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An Experimental Study on Resisting Force of Scaffolding Frames using Buckled Pipe

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Abstracts : There are many structural problems when the scaffolding frame is applied to a construction site .contractor may use a used pipe or buckled pipe which they lended them from commercial firms without any inspection of those materials even though they have been used and exposed to weather for a long times. Therefore, they should be checked of their current capacity, comparing with the original one so that construction contractor can apply their capacity to a temporary frame depending on the site situation against collapsion of those. This study is mainly focused on the behavior of a scaffolding frame using prebuckled pipes.Additionally, standard frame with bracing and without bracing case are also tested for comparing with the prebuckled case. Prebuckled case has its capacity less approximately 20 % than the standard frame.

Keywords : prebuckled, scaffolding frame, vertical force

1. Introduction

Table 1. Comparison of safety regulation of each country

Kinds		Korea	Japan	U S A	Germany
Material	Material	368 article	559 article	1926.451	-
	Material quality	360	560	1926.452	BGR 165 7
	Maximum live load	370	562	1926.451 (b)	BGR 167 5
Fabrication	Work platform structure	371	-	1926.451 (c)	BGR 167 5
	Fabrication and dismantling	372	564	1926.451 (c)	BGR 167 7
	Repair	374	567		BGR 167 10
Scaffolding	Work consideration of fabrication	377	570	1926.452 (b)	BGR 166 5
	Structure	378	571	-	BGR 165 5.2
	Strength check	573	379	-	-

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Frame of steel pipe scaffoldings are not clarified more than tublar frame but they are commonly used at a construction site.

"The below two points can be a critical aspects which we have to consider for structural anaysis for scaffolding frame.

1) Deflection of work platform is limited to 1/100 of column space of scaffolding.

2) Safety factor

① permanent load (self weight)

② live load (impact and wind load)

2. Methodoly

Steel pipe-framed scaffolding are mainly used at a construction site, specially in case of building construction. Therefore, is focused on thise kind of scaffolding such as behavior of actual field scaffolding, fracture shape and mechanism, behavior at an unstable phenomina.

Horizontal connection components between scaffolding and the structure part are ignored in this study.

1) Considerations in this study are taken into account are surveyed through the existing foreign and domestic materials.

2) Standard scaffolding with bracing is tested in comparison with the other three different field cases such as scaffolding without base jack; without bracing with pre-buckled pipe component.

3) The height of test frame is adjusted to fit to the loading machine, even thought all the conditions are basically field-oriented.

3. Test

3.1 Setup of test and type

Commercially-made steel pipe with SPS500 have been used in order to make same field condition while they are considered into four variables using fixing clamp, auto clamp, base jack, in case of "without bracing, without base jack, with buckled pipe, with standard condition (having bracing, base jack, without pre buckled pipe component).

Table 2. Mechanical properties of steel pipe

Yielding point	36
Tensile strength	51
Moment of inertia	9.32
Section modulous	3.83
Radius of section	1.64

Table 3. Size of steel pipe component

Kind	Inside diameter	Thickness	Weight
6m			15.78 ton
4m			10.52 ton
3m	48.6mm	2.6t	7.89 ton
2m			5.26 ton
1.5m			3.95 ton

3.2 Test setup and instrumentation

All the result have are measured using data logger TDS-602 through strain gauges made by Japanese Tokyo Sokki with 1000 Tone UTM made by ESH testing, UK.

All the strain gauges are installed as shown Fig. 1. They have been attached to the components in a short time, such as temperature humidity.

3.3 Test Result

3.3.1 load-deformation

Maximum capacity of standard model showed 8.06 tone. The model without bracing showed 4.92 tone (b), the model without base jack (c) Fig. 1 showed 4.09 tone, a model with pre buckled pipe component showed 4.28tone (c) Fig. 1 the model with pre-buckled pipe scaffolding has been displaced more 13mm horizontally than the standard one. They are shown on table 4.

