## ( / / / / / / )

\*

## : سكوى اسپار، تئورى تفرق، تابع پتانسيل، معادله لاپلاس، تفاضل محدود

()



.

.

.

. . .

. . .

Email: ketabdar@aut.ac.ir , : , : :

ww<sup>\*</sup>w.SID.ir

.

(

.[]

:

.

Kim Ran. .[ ] . . Agarwal و Jain . . .[ ] . Klifsman Veldman ) VOF .[ ] . Kato Teng. . . ) . ( / .[ ] . Newman Ray . . . .[ ] . 1 .

:

تحلیل دینامیکی اندرکنش .....

(

$$x_{j}$$

$$\phi_R = \sum_{n=1}^{6} \dot{x}_j \cdot \phi_j \tag{()}$$

.

.

 $\nabla^2 \hat{\phi}_D = 0$  $-\omega^2 \cdot \hat{\phi}_D + g \left. \frac{\partial \hat{\phi}_D}{\partial z} \right|_{z=0} = 0$ 

:

 $\frac{\partial \hat{\phi}_D}{\partial z} \bigg|_{z=-h} = 0$  $\frac{\partial \hat{\phi}_D}{\partial n} = -\frac{\partial \hat{\phi}_I}{\partial n}$ 

j

$$\phi = \phi_I + \phi_D + \phi_R$$
 ( )

$$\nabla^2 \hat{\phi}_I = 0 \tag{()}$$

$$-\omega^{2}\cdot\hat{\phi}_{I} + g \left.\frac{\partial\hat{\phi}_{I}}{\partial z}\right|_{z=0} = 0 \qquad ()$$

$$\frac{\partial \hat{\phi}_I}{\partial z} \bigg|_{z=-h} = 0 \tag{()}$$

•

( )

( )

:

$$\frac{\partial \phi}{\partial z} + \frac{1}{g} \frac{\partial^2 \phi}{\partial t^2} \bigg|_{z=0} = 0$$
 ()

$$\nabla \phi \cdot \hat{n} = \frac{\partial \phi}{\partial n} = 0$$
 ()

$$\frac{\partial \phi_{I}}{\partial n} + \frac{\partial \phi_{D}}{\partial n} + \frac{\partial \phi_{R}}{\partial n} = V_{B}$$
())
$$n \qquad V_{B}$$

$$\frac{\partial \phi_I}{\partial n} + \frac{\partial \phi_D}{\partial n} = 0 \tag{()}$$

$$\frac{\partial \phi_R}{\partial n} = V_B \tag{)}$$

$$\nabla^{2} \phi_{R} = 0 \qquad ()$$

$$\frac{\partial^{2} \phi_{R}}{\partial t^{2}} + g \frac{\partial \phi_{R}}{\partial z}\Big|_{z=0} = 0 \qquad ()$$

:  

$$\phi(x, y, z, t) =$$

$$\operatorname{Re}\left\{\left[a \cdot \hat{\phi}_{I} + a \cdot \hat{\phi}_{D}\right] \cdot e^{i\omega t} + \phi_{R}\right\}$$
()

www.SID.ir

$$\frac{\partial \phi_R}{\partial z}\Big|_{z=-h} = 0 \tag{()}$$

$$\frac{\partial \phi_R}{\partial n} = \nabla \phi_R \cdot \hat{n} = \vec{V}_B \cdot \hat{n} \tag{()}$$

$$F(t) = \iint_{\overline{s}} P(t) \cdot \hat{n} \cdot ds = \iint_{\overline{s}} \rho \cdot \frac{d\phi}{dt} \cdot \hat{n} \cdot ds \qquad ()$$

.

C(t)

.

$$F(t) = ( )$$
  

$$\operatorname{Re}\{\iint_{\overline{s}} i\rho\omega \cdot \boldsymbol{e}^{i\omega t} \cdot \hat{n} \cdot (a[\hat{\phi}_{l} + \hat{\phi}_{D}] + \hat{x}_{n} \cdot \hat{\phi}_{R}) \cdot ds\}$$

(

.

$$F(t) = \operatorname{Re}\{\hat{F} \cdot e^{i\omega t}\}$$

$$= \operatorname{Re}\{a \cdot (\hat{F}_{I} + \hat{F}_{D}) \cdot e^{i\omega t} + \overline{x}_{n}\hat{F}_{R} \cdot e^{i\omega t}\}$$

$$\hat{F}$$

$$()$$

$$\hat{F}_{I} = i\omega\rho \cdot \iint_{S} \hat{\phi}_{I} \cdot ds \qquad ()$$

$$\hat{F}_D = i\omega\rho \cdot \iint_{\tilde{S}} \hat{\phi}_D \cdot ds \tag{()}$$

$$\hat{F}_{R} = i\omega\rho \cdot \iint_{\overline{S}} \hat{\phi}_{R} \cdot ds \qquad ()$$

$$a \cdot \hat{F}_D \qquad \qquad a \cdot \hat{F}_I \\ a \cdot (\hat{F}_I + \hat{F}_D)$$

.

