Structural Audit Report
of
"K.G Mittal College, Malad (West) Mumbai

SEPTEMBER - 2020

STRUCTWEL DESIGNERS & CONSULTANTS PVT. LTD.

Structwel, Plot No. 15, Sector 24, Turbhe,

ISO 9001 : 2015 Certified

Tel. : +91-22-6854 1010 Fax.: +91-22-6854 1007

Email : info@structwel.com Web : http://www.structwel.com

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PRINCIPAL
SMT.K. G. MITTAL COLLEGE OF
ARTS & COMMERCE
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Malad (West), Mumbai - 400 064

Contents

1. INTRODUCTION:

M/s STRUCTWEL DESIGNERS AND CONSULTANTS PVT. LTD. has been appointed to inspect and analyse the condition of **"K.G Mittal College Building"** situated at Malad (West), Mumbai and subsequently submit an audit report.

Accordingly, a team of expert and engineers carried out a series of detailed visual inspection. Besides the inspection, material testing by adopting specialized 'Non - Destructive Testing' techniques was also carried out in a proper sequence. In line with this, Non-Destructive Tests (N.D.T) like Ultrasonic Pulse Velocity (USPV), Cover Meter, Carbonation, Concrete Core Strength, Rebound Hammer, Half-Cell Potential, Chemical Analysis etc. were conducted.

This was done mainly to identify distresses; if any, and their effects on the structural stability and serviceability of the structure.

The 'Inspection Report' comprising of Observations, Non - Destructive Testing Reports, Inference of NDT, Photographs of distresses and Emerging Recommendations etc. is attached herewith.

2. SCOPE OF WORK:

- To carry out a detailed visual inspection and distress survey of the entire building under reference. To assess the general condition of the structure from stability point of view.
- To collect photographic evidence of the locations where structural and non-structural distresses are observed.
- To carry out a structural audit/condition survey including all the necessary testing to ascertain the defects/damages/distresses etc. in the structure.
- To carry out appropriate Non-Destructive Testing.

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- To prepare and submit a detailed report incorporating all of the above along with the photographic evidence, inference of non-destructive testing reports, conclusion, recommendations etc.

For the purpose of this report, we have assumed without further enquiry that all the documents/drawings and information furnished to us, if any, conform to the original documents/drawings based on which the building was built.

The audit is carried out with the primary assumption that the client has disclosed all the information/facts/data of the structure; and has not intentionally or unintentionally falsified/hidden any facts/information or data which may or may not be useful for the complete understanding of the problems of the structure. Further, this report/opinion is based on certain information and documents/drawings submitted by the client that M/s Structwel has relied on, but has not independently verified; other than the data M/s Structwel has originally prepared. Therefore, this certification/statement of professional opinion is limited to the information made available to M/s Structwel at the time this report was written.

3. PURPOSE OF INVESTIGATION:

- To assess the existing condition of the structure, identify distresses; if any, and recommend remedial measures for the same based on the inference of NDT test results/conclusions.

4. HISTORY/SALIENT FEATURES OF THE STRUCTURE

- The structure under reference i.e. **"K.G Mittal College Building"** is situated in Malad (West) Mumbai.
- The existing structure is an R.C.C. framed structure of Ground plus 5 upper floors.
- The year of construction of the structure is 1990; as reported.

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➢ The building is provided with regular sufficient opening enclosed by wooden doors and Aluminium windows.

➢ All the walls are constructed in masonry and finished with sand faced plaster externally and smooth finished internally.

➢ The building has Two R.C.C. staircases provided for safe access till the Terrace floor. Thereafter, an M.S. ladder is provided to access the O.H water tank.

➢ The terrace area is finished partly with China Chips and partly with IPS layer.

5. LIMITATIONS:

➢ This is a sample audit and not a 100% audit. Structural stability of a structure assures that the entire structure will not collapse under an expected and agreed load. This does not guarantee that an individual component of the structure will not collapse due to any eventuality.

➢ Our responsibility ceases from the moment the structure is over loaded due to any of the reasons including natural calamities. In such a case, a fresh audit shall be carried out.

6. PROFORMA-B

	PROFORMA "B"	
	Sub.: Structural Audit of "K.G Mittal College Building" located at Malad (West), Mumbai – 400064	
	Name of Consultant :- Structwel Designers & Consultants Pvt. Ltd.	
1	**Name of Building**	**"K.G Mittal College"**
2	**CTS no./ Ward**	P - N Ward of MCGM
3	**No. of Stories**	Ground+5 Stories
4	**Year of Construction**	1990 as reported (30 years old structure)
5	**User Department**	**"College Building"**

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6	**Date of Inspection by the Consultant**	10.09.2020
7	**Date of Preparation of the Report**	11.09.2020
8	**Validity of Report (should be minimum six months)**	Yes
9	**Mode of Construction of the Building**	
	i. Foundation	No data is available.
	ii. Floor	RCC slab finished with various tiles
	iii. Walls	The structure is enclosed with masonry walls of thickness of 300mm (with plaster) externally. Internal partition walls are 260mm (with plaster) thick.
	iv. Beams	RCC
	v. Columns	RCC
	vi. Roof	RCC
	vii. Over Head Tank	An RCC Over-head tank is placed on the headroom slab.
10	**History of Repairs done year-wise**	
	(a) Slab recasting	No data is available.
	(b) Column Jacketing	No data is available.
	(i) Structural Repairs	No specific data is available for the same.
	(ii) Tenantable Repairs	No specific data is available for the same.
	(iii) Roof / Waterproofing	Brick bat-coba type waterproofing is provided on the terrace slab, as reported. It is partly finished with China Chips and partly with IPS.
	(iv) Plumbing	G.I. pipes are provided for plumbing and PVC pipes are provided for sanitary system.
	(v) Additions / Alternation, if any	No Addition and alternation seem to have been made as verified with existing available Plans.

