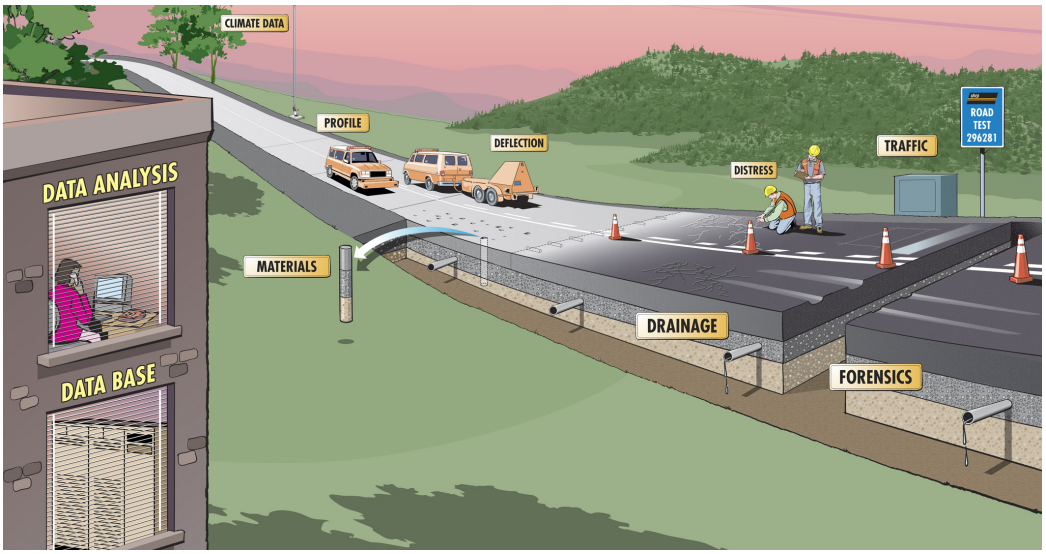

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LTPP Analysis-Ready Datasets: Saving Users Thousands of Hours of Data Wrangling and Giving More Focus to Data Analysis

The goal of the Long-Term Pavement Performance (LTPP) program is "to increase pavement life by the investigation of long-term performance…."[1] One of six objectives identified to support this goal was the establishment of a national pavement performance database.[2] Since 1989 when data collection commenced, the LTPP program has been assembling such a database. Today, the database is the world's premier source of data and information on pavement structure and performance, but understanding and using the database is not necessarily an easy undertaking. For starters, the data are typically distributed across multiple database tables, making some data elements hard to mine. Frequently, multiple values for a given data element make it difficult to know which ones to use. In addition, the data may have to be further interpreted to present meaningful results.

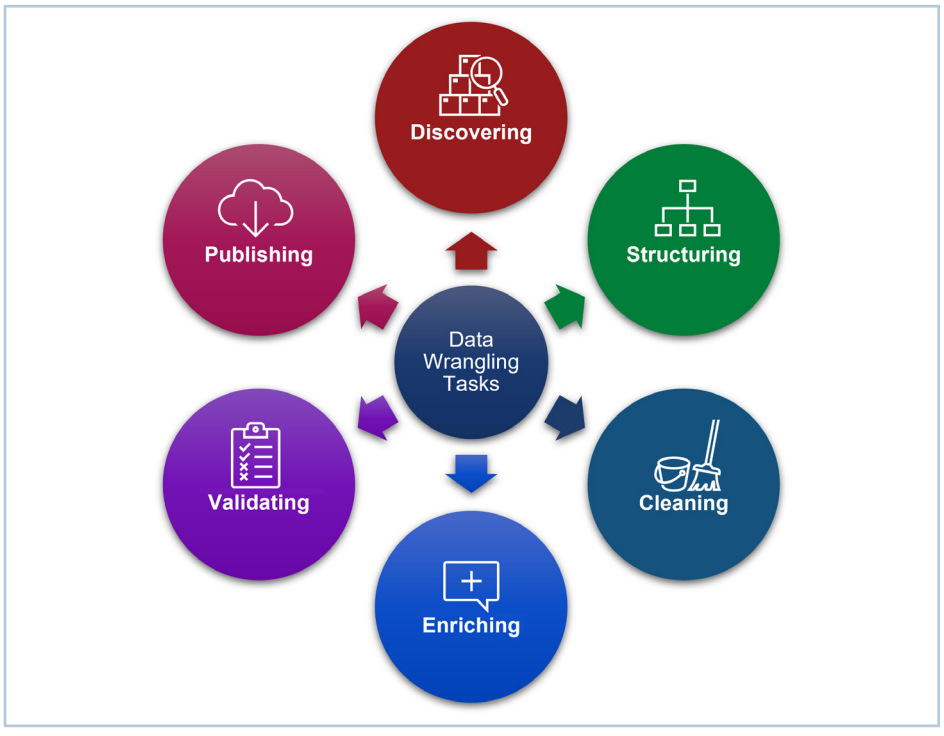

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Figure 1. Illustration. Tasks completed to create analysis-ready datasets.

