Study on the Effect of Bond Slip on Seismic Performance of RC Piers by Finite Element Analysis

山口大学大学院　非会員　○Shao Peilun
山口大学大学院　正会員　渡邊　学歩
山口大学大学院　学生会員　Elfrido Elias Tita

1. Introduction

In many previous studies, it has been shown that the bond-slip between rebar and concrete has a significant effect on the deformation capacity of reinforced concrete columns. In this study, we analyze the results of seismic response analysis of an RC pier in accordance with the Japanese highway standard specifications of bridges for the Nishihara village records of the 2016 Kumamoto earthquake and discuss the effect of bond-slip on the deformation performance of columns.

2. FE model and material models

In this study, finite element analysis was performed using the general-purpose structural analysis code DIANA. The concrete and the reinforcement were idealized with plane stress elements and embedded reinforcement elements, respectively. Especially, the bond-slip behavior between the rebar and the concrete was idealized by the interface element. The nonlinearity of the interface is provided by the CEB-FIP model with bond strength reduction phenomenon as shown in Fig.1. The weight of the superstructure supported by the column was set as 643 tons so that the first natural period of the system becomes 1.15 s.

The ground motion records of Fault-Normal and Fault-Parallel components were used in the analysis as shown in Fig.2 (a). Those are normalized so that PGA becomes 1g. Fig.2 (b) shows the seismic response spectrum for both components, respectively.

3. Discussion of the Seismic Response Analysis Results

The lateral force-relative displacement hysteretic curves of bond and without bond obtained for the analysis are shown in Fig.3.Fig.3 (a) shows the normalized FN results of FEA, the elastic phase is almost the same for both cases-bond slip and without bond after the maximum horizontal force of 4.4×10^3 kN, the maximum plastic deformation is almost the

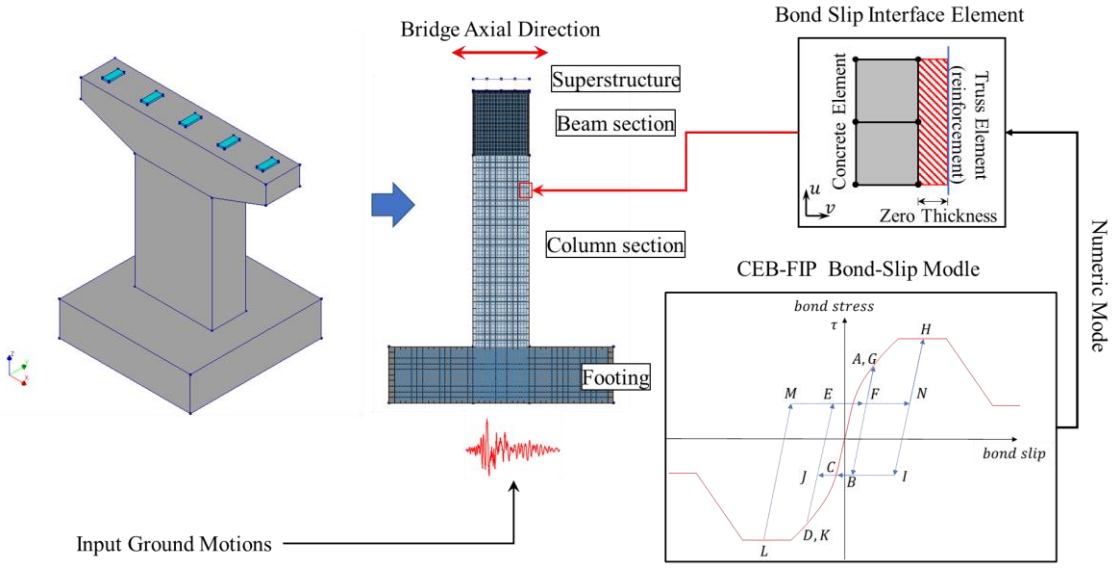
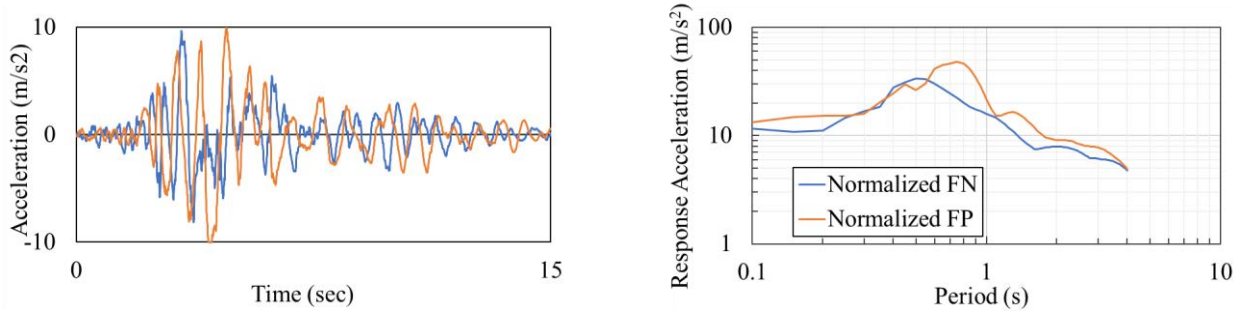


