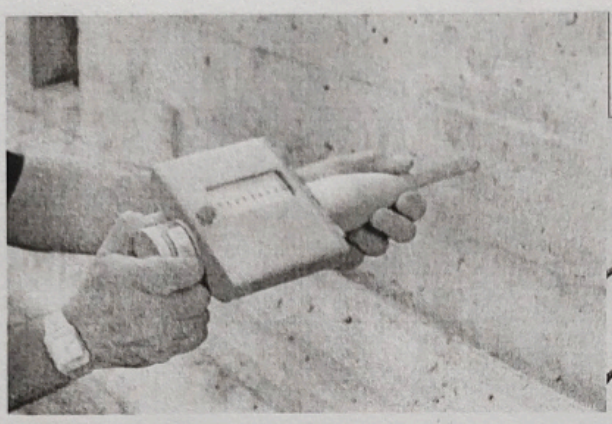
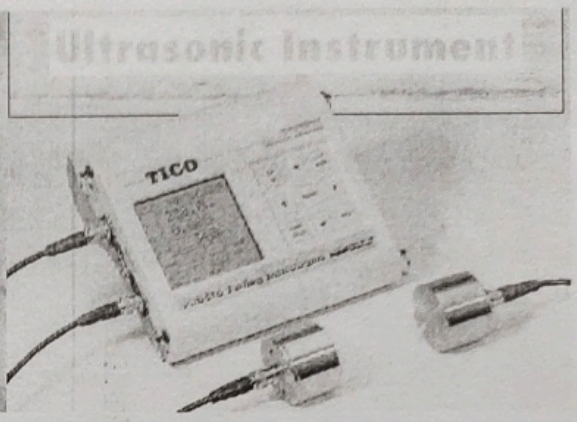
REPORT OF CONDITION ASSESSMENT





GOVT. MODEL HIGH SCHOOL SECTOR-12(PGI) CHANDIGARH

TEAMING TOGETHER

NITTTR
CHANDIGARH

National Institute of Technical Teachers Training & Research

Sector-26, Chandigarh

1. INTRODUCTION

There is a newly constructed building of Govt. Model High School Sector-12(PGI) Chandigarh. The building was completed in 2020. The Principal of the school requested to the civil engineering department of NITTTR, Chandigarh to check the building along with condition survey to assess the quality of concrete by Non-Destructive Testing method and issue necessary stability certificate. The visual examination was carried to find out/ locate the dampness, cracks and other defects in the buildings. The structure is constructed as G+3.

1.1 Objective

The study involves determination of in-situ strength of building under investigation. The buildings are being used for office and school purposes.

The specific objectives of the study are to know:
- The present strength of concrete.
- The present quality of concrete.
- Visual inspection

NDT tests to assess the quality of concrete structures.
- To assess the existing quality and allowable characteristic strength of concrete in the slab, beam and column elements, so that the same can be utilized for overall structural safety appraisal of the structure if required. Besides, in case of any inadequacy in the concrete quality being revealed, suitable remedial measures can also be suggested.
- To diagnose the causes of the distress so as to undertake suitable remedial measures for rehabilitation of the structure taking account of the causes

2. ASSESSMENT OF INTEGRITY OF STRUCTURES

Despite the high durability of concrete as construction material, there are occasions when a structure shows signs of deterioration. Damage may occur from a variety of causes: accidental overloading, foundation settlement, or (construction faults / poor detailing) poor workmanship. An even more common cause of damage is corrosion of reinforcement, which leads to cracking and spalling of the concrete cover.

Concrete structures that are in use under severe conditions need to be specifically inspected to determine the extent of damage and assess Integrity of structures. Several techniques and methods are available for assessing the condition of such structures.

The first step in successful integrating testing is to carry out a thorough investigation. It is essential to determine if the major portion of the structure is of suitable quality. In addition, knowledge of the intensity and extent of damage is required for executing an appropriate repair scheme. The aim of the investigation should be:

- To identify the cause of the damage and the source of the problem;
- To determine the extent of damage;
- To determine material properties;
- To assess the safety and serviceability of the structure;
- To provide recommendations on remedial and preventive measures;
- To estimate the cost of repair or replacement.

