EXECUTIVE SUMMARY

CONSTRUCTION QUALITY ASSESMENT REPORT

TOWER 'A', 'B', 'C' & 'D' OF 864 EWS TENEMENTS [S + 9 FLOORS] AT K.P. PARK, CHENNAI

CUBE ENVIRONMENT LABORATORY
ISO 9001, ISO 14001, ISO 45001
NABL ISO/IEC 17025:2017

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1. **Objectives.** Carryout **Independent Quality Assessment** of the completed four towers of 864 No. of EWS tenements of Stilt + 9 floors in KP Park in respect of the following: -

   1.1. **Quality of concrete in structural elements** namely **columns, beams** and **floor slabs** through conduct of appropriate Non-Destructive [NDT] and Partial Destructive [PDT] tests.

   1.2. **Quality of non-structural and fit-out materials**.

   1.3. **Quality of workmanship**.

2. **Terms of Reference.**

   2.1. Structures were reviewed for quality on '**As Is Where Is**' condition.

   2.2. Inspection Dates.

   (a) Initial Sampling & Inspection. From 25 August 2021 to 07 September 2021.

   (b) Additional Sampling & Inspection. From 21 September 2021 to 25 September 2011.

   2.3. Quality assessment has been carried out in respect of the **superstructures as seen above the ground level**.

3. **Scope.**

   3.1. **Concrete Structural Elements.**

   (a) Non-Destructive Tests.

(i)	Rebound Hammer Test.	100 No.
(ii)	Ultrasonic Pulse Velocity (UPV) Test.	100 + 20 No.

   (b) Partial Destructive tests.

(i)	Concrete Core Test.	100 + 09 No.
(ii)	Chemical Analysis for pH & Chloride	100 No.

   3.2. **Non-Structural & Fit out Materials.**

   (a) Sampling of cement plaster and evaluation of mix proportion — 100 No.

   (b) Random review of major non-structural & fit-out materials.

   3.3. **Workmanship.**

   (a) RCC elements.
   (b) Masonry works.
   (c) Joineries.
   (d) Services: MEP, Firefighting, Elevators & DG sets.

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4. **Methodology.**

4.1. **Document Review.** The undermentioned documents were sought and reviewed to assess the **Quality Assurance & Quality Control protocols adopted** during the execution of the said four blocks: -

(a) Contract Agreement & Technical Specifications.
(b) Good For Construction drawings.
(c) Quality Assurance Protocols adopted during construction.
(d) Quality Control records of construction.

4.2. **Quality Assessment of Concrete Structural Elements.**

4.2.1. **Visual Inspection.** Visual inspection of interior and exterior of superstructures were carried out to check for the following: -

(a) External distress, deformities & cracks.
(b) Alignment and verticality deviations / mismatches.

4.2.2. **Fixing the Sampling Location of NDT & PDT.** Selected on a clockwise direction from stilt to terrace floor, with samples drawn from every floor. Sample size for Block A, B & C was fixed as 28 No. and block D as 16 No. being smaller in built up area.

4.2.3. **Testing Protocol Adopted.** Carried out in presence of TNUHDB officials & execution agency and laboratory testing as per IS Code provisions

4.2.4. **Assessment Guidelines.** Individual Blocks have been considered as an entity for the purpose of test sampling of Concrete Cores to assess the **quality of concrete in structural elements** namely **columns, beams** and **floor slabs** of the respective blocks and supplemented by NDT tests (Rebound Hammer & Ultrasonic Pulse Velocity).

(a) Rebound Hammer Test. A preliminary or complimentary method to other tests to **assess the quality of near surface layer of the concrete**.

Average Rebound Number	Quality of Concrete
> 40	Very Good
30 to 39	Good
20 to 29	Satisfactory
< 20	Poor Concrete

(b) Ultrasonic Pulse Velocity (UPV) Test. To establish the homogeneity, presence of cracks, voids, and other imperfections, quality of the concrete in relation to the standard requirements etc.

Average Values of Pulse Velocity by Cross Probing/direct method of measurement	Concrete Quality Grading
For Concrete (> M 25)	
Above 4.50 km/s	Excellent
Between 3.75 - 4.50 km/s	Good
Below 3.75 km/s	Doubtful*

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(c) Concrete Core Tests. To assess the equivalent concrete cube compressive strength as per clause B-2.5.1 of IS 516 (Part 4): 2018 (First Revision), if average of equivalent cube strength of **minimum three cores is more than 0.85 times** the specified cube strength (characteristic strength fck) and **no individual core has equivalent cube strength of less than 0.75 times** specified cube strength (fck), the core test results are considered satisfactory.

(d) Chemical Analysis of Concrete Powder Samples. Tested for Chloride and pH in core samples as per IS: 456-2000 RA 2016.

4.2.5. **Locations Tested.**

(a) Initial Sampling.

S. No.	Building	Test Locations in No.			
		Column	Beam	Slab	Total
1	Block A	12	13	3	**28**
2	Block B	13	11	4	**28**
3	Block C	13	11	4	**28**
4	Block D	7	7	2	**16**
	Total	**45**	**42**	**13**	**100**

(b) Additional Sampling.

