Case Study for "Structural Damages Assessment Report to Office Building Apartment, Dredging Corporation of India Limited, F2-B1 & F2-B2, Rainbow Shops & Apartments, Vashi, Navi Mumbai"

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Abstract

This report presents the findings of a visual structural damage assessment conducted for an office building of the Dredging Corporation of India Limited in Navi Mumbai, India. The objective was to evaluate the structural integrity of the aged reinforced concrete framed building to ascertain its condition status and recommend urgent remedial actions. The methodology employed a comprehensive visual reconnaissance survey, supplemented by hammer tapping, to identify defects including concrete spalling, crack mapping, reinforcement corrosion, and water ingress. Results indicate severe structural deterioration in load-bearing elements, with a high probability of active corrosion and significant water damage, compromising the building's safety and stability. The significance of the assessment lies in its urgent call for immediate propping and comprehensive scientific repairs to prevent potential collapse, thereby safeguarding human life and outlining a critical methodology for assessing aging infrastructure in coastal urban environments.

1. Introduction

This report details the findings and recommendations of a Structural Damages Assessment conducted for the office premises of the Dredging Corporation of India Limited, located at Units F2-B1 & F2-B2, Rainbow Shops & Apartments, Sector 10, Juhu Nagar, Vashi, Navi Mumbai.

The assessment was initiated following a request from the client, stemming from visible signs of distress within the property, including cracking, spalling concrete, and water leakage. The primary objective of this investigation was to perform a broad-based visual reconnaissance survey to establish the current condition status of the building's structural and non-structural elements. The purpose is to diagnose the extent and causes of observed deterioration and to prescribe a scientifically sound, prioritized action plan for immediate remediation and long-term durability enhancement.

The scope of this assessment was limited to a visual inspection of accessible areas, utilizing non-destructive techniques such as hammer tapping and binocular observation to evaluate concrete integrity, plaster adhesion, and crack patterns. It is critical to note that this evaluation did not include invasive testing, analysis of the foundation system, or a seismic assessment. The findings and recommendations contained herein are based solely on conditions observed during the site visit on 24th January 2021 and are subject to the constraints and disclaimers outlined in this document.

The following report systematically presents the salient details of the structure, a comprehensive log of observations with photographic evidence, distress mapping, an analysis of probable causes, and a detailed methodology for essential remedial measures. The conclusion underscores the urgency of implementing the proposed repairs to ensure structural safety and prevent further degradation.

2. Objectives

The primary objectives of this Structural Damages Assessment report are as follows:

1. To conduct a broad-based Visual Reconnaissance Survey of the office building (F2-B1 & F2-B2, Rainbow Shops & Apartments) to establish the current physical and structural condition status of the premises.

2. To identify, document, and map all observable structural defects and signs of distress, including but not limited to:

   - Cracks in RCC columns, beams, slabs, and masonry walls.
   - Concrete spalling, delamination, and cover failure.
   - Exposure and corrosion of reinforcement.
   - Water leakage and seepage points.

3. To ascertain the probable causes of the observed deterioration, focusing on factors such as ageing, corrosion, water ingress, and lack of maintenance.

4. To provide a prioritized set of recommendations and detailed remedial measures aimed at:

   - Safeguarding the structural stability and preventing potential collapse.
   - Arresting further deterioration.
   - Enhancing the long-term durability of the building.

5. To issue an Immediate Action Plan, including the necessity for temporary propping, to ensure human safety and guide the client in undertaking urgent repairs without delay.

3. Scope of The Case Study

These structural damages assessment is defined by the following inclusive and exclusive parameters:

Inclusions (Within Scope):

1. Visual Reconnaissance Survey: A comprehensive visual inspection of all accessible areas of the office premises in F2/B1 and F2/B2.

2. Condition Assessment of Visible Elements:

   - Structural: Condition of visible Reinforced Concrete (RCC) elements—columns, beams, slabs, chajjas (sunshades/overhangs).
   - Non-Structural: Condition of internal and external plaster, masonry walls, floor tiles, doors, windows, and paints.
   - Services: Observable state of electrical wiring, plumbing, and sanitary fittings.

3. Non-Destructive Evaluation Techniques: Use of basic tools including:
   - Hammer tapping to detect hollow plaster and delaminated concrete.
   - Visual examination with binoculars for elevated areas.
   - Measurement tapes for crack width mapping.
4. Documentation: Creation of:
   - Detailed observation logs.
   - Distress mapping plans.
   - Photographic evidence of all major defects.
5. Analysis and Recommendation: Provision of:
   - Probable causes for identified distress.
   - A prioritized immediate action plan.
   - Detailed methodological guidelines for scientific repairs and rehabilitation.

