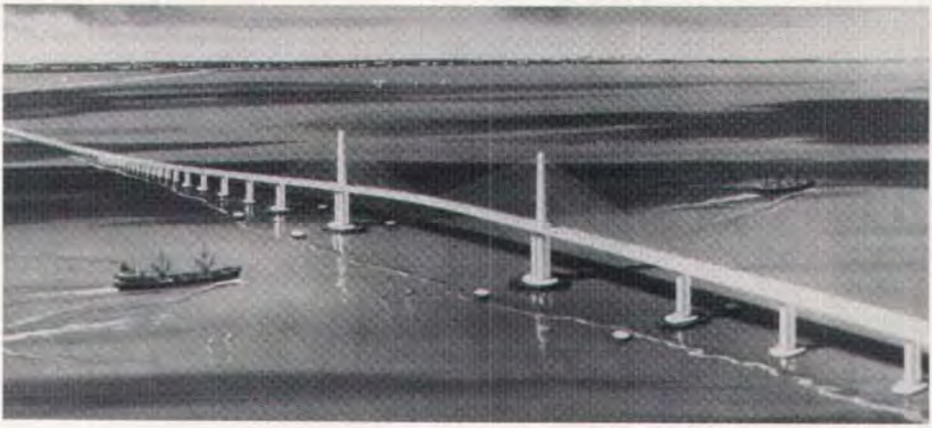

Microcomputer Technology Assists Florida DOT

Five years after the catastrophic collapse of the Sunshine Skyway Bridge, the Florida Department of Transportation (FDOT) began building a replacement bridge 1000 ft (304.8 m) east of the existing crossing as shown above. The new bridge at the mouth of Tampa Bay, spanning between Bradenton and St. Petersburg, will be the longest cable-stayed bridge in North America. Its main span, made up of 97 precast segmental bridge segments, is 1200 ft (365.7 m) long.

To closely monitor the behavior and performance of the bridge, FDOT, through its consultant, SKYCEI*, has contracted with Construction Technology Laboratories (CTL), Skokie, Illinois to develop, design, and install a state-of-the-art instrumentation system to monitor this 21,878-ft (6668.4m) long project during and after construction. The latest field instrumentation and microcomputer technology is being used.

OBJECTIVES AND BENEFITS OF FIELD INSTRUMENTATION

The objectives of instrumenting the Sunshine Skyway Bridge are twofold. The short-term objective is to provide background data for quality assurance during segment fabrication and other construction phases. Readings from the installed sensors are recorded during and after construction so that the data can either confirm or dispute design assumptions. These measurements also will allow comparisons between actual and predicted bridge behavior, allowing prompt

* SKYCEI, which is a joint-venture of four engineering firms with various disciplines and expertise, is the construction engineering and inspection consultant at the bridge site for FDOT.

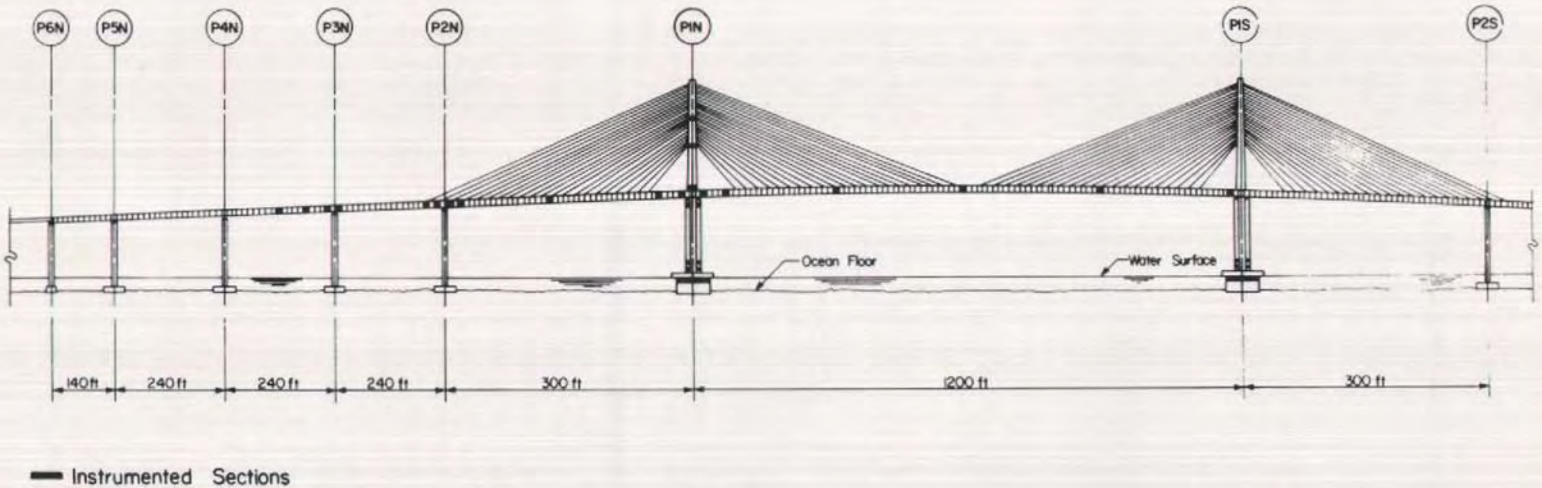

Fig. 2. Instrumentation locations.

modifications to be made, if necessary. In addition, the effect of accidental or abnormal construction loading can also be measured to help circumvent costly time delays and/or repairs.