A typical investigation involves the following processes:-
- Inspecting the site, with special attention to potential safety hazards;
- Studying the design, construction details, and loading history of the structure;

- Planning a condition survey;
- Executing the condition survey;
- Laboratory testing of material samples secured from the structure;
- Analyzing and interpreting the acquired data;
- Load testing individual members, if necessary.

The different methods for inspecting concrete structures may be simply classified as:

- Visual
- Mechanical / physical inspection
- Chemical analysis, and
- Electrochemical testing

2.1 Initial Visual Inspection

Visual examination is the starting point of inspection. Cracks, rust staining, and spalling are the most obvious defects which can be identified. Often the location of these can give a good indication of the cause of the problem, but an open mind must be kept at this stage until further investigation is undertaken to confirm the root cause. If visual inspection of a structure suggests that a problem may be present, an in-depth examination should be carried out.

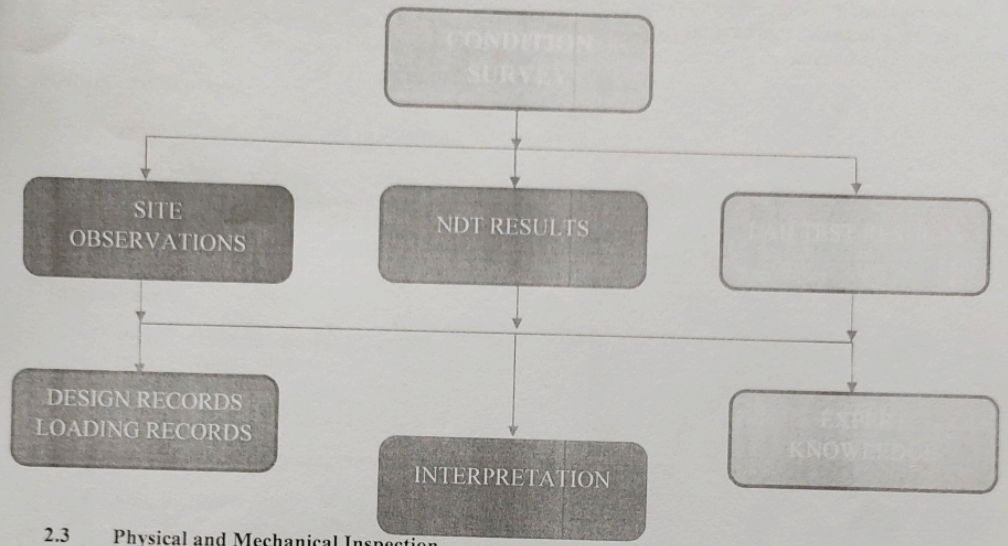
The purpose of the site inspection is to identify the type and age of construction, gravity and lateral load resisting systems, and to make a preliminary assessment of the existing condition of the structure. Visual defects may be related to poor workmanship or material deterioration. These show up as excessive deflection and flexural cracking, while foundation movements may cause diagonal cracks. Material deterioration is normally indicated by cracking and spalling. It is particularly important to differentiate between the various types of cracks found. Examination of crack patterns often suggests the most probable cause of the problem.

Access facilities are usually minimal, so the extent of examination is limited. Hammer- tapping (to locate hollowness or delamination), and the use of the Schmidt Hammer, cover meter, or crack width gauge are often helpful. Potential problems associated with cracking, excessive deflections, water permeability, and evidence of corrosion should be specially noted. By observing the site and examining pertinent drawings and records, the probable causes of damage are deduced, and the areas of serious concern are located. It is often possible to judge whether the damage is corrosion related and this is useful in planning the subsequent detailed survey.

