Structural Dynamics

CIVIL ENGINEERING VIRTUAL LABORATORY

INTRODUCTION:

Torsional responses of building structures could be induced by structural eccentricities and by varying multiple ground excitations. Generally torsion occurs in structures which are unsymmetrical.
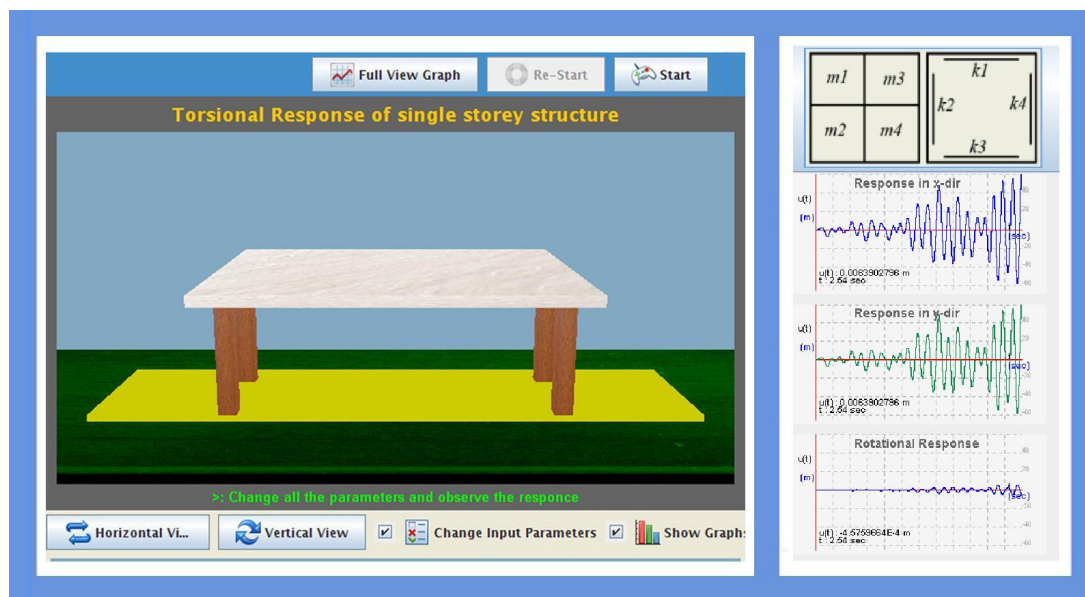
THEORY:

Equation of motion excluding damping forces

$$m\ddot{u} + ku = -m\ddot{u}_g$$

For two way unsymmetrical system:

$$\begin{bmatrix} m & 0 & 0 \\ 0 & m & 0 \\ 0 & 0 & I_o \end{bmatrix} \begin{Bmatrix} \ddot{u}_x \\ \ddot{u}_y \\ \ddot{u}_\theta \end{Bmatrix} + \begin{bmatrix} k_{xx} & 0 & k_{x\theta} \\ 0 & k_{yy} & k_{y\theta} \\ k_{\theta x} & k_{\theta y} & k_{\theta\theta} \end{bmatrix} \begin{Bmatrix} u_x \\ u_y \\ u_\theta \end{Bmatrix} = -\begin{Bmatrix} m\ddot{u}_{gx}(t) \\ m\ddot{u}_{gy}(t) \\ I_o\ddot{u}_{g\theta}(t) \end{Bmatrix}$$