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11	**Condition of -**	
	Internal plaster	Internal plaster is noted with damages of localized nature.
	External plaster	The external plaster is noted to be in good condition.
	Plumbing	No major defects are observed in the existing plumbing lines except for the leakage/seepage issues due to opened out joints.
	Drains line/chambers	No overflow is noted.
12	**Observations:**	
	(a) Doors & windows don't close	Doors & windows close properly.
	(b) Columns & steel exposed	Yes. The existing columns, slabs soffits, chhajja soffits/drops etc. are noted affected with corrosion related damages at a few locations.
	(c) Settlement, uneven flooring gaps between the skirting & floor	No settlement is observed anywhere in the structure.
	(d) Foundation settlement	No signs of settlement of the foundation are observed anywhere in the structure.
	(e) Deflections / sagging	No signs of deflections/sagging are observed anywhere in the structure
	(f) Major cracks in the columns / beams	Yes. Cracks are noted in the R.C.C. columns & beams at a few locations and a diagonal crack is noted on the beam at many locations.
	(g) Seepages/Leakages	Leakage/seepage issues of localized nature are observed through the terrace and external walls.
	(h) Staircase area /column condition	Columns in the staircase area are found in good condition. Staircase area & head rooms are noted with separation cracks between the RCC members and masonry walls.
	(i) Lift walls	Therefore, detailed visual inspection of the lift

			walls could not be carried out.	
	(j) U. G. Tank		Not observed.	
	(k) OHT / Column condition		IPS Cracks are noted in the top slab.	
	(l) Parapet at terrace		The parapet wall is found in good condition in general except for distresses like weathered surface, cracks etc. of localized nature.	
	(m) Chhajja		Minor IPS cracks are noted on the headroom Chhajja.	
	(n) Common areas		Common areas i.e. passage areas in front of rooms, staircase areas etc. are seen affected with distresses like localized leakage/seepage issues, peeling of paint etc.	
	(o) Toilets blocks		No major distress is noted in the toilet blocks except for cracks in the plaster masonry wall.	
	(p) Terrace/Waterproofing		The detailed visual inspection of the entire terrace area revealed no major distresses except for the cracks developed in the top finishing layer of the existing waterproofing system. However; leakage/seepage issues are observed on the floor beneath.	
	(q) Vegetation		Localized vegetation growth is noted in the Terrace area.	
13	**Test carried out on the structure/ observations thereof-**		**Findings**	**Range as per IS code**
	NDT	**Ultrasonic pulse velocity Test:**	Readings indicate 'Poor' quality of concrete.	Velocity below 3.00 km/sec indicates 'Poor' quality of concrete.
		Schmidt Rebound Hammer Test:	Average compressive strength is 42 N/mm² for beams and 42 N/mm² for columns.	
		Half-Cell Potential Test :	Readings indicate **High probability of active corrosion.**	The readings more negative than -350 mV indicate high probability of Active corrosion.

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		Cover Meter Test:	• The readings for cover of concrete obtained for the RCC columns are in the range of 56 mm to 75 mm which are in the acceptable range. • The readings for the cover of concrete obtained for the RCC beams are in the range of 38 mm to 59 mm. which are in the acceptable range.	The cover of column should be 40mm minimum as per the permissible limit stated by the IS 456 2000.
		Carbonation Depth Test:	Carbonation is limited to the cover of concrete.	
		Core test :	• The compressive strength revealed, after conducting the test on the core samples extracted; is in the range of **10.97 N/mm2-18.04 N/mm2.**	The original grade of the concrete is Unknown.
		Chemical analysis :	• Average pH of Concrete has dropped to 11.80 as compared to fresh concrete i.e. 13. This is alarming as the alkaline barrier in the cover concrete is turning acidic; hence, care needs to be taken for the protection of the	pH – 13 is considered for fresh concrete. Permissible limit for Chloride content is 0.60 kg/m³ by the weight of the concrete. Permissible Sulphate content by percentage weight of

			concrete. • The chloride content is within the permissible limits at all the representative locations where the test was carried out. • The sulphate content is within the permissible limits at all the representative locations where the test was carried out.	Cement is 4%.
14	**Distress Mapping plan & Photographs with caption about description of structural members and their locations**		Photographs with captions are enclosed along with the Structural Audit Report.	
15	**Brief Description of repairs to be done**			
	Water proofing		The existing waterproofing provided for the terrace should be patch repaired by doing crack filling/grouting etc.	
	External Plaster		Not Required as per the existing condition observed during the inspection.	
	Structural Repair		Area of the existing RCC members affected with corrosion related damages should be patch repaired using Polymer Modified Mortar as per the standard methodology. Please refer to the recommendation part of this compilation.	
	Column jacketing		Not required	
	Slab Recasting		Not required	

	RCC cover to be replaced	Yes. The damaged existing spalled cover concrete should be removed and the area should be patch repaired using Polymer Modified Mortar as per the standard methodology. Please refer to the recommendation part of this compilation.	
	Beam recasting	Not required	
	Partial Evacuation during repairs needed	Not required	
	Propping	Not required. However; decision regarding the same shall be taken during the repairs phase after inspecting the area exposed and the condition thereof.	
16	**Conclusion of Consultants -**	**Observations**	**Key Reason**
	i) Whether the structure is livable/or whether it is to be evacuated & pulled down	It is a liveable structure.	No settlement is noted anywhere in the structure.
	ii) Whether the structure requires tenantable repairs/Major structural repairs & its time frame	Structural repairs are required. The time frame of repairs should be of 06 - 08 months.	Cracks are noted in the structural members.
	iii) Whether the structure can be allowed to be occupied during the course of repairs.	Yes, the structure can be allowed to be occupied during the course of repairs.	The structural repairs are of localized nature.
	iv) Nature /Methodology of repairs	Please refer to the recommendation part of this compilation.	
	v) Whether the structure requires immediate propping. If so, its propping plan /methodology given	Not required. However; decision regarding the same shall be taken during the repairs phase after inspecting the area exposed and the condition thereof.	
	vi) Whether immediate safety measures are required – What is specific recommendation?	No immediate safety measure noted during the Inspection.	

