The 5th Inter-University Invitational Civil Engineering Competition

2008.1.26~2008.1.30

Competition Instruction

Organized by:

College of Civil Engineering, Tongji University, Shanghai, China

Sponsored by:

Zhejiang DY-link CO., LTD，Hangzhou, Zhejiang, China

The 5th Inter-University Invitational Civil Engineering Competition

Brief Introduction

The 5th Inter-University Invitational Civil Engineering Competition (5th IUICEC), will be hosted by College of Civil Engineering, Tongji University from 26 to 30 of January, 2008 at Tongji University, Shanghai, China.

Note

- ✓ We suggest each participating university to send one team consisting of three undergraduate students, including minimum one female student
- ✓ We suggest a team leader shall be appointed.
- ✓ The competition will lasted 4~5 days, and in these days, a simple structure model with some certain requirements will be fabricated in site by each team.
- ✓ And finally, those teams will ranked by their works depend on some structural performance.

Tentative Schedule

Jan. 26th	Saturday	Registration and submit the structure design report	
Jan. 27th	Sunday	Opening Ceremony	
		Model fabrication	Welcome Dinner
Jan. 28 th	Monday	Model fabrication	Brain Twister
Jan. 29 th	Tuesday	Model Loading Test	Closing Ceremony
Jan. 30 th	Wednesday	Sightseeing Tour	Departure

Please Contact to

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1 Content of the Competition

The content of the 5IUICEC includes three parts, which are model design, model fabrication, and model tests.

Structure design should be completed before Jan 26, 2008. When participants registration, the structural design report should be submitted to the jury of the 5IUICEC. The highest score of report is 15 points for the best analysis and calculation of model design. Then on the second day, every team will be provided with materials and tools for model fabrication.

Model fabrication is suggested to start according to the design report after participants receiving the materials and tools. It will take almost two days for every team to finish the model.

Model tests will be held on Jan 29th, 2008. Loading test include three steps, static vertical loading test, static horizontal loading test, and impact horizontal loading test. All teams are suggested to installing their models on test table in 10 minutes, then to carrying on loading test step by step under the guidance and supervision of jury. The score of model's behavior will be automatically recorded and marked on site in time.

1.1 Subject of the Competition

Design and fabricate a scaled crane-like structure. The structural type is not specified and not limited.

1.2 Materials, Tools and Facilities

1.2.1 Material

Balsa wood slat	**Dimension:**	**1mm × 55mm × 1000mm**
	Density:	500kg/m^3
Nylon rope:	**Dimension:**	Ø1mm

Notes:

a) The materials and adhesive will be provided by the organizer, and use of other materials is not allowed.

b) The tension strength of balsa wood slat and nylon rope are tested by the organizer, which listed in Appendix 1, for your reference.

1.2.2 Connections

Connection	Type	Property
Adhesive	α-cyanaloc acrylic resin adhesive	CH2=C(CN)-COO-C2H5
Screw	M4	Ø5mm

Note:

Screws can only be used to fix the structure to the base. But the weight of the screws is included in the total mass of a model.

1.2.3 Facilities and Tools

The Organizing Committee will provide the participants with following tools:

Tools：	Cutter Knives	Steel Ruler	Triangle Rulers	Sand Papers	Compass
	Protractor	Scissors	Drawing Board	Pencils	

Notes:

The other tools are suggested not to be used in fabrication site.

1.3 Dimensions and Requirements

1.3.1 Dimensions

The crane-like structural model should be made of wood slat and optional nylon rope, with height of 550mm at the crane hoisting point, which should span over a horizontal distance of 500mm from the centre of the base in X direction. The height of the cross section of the cantilever end is not more than 50mm. Any structural member should evade a quarter cylinder area at a radius of 500mm, as shown in Fig.1.

The participants should design an appropriate section for loading, including a 20mm expended length at the hoisting point for the installation of loading system and displacement meter.

1.3.2 Foundation

In the loading test the model will be fixed to the base by two types of corner buttresses shown in the graph, one of which is in an unchangeable form while the other can be specifically adjusted. The screws can be use optionally, but the location should be corresponded to the one in buttresses. There are also two types of brass wedge blocks with certain obliquity (15°, 30°) for the cases of special bottom sections. The geometrical center of the bottom section of the

model should coincide with that of the base.

