

Renovation of Boys Hostel in College Campus: Structural Assessment, Retrofitting Design and Cost Estimation

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Abstract — This paper presents a comprehensive structural assessment and renovation study of an existing RCC G+2 Boys Hostel building at Dr. J. J. Magdum College of Engineering, Jaysingpur. The structure exhibited significant defects including beam/slab cracking, concrete spalling, reinforcement corrosion, dampness, and waterproofing failures. A systematic condition assessment was conducted through visual inspection, crack mapping, and Rebound Hammer NDT (IS 13311 Part 2:1992) on all 132 RCC columns across three floors. In-situ fck values ranged from 9 MPa to 30.5 MPa. Using IS 456:2000, columns were classified as Safe (26), Marginal (22), Deficient (47), and Severely Deficient (37). RCC column jacketing with M30 concrete and Fe 500 steel was designed for governing columns C3 and C11 (fck = 9 MPa), raising capacity from 593 kN to 3,514 kN. Second-floor slab reconstruction using AAC Panel Slab System provides 55–60% dead load reduction. Complete replanning of plumbing (CPVC/uPVC, 30,000 L storage, solar heaters) and electrification (FRLS copper, RCCB per room, BEE 5-star fixtures) was carried out as per IS codes. Detailed BOQ using Maharashtra PWD SSR 2022-23 (incl. 18% GST) estimates total renovation cost at ₹1.35 Crore — approximately 55% less than full reconstruction (₹3.01 Crore), validating renovation as a technically sound and economically sustainable alternative.

Keywords — RCC Column Jacketing, Rebound Hammer Test, AAC Panel Slab, IS 456:2000, Structural Retrofitting, Renovation, Boys Hostel, NDT, Cost Estimation, Maharashtra PWD SSR

I. INTRODUCTION

Infrastructure maintenance is a critical aspect of sustainable civil engineering. Institutional buildings such as hostels undergo continuous occupancy and environmental exposure, causing gradual deterioration. The Boys Hostel at Dr. J. J. Magdum College of Engineering, Jaysingpur is a G+2 RCC framed structure in service for several years [1]. Visible distress — cracks in beams and slabs, concrete spalling, reinforcement corrosion, dampness, and waterproofing failures — necessitated detailed structural investigation and planned renovation.

Advances in structural rehabilitation have made renovation a viable, economical, and sustainable alternative, requiring 40–60% less investment while extending service life by 20–30 years [2]. This study applies systematic condition assessment, NDT on 132 RCC columns, retrofitting design, MEP redesign, and SSR-based cost estimation. The 132-column dataset (vs. typical studies of 50–60) provides a robust statistical basis for structural classification and intervention planning.

II. LITERATURE REVIEW

Karsh & Shukla (2024) [3] studied retrofitting of a hostel in Chhattisgarh, documenting column jacketing and waterproofing. Retrofitting cost 45–55% of reconstruction, extending service life by 25–30 years. Keshmiri et al. (2024) [4] presented a four-phase rehabilitation framework recommending epoxy injection for cracks >0.3 mm and FRP strengthening for flexural deficiency. Puneet Kumar et al. (2019) [5] reviewed seismic retrofitting, recommending RCC jacketing and crack grouting. Anumol Raju et al. (2013) [6] investigated FRP retrofitting of RC beams, showing 30–60% flexural capacity increase. EMPA Building Science Lab (2011) [7] documented European case studies showing 40% cost savings versus full reconstruction.

III. METHODOLOGY

A. Visual Inspection and Condition Survey

A systematic visual survey was conducted floor-by-floor, room-by-room across all accessible areas: external façade, internal walls, RCC columns on all floors, beams, lintels, slabs, staircases, toilets, terrace, and parapet walls. Defects were documented through high-resolution photography, crack mapping (color-coded), and digital recording in MS Excel and Notion. Crack classification: Hairline (<0.1 mm), Minor (0.1–0.3 mm), Moderate (0.3–1.0 mm), Major (>1.0 mm).



