The 2016 World Congress on
The 2016 Structures Congress (Structures16)
Jeju Island, Korea, August 28-September 1, 2016

P-M **Interaction Curve for a Reinforced Concrete Column Exposed to Elevated Temperature**

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ABSTRACT

Structural performance of a reinforced concrete (RC) column is greatly influenced by its slenderness ratio. Especially, under the elevated temperature, secondary moment can be additionally induced by the loss of cross-section. In this study, therefore, the axial force-flexural moment (*P-M*) interaction model of a RC column exposed to fire was proposed, which considers the slenderness effect due to fire damage. The 500 °C isotherm method presented in Eurocode2 was adopted to consider the fire damage, and the nonlinearity of materials was also reflected. In addition, in order to consider initial imperfection, the maximum axial strength was limited by Rankine load. The proposed *P-M* interaction model was verified with test results collected from existing studies. The results showed that the proposed model evaluated the fire-resisting performance of the specimens very accurately.

1. INTRODUCTION

Fig. 1 shows *P-M* interaction curves of a reinforced concrete (RC) column exposed to fire. It shows that the potential capacities of the RC column member rapidly

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Note: Paper to be submitted to "Computers and Concrete, An International Journal" for the purpose of Special Issue.

decrease due to the fire damage as the fire exposure time increases. In addition, the RC column is gradually changed to behave like a slender column because of the cross-sectional loss caused by the fire damage (Tan 2003). In this study, a new *P-M* interaction curve model was developed to evaluate fire resistance performances of RC columns, in which the material strength and stiffness degradations and the additional secondary effect (*P-δ* moment) due to fire damage were also considered.

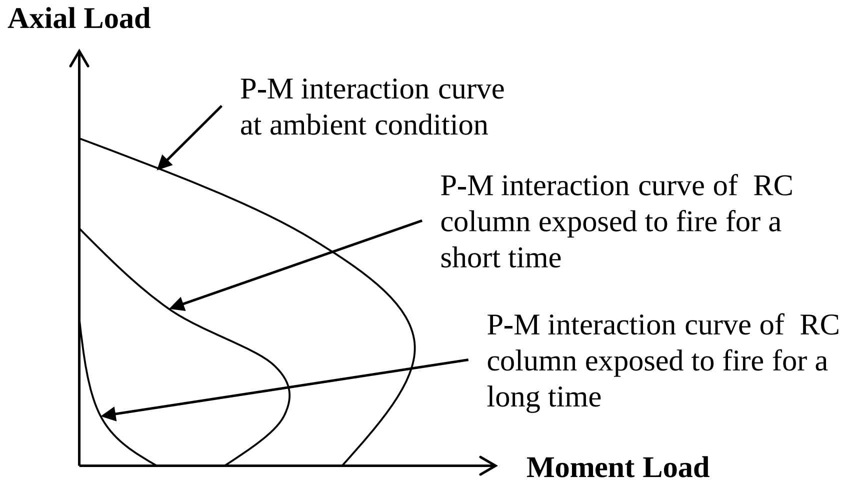

Fig. 1 Strength degradations of RC columns due to fire damage

2. PROPOSED MODEL

2.1 Sectional analysis model

This study used the 500 °C isotherm method to reflect the influence of fire on axial and flexural strengths of a RC section in a simple manner. Fig. 2 shows the main concept of the 500°C isotherm method. The effective sectional area of the concrete reduced by fire damage ($A_{reduced}$) was used, and it can be calculated based on the 500°C penetration depth (x_{500}). The constitutive models of a reinforcing bar presented in Eurocode2 (EN 1992-1-2 2004) were adopted to consider the effect of temperature on the yield strength ($f_{y,T}$) and the modulus of elasticity ($E_{s,T}$) of the reinforcing bar at a specific fire exposed time.

2.2 Effect of secondary moment (P-δ Effect)

The primary moment (M_{1st}) of the RC column can be calculated by subtracting the secondary moment ($P\delta_{mid}$) from the typical moment-curvature ($M_{mid} - \phi_{mid}$) response curve of the central cross-section of the RC column subjected to combined axial force and flexural moment, as follows: