

Structural Mechanics

12.5 Free vibration of two-DOF system

(两个自由度体系的自由振动)

内容(Contents):

1. 概念(Concept): 振型 (Mode shape) , 振型正交性。
2. 理论(Theory): 牛顿第二定律, 和线性方程组的求解
3. 应用(Application): Whipping effect “鞭梢效应”

要求(Requirements):

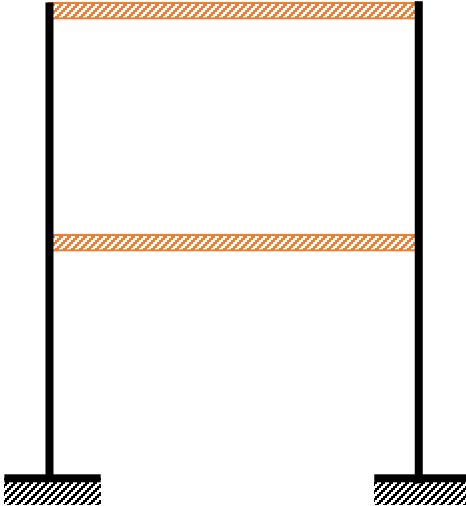
运动方程的建立（刚度法和柔度法）； 熟练频率和振型的求法； 理解振型正交性的物理意义。

作业(Homework): 10-17, 19, 20。

12.5 Free vibration of two-DOF system

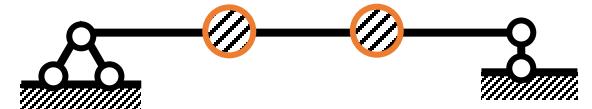
(1) The system have to be simplified into double or multi-DOF system

Multi-story building, bent frame with unequal height



(2) In order to obtain more accurate result

Chimney, high-rise building



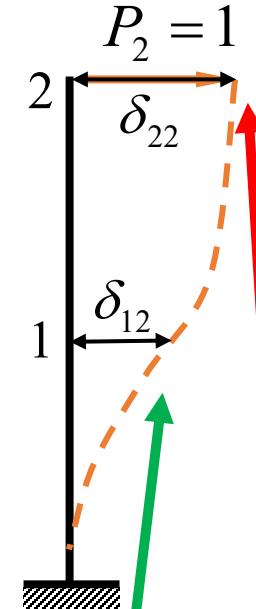
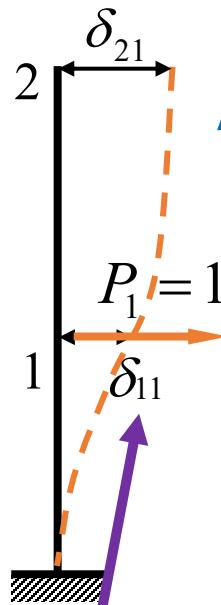
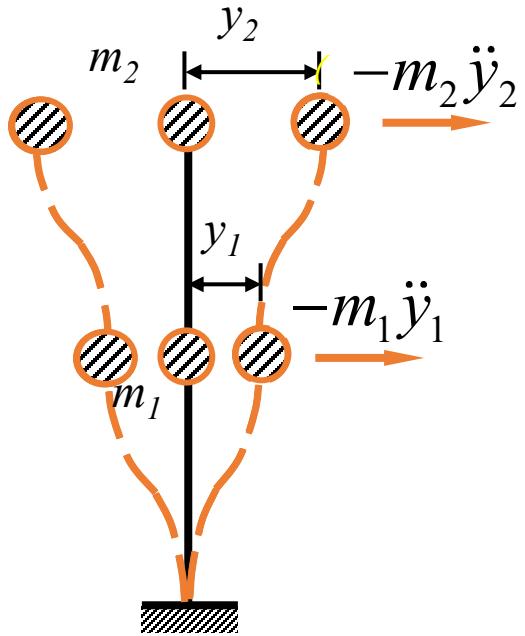
Fundamental methods:

Stiffness method: Based on the force equilibrium equations

Flexibility method: Based on the displacement compatibility condition

(1) Flexibility method

flexibility coefficient: δ

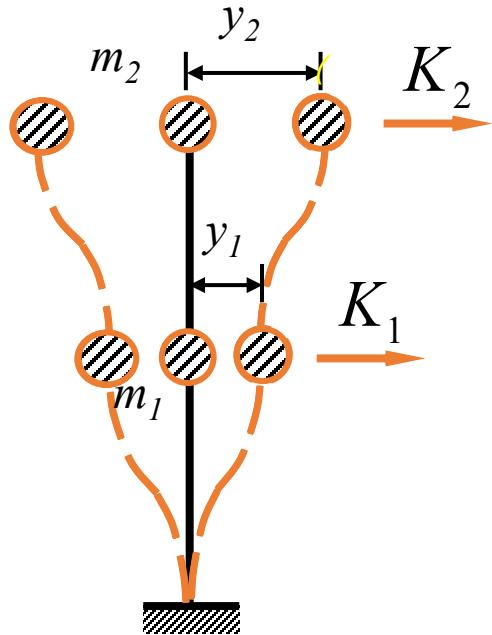


To establish
equations:

$$y_1(t) = \delta_{11}[-m_1\ddot{y}_1(t)] + \delta_{12}[-m_2\ddot{y}_2(t)]$$

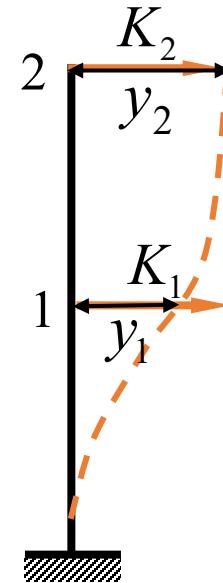
$$y_2(t) = \delta_{21}[-m_1\ddot{y}_1(t)] + \delta_{22}[-m_2\ddot{y}_2(t)]$$

(2) Stiffness method



The diagram shows two masses, m_1 and m_2 , connected by a horizontal spring with stiffness K_1 and K_2 respectively. The mass m_1 is at the bottom, and the mass m_2 is at the top. Each mass is subject to an external inertial force $m_1\ddot{y}_1$ and $m_2\ddot{y}_2$ pointing to the left. The spring force is directed to the left for both masses.