Fig. 1: Visual Inspection and Defect Documentation

B. Non-Destructive Testing — Rebound Hammer (IS 13311 Part 2:1992)

The Rebound Hammer (Schmidt Hammer) test was performed on all 132 RCC columns across Ground Floor (C1–C44), First Floor (C45–C88), and Second Floor (C89–C132) as per IS 13311 Part 2:1992 [8]. Minimum 9 test points per column; readings deviating more than 6 units from mean were discarded. Average rebound number converted to in-situ fck using manufacturer's calibration chart.



Fig. 2: Rebound Hammer NDT on RCC Columns

C. Structural Adequacy Assessment — IS 456:2000

Axial load capacity of each column computed using the IS 456:2000 short column formula:

$$P_u = 0.4 \times f_{ck} \times A_c + 0.67 \times f_y \times A_{sc} \dots (1)$$

Column size = 450×230 mm; $A_g = 103,500 \text{ mm}^2$; $A_{sc} = 804 \text{ mm}^2$ (4-16mm bars); $A_c = 102,696 \text{ mm}^2$; $f_y = 415 \text{ MPa}$; $P_{u,req} = 1,300 \text{ kN}$. Classification thresholds: Safe ($\leq 10\%$ deficiency), Marginal (10–20%), Deficient (20–40%), Severely Deficient ($>40\%$).

IV. RESULTS AND DISCUSSION

A. NDT Results — All 132 Columns

TABLE I — REBOUND HAMMER RESULTS (ALL 132 COLUMNS)

Col	fck	Col	fck	Col	fck	Col	fck
C1	12	C34	13.5	C67	15.5	C100	17
C2	22	C35	19.5	C68	17	C101	19
C3	9	C36	17.5	C69	13	C102	17
C4	21.5	C37	23	C70	15.5	C103	12
C5	28.5	C38	21.5	C71	18	C104	11
C6	29.5	C39	16	C72	21.5	C105	19
C7	27	C40	29.5	C73	16.5	C106	15
C8	28	C41	25	C74	14.5	C107	23
C9	11	C42	15.5	C75	22	C108	20
C10	27	C43	27.5	C76	23.5	C109	21
C11	9	C44	24	C77	21.5	C110	22
C12	25	C45	14.5	C78	24	C111	14
C13	11.5	C46	30.5	C79	16	C112	19
C14	10.5	C47	13	C80	17.5	C113	14
C15	17	C48	16.5	C81	14.5	C114	17
C16	15	C49	20	C82	21.5	C115	20
C17	27	C50	12.5	C83	26	C116	15
C18	22.5	C51	13	C84	22.5	C117	14
C19	16.5	C52	20.5	C85	25	C118	15
C20	19.5	C53	17.5	C86	27.5	C119	23
C21	13	C54	15	C87	20	C120	25
C22	13.5	C55	12	C88	18.5	C121	24
C23	19	C56	12	C89	18.5	C122	19.5
C24	22	C57	13.5	C90	20	C123	20
C25	20.5	C58	14	C91	14	C124	20.5
C26	10.5	C59	26.5	C92	15	C125	27
C27	13.5	C60	27.5	C93	18	C126	20
C28	15	C61	13.5	C94	13	C127	24
C29	23.5	C62	20.5	C95	12.5	C128	19
C30	27.5	C63	23.5	C96	11	C129	17
C31	20.5	C64	20	C97	21	C130	13
C32	17.5	C65	17	C98	11	C131	15
C33	11	C66	18.5	C99	10	C132	13

fck values ranged from 9 MPa to 30.5 MPa. Columns C3 and C11 (fck = 9 MPa) are the weakest, governing the retrofitting design. Significant concrete degradation in ground floor columns is attributed to moisture ingress and carbonation over years of service.

