Report No:0218: 2023: SS

TECHNICAL REPORT

Report on: Condition Assessment of existing **Terminal T1, Chiller Unit** and **AC Plant** of Thiruvananthapuram International Airport (TKIAL) Thiruvananthapuram, Kerala.

Report for: **M/s. TRV (Kerala) International Airport Limited**
Administrative Block,
Thiruvananthapuram International Airport,
Thiruvananthapuram – 695 008.
Kerala State, India.

STPL

2023

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Report on	:	Condition Assessment of existing **Terminal T1, Chiller Unit and AC Plant (Cooling tower)** of Thiruvananthapuram International Airport (TKIAL) at Thiruvananthapuram, Kerala.
Report for	:	**M/s. TRV (Kerala) International Airport Limited** Administrative Block, Thiruvananthapuram International Airport, Thiruvananthapuram – 695 008. Kerala State, India.
Reference	:	SO No: 5700330018 dated on 10.08.2023
Period of Assessment	:	14th August to 21st August 2023
Assessment study carried out under the guidance of	:	Sri. Sudarshan S Iyengar Senior Director - (NDT, R & R Services) **M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.**
Assessment study carried out by	:	Mr. Shivanna B C Deputy Manager Mr. Vinay N M Senior Engineer Mr. Kishore H B Testing Assistant Mr. Rajesh M Testing Assistant **M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.**
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Total No. of Pages	:	**86 No's**

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1. INTRODUCTION:

The **"Terminal – T1"** of Thiruvananthapuram International Airport Limited (TKIAL) at Thiruvananthapuram, Kerala comprises of various buildings related to Aviation such as, Terminal building, Aero bridges, Technical Block, Air Traffic Control Tower, Chiller plant, Cooling tower, Canteen, CMD office, AHU, Porch etc. As informed the terminal and other related structures were built about 40 years ago and since then it is in operation.

The up-gradation and new construction of existing **Airport buildings** along with necessary infrastructure and facilities was under taken by **TKIAL,** a group of **ADANI AIRPORT HOLDINGS LIMITED** (AAHL) on Operations, Management and Development (OMD) conditions for long term lease.

2. NEED FOR STRUCTURAL ASSESSMENT:

In-spite of few modifications and up-gradation of the terminal by Airport Authority of India (AAI) all these years, still the existing facilities could not cadre the present Air traffic requirement in addition to the other infrastructure. Hence, the management of AAHL after took over the Airport on OMD, it is decided to conduct detailed condition assessment of following identified buildings to know the present condition as they are constructed very long back.

3. LIST OF BUILDINGS IDENTIFIED FOR CONDITION ASSESSMENT AT PRESENT:

The following structures were identified for carrying out condition assessment study:

1. Terminal T1 building
2. Chiller Unit and AC Plant

4. TERM OF REFERENCE:

STEDRANT Technoclinic Private Limited (STPL) has been consulted by TKIAL for the condition assessment of the above structures to know the present condition and suitability for the future Air traffic growth.

5. METHODOLOGY OF ASSESMENT:

For carrying out condition assessment and feasibility study, the following methodology has been adopted.

a. Study of structural systems.
b. Visual inspection (VI) of all the above structures for any visible distress/damage if any and it will be documented through photographs.
c. Preparation of part layout plans of the structures to indicate distress regions.
d. Carrying out Rebound Hammer Test.
e. Carrying out Ultrasonic Pulse Velocity Test.
f. Carrying out Cover Meter Test.
g. Carrying out Half-cell Potential Measurement test.
h. Carrying out Carbonation Test.
i. Extraction of concrete core samples from RC members at random locations and carrying out compressive strength test.
j. Carrying out Chemical Analysis.
k. Carrying out Ultrasonic Thickness Test.

The following are the details of the individual study carried out:

1. Study of structural systems.

The structural system adopted for the two buildings are found to be in order and satisfying the requirement of that time. Further, there is no structural drawings, details of soil test conducted earlier and construction details were not made available to STPL for any kind of verification.

2. Visual inspection (VI) of all the identified structures.

All the identified structures were inspected in detail for any visible distress. Further, wherever, false ceiling, cladding etc., were provided on the RC members got removed for inspection. All the observed distress features were documented through still photographs and location of each building.

3. Preparation of part layout plans of the structures to indicate distress regions.

As the relevant layout drawings were not available, hence detailed physical measurement of all the identified buildings for the preparation of existing layout plan to facilitate grid identification reference while conducting inspection and testing.

In addition, the dimensions of RC columns, beams and slabs were physically measured and recorded for reference.

4. Carrying out Rebound Hammer Test.

Before commencement of a test, the rebound hammer should be tested against the calibrated test anvil, to get reliable results.

For taking a measurement, the hammer should be held at right angles to the surface of the structure. The test thus can be conducted horizontally on vertical surface and vertically upwards or downwards on horizontal surfaces.

If the situation so demands, the hammer can be held at intermediate angles also, but in each case, the rebound number will be different for the same concrete. Suitable corrections have to be applied for position of hammer, to arrive at the correct value.

The following should be observed during testing.

a. The surface should be smooth, clean and dry
b. The loosely adhering scale should be rubbed off with a grinding wheel or stone, before testing.
c. Do not conduct test on rough surfaces resulting from incomplete compaction, loss of grout, spalled or tooled surfaces.
d. The point of impact should be at least 20mm away from edge or shape discontinuity.

Around each point of observation, six readings of rebound indices are taken and average of these readings after deleting outliers.

Procedure for obtaining correlation between compressive strength of concrete and Rebound number

The most satisfactory way of establishing a correlation between compressive strength of concrete and its rebound number is to measure both the properties simultaneously on concrete cubes. The concrete cubes specimens are held in a compression testing machine under a fixed load, measurements of rebound number taken and then the compressive strength determined as per IS 516: 1959. The fixed load required is of the order of 7 N/mm2. At least nine readings should be taken on each of the two vertical faces accessible in the compression testing machine when using the rebound hammers. Only the vertical faces of the cubes as cast should be tested. The points of impact on the specimen must not be nearer an edge than 20mm and should be not less than 20mm from each other. The same points must not be impacted more than once.

Interpretation of results

After obtaining the correlation between compressive strength and rebound number, the strength of structure can be assessed. In general, the rebound number increases as the strength increases and is also affected by a number of parameters i.e., type of cement, type of aggregate, surface condition and moisture content of the concrete, curing and age of concrete, carbonation of concrete surface etc. Moreover, the rebound index is indicative of compressive strength of concrete up to a limited depth from the surface. The internal cracks, flaws etc. or heterogeneity across the cross section will not be indicated by rebound numbers.

As such the estimation of strength of concrete by rebound hammer method cannot be held to be very accurate and probable accuracy of prediction of concrete strength in a structure is ± 25 percent.

Reference Standards

The rebound hammer testing was carried out as per **IS: 516 (Part 5 / Sec 4):2020.**

5. Carrying out Ultrasonic Pulse Velocity Test:

The equipment should be calibrated before starting the observation and at the end of test to ensure accuracy of the measurement and performance of the equipment. It is done by measuring transit time on a standard calibration bar supplied along with the equipment.

A platform/staging of suitable height should be erected to have an access to the measuring locations. The location of measurement should be marked and numbered with chalk prior to actual measurement (pre decided locations).

Mounting of Transducers

The direction in which the maximum energy is propagated is normally at right angles to the face of the transmitting transducer, it is also possible to detect pulses which have traveled through the concrete in some other direction. The receiving transducer detects the arrival of component of the pulse which arrives earliest. This is generally the leading edge of the longitudinal vibration. It is possible, therefore, to make measurements of pulse velocity by placing the two transducers in the following manners:

Direct Transmission (on opposite faces)

This arrangement is the most preferred arrangement in which transducers are kept directly opposite to each other on opposite faces of the concrete. The transfer of energy between transducers is maximum in this arrangement. The accuracy of velocity determination is governed by the accuracy of the path length measurement. Utmost care should be taken for accurate measurement of the same. The couplant used should be spread as thinly as possible to avoid any end effects resulting from the different velocities of pulse in couplant and concrete.

Semi-Direct Transmission

This arrangement is used when it is not possible to have direct transmission (may be due to limited access). It is less sensitive as compared to direct transmission arrangement. There may be some reduction in the accuracy of path length measurement, still it is found to be sufficiently accurate. This arrangement is otherwise similar to direct transmission.

Indirect or Surface Transmission

Indirect transmission should be used when only one face of the concrete is accessible (when other two arrangements are not possible). It is the least sensitive out of the three arrangements. For a given path length, the receiving transducer get signal of only about 2% or 3% of amplitude that produced by direct transmission. Furthermore, this arrangement gives pulse velocity measurements which are usually influenced by the surface concrete which is often having different composition from that below surface concrete. Therefore, the test results may not be correct representative of whole mass of concrete. The indirect velocity is invariably lower than the direct velocity on the same concrete element. This difference may vary from **5% to 20%** depending on the quality of the concrete. Wherever practicable, site measurements should be made to determine this difference.

There should be adequate acoustical coupling between concrete and the face of each transducer to ensure that the ultrasonic pulses generated at the transmitting transducer should be able to pass into the concrete and detected by the receiving transducer with minimum losses. It is important to ensure that the layer of smoothing medium should be as thin as possible. Couplant like petroleum jelly, grease, soft soap and kaolin/glycerol paste are used as a coupling medium between transducer and concrete.

Most of the concrete surfaces are sufficiently smooth. Uneven or rough surfaces should be smoothened using carborundum stone before placing of transducers. Alternatively, a smoothing medium such as quick setting epoxy resin or plaster can also be used, but good adhesion between concrete surface and smoothing medium has to be ensured so that the pulse is propagated with minimum losses into the concrete.

Transducers are then pressed against the concrete surface and held manually. It is important that only a very thin layer of coupling medium separates the surface of the concrete from its contacting transducer. The distance between the measuring points should be accurately measured. Repeated readings of the transit time should be observed until a minimum value is obtained.

Once the ultrasonic pulse impinges on the surface of the material, the maximum energy is propagated at right angle to the face of the transmitting transducers and best results are, therefore, obtained when the receiving transducer is placed on the opposite face of the concrete member known as Direct Transmission.

The pulse velocity can be measured by Direct Transmission, Semi-direct Transmission and Indirect or Surface Transmission. Normally, Direct Transmission is preferred being more reliable and standardized. (Various codes give correlation between concrete quality and pulse velocity for Direct Transmission only). The size of aggregates influences the pulse velocity measurement. The minimum path length should be 100 mm for concrete in which the nominal maximum size of aggregate is 20mm or less and 150mm for aggregate size between 20 mm and 40mm.

Reference Standards

The Ultrasonic pulse velocity test was conducted as covered in **IS – 516- Part -5 (Section - 1) 2018.**

6. Carrying out Cover Meter Test

To ensure satisfactory working of **Profometer 6** and to get accurate results, it should be calibrated before starting the operations and at the end of the test. For this purpose, calibration test block provided with the instrument should be used. To check the calibration accuracy, the size and cover of the reinforcement of the test block is measured at different locations on test block and the recorded data should match with the standard values prescribed on the test block.

Path measuring device and spot probes are together used for path measurements and scanning of rebars. These are connected with Profometer 6 with cables and are moved on the concrete surface for scanning the rebars and measuring the spacing. As soon as the bar is located, it is displayed on the screen. Once the bar is located, it is marked on the concrete surface.

Diameter probe is used for measuring the diameter of bars. It is also connected with Profometer 6 by one cable. After finding out the location of rebar, the diameter probe is placed on the bar parallel to bar axis. Four readings are displayed and mean value of these readings is taken as diameter of bar.

Depth probe of the Profometer 6 is used to measure the cover. It is also connected with Profometer 6 by cable and is placed exactly on the bar as soon as, the depth probe is above a rebar or nearest to it, it gives an audio signal through a short beep and visual display. Simultaneously, the measured concrete cover is stored in memory.

For carrying out this test, the proper assess is essential. For this purpose, proper staging, ladder or a suspended platform may be provided. Before actual scanning, marking is done with chalk on the concrete surface by dividing it into panels of equal areas.

Reference Standards

The cover meter test was conducted in accordance with **BS 1881 (P204): 1988.**

7. Carrying out Electrochemical Half-Cell Potentiometer Test

The corrosion analysing instrument operates as digital voltmeter. Voltage of + 999 mV DC can be measured using this instrument. The potential in millivolts is measured with rod electrodes at different locations on the structure. The measured voltage depends upon the type of the half-cell, and conversion factors are available to convert readings obtained with other half cells to copper-sulphate half-cell. Testing is usually performed at points arranged in a grid. The required spacing between test points depends on the particular structure. Excessive spacing can miss points of activity or provide insufficient data for proper evaluation, while closer spacing increase the cost of survey. In surveying bridge decks, ASTM C 876 recommends a spacing of 1.2 meter. If the difference in voltage between adjacent points exceeds 150 mV, a closer spacing is suggested. A key aspect of this test is to ensure that the concrete is sufficiently moist to complete the circuit necessary for a valid measurement. If the measured value of the half-cell potential varies with time,

pre wetting of the concrete is required. Although pre wetting is necessary, there should be no free surface water between test points at the time of potential measurement. The concrete is sufficiently moist if the measured potential at a test point does not change by more than + 20 mV within a 5 min. period. If stability cannot be achieved by pre-wetting, it may be because of stray electrical currents or excessive electrical resistance in the circuit. In either case, the half-cell potential method should not be used. Testing should be performed between temperature range of 17 to 280C.

Reference Standards

The Electro chemical half-cell potentiometer test was conducted as covered under **ASTM C 876 – 15.**

8. Carrying out Carbonation Test on Concrete

Carbonation on concrete in cover results in loss of protection to the steel against corrosion. The depth of carbonation can be measured by spraying the freshly fractured concrete surface with a 0.2% solution of phenolphthalein in ethanol. Since phenolphthalein is a pH indicator, the magenta (pink colour) area presents un-carbonated concrete and the remaining (colorless) portion, the carbonated area. The change in colour occurs at around pH 10 of concrete.

The test must be applied only to freshly exposed surfaces, because reaction with atmospheric carbon dioxide starts immediately. Relating carbonation depth to concrete cover is one of the main indicators of corrosion.

Reference Standards

The Carbonation test was conducted as covered under **BS EN: 14630-2006.**

9. Carrying out Concrete Core Extraction & Testing

Object

In order to assess the in-situ compressive strength of concrete in a selected structural member, a core of suitable diameter and length will be extracted using diamond core cutter.

Apparatus

A core drill shall be used for securing cylindrical core specimens. For specimens taken perpendicular to the horizontal surface, a short drill is satisfactory. For inclined holes, a

diamond drill is satisfactory. The instrument used for extracting core here is Tyrolit Diamond core cutter from Austria.

Test Specimens

A core specimen for the determination of compressive strength shall have a diameter at least three times the maximum nominal size of the coarse aggregate used in the concrete, and in no case shall the diameter of the specimen be less than twice the maximum nominal size of the coarse aggregate. The length of the specimen, when capped, shall be as nearly as practicable twice its diameter.

Core Drilling

A core specimen taken perpendicular to a horizontal surface shall be located, when possible, with its axis perpendicular to the bed of the concrete as originally placed. A specimen taken perpendicular to a vertical Surface, or perpendicular to a surface with a batter, shall be taken from near the middle of a unit of deposit.

Reference Standards

The extracted concrete core samples were tested for compressive strength as per **IS: 456-2000 (Reaffirmed in 2016) and IS: 516 (Part 4): 2018.**

10. Chemical Analysis of Concrete

Concrete samples will be collected from the structural members by appropriate means for assessing overall Chlorides & Sulphate content and level of pH.

A rotary percussion drill is used to collect a pulverized sample of concrete or powder samples from concrete cores will be used for carrying out chemical analysis. If different samples are obtained from different concrete depths, it can be established whether the chloride contamination was there in the original concrete or the same has come from the environment Extraction of concrete core samples.

Reference Standards

IS: 14959 (Part II) 2001 for chlorides and NCB 9th International Seminar Vol.3 Page 500 VII for pH.

11. Carrying out Ultrasonic Thickness Test

To assess the thickness of structural steel members, generally ultrasonic method will be adopted. The measurement obtained from Ultrasonic Thickness measurement test was carried out at randomly selected members.

A very useful tool in the structural audit / survey. Whenever, the measurement of thickness of existing members to be carried out for analysis, especially in structural steel structures, M S Chimney, Stacks, Gantry girders, Pipe racks, Pipelines etc.

Using the Ultrasonic thickness Gauge one can find out the precise thickness of all such steel / metal structures, components.

