別紙様式８

研　究　主　論　文　抄　録

論文題目

Static and Dynamic Behavior of Reinforced Concrete Abutments with the Wing Wall
（ウィング壁を持つ鉄筋コンクリート橋台の静的および動的挙動）

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主論文要旨

Abutment plays an important role on the performance of bridge. It has been found that the behavior of abutment influences significantly the response of an entire bridge during unexpectedly severe earthquakes. Major earthquakes in the past caused collapsing of many abutments due to high stress which is the most common problems observed during the inspection of abutment failure. Therefore, a new type of abutment is required in order to increase the seismic resistant of abutment. Seismic response investigation of reinforced concrete abutment is very important in term of the ability to survive in severe earthquake. Furthermore, a proper material model of reinforced concrete should be capable in representing the behavior of materials within finite element packages.

Seismic design method for highway bridges in Japan have been developed and improved based on the evaluation from past large earthquakes of Hyogo-ken Nanbu earthquake in 1995. Previously, the consideration of 10 cm gap was used in the real bridge in Japan. However, after this earthquake, several damages on the bridges with typical model of abutment occurred such as collision among adjacent decks, also between deck and abutment. Consequently, collision becomes one of the important aspects to be assessed in the seismic performance of the bridge. Consideration of 3-dimensional model of concrete girder bridge based on the real bridge in Japan supported with pier and abutments are taken into account with an effect of earth pressure during earthquake and

input seismic ground motions.

The aim of this study is to investigate the static and dynamic behavior of 3-D reinforced concrete abutments with the wing wall on the girder bridges. The study was focused on the behavior of different types of abutment modeling approaches on static and dynamic analysis including Type 1 as abutment without wing wall, Type 2 as the typical model in Japan and Type 3 as the abutment with full wing wall. The new type of abutment Type 4 was investigated as a proposed model in order to develop the seismic capacity resistance of abutment. Effect of material nonlinearity was considered in all analyses. In addition, effect of the displacement restriction by using gap variation between superstructure and parapet wall and seismic isolation rubber were taking into account for analysis of the dynamic response of bridge. Finally, effect of earth pressure during an earthquake was considered in the analysis. The behaviors of abutments such as displacement and stress distribution on concrete girder bridge model were investigated, as well as the spreading of the cracking area was also observed to determine the critical area of abutment.

In Chapter 1, a brief introduction on background of the research, literature reviews and objective of the research were given.

In Chapter 2, the elastic behavior of reinforced concrete abutments considering the effect of the wing wall were investigated. The detailed modeling of 3-D reinforced concrete abutments subjected to static horizontal loads through the unseating prevention structure were analyzed, according to the JSHB 2002. The finite element software of ABAQUS was used in analysis with the geometrical modeling of three dimensional solid elements (C3D8R) for concrete and two dimensional trusses (T3D2) for reinforcing bars. Numerical analysis was limited to the elastic region of material. Static analysis was carried out in four different abutment modeling approaches to investigate the effect of the wing wall on the behavior of abutments, in order to develop the seismic resistant of abutment.

In Chapter 3, an eigenvalue and dynamic behavior of reinforced concrete abutments subjected to ground motions on the elastic region was given. Numerical studies were carried out in four different abutment modeling shown in previous chapter. In addition, the seismic performance of typical abutment model in Japan and proposed model of abutment Type 4 were analyzed in order to develop the high seismic capacity resistance of abutment. Level 2 earthquake ground accelerations were used as an input dynamic load.

In Chapter 4, determination of the elasto-plastic behavior of 3-D reinforced concrete abutments considering to the effect of the wing wall was performed. The finite element software of ABAQUS with the Concrete Damaged Plasticity method was used as the finite element analysis method. In addition, simplifying the abutments model by omitting the footing of abutment was developed. Then, numerical studies were carried out in four different abutment modeling approaches in order to increase the seismic resistant of abutment, subjected to horizontal loads through the unseating prevention structures. The results were used to predict the effect of the wing wall on the behavior of abutment.

In Chapter 5, the seismic response behavior of concrete girder bridges taking into account the effect of collision on parapet wall were discussed. In addition, adopting of seismic isolation rubber on pier structure and wing wall on parapet was performed. Two spans concrete girder bridges with variation of gap were examined in theoretically by 3D FEM model of ABAQUS. The abutment was simplified by parapet wall which was modeled by 3D reinforced concrete structure. In order to examine the seismic behavior of bridge, six different inputs of seismic ground accelerations were applied at footing of pier structure. Effect of soil pressure during earthquake was not taken into account.

In Chapter 6, the seismic response on girder bridges taking into account the effect of displacement restriction and wing wall types was discussed. Four different abutments modeling approaches described in the previous chapter were installed in two spans concrete girder bridges subjected to Level 2 seismic ground motion. Gap between superstructure and parapet wall was chosen to be 10 cm and 20 cm to analyze the effect of displacement restriction on the behavior of

3-dimensional reinforced concrete abutment. Effect of earth pressure during earthquake was taken into account. The proposed model of abutment was analyzed in comparison with other types of abutments.

In Chapter 7, summary and conclusions on the present research work were presented, followed by some future work topics.