

FY 2024 INDOT Research Program Summary of IMPACT



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Impacting INDOT's Strategic Objectives: Safety, Mobility, Economic Competitiveness, Customer Service, Asset Sustainability, Organization & Workforce, and Innovation & Technology

Introduction: The INDOT/JTRP Research Program is an established and nationally recognized state DOT Research Program that has partnered with practitioners, academia, and industry since 1937 to address Indiana's transportation needs and challenges. Several state DOTs have modeled their state research programs after the Indiana program and the program has received national recognition for its impact on national transportation issues. Each year, the Indiana DOT provides two reports highlighting the quantitative and qualitative benefits delivered by the program. One report is the Return on Investment (ROI) that quantifies the cost savings to customers (user costs and safety) and to INDOT (agency savings) INDOT Research Program Return on Investment. The second report is the summary of IMPACT that highlights the qualitative benefits derived from the program. Together, these reports provide a comprehensive snapshot of the benefits, savings and impacts from the INDOT/JTRP Research Program. As research findings can significantly impact DOTs resulting in large returns on investment, it behooves researchers to quantify and qualify these benefits and savings to provide credibility to the program and in turn market this message to leadership. These ROI and IMPACT reports help validate to stakeholders and others the value of a successful research program. A previous INDOT Commissioner noted that *a viable research program was essential for a DOT to remain competitive and to continue to advance when there is a climate of scarce resources*. Even when resources are not scarce, DOTs must position themselves as good stewards and forward thinking. A good DOT research program is one way to accomplish this end.

In 2019, INDOT unveiled its updated Strategic Plan. Strategic Objectives included: Safety, Mobility, Economic Competitiveness, Customer Service, Asset Sustainability, Organization & Workforce, and Innovation & Technology. The Research Program provides direct support to the Strategic Plan for INDOT to fulfill its Strategic Objectives outlined in the Strategic Plan.

In 2020 and 2021 the COVID19 pandemic challenged INDOT, the State of Indiana, the country, and the world. COVID 19 affected the INDOT Research Program as well, however, the Program adapted quickly with new practices and approaches to keep the Program functional, efficient, and effective. With the signing of Infrastructure Investment and Jobs Act (IIJA), the United States Department of Transportation (USDOT) and the Federal Highways Administration (FHWA) encourages research mitigating the adverse effects of climate fluctuations and promoting, resiliency, sustainability, innovation, and safety workforce development.

This summary highlights projects completed in FY 2024. Additional accomplishments are also included such as awards, contributions from specialized testing programs, performance metrics, continuous improvement initiatives, and the relatively new forensic investigation program.

Following is a listing of IMPACT areas and research projects and activities that resulted in qualifiable benefits to customers and stakeholders.

Strategic Plan Impact Areas

Safety & Mobility (page 4)

Asset Sustainability (page 7)

Innovation & Technology and Economic Competitiveness (page 10)

Customer Service and Organization & Workforce (page 12)



Other Program Impact Areas:

Every Day Counts, EDC (page 14)

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Strategic Plan Impact Areas

These are select examples of projects. Each individual project can be downloaded from <https://docs.lib.purdue.edu/jtrp/> for additional information.

IMPACT on Safety & Mobility (select examples)

- SPR-4438, Field Test Bed for Evaluating Embedded Vehicle Sensors with Indiana Companies (<https://doi.org/10.5703/1288284317385>)
- SPR-4536, Implementation of Enhanced Probe Data (CANBUS) for Tactical Work zone and Winter Operations Management (<https://doi.org/10.5703/1288284317643>)
- SPR-4540, Incorporating Time Dependent Data to Pro-Active Safety Management (<https://doi.org/10.5703/1288284317700>)
- SPR-4603, Crowdsourcing/Winter Operations Dashboard Upgrade (<https://doi.org/10.5703/1288284317652>)
- SPR-4629, Implementation and Assessment of Highway Intrusion Technologies (<https://doi.org/10.5703/1288284317727>)
- SPR-4639, Connected Vehicle Centric Dashboards for TMC of the Future (<https://doi.org/10.5703/1288284317642>)
- SPR-4640, Geometric Constraints and Visual Field Related to Speed Management (<https://doi.org/10.5703/1288284317735>)
- SPR-4642, Effectiveness of Contrast Markings on Roadways and Orange Markings in Work Zones (<https://doi.org/10.5703/1288284317683>)
- SPR-4646, Advancing INDOT's Friction Test Program for Seamless Coverage of System (<https://doi.org/10.5703/1288284317734>)

- SPR-4738, Origin-Destination Counts in Weaving Area Utilizing Existing Field Data (<https://doi.org/10.5703/1288284317719>)
- SPR-4743, Traffic Management Geo-cast Study with Connected vehicles on Indiana Highways (<https://doi.org/10.5703/1288284317753>)

