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EXTENDED ABSTRACT

Evaluation of Sensitivity Analysis Methods in RC Frame exposed Post-Earthquake Fire

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1. Introduction

Several loads over the lifetime of buildings threaten the safety of structures. Earthquake, fire, explosion and ... hazard that jeopardize the safety of the structure. The purpose of this study is to investigate the methods and effects of different parameters on the strength of reinforced concrete frames in the post-earthquake fire scenario. For this purpose, a 7-story concrete frame is designed and mechanically-Thermally molded. After modeling, using three methods of Monte Carlo simulation (MCS), Trento diagram (TDA) and first-order second moment (FOSM), the effect of design parameters on RC frame in post-earthquake fire loading was investigated.

2. Methodology

2.1. Sensitivity Analysis

Three different methods based on the probability theory were adopted: (1) Monte Carlo simulation (MCS), (2) Tornado Diagram Analysis (TDA), and (3) the First-Order Second Moment (FOSM) method. MCS is one of the methods widely used to analyze random problems. In this method, random variables are represented by sets of deterministic values that are used to produce sets of deterministic outputs. Then probabilistic forms of outputs are constructed. Because of its robustness, MCS is frequently used to validate other probabilistic analysis methods (Kim et al. 2011).

TDA is one of the sensitivity analysis tools commonly used in decision analysis. In TDA, the upper and lower bounds of a random variable are selected and the corresponding structural responses are obtained. The difference between such structural responses, referred to as swing, is considered as a measure of sensitivity.

In the FOSM method, means and standard deviations (SD) of random variables are assumed and the mean and SD of structural responses are obtained where SD can be used as a measure of sensitivity. The advantage of the FOSM method is that the analysis procedure is simpler than rigorous probabilistic methods such as the first-order reliability method, stochastic finite element method, and the MCS method, while major probabilistic properties of the structural responses can be obtained (Guo et al. 2014).

2.2. Thermo-Mechanical properties of materials

In this study, thermal conductivity and specific heat parameters are considered as a temperature function. Different values of thermal conductivity and specific heat of concrete materials are indicated in Fig. 1 and Fig. 2. Thermal characteristic of steel and concrete material in high temperature indicated in Table 1. In this study

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heat transfer analysis was applied in Abaqus Software and mechanical thermal analysis was applied in open sees.

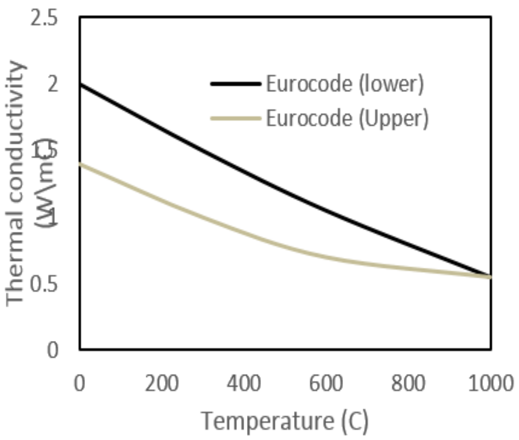


Fig. 1. Concrete thermal conductivity

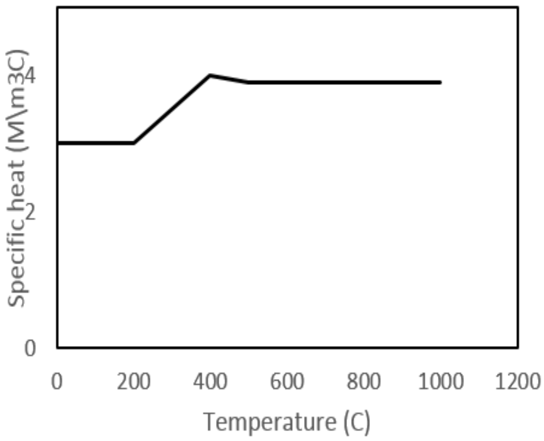


Fig. 2. Concrete specific heat

2.3. Fire Loading

In this research, the temperature curve provided by ISO 834 for the application of thermal load to the elements has been used. In this research, it is assumed that the thermal load is so applied to the structure as to cause a failure in the structure. The thermal loading in the structure continues so that one of the elements exposed to the thermal load is failed.