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	vii) Enhancement in life of the structure after repairs. Frequency of repairs required in the extended life period.	The life of the structures will be extended by 10-15 years after carrying out the recommended repairs. Frequency of repairs will be of 3 years.	
	viii) Projected repair cost/Sq. ft.	Rs. 350/- per Sq. ft.	
	ix) Specific remarks, whether the building needs to be vacated/demolished /repaired	-	-
	x) Whether the structure is in extremely critical condition	No.	Please refer to the observations & photographic evidence
17	**Critical observations**	Enclosed in the Audit report.	
18	**Classification of Buildings**	**Category**	**Auditors Final Conclusion**
		C2-B	No eviction, structural repairs only

Structural Auditor:

Mr. Kaustubh R. Raikar -STR/R/65

M/s. Structwel Designers & Consultants Pvt. Ltd.

Address: Plot No.15, Sector-24, off

Panvel Highway, Turbhe – 400 705

Classification of Building-	**Category**
To be evacuated/demolished immediately	C1
To be evacuated and /or partially demolished requiring major structural repairs	C2-A
No eviction, structural repairs only	C2-B
No eviction, needs minor repairs only	C3

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7. DETAILED OBSERVATIONS

A structural audit is an important technical requirement for any structure and has a series of parameters to be adequately investigated and assuredly complied with.

During this exercise, the structure was inspected thoroughly on several occasions to record, verify and study the distresses, level of malfunctioning and corrosion levels in the R.C.C. members.

In the period of approximately last 30 years of its existence, various defects have developed in the said structures and the same are incorporated in this compilation.

Detailed summary of Structural assessment report is submitted herewith in this compilation

External Observation

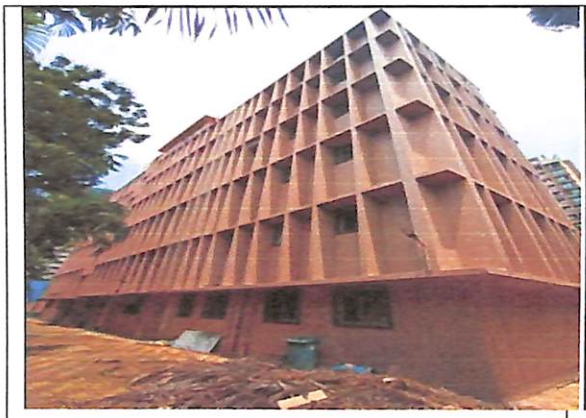
- No major distress is noted in the external area.

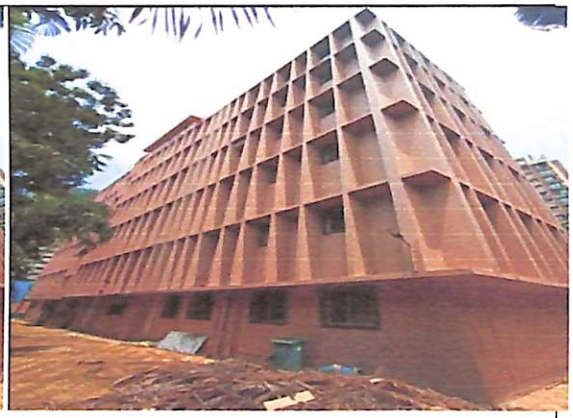
Location: – South Side elevation

Distress: – No distress observed.

Location: – East Side elevation

Distress: – No distress observed.





Location: – North Side Elevation

Distress: – No distress observed.

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Location: – East Side Elevation	
Distress: - No distress observed.	

Internal Observation

- Cracks are noted on the beams, lintel and columns at some places due to corrosion of reinforcement.
- Diagonal cracks are noted on the beams at many locations.
- Through and diagonal cracks are noted on the masonry walls.
- Cracks are seen on the ceiling due to corrosion of reinforcement.
- Cracks are seen in the plaster of the toilet partition masonry wall.
- Cracks are noted on columns at a few locations due to corrosion.
- Leakage /seepage is observed on the walls and ceilings.

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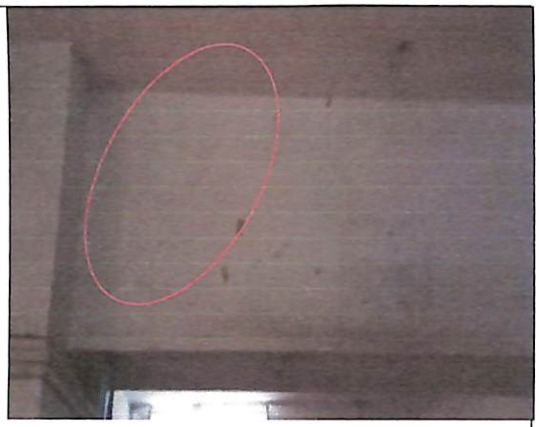

Location: – Auditorium Hall

Distress: — A lintel crack is seen on the window. Also, a diagonal crack is seen in the beam.

