Graduate Certificate in Design and Analysis of Tall Buildings (Part II)

Performance Based Design of Tall Buildings

Acceleration is the rate of change of velocity of an object with respect to time, and it is a critical parameter in the design of tall buildings as it affects the structural response to wind and seismic loads. Acceleration can be measured in terms of units of distance per unit time squared, such as meters per second squared. Related terms include deceleration, which is the rate of change of velocity in the opposite direction, and velocity, which is the rate of change of distance with respect to time. In the context of tall buildings, acceleration is used to calculate the structural response to dynamic loads, such as wind and seismic forces.

Air Density is the mass per unit volume of air and is an important parameter in the design of tall buildings as it affects the wind loads on the structure. Air density can be affected by factors such as temperature, humidity, and altitude, and it is typically measured in units of kilograms per cubic meter. Related terms include air pressure, which is the force per unit area exerted by the air, and temperature, which is a measure of the thermal energy of the air. In the context of tall buildings, air density is used to calculate the wind loads on the structure, which is critical for ensuring the structural integrity of the building.

Aspect Ratio is the ratio of the height of a building to its width and is an important parameter in the design of tall buildings as it affects the structural response to wind and seismic loads. Aspect ratio can be used to classify buildings into different categories, such as low-rise, mid-rise, and high-rise buildings. Related terms include slenderness ratio, which is the ratio of the height of a building to its thickness, and width-to-height ratio, which is the inverse of the aspect ratio. In the context of tall buildings, aspect ratio is used to determine the structural system and the type of foundation required.

Base Shear is the total horizontal force exerted on a building at its base due to wind or seismic loads and is an important parameter in the design of tall buildings as it affects the structural response to dynamic loads. Base shear can be calculated using various methods, including the equivalent static method and the dynamic analysis method. Related terms include shear force, which is the force that causes an object to deform by sliding along a plane, and moment, which is the force that causes an object to rotate. In the context of tall buildings, base shear is used to design the foundation and the structural system of the building.

Bending Moment is the force that causes an object to bend or curve and is an important parameter in the design of tall buildings as it affects the structural response to wind and seismic loads. Bending moment can be calculated using various methods, including the equivalent static method and the dynamic analysis method. Related terms include torsion, which is the force that causes an object to twist, and shear, which is the force that causes an object to deform by sliding along a plane. In the context of tall buildings, bending moment is used to design the structural system of the building, including the beams and columns.

Buckling is a type of failure that occurs when a column or other slender structural element is subjected to a compressive load and is an important parameter in the design of tall buildings as it affects the structural integrity of the building. Buckling can be caused by various factors, including imperfections in the structural element, loads that are not perfectly axial, and boundary conditions that are not perfectly fixed. Related terms include yielding, which is the stress at which a material begins to deform plastically, and fracture, which is the stress at which a material fails. In the context of tall buildings, buckling is used to determine the capacity of the structural elements and to ensure that the building can resist various types of loads.

Column is a vertical structural element that carries compressive loads and is an important component of tall buildings as it affects the structural integrity of the building. Columns can be made of various materials, including steel, concrete, and wood, and can be designed using various methods, including the equivalent static method and the dynamic analysis method. Related terms include beam, which is a horizontal structural element that carries transverse loads, and slab, which is a horizontal structural element that carries distributed loads. In the context of tall buildings, columns are used to support the weight of the building and to resist various types of loads, including wind and seismic forces.

Concrete is a type of building material that is made from a mixture of cement, water, and aggregates and is an important component of tall buildings as it affects the structural integrity of the building. Concrete can be designed to have various properties, including strength, durability, and workability, and can be used to make various structural elements, including columns, beams, and slabs. Related terms include steel, which is a type of metal that is commonly used in tall buildings, and wood, which is a type of natural material that is commonly used in low-rise buildings. In the context of tall buildings, concrete is used to make the structural elements of the building, including the foundation, columns, and beams.

Cross-Sectional Area is the area of a structural element, such as a column or beam, and is an important parameter in the design of tall buildings as it affects the structural response to wind and seismic loads. Cross-sectional area can be calculated using various methods, including the equivalent static method and the dynamic analysis method. Related terms include perimeter, which is the distance around a structural element, and radius, which is the distance from the center of a structural element to its edge. In the context of tall buildings, cross-sectional area is used to determine the capacity of the structural elements and to ensure that the building can resist various types of loads.

Damping is the energy dissipation that occurs in a structural system due to friction or other mechanisms and is an important parameter in the design of tall buildings as it affects the structural response to wind and seismic loads. Damping can be classified into different types, including viscous damping, friction damping, and hysteretic damping. Related terms include stiffness, which is the force required to produce a unit deformation, and mass, which is the amount of matter in a structural system. In the context of tall buildings, damping is used to reduce the response of the building to dynamic loads, such as wind and seismic forces.

