PRAPTI ASSOCIATE
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29th Aug 2024

To,
Lloyds Engineering Work Ltd
A2, 2nd Floor, Madhu Estate,
Pandurang Bhudkar Marg,
Parel (E), Mumbai.

Sub: Structural Audit & Condition Assessment report for the Structure of A-6/3, B & C Shop A-5/5 MIDC Industrial Area, Murbad and Plot K3 in Additional MIDC Industrial Area, Murbad, Dist. Thane- 421 401.

Resp. Sir,

We have get done NDT test for the entire building to know the condition of structure, hereby we are submitting NDT report along with the building current condition report of Factory Building / Sheds on Plot No A-6/3, B & C Shop A-5/5 MIDC Industrial Area, Murbad and Plot K3 in Additional MIDC Industrial Area, Murbad, Dist. Thane- 421 401.

For Prapti Associate

PRAPTI ASSOCIATE ★ M-160135-5 Chartered Engineer ★ CONSULTING ENGINEER

Ram Marathe
Structural License No. NMMC / TPO / S.E. /161

Flat No. 605, B wing, Sai Villa Apartments, Gauripada, Kalyan(W) - 421301

Annexure - 2 P R O F O R M A 'B'		
Subject: Report of Structural Assessment of the building.		
Name of Consultants		PRAPTI ASSOCIATES
1	Name of Building	A-6/3, A-5/5 & K3
2	Address	MIDC Industrial Area, Murbad, Thane.
3	No of floors	A-6/3: Ground + 2 floors Partly RCC Structure & Partly M. S. Structure, A-5/5 : M. S. Structure floor Partly RCC Structure & Partly M. S. Structure K3 : M. S. Structure floor Partly RCC Structure & Partly M. S. Structure.
4	Year of Construction and age of building	1998 (26 Years old) approx.
5	Name of the Zone	--
6	Date of Inspection by Registered Structural Engineer	12th Aug 2024 to 20th Aug 2024
7	Date of preparation of Report	23rd Aug 2024
8	Validity Period of report	1 YEAR
9	Type of Construction of existing Bldg. (As per Structural Engineer Report)	
I.	Foundation	R.C.C
II.	Floors	R.C.C
III.	Beams	A-6/3 : M.S. Structure A-5/5 : M.S Structure K3 : M. S. Structure
IV.	Columns	A-6/3 : M.S. Structure A-5/5 : M.S Structure K3 : M. S. Structure
V.	Roof	A-6/3 : Partly RCC & Partly M. S. Sheets A-5/5 : M. S. Sheets K3 : M. S. Sheets

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VI.	Walls	A-6/3 : Brick work/ M. S Sheet covering A-5/5 : Brick work/ M. S Sheet covering K3 : Brick work/ M. S Sheet covering
10	History of Repairs done Year wise	
I.	Slab Recasting	No
II.	Column Jacketing	M. S. Structure has been jacketed in all the Structure
III.	Structural Repair	No
IV.	Waterproofing	Yes in A-6/3 RCC terrace, Membrane sheets has been laid
V.	Tenantable Repairs	No
VI.	Plumbing Work	Yes in A-6/3 (Need Based Only)
VII.	Painting Work	Yes in A-6/3 , A-5/5 and K3
VIII.	Additions / Alterations if any	Yes in A-6/3 , A-5/5 and K3
11	Condition of	
I.	Internal Plaster	**Not in Good Condition**
II.	External Plaster	A-6/3 , A-5/5 and K3 **Cracks, Moss fungus have been formed at some places, Debonded plaster has been also observed.**
III.	G.I Plumbing Work	Working Condition
IV.	Drainage / Chambers	Working Condition
12	Observation	
a)	Doors & Window Don't Close	No
b)	Reinforcement Exposed	Yes
c)	Settlement uneven Flooring gaps between and skirting & floors	No
d)	Foundation Settlement	No
e)	Deflection / Sagging	No
f)	External columns / Beam	A-6/3 , A-5/5 and K3 Cracks has been formed at many places
g)	Under Ground Water Tank	---

