Developing Methodologies to Predict and Quantify the benefits of Research that Creates Durable and Longer Lasting Highway Infrastructure

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The Research Problem

- The transfer of new technologies into practice is the goal of IRISE research
- More durable and longer lasting highway infrastructure creates benefits to extend the life of highways and bridges
- These benefits must be measured decades into the future
- The challenge is to quantify and predict benefits for many of these advancements

Project Objectives

- Benefits must be considered in the cost of design, construction and maintenance phases of highway infrastructure projects
- Environmental impacts and sustainability benefits are difficult to evaluate but need to be considered
- Methodologies have been developed that quantify and can extrapolate cost and user data available on an appropriate scale (state or project) for highway infrastructure and user costs or case studies

IRISE Projects Evaluated

- Material Compatibility Repair for Pavements
- Evaluation of Pavement Surface Distresses Related to Pavement Marking
- Remote-Controlled Technology Assessment for Safer Pavement Construction
- Development of Simplified Mechanistic-Empirical Design Tool for Pennsylvania Rigid Pavements
- Early Opening of Concrete Repairs to Traffic

Application of Research Results

Material Compatibility Repair - PI Dr. Stephen Sachs

- Partial-depth repairs are between commonly used concrete pavement and bridge deck rehabilitation methods
- Partial-depth repairs have a short service life
- The research developed best practices to develop MCRs
- A comparison of current and expected service life applied to the MCR improved method repair costs resulted in the estimate of benefits

Application of Research Results

Material Compatibility Repair - PI Dr. Stephen Sachs

- A comparison of current and expected service life applied to the MCR improved method repair costs resulted in the estimate of benefits using ECMS cost data:

Application of Research Results

Material Compatibility Repair - PI Dr. Stephen Sachs

Pavement Repair Research Results Benefit Analysis Summary					
Repair Method and PennDOT Costs per Year	Total Repairs Cost	Adjustment for Increased Repair Costs (7%)	Average 2 Year Life Cycle Annual Replacement Costs - Current Method	Average 15 Year Annual Life Cycle Replacement Costs - New Method	Potential Savings over 15 Year Cycle of Repairs
Partial Depth Repairs (Material Comptable Repairs)					
2018	$1,049,049.65	$1,122,483.13	$600,339	$85,648	$7,720,360
2019	$3,045,572.50	$3,258,762.58			
2020	$383,670.00	$410,526.90			
2021	$324,420.00	$347,129.40			

Application of Research Results

Preliminary Evaluation of Pavement Surface Distresses Related to Pavement Marking QC - PI Dr. Lev Khazanovich

- When joints are repaired the reapplied pavement markings are a cost that could be eliminated if longer lasting joints were constructed
- Recommendations to Improve Longitudinal Joint Performance
- Improving longitudinal joint compaction
- Changing the placement of the marking

Application of Research Results

Preliminary Evaluation of Pavement Surface Distresses Related to Pavement Marking - QC - PI Dr. Lev Khazanovich

- Two case studies of recent asphalt major longitudinal joint repair projects from ECMS (Allegheny and Beaver County Interstates) has determined that 1,180,950 lineal feet of longitudinal joints were repaired at $1.60/LF

- When joints are repaired the reapplied pavement markings are a cost that could be eliminated if longer lasting joints were constructed

Application of Research Results

Preliminary Evaluation of Pavement Surface Distresses Related to Pavement Marking - QC - PI Dr. Lev Khazanovich

- The per lineal foot cost average for lane markings applications per ECMS is $3 for thermoplastic and $1 for paint

- The potential savings for reapplication of longitudinal pavement markings per year could be $1,937,772 for thermoplastic for the two case studies evaluated

Application of Research Results

Remote-Controlled Technology Assessment for Safer Pavement Construction and QA/QC - PI Dr. Lev Khazanovich

- Pennsylvania Highway Worker Injury Reports of Vehicles intruding into active work zones totaled 143 crashes from 2017-2020

Application of Research Results

Remote-Controlled Technology Assessment for Safer Pavement Construction and QA/QC - PI Dr. Lev Khazanovich

- Three technologies were identified to improve worker safety in work zones:
  - Automated Real-Time Thermal Profiling for Asphalt Paving based on the Pave IR system
  - Remote-Controlled GPR (Ground Penetrating Radar)
  - Autonomous Impact Protection Vehicle (AIPV)

Application of Research Results

Remote-Controlled Technology Assessment for Safer Pavement Construction and QA/

- Value of Highway Worker Injury Reports of Vehicles intruding into active work zones totaled 23 that could be mitigated by technologies being investigated were determined

Year	Number of Injuries	Average Cost	Total	Inflation Factor	Present Value
2017	11	$20,227	$222,297	1.6	$355,995.20
2018	4	$20,227	$80,908	1.7	$137,543.60
2019	6	$20,227	$121,362	1.75	$212,383.50
2020	2	$20,227	$40,454	1.82	$73,626.28
Total					$779,548.58

Application of Research Results

Development of Simplified Mechanistic-Empirical Design Tool for Pennsylvania Rigid Pavements - PI Dr. Lev Khazanovich

- Three case studies were identified to illustrate the benefits of using the ME design method that would result in less concrete pavement depth

Application of Research Results

Development of Simplified Mechanistic-Empirical Design Tool for Pennsylvania Rigid Pavements - PI Dr. Lev Khazanovich

- The case study projects included:
  - Route 119 in Westmoreland County concrete restoration project replacement by PennDOT District 12-0
  - Ivory Avenue in the City of Pittsburgh planned to have the concrete pavement replaced by Allegheny County
  - The Southern Beltway new highway construction, Pennsylvania Turnpike Commission project

