# ผลตอบสนองทางพลศาสตร์สำหรับเคเบิ้ลยึดโยงแผงโซล่าเซลล์ลอยน้ำเมื่อรับการกระตุ้นที่ปลายด้านบน
# Dynamic Responses of a Floating Solar Mooring Cable with the Top End Excitation

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## บทคัดย่อ



## 1. บทนำ

30

[1]

Newmark

[2]

penalty

Lee [3]

PFRP

PFRP

, , ,

,

## Abstract

This research aims to investigate the effect of top end excitation on the dynamic responses of a mooring cable, which is installed in a floating photovoltaic system. The mathematical model formulation of the elastic cable is developed based on the principle of virtual work. The nonlinear static configurations of cables are evaluated by using the nonlinear finite element procedure. The Newmark's time integration is applied to determine the dynamic responses of a mooring cable due to the harmonic top end excitation. The constraint conditions of the top end excitation are imposed in the equation of motions by using the penalty method. According to the top end sway and heave excitation, the effects of amplitude and frequency of the top end excitation on the dynamic responses of cable are investigated.

Keywords: Dynamic responses, Finite element method, Floating solar photovoltaic, Mooring Cable, Top end excitation

[4]

[5-6]

[6]

[7]

[8]

Newmark

[ ]

Newmark

Klaycham

[ ]

penalty

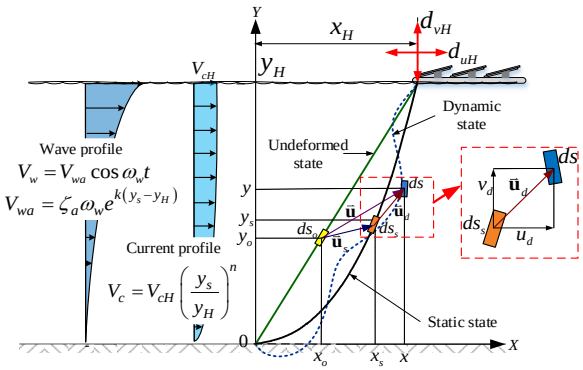
Newmark

[10]

penalty

Newmark

## 2. แบบจำลองทางคณิตศาสตร์




**รูปที่ 1**

(Hinge)

$s'_s = \left(1 + x'^2_s\right)^{1/2}$

$\rho_e$ ( )
$A_e$ ( )
$C_a$
$m_P$
$\rho_P$
$A_P$
$E$
$V_{cH}$
$\zeta_a$
$\omega_w$
$y_H$
$g$
$()'$ $y_s$ $x_s$ $y_s$
$N_{as}$
$C^*_{eqx}, C^*_{eqy}, C^*_{eqxy}, C^*_{Dx}$ $C^*_{Dxy1}$
$n$
[10] $[\mathbf{N}_d]$
$\{\mathbf{d}_d\}, \{\dot{\mathbf{d}}_d\}$ $\{\ddot{\mathbf{d}}_d\}$
node
Klaycham [ ]

*2.2*

penalty

$d_{uH} = u_0 \sin\left(\omega_u t + \phi_u\right)$
$d_{vH} = v_0 \sin\left(\omega_v t + \phi_v\right)$

$d_{uH}$
$d_{vH}$
$u_0$
$v_0$
$\omega_u$
$\omega_v$
$\Phi_u$
$\Phi_v$

penalty

$$\{\mathbf{t}\} = [\mathbf{K}_\alpha]^T \{\mathbf{D}_d\} - \{\mathbf{P}\} = \{\mathbf{0}\}$$

$[\mathbf{K}_\alpha]$ node

$$[\mathbf{K}_\alpha]^T = \begin{bmatrix} 0 & 0 & \dots & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \dots & 0 & 0 & 0 & 1 & 0 & 0 \end{bmatrix}$$

$\{\mathbf{P}\}$

$$\{\mathbf{P}\} = \begin{Bmatrix} u_0 \sin\left(\omega_u t + \phi_u\right) \\ v_0 \sin\left(\omega_v t + \phi_v\right) \end{Bmatrix}$$