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h)	OHT/ Column Condition	A-6/3 water tank is leakage
i)	Seepage / Leakages	Yes, at few places
j)	Parapet Walls at terraces	Good Condition (A-6/3)
k)	Terrace Water Proofing	Bad Condition (A-6/3)
l)	Vegetation	No
m)	Lift Wall	--
n)	Toilet blocks	Good Condition
o)	Common area	Good Condition
p)	Staircase area /column condition	Good Condition
q)	Stilt are columns	---
13	Test Carried out on Structural Members	
a)	Ultrasonic Pulse Velocity Test	YES
b)	Rebound Hammer Test	YES
c)	Half Cell Potential Test	YES
d)	Carbonation Depth Test	YES
e)	Core Test	YES
f)	Dry Penetration Test	YES
g)	Ultrasonic Gauge Thickness	YES
14	Distress Mapping plan & Photographs with description of structural member & location	YES
15	Brief Description of Repairs to be Done	
a)	Water Proofing	**Yes work (A-6/3)**
b)	External Plaster	**Yes to be carried out patch work (A-6/3)**
c)	Structural repairs	A-6/3 , A-5/5 and K3 : **Structural Columns need to be strengthened and repaired, Concrete members need to be repaired with PMM & Micro Concrete**

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		work
i.	Column jacketing	No
ii.	Slab recasting	No
iii.	RCC cover to be replaced	No
iv.	Beam recasting	No
a)	Partial Evacuation during repairs needed	No
b)	Propping	No
v	Pre Coated Sheeting on Roof and Walls	
a)	Roof Sheeting	**Deteriorated and is source of Leakage during monsoon in all Structures** (A-6/3 , A-5/5 and K3)
b)	Wall Cladding Sheeting	**Deteriorated, will be further damages during Structural Strengthening and needs replacement in all Structures** (A-6/3 , A-5/5 and K3)
16	Conclusion of the Consultants	
	Whether Structure is Livable / or whether it is to be evacuated & pulled down	Livable
	Whether Structure Required tenantable repairs/Major structural repairs & its time frame	Major Structural Repair is required within period of 1 year
	Whether structure can be allowed to occupy during course of repairs	Yes
	Nature/Methodology of repairs	**In all Structures** (A-6/3 , A-5/5 and K3) **Structural Members Restoration & Strengthening, Repair & Restoration of Concrete Structural Members, Replacement of Roof Sheeting and Wall Cladding & Flashings.**
	Whether Structure requires immediate propping. If so, its propping plan/methodology given	No
	Whether other immediate safety measures required – what is specific recommendation?	NOT REQUIRED

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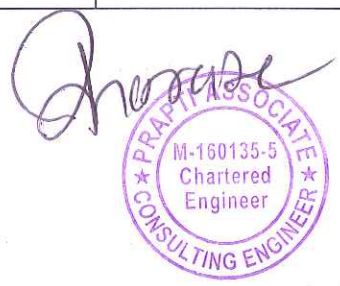
	Enhancement in life of structure after repairs/frequency of repairs required in extended life period	5 YEARS	
	Projected repair cost/Sq.ft	---	
	Projected reconstruction cost/Sq.ft	---	
	Specific remarks, whether building needs to be vacated/demolished/ repairable	REPAIRABLE	
	Whether structure in extremely critical condition	No	
17	Critical observation	No	
18	Classification of Bldgs.	Category	Auditors Final Conclusion
	To be evacuated / demolition immediately	C1	NO
	To be evacuated and/ or partial demolition requiring major structural repairs only	C2-A	NO
	No eviction only structural repairs	C2-B	YES
	No eviction needs minor repairs only	C3	NO



Introduction

Project Name	:	**Llyods Engineering Works Ltd**
Address	:	**A-A-6/3, B & C Shop A-5/5 MIDC Industrial Area, Murbad and Plot K3 in Additional MIDC Industrial Area, Murbad, Dist. Thane- 421 401.**
Building Age	:	Approx. 26 Years old
Scope of work	:	Detailed Structural investigation of the Columns & Beams.
Compiled by	:	**Prapti Associate**
Inspected on	:	Inspection carried out on 2nd July 2024 to 6th July 2024
Analysis	:	The compilation of all the data of observation was carried out at site by the Survey team. The results of these observations are compiled and are presented in this document.

