University of Tabriz

Journal of Civil and Environmental Engineering
Volume 52 (2022), Issue 3 (Autumn), 1-7

EXTENDED ABSTRACT

Investigation of the Behavior Factor of Concrete Moment Frame with Concrete Voided Slab Constructed By Spherical and Cubic Balls

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Received: 27 September 2019; **Accepted:** 21 April 2021

Keywords:
Behavior coefficient, Ductility, Spherical hollow slab, Cubic hollow slab, Concrete moment frame.

1. Introduction

In order to prevent damage caused by earthquakes in different types of structures including concrete structures, various methods are used by structural engineers considering terms of design and working conditions. This research aimed to evaluate the performance of these structures in different conditions and evaluate their impact on the structural behavior coefficient. For this purpose, ABAQUS finite element software has been utilized to model a concrete moment frame with one span in one floor equipped with simple concrete slab, spherical and cubic hollow slabs in different conditions.

2. Methodology

2.1. Validation study

The double-sided reinforced concrete slab used by Lmiam et al. (2003) with 7cm thickness, 130cm width and 170cm length is also considered as the main model. Steel wire mesh reinforcement grid with a spacing of 20 cm in diameter 6 mm and 17 mm concrete cover has been selected for modeling in Abacus software. The average 28-day compressive strength of concrete is 30 MPa with a modulus of elasticity of 25 GPa. The reinforcement strength of the steel is about 540 MPa with a modulus of elasticity of 200 GPa. Reinforced concrete slab with all four sides mounted on a simple stand and centered at the center of the slab as shown in Fig. 1.

2.2. FE modeling

The lateral behavior of one-storey bending frame structure under three different conditions of slab arrow, spherical and cubic slab is evaluated and compared with modeling and analysis in ABAQUS software. The present project was carried out at a site with moderate seismic hazard (ground acceleration ratio of 0.25) and type III soil type with residential use whose significance according to Group 3 is 2800 equal to 1 in the regulations. The slab has a length and width of 2 meters and a beam and column of 2 cm to 2 cm. The concrete cover is 20 mm, the average ultimate compressive strength of 28 MPa with a modulus of elasticity of 30 GPa. The reinforcing steel resistance around 400 MPa with a modulus of elasticity of 200 GPa have been selected for modeling in Abacus software. The slab thickness is 30 cm. In all three models (slab arrow, cubic hollow slab, and spherical hollow slab) of 12 mm AIII rebar grid in two directions with 15 cm spacing in each of four columns of 8 mm AIII rebar with 16 mm diameter Longitudinal and 10 mm bumps were used at 15 cm intervals.

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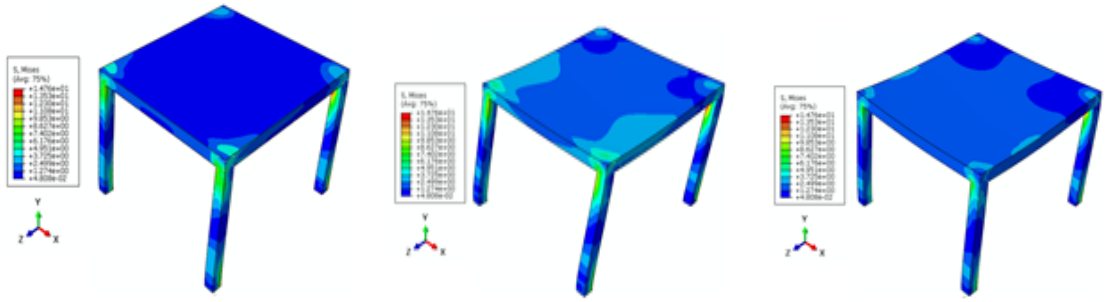
3. Results and discussion

The use of ordinary slab has been associated with considerable stiffness in floor. Maximum stresses often occur in columns. The use of cubic hollow and spherical voided slabs has caused the distribution of stress throughout the building and the slab has shown more flexibility.



(a) (b) (c)

Fig. 1. stress contours and displacement shape under lateral load: a) Frame with ordinary slab (Model-01), b) Frame with cubic voided slab (Model-02), c) Frame with spherical voided slab (Model-03)

Load-Deflection curves and also Ideal curves are plotted to calculate and evaluate the behavior factor. The ideal curves are obtained, assuming the equal positive and negative area between ideal and real load-deflection curves. The results show that the behavior factor of the moment frame with spherical voided slab (Model-03) and with cubic voided slab (Model-02) are 46.3% and 32.79% grater in comparison with the moment frame with ordinary slab. Assessment results of behavior factor are represented in Table 1.

Table 1. Behavior factor in different models

Model	$\delta_y\ (cm)$	$\delta_{max}\ (cm)$	R	Increase rate (%)
Model-01	0.15	2.2	4.88	-
Model-02	0.18	3.5	6.48	32.79
Model-03	0.35	7.7	7.14	46.3

4. Conclusions

The use of an ordinary slab with a solid cross-section, although it has shown fewer cracks against the applied lateral loads, but it shows much more stiffness and has a lower behavior factor in comparison with voided slab models. Also, the use of cubic voided slab has increased the behavior factor but the expansion of tensile cracks created by the concentration of stress in the corner of the hollow sections is not a desirable phenomenon. In the conditions of using spherical voided slabs, in addition to observing suitable flexibility, the cracks are propagated uniformly and in acceptably forms. Appropriate behavior factor and weight reduction are observed in moment frame with spherical voided slab. However, concluding on the seismic behavior of hollow concrete slabs in structures with real dimensions and a higher degree redundancy during large earthquakes requires further studies in this area.

5. References

ABAQUS v.6.10., “Standard User’s Manual”, Hibbitt, Karlsson & Sorensen Incorporation, 2010.

Limam O, Nguyen VT, Foret G, “Numerical and Experimental Analysis of two-way Slabs Strengthened with CFRP Strips”, Engineering Structures, 2005, 27 (6), 841-845.