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- Overview of Structural Dynamics
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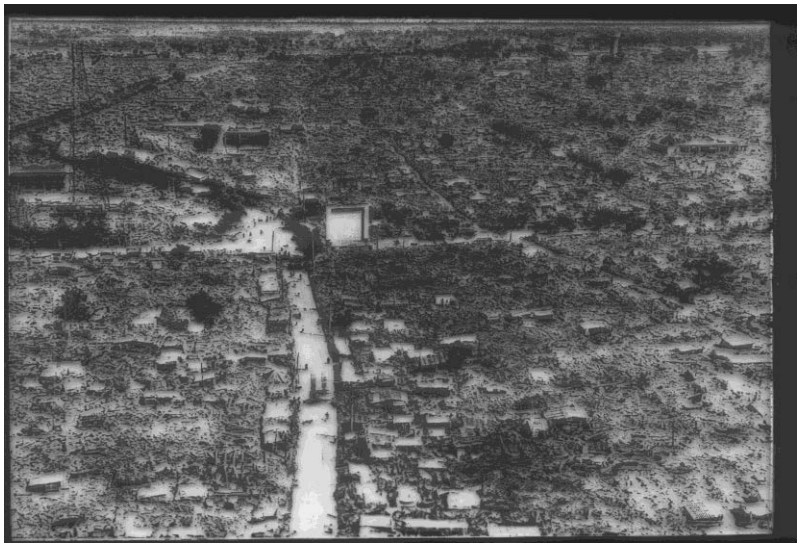
- Formulation of Equation of Motion

Why dynamic/vibration analysis?



Earthquake

Wind

Walking load

Man-made?

- Dynamic/vibration analysis

  '*dynamic*' – time-varying/ time-dependent

  '*vibration*' - oscillate back-and-forth movement about its initial equilibrium position

- Determination of the displacement and the internal forces of a structure due to time-dependent external loads or initial conditions
- "…methods for analyzing the stresses and deflections developed in any given type of structure when it is subjected to be an arbitrary dynamic loading. "
- Structural dynamics is a type of structural analysis that finds out the behavior of structures subjected to dynamic (actions having high acceleration) loading

Four types of structural dynamic analysis problems

- Structural dynamic problem (Direct)
- Structural identification problem (indirect)
- Excitation identification problem (Indirect)
- Hybrid identification problem (Indirect)

- Description of motion

  Time-dependent coordinates

$$X^T = \left[x_1(t), x_2(t), \cdots, x_n(t) \right]$$

$x_i(t)$: Degree of freedom

- Specifies the displacement components and rotation components of a system of mass particles or extended rigid bodies from a know referential state (static equilibrium state)

- Types of Loading

  Significance of loading type: different solutions for different types of loading

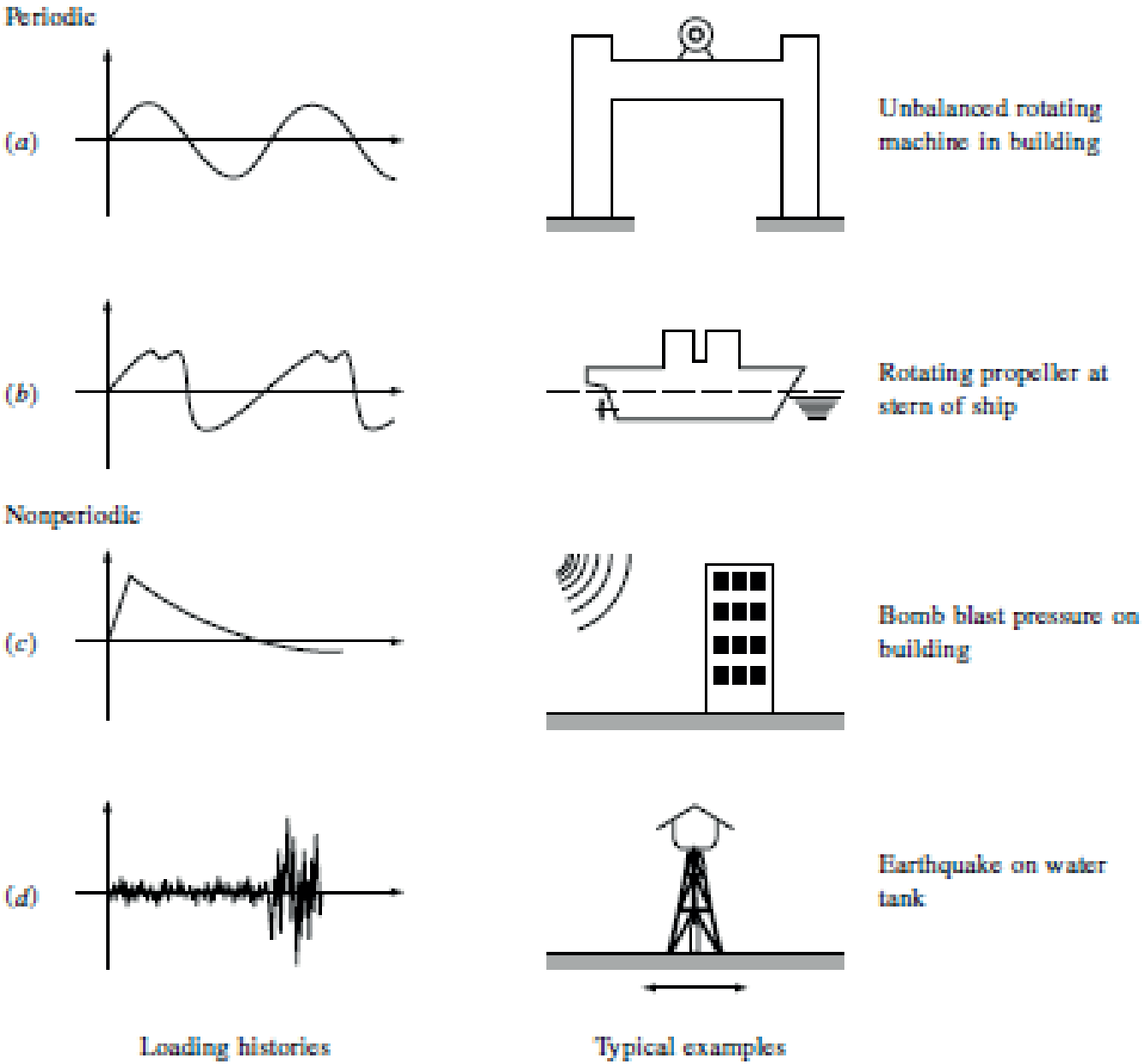
  what is "dynamic"

- Deterministic loading

  - Periodic loading (harmonic/ Non-harmonic)
  - Non-periodic loading (Impulsive loading/ step Loading/ Others)

- Random loading

  - Wind
  - Earthquake
  - Sea waves
  - etc.


Periodic
(a)
(b)
Nonperiodic
(c)
(d)
Unbalanced rotating machine in building
Rotating propeller at stern of ship
Bomb blast pressure on building
Earthquake on water tank
Loading histories
Typical examples

Statistic Vs. Dynamic analysis

- Time-varying: magnitude, direction, and/or position varies with time
- The essential difference between the statistical and dynamical analysis is: inertial force (inertia force), which resist acceleration of the structure in this way are the most important distinguishing characteristics of a structural-dynamic problem.