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# Using SR-4 Gages to Measure Strains in Wire Strand

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Using the data from strain gages mounted on individual wires, the designer can accurately predict what values of the elastic properties can be expected from the strand as a whole.

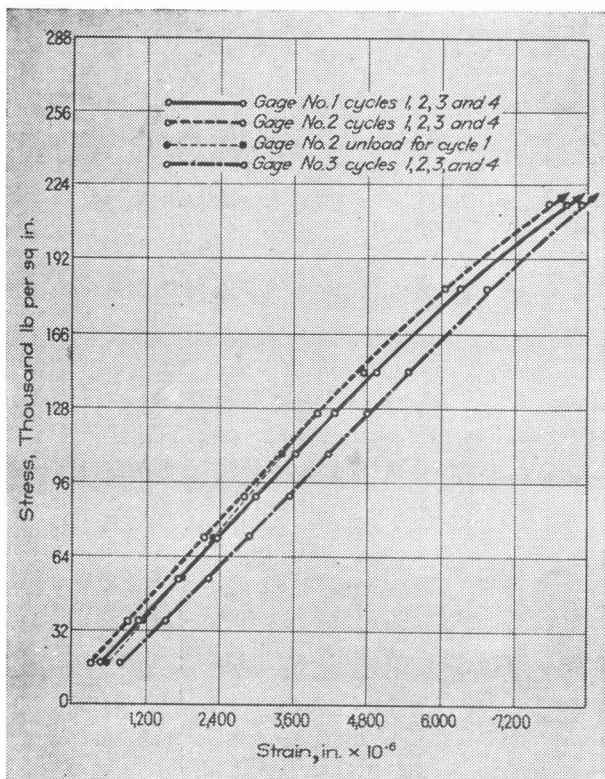


Fig. 1—Stress-strain curve for four gages and four load cycles. Load for cycles 1, 2 and 3 was 124,500 psi. Strand was loaded to failure for the last cycle.

A SATISFACTORY TECHNIQUE for measuring stresses in the individual wires of small steel strand with SR-4 strain gages has recently been developed. It was a result of a test program on pretensioned, prestressed concrete beams. The strand, which served as a reinforcing member, was 0.308 in. in diameter and consisted of six 0.10 in. wires twisted around a central wire of 0.108 in. diameter.

For a complete interpretation of the test results accurate measurements had to be made of the prestressing force, the creep, the reduction of stress due to the volumetric change of the concrete, and the behavior of the strand during release of initial tension as well as during the application of the live load. A preliminary study investigated the practicability of crimping a small metallic tube on the strand and then applying SR-4 gages on the tube. This proved to be unsatisfactory because of the inability of the tube and strand to act as a unit.

With the new technique a portion of the strand was swaged so that the width of each wire was increased to  $\pm \frac{1}{8}$  inch without any loss in ultimate strength of the strand. Type A-12, SR-4 gages were chosen because they provided (1) sufficient length to enable accurate orientation of the grid of the gage along the longitudinal helical surface presented by each wire; (2) a narrow width so that the complete grid could be located on only one wire.

To establish the reliability of this procedure, a seven-foot length of strand containing standard leaded end fittings was swaged in three places, viz. at the mid-length and near each end. After the swaged areas were thoroughly cleaned and roughened with emery paper, four A-12 gages were mounted with a cellulose acetate cement. One gage was located at each end and two were placed in the mid-length swaged portion. One of the end gages was placed on the same wire that contained one of the gages on the mid-length swaged portion. The other gage located at the mid-length was placed on a diametrically opposite wire. All gages were cured for 12 hours at 120 F before testing.

Load was applied to the seven-foot length of strand, by a 300,000 lb. hydraulic testing machine. Strains were recorded over four cycles of loading. The loading operation consisted of loading the strand to 124,500 psi, releasing to 17,750 psi, repeating for two more cycles, and then loading to failure.

The results of the recorded strains for the four load cycles are shown in Fig. 1. Gage No. 1, located at the mid-length of the strand, had an identical load and unload curve for the first three cycles. Gage No. 3, also located at the mid-length of the strand, exhibited the same characteristic, although it produced a curve slightly different than that of gage No. 1. Gage No. 2, located at one end of the strand and mounted on the same wire as No. 3, produced slightly different load and unload curves for the first cycle of loading. However, the load and unload curves of gage No. 2 for cycles 2 and 3, follow identically the unload curve of the first cycle. Gage No. 4 was damaged in the process of readying the strand for test. For load cycles 2, 3, and 4, all gages yielded very nearly the same modulus of elasticity, the average value of which is 28,100,000 psi. This value is for a single wire of the strand. The manufacturer's figure for the whole strand is 28,500,000 psi. By comparing these two values, it was concluded that the modulus of elasticity for a strand of this type can be determined with a satisfactory degree of accuracy by using Hooke's Law on one of the wires which makes up the strand.

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