Reinforcements of the Cylindrical Panel with Opening

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Abstract

Reinforced concrete (R/C) cylindrical chimney has a large opening at the lower portion to take in a flue-gas. Also, the cylindrical roof has infrequently a opening to take in the sunlight. The region around the hole is prone to decrease the strength and the stress concentration is arisen at the cornors. It was reported that R/C chemney with wide opening was destroyed due to the earthquake. Therefore, particular reinforcements have been supplied around the opening. To improve the flat panel strength with hole, many researchers have been studied. In the same manner, the design code of the chimney with hole was recommended [1]. The thickness of the concrete around the hole is increased and the meridional and hoop reinforcements were placed equivalent to the loss amount of reinforcements at the hole. In addition, the diagonal reinforcements were placed to prevent the corner failures as well. However, in case of placing the diagonal reinforcements in the shell, the placing works are laborious because reinforcing bars have curved shape and diagonal. Ami stated the difficulties to place them and the requirement of improving these works [2].

In this paper, the improved reinforcement method was applied instead of placing the conventional diagonal reinforcements. In this methods, only the hoop and the meridional reinforcements equivalent to the diagonal reinforcements were arranged around the corners. FEM analyses were done to evaluate the efficiencies of the improved reinforcing method comparing with the conventional reinforcing method.

In numerical analyses, four types of model were examined. One model was R/C panel without hole and three models were R/C panels with hole. These three models contains the model with the conventional reinforcement, the model only with hoop and meridional reinforcements and the model with improved reinforcements. Numerical models were cylindrical panel supported on hoop edges and free along the meridional edges. The applied loads were the axial compression, the axial tension and the lateral bending. The concrete was modeled as the three dimetional element with elastic and plastic constitutive relation under Drucker Prager criterion. Each reinforcement was modeled as the thin shell sheet with bilinear elastic plastic material.The stiffness, the ultimate strength and the crack propagations were compared among these models.

From the numerical analyses of the models under the axial compressive and axial tensile loads, the model with the improved reinforced method, that is the replacement of the diagonal reinforcement to the eauivalent meridional and hoop reinforcements at corners, shows the slightly snall initial stiffmess and the same load carrying capacity comparing with the model using the conventional reinforcement method. Both models shows the same crack propergation. From the numerical results under uniformly distributed lateral load, the stiffness and the ultimate load of the improved model shows almost the same as those of the conventional model. Although the experimental results to confirm the validities of the improved reinforcement methd are required, it will be the usefull method to reduce the placement work of diagonal reinforcements at the shell opening.

References

[1] ACI Committee 307, *Code Requirements for Reinforced Concrete Chimneys and Commentary*, ACI, 2008.

[2] Sami A. K., Dovlet A and Selcuk A., An investigation of Opening Reinforcement Configurations for Reinforced Concrete Chimneys, *ICCT 2016 International Conference on Industrial Chimneys & Cooling Towers Rotterdam*, 213-218, 2016