PROJECT OVERVIEW STATEMENT

The Audit was aimed to evaluating the general condition of the structure with special emphasis on the structural stability.

Survey was aimed to identify:

- Structural defects, failure and the extent of damages.
- Defects in Concrete.
- Corrosion in M. S. Structure
- Condition of structure

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Project Goal

- Identification of distressed areas by visual survey and diagnosis of distress through observation.
- Determining the cause.
- Evaluation of present condition of structure.

Primary Project objectives

- Improving the functional aspects without disturbing the Stability of the structure in the best techno-commercial solution.

Responsibility of M/s. Prapti Associate is Restricted to Technical advice and monitoring of the actual work carried out by the contractor.

PRINCIPLES

VISUAL OBSERVATIONS:

The buildings were investigated for observation from inside & outside of the building. Most of the column, beams & slab & M. S. Structure within the section were observed for a range of defects in the structure.

NON DESTRUCTIVE OBSERVATIONS:

Many of the columns of the building were subjected to tests by Ultrasonic Pulse Velocity, Rebound Hammer, Core test, Carbonation & Half Cell potential for RCC Structure & Dry Penetration Test & Ultrasonic Gauge Thickness for M. S. Structure. The readings were recorded in the observation sheets, which were evaluated further for remedial measures.

REPORT ON NON DESTRUCTIVE TESTING OF RCC MEMBERS

1] INSPECTION & TESTING:

The aim of testing was to arrive at the general quality of concrete, rather than evaluating each RCC Members in detail. Hence, a few RCC members at random were tested. Ultrasonic Pulse Velocity (UPV) measurements were taken for Columns.

The Pulse Velocity observations on relevant members are included in the tables enclosed. The readings were taken on portions of RCC members / concrete that had developed significant visible cracking. Hence, these can be treated as representing the true quality of Concrete as such.

Rebound Hammer test readings were also taken to assess the compressive strength of the above members. Both Horizontal & Vertical up directions of testing were used. The Rebound Hammer observation on relevant members is also included in the tables enclosed.

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INSTRUMENTAL TEST

Ultra Pulse Velocity Test: This test is done to assess the quality of concrete by ultrasonic pulse velocity method as per IS-516 (Part 5 /Sec 1) 2018. The underlying principle of this test is - The method consists of measuring the time of travel of an

ultrasonic pulse passing through the concrete being tested. The Assumption report is given separately.

Rebound Hammer Test: This test measures the surface hardness of concrete. For structures, the hardness reading is used to co-relate the strength of concrete. The hammer has to be used normal to the test surface, vertically (up or down) or horizontally depending on the structural element. IS Codes applicable: IS-516 (Part 5 /Sec 4) 2020. References: IS 516: 1959 Test for strength of concrete IS 8900: 1978 Criteria for rejection of outlying observations.

Core Test : The cores are tested for compression in our in-house Laboratory as per guidelines given in IS: 516 (Part 4) : 2018. Further analysis is done based on the report given by the laboratory.

Estimation of Cube Strength Estimation of equivalent cube compressive strength is carried out in following steps as per guidelines given in SP: 24 Clause 16.3.2. Compressive strength of each core sample is worked out by
fo = Load/cross sectional area. If 'Length / diameter' ratio of core sample is less than 2, then correction factor 'k' is worked out as per IS: 516 (Part 4) : 2018.

Half cell Potential Test: Electrochemical Half-cell Potentiometer test provides a relatively quick method of assessing reinforcement corrosion over a wide area without the need of wholesale removal of the concrete cover. Quantitative measurements are made so that a structure can be monitored over a period of time and deterioration can be noted. The assumption report is given separately in the report.

Carbonation Test: Concrete structures undergoes a deterioration of properties and structural performances in the materials caused by cracking and deterioration/damage to the concrete owing to a variety of physical and environmental factors as time passes after the completion of construction.