Note:

Participants are suggested to pay much attention to the fixation form in the model design, because it has significant impact to the final result and to the time for model installation, which is limited.

1.4 Testing procedure

Load tests include static vertical load test, static horizontal load test and impact horizontal load test. The vertical static load test must be carried out first. Only those models that pass the static vertical load test and horizontal load test will be allowed to take the following horizontal impact load test described.

1.4.1 Static vertical load

In this part, the model will be loaded downwards at the top of the hoisting point of the cantilever. The vertical load will be applied in three steps by 20N each time, thus the total load in vertical direction is 68.2N including the weight of the loading carriage. The final vertical displacement of the loading point (Point A) in this part should not exceed 12mm or the score will be reduced correspondingly.

1.4.2 Static horizontal load

After the vertical load test, a static horizontal load will be imposed firstly on the top of the cantilever (point A) along the horizontal direction (in -Y direction shown in Fig.1) perpendicular to the axis of the cantilever by a pulley system, which is 28.2N consisted of 20N of a weight and 8.2N of the loading carriage. The final horizontal displacement of the loading point (Point A) in this part should not exceed 10mm or the score will be reduced correspondingly.

1.4.3 Horizontal impact load

Keep the original vertical load (68.2N) unchanged and lift up the weight of 20N on the horizontal load imposing system to a height of 95mm from the bottom of the carriage (5mm below the vertex of the 2 φ6 guiding rod which is already marked), then release it out of a sudden to impose an impact load. The model not collapse or still standing in 10 seconds after impacted will be given the final score on site in time.

Note:

The displacements caused by the load carriage and the impact load are not recorded and calculated. That is, the initial displacement is 0.000mm in vertical direction and horizontal direction when the carriages are hanged on the hoisting point A for the following static vertical loading and horizontal loading.