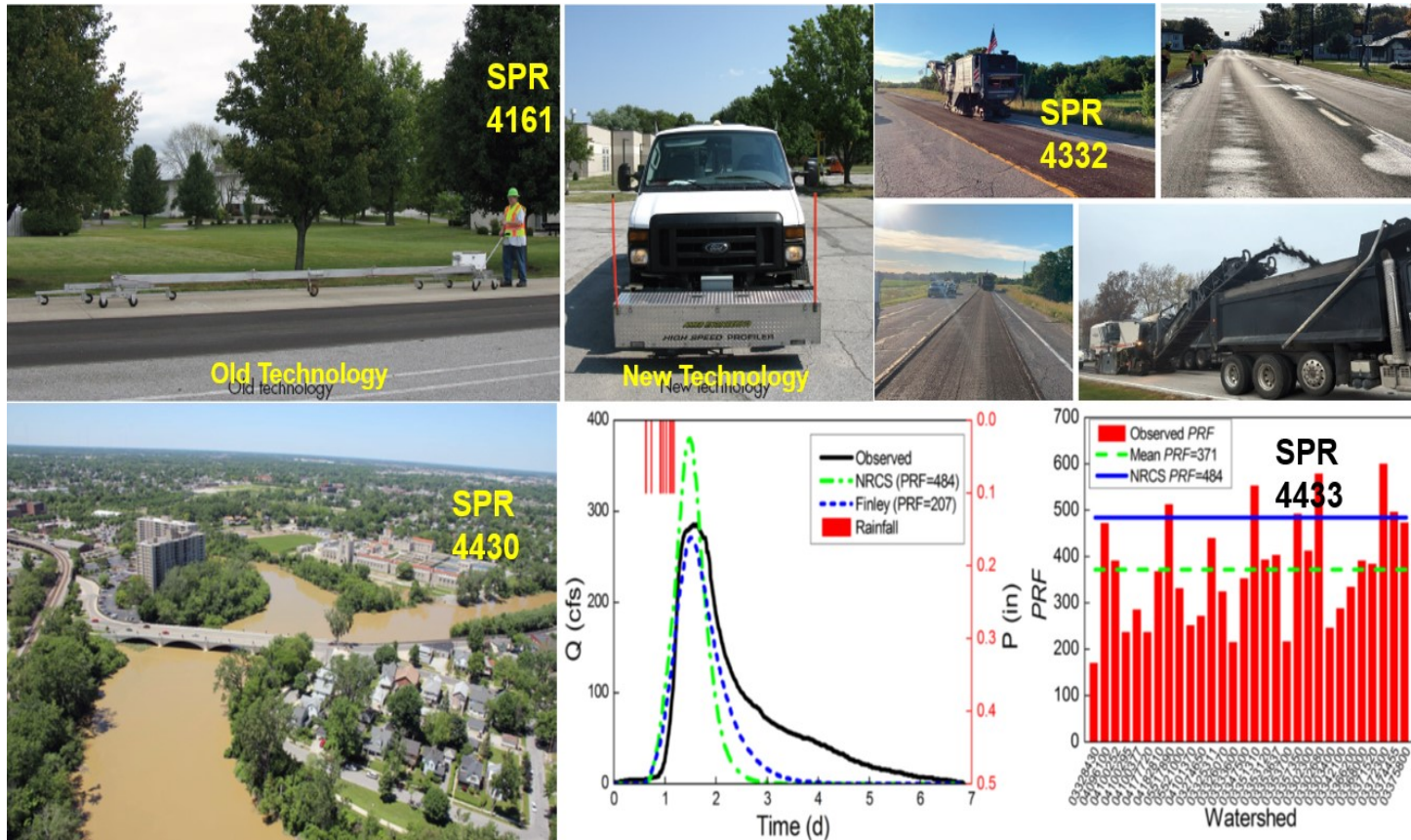




IMPACT on Asset Sustainability (select examples)

- SPR-4161, Implementation of Methods and Specifications for the Use of Inertial Profilers and the International Roughness Index for Newly Constructed Pavement (<https://doi.org/10.5703/1288284317661>)
- SPR-4332, Performance Related Specification for Pavement Milling (<https://doi.org/10.5703/1288284317752>)
- SPR-4430, Multiple Water Course Joint Probability Analysis Procedure Development for Indiana Specific Watersheds (<https://doi.org/10.5703/1288284317616>)
- SPR-4433, Unit Hydrograph Method Refinement at Higher Resolution (<https://doi.org/10.5703/1288284317644>)
- SPR-4445, Long Term Project and Network Level NDT Implementation Plan for Indiana (<https://doi.org/10.5703/1288284317582>)
- SPR-4514, Material Characterization & MEPDG Input Parameters for Indiana Superpave 5 Asphalt Mixtures (<https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=3408&context=jtrp>)
- SPR-4516, Development of Protocols for Reuse Assessment of Existing Foundations in Bridge Rehabilitation and Replacement Projects (<https://doi.org/10.5703/1288284317654>)
- SPR-4518, Review of Indiana Asphalt Binders (In-Situ PG Grade asphalt determination) (<https://doi.org/10.5703/1288284317721>)
- SPR-4535, Development of a Formalized Program for In-service Inspection of Pedestrian Bridges
- SPR-4547, Data Interpretation of Automated Plate Load Test (APLT) for Realtime, In Situ Determination of Unbound Layer Resilient Modulus (<https://doi.org/10.5703/1288284317653>)