2.2 Condition Survey

The purpose of the survey is to collect sufficient data to pinpoint the cause and source of the problem and to determine the extent of the damage. Depending on the probable cause of the damage, the site work involves a combination of the following processes:

- Detailed visual inspection;
- Survey of cracks, spalls, steel pitting and other defects;
- Potential mapping with half cell potentiometer, or similar instrument, that identifies zones of high corrosion risk;
- Drilling holes or mini-cores for carbonation test and chloride content analysis;
- Coring of concrete for determination of strength and petrography examination;
- Measurement of concrete cover and reinforcing bar spacing with cover meter;
- Schmidt hammer test for Delamination or compressive strength (comparison only);
- Ultrasonic test for honeycombing depth of cracks, or compressive strength (comparison only);
- Assessment of depth of discoloration (in the damage) with hammer and chisel.



2.3 Physical and Mechanical Inspection

This comprises of a series of tests conducted physically on the structure to assess its condition. This covers the range of nondestructive tests and semi destructive tests, conducted in-situ. The various tests conducted are as follows:

(a) Simple Hammer

A simple hammer can be effectively utilized to get an idea about the nature and extent of damage in a distressed structure. The sound heard on tapping the surface indicates the qualitative nature. A metallic sound indicates undamaged area while a dull thud indicates delaminated areas. This simple instrument can throw light on the following aspects:

- Delamination of cover concrete
- Presence of honeycombs
- Sulphate attack

(b) Strength tests

The strength, integrity of concrete, presence of cracks and delamination are determined by the following tests.

Rebound Hammer Test

Purpose:-

This test gives a measure of the surface hardness of the concrete surface. Although there is no direct relationship between this measurement of surface hardness and strength, an empirical relationship exists.

Rebound hammer is the best known methods of comparing the concrete in different parts of a structure and indirectly assessing concrete strength. The rebound hammer should be considered as a means of assessing variations of strength within a structure rather than an accurate means of assessing the strength.

Objective of testing:-

Rebound hammer test is performed to determine the following:

- ✓ Surface hardness
- ✓ Uniformity of concrete over the structure
- ✓ Grade of concrete
- ✓ Estimated strength which is derived from establishing a relationship between in-situ core strength and rebound number.

References:-

- ✓ BS 6089:1981 and BS 1881:Part 202,
- ✓ IS13311(Part2):1992
- ✓ ASTM C 805-02

Influencing factors:-

Rebound hammer test results are considerably influenced by these factors:

- ✓ Size, shape and rigidity of the specimen
- ✓ Age of test specimen
- ✓ Smoothness of surface and internal moisture condition of the concrete
- ✓ Carbonation of concrete surface

Testing Method:-

According to ASTM C 805-02 clause 7.1 the concrete members to be tested shall be at least 100mm thick and fixed within a structure. Towelled surfaces generally exhibit high rebound numbers than screed or formed finishes. Do not compare the test results if the form material against which the concrete is placed is not similar.

Heavily textured, soft or surfaces with loose mortar shall be ground flat with abrasive stone. Smooth formed or towelled surfaces do not have to be ground prior to testing.

Also this test is not conducted directly over the reinforcing bars having cover less than 20mm. The surface under test should be clean and smooth because rough surfaces cannot be tested as they do not give reliable results. Dirt or other loose material on the surface can be removed using a grinding stone prior to test. The rebound hammer commercially known, as Schmidt Hammer is a simple hand held device that the measures the rebound of a spring loaded mass from a concrete surface, when released with a known energy. There is a reasonably correlation between surface hardness and compressive strength, and thus the device gives a fair indication of strength or variation in strength. The testing can be carried out on a grid pattern marked on the structure. This grid pattern will be useful for further tests such as Ultrasonic Scanning, Potential Resistivity, and Corrosion Rate measurements. The quality of concrete cover is rated using the Schmidt-Hammer-number as given in Table1 below.

