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Study on structural robustness to resist progressive collapse of vertical irregularly base-isolated structures

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ABSTRACT

It is necessary to establish qualitative analysis of structural robustness to ensure that the design meets the engineering requirements. The existing damage analysis methods such as Incremental Dynamic Analysis and Static Pushover Analysis which are used to determine the overall response of the structure without focusing on the local damage of the single structural component. From the macroscopic point of view, the local damage on each structural component can cause the progressive collapse of the overall structure and reduce the structural robustness. Particularly for the construction of special based isolation system and superstructure, the impact of accidental bearing failure on the overall structure of the impact of progressive collapse cannot be determined directly. This study starts with the damage risk and the importance of the single component, and the failure of the single component is related to the collapse of the whole structure. Based on the Alternative Load Path Method, the quantitative analysis method of structural anti-progressive collapse is proposed, and the vertical irregular base-isolated structures are compared and analyzed. The robustness of the isolated structure after the failure of the isolated bearing is discussed. The result shows that, qualitative analysis of structural robustness proposed in this study can be used to provide reference for the selection of building scheme and analysis of structural robustness. The robustness of the structure does not only depend on the property of structure itself but also the external load applying on the structure. It is suggested that reasonable protection measures should be set for the isolation bearing with greater vulnerability coefficient which may suffer from extreme accidents and the potential risk of isolation bearing with greater component importance coefficient is eliminated or reduced.

1. Introduction

Progressive collapse of a structure refers to the collapse of the main structure and destruction of the components connected to it, resulting in the collapse of the entire structure or a disproportionate collapse (Ellingwood et al., 2005; Kiakojouri et al., 2021). The progressive collapse events may cause great economic losses and safety hazards to the building resident. It has become one of the major issues threatening public safety, and has become a concern of engineers. Accidents such as gas explosions, bomb attacks, vehicle crashes, design or construction errors, and fire are common factors that may cause a progressive structural collapse. Although there are few cases of progressive collapse of building structures in daily life, many countries enforced a preventive method of progressive collapse design in their structural design codes. Adoption of the aforesaid design code aims to avoid the catastrophic consequences of progressive collapse.

Progressive collapse of structures received more attention after the Ronan Point collapse in London in 1968 (Pearson and Delatte, 2005), the Alfred P. Murrah Federal Building in Oklahoma in 1995 (Corley et al., 1998), and the terrorist attacks on the World Trade Center in 2001 (Bazant and Zhou, 2002). Especially in the past two decades, scholars from various countries have obtained many research results in the field of progressive structural collapse by means of experimental research, numerical simulation, and theoretical research. Consequently, several

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