論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Response Evaluation and Seismic Collapse Assessment of Base-isolated RC Buildings
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出典(和文)	学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第10894号, 授与年月日:2018年3月26日, 学位の種別:課程博士, 審査員:WIJEYEWICKREMA ANIL,廣瀬 壮一,岩波 光保,佐々木 栄一,千々和 伸浩
Citation(English)	Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第10894号, Conferred date:2018/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	Civil Engineering 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 (Philosophy) Doctor of
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis presents a comprehensive study of mid-rise base-isolated reinforced concrete (RC) buildings with the main focus on response evaluation, collapse assessment, cost analysis and seismic pounding subject to different suites of ground motions.

This study is first focused on investigating the behavior of mid-rise base-isolated buildings subjected to far-fault and near-fault ground motions using various isolation system parameters. Nonlinear response history analysis of finite element models of 4-, 8-, and 12-story base-isolated RC moment resisting frame (BI-MRF) buildings using scaled records representative of design earthquake (DE) and risk-targeted maximum considered earthquake (MCE_R) levels are carried out. The results are compared to its fixed-base counterpart, which shows that using isolation system helps to enhance the performance of base-isolated buildings even up to 12-story (the tallest considered in this study). In addition, the applicability of a rigid superstructure to predict the isolator displacement demand is investigated which shows that isolator displacement demands can be estimated accurately by using a rigid body for the superstructure.

Seismic performance of base-isolated buildings using ground motions with fling-step and forward-directivity characteristics is investigated. For this purpose, a 10-story base-isolated RC moment resisting frame (BI-MRF) building and a 10-story RC shear-wall frame (BI-SWF) building are considered and comparative analysis is carried out. Additionally two types of closed form pulses that represent fling-step and forward-directivity effects are employed to understand the behavior of pulse period on the superstructure and the isolation system response. Although both types of ground motion result in satisfactory performance of base-isolated buildings in limiting the damage to structural and non-structural components, forward-directivity ground motions resulted in larger response compared to ground motions with fling-step characteristics. Under both types of ground motions, BI-SWF building resulted in smaller response in terms of inter-story drift ratio compared to BI-MRF building, showing a superior performance in terms of limiting damage to structural and non-structural components. It is also found that the ratio of pulse period to the fundamental period of the buildings governs the response of the superstructure and the isolation system. A value of this ratio close to unity results in a larger response compared to other values.

Probabilistic analysis of base-isolated buildings with and without shear walls are carried out next to investigate the performance over a range of seismic hazard. Fragility curves, which describes how the probability of exceeding any damage state increases as a function of ground motion intensity are developed, based on the results of incremental dynamic analysis (IDA) using a suite of 20 near-fault ground motions. The results of the fragility curves for collapse level are combined with the seismic hazard curve of the site to calculate the mean annual frequency of collapse, which describes the frequency of any structure to collapse in a year. The results obtained from fragility analysis indicate that BI-MRF building has a greater probability of exceeding any structural performance level compared to BI-SWF building. Collapse margin ratio (CMR), mean annual frequency of collapse, and probability of collapse in 50-years period all obtained on the basis of fragility analysis shows similar result where BI-SWF building has a better performance compared to that of BI-MRF building. The same buildings are again used to investigate the effect of seismic pounding with a moat wall. A modified Kelvin-Voigt model is used to simulate the seismic pounding between the impacting nodes. It is found that seismic pounding cause an increase in the response of base-isolated buildings especially at the lower floor levels. Fragility curves indicate a similar behavior to that of no pounding case where BI-SWF building has a better performance compared to that of BI-MRF building. However, comparing the case of pounding with no

pounding, the mean annual frequency of collapse and probability of collapse in 50 years period increases by about 1.3 times which indicates that pounding can degrade the performance of base-isolated buildings. However, the probability of collapse in 50 years period for BI-SWF building for no pounding and pounding cases is well below the limiting value of the ASCE 7-10 code.

The cost incurred due to the damage to structural and non-structural components and downtime loss under DE and MCE_R-levels is obtained. The result shows that BI-SWF building has larger repair cost and downtime compared to BI-MRF building. This contradicts to the result of fragility analysis, where BI-MRF building has a greater probability of collapse compared to BI-SWF building. This is due to the reason that the calculation of loss is based on the response at all the floor levels, while the probability of exceedance of any damage state is based on the maximum value of response along the building height.

Furthermore, the influence of vertical excitation and lead core heating on the displacement demands of lead rubber bearing (LRB) is investigated. The displacement demands obtained are compared to that of the code based equivalent lateral force (ELF) procedure. For this, nonlinear response-history analysis are conducted considering a range of isolation system parameters, subjected to combined horizontal and vertical excitation. In addition to this, the effect of lead core heating is also considered. The displacement demands obtained from far-fault ground motions are well-estimated by the ELF procedure considering both the vertical excitation and lead core heating while they are underestimated in the case of near-fault ground motions. Finally an equation is proposed which provides a reasonable estimate of the displacement demands than those provided by the current provisions of ASCE 7-10.