	Uni-axial eccentricity
P(*u*)	Ultimate design load
P	Axial load
Leff	Effective length of column

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