Dynamic Analysis Using Similitude Law Considering Strain Distortion

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Summary

It is necessary to evaluate the exact dynamic response of RC column to prevent the seismic failure by huge earthquake. To evaluate the reasonable dynamic response, seismic test of real structures is required. However, by the limitation from the capacity of test facility and cost for making test specimen, seismic test using real-scale structures is typically not possible option. Therefore, test using small-scale model become an economic alternative to evaluate the dynamic response.

In this study, the development of reasonable similitude law to evaluate an RC column's dynamic response is discussed. To make the small-scale model of RC structures, it is necessary to use micro-concrete whose aggregate size is smaller than normal concrete to minimize the effect by size effect. Therefore, the material characteristic of concrete for both prototype and scaled model becomes much different. But the material characteristic of reinforcement for both prototype and scaled model is typically not much different. From this discrepancy, a strain distortion is caused and a similitude law called True replica model which is generally used for dynamic small scale test is not valid to predict the response of prototype anymore.

To solve the above mentioned problem, new similitude law to minimize the error from the strain distortion is suggested. A concept of strain ratio which is defined as the ratio between the concrete strain of prototype and scaled model is adopted. And a new method for estimating the strain ratio is suggested. Numerical examples for static and dynamic analysis of RC column with rectangular section are conducted to validate the suggested similitude law. Analysis results shows that response of scaled RC model adopting suggested similitude law can exactly forecast the response of prototype structures.

Keywords: similitude law; strain distortion; scaled model; dynamic analysis

1. Introduction

In many experimental studies on seismic performance evaluation of structures, using a prototype specimen whose size is similar to a real scale structure is often not possible by limitations from a size and capacity of testing facility and equipment such as a size of shaking table and a capacity of hydraulic actuators. Cost for making test specimen also becomes more expensive as the size of specimen is increased. In this case, the test using small scale model becomes reasonable and economic alternative. Using small scale model, whose size is geometrically decreased along the specific scale factor, the testing facility which has not enough capacity for test with real scale prototype become usable. However, from the natural characteristic of small scale model test, it is necessary for researchers to estimate the actual response of the prototype from the experimentally obtained response of small scale model. For an exact estimation, a proper and reasonable similitude law is needed.

In general, a micro-concrete which is made by aggregate whose size is reduced along geometrical

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