



A STUDY ON THE DEFORMATION AND RESPONSE OF A FISH CAGE IN CURRENTS AND WAVES

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Introduction

- Abstract

- Fish cages are increasingly important
- It is more difficult to install the cage in offshore due to poor water quality



Open sea cages are needed to new design technology due to harsh oceanic factors

● Purpose

- Two different types of the model cages were used for the current and wave experiments
- To understand the differences of submergence deformation and tension acting on the mooring line were measured.
- Providing more accurate data to design of fish cage

Materials and methods

- **Materials - Cage**

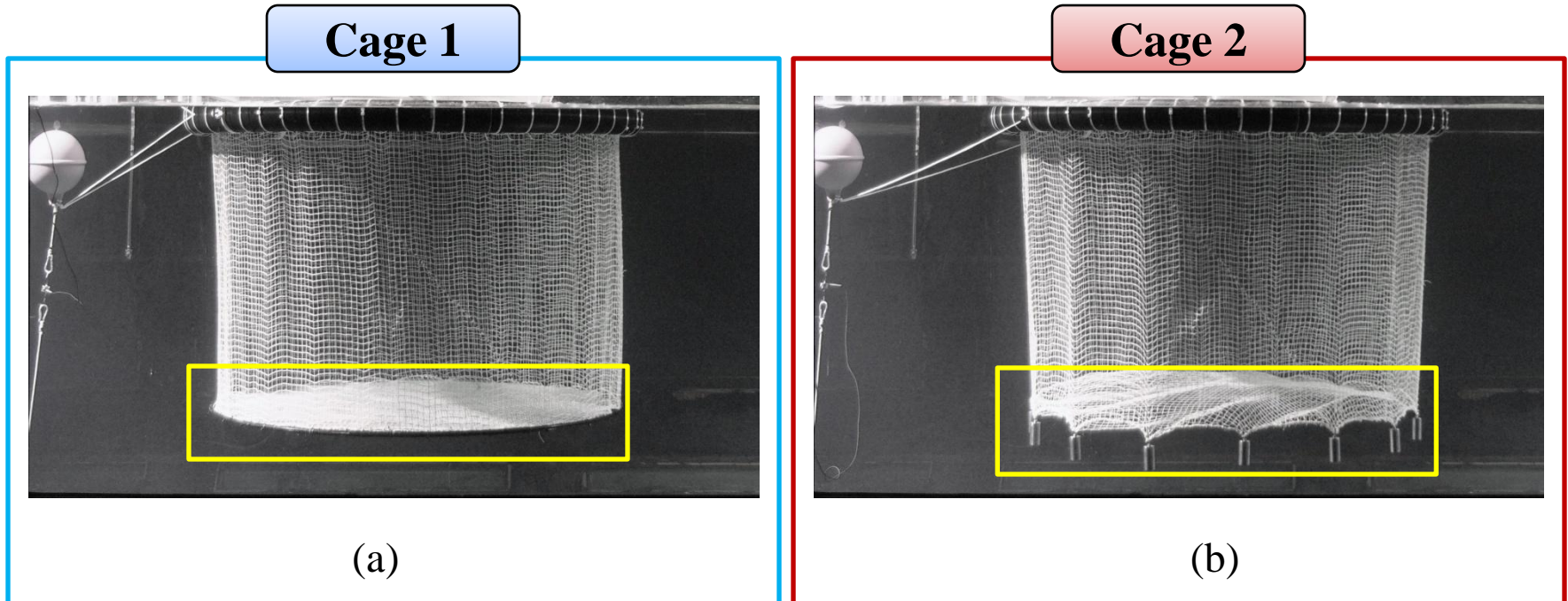


Fig. 1 Pictures of physical models and structural components; (a) model cage 1 with sinking collar and (b) model cage 2 with bottom weight sinkers.

Materials and methods

- **Materials – Specifications of cage models**

Table 1. Compare Cage1 with Cage2

Item	Cage 1 (with a sinking collar)	Cage 2 (with weights)
Floating Collar	Material : HDPE Density(gm/cc) : 0.953	
Netting	Material : Nylon Mesh Type : Knotless	
Bottom weights	Material : Staninless Weight(kg) : 7 Diameter(mm) : 1375 Thickness : 15	-
Sinking Collar	-	Material : Iron Number of piece : 14 Total weight(kg) : 7

