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Mata Kuliah : Dinamika Struktur & Pengantar Rekayasa Kegempaan
Kode : TSP – 302
SKS : 3 SKS

Earthquake Analysis of Linear MDoF System

Pertemuan – 11

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- TIU :
- Mahasiswa dapat menjelaskan fenomena-fenomena dinamik secara fisik.
- Mahasiswa dapat membuat model matematik dari masalah teknis yang ada serta mencari solusinya

- TIK :
  - Mahasiswa dapat menghitung respon struktur MDoF akibat beban gempa bumi

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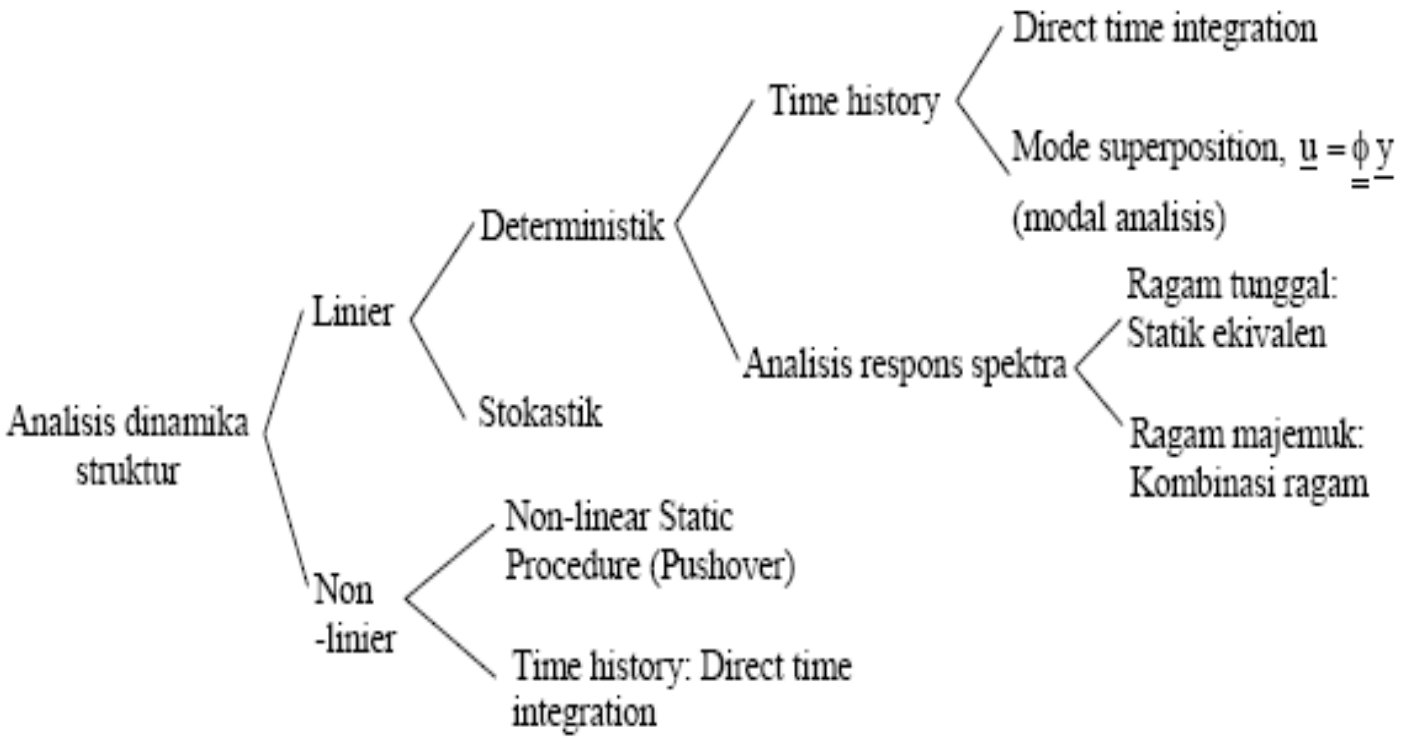
- Sub Pokok Bahasan :
  - Persamaan Gerak Sistem MDoF Akibat Beban Gempa Bumi
  - Analisis Riwayat Waktu
  - Analisis Spektrum Respon


Analisis dinamika struktur
Linier
Non -linier
Deterministik
Stokastik
Non-linear Static Procedure (Pushover)
Time history: Direct time integration
Time history
Analisis respons spektra
Direct time integration
Mode superposition, $\underline{u} = \underline{\underline{\phi}}\,\underline{y}$ (modal analisis)
Ragam tunggal: Statik ekivalen
Ragam majemuk: Kombinasi ragam

