
Measuring Needs

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PAVEMENTS: GENERAL DESIGN INFORMATION NEEDS IN RENEWAL PROJECTS

- **Past monitoring and performance (condition surveys, deflection testing)**
- **Age**
- **Extent and severity of distress**
- **Presence of defects**
- **Structural strength (Layer moduli)**
- **Ride, Skid**
- **Adequacy of drainage**
- **traffic (makeup, expected, growth)**
- **need for soil stabilization**
- **potential for reclaiming existing materials**

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

PAVEMENTS: GENERAL CONSTRUCTION INFORMATION NEEDS IN RENEWAL PROJECTS

- Smoothness**
- Density**
- Uniformity (material and construction)**
- Consistent material**
- Consistent production**
- Consistent laydown**

PAVEMENTS: GENERAL PERFORMANCE MONITORING INFORMATION NEEDS IN RENEWAL PROJECTS

- Occurrence of distress (visual distress rating)**
- Change in functional properties with time**
- Change in structural properties with time**
- Changes in traffic volume and makeup**
- Durability (for concrete – permeability, chloride penetration, etc.)**

FLEXIBLE PAVEMENTS: BASIC DESIGN PROPERTIES NEEDED FOR RENEWAL PROJECTS

- **Modulus or stiffness of layers**
- **Material characterization (stripped ACP, degree of bonding, chemical properties such as sulfates)**
- **Linear variability throughout section (uniformity of cross section, material properties, and subgrade support)**
- **Rutting potential of existing layers**
- **Subgrade support**
- **Thickness**

FLEXIBLE PAVEMENTS: BASIC DESIGN PROPERTIES NEEDED FOR RENEWAL PROJECTS (continued)

- **Poisson's Ratio**
- **Expansive or Soft Soil Concerns**
- **Soils concerns in a freeze/thaw environment**
- **Sulfates/organics in soils**
- **Drainage characteristics**
- **Existing defects**
- **Parameters needed for ME design**

FLEXIBLE PAVEMENTS: BASIC CONSTRUCTION PROPERTIES NEEDED FOR RENEWAL PROJECTS

- **Density**
- **Thickness**
- **Ride quality (IRI or other)**
- **ACP content**
- **ACP segregation**
- **ACP volumetrics**
- **Moisture content**
- **Layer Uniformity**
- **Shear strength between layers**
- **Stabilizer type and content**

FLEXIBLE PAVEMENTS: BASIC PERFORMANCE MONITORING PROPERTIES NEEDED FOR RENEWAL PROJECTS

- **Distress rating/measurement (including rut depth)**
- **Ride quality (IRI or other)**
- **Skid**
- **Noise**

RIGID PAVEMENTS: BASIC DESIGN PROPERTIES NEEDED FOR RENEWAL PROJECTS

- **Load transfer efficiency of joints**
- **Degree of faulting**
- **Thickness**
- **Layer moduli**
- **Quality of slab support**
- **Presence of voids**
- **Condition of concrete**
- **Defects in concrete**
- **Linear variability throughout section (uniformity of cross section/material properties/subgrade support)**

RIGID PAVEMENTS: BASIC DESIGN PROPERTIES NEEDED FOR RENEWAL PROJECTS (Continued)

- **Drainage conditions**
- **Aggregate Coefficient of Thermal Expansion**
- **Poisson's Ratio**
- **Expansive or Soft Soil Concerns**
- **Soils concerns in a freeze/thaw environment**
- **Sulfates/organics in soils**
- **Drainage characteristics**
- **Existing defects**
- **Parameters needed for ME design**

RIGID PAVEMENTS: BASIC CONSTRUCTION PROPERTIES NEEDED FOR RENEWAL PROJECTS

- Ride quality (IRI or other)**
- Thickness**
- Compressive strength**
- Flexural Strength**
- Aggregate Coefficient of Thermal Expansion**
- Texture**
- when to open to traffic**
- Moisture content**
- Layer Uniformity**
- Shear strength between layers**
- Stabilizer type and content**

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

RIGID PAVEMENTS: BASIC PERFORMANCE MONITORING PROPERTIES NEEDED FOR RENEWAL PROJECTS

- **Distress rating/measurement (including%
cracking)**
- **Ride quality (IRI or other)**
- **Load Transfer**
- **Texture**
- **Faulting**
- **Pumping**
- **Skid Resistance**
- **ASR/DEF formation**
- **Noise**