$$\hat{F}_{R} = \omega^{2} \cdot m_{n} - i\omega \cdot C_{n} \qquad ()$$

$$: \qquad ()$$

$$m_n = \rho \cdot \iint_{S} \operatorname{Re}[\phi_R] \cdot \hat{n} \cdot ds \qquad ()$$

$$x_n = \hat{x}_n \cdot e^{i\omega t}$$
  
.  $j = 1, 2, 3, ..., 6$ 

$$\hat{\phi}(x,z) = \frac{i\omega}{k} \frac{Cosh(k[z+h])}{Sinh(kh)} \cdot e^{-ikx} \quad ()$$
k, h

$$\frac{\partial \phi}{\partial n} = \operatorname{Re} \{ a \cdot e^{i \omega t} (\nabla \hat{\phi}_{I} + \nabla \hat{\phi}_{D}) \cdot \hat{n}$$

$$+ \hat{x}_{n} \cdot e^{i \omega t} \cdot \nabla \hat{\phi}_{R} \cdot \hat{n} \}$$

$$()$$

$$\hat{n} \cdot (\nabla \hat{\phi}_I + \nabla \hat{\phi}_D) = 0 \tag{()}$$

$$\frac{\partial \phi}{\partial n} = \operatorname{Re} \{ \hat{x}_n \cdot \boldsymbol{e}^{i o t} \cdot \nabla \hat{\phi}_R \cdot \hat{n} \}$$
 ( )

$$P(t) + \rho \frac{\partial \phi}{\partial t} + \frac{1}{2} \rho |\nabla \phi|^2 + \rho g z = C(t) \qquad ()$$

.

.

تحلیل دینامیکی اندرکنش .....

.

ω

$$C_n = i \cdot \rho \cdot \omega \cdot \iint_{\overline{s}} \operatorname{Im}[\phi_R] \cdot \hat{n} \cdot ds \tag{()}$$

$$\begin{split} F(t) &= -\omega^2 \cdot M \cdot \hat{x}_3 \cdot e^{i\omega t} \qquad () \\ &= \operatorname{Re} \left\{ a \cdot (\hat{F}_I + \hat{F}_D) \cdot e^{i\omega t} + \hat{x}_n \hat{F}_R \cdot e^{i\omega t} + F_{Hydrostatic} \right\} \\ &\quad F_{Hydrostatic} = K_n \cdot x_n(t) \\ & () \end{split}$$

.[ ].

:

 $\frac{\hat{x}_n}{a} = \frac{\hat{F}_I + \hat{F}_D}{-\omega^2 \cdot (M + m_n) + i\omega \cdot C_n + K_n}$ ()

Newman Ray WAMIT MOSES

:

()

.

Length [m]	400
Radius [m]	20
KG [m]	200
Draft [m]	200
Mass [Ton]	256011
Ixx [m]	115.9
Iyy [m]	115.9
Izz [m]	14.14

.

.

()()

.

Newman Ray

.

Newman Ray



()

.



www.SID.ir

تحلیل دینامیکی اندرکنش ....



- Ran, Z., Kim, M. H., Niedzwecki, J. M. and Johnson, R. P. (1996). "Responses of a spar platform in random waves and currents (Experiment Vs. Theory)." *International Journal of Offshore and Polar Engineering*, Vol. 6, No. 1.
- 2 Agarwal, A. K. and Jain, A. K. (2002). "Nonlinear coupled dynamic response of offshore Spar platforms under regular sea waves." *Ocean Engineering*, Vol.30, PP.487-516.
- 3 -Veldman, A. E. P. and Kleefsman, K. M. T. (2000). *Numerical Simulation of Wave Loading on a Spar Platform. University of Groningen, Department of Mathematics*, P.O. Box 800, 9700 AV Groningen, The Netherlands.
- 4 -Teng, B. and Kato, S. (2002). "Third order force on axisymmetric bodies." *Ocean Engineering*, Vol. 29, PP. 815-843.

- 5 Teng, B. and Kato, S. (1999). "A method for second-order diffraction potential from an axisymmetric body." *Ocean Engineering*, Vol. 26, PP. 1359-1387.
- 6 Ray, J. (2000). WAMIT-MOSES Hydrodynamic Analysis Comparison Study. New York Hull Engineering Department, USA.
- 7 Chakrabarti, S. K. (1987). *Hydrodynamics of Offshore Structures*. Computational Mechanics Publication, GB.
- 8 Patel, M. H. (1989). Dynamics of Offshore Structures, Butterworth & co. Ltd, UK.
- 9-Hoffmann, K. A. and Chiang, S. T. (1989) "Computational fluid dynamics for engineers." Engineering

Education System.

- 1 Spar
- 2 Catenary
- 3 Morrison's Equation
- 4 Diffraction
- 5 Finite Volume
- 6 Boundary Element
- 7 Finite Difference
- 8 Laplace Equation
- 9 Incident
- 10 Radiation
- 11 Froude-Krylove
- 12 Structured Uniform Mesh
- 13 Gauss-Sidel
- 14 Line Iterative Method