Exclusions (Outside Scope):

1. Invasive Testing & Detailed Analysis: No non-destructive testing (NDT) like rebound hammer, ultrasonic pulse velocity, or cover meter measurements was conducted.
2. Foundation Assessment: The condition of the building's foundation and substructure was not inspected and is beyond the scope of this report.
3. Seismic Assessment: An evaluation of the building's seismic (earthquake) resistance was not performed.
4. Load Capacity Analysis: No structural design calculations or analysis of current load-bearing capacity was undertaken.
5. Review of Historical Drawings: Although attempted, the assessment was carried out in the absence of original architectural or structural drawings due to their unavailability.
6. Cost Estimation: The report does not include any bill of quantities, cost analysis, or budget estimates for the suggested repairs.

4. Remedial Methodology

The report prescribes a systematic, scientific approach to repairs, prioritizing safety and structural integrity. The methodology is segmented by the type of defect and the element requiring attention.

A. Immediate Safety Measures

1. Temporary Propping:

- Action: Erect Mild Steel (M.S.) props at 1.2-meter centers (in both directions) beneath severely damaged slabs and beams.
- Purpose: To partially relieve the load on compromised structural elements and prevent potential collapse during repair work.
- Specification: Props must use 4”x4” wooden planks (chavis) at the top for proper load distribution and be fixed in a "scientific way."

B. Repair of Severely Deteriorated RCC Elements

This is the core structural repair process, to be executed in the following sequence:

1. Temporary Support: Provide supports as needed (per engineer's instruction).
2. Preparation: Carefully remove all loose, spalled, and damaged concrete up to sound material, exposing corroded reinforcement.
3. Reinforcement Treatment:
   - Clean bars of all rust.
   - Apply a rust passivator/convertor chemical.
   - Apply a protective coat of rust inhibitor.
   - Install additional reinforcement (rings, lapping rods, weld mesh) as required by the design.
4. Grouting: Perform cementation grouting with non-shrink additives to fill internal voids and honeycombs.
5. Concrete Restoration:
   - For cover failure ≤25mm: Apply polymer-modified mortar (1:5:15 mix).
   - For cover failure >25mm: Execute micro-concreting to the designed thickness, incorporating new reinforcement and shear connectors to bond old and new concrete.

C. Treatment of Cracks

1. Preparation: Open cracks into a 'V' groove (50-75mm wide) by chiseling.
2. Cleaning: Clean thoroughly with a water jet.
3. Bonding: Moisten the crack and apply a primer coat of polymer-cement slurry (1:1).
4. Filling: Immediately fill with polymer-modified mortar (1:5:15).
5. Pressure Grouting: For thorough sealing, fix nipples at 1.0m intervals and inject cementitious grout (with non-shrink additive) under pressure.

D. Waterproofing & Replacement of Building Envelope

1. External/Internal Plaster & Chajjas:
   - Remove all damaged plaster and faulty waterproofing.
   - Repair underlying RCC elements (as per Section B).
   - Re-plaster in two coats. On chajjas, provide a cement-finish waterproofing with a proper brick-bat *coba* and slope.
2. External & Internal Paint:
   - Scrape, clean, and pressure-wash surfaces.
   - Seal cracks with a flexible, fiber-reinforced acrylic filler.
   - Apply one coat of exterior-grade base coat and two coats of exterior-grade top coat (specific products recommended).
3. Floor Areas:
   - Remove existing floor tiles up to the base slab.
   - Perform necessary structural slab repairs.
   - Re-waterproof with 50mm PCC (1:2:4) overlaid by a 4mm thick APP membrane and new screed.

E. Interior & Services Rehabilitation

1. Insides of Premises: Carry out need-based repairs, re-plastering, and repainting.
2. Drain Pipes: Replace all damaged/corroded cast iron drain, vent, and rainwater pipes with new CI pipes and fittings.
3. Electrical & Plumbing: Complete replacement of all wiring, plumbing lines, and sanitary fixtures is recommended.
4. Toilets/Baths (Leakage Rectification): A staged diagnostic approach is prescribed:
   - Stage 1: Replace all leaky external drain pipes and seal ducts.
   - Stage 2: Re-grout all floor tile joints.
   - Stage 3: leakage persists, replace cracked Nahanni traps/P-traps.
   - Stage 4: leakage continues, pressure test and repair concealed pipes.
   - Stage 5 (Last Resort): Break and re-do the entire toilet waterproofing system.

F. New Construction Work

- Execute the planned new extension works for the toilet, bedroom, and kitchen in the F2/B1 apartment as per design.

5. Methods of Investigation

The investigation was conducted using a systematic, non-destructive visual approach to identify and document structural distress. The methodology comprised the following steps:

1. Visual Reconnaissance: A comprehensive walk-through of all accessible areas of the F2/B1 and F2/B2 apartments, including external balconies and internal rooms.
2. Tool-Assisted Examination:
   - Hammer Tapping: A standard hammer was used to sound concrete and plaster surfaces. This acoustic method helped identify areas of hollowness, delamination, and subsurface voids where the material had lost bond with the substrate.
   - Binoculars: Used for detailed visual inspection of elevated or difficult-to-access elements like high beams, column tops, and soffits of chajjas.
   - Measurement Tape: Employed to measure crack widths and map their propagation.
3. Physical Documentation:
   - Distress Mapping: Defects were manually recorded and marked on sketched floor plans using a standardized legend (e.g., C/C for column cracks, B/R for corroded beam reinforcement).
   - Photographic Log: Extensive photographs were taken of all significant defects, both from a distance for context and up close for detail, creating a visual record of the condition.