BRIDGES: GENERAL DESIGN INFORMATION NEEDS FOR RENEWAL PROJECTS

General:

- Past monitoring

Deck:

- Type and extent of existing defects

Foundation

- Condition of support columns
- Erosion potential (Scour)
- Settlement

BRIDGES: GENERAL CONSTRUCTION INFORMATION NEEDS FOR RENEWAL PROJECTS

- Uniformity and adequacy of repair techniques**
- Smoothness**
- Skid Resistance**

BRIDGES: GENERAL PERFORMANCE MONITORING INFORMATION NEEDS FOR RENEWAL PROJECTS

- Changes in engineering properties with time**
- Cold weather performance (skid)**

BRIDGES: BASIC DESIGN PROPERTIES NEEDED FOR RENEWAL PROJECTS

- Concrete and Steel Modulus**
- Concrete Compressive Strength**
- Yield Strength of Steel**
- Soil Shear Strength**
- Rate of steel corrosion**
- Existing defects in structural members**
- Foundation materials and strengths**

BRIDGES: BASIC DESIGN PROPERTIES NEEDED FOR RENEWAL PROJECTS (continued)

- Piling capacities**
- Existing pile depths**
- Liquefaction potential**
- Streambed characteristics**
- Presence of lead based paint on existing members**
- Treated timber properties**

BRIDGES: BASIC CONSTRUCTION PROPERTIES NEEDED FOR RENEWAL PROJECTS

- Concrete Compressive Strength**
- Concrete permeability**
- Yield Strength of Steel**
- Defects in structural members**
- Defects in Connections (NDT at the fabrication plant)**

BRIDGES: BASIC PERFORMANCE MONITORING PROPERTIES NEEDED FOR RENEWAL PROJECTS

- Visual Distress Rating**
- Defects in structural members**
- Defects in Connections**
- Scour of Foundations**
- Fatigue cracking**
- ASR/DEF**
- Rate of steel corrosion**

EARTHWORKS: GENERAL DESIGN INFORMATION NEEDS FOR RENEWAL PROJECTS

- Variability of materials types**
- Profile with depth**
- Engineering properties of materials**
- Drainage**
- Soil properties**
- In place characteristics**
- Uniformity of material strength and thickness**

EARTHWORKS: GENERAL CONSTRUCTION INFORMATION NEEDS FOR RENEWAL PROJECTS

- Compaction profile**
- Moisture content**
- Stiffness**

EARTHWORKS: GENERAL PERFORMANCE MONITORING INFORMATION NEEDS FOR RENEWAL PROJECTS

- Changes in engineering properties with time**
- Impact of Moisture**

EARTHWORKS: BASIC DESIGN PROPERTIES NEEDED FOR RENEWAL PROJECTS

- Atterberg Limits (PI)**
- Soil/Rock Classification**
- Shear Strength (i.e., CBR, etc.)**
- Density**
- Stiffness**
- Expansive or Soft Soil Concerns**
- Existing defects**
- Sulfates**
- Presence of Collapsible soils**
- In place moisture content**

EARTHWORKS: BASIC CONSTRUCTION PROPERTIES NEEDED FOR RENEWAL PROJECTS

- Density**
- Atterberg Limits (PI)**
- Swell**
- Shear Strength**
- Consolidation**
- % sulfate & pH**
- In place moisture content**

EARTHWORKS: BASIC PERFORMANCE MONITORING PROPERTIES NEEDED FOR RENEWAL PROJECTS

– Visual Distress Rating

TUNNELS: GENERAL DESIGN INFORMATION NEEDS FOR RENEWAL PROJECTS

- **Presence and extent of defects such as voids**
- **Locating trapped moisture**
- **Deterioration of liner rebars and concrete,
insufficient rebar cover,**
- **Member condition**
- **Groundwater build up,**
- **Concrete cracks**

TUNNELS: GENERAL DESIGN INFORMATION NEEDS FOR RENEWAL PROJECTS (continued)

- Leakage/seepage characteristics,**
- Portal stability and deterioration of ground support and retaining wall structural,**
- Remaining fatigue life**
- Improving lighting, ITS, fire detection, and drainage**
- Drainage system effectiveness**

TUNNELS: GENERAL CONSTRUCTION INFORMATION NEEDS FOR RENEWAL PROJECTS

- Uniformity of repair techniques**
- Adequacy of repairs,**
- QA/QC of the repair to meet design
criteria/requirements**

