Frequently Asked Questions

Question 01:

1. Elaborate the following terms:
    a. Urban Planning.
    b. Repair of Buildings
    c. Restoration of Buildings
    d. Strengthening of Buildings

Answer:

Urban Planning:

- Urban planning is a technical and political process concerned with the development and use of land, planning permission, protection and use of the environment, public welfare, and the design of the urban environment, including air, water, and the infrastructure passing into and out of urban areas, such as transportation, communications, and distribution networks.

Repair of Buildings:

- ✓ The main purpose of repairs is to bring back the architectural shape of the building so that all services start working and the functioning of building is resumed quickly.
- ✓ Repair does not pretend to improve the structural strength of the building and can be very deceptive for meeting the strength requirements of the next earthquake.

Restoration of Buildings:

- It is the restitution of the strength the building had before the damage occurred. This type of action must be undertaken when there is

evidence that the structural damage can be attributed to exceptional phenomena that are not likely to happen again and that the original strength provides an adequate level of safety.

- The main purpose of restoration is to carry out structural repairs to load bearing elements. It may involve cutting portions of the elements and rebuilding them or simply adding more structural material so that the original strength is more or less restored.
- The process may involve inserting temporary supports, underpinning, etc.

Strengthening of Buildings:

- The seismic behaviour of old existing buildings is affected by their original structural inadequacies, material degradation due to time, and alterations carried out during use over the years such as making new openings addition of new parts inducing dissymmetry in plan and elevation, etc.
- Commonly, strengthening procedures should aim at one or more of the following objectives:

(i) Increasing the lateral strength in one or both directions, by reinforcement or by increasing wall areas or the number of walls and columns.

(ii) Giving unity to the structure by providing a proper connection between its resisting elements, in such a way that inertia forces generated by the vibration of the building can be transmitted to the members that have the ability to resist them. Typical important aspects are the connections between roofs or floors and walls, between intersecting walls and between walls and foundations.

Question 02:

What are the typical vulnerabilities of existing buildings?

Answer:

The problems of repairs, restoration and seismic strengthening of buildings are briefly stated below:

(i) Before the occurrence of the probable earthquake, the required strengthening of seismically weak buildings is to be determined by a survey andanalysis of the structures.

(ii) Just after a damaging earthquake, temporary supports and emergency repairs are to be carried so that precariously standing buildings may

not collapse during aftershocks and the less damaged ones could be quickly brought back into use.

(iii) The real repair and strengthening problems are faced at the stage afterthe earthquake when things start settling down. At this stage distinctionhas to be made in the type of action required, that is, repairs, restorationand strengthening, since the cost, time and skill required in the threemay be quite different.

(iv) The decision as to whether a given building needs to be strengthened and to what degree, must be based on calculations that show if the levels of safety demanded by present codes and recommendations are met.

(v) The method of repair and strengthening would naturally depend very largely on the structural scheme and materials used for the construction of the building in the first instance, the technology that is feasible to adopt quickly and on the amount of funds that can be assigned to the task, usually very limited.

Question 03:

Elaborate the concepts of repair, restoration and Strengthening of existing buildings.

Answer:

Repairs

- The main purpose of repairs is to bring back the architectural shape of the building so that all services start working and the functioning of building is resumed quickly.
- Repair does not pretend to improve the structural strength of the building and can be very deceptive for meeting the strength requirements of the next earthquake.
- The actions will include the following:

- Patching up of defects such as cracks and fall of plaster.
- Repairing doors, windows, replacement of glass panes.
- Checking and repairing electric wiring.
- Checking and repairing gas pipes, water pipes and plumbing services.
- Re-building non-structural walls, smoke chimneys, boundary walls, etc.
- Re-plastering of walls as required.
- Rearranging disturbed roofing tiles.
- Relaying cracked flooring at ground level.
- Redecoration, whitewashing, painting, etc.

- The architectural repairs as stated do not restore the original structural strength of cracked walls or columns and may sometimes be very illusive, since the redecorates building will hide all the weaknesses and the building will suffer even more severe damage if shaken again by an

equal shock since the original energy absorbing capacity will not be available.

Restoration

- It is the restitution of the strength the building had before the damage occurred. This type of action must be undertaken when there is evidence that the structural damage can be attributed to exceptional phenomena that are not likely to happen again and that the original strength provides an adequate level of safety.
- The main purpose of restoration is to carry out structural repairs to load bearing elements. It may involve cutting portions of the elements and rebuilding them or simply adding more structural material so that the original strength is more or less restored.
- The process may involve inserting temporary supports, underpinning, etc.
- Some of the approaches are:

- Removal of portions of cracked masonry walls and piers and rebuilding them in richer mortar. Use of non shrinking mortar will be preferable.
- Addition of reinforcing mesh on both -faces of the cracked wall, holding it to the wall through spikes or bolts and then covering it suitably. Several alternatives have been used.
- Injecting epoxy like material, which is strong in tension, into the cracks in walls, columns, beams, etc.

