

CASE STUDY ON DIAGNOSIS AND REPAIR OF FAILURES IN RCC BUILDING

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Abstract - Reinforced concrete structures are designed for specific purpose and life span. The sustainability of these structures depends on utility and maintenance at different phase of life. At initial stage of the structure some preliminary failure symptoms are observed, which, if not rectified may further leads to damage, deterioration and may results in dilapidation. Before reaching to such alarming condition, the structure must rehabilitate and repaired with certain specific techniques and material. The purpose of this research is to diagnose the failure symptoms observed in G+3 Residential Apartment and suggest various repair and rehabilitation techniques to fix the problem.

Key Words: Repair, rehabilitation, RCC Failure, Building Failure, Failure Diagnosis, Polymer modified concrete

1. INTRODUCTION

Residential buildings are constructed for calculated design load, environmental conditions and utility. But during service period certain critical conditions entertained are excessive loading due to extension of structures, poor drainage conditions and varying environmental condition. These situations if not technically entertained may lead to deterioration of structural and non-structural components of structure. Some other causes which leads to failure includes, improper workmanship, poor material or lean grade of concrete used for construction.

The process of deterioration starts by exhibiting some preliminary failure symptoms, such as hairline cracks, spalling and delamination of concrete, corrosion of reinforcement. These symptoms must be diagnosed and repaired on time before these may lead to further deterioration and catastrophic failure of structure.

1.1 Types of failures

RCC structures demonstrate two types of failures:

1. **Structural Failure:** This failure is basically due to design deficiency, that is, when the applied load exceeds the design If serviceability aspect is not considered then the structure fails due to cracking, deflection or corrosion, deterioration.

2. **Non Structural Failure:** This failure in structure is basically due to external factors such as improper utility, improper drainage, chemical damage, and physical. The major cause of such failure is improper quality of material used and poor workmanship.

1.2 Failures at various stages

Structure shows failure symptoms in every stages of life. Even the construction stage exhibits certain failure symptoms, which is basically due to improper curing, workmanship and material quality. Such minor failures must be rectified by certain repair methods and taking some preventive measures during construction.

During serviceability period of the structure, the structure must be monitored at certain interval for its maintenance. Some preliminary failure symptoms such as hairline cracks, honeycomb in concrete is observed. The diagnosis of failure at preliminary stage is necessary so that it may not lead to secondary failures. Repair and in certain cases rehabilitation may fix the problem. But, if at this phase the failures is not rectified them these may lead to the catastrophic failure of the structure; and only rehabilitation or reconstruction is only possible solution.

CONSTRUCTION STAGE	UTILITY PHASE		FAILURE OF STRUCTURE
MINOR FAILURES/ DAMAGES	PRELIMINARY FAILURE	SECONDARY FAILURE	FATAL FAILURE
	REPAIR	REHABILITATION	

Fig -1: Failure at various stages in RCC Structure

2. RESEARCH OBJECTIVE

Major objectives of the research work are:

1. Diagnosis of failure symptoms observed in various components of the building.
2. Suggesting various repair and rehabilitation techniques.

3. MAJOR STEPS OF RESEARCH

3.1 Inspection of building and components exhibiting failure symptoms

The RCC structure selected for study is Residential G+ 3 apartment in Dwarka, Delhi. The age of structure is between 15-20 years. The building demonstrates various failure symptoms which is basically due to age of structure, improper drainage and further extension of structure, without technical guidance.

The failure is observed in almost all structural as well as non-structural components of the building such as, beam, column, slab, walls, parapet, and sunshade.



Fig -2: G+3 Residential Building

3.2 Diagnosing various symptoms of failure

Since the building was not inspected and maintained at required interval, hence a large number of failures were observed.

- Exposure of reinforcement to open environment: Incorrect grade of concrete, poor workmanship and improper drainage deteriorate the cover, thus the reinforcement gets exposed to the environment. In this particular case, the reinforcement exposure is mostly seen in top floor, when further inspected it is observed that on the terrace there is growth of vegetation and roots penetrate through the concrete thus exposing the reinforcement.