This method is used to measure thickness of metals by using Ultrasonic Pulse Echo method. This test is applicable to all such materials which will give a clear resolvable back wall echo like all metals and which do not have variation in the Ultrasonic pulse velocity in any direction. This method is applicable to evaluate in variation in thickness point to point. This testing is more useful where the access is only in one direction. (Reproduced from IS: **15435 - 2003, (RA - 2013)**

Reference Standards

The Ultrasonic Thickness Test was conducted as covered under **Indian Standards IS: 15435 - 2003, (RA - 2013).**

G. INFRENCES:

Based on the observations and results of the tests carried out, an appropriate recommendations are suggested for the each structure.

H. CONCLUSIONS:

From the detailed investigative studies carried out for the all the three identified structures, it is inferred that construction of new structure will be the best option considering the present condition, age factor, durability and future requirement.

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ASSESSMENT OF TERMINAL T1 BUILDING

1. ABOUT STRUCTURE

The existing **'Terminal T1'** building is an RC framed structure with north light roofing system and conventional RC beam slab system. All infilled and peripheral walls were built by using laterite block masonry. The building comprising of ground plus two upper floors of different heights.

The building consists of front and rear Porches, two Aero bridges, baggage claim area, VIP Lounge, Fire control room, CMD office, AHU etc., in the ground floor. In the first floor Security hold, Extended security hold, Server rooms, Office rooms and AHU are located. Whereas, in the 2nd floor, offices are located.

(Refer Layout Plan in the appendix)

1.1 PHYSICAL OBSERVATIONS AND PHOTOGRAPHIC EVIDENCES ALONG WITH DRAWINGS

Following are the physical observations made during inspection. The findings of the observations are documented through photographs:

Ground Floor

i. In ground floor consisting Porches, two Aero bridges, baggage claim area, VIP Lounge, Fire control room, CMD office, AHU, Commercial shops and Office rooms etc. In addition, the most of the reinforced concrete (RC) members, partition walls and external walls shall be covered with POP false ceiling and cladding (PH 01 - 09).

ii. Vitrified tiles were observed to be provided in flooring at most of the regions (PH 08).

iii. Dampness and damp patches were observed in masonry walls (PH 10).

iv. Severe corrosion was observed on the structural steel members at many locations (PH 11).

v. Patch up works was observed at few locations (PH 12).

vi. Cracks were observed in masonry parapet walls (PH 13.

vii. Growth of vegetation was observed at parapet wall (PH 14).

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TERMINAL T1 BUILDING

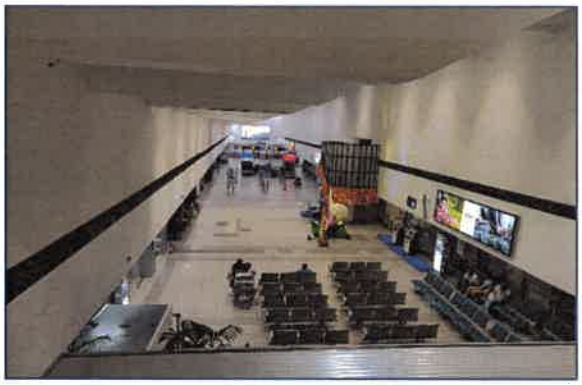
Front View

Rear View

Photographic Documentation

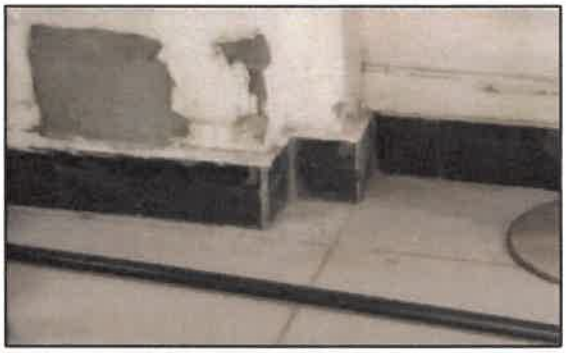
PH O2 - General views of external side

PH O4- General views of external side



PH 06 - General views of internal side

PH 08 - General views of internal side

	
PH 09 - General view of Aero bridge	PH 10 - Dampness in masonry walls
	
PH 11 - Severe Corrosion	PH 12 - Patch up work
	
PH 13 - Cracks in masonry walls	PH 14 - Growth of vegetation

(Refer enclosed drawing for floor identification)

First Floor

i. In first floor consisting Security hold, Extended security hold, Server rooms, Office rooms and AHU are located. In addition, the most of the reinforced concrete (RC) members, partition walls and external walls shall be covered with POP false ceiling and cladding (PH 01 to PH 04).

i. Mosaic tiles were observed to be provided in in flooring at most of the regions (PH 02).

ii. Leakages from the ceiling slab was observed at many locations (PH 05).

iii. Dampness, damp patches and peeling of paint were observed in ceiling slab and beams at many locations. (PH 05 & PH 06)

iv. Severe cracks were observed in columns, beams and bottom of ceiling slab in many locations at internal side. (PH 07 -PH 10)

v. Spalling of cover concrete was observed in the columns, beams and bottom of ceiling slab internal side. (PH 07 -PH 10)

vi. Exposure of corroded rebars in the columns, beams and bottom of ceiling slab at internal side. (PH 07 -PH 10)

vii. Severe cracks were observed in beams and bottom of ceiling slab of cantilever region in many locations at external side. (PH 11 & 12)

viii. Spalling of cover concrete was observed beams and bottom of ceiling slab of cantilever region in many locations at external side. (PH 11 & 12)

ix. Exposure of corroded rebars were observed beams and bottom of ceiling slab of cantilever region in many locations at external side. (PH 11 & 12)

x. Growth of vegetation was observed at parapet wall (PH 13)

xi. Leakages, dampness, damp patches and peeling of paint were observed in bottom of ceiling slab at cantilever region. (PH 14)

Photographic Documentation

	
PH 01 - General View	PH 02 - General View

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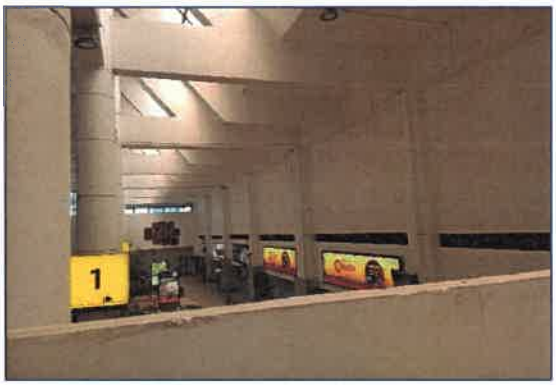	
PH 03 - General View	PH 04 - General View
	
PH 05 – Leakage and dampness in beams and slab in internal side	PH 06 - Severe spalling and exposure of corroded rebars in internal side
	
PH 07 – Cracks & exposure of corroded rebars in ceiling slab in internal side	PH 08 – Cracks & exposure of corroded rebars in internal side

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PH 09 - Cracks in columns and beams in internal side	PH 10 - Spalling of cover concrete and exposure of corroded rebars in internal side
	
PH 11 - Cracks in beams and slabs in external side	PH 12 - Spalling of cover concrete and exposure of corroded rebars in external side
	
PH 13 – Growth of vegetation on the RC members	PH 14 – Dampness in cantilever slab in external side

(Refer enclosed drawing for identification)

Second Floor

i. In second floor consisting office rooms and the most of the reinforced concrete (RC) members and partition walls shall be covered with POP false ceiling and cladding (PH 01 & 02).

ii. Cracks were observed in the bottom ceiling slab at few locations. (PH 03)

iii. Leakages were observed in the bottom of ceiling slab at cantilever region. (PH 04)

iv. Dampness, damp patches and peeling of paint were observed in the bottom of ceiling slab at cantilever region. (PH 04)

v. Window frames and glasses was observed to be damaged at many locations in external side. (PH 05)

vi. Growth of fungus were observed over the window frames and window glasses. (PH 06)

Photographic Documentation

PH 01 - General view

PH 02 - General view

PH 03 - Crack in ceiling slab

PH 04 – Leakages & dampness in ceiling slab

PH 05 - Damaged window frames

PH 06- Growth of fungus near window regions

(Refer enclosed drawing for floor identification)

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Terrace

i. Solar panels were observed to be provided at few regions. (PH 01 & 03)

ii. The structural steel roofing system provided (only for two bays) on the terrace to protect chiller's and other utility equipment's are found to be severely corroded and distressed (PH 05).

iii. The steel ladder's provided on roof top are found to be severally corroded. (PH 06)

iv. Bituminous water proofing membrane was observed to be provided for expansion joint (PH 07)

v. Temporary plastic sheet was observed to be provided over expansion joint to arrest water leakages (PH 08)

vi. Cracks were observed in the existing parapet walls at many locations. (PH 09 & 10)

vii. Growth of fungus /vegetation was observed over the WPC and parapet walls at many locations. (PH 11 & 12)

viii. Inadequate slope provided in the existing WPC for effective disposal of water during rains (PH 13).

ix. Water stagnation patches were observed over WPC at many locations (PH 13).

x. Deterioration of water proofing coting was observed at many locations. (PH 14)

Photographic Documentation

PH 03 - General Views	PH 04 - General Views
	
PH 05 – Severe corrosion was observed on structural steel members	PH 06 Corrosion on steel ladder
	
PH 07 – Bituminous water proofing membrane was observed at expansion joint region	PH 08 – Temporary sheet provided over expansion joint to arrest water leakage
	
PH 09 – Cracks in parapet wall	PH 10 – Cracks in parapet wall

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PH 11 – Growth of fungus over the WPC	PH 12 – Growth of vegetation over the WPC
	
PH 13 – Water stagnation dry patches	PH 14 – Deterioration of water proofing coat

1.2 RESULTS OF TESTS

In order to assess the extent of distress in the building, following assessment studies/tests were carried out at all the accessible regions:

1.2.1 The **Rebound Hammer test** was carried out on RC columns, beams & slabs at random. From the results of the Rebound Hammer test, it is observed that the strength of concrete near to surface in the tested regions of RC members is in the range of **16.0 N/sq.mm** to **23.0 N/sq.mm**. As per calibration chart developed for the above test instrument.

The details of test are tabulated in ***Table – 1.3.1*** and corresponding reference chart is appended in ***Table – 1.3.1A.***

Rebound Hammer Test is in Progress

1.2.2 The **Ultrasonic Pulse Velocity test** was conducted on RC columns, beams and slabs at random. From the results of the Ultrasonic Pulse Velocity test, it is observed that the quality grading of concrete in the tested RC members fall under the category of **"Doubtful to Good Concrete"** as per Table-1 of IS: 516 (Part 5/Sec 1): 2018 & Amendment No.1 November 2019.

The details of test are tabulated in ***Table - 1.3.2*** and corresponding quality grading chart is appended in ***Table - 1.3.2A.***

Ultrasonic Pulse Velocity Test is in Progress

1.2.3 The **Cover meter studies** were carried out on RC columns, beams & slabs at random. It is observed that the cover provided to the rebars are found to be **in order** in most of the tested RC members.

The details of test are tabulated in ***Table - 1.3.3.***

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Cover Meter Test is in Progress

1.2.4 The **Electro Chemical Half - Cell Potentiometer test** was carried out on RC columns, beams & slabs at random. From the results of the Half-Cell Potential test, the corrosion status of reinforcing bars in most of the tested RC members is found to be in **"Uncertainty of corrosion" (i.e., Moderate stage) to "High Probability of corrosion" (i.e., Advanced stage).**

The details of test are tabulated in ***Table – 1.3.4*** and corresponding reference chart is appended in ***Table – 1.3.4A***.

Half-Cell Potentail Measurment Test is in Progress

1.2.5 The **Carbonation test** was carried out on RC columns, beams & slabs at random. From the results of test, it is observed that the carbonation of concrete is confined to **10 mm to 15 mm.** Whereas, in ceiling slab of 1st floor and 2nd floor at leakage/concrete spalling region, it has reached reinforcement level and cover concrete has lost its alkalinity which is essential to protect the reinforcing bars against potential corrosion.

The details of test are tabulated in ***Table – 1.3.5.***

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Carbonation Test is in Progress

1.2.6 The **strength of in-situ concrete** of RC columns (6 no's) at random. From the results of the core tests observed that the strength of concrete in RC columns is found to be varying in the range of **14.74 N/sq.mm** to **20.17 N/sq.mm.**

The details of test are tabulated in ***Table – 1.3.6.***


Extraction of Concrete Core Samples is in Progress

1.2.7 The **Ultrasonic Thickness test** was carried out on structural steel members at random. From the results of test, it is inferred that there is no considerable reduction in thickness of existing steel members in spite of age and saline atmosphere.

1.2.8 The details of test are tabulated in ***Table – 1.3.7.***


Ultrasonic Thickness Test is in Progress

1.2.9 The **Concrete samples** were collected from the RC columns and tested in our laboratory for determination of following parameters:

The details of test are tabulated in ***Table – 1.3.8.***

1.2.10 The **Chloride Determination Test** was carried out on concrete estimate the level of chlorides in the concrete. From the results of chemical analysis on concrete samples it is inferred that the overall chloride in RC columns is found to be in the range of **0.67 Kg/Cu.m to 0.85 Kg/Cu.m** as against the permissible limit of 0.6 Kg/Cu.m as per standards.

The details of test are tabulated in ***Table –1.3.9.***

1.2.11 The **Sulphate determination Test** on concrete was carried out to estimate the level of sulphates in the concrete. From the results of sulphate content on RC members, it is observed that the sulphate content in RC members is found to be in the range **0.12 % to 0.35%** as against the permissible limit of 4% as per standards.

The details of test are tabulated in ***Table – 1.3.9.***

1.2.12 The **pH Test** was carried out on concrete. The pH value of concrete in the tested RC members are found to be in the range of **11.28 to 11.63** which is more than the desired level of **"not less than 10"**.

The details of test are tabulated in ***Table – 1.3.9.***

1.3 INFERENCES

Based on the detailed physical observations, results of non-destructive, semi-destructive and laboratory tests the following inferences are drawn;

a. The cracks in brick/block masonry parapet are mainly due to shrinkage and temperature effect.

b. Dampness/damp patches, growth of fungus and peeling of paint in masonry walls are essentially due to leakage/seepage of water during rains over a period of time.

c. Dampness, damp patches, leaching and leakages in ceiling slab of 2nd floor at cantilever region are essentially due to cracks in WPC, which has resulted in entry of water during rains subsequently dripping down from the slab.

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d. While finishing WPC, if proper gradient is not provided which may lead to stagnation of water during rains on WPC. Over a period of time these stagnated spots become blackish due to growth of fungus.

e. The distress observed in the structural steel roofing system and ladder is mainly due corrosion. The corrosion has been initiated on account of constant moist environment in view of locating chiller units and also saline atmosphere.

f. Cracks along the rebars, spalling of cover concrete, formation of scales and reduction in rebar dia in RC members are essentially due to corrosion of rebars. Corrosion of rebars in RC members is essentially due to poor quality of cover concrete, seepage of water from the floor/roof slab above over a prolonged period of time. Further the problem has further aggravated due to inadequate or no maintenance.

g. From the results of **Rebound Hammer test**, it is inferred that the in-situ strength of concrete near to surface in the tested RC members is in the range of **16.0 N/sq.mm** to **23.0 N/sq:mm**.

h. From the results of the Ultrasonic Pulse Velocity test, it is inferred that quality grading of concrete in the tested regions of RC column and beams falls under the category of **"Doubtful to Good Concrete"** as per IS 516 (Part 5 / Sec 1): 2018 & Amended No.1 in Nov 2019, indicating variation/non-uniformity of concrete at few of the tested regions due to presence of void and honeycombs in the concrete.

i. From the findings of **Cover meter scanning,** it is observed that the cover provided to the re-bars is found to be **in order** in most of the tested RC columns, beams and ceiling slab.

j. From the results of the **Half-Cell Potential test,** the corrosion status of reinforcing bars in the tested RC members is found to be in range of "Uncertainty of corrosion" (i.e., Moderate stage) to **"High probability of corrosion"** (i.e., Advanced stage of corrosion). In RC columns, beams and slabs at distressed regions of 1st and 2nd floor, the readings show **"High probability of corrosion"** (i.e., Advanced stage).

k. From the results of **Carbonation Test** indicate that the carbonation front in concrete has extended up to **10 mm to 15 mm** in majority of RC members. In severely distressed regions of beams and slabs at 1st and 2nd floor region and also cantilever beams and slab of 1st and 2nd floor, the carbonation has reached reinforcement level

and cover concrete has lost its alkalinity, which is essential to protect the reinforcing bars against potential corrosion.

l. From the results of the core tests, it is inferred that the in-situ compressive strength of concrete in RC columns is found to be in the range of **14.74 N/sq.mm to 20.17 N/sq.mm.**

m. From the results of **Chemical Tests** on concrete samples, it is inferred that the sulphate content and pH value are within the permissible limits. Whereas chloride content in tested sample of columns is higher than the permissible limit of **0.6 kg/cum**. Which indicates the chloride intrusion might have come from water / fine aggregates during construction stage or from the saline atmosphere over a period of time.