TUNNELS: GENERAL PERFORMANCE MONITORING INFORMATION NEEDS FOR RENEWAL PROJECTS

- Changes in engineering properties with time**
- Check adequacy of repair and plan follow up maintenance**
- Remaining fatigue life**

TUNNELS: BASIC DESIGN PROPERTIES NEEDED FOR RENEWAL PROJECTS

- **Design criteria satisfying up-to-date static and seismic codes**
- **Concrete and Steel Modulus**
- **Concrete Compressive Strength**
- **Charpy Notch Values**
- **Yield Strength of Steel**

TUNNELS: BASIC DESIGN PROPERTIES NEEDED FOR RENEWAL PROJECTS (continued)

- Soil/rock strength Properties**
- Existing defects**
- Deterioration/degradation of the supporting soil/rock structure due to ground movement associates with slope instability, seismic loading or adjacent surface/underground construction/development activities**

TUNNELS: BASIC CONSTRUCTION PROPERTIES NEEDED FOR RENEWAL PROJECTS

- Compressive Strength of concrete and shotcrete**
- Yield Strength of Steel**
- Defects in Steel Members**
- Defects in Connections (NDT at the fabrication plant)**
- Thickness of the shotcrete and concrete, reinforcement rebars, and concrete/shotcrete cover requirements**

TUNNELS: BASIC PERFORMANCE MONITORING PROPERTIES NEEDED FOR RENEWAL PROJECTS

- Visual Distress Rating**
- Defects in Steel Members**
- Defects in Connections**
- ASR/DEF**
- Crack growth**
- Fatigue Cycles**

OTHER STRUCTURES: GENERAL DESIGN INFORMATION NEEDS FOR RENEWAL PROJECTS (Retaining walls)

- Past monitoring**
- Presence of Voids, trapped water**
- Functionality of drainage systems**
- Movement**
- Corrosion**

OTHER STRUCTURES: GENERAL CONSTRUCTION INFORMATION NEEDS FOR RENEWAL PROJECTS

- Uniformity and adequacy of repair techniques**
- movement**

OTHER STRUCTURES: GENERAL PERFORMANCE MONITORING INFORMATION NEEDS FOR RENEWAL PROJECTS

- Changes in engineering properties with time**
- Adequacy of drainage**
- Movement**
- Corrosion**

OTHER STRUCTURES: BASIC DESIGN PROPERTIES NEEDED FOR RENEWAL PROJECTS

- Existing defects**
- Movement**
- Corrosion**

OTHER STRUCTURES: BASIC CONSTRUCTION PROPERTIES NEEDED FOR RENEWAL PROJECTS

– Movement

OTHER STRUCTURES: BASIC PERFORMANCE MONITORING PROPERTIES NEEDED FOR RENEWAL PROJECTS

- Movement**
- Corrosion**

Types of Projects Proposed:

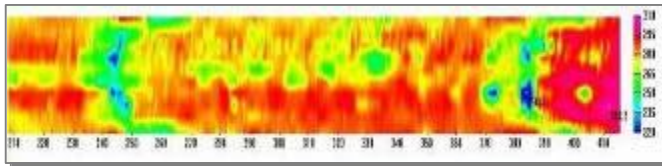
- Demonstration projects
 - Technology transfer of implemented NDT techniques
- Focused development projects
 - Promising technology where more development is needed
- Experimental research projects
 - DOT need identified and several technologies can be used to address need
- Unfulfilled needs
 - No current NDT technique

PAVEMENT NDT NEEDS

- **Priority 1 - New nondestructive quality control tools for ensuring quality construction (Construction)**
- **Priority 1 - Interlayer bonding (Design, Construction, and Performance Monitoring)**
- **Priority 1 - Continuous Deflection Device at the Highest Possible Speed (Design and Performance Monitoring).**
- **These were ranked as first priority because the team believes addressing these needs would have more significant impact on pavement renewal projects than the other needs.**

Projects That Address New Nondestructive Quality Control Tools for Ensuring Quality Construction (Construction)

- D1: Infrared and GPR for Uniformity Measurements on New HMA Layers
- D2: Inertial Profilers for Construction Testing of Pavement Smoothness
- F1: FTIR/XRF/Raman Spectrography to Fingerprint Construction Materials
- F4: Real-Time Smoothness Measurements on PCC Pavements During Construction