Mass point isolator

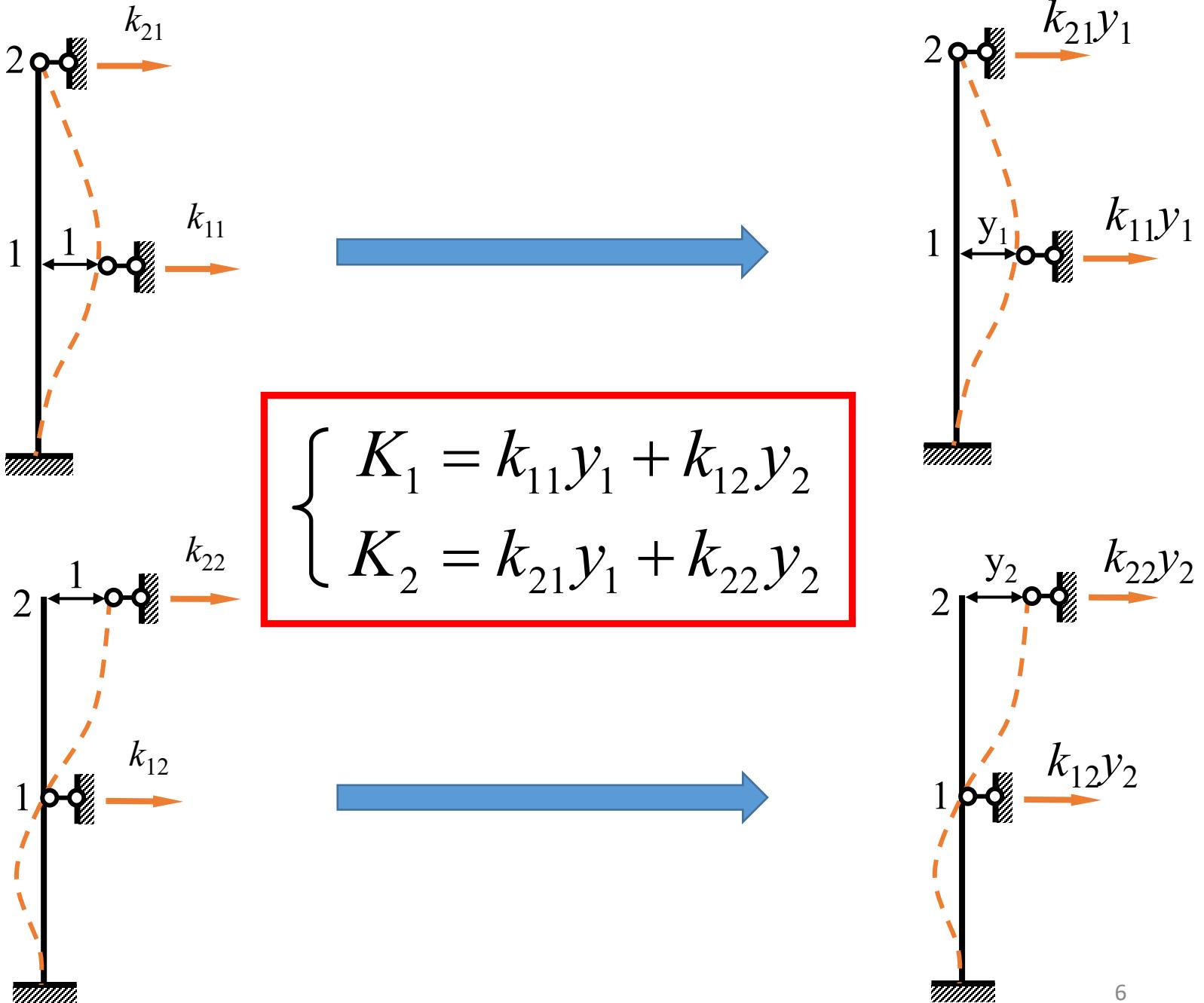
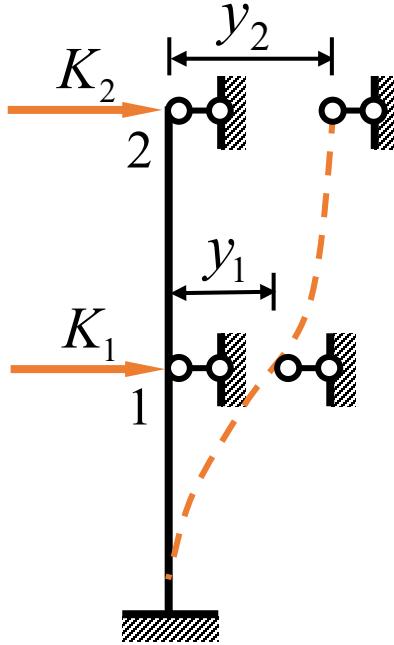


To establish
equations:

$$m_1 \ddot{y}_1(t) + K_1 = 0$$

How to determine?

Stiffness coefficient: k



Stiffness coefficient: k

$$\begin{cases} K_1 = k_{11}y_1 + k_{12}y_2 \\ K_2 = k_{21}y_1 + k_{22}y_2 \end{cases}$$



$$\begin{cases} m_1\ddot{y}_1(t) + K_1 = 0 \\ m_2\ddot{y}_2(t) + K_2 = 0 \end{cases}$$

$$m_1\ddot{y}_1(t) + k_{11}y_1 + k_{12}y_2 = 0$$

Therefore:

$$m_2\ddot{y}_2(t) + k_{21}y_1 + k_{22}y_2 = 0$$

以上内容仅为本文档的试下载部分，为可阅读页数的一半内容。如要下载或阅读全文，请访问：<https://d.book118.com/118061045021006036>