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Reinforced Concrete Column-Foundation Connections with Mechanical Splices

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ABSTRACT

The reinforcement splices are inevitable in modern reinforced concrete (RC) constructions, and various types of reinforcement splicing methods are currently available in practice. In this study, to overcome some disadvantages in a traditional lap splicing method, the grouted-mechanical splices with thread-deformed reinforcing bars were adopted in RC column-foundation connections. Typical cyclic loading tests were conducted on RC column-foundation specimens, and test results were compared with numerical analysis results. The finding obtained from this study indicated that the grouted mechanical splicing method utilizing the thread-deformed reinforcing bars can provide improved constructability and good seismic performances.

1. INTRODUCTION

Commercially available reinforcing bars are generally produced in a limited length to ensure smooth shipments and better quality control in steel manufacturing plants, and thus the splices of reinforcing bars are inevitable in a typical reinforced concrete (RC) construction to achieve their proper continuities and integrities. (Lee et al.

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2013 & Hwang et al. 2016) To improve low constructability and disadvantages inherent in traditional splicing methods, this study proposed a combo-type mechanical splicing method utilizing the screw-ribbed (i.e., thread-deformed) reinforcing bars, and the seismic performances of RC column-foundation connections with the combo-type mechanical splices were evaluated by cyclic loading tests. In the test program, the presence of grouting in mechanical sleeves, the locations of splices, and the compressive strengths of concrete were considered as the main variables, and the test results showed that RC column-foundation connections with mechanical splices can provide the comparable seismic performances with that reinforced with continuous reinforcements. In addition, it was confirmed that non-grouted mechanical splices are also applicable in RC intermediate moment frames specified in the current building code.

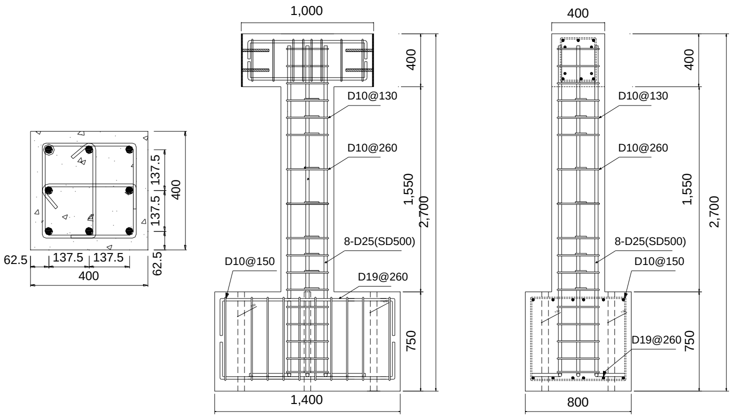
2. TEST PROGRAM

The key test variables of this experimental campaign include the splice location, the compressive strength of concrete, and the presence of grouts in mechanical sleeves, and Table 1 shows the summary and list of the test specimens. A total of seven specimens were fabricated and tested in this study, as summarized in Table 1, and all the specimens were reinforced with screw-ribbed reinforcing bars in the longitudinal direction. The C6 specimen shown is a control specimen without mechanical splice, and its design compressive strength of concrete was 60 MPa. The S6J series specimens are identical to the C6 specimen in all the dimensional and material properties, but the longitudinal reinforcements used in those series specimens were spliced using grouted mechanical sleeves at the column-foundation connection region. For the S6D and S3D series specimens shown in Fig. 1, mechanical splices were applied at the section 1.5h apart from the column-foundation connection, and their design compressive strengths of concrete were 60 MPa and 30 MPa, respectively. In this study, to evaluate the possibility of omissions of the grouting procedures, which is inevitably conducted in the actual construction sites, the RC column-foundation connections with non-grouted sleeves were also considered in each series (i.e., the S6JX, S6DX and S3DX specimens), so that the applicability and workability of the proposed reinforcement splicing method can be improved by simplifying onsite construction works.

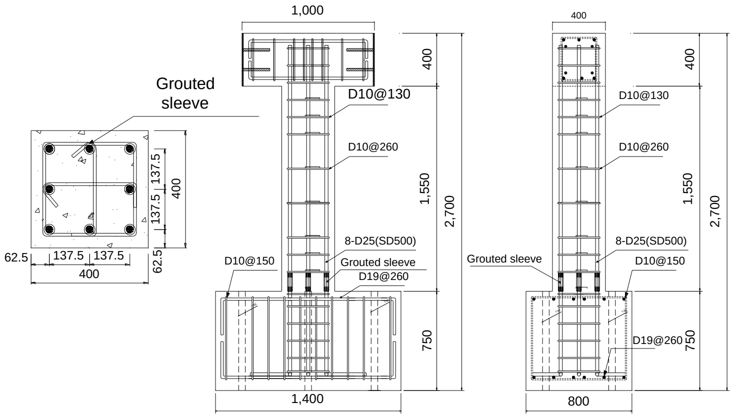
Table 1 – Summary of test specimens

Specimen ID	f_c' (MPa)	Location of splices *	Grouting	f_y (MPa)**
C6	79.8	-	-	559.8
S6JO	79.8	Joint	O	522.1
S6JX	79.8	Joint	X	526.2
S6DO	79.8	2.0*h*	O	522.1
S6DX	79.8	2.0*h*	X	526.2
S3DO	36.8	2.0*h*	O	522.1