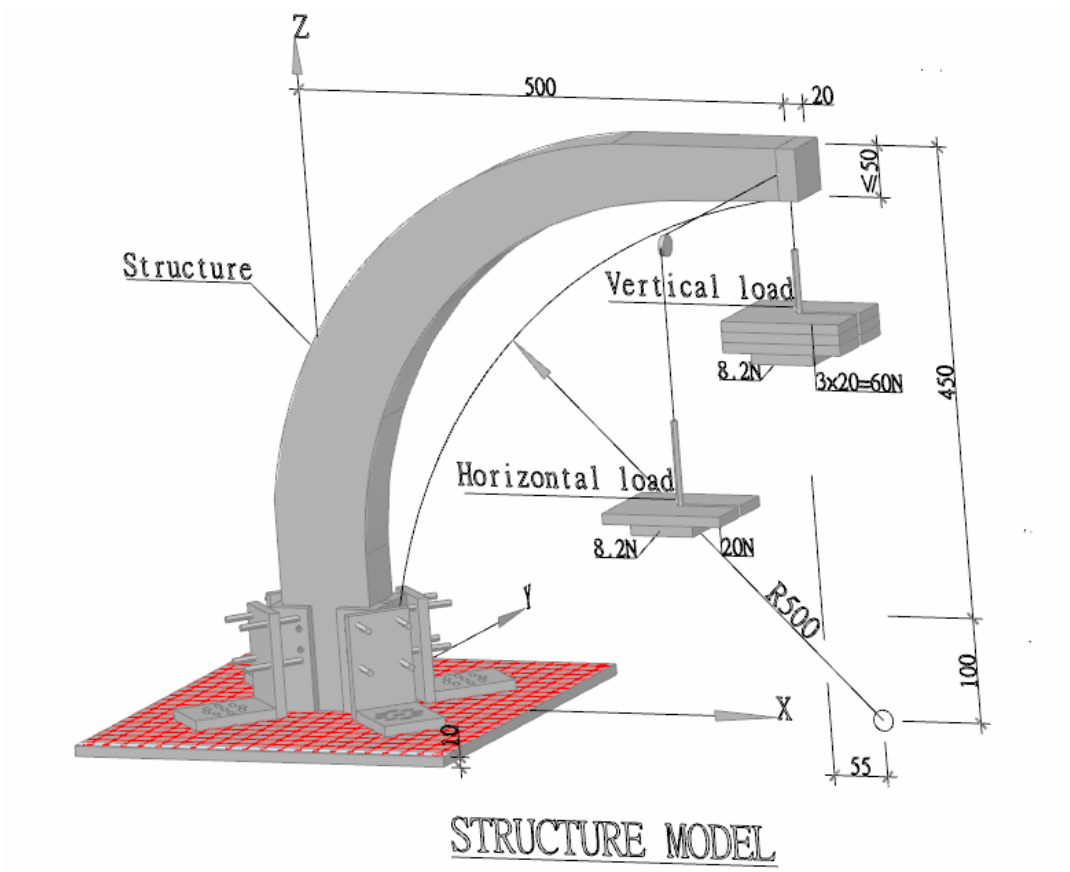

Z
500
20
≤50
Structure
Vertical load
8.2N
3x20=60N
450
Horizontal load
8.2N
20N
R500
Y
X
100
10
55
STRUCTURE MODEL

Fig.1

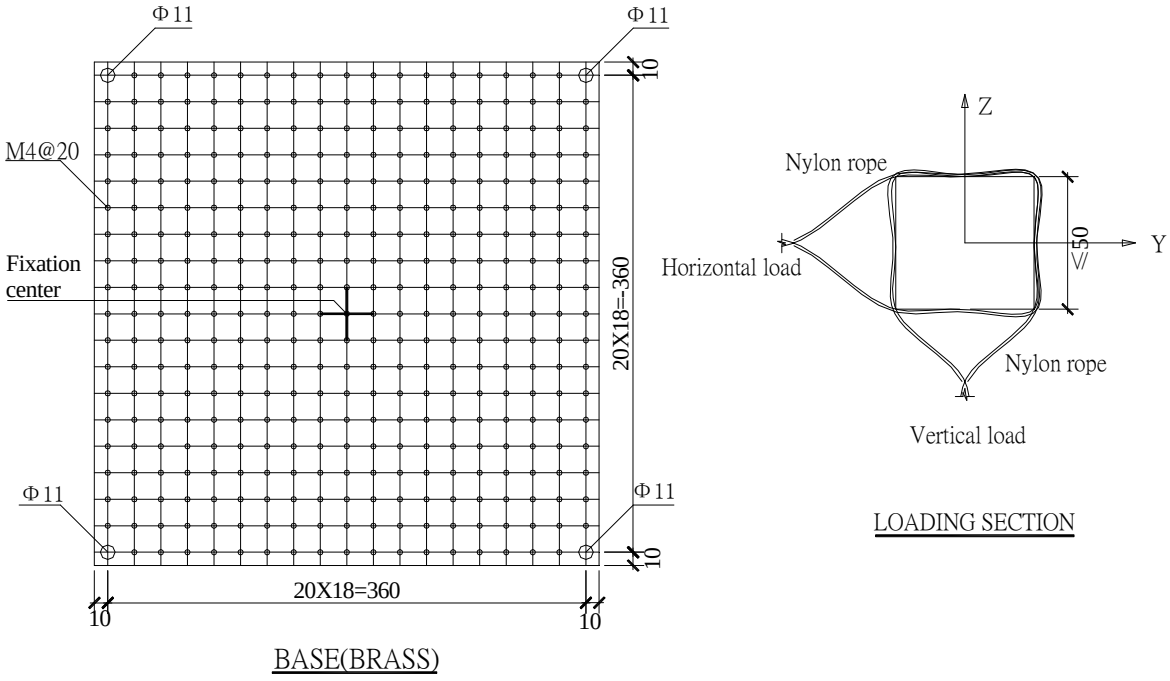

Φ11
Φ11
10
M4@20
Fixation
center
20X18=360
Φ11
Φ11
10
20X18=360
10
10
BASE(BRASS)
Z
Nylon rope
Horizontal load
50
Y
Nylon rope
Vertical load
LOADING SECTION