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Project That Addresses Interlayer Bonding (Design, Construction, and Performance Monitoring)

- E1: Nondestructive Testing to Identify Delaminations between HMA Layers



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Project That Addresses Continuous Deflection Device at the Highest Possible Speed (Design and Performance Monitoring)

- F2: Development of Continuous Deflection Sensors



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

PAVEMENT NDT NEEDS

- **Priority 2 - Plant Quality Control (Construction); Experimental Research to use various tools**
- **Priority 2 - Layer Thicknesses (Design, Construction, and Performance Monitoring); GPR Demonstration Project and Focused Development Project for Air-Coupled Ultrasound**
- **Priority 2 - Layer Material Properties (Design, Construction, and Performance Monitoring); Experimental Research to merge technologies**
- **Priority 2 - Identifying Problematic Soils (Design and Construction); Unfulfilled Need**
- **Priority 2 - Early Detection of Concrete Deterioration Mechanisms (Design and Performance Monitoring); Experimental Research to evaluate and integrate tools**

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

PAVEMENT NDT NEEDS

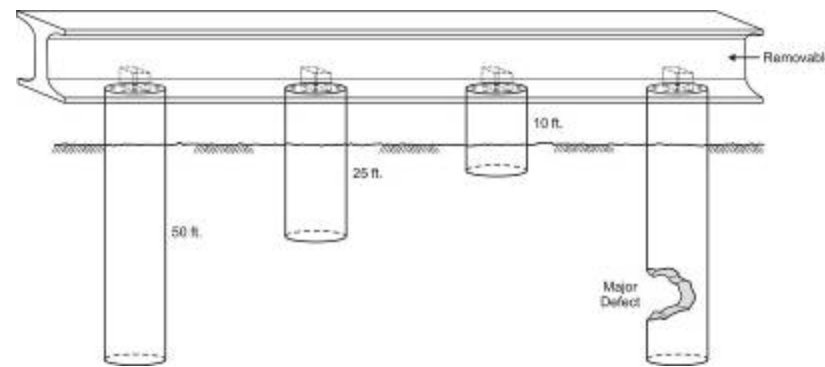
- **Priority 3 - Distress Measurements (Design and Performance Monitoring); Demonstration Project involving various techniques**
- **Priority 3 - Performance Monitoring of Profiles of Riding Quality and Dynamic Loads (Performance Monitoring); Focused Development project to improve methods**
- **Priority 3 - Pavement Surface Properties for Safety and Noise Issues (Design, Construction, and Performance Monitoring); Focused Development project for laser based systems**

BRIDGE NDT NEEDS

- **Priority 1 - Foundation Investigation Tools Where Concerns Exist (Design, Construction, and Performance Monitoring)**
- **Priority 1 - Automated methods of accurately profiling bridges (Performance Monitoring and Construction)**
- **Priority 1 - Identify deterioration of bridge decks, including the cause of deterioration (Design and Performance Monitoring)**
- **These were ranked as first priority because the team believes addressing these needs would have more significant impact on bridge renewal projects than the other needs.**

Project That Addresses Foundation Investigation Tools Where Concerns Exist (Design, Construction, and Performance Monitoring)

U1: New Technologies for Mapping Unknown Bridge Foundations



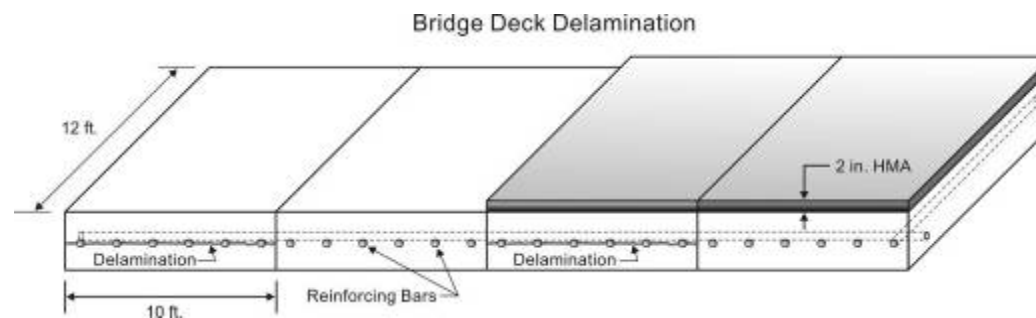
PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Project That Addresses Automated Methods of Accurately Profiling Bridges (Performance Monitoring and Construction)