Location: – Auditorium Hall & GYM Khana

Distress: — Leakage/seepage is noted on the ceiling & wall.

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Location: – Class Room No. 1 (1st Floor)

Distress: — Cracks are noted on the column due to corrosion. Also, a diagonal crack is noted in the wall.

Location: – Class Room No. 4 (2nd Floor)

Distress: — A diagonal crack is noted on the wall.

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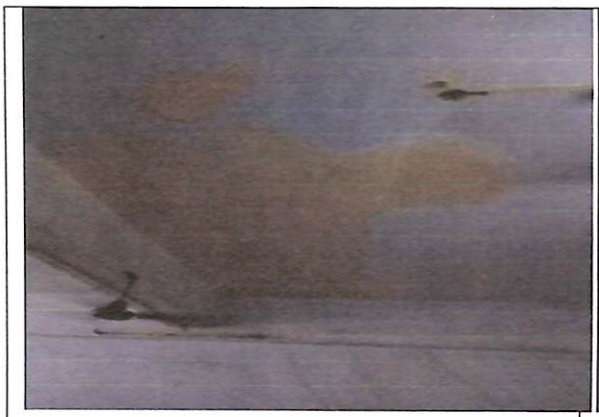
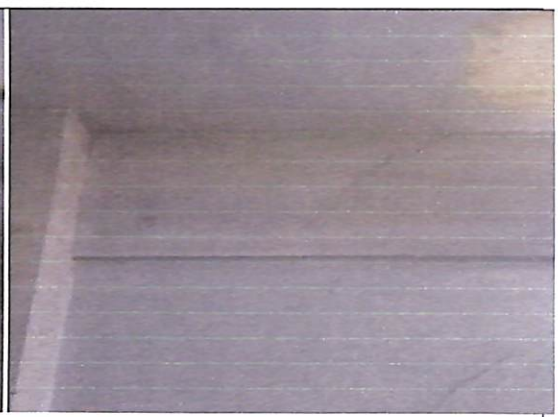
Location: – Class Room No. 4 (2nd Floor)

Distress: — A through diagonal crack is noted on the wall.





Location: – Class Room No. 205 (2nd Floor)

Distress: — Patch repair work is noted on the ceiling & a diagonal crack is noted on the beam.

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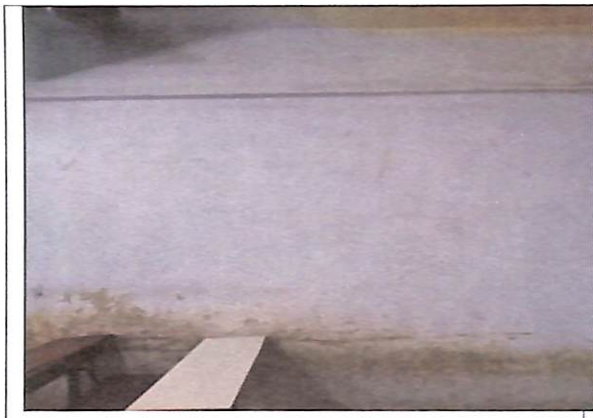	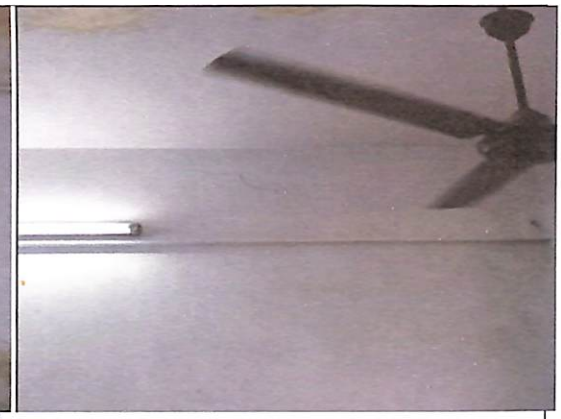
Location: – Class Room No. 201 (2nd Floor)	
Distress: — A diagonal crack is noted on the beam.	

	
Location: – Room no.502	**Location:** - Room no.503
Distress: – A crack is noted in the masonry wall.	**Distress:** Leakage/Seepage marks are noted on the slab.

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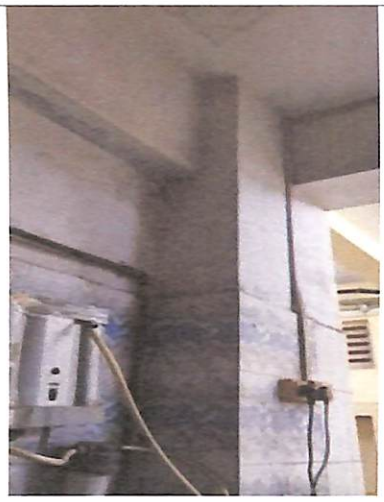
Location: – Room No.504	**Location: -** Dusk Side Beam.
Distress: – Leakage/Seepage marks are noted on the wall.	**Distress:** Cracks are noted on the beam bottom due to corrosion of reinforcement.

	
Location: – Room No.505	**Location: -**
Distress: – Cracks are noted on the beam bottom due to corrosion of reinforcement.	**Distress:** Leakage marks are seen on the passage side wall.

	
Location: – Fifth Floor Toilet Area	**Location:** -Toilet area
Distress: – Cracks are noted on the column due to corrosion of reinforcement.	**Distress:** Cracks are noted on the beam bottom due to corrosion of reinforcement.

	
Location: – Room No .502	**Location:** - Room No .501
Distress: – A diagonal crack is noted on the masonry wall.	**Distress:** Leakage/Seepage marks are noted on the slab.