B. Structural Adequacy Assessment

TABLE II — AXIAL CAPACITY (REPRESENTATIVE COLUMNS)

Col	fck (MPa)	Ac (mm ²)	Asc (mm ²)	fy (MPa)	Pu,old (kN)	Pu,req (kN)	Def. (kN)	% Def.	Status
C3	9	102696	804	415	593.3	1300	706.7	54.4	Sev. Def.
C11	9	102696	804	415	593.3	1300	706.7	54.4	Sev. Def.
C14	10.5	102696	804	415	654.9	1300	645.1	49.6	Sev. Def.
C21	13	102696	804	415	757.6	1300	542.4	41.7	Sev. Def.
C15	17	102696	804	415	921.9	1300	378.1	29.1	Deficient
C18	22.5	102696	804	415	1147.8	1300	152.2	11.7	Marginal
C5	28.5	102696	804	415	1394.3	1300	0	0	Safe

Col	fck (MPa)	Ac (mm ²)	Asc (mm ²)	fy (MPa)	Pu,old (kN)	Pu,req (kN)	Def. (kN)	% Def.	Status
C46	30.5	102696	804	415	1476.4	1300	0	0	Safe

TABLE III — COLUMN STATUS SUMMARY (132 COLUMNS)

Status Category	No.	%	Action
Safe	26	19.7%	No retrofitting
Marginal	22	16.7%	Monitor / minor
Deficient	47	35.6%	Retrofitting reqd.
Severely Def.	37	28.0%	Urgent retrofitting
TOTAL	132	100%	—

C. RCC Column Jacketing — Governing Columns C3 & C11

Existing capacity (Eq. 1): $P_{u,old} = 0.4(9)(102,696) + 0.67(415)(804) = 593 \text{ kN}$. Deficiency = $1,300 - 593 = 707 \text{ kN} \rightarrow$ Retrofitting required.

Jacketing design: thickness 75 mm all sides $\rightarrow$ New size $600 \times 380 \text{ mm}$; M30 concrete; Fe 500 steel; 8 bars $\times$ 16 mm (Asc,jacket = $1,608 \text{ mm}^2$); Total Asc = $2,412 \text{ mm}^2$; $A_{c,new} = 225,588 \text{ mm}^2$.

Retrofitted capacity: $P_{u,new} = 0.4(30)(225,588) + 0.67(500)(2,412) = 3,514 \text{ kN} \gg 1,300 \text{ kN} \rightarrow \text{SAFE} \checkmark$

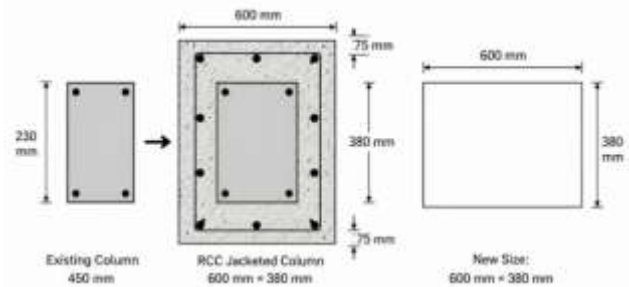


Fig. 3: RCC Column Jacketing Detail

TABLE IV — COLUMN JACKETING COST (PER COLUMN & TOTAL 132)

Item of Work	Qty / Unit	Amount (₹)
Surface prep & hacking	6.0 m ²	720
Dowel bars 12mm@300 c/c	20 Nos	1,600
Epoxy bonding agent	1 L	900
Steel Fe500 (55 kg/col)	55 kg	4,125
Shuttering	7.5 m ²	4,875
RCC M30 concrete (0.374 m ³)	0.374 m ³	2,618
Labour & curing	L.S.	1,200
Sub-total	—	16,038
Add 10% overheads	—	1,602
Total per column	—	₹17,640
132 columns $\times$ ₹17,640	—	₹23,28,480

D. Second Floor Slab — AAC Panel Slab Reconstruction

Critical deterioration (severe deflection cracking, delamination) of 2nd floor slab necessitated reconstruction. AAC Panel Slab System adopted: 125 mm thick panels, AAC density 600 kg/m^3 . Dead load = 0.75 kN/m^2 vs. RCC $3.75 \text{ kN/m}^2 \rightarrow 55\text{--}60\%$ reduction. Total slab area = $42.27 \times 11.63 = 491.6 \text{ m}^2$. Total design load = 4.75 kN/m^2 — within panel capacity for 4.4 m span.