- SPR-4601, Field Handbook for Maintenance and Preservation Treatments of Concrete Pavements (<https://doi.org/10.5703/1288284317725>)
- SPR-4631, Evaluation of the Potential Benefits of Implementing the AASHTO Guide Specifications for the Analysis and Identification of Fracture Critical Members and System Redundant Members (<https://doi.org/10.5703/1288284317746>)





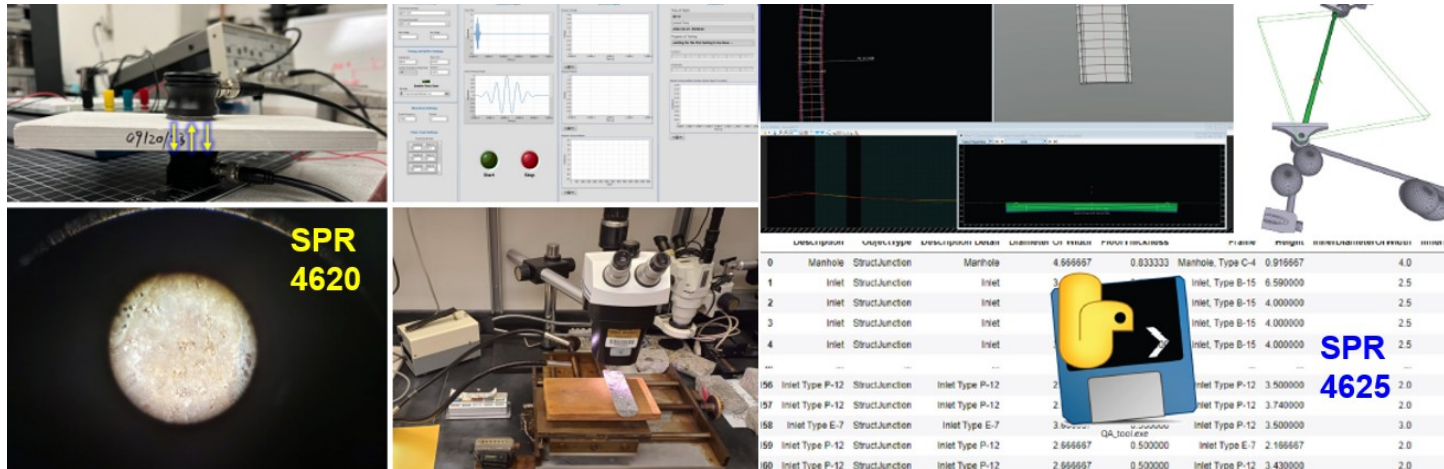


Impact on Innovation & Technology and Economic Competitiveness (select examples)

- SPR-4511, Integrating Transformative Technologies in Indiana's Transportation Operations (<https://doi.org/10.5703/1288284317651>)
- SPR-4607, Full-scale Dynamic Wireless Power Transfer and Pilot Project Implementation (<https://doi.org/10.5703/1288284317744>)
- SPR-4608, Forecasting Shifts in Hoosiers' Travel Demand and Behavior (<https://doi.org/10.5703/1288284317685>)

- SPR-4609, Economic Effect of Active Transportation Features and Association of Healthcare Industry and Transportation (<https://doi.org/10.5703/1288284317655>)
- SPR-4620, Developing AI-assisted In-situ NDT Method for Air-Void Distribution Testing in Fresh and Hardened Concrete (<https://doi.org/10.5703/1288284317745>)
- SPR-4625, BIM Standards for Roads and Related Transportation Assets (<https://doi.org/10.5703/1288284317641>)





IMPACT on Customer Service and Organization & Workforce (select examples)

- **SPR-4606, Overweight Divisible Loads: Permit Administration and Impact on Indiana's Road Infrastructure and Safety** (<https://doi.org/10.5703/1288284317749>)
- **SPR-4634, Investigating Consistency among Bridge Inspectors Using Simulated Virtual Reality Testbed** (<https://doi.org/10.5703/1288284317660>)
- **SPR-4710, INDOT Project Change Orders – Root Causes and Recommendations** (<https://doi.org/10.5703/1288284317747>)
- **SPR 4753, Implementation Grant: Field Implementation of Concrete Strength Sensor to Determine Optimal Traffic Opening Time** (<https://doi.org/10.5703/1288284317724>)
- **INDOT staff serving as business owners/SAC with faculty, practitioners, other DOT staff (INDOT staff indicates positive professional development from SAC engagement)**



Other Program Impact Areas

Every Day Counts, EDC, (National IMPACT select examples)

- Partnership with FHWA in EDC Initiatives
- Facilitating the 7 Innovations in EDC 7 (Listed Below)
- Participated in National STIC Meetings.
- \$955K STIC Incentives leveraging 11 INDOT studies.
- Participated in National Pooled Fund Studies, PFS.

