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Empirical model for determining fire resistance of Reinforced Concrete columns

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HIGHLIGHTS

- Fourteen RC Columns tested for determining fire resistance under standard fire curves.
- Two grades of column with varying spalling levels are tested for varying load eccentricity.
- Empirical Model is developed for determining fire resistance of RC columns for varying spalling levels.
- Empirical model has better feasibility than other models and predicts fire resistance for varying parametric variations.

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ABSTRACT

Fire resistance of Reinforced Concrete (RC) columns is affected by explosive spalling of concrete. Existing models for determining fire resistance of reinforced concrete columns do not generally account for the effects of spalling. The data from tests conducted in this study and other studies available from the literature have been used to develop an empirical model. This study attempts to develop a model for determining fire resistance of reinforced concrete columns by incorporating the influence of various key parameters including pre-mature spalling of concrete during fire. The model also incorporates the effect of local buckling of longitudinal reinforcement triggered by explosive spalling. The model further incorporates the role of reinforcement configuration in determining fire resistance. A standard equation is developed for a full ISO-834 fire scenario in RC columns. The model is seen to predict greater than 75% safe results. These are better predicted for range of influencing parameters.

1. Introduction

Reinforced Concrete (RC) structures are still most common in developing countries of the world. With rise of fire events globally, the importance of study of fire resistance of RC structures also increases. Even though concrete has good thermal properties, it does suffer significant damage on account of spalling during fire besides also having large thermal gradients. The need for study of fire resistance of RC columns arises from the fact that columns play a critical role in a structural framework. The performance of column during fire is altogether complex. And the performance criteria require accurate determination of fire resistance of RC column. Few empirical models – EN 1992–1-2 [11], AS 3600 [5], Kodur and Raut [20] are available for determination of fire resistance of RC column. The parameters that have been considered for determining fire resistance in empirical models are load ratio, load eccentricity, fire exposure faces, column geometry, concrete cover, steel ratio and concrete strength. Other parameters that also need to be considered in determining fire resistance of RC columns are the nature of loading and the spalling scenarios expected. Although many of these broad parameters have been taken care of in these empirical models but the role of spalling, particularly explosive and large scale spalling has not been considered in any of the empirical models in determination of fire resistance of RC column. Moreover, these methods ignore the role of reinforcement detailing and the confinement of columns.

Experimental tests were conducted on fourteen full-scale RC columns in order to determine the effect of various parameters influencing the fire resistance of RC columns. The limiting effect of spalling on fire resistance along-with influence of reinforcement detailing and confinement due to transverse reinforcement spacing were also determined from these tests. The empirical model was developed for determination of fire resistance of RC columns. This is based on the major influencing parameters considered in earlier models. This model considers two levels of spalling for determin-

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