Deployment of Emerging SHRP2 Technologies at the California Department of Transportation

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FHWA NDE Technologies for Evaluating Asphalt Pavement-
Virtual User-Group Peer Exchange
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Introduction

• History of GPR at Caltrans
• Caltrans SHRP2 Implementation
• Post-SHRP2 Deployment
• Continuing Improvements
History of Caltrans GPR Development

1998
Single-Channel
• Geotech, Utilities, NDT

2000
Tow Cart
• Pavements

2001
2-½ D Applications
• Void mapping
• Pavement evaluation

2006
3-D Visualization

2008
Upgrades (Single-Channel)
• Improved tow cart, larger grids, high sample density

2009
Pavement Management
• 58,000 Lane Miles (2009-12)

2012
3-D NDT (Single-Channel)
• Utilities, NDT

2015
Multichannel Radar
• Product Demos
• Bridge Deck Pilot Study

2016
SHRP2 Round 6 & 7
• Pavement, Bridge Decks, Tunnels Utilities

2019
SHRP2 Deployment

2020
3-D NDT (Single-Channel)
• Utilities, NDT
Multichannel GPR (3D Radar)

**Hardware**

**GeoScope™ Controller Unit**
- Step-frequency continuous waveform radar
- Real-time 3D Display
- GPS/Total Station interface
- Max 1.4-in sample spacing @ 50 MPH

**DX series & DXG series ultra-wideband antenna arrays**
- 200 MHz - 3.0 GHz
- 8 - 41 channels (0.6 – 3.1m scan width)
- Air-coupled and ground-coupled models

**Software**

**Examiner™**
- Fast and intuitive
- Annotate features, utilities, map layers and more
- Export findings ready for drawing production and information/reports
- Dramatically improves office processing times, comparable to single-channel processing

Caltrans Focus Area - Renewal

- USER INCENTIVE
  - Nondestructive Testing for Concrete Bridge Decks (R06A)
  - Nondestructive Testing for Tunnel Linings (R06G)
- PROOF OF CONCEPT
  - Advanced Methods to Identify Pavement Delamination (R06D)
- LEAD ADOPTER
  - Utility Investigation Technologies (R01B)

Technology Overlap

- Several technologies deployed under SHRP2
  - Multichannel GPR
  - Time-domain EM
  - Thermal IR
- No single grant provided full funding
- Leverage multiple grants for technology acquisition
Caltrans SHRP2 Goals

- **SHRP2**
  - Validate GPR technology for diverse applications
  - Bring high-speed GPR technology to Caltrans for utilities, pavements, bridge decks, tunnels.

- **Post SHRP2:**
  - Deploy Thermal IR for bridge decks
  - Improve testing methodology and reporting
  - Training and technology transfer
  - Develop appropriate roles, responsibilities and business practices for collaboration
GPR Van, Air-Launched Assembly

- Limited to shallow investigation (2-5 ft)
- Bridge Decks, Asphalt Pavements
- Acquisition speed up to posted speed limit
- No lane closure required
GPR Van, Ground-Coupled Assembly

- Better for deeper investigation (5-10 ft)
- Better for concrete pavement & utilities
- Acquisition at 15 MPH max (current)
- Lane closure may be needed
- Faster acquisition hardware in development
- New antenna model in development for even deeper investigation
Types of Outputs From GPR Results

Analysis Outputs

• Total pavement thickness
• Intra-layer (Overlay) thickness
• Overlay delamination
• Void distribution
• Rebar location/depth
• Concrete thickness/condition
• Subsurface utility location

QC Outputs

• Gridding accuracy
• Intra-layer accuracy
• Georeferencing accuracy
• Depth/thickness correlation
Current Deployed Applications

Pavement Design & Inspection

• Concrete Over Asphalt Overlay (COA)
• Void detection in concrete pavements
• Construction QC for concrete pavements

Subsurface Utility Engineering

Bridge Deck Design & Forensics

• Overlay thickness and delamination
• Depth to top of deck mat for:
  ✓ Mill and overlay
  ✓ Sawcut clearance for signal coil installation
  ✓ Construction QC
For evaluation of HMA delamination and stripping, seasonal variation in pavement moisture content creates scheduling constraints dependent upon regional climate.
Yolo County, SR 113 (Concrete Overlay)

DATA OUTPUT

• Total pavement thickness
  ✓ (6” mill specified)

  Mean Thickness Error = 1.10 in
  Standard Dev. = 1.61 in
Kern County, SR 99 (Continuous-Reinforced Concrete)

Mean Thickness Error = 0.12 in
Standard Dev. = 0.73 in

GPR Thickness (ft)

Core Thickness (ft)

Core Number

Core Thickness (ft)

GPR Thickness (ft)

Mean Thickness Error = 0.12 in
Standard Dev. = 0.73 in

Core Number

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GPR Thickness (ft)

Mean Thickness Error = 0.12 in
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Core Number

Core Thickness (ft)

GPR Thickness (ft)
San Diego County, SR 8 (PCC Pavement)

- GPR acquired to assist investigation of pavement subsidence
- Multiple geophysical methods deployed
- Area of potential voids followed up by coring

DATA OUTPUT
- Void Detection/Distribution
SR 8, Test Core Confirmation

• Cores show excellent agreement with GPR data

• Provided vital information for estimating grout quantities needed for pressure-injection stabilization of slabs
Bridge Decks (Forensics)

DATA OUTPUT

• Depth to top of mat (contract spec = 1.75 in)

• “Heat Map” contour plot of depth to top of mat
  ✓ Overlaid on 1.75-in slice view
• Mix of in-house and consultant support work
• Consultant support for large-scale projects and peak demand
• Recent example
  – Riverside County, SR 10 (Concrete Overlay)
    • Two GPR consultants used
    • >115 lane miles total
Subsurface Utility Engineering

- Highway Realignment
- Maintenance Station Construction
  - Redevelopment
  - New Construction
- MCGPR not a primary tool for SUE
  - TDEM, FDEM, Pipe & Cable locators better
  - Single-channel & MCGPR complementary use
Findings

- Multichannel GPR arrays make large area survey acquisition cost-effective
- Ultra-fast I/O = 3D GPR acquisition at near-highway speeds
- Improved post-processing software renders faster interpretation and reduces processing cost
- Outputs provide valuable data for project design
- Better information can reduce construction claims and reduce delay payouts.
Going Forward

- **Process Improvement**
  - QA/QC
  - Automation of data processing & analysis

- **Integration with visual/thermal imaging systems**
  - Full synthesis with existing systems
  - “One-Pass” acquisition
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