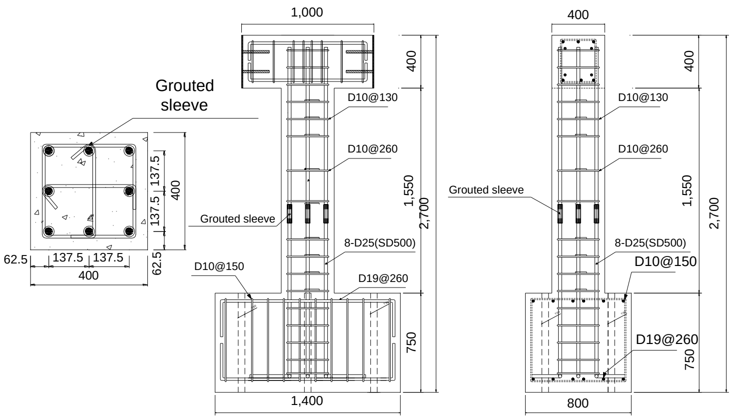
S3DX	36.8	2.0*h*	X	526.2



(a) Specimen C6



(b) S6J series specimens



(c) S6D and S3D series specimens

Fig. 1 – Dimensional details of test specimens

3. TEST RESULTS

As shown in Fig. 2, it appeared that the seismic performances of the column-foundation connections with mechanical splices are comparable to that with no splice, and the better post-peak behaviors including the enhanced deformation capacity can be achieved when mechanical splices are located near the column-foundation joint region compared to the case where mechanical splices are located at the section 2.0*h* apart from the column-foundation connection reinforced with the smaller hoop reinforcement ratio. In addition, as shown in Fig. 3, the column-foundation connection with non-grouted mechanical sleeves showed almost identical seismic performances compared to those with grouted sleeves, and thus the mechanical splices with the screw-ribbed reinforcing bars can be applied even without grouting for RC intermediate moment frames when the detailed requirements of Type 2 mechanical splice specified in ACI318-14 are fully satisfied.

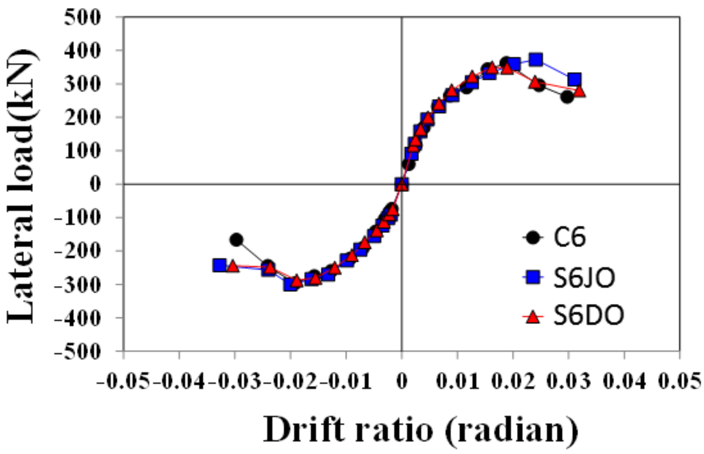


Fig. 2 – Effect of splice location

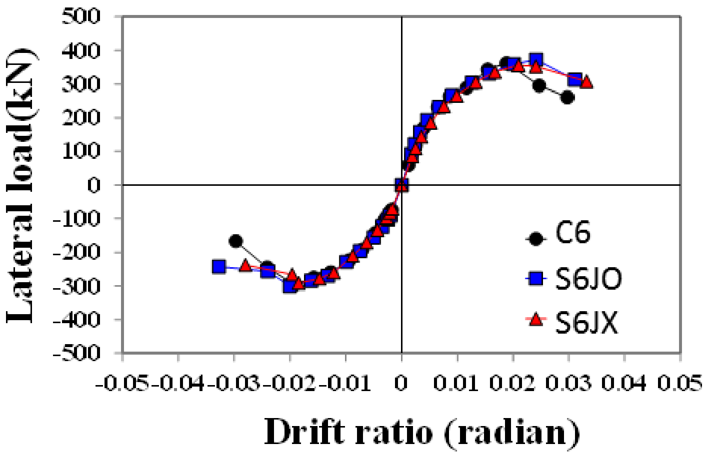


Fig. 3 – Effect of grouting

4. Conclusion

Based on the test results, it can be confirmed that the proposed mechanical splicing method can be used in RC intermediate moment frames regardless of the concrete compressive strength, locations of splices, and presence of the grouting in the mechanical coupler devices. The applications of the mechanical splices used in this study showed marginal effects on the overall lateral behavior of the column-foundation connections.

REFERENCES

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