FE Analysis for 1/3-scaled RC Building Structure under Biaxial Earthquake Loading

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ABSTRACT

The CAMUS 2000-1 experimental program were performed in France to investigate of the 1/3-scaled reinforced concrete bearing walls behavior on the shaking table under biaxial earthquake loading. The nonlinear 3D finite element analysis of push over test and linear dynamic analysis under biaxial earthquake loading are investigated with the concrete damaged plasticity model using ABAQUS.

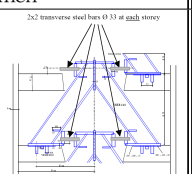
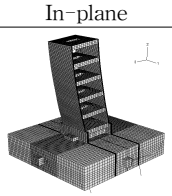
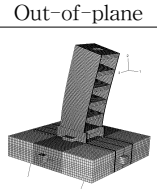
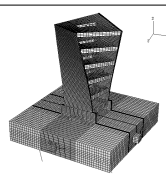
1. Introduction

The CAMUS project was taken place in France Azalee shaking table to evaluating the lightly reinforced concrete shear walls behavior under biaxial seismic loading. The 1/3-scaled 5-floor reinforced concrete building structural model is composed of two parallel walls linked by square floors and lateral triangular steel bracing. A total of 23.6 tons was installed in the form of concrete blocks. The structure have been tested under 0.15g(RUN1), 0.4g(RUN2) and 0.55g(RUN3) nominal accelerations.

2. Modeling of structure

The specimen was composed of two thin concrete wall with steel reinforcement following the French PS92 seismic design code. The steel reinforcement ratio changes up to second floor and constants above the second floor. A total of 8 actuators for the vertical and transverse direction supports the shaking table. The stiffness and the strength in the perpendicular direction are increased by adding some lateral triangular steel bracing(Table 1). The 3D finite element model consists of brick elements which are used for shaking table, shear wall and floor. To describe the reinforcement steel and eight actuator, the truss elements are used. The lateral triangular steel bracing is replaced by beam element. Results for frequency analysis of the model and experimental are in Table 1.

Table 1. CAMUS Specimen and eigen-frequencies of FE model

Specimen		Direction	In-plane	Out-of-plane	Torsion
		Mode shape			
Setting	Lateral bracing	Comp.(Exp.)	5.61(5.8)Hz	5.64(6.25)Hz	11.67(11.5-11.7)Hz

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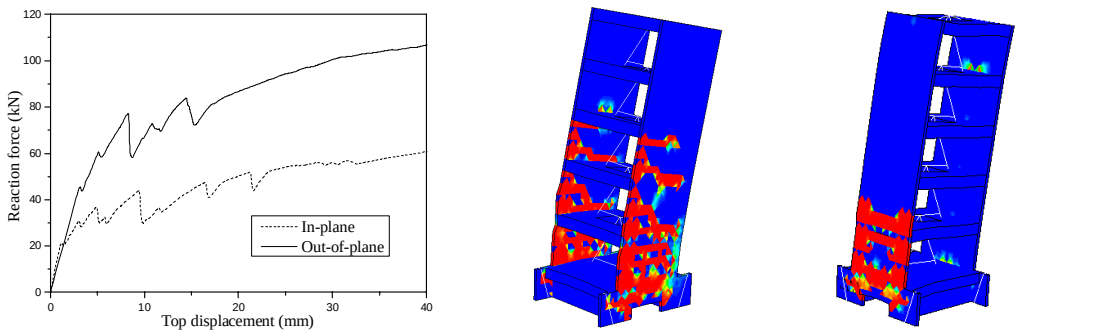
3. Nonlinear push-over analysis and earthquake analysis

The push-over analysis using the ABAQUS concrete damaged plasticity model is performed for verifying ductility of specimen. A uniformly distribute displacement is applied on the top floor in the in-plane and out-of-plane direction. The results of test are in Figure 2.

Assuming a 2% critical damping factor for the first and second natural frequency, the damping parameters α and β were calculated for Rayleigh damping. The Figure 3. is the relative displacement history at top floor for the linear dynamic analysis under the bi-directional loading(RUN1) at the shaking table.



(a) Load-displacement relation (b) In-plane tension damage (c) Out-of-plane tension damage

Figure 2. Push-over analysis result: Load-displacement relation at the top floor and tension damage

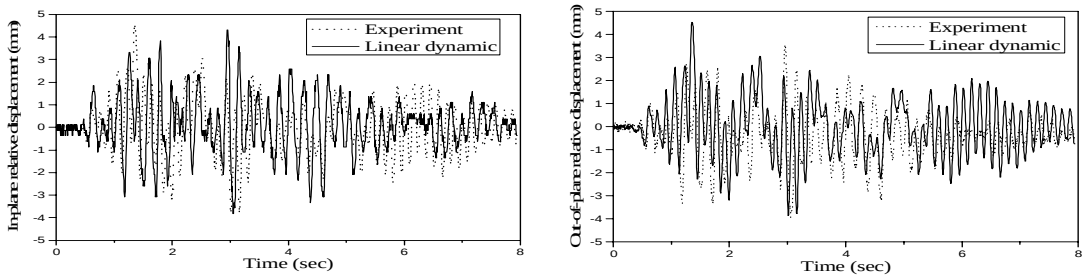


Figure 3. Relative displacement history at top floor: RUN1

4. Discussion

The linear dynamic analysis of the RC structure under bidirectional seismic loading was performed. The nonlinear dynamic analysis has been performing to define the structure earthquake response more specifically for the different acceleration level RUN1, RUN2 and RUN3.

References

1. HKS INC.(2003), "ABAQUS Standard Manual 6.2-1", NY, USA
2. I. Rhee, K.J. Willam, B.P. Shing, "Dynamic Analysis of a Reinforced Concrete Structure Using Plasticity and Interface Damage Models", FRAMCOS-4, 2004