Application of Research Results

Development of Simplified Mechanistic-Empirical Design Tool for Pennsylvania Rigid Pavements - PI Dr. Lev Khazanovich

- A Pitt Rigid ME alternative pavement design was performed for each project:

Project	Original Design	PittRigid ME Design	Concrete Pavement Reduction
Southern Beltway Plain Cement Concrete Pavement RPS	12 inches	9 inches	3 inches
US-119 Plain Cement Concrete Pavement RPS	12 inches	8 inches	4 inches
Ivory Avenue Plain Cement Concrete Pavement RPS	10 inches	8 inches	2 inches

Application of Research Results

Development of Simplified Mechanistic-Empirical Design Tool for Pennsylvania Rigid Pavements - PI Dr. Lev Khazanovich – Benefit Results

Project	Original Design Total Costs	PittRigid ME Design Total Costs	Cost Reduction
Southern Beltway Plain Cement Concrete Pavement RPS	$44,025,986	$37,422,088	$6,603,898
US-119 Plain Cement Concrete Pavement RPS	$10,640,273	$9,044,232	$1,596,041
Ivory Avenue Plain Cement Concrete Pavement RPS	$210,375	$178,819	$31,556
		Total	$8,231,495

Application of Research Results

Early Opening to Concrete Pavements to Traffic – PI Dr. Lev Khazanovich

- Earlier opening of concrete pavement to traffic without an impact to short- and long-term pavement performance can reduce construction time and improve driver satisfaction
- To evaluate the estimation of concrete strength, laboratory and field studies were conducted using maturity and ultrasonic tomography
- A web-based tool was created to facilitate the implementation of this procedure for determining the optimal time when paving projects can be opened

Application of Research Results

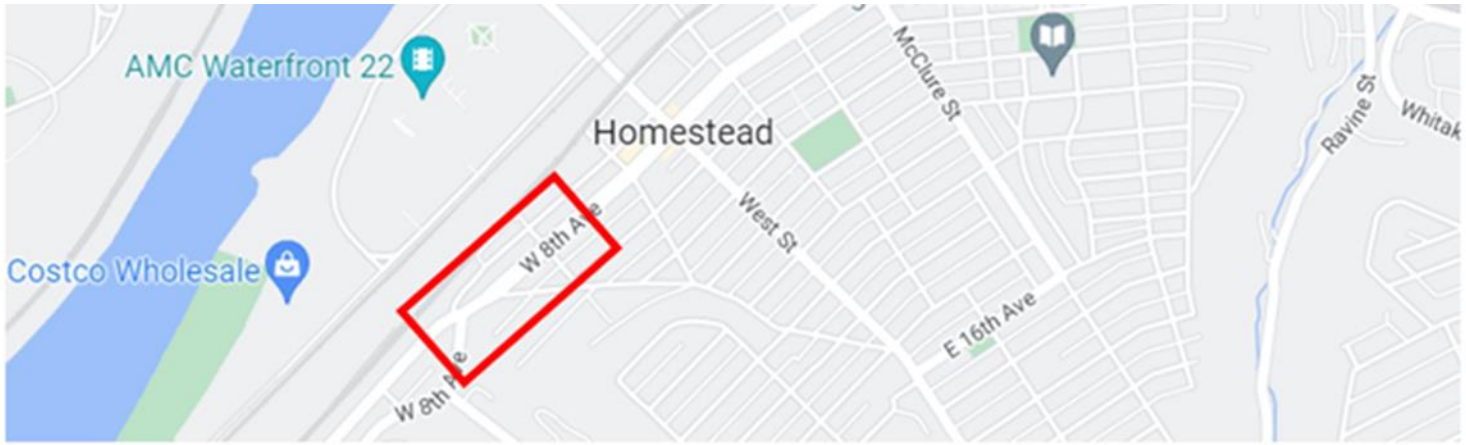
Early Opening to Concrete Pavements to Traffic – PI Dr. Lev Khazanovich

- Traffic Simulation Model of Urban Network closure of 7th Between Penn Avenue and Ft. Duquesne Boulevard in Pittsburgh was created

Application of Research Results

Early Opening to Concrete Pavements to Traffic – PI Dr. Lev Khazanovich

- Case Study of PennDOT Project Route 837 Construction Project PennDOT District 11-0 Golden Triangle Construction Contractor



Application of Research Results

Early Opening to Concrete Pavements to Traffic – PI Dr. Lev Khazanovich

- Using a traffic simulation model of a hypothetical street closure in an urban setting estimates a benefit $123,645 of user costs for every 24 hrs. of early opening in Pittsburgh case study

- A case study of a recent construction project on Route 837 revealed that the use of the Early Opening test methods could provide a benefit $40,950 in reduced material costs (HES Concrete eliminated)

Summary

- Material Compatibility Repair for Pavements – over **$7,000,000** in pavement repair savings over 4 years in Pennsylvania
- Evaluation of Pavement Surface Distresses Related to Pavement Marking –For two case studies reapplication of longitudinal pavement markings per year could save almost **$2,000,000**
- Remote-Controlled Technology Assessment for Safer Pavement Construction – From 2017 to 2020 a total of **23 injuries** to highway workers could have been avoided with significant savings

Summary

- Development of Simplified Mechanistic-Empirical Design Tool for Pennsylvania Rigid Pavements – 3 case studies of new construction, rehabilitation of an arterial and a street reconstruction estimated a savings of over **$8,000,000**
- Early Opening of Concrete Repairs to Traffic – two case studies illustrated **significant savings in construction and user costs**