DEPARTMENT OF CIVIL ENGINEERING

Subject (Name and Code): NDT of Concrete Structures (CIE 4080) Semester: VII

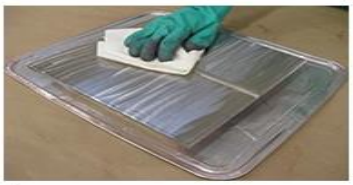
Date of the Examination: Month/Year: 2023

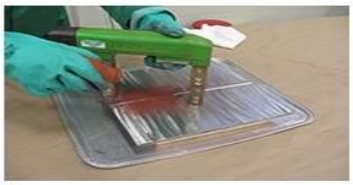
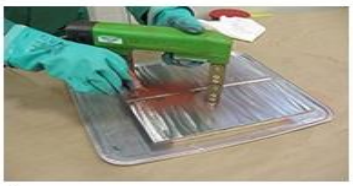
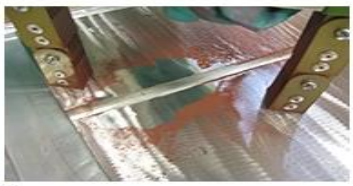
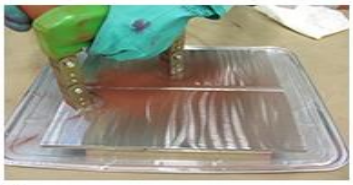
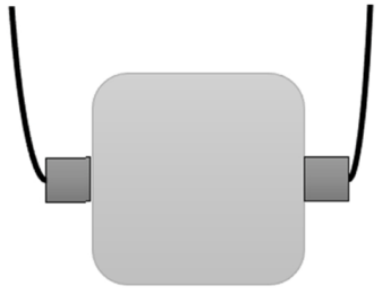
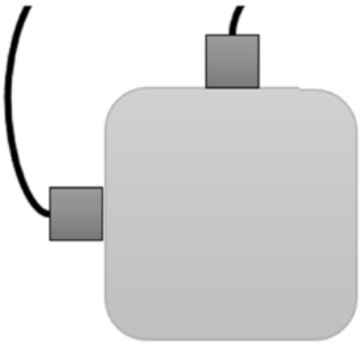
Name of the Faculty Member: GMG Head of the Department: Dr PGS

SCHEME OF EVALUATION (END SEMESTER)

<table>
<tr><th>Q.No</th><th>Questions</th><th>Marks</th></tr>
<tr><td>1A</td><td>VIT is performed as a preliminary investigation of concrete.
It enables us to detect defects open to the surface.
It is most economical inspection technique but limited to surface defect only.</td><td>1+1=2</td></tr>
<tr><td>1B</td><td>LT enables us to detect any leakages in tubes thus ensuring the safety against any loss of pressure inside the tube, no escape of toxic fluid to surroundings and improving the efficiency of fluid transport.</td><td>1+1+1=3</td></tr>
<tr><td>1C</td><td>
<table>
<tr><th>Index</th><th>Defect</th><th>causes</th><th>effect</th><th>Remedial measures</th></tr>
<tr><td>a</td><td>Plastic shrinkage crack</td><td>Cracking that occurs in the surface of fresh concrete soon after it is placed and while it is still plastic. Improper mix design, presence of silt and clay in sand.</td><td>Durability of the structure</td><td>Grouting</td></tr>
<tr><td>b</td><td>Chalking</td><td>The formation of loose powder resulting from the disintegration of the surface of concrete or an applied coating such as cementitious coating.</td><td>No major effect on structure</td><td>Resurfacing or re-plastering if required</td></tr>
</table>
</td><td>1.5+1+1.5+1=5</td></tr>
</table>

		c	Efflorescence	Deposit of salts, usually white, formed on a surface, the substance having emerged in solution from within either concrete or masonry and subsequently been precipitated by a reaction, such as carbonation or evaporation.	Durability of concrete structure	Resurfacing or re-plastering	
		d	Mortar flacking	a form of scaling over coarse aggregate.	Durability of structure.	Resurfacing or re-plastering	
2A	It is not the true measure of concrete's strength/quality. It damages the concrete. May damage the reinforcement. Cracks caused after testing will affect the durability of the structure.						**0.5*4=2**
2B		NDT of corrosion of reinforcement in concrete	Merits/Demerits				**Any 3, 1*3=3**
		Half-cell potential	Simple and economical however qualitative				
		Radiography	Effective but expensive and hazardous				
		GPS	Effective but expensive and requires skills to interpret the result				
		Wenner Probe	Simple and cost effective but cannot measure rate of corrosion.				
2C	Definition and explanation of test procedure						**1+4=5**

<table>
<tr><td>3A</td><td>

1.
Clean the surface to be examined. This may be accomplished using detergents, organic solvents, descaling solutions, paint removers, vapor degreasing, sand or grit blasting, or ultrasonic cleaning methods.

2.
Introduce a magnetic field into the part.

3.
Apply the ferromagnetic medium while the part is still magnetized.

4.
Remove excess ferromagnetic medium with a light air stream from a bulb, syringe, or other source of low-pressure dry air.