( ) $\partial t/\partial D_d=0$
( )

$$[\mathbf{M}]\{\ddot{\mathbf{D}}_d\} + [\mathbf{C}]\{\dot{\mathbf{D}}_d\} + [\mathbf{K}]^* \{\mathbf{D}_d\} = \{\mathbf{F}\}^*$$

$$[\mathbf{K}]^* = [\mathbf{K}] + [\mathbf{K}_\alpha][\boldsymbol{\alpha}][\mathbf{K}_\alpha]^T$$
$$\{\mathbf{F}\}^* = \{\mathbf{F}\} + [\mathbf{K}_\alpha][\boldsymbol{\alpha}]\{\mathbf{P}\}$$

$[\boldsymbol{\alpha}]$ penalty

$$[\boldsymbol{\alpha}] = \alpha[\mathbf{I}]$$

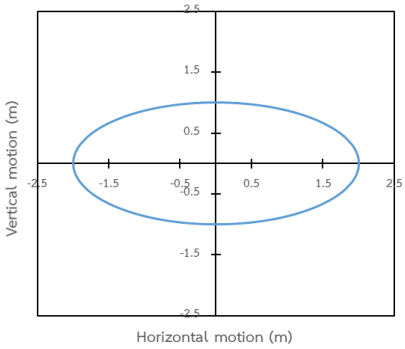
$\alpha$ penalty $[\mathbf{I}]$ 2x2

$\alpha$
Klaycham [10]
3
Newmark
$\gamma$ =1/2, $\beta$=