B. Elements and Areas Investigated

The investigation focused on the following building components:

- Primary Structural Elements: RCC columns, beams, slabs, and chajjas (sunshades).
- Secondary Elements: Internal and external brick/block masonry walls.
- Finishes and Envelope: Internal and external plaster, paint, floor tiles, doors, and windows.
- Services: Observable conditions of electrical conduits, plumbing fixtures, and drainage points.
- Specific Problem Areas: Locations reported with leaks, seepage, and visible spalling were given particular attention.

C. Identified Constraints and Limitations

The investigation was bounded by several practical constraints, which define the scope and certainty of its findings:

1. Non-Invasive Scope: The assessment was strictly visual and non-destructive. No material was removed, and no subsurface or laboratory testing was performed.

2. Access Limitations: The inspection was constrained by:

   - Fixed Furnishings: Structural elements concealed behind fixed furniture, wall cladding, or built-in cupboards could not be inspected.
   - Interior Works: Areas under renovation or covered by recent finishes were inaccessible
   - Limited External Access: Inspection of the building's full external facade was limited to balcony areas.

3. Absence of Design Data: Critical information was unavailable:

   - No Drawings: Neither architectural nor structural drawings were provided, preventing an understanding of the original design, reinforcement details, or material specifications.
   - Unknown History: The exact year of construction and history of past repairs were not known, limiting causal analysis.

4. Excluded Critical Assessments: The following vital engineering evaluations were explicitly outside the scope of this investigation:

   - Foundation Inspection: The condition of the substructure and foundations was not assessed.
   - Non-Destructive Testing (NDT): Quantitative tests (e.g., rebound hammer for concrete strength, ultrasonic pulse velocity for homogeneity, cover meter for reinforcement location) were not conducted.
   - Seismic Assessment: The building's vulnerability and performance during an earthquake were not evaluated.
   - Load Rating Analysis: The current load-bearing capacity of structural members was not calculated.

Conclusion on Investigation Depth

This Detailed Investigation was a Level-I visual condition survey as per standard engineering practice. It successfully identified symptomatic defects and areas of urgent concern. However, the constraints mean the report is a diagnostic first step. A Level-II investigation involving NDT and material testing would be required to quantify the extent of damage, determine residual strength, and finalize detailed repair designs. The recommendations are therefore based on observed pathology and standard repair practices for such symptoms.

6. Testing and Condition Assessment

This section details the specific observations, diagnostic evaluations, and conclusions drawn from the visual investigation regarding the material and structural condition of the building.

A. Summary of Defects Observed

Sr. No.	Area/Element	Observed Defects
1	Primary RCC Structure	1. Cracked and damaged RCC columns and beams. 2. Cracked, spalled concrete with exposed and corroded reinforcement in columns and chajja bottoms. 3. Cracked RCC chajjas (sunshades).
2	Cracks	1. Horizontal, vertical, and diagonal cracks in both RCC members and masonry walls.
3	External Walls/Chajjas	1. Discoloured plaster. 2. Fungus formation (indicative of chronic dampness). 3. Cracked chajja tops.
4	Internal Areas	1. Cracked/spalled concrete in slabs, beams, columns. 2. Hollow and cracked plaster over RCC. 3. Floor tile leakages. 4. Discoloured internal paint.
5	Toilets/Baths	1. Cracks in RCC elements, indicating possible movement or water damage.
6	Finishes & Services	1. Doors/windows in non-repairable condition. 2. Shabby, discoloured floor tiles requiring full replacement. 3. Electrical wiring and plumbing systems deemed necessary for complete replacement.

B. In-Situ Diagnostic Assessment (Visual & Tactile)

The consultant performed the following qualitative assessments based on direct observation and hammer-sounding:

1. Concrete Compressive Strength (Qualitative): Rated as "Poor." This judgment is based on the widespread spalling, extensive cracking, and the ease with which loose concrete could be identified, indicating advanced deterioration and probable loss of design strength.

2. Extent of Reinforcement Corrosion: Assessed as having a "50% to 90% Probability of Active Corrosion." This high probability is evidenced by:

- Active Corrosion Sites: Numerous locations with exposed, rusted rebars (particularly in column and chajja soffits).
- Indirect Evidence: Crack patterns (especially horizontal cracks along reinforcement lines), delamination, and concrete spalling directly caused by rust expansion.

3. Carbonation Depth (Estimated): The average carbonation depth was estimated to be 10mm. Carbonation is the process where carbon dioxide penetrates concrete, lowering its alkalinity and destroying the passive layer that protects steel from corrosion. An average depth of 10mm suggests the protective cover over the reinforcement has been compromised in many areas, confirming the visual evidence of corrosion.