To address these challenges, the LTPP program undertook a process to generate analysis-ready datasets (ARDs) for all sections in the database so that data users would not have to spend substantial effort wrangling data, (i.e., finding, extracting, merging, and interpreting the available data to develop a suitable input dataset for analysis). The resulting ARDs provide numerous benefits such as simpler data handling, easier analysis and mining data for trends, efficient use of time, and descriptive visualization of data.[3]

Since pavement performance is affected by the separate and combined effects of the pavement structure, traffic loadings, and climatic conditions, the ARDs identified and developed by the LTPP program are as follows:

- Analysis-ready materials dataset (ARMAD)—Thicknesses and layer material properties.
- Analysis-ready climate dataset (ARCLD)—Modern-Era Retrospective Analysis for Research and Applications (MERRA-2)[4] data, including hourly, daily, and monthly statistics for precipitation, temperature, wind, and humidity.[5]
- Analysis-ready traffic dataset (ARTRD)—Input data needed by the AASHTOWare® Pavement Mechanistic-Empirical Design (PMED), annual time series truck volumes and axle loadings, and summary statistics for truck volumes.[6]
- Analysis-ready performance dataset (ARPED)—Pavement surface distresses, International Roughness Indices, transverse profile indices (rutting), and load transfer efficiency.
- Analysis-ready construction features dataset (ARCFD)—Transverse joint properties, shoulder properties, subsurface drainage information, and Magnetic Imaging Tomography (MIT) Scan results for LTPP sections.

The first dataset, ARMAD, was incorporated into LTPP Standard Data Release (SDR) 36, which was released in 2022.[3,7] This dataset was expanded in SDR 37 (released in 2023) to include data from the LTPP Specific Pavement Study (SPS) Warm-Mix Asphalt Overlay of Asphalt Pavements Experiment (SPS-10) test sections, new laboratory materials testing data, and corrections to data issues.[7] SDR 37 also incorporated ARCLD, ARTRD, and ARPED, which are readily available via the LTPP InfoPave™ web portal.[3,7]

Given their value, it is anticipated that the LTPP program will continue to work on the development of new ARDs. Efforts for incorporating new data into the existing ARDs or making corrections to the existing ARDs will continue, as needed. LTPP data users can submit ideas for enhancing the existing ARDs or make suggestions for new ARDs by contacting the LTPP Customer Support Service Center (email: ltppinfo@dot.gov).

Testimonials

"*The LTPP data continues to be invaluable to local MEPDG validation and calibration purposes, but now it has been made much simpler thanks to the LTPP ARDs*," says Harold Von Quintus, P.E.

"*In the mid-2000s, I struggled with LTPP data wrangling and filling data gaps. The data were needed to perform the modeling in the FHWA High-Performance Concrete Paving software, which calculates the progression of the concrete's strength gain and developing stresses at the early age after placement. The models' inputs included materials, pavement structural information, construction, and environmental conditions. Today's ARDs would have saved me a tremendous amount of time and effort*," says Dr. George Chang, P.E.

"*In addition to the value to practitioners, ARDs will be a great resource for educators and students. Professors will be able to present real-world datasets of pavement structure, traffic, climate, and performance for students to analyze. Much more realistic and valuable than the 'toy' problems found in most textbooks*," says Dr. Charles Schwartz.

In Brief

Winners of the 2023 Student Data Analysis Contest

Three papers were selected for awards in the Long-Term Infrastructure Performance (LTIP) Student Data Analysis Contest. The student winners are as follows:

- Lawrencia Akuffo, research assistant, and Adriana Trias Blanco, assistant professor from Rowan University.
  First Place (Bridge): "Quantification of the Correlation Between Bridge Skew Angle and Deterioration Rate."
- Bingyan Cui, Ph.D. student, Xiao Chen, Ph.D. student, Zhe Wan, post doctorate, and Hao Wang, professor from Rutgers University.
  First Place (Pavement): "Predicting Asphalt Pavement Deterioration Under Climate Change Uncertainty Using Bayesian Neural Network."

Source: FHWA.

Figure 2. Photo. Second-Place LTIP Student Winner (Pavement) Jian Liu proudly received a certificate for his winning paper.

Source: FHWA.

Figure 3. Photo. First-Place LTIP Student Winners (Left to Right): Bingyan Cui (Pavement) and Lawrencia Akuffo (Bridge) being recognized at LTBP Program Lectern Session.

- Jian Liu, Daodao Zhou, Fangyu Liu, and Linbing Wang, Ph.D., P.E., professor from Virginia Polytechnic Institute and State University.
  Second Place (Pavement): "Accelerated Balanced Asphalt Mix Design Based on Machine Learning and Nondominated Sorting Genetic Algorithm-II (NSGA-II)."

The winners were recognized at the Transportation Research Board 103rd Annual Meeting at the Long-Term Bridge Performance Program Lectern Session 2197 on Monday, January 8, 2024, and the first-place bridge winner presented at this session.[8] The two pavement winners presented their winning papers at the Performance Analysis Workshop 5012 on Thursday, January 11, 2024.[9]

It was the first time since the LTIP Student Contest started in 2021 that the first-place winners in both the pavement and bridge categories were female. Congratulations to the winners and thank you to everyone who participated. This year's LTIP Student Data Analysis Contest is already underway, and papers are due August 1, 2024.[10]

Transportation Pooled Fund Solicitations

Two active Transportation Pooled Fund (TPF) Program research projects involve the LTPP program. One continues the forensic investigations of LTPP test sections (LTPP Forensic Investigations—Stage 2, TPF-5(500)),[11] and the other evaluates and documents the long-term performance of pavement preservation treatments (National Partnership to Implement Quality Preventive Maintenance Treatment Construction and Data Collection Practices (PG Phase III), TPF-5 (522)).[12] Please consider partnering in these new efforts.

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