Dry penetration Test : This dye penetration test is a type of non-destructive used to detect surface flaws on a material or welds. The dye penetration test uses a liquid called a penetrant that flows into any flaws on the material's surface like porosity cracks, laps seams and other discontinuities in the surface.

To increase the visibility of the surface discontinuities, making them easier to detect and measure is the cost-effective method used to locate surface breaking, Leaks, cracks and forging defects are some defects which can be identified by using dye penetrant test. But, for detecting non-metallic inclusions, one will have to do a magnaflux test as shown in graphical representation below.

Ultrasonic Gauge Thickness: Ultrasonic thickness measurement (UTM) is a non-destructive testing method used to inspect the metal thickness of metal sheets, piping and structural steel. Thickness measuring is essential across many industries to monitor corrosion, erosion, strength to withstand load and any other damages that could affect the performance of the structure it is meant for.

A standard frequency used by an ultrasonic thickness gauge is 5 MHz. This test of Ultrasonic coating thickness gauges required couplet gel, paste or liquid format to be used to eliminate gaps between the transducer and the test piece.

The major purpose of this test in current case is to understand the effective thickness of steel to evaluate its load bearing capacity.

2] DISCUSSIONS:

The summary of results of Nondestructive tests is enclosed.

Standard Deviation:

It is a measure of uniformity of scatter of the results obtained. A normal or Gaussian distribution of results is usually assumed for concrete. This distribution (curve) has a specific mathematical relation between the average, standard Deviation and the number of results below or above a specific value of the result.

Characteristic strength = Mean Strength -1.65 x S.D. The strength of concrete, where 95% of the results are expected to be above that value, is called characteristic strength.

A lower value of standard deviation indicates a greater uniformity, whereas a higher value of S.D. indicates wide scatter.

Since the strength of concrete in a structure has a wide range of values from 5N/mm2 (M5 = 50 kg/cm^2) to 50N/mm^2 (M50 = 500kg/cm^2) or more, a suitable measure of variability has to be used. For concrete higher than M25 grade, standard Deviation tends to be constant. Vide IS 456 code of practice for plain and reinforced concrete, the total number of test results required to constitute an acceptable record for calculation of standard Deviation shall be not less than 32.

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Estimated standard deviation $s = \sqrt{\sum \Delta^2 / n - 1}$ where Δ= deviation of the individual strength from the average strength of n samples, and n = number of sample test results.

Hence, the value of standard deviation, given in the code for the respective grade of concrete, may be assumed.

All the Ultrasonic Pulse Velocity Values are less than 3Km/sec, indicating doubtful quality of concrete. It may be due to non-uniformity, presence of internal flaws, cracks or segregation etc., indicative of the level of workmanship employed.

It is to be noted that testing is conducted on sound surface relatively free from cracks and thus reflecting true picture of concrete. The strength of concrete tested is not to be confused with the load bearing capacity of the RCC member. The concrete may be good in the core region of the member tested but the load bearing capacity of the member may have reduced due to corrosion in the steel.

The continuing corrosion of reinforcement has a multiple effect. The area of reinforcement is gradually reduced and the cracks induced in concrete (mostly in the cover concrete) in turn reduce the strength of concrete. This together goes reducing the load carrying capacity and it is necessary to adopt suitable measures for repairs / strengthening so that the deterioration is arrested or at least its rate is reduced considerably.

3] CONCLUSIONS:-

1] **Ultrasonic Pulse Velocity values range from 2.93 to 1.93 Km/Sec. for A-6/3 Structure & 2 places above 3.5 Km/Sec., 2.06 to 1.59 Km/Sec. for A-5/5 Structure & and 1.94 to 1.28 Km/Sec. poor quality, in average results shows 2.61, 2.06 & 1.94 km/sec which is poor quality.**

2] **The concrete mix or grade at this site is not known, the compressive strength value determined by Rebound Hammer tests. The statistical analysis of test results indicates average in – situ compressive strength of the column concrete tested as A-6/3 is 34.17 N/mm^2, A-5/5 is 34.59 N/mm^2,**