4. Concrete Integrity: Noted to have "Extensive Voids and Honeycombing." This defect, visible at several locations, indicates poor original compaction/construction quality. These voids allow easier ingress of moisture and pollutants, accelerating carbonation and corrosion.

C. Condition Rating and Probable Causes

Overall Structural Condition Status: "Structural Deteriorations Noted" with a prognosis of active and worsening damage.

Identified Probable Causes of Distress:

1. Age-Related Deterioration: Long-term wear and tear, compounded by a lack of preventive maintenance.
2. Severe Reinforcement Corrosion: The primary driver of damage, caused by:
   - Inadequate Concrete Cover
   - Presence of Honeycombed Concrete
   - Advanced Carbonation (estimated 10mm depth)
3. Chronic Water Ingress: The major accelerating factor, from:
   - Leaking Toilets & Bathrooms
   - Damaged/Cracked Chajjas (failed waterproofing)
   - Leaking/Damaged Drainage and Water Pipes
   - Seepage through External Walls
4. Environmental Exposure: Coastal location (Navi Mumbai) subjecting the structure to salt-laden, humid air, which accelerates corrosion.

Conclusion of Condition Assessment

The testing and condition assessment conclude that the building is in a state of advanced and active deterioration. The concrete has lost significant integrity, the reinforcement is actively corroding, and these processes are being accelerated by persistent moisture ingress. The defects are not merely cosmetic; they indicate a reduction in the load-carrying

capacity of key structural elements (columns, beams, slabs). The condition presents a clear and immediate risk to building safety, necessitating urgent intervention as outlined in the remedial methodology.

7. Condition Assessment Criteria

This section defines the framework, references, and qualitative scales used to evaluate and categorize the defects observed during the visual reconnaissance survey. The assessment did not employ formal, codified rating systems but was based on established engineering principles for visual inspection.

A. Framework for Visual Assessment

The assessment was guided by a systematic approach to identify, locate, and characterize defects. The primary criteria were:

1. Presence and Type of Defect: Identifying the specific pathology (e.g., crack, spall, corrosion stain, leakage, hollow sound).
2. Location and Extent: Mapping the defect to specific structural elements (Column, Beam, Slab, Wall) and estimating its spread (localized vs. widespread).
3. Severity: Qualitatively judging the seriousness of the defect based on its nature, size, and potential impact on structural integrity and durability.
4. Urgency of Response: Determining the immediacy of the repair need based on the severity and its implications for safety and continued deterioration.

B. Qualitative Severity Classifications

While not explicitly defined in the report, the consultant's observations and recommendations imply the use of the following descriptive severity scales:

1. For Structural Defects (Cracks, Spalling, Corrosion):
   - Mild: Hairline cracks (<0.5mm), minor surface discoloration, initial stages of rust staining without material loss.
   - Moderate: Open cracks (0.5mm – 2mm), localized concrete spalling (<25mm deep), active corrosion with some section loss of rebar, hollow plaster areas.
   - Severe: Wide cracks (>2mm), extensive spalling with exposed and corroded reinforcement, deep delamination, elements showing significant distortion or loss of section. The report consistently uses terms like "severely damaged," "severely deteriorated," and "severely spalled" for the worst cases.
2. For Water Ingress and Dampness:
   - Active Leakage: Visible water flow or dripping, saturated surfaces.
   - Seepage/Dampness: Staining, fungus/mold growth, moist surfaces without active flow.

- Salt Efflorescence: White powder deposits indicating a history of moisture movement and evaporation.

3. For Material Condition (Implied from Observations):

- Poor: Widespread defects, loss of material integrity, advanced deterioration (as concluded for in-situ concrete compressive strength).
- Repairable: Damaged but can be restored through recommended remedial measures (as noted for the state of the apartments).
- Non-Repairable: Elements beyond economical or effective repair, requiring replacement (as concluded for doors, windows, wiring, and plumbing).

C. Assessment Tools and Their Diagnostic Purpose

The simple tools used were directly linked to specific condition criteria:

Tool	Purpose / What it Assessed	Condition Indicator
Visual Examination	To identify cracks, stains, deformation, corrosion, biological growth, and surface defects.	Type, location, and visual severity of defect.
Hammer Tapping	To detect hollowness and delamination in plaster and concrete cover.	Loss of bond between layers, subsurface voids, and hidden deterioration. A dull, hollow sound indicates a problem.
Binoculars	To closely inspect defects in inaccessible areas (high ceilings, external elevations).	Extent of defects in areas not reachable for close physical inspection.
Measurement Tape	To measure crack width and length.	Quantification of crack size, a key parameter in judging severity and monitoring progression.

D. Legend as a Standardized Criteria Key

The report uses a defined legend (e.g., C/C, B/R, L/S) to consistently classify and record each observed defect. This legend itself is a critical part of the assessment criteria, ensuring standardized notation for:

- Element Type: C (Column), B (Beam), S (Slab), W (Wall), etc.
- Defect Type: /C (Cracks/Cover failure), /R (Corroded Reinforcement), /S (Sagging), L/ (Leakage), etc.