EDC-7 Innovation	INDOT SME	FHWA Counterpart	Baseline Status	Goal Status (to be attained by 2025)
Nighttime Visibility for Safety	Dan McCoy, Dave Boruff	Eryn Fletcher; eryn.fletcher@dot.gov	Assessment	Institutionalized
Next Generation TIM: Technology for Saving Lives	Ed Cox, Hillary Lowther	Karen Stippich; karen.stippich@dot.gov	Development	Demonstration
Integrating GHG Assessment and Reduction Targets in Transportation Planning	Alison Shaner, Nunnally, Baukert	Patrick Carpenter (patrick.carpenter@dot.gov); Kari Carmany-George (k.carmanygeorge@dot.gov)	Development	Demonstration
Enhancing Performance with Internally Cured Concrete (EPIC2)	Matt Beeson, Mike Nelson	Tom Duncan; thomas.l.duncan@dot.gov	Assessment	Assessment
EPDs for Sustainable Project Delivery	Beeson, Elena Cruz	Tom Duncan; thomas.l.duncan@dot.gov	Development	Demonstration
Rethinking DBE for Design-Build	Casson, Kiefner	Kenneth Woodruff; kenneth.woodruff@dot.gov	Institutionalized	Institutionalized
Strategic Workforce Development	Elizabeth Kiefner	Kenneth Woodruff; kenneth.woodruff@dot.gov	Institutionalized	Institutionalized

Additional STIC Project Funding

Fiscal Year	STIC Incentive Project	Funds Allocated
2024	Connected Vehicle Trajectory Data to Screen Network for Hard Braking and Hard Acceleration Events	\$125,000
2023	Host Midwest Regional Innovation Peer Exchanges	\$50,000
2022	Apply origin-destination data patterns in Freeway Weaving Areas	\$100,000
2021	Upgrade web-based Winter Operations Dashboard using enhanced probe data	\$100,000
2020	1. Implement Enhanced Probe Data for Tactical Work Zone Operations (\$41,000) 2. Expand project bundling with machine learning for local agencies (\$35,000) 3. Expand current Virtual Public Involvement (VPI) efforts (\$24,000)	\$100,000
2019	Develop Mobile Mapping System Manual of Operations.	\$100,000
2018	Implementation of Intelligent Snowplow System	\$100,000
2017	Implementation of Connected Vehicle Corridor Deployment and Performance Measures for Assessment	\$100,000
2016	Implementation of LiDAR-Based Mobile Mapping System for Lane Width Evaluation and Reporting in Work Zones for INDOT Traffic Management	\$100,000
2014	Development of Intelligent Compaction standard specification for soil embankment and subgrade compaction	\$80,000

Enhancing Internal Services, Intentional Partnership and Engagement & Networking (select examples)

- Celebrating Mark Bowman Retirement (July 31, 2023, JTRP Board & Executive Committee Meeting)
- Budget Staff Visit to INDOT R&D (July, 2023)
- 2023 Pavement ME Design User Group Meeting (September 5-7, 2023)
- All Indiana Universities All Faculty Meeting (September 12, 2023)
- Poster presentation and INDOT R&D pavement testing equipment demonstration (September 20, 2023, Indiana Fairground).
- Demonstration of INDOT R&D - 3D Laser and 3D GPR (September 28, 2023, in Greenfield).
- FY 25 INDOT/JTRP Research Program Focus Groups Initiation meeting (October 23, 2023)
- R&D Open House (October 26, 2023)
- Vincennes Research Program Briefing (November 14, 2023)
- INDOT People Services Site Visit(November 17, 2023)
- Site Visit fprDDCs(November 28, 2023)
- INDOT Crawfordsville District CPM (December 12, 2023)
- 2024 TRB Annual meeting (presentations, papers, posters)
- Meeting with the Commissioner and Executive Staff to solicit their research needs and present the research needs and ideas received from INDOT Staff, Academia, and Industry (February 2, 2024)
- Annual Research Fair (February 22, 2024)
- Road School 2024
- Commissioner's Leadership Program (CLP) Group Visit to INDOT R&D – October 18, 2024
- Japanese Delegation Makes Special Trip to learn from INDOT – Inside INDOT October-November 2024
- NCHRP, TRB, AASHTO Committees membership.



