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RESEARCH ARTICLE-CIVIL ENGINEERING

Statistical Review of the Fire Resistance of Concrete Columns

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Abstract
Fire resistance of a structural element is predicted by numerical, analytical and empirical methods while as codes mostly provide prescriptive guidelines for determining fire resistance of RC columns. Many of these methods are reviewed for examining the influence of structural, material, mechanical and heating-related parametric variations on fire resistance of RC columns. Further, the feasibility of these methods in determining fire resistance of RC columns is reviewed. Moreover, emphasis is given on reviewing the role of spalling of concrete on fire resistance of RC columns. Accordingly, a systematic review of experimental data on fire resistance of RC columns is performed. The parametric variability and experimental discrepancy are both studied for fire resistance determination of RC columns.

Keywords Concrete · Column · Fire resistance · Review · Spalling

1 Introduction

Fire is a natural or a man-made disaster. Multi-story buildings in urban areas are more vulnerable to fires—[1,2]. The important fire incidents in multi-story buildings of last 2 years are given in Table 1. As concrete is one of the most widely used building material in structures; the property of spalling of concrete beyond 600C and disintegration around 800C makes it vulnerable to fires. Moreover, the reinforcing steel undergoes softening beyond 550C. Column being an important structural element is required to perform well during fire so as to avoid failure of building. The fire resistance of reinforced concrete (RC) columns when seen though prism of stability depends on many structural, material, mechanical and heating-related parameters—[3–5]. It particularly depends on the spalling of concrete, which tends to decrease drastically for 'high-strength concrete' (HSC) columns due to explosive spalling—[6]. If visualized at material level, the reduction in mechanical and thermal properties of concrete and steel at elevated temperature has an impact on fire resistance of RC columns—[7]. Broadly at element level, these parameters can be related through deformations in RC columns in order to compare their fire-resistant behaviors—[8]. Also at element level; column geometry, its detailing and heating scenarios during fire have consequential effect on fire resistance of RC columns. There are numerical [9–13], analytical [4,14–20], empirical [4,5,21–30], and codal prescriptive methods [31–36] available for prediction of fire resistance of RC columns. These all methods have limitations which are evaluated in this study under feasibility analysis. During this analysis, the predicted fire resistance of RC columns is compared with the fire resistance measured experimentally. Furthermore, the feasibility of predicted fire resistance for RC columns is evaluated for different parametric variations. In succeeding sections, the systematic review is conducted for evaluating and comparing the fire resistance of RC columns.

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2 Effect of Material Properties On Fire Resistance of RC Columns

Physical and chemical properties of materials have an impact on fire resistance of RC columns. The type of aggregates, moisture content of concrete, relative humidity of concrete, presence of fibers and silica fume have an impact on fire resistance of RC columns. Besides these, mechanical strength of concrete and steel have an impact on fire resistance of RC columns. Both mechanical and thermal properties of concrete and steel decreases with increase in temperature of RC