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Experimental Comparison on Concrete Members with Different Rebar Splices Subjected to Cyclic Loading

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1. Introduction

In nuclear power plant structures, the mechanical rebar splices are designated and constructed on the basis of ACI and ASME code. Regardless of good performance of splicing rebars, the splicing method of rebar is not applied to construction field if it has not registered on the related ASME code. The mechanical splices used for this study are the types of cold roll formed parallel threaded splices. This mechanical splices were registered newly in ASME Section III division 2 CC 4333 'Mechanical Splices' in 2004. This study is focused on evaluating structural performance of this mechanical splices.

2. Experiment

2.1 The Setup of Specimen

For the consideration of the size of the load frame and the quantity of hydraulic equipment, the specimens were designed as follows: the cross section is 350 mm by 500mm, length 3,000mm. ASTM A615 Grade B #11 for main rebar, 16mm diameter for stirrup was used. The tested compression strength of concrete is 314 Mpa at average, and the tested yield strength of #11 rebar is 694Mpa on average. These strengths are beyond the requirement of nominal strength. Experimental parameters consisted of three cases: a specimen with no spliced rebars, a specimen with mechanical spliced rebars only, a specimen with lap spliced rebars only.

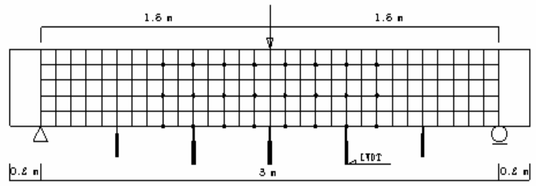


Fig. 1 the outline of concrete specimen

Specimen	Type of Splices
N11CNSP	Concrete member with no spliced rebars
N11LSP3	Concrete member with lap spliced rebars
N11CPT01 N11CPT02	Concrete member with 3 mechanical couplers only

Table. 1 List of Specimens

2.2 Loading Plan

An overview of typical test setup is shown like Fig. 2 as loading a specimen with actuator system and zig. The test setup was designed to simulate concrete beam in flexural moment resisting frame under typical vertical loading. The load was applied vertically to the center point of the beam at the speed of 20mm/100s, repeatedly putting the cyclic load upwards and downwards to be emplified by story drift ratio similar to earthquake, until the specimen reached to fail.

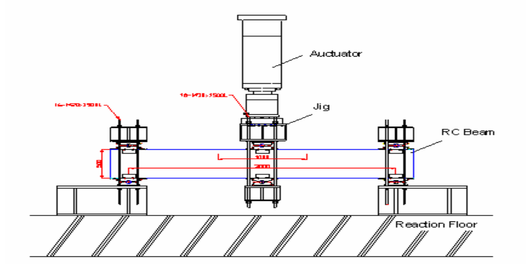
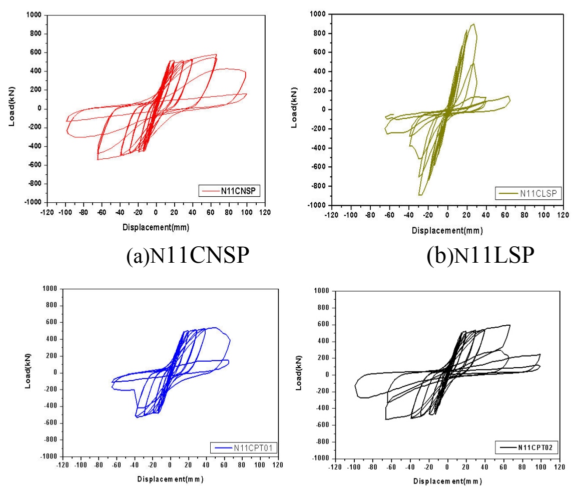


Fig. 2 The outline of Test setup

3. Test results and Discussions

3.1 Test Results

The following figures are the load-displacement relations related to four specimens, after failure of members was occurred. Based on failure mode of each specimen, structural members against seismic behavior were compared to maximum strength, ductility and energy dissipation capacity respectively .



(a)N11CNSP (b)N11LSP

(c) N11CPT01 (d) N11CPT02

Fig. 3 Load-displacement curve

3.2 Comparison of Ductility

The results of cyclic load test were shown in table.2. For comparison of each Response Quantities of Specimens, it is defined as follows: yield strength in equation is Pycal, yield Strength in test is Pyexp, maximum load is Pmax, yield displacement is Δy, maximum displacement is Δmax and Ductility ratio is described as μ. Among three specimens, when compared the specimen by lapping only(N11CNSP) with the specimen by mechanical couplers only(N11CPT), these specimens had the eqivalent values of ductility ratio 4.15. But the specimen by lap splicing only(N11LSP3) had much fewer value than the other specimens.

	N11CNSP	N11LSP3	N11CPT (average)
P *yexp (kN)*	513	837	502
P *ycal (kN)*	534	534	534
P*max (kN)*	583	899	568
Δy(mm)	15.28	19.64	15.27
Δmax(mm)	63.42	29.26	63.4
μ	4.15	1.49	4.15

Table 2 Response Quantities of Specimens

3.3 Comparison of Energy dissipation Capacity

The comparison on the dissipation capacity of accumulated energy was shown in Fig.4. For the quantative comparison, in condition that the cumulative energy of specimen (N11CNSP) was set as 100%, the specimen with lap spliced rebars only was recorded as 31%. Contrastingly the specimens with mechanically spliced rebars(N11CPT01, N11CPT02) were recoreded as 57%, 92%, respectively.

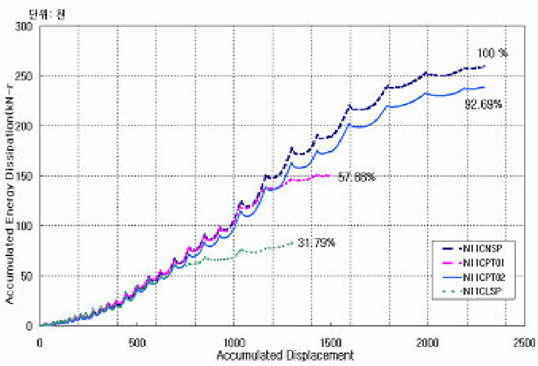


Fig. 4 the dissipation capacity of accumulated energy

4. Conclusion

The purpose of this experiment was to identify the applicability by comparing the lapping method of rebar with the mechanical rebar splices method enrolled newly in ASME code. Concrete memebers embedded in different splicing methods were tested under cyclic load and the final results were as follows :

The ductility ratio(μ) of each specimen was adversely affected on the splicing methods. The mechanical rebar splices method showed an excellent ductile behavior 2.8 times than the traditional lapping method in plastic region.

As for the accumulated dissipation energy capacity, it was identified that the mechanical rebar splices had 1.8 times better performance to resist seismic behavior than the traditional lapping method.

REFERENCES

[1] ASME SEC Ⅲ DIV.2 CC-4330, 'Splicing of Reinforcing Bar'

[2] Atorod Azizinamini, 'Proposed Modifications to ACI 318-95 Tension Development and Lap Splice for High-Strength Concrete' ; ACI Structural Journal /November-December 1999., pp.922 ~ 926