UTC Project Information	
Project Title	MPC-649 – Assessment of Safe Work Indicators in Transportation Construction Using Personal Monitoring Systems
University	University of Colorado Denver
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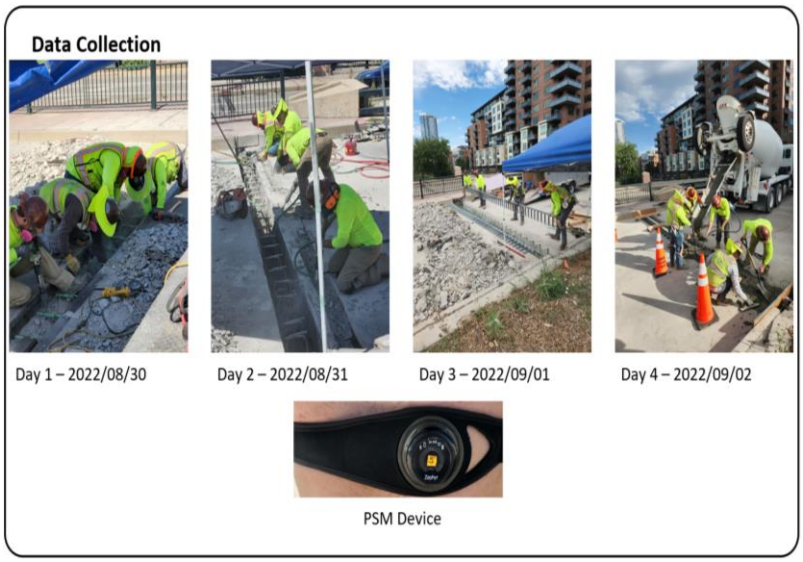
Funding Source(s) and Amounts Provided (by each agency or organization)	USDOT, Office of the Assistant Secretary for Research and Technology $60,000 GE Johnson equipment donation – $18,000 ORS Large Grant – $12,000 Faculty Summer Salary – $10,000 University of Colorado Denver – $20,000
Total Project Cost	$120,000
Agency ID or Contract Number	69A3551747108
Start and End Dates	March 26, 2021 to July 31, 2024
Brief Description of Research Project	The objective of this research is to develop and implement a non-intrusive system for monitoring and providing feedback regarding individual transportation construction workers' physical health and performance. Our piloted system synchronizes physiological data with on-site observation. Specifically, the system aligns Zephyr Bioharness, an off-the-shelf physiological monitoring (PSM) device (chest strap) to roadway construction activities. Due to the complexity of actual construction work, data will be reported and documented by the construction workers according using time and work activity codes, as well as on-site observation by researchers Monitored stress indicators include: heart rate, breathing rate, posture, physiological load, and mechanical load. Machine Learning will be used to analyze the data and predict future stress indicators.

Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	Data Set of five construction workers working on a bridge rehabilitation project that shows: • Physical demands during bridge rehabilitation can be highly variable depending on construction activity. • Concrete demolishing and jackhammer operation resulted in highest %HRR levels and average daily %HRR. • Bridge Rehabilitation construction work shown to be "high" exertion (threshold and sustained). • Deep learning models indicate that Long Short-Term Memory Network (LSTM), Bidirectional LSTM (BiLSTM), Gated Recurrent Unit (GRU), and Bidirectional GRU (BiGRU) have similar predictive performance. • LSTM had the best overall performance in HR prediction with Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Mean Absolute Percentage Error (MAPE) of 5.4, 7.34, and 5.77%, respectively. 
Impacts/Benefits of Implementation (actual, not anticipated)	Successful demonstration of 1 minute forecasting of transportation construction worker heart rate to increase safety.
Web Links • Reports • Project Website	• MPC Final Report – Assessment of Safe Work Indicators in Transportation Construction Using Personal Monitoring Systems • Journal Paper – Heart Rate Modeling and Prediction of Construction Workers Based on Physical Activity Using Deep Learning