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Strain measurements on saturated concrete specimens*

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Contribution by J. B. Read

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Experiments similar to those performed at Imperial College have been carried out at the Cement and Concrete Association as part of an investigation into the possibility of using electrical resistance strain gauges inside a mass of concrete and independent of any reinforcement. Gauges developed elsewhere⁽¹⁾ have used fibre-glass and epoxy resin as a protective coating. At the Cement and Concrete Association, a 1 in. foil gauge was embedded in a sheet of Araldite with a surface coating of sand to improve bond characteristics; the gauge was $1\frac{1}{2} \times \frac{5}{8} \times \frac{1}{16}$ in. over-all and had a modulus of elasticity of 0.48×10^6 lb/in².

The gauge was positioned and alined along the central axis of a 6 × 12 in. cylinder of heavily vibrated micro-concrete. Readings obtained during setting, hardening and curing of the concrete indicated that the gauge worked satisfactorily under saturated conditions.

When the concrete had dried out, further electrical resistance strain gauges were attached to the surface of the cylinder, in the conventional manner and in planes parallel to the internal gauge. The cylinder was then tested in compression and the results obtained are shown in Figure I. The first loading showed the internal strains to be higher than the surface strains and, as a check, the cylinder was inverted and re-loaded. This loading was then repeated with a different type of ball seating. All tests indicated that the internal strains were larger than the surface strains and, possibly by coincidence, the ratio of the internal to external strain was similar to that obtained at Imperial College for in-surface to on-surface strains. The modulus of elasticity for the concrete, obtained from the surface strains, was 4.4×10^6 lb/in².

The gauge worked well on short loading tests, seemed robust and able to withstand heavy vibration and indicated its use as an alternative to the gauge suggested by Imperial College. However, further work is required to study the behaviour of the gauge with concrete of different sizes of aggregate and with different types of vibration and to investigate long-term stability.

Figure I: Comparison between on-surface and internal strain readings.

*Pages 143-150 of Magazine No. 45.

REFERENCE

1. HONDROS, G. and MOORE, G. J. Epoxy resin protection of electrical resistance strain gauges for general use in concrete. *Civil Engineering and Public Works Review*. Vol. 57, No. 671. June 1962. pp. 756–758.

Reply by the authors

The authors were very pleased to receive the contribution of Mr Read since it adds considerable support to two points made in their paper. Firstly, with the technique described by ourselves and Mr Read, Araldite-bonded sand-covered strain gauges are easy to make, robust and reliable and can be used for in-

surface and internal strain-gauge measurements on saturated and dry concrete specimens. Secondly, strains on the external surfaces of both prismatic and cylindrical specimens are considerably smaller than those measured just within the surface or internally. As Mr Read dried out his specimen before testing, it might be argued that, owing to differential shrinkage, the surface concrete had different deformational characteristics from the internal concrete. Yet our tests showed that this effect occurs both on saturated and dry concrete specimens. It seems reasonable to conclude, therefore, that this strain difference is a basic phenomenon of mortars and concretes, the reason for which has still to be explained.