TABLE-1
QUALITY OF CONCRETE COVER
(Comparative Hardness of the cover zone)

Instrument	Average Rebound Number	Quality of Concrete
Schmidt Hammer N-TYPE	Greater than 40	Very good hard layer
	30 to 40	Good layer
	20 to 30	Fair
	Less than 20	Poor concrete
	0	Delaminated
Schmidt Hammer P-TYPE	Above 75	Excellent
	55 to 75	Very Good
	40 to 55	Good
	30 to 40	Reasonable
	20 to 30	Average
	Below 20	Poor

Ultrasonic Pulse Velocity Test

Although there is no fundamental relationship between pulse velocity and strength, an estimation of strength can be obtained by correlation. The method has perhaps a greater potential for comparing known sound concrete with affected concrete. Ultrasonic pulse velocity is a means of assessing variations in the apparent strength of concrete. The quality gradation of concrete can be appraised at best qualitatively as `excellent', `good', `medium' or `doubtful'. The meanings of the term `excellent', `good', `medium' and `doubtful' are based on ultra sonic pulse velocity measured at site and are as per the nomenclature of IS 13311(part-1): 1992.

Objective of testing:-

Ultrasonic pulse velocity test is used to establish the following:

- ✓ Homogeneity of concrete
- ✓ Presence of cracks voids, honeycombing and other imperfections
- ✓ Changes in the structure of concrete which may occur with time.
- ✓ Quality of one element of concrete in relation to another i.e. comparative quality analysis and gradation of concrete.
- ✓ The values of dynamic elastic modulus of the concrete.

References:-

- ✓ BS 6089:1981 and BS 1881:Part203
- ✓ IS 13311:Part1:1992
- ✓ ASTM: C597-83.

Influencing factors:-

The velocity of a pulse of ultrasonic energy in concrete is influenced by the stiffness and mechanical strength of the concrete

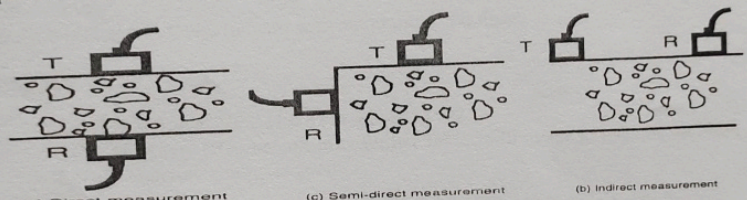
- ✓ Moisture content: The moisture content of the concrete have a small effect in the velocity and can increase the pulse velocity by 2%.
- ✓ Surface condition: The testing surface should be smooth any roughness cannot provide reliable readings because of gap between transducers and testing surface.

- ✓ **Temperature:** Ideal Temperature is between 5^0C and 30^0C; Temperature between 30^0C to 60^0C can reduce the pulse velocity up to 5%; below freezing temperature results in an increase the pulse velocity up to 7.5%.
- ✓ Stress: When concrete is subjected to a stress which is abnormally high for a quality of concrete, the pulse velocity may be reduced due to development of micro-cracks.
- ✓ Reinforcing bars: The velocity measured in reinforced concrete in the vicinity of reinforcing bars is usually higher than in plain concrete because pulse velocity in steel is 1.2-1.9 times the velocity in plain concrete. Wherever possible, measurements should be made in such a way that steel does not lie in the path of the pulse.

Testing method:-

According to IS 13311(Part1):1992 clause 5.2 transducers with a frequency of 50 to 60 kHz are useful for most all round applications, and as per IS 13311(Part1):1992 clause 6.2 the path length should be long enough not to be significantly influenced by the heterogeneous nature of concrete. This test requires a flat surface generally only appropriate for un-spalled surfaces.

In view of inherent variability in the test results, sufficient number of readings should be taken by dividing the entire structure in suitable grid of markings 30x30 cm or even smaller. Each junction point of the grid becomes a point of observation. There are three possible methods of testing according to the type of surface:



(a) Direct measurement (c) Semi-direct measurement (b) Indirect measurement

Table 2: Velocity Criterion for Concrete Quality Grading
[Ref: IS13311 (part-1)]

Sr. No.	USPV by Cross Probing (m/sec)	Concrete Quality Grading.
1	Above 4500	Excellent
2	3500 - 4500	Good
3	3000 – 3500	Medium
4	Below 3000	Doubtful

Non-destructive testing using ultrasonic technique and rebound hammer, at different locations on raft for finding the quality of concrete and other defects. The observations by ultrasonic technique were taken by indirect arrangement at all the locations as per the IS-13311(Part-I) the indirect velocity is invariably lower than the direct velocity on the same concrete element. This difference may vary from 5 to 20 percent depending largely on the quality of the concrete under test. The correction factor of 15% is applied over the UPV test results the velocity found out by ultrasonic method is compared with the IS-standard ie. (IS-13311 part-1) results to find the satisfaction level of quality of concrete.