S. No.	Building	Test Locations in No.			
		Column	Beam	Slab	Total
1	Block A	10	10	Nil	**20**
2	Block B	03	Nil	Nil	**03**
3	Block D	06	Nil	Nil	**06**
	Total	**19**	**10**	Nil	**29**

4.3. **Quality Assessment of Non-Structural & Fit-out Materials.**

4.3.1. **Visual Inspection.** Visual inspection of the blocks and tenements were carried out to check the Masonry – Brickwork, Plastering, Tiling, Joineries.

4.3.2. **Random Sampling.** Cement plaster samples were extracted from all the blocks and tested in IIT Madras Laboratory to compare with technical specifications.

4.4. **Assessment of Workmanship.**

4.4.1. **Visual Inspection.** Visual inspection of the blocks and tenements were carried out to check RCC Elements, Masonry – Brickwork, Plastering, Tiling, Joineries and trunk infrastructure services.

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4.4.2. **Locations Tested.** Summary of total tenements inspected in each block are tabulated below: -

S. No.	Building	Inspected Tenements		
		Total No.	In No.	In %
1	Block A	252	115	46%
2	Block B	252	107	42%
3	Block C	252	130	52%
4	Block D	108	42	39%
	Total	**864**	**394**	**46%**

5. **Observations & Inferences.**

5.1. **Document Review.**

(a) Had required details with appropriate specifications were included in the contract agreement for Non-Structural & Fit-out materials, more effective quality assurance during construction could have been possible.
(b) Establishment of site QC laboratory during construction had not been mandated in the contract agreement and the TPQA agency **had also flagged this**.
(c) More frequent / monthly TPQA inspections as well as initiation of timely corrective actions based on TPQA observations **could have facilitated better quality standards**.

5.2. **Concrete Structural Elements.**

5.2.1. **Visual Inspection.** No deformities / cracks and no major misalignment / verticality issues observed in conjunction with occupancy of these four towers for the past two years and absence of any distress **do not indicate any apparent structural problems as on date**.

5.2.2. **Non-Destructive & Partial Destructive Tests.**

(a) **Block A.**

(i) Rebound Hammer Test. Surface hardness of concrete on **all the 28 No. tested locations** were found varying from **'Satisfactory to 'Very Good'**

(ii) **Ultrasonic Pulse Velocity Test.** Integrity of the concrete in **43 [28+20] No. of tested locations** were found to be **'Good',** whereas in undermentioned 5 No. of locations **[17%]** were found **'Doubtful'**.

(aa) Beam at Stilt floor near Gate : 4
(ab) Column at third floor at Tenement No. 60
(ac) Beam at fifth floor at Tenement No. 115
(ad) Column at fifth floor at Tenement No. 135
(ae) Lift column / wall at sixth floor near Tenement No. 146

Needs be repaired with 'Low Viscous Epoxy Resin' to improve the integrity of concrete.

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(iii) **Concrete Core Test.** The average compressive strength of all 28 samples were found to be **38.30 N/mm²** and thus collectively satisfy the 0.85 fck [**25.5 N/mm²**] and also individual samples satisfy 0.75 fck [**22.5 N/mm²**] criteria for the required grade of concrete of '30 N/mm² and **hence, adequate**.

(iv) Chemical Analysis of Concrete Powder Samples. Value of chloride and pH content obtained from all 28 locations were **found within IS code limits**.

(b) **Block B.**

(i) Rebound Hammer Test. Surface hardness of concrete on **all the 28 No. tested locations** were found varying from **'Good' to 'Very Good'**

(ii) Ultrasonic Pulse Velocity Test. Integrity of the concrete on all **28 No.** tested locations were found to be **'Good'.**

(iii) Concrete Core Test.

(aa) The overall average compressive strength of 31 [28 + 3 No.] concrete core test results, 34.08 N/mm², though seems meeting the 0.85 fck of M30 grade criteria, it could not be validated due to the deficiencies detected within.

(ab) Compressive strength of the concrete obtained in the **four structural elements** obtained through Core Test **in 2nd floor did not satisfy the minimum qualifying criteria of 0.75fck of M 30 grade of concrete for which the structure has been designed for;** as per clause B-2.5.1 in IS 516 (Part 4): 2018 & 17.4.3 of IS456 2000 for M30 grade concrete.

(ac) Hence, it implicates the need to **reanalyse the structural adequacy of the Block 'B' for M25 grade of concrete by the EPC Contractor.**

(iv) Chemical Analysis of Concrete Powder Samples. Value of chloride and pH content obtained from all 28 locations were **found within IS code limits**.

(c) **Block C.**

(i) Rebound Hammer Test. Surface hardness of concrete on **all the 28 No. tested locations** were found varying from **''Good' to 'Very Good'**

(ii) Ultrasonic Pulse Velocity Test. Integrity of the concrete on all **28 No.** tested locations were found to be **'Good'.**

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(iii) **Concrete Core Test.** The average compressive strength of all 28 samples were found to be **38.05 N/mm²** and thus collectively satisfy the 0.85 fck [**25.5 N/mm²**] and also individual samples satisfy 0.75 fck [**22.5 N/mm²**] criteria for the required grade of concrete of '30 N/mm²' and **hence, adequate**.

