

# 와이어 래핑 방법을 이용한 침몰 선박의 인양 시뮬레이션

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## Lifting Simulation of a Sunken Ship Using the Wire Wrapping Method

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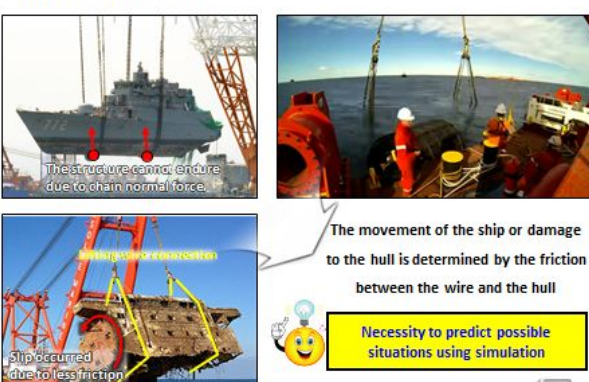
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핵심용어 : 와이어 래핑 방법, 선체 인양, 와이어 마찰력

Key Words : wire wrapping method, wreck removal, wire friction

**1. Introduction**  
(2) Research Necessities



The structure cannot endure due to chain normal force.

Slip occurred due to less friction

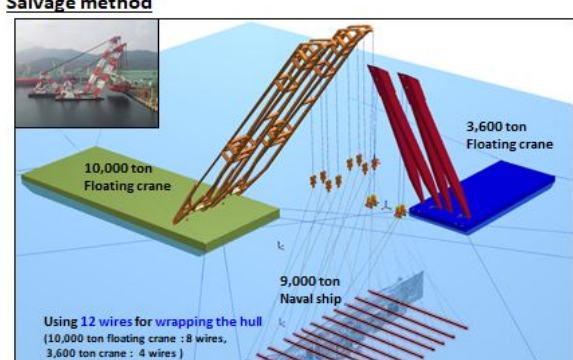
The movement of the ship or damage to the hull is determined by the friction between the wire and the hull

Necessity to predict possible situations using simulation

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**3. Application**  
(2) Lifting Naval Ship Using Wire Wrapping Method

**Salvage method**



10,000 ton Floating crane

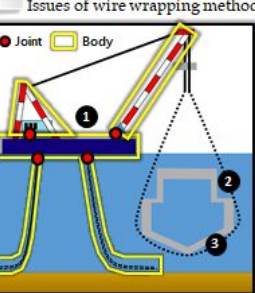
3,600 ton Floating crane

9,000 ton Naval ship

Using 12 wires for wrapping the hull (10,000 ton floating crane : 8 wires, 3,600 ton crane : 4 wires)

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**2. Theoretical backgrounds**  
Issues of wire wrapping method



1 **Multibody dynamics**  
Discrete Euler-Lagrange equation

$$\begin{bmatrix} M & -G \\ G & \varepsilon \end{bmatrix} \begin{bmatrix} \ddot{q}_{i+1} \\ \ddot{\lambda}_{i+1} \end{bmatrix} = \begin{bmatrix} M(2\dot{q}_i - \dot{q}_{i+1}) - h^2 F(q_i, \dot{q}_{i+1}) \\ -g(q_i) + G_i q_i \end{bmatrix}$$

2 **Wire contact**  
Constraint-based Wire Rope with Contact

- Constraint-based wire  $g_i(q) = l - l_{initial} = 0$
- Constraint-based wire with contact  $g_i'(q) = l_{in} + l_{out} - l_{initial} = 0$

3 **Wire friction analysis**

Sliding along the wire

Sliding across the wire

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**4. Conclusions and future works**

**Conclusions**

- In this study, wire wrapping method is adopted for the multibody system using multibody dynamics.
- The friction between the wire rope and the hull is applied by two different ways (Sliding along the wire & Slide across the wire) and simulation performed well.

**Future works**

- It will be applied to the dynamic analysis of various cases in wreck removal.
- It will be compared with the actual wreck removal result.

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