- Equation of Motion

$$[m]\{\ddot{u}\}+[c]\{\dot{u}\}+[k]\{u\}=-[m]\{1\}\ddot{u}_g(t)$$

- With $\{1\}=\begin{Bmatrix}1\\1\\1\\\vdots\\1\end{Bmatrix}$
- Introducing the modal analysis equation ,

$$\{u\}=[\phi]\{q\}$$

- and pre-multiply with $[\phi]^T$

$$\underbrace{[\phi]^T[m][\phi]}_{M_n}\{\ddot{q}\}+\underbrace{[\phi]^T[c][\phi]}_{C_n}\{\dot{q}\}+\underbrace{[\phi]^T[k][\phi]}_{K_n}\{q\}=-\underbrace{[\phi]^T[m]\{1\}}_{L_n}\ddot{u}_g(t) \quad \textbf{(1)}$$

M_n = Generalized Mass
C_n = Generalized Damping
K_n = Generalized Stiffness
L_n = Earthquake Excitation Factor

$$\Gamma = \frac{L_n}{M_n} = \text{Modal Participation Factor}$$

$$\frac{L_n^{\,2}}{M_n} \rightarrow \text{effective modal mass}$$

- Dividing Eq.(1) by M_n, gives :

$$\ddot{q}_n + 2\xi_n \omega_n \dot{q}_n + \omega_n^2 q_n = -\Gamma_n \ddot{u}_g(t) \qquad \textbf{(2)}$$

- Let $q_n(t) = \Gamma_n D_n(t)$ **(3)**

- Eq. (2) becomes :

$$\ddot{D}_n + 2\xi_n \omega_n \dot{D}_n + \omega_n^2 D_n = -\ddot{u}_g(t) \qquad \textbf{(4)}$$

- The $q_n(t)$ is readily available once Eq.(4) has been solved for $D_n(t)$, utilizing numerical time stepping methods for SDF systems.

Response History Analysis

$$\{u_n(t)\} = \{\phi_n\} q_n(t) = \Gamma_n \{\phi_n\} D_n(t) \quad \textbf{(5)}$$

$$\{f_n(t)\} = \Gamma_n [m] \{\phi_n\} A_n(t) \quad \textbf{(6)}$$

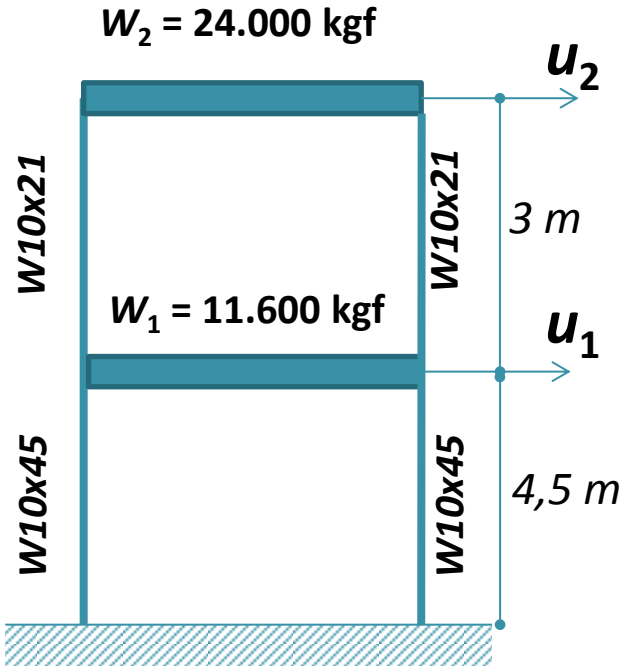
Response Spectrum Analysis

$$u_{jn} = \Gamma_n \phi_{jn} D_n \quad \textbf{(7)}$$

$$f_{jn} = \Gamma_n m_j \phi_{jn} A_n \quad \textbf{(8)}$$

Example 1

- Determine :
  1. Equations for the floor displacement and the story shears for the shear frame in figure subjected to ground motion $\ddot{u}_g(t)$
  2. Plot the time history of the floor displacement if the shear frame subjected to El Centro 1940 N-S Ground Motion



$$\omega_1 = 10{,}76 \qquad \omega_2 = 38{,}28$$

$$[\phi] = \begin{bmatrix} \phi_{11} & \phi_{12} \\ \phi_{21} & \phi_{22} \end{bmatrix} = \begin{bmatrix} 0{,}6809 & -3{,}0385 \\ 1 & 1 \end{bmatrix}$$