(iv) Chemical Analysis of Concrete Powder Samples. Value of chloride and pH content obtained from all 28 locations were **found within IS code limits**.

(d) **Block D.**

(i) Rebound Hammer Test. Surface hardness of concrete on **all the 28 No. tested locations** were found varying from **'Good' to 'Very Good'**

(ii) Ultrasonic Pulse Velocity Test. Integrity of the concrete on all **28 No.** tested locations were found to be **'Good'** to **'Excellent'.**

(iii) **Concrete Core Test.**

(aa) The overall average compressive strength of 21 [16 +6 No.] concrete core test results, 35.22 N/mm², **including the outlier** (as per footnote in clause B-2.5.2 of IS 516 (Part 4): 2018) in one sample 'column at seventh floor opposite Tenement No. 80' reveal that **compressive strength of the concrete obtained in the various structural elements obtained through Core Test samples is found to meet M 30 grade of concrete for which the structure has been designed for;** as per the requirement in clause B-2.5.1 of IS 516 (Part 4): 2018 & 17.4.3 of IS456 2000, subject to the following.

(ab) The **outlying structural member Column at seventh floor opposite Tenement No. 80 should be retrofitted using Carbon Fibre Reinforced Polymer (CFRP) wrapping**
to meet the requirements of M30 grade of concrete.

(iv) Chemical Analysis of Concrete Powder Samples. Value of chloride and pH content obtained from all 28 locations were **found within IS code limits**.

5.3. **Non-Structural / Fit out Materials.**

5.3.1. Visual Inspection. No major physical defects were observed on the non-structural and fit out items except for **extensive defects in cement plaster.**

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5.3.2. Cement Plaster.

(a) The value of cement mortar proportions obtained in the samples extracted from the ceilings, lofts & beams as well as walls & columns of all the blocks were found to be ranging from 1:2.4 to 1: 15.70.

(b) In majority (nearly 70 %) of the samples the cement content is still **significantly lower than the required specifications.**

(c) Cement plaster needs to be redone as per IS Code 1661: 1972 [Reaffirmed 2001] and Best Engineering Practices. It needs to be ensured that all the defective surfaces identified by CUBE and other locations to be jointly verified by TNUHDB & EPC Contactor are redone.

5.4. **Quality Assessment of Workmanship.**

(a) Poor quality and **unacceptable workmanship of plastering** is one of the major and most critical defects observed in most of the tenements.

(b) Potential causes of this might be due to one or more of the undermentioned reasons: -

(i) Quality of materials; cement, sand and water used for mortar preparation.

(ii) Lean mix of mortar with **exceedingly low cement content**.

(iii) Exceedingly excess thickness of plaster, that too not done in layers.

(iv) Improper application of plaster with inadequate surface preparation.

(v) Inadequate curing.

(c) Shortcomings observed in tiling works such as improper fixing, hollowness, inadequate grouting at the edges are the leading causes for widespread seepages.

(d) Improper sealing of closets and floor traps also contribute to the seepage issues observed.

(e) Unauthorized modifications to toilets and plumbing lines have further complicated the seepage issues and would definitely lead to blockages of the sewer lines in the future.

(f) These seepages have led to dampness, blistering of wall plasters, peeling off of paints on both the internal and external masonry walls.

(g) Ill fittings of UPVC Windows & MS Grills pose safety and security concerns to the tenements.

(h) Standard engineering practices have not been considered during the construction of parapet wall and barricading of large masonry opening at the corridors posing Fall Safety Hazards.

(i) Shortcomings observed in Electrical panel room, Fire Panels, Meter boards, DG sets and Pump motors and earth pit arrangements such as missing Main fuse cut outs, bus bar, exposed MCBs, improper cable dressing and missed earthing provisions pose major electrical hazards.

(j) Improper / inadequate installation and poor maintenance of the trunk infrastructure services such as Firefighting, Elevators, DG backup sets, water supply, sewerage lines and storm water drains has resulted in their non-functionality.

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6. **Conclusion & Way Forward.**

6.1. The quality assessment of concrete structures in each block signifies overall adequacy towards quality of concrete used in structural elements except for the deficiencies detected which require repair and or retrofitting in Block 'A' & 'D' and reanalyzing the structural adequacy of the Block 'B' by downscaling the concrete grade to M25 and check the adequacy of design as recommended.

6.2. Addressing the non-structural / fit-out materials and workmanship defects highlighted in the preceding sections of the report would help in meeting the aspirations of the allottees.

6.3. Unauthorized alterations / modifications to be strongly prohibited and allottees to be educated for proper maintenance of the tenements and amenities.

6.4. Periodic & regular maintenance of trunk infrastructure of the KP Park would not only enhance the serviceability of the said towers but also invoke maximum satisfaction quotient of the occupants.

6.5. TNUHDB may consider to adopt holistic and fool-proof quality assurance protocols and quality control procedures during all three stages of execution namely pre construction, during construction and post construction stage.

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