因應國際規範修訂與國內近斷層地震效應對於國內隔減震建築設計規範之研修考量

Recommendations for Revision of Current Taiwan Seismic Isolation and Energy Dissipation Design Codes

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摘要

我國於 2005 年頒布施行的建築物耐震設計規範及解說中，首次增加了「隔震建築物設計」與「含被動消能系統建築物之設計」兩章節，爾後於 2011 年頒布施行的修正版本中，僅針對「隔震建築物設計」之內容進行微幅調整。在 1999 年九二一集集大地震及國內相關規範提出後，隔減震技術已廣泛應用於國內多項重要公共工程與民生建築，至今國內已超過 150 個建案採用隔震設計，近 400 個建案採用速度型消能元件進行減震設計。除此之外，國內於近十年內亦開始將隔減震技術應用於橋梁新建與補強工程。目前國內隔減震建築設計規範之分析與測試規定，主要仍依循 FEMA 273 與 274 (1997 年)之報告內容。然而，於 FEMA368 與 369(2000 年)以及其後發行的相關正式報告與準則，包括 FEMA 450(2003 年)，以及 ASCE/SEI 7-05、7-10、7-16，隔減震建築之設計精神已有大幅變更，其中包括考慮性能導向與風險告知之設計地震需求、同時考慮第一與殘餘模態之等效線性靜力分析與反應譜動力分析程序、以及合理考慮變異性之邊界值分析；此外，分析時採用之地震歷時選取以及人造地震歷時製作，亦有因應近年全球記錄到的長延時與近斷層地表運動，而有所合理建議。因此，隨著全球耐震概念的演進及設計規範的脈動、因應國內工程業界於實務設計之回饋意見、以及鑒於國內近期多記錄到具有長週期高脈衝速度效應之近斷層地表運動(如 1999 年九二一集集大地震與 2018 年花蓮地震)，實迫切需要提出國內下一世代隔減震建築設計規範修訂方向與草案。

本研究的主軸為因應國際規範修訂、國內近斷層地震效應，提出國內隔減震建築設計規範之修正對策，以達到與全球並駕齊驅之目標，並同時兼顧本土特性與有效解決品管不良問題，研究內容包含對於國內外重要文獻蒐集與彙整(如 ASCE/SEI 7-16)，以及目前國內針對近斷層地表運動效應對於地震工程之衝擊與因應對策。除此之外，更進一步提出目前國內隔減震建築設計規範可能且可行之研修方向，包括地震需求、分析與

設計方法、試驗規定與檢核標準等。預期本計畫最終將會提出國內隔減震建築設計規範之修正草案，包含相關分析設計與測試要求，可供國內相關工程師、產品供應商、以及公務部門使用。於此可有效且正確地推廣隔減震技術，使國內隔減震技術發展更為成熟。

關鍵詞：建築物耐震設計規範及解說、隔震建築物設計、含被動消能系統建築物之設計、耐震設計規範修訂、近斷層地震效應

Abstract

In 2005, the two new chapters,「Seismic design requirements for seismically isolated structure」and「Seismic design requirements for structures with damping systems」, have been firstly approved in the previous version of Taiwan seismic design code. Afterward, merely the former chapter was slightly revised in the current code, which was approved in 2011. Following the 921 Chi-Chi Earthquake and the proposing of new codes, the technologies of seismic isolation and energy dissipation have been widely applied in many public constructions and private buildings. Until present, there are more than 150 seismically isolated buildings and 400 damping system embedded structures. Moreover, in the last decade, such techniques have been applied in bridge and retrofit structures. The current Taiwan seismic design code still follows the American FEMA 273 and FEMA 274 standards, which are approved in 1997. However, according to the FEMA 368 and FEMA 369, approved in 2000, and the afterward FEMA 450 (approved in 2003), as well as ASCE/SEI 7-05, 7-10, and 7-16, the design concepts for seismic isolation and energy dissipation have been significantly improved, such as the linear static and dynamic spectrum analysis considering first and higher structural modes, and reasonably considering the boundary problems lead from the variabilities on isolation and energy dissipation devices. Furthermore, several suggestions have been made for deciding seismic ground motions, adapted for dynamic time history analysis, owing to the study on the near-field earthquake effects and long period ground motions. Therefore, in view of the improvements of global seismic design concept and the near-field ground motions discovered recent years in Taiwan, it is necessary and imperative to propose a revision for seismic design code on seismic isolation and energy dissipation.

In this context, this study aims to propose a revision to the current Taiwan seismic design code considering the latest global seismic design codes and the near-field effects discovered in Taiwan. The objects are to keep pace with the global developments in the seismic structural design field and to solve the quality control problems for isolation and energy dissipation devices in Taiwan. To this end, this study begins with references collecting and compaction. The American ASCE/SEI 7-16 standard will be focused. On the other hand, the study on the impacts and effects caused from near-field ground motions happened in Taiwan will be conducted. Besides, the revisions to seismic design code, such as requirements of seismic ground motions, seismic design and analysis process, and testing provisions, could greatly improve the promotion of seismic isolation and energy dissipation design in Taiwan.

Keywords：Taiwan seismic design code, seismic design requirements for seismically isolated

structure, seismic design requirements for structures with damping systems, revisions of design codes, near-field earthquake effect.

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