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Failure Behavior of Load Measurable Turnbuckle

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ABSTRACT

It is difficult to control tension of the tension member. So, the new turnbuckle to control and measure tensile force easily has been developed. This paper presents ultimate loads and failure shapes of the new turnbuckles which have the measuring load capacities of 100kN, 200kN and 300kN. The ultimate loads are approximately 5 times and the elastic limit loads are about 1.5 times larger than the designated measuring load capacity.

1. INTRODUCTION

Tension member is widely used in various construction field such as suspension bridges, cable trusses, grid shell and so on. However, it is hard to control tension of the tension member. Therefore, the device that precisely measures tensile force is need. One of devices inserted between tension elements is turnbuckle. The turnbuckle can adjust tensile force into element by rotating the body but the conventional turnbuckle is incapable of measuring the tensile force without specific measuring equipment. In previous researches (Shin & Hwang, 2003; Shin & Lee, 2006; Lee & Shin, 2009), the turnbuckle that can adjust and also measure tensile force (new turnbuckle) has been developed. The new turnbuckles which have the measuring load capacities of 100kN, 200kN and 300kN have been tested and analyzed for determining their size, shape and validation of the measuring ability (Shin, Lee & Lee, 2011; Shin & Lee, 2011).

2. CONCEPT OF NEW TURNBUCKLE

The general turnbuckle looks like Fig .1 (a). The turnbuckle can adjust tensile force into element by rotating the body but the conventional turnbuckle is incapable of

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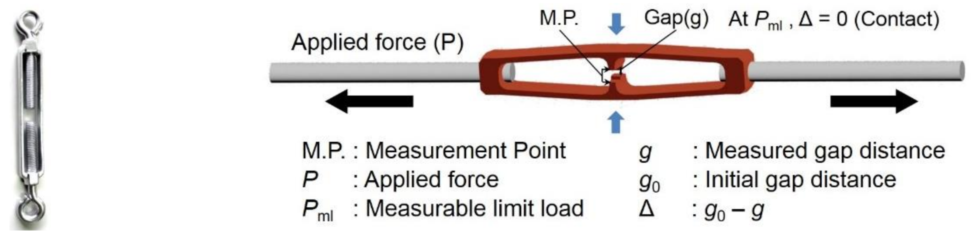
measuring the tensile force without specific measuring equipment. The concept of new turnbuckle with pre-bended member is shown in Fig .1 (b). The new turnbuckle has measurement point (M.P.) and gap in the center of body. The new turnbuckle has measurement point (M.P.) and gap in the center of body. After acting on the applied force (*P*), the initial distance of gap (g_0) is changed linearly with the tensile force. By acting on the applied force, gap distance (*g*) is getting smaller and gap surface eventually contact each other (*g*=0) when the measurable limit load (P_{ml}) is applied.



(a) (b)

Fig. 1 (a) General turnbuckle (b) Concept of new turnbuckle for measuring tensile force

3. TEST FOR MEASURING ULTIMATE LOAD

Tests for measuring ultimate load were carried out using the new turnbuckle that made for measuring the tensile forces which were 100kN, 200kN and 300kN, respectively. Fig .2 and Table .1 present specifications of specimens determined through previous test and analysis (Lee, Shin & Lee, 2013).

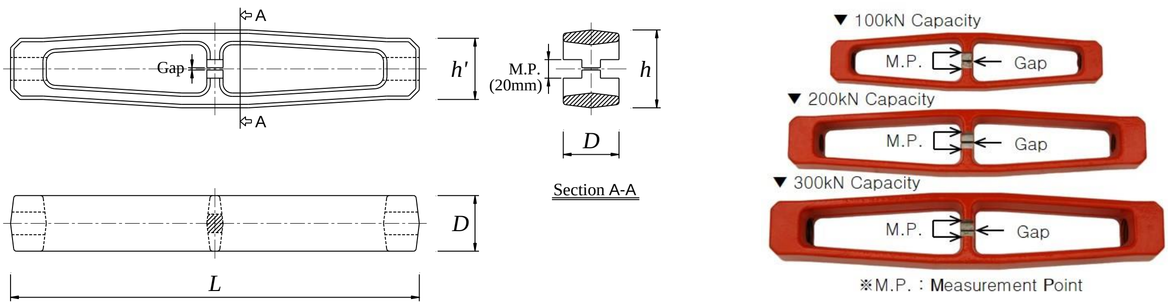


Fig .2 Detail of new turnbuckle

Table .1 Specification of new turnbuckle specimens

Specimen*	Width		Depth (*D*, mm)	Length (*L*, mm)	M.P. (mm)	Gap (mm)
	h (mm)	*h'* (mm)				
TB100-2.4	74	55	40	342	20	2.4
TB200-2.5	84	66	60	440		2.5

TB300-2.8	94	74	70	480		2.8

*TB100-2.4 : 100-measurable limit load (kN), 2.4-gap size (mm)

The test specimens were placed in the center of the UTM, and the tensile force was applied directly using one or two shackles. Fig .3 shows experimental setup for new turnbuckles. Strain gauges were attached to the part changed in width for observing whether local yielding occurred.

