1. **Define progressive collapse?**

   Progressive collapse occurs when the sudden loss of a critical load bearing element initiates a chain reaction of structural element failures, eventually resulting in partial or full collapse of the structure.

2. **Write the approaches to avoid collapse?**
   - Redundancy or alternate load path
   - Local resistance
   - Interconnection or continuity

3. **What are the reinforced concrete design requirements?**
   - Material properties for reinforced concrete
   - Strength reduction factor for reinforced concrete tie force
   - Proportioning of ties
   - Continuity and anchorages of ties
   - Internal ties
   - Peripheral ties
   - Horizontal ties to external columns and walls
   - Vertical ties
   - Elements with deficient vertical design tie strengths.

4. **Define degree of progressivity**

   Degree of progressivity is defined as the ratio of total collapse area or volume to the area or volume damaged directly by the triggering event.

5. **List the codes and standards for progressive collapse?**
   - ASCE 7-02
   - ACI 318 -02
   - GSA PBS Facilities and standards 2000
   - GSA PBS Facilities and standards 2003
   - GSA PBS progressive collapse guidelines 2003

6. **How to achieve structural integrity in a structure?**
   - Connections between structural components should be ductile.
   - Good plan layout
   - Providing an integrated system of ties among the principal elements of the structural system.
   - By changing the direction of span of floor slab.

7. Define the term equivalent design loads?

In the arrangement the bearing is subjected to generally acting forces in various magnitudes at various rotational speeds and with different acting period. From the point of view of calculation methodology the acting forces should be recalculated into the constant load b which the bearing will have the same life as it reaches in the conditions of the actual load. Such re calculated constant radial or axial load is called the equivalent load.

8. What is strong column weak beam concept?

In a building a column is more important than a beam, because its supports the load till the foundation. If a beam breaks it will result in a partial collapse but if a column breaks it will result in catastrophic failure.

That is the reason why we have to always design our columns stronger than beams.

9. Define the term abnormal loads?

Loads other than conventional design loads (dead, live, wind, seismic, etc.) for structures such as air blast pressures generated by an explosion or impact by vehicles etc.

10. Explain the importance factor and response reduction factor used in static analysis for calculation of design seismic force?

The importance factor originated with the seismic base shear equation in the 1976 uniform building code (UBC). The concept at that time was that the importance factor increased the design seismic force in order to provide additional seismic resistance to prevent catastrophic collapse. The American society of Civil Engineer's minimum design loads for buildings and other structures (ASCE 7-98) the importance factor appears in the velocity pressure equation for wind design and in the flat roof snow load equation for snow load design. There are three different importance factors namely: wind, snow and seismic.

11. What are the types of collapse in progressive structural elements?

This is a form of "domino effect" failure that can occur in a reinforced concrete structure whereby a failure starting in a particular component rapidly propagates to other components precipitating a major or even a total collapse.

Three common collapses are as follows:

- High rise concrete flat plate structures (during construction or earthquake)
- Formwork for concrete structures
- High rise structures constructed with precast concrete elements.

12. Write the assumptions for the dynamic analysis procedure?

- The structure is modeled as two dimensional.
- Effects of large deflections are neglected.
- Elastic perfectly plastic moment rotation relationships are used.
- Equivalent structural damping of 5% is assumed throughout the analysis.
- All beams to column connections are moment resistant and are stronger than the beams, so plastic hinges will form in the body and not in the column or in the joint. (Strong column weak beam principle).
- All beams are adequately confined by shear reinforcement so that beams are not shear controlled.
- Columns have adequate strength to resist additional load redistribution due to loss of the primary columns.

13. What are the special requirements for building in high seismic zones?

- Large panel building in high seismic zones are recommended to be constructed with closed symmetrical layout.
- The height of the building shall generally restricted 10 storey's in zone IV and 7 storey's in zone V.
- The vertical and horizontal joints for wall panels shall be designed as keyed joints.

14. What are the provisions made in prefabricated RC floors in a cyclone prone zone?

- Prefabricated RC Elements of various design placed side by side where as RC slabs are rigid in their own planes, the other types will require their integration through diagonal bracing or topping RC screed. (Structural deck concrete).
- Structural deck concrete of grade not leaner than M20 should be provided over precast components to act monolithic with them.

15. What are the advantages of design of progressive collapse in structures?

- *Provides enhanced accurate analysis because:*
  - ✓ Plastic hinges are not assumed: rather they are automatically calculated and generated without any user intervention. Collapse areas are not assumed: rather when a plastic hinge fails the solver automatically separates the section that fails allowing it to behave naturally within the collapse scenario.
- *Quick & easy modeling:*
  - ✓ Automatic mesh adjustments
  - ✓ Automatic spring generation
  - ✓ Data exchange available with several FEM and BIM Software applications.

16. What are the features of progressive collapse?

Structural components can be removed either simultaneously or at custom intervals.

Analysis is performed automatically within the solver. Gravity analysis is provided by default with nonlinear dynamic analysis to simulate the accumulated effects of progressive collapse without any user intervention.

Users can truly understand the cause and how the structure collapses beacuses ELS allows them to witness the entire duration of the collapse process, verify which parts of the structure will collapse and predict the effects of falling debris on adjacent structures.

17. What is meant by progressive collapse analysis?

Extreme loading for structures (ELS) software allows structural engineers to accurately analyze and visualize progressive collapse resulting from extreme loading conditions including earthquake laods, blast loads dynamic loads and impact loads. Engineers can also determine structures vulnerability to progressive collapse by creating multiple event scenarios which will simulate the failure of different components so as to determine whether the resulting collapse will be partial or complete.

18. Define equivalent static analysis

The equivalent static analysis approach defines a series of forces acting on a building to represent the effect of earthquake ground motion typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode.

19. Define response spectrum analysis

This approach permits the multiple modes of response of a building to be taken into account in the frequency domain. This is required in many building codes for all except for very simple or very complex structures

20. Define linear dynamic analysis.

Static procedures are appropriate when higher mode effects are not significant. This is generally true for short, regular buildings. Therefore for tall buildings with torsional irregularities or non-orthogonal systems, a dynamic procedure is required. In linear dynamic analysis, the building is modeled as a multi degree of freedom system with a linear elastic stiffness matrix and an equivalent viscous damping matrix.