2.4. Earthquake load

In this research, pushover analysis is used to simulate structural behavior in seismic load. Three levels of IO, LS, and CP are considered for assessing the behavior of the structure in the post-earthquake fire scenario in push-overt analysis.

3. FE Modeling

In this research, a 7-story three-dimensional structure with 4span (5-meter) with a square plan is considered. After the initial design, the mid frame of the structure has been selected as a frame for mechanical-thermal analysis.

4. Analysis result

The results show that in the PEF analysis, the frame resistance at the IO performance level is approximately equal to the resistance in the case where the frame is exposed to fire load. At this level, the structure has resisted 13816 seconds, and then the first failure in the frame has occurred. The failure time in the frame in the PEF analysis has been reduced at a level of LS performance to about 7140 seconds. At the CP performance level, the failure time was reduced to 4076 seconds (Fig. 3).

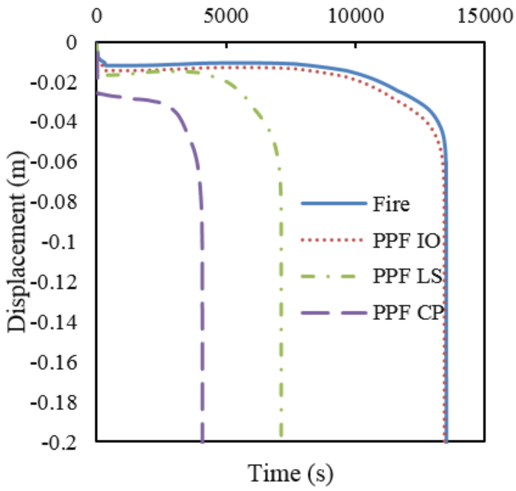
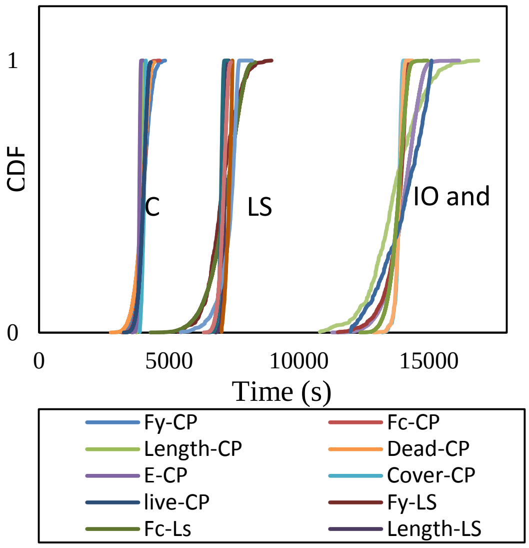


Fig. 3. Resistance of RC frame

After examining the response of a concrete frame under PEF loads, the sensitivity of the first time of the concrete frame failure in the post-earthquake fire scenario was investigated. Fig. 4 shows the CDF and for the frame in PEF analysis in IO, LS and CP level and CP level for stativity analyzing.



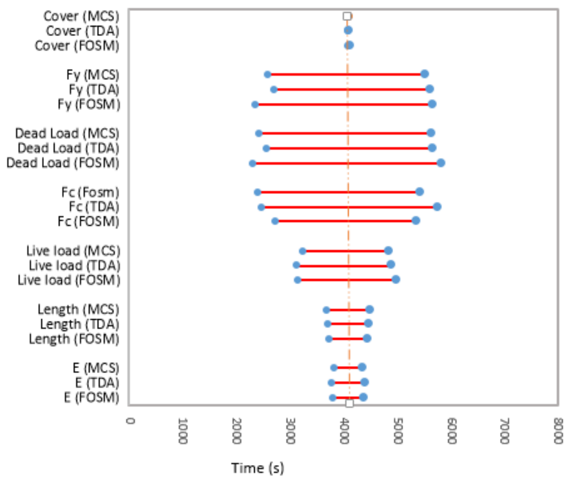


Fig. 4. CDF and Sensitivity result in CP performance level

5. Result

The failure time of a concrete frame decreases in post-earthquake fire loading by increasing the level of performance. This reduction is 51% for the LS level and 29% for the CP level. It shows that rupture time has the highest sensitivity to seismic load. At all performance levels, among the design parameters, the yield stress of the armature has the highest sensitivity among other variables. The modulus of elasticity of the armature and the length of the span have the least sensitivity among different parameters.

6. References

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