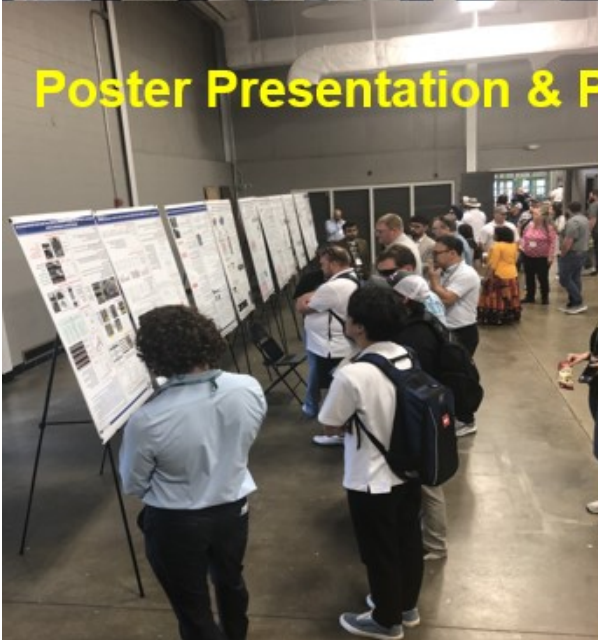
Budget Staff Visit to R&D



September 2023 Pavement ME Design User Group Meeting

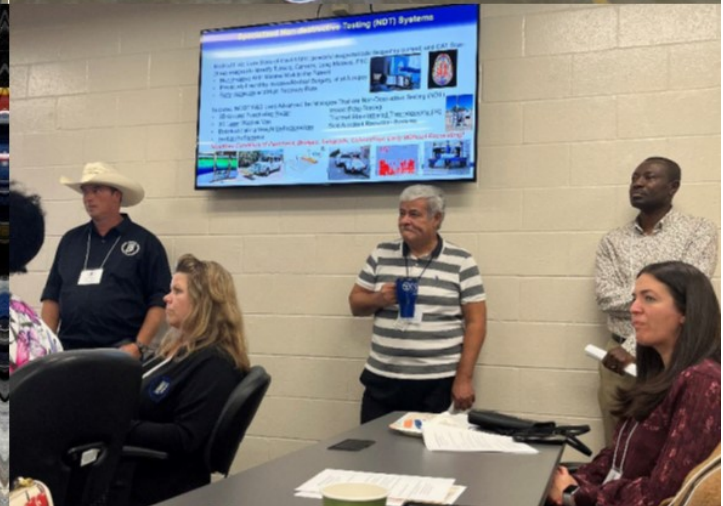


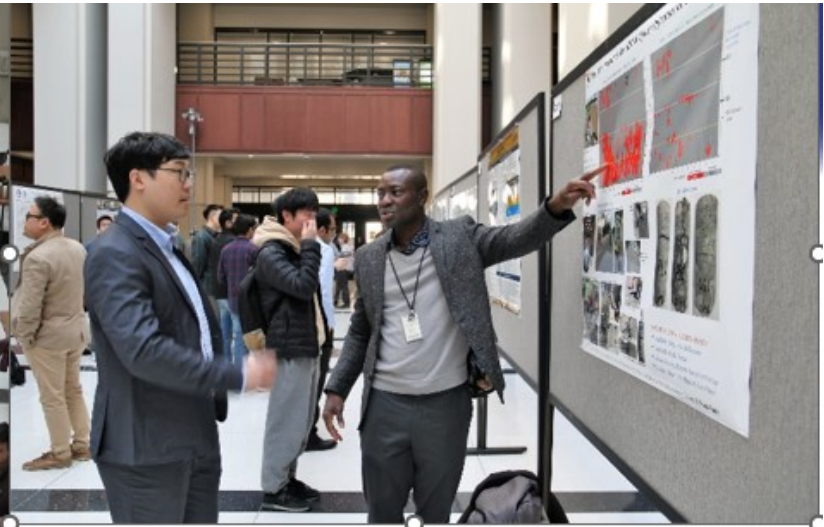
Poster Presentation & Pavement Testing Equipment Demonstration



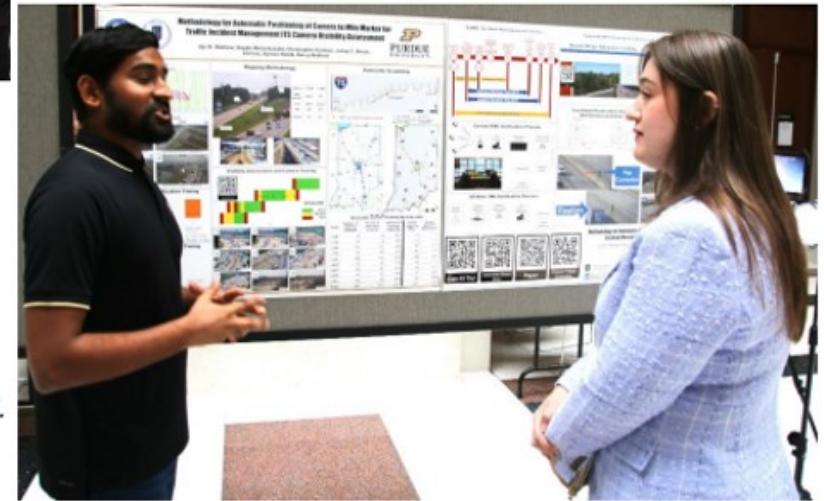


R&D Open House

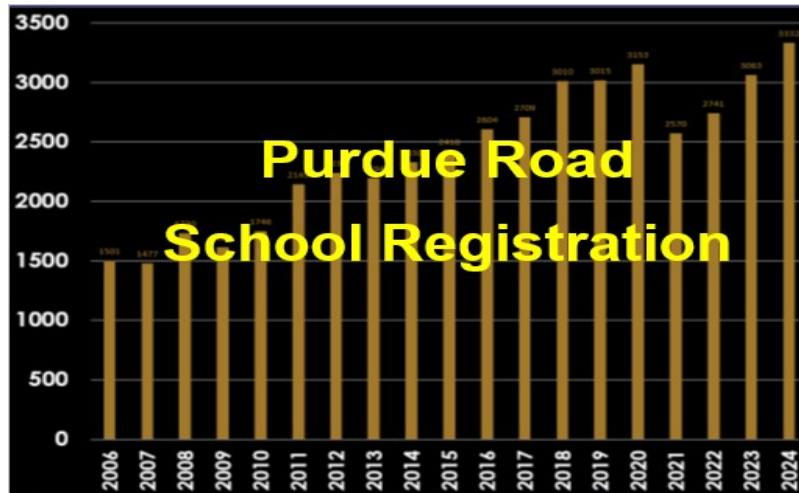




Scenes from last year's Research Program Innovation Fair in the Indiana Government Center South atrium in Indianapolis. This year's fair is Feb. 22.