E. Key Deduced Performance Criteria

The overall condition judgment was based on the following inferred engineering performance criteria:

1. Structural Safety: Are load-bearing elements compromised? (Evidence: severe spalling, wide structural cracks).
2. Serviceability: Is the building able to perform its intended function without excessive leakage or deterioration? (Evidence: chronic leaks, failed finishes).
3. Durability: Is the rate of deterioration acceptable, or is it accelerating? (Evidence: active corrosion, carbonation, ongoing water ingress).
4. Imminent Risk: Is there a threat of sudden or progressive collapse? (Conclusion: Yes, necessitating immediate propping).

Conclusion on Assessment Criteria

The condition assessment was conducted using a well-established, practice-based visual methodology. While it lacked quantitative measurement tools (like crack microscopes or NDT), it employed standard qualitative engineering judgment to categorize severity, identify failure mechanisms, and, most critically, determine the urgency of response based on the clear evidence of advanced material degradation and compromised structural capacity. The criteria were sufficient to conclude that the building presents a high-risk condition requiring immediate intervention.

8. Summary of Assessed Condition

This report presents the findings of a comprehensive visual structural damage assessment conducted for the office building of the Dredging Corporation of India Limited at Rainbow Shops & Apartments, Vashi, Navi Mumbai. The assessment was performed to evaluate the current structural integrity and prescribe urgent remedial measures.

1. Key Findings & Observations

- Widespread Structural Deterioration: The Reinforced Concrete (RCC) framed structure exhibits severe and advanced degradation. Critical load-bearing elements, including columns, beams, slabs, and chajjas (sunshades), show extensive cracking, concrete spalling (chipping), delamination, and exposure of severely corroded steel reinforcement.
- Active Corrosion Mechanism: There is a 50-90% probability of active corrosion within the reinforcement. This is driven by carbonation (estimated average depth of 10mm) and persistent moisture ingress, which has destroyed the protective alkaline layer around the steel.
- Chronic Water Ingress: Multiple sources of water infiltration are accelerating the damage, including leaking toilets/bathrooms, damaged drainage pipes, and failed waterproofing on external chajjas and terraces.

- Poor Material Condition: The in-situ concrete is assessed to be of poor compressive strength with extensive voids and honeycombing, indicating substandard original construction quality and/or severe age-related decay.
- Non-Structural & Service Failures: The building interiors are in a dilapidated state. Floor tiles, internal plaster, paint, electrical wiring, and plumbing/sanitary systems are beyond repair and require complete replacement.

2. Condition Status & Risk Level

The overall condition of the building is classified as structurally deficient and unsafe. The observed defects are not superficial; they indicate a significant reduction in the load-carrying capacity of primary structural members. The combination of material loss, active corrosion, and water damage poses a high and imminent risk to the stability of the structure, with a clear potential for progressive collapse if left unaddressed.

3. Root Causes Identified

The deterioration is attributed to a combination of:

- Age-related wear and tear exacerbated by a complete lack of preventive maintenance.
- Inherent construction defects (inadequate concrete cover, honeycombing).
- Aggressive environmental exposure (coastal climate).
- Chronic water leakage from failed building services and envelope.

4. Urgent Recommendations

Immediate action is mandated to prevent a catastrophe. The prioritized action plan is:

1. Immediate Temporary Propping: Erect M.S. props under severely damaged slabs and beams to provide emergency support.
2. Execute Comprehensive Structural Repairs: Follow the detailed scientific methodology for concrete repair, rust treatment, crack injection, and member strengthening.
3. Eliminate Water Sources: Systematically repair all leaks, replace all damaged pipes, and re-waterproof terraces and toilets.
4. Complete Rehabilitation: Undertake full interior refurbishment, including replacement of all finishes, electrical, and plumbing systems.

9. Structural Issues Repairing Methodology

This section details the specific, step-by-step scientific methodology prescribed for the repair and restoration of the building's critically deteriorated structural elements. The approach prioritizes safety, durability, and the restoration of load-carrying capacity.

A. Guiding Principles

1. Safety First: All repairs must be preceded by temporary propping of affected spans to offload damaged members.

2. Systematic Progression: Follow a strict sequence: Support → Expose → Diagnose → Treat → Rebuild → Protect.

3. Material Compatibility: Use polymer-modified mortars and non-shrink grouts to ensure bond and durability.

4. Corrosion Management: The methodology focuses on arresting active corrosion, not just cosmetic repair.

B. Step-by-Step Repair Protocol for RCC Members

PHASE 1: PREPARATORY & SAFETY WORKS

1. Temporary Support: Erect M.S. Props @ 1.2m c/c in both directions beneath the slab/beam to be repaired, using 4"x4" wooden planks (chavis) for load distribution.