Materials and methods

- Materials – Specifications of cage models

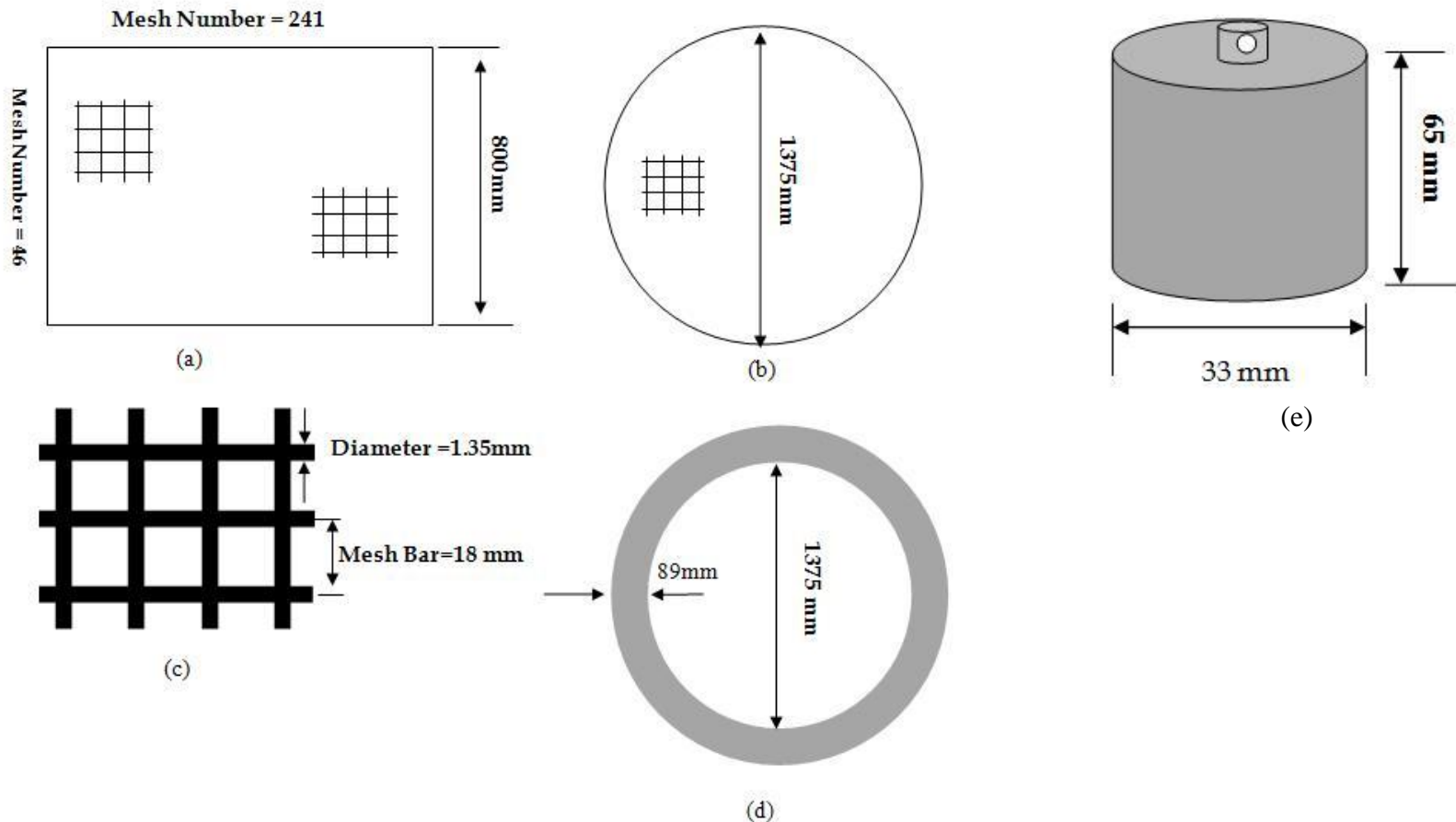


Fig. 2 Design plans for cage components; (a) netting, (b) bottom panel and (c) mesh, (d) thickness and diameter of floating collar and (e) weights.

Materials and methods

- Flume tank test set up (unit : cm)

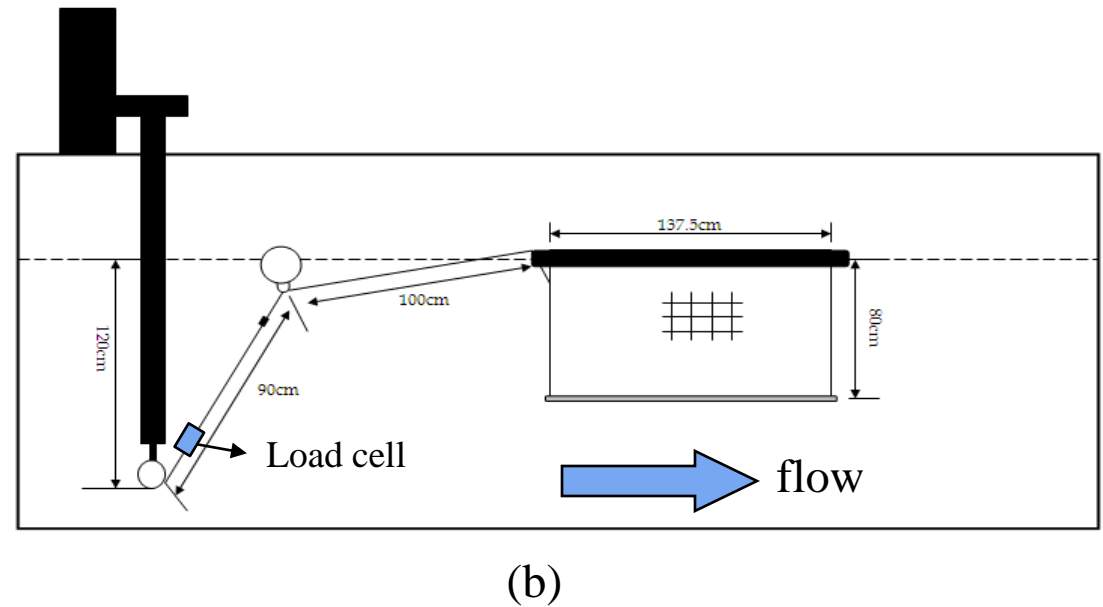
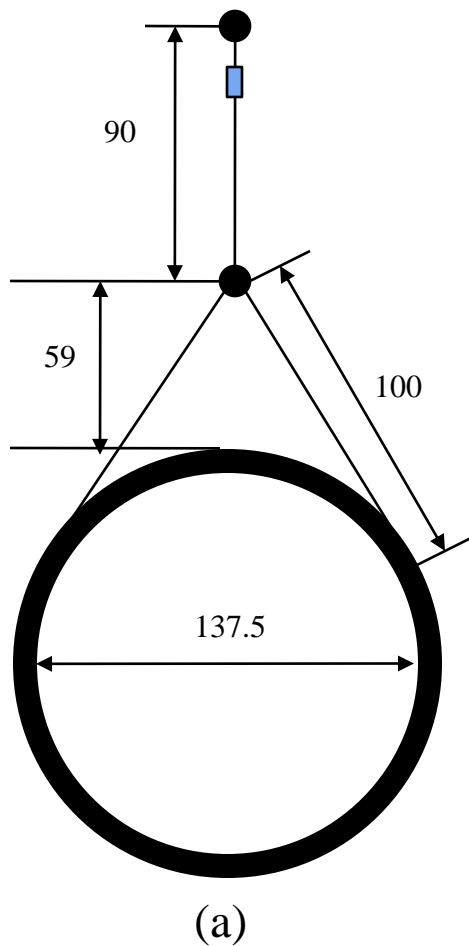