Based on the observations and results of various tests carried out, it is inferred that the structural members found to be **moderately distressed.**

1.4 CONCLUDING REMARKS

Based on the detailed assessment study, revealed that the existing structural members were not found to be up to the standard. This could be inherent problem or the age effect. In addition, the distress observed in few of the RC members has further impact on the structure durability.

In spite of above deficiency and distress, still the structure has performed all these years for the intended purpose.

Considering inherent problem, deficiency in construction, age factor and durability, it is not technically viable for up-gradation from the point of durability, meeting the present passenger's traffic and extended life.

In our opinion, reconstruction of the **Terminal T1** building to the present standards and requirement will be the best option from the point of durability and long life.

SHIVANNA B C
Dy. Manager

STEDRANT TECHNOCLINIC PVT. LTD.

SUDARSHAN S IYENGAR
Senior Director
(NDT, R & R Services)

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APPENDIX

Tables

Drawings

TABLES

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TABLE - 1.3.1
REBOUND HAMMER TEST RESULTS

Client	: **M/s. TRV (Kerala) International Airport Limited** Administrative Block, Thiruvananthapuram International Airport, Thiruvananthapuram - 695 008. Kerala State, India.
Project*	: Condition Assessment of existing Terminal Building (T1) of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.
Date/Period of test	: 14th August to 21st August.
Members tested	: RC Columns, Beams & Slabs.
Grade of concrete	: Unkown
Age of concrete*	: More than 28 days
Reason for test	: To ascertain the surface strength of in-situ concrete
Test conducted by	: Mr. Vinay N M - Engineer |NDT Mr. Rajesh M - Sr. Testing Assistant | NDT Mr. Kishor H B - Testing Assistant | NDT **M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.**
Test Witnessed by	: Mr. Shalin K - Associate Manager (E & M - Civil) Mr. Akshay R - Civil Engineer (E & M - Civil)
Test Instrument	: Schmidt Hammer, N Type.
Make & Sl. No	: M/s Proceq, Switzerland, Sl No 174920
Technical references	: Indian Standards IS: 516 (Part 5/Sec 4) : 2020

Sl. No.	Floor level / Location*	Structural Member/Grid Identification*	Position & Orientation	Average Rebound Number++	Remarks
1	Ground floor	RC Column - E/9	Horizontal	27	Refer Table-1.3.1A for Estimated Compressive strength range of in-situ concrete
2		RC Column - E/8	Horizontal	31	
3		RC Column - G/9	Horizontal	25	
4		RC Column - G/8	Horizontal	25	
5		RC Column - G/11	Horizontal	28	
6		RC Column - G/14	Horizontal	29	
7	Double Height	RC Beam - F/8-9	Horizontal	31	
8		RC Beam - E-F/9	Horizontal	31	
9		RC Beam - B-C/12'	Horizontal	31	
10		RC Beam - F-G/3	Horizontal	31	

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TABLE - 1.3.1
REBOUND HAMMER TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member/Grid Identification*	Position & Orientation	Average Rebound Number++	Remarks
11		RC Column - A/14	Horizontal	29	
12		RC Column - B/1-2	Horizontal	28	
13		RC Column - B/11	Horizontal	25	
14		RC Beam - A-B/11	Horizontal	26	
15		RC Beam - A-B/10	Horizontal	27	
16		RC Column - B/10	Horizontal	30	
17		RC Column - C/9	Horizontal	31	
18	First floor	RC Column - D/10	Horizontal	30	Refer Table-1.3.1A for Estimated Compressive strength range of in-situ concrete
19		RC Column - D/11	Horizontal	28	
20		RC Column - H/10	Horizontal	29	
21		RC Column - H/12	Horizontal	31	
22		RC Column - H/7	Horizontal	31	
23		RC Column - H/4	Horizontal	31	
24		RC Column - G/10	Horizontal	29	
25		RC Column - G/5	Horizontal	30	
26		RC Beam - B/1-2	Horizontal	27	
27		RC Slab A-B/13-14	Vertical Upwards	31	
28		RC Beam - A-B/12	Horizontal	29	
29		RC Beam - A-B/11	Horizontal	31	

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TABLE - 1.3.1
REBOUND HAMMER TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member/Grid Identification*	Position & Orientation	Average Rebound Number++	Remarks
30	First floor	RC Beam - A-B/10	Horizontal	30	Refer Table-1.3.1A for Estimated Compressive strength range of in-situ concrete
31		RC Slab - A-B/9-10	Vertical Upwards	27	
32		RC Beam - B/7-9	Horizontal	28	
33		RC Beam - A-B/4	Horizontal	30	
34		RC Slab - A-B/1-2	Vertical	30	

**Drawing No: STPL/NDT/2023-218/TRV/01-03 for grid identification.

++ After applying necessary correction factors for the direction of impact

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NOTE:

(i) The Results relate only to the members tested.

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(iii) Any corrections invalidates this report.

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TABLE - 1.3.1A
REFERENCE STRENGTH CHART FOR REBOUND HAMMER TEST

Instrument : Schmidt Hammer, N Type

Sl. No : 174920

Make : M/s Proceq, Switzerland

REBOUND HAMMER NUMBER	ESTIMATED COMPRESSIVE STRENGTH RANGE (N/Sq.mm)
22 to 25	12 to 16
26 to 29	17 to 21
30 to 33	22 to 26
34 to 37	27 to 31
38 to 41	32 to 36
42 to 45	37 to 41
46 to 49	42 to 45
50 and above	>45

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Note:

1 Estimated compressive strength is worked out based on the Calibration Chart developed for the above test instrument in our laboratory.

2 As per clause 8.1 of Indian Standards IS: 516 (Part5/Sec4):2020, the estimation of strength of concrete by rebound hammer method cannot be held to be very accurate and probable accuracy of prediction of concrete strength in a structure is ± 25 percent.

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TABLE - 1.3.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Client	:	**M/s. TRV (Kerala) International Airport Limited** Administrative Block, Thiruvananthapuram International Airport, Thiruvananthapuram - 695 008. Kerala State, India.
Project*	:	Condition Assessment of existing Terminal Building (T1) of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.
Period of test	:	14th August to 21st August.
Members tested*	:	RC Columns, Beams.
Grade of concrete	:	Unkown
Age of concrete*	:	More than 28 days
Reason for test	:	To ascertain the quality/uniformity of in-situ concrete
Test conducted by	:	Mr. Vinay N M - Engineer | NDT Mr. Rajesh M - Sr. Testing Assistant | NDT Mr. Kishor H B - Testing Assistant | NDT **M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.**
Test Witnessed by	:	Mr. Shalin K - Associate Manager (E & M - Civil) Mr. Akshay R– Civil Engineer (E & M - Civil)
Test Instrument	:	PUNDIT LAB+ (Portable Ultrasonic Non-destructive Digital Indicating Tester)
Make & Sl. No	:	M/s. Proceq - Switzerland, PL02-004-0393 C0
Technical references	:	Indian Standards IS: 516 (Part 5/Sec 1) : 2018

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
1	Ground floor	RC Column E/8	EL - 300	3.37	3.5	Direct Method 31°C	Refer Table-1.3.2A for Concrete Quality Grading Chart
			EL - 600	3.41			
			EL - 900	3.55			
			EL - 1200	3.59			
			EL - 1500	3.59			
			EL - 1800	3.70			
			EL - 2100	3.24			
2		RC Column G/7	EL - 300	3.16	3.7		
			EL - 600	3.82			
			EL - 900	3.95			
			EL - 1200	4.00			
			EL - 1500	3.75			

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TABLE - 1.3.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
3	Ground floor	RC Column E/9	EL - 300	3.55	3.4	Direct Method 31°C	Refer Table-1.3.2A for Concrete Quality Grading Chart
			EL - 600	3.35			
			EL - 900	3.37			
			EL - 1200	3.61			
			EL - 1500	3.33			
			EL - 1800	3.30			
4		RC Column G/8	EL - 300	2.22	2.8		
			EL - 600	2.27			
			EL - 900	3.57			
			EL - 1200	2.42			
			EL - 1500	3.28			
5		RC Column H/5	EL - 300	2.14	2.6		
			EL - 600	2.42			
			EL - 900	3.13			
			EL - 1200	2.65			
6		RC Column H/7	EL - 300	3.55	3.4		
			EL - 600	3.41			
			EL - 900	3.70			
			EL - 1200	3.11			
			EL - 1500	3.08			
7		RC Column H/11	EL - 300	2.98	2.9		
			EL - 600	2.97			
			EL - 900	2.97			
			EL - 1200	2.97			
			EL - 1500	2.91			
			EL - 1800	2.67			
			EL - 2100	2.61			
8		RC Column H/12	EL - 300	4.09	4.4		
			EL - 600	4.14			
			EL - 900	4.64			
			EL - 1200	4.64			
			EL - 1500	4.48			
9	Double Height	RC Beam F/8-9	EL - 300	1.76	2.4	In-Direct Method 29°C	
				1.74			
				3.26			
				3.37			
				2.14			
				2.07			

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TABLE - 1.3.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
10	Double Height	RC Beam E-F/9	EL - 300	1.96	1.9	In-Direct Method 29°C	
				1.99			
				1.96			
				1.95			
				1.79			
				1.76			
11		RC Beam B-C/12'	EL - 300	3.81	3.9		
				4.08			
				3.33			
				3.60			
				3.85			
				3.85			
				4.35		Direct Method 31°C	Refer Table 1.3.2A for Concrete Quality Grading Chart
				4.12			
12		RC Beam F-G/3	EL - 300	3.70	3.6		
				3.67			
				3.39			
				3.67			
				3.70			
				3.51			
				3.60			
				3.60			
13	First floor	RC Column B/13	EL - 800	4.44	4.2		
			EL - 1100	4.20			
			EL - 1400	4.11			
			EL - 1700	4.17			
			EL - 2000	4.23			
14		RC Column B/11	EL - 800	4.15	4.1		
			EL - 1100	4.03			
			EL - 1400	3.97			
			EL - 1700	4.21			

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TABLE - 1.3.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
15	First floor	RC Column B/7	EL - 800	3.95	3.5	Direct Method 29°C	Refer Table 1.3.2A for Concrete Quality Grading Chart
			EL - 1100	3.26			
			EL - 1400	3.21			
			EL - 1700	3.53			
			EL - 2000	3.75			
16		RC Column B/5	EL - 800	4.29	4.2		
			EL - 1100	4.26			
			EL - 1400	4.17			
			EL - 1700	4.29			
			EL - 2000	4.11			
17		RC Column B/3	EL - 800	4.14	4.1		
			EL - 1100	4.17			
			EL - 1400	4.17			
			EL - 1700	4.14			
			EL - 2000	4.08			
18		RC Column B/2	EL - 800	3.87	3.8		
			EL - 1100	3.75			
			EL - 1400	3.90			
			EL - 1700	3.82			
			EL - 2000	3.87			

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TABLE - 1.3.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
19		RC Beam A-B/15	EL - 150	4.04	4.2		
				4.17			
				4.12			
				4.30			
				4.26			
				4.17			
20		RC Beam A-B/13	EL - 150	3.64	4.0		
				4.08			
				4.04			
				4.08			
	First floor			4.00		Direct Method 29°C	Refer Table-1.3.2A for Concrete Quality Grading Chart
21		RC Beam A-B/11	EL - 150	2.74	3.6		
				3.76			
				3.71			
				3.86			
				3.71			
22		RC Beam A-B/9	EL - 150	3.81	3.5		
				3.54			
				3.39			
				3.36			
				3.42			
23		RC Beam A-B/7	EL - 150	3.57	3.6		
				3.74			
				3.60			
				3.67			
				3.54			
24		RC Beam A-B/5	EL - 150	4.08	4.0		
				3.85			
				4.04			
				3.81			
				4.08			

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TABLE - 1.3.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
25		RC Beam A-B/3	EL - 150	3.74	3.7		
				3.67			
				3.67			
				3.77			
				3.64			
26		RC Beam A/2-3	EL - 150	4.17	4.0		
				4.00			
				3.96			
				4.00			
				4.00			
		RC Beam A-B/2		4.12			
				4.12			
27	First floor		EL - 150	4.21	4.1	Direct Method 29°C	Refer Table 1.3.2A for Concrete Quality Grading Chart
				4.00			
				4.00			
28		RC Beam A-B/1'	EL - 150	3.03	2.5		
				2.94			
				2.50			
				2.00			
				2.27			
29		RC Beam C-D/15	EL - 150	4.40	4.3		
				4.30			
				4.40			
				4.40			
				4.40			
				4.21			
30		RC Column C/15	EL - 300	4.08	4.3		
			EL - 600	4.40			
			EL - 900	4.21			
			EL - 1200	4.60			
			EL - 1500	4.44			
			EL - 1800	4.44			
			EL - 2100	4.04			

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TABLE - 1.3.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
31	First floor	RC Column D/15	EL - 300	4.03	4.0	Direct Method 29°C	Refer Table 1.3.2A for Concrete Quality Grading Chart
			EL - 600	4.00			
			EL - 900	3.87			
			EL - 1200	4.05			
			EL - 1500	3.97			
			EL - 1800	4.08			
32		RC Column D/14	EL - 300	4.17	4.1		
			EL - 600	3.92			
			EL - 900	4.00			
			EL - 1200	4.00			
			EL - 1500	4.21			
			EL - 1800	4.21			
33		RC Column D/11	EL - 300	3.87	3.8		
			EL - 600	3.95			
			EL - 900	3.73			
			EL - 1200	3.92			
			EL - 1500	3.70			
			EL - 1800	3.82			
34		RC Column D/9	EL - 300	4.40	4.0		
			EL - 600	4.35			
			EL - 900	3.64			
			EL - 1200	4.26			
			EL - 1500	3.67			
			EL - 1800	3.51			
35		RC Beam D/13-14	EL - 300	4.04	4.0		
			EL - 600	3.74			
			EL - 900	4.08			
			EL - 1200	4.12			

**Drawing No: STPL/NDT/2023-218/TRV//01-03 for grid identification.

NOTE:

(i) The Results relate only to the members tested.

(ii) Report shall not be reproduced, except in full, without the written approval of the laboratory

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TABLE - 1.3.2A

REFERENCE QUALITY GRADING CHART FOR ULTRASONIC PULSE VELOCITY TEST

Pulse Velocity (Km/sec)	Concrete Quality Grading
For Concrete (≤ M 25)	
Below 3.50	Doubtful
3.50 to 4.50	Good
Above 4.50	Excellent
For Concrete (> M 25)	
Below 3.75	Doubtful
3.75 to 4.50	Good
Above 4.50	Excellent

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Note:

Concrete quality grading for different velocity criterion as reproduced from Amendment No.1 November 2019 to IS 516 (Part 5/Sec 1): 2018, (Page 4, Table 1).

In case of "**Doubtful quality**", it may be necessary to carry out further testing.