- U2: Detecting Movement in Structures with Inertial Profile Data

Project That Addresses Identifying Deterioration of Bridge Decks, Including the Cause of Deterioration (Design and Performance Monitoring)

- E2: Nondestructive Testing to Identify Bridge Deck Deterioration



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

BRIDGE NDT NEEDS

- **Priority 2 - Scour around Bridge Support systems (Design and Performance Monitoring); Experimental Research to develop monitoring systems**
- **Priority 2 - Identifying fatigue and fracture damage in structural elements (Design and Performance Monitoring); Demonstration Project for Ultrasonic Scanning**
- **Priority 2 - Detecting problems at bridge approaches, including abutments (Design and Performance Monitoring); GPR demonstration project**
- **Priority 2 - Early detection of concrete deterioration mechanisms (Design and Performance Monitoring); Experimental research to identify and integrate tools**
- **Priority 2 - Reinforcing steel corrosion (Design and Performance Monitoring); Experimental research to identify and integrate tools**

BRIDGE NDT NEEDS

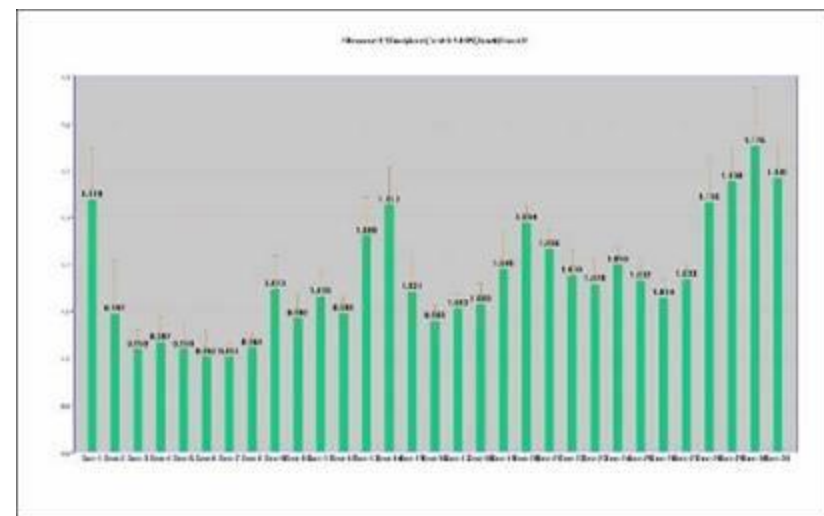
- **Priority 3 - Corrosion of steel elements for steel bridges (Design and Performance Monitoring); Experimental Research**
- **Priority 3 - Global testing of bridge structures to identify deficiencies in the structures (Design and Performance Monitoring); Modal (Vibration) Analysis Demonstration Project**

EARTHWORKS NDT NEEDS

- Priority 1 - Validation tools for quality assurance (Construction)**
- Priority 1 - Better NDT tools for mapping projects (Design)**

Project That Addresses Validation Tools for Quality Assurance (Construction)

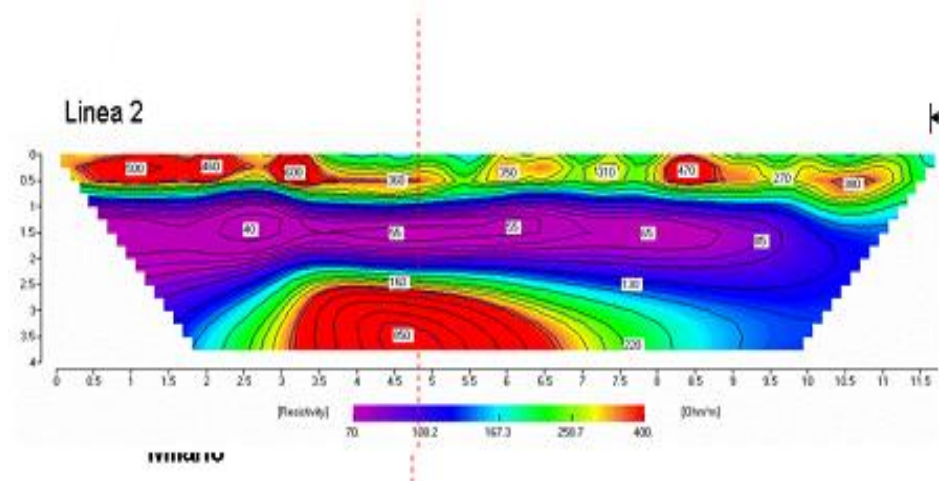
- F3: Implementation Program for Intelligent
Compaction



