



Introduction to Earthquake Engineering

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• Retrofitting

- Retrofitting is the process of modifying something after it has been manufactured.
- Retrofitting a building involves changing its systems or structure after its initial construction and occupation.
- This work can improve amenities for the building's occupants and improve the performance of the building. As technology develops, building retrofits can significantly reduce energy and water usage.
- Retrofitting is described as the procedure of change of existing structures such as Residential buildings, bridges, and historical buildings to make them impervious against seismic action like Earthquakes, Volcanic Eruptions, and other natural disasters that include landslides, tsunamis, floods, thunderstorms.
- Retrofitting of RCC structural members is done so that the deteriorated concrete element structure regains its strength. It also helps to prevent further distress in concrete elements



- **Seismic Retrofitting**

- seismic retrofit, the process of strengthening older buildings in order to make them earthquake-resistant



• Why Retrofitting is Needed

- As time passes many **environmental factors** going on around impact the structure. Out of all these factors, the most damaging is an earthquake that disturbs the internal structure of the building, and thus gradually building starts losing its strength and stability. As a result, the structure becomes unsafe for future use and might cause massive loss.
- The **level of deterioration** caused to the concrete element structure is occurring at an alarming rate. It has been confirmed that even if all the specific building code is followed still there is a high risk of deterioration of concrete element and corrosion of reinforcement.
- **Steel corrosion** is considered as one of the severe cause behind the deterioration of reinforced concrete element and this could create cracks or reduce the effective area of the reinforcement, spalls the concrete cover, and might lead to collapse.



- **Performance of Retrofitting**

- Presently a-days retrofitting is extending its legs on the planet out of control, as a considerable lot of the recorded, public, and private significant designs get genuine old and become feeble because of passing time. Retrofitting is perhaps the most ideal alternative to make an existing lacking structure protected against future dangers or other natural powers.



- **Performance of Retrofitting**

- Retrofitting is the cycle of expansion of new highlights to more established structures, legacy structures, spans, and so on Retrofitting diminishes the weakness of harm of an existing design during a not-so-distant future seismic movement.
- It is the alteration of existing designs to make them more impervious to seismic activity, movement of the ground, and disappointment of soil because of seismic tremors or other characteristic cataclysms, for example, twisters, typhoons, and winds with high velocity caused by tempest, snowfall, hailstorms.



• Road Map to Retrofitting structure

- The basic objective behind retrofitting or repair works is to extend the service life, enhance the performance of the structure or increase the load-bearing capacity. The rational approach to any retrofitting work is to keep into consideration the main cause of the deterioration along with the symptoms.
- Only treating the symptoms without proper understanding of the main cause of the problems leads to camouflaged defects identification beneath the finished work. It is said that repair of the retrofitting work should be avoided and for that, we need to follow the below-mentioned steps.
- Preparation of drawings and specifications
- Condition Evaluation
- Selection of materials and repair methods
- Determination of the main cause behind the deterioration
- Execution process
- Maintenance after completion of the retrofitting work
- Appropriate quality control measures

- **Problems need to be addressed**

- Evaluation models and damage assessment
- Design and analysis of suitable repair methods and techniques
- Bridge rehabilitation
- Seismic retrofitting
- Strengthening and refurbishment techniques
- Materials for repair, protection, and rehabilitation
- Durability Considerations
- Performance monitoring and distress diagnostics, Non- Destructive test
- Structural Condition assessment

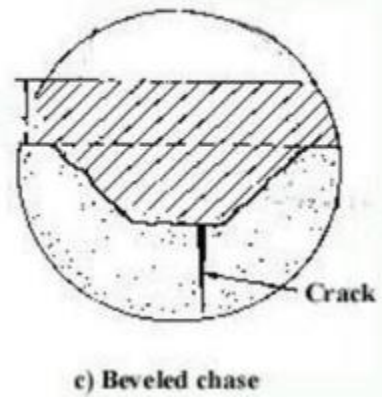
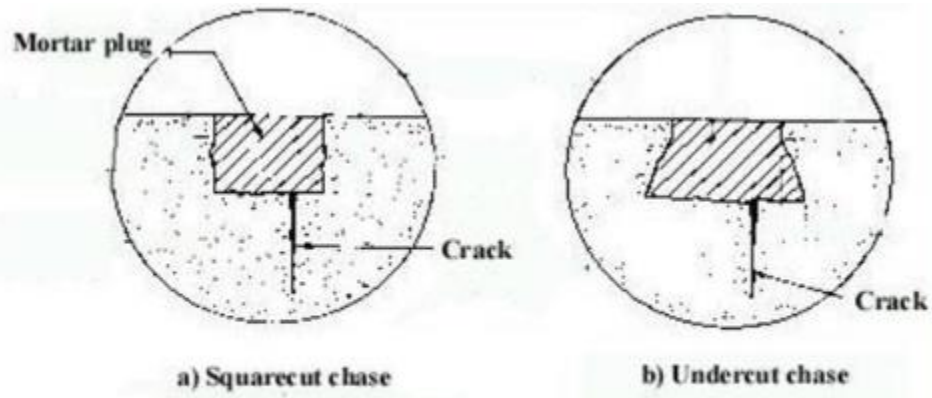
• Types and Techniques of Retrofitting