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TABLE - 1.3.3
COVER METER TEST RESULTS

Client	:	**M/s. TRV (Kerala) International Airport Limited** Administrative Block, Thiruvananthapuram International Airport, Thiruvananthapuram - 695 008. Kerala State, India.
Project*	:	Condition Assessment of existing Terminal Building (T1) of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.
Date/Period of test	:	14th August to 21st August.
Grade of concrete	:	Unkown
Members tested	:	RC Columns & Beams.
Age of concrete*	:	More than 28 days
Reason for test	:	To assess the thickness of cover concrete provided to the rebars
Test conducted by	:	Mr. Vinay N M - Engineer | NDT Mr. Rajesh M - Sr. Testing Assistant | NDT Mr. Kishor H B - Testing Assistant | NDT **M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.**
Test witnessed by	:	Mr. Shalin K - Associate Manager (E & M - Civil) Mr. Akshay R - Civil Engineer (E & M - Civil)
Test Instrument	:	Profometer – 6, Version 600
Make & Sl. No	:	M/s. Proceq, Switzerland Sl No. UP01-002-1329
Technical Reference	:	BS: 1881 - (Part 204) & Test Instrument

Sl. No.	Floor level / Location*	Structural Member / Grid Identification*	Range of Cover Concrete (mm)
1	Ground floor	RC Column - H/10	35 to 46
2		RC Column - H/6	42 to 50
3		RC Column - G/11	35 to 42
4		RC Column - H/12	42 to 50
5		RC Column - G/8	40 to 45
6		RC Column - G/12	36 to 44
		RC Column - G/7	39 to 45
7		RC Column - H/5	35 to 45
8	Double Height	RC Beam - F/8-9	40 to 50
9		RC Beam - E-F/9	38 to 50
10		RC Beam - B-C/12'	35 to 45
11		RC Beam - F-G/3	40 to 50

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TABLE - 1.3.3
COVER METER TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification*	Range of Cover Concrete (mm)
12	First floor	RC Column - B/15	35 to 45
13		RC Column - B/11	40 to 44
14		RC Column - B/4	45 to 50
15		RC Beam - A-B/10	32 to 40
16		RC Beam - A-B/7	30 to 36

**Drawing No: STPL/NDT/2023-218/TRV/01-03 for grid identification.

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NOTE:

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TABLE - 1.3.4
HALF-CELL POTENTIAL DIFFERENCE TEST RESULTS

Client	:	**M/s. TRV (Kerala) International Airport Limited** Administrative Block, Thiruvananthapuram International Airport, Thiruvananthapuram - 695 008. Kerala State, India.
Project*	:	Condition Assessment of existing Terminal Building (T1) of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.
Members tested*	:	RC Columns
Period of test	:	14th August to 21st August.
Test conducted by	:	Mr. Vinay N M - Engineer | NDT Mr. Rajesh M - Sr. Testing Assistant | NDT Mr. Kishor H B - Testing Assistant | NDT **M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.**
Test witnessed by	:	Mr. Shalin K - Associate Manager (E & M - Civil) Mr. Akshay R - Civil Engineer (E & M - Civil)
Test Instrument	:	Electro Chemical half-cell Potential Tube & Digital Multimeter
Make	:	Mastech, India
Technical references	:	As per ASTM C 876 – 91 (Reapproved 1999)

SL. No.	Structural Member	Grid Identification**	Half Cell Measurements Measured potential difference (mV)	Remarks
1	Ground floor	RC Column - H/12	-220 to -280	Refer Table - 1.3.4A for Probability of corrosion
2		RC Column - H/7	-210 to -230	
3		RC Column - H/4	-200 to -240	
4		RC Column - G/10	-240 to -260	
5	First floor	RC Column - B/15	-250 to -300	
6		RC Column - B/11	-200 to -220	
7		RC Column - B/4	-230 to -250	
8		RC Column - B/9	-240 to -270	
9		RC Beam - A-B/11	-210 to -250	
10		RC Beam - C-D/15	-240 to -272	
11		RC Beam - D/12-13	-220 to -255	
12		RC Beam - A-B/7	-230 to -250	
13		RC Slab - BC/ 5-6	-362 to -482	
14		RC Slab - BC/ 6-7	-345 to -456	
15		RC Slab - A-B/7	-356 to -446	

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TABLE - 1.3.4
HALF-CELL POTENTIAL DIFFERENCE TEST RESULTS

SL. No.	Structural Member	Grid Identification**	Half Cell Measurements Measured potential difference (mV)	Remarks
16	2nd Floor	RC Cantilever Beam - H/7	-359 to -442	Refer Table - 1.3.4A for Probability of corrosion
17		RC Cantilever Beam - H/13	-332 to -426	
18		RC Cantilever Slab b/w - H/13 & H/12	-362 to -473	

**Refer Drawing No: STPL/NDT/2023-218/TRV/01-03 for grid identification

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NOTE:

(i) The Results relate only to the members tested.

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TABLE - 1.3.4A

REFERENCE CHART FOR HALF CELL POTENTIAL DIFFERENCE MEASUREMENT TEST

SL. No.	Measured Potential Difference	Probability of Corrosion
1	More positive than (-) 200 mv	High probability of No corrosion (i.e Initial stage)
2	Between (-) 200 mv to (-) 350 mv	Uncertainty of corrosion (i.e moderate stage)
3	More negative than (-) 350 mv	High probability of corrosion (i.e advanced stage)

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TABLE - 1.3.5
CARBONATION TEST RESULTS

Client : **M/s. TRV (Kerala) International Airport Limited**
Administrative Block, Thiruvananthapuram International Airport,Thiruvananthapuram - 695 008.
Kerala State, India.

Project* : Condition Assessment of existing Terminal Building (T1) of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.

Members tested* : RC Columns & Beams.

Period of test : 14th August to 21st August.

Test conducted by : Mr. Vinay N M - Engineer | NDT
Mr. Rajesh M - Sr. Testing Assistant | NDT
Mr. Kishor H B - Testing Assistant | NDT
M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.

Test witnessed by : Mr. Shalin K - Associate Manager (E & M - Civil)
Mr. Akshay R - Civil Engineer (E & M - Civil)

Chemical used for : Dilute Alcohol added with Phenolphthalein

Technical references : BS EN: 14630-2006

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Carbonation Level
1	First floor	RC Column - B/14	Carbonation upto 10mm
2		RC Beam - A-B/14	Carbonation upto 10mm
3		RC Column - B/12	Carbonation upto 12 mm
4		RC Beam - A-B/12	Carbonation upto 15mm
5		RC Column - B/15	Carbonation upto15 mm
6		RC Column - B/11	Carbonation upto 15 mm
7		RC Column - B/4	Carbonation upto 15 mm
8		RC Slab - BC/ 5-6	Up to rebar level
9		RC Slab - BC/ 6-7	Up to rebar level
10		RC Slab - BC/7-8	Up to rebar level

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TABLE - 1.3.5
CARBONATION TEST RESULTS

11	2nd Floor	RC Cantilever Beam - H/7	Up to rebar level
12		RC Cantilever Beam - H/13	Up to rebar level
13		RC Cantilever Slab b/w - H/13 & H/12	Up to rebar level

**Drawing No: STPL/NDT/2023-218/TRV/01-03 for grid identification.

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NOTE:

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TABLE - 1.3.6
CONCRETE CORE TEST RESULTS

Client : **M/s. TRV (Kerala) International Airport Limited**
Administrative Block, Thiruvananthapuram International Airport,Thiruvananthapuram - 695 008.
Kerala State, India.

Project* : Condition Assessment of existing Terminal Building (T1) of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.

Core extracted from : RC Columns.

Date of Cores Extracted : 19th August & 20th August 2023.

Date of Test : 25th August 2023.

Grade of Concrete : Unkown

Age of concrete* : More than 28 days

Capping material used : EPCO KP 350 (PART A) & EPCO HP 350 (PART B) from M/s. Krishna Conchem Products Pvt. Ltd.,

Technical references : IS: 456-2000 (Reaffirmed in 2021) and IS:516 (Part 4): 2018

Core Nos.	Member Identification**	Core Length** * (l) (mm)	Core Dia (d) (mm)	Core Wt.*** (Kg.)	C/S Area (Sq.mm)	Density of concrete (Kg/Cu.m)	Failure load (kN)	Core Comp. Strength# (N/sq.mm)	l/d Ratio	Correction factor for (l/d) ratio+	Corrected Cyl. Comp Strength (N/sq.mm)	Equivalent Cube Comp. Strength ++ (N/sq.mm)
Ground Floor												
1	RC Column - H/11	123.36	64	0.89	3217	2234.82	48.24	15.89	1.93	0.99	15.76	19.70
2	RC Column - H/10	73.92	64	0.48	3217	2035.06	50.15	16.52	1.16	0.91	14.98	18.73
3	RC Column - H/8	80.12	64	0.49	3217	1916.37	39.00	12.85	1.25	0.92	11.79	14.74

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TABLE - 1.3.6
CONCRETE CORE TEST RESULTS

First Floor												
4	RC Column - B/15	82.41	64	0.58	3217	2179.93	53.16	17.51	1.29	0.92	16.14	20.17
5	RC Column - B/11	122.60	64	0.94	3217	2390.64	48.25	15.89	1.92	0.99	15.74	19.68
6	RC Column - B/4	123.50	64	0.94	3217	2370.71	45.28	14.91	1.93	0.99	14.80	18.50

Type of Failure in the tested core samples -Typical compressive failure

** Refer enclosed drawing STPL/NDT/2023-218/TRV/01-03 for grid identification.

*** Core length and core weight after trimming and capping.

After applying correction factor for diameter of core which is less than 70 mm (strength of core x 1.06) and for 75 mm ± 5mm (strength of core x 1.03) as per Cl.8.4.1 of IS 516 (Part 4): 2018

+ For l/d ratio, correction factors are as per Cl. 8.4.2 of IS 516 (Part 4): 2018.

++ Equivalent cube compressive strength = 1.25 x corrected cylinder compressive strength as per Cl. 8.4.2 of IS 516 (Part 4): 2018.

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TABLE - 1.3.7
RESULTS OF ULTRASONIC THICKNESS MEASUREMENT

Client* : **M/s. TRV (Kerala) International Airport Limited**
Administrative Block, Thiruvananthapuram International Airport,
Thiruvananthapuram - 695 008.
Kerala State, India.

Project* : Condition Assessment of existing Terminal Building (T1) of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.

Members tested : Steel members of Structural steel.

Date of test : 21st August 2023.

Test conducted by : Mr. Vinay N M - Engineer | NDT
Mr. Rajesh M - Sr. Testing Assistant | NDT
Mr. Kishor H B - Testing Assistant | NDT
M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.

Test witnessed by : Mr. Shalin K - Associate Manager (E & M - Civil)
Mr. Akshay R - Civil Engineer (E & M - Civil)

Test Instrument : Ultrasonic Thickness guage - EDISON-1

Make : M/s. Modsonic,

Technical Reference : IS 15435 : 2003 (Reaffirmed Year : 2020)

Sl. No.	Floor level / Location*	Structural Member / Grid Identification*	Measured Thicknesss (mm)
1	Ground floor	Main Truss Bottom Chord	5.00
		Main Truss Top Chord	5.00
2		Main Truss Inclined member	3.00
3		Main Truss Vertical member	3.00
4		Secondary Truss Bottom chord	3.00
5		Secondary Truss Top chord	3.00
6		Purlins	3.00

*Refer enclosed Drawing No: STPL/NDT/2023-218/TRV/04 for grid identification

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NOTE:

(i) The Results relate only to the joints tested.

(ii) Report shall not be reproduced, except in full, without the written approval of the laboratory

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Table - 1.3.8

Results of Chemical Analysis of Concrete sample

Client : **M/s. TRV (Kerala) International Airport Limited**
Administrative Block, Thiruvananthapuram International Airport,Thiruvananthapuram - 695 008.
Kerala State, India.

*Project** : Condition Assessment of existing Terminal Building (T1) of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.

*Members tested** : Concrete samples collected from identified regions of RC columns.

Period of test : 25.08.2023 to 28.08.2023.

Technical references : IS: 14959 (Part 2) 2001 RA 2016 for chlorides, BS 1881 Part 124 1988 for Sulphate and IS 2720 (Part 26) 1987 RA 2016 for pH

Sl. No.	Floor level / Location/Structural Member/Id*	Chloride Content (Kg/Cum)	Sulphate Content SO_3 (%) by mass	pH Value	Requirements
1	RC Column - H/11	0.85	0.35	11.28	As per Cl: 8.2.5.2 Table-7, of IS: 456-2000 limits of acid **soluble chloride content** in reinforced concrete or plain concrete containing embedded metal should not exceed 0.6 kg/Cu.m As per Cl: 8.2.5.3 of IS: 456-2000 The total water soluble sulphate content of the concrete mix expressed as SO3 should not exceed 4% by mass of the cement in the mix **pH** preferably shall not be less than 10 as per studies carried out
2	RC Column - B/4	0.75	0.17	11.39	
3	RC Column - B/15	0.67	0.12	11.63	

* Refer enclosed drawing no STPL/NDT/2023-218/TRV/01-03 for grid identification

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NOTE:

(i) The Results relate only to the members tested.
(ii) Report shall not be reproduced, except in full, without the written approval of the laboratory
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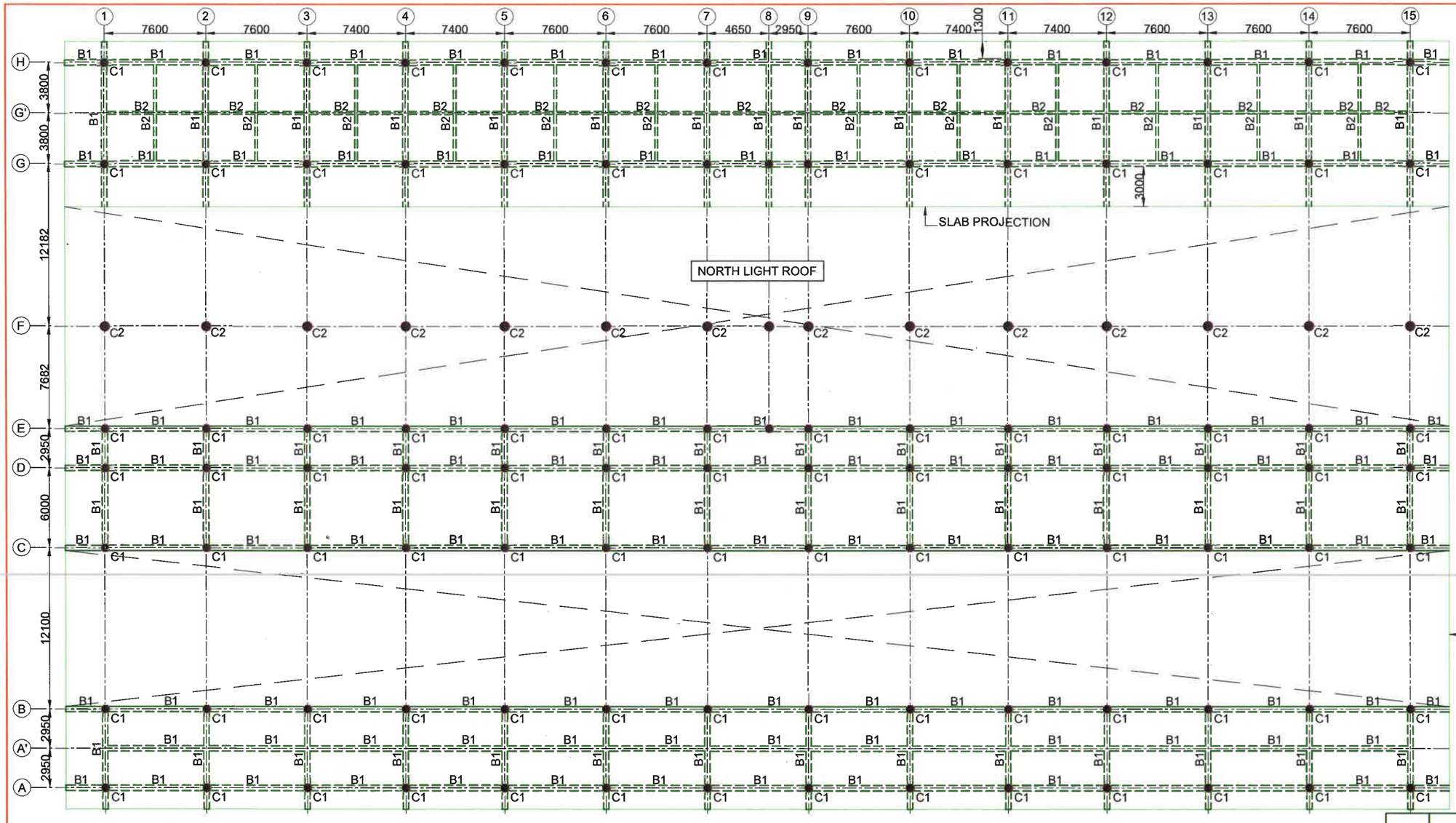
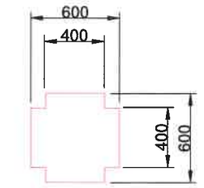
******

DRAWINGS





COLUMN C1

CIRCULAR COLUMN C2

BEAMS
B1(400X650)
B2(200X650)

NOTES :-

1. ALL DIMENSIONS ARE IN mm
2. FOLLOW WRITTEN DIMENSIONS ONLY.
3. IF ANY DISCREPANCY FOUND IN THE DRAWING, IT SHALL BE BROUGHT TO THE NOTICE OF THE CONSULTANT BEFORE EXECUTION.

REV.NO.	DATE	DESCRIPTION	REMARKS

CONSULTANTS:-

STEDRANT TECHNOCLINIC PVT. LTD.
"Sunvak Pride", # 95, Model House Street,
Basavanagudi, Bengaluru - 560 004
Tel. : 080-26629992.

STEDRANT TECHNOCLINIC PVT. LTD.

PROJECT:-

CONDITION ASSESSMENT OF EXISTING TERMINAL (T1) BUILDING OF THIRUVANANTHAPURAM INTERNATIONAL AIRPORT (TIAL) AT THIRUVANANTHAPURAM, KERALA.