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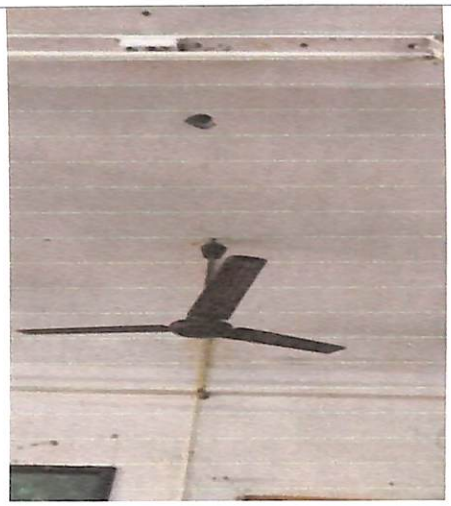
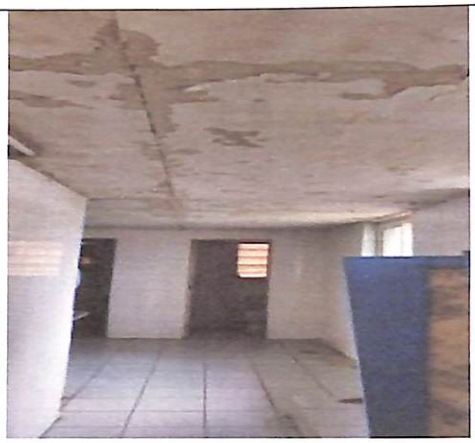
	
Location: – Room No.508	
Distress: – Cracks are noted on the slab due to corrosion of reinforcement.	

	
Location: – Room No.508	**Location:** - Room No. Passages area
Distress: – Cracks are noted on the beam bottom due to corrosion of reinforcement.	**Distress:** Bulging of cover concrete is noted on the slab.

	
Location: – Fourth Floor Ladies Toilet	**Location:** - Fourth Floor Gents Toilet
Distress: –The Soffit of slab and walls couldn't be accessed due to false ceiling and dado tiles.	

	
Location: – Room No.404	**Location:** - Room No.404
Distress: – A diagonal crack is noted on the beam.	

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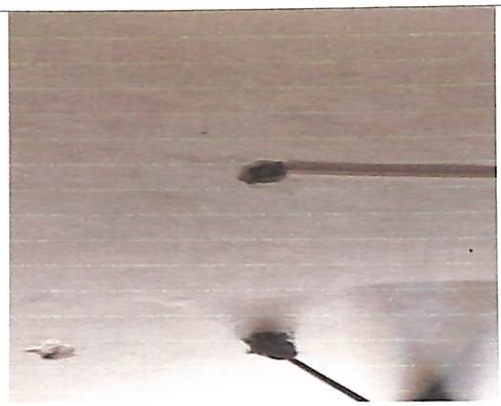
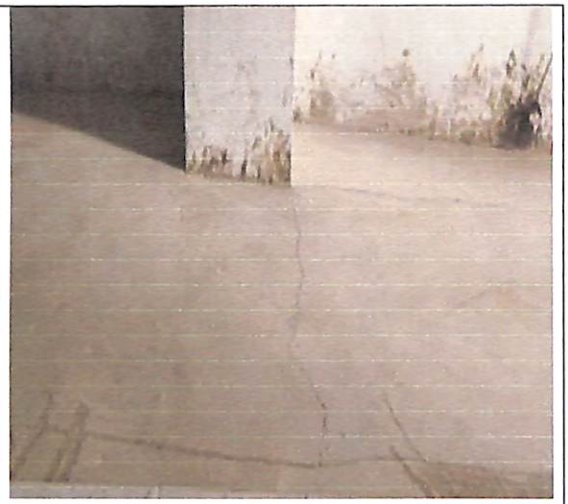
	
Location: – Room No.	**Location:** - Gyan sagar
Distress: – A diagonal crack is noted on the masonry wall.	**Distress:** Cracks are noted on the slab due to corrosion of reinforcement.

	
Location: - Fourth Floor Ladies wash Room	
Distress: Vertical and horizontal cracks are seen on the masonry wall.	

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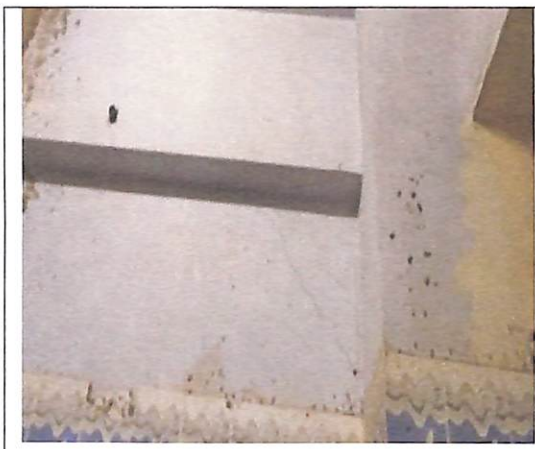
Location: – Room No.308	**Location: -** Room No.301
Distress: – A diagonal crack is noted on the masonry wall.	

	
Location: – Third Floor Toilet	**Location: –** Third Floor Toilet
Distress: — A diagonal crack is noted on the masonry wall.	**Distress: —** A vertical crack is noted on the masonry wall.