Dead Load is the weight of a building, including the weight of the structural elements, walls, floors, and

roof, and is an important parameter in the design of tall buildings as it affects the structural response to wind and seismic loads. Dead load can be calculated using various methods, including the equivalent static method and the dynamic analysis method. Related terms include live load, which is the weight of the occupants, furniture, and other items in the building, and wind load, which is the force exerted on the building by the wind. In the context of tall buildings, dead load is used to determine the capacity of the structural elements and to ensure that the building can resist various types of loads.

Deflection is the displacement of a structural element, such as a beam or column, under load and is an important parameter in the design of tall buildings as it affects the structural integrity of the building. Deflection can be calculated using various methods, including the equivalent static method and the dynamic analysis method. Related terms include strain, which is the ratio of deformation to the original of a structural element, and stress, which is the force per unit area of a structural element. In the context of tall buildings, deflection is used to determine the capacity of the structural elements and to ensure that the building can resist various types of loads.

Displacement is the change in the position of a structural element, such as a column or beam, under load and is an important parameter in the design of tall buildings as it affects the structural integrity of the building. Displacement can be calculated using various methods, including the equivalent static method and the dynamic analysis method. Related terms include velocity, which is the rate of change of displacement with respect to time, and acceleration, which is the rate of change of velocity with respect to time. In the context of tall buildings, displacement is used to determine the capacity of the structural elements and to ensure that the building can resist various types of loads.

Dynamic Analysis is a type of analysis that is used to study the behavior of a structural system under dynamic loads, such as wind and seismic forces, and is an important parameter in the design of tall buildings as it affects the structural response to dynamic loads. Dynamic analysis can be classified into different types, including analysis, response spectrum analysis, and pushover analysis. Related terms include static analysis, which is a type of analysis that is used to study the behavior of a structural system under static loads, and modal analysis, which is a type of analysis that is used to study the vibration modes of a structural system. In the context of tall buildings, dynamic analysis is used to determine the response of the building to dynamic loads and to ensure that the building can resist various types of loads.

Earthquake is a type of natural disaster that can cause significant damage to tall buildings and is an important parameter in the design of tall buildings as it affects the structural response to seismic loads. Earthquakes can be classified into different types, including tectonic earthquakes, volcanic earthquakes, and human-induced earthquakes. Related terms include seismic load, which is the force exerted on a building by an earthquake, and tsunami, which is a type of natural disaster that can cause significant damage to coastal areas. In the context of tall buildings, earthquakes are used to determine the response of the building to seismic loads and to ensure that the building can resist various types of loads.

Eigenvalue is a value that represents the vibration frequency of a structural system and is an important

parameter in the design of tall buildings as it affects the structural response to dynamic loads. Eigenvalue can be calculated using various methods, including the finite element method and the boundary element method. Related terms include eigenvector, which is a vector that represents the mode shape of a structural system, and modal analysis, which is a type of analysis that is used to study the vibration modes of a structural system. In the context of tall buildings, eigenvalue is used to determine the response of the building to dynamic loads and to ensure that the building can resist various types of loads.

Equivalent Static Method is a type of analysis that is used to study the behavior of a structural system under static loads, such as dead loads and live loads, and is an important parameter in the design of tall buildings as it affects the structural response to static loads. Equivalent static method can be classified into different types, including the uniform load method and the concentrated load method. Related terms include dynamic analysis, which is a type of analysis that is used to study the behavior of a structural system under dynamic loads, and modal analysis, which is a type of analysis that is used to study the vibration modes of a structural system. In the context of tall buildings, equivalent static method is used to determine the response of the building to static loads and to ensure that the building can resist various types of loads.

Failure is the loss of load-carrying capacity of a structural element, such as a column or beam, and is an important parameter in the design of tall buildings as it affects the structural integrity of the building. Failure can be classified into different types, including ductile failure, brittle failure, and fatigue failure. Related terms include yielding, which is the stress at which a material begins to deform plastically, and fracture, which is the stress at which a material fails. In the context of tall buildings, failure is used to determine the capacity of the structural elements and to ensure that the building can resist various types of loads.

Finite Element Method is a type of analysis that is used to study the behavior of a structural system by dividing it into smaller elements and is an important parameter in the design of tall buildings as it affects the structural response to various types of loads. Finite element method can be classified into different types, including the linear finite element method and the nonlinear finite element method. Related terms include boundary element method, which is a type of analysis that is used to study the behavior of a structural system by dividing it into smaller elements, and modal analysis, which is a type of analysis that is used to study the vibration modes of a structural system. In the context of tall buildings, finite element method is used to determine the response of the building to various types of loads and to ensure that the building can resist various types of loads.