DWN	SHIVA.B
FIELD INVST. BY	V.N.M
CHK	S.B.C
APPVD	S.S

CLIENT:-

M/s. TRV (KERALA) INTERNATIONAL AIRPORT LIMITED ADMINISTRATIVE BLOCK, THIRUVANANTHAPURAM INTERNATIONAL AIRPORT,THIRUVANANTHAPURAM-695 008. KERALA STATE, INDIA.

REPORT No: 218

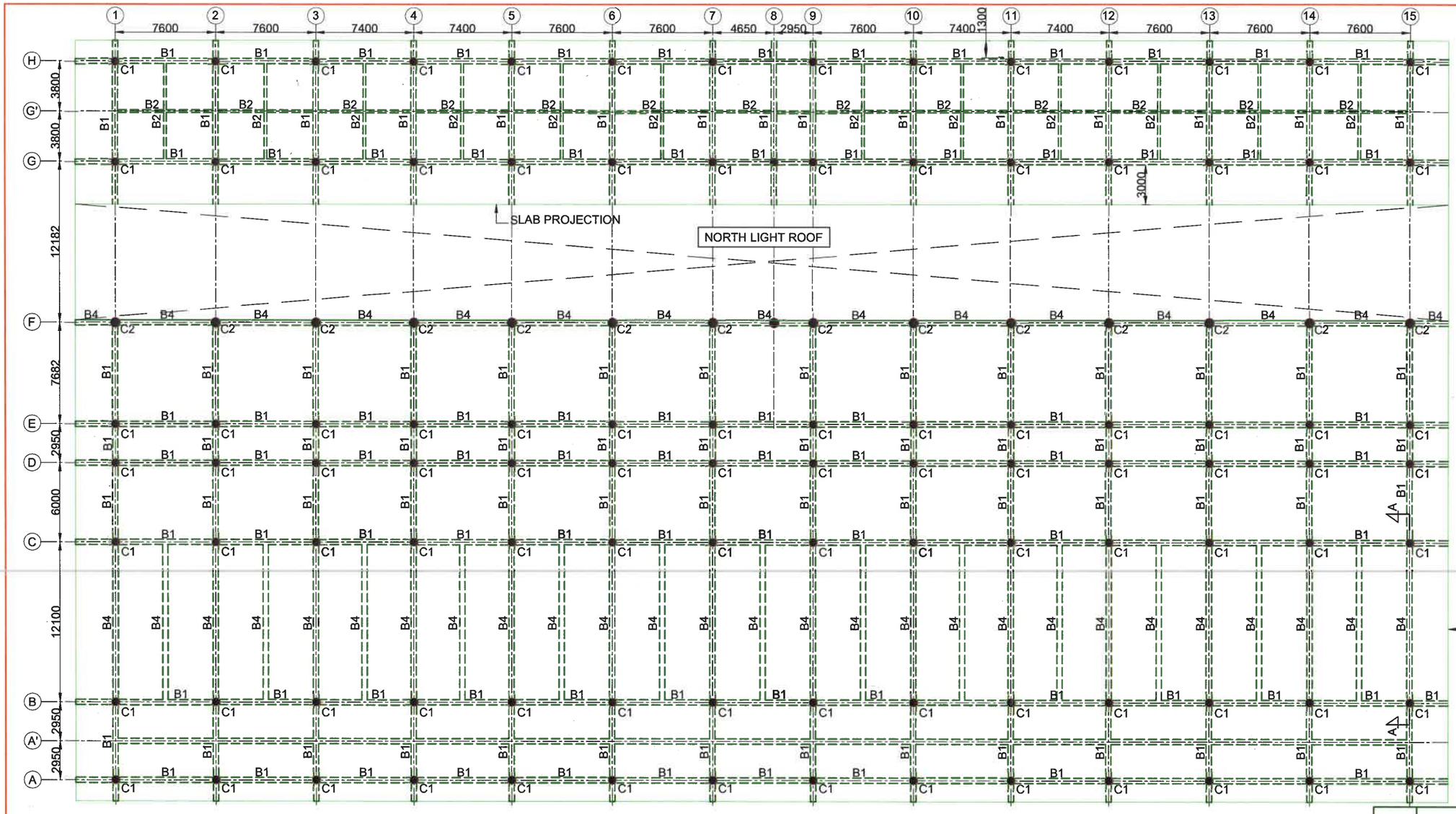
PAGE.No: 54a

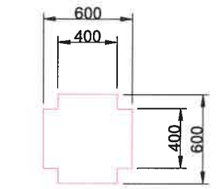
TITLE:-

EXISTING COLUMN & BEAM LAYOUT OF GROUND FLOOR CEILING LEVEL (TERMINAL BUILDING)

Rev No:

SCALE	DATE	Dwg.No
N.T.S	26-08-2023	STPL/NDT/2023-218/TRV/01

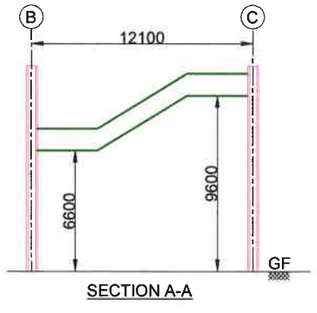




COLUMN C1

CIRCULAR COLUMN C2

BEAMS
B1(400X650)
B2(200X650)
B4(400X1200)



SECTION A-A

NOTES :-

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CONSULTANTS:-

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"Sunvak Pride", # 95, Model House Street,
Basavanagudi, Bengaluru - 560 004
Tel. : 080-26629992.

STEDRANT TECHNOCLINIC PVT. LTD. STPL

PROJECT:-
CONDITION ASSESSMENT OF EXISTING TERMINAL (T1) BUILDING OF THIRUVANANTHAPURAM INTERNATIONAL AIRPORT (TIAL) AT THIRUVANANTHAPURAM, KERALA.

DWN	SHIVA.B
FIELD INVST. BY	V.N.M
CHK	S.B.C
APPVD	S.S

CLIENT:-
M/s. TRV (KERALA) INTERNATIONAL AIRPORT LIMITED ADMINISTRATIVE BLOCK, THIRUVANANTHAPURAM INTERNATIONAL AIRPORT,THIRUVANANTHAPURAM-695 008. KERALA STATE, INDIA.

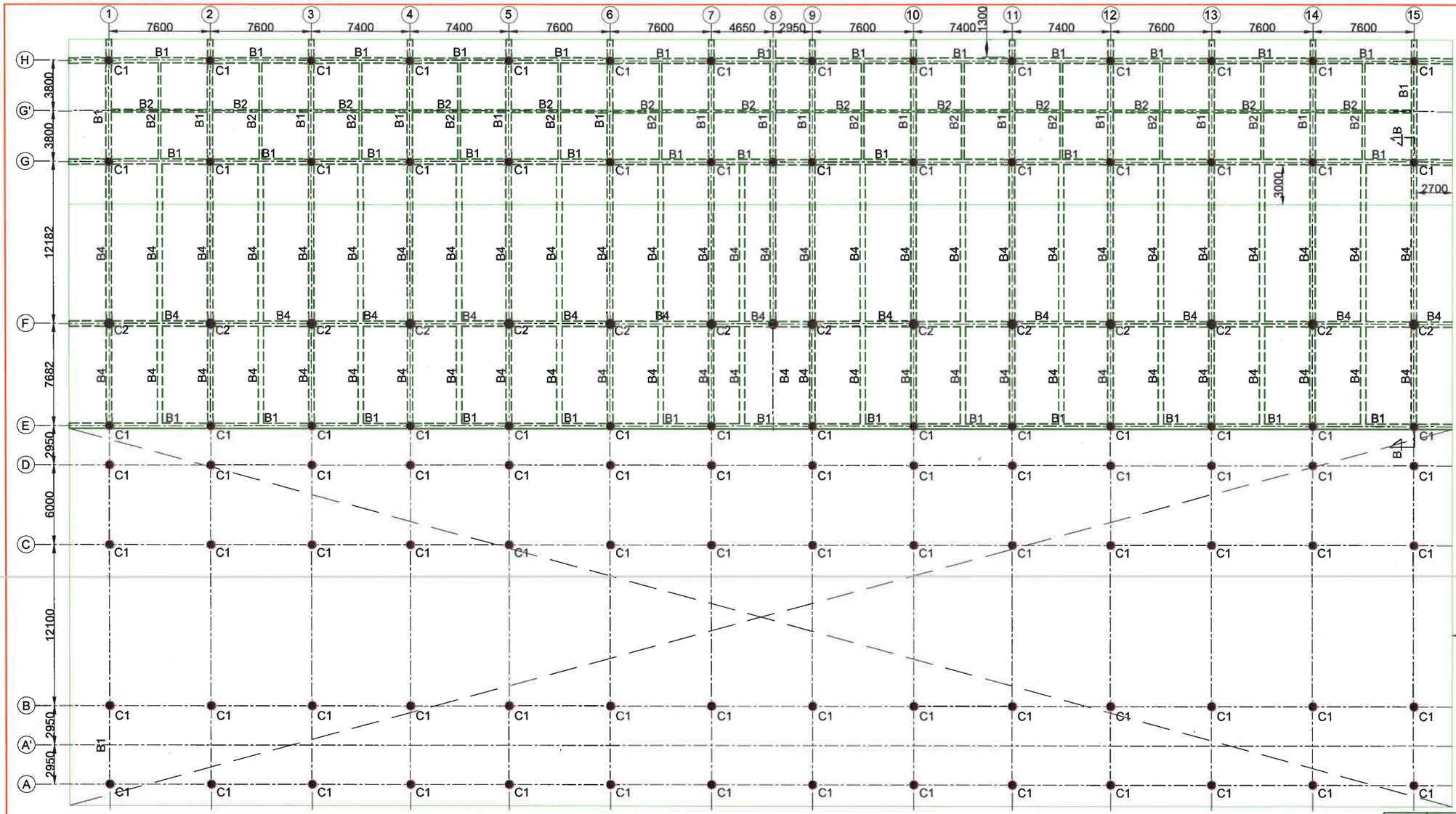
REPORT No: 218

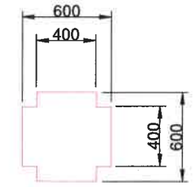
PAGE.No: 54b

TITLE:-
EXISTING COLUMN & BEAM LAYOUT OF FIRST FLOOR CEILING LEVEL (TERMINAL BUILDING)

Rev No:

SCALE	DATE	Dwg.No
N.T.S	26-08-2023	STPL/NDT/2023-218/TRV/02

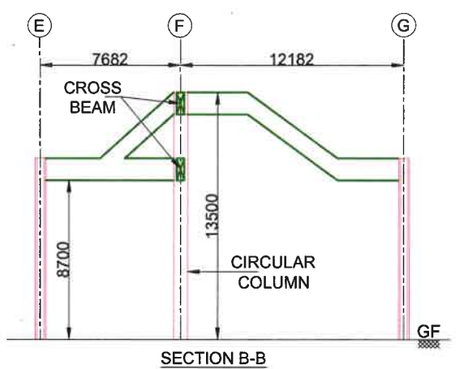




COLUMN C1

CIRCULAR COLUMN C2

BEAMS
B1(400X650)
B2(200X650)
B4(400X1200)



SECTION B-B

NOTES :-

1. ALL DIMENSIONS ARE IN mm
2. FOLLOW WRITTEN DIMENSIONS ONLY.
3. IF ANY DISCREPANCY FOUND IN THE DRAWING, IT SHALL BE BROUGHT TO THE NOTICE OF THE CONSULTANT BEFORE EXECUTION.

REV.NO.	DATE	DESCRIPTION	REMARKS

CONSULTANTS:-

STEDRANT TECHNOCLINIC PVT. LTD.

"Sunvak Pride", # 95, Model House Street,
Basavanagudi, Bengaluru - 560 004
Tel. : 080-26629992.

PROJECT:-

CONDITION ASSESSMENT OF EXISTING TERMINAL (T1) BUILDING OF THIRUVANANTHAPURAM INTERNATIONAL AIRPORT (TIAL) AT THIRUVANANTHAPURAM, KERALA.

DWN	SHIVA.B
FIELD INVST. BY	V.N.M
CHK	S.B.C
APPVD	S.S

CLIENT:-

M/s. TRV (KERALA) INTERNATIONAL AIRPORT LIMITED ADMINISTRATIVE BLOCK, THIRUVANANTHAPURAM INTERNATIONAL AIRPORT,THIRUVANANTHAPURAM-695 008. KERALA STATE, INDIA.

REPORT No: 218

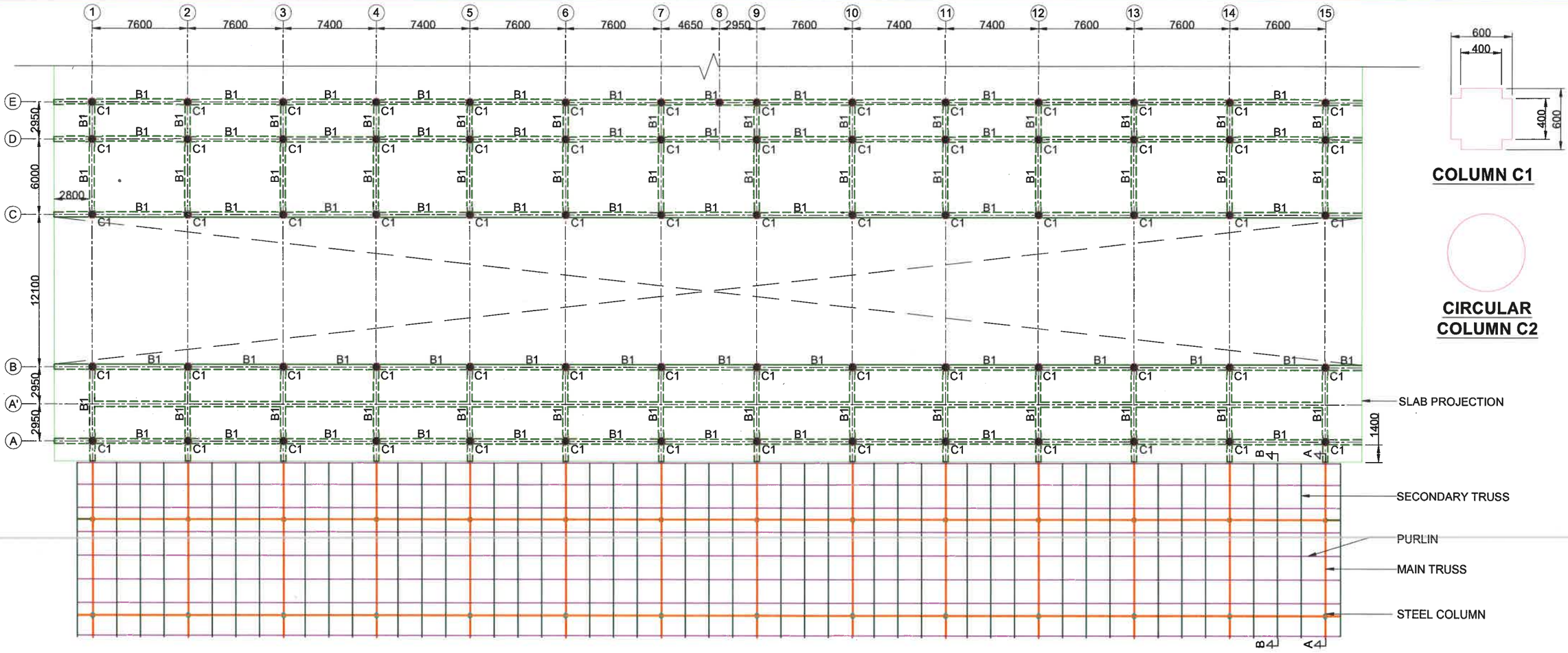
PAGE.No: 54c

TITLE:-

EXISTING COLUMN & BEAM LAYOUT OF SECOND FLOOR CEILING LEVEL (TERMINAL BUILDING)

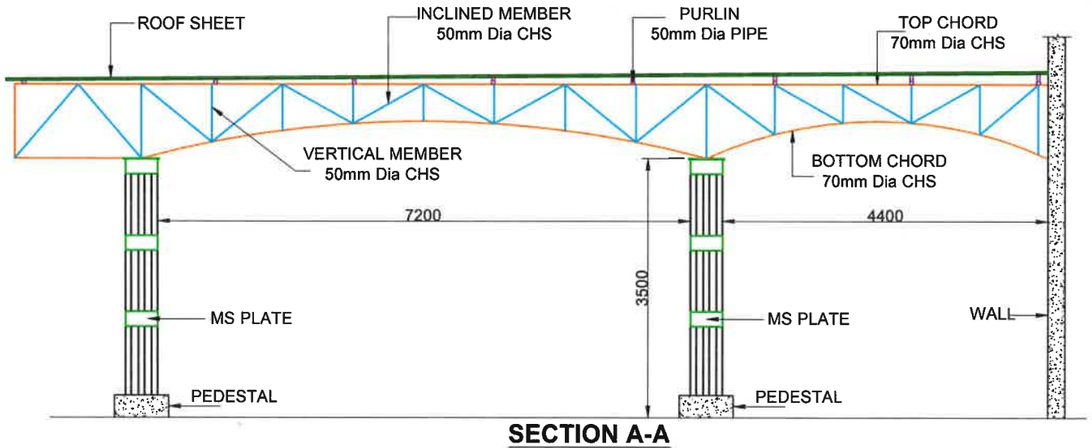
Rev No:

SCALE	DATE	Dwg.No
N.T.S	26-08-2023	STPL/NDT/2023-218/TRV/03

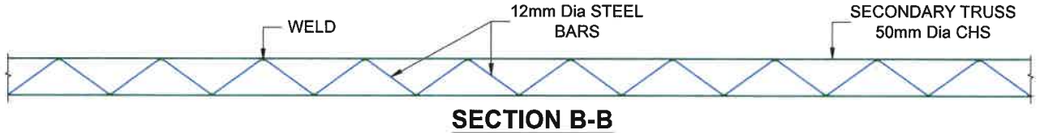


COLUMN C1

CIRCULAR COLUMN C2



SECTION A-A



SECTION B-B

NOTES :-

1. ALL DIMENSIONS ARE IN mm
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REV.NO.	DATE	DESCRIPTION	REMARKS

CONSULTANTS:-

STEDRANT TECHNOCLINIC PVT. LTD.