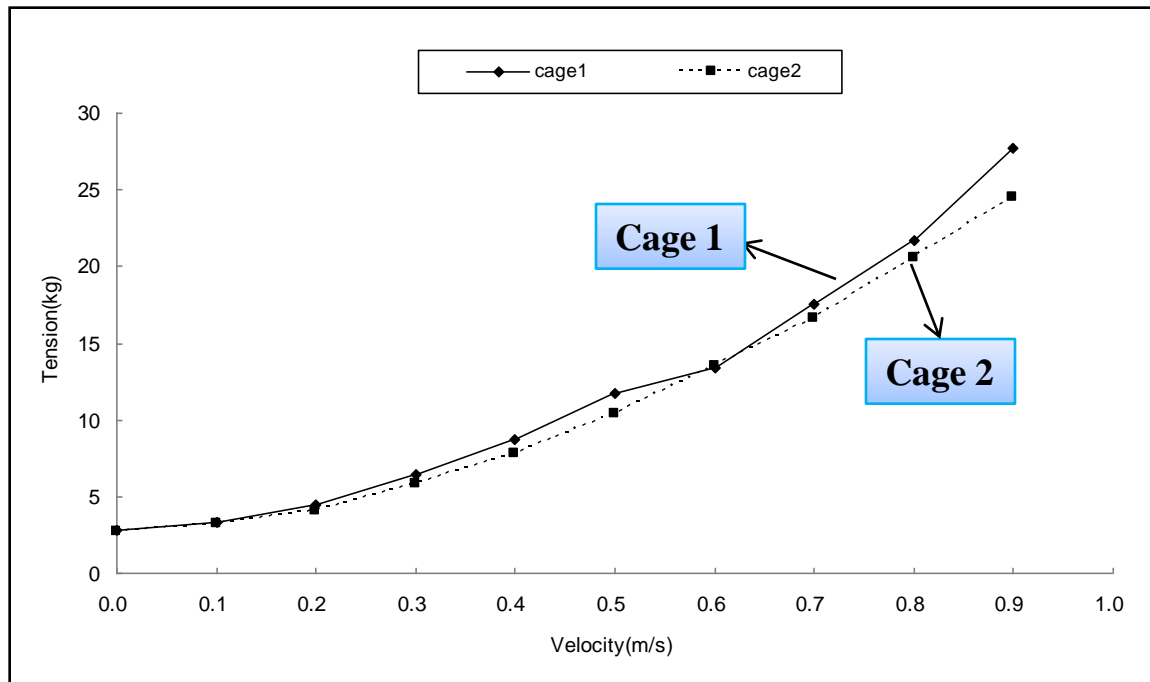
Fig. 3 Designs and experimental arrangement of cages in flume tank (a) dimensions of the mooring system in the flume tank (top view), (b) side view of cage model

- **Flume tank test set up**

- **Flume tank (unit : m)**
 - ✓ Size : 25.4(L) x 4.5(W) x 8.7(H)
 - ✓ Observe window : 8(L) x 2.8(W) x 1.8(H)
 - ✓ Depth : 1.4
- **Condition of current speed**
 - ✓ 0m/s ~ 0.9m/s (interval : 0.1m/s)

Result and discussion

● Result of current velocities



Tension

- Cage 1 higher than Cage 2
- Cage 1 shall have a greater tension than Cage 2 above the current speed

Fig. 5 Variations in tension acting on the mooring line

Result and discussion

- **Result of current velocities**

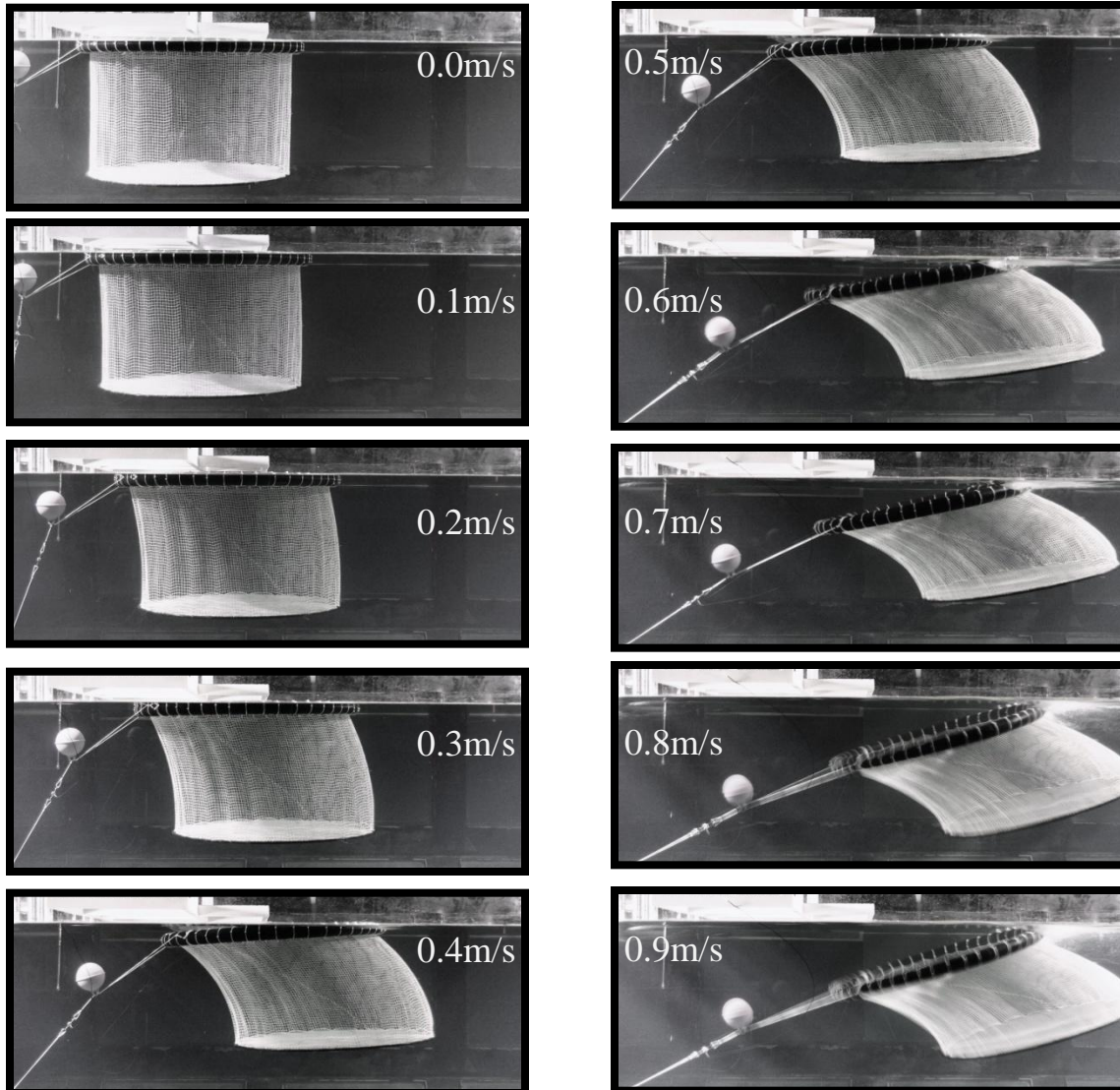


Fig. 6 Show the deformation of the model cages 1 according to the current velocity