Floor is a horizontal structural element that carries distributed loads, such as the weight of the occupants and the weight of the furniture, and is an important component of tall buildings as it affects the structural integrity of the building. Floors can be made of various materials, including concrete, steel, and wood, and can be designed using various methods, including the equivalent static method and the dynamic analysis method. Related terms include slab, which is a type of floor that is made of concrete or other materials, and beam, which is a type of structural element that carries transverse loads. In the context of tall buildings, floors are used to support the weight of the building and to resist various types of loads, including wind

and seismic forces.

Foundation is a structural element that carries the weight of a building and transfers it to the ground and is an important component of tall buildings as it affects the structural integrity of the building. Foundations can be made of various materials, including concrete, steel, and wood, and can be designed using various methods, including the equivalent static method and the dynamic analysis method. Related terms include piling, which is a type of foundation that is made of steel or concrete piles, and footing, which is a type of foundation that is made of concrete or other materials. In the context of tall buildings, foundations are used to support the weight of the building and to resist various types of loads, including wind and seismic forces.

Frequency is the number of cycles per second of a vibration or oscillation and is an important parameter in the design of tall buildings as it affects the structural response to dynamic loads. Frequency can be classified into different types, including natural frequency, forced frequency, and resonant frequency. Related terms include period, which is the time it takes for a vibration or oscillation to complete one cycle, and amplitude, which is the maximum displacement of a vibration or oscillation. In the context of tall buildings, frequency is used to determine the response of the building to dynamic loads and to ensure that the building can resist various types of loads.

Friction is the force that opposes the motion of two surfaces in contact and is an important parameter in the design of tall buildings as it affects the structural response to wind and seismic loads. Friction can be classified into different types, including static friction, kinetic friction, and rolling friction. Related terms include lubrication, which is the process of reducing friction between two surfaces by introducing a fluid or gas between them, and wear, which is the loss of material from a surface due to friction. In the context of tall buildings, friction is used to determine the response of the building to wind and seismic loads and to ensure that the building can resist various types of loads.

Gravity is the force that attracts two objects with mass towards each other and is an important parameter in the design of tall buildings as it affects the structural response to wind and seismic loads. Gravity can be classified into different types, including uniform gravity and non-uniform gravity. Related terms include weight, which is the force exerted on an object by gravity, and mass, which is the amount of matter in an object. In the context of tall buildings, gravity is used to determine the response of the building to wind and seismic loads and to ensure that the building can resist various types of loads.

Height is the vertical distance between the base and the top of a building and is an important parameter in the design of tall buildings as it affects the structural response to wind and seismic loads. Height can be classified into different types, including structural height, architectural height, and occupied height. Related terms include width, which is the horizontal distance between the sides of a building, and depth, which is the horizontal distance between the front and back of a building. In the context of tall buildings, height is used to determine the response of the building to wind and seismic loads and to ensure that the building can resist various types of loads.

Hysteretic is the energy dissipation that occurs in a structural system due to friction or other mechanisms and is an important parameter in the design of tall buildings as it affects the structural response to dynamic loads. Hysteretic can be classified into different types, including elastic hysteretic and inelastic hysteretic. Related terms include damping, which is the energy dissipation that occurs in a structural system due to friction or other mechanisms, and stiffness, which is the force required to produce a unit deformation. In the context of tall buildings, hysteretic is used to determine the response of the building to dynamic loads and to ensure that the building can resist various types of loads.

Inspection is the process of examining a structural system to identify any defects or damage and is an important parameter in the design of tall buildings as it affects the structural integrity of the building. Inspection can be classified into different types, including visual inspection, non-destructive testing, and destructive testing. Related terms include maintenance, which is the process of maintaining a structural system to ensure that it remains in good condition, and repair, which is the process of fixing any defects or damage that are identified during an inspection. In the context of tall buildings, inspection is used to ensure that the building remains in good condition and can resist various types of loads.

Load is the force that is applied to a structural system, such as a column or beam, and is an important parameter in the design of tall buildings as it affects the structural response to various types of loads. Load can be classified into different types, including dead load, live load, and wind load. Related terms include stress, which is the force per unit area of a structural element, and strain, which is the ratio of deformation to the original length of a structural element. In the context of tall buildings, load is used to determine the response of the building to various types of loads and to ensure that the building can resist various types of loads.

Material is the substance that is used to make a structural element, such as a column or beam, and is an important parameter in the design of tall buildings as it affects the structural integrity of the building. Material can be classified into different types, including concrete, steel, and wood. Related terms include properties, which are the characteristics of a material that affect its behavior, such as strength, stiffness, and density. In the context of tall buildings, material is used to make the structural elements of the building, including the columns, beams, and slabs.