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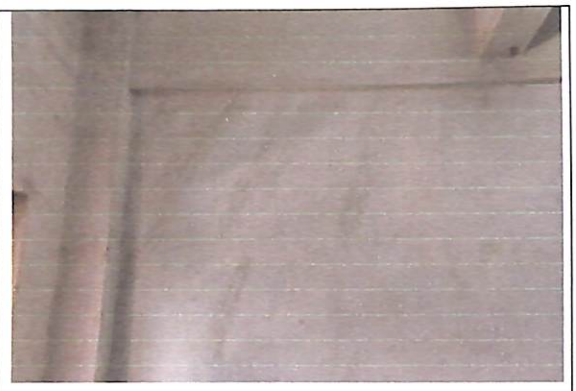
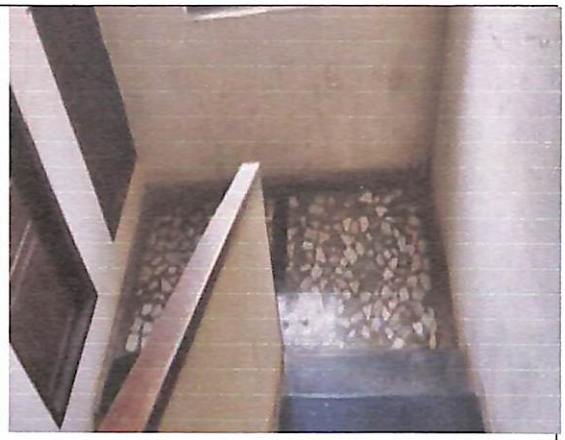


Location: – Room No.304

Distress: — A diagonal crack is noted on the masonry wall.

Common and Staircase Area



Location: – Staircase area

Distress: — No distress observed.

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Terrace Area

- Cracks are seen in the IPS waterproofing.
- Vegetation and moss growth is seen on the pedestal.
- Fine cracks are noted in the IPS Flooring of the Headroom.
- Cracks are seen in the plaster on the North side Headroom and OHWT External wall.
- Cracks are seen in the IPS Flooring and in the top Slab of OHWT.

	
Location- Terrace	**Location- Terrace**
Distress: – View of the Terrace Part of IPS	**Distress:** View of the Terrace Part of China Chips

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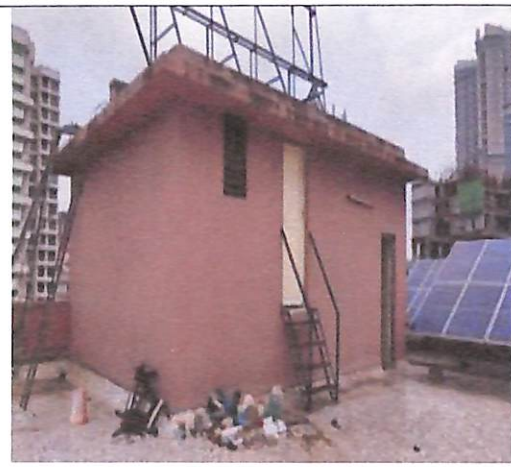
Location- Terrace	**Location- Terrace**
Distress: – Cracks are noted in the IPS waterproofing.	

Location: – Terrace

Distress: – Vegetation and moss growth is noted on the pedestal.

	
Location: – North Side Headroom	**Location: –** North Side Headroom
Distress: – View	**Distress:** Fine cracks are noted in the IPS Flooring.

	
Location: – North Side Headroom	**Location: –** North Side Headroom
Distress: –Cracks are noted in the IPS Flooring.	

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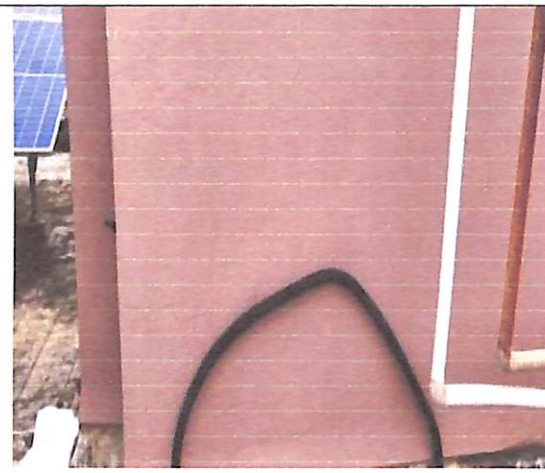
Location: – North Side Headroom	**Location: –** North Side Headroom
Distress: – Cracks are noted in the IPS Flooring.	

	
Location: – OHWT	**Location: –** OHWT
Distress: – Cracks are seen in the plaster of the external wall.	

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Location: – Top surface	
Distress: – Cracks are seen in the top surface.	**Distress:** Cracks are seen in the top surface.

8. NON-DESTRUCTIVE TESTING

The Non-Destructive Testing done is based on random sampling and is considered to be a true representation of the condition of the structure. However small, the probability of inadequate random sampling does exist, and cannot be neglected. It is not feasible to carry out NDT on 100% of the structural elements/members.

Non-Destructive testing is a method by which the existing condition of the structure can be analysed without causing damages to the structure.

These methods are non-destructive as they do not impair the function of the structure and evaluate changes in properties with time.

Based on the nature of distresses observed, the following non-destructive tests were suggested and carried out:-

- Ultra-Sonic Pulse Velocity (Ref. IS: 516 Part 5/Sec 1:2018)
  - To check the homogeneity of concrete

- Half-cell potentiometer test (Ref. : ASTM/C876-80)
  - To check the probability of corrosion level in reinforcement
- Schmidt Rebound Hammer Test (Ref.: IS: 13311 Part II)
  - To check the approximate compressive strength of concrete
- Concrete core extraction for compressive strength
  - To acquire the actual compressive strength of the concrete in the structure
- Chemical Analysis Test (Ref.: BS: 1881- Part 124:1998)
  - To check the pH, Chloride & Sulphate content in the concrete
- Carbonation test (Ref : BS: 1881: Part 201:1986)
  - To check the depth of carbonation of the concrete

1.1 ULTRASONIC PULSE VELOCITY TEST

This instrument works on the principle of passing high frequency sound waves through the body of the concrete & measuring the time taken. Distance of the path length divided by the time taken provides velocity of the waves through the concrete member being tested.