"Sunvak Pride", # 95, Model House Street,
Basavanagudi, Bengaluru - 560 004
Tel. : 080-26629992.

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PROJECT:-

CONDITION ASSESSMENT OF EXISTING TERMINAL (T1) BUILDING OF THIRUVANANTHAPURAM INTERNATIONAL AIRPORT (TIAL) AT THIRUVANANTHAPURAM, KERALA.

DWN	SHIVA.B
FIELD INVST. BY	V.N.M
CHK	S.B.C
APPVD	S.S

CLIENT:-

M/s. TRV (KERALA) INTERNATIONAL AIRPORT LIMITED ADMINISTRATIVE BLOCK, THIRUVANANTHAPURAM INTERNATIONAL AIRPORT,THIRUVANANTHAPURAM-695 008. KERALA STATE, INDIA.

REPORT No: 218

PAGE.No: 54d

TITLE:-

EXISTING TRUSS PLAN, SECTION & DETAILS (TERMINAL BUILDING)

Rev No:

SCALE	DATE	Dwg.No
N.T.S	26-08-2023	STPL/NDT/2023-218/TRV/04

CHILLER UNIT AND AC PLANT

Chiller Unit

AC Plant

2. INTRODUCTION:

The existing **"Chiller Unit and AC Plant"** of **Terminal T1** in Thiruvananthapuram International Airport Limited (TKIAL) at Thiruvananthapuram, Kerala. The **Chiller Unit structure** consist of RC frame with infilled masonry walls comprises of ground floor only the height of the floor is about 5.5 m.

The **AC Plant structure** consist of RC frame with two levels, the each level is about 3 m height. As informed, both the structures were constructed about 40 years ago and since then it is in service.

2.1 PHYSICAL OBSERVATIONS AND PHOTOGRAPHIC DOCUMENTATION ALONG WITH DRAWINGS

Following are the physical observations made during inspection. The findings of the observations are documented through photographs:

Chiller Unit

i. Patch up works was observed to be carried out at many locations. (PH 03)
ii. Dampness, damp patches and peeling of paint were observed at many locations in masonry walls (PH 04).
iii. Cracks were observed in masonry walls at few locations. (PH 05 & 06)
iv. Growth of fungus / vegetation was observed on parapet wall at many locations. (PH 07)
v. Water stagnation dry patches were observed over WPC at many locations. (PH 08)

Photographic Documentation

	
PH 01 - General View	PH 02 – Internal View

	
PH 03 – Patch up work	PH 04 – Dampness and damp patches in masonry walls
	
PH 05 – Cracks in masonry wall	PH 06 – Crack in masonry wall
	
PH 07 – Growth of vegetation on the parapet walls	PH 08 – Stagnation of water dry patches over WPC

AC Plant

vi. Leakages from the AC units was observed at many locations (PH 03).

vii. Dampness, damp patches and peeling of paint were observed in columns and beams at many locations. (PH 03 & 04)

viii. Severe cracks were observed in columns and beams at internal side. (PH 05 & 06)

ix. Spalling of cover concrete was observed in the columns and beams at many locations. (PH 07 - 08)

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x. Exposure of corroded rebars in the columns and beams at many locations. (PH 09-10)

xi. Severe corrosion was observed over the structural steel members and MS pipes. (PH 10)

	
PH 01 - General View	PH 02 –Top View
	
PH 03 – Dampness and damp patches in RC members	PH 04 – Dampness and damp patches in RC members
	
PH 05 – Severe cracks in RC members	PH 06 – Severe cracks in RC members

	
PH 07 – Spalling of concrete and exposure corroded rebars in RC members	PH 08 – Spalling of concrete and exposure corroded rebars in RC members
	
PH 09 – Severe Corrosion on structural steel angles and MS pipes	PH 10 – Severe Corrosion on structural steel angles and MS pipes

(Refer enclosed drawing for identification)

2.2 RESULTS OF TESTS

In order to assess the extent of distress in the building, following assessment studies/tests were carried out at all the accessible regions:

2.2.1 The **Rebound Hammer test** was carried out on RC columns, beams & slabs of **Chiller Unit** at random. From the results of the Rebound Hammer test, it is observed that the strength of concrete near to surface in the tested regions of RC members is in the range of **16.0 N/sq.mm** to **26.0 N/sq.mm**. In RC columns and beams of **AC Plant** is in the range of **16.0 N/sq.mm** to **23.0 N/sq.mm**. As per calibration chart developed for the above test instrument.

The details of test are tabulated in ***Table – 2.2.1*** and corresponding reference chart is appended in ***Table – 2.2.1A.***

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Rebound Hammer Test is in Progress

2.2.2 The **Ultrasonic Pulse Velocity test** was conducted on RC columns, beams and slabs of **Chiller Unit** at random. From the results of the Ultrasonic Pulse Velocity test, it is observed that the quality grading of concrete in the tested RC members fall under the category of **"Good Concrete".** In RC columns and beams of **AC Plant** fall under the category of **"Doubtful to Good Concrete"** as per Table-1 of IS: 516 (Part 5/Sec 1): 2018 & Amendment No.1 November 2019.

The details of test are tabulated in ***Table* – 2.2.2** and corresponding quality grading chart is appended in ***Table* – 2.2.2A.**

Ultrasonic Pulse Velocity Test is in Progress

2.2.3 The **Cover meter studies** were carried out on RC columns, beams & slabs of **Chiller Unit** at random. It is observed that the cover provided to the rebars are found to be **in order** in most of the tested RC members. In RC columns and beams of **AC Plant** the cover provided to the rebars are found to be **in order** in most of the tested RC members.

The details of test are tabulated in ***Table* – 2.2.3.**

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Cover Meter Test is in Progress

2.2.4 The **Electro Chemical Half - Cell Potentiometer test** was carried out on RC columns, beams & slabs of Chiller Unit at random. From the results of the Half-Cell Potential test, the corrosion status of reinforcing bars in most of the tested RC members is found to be in **"Uncertainty of corrosion" (i.e., Moderate stage) to "High Probability of corrosion" (i.e., Advanced stage).**

In RC columns and beams of **AC Plant,** the corrosion status of reinforcing bars in most of the tested RC members is found to be in **"High Probability of corrosion" (i.e., Advanced stage).**

The details of test are tabulated in ***Table* – 2.2.4** and corresponding reference chart is appended in ***Table* – 2.2.4A**.

Half-Cell Potential Measurement Test is in Progress

2.2.5 The **Carbonation test** was carried out on RC columns, beams & slabs of **Chiller Unit** at random. it is observed that the carbonation of concrete is confined to **5 mm to 10 mm** in few of the members. In RC columns and beams of **AC plant** the carbonation of concrete is confined to **10 mm to 15 mm.** Whereas, in RC columns and beams of **AC Plant** at leakage/concrete spalling region, it has reached reinforcement level and

cover concrete has lost its alkalinity which is essential to protect the reinforcing bars against potential corrosion.

The details of test are tabulated in ***Table – 2.2.5.***


Carbonation Test is in Progress

2.2.6 The **strength of in-situ concrete** of RC columns (3 no's in each structure) at random. From the results of the core tests observed that the strength of concrete in RC columns of **Chiller Unit** is found to be varying in the range of **16.97 N/sq.mm** to **22.69 N/sq.mm.** In RC columns of **AC plant** is found to be varying in the range of **14.98 N/sq.mm** to **19.87 N/sq.mm.**

The details of test are tabulated in ***Table – 2.2.6.***


Extraction of Concrete Core Samples is in Progress

2.2.7 The **Concrete samples** were collected from the RC columns and tested in our laboratory for determination of following parameters:

The details of test are tabulated in ***Table – 2.2.7.***

2.2.7.1 The **Chloride Determination Test** was carried out on concrete estimate the level of chlorides in the concrete. From the results of chemical analysis on concrete samples it is inferred that the overall chloride in RC columns is found to be in the range of

0.68 Kg/Cu.m to 0.89 Kg/Cu.m in **Chiller Plant** and in RC columns of **AC Plant** is found to be in the range of **0.17 Kg/Cu.m to 0.44 Kg/Cu.m** as against the permissible limit of 0.6 Kg/Cu.m as per standards.

2.2.7.2 The **Sulphate determination Test** on concrete was carried out to estimate the level of sulphates in the concrete. From the results of sulphate content on RC members, it is observed that the sulphate content in RC members is found to be in the range **0.25 % to 0.68 % and** in RC columns of **AC Plant** is found to be in the range of **0.07 % to 0.16 %** as against the permissible limit of 4% as per standards.

2.2.7.3 The **pH Test** was carried out on concrete. The pH value of interior concrete in the tested RC members is found to be in the range of **11.21 to 11.38 and** in RC columns of **AC Plant** is found to be in the range of **11.08 to 11.42** which is more than the desired level of **"not less than 10"**.

2.3 INFERENCES

Based on the detailed physical observations, results of non-destructive, semi-destructive and laboratory tests the following inferences are drawn;

a. Dampness/damp patches, growth of fungus and peeling of paint in masonry walls are essentially due to leakage/seepage of water during rains over a period of time.

b. Cracks along the rebars, spalling of cover concrete, formation of scales and reduction in rebar dia in RC members of AC Plant are essentially due to corrosion of rebars. Corrosion of rebars in RC members is essentially due to poor quality of cover concrete, seepage of water from the floor/roof slab above over a prolonged period of time. Further the problem has further aggravated due to inadequate or no maintenance.

c. From the results of the Rebound Hammer test, it is observed that the strength of concrete near to surface in the tested regions of RC members is in the range of **16.0 N/sq.mm to 26.0 N/sq.mm.** In RC columns and beams of **AC Plant** is in the range of **16.0 N/sq.mm to 23.0 N/sq.mm.** As per calibration chart developed for the above test instrument.

d. From the results of the **Ultrasonic Pulse Velocity test,** it is inferred that the quality grading of concrete in the tested RC members fall under the category of **"Good Concrete".** In RC columns and beams of **AC Plant** fall under the category of

"Doubtful to Good Concrete" as per Table-1 of IS: 516 (Part 5/Sec 1): 2018 & Amendment No.1 November 2019.

e. From the **Cover meter studies** were carried out on RC columns, beams & slabs of **Chiller Unit** at random. It is observed that the cover provided to the rebars are found to be **in order** in most of the tested RC members. In RC columns and beams of **AC Plant** the cover provided to the rebars are found to be **in order** in most of the tested RC members.

f. From the results of the **Half-Cell Potential test,** the corrosion status of reinforcing bars in most of the tested RC members is found to be in **"Uncertainty of corrosion" (i.e., Moderate stage) to "High Probability of corrosion" (i.e., Advanced stage).**

In RC columns and beams of **AC Plant,** the corrosion status of reinforcing bars in most of the tested RC members is found to be in **"High Probability of corrosion" (i.e., Advanced stage).**

g. From the **Carbonation test** was carried out on RC columns, beams & slabs of **Chiller Unit** at random. It is inferred that the carbonation of concrete is confined to **5 mm to 10 mm** in few of the members. In RC columns and beams of **AC plant** the carbonation of concrete is confined to **10 mm to 15 mm.** Whereas, in RC columns and beams of **AC Plant** at leakage/concrete spalling region, it has reached reinforcement level and cover concrete has lost its alkalinity which is essential to protect the reinforcing bars against potential corrosion.

h. From the results of the core tests, it is inferred that the in-situ compressive strength of concrete in RC columns of **Chiller Unit** is found to be varying in the range of **16.95 N/sq.mm** to **22.36 N/sq.mm.** In RC columns of **AC plant** is found to be varying in the range of **14.98 N/sq.mm** to **19.91 N/sq.mm.**

i. The results of **Chemical Tests** on concrete samples of **Chiller Plant,** it is inferred that the chloride content, sulphate content and pH value are within the permissible limits. However, in **AC Plant** the sulphate content and pH value are within the permissible limits. Whereas chloride content in tested sample of columns is higher than the permissible limit of **0.6 kg/cum** Which indicates the chloride intrusion might have come from water / fine aggregates during construction stage or from the saline atmosphere over a period of time.

Based on the observations and results of various tests carried out, it is inferred that the distress observed in the **Chiller Unit** is minor in nature. Whereas, in **AC Plant** it is severe in nature.

2.4 CONCLUDING REMARKS

The detailed assessment study, revealed that the distress observed in **Chiller Unit** is not so severe, this can be retained for some time with repairs till the new structure has been built to the present requirement.

Whereas, the distress observed in the **AC Plant** is found to be severe. Hence, reconstruction of the same shall be taken up at the earliest. Till such time repair measure shall be carried out.

Considering the age factor, to meet the present requirement and also future development, it is preferable to reconstruct both the structures during up-gradation of the Airport.

SHIVANNA B C
Dy. Manager

STEDRANT TECHNOCLINIC PVT. LTD.

SUDARSHAN S IYENGAR
Senior Director
(NDT, R & R Services)

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APPENDIX

Tables

Drawings

TABLES

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TABLE - 2.2.1
REBOUND HAMMER TEST RESULTS

Client : **M/s. TRV (Kerala) International Airport Limited**
Administrative Block, Thiruvananthapuram International Airport,
Thiruvananthapuram - 695 008.
Kerala State, India.

Project* : Condition Assessment of existing AC Plant & Chiller Unit of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.

Date/Period of test : 14th August to 21st August.

Members tested : RC Columns, Beams & Slabs.

Grade of concrete : Unkown

Age of concrete* : More than 28 days

Reason for test : To ascertain the surface strength of in-situ concrete

Test conducted by : Mr. Vinay N M - Engineer | NDT
Mr. Rajesh M - Sr. Testing Assistant | NDT
Mr. Kishor H B - Testing Assistant | NDT
M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.

Test Witnessed by : Mr. Shalin K - Associate Manager (E & M - Civil)
Mr. Akshay R - Civil Engineer (E & M - Civil)

Test Instrument : Schmidt Hammer, N Type.

Make & Sl. No : M/s Proceq, Switzerland, Sl No 174920

Technical references : Indian Standards IS: 516 (Part 5/Sec 4) : 2020

Sl. No.	Floor level / Location*	Structural Member/Grid Identification*	Position & Orientation	Average Rebound Number++	Remarks
1	Ground floor	RC Column - B/3	Horizontal	33	Refer Table-2.2.1A for Estimated Compressive strength range of in-situ concrete
2		RC Column - A/2	Horizontal	38	
3		RC Column - B/1	Horizontal	33	
4		RC Column - A/4	Horizontal	39	
5		RC Column - A/3	Horizontal	37	
6		RC Column - B/1	Horizontal	37	
7		RC Beam - B/3'-3"	Horizontal	35	
8		RC Beam - A/2-3	Horizontal	33	
9		RC Beam - A-B/2	Horizontal	32	
10		RC Beam - A-B/1'	Horizontal	33	

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TABLE - 2.2.1
REBOUND HAMMER TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member/Grid Identification*	Position & Orientation	Average Rebound Number++	Remarks
11	Ground floor	RC Column - A/1	Horizontal	34	Refer Table-2.2.1A for Estimated Compressive strength range of in-situ concrete
12		RC Beam - A-B/3	Horizontal	33	
13		RC Column - A/4	Horizontal	38	
CHILLER UNIT					
14	Ground floor	RC Column - A/7	Horizontal	33	
15		RC Column - A/4	Horizontal	38	
16		RC Column - B/4	Horizontal	36	
17		RC Column - A/2	Horizontal	34	
18		RC Column - B/1	Horizontal	33	
19		RC Column - C/3	Horizontal	35	
20		RC Column - C/5	Horizontal	35	
21		RC Beam - B/4-4'	Horizontal	33	
22		RC Beam - A-B/4'	Horizontal	33	
23		RC Beam - A-B/2	Horizontal	35	
24		RC Slab - A-B/4-4'	Vertical upwards	35	
25		RC Slab - A-B/2-2'	Vertical upwards	33	

**Drawing No: STPL/NDT/2023-218/TRV/01-02 for grid identification.

++ After applying necessary correction factors for the direction of impact

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NOTE:

(i) The Results relate only to the members tested.