A presenter (left) interacts with INDOT Chief of Staff Andrea Zimmerman.



Rusty Fowler (from left), Jane Twaddle, and Barry Partridge at this year's Purdue Road School in West Lafayette.





State and National Recognitions (select examples)

- ERIN and Inside INDOT newsletter articles
 - SPR-4436 “Road Condition Detection and Classification from Existing CCTV Feed” won the **2023 Sweet 16 AASHTO High Value Research Award** (Inside INDOT – August 2023)
 - AASHTO & FHWA selected the “Member-level Redundancy in Built-up Steel Members (TPF-5(253)) submitted by INDOT as the recipient of **a 2024 Transportation**

Pooled Fund (TPF) Excellence Award. This award recognizes the exemplary achievements of partner agencies that contributed to this study.

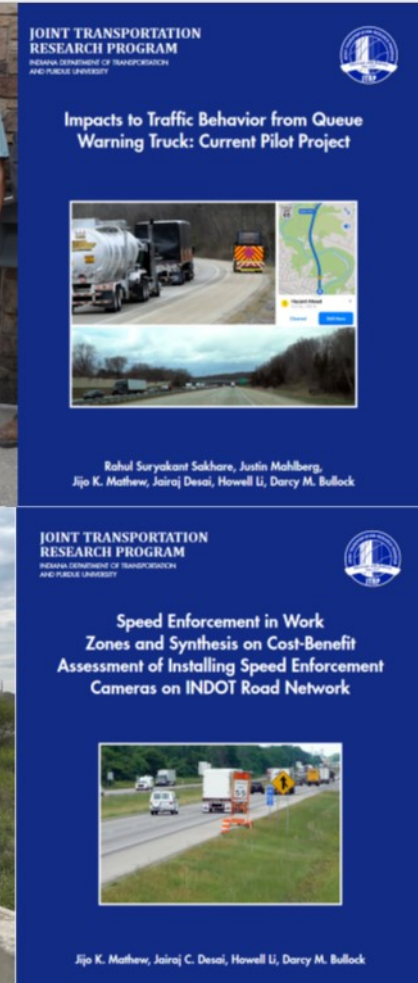
- **SPR-4600 “Impacts to Traffic Behavior from Queue Warning Truck Pilot Project”
2024 Sweet 16 AASHTO High Value Research Award**
- **SPR-4637 “Speed Enforcement in Work Zones and Synthesis on Cost-Benefit Assessment of Installing Speed Enforcement Cameras on INDOT Road Network 2024 Sweet 16 AASHTO Safety, Security, and Emergencies Supplemental Award.**
- **SPR-4646, Advancing INDOT’s Friction Test Program for Seamless Coverage of System – A TRB Paper Award for " Investigation of Locked Wheel Skid Tester Practicability on Horizontal Curves: A Camera-based Field Implementation" – January 2024**
- ***R&D Staff Markets the Amazing Benefits of INDOT Research – Inside INDOT February 2024.***
- **Visits & Interviews by CNBC, New York Times, Indy Star, Scripps National and INPOWER Indiana regarding electric vehicles & Road Electrification – April, May 2024**
- **Colts Player, INDOT Employees Help Conferences Achieve Success. Referring to INDOT R&D proactive participation in the National Pavement Preservation Conference (Inside INDOT – October 2023)**
- **R&D Open House Opens the Eyes of INDOT Directors (Inside INDOT – November 2023)**
- **INDOT Shines During National Bridge Conference (Inside INDOT – June 2024)**
- **Important Initiatives (Inside INDOT – June 2024)**



2023 AASHTO Sweet 16 Award SPR 4436

INDOT's Barry Partridge (from left, top photo), JTRP's Darcy Bullock, INDOT's Jim Poturalski, and IUPUI's Stanley Chien and Yaobin Chen. INDOT's Tim Wells (top-right photo) and INDOT's Ed Cox (bottom-right photo).







EXECUTIVE PRIORITY POINTS

Executive Priority Points focus on important agency information or actions that all INDOT employees should know.

☒ Managers: Please share and discuss these priority points with your employees.

☒ Employees: If your manager has not discussed these with you by the end of business tomorrow, please seek them out.

