

Combination of hot-cured bonding and spot-welding solves strain-gage installation problem on oil pipe

by Karl Kumpf

For reasons of reliability, the operator of an underground pipeline for the supply of oil at a temperature of 160°C (320°F) was interested in finding the operational strains occurring in the pipe walls in the vicinity of the pipe bends. This information would enable the operator to take precautions against any expected damage to the pipeline. Strain gages that could be applied to specified measuring points on the pipe presented a suitable measurement method. The regions of the pipeline to be tested had to be exposed and the bitumen covering removed which had been applied around the pipe for corrosion protection and thermal insulation. **Figure 1** shows the section of exposed pipe.

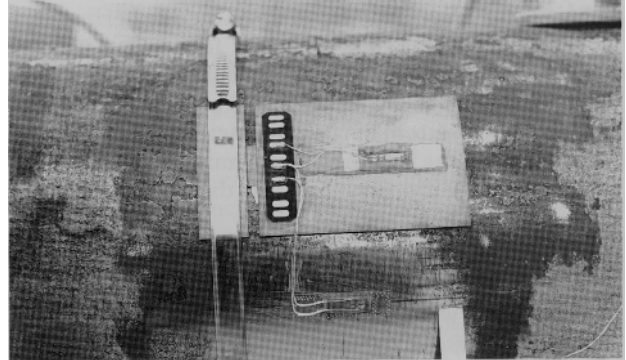


Fig. 2: Measurement object and compensation panel with type LS 31 Weld-On Strain Gage.

Since the pipe-wall temperature in operation was about 160°C, only a stable hot-curing cement could be considered for bonding the strain gage. However, carrying out hot-cured bonding directly on the pipe would have been difficult. Using the pipe temperature for curing was not to be recommended, because the curing temperature for optimum bonding should be about 20 K (36°F) higher than the operating temperature of the measuring point. In addition, hot-curing requires that the strain gage is pressed on with a clamping device which would in this case have meant extra expense.

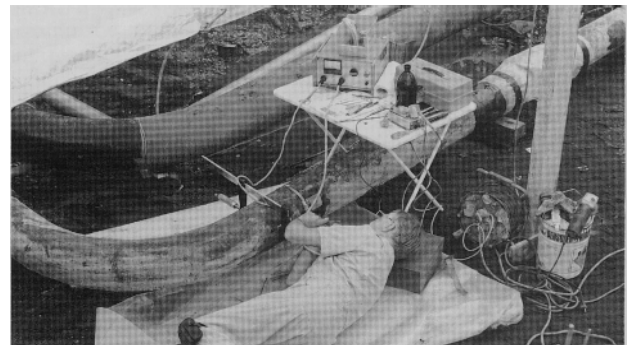


Fig. 3: Measurement technician during spot welding.

The problem was solved using LS 31 Weld-On Strain Gages. These consist of a carrier, 0.1 mm (0.004 in) thick, with a hot-applied foil strain gage having 350 Ω nominal resistance (constantan grid, polyimide carrier) and integral connecting leads. The carrier foil is fastened to the measurement object by spot welding. A full bridge comprising two diametrically opposed half bridges on the pipe circumference was mounted at each measuring point on the pipe. The active gages in these bridges were welded in the longitudinal direction directly onto the pipe and the compensation gages

were welded to mechanically unloaded panel sections. The panels with the compensation gages were previously prepared in the workshop so that they just needed fastening to the pipe with a band clamp. **Figure 2** shows one half of the full-bridge circuit installed on the pipe and the measurement technician can be seen in **Fig. 3** welding an active strain gage. This picture also shows the spot-welding equipment and the grounding point attached to the pipe with a screw clamp.

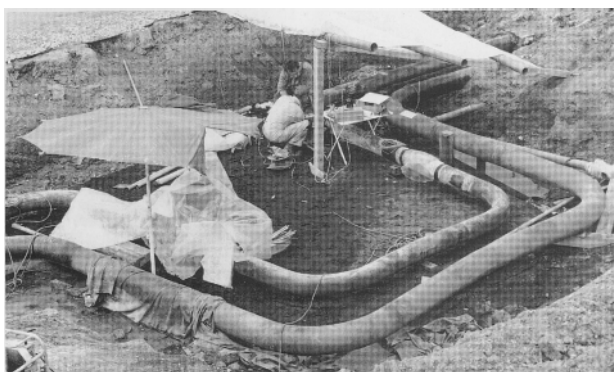


Fig. 1: The exposed pipeline to be tested.

The measurement signal was passed via a screened cable to a UPM 60 Multi-point Measuring Unit situated on a car trailer. The equipment grounding points used during the measurement were attached to the pipeline. The screen of the measuring lead was connected to ground at the equipment end and was open at the measuring-point end. This method eliminated any interference due to the high-voltage line which passed directly over the measuring point.

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