Result and discussion

- Result of current velocities

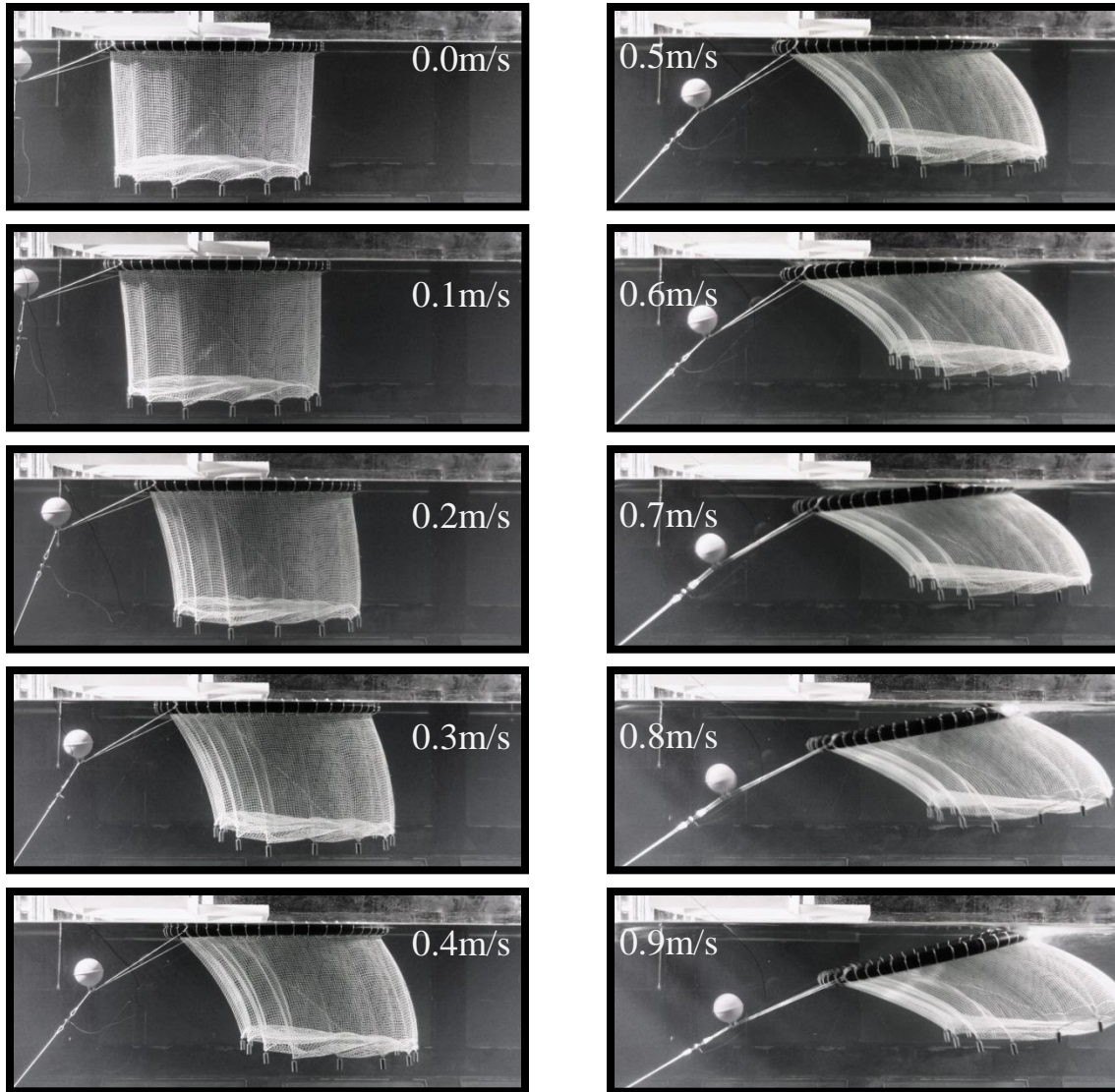
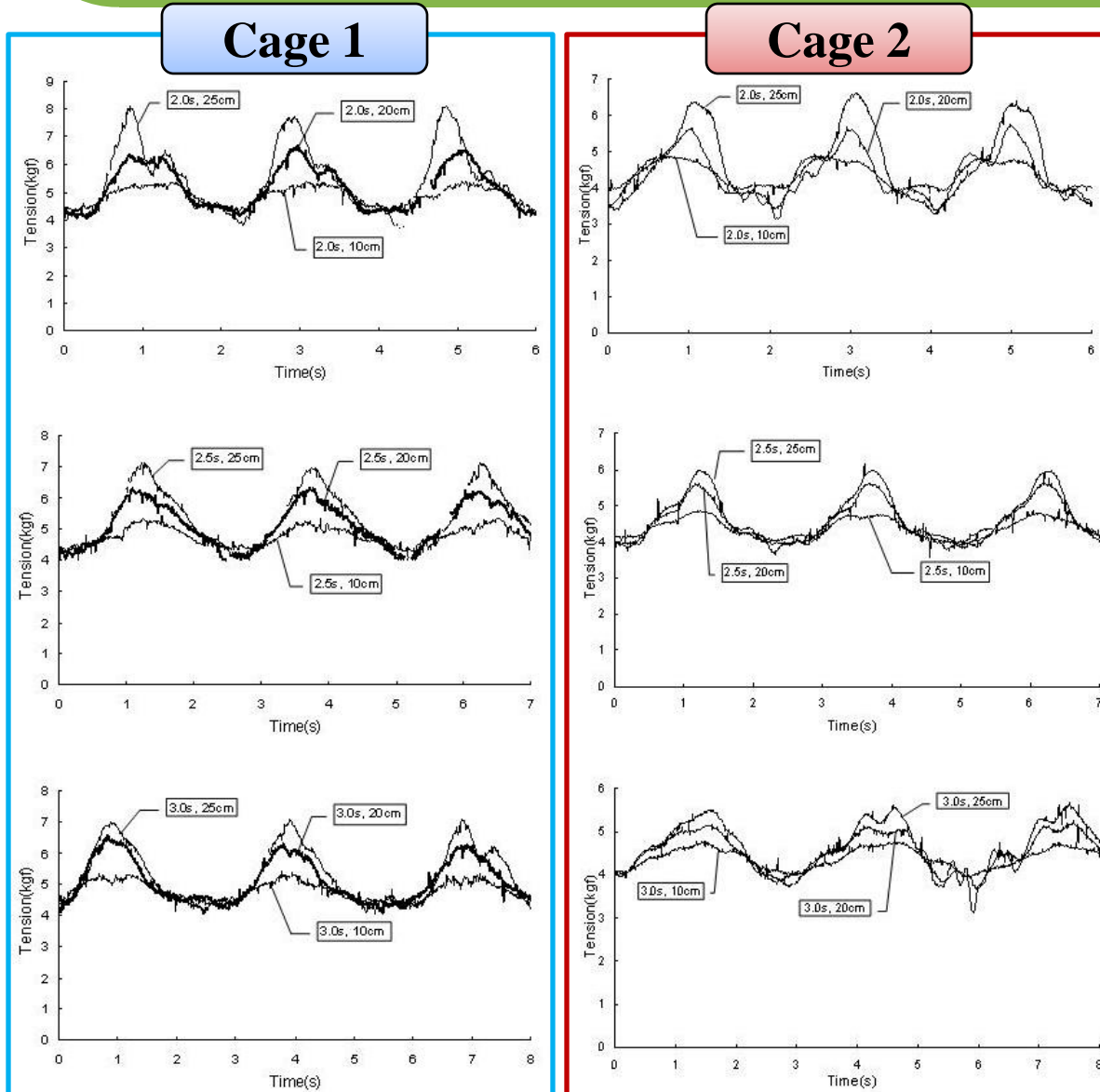


