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Enhancement of Seismic Performance of Reinforced Concrete Beams with Non-structural Walls

（壁付鉄筋コンクリート部材の耐震性能の高度化に関する研究）

Abstract

Objectives-This dissertation aims to experimentally observe methods for enhancement of seismic performance of buildings utilizing potential capability of the reinforced concrete non-structural walls. Case study of this dissertation is the post-disaster management buildings which are required to have higher capability and the ability of remaining functional after large possible earthquake. In order to achieve the dissertation objectives, the following tasks were performed:

Japanese building design review-The review of Japanese building design covered three basic topics. The first topic focused on the seismic design criteria of reinforced concrete building provided by Architecture Institute of japan (AIJ). Particularly, capacity design method for mid to high-rise building was reviewed and approaches for simply implementation of the method were suggested. The second topic focused on review of the possible future earthquakes which is predicted to be happened in the future with high intensity. The third topic focused on the review of design criteria of post-disaster management building provided by National Institute for Land and Infrastructure Management (NILIM). The review was followed by design method and literature review of typical non-structural reinforced concrete walls.

First experimental studies-The first experimental program included static and dynamic tests. The specimens which were comprised from a beam with spandrels (hanging and standing wall) were tested under static cyclic loading test. The dynamic experimental test was a proceeding of the cyclic loading test which was aimed to ascertain the effectiveness of the proposed method of detailing of the non-structural wall used in the static cyclic loading test. In the dynamic test, a full scale three story building was to be tested on the world's largest shaking table of E-defense under artificial earthquakes.

Shear strength prediction of beam members using experimental data-The data obtained from first experimental test and a data from a former experimental test was evaluated in order to observe methods of prediction of shear strength capacity of beam member with spandrels. The analytical evaluation of the experimental data resulted in proposing of an equation for prediction of shear strength of a member with spandrel (with hanging and standing walls). Likewise, correlation between shear and normal strength of beams was addressed considering Mohr-coulomb criteria for prediction of shear strength of concrete.

Second experimental study-The second experimental program which was continuity of the first experimental test, had six specimens and tested under cyclic loading method. Each specimen comprised

from a beam and hanging wall without seismic slit. The experimental test observed the impact of transverse reinforcement, the anchored and non-anchored detailing of longitudinal reinforcement; impact of boundary confinement on the longitudinal bars considering different detailing; and slenderness impact on the performance of hanging wall.

Evaluation of analytical model with experimental data-The data of second experimental test was analytically evaluated to verify the impact of confinements on the concrete considering better workability of non-anchored reinforcement and confinement along with concrete. The evaluation results ascertained accuracy of the existed analytical models for evaluation of the beam members. For evaluation of the experimental data the (Hognested, et al.,1951; and Mander, et al., 1984) models was used.

Major findings- Firstly, utilizing potential capability of the reinforced concrete non-structural walls improves seismic capability of beam members and leads the building to have ability of remaining functional after earthquake. A method of non-structural wall connection with moment resisting frame was suggested that provides a mechanism helping appropriate involvement of the non-structural wall in load carrying scenario. Secondly**,** the analytical evaluation of the experimental data provided to propose a simple equation for shear strength prediction of a beam having monolithic spandrels. The proposed Equation can predict shear strength capacity of the component with significant accuracy. Thirdly, a method of reinforcement detailing of the reinforced concrete non-structure wall was proposed that confers higher capability to the wall and enhance the seismic capability of the buildings. The method suggests construction of the beam members without seismic slit and non-anchorage of the longitudinal bars along with placement of boundary confinement. Finally, the observed indication of the researches in this dissertation can be further improved for other type reinforced concrete walls.