(ii) Report shall not be reproduced, except in full, without the written approval of the laboratory

(iii) Any corrections invalidates this report.

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TABLE - 2.2.1A
REFERENCE STRENGTH CHART FOR REBOUND HAMMER TEST

Instrument : Schmidt Hammer, N Type

Sl. No : 174920

Make : M/s Proceq, Switzerland

REBOUND HAMMER NUMBER	ESTIMATED COMPRESSIVE STRENGTH RANGE (N/Sq.mm)
22 to 25	12 to 16
26 to 29	17 to 21
30 to 33	22 to 26
34 to 37	27 to 31
38 to 41	32 to 36
42 to 45	37 to 41
46 to 49	42 to 45
50 and above	>45

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Note:

1 Estimated compressive strength is worked out based on the Calibration Chart developed for the above test instrument in our laboratory.

2 As per clause 8.1 of Indian Standards IS: 516 (Part5/Sec4):2020, the estimation of strength of concrete by rebound hammer method cannot be held to be very accurate and probable accuracy of prediction of concrete strength in a structure is ± 25 percent.

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TABLE - 2.2.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Client	:	**M/s. TRV (Kerala) International Airport Limited** Administrative Block, Thiruvananthapuram International Airport, Thiruvananthapuram - 695 008. Kerala State, India.
Project*	:	Condition Assessment of existing AC Plant & Chiller Unit of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.
Period of test	:	14th August to 21st August.
Members tested*	:	RC Columns, Beams.
Grade of concrete	:	Unkown
Age of concrete*	:	More than 28 days
Reason for test	:	To ascertain the quality/uniformity of in-situ concrete
Test conducted by	:	Mr. Vinay N M - Engineer | NDT Mr. Rajesh M - Sr. Testing Assistant | NDT Mr. Kishor H B - Testing Assistant | NDT **M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.**
Test Witnessed by	:	Mr. Shalin K - Associate Manager (E & M - Civil) Mr. Akshay R - Civil Engineer (E & M - Civil)
Test Instrument	:	PUNDIT LAB+ (Portable Ultrasonic Non-destructive Digital Indicating Tester)
Make & Sl. No	:	M/s. Proceq - Switzerland, PL02-004-0393 C0
Technical references	:	Indian Standards IS: 516 (Part 5/Sec 1) : 2018

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
1	Ground floor	RC Column B/4	EL - 300	4.00	4.2	Direct Method 31°C	Refer Table 2.2.2A for Concrete Quality Grading Chart
			EL - 600	4.51			
			EL - 900	4.57			
			EL - 1200	4.10			
			EL - 1500	3.90			
			EL - 1800	4.05			
			EL - 2100	4.51			
2		RC Column A/3	EL - 300	4.10	4.2		
			EL - 600	4.44			
			EL - 900	4.05			
			EL - 1200	4.21			
			EL - 1500	4.05			

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TABLE - 2.2.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
3	Ground floor	RC Column B/3	EL - 300	3.86	3.9	Direct Method 31°C	Refer Table 2.2.2A for Concrete Quality Grading Chart
			EL - 600	3.76			
			EL - 900	3.90			
			EL - 1200	4.00			
			EL - 1500	3.90			
			EL - 1800	3.86			
			EL - 2100	4.16			
4		RC Column B/2	EL - 300	4.10	4.3		
			EL - 600	4.16			
			EL - 900	4.57			
			EL - 1200	4.57			
			EL - 1500	4.32			
			EL - 1800	4.10			
			EL - 2100	4.27			
5		RC Column B/1	EL - 300	4.57	4.2		
			EL - 600	4.51			
			EL - 900	4.44			
			EL - 1200	4.44			
			EL - 1500	3.64			
			EL - 1800	3.56			
			EL - 2100	3.95			
6		RC Column A/4	EL - 300	4.03	4.1		
			EL - 600	3.97			
			EL - 900	4.08			
			EL - 1200	4.25			
			EL - 1500	4.31			
7		RC Beam A-B/2"	EL - 200	4.21	4.3		
				4.38			
				4.27			
				4.32			
				4.51			
				4.32			
				4.38			
8		RC Beam A-B/1"	EL - 200	4.27	4.1		
				4.32			
				3.72			
				4.32			
				3.76			

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TABLE - 2.2.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
9	Ground floor	RC Beam A-B/3	EL - 200	4.18	4.4	Direct Method 31°C	Refer Table 2.2.2A for Concrete Quality Grading Chart
				4.40			
				4.46			
				4.52			
				4.34			
				4.46			
10		RC Beam A-B/3'	EL - 200	4.27	4.1		
				4.05			
				3.90			
				3.95			
				4.27			
				4.05			
				3.47			
				3.71			
11		RC Beam A-B/4	EL - 200	3.37	3.4		
				3.40			
				3.24			
				3.33			
12	First floor	RC Column B/4	EL - 300	4.31	4.2		
			EL - 600	3.92			
			EL - 900	4.49			
			EL - 1200	4.31			
			EL - 1500	4.43			
			EL - 1800	3.92			
13		RC Column B/3	EL - 300	4.27	4.1		
			EL - 600	4.10			
			EL - 900	4.27			
			EL - 1200	4.44			
			EL - 1500	3.76			
			EL - 1800	3.60			
14		RC Column A/1	EL - 300	4.12	4.1		
			EL - 600	4.04			
			EL - 900	4.08			
			EL - 1200	4.00			
15	First floor	RC Column A/2	EL - 300	4.19	3.8		
			EL - 600	3.69			
			EL - 900	3.56			
			EL - 1200	3.48			
			EL - 1500	3.92			

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TABLE - 2.2.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
CHILLER UNIT							
16	Ground floor	RC Column B/4	EL - 300	3.55	3.6	Direct Method 31°C	Refer Table 2.2.2A for Concrete Quality Grading Chart
			EL - 600	4.10			
			EL - 900	3.41			
			EL - 1200	3.71			
			EL - 1500	3.58			
			EL - 1800	3.58			
			EL - 2100	3.31			
17		RC Column B/5	EL - 300	4.40	4.3		
			EL - 600	4.40			
			EL - 900	4.34			
			EL - 1200	4.18			
			EL - 1500	4.07			
			EL - 1800	4.34			
18		RC Column C/2	EL - 300	3.67	3.9		
			EL - 600	4.07			
			EL - 900	3.67			
			EL - 1200	3.88			
			EL - 1500	3.98			
			EL - 1800	3.93			
			EL - 2100	4.02			
19		RC Column B/2	EL - 300	3.76	4.2		
			EL - 600	3.90			
			EL - 900	4.16			
			EL - 1200	4.16			
			EL - 1500	4.51			
			EL - 1800	4.38			
			EL - 2100	4.44			

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TABLE - 2.2.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
20	Ground floor	RC Column A/2	EL - 300	3.52	3.7	Direct Method 31°C	Refer Table 2.2.2A for Concrete Quality Grading Chart
			EL - 600	3.68			
			EL - 900	3.64			
			EL - 1200	3.64			
			EL - 1500	3.95			
			EL - 1800	3.90			
			EL - 2100	3.76			
			EL - 300	4.62			
21		RC Column A/4	EL - 600	4.53	4.5		
			EL - 900	4.57			
			EL - 1200	4.53			
			EL - 1500	4.53			
			EL - 1800	4.43			
			EL - 2100	4.22			
22		RC Beam B/4-4'	EL - 150	3.51	4.2		
				4.46			
				4.52			
				4.40			
				4.23			
23		RC Beam A-B/4'	EL - 150	3.98	3.6		
				3.51			
				3.55			
				3.59			
				3.51			

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TABLE - 2.2.2
ULTRSONIC PULSE VELOCITY TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Position	Pulse Velocity (Km/Sec)	Average Pulse Velocity (Km/Sec)	Method of test & Temperature	Remarks
24	Ground floor	RC Beam A-B/2	EL - 150	4.07	4.1	Direct Method 31°C	Refer Table-2.2.2A for Concrete Quality Grading Chart
				4.18			
				4.23			
				3.93			
				4.18			
				3.88			

**Drawing No: STPL/NDT/2023-218/TRV//01-02 for grid identification.

NOTE:

(i) The Results relate only to the members tested.

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TABLE - 2.2.2A

REFERENCE QUALITY GRADING CHART FOR ULTRASONIC PULSE VELOCITY TEST

Pulse Velocity (Km/sec)	Concrete Quality Grading
For Concrete (≤ M 25)	
Below 3.50	Doubtful
3.50 to 4.50	Good
Above 4.50	Excellent
For Concrete (> M 25)	
Below 3.75	Doubtful
3.75 to 4.50	Good
Above 4.50	Excellent

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Note:

Concrete quality grading for different velocity criterion as reproduced from Amendment No.1 November 2019 to IS 516 (Part 5/Sec 1): 2018, (Page 4, Table 1).

In case of "**Doubtful quality**", it may be necessary to carry out further testing.

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TABLE - 2.2.3
COVER METER TEST RESULTS

Client	: **M/s. TRV (Kerala) International Airport Limited** Administrative Block, Thiruvananthapuram International Airport, Thiruvananthapuram - 695 008. Kerala State, India.
Project*	: Condition Assessment of existing AC Plant & Chiller Unit of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.
Date/Period of test	: 14th August to 21st August.
Grade of concrete	: Unkown
Members tested	: RC Columns, Beams & Slabs.
Age of concrete*	: More than 28 days
Reason for test	: To assess the thickness of cover concrete provided to the rebars
Test conducted by	: Mr. Vinay N M - Engineer |NDT Mr. Rajesh M - Sr. Testing Assistant | NDT Mr. Kishor H B - Testing Assistant | NDT **M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.**
Test witnessed by	: Mr. Shalin K - Associate Manager (E & M - Civil) Mr. Akshay R - Civil Engineer (E & M - Civil)
Test Instrument	: Profometer – 6, Version 600
Make & Sl. No	: M/s. Proceq, Switzerland Sl No. UP01-002-1329
Technical Reference	: BS: 1881 - (Part 204) & Test Instrument

Sl. No.	Floor level / Location*	Structural Member / Grid Identification*	Range of Cover Concrete (mm)
1	Ground floor	RC Column - B/4	35 to 45
2		RC Slab - A-B/3	28 to 35
3		RC Column - B/2	25 to 38
4		RC Column - A/1	34 to 40
5		RC Beam - A-B/1'	30 to 35
6		RC Beam - B/3-4	28 to 32
7		RC Column - B/1	35 to 42
8		RC Column - A/3	32 to 40
9		RC Column - B/3	40 to 46
CHILLER UNIT			
10	Ground floor	RC Column - A/4	31 to 33
11		RC Column - B/4	35 to 44
12		RC Column - B/6	25 to 35
13		RC Column - C/2	20 to 35
14		RC Column - B/1	30 to 40

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TABLE - 2.2.3
COVER METER TEST RESULTS

Sl. No.	Floor level / Location*	Structural Member / Grid Identification*	Range of Cover Concrete (mm)
15	Ground floor	RC Column - A/2	28 to 32
16		RC Beam - A-B/4'	40 to 44
17		RC Beam - A-B/2	31 to 38
18		RC Slab - A-B/4-4'	27 to 35
19		RC Slab - A-B/2'-2	25 to 30

**Drawing No: STPL/NDT/2023-218/TRV/01-02 for grid identification.

NOTE:

(i) The Results relate only to the members tested.

(ii) Report shall not be reproduced, except in full, without the written approval of the laboratory.

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TABLE - 2.2.4
HALF-CELL POTENTIAL DIFFERENCE TEST RESULTS

Client	:	**M/s. TRV (Kerala) International Airport Limited** Administrative Block, Thiruvananthapuram International Airport, Thiruvananthapuram - 695 008. Kerala State, India.
Project*	:	Condition Assessment of existing AC Plant & Chiller Unit of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.
Members tested*	:	RC Columns & Beams.
Period of test	:	14th August to 21st August.
Test conducted by	:	Mr. Vinay N M - Engineer |NDT Mr. Rajesh M - Sr. Testing Assistant | NDT Mr. Kishor H B - Testing Assistant | NDT **M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.**
Test witnessed by	:	Mr. Shalin K - Associate Manager (E & M - Civil) Mr. Akshay R - Civil Engineer (E & M - Civil)
Test Instrument	:	Electro Chemical half-cell Potential Tube & Digital Multimeter
Make	:	Mastech, India
Technical references	:	As per ASTM C 876 – 91 (Reapproved 1999)

SL. No.	Structural Member	Grid Identification**	Half Cell Measurements Measured potential difference (mV)	Remarks
1	Ground floor	RC Column - A/4	-373 to -420	Refer Table - 2.2.4A for Probability of corrosion
2		RC Column - A/2	-410 to -480	
3		RC Column - B/4	-420 to -435	
4		RC Beam - B/2-3	-360 to -400	
5		RC Beam - A-B/2	-410 to -465	
6		RC Beam - A-B/1"	-375 to -390	
CHILLER PLANT				
7	Ground floor	RC Column - C/1	-210 to -245	
8		RC Column - B/1	-240 to -280	
9		RC Column - B/2	-200 to -240	
10		RC Column - C/2	-230 to -397	
11		RC Column - A/5	-210 to -369	

**Refer Drawing No: STPL/NDT/2023-218/TRV/01-02 for grid identification.

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NOTE:

(i) The Results relate only to the members tested.

(ii) Report shall not be reproduced, except in full, without the written approval of the laboratory

(iii) Any corrections invalidates this report.

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TABLE – 2.2.4A

REFERENCE CHART FOR HALF CELL POTENTIAL DIFFERENCE MEASUREMENT TEST

SL. No.	Measured Potential Difference	Probability of Corrosion
1	More positive than (-) 200 mv	High probability of No corrosion (i.e Initial stage)
2	Between (-) 200 mv to (-) 350 mv	Uncertainty of corrosion (i.e moderate stage)
3	More negative than (-) 350 mv	High probability of corrosion (i.e advanced stage)

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TC - 6899

TABLE - 2.2.5
CARBONATION TEST RESULTS

Client : **M/s. TRV (Kerala) International Airport Limited**
Administrative Block, Thiruvananthapuram International Airport,Thiruvananthapuram - 695 008.
Kerala State, India.

Project* : Condition Assessment of existing AC Plant & Chiller Unit of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.

Members tested* : RC Columns & Beams.

Period of test : 14th August to 21st August.

Test conducted by : Mr. Vinay N M - Engineer | NDT
Mr. Rajesh M - Sr. Testing Assistant | NDT
Mr. Kishor H B - Testing Assistant | NDT
M/s. Stedrant Technoclinic Pvt. Ltd., Bengaluru.

Test witnessed by : Mr. Shalin K - Associate Manager (E & M - Civil)
Mr. Akshay R - Civil Engineer (E & M - Civil)

Chemical used for : Dilute Alcohol added with Phenolphthalein

Technical references : BS EN: 14630-2006

Sl. No.	Floor level / Location*	Structural Member / Grid Identification**	Carbonation Level
AC Plant			
1	Ground floor	RC Beam - A-B/2''	Carbonation upto 10mm
2		RC Beam - A-B/1'	Carbonation upto 5mm
3		RC Column - B/3	Carbonation upto 10mm
4		RC Column - A/1	Carbonation upto 5mm
5		RC Column - A/4	Carbonation upto 10mm
6		RC Column - A/2	Carbonation upto 5mm
7		RC Beam - B/3-4	Carbonation upto 10mm
8		RC Beam - A-B/2	Carbonation upto 5mm
9		RC Beam - A/1-2	Carbonation upto 10mm

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TABLE - 2.2.5
CARBONATION TEST RESULTS

CHILLER UNIT			
10	Ground floor	RC Column - B/2	Carbonation upto 5mm
11		RC Column - C/1	Carbonation upto 5mm
12		RC Column - B/1	Carbonation upto 10mm
13		RC Beam - B/4-4'	Carbonation upto 10mm
14		RC Beam - A-B/4'	Carbonation upto 10mm
15		RC Beam - A-B/2	Carbonation upto 10mm

**Drawing No: STPL/NDT/2023-218/TRV/01-02 for grid identification.

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TABLE - 2.2.6
CONCRETE CORE TEST RESULTS

Client : **M/s. TRV (Kerala) International Airport Limited**
Administrative Block, Thiruvananthapuram International Airport,Thiruvananthapuram - 695 008.
Kerala State, India.