## 3. ผลการวิเคราะห์เชิงตัวเลข

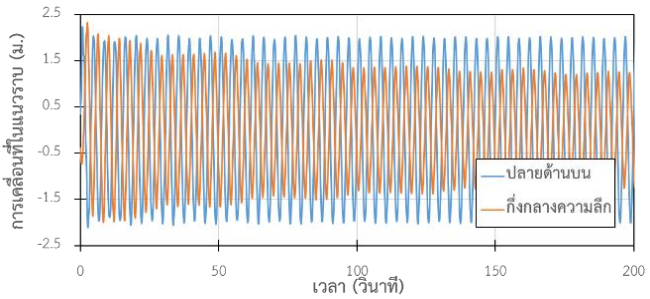
*3.1*

*3.3*

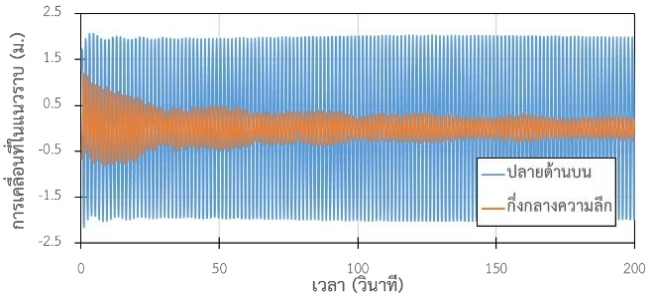



**รูปที่ 7**

90




$\omega_1$




$\omega_4$

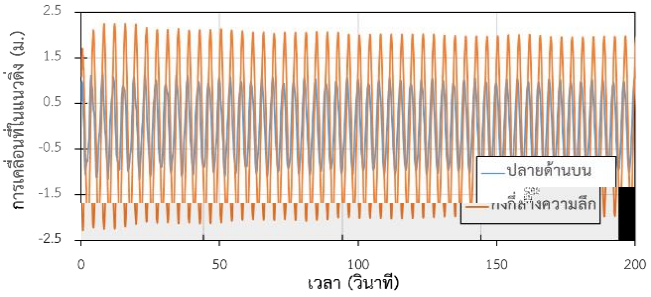
**รูปที่ 8**

$\omega_1$,

$\omega_2$, $\omega_3$ $\omega_4$ , , 5

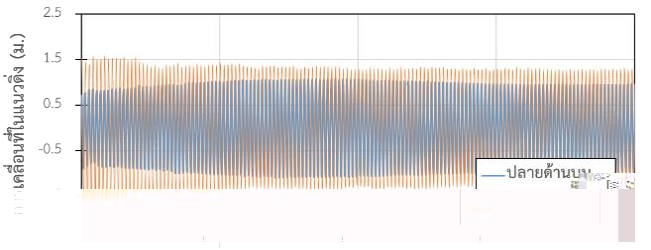
$A_1$, $A_2$, $A_3$ $A_4$ , ,

$A_3$




$\omega_1$

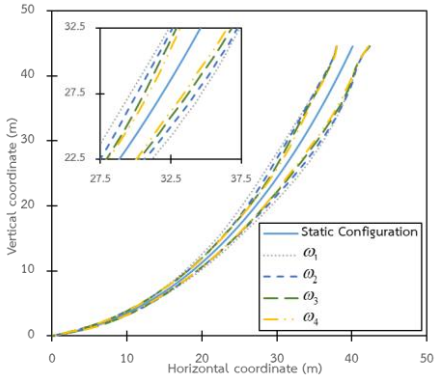
$A_2$

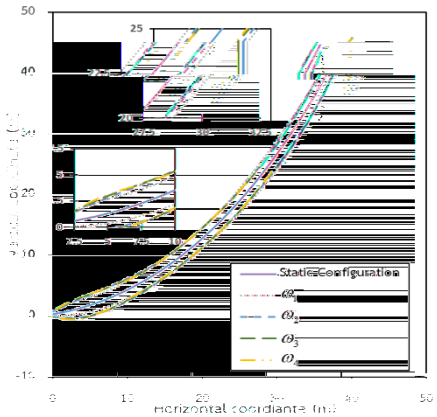



$\omega_4$

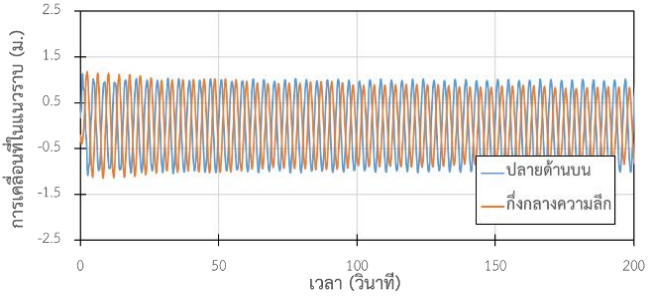
Steady state