Fig.2

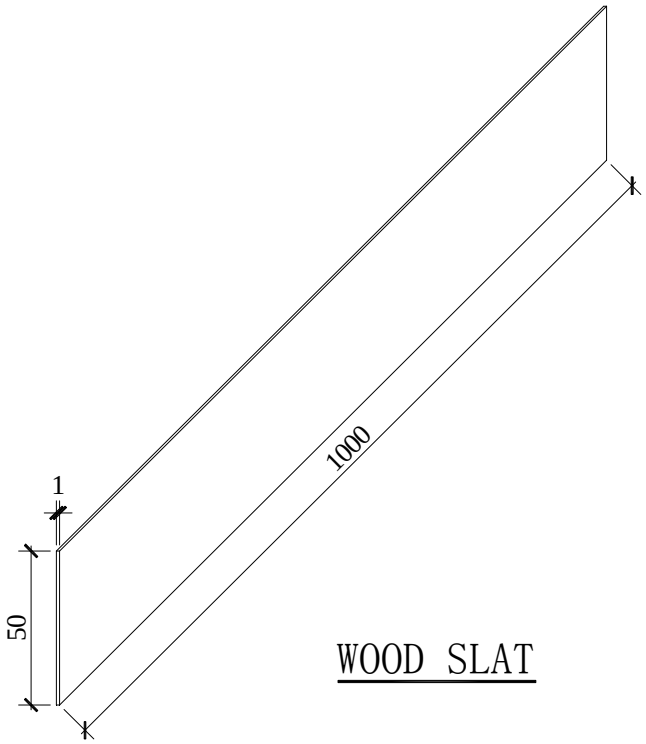

1
50
1000
WOOD SLAT

Fig.3

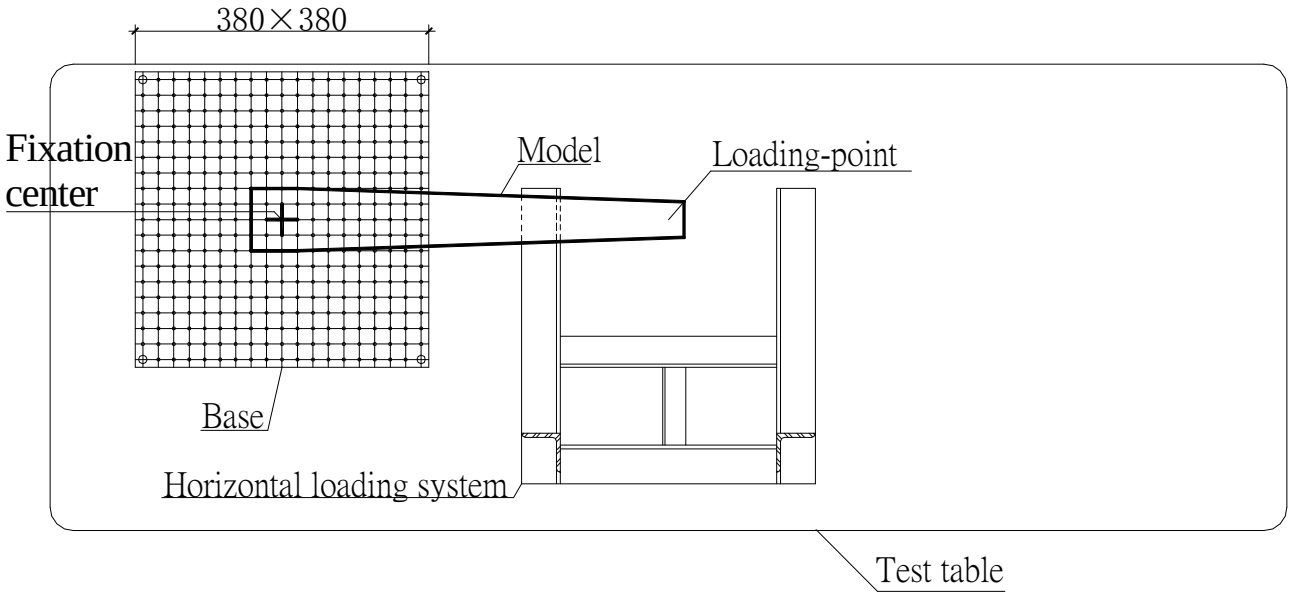

380×380
Fixation center
Model
Loading-point
Base
Horizontal loading system
Test table
PLANFORM

Fig.4

2 Assessment

The total score will be given 15 points for model design, 15 points for model appearance and 70 points for the structure behavior according to following rules by the jury.