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Project That Addresses Better NDT Tools for Mapping Projects (Design)

- D3: Field Demonstration of Resistivity Mapping



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

EARTHWORKS NDT NEEDS

- Priority 2 - Earthwork performance monitoring (Performance Monitoring); Experimental Research**

TUNNELS NDT NEEDS

- Priority 1 - Changes in profile over time (Performance Monitoring)**
- Priority 1 - Mapping voids, bonding, and moisture behind tunnel linings (Design and Performance Monitoring)**

Project That Addresses Changes in Profile Over Time (Performance Monitoring)

- **D4: Monitoring Changes in Tunnel Profiles**



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Project That Addresses Mapping Voids, Bonding, and Moisture Behind Tunnel Linings (Design and Performance Monitoring)

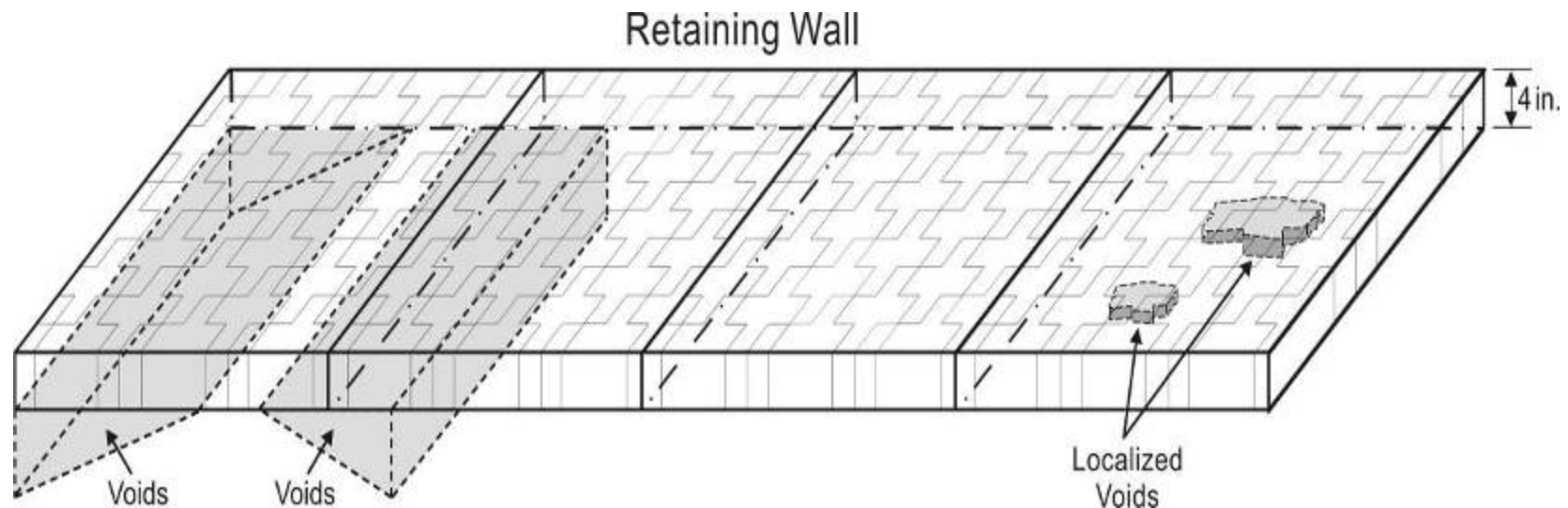
- U3: Mapping Voids behind Tunnel Linings and Retaining Walls (?)

TUNNELS NDT NEEDS

- **Priority 2 - Quality assurance of tunnel components (Construction); GPR Demonstration Project**
- **Priority 3 - Deterioration of tunnel linings (Design and Performance Monitoring); Experimental Research to evaluate and integrate various tools**

OTHER STRUCTURES NDT NEEDS

- **Priority 1 - Mapping voids, bonding, and moisture behind retaining walls (Design and Performance Monitoring)**



PRELIMINARY FINDINGS – SUBJECT TO UPDATES