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学 位 論 文 内 容 の 要 旨

In recent earthquakes, RC bridges with low ductility suffered extensive damage. Typical damages of these bridges include brittle failure after yield of longitudinal reinforcement, large residual displacement and disability to be repaired. However, the influential aspects on ultimate stage, residual response and the detailed failure mechanisms, have not been evaluated in details.

Despite the variations of structural properties and failure characteristics, it is possible to gain insight into structural behavior and to identify potential weakness in existing and new bridges, by studying the failure mechanisms of actual bridges or based on experimental tests. On one hand, bridges failed in actual earthquakes have provided valuable real examples to be studied. On the other hand, experimental tests have been widely performed to provide more measurable and observable damage progress. However, scale effect and loading protocol have noticeable influence and lead to notable differences between experimental result and reality.

Therefore, focusing on the seismic behavior and the failure mechanisms of full scale RC bridges, the evaluation on the RC arch bridge which was affected in actual earthquake, and on the full scale RC column specimens based on excitation table tests, were presented in this study on following topics:

- (1) Failure mechanisms of RC rigid-frame arch bridge affected by actual earthquake;
- (2) Influence by axial load variation on the seismic behavior of actual RC rigid-frame arch bridge and its failure;
- (3) Mechanisms of noticeable residual displacement occurred to full scale RC column.

This thesis included total 6 chapters:

Chapter 1 introduced the general research background and research topics on the failure mechanisms and the seismic behavior of full scale RC structures with low ductility under earthquake effect, as well as the research objectives.

In Chapter 2, literature reviews were presented, related to the ductility of RC columns, the seismic behavior of RC arch bridges and residual response of RC columns.

In Chapter 3, the failure mechanisms of a RC arch bridge were studied in details. Based on 2-span dynamic analyses, it was found that under high axial load up to 65% of axial compression capacity, the ductility of arch legs was weakened significantly. Furthermore, the exposure of pile made P3 more deformable, and caused more severe local failure on Span 4. Therefore, these local failures reduced the degree of static indeterminacy, which resulted in the gradual loss of entire stability. Consequently, Span 3 and Span 4 collapsed finally.

In Chapter 4, the influence of M-N interaction on arch leg was evaluated based on the analyses for the collapsed Span 3 and Span 4. The flexural damage was found underestimated if M-N interaction was neglected. Besides, the severe failure of arch legs, the main supporting member, and further collapse of Span 3 and Span 4 should have been possibly avoided by adding the ties volume or by enlarging the sectional area.

In Chapter 5, the seismic behaviors of full scale RC columns based on excitation table tests were studied. Dynamic analysis was conducted, to evaluate the mechanisms, especially focusing on the occurrence of residual response. It was found that frictional force of movable bearing caused notable horizontal load to remain acting on column top. This load mainly led to the noticeable residual displacement. Besides, the friction-free assumption according to specification might not be safe, since it might lead to the significant underestimation of residual displacement.

In Chapter 6, the conclusions drawn according to this study were summarized.

学 位 論 文 審 査 の 結 果 の 要 旨

Based on the statement above, this study, focusing on the full scale RC structures, presented the new evaluations on the failure mechanisms and on the influence due to the variation of axial load for RC arch bridges, and presented the original research on the mechanisms of residual displacement for RC bridge columns. Thereby, this thesis is recognized for having satisfied the requirement for doctoral thesis.

In addition, comprehension was able to be obtained by appropriately answering the questions from members of the dissertation committee and other attendees in the final examination.

Based on the aforementioned results, this dissertation committee herein approves that this candidate is qualified in the final examination.