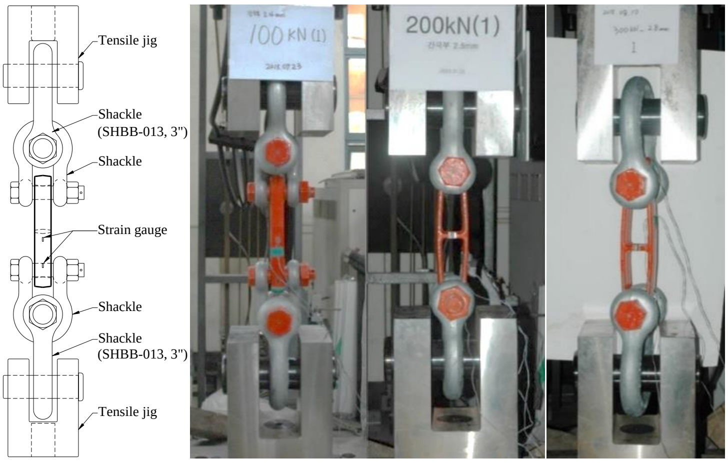


Fig .3 Experimental setup for tensile tests

Fig .4 and Fig .5 show the tensile test results and failure shapes of the new turnbuckle for measurable limit load of 200kN and 300kN. Elastic limit load is the maximum load which the new turnbuckle can deform elastically and return to its original shape, initial gap distance, when the applied tensile force is removed.

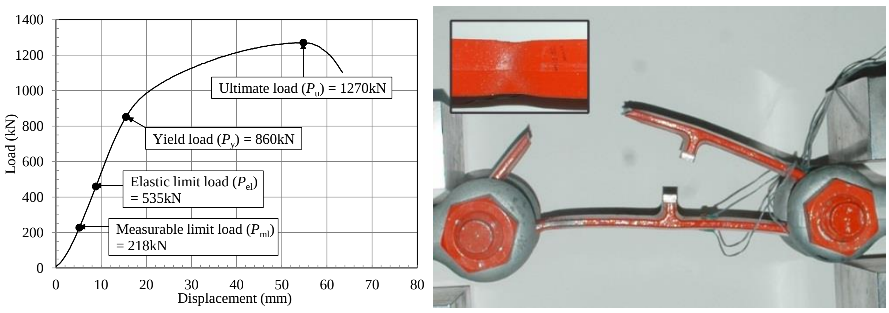


Fig .4 Test result and failure shape of TB200-2.5

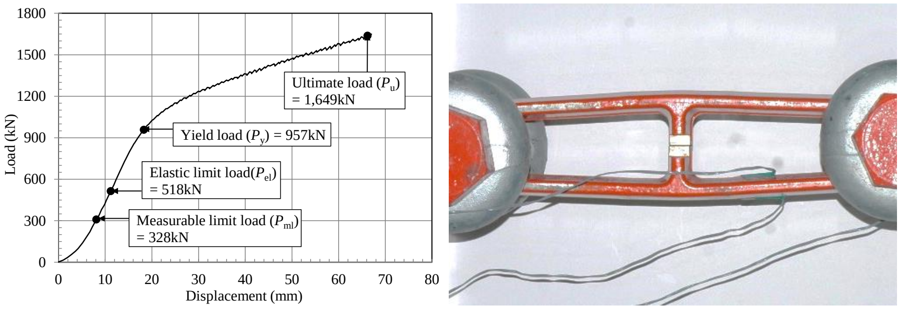


Fig .5 Test result and failure shape of TB300-2.8

The large plastic deformation and necking occurred in the body and the ductile fractures were observed for TB100 and TB200. Before TB300-2.8 specimen was fractured, shackle pins yielded and tensile test was finished at 1,649kN. Table .2 shows summary of measured loads and the load ratio, measurable limit load to elastic limit, yield and ultimate load. Elastic limit loads are 1.5 times and yield loads are 3 times larger than measurable limit load.

Table .2 Summary of measured load

Specimen	Measurable limit load, P_{ml} (kN)	Elastic limit load		Yield load		Ultimate load	
		P_{el}	P_{el}/P_{ml}	P_y	P_y/P_{ml}	P_u	P_u/P_{ml}
TB100-2.4	115	170	1.48	493	4.29	721	6.27
TB200-2.5	218	535	2.45	860	3.98	1,270	5.83
TB300-2.8	328	518	1.58	957	2.92	1,649	5.03

4. CONCLUSIONS

This study is about ultimate load and failure shape of the new turnbuckle. The ultimate loads are nearly 5 times larger than measurable limit load and new turnbuckles exhibit ductile failure. It is shown that new turnbuckle can properly perform like conventional turnbuckle when tensile force beyond the measurable limit load is applied.

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