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SEISMIC PERFORMANCE ANALYSIS OF THE HALL-COLUMN SYSTEM OF A TEMPLE STRUCTURE

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A mosque building was designed to be constructed in a seismic region of high intensity. Its main building, Prayer Hall, was constructed in a site of 145m×145m by 32 RC columns with a maximum height of 45m aligned in the central area of 105m×105m and 180 smaller RC columns with height of 23m around. Umbrella shaped capitals were designed to be steel and they were interconnected to form the roof. Columns were of hollow octagonal cross-section with a maximum section dimension of 1620mm and 810mm respectively and a wall thickness of 200mm. They will be centrifugally prefabricated in segments and socketed together in site. Two column groups of different heights are connected with comprehensive steel trusses.

Hall columns have almost no lateral restriction along their height. The lateral load resistance of the socket hollow columns as well as the hall building as a whole therefore needs a thorough investigation. In this paper, two numerical computational models for the whole Prayer Hall building, Primary Structural Model (PS model) built up by design modeling and Degraded Structural Model (DS model) in which the stiffness of the steel trusses had decreased by 100 times, had been established by ANSYS program. The finite element model consists of 37592 beam elements and 18242 shell elements with a total mass of 15430t. Meanwhile, a perfect column model without segments and a socket column model by initial design had been set up to evaluate the seismic performance of the socketed columns. The interface effects of the socket column model were modeled by non-linear springs. The Fig.1 shows the finite element model of the simplified structure. The Finite element model of socket column is demonstrated in Fig.2.

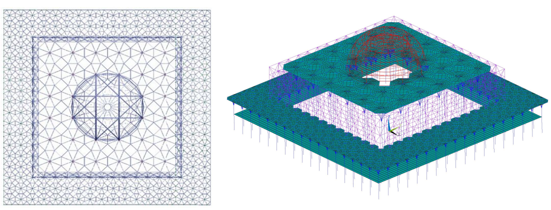
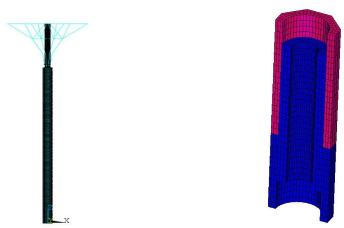


Fig. 1 Finite element model of the simplified structure



(b) Typical column model (c) Socket part model
Fig. 2 Finite element model of socket column

Linear elastic responses and Pushover analysis have been performed. The primal natural vibration periods is listed in the Table 1 while the deformation of typical concrete columns of different models is illustrated in Fig.3. It shows that the decreased stiffness of the steel trusses is making the fundamental translational periods longer by about 4%, reducing the stiffness of the structure and distinctly increasing the relative deflection of the two column groups.

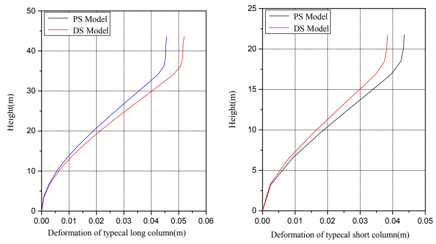
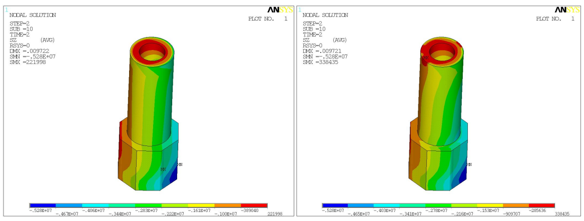


Fig. 3 Deformation of typical concrete columns of different models

Table 1 Natural period and vibration modes

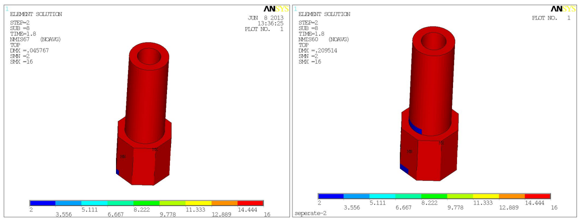
PS	Mode	1	2	3	185
	Period	1.629	1.629	1.320	0.313
	Vibration	Y	X	RroZ	Z
DS	Mode	1	2	3	481
	Period	1.701	1.701	1.335	0.313
	Vibration	Y	X	RroZ	Z

Local load performance for a single column, which was at the most unfavorable place, had been carried out further in detail. It is shown in Fig.4-5 that, in comparing with a complete column, stress concentration may take place at the end section of socket for a segmented column. This degraded the lateral load bearing capacity of the column finally.



(a) Perfect Column Model (b) Socket Column Model

Fig. 4 Vertical normal stress distribution of the socket part



(a) Perfect Column Model (b) Socket Column Model

Fig. 5 Cracking of the concrete in the socket part

This article has studied the seismic performance of PS and DS models of the whole Prayer Hall building. The results showed that the interconnected umbrella shaped capitals and the steel trusses were functioning appropriately as the lateral resisting system and the deformation coordinator of the whole structure. From the comparison of local load performance for the perfect model and the socket model of the typical column, it is concluded that prefabricated socket members should be used with caution in seismic design.

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