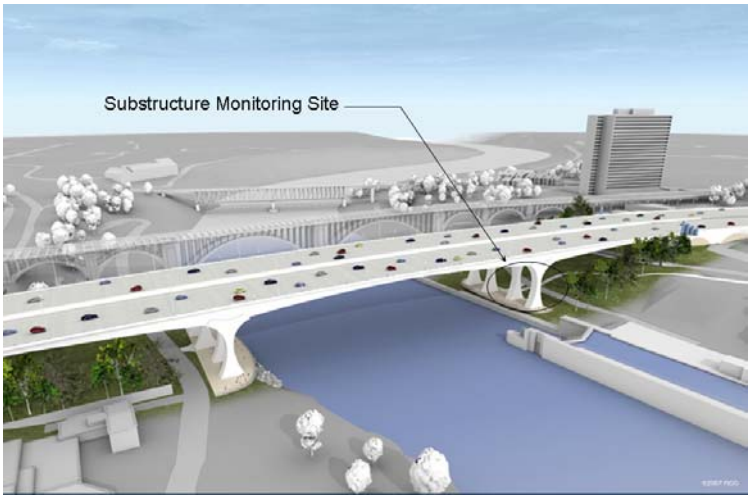
Foundation Health Monitoring of the New I-35 St. Anthony Falls Bridge in Minneapolis, Minnesota

Applications for monitoring field instruments (both short and long-term) have been available for several decades. What has changed more recently is the quality of the data acquisition systems (DAS), the ability to be self-powered, cellular technology to contact and download remotely, and finally, the cost-effectiveness of these systems. To this end, the tragic collapse of the I-35W bridge in Minneapolis, Minnesota has heightened the need to implement bridge health monitoring of all kinds (both super-structural and sub-structural). USF under the direction of Dr. Gray Mullins and the Federal Highway Administration have teamed with F&GE (Plant City), University of Minnesota, Minnesota DOT, Army Corps of Engineers, and the design build team (Figg and Flatiron/Manson) to provide live monitoring of the sub-structural loads during construction and ultimately long-term health monitoring of the bridge.

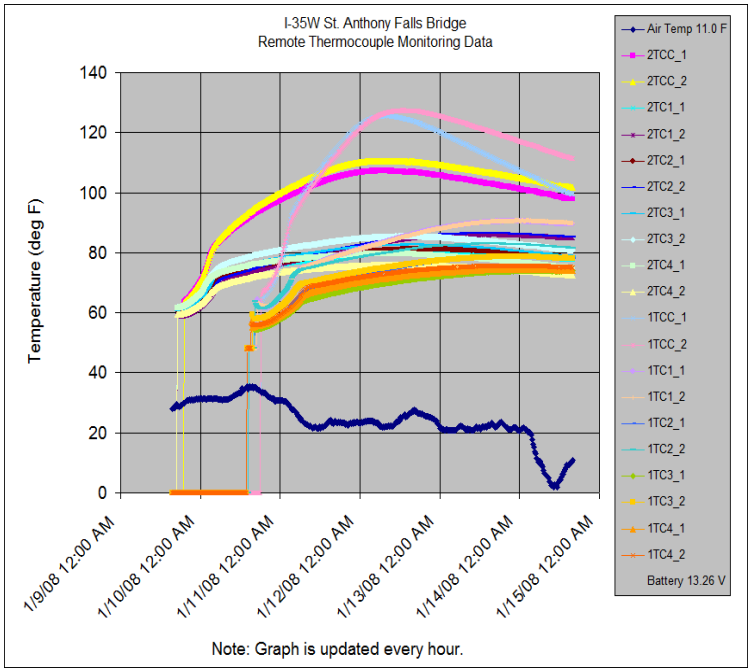
The I-35W bridge replacement is a fast-paced design-build effort wherein the design-build team is working closely with MnDOT and FHWA to assure a quality product completed by December, 2008. One aspect of the project's quality assure is to make use of newer developments in instrumentation, data collection and monitoring capabilities which dovetails with the present FHWA/USF/FGE projects. At the request of the FHWA, the USF/FGE team under the direction of Dr. Mullins quickly mobilized to both meet with MnDOT, FHWA, the designers and the contractor to discuss possible solutions and to implement a sub-structure health monitoring (SSHM) program that would not impede the construction progress. Means to remotely review the collected data via internet were subsequently set in place that are intended to continue throughout the construction process and the entirety of this project. Up to date information can be viewed at http://geotech.eng.usf.edu/I35.html .



Rendering of the new I-35 bridge showing USF/FHWA/FGE monitoring site.

The SSHM developed for this project involves only the South Bound Pier 2 columns (interior and exterior) and Shafts 1 and 2 (2SB-1 and 2SB-2, respectively) under the exterior column. Therein, two types of strain gages and thermocouples will be installed to monitor three phases of the bridge/foundation system: (1) internal shaft temperature, (2) construction loads, and (3) long-term health monitoring.

Phase 1 Internal Temperature Monitoring: The internal shaft temperature increase due to the heat of hydration will be monitored for an extended period of time to better understand mass concrete effects in drilled shafts using high performance concrete (in this case Self Consolidating Concrete; SCC). This aligns with on-going USF/FDOT studies now addressing mass concrete effects in drilled shafts of all sizes as well as the use of SCC and low heat of hydration mixes to mitigate these conditions. Temperature traces for the thermocouples in both of the shafts can be tracked at http://geotech.eng.usf.edu/I35TC.htm for hourly updates.



Temperature/time traces for thermocouples in both instrumented shafts

Phase 2 Construction Load Monitoring: The loads due to construction will be monitored as they increase and are distributed down the length of the shaft. Additionally, by correlating the number of box sections and their respective weights to the measured strain in each column, the column strain gages can be calibrated with increased confidence. These values will also be compared to more traditional means of computing load from concrete modulus and strain in the column. This phase will begin by mid February, 2008; look for real-time load monitoring at the same site after that time.

Phase 3 Long-Term Health Monitoring: Using the calibrations/correlations developed during Phase 2, variations in shaft and column loads will be used to identify aberrant conditions that will then be used to alert officials to take appropriate action. At present, the USF/FHWA/FGE involvement will entail monitoring the post construction loads until such time that MnDOT and the University of Minnesota choose and/or are ready to have these gages connected to the DAS tailored to meet the needs of both the superstructure and substructure instrumentation. This phase will begin near the end of the year.

For further information concerning *Foundation and Structural Health Monitoring* and/or *Mass Concrete Effects in Drilled Shafts* contact Dr. Mullins at gmullins@eng.usf.edu .