5.
Interpret and evaluate any indications to the applicable acceptance standard.

6.
Turn the yoke 90 degrees from the original position and repeat steps 2-5. Clean and demagnetize if necessary.
</td><td>1+1(dia.) = 2</td></tr>
<tr><td>3B</td><td>
<table>
<tr><td>  </td><td>Direct: most effective and accurate. Ensure the effective transmission of ultrasound. Widely preferred.</td></tr>
<tr><td>  </td><td>Semi-direct: effectiveness and accuracy are lesser than the direct method. Preferred for inspection of columns, and large sections.</td></tr>
</table>
</td><td>1.5+1.5 (dia.) = 3</td></tr>
<tr><td>3C</td><td>Computed tomography (CT) involves the generation of cross-sectional views instead of a planar projection. The CT image is comparable to that obtained by making a radiograph of a physically sectioned thin planar slab from an object.
This cross-sectional image is not obscured by overlying and underlying structures and is highly sensitive to small differences in relative density. Moreover, CT images are easier to interpret than radiographs.
Basic Principles of Computed Tomography
The basic technique of computed tomography is illustrated in Fig. A thin slice of the</td><td>3+2 (dia.) = 5</td></tr>
</table>

testpiece is interrogated with a thin beam of radiation, which is attenuated as it passes through the testpiece. The fraction of the x-ray beam that is attenuated is directly related to the density and thickness of material through which the beam has traveled and to the composition of the material and the energy of the x-ray beam. Computed tomography utilizes this information, from many different angles, to determine cross-sectional configuration with the aid of a computerized reconstruction algorithm. This reconstruction algorithm quantitatively determines the point-by-point mapping of the relative radiation attenuation coefficients from the set of one-dimensional radiation measurements.

The CT scanning system contains a radiation source and radiation detector along with a precision manipulator to scan a cross-sectional slice from different angles. The x-ray detector is usually a linear array, that is, a series of individual x-ray sensors arranged in a line. The x-ray source is collimated to form a thin fan beam that is wide enough to expose all of the detector elements (Fig). The narrow beam thickness defines the thickness of the cross-sectional slice to be measured. The data acquisition system reads the signal from each individual detector, converts these measurements to numeric values, and transfers the data to a computer to be processed. To obtain the full set of transmission data required to produce the CT image, the object, source, or detector moves while a sequence of measurements is made. This motion may involve rotation of the test object relative to the source and the detector array (Fig.) or a combination of rotation and translation. The various types of scanning geometries are discussed in the section "CT System Design and Equipment" in this article.

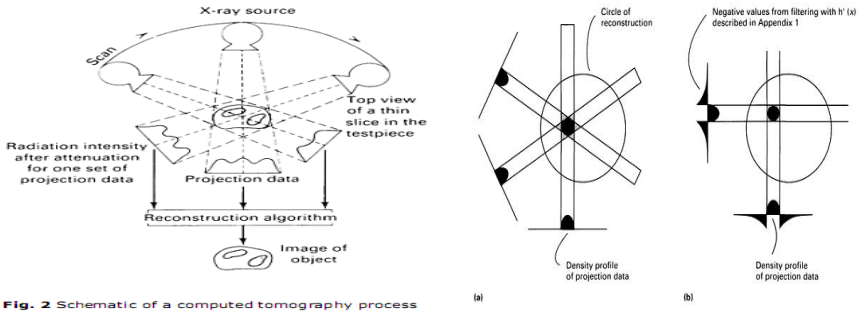


Fig. 2 Schematic of a computed tomography process

4A

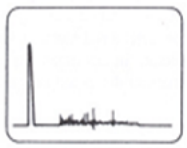
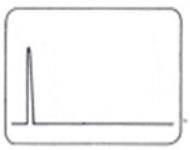
Potential difference levels (mv)	Chance of re-bar being corroded
less than –500	visible evidence of corrosion
-350 to -500	95%
-200 to -350	50%
More than -200	5%

2

4B — **3**

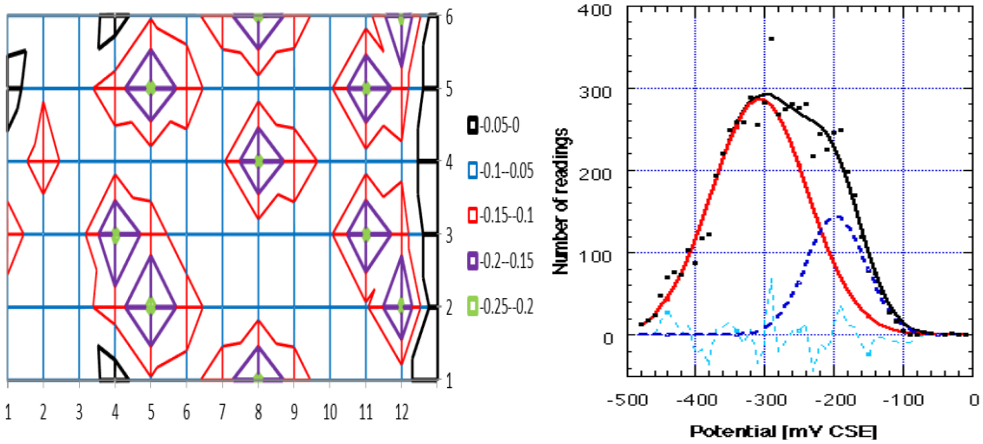
Longitudinal pulse velocity		Quality of concrete
km/s.10^3	ft/s	
>4.5	>15	excellent
3.5-4.5	12-15	good
3.0-3.5	10-12	doubtful
2.0-3.0	7-10	poor
<2.0	<7	very poor