1. **Indiana State Fair**: We have an extremely limited number of available volunteer spots left for the fair if you are interested! [Sign up here](#).
2. **Research**: INDOT was honored as one of the Sweet 16 selections among the annual High Value Research Project submissions by the American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee. The national competition emphasizes the benefits of research and implementation strategies by state DOTs. Indiana's project, "Impacts to Traffic Behavior from Queue Warning Truck: Current Pilot Project", was led by Purdue Professor Darcy Bullock, in conjunction with INDOT's Research & Development Manager Tim Wells and Seymour DDC Tony McClellan. This project demonstrated the potential to reduce hard-braking and crash risks by 80% by deploying Queue Warning Trucks in work zones with queuing. This research has led INDOT to implement this technology. Additionally, this has been implemented on a national scale by other states.

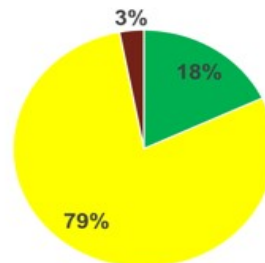
FY 23 Research Program Return on Investment (ROI)

❖ 29 Completed Projects

Agency B/C 2:1
None-Agency B/C Ratio 1.6:1
Total B/C Ratio 3.6:1

❖ 251 Completed Projects

Agency B/C 10:1
None-Agency B/C Ratio 7:1
Total B/C Ratio 17:1

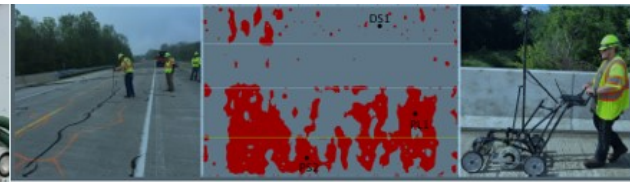


Quantifiable Benefits Project	Qualitative Benefits Projects	Projects Not Successfully Implemented
46	199	6

- Quantifiable Benefits Project
- Qualitative Benefits Projects
- Projects Not Successfully Implemented



- **Miscellaneous Research News, Webinars/Workshops & High-Profile Articles**
 - **Purdue, INDOT partner for electric charging highway study – WTHR Article & Story - April 25, 2024**
 - **INDOT, Purdue, Cummins break ground on wireless roadway project in West Lafayette – INDOT News Release – May 2, 2024**
 - **TRB Webinar: Pavement Foundations—Designing for 100 Years (Design and Construction to Achieve Long Lasting Pavement Kumar Dave and Nayyar Siddiki) - May 30, 2024**
 - **NCHRP 20-44(49) Principal Investigators Value INDOT/JTRP Research Program after an Interview & Discussions – June 2024.**
 - **Monthly NDE Peer Exchange Webinar Series (October 2023)**
 - **TRB Webinar: Superpave Volumetric Mix Design—Beyond the Basics (October 2023)**
 - **Focus on Safety – Mapping & Documenting Roadway crash scenes - Erin December 11, 2023**



October 23, 2023 | 1:00 pm EST

Long-Term Project and Network-Level NDT Implementation Plan for Indiana

The Indiana Department of Transportation through a study with Purdue University investigated multiple NDT methods to evaluate deck conditions. Results from both in-house staff and consultants were compared to look for accuracy and repeatability. Both network-level and project level recommendations were given.

Presenters:

Anne Rearick
Director of Bridge Management
Indiana Department of Transportation

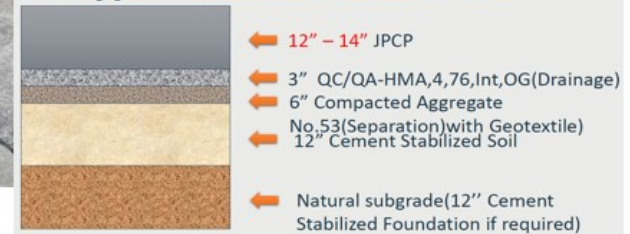
Prince Baah
Bridge Structural Research Engineer
Indiana Department of Transportation

Zoom Meeting

Join on your computer or mobile app
[Click here to join the meeting](#)

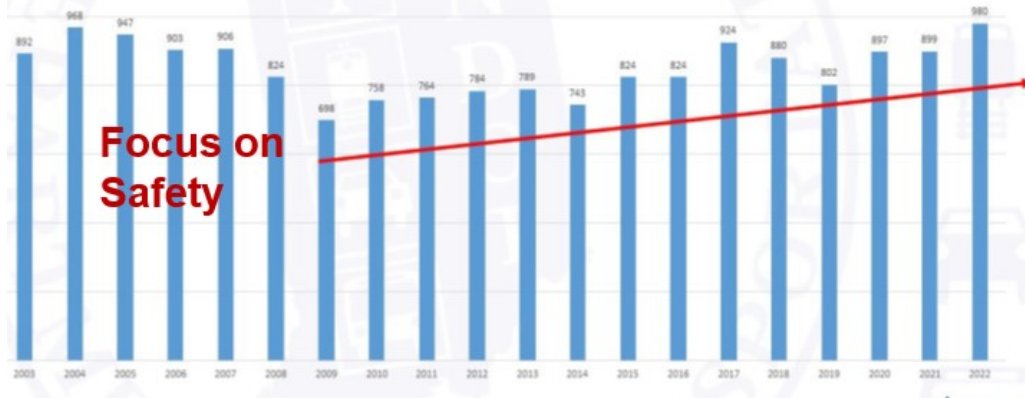
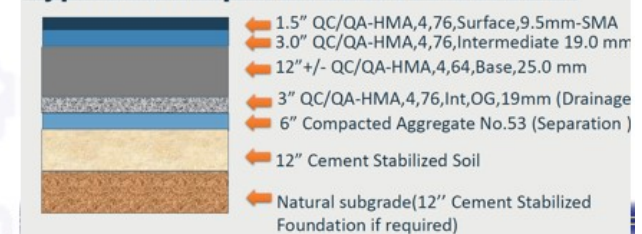
Or call in (audio only): +1(669)254-5252
Meeting ID: 161 682 3220
Passcode: 010531