2. Controlled Removal: Using hand tools or low-impact mechanical means, carefully chip away all loose, spalled, delaminated, and unsound concrete until a solid substrate with well-bonded concrete is reached. Remove concrete behind exposed rebars to assess full circumference.

PHASE 2: REINFORCEMENT TREATMENT & ASSESSMENT

1. Reinforcement Exposure: Clean all exposed steel reinforcement bars (rebars) thoroughly using wire brushing or grit blasting to remove all rust, scale, and debris.
2. Assessment & Augmentation: Inspect the remaining rebar cross-section. If section loss is significant, tie additional reinforcement (rings, lapping bars, weld mesh) as per design requirement to restore structural capacity.
3. Chemical Treatment:
   I. Apply a rust passivator/convertor chemical to neutralize any residual rust and passivate the steel surface.
   II. Apply a protective coating of rust inhibitor (e.g., zinc-rich epoxy primer) to form a barrier against future corrosion.

PHASE 3: CONCRETE RESTORATION & RECONSTRUCTION

1. Grouting of Voids: For elements with internal honeycombing, perform cementation pressure grouting with non-shrink additives to fill voids and consolidate the core.

2. Surface Preparation: Clean the prepared concrete surface with a water jet and apply a bonding coat (polymer-cement slurry, typically 1:1).

3. Rebuilding the Section: Based on the depth of repair:

I. For shallow repairs (up to 25mm depth): Apply polymer-modified mortar in a specified mix (e.g., 1:5:15) in layers.

II. For deep repairs (>25mm depth): Execute micro-concreting using a high-strength, non-shrink, flowable repair concrete. Install shear connectors (dowel bars) into the sound old concrete to ensure composite action between the old and new material.

PHASE 4: CRACK REPAIR (FOR STRUCTURAL CRACKS)

1. Crack Stitching: For active structural cracks, the repair involves:

I. Routing & Grooving: Open the crack into a 'V'-groove (50-75mm wide).

II. Cleaning: High-pressure water jet cleaning.

III. Bonding & Filling: Apply polymer slurry, then pack with polymer-modified mortar.

IV. Pressure Grouting: Install injection ports at 1.0m intervals and pressure-inject a cementitious chemical grout (with CEBEX 100 or equivalent non-shrink additive) to ensure the crack is filled through its entire depth and length.

C. Methodology for Specific Structural Issues

1. Severely Spalled Columns/Beams: Follow the full protocol (Phases 1-3). Columns may require jacketing with new reinforcement and micro-concrete if core strength is too low.

2. Cracked Chajjas (Sunshades): Repair underlying RCC element as above. Critical Step: After repair, ensure a new integral waterproofing system is installed with a proper slope and brick-bat *coba*, finished with a waterproof cement plaster.

3. Leaking Toilet Slabs (Source of Corrosion):

I. Remove all floor finishes and screed up to the structural slab.

II. Repair the slab from above using the RCC repair protocol.

III. Apply a new, robust integrated waterproofing system (e.g., PCC layer + APP membrane) with sealed upturns at walls, before relaying new flooring.

D. Quality Control & Compliance

1. Staged Inspection: Each phase requires inspection and approval by the consulting engineer before proceeding to the next.

2. Material Certification: All chemicals, polymers, and repair mortars must be from approved manufacturers with technical data sheets.

3. Workmanship: To be carried out by experienced specialty repair contractors under strict technical supervision.

Final Note: This methodology is a prescriptive guideline. The exact detail, especially the design of reinforcement augmentation, must be finalized by the Structural Consultant after the complete exposure of damaged elements during the preparatory phase.

10. Utilization of Gantt Chart for Scheduling Repair Activities

A Gantt chart (or bar chart) is essential for planning, coordinating, and monitoring the complex, multi-stage repair program outlined in the structural assessment report. It visually represents the project timeline, task dependencies, and resource allocation, ensuring the urgent repairs are executed efficiently and safely.

Below is a proposed Gantt chart structure for scheduling the key repair activities.

Gantt Chart: Structural Repair & Rehabilitation Schedule

Phase / Task ID	Task Description	Week 1-2	Week 3-4	Week 5-8	Week 9-12	Week 13-16	Dependencies
PHASE 0: MOBILIZATION & SETUP							
P0.1	Site Mobilization, Safety Setup, Scaffolding Erection	■					
P0.2	**IMMEDIATE: Installation of Temporary M.S. Props** (as per propping plan)	■					P0.1
PHASE 1: CRITICAL STRUCTURAL REPAIRS							
P1.1	**Priority 1:** Concrete breakout & prep of severely damaged Columns/Beams/Chajjas	■	■				P0.2
P1.2	Reinforcement treatment (cleaning, passivation, augmentation)		■	■			P1.1
P1.3	Micro-concreting / Polymer mortar application & curing			■	■		P1.2
P1.4	Crack stitching & pressure grouting of major structural cracks		■	■			P0.2, P1.1
PHASE 2: WATERPROOFING & ENVELOPE REPAIRS							
P2.1	Replacement of all damaged external drainage & water pipes	■	■				