Where

$$I_0 = \frac{m(b^2 + d^2)}{12}$$
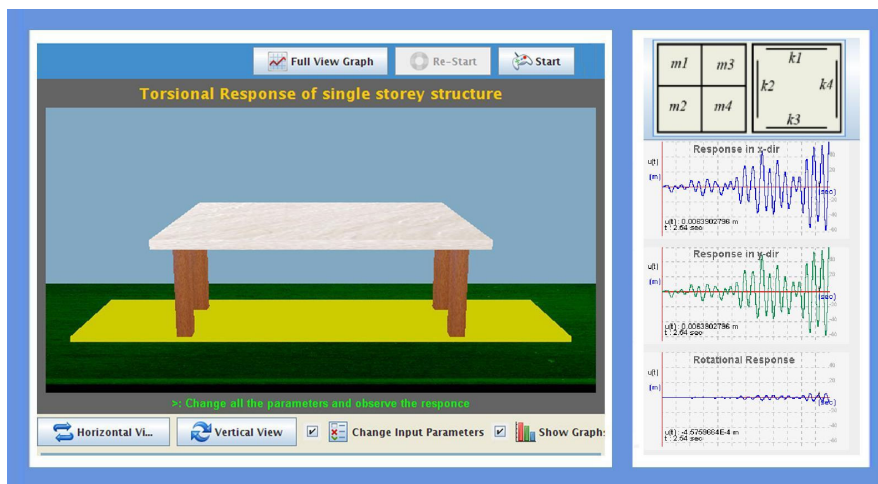
$$k_{xx} = k_1 + k_3$$

$$k_{yy} = k_2 + k_4$$

If the system is symmetric about x-axis then $k_{x\theta} = k_{\theta x} = 0$

If the system is symmetric about y-axis then $k_{y\theta} = k_{\theta y} = 0$

OBJECTIVE:

To find out the responses of 3 DOF's (2 translations and 1 rotation) of a single storey structure especially torsional response along with translations.

MANUAL:

Here mass of slab is given as 4 parts and stiffness as 4 parts in both directions. Experiment starts with default values of masses and stiffnesses. Observe the SDOF response in 3 directions (2 translations and 1 rotation/torsion)

Observation 1:

Here in this stage, user can change mass of slab corresponding to default value by keeping all other as default values. Observe the difference in 3 directions response.
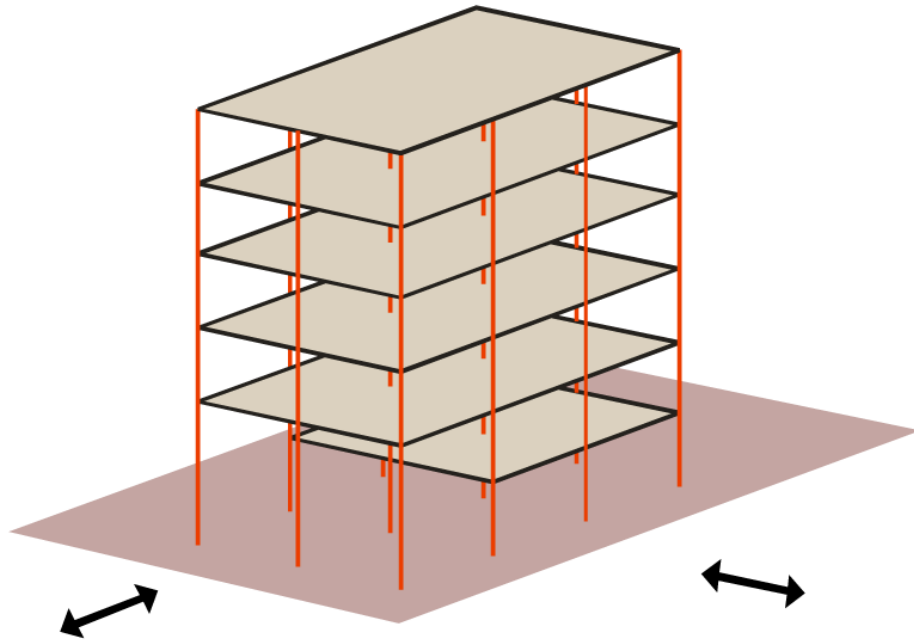
Observation 2:

Here in this stage, user can change stiffness corresponding to default value by keeping all other as default values. Observe the difference in 3 directions response

Observation 3:

In this stage, user can change all the parameters including damping ratio and earthquake data and observe the variations/difference in all directions responses of structure.

PART - 2
ANIMATION STEPS

Torsional Response

PART – 3

VIRTUAL LAB FRAME