Fig. 7 Show the deformation of the model cages 2 according to the current speed

Result and discussion

● Result of waves



Tension

- Inverse proportion to the wave cycle and in proportion to the wave height
- Cage 1 Higher than Cage 2

Fig. 8 Show the tension of the model cages according to waves

Result and discussion

- Result of waves

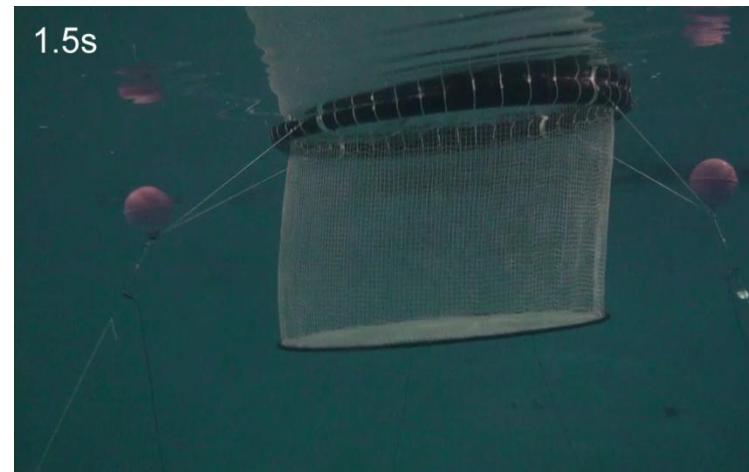
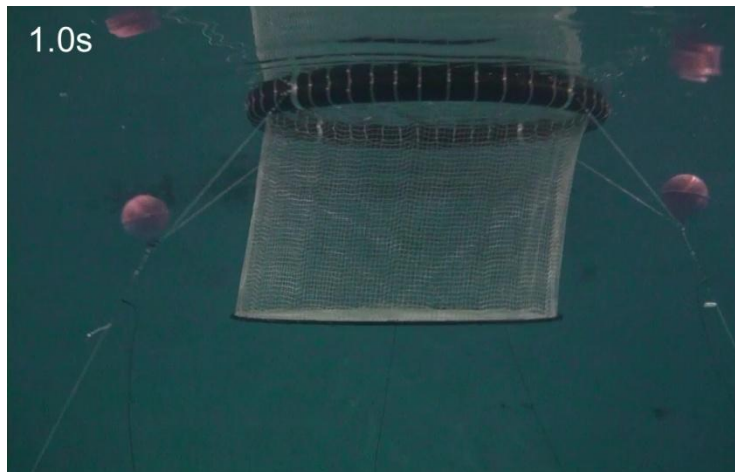
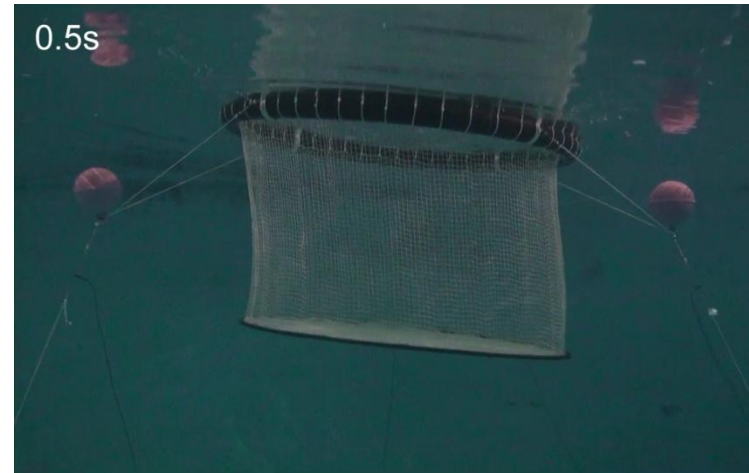


Fig. 9 Successive side shapes of the model cage exposed to waves(2.0s, 20cm);
(a) cage 1 with the sinking collar

