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Support system for apple tree to wind damage

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ABSTRACT

A number of apple trees have collapsed in Korea due to a typhoon. In fact, an apple tree is protected by various types of support system. However, despite the fact that the apple tree has a support, the trees have been damaged. The reason why the trees have collapsed is that the installation of a support is not based on a scientific fact. The purpose of this study is to evaluate the structural safety of anti-disaster support system for apple tree. Equivalent static tests of support systems which are fence and matrix support, were carried out.

1. INTRODUCTION

For several years, damage to apple orchard has increased because of unforeseen weather phenomena. Especially, fruit drop and lodging due to typhoon or strong winds have caused economic loss. Facilities can reduce damage to apple tree are there force needed. An apple tree is protected by various types of support system in Korea. However, a windfall and lodging of the apple tree have been frequently repeated every year. The reason why the apple tree has collapsed is that the installation of support is not based on a scientific fact. This study carried out static test of fence and matrix support systems for evaluating the stability of support system.

There are three major types of support system; steel tube, cement pole, and single conduit pole. However, a great part of support systems (Lespinasse and Delort 1986) were originated in the infrequent typhoon occurrence area and focused on productivity benefit (Palmer et al. 1992). Accordingly, methods can improve performance of support system have been studied (Gardiner et al. 2005).

2. EQUIVALENT STATIC TEST OF SUPPORT SYSTEM

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In order to evaluate the wind resistant of support system for apple tree, equivalent static tests of fence and matrix type supports were carried out. Fence support system was three bays of line and end posts with four-cable lines which were connected to each post, and end posts were supported on the ground with strut wire. Matrix support system was connected to three fence supports. To apply wind loads on the support, chain blocks were connected to the posts and pulled toward lateral direction. Fig. 1 and Fig. 2 illustrate floor plan of each support system.

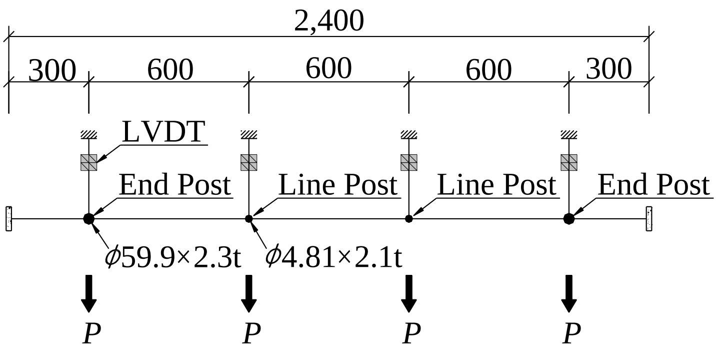

Fig. 1 Floor plan of fence support system

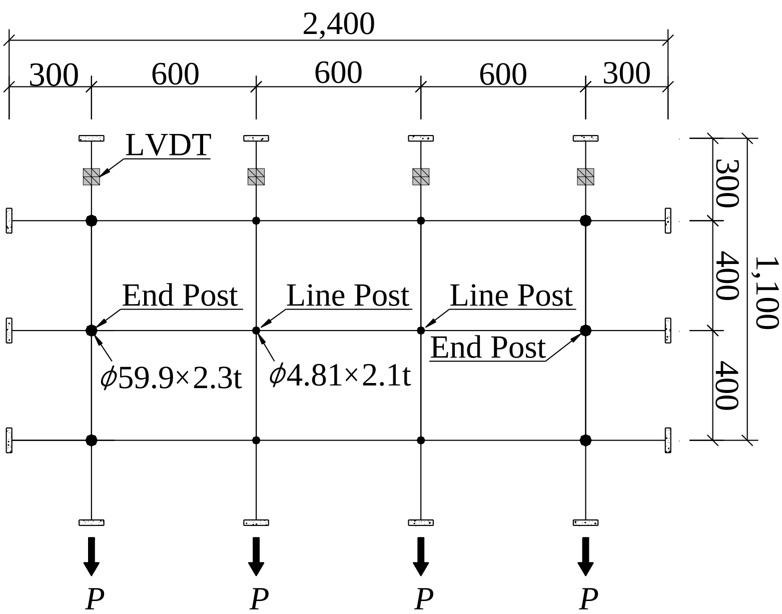

Fig. 2 Floor plan of matrix support system

A turnover test for apple tree was carried out and degree of turnover was presented about 10° (Kang et al. 2015). In this study, the deflection of support according to the height of loading point and degree of overturning was 236mm in fence support and 580mm in matrix support.

