

Specification No: SIM2018CONCRETE

Title: Nondestructive location and marking of critical embedment's in concrete.

Purpose:

The purpose of this specification is to provide engineers and specifiers a suggested framework for detailing the minimum requirements for a nondestructive subsurface investigation in concrete.

Accompanying Documents:

- Practice SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing, GPR*.
- Subsurface Investigation Methodology (*SIM*), White Paper

1. Codes, Standards & Definitions

- 1.1 Occupational Safety and Health Administration Safety and Health Standards Digest Construction Industry (OSHA) - 3149/1996)
- 1.2 American Society for Nondestructive Testing, (ASNT). The ASNT is the world's largest technical society for nondestructive testing (NDT) professionals. The society provides a forum for exchange of NDT technical information; NDT educational materials and programs; as well as standards and services for the qualification and certification of NDT personnel.
- 1.3 Recommended Practice No. SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing. This Recommended Practice establishes the general framework for a qualification and certification program. In addition, the document provides the educational experience and training recommendations for different test methods including use and application of ground penetrating RADAR. This recommended practice is not intended to be used as a strict specification. It is recognized, however, that contracts require programs which meet the intent of this document. For such contracts, purchaser and supplier must agree upon acceptability of an employer's program.
- 1.4 Federal Communications Division, (FCC). The Federal Communications Commission (FCC) is an independent United States government agency. The FCC was established by the Communications Act of 1934 and is charged with regulating interstate and international communications by radio, television, wire, satellite and cable. The concrete scanning contractor shall adhere to all applicable safety guidelines in accordance with federal, state, and local ordinances.
- 1.5 Definitions
 - 1.5.1 **Subsurface Investigation Methodology, (SIM)** – Set of methods, field motoring, and necessary equipment required for a complete subsurface investigation of a concrete structure resulting in an on-slab mark out of critical targets, examples being: PVC conduits, structural steel reinforcement, post tension cables, and other embedment's.
 - 1.5.2 **Owner** – Legal owner of the structure to be scanned.
 - 1.5.3 **Contracting agency** – The contractor hired directly or indirectly by the owner who is sub-letting the scanning requirements to a scanning contractor.
 - 1.5.4 **Scanning contractor** – The contractor hired to perform the scanning operation.
 - 1.5.5 **Embedments / Targets** – Objects within the area to be scanned that could be damaged during a coring or cutting operation within that area. Example of embedments are reinforcing rod, cable and utilities such as electrical power and communication lines.
 - 1.5.6 **Ground Penetrating Radar (GPR)** – A geophysical method that uses pulses of electromagnetic wave energy to image the subsurface. Ground penetrating

radar transmits energy in the microwave band of the of the electromagnetic spectrum

- 1.5.7 **Frequency** – The frequency describes the number of waveforms transmitted from a GPR antenna per second. Frequency is measured in cycles per second, or Hertz (Hz).
- 1.5.8 **Suspended Concrete Slab** – Suspended slabs are above-ground slabs which are not directly in contact with the earth. They are commonly used to create floors for the upper stories of buildings.
- 1.5.9 **Concrete Slab on Grade** – A concrete slab that is to serve as the foundation for the structure is formed from a mold set into the ground. The concrete is then placed into the mold, leaving no space between the ground and the structure.
- 1.5.10 **Structural metal decking** – Metal decking, pan decking or form decking can be any floor or roof deck product used as a concrete form. It typically is connected to a structural metal frame through welding or metal fasteners. Steel reinforcement will be installed on the decking surface to accommodate concrete specifications.
- 1.5.11 **Line Scan** – Collection of one straight line of GPR data resulting in the display of a cross-sectional depth representation of the RADAR signal moving through the material scanned.
- 1.5.12 **Electromagnetic locator (EM)** – Also known as a pipe and cable locator, is used for tracing utility lines, metallic pipes and clearing excavation and drilling locations. These utility locators consist of two main parts, a transmitter and a receiver.

2. SIM Prerequisite Qualifications

- 2.1 Scanning contractor shall submit certification of experienced-based training that meets or exceeds the guidelines detailed in ASNT document 'Recommended Practice SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing Level I*'. The ASNT document recommends 8 hours as a minimum for training and a minimum of 60 hours practicing GPR in order to be a certified NDT Level I in Ground Penetrating Radar.
- 2.2 Scanning contractor shall utilize detailed methods, Subsurface Investigation Methodology, SIM requirement for competent field personnel:
 - 2.2.1.1 Field mentoring, 4 weeks of application training from mentor.
 - 2.2.1.2 80 hours of classroom curriculum, GPR theory, test slab training, SIM investigative method training.
 - 2.2.1.3 Post classroom training mentoring, 4-week practical application of testing equipment and investigative methods.
- 2.3 Field technicians shall maintain minimum OSHA 10 safety training certificate.
- 2.4 Scan contractor insurance requirements, commercial liability insurance \$1,000,000 limit with \$5,000,000 umbrella (includes auto and worker comp), professional liability \$2,000,000 limit.
- 2.5 GPR equipment provided by scanning contractor:
 - 2.5.1.1 Ground penetrating radar system, to include:

- 2.5.1.2 Radar Data Acquisition System/Controller with integrated display.
- 2.5.1.3 Applicable RADAR antennas, utility and concrete. Concrete antennas shall be capable of cross-polarizing for embedded PVC conduit investigation.
- 2.5.1.4 Miscellaneous hardware, cables, hand cart, marking tape, and power supply.