Fig -3: Reinforcement exposure

- Flexural Cracks in beam: When actual load increases the design limit such failures are observed in beam. While In-situ inspection it had been observed that there is further extension of structure on the floor just above the beam resulting in excessive increase in load thus causing flexural failure.



Fig -4: Flexural Cracks in Beam

- Cracks in column: Thermal variation, excessive loading leads to cracks in column.



Fig -5: Cracks in Column

- Spalling of concrete: Due to typical stresses, concrete break down into fragments, resulting in spalling of concrete.



Fig -6: Spalling of concrete

- Drainage and seepage problem: Improper drainage system, broken drain pipes and improper tank overflow system results in seepage problem. This problem is most commonly seen in almost all the part of the apartment.



Fig -7: Seepage



Fig -10: Flaking of plaster

- Deterioration of cover: Due to variation of environmental conditions, minor cracks are seen as preliminary symptom, which if not repaired may further leads ton deterioration of cover. Other possible causes of cover deterioration are incorrect proportion of concrete and large size of coarse aggregate used.



Fig -8: Deterioration of cover

- Failure of chajja: Extensive spalling of concrete from chajja is observed, due to use of improper grade of concrete, water cement ratio and improper cover.



Fig -9: Failure of chajja

- Flaking of plaster from walls: Incorrect cement sand proportion, poor workmanship and improper curing leads to abrasion and flaking of plaster.

3.3 Suggesting suitable repair and rehabilitation technique

- Repair of Spalling

STEP 1: Removal of loosen or spalled concrete.

STEP 2: Application of polymer modified cement mortar.

- Repair of reinforcement exposure and cover deterioration

STEP 1: Removal of loosen concrete, if any.

STEP 2: Cleaning of corrosion from reinforcement bar using wire brush.

STEP 3: Application of anti-corrosive primer over reinforcement.

STEP 4: Plastering with polymer modified cement mortar.

- Repair of Seepage problem from terrace

STEP 1: Clean the terrace surface, removal algal growth and uproot the vegetation growth (as seen in this case)

STEP 2: Apply kerosene oil primer followed by bitumen painting over the surface.

STEP 3: Provide 400 micron polyethylene sheet with bitumen near water drains.

STEP 4: Refix all the drain pipes, so that no leakage is there.

STEP 5: Provide proper tank overflow system.

STEP 6: Provide proper finish with appropriate slope towards the drain.

- Repair of Cracks in beam/ column

STEP 1: Remove the plaster/ finish over the surface and roughen the smooth surface.

STEP 2: Seal the cracked portion of structure by injecting or grouting polymer modified cement slurry.

- Repair of Flaking of plaster

STEP 1: Remove the finishing or flaked plaster.

STEP 2: Roughening the surface for bonding and application of repair material.

STEP 3: Re- plastering the surface with 1:3 cement mortar mix.

- Rehabilitation of failed chajja

STEP 1: Remove all the loose and flaked concrete.

STEP 2: Clean the corroded reinforcement with wire brush.

STEP 3: Recasting of chajja using M20 grade of concrete.

STEP 3: Apply finish coat of 1:3 cement mortar plasters.

BIOGRAPHY



Shubhangi Saxena has worked as guest faculty in Government Engineering College, Bharatpur, Rajasthan. She had received her M.Tech degree with the specialization of Construction Technology and Management in NITTTR, Bhopal. Her area of interest is in the study of concrete durability and project planning.

3. CONCLUSION

Residential apartment site had been investigated, and all the failure symptoms observed is reported. Some failures were at preliminary stage, but most of them were at alarming stage. Such symptoms must be repaired and rehabilitated as early as possible. Effective solution to repair the failure is proposed. The repair and rehabilitation steps can be further applied to other sites with similar failures observed.

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