Table 4. Maximum load and deformation

Model	Specimen	Maximum resistant capacity (tonf)	Maximum displacement(mm)
Standard model	(a)	8.06	21.96
Without bracing	(b)	4.92	25.12
Without base jack	(c)	4.09	29.37
With pre buckled pipe	(d)	4.28	34.72

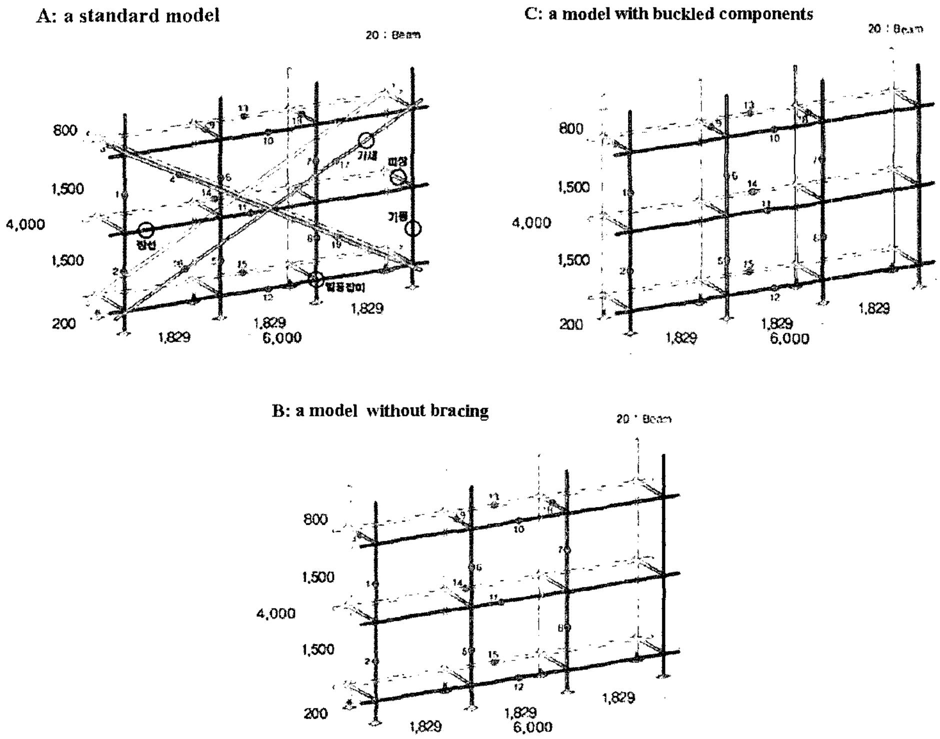


Fig. 1. A model without base jack

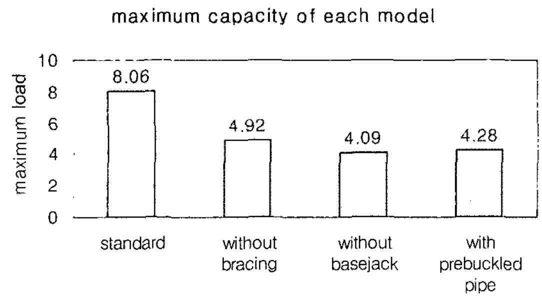


Fig. 2. Graph of each model with maximum load

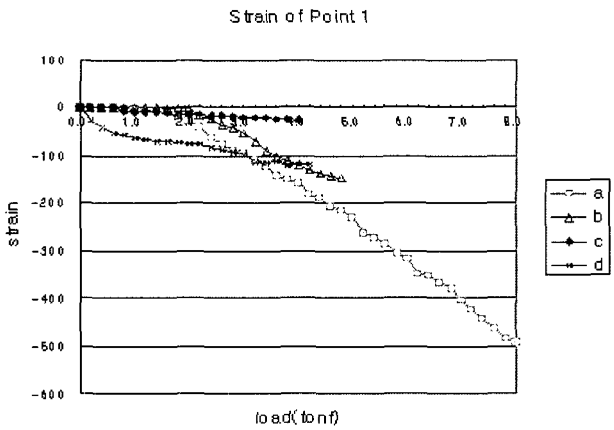


Fig. 3. Strain at point 1

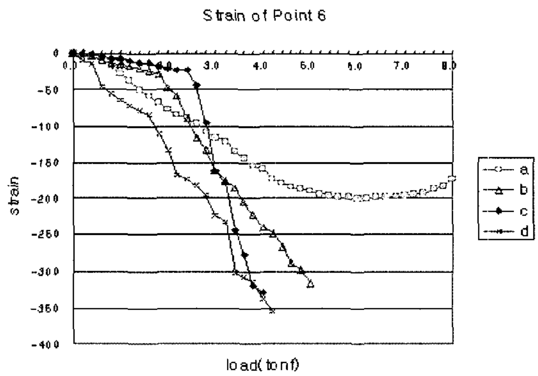


Fig. 4. Strain at point 6

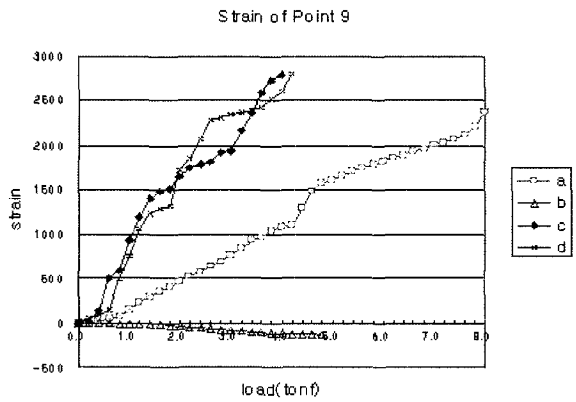


Fig. 5. Strain at point 9

Table 5. Strain at point 1

LOAD(tonf)	a	b	c	d
0.0	0.00	0.00	0.00	0.00
0.2	0.00	0.00	0.00	-25.59
0.4	0.00	0.95	0.00	-42.65
0.6	0.00	0.00	0.00	-54.03
0.8	-0.95	0.00	-7.58	-55.92
1.0	-1.90	0.00	-8.53	-64.45
1.2	-3.79	0.00	-9.48	-66.35
1.4	-7.58	0.00	-10.43	-72.04
1.6	-11.37	-0.95	-11.37	-72.04
1.8	-21.80	-1.00	-13.27	-72.99
2.0	-29.38	-1.90	-14.22	-76.78