**รูปที่ 9**

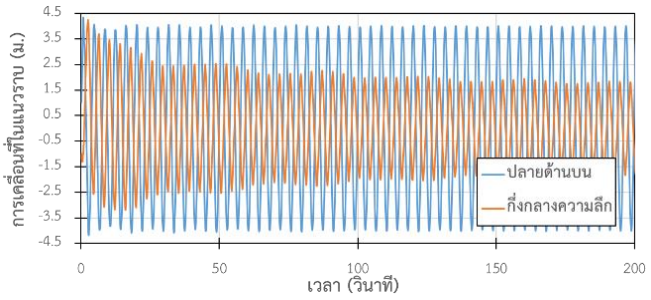



**รูปที่ 10**




$A_1$




$A_4$

**รูปที่ 11**

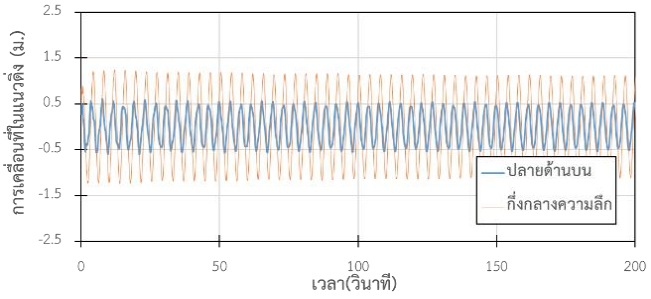
0

0

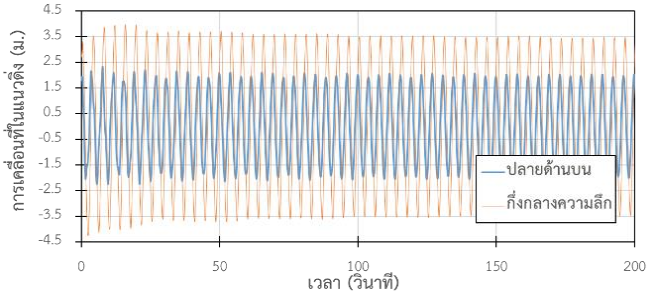
$\omega_1$ 1 1

2

2

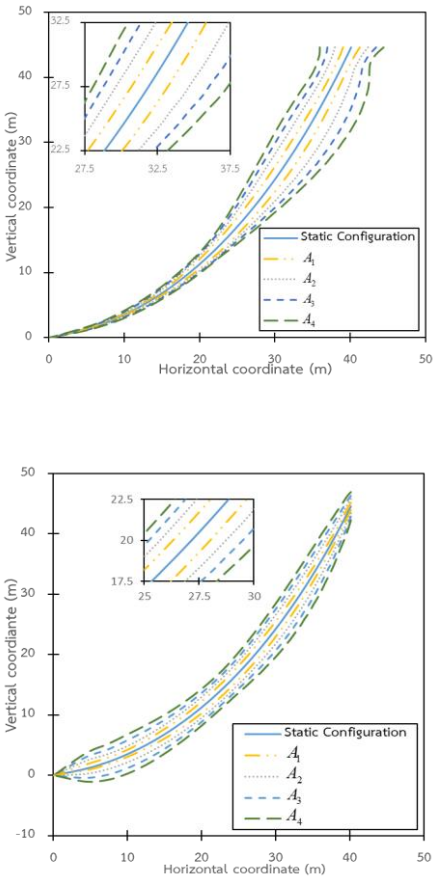



$A_1$

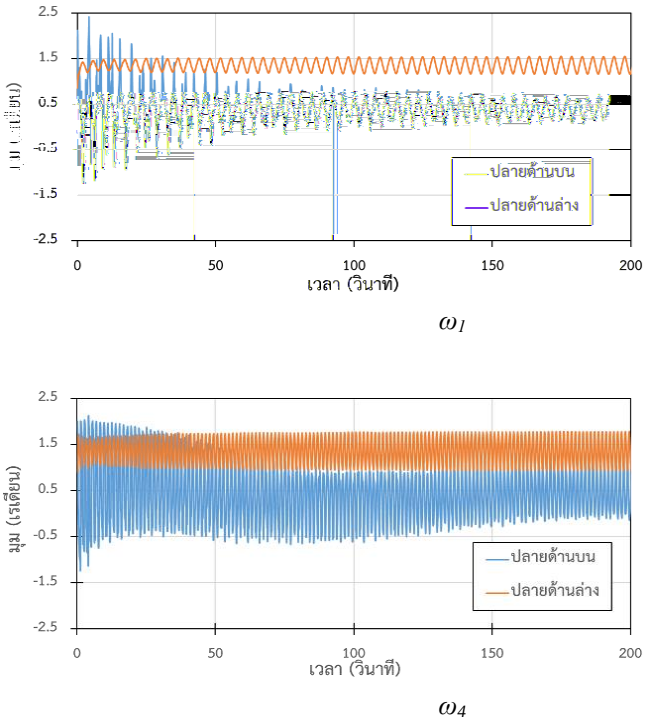



$A_4$

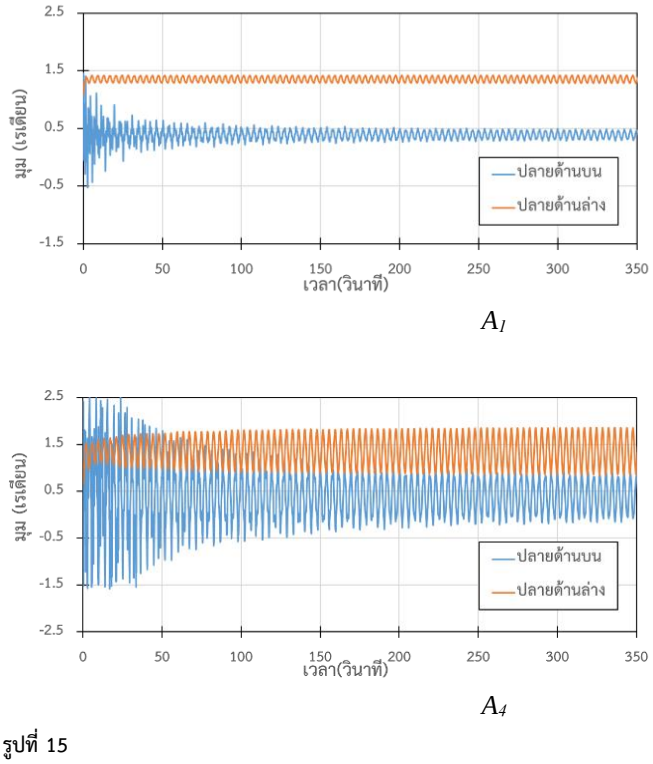
**รูปที่ 12**




รูปที่ 13




รูปที่ 14




รูปที่ 15

## 4. สรุปผลการวิจัย

## กิตติกรรมประกาศ

## เอกสารอ้างอิง

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[9] ,

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