4C — **2+2+1=5**

Index	Defect	Sonogram – A scan	Description
a	Micro-porosity		'grass' on the CRT trace and with loss of the back wall echo.
b	Spherical inclusion		a small defect echo coupled with a small back-wall echo
c	Plane defect at some angle		no echo

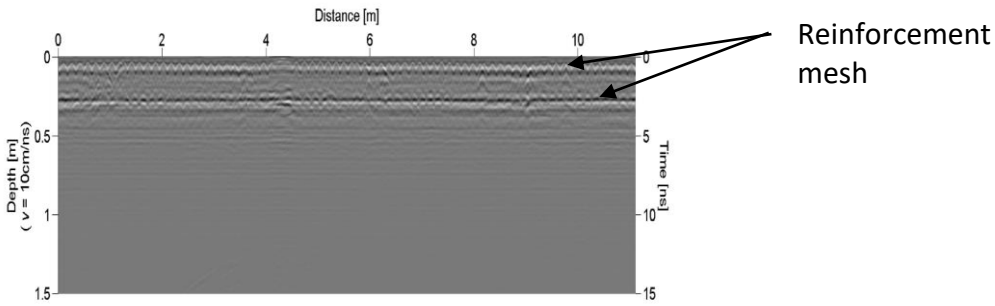
5A — **1+1 = 2**

Measurements can be presented either with a equipotential contour map which provides a graphical delineation of areas in the member where corrosion activity may be occurring or with a cumulative frequency diagram which provides an indication of the magnitude of affected area of the concrete member.



5B — **1.5+1.5 = 3**

Figure shows the GPR map collected along the circumference of the well. A set of distinct parabolas can be easily identified at a depth of approximately 3.5 cm and

	21.5 cm. It indicate regularly spaced (at a distance of about 20 cm) steel reinforcing meshes. Strong reflection form the underside of the well is visible at a depth of about 25 cm.  	

5C

Defect id	Type of probe and probe technique	Description	Wave signature
1	Normal probe and reflection technique	Here transmission probe technique can also be adopted. The defect is compound, tensile crack located close to the surface in the tension zone. When the probe is placed over the defect portion, strong defect echoes, with amplitude greater than backwall echo are produced. The defect echoes are found close to the initial pulse echo indicating the defect is present near to the surface.	Please refer the description to understand the nature of wave signatures.
2	Normal probe and reflection technique	Here transmission probe technique can also be adopted. The defect is compression cracks. The probe should be placed opposite to the defect. This is because, if the probe is kept above the defect, the defect may not be effectively detected due to null zone. When the probe is placed opposite to the defect portion, strong defect echoes with larger amplitude then the backwall echo is produced. The defect echoes will be situated away from initial pulse echo but close to backwall echo indicating the location of defect.	-Ditto -

5

3	Norma probe, indirect transmission probe technique	The defect is diagonal crack (not necessarily shear crack). Here reflection probe technique cannot be used because, when used may produce initial pulse only. When indirect transmission is used, wherein the probes are held side by side over the defect portion in tension zone, there can be defect echo with amplitude slightly more than backwall echo.	-Ditto -	
4	Not applicable	Honeycomb is not a structural defect and it is the type of surface defect caused due the poor workmanship. Honeycomb normally can be recognised by visual inspection. If Ultrasound is used, the sound wave will get reflected in all directions.	-Ditto -	
5	Normal probe and reflection technique	Here transmission probe technique can also be adopted. The defect is diagonal crack (not necessarily shear crack). When reflection technique is used, mild defect echoes will be formed close to initial pulse echo which will be followed by little or no backwall echo.	-Ditto -	
6	Normal probe and reflection technique would be ineffective. Norma probe, direct	The defect is elliptical in nature. Therefore, when normal probe and reflection technique would be ineffective because the ultrasound waves will get reflected in lateral direction upon	-Ditto -	

	transmission probe technique can be used.	interacting with elliptical defect.	
7	Normal probe and reflection technique	Here transmission probe technique can also be adopted. The defect is not a tensile crack, compression crack and shear crack. When reflection probe technique is used, there would be initial pulse echo followed by defect echoes and little or no backwall echo. The defect echoes will be situated nearly mid, between initial and backwall echo representing the defect position.	-Ditto -
8	Same as 2	Same as 2	