Fig. 4: AAC Panel Slab System

TABLE V — AAC SLAB RECONSTRUCTION COST

Description	Qty	Rate	Amount (₹)
Demolition of RCC slab	491.6 m ²	250	1,22,900
Surface preparation	491.6 m ²	50	24,580
AAC panel supply & install	491.6 m ²	1,200	5,89,920
Joint grouting	491.6 m ²	80	39,328
M20 concrete topping 50mm	24.6 m ³	6,500	1,59,900
Reinforcement steel	615 kg	75	46,125
Edge shuttering	60 m ²	500	30,000
Floor finishing	491.6 m ²	500	2,45,800
Subtotal	—	—	12,58,553
Contingency 5%	—	—	62,928
Contractor profit 10%	—	—	1,25,855
TOTAL AAC SLAB	—	—	₹14,50,000

E. Staircase Beam Jacketing

Staircase beam (230×300 mm, fck = 15 MPa, Fe 415): Design load = 26.0 kN/m; Mu,demand = 44.7 kN·m > Mu,capacity = 32 kN·m → Deficient. RCC jacketing (75 mm bottom + sides): New size 380×450 mm; M25 concrete. Retrofitted: Mu,new = 220 kN·m >> 44.7 kN·m → SAFE ✓.



Fig. 5: RCC Beam Jacketing Detail

F. Redesigned Water Supply & Plumbing System

Existing GI pipes were severely corroded with 30–40% water loss to leakage and no floor-level isolation. Redesign uses: (a) 32mm CPVC IS 15778 main risers + 20mm branches for all supply, (b) 110mm uPVC IS 4985 for all SVP and waste runs. Storage: 30,000 L total — 25,000 L sanitary (5×5000L Sintex, terrace) + 5,000 L dedicated drinking water (above staircase) per IS 1172 (135 L/person/day for 55 rooms). PRV at inlet, floor isolation valves, submersible pump, underground sump 22,500 L, and 5 solar water heaters on terrace.

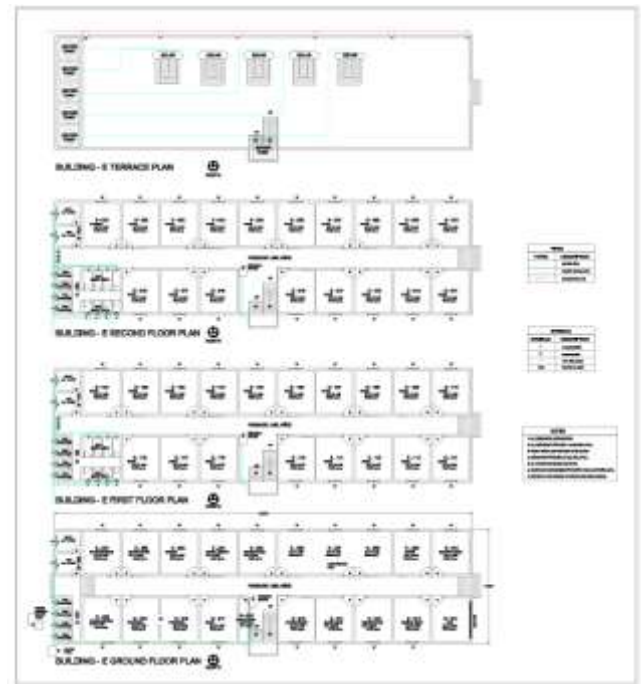


Fig. 7: Redesigned Plumbing Network

TABLE VI — PLUMBING COST ESTIMATE (INCL. 18% GST)