The long-term objective is to predict and assure long-term bridge behavior as well as verify certain design assumptions related to time-dependent behavior. In addition, effects of temperature, wind, time-dependent movements, support settlement, accidental impact, overloads, and other factors also can be assessed. Field instrumentation will also be used as part of a maintenance and inspection program, confirming bridge integrity by measuring concrete strain variations, changes in vertical deflection of the bridge spans, and rotations. The cost savings in performing regular inspection by using this instrumentation is substantial, especially for large and complex structures like the Sunshine Skyway Bridge.

CTL MONITORS SKYWAY FROM THE BEGINNING

CTL has not only been responsible for developing the instrumentation program and monitoring the behavior of the Sunshine Skyway Bridge during and after construction, but also has aided FDOT in the design phase by evaluating the long-term properties of the proposed concrete. Compressive strength, coefficient of thermal expansion, creep, and shrinkage were determined at various concrete ages. The actual concrete properties were then compared with design values to determine any discrepancies. These data are also being used to predict long-term bridge behavior.

When construction of the main span began, CTL was on site to install the instruments. Three types of bridge components were selected for instrumentation: piers, pylons, and box girder segments. The instrumentation locations shown in Fig. 2 were jointly decided by FDOT, Figg & Muller Engineers, Inc. (designer), SKYCEI (construction consultant), and CTL.

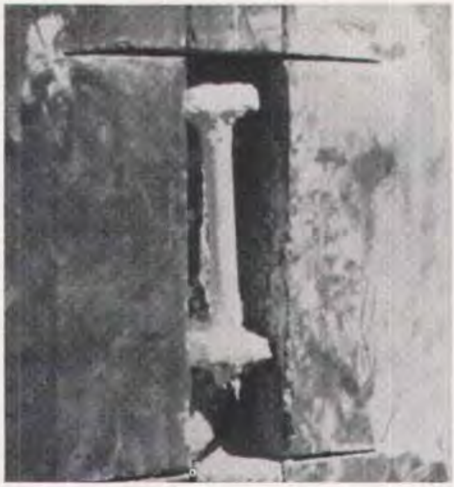

Fig. 3. Installed strain gauge after concrete casting.

The two main piers supporting the cable-stayed spans were instrumented. In the north pier, six sections were instrumented and, with the exception of the pier section 8 ft (2.4 m) below the roadway, all the gauges were installed after the pier was cast (Fig. 3). The strain gauges for the pier section below the roadway were installed before concrete casting as shown in Fig. 4. Five sections in the south pier were similar instrumented, however, no strain sensors were installed at the pier section 8-ft below the roadway.

Three pylon sections on top of the north pier were also instrumented. Both temperature and strain sensors were installed before concrete casting at 8, 85 and 145 ft (2.4, 25.9 and 44.2 m).

Lastly, seventeen large roadway segments also will be instrumented. Both temperature end concrete strain sensors are being installed before casting in the precasting plant as shown in Fig. 5.

Altogether, a total of 534 gauges will be used in the instrumentation program—228 concrete strain meters and 306 temperature sensors. This represents the most intensive instrumentation program for a long

Fig. 4. Installation of gauges before concrete casting.

Fig. 5. Installed gauges at precasting plant.

span bridge in America. Initially, readings were taken manually until an automatic data acquisition system could be installed at the bridge site. Now readings can be taken before and after each event that causes strain or stress changes in the sections. This monitoring will continue for a period of five years.

MICROCOMPUTER REDUCES TIME AND COST

By positioning remote signal processors at eight strategic locations in the piers and roadway segments, monitoring of all sensors can be centralized from one convenient location, using a single microcomputer to read and record data within seconds. A picture of a single processor is shown in Fig. 6.

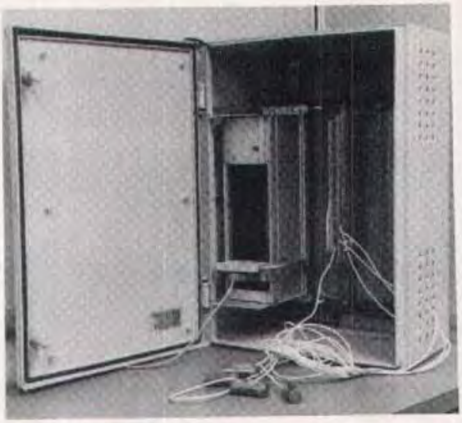
Fig. 6. Signal processor.

Traditionally, readings of installed sensors were taken manually, and as such, at least two technicians were needed to record the data. Also, with the wide-scatter placement of sensors (shown in Fig. 2), near instantaneous manual readings were impossible. However, the remote signal processors eliminate the time delays caused by manual techniques because signals are digitized similar to a telephone digitizing voices before data transmission. This permits the transmission of data undisturbed over long cable lengths. Currently the instrumentation program scans gauges located over half a mile apart.

Another feature of the data acquisition system is that to signal processors are connected in a closed-loop arrangement. Accidental damage of the data communication cable at any one point will not disturb the communication link to the microcomputer. This excellent safety feature ensures uninterrupted data recording.

The microcomputer also has a built-in, real-time clock, allowing readings to be taken at preprogrammed times and dates, as desired. This data can then be displayed in commonly accepted engineering units, in unreduced formats, or on a magnetic cartridge which can be sent back to CTL headquarters for further data reduction and analysis without interrupting field data recording operations. As a result, economical monitoring of the Sunshine Skyway Bridge can be achieved over a long period of time.

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