Notes:

a. Only materials supplied by the organizer can be used in the competition. Models fabricated with any materials which are not provided by the organizer will not be allowed for load testing, and will not be eligible for any awards.

b. The dimensions of the structure should meet the set requirements. Models do not conform to the dimension rules will not be approved for loading test; neither will they be eligible for any awards.

c. All models that pass the preliminary check will be numbered according to their weight. No other marks will be made on the models.

2.1 Structure Report（15%）

The participants should summit the structural design report when registration to 5IUICEC organizing committee. The report is suggested including the plan, detailed drawings of the model, the calculation of structure capacity and stabilization, as well as the horizontal and vertical displacements of hoisting point when subjected to the horizontal and vertical loads respectively. The report will be ranked as ***excellent, fine, ordinary or bad*** and corresponding points will be given in the following form.

rank	excellent	fine	ordinary	bad
points	15	12	9	6

2.2 Model Appearance (15 %)

All the models will be ranked as ***excellent, fine, ordinary or bad*** according to design idea, sense of innovation, proportion and elegance, and will be given corresponding marks respectively.

rank	excellent	fine	ordinary	bad
points	15	12	9	6

2.3 Structure Behavior (70 %)

The lightest model which passes all loading tests within the permitted displacements will be given 70 points for this item. The score for the structural performance of Model ***i*** *i*s calculated by

$$S_i = 70 \cdot \frac{M_{lightest}}{M_i} \cdot \beta$$

Which: S_i is the score of structure behavior of Model *i*.

$M_{lightest}$ is the lightest mass of all models which passes the three loading tests.

M_i is the mass of the tested Model *i*.

β_i is the reduction coefficient for unfavorable tested displacement of Model *i*, which calculated as

$$\beta_i = \frac{12}{d_v} \cdot \frac{10}{d_h}$$

The d_v and d_h are the vertical displacement and horizontal displacement respectively which automatically recorded after static loading tests.

Notes:

a. The structure will be marked zero for this item if it collapses during the loading procedure or shows no capability for the next load step. The structure which could not hold the load for 10s after the impact load will not be given scores for this item.

b. When two models gain the same score, the lighter one will be ranked before the other.

c. The final score for each participating team is the sum of the scores obtained from each item stated above and will be announced right away.

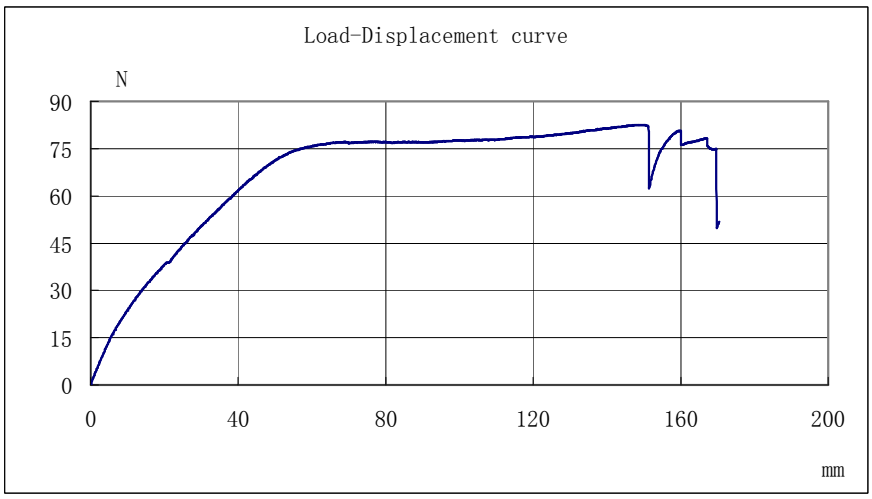
The 5th IUICEC Organizing Committee
College of Civil Engineering
Tongji University
Dec. 12th, 2007

Appendix 1

Test on Tensile Strength of Nylon Cord

Ten nylon cord specimens were tested, and the diameters of the specimens are 1mm. The Loading speed is 10mm per minute.