- Sealing with Epoxies
- Stitching
- Blanketing
- Routing and Sealing
- External Stressing
- Autogenous Healing
- Overlays
- Grouting
- <https://expertcivil.com/retrofitting-purpose-types-advantage-disadvantage/>

- **Techniques of Retrofitting**

- **Sealing with Epoxies:** Cracks in the concrete element could be sealed with the help of epoxy by injecting them with pressure.
- **Stitching:** With the help of iron or steel dogs a cracked concrete part could be retrofitted by stitching in the same manner as we stitch clothes.
- **Blanketing:** This technique of retrofitting is used on a large scale to seal the dormant as well as active cracks.
- **Routing and Sealing:** Under this method of retrofitting the cracks along the affected surfaces are first enlarged and then a suitable material is used to seal them and fill them up such as Hot-Tar used on road pavements.





- **Techniques of Retrofitting**

- **External Stressing:** This process of retrofitting involves the process of counteracting the stress due to which the crack has been caused. It provides a residual compression and overcomes the tension, applied using rods and pressing wires.
- **Autogenous Healing:** The unique ability of concrete elements to heal cracks by itself is known as Autogenous Healing. Basically used to seal dormant cracks such as cracks in water tanks or cracks caused due to temporary loading.
- **Overlays:** These are types of retrofitting used to improve load-bearing capacity, drainage, rideability or to protect underlying concrete elements from aggressive environments.
- **Grouting:** This process of retrofitting is similar to that of sealing with epoxies. It is basically a mortar paste that is mixed with adhesives to help increase the bonding properties.



- **Types of Retrofitting**

- There are following two types of retrofitting:

- **Local Retrofitting**

- Jacketing of beams
- jacketing of beam-column joints
- Strengthening individual footings

- Jacketing of Columns

- **Global Retrofitting**

- Adding shear wall
- Adding infill wall
- Mass Reduction
- Wall Thickening
- Adding Braces

- **Reinforced Concrete Structures**
- Two important methods that can be carried on improving concrete structures are these: –
- Adding New Structural Elements
- Strengthening Existing Elements
- **Masonry Structure**
- Other methods include Retrofitting through roofs, doors, and windows.

• **Advantages of Retrofitting**

- Increases the life of the building.
- Is economical.
- It is pocket friendly
- Helps in increasing stability and sustainability
- Prepares the building to bear different weather conditions
- Helps in strengthening and enhancement of the structure.

• **Disadvantages of Retrofitting**

- Small irresponsibility can cause further damage.
- Chances are that it can damage historical buildings.
- Need critical and expert analysis before Retrofitting.
- Requires expert analysis before proceeding to retrofit
- High risk of causing damage to Heritage Sites
- Normal negligence could cause major damage
- Manpower involved needs to be of good expertise.

• Analysis of Retrofitting

- Before applying any maintenance strategy, it is important to have an arranged way to analyze the state of cement and support.
- This will require very specialized assessment and comprehension of the conduct of the primary buildings, which is being fixed. According to these analysis materials and method for retrofit is utilized.
- This ensures safety. The choice to retrofit or supplant a construction or its segments can be chosen after the thought of administration life of designs that are set up dependent on the financial and specialized advancements.

- **Retrofitting Performance Objectives**

- Public Safety
- Structure Survivability
- Structure Functionality
- **Structure Un Affected**
- This level of retrofit is preformed for historic buildings of high cultural importance

**THANK
YOU!**