Depending on the velocity, the quality of concrete as regard to the homogeneity can be judged. Lower velocity (less than 3 km/sec) indicates one of the defects like honeycombing, cracks, voids, deboning etc. at the location of the test.

The concrete surface is thoroughly cleaned & dried. The instrument is calibrated before taking readings. Coupling medium such as grease is applied to the probes, and reading is taken for the pulse velocity at the location. Appropriate correction factors; wherever desired, are applied for the presence of steel.

As per the IS, velocity below 3.00 km/sec indicates 'Poor' quality of concrete, velocity between 3.00 & 3.75 km/sec indicates 'Doubtful' quality of concrete, velocity between 3.75 & 4.40 km/sec indicates 'Good' quality of concrete and velocity above 4.40 km/sec indicates 'Excellent' quality of concrete. We can judge the quality of concrete from the above parameters.

Details of Testing

The test was conducted at total 51 representative locations on the beams and columns. (as marked in the plan attached)

Table I: Results of Ultrasonic pulse Velocity Test

Member	No. of Tests	Min. (Km/sec)	Max. (Km/sec)	Average (Km/sec)	Remark
Columns	21	1.56	3.92	2.40	Poor quality
Beams	30	1.74	3.92	2.76	

Conclusion

All the readings of USPV tests revealed 'Poor' quality of concrete where the test was carried out on representative basis. There is a possibility of presence of voids/cracks/honey combing etc. inside the concrete matrix at these particular locations. Hence, the RCC members need attention for proper repairs/rectification.

Please refer the test results attached herewith for details.

1.2 HALF CELL POTENTIOMETER

Half-Cell Potentiometer works on the principle of measuring milli-voltage in the circuit of reinforcement & cover concrete using copper sulphate half-cell. This test measures the corrosion potential of the embedded steel in concrete with half-cell ($Cu/CuSo_4$). This method essentially consists of measurement of the absolute potential at the concrete surface with reference to an electrode. It is necessary to have direct electrical connections to the embedded steel. The measured absolute potential with reference to the reference electrode is considered to be the best criterion for assessing the corrosion status of the embedded steel rods. The test is fairly indicative of corrosion response of the present and future. The negative terminal of the voltmeter is connected directly to a protruding end

of the embedded steel by means of a "crocodile clamp". The digital handhold operated milli-voltmeter will show the potential measurements.

The following precautions are to be taken:-

The protruding embedded steel bar must be cleaned with an abrasive paper before making electrical connection to ensure low electrical contact resistance. The concrete surface has to be cleaned thoroughly with a soft wire brush to remove the adhering calcium carbonated layers, which may cause high electrical resistance during the potential measurement. This is essential preparatory requirement and has been ensured all along.

The concrete surface that needs to be tested has to be kept wet uniformly before the commencement of potential measurement. The readings more negative than -350 mV indicate high probability of Active corrosion. The readings more positive than -200 mV indicate high probability of no-corrosion. The readings between -200 mV & -350 mV indicate uncertainty of corrosion and positive readings indicate probability of insufficient moisture in the concrete. The existence of corrosion in steel has been further confirmed by the high percentage of chloride and less pH value obtained by other methods of testing. Such a series of corroborative testing techniques are evolved to reach at the most reliable findings.

Details of Testing

The test was conducted at total 2 representative locations. **(as marked in the plan attached)**

Table II: Result of Half-cell Potentiometer test

Member	No. of Tests	Min. mV	Max. mV	Average mV	Remark
Beams	02	-224	-512	-312	High probability of active corrosion

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Conclusion

Half-Cell Potentiometer readings indicate **High probability of active corrosion** in the R.C.C. members at all the locations.

Please refer the test results attached herewith for details.

1.3 SCHMIDT REBOUND HAMMER TEST

A total of 16 impact readings obtained were taken at each location and an average of middle ten was calculated after discarding the top three and bottom three readings. In this manner, total 16 points were tested on the RCC members.

The probable accuracy of prediction of concrete strength by the Rebound Hammer is + 25% as per the IS code 13311(part-II). However, since the concrete under investigation is old and may be carbonated as also the result depends on the surface hardness at that particular location, the results obtained from the Rebound Hammer are not much dependable for quantitative assessment and shall be considered only for qualitative assessment. These results shall be compared with the compressive strength obtained by core extraction.

Details of Testing

The test was conducted at total 9 representative locations. (as marked in the plan attached)

Table III: Result of Rebound Hammer Test

Location	Nos. of tests	Minimum		Maximum		Average	
		Kg/cm^2	N/mm^2	Kg/cm^2	N/mm^2	Kg/cm^2	N/mm^2
Columns	05	360	35	440	43	430	42
Beams	04	415	41	450	44	433	42

Please refer the test results attached herewith for details.

1.4 CONCRETE COMPRESSIVE CORE STRENGTH

This test is performed to acquire the actual strength of concrete in the structure.

The compressive strength is performed by extracting 75 mm diameter cores from the structural member of the structure and testing the same in a laboratory on a compression testing machine for compressive strength.

This test was conducted at 5 locations on the columns and 1 location on the beam (as marked in the plan attached).