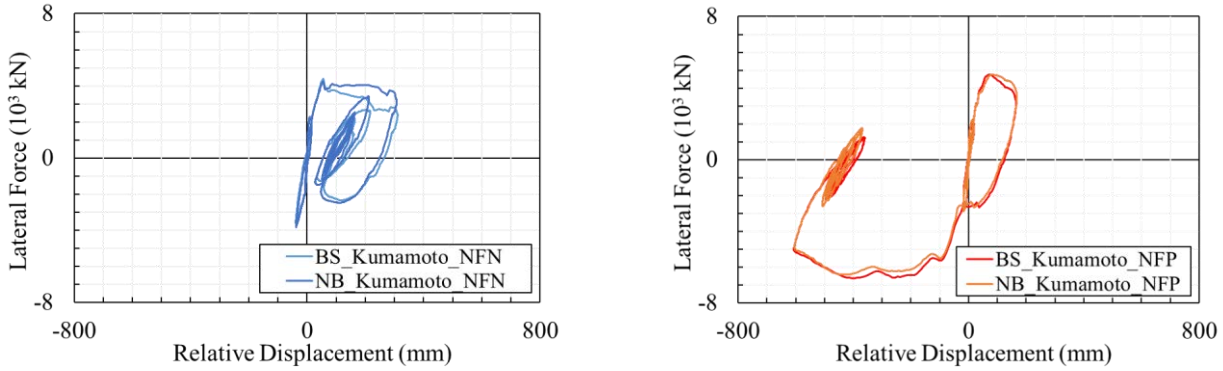
Fig.1　FE model of RC Pier Specimen & Modeling of Bond-Slip

キーワード　RC Piers, Finite Element Analysis, Bond Slip, Seismic Response Analysis
連絡先　〒755-0097 宇部市常盤台 2 丁目 16-1　山口大学工学部　創成科学研究科
山口大学工学部　創成科学研究科 TEL0836-85-9302



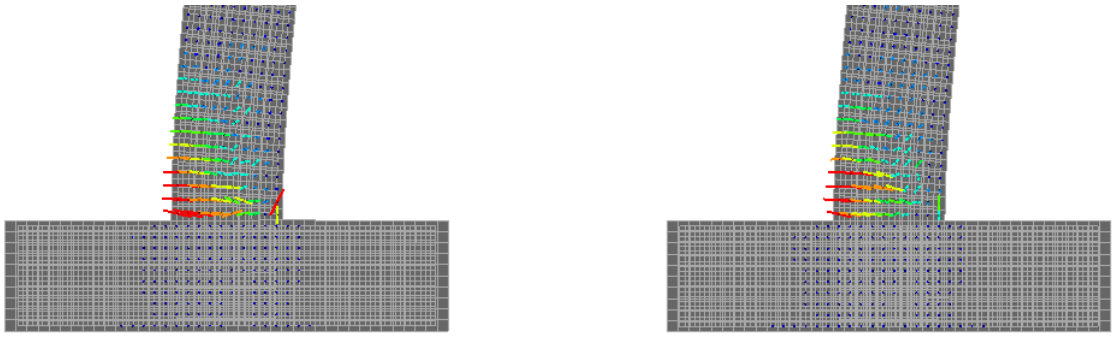
(a) Ground Motions (b) Response Spectra

Fig.2 Normalized Ground motions used in the analysis (Nishihara village Records in 2016 Kumamoto Eq.)



(a) Fault-Normal (b) Fault- Parallel

Fig.3 Lateral force & relative displacement hysteretic curve by the FE Simulation.



(a) Without Bond Slip (b) Bond Slip

Fig.4 Crack damage contour at pier boundary of Normalized FN

same at the 300mm level. However, the case without bond slip can maintain a constant bearing capacity, while the case with bond slip shows that the bearing capacity decreases by about 25% until the end of the case with adhesion.

Fig.3 (b) shows the results of the analysis with the normalized FP. The maximum horizontal force was almost the same as 6.5×10^3kN for the two cases, which was about 50% higher than the results for the FN, and then the case considering the bond-slip did not show the load-carrying capacity reduction phenomenon as mentioned above. And the maximum plastic deformation doubled compared to the result NFN.

Fig.4 shows a crack distribution contour of the pier base. Compared to Fig.4 (a) where without bond slip, the concrete damage on the compressed side of the pier for Fig.4 (b) with bond slip is reduced, and the crack width on the contact surface with the foundation is also reduced.

4. Conclusions

Through the FE analysis, although it is considered the bond-slip of rebar will lead to decreasing in load capacity, it doesn't have a significant effect on the plastic deformation of the column, and at the same time, the bond-slip phenomenon reduces the damage of concrete.