Result and discussion

- **Result of waves**

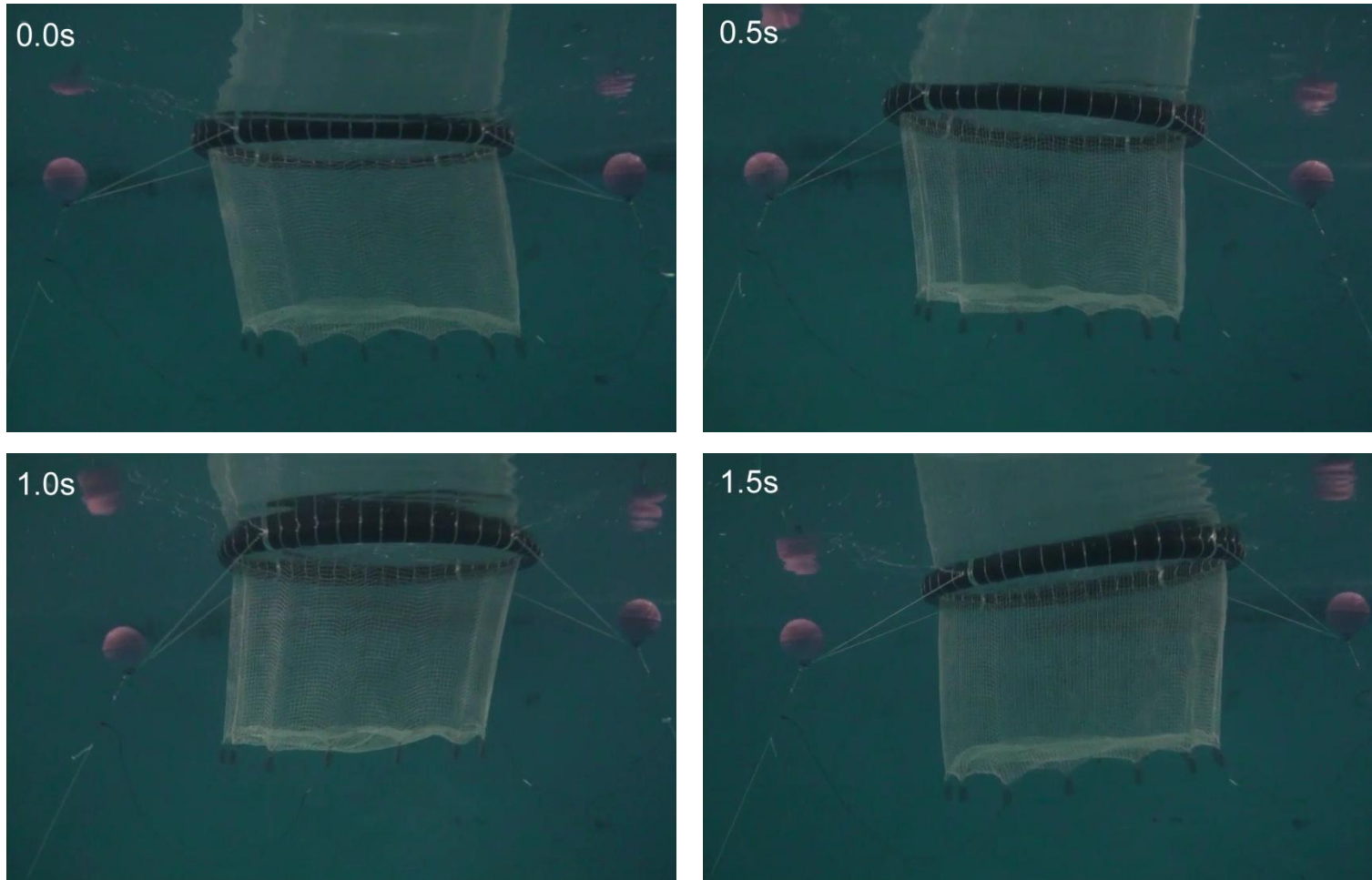


Fig. 10 Successive side shapes of the model cage exposed to waves(2.0s, 20cm);
(a) cage 2 with weights

● Conclusion

- As the current speed increase, the tension increases and deformation of the cage model is also increased
- Cage 1 is less deformed than cage 2 at specific current speed but tension more than cage 2
- According to results of comparing tensions acting on Cage 1 and Cage 2 in waves, the tension is inversely proportional to the wave period and in proportional to the wave height.
- Cage 1 is less deformed than cage 2 at specific wave and more tension than cage 2

Results of Fish Cage Simulation

● 0.7m/s

금영_4ton_c14_수평.fxn - SimuCage

File View ViewSetting Simulation Movie Play Speed Record DataSetting WaveControl Calculation Method Connect Rope User Help

▶ X-axis ▶ Y-axis ▶ Z-axis

Elapsed time : 134.072006 sec
Water Depth : 60.00 m
Time Step : 0.000200 sec
Saving Interval : 1.00 sec
Boundary Area : 0.00
Total Frame : 0
Loaded Frame : 0, Played Frame : 0
Cage Volume : 0.00000
Calculation Method : Runge Kutta
Current 1 : Direction 270.00 Speed 0.70 m/s

Record List

Recorded Data

1	0.00200
2	2.00011
3	4.00004
4	6.00018
5	8.00013
6	10.00004
7	12.00015
8	14.00007
9	16.00018
10	18.00009
11	20.00000
12	22.00012