Modal Analysis is a type of analysis that is used to study the vibration modes of a structural system and is an important parameter in the design of tall buildings as it affects the structural response to dynamic loads. Modal analysis can be classified into different types, including undamped modal analysis and damped modal analysis. Related terms include eigenvalue, which is the value that represents the vibration frequency of a structural system, and eigenvector, which is the vector that represents the mode shape of a structural system. In the context of tall buildings, modal analysis is used to determine the response of the building to dynamic loads and to ensure that the building can resist various types of loads.

Moment is the force that causes an object to rotate and is an important parameter in the design of tall buildings as it affects the structural response to wind and seismic loads. Moment can be classified into

different types, including bending moment, torsional moment, and twisting moment. Related terms include torque, which is the force that causes an object to rotate, and rotation, which is the motion of an object around a axis. In the context of tall buildings, moment is used to determine the response of the building to wind and seismic loads and to ensure that the building can resist various types of loads.

Natural Frequency is the vibration frequency of a structural system in the absence of any external forces and is an important parameter in the design of tall buildings as it affects the structural response to dynamic loads. Natural frequency can be classified into different types, including fundamental frequency, harmonic frequency, and overtones. Related terms include damping, which is the energy dissipation that occurs in a structural system due to friction or other mechanisms, and stiffness, which is the force required to produce a unit deformation. In the context of tall buildings, natural frequency is used to determine the response of the building to dynamic loads and to ensure that the building can resist various types of loads.

Performance-Based Design is a type of design that is used to ensure that a building can resist various types of loads, including wind and seismic loads, and is an important parameter in the design of tall buildings as it affects the structural integrity of the building. Performance-based design can be classified into different types, including linear performance-based design and nonlinear performance-based design. Related terms include analysis, which is the process of studying the behavior of a structural system, and simulation, which is the process of modeling the behavior of a structural system. In the context of tall buildings, performance-based design is used to ensure that the building can resist various types of loads and to ensure that the building can perform as intended.

Pile is a type of foundation that is made of steel or concrete and is used to transfer the weight of a building to the ground and is an important component of tall buildings as it affects the structural integrity of the building. Piles can be classified into different types, including end-bearing piles, friction piles, and composite piles. Related terms include footing, which is a type of foundation that is made of concrete or other materials, and caisson, which is a type of foundation that is made of steel or concrete. In the context of tall buildings, piles are used to support the weight of the building and to resist various types of loads, including wind and seismic forces.

Pushover Analysis is a type of analysis that is used to study the behavior of a structural system under lateral loads, such as wind and seismic loads, and is an important parameter in the design of tall buildings as it affects the structural response to dynamic loads. Pushover analysis can be classified into different types, including linear pushover analysis and nonlinear pushover analysis. Related terms include static analysis, which is a type of analysis that is used to study the behavior of a structural system under static loads, and modal analysis, which is a type of analysis that is used to study the vibration modes of a structural system. In the context of tall buildings, pushover analysis is used to determine the response of the building to dynamic loads and to ensure that the building can resist various types of loads.

Resonance is the phenomenon where a structural system vibrates at a frequency that is equal to its natural frequency and is an important parameter in the design of tall buildings as it affects the structural response

to dynamic loads. Resonance can be classified into different types, including undamped resonance and damped resonance. Related terms include damping, which is the energy dissipation that occurs in a structural system due to friction or other mechanisms, and stiffness, which is the force required to produce a unit deformation. In the context of tall buildings, resonance is used to determine the response of the building to dynamic loads and to ensure that the building can resist various types of loads.

Response Spectrum is a type of analysis that is used to study the behavior of a structural system under dynamic loads, such as wind and seismic loads, and is an important parameter in the design of tall buildings as it affects the structural response to dynamic loads. Response spectrum can be classified into different types, including elastic response spectrum and inelastic response spectrum. Related terms include modal analysis, which is a type of analysis that is used to study the vibration modes of a structural system, and time-history analysis, which is a type of analysis that is used to study the behavior of a structural system over time. In the context of tall buildings, response spectrum is used to determine the response of the building to dynamic loads and to ensure that the building can resist various types of loads.

Roof is a horizontal structural element that carries distributed loads, such as the weight of the roofing material and the weight of any equipment or accessories, and is an important component of tall buildings as it affects the structural integrity of the building. Roofs can be made of various materials, including concrete, steel, and wood, and can be designed using various methods, including the equivalent static method and the dynamic analysis method. Related terms include floor, which is a horizontal structural element that carries distributed loads, and <