Description	Qty	Amount (₹)
32mm CPVC pipe – main risers + mains	148 Rmt	1,29,352
20mm CPVC pipe – WC, basin & shower	175 Rmt	89,075
110mm uPVC SVP stacks + drain runs	88 Rmt	1,29,800
150mm uPVC underground drain	15 Rmt	25,665
Indian WC with cistern IS 2556 (34 Nos)	34 Nos	1,71,360
Wash basin wall-hung (14 Nos)	14 Nos	94,948
Floor trap 100mm uPVC (34 Nos)	34 Nos	20,536
Inspection chambers 450×450mm (8 Nos)	8 Nos	1,36,024
European WC with concealed system (20)	20 Nos	2,00,000
Ball valves, angle cocks & PRV 50mm	1 LS	50,400
Sintex OHT 5000L×5 – sanitary (terrace)	25,000 L	1,37,500
Sintex OHT 5000L×1 – drinking water	5,000 L	27,500
RCC staging for 6 OHT tanks (ht 1.5m)	1 LS	72,000
Submersible pump 0.75HP + DOL starter	1 Set	33,040
Underground sump 3×7500L ferrocement	1 LS	1,51,200
Solar powered water heaters (5 Nos)	5 Nos	5,75,000
Testing, flushing & commissioning	1 LS	16,800
GRAND TOTAL – PLUMBING (incl. GST)	—	₹20,60,200

G. Redesigned Electrification System

Existing wiring was non-FRLS without RCCB protection, no sub-distribution, and overloaded circuits. Redesign: 2.5mm² FRLS IS 694 copper conductors for all branch circuits; 25mm HMS PVC IS 9537 FRLS conduits; 1 MDB (GF) + 3 SDBs (one per floor); RCCB 30mA 2P per room (55 Nos) per IE Rules 1956; BEE 5-star ceiling fans and LED fittings; SPD Type-2 at MDB for

lightning protection; plate earthing IS 3043 × 2 sets; all compliant with NBC 2016 Part 8.

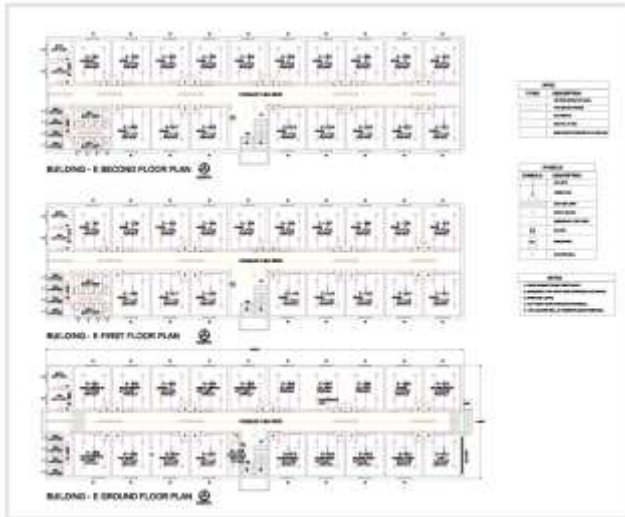


Fig. 6: Redesigned Electrification Network

TABLE VII — ELECTRIFICATION COST ESTIMATE (INCL. 18% GST)