Matrix support system was tied to three fence support systems by mat wire. Yield moment (M_y) and yield load (P_y) of line post and end post in matrix support system are equal to three times of each single post. Table 1 is result of the yield moment and yield load (Architectural Institute of Korea 2009).

Table 1. The result of the yield moment and the yield load

Type	Post type	H (mm)	F_y (MPa)	M_y (N·mm)	P_y (N)
Fence support system	End Post	1,300	295	1,702,740	1,310
	Line Post			986,775	759
Matrix support system	End Post	3,200		1,702,740	1,596
	Line Post			986,775	924

2.1 EQUIVALENT STATIC TEST OF FENCE SUPPORT SYSTEM

Fig. 3 depicts the equivalent static test before collapsing of the fence support. The plastic hinge was located at ground level and these were mainly formed not on end posts but on line posts. Fig. 4 show load-displacement relationship obtained from the results of equivalent static test of fence support system and displacement of overturning, the yield load of the line post and end post are presented, respectively. When the displacement of support was reached on the overturning, the line posts exhibit the load over the yield load but end posts does not. The fence support system shows a bi-liner load-displacement behavior and the same tendency.

Fig. 3 Test of fence support system

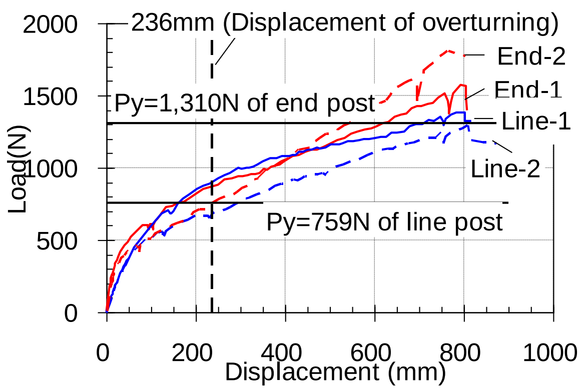

Fig. 4 The test result

2.2 EQUIVALENT STATIC TEST OF MATRIX SUPPORT SYSTEM

A plastic hinge was formed on the both posts and located at connection to strut wire as shown in Fig. 5. The turnbuckle (3/8 in) yielded on the hook during the test for matrix support system as. The result was finished because turnbuckle yielded. Fig. 6

show load-displacement relationship obtained from the results of equivalent static test of matrix support system. The loads of the line and end posts exhibited over the yield load. Especially, the maximum load of end posts was three times greater than the yield load of it.

Fig. 5 Test of matrix support system

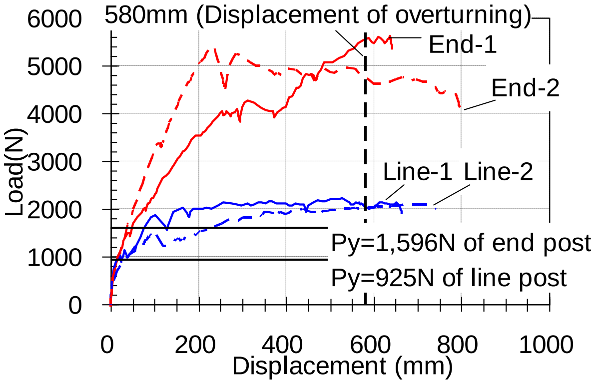

Fig. 6 The test results

3. CONCLUSIONS

The test result of fence support system shows a bi-liner load-displacement behavior. When the displacement of support was reached on the overturning, the line posts exhibit the load over the yield load but end posts does not. In matrix support system case the maximum load of end posts are three times greater than the yield load of it. This study is supposed to provide overturning load for wind resistant design.

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