Specimen	Ultimate load(N)	Tensile strength(N/mm^2)	Modulus(N/mm^2)
1	76.47	97.41	998
2	80.45	102.48	1032
3	79.87	101.75	1539
4	80.51	102.56	1513
5	83.71	106.64	1205
6	83.33	106.15	1058
7	82.56	105.17	1060
8	82.62	105.25	983
9	76.21	97.08	1294
10	80.45	102.48	1213
Equalizing value $\bar{X}$	80.62	102.70	1189.5
Standard deviation $S=\sqrt{\frac{\sum(X_i-\bar{X})^2}{n-1}}$	2.62	3.34	204.6
Variance $S_v=\pm\frac{S}{\sqrt{n}}$	± 0.83	± 1.06	± 64.7
Coefficient of variability $V=\frac{S}{\bar{X}}\times 100$	3.25	3.25	17.2
Reliability of standard $P=\frac{2S_v}{\bar{X}}\times 100$	2.06	2.06	10.9



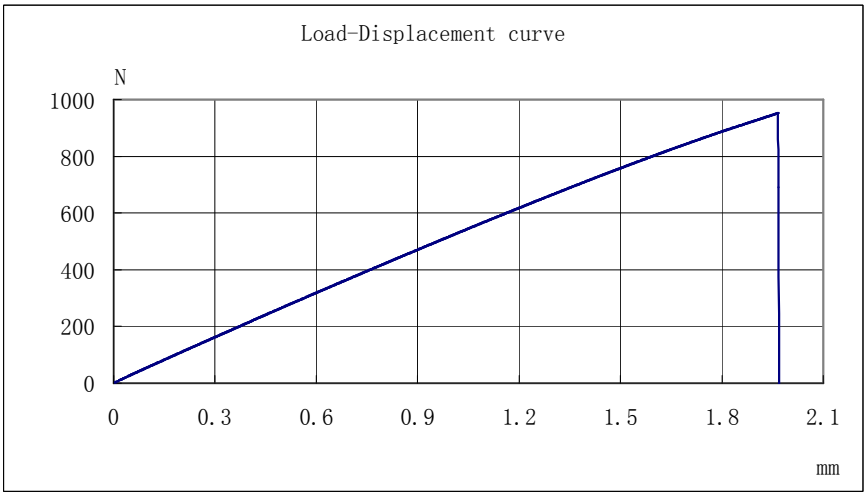
Typical curve of test on tensile strength of nylon cord

Test on Tensile Strength of Wood Slat

Thirty-five specimens were tested, and the cross-sections of the specimens are $1mm \times 27.5mm$. The Loading speed is 1mm per minute.

Specimen	Ultimate load(N)	Tensile strength(N/mm^2)	Modulus(N/mm^2)
1	1074.10	39.06	4882
2	926.41	33.69	4555
3	1042.63	37.91	4025
4	1037.18	37.72	3666
5	871.86	31.70	3967
6	790.19	28.73	3298
7	957.75	34.83	4556
8	1208.27	43.94	4476
9	855.06	31.09	4076
10	786.40	28.60	3651
11	990.00	36.00	4696
12	1120.19	40.73	4725
13	970.83	35.30	4122
14	994.16	36.15	4203
15	838.84	30.50	3774
16	786.15	28.59	4207
17	771.73	28.06	3946
18	1043.52	37.95	4949
19	788.27	28.66	3961
20	1053.08	38.29	4866
21	1132.63	41.19	4570
22	966.85	35.16	4537
23	974.03	35.42	4381
24	1163.39	42.31	4301
25	1001.79	36.43	5560
26	757.62	27.55	4111
27	811.15	29.50	3921
28	899.29	32.70	4732
29	769.29	27.97	3559
30	998.40	36.31	5628
31	1051.02	38.22	5504
32	991.92	36.07	4972
33	917.69	33.37	6111
34	952.37	34.63	4577
35	977.24	35.54	5160
Equalizing value $\bar{X}$	950.61	34.57	4463.6
Standard deviation $S = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n-1}}$	121.97	4.44	634.2

Variance $S_v = \pm \frac{S}{\sqrt{n}}$	± 20.62	± 0.75	± 107.2
Coefficient of variability $V = \frac{S}{\overline{X}} \times 100$	12.83	12.83	14.2
Reliability of standard $P = \frac{2S_v}{\overline{X}} \times 100$	4.34	4.34	4.8



Typical curve of test on tensile strength of wood board