Add Delete

Selection

POINT

Num		
Posit (m)	X	
	Y	
	Z	
Speed (m/s)	X	
	Y	
	Z	
Type		
Distance		m

LINE

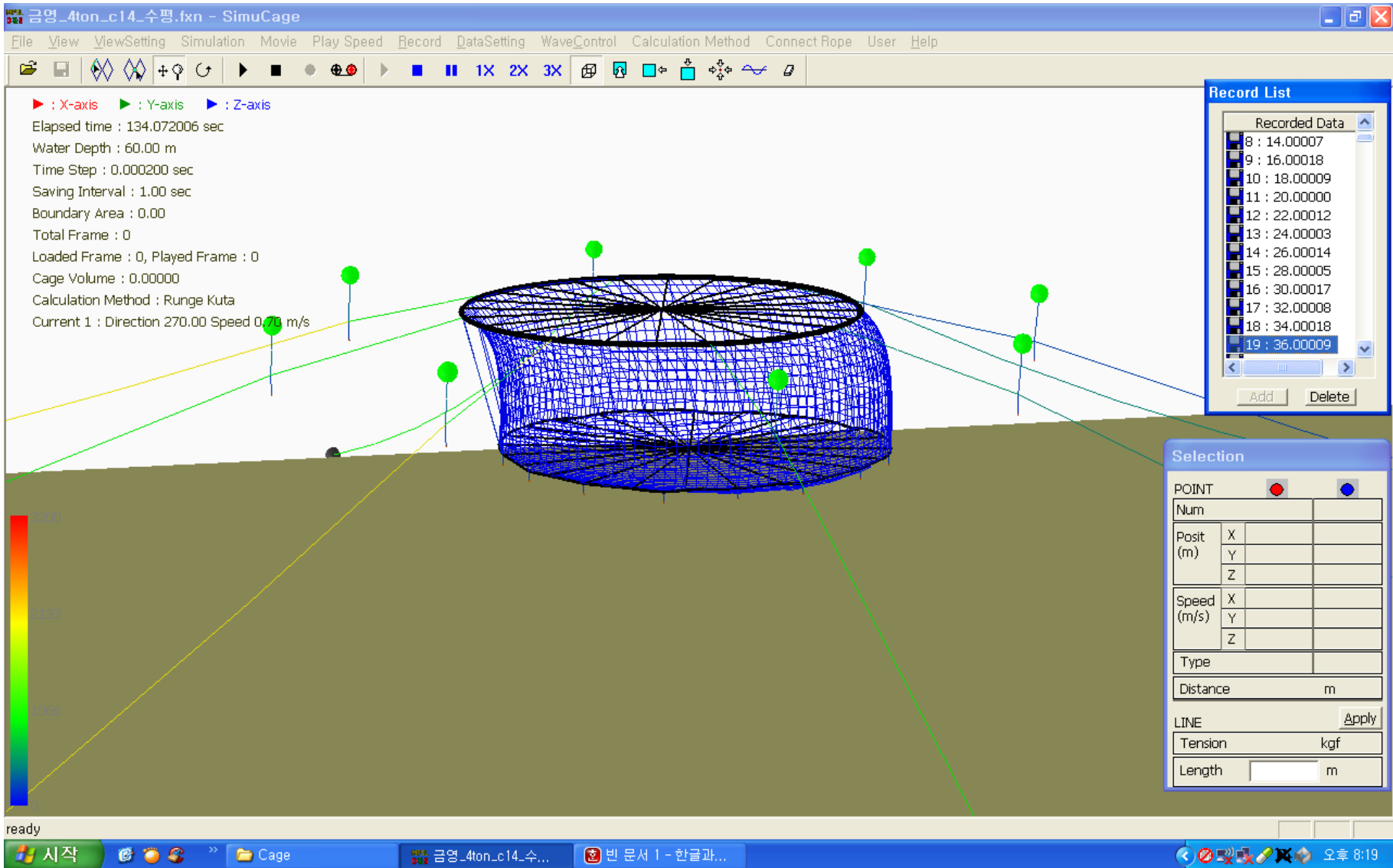
Tension	kgf
Length	m

ready

시작 Cage 금영_4ton_c14_수... 빈 문서 1 - 한글과... 오후 8:17

Results of Fish Cage Simulation

● 0.7m/s



Results of Fish Cage Simulation

● 0.7m/s

금영_4ton_c14_수평.fxn - SimuCage

File View ViewSetting Simulation Movie Play Speed Record DataSetting WaveControl Calculation Method Connect Rope User Help

▶ : X-axis ▶ : Y-axis ▶ : Z-axis

Elapsed time : 134.072006 sec
Water Depth : 60.00 m
Time Step : 0.000200 sec
Saving Interval : 1.00 sec
Boundary Area : 0.00
Total Frame : 0
Loaded Frame : 0, Played Frame : 0
Cage Volume : 0.00000
Calculation Method : Runge Kutta
Current 1 : Direction 270.00 Speed 0.70 m/s

Record List

Recorded Data

- 12 : 22.00012
- 13 : 24.00003
- 14 : 26.00014
- 15 : 28.00005
- 16 : 30.00017
- 17 : 32.00008
- 18 : 34.00018
- 19 : 36.00009
- 20 : 38.00020
- 21 : 40.00011
- 22 : 42.00002
- 23 : 44.00012

Add Delete

Selection

POINT

Num		
Posit (m)	X	
	Y	
	Z	
Speed (m/s)	X	
	Y	
	Z	
Type		
Distance		m

LINE Apply

Tension	kgf
Length	m

ready

시작 Cage 금영_4ton_c14_수... 빈 문서 1 - 한글과... 오후 8:19

Results of Fish Cage Simulation

● 0.7m/s

금영_4ton_c14_수평.fxn - SimuCage

File View ViewSetting Simulation Movie Play Speed Record DataSetting WaveControl Calculation Method Connect Rope User Help

▶ : X-axis ▶ : Y-axis ▶ : Z-axis

Elapsed time : 134.072006 sec
Water Depth : 60.00 m
Time Step : 0.000200 sec
Saving Interval : 1.00 sec
Boundary Area : 0.00
Total Frame : 0
Loaded Frame : 0, Played Frame : 0
Cage Volume : 0.00000
Calculation Method : Runge Kutta
Current 1 : Direction 270.00 Speed 0.70 m/s

Record List

Recorded Data

15	: 28.00005
16	: 30.00017
17	: 32.00008
18	: 34.00018
19	: 36.00009
20	: 38.00020
21	: 40.00011
22	: 42.00002
23	: 44.00012
24	: 46.00003
25	: 48.00014
26	: 50.00005

Add Delete

Selection

POINT

Num		
Posit (m)	X	
	Y	
	Z	
Speed (m/s)	X	
	Y	
	Z	
Type		
Distance		m

LINE

Tension	kgf
Length	m

ready

시작 Cage 금영_4ton_c14_수... 빈 문서 1 - 한글과... 오후 8:20

Results of Fish Cage Simulation

● 0.7m/s

금영_4ton_c14_수평.fxn - SimuCage

File View ViewSetting Simulation Movie Play Speed Record DataSetting WaveControl Calculation Method Connect Rope User Help

