Concrete Columns that Don't Collapse Easily During Large Earthquakes

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Summary

In the Hanshin-Awaji Earthquake disaster, many reinforced concrete rigid-framed viaducts for the railway collapsed by the failure of the columns. Therefore, the predicted earthquake has been greatly improved in design standard. However, because the ductility of the reinforced concrete column by the reinforcing bar arrangement at that time was insufficient, it was necessary to increase the yield seismic coefficient. Then, authors confirmed experimentally the new method of the reinforcing bar arrangement that was able to take more than twice ductility at that time. This new method is that a method of arranging a lot of circle hoop reinforcements inside of the longitudinal reinforcements instead of arranging many hoop reinforcements outside of the longitudinal reinforcements. Now, the all reinforced concrete rigid-framed viaducts for the railway designed in East Japan Railway Company adopt this new method.

Keywords: large earthquake, reinforced concrete rigid-framed viaduct, ductility

1. Introduction

In the Hanshin-Awaji Earthquake disaster, many reinforced concrete rigid-framed viaducts for the railway collapsed by the failure of the columns. As a result, the seismic design standard for railway structures in Japan required a certain low damage level against the extremely rare and large earthquake that was greatly improved. Railway concrete structures are generally designed in consideration of the ductility of the RC member at a large-scale earthquake. Many hoop reinforcements around the longitudinal reinforcements were usually arranged to improve the ductility of the RC member. However, this reinforcing bar arrangement caused a rapid strength decrease because longitudinal reinforcement buckled and embedment hook of hoop reinforcements could not function under the large-scale cyclic load. Therefore, there was a limit in improving the ductility of the RC member.

Then we invented the new reinforcing bar arrangement by which the ductility of the RC member could be improved to twice or more and we confirmed the performance by the experiment. As a result, we could design the new RC viaduct that had the member with the same degree of the size as the structure designed by conventional design standard. In this report, we introduce the experimental results and two cases that are adopted the new reinforcing bar arrangement.

2. Experiment of new reinforcing bar arrangement

2.1 Performance of the RC member in design

In Deign Standards for Railway Structures and Commentary (Seismic Design), the ductility of the RC column is shown in the form of the 3 breaking point and 4 inclinations shown in Figure 1, where C is the point that crack occurs in concrete, and Y is the point that the longitudinal reinforcement yields, and M is the point that the compressive strain of the concrete reaches 0.0035, and N is the point that can keep the moment at the point Y. In deign standard, it is regulated that

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