2.6 Electromagnetic Locating Equipment, "Pipe Locator":

- 2.6.1.1 Capable of receiving electromagnetic and communication line frequencies passively or induced from potentially imbedded power or communication lines.

3. Investigation Scope

3.0 Scanning contractor will utilize available as-builts and prints/plans and previously detailed equipment to locate and mark out steel reinforcement, conduits, and other anomalies within slab.

- 3.1 This mark out may include depth estimates of targets.
- 3.2 If the scan area includes a slab on grade and the post scan work requires trenching, a lower frequency antenna may be used to locate targets in the backfill material under the slab.
- 3.3 Review of equipment capabilities and potential job-site performance impedances.

4. SIM Pre-scan Investigation

4.0 SIM Pre-investigation Steps:

- 4.1 Job Hazard Analysis, form review, or equal site safety review documentation. Review and sign site safety plan if applicable.
- 4.2 Site walk and project scope meeting, review scan locations. Note: look for visible clues such as electrical rooms, PT grout pockets, visible conduits, etc.
- 4.3 Site contact interview, slab construction, thickness, age, anticipated critical targets.
- 4.4 Request to view the slab underneath if a suspended slab.
- 4.5 Determine whether GPR data samples be required for reporting.
- 4.6 Type of markings (permanent vs. temporary)
- 4.7 Client deliverable requirements, report format/documentation

5. SIM Scanning Procedures

5.0 Quality of scan data

- 5.1 It is recommended that the scanning contractor calibrate the GPR system to the concrete. This calibration may be estimated or a test performed to determine the correct dielectric of the concrete. This may be an automated function of the equipment.
- 5.2 Perform several line scans in the scan area to determine a rough understanding of how the structural reinforcement travels in the concrete and the potential for other targets.
- 5.3 Note the ability to see the bottom of the concrete slab. If it is not apparent, determine possible reasons for its not being seen.
- 5.4 Review the clarity of the scan data. Adjustments in gain and other settings may be necessary.

6. SIM Methods for Complete Investigation

- 6.0 Follow and document the SIM methods applied.
 - 6.1 Confirm information slab specification as detailed by site contact or available prints.
 - 6.1.1 Basic structure of slab reinforcement.
 - 6.1.2 Thickness of slab.
 - 6.1.3 Slab on grade.
 - 6.1.4 Suspended slab construction.
 - 6.2 Scan and mark targets in the scan area.
 - 6.2.1 Collect line scan data perpendicular to steel reinforcement targets.
 - 6.2.2 Mark out one target at a time in one direction at a time.
 - 6.2.3 Mark a minimum of 3 points per item.
 - 6.2.4 Draw all lines using a straight edge.
 - 6.2.5 Draw each target 1" wide or greater depending on the type of target and the situation.
 - 6.2.6 Use continuation arrows at the end of each line if the item continues beyond the scan area.
 - 6.2.7 Check findings using angled scans with at least 2 scans at each 45-degree angle.
 - 6.2.8 Check findings using cross polarized scans with at least 2 scans at each 90-degree angle.
 - 6.2.9 Check accuracy of all markings by inserting a reference dash at the center of each marking while scanning forward.
 - 6.2.10 Use electromagnetic receiver and transmitter to connect to exposed utilities if possible.
 - 6.2.11 Perform a passive sweep of each area with electromagnetic receiver using both Power and Radio modes.
 - 6.2.12 Mark the scan boundaries for each scan location.
 - 6.2.13 Document findings with photos and additional reporting if required.

7. SIM Post investigation hand off

- 7.0 If possible, a recap and review of findings with site contact
 - 7.1 Explain scan findings, where did the technologies work well and where results were inconclusive due to interference and or site conditions.
 - 7.2 Explain markings and depth estimates.
 - 7.3 Review original scope to confirm expectations were met/exceeded.

Conclusion:

This specification details steps and methods that ensure the best nondestructive scan results. There is an emphasis on the value of training and mentorship because of the many potential scenarios a field technician may encounter and the many ways the equipment can be applied. The SIM approach, (experienced-based training combined with technology) has proven to be consistently accurate and efficient in accounting for site variability.

Please visit www.simspec.org for more information and detailed SIM specification.