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3. RESULTS

Visual Inspection:

- No Seepage & Dampness was observed in the building.
- The cover of concrete was found ok as per the requirement.
- No deterioration due to Chlorides and sulphates was observed in any member of the building.
- There were no signs of corrosion in any of the RCC members.
- No defects such as honeycombing, structural cracks and settlement etc were observed.
- There was no affect on concrete because of alkali-silica reaction as crumbling of concrete, spalling, volumetric expansion was not observed.
- The overall condition of the building was observed to be good.
- All the building finishes such as plaster, wooden cladding false ceiling etc were found to be in good condition.
- All the building was found to be in well maintained condition,

3.1 TEST RESULTS

A. Average value of UPV (IS13311-part-I, 1992)

i) **RCC Members (Beams/columns/Slabs)** 3600-3880 m/sec at various locations
Result- concrete quality is good

B. Average value of Rebound Hammer N-Tpye (IS13311-part-I, 1992)

i) Average Rebound No - 40 to 47
Strength range - M25 corresponding to N-Type rebound hammer

4 CONCLUSIONS:

Based on the investigation & study carried out on various members, the following conclusions are drawn:.

- The load carrying capacity of the slab and beams is based on concrete grade M20 and condition of the building is found ok as per the relevant codal provisions.
- The general quality of concrete is in the range of good corresponding to the Ultra sonic Pulse Velocity test.
- The quality of Brick Masonry columns is in the range of very Good to Excellent corresponding to P-Type rebound hammer.
- As per IS code requirement the structure is stable as per test results mentioned above the stability of the building is found to be good.
- Hence based on the above conclusions the occupied building with respect to stability found to be in good condition.

Dr. Sanjay Sharma
Professor & Head
Civil Engineering Department
UIET, Sector 26, Chandigarh

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Prof & Head
Civil engineering Department.

NATIONAL INSTITUTE OF TECHNICAL TEACHERS' TRAINING & RESEARCH
SECTOR-26, CHANDIGARH-160019 (INDIA)
(Established by Ministry of Human Resource Development, Govt. of India)
EPABX: 2759500, 2759514
FAX: 0172-2791366, 2793893

E-mail: director@nitttrchd.ac.in,
Web site: www.nitttrchd.ac.in

NITTTR/CCT&SD/R-1 Dated: 24-06-2021

Headmistress
Govt Model High School,
Sector-12, Chandigarh.

Subject: - Condition assessment and stability certificate
Reference: Your letter no GMHS-12/2021-22/108 on dated 17/06/2021.

Dear Sir/Madam,

As per the site inspection and test results of Non-destructive testing results of Govt. Model High School, Sector-12, Chandigarh. Following conclusions are drawn:

- The average relative strength of concrete varies from 28-35N/mm^2 corresponding to the rebound hammer test.
- The general quality of concrete is in the range of good corresponding to the Ultra sonic Pulse Velocity test.
- The load carrying capacity of the slab and beams can be calculated based on concrete grade**M25** and design is found ok as per the relevant codal provisions.
- The load carrying capacity of the column can be calculated based on concrete grade=**M25**
- Since the quality of concrete is very good, it shows the absence of corrosion, honeycombing, cracks and voids etc at the locations where test were conducted.
- As per test results mentioned above the construction is carried out as per the approved design and drawings.
- All the building blocks were found to be in well maintained condition. The existing structure design is stable as per IS Code requirement.
- The drawings and design of the buildings are also checked in accordance with the relevant Indian Standard Codes (with latest amendments) including Indian Standard Codes for structure resistant to earthquake.
- The occupied buildings with respect to stability, found to be in good condition.

Dr. Sanjay Sharma
Head
Engineering Department
NITTTR, Sector 26, Chandigarh

Dr. Sanjay Sharma
Prof. & Head
Civil engineering Department.