2.2	-42.65	-16.11	-15.17	-76.78
2.4	-64.45	-24.64	-16.11	-82.46
2.6	-76.78	-36.02	-17.06	-88.15
2.8	-88.15	-41.71	-18.96	-94.79
3.0	-96.68	-54.98	-20.85	-99.53
3.2	-109.95	-70.14	-21.80	-112.80
3.4	-124.17	-91.94	-22.75	-116.59
3.6	-143.13	-104.27	-23.70	-109.95
3.8	-149.76	-109.95	-24.64	-120.38
4.0	-158.29	-121.33	-25.59	-119.43
4.2	-183.89	-130.81		-117.54
4.4	-190.53	-138.39		
4.6	-206.64	-144.08		
4.8	-215.01	-148.05		
5.0	-229.38			
5.2	-261.61			
5.4	-272.99			
5.6	-284.36			
5.8	-304.27			
6.0	-317.54			
6.2	-349.34			
6.4	-352.61			
6.6	-365.88			
6.8	-379.15			
7.0	-402.84			
7.2	-423.70			
7.4	-443.60			
7.6	-462.56			
7.8	-486.26			
8.0	-492.89			

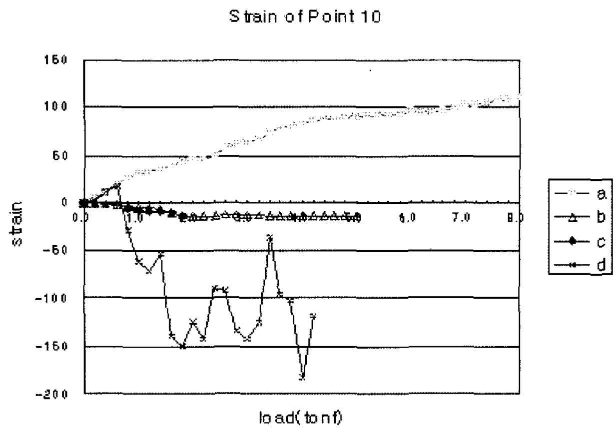


Fig. 6. Strain at point 10

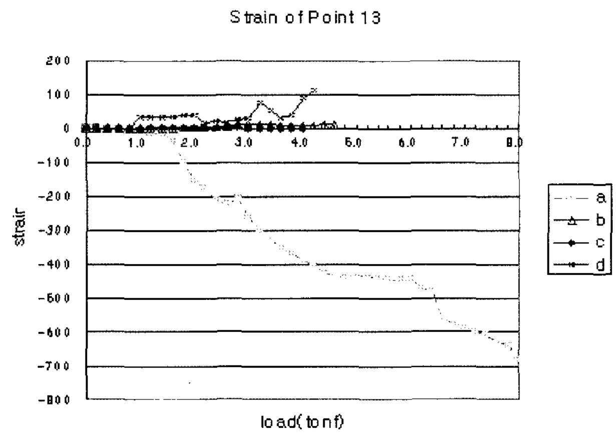


Fig. 7. Strain at point 13

The above means the value of strain to load, and (a) shows strains of 8tonf, (b) does ones of 4.92ton, (c) shows ones of 4.09tonf, (d) shows ones of 4.38tonf.