Description	Qty	Amount (₹)
25mm ² XLPE armoured cable – incomer MDB	25 Rmt	30,975
10mm ² FRLS 4-core – MDB to SDBs (feeders)	68 Rmt	36,924
2.5mm ² FRLS 2-core – ALL branch circuits	3,480 Rmt	2,54,040
1.5mm ² FRLS earth wire – bonding	600 Rmt	14,400
32mm HMS PVC FRLS conduit – feeders	88 Rmt	18,656
25mm HMS PVC FRLS conduit – branch	3,060 Rmt	4,59,000
GI pull boxes + conduit fittings (LS)	1 LS	43,000
MDB 100A 4P incl. RCCB, SPD, energy meter	1 No	53,100
SDB 63A 4P per floor × 3 Nos	3 Nos	53,100
RCCB 30mA 2P 32A – per room (55 Nos)	55 Nos	71,610
MCB 32A SP – per room (55 Nos)	55 Nos	33,935
MCB 63A 4P – SDB incomer × 3	3 Nos	8,493
LED 18W (rooms) + LED batten (corridors) 162	162 Nos	1,24,254
Ceiling fan BEE 5-star 1200mm (55 Nos)	55 Nos	1,42,780
Exhaust fan 300mm ISI – toilets (34 Nos)	34 Nos	72,216
Geyser 25L 2kW BEE 5-star (14 Nos)	14 Nos	1,23,900
Modular switches, sockets & plates	1 LS	72,000
Plate earthing IS 3043 × 2 sets	2 Set	42,480
Testing, commissioning & inspection	1 LS	21,240
GRAND TOTAL – ELECTRIFICATION (incl. GST)	—	₹16,76,103

H. Plastering and Painting

Total floor area: 491.6 m² × 3 floors = 1,474.8 m². Wall surface area = 2.5 × floor area = 3,687 m² (standard thumb rule). Rates from Maharashtra PWD SSR 2022-23.

TABLE VIII — PLASTERING & PAINTING COST

Description	Area (m ²)	Rate (₹)	Amount (₹)
Internal Cement Plaster 12mm CM 1:6	3,687	240	8,84,880
Internal Emulsion Paint (2 coats)	3,687	120	4,42,440
External Texture Paint (2 coats)	3,687	150	5,53,050
Subtotal Plastering + Painting	—	—	18,80,370
GST @ 18%	—	—	3,38,467
GRAND TOTAL (incl. GST)	—	—	₹22,18,837

I. Column Retrofitting Plan

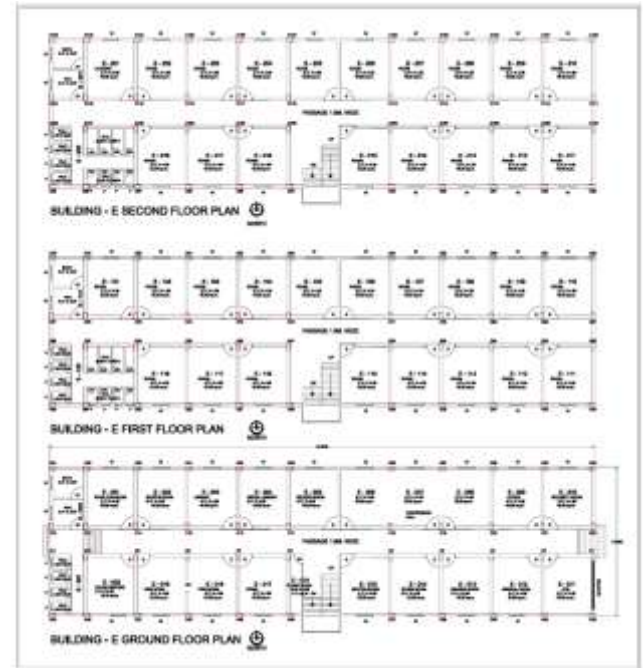


Fig. 8: 2D Column Retrofitting Plan

J. Overall Project Cost Summary

TABLE IX — GRAND COST SUMMARY (SSR 2022-23, INCL. GST)

Sr.	Head of Work	Amount (₹)	%
1	Structural Retrofitting – 132 cols jacketing	₹23,28,480	17.19%
2	AAC Slab Reconstruction – 2nd Floor	₹14,50,000	10.70%
3	Waterproofing (Terrace + Bathrooms + DPC)	₹5,43,200	4.01%
4	Crack Repair & Epoxy Grouting	₹5,12,214	3.78%
5	Plumbing – CPVC + uPVC + fixtures + solar	₹20,60,200	15.21%
6	Electrification – wiring + fittings + boards	₹16,76,103	12.37%
7	Plastering, Flooring & Painting	₹22,18,837	16.38%
8	Carpentry – Doors, Windows, Grills	₹7,28,000	5.37%
9	Tiles and Dado work	₹10,25,000	7.57%
	Sub-Total (Direct Cost)	₹1,25,42,034	
	Contingency @ 5%	₹6,27,101	
	PMC / Supervision @ 3%	₹3,76,261	
	GRAND TOTAL (incl. GST)	₹1,35,45,396	100%

