# Development Of Multi-Step Deformation Absorption Concept To Enhance The Seismic Performance Of Bridge Structures

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In the seismic design of bridge structures, energy absorption member by ductile nonlinear behavior is generally limited to one member such as at the bottom of column. However, considering the possible occurrence of an excessive seismic event that exceeds the design expectation, there is a significant limitation to rely on the deformation absorption capacity by only one member. To solve such a problem, in this research, we propose a Multi-Step Deformation Absorption Concept that is the structural behavior control mechanism to absorb the deformation and energy in multi-phases not only at the bottom of columns, but superstructure, bearing supports and foundations. And the control method to attain the multi-step deformation absorption is investigated. This concept is expected to reduce the degree of damage to each member and to improve the deformation absorption performance of the entire bridge structures. We studied the necessary control method to gradually absorb the deformation as for an example road bridge with three members including seismic isolator, bridge column and spread foundation. We performed a series of static pushover analyses and dynamic time history analyses with the earthquake ground motions for the model bridge. The secondary rigidity of the nonlinear force-displacement relation of the bridge column was assumed as a key parameter of the control method and the deformation absorption characteristics of each member were analyzed. From the analytical results, in the case when appropriate secondary rigidity was given to the bridge column, the resistance force of the column increased as the deformation of the column increased, and the deformation shifted from the plastic deformation of the column to the rocking deformation of the spread foundation. From this result, by imparting the appropriate secondary rigidity to the column, the multi-step deformation absorption mechanism by a total of three members with seismic isolator, bridge column and spread foundation, was realized. It was also shown that the amount of damage to the bridge column can be reduced and the deformation absorption performance of the entire structure can be improved.