Phase / Task ID	Task Description	Week 1-2	Week 3-4	Week 5-8	Week 9-12	Week 13-16	Dependencies
P2.2	Removal of failed chajja waterproofing & preparation			■			P1.3 (for repaired chajjas)
P2.3	Application of new waterproofing systems on chajjas & terraces				■		P2.2
P2.4	Toilet leakage rectification (staged process: pipe seal → trap replacement → full re-waterproofing if needed)		■	■	■		P2.1
PHASE 3: INTERIOR REHABILITATION							
P3.1	Complete rewiring & new plumbing rough-in			■	■		P1.3, P2.4
P3.2	Re-plastering of walls & ceilings				■	■	P1.3, P2.4, P3.1
P3.3	Replacement of floor tiles & wall tiles					■	P3.2
P3.4	Painting (internal & external)					■	P3.3, P2.3
P3.5	Installation of new doors, windows, sanitary ware, & electrical fixtures					■	P3.4
PHASE 4: FINALIZATION							
P4.1	Demobilization: Remove props, scaffolding, site clearance					■	All structural work signed off
P4.2	Final Inspection & Handover					■	P4.1

Key Insights from the Gantt Chart:

1. **Critical Path & Urgency:** The sequence **P0.2 (Propping) → P1.1 (Breakout) → P1.2 (Rebar) → P1.3 (Concreting)** forms the **critical path** for structural safety. These tasks must not be delayed.

2. **Parallel Processing:** Several activities can run in parallel to save time (e.g., pipe replacement (P2.1) can start early while props are being installed).

3. **Phased Dependencies:**

   - **Interior work (Phase 3) CANNOT begin** until structural repairs (Phase 1) and waterproofing (Phase 2) in those areas are fully complete and cured. This prevents new finishes from being damaged by ongoing core repairs.
   - All electrical/plumbing rough-in must be done before re-plastering.

4. **Realistic Timeline:** The chart suggests a **~16-week (4-month) timeline** for comprehensive repairs, reflecting the scale and sequential nature of the work.

5. **Monitoring Tool:** This chart serves as a baseline for the project manager to track progress. Delays in any task (especially on the critical path) will directly impact the project completion date.

11. Conclusion

This structural damages assessment report presents a critical evaluation of the office building premises of the Dredging Corporation of India Limited at Rainbow Shops & Apartments, Vashi. Based on a comprehensive visual reconnaissance survey, the findings are unequivocal and demand immediate, decisive action.

1. **Critical Condition Status:** The building is in a state of severe and active structural deterioration. The reinforced concrete framework exhibits extensive cracking, spalling, and widespread corrosion of reinforcement, significantly compromising its load-bearing capacity. The estimated carbonation depth and visible active corrosion indicate a progressive failure mechanism that is being accelerated by chronic water ingress from failed services and the building envelope. The structure has moved beyond routine maintenance and is now in a condition that poses a direct and imminent risk to occupant safety.
2. **Root Cause Analysis:** The deterioration is attributed to a confluence of factors: the natural ageing process, inherent construction deficiencies (inadequate cover, honeycombing), a complete lack of preventive maintenance, and the aggressive coastal environment of Navi Mumbai. Persistent water leakage has acted as the primary catalyst, accelerating corrosion and material degradation.
3. **Non-Negotiable Recommendations:** Implementation of the report's recommendations is not optional but a **mandatory safety imperative**. The prescribed course of action must be executed in its entirety and in the specified sequence:

- **Immediate Temporary Propping** is required to mitigate the risk of sudden collapse during repair operations.
- **Scientific Structural Repairs**, following the detailed methodology for concrete restoration and corrosion arrest, are essential to restore stability.
- **Complete Elimination of Water Ingress** through systematic waterproofing and services replacement is crucial to ensure long-term durability.
- **Full Interior Rehabilitation** is necessary to bring the premises to a functional and safe operational standard.

4. **Final Directive and Warning:** This report serves as a formal and urgent directive. The 18-week rehabilitation schedule outlined provides a realistic roadmap for recovery. Any delay in initiating or executing this action plan will have severe consequences: it will lead to accelerated deterioration, exponentially higher future repair costs, and, most critically, will dangerously elevate the risk of structural failure, potentially resulting in loss of life. The responsibility to act swiftly and comprehensively rests entirely with the building owner.

In summation, the building is unsafe in its current state. The time for assessment is over; the time for urgent, disciplined, and scientifically guided intervention is now.

12. Acknowledgements

The Indian Maritime University, Navi Mumbai, wishes to formally acknowledge the cooperation and assistance that made this structural assessment possible.

We extend our sincere gratitude to:

- The Chief Project Manager and Management of Dredging Corporation of India Limited, Navi Mumbai, for entrusting us with this critical assessment and for their proactive initiative in seeking to address the structural concerns of their office premises.
- The Occupants and Staff present at the office premises in F2/B1 and F2/B2, Rainbow Shops & Apartments, for their cooperation during the site inspection. Their willingness to provide access, share observations regarding leaks and defects, and facilitate our work was essential to the thoroughness of this survey.
- Our Technical Team for their diligent efforts during the visual reconnaissance and the subsequent compilation of this detailed report.