Table IV Results of concrete core strength test

Members	No. of tests	Min. Equivalent Compressive strength (N/mm^2)	Max. Equivalent Compressive strength (N/mm^2)	Average Equivalent Compressive strength (N/mm^2)
Columns and Beam	06	10.97	18.04	14.80

Conclusion

The average equivalent compressive strength obtained for the columns is 10.97 N/mm^2 which is in the range of 18.04 N/mm^2 to 14.80 N/mm^2.

Please refer N.D.T. reports attached herewith for more details.

1.5 CHEMICAL ANALYSIS

It is of utmost concern to check the Sulphate, Chloride, pH value of concrete and cross verify the same as per British Standard.

This test indicates chloride content in the concrete indicating the extent of corrosion of steel and pH value. If it is low, it indicates 'acidic' in nature. Low Sulphate content shows that there may not be any effect on the strength of concrete. High chloride content in cover concrete indicates the

possibility of corrosion in the reinforcement bars. The higher percentage of chloride & Sulphate indicates deterioration of concrete and possibility of its disintegration. The samples are tested for Chloride, Sulphate and pH value. The pH of fresh concrete generally ranges between 12 & 13. pH around 10 is generally considered low for concrete and is an indication of assured carbonation. Drop in pH increases the acidity of concrete which induces accelerated corrosion.

The permissible limit for Chloride is 0.6 Kg/m^3 by weight of concrete.

The permissible Sulphate content by percentage weight of cement is 4%.

Details of Testing

The test was conducted at total 5 representative locations on the columns and 1 location on the beam. (as marked in the plan attached)

Table I: Results of Chemical analysis

Members	No. of Tests	pH			Chloride (kg/cm^3)			Sulphur % by weight of cement		
		Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Columns	12	11.65	11.99	11.80	0.24	0.37	0.31	2.08	2.83	2.50

Conclusion:

Average pH of concrete has dropped to 11.05 as compared to fresh concrete i.e. 13. This is alarming as the alkaline barrier in the cover concrete is turning acidic; hence, care needs to be taken for the protection of the concrete.

- The chloride content is within the permissible limit at the representative locations where the test was carried out.
- Sulphate content is within the permissible limit at the representative locations where the test was carried out.

Please refer N.D.T reports attached herewith for more details.

SMT. KAMALADEVI GAURIDUTT MITTAL COLLEGE OF ARTS & COMMERCE

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1.6 CARBONATION TEST

This test is carried out to measure the depth of concrete from the external face up to which it has undergone carbonation.

The test requires core samples of 25 mm or 50 mm diameter to be taken out from a depth of about 80 to 100 mm; higher diameter cores taken can also be used for this test. The core sample is sprayed by 2% Phenolphthalein solution starting from the exposed or external surface of concrete. If sprayed concrete turns Pink, it is considered as non-carbonated. The depth of carbonation is measured in milli-meters as "the depth from the external face of concrete to the point beyond which the phenolphthalein sprayed concrete turns pink in colour".

If the core of concrete is not available, the test can be performed by suitably exposing the concrete by cutting or breaking with a chisel and performing the test on this freshly exposed surface as described above.

The test was conducted at 03 locations on the cores extracted from the RCC columns. (as marked in the plan attached)

Table II: Result of Carbonation of concrete test

Members	No. of Tests	Min. (mm)	Max. (mm)	Avg. (mm)
Columns	03	28	36	31

Conclusion:

Hence, the tests carried out at various locations reveal that the ingress of carbonation is limited to the concrete cover.

SMT. KAMLADEVI GAURIDUTT MITTAL COLLEGE OF ARTS & COMMERCE

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SMT.K. G. MITTAL COLLEGE OF
ARTS & COMMERCE
Nahar Nagar, Near Navy Nagar,
Malad (West), Mumbai - 400 064

9. RECOMMENDATIONS

The following recommendations are made in light of the observed defects for the efficient improvement in the serviceable life and performance of the structures under reference:

- Repairs like polymer/epoxy/micro concrete treatment are to be carried out at the locations where corrosion cracks, spalling of concrete and exposed reinforcement are observed after carrying out corrosion treatment.
- Low viscous epoxy/cement grouting is to be provided to the slabs to overcome the voids, honey combing and leakage related issues.
- As the excessive cracking is noted on the beams, the beams are to be grouted with low viscous epoxy grout.
- Crack Filling in the brick wall to be done by cement grout.
- 2 coats of 100% paint are to be applied internally over one coat of primer after preparing the surface properly.

SMT. KAMALADEVI GAURISHANKAR MITTAL COLLEGE OF ARTS & COMMERCE

PRINCIPAL
SMT.K. G. MITTAL COLLEGE OF
ARTS & COMMERCE
Nahar Nagar, Near Navy Nagar,
Malad (West), Mumbai - 400 064

10. CONCLUSION

The Structure shows several types of damages and distresses. However, looking at the nature and extent thereof, it can be concluded that the Structure is in repairable condition. However, it requires major repairs as suggested in the recommendations so as to restore the same to its sound structural condition.

Our scope is limited to study and identify the structural distresses that are observed in the structure during its service life. Our study and examination consider/ assume that the original structural design of the structure is compliant of all the applicable Indian standards and is structurally safe to carry out the intended design load.

If the civil and structural repairs as suggested in the recommendations are carried out by adopting appropriate techniques and using proper materials as also by undertaking periodic maintenance works, the serviceable life span of the structure could be extended considerably by up to 10 to 15 years.

Timely maintenance is important so as to ensure proper treatment to the areas which may show distresses during its serviceable life.

Prepared by

Swanand Raikar

Project Manager

Approved by

Jayant Kadam

Technical Director

PRINCIPAL
SMT.K. G. MITTAL COLLEGE OF
ARTS & COMMERCE
Nahar Nagar, Near Navy Nagar,
Malad (West), Mumbai - 400 064