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Article / Book Information

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種別(和文)	論文要旨
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論 文 要 旨

THESIS SUMMARY

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学生氏名： Student's Name	Gobirahavan Rajeswaran	指導教員（主）： Academic Supervisor(main)	Associate Prof. Anil C. Wijeyewickrema
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis presents improved seismic design procedure and performance using modified analysis methods for reinforce concrete moment resisting frame (RC-MRF) with viscous dampers.

This study first focuses on the development of a non-iterative alternative methodology to calculate viscous characteristics (peak relative viscous damper displacements, peak viscous damper forces, and viscous damper constants) for retrofitting RC-MRF buildings, to achieve a prescribed target performance level for the current earthquake hazard. The methodology consists of four steps. In short, the response indicators of the building are calculated using nonlinear response history analysis (NLRHA); viscous damper characteristics are calculated by estimating the peak viscous damper forces in terms of supplemental viscous damping and peak shear forces of the unretrofitted building; and currently available expressions are used for the displacement of the retrofitted building and the equivalent single degree of freedom (SDOF) system displacements, to the supplemental viscous damping. The proposed design methodology is applied, and it is shown that RC-MRF buildings satisfy the target performance.

Next, equations for inelastic displacement ratio and inelastic velocity ratio are proposed in terms of the following design parameters: viscous damping ratio, displacement ductility, and elastic period. The equations are proposed by conducting NLRHA for multiple sets single degree of freedom (SDOF) systems, where different design parameters are selected for each set. Near fault ground motions with fling step and forward directivity are used for NLRHA. The proposed expressions are applied in the direct displacement-based design (DDBD) procedure to calculate design values for equivalent SDOF systems with damping. The design values using the proposed equations show better results than the convectional DDBD procedure.

Previous researchers have extended the DDBD procedure, to design RC-MRF buildings with linear viscous dampers (LVDs). In those studies, the viscous damper forces are found to be larger than the design viscous damper forces because the actual relative structural velocity is different from the pseudo-velocity and also due to higher mode effects. In the present study, a damper velocity correction factor is introduced along the height of the RC-MRF with LVDs, to calculate the corrected velocity of the LVD from the design velocity of the LVD, when the DDBD procedure is used. In addition, the DDBD procedure is then used to design RC-MRFs with nonlinear viscous dampers (NLVDs) making use of the proposed damper velocity correction factor, by calculating viscous damper forces and viscous damper constants, using the equal energy (EE) dissipation

approach or the equal power (EP) consumption approach. The accuracy of the proposed damper velocity correction factor is evaluated by carrying out NLRHA for two sets of RC-MRFs with NLVDs, one set where the damper velocity correction factor is not used, and the other set where it is used. Design NLVD forces of RC-MRFs using the correction factor either agree with NLRHA results or are slightly more conservative. When the damper velocity correction factor is used, the peak inter-story drift ratio from NLRHA is reduced, especially in the top stories of the RC-MRFs and there is no significant difference in the peak story shear forces.

Furthermore, viscous damper constants of NLVDs are directly proportional to peak story shear forces and inversely proportional to peak damper displacement with the exponent of velocity coefficient, when the DDBD procedure is applied to RC-MRF buildings with NLVDs. Hence, responses of RC-MRFs are compared when different methods are used to distribute the viscous damper constants. Total design viscous damper forces calculated from the DDBD procedure are kept constant, and viscous damper constants in each story are distributed proportionally to story mass, design story shear force, or design inter-story drift ratio. In addition, viscous dampers with the same damper constant are distributed either in the top or bottom half of the buildings. There is no significant difference in the response for the distribution propositional to design IDR, story mass, design story shear force with results from conventional DDBD procedure. The responses are not controlled at the stories where the viscous dampers are not installed.

Finally, a study is performed to compare the response of RC-MRF buildings with viscous dampers using uniform hazard spectrum (UHS) and conditional mean spectrum (CMS). Generally, UHS is used as the target spectrum in NLRHA. Recently, it has been shown that UHS is unsuitable for predicting target response since it conservatively estimates the spectral acceleration for all periods in the spectrum. Hence, an alternative spectrum has been recently proposed, defined as CMS, which is conditioned by the spectral acceleration for a specific period. In this study, the response is compared for 4-story RC-MRF with LVDs using NLRHA for UHS and CMS. Conditional mean spectra are constructed by using a target period close to the fundamental period, twice the fundamental period, and second mode period of the building. The building response is maximum when the target period of the CMS is close to the fundamental period of the building, and the responses are close to the results obtained using UHS.

Results presented in this study will be useful for calculating viscous damper characteristics to achieve a target performance when retrofitting RC-MRF buildings or while designing new RC-MRF buildings using DDBD procedure with viscous dampers. In addition, response of RC-MRF buildings with viscous dampers using NLRHA is discussed.