This collaborative effort was fundamental in enabling a comprehensive evaluation of the building's condition. We trust this report will serve as a vital tool for ensuring the safety and longevity of the structure.

Reference:

[1]. Handbook on Repairs and Rehabilitation of RCC Buildings., CPWD Publications.

[2]. IS 3067:1988 -Code of practice for general design details and preparatory work for damp-proofing and waterproofing of buildings.

[3]. National Disaster Management Guidelines Seismic Retrofitting of Deficient Buildings and Structures.

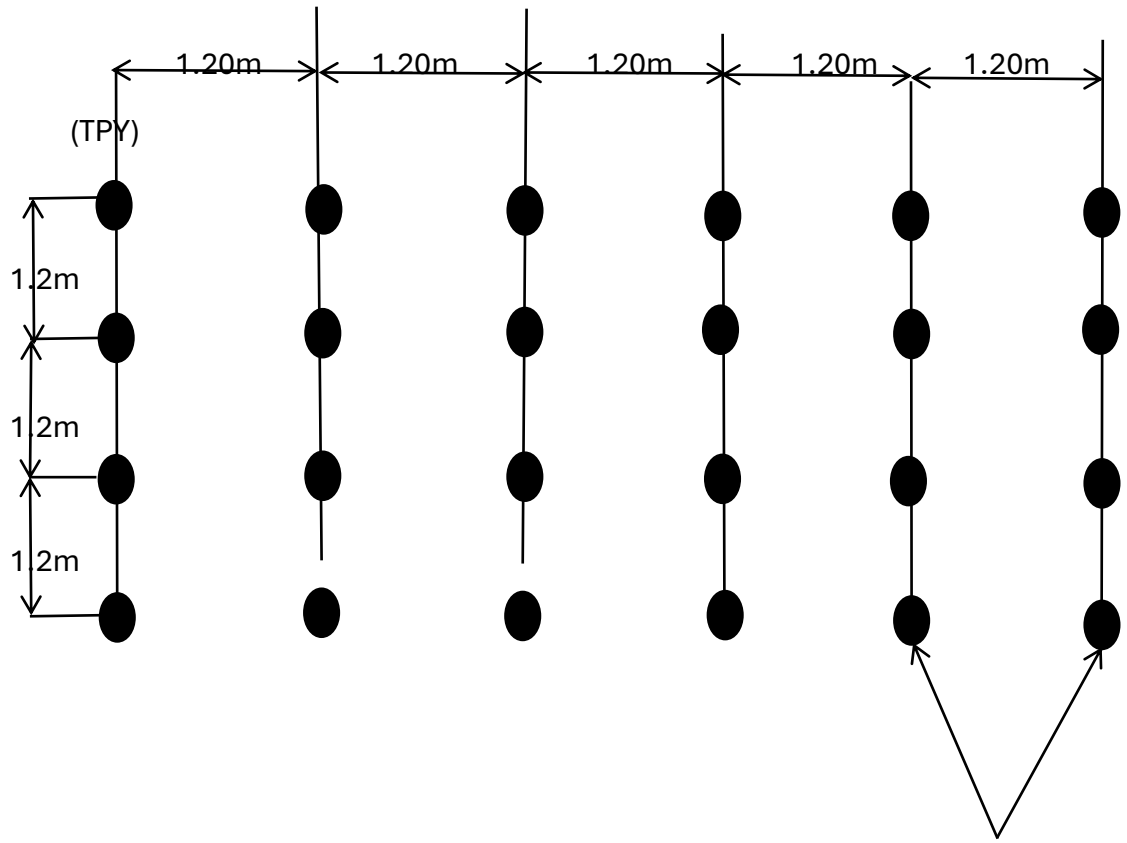
BIOGRAPHIES (Author)

Er. B. Satheeshkumar is a seasoned Chartered and Professional Civil Engineer with over two decades of comprehensive experience in project management, construction, and estate management. His expertise spans diverse sectors including industrial plants, institutional infrastructure, green buildings, and power projects. A proactive leader, he has a proven track record of delivering complex,

	high-value projects on schedule and within budget while upholding stringent quality and safety standards. His technical acumen is complemented by strong skills in stakeholder coordination, team mentorship, and strategic planning.

Annexure -1

Propping Plan



M.S. Props @1.20m c/c both ways

NOTES:

1. Use Good Quality M.S Props.
2. Props Should be Fixed at 1.2 Mt C/C in Both Direction.
3. At Top of The Props Use Wooden Chavis Of Size 4" X 4" (Along the Direction of Long Span.
4. Propping Should be done in Scientific Way
5. Props Should be Fixed Properly.

Annexure -2

OFFICE DCI F2-B1

OFFICE DCI F2-B2