Close-Range Photogrammetric Measurement for Structural Analysis

Dimensional surveys of structural features are generally required to document existing conditions for engineering analysis and planning. Traditionally, survey crews obtain measurements using conventional equipment and methods, which involve physically placing measurement devices on every key feature. For a recent bridge renovation project, James W. Sewall Company was contracted to conduct a dimensional inspection survey for a cable suspension bridge while minimizing traffic interruption on a major state route. Safety was also a critical issue - traditional methodology dictated that a person climb upon each of the four suspension cables to the two bridge towers. Sewall utilized digital close-range photogrammetry to measure structural features with high accuracy, increased safety, and minimal impact on traffic flow.

Origin: Photogrammetric techniques, measuring objects from photographs, have been utilized since the late 1800s. These methods are most commonly used for mapping large areas from aerial photographs. Close-range photogrammetry is a technique for accurately measuring objects directly from photographs or digital images captured with a camera at close range. Multiple, overlapping images taken from different perspectives, produces measurements that can be used to create accurate as-built 3D models. Knowing the position of camera is not necessary because the geometry of the object is established directly from the images. Close-range photogrammetric methods have been successfully applied to projects in archaeology, architecture, automotive and aerospace engineering, and accident reconstruction.

Innovative Use: Working closely with the engineering firm Parsons Transportation Group, Inc., Sewall used digital close-range photogrammetric techniques to produce accurate, precise dimensional measurements of the half-mile-long Waldo-Hancock cable suspension bridge between Prospect and Verona, Maine. Sewall acquired digital images of the bridge from a helicopter using Kodak DCS660 and Imetric digital cameras and controlled the images utilizing real-time kinematic (RTK) GPS methods. From the photographs, Sewall provided information on the current bridge and cable geometry for structural analysis. The measurements included elevations and offsets for the cables, trusses, and piers, as well as the main tower and cable bent elevations. Measurements for critical dimensions of the bridge were measured to accuracy comparable to that of a conventional survey. If specified, however, accuracies exceeding 0.01 foot can be achieved through close-range photogrammetric methods.

Benefits: Compared to traditional surveying methods, this measurement approach was efficient and rapid, significantly reducing the time required to collect data in the field. Measurements collected in less than three days in the field would have taken 10 days in a conventional survey. Second, it was considerably safer. Sewall surveyors were able to obtain precise measurements without physically accessing each measurement point. Third, the method was non-intrusive, creating minimal impact on traffic flow. Finally, the process produced a comprehensive visual record of existing site conditions from which any identifiable features can be measured or geometrically assessed at a later date.

The same process can be used to obtain dimensional measurements efficiently on inaccessible structures such as tunnels and dams, and large or complex facilities such as refineries or water treatment plants. Close-range photogrammetric measurements can be integrated with 3D modeling and reverse engineering processes. The acquired data is infinite and the cost savings substantial.

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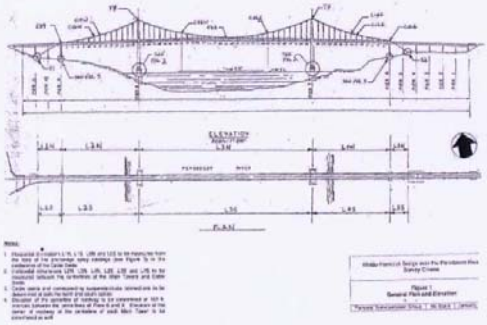
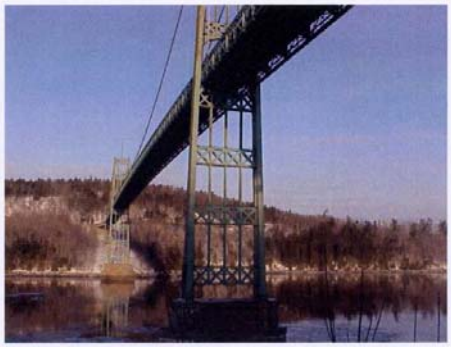
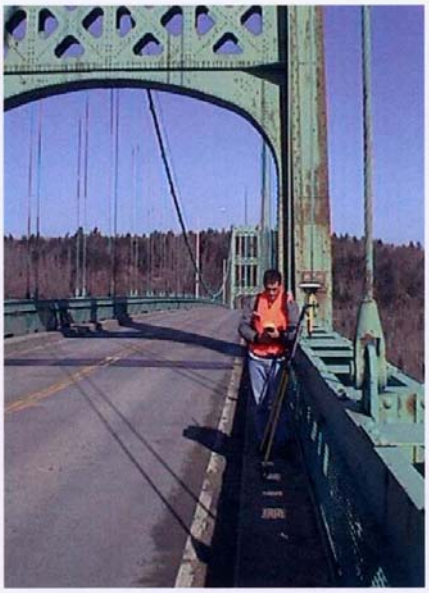


Engineering plan of the Waldo-Hancock Bridge showing measurement points



Waldo-Hancock Bridge

Punch mark control station



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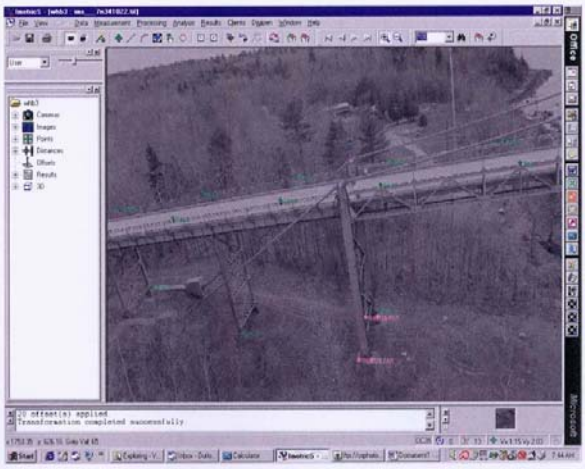
Establishing GPS control

Monitoring temperature during measurement

Capturing imagery



Screenshot of photogrammetric measurement