K. Cost Comparison — Renovation vs. Reconstruction

New construction rate: ₹1,550/Sq.Ft (SSR 2022-23, RCC framed hostel). Floor area: 15,874 Sq.Ft. Demolition: ₹100/Sq.Ft (SSR average).

TABLE X — RENOVATION VS. FULL RECONSTRUCTION

Particulars	New Const. (₹)	Retrofitting (₹)
Direct / Base Cost	₹2,85,04,700	₹1,25,42,034
Demolition Cost	₹15,87,400	Nil
Contingency + PMC	Included	₹10,03,362
GRAND TOTAL	₹3,01,53,000	₹1,35,45,396
Saving (₹)	—	₹1,66,07,604 (~55%)

Retrofitting saves approximately ₹1,66,07,604 (~55%) over full reconstruction. Project duration reduces from 18–24 months to 6–9 months, with phased occupancy possible during construction.

V. CONCLUSION

The Rebound Hammer NDT on all 132 RCC columns revealed fck ranging from 9 MPa to 30.5 MPa. Column status: **26 Safe, 22 Marginal, 47 Deficient, 37 Severely Deficient**. Columns C3 and C11 (fck = 9 MPa) govern retrofitting design; jacketing raises capacity from 593 kN to 3,514 kN. AAC slab reconstruction provides 55–60% dead load reduction. Staircase beam jacketing increases flexural capacity from 32 kN·m to 220 kN·m. Redesigned plumbing and electrification systems significantly improve safety, hygiene, and energy efficiency.

Total renovation cost ≈ ₹1.35 Crore (incl. GST, 5% contingency, 3% PMC) — 55% less than reconstruction (₹3.01 Crore). Scientific condition assessment combined with planned rehabilitation extends institutional building service life by 20–30 years.

REFERENCES. UNDEFINED

- [1] IS 456:2000, Plain and Reinforced Concrete – Code of Practice, BIS, New Delhi, 2000.
- [2] IS 875 (Part 2):1987, Code of Practice for Design Loads – Imposed Loads, BIS, New Delhi.
- [3] N. Karsh and V. K. Shukla, "Structural Retrofitting of an Existing Hostel Building," Int. J. Civil Engg. Research, vol. 15, no. 2, 2024.
- [4] A. Keshmiri et al., "A Systematic Framework for Structural Rehabilitation of Existing Buildings," J. Building Engineering, July 2024.
- [5] Puneet Kumar et al., "Seismic Retrofitting of Masonry Structures – A Review," IJRTE, vol. 8, 2019.
- [6] Anumol Raju et al., "FRP Retrofitting of RC Beams," Int. J. Engg. Research, vol. 2, 2013.
- [7] EMPA Building Science Lab, European Renovation Case Studies, Swiss Fed. Laboratories, March 2011.
- [8] IS 13311 (Part 2):1992, NDT of Concrete – Rebound Hammer Method, BIS, New Delhi.
- [9] IS 15988:2013, Seismic Evaluation and Strengthening of Existing RCC Buildings, BIS, New Delhi.
- [10] Maharashtra PWD, Schedule of Rates (DSR) 2022-23, Govt. of Maharashtra, Mumbai.
- [11] IS 15778, CPVC Pipes for Hot & Cold Water Supplies, BIS, New Delhi.
- [12] IS 4985, uPVC Pipes for Soil, Waste and Vent Systems, BIS, New Delhi.
- [13] IS 694, PVC Insulated FRLS Cables up to 1100 V, BIS, New Delhi.
- [14] P. C. Varghese, Advanced Reinforced Concrete Design, PHI Learning, 2nd ed., 2012.