3] **The average equivalent cube compressive strength of the column concrete tested as A-6/3 is 24.86 N/mm^2, A-5/5 is 28.3 N/mm^2, and respectively. The core test results alone, the concrete tested could be classified as of M15 to M20 grade.**

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4] **whereas Half - Cell Potential average result shows for A-6/3 structure is -0.29V, A-6/3 structure is -0.29V, and for Corrosion activity is uncertain Thus, test results indicate medium risk of active corrosion of reinforcement steel.**

5] **Average Depth of Carbonation in A-6/3 Structure is 32.25mm, A-5/5 Structure is 37.5mm, and. The carbonation test results indicate depth of carbonation as 'High' in all Structures.**

6] **Dry penetration test results indicates that Liner & Non-Liner are visible at many places in all the three units.**

7] **Ultrasonic Gauge Thickness can be concluded that, in average ISMB/ ISMC section of A-6/3 has been loss by 14.02 %, 10.48% in A-5/5.**

4] GENERAL STRENGTH EVALUATION BY NDT TESTING

In short span of four decades Non-Destructive Testing has achieved an important place in the control of quality of hardened concrete and the evaluation of existing concrete structures with regard to strength and durability.

In certain instances for example when investigating width and depth of crack as well as voids and corrosion in concrete nondestructive test methods are the only one that can provide a reasonable answer. It is very difficult to predict the life of building based on the some sample test conducted at site, but some judgment can be derived from the test data along with detailed site inspection made at site.

In the normal practice about 25 to 30 % strength improvement may done in the existing strength of the particular structural element, by using standard strength improvement methods.

As per IS 456 B 2000 in general 20 % strength deviation is occasionally accepted considering overall soundness of the structure. By using this thumb rules the undersigned had developed one ready reference to conclude the overall strength and durability of the structure.

Better durability of structure or concrete means better resistance to abrasion, weathering, chemical attack, frost, fire, snow, wind, rain, temperature difference and action of chemical salts in the surrounding atmosphere. In general concrete with high cement content, optimum water cement ratio, heavy aggregate, dense compaction, lo w porosity and permeability and optimum cover is more durable.

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As per IS 13311(Part 1): 1992: The estimation of strength of concrete by rebound hammer method cannot held to be very accurate and probable accuracy of prediction of concrete strength in structure is +/-25%.

CORROSSION:

Rusting of Iron and steel is the most commonly process of corrosion. The following equations describe the formation process of rust.

2 Fe + H2O +11/2 02 ----2 FeO (OH)

Iron+ Water+ Oxygen ---- Hydrated Iron Oxide

Concrete is permeable to water and solution of chloride & sulphate. Penetration of the solution of these chemicals can produce a gradual change in the condition within the concrete ultimately leading to Corrosion of Steel and deterioration of concrete looses its alkalinity. Major constituents like Carbon dioxide, Sulphates, Sulphor dioxide etc. cause the loss of alkalinity in concrete.

Any corrosion of reinforcement results in the formation of rust, which occupies a volume of about 2.2 times that of iron from which it is formed. This corrosion product has literally no place to go so that it produces large internal pressure as high as ton / inch 2 around the concrete resulting in longitudinal cracks parallel to reinforcement and crack the concrete.

OBSERVATION & RECOMMENDATION

We have observed some cracks on Columns & Beams externally in A-6/3 Structure. Some of the test report showing signs of weakness in RCC structural members & Penetration Test & Ultrasonic Gauge Thickness.

In all the three Structurs, extensive Scaling is observed on the Structural members and the structural members have deteriorated and hence requires immediate strengthening of the Members considering the load of the Crane and Job work being done on site.