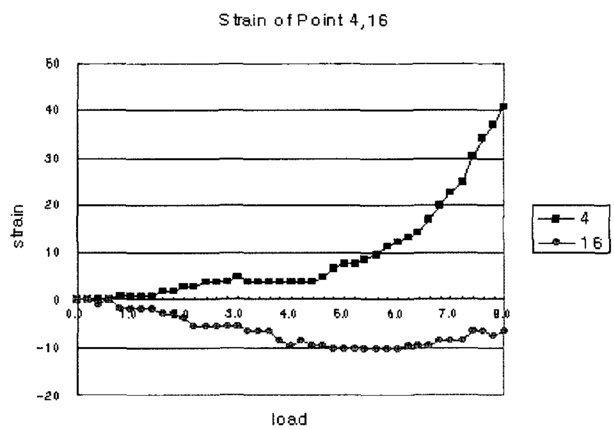


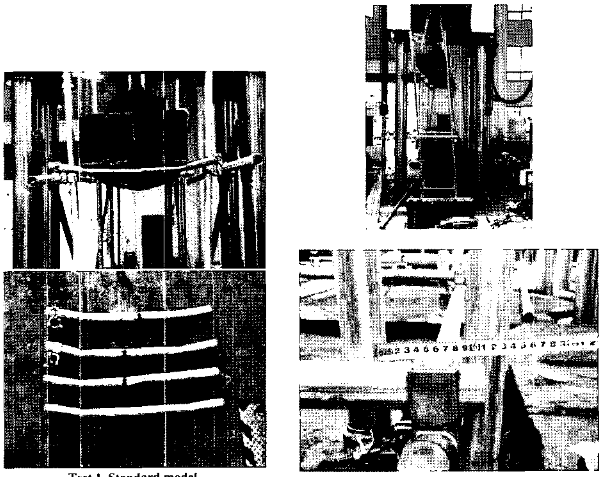
Fig. 8. Strain at point 4, 16

3.3.2 horizontal distance of each column component

Table 6. Horizontal distance of each column component after test

models	Maximum displacement (cm)
Standard	0.5
Without bracing	3.5
Without base jack	4.3
With buckled pipe	4.0

*where all the results are compared with #1 gauge result.



Test 1. Standard model   Test 2. Model without bracing

Fig. 9. Pictures of each test model

4. Analysis

1) Maximum resistant capacity of each type showed that model without bracing is approximatery 63~1%, one without a base jack; 50.7%, one with pre buckled model; 53.1%

2) A model without bracing was buckled with some sway to a side.

3) It is shown that more displacement of the frame components was occurred at the central pipe component.

4) A frame using buckled pipes showed approximately 20 % less capacity than the standard one.

5) There was almost no deformation in standard case but showed a considerable buckled with sway in the rest three (3) cases.

6) A model without base jack was buckled or twisted due to concentration of vertical component of force on the point.

7) A standard model showed that all the load were uniformly-distributed on each component when they were deformed.

8) Each component can be uniformly loaded, even thought pre-buckled steel pipes are fabricated.

9) Models without bracing were seven times more swayed than the standard one, and the other two models such as, without base jack, with pre buckled pipe components, were eight times more swayed than the standard one.

5. Conclusion

Scaffolding as temporary structure are used to being temporary structure for a few months or a few days in a short time. This temporary structure may be installed only by technician's experience without any standard or code. Most cases of scaffolding at site such as without base jack, without bracing, with pre-buckled pipe components have been tasted to verify how much each case will be effected to the scaffolding frame.

They are as follows;

1) Scaffolding with bracing has aprroximately 30 % more capacity than the other cases without it.

2) The loads on scaffolding can be uniformly distributed by bracing on it. And it is thought that bracing on it itself can be a method to prevent callapsion of scaffolding.

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