Evaluation on Tensile Strength and Applicability of Tapered Rolled Thread Coupler

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1. Introduction

Various diameters of reinforcing bars, ASTM A 615 Grade 60 #11, #14, and #18, are used for construction of Nuclear Power Plant structures. But due to the large diameter of these rebar, placing rebar is difficult. This study suggests a new tapered rolled thread coupler which have improved workability and fastening force. To evaluate tensile strength and applicability, the tensile test are conducted and static load-carrying capacity of rolled thread coupler are evaluated.

2. Tapered Rolled Thread Coupler

Tapered rolled thread coupler is one of the mechanical rebar development. Both ends of rebars are processed by forging and rolling, and the coupler are manufactured with same rolled thread pitch. Fig 1 shows the tapered rolled thread coupler. The tapered rolled thread coupler has the following advantages. First the workability of the rebar is improved. Second, cross sectional area of tapered rolled thread coupler is larger than cross sectional area of parallel thread coupler. Third, fastening force are applied to both direction in tapered rolled thread coupler. It can increase the fastening between rebar and coupler. Fig 2 shows the comparisons between tapered rolled thread coupler and parallel thread coupler.

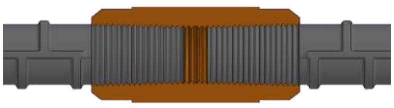
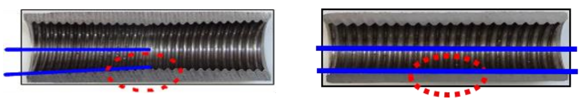
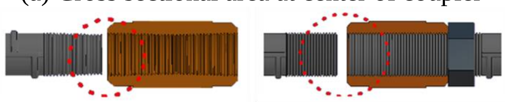


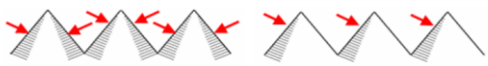
Fig. 1 Tapered rolled thread coupler



(a) Cross sectional area at center of coupler



(b) Workability



(c) Fastening force

Fig. 2 Comparisons between tapered rolled thread coupler and parallel thread coupler

3. Tensile Test for Rebars Connected with Tapered Rolled Thread Coupler

3.1 Specimens and Test Method

Tensile tests are conducted to evaluate tensile strength of ASTM A615 Grade 60 rebars, #11 (35.8mm), #14 (43mm), #18 (57mm), connected with tapered rolled thread coupler. In the tests on the reference rebars which are not connected with coupler, the tensile strength are observed under the same conditions. The speed of the displacement increase is controlled at 0.2 mm/sec until failure of rebar. Fig. 3 shows the test set-up of the tensile tests.

Fig. 3 Test set-up of the tensile test

3.2 Test Results

Table 1~3 describe the results of the tensile strength of each rebars. The tensile strengths are compared to verify the proposed coupler. The results show the tensile strength differences between rebars without coupler and rebars with coupler are 0.1~1.7%. Therefore, the tensile strength of rebars connected with proposed coupler is within the margin of error.

Table I: Tensile strength results (#18) (unit: MPa)

No.	Tensile strength	Avg.	Yield strength	Avg.
w/o coupler	688	688 (1.000)	486	486 (1.000)
Coupler-1	689	687.2 (0.999)	484	486 (1.000)
Coupler-2	688		489	
Coupler-3	687		487	
Coupler-4	682		481	
Coupler-5	690		489	

Table II: Tensile strength results (#14) (unit: MPa)

No.	Tensile strength	Avg.	Yield strength	Avg.
w/o coupler	707	707 (1.000)	508	508 (1.000)
Coupler-1	709	710.6 (1.005)	518	511.8 (1.007)
Coupler-2	713		514	
Coupler-3	713		512	
Coupler-4	714		513	
Coupler-5	704		502	

Table III: Tensile strength results (#11) (unit: MPa)

No.	Tensile strength	Avg.	Yield strength	Avg.
w/o coupler	683	683 (1.000)	470	470 (1.000)
Coupler-1	690	694.8 (1.017)	472	476.6 (1.014)
Coupler-2	692		474	
Coupler-3	696		477	
Coupler-4	699		481	
Coupler-5	697		479	

4. Loading Test on the RC Column with Rebars Connected with Tapered Rolled Thread Coupler

4.1 Specimens and Test Method

To validate the applicability of tapered rolled thread coupler, monotonic loading test and cyclic loading test are conducted. Total eight specimens with the same section and with different rebar connection are made. The specimens are shown in Fig. 4. In the test 200kN vertical load is applied to head of column to replace super structure's weight in the real structure. In the monotonic tests, the horizontal load is applied by controlling at 3mm/min. In the cyclic tests, horizontal load is applied through cyclic displacement schedule in ISO 16670. Fig. 5 shows test set-up.

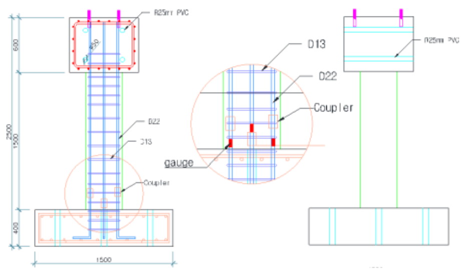


Fig. 4 Details of specimen (Tapered rolled thread coupler)

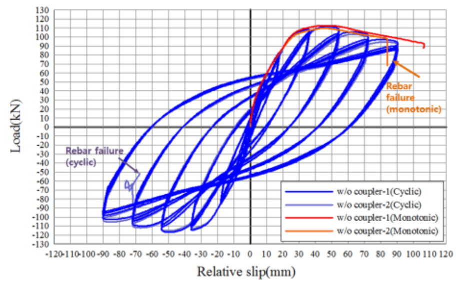
Fig. 5 Test set-up

4.2 Test Results

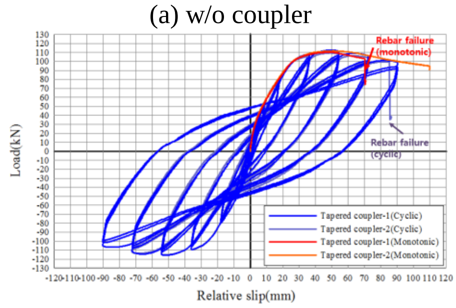
Load-displacement relationship of the specimens are compared to validate the agreement of the load-carrying capacity which can be different due to coupler. Fig. 6 shows the load-horizontal displacement relationship at the head of column. Table IV shows quantitative comparison of monotonic loading test specimens in terms. The results show the ultimate load differences between rebars without coupler and rebars with coupler are less than 0.2%. Therefore, the load-carrying capacity of specimens with proposed coupler is within the margin of error.

Table IV: Test results of monotonic loading test

Specimen		F_u (kN)	u_u (mm)	u_{max} (mm)
w/o coupler	1	112.8	45.6	63.9
	2	109.6	45.6	84.5
	Avg.	111.2	45.6	74.2
coupler	1	110.3	49.5	70.7
	2	111.7	50.9	85.8
	Avg.	111.0	50.2	78.3



(a) w/o coupler



(b) Tapered rolled thread coupler

Fig. 6 Test results

5. Conclusions

In the both tensile tests and column tests, the good agreement of load-carrying capacity are shown. Therefore the proposed tapered rolled thread coupler can be applied to the NPP to replace conventional coupler.

REFERENCES

[1] International Standard, ISO 16670 : Timber structures – Joints made with mechanical fasteners – Quasi-static reversed cyclic test method, 2003.
[2] KEPCO Research Institute, A study on development of mechanical rebar anchorage and splices, 2005.