Typical JPCP cross section



Construction to Achieve Long Lasting Pavement

Typical HMA pavement cross section



Focus on Safety

Forensic Investigations and Specialized Testing Programs (select examples)

- Forensic capabilities & data driven decision-making capabilities, direct result of research program.
- Bridge Deck Epoxy Injects INDOT with Asset Sustainability and Innovation
- New Trailer Helps INDOT Get Ahead in Bridge Innovation
- NDT of Bridge Decks Efforts – Results & Implications
- District recognitions for INDOT R&D testing efforts
- Friction and Texture Quality testing to ensure the material met specifications.
- Identification of bridges with low friction numbers
- **Completion of 677 specialized testing and forensic investigations** assessing Indiana roadways and bridges providing design, maintenance, rehabilitation and reconstruction recommendations to decision makers. Specialized testing uses state-of-the-art non-destructive testing (NDT) equipment for data-driven decision-making. Amongst the special equipment used are the pavement stiffness falling weight deflectometer, pavement surface skid resistance, ground penetrating radars, 3D lasers and other nondestructive testing equipment.
- **R&D Specialized Testing is 3-5 times less costly than consultant testing.**
- **An independent consultant found specialized testing results impact \$66.9M of departmental decisions annually. Forensic investigations impacted \$2.5M/yr.**
- **Total Fiscal Impact from R&D Specialized Testing was:**

• Settle contractor disputes	2.5
• Improved safety (HFST)	12.6
• Bridge deck decisions	9.0
• Epoxy injection decisions	9.6
• Contractor incentives	11.6
• Reduce change orders	<u>21.6</u>
TOTAL	\$66.9 M
- **Customers noted the following non-fiscal benefits:**
 - Trust & expertise
 - Avoiding conflicts of interest
 - Rapid response
 - Consistency of results
 - Refining mix specifications
 - High customer satisfaction
 - Confidence in INDOT decision-making
 - Positive litigation outcomes



Specialized Testing & Forensic Investigation Equipment – Pictures by Indy Star

Program Metrics & Venues for Continuous Improvement

Eight Objective Performance measures for INDOT Research Program;

#	Description	Goal
1	% Final Report submitted on time of Active Projects	>90%
2	% Successful Implementation of completed projects in a FY (KPI 6)	>90%
3	Return on Investment in a FY (B/C)	> 2
4	Percent Customer Satisfaction Score Meeting or Exceeding Expectations	> 90%
5	# & Percent of Time Extensions	Specifying a Goal
6	% Progress reports submitted on time	100%
7	% Draft Final Report submitted on time	> 90%
8	% Successful Communications	> 90%

- Continue Linkage of 2022 Peer Exchange Results (Focus on Resiliency, Sustainability, Mitigation of Adverse Effects of Climate Changes) to User's Manual, Summary of Impact & ROI reports, Customer Service Surveys, Implementation Plans and Template Research Need Statements.
- Continue Mapping research projects to INDOT Goals & Strategic Priorities.
- Collaborate with the new Innovation Office for opportunities, to share current innovations and how the two offices can support each other's mission as in EDC National Summits.
- Continue exploring new methods to communicate research results and innovations using online webinars (mirror the TRB webinar format).
- FY 2024 (on February 21) Show Case & Peer Group meetings, focusing on peer groups to identify research needs on an ongoing basis. FY 2024 Prioritized needs and Ideas was held on February 21. Faculty Liaisons were engaged in Focus Groups.

- FY 2025, 168 research needs submitted, 57 research projects funded (including 17 expansions), 113 active projects.
- Smartsheet tracking software used for project management (active projects, needs identified, tracking implementation status).

Resources and Links

- **Indiana Government**
www.in.gov
- **Indiana Department of Transportation, INDOT**
www.in.gov/indot
- **INDOT Research & Development Division Contact Information**
www.in.gov/indot/2700.htm
 - Submission of Research Needs & Ideas (www.in.gov/indot/2404.htm)
 - Innovative Research Needs & Ideas (www.in.gov/indot/2404.htm)
 - Research Program IMPACT Report (www.in.gov/indot/2404.htm)
 - Research Program Return on Investment (www.in.gov/indot/2404.htm)
- **Research Program User's Manual**
(https://engineering.purdue.edu/JTRP/files/UsersManual_2022_12.pdf)
- **Joint Transportation Research Program**
<https://engineering.purdue.edu/JTRP>
- **Innovation Office and Submission Link (only through the intranet) - [Innovation at INDOT](#)**