According to our visual inspection & NDT test report we suggest to;

1) **Strengthen the structural members with Polymer Modified Treatment & Jacketing work to RCC Columns of the building**
2) **Strengthen the structural members with welding with MS Plates in the web of the Structural Members**
3) **M. S. Structure columns needs Jacketing with RCC**

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4) **For all the 3 Structures, Additional to that some of the M. S. Structure columns need to be Strengthen with RCC & Additional support of M. S. Frame/ MS Plate/ MS Angles & all the 3 structures ISMB/ ISMC sections to be rectified for strengthening**

CRITICAL CONDITIONS OBSERVED

For Structure 6/3, additional MS plates have been welded to web areas of the vertical I-beam. Few bends have also been observed to the fabricated supporting structures, strengthening of these member is critical. There have been warps observed to the web areas as per the NDT test results. The side supports of the main structure supporting the cranes needs to be provided with cross-sectional angular steel for load distribution and thus resisting the occurrence of bends or buckle in the structure. The horizontal I beams running below the crane needs to be provided with load distribution technique. The mid-section supporting 2 crane system running on either sides of it, will need to strengthen the MS structural members and provide with RCC column for improving the load capacity of existing structure.

For structure 5/5, the mid supporting structure has been provided with RCC concreting. Such concreting should carry the base plate at the top so that the load of the horizontal structure where the crane is having the movement can be directly transferred to the RCC element that is construction. It is suggested to strengthen the MS structure and extend the RCC element upto the base of the horizontal I beam. This horizontal I beam shall be directly resting over the RCC top surface.

For structure K3, though the structure is not found to be in acceptable condition, it is suggested to provide cross-sectional supports for the horizontal long supported spans for increased life. It is suggested to strengthen the MS structure and extend the RCC element up to the base of the horizontal I beam. This horizontal I beam shall be directly resting over the RCC top surface.

CONCLUSION

From the data accumulated as above, the following conclusions can be drawn. The building is 26 years old & used for heavy industrial purpose.

- Cracks on Plaster and RCC work are observed on external walls at many places.
- Leakage/dampness occurs though external rain facing walls.
- Leakage & Plant growth in plumbing line observed.
- Cracks are observed in RCC work such as beams & columns.
- Building surrounding pavement is in good condition.

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RECOMMENDATION

1) **A-6/3:** Base plates welded to the web section of I beam needs to be provided to the other parallel I beam as well. Cross sectional support needs to be provided to the side supporting structures for rigidity and stability of the structure. The mid sectional support needs to be converted to RCC for increasing the performance of the structure. Strengthen the structural members with welding with MS Plates in the web of the Structural Members and Replacement of Roof Sheeting and Wall Cladding

2) **A-5/5:** The submitted RCC column for the mid-section needs to be taken upto the base plate of horizontal section of I beam. Proper surface preparation shall be carried at the joint of such RCC elements. Strengthen the structural members with welding with MS Plates in the web of the Structural Members and Replacement of Roof Sheeting and Wall Cladding

3) **K3:** Longer spans needs to be provided with cross sectional angles to evenly distribute the load. Strengthen the structural members with welding with MS Plates in the web of the Structural Members and Replacement of Roof Sheeting and Wall Cladding

CLASSIFIACTION OF BUILDING: - "LLYODS ENGINEERING WORKS LTD AT PLOT NO – A-6/3, A-5/5 & K3 IS IN C2-B, CATEGORY.

Notes:-

1) The report is based on NDT test & visual inspection of the accessible area & the data provided by the occupants only. The aim is to have a preliminary health checkup of the building.

2) This report marks the completion of structure audit work.

3) Inspection of foundations & seismic assessment are beyond the scope of structural audit & no investigations of foundation and of seismic safety have been carried out. As per our observation all the 3 structures are in a stable condition.

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REMEDIAL MEASURES

Remedial measures suggested are essential. Structural Rehabilitation needs to be done in spite of economic constraints. The other works can be carried out as per budgetary constraints. Delay in carrying out the repair works can lead to enhanced propagation of failures and shall become unsafe condition for operation in future if not attended now.

Finally, the responsibility of M/s. PRAPTI ASSOCIATE is limited to technical advice only on matters referred to in this report. All procedural, legal or operational matters including implementation, supervision and execution of site will be the responsibility of the party using this report, in the event of absence of M/s. PRAPTI ASSOCIATE as Project Consultants.

Thanking you & assuring you of our best services at all times.
Yours sincerely,

FOR PRAPTI ASSOCIATE

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Note : Attached NDT report, Location of tests & Photographs (44 Pages)

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