DERIVATIVE SEAKEEPING QUANTITIES

THE PRINCIPAL SEAKEEPING QUANTITY FROM A SEAKEEPING ANALYSIS OF A FLOATING BODY AT ZERO OR FORWARD SPEED IS THE

RESPONSE AMPLITUDE OPERATOR / RAO

$$\xi_j(t) = \mathrm{Re}\left\{ \Xi_j(\omega)\, e^{i\omega t} \right\}$$

- $$\mathrm{RAO} = \frac{\Xi_j(\omega)}{A}, \quad j = 1, 2, 3$$

$$= \frac{\Xi_j(\omega)}{A/L}, \quad j = 4, 5, 6$$

WHERE L IS A CHARACTERISTIC LENGTH. THE RAO IS A COMPLEX QUANTITY WITH PHASE DEFINED RELATIVE TO THE AMBIENT WAVE ELEVATION AT THE ORIGIN OF THE COORDINATE SYSTEM

$$\zeta_I = \mathrm{Re}\left\{ A\, e^{i\omega t} \right\}$$

IT FOLLOWS THAT THE ONLY SEAKEEPING QUANTITY WITH $\mathrm{RAO} \equiv 1$ IS $\zeta_I(t)$.—

A PARTIAL LIST OF DERIVATIVE SEAKEEPING QUANTITIES OF INTEREST IN PRACTICE IS:

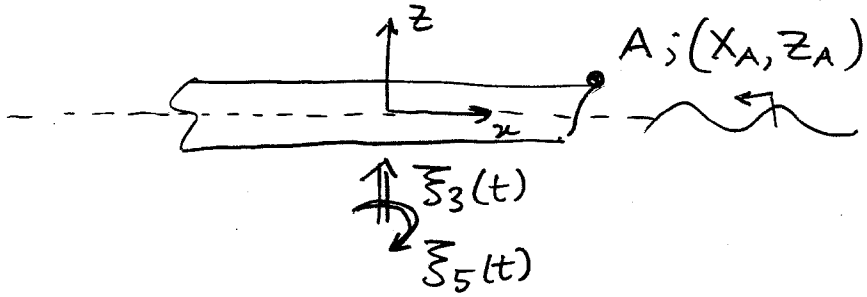
- FREE-SURFACE ELEVATION. NEEDED TO ESTIMATE THE CLEARANCE UNDER THE DECK OF OFFSHORE PLATFORMS
- VESSEL KINEMATICS AT SPECIFIED POINTS. E.G. NEEDED TO ESTIMATE THE MOTION PROPERTIES OF CONTAIRIZED CARGO
- RELATIVE WAVE ELEVATION AND VELOCITY NEAR THE BOW OF A SHIP. NEEDED TO ESTIMATE THE OCCURENCE AND SEVERITY OF SLAMMING.
- LOCAL AND GLOBAL STRUCTURAL LOADS NEEDED FOR THE VESSEL STRUCTURAL DESIGN

ACCORDING TO LINEAR THEORY, ALL DERIVATIVE QUANTITIES WHICH ARE LINEAR SUPERPOSITIONS OF OTHER QUANTITIES, TAKE THE FORM

$$Z(t) = \mathrm{Re}\{Z(\omega)e^{i\omega t}\}, \quad RAO = \frac{Z(\omega)}{A}. \_$$

EXAMPLE 1

- ACCELERATION RAO AT THE BOW OF A SHIP



THE VERTICAL DISPLACEMENT OF POINT A DUE TO THE VESSEL HEAVE & PITCH MOTIONS IS

$$\xi_A(t) = \xi_3(t) - x_A\,\xi_5(t)$$

$$\frac{d^2\xi_A(t)}{dt^2} = \ddot{\xi}_3(t) - x_A\,\ddot{\xi}_5(t)$$

$$= \mathrm{Re}\left\{-\omega^2\left[\Pi_3 - x_A\,\Pi_5\right]e^{i\omega t}\right\}$$

SO THE CORRESPONDING RAO IN WAVES OF AMPLITUDE A IS:

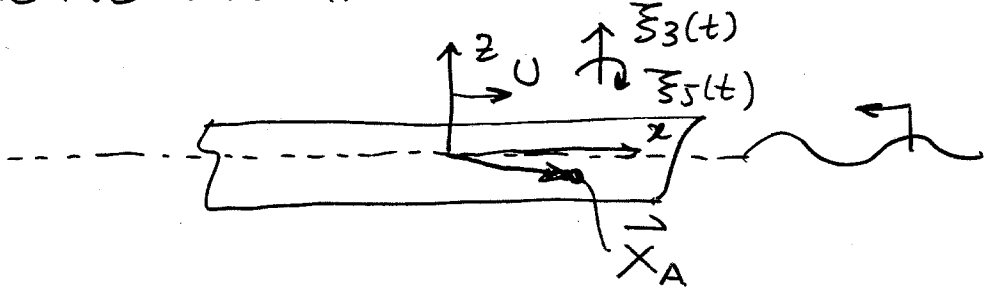
$$\mathrm{RAO} = \frac{-\omega^2(\Pi_3 - x_A\,\Pi_5)}{A}$$

$$= -\omega^2\left(\mathrm{RAO}_3 - x_A\,\mathrm{RAO}_5\right).$$

SO THE RAO OF THE VERTICAL ACCELERATION AT THE BOW IS A LINEAR COMBINATION OF THE HEAVE AND PITCH RAO'S.

EXAMPLE 2

- HYDRODYNAMIC PRESSURE DISTURBANCE AT A FIXED POINT ON A SHIP HULL OSCILLATING IN HEAVE & PITCH IN WAVES



THE LINEAR HYDRODYNAMIC PRESSURE AT A POINT A LOCATED AT $\vec{X}_A$ RELATIVE TO THE SHIP FRAME IS:

$$p_A = \mathrm{Re}\left\{ P_A e^{i\omega t} \right\}$$

WHERE

$$P_A = -\rho \Big\{ \underbrace{\left(i\omega - U\frac{\partial}{\partial x}\right)(\varphi_3 + \varphi_5)}_{\text{RADIATION}} + \underbrace{\left(i\omega - U\frac{\partial}{\partial x}\right)(\varphi_I + \varphi_D)}_{\text{DIFFRACTION}} + \underbrace{g\,(\Xi_3 - x\,\Xi_5)}_{\text{HYDROSTATIC DISTURBANCE}} \Big\}_{\vec{X}_A}$$

$$\text{RAO} = P_A / A \cdot —$$