▶ X-axis ▶ Y-axis ▶ Z-axis

Elapsed time : 134.072006 sec
Water Depth : 60.00 m
Time Step : 0.000200 sec
Saving Interval : 1.00 sec
Boundary Area : 0.00
Total Frame : 0
Loaded Frame : 0, Played Frame : 0
Cage Volume : 0.00000
Calculation Method : Runge Kutta
Current 1 : Direction 270.00 Speed 0.70 m/s

Record List

Recorded Data

- 18 : 34.00018
- 19 : 36.00009
- 20 : 38.00020
- 21 : 40.00011
- 22 : 42.00002
- 23 : 44.00012
- 24 : 46.00003
- 25 : 48.00014
- 26 : 50.00005
- 27 : 52.00015
- 28 : 54.00006
- 29 : 56.00017

Add Delete

Selection

POINT

Num		
Posit (m)	X	
	Y	
	Z	
Speed (m/s)	X	
	Y	
	Z	
Type		
Distance		m

LINE

Tension	kgf
Length	m

ready

시작 Cage 금영_4ton_c14_수... 빈 문서 1 - 한글과... 오후 8:20

Results of Fish Cage Simulation

● 0.7m/s

금영_4ton_c14_수평.fxn - SimuCage

File View ViewSetting Simulation Movie Play Speed Record DataSetting WaveControl Calculation Method Connect Rope User Help

▶ X-axis ▶ Y-axis ▶ Z-axis

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Water Depth : 60.00 m
Time Step : 0.000200 sec
Saving Interval : 1.00 sec
Boundary Area : 0.00
Total Frame : 0
Loaded Frame : 0, Played Frame : 0
Cage Volume : 0.00000
Calculation Method : Runge Kutta
Current 1 : Direction 270.00 Speed 0.70 m/s

Record List

Recorded Data

- 22 : 42.00002
- 23 : 44.00012
- 24 : 46.00003
- 25 : 48.00014
- 26 : 50.00005
- 27 : 52.00015
- 28 : 54.00006
- 29 : 56.00017
- 30 : 58.00008
- 31 : 60.00018
- 32 : 62.00009
- 33 : 64.00020

Add Delete

Selection

POINT

Num		
Posit (m)	X	
	Y	
	Z	
Speed (m/s)	X	
	Y	
	Z	
Type		
Distance		m

LINE

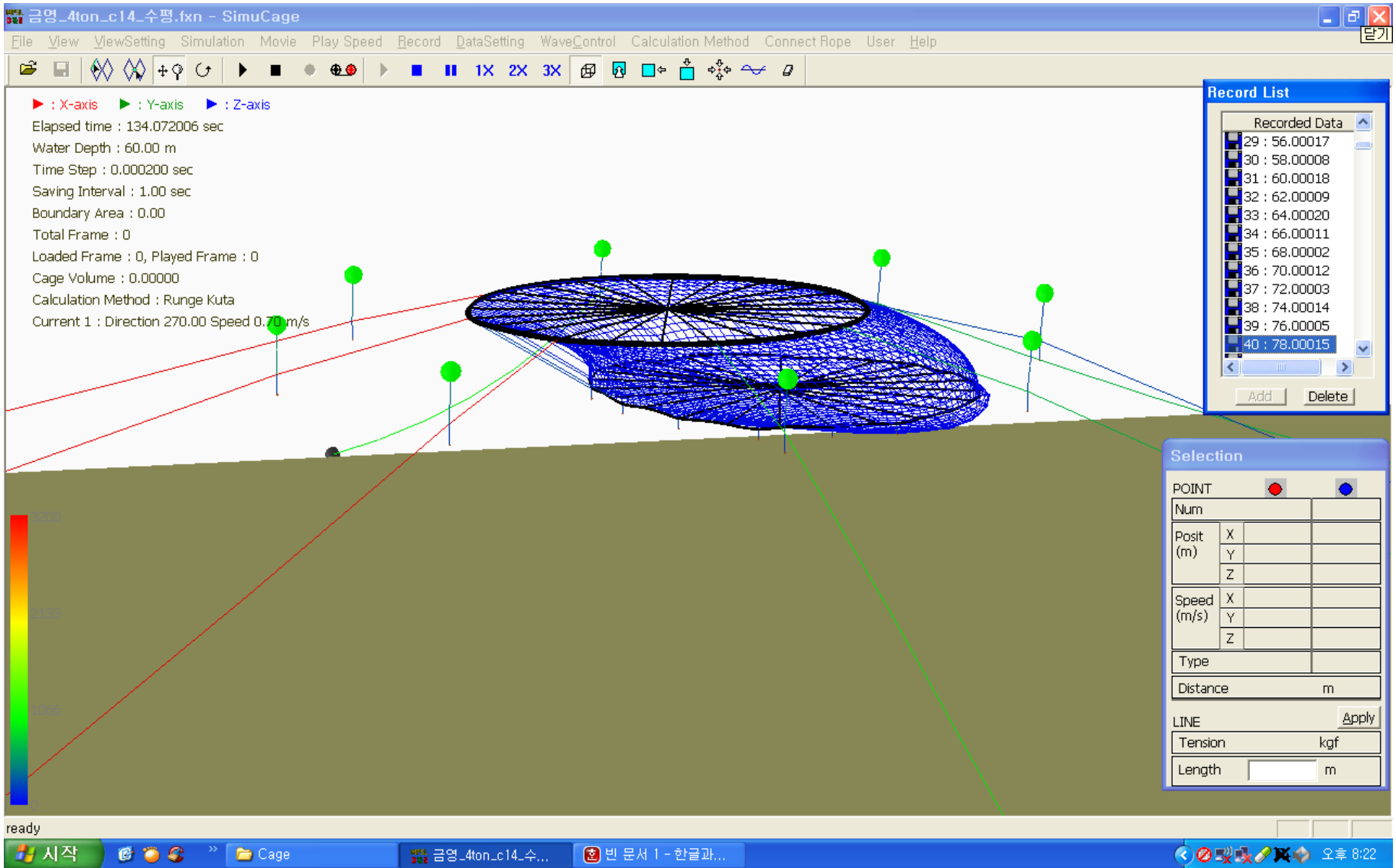
Tension	kgf
Length	m

ready

시작 Cage 금영_4ton_c14_수... 빈 문서 1 - 한글과... 오후 8:21

Results of Fish Cage Simulation

● 0.7m/s



Thank You !