Strengthening of Existing Buildings

- The seismic behaviour of old existing buildings is affected by their original structural inadequacies, material degradation due to time, and alterations carried out during use over the years such as making new

openings addition of new parts inducing dissymmetry in plan and elevation, etc.

- The possibility of substituting them with new earthquake resistant buildings is generally neglected due to historical, artistic, social and economical reasons.
- The complete replacement of the buildings in a given area will also lead to destroying a number of social and human links. Therefore seismic strengthening of existing damaged or undamaged buildings can be a definite requirement in same areas.
- Strengthening is an improvement over the original strength when the evaluation of the building indicates that the strength available before the damage was insufficient and restoration alone will not be adequate in future quakes.
- The extent of the modifications must be determined by the general principles and design methods stated in earlier chapters, and should not be limited to increasing the strength of members that have been damaged but should consider the overall behavior of the structure.
- Commonly, strengthening procedures should aim at one or more of the following objectives:

- Increasing the lateral strength in one or both directions, by reinforcement or by increasing wall areas or the number of walls and columns.
- Giving unity to the structure by providing a proper connection between its resisting elements, in such a way that inertia forces generated by the vibration of the building can be transmitted to the members that have the ability to resist them. Typical important aspects are the connections between roofs or floors and walls, between intersecting walls and between walls and foundations.

- Eliminating features that are sources of weakness or that produce concentrations of stresses in some members. Asymmetrical plan distribution ofresisting members, abrupt changes of stiffness from one floor to the other,concentration of large masses, large openings in walls without a proper peripheral reinforcement are examples of defect of this kind.

- Avoiding the possibility of brittle modes of failure by proper reinforcement and connection of resisting members. Since its cost may go to as high as 50 to 60% of the cost of rebuilding, the justification of such strengthening must be fully considered.

Question 04:

What are the various repair materials? Elaborate.

Answer:

- The most common materials for damage repair works of various types are cement and steel.
- In many situations non-shrinking cement or an admixture like aluminium powder in the ordinary Portland cement will be admissible.
- Steel may be required in many forms, like bolts, rods, angles, channels, expanded metal and welded wire fabric.
- Wood and bamboo are the most common material for providing temporarysupports and scaffolding etc., and will be required in the form of rounds, sleepers, planks, etc.

Shotcrete

- Shotcrete is a method of applying a combination of sand and portland cement which mixed pneumatically and conveyed in dry state to the nozzle of a pressure gun, where water is mixed and hydration takes place just prior to expulsion.

- The material bonds perfectly to properly prepared surface of masonry and steel.
- In versatility of application to curved or irregular surfaces, its high strength after application and good physical characteristics, make for an ideal means to achieve added structural capability in walls and other elements.
- There are some minor restrictions of clearance, thickness, direction of application, etc.

Epoxy resins

- Epoxy resins are excellent binding agents with high tensile strength. There are chemical preparations the compositions of which can be changed as per requirements.
- The epoxy components are mixed just prior to application. The product is of low viscosity and can be injected in small cracks too.
- The higher viscosity epoxy resin can be used for surface coating or filling larger cracks or holes.
- The epoxy mixture strength is dependent upon the temperature of curing (lower strength for higher temperature)and method of application.

Epoxy mortar

- For larger void spaces, it is possible to combine epoxy resins of either low viscosity or higher viscosity, with sand aggregate to form epoxy mortar.
- Epoxy mortar mixture has higher compressive strength, higher tensile strength and a lower modulus of elasticity than Portland cement concrete.

- Thus the mortar is not a stiff material for replacing reinforced concrete. It is also reported that epoxy is a combustible material. Therefore it is not used alone.
- The sand aggregate mixed to form the epoxy mortar provides a heat sink for heat generated and it provides increased modulus of elasticity too.

Gypsum cement mortar

- It has got rather limited use for structural application. It has lowest strength at failure among these three materials.

Quick-setting cement mortar

- This material is patented and was originally developed for the use as a repair material for reinforced concrete floors adjacent to steel blast furnaces.
- It is a non-hydrous magnesium phosphate cement with two components, a liquid and a dry, which can be mixed in a manner similar to Portland cement concrete.

Mechanical anchors

- Mechanical type of anchors employ wedging action to provide anchorage.
- Some of the anchors provide both shear and tension resistance. Such anchors are manufactured to give sufficient strength.
- Alternatively chemical anchors bonded in drilled holes polymer adhesives can be used.