Project* : Condition Assessment of existing AC Plant & Chiller Unit of Thiruvananthapuram International Airport (TIAL) at Thiruvananthapuram, kerala.

Core extracted from : RC Columns.

Date of Cores Extracted : 19th August & 20th August 2023.

Date of Test : 25th August 2023.

Grade of Concrete : Unkown

Age of concrete* : More than 28 days

Capping material used : EPCO KP 350 (PART A) & EPCO HP 350 (PART B) from M/s. Krishna Conchem Products Pvt. Ltd.,

Technical references : IS: 456-2000 (Reaffirmed in 2021) and IS:516 (Part 4): 2018

Core Nos.	Member Identification**	Core Length** * (l) (mm)	Core Dia (d) (mm)	Core Wt.*** (Kg.)	C/S Area (Sq.mm)	Density of concrete (Kg/Cu.m)	Failure load (kN)	Core Comp. Strength# (N/sq.mm)	l/d Ratio	Correction factor for (l/d) ratio+	Corrected Cyl. Comp Strength (N/sq.mm)	Equivalent Cube Comp. Strength ++ (N/sq.mm)
Ground Floor												
1	RC Column - B/4	123.59	64	0.91	3217	2296.05	55.54	18.29	1.93	0.99	18.15	22.69
2	RC Column - A/2	123.05	64	0.95	3217	2386.95	48.68	16.03	1.92	0.99	15.90	19.87
3	RC Column - B/1	122.51	64	0.90	3217	2288.38	41.62	13.71	1.91	0.99	13.58	16.97
CHILLER PLANT												
1	RC Column - B/2	122.55	64	0.94	3217	2373.87	36.74	12.10	1.91	0.99	11.99	14.98

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TC - 6899

TABLE - 2.2.6
CONCRETE CORE TEST RESULTS

2	RC Column - C/1	98.39	64	0.73	3217	2290.24	42.54	14.01	1.54	0.95	13.30	16.62
3	RC Column - B/1	113.95	64	0.86	3217	2343.00	49.46	16.29	1.78	0.98	15.90	19.87

Type of Failure in the tested core samples -Typical compressive failure

** Refer enclosed drawing STPL/NDT/2023-218/TRV/01-02 for grid identification.

*** Core length and core weight after trimming and capping.

After applying correction factor for diameter of core which is less than 70 mm (strength of core x 1.06) and for 75 mm ± 5mm (strength of core x 1.03) as per Cl.8.4.1 of IS 516 (Part 4): 2018

+ For l/d ratio, correction factors are as per Cl. 8.4.2 of IS 516 (Part 4): 2018.

++ Equivalent cube compressive strength = 1.25 x corrected cylinder compressive strength as per Cl. 8.4.2 of IS 516 (Part 4): 2018.

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Table - 2.2.7

Results of Chemical Analysis of Concrete sample

Client : **M/s. TRV (Kerala) International Airport Limited**
Administrative Block, Thiruvananthapuram International Airport,Thiruvananthapuram - 695 008.
Kerala State, India.

*Project** : Condition Assessment of existing Technical Block of Thiruvananthapuram International Airport (TKIAL) at Thiruvananthapuram, kerala.

*Members tested** : Concrete samples collected from identified regions of RC columns.

Period of test : 25.08.2023 to 28.05.2023.

Technical references : IS: 14959 (Part 2) 2001 RA 2016 for chlorides, BS 1881 Part 124 1988 for Sulphate and IS 2720 (Part 26) 1987 RA 2016 for pH

Sl. No.	Floor level / Location/Structural Member/Id*	Chloride Content (Kg/Cum)	Sulphate Content SO_3 (%) by mass	pH Value	Requirements
1	Chiller Unit RC Column - B/4	0.68	0.68	11.35	As per Cl: 8.2.5.2 Table-7, of IS: 456-2000 limits of acid **soluble chloride content** in reinforced concrete or plain concrete containing embedded metal should not exceed 0.6 kg/Cu.m As per Cl: 8.2.5.3 of IS: 456-2000 The total water soluble sulphate content of the concrete mix expressed as SO3 should not exceed 4% by mass of the cement in the mix **pH** preferably shall not be less than 10 as per studies carried out
2	Chiller Unit RC Column - B/5	0.75	0.48	11.42	
3	Chiller Unit RC Column - B/2	0.89	0.25	11.08	
4	AC Plant RC Beam - B/4	0.17	0.07	11.34	
5	AC Plant RC Beam - A/4	0.28	0.16	11.38	
6	AC Plant RC Beam - A/2	0.44	0.15	11.21	

* Refer enclosed drawing no STPL/NDT/2023-218/TRV/01-03 for grid identification

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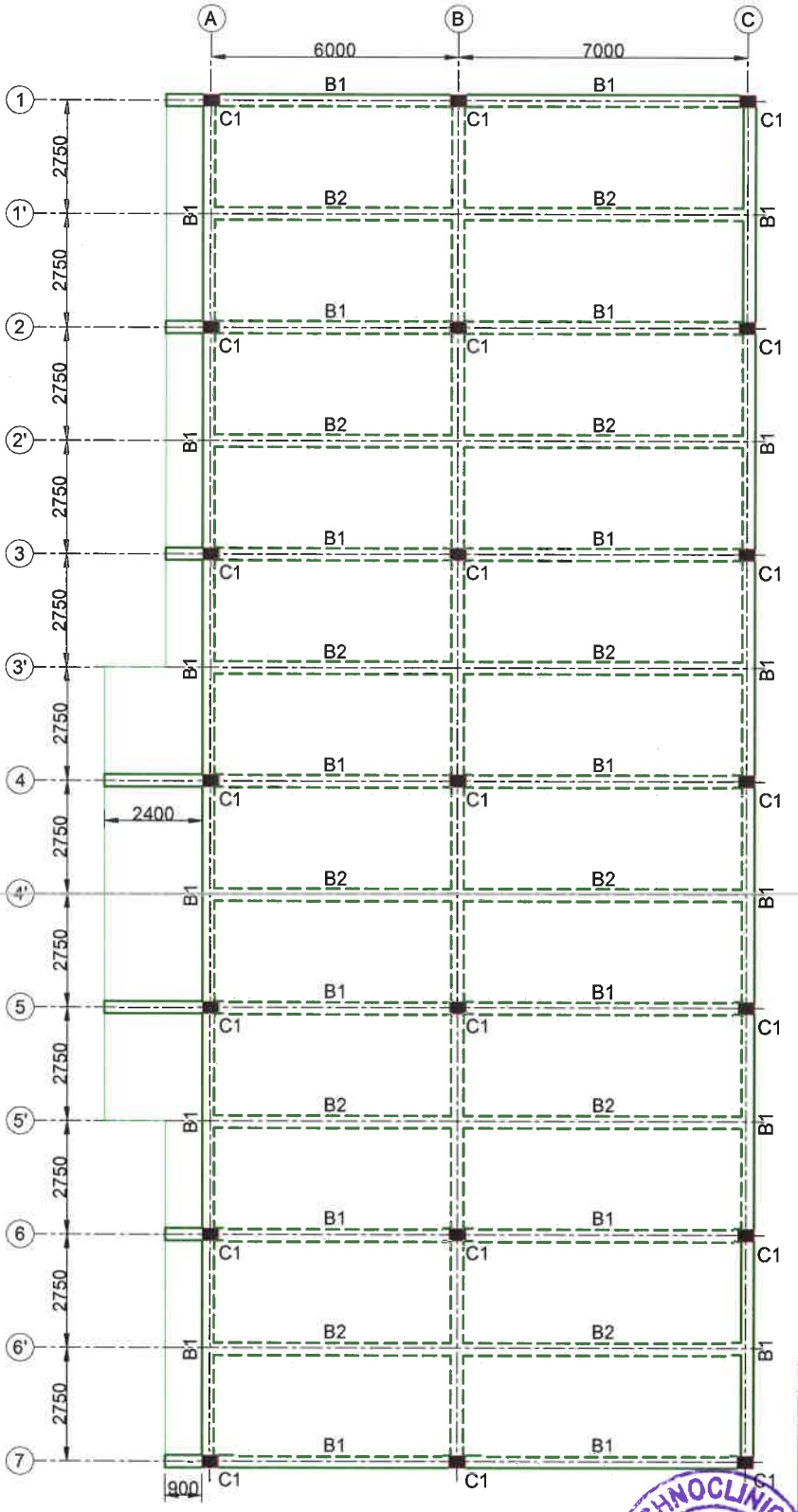
DRAWINGS



COLUMN
C1(300X400)
BEAM
B1(300X600)
B2(300X450)

REV.NO.	DATE	DESCRIPTION	REMARKS

CONSULTANTS:-

STEDRANT TECHNOCLINIC PVT. LTD.

STPL

"Sunvak Pride", # 95, Model House Street,
Basavanagudi, Bengaluru - 560 004
Tel. : 080-26629992.

PROJECT:-
CONDITION ASSESSMENT OF EXISTING CHILLER UNIT OF THIRUVANANTHAPURAM INTERNATIONAL AIRPORT (TIAL) AT THIRUVANANTHAPURAM, KERALA.

DWN	SHIVA.B
FIELD INVST. BY	V.N.M
CHK	S.B.C
APPVD	S.S

CLIENT:-
M/s. TRV (KERALA) INTERNATIONAL AIRPORT LIMITED
ADMINISTRATIVE BLOCK, THIRUVANANTHAPURAM INTERNATIONAL AIRPORT,THIRUVANANTHAPURAM - 695 008. KERALA STATE, INDIA.

REPORT No: 218

PAGE.No: 85

TITLE:-
EXISTING COLUMN & BEAM LAYOUT OF CHILLER UNIT

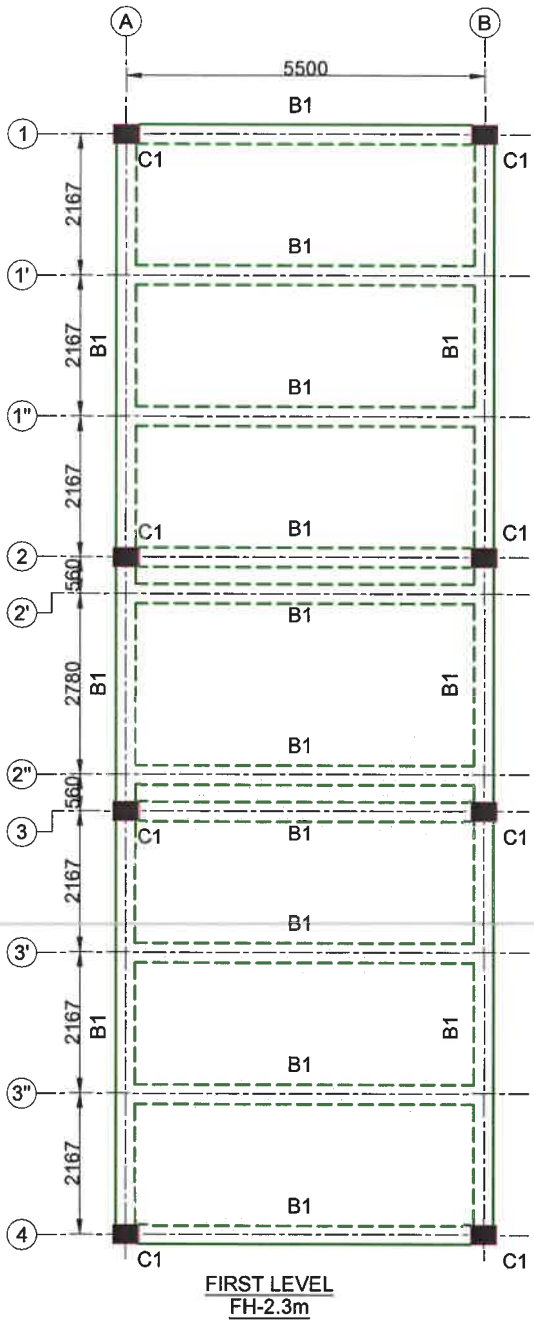
Rev No:

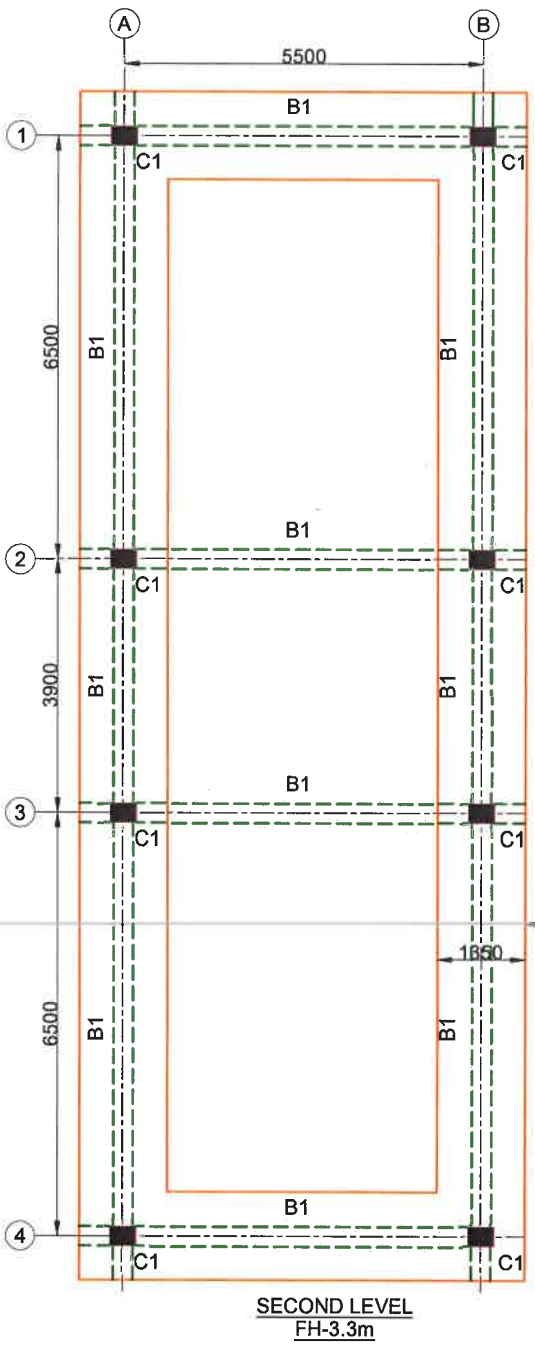
SCALE	DATE	Dwg.No
N.T.S	26-08-2023	STPL/NDT/2023-218/TRV/01

NOTES :-

1. ALL DIMENSIONS ARE IN mm
2. FOLLOW WRITTEN DIMENSIONS ONLY.
3. IF ANY DISCREPANCY FOUND IN THE DRAWING, IT SHALL BE BROUGHT TO THE NOTICE OF THE STRUCTURAL CONSULTANT BEFORE EXECUTION.

STEDRANT TECHNOCLINIC PVT. LTD.





COLUMN
C1(300X400)
BEAM
B1(300X400)

REV.NO.	DATE	DESCRIPTION	REMARKS

CONSULTANTS:-

STEDRANT TECHNOCLINIC PVT. LTD.

"Sunvak Pride", # 95, Model House Street,
Basavanagudi, Bengaluru - 560 004
Tel. : 080-26629992.

STEDRANT TECHNOCLINIC PVT. LTD.

PROJECT:-
CONDITION ASSESSMENT OF EXISTING AC PLANT OF THIRUVANANTHAPURAM INTERNATIONAL AIRPORT (TIAL) AT THIRUVANANTHAPURAM, KERALA.

DWN	SHIVA.B
FIELD INVST. BY	V.N.M
CHK	S.B.C
APPVD	S.S

CLIENT:-
M/s. TRV (KERALA) INTERNATIONAL AIRPORT LIMITED ADMINISTRATIVE BLOCK, THIRUVANANTHAPURAM INTERNATIONAL AIRPORT,THIRUVANANTHAPURAM - 695 008. KERALA STATE, INDIA.

REPORT No: 218

PAGE.No: 86

TITLE:-
EXISTING COLUMN & BEAM LAYOUT OF AC PLANT

Rev No:

SCALE	DATE	Dwg.No
N.T.S	26-08-2023	STPL/NDT/2023-218/TRV/02

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