PROTO MANUFACTURING

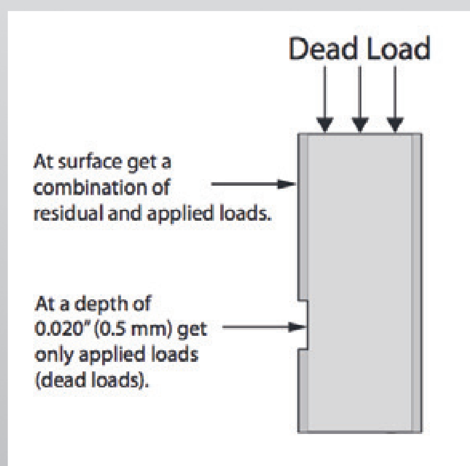
BRIDGES

Dead Load Measurement Using X-ray Diffraction

BRIDGES

DEAD LOAD

The weight of the concrete and the steel superstructure in a bridge and thus the resultant dead load in each of the critical members are well known when it is initially constructed assuming all goes to plan. However, these loads can change as a result of major maintenance and repair, or any significant damage to the structure which causes the loads to redistribute and thus change the dead loads and the load path. Therefore it is important to know what these new dead loads and load paths are to ensure safe and reliable operation of the bridge. The "in-service" dead loads in metal bridge components can be measured using Proto's X-ray Diffraction (XRD) systems quickly and cost effectively without disrupting structure use.



DEAD LOAD MEASUREMENT

- XRD measures total strain in the member.
- At the surface most strains are due to fabrication. These strains quickly decrease with depth.
- Electropolishing a small spot on the member to a depth of 0.020" (0.5 mm) gets to an area of the member where mainly strain due to the dead loads are present.
- XRD Strain x Elastic Constant x Cross Sectional Area of the Member = Dead Load (kips)

HOW TO USE XRD TO MEASURE DEADLOAD

- Identify element and locations on the element to measure.
- At the measurement location electropolish a small spot to a depth of 0.020" (0.5 mm).
- Measure stresss (ksi) in the desired directions with XRD.
- Multiply the stress results in ksi by the cross sectional area at the measurement location to get kips deadload.

HOW XRD DEAD LOAD MEASUREMENT CAN HELP YOUR BRIDGE

- Determine dead load and load path in structural members (stress or lbf).
- Provide base-line loads for other bridge instrumentation.
- Ensure every fracture critical member has been checked for:

a. Design errors
b. Changes in deck load
c. Damage to the bridge
d. Modifications from the original design
e. Load rating

- Load path can be accurately determined by measuring all the elements of interest.
- The "in-service" dead loads in metal bridge components can be measured using XRD without disrupting use of the structure.
- The change in dead load and load path can be monitored over time to develop trends.
- Determine the stresses in areas that are cracking.

CASE STUDY: FRANKLIN SQUARE BRIDGE

The Manhattan Approach to the Brooklyn Bridge was opened in 1883. Known as the Franklin Square Bridge, the span is made up of six parallel wrought iron eyebar trusses. When the bridge was built, the deck consisted of a two lane carriageway on each side of the bridge above the outer two trusses. Since then the transit tracks have been removed and replaced by concrete decks increasing the dead load of the bridge by 55 percent. This increased load caused some concern that some members of the eyebars may be experiencing significantly high loads. Additionally there was concern that many of the pins connecting the eyebars may have deformed resulting in additional stress redistributions around the pins and eyebars. Using a Proto iXRD portable x-ray diffraction system Proto successfully measured the dead loads in the eyebars and found that not all the eyebars bear the same load and that some of the eyebars bear very high loads approaching yield while others bear very small loads approaching zero. This information assisted in the determination that the bridge was unsafe. As a result six steel arches were added to support the existing trusses.

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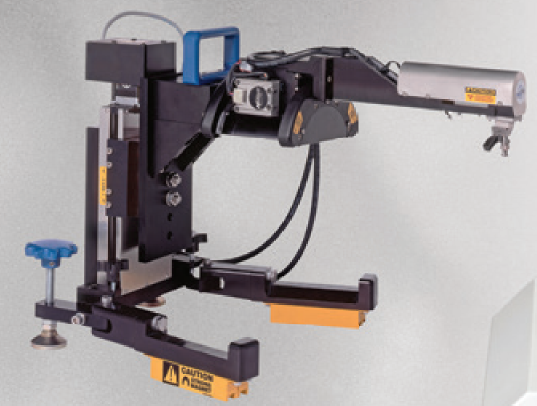

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