LABORATORY EVALUATION OF FULL-SIZE, ELASTOMERIC, BRIDGE BEARING PADS

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Elastomeric, bridge bearing pads, which were reinforced by layers of steel, fiberglass, or polyester cloth, were evaluated by laboratory testing. Full-size specimens were loaded in simulated service conditions. Steel and fiberglass reinforcement showed decided superiority.

ABRIDGMENT

•ELASTOMERIC pads were first used as bridge bearings in the United States in the late 1950s generally because a satisfactory bearing device that could accommodate the relatively severe end rotation and translation associated with prestressed concrete structures was needed. Bearings more economical and maintenance free than those used previously also were desired. At that time, California started a research project to establish design guidelines and specifications for these pads (1). That study revealed that neoprene pads reinforced at ½-in. (12.7-mm) intervals with steel sheet or polyester fabric performed satisfactorily in the bridges constructed during that period. The polyester fabric became the most commonly used reinforcement in California. Polyester fabric is less expensive than steel because large pads can be fabricated, stockpiled, and sliced into custom sizes on demand. Steel-reinforced pads must be fabricated individually to the desired size because the edges of the steel must be covered with elastomer for corrosion protection.

During the 1960s, use of prestressed concrete bridges became more common and typical span lengths became longer because of designers' interest in economy, safety, and aesthetics. Consequently, bearing pads became larger in both plan area and thickness to accommodate increased loads, translations, and rotations. As pad sizes increased, construction personnel began to notice pad deflections that were considerably different from those anticipated. At that time pad deflections were predicted on the basis of tests performed on relatively small pads. Some design data (2) were extrapolated to estimate the behavior of the pads being used. When it became apparent that extrapolation of data from small pads would not ensure satisfactory performance of large pads, the research project that will be discussed in this paper was initiated to evaluate the physical characteristics of full-size bearing pads and to modify the pertinent specifications and design criteria if necessary.

The objective of this research was to evaluate the performance of full-size bearing pads under test conditions simulating actual field use. Various shapes and sizes of pads up to 7 ft^2 (0.65 m^2) in plan area and 5 in. (127 mm) in thickness were subjected to compressive, cycling, creep, translation, rotation, and ultimate-strength tests. Typical pads consisted of 55-durometer-hardness neoprene reinforced at ½-in. (12.7-mm) intervals with steel, polyester, or fiberglass reinforcement.

This abridgment is a condensed version of a more detailed paper that is available elsewhere (3).

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CONCLUSIONS

These conclusions are based on laboratory testing at approximately 70 F (21 C) and apply to pads fabricated in accordance with California specifications (3). The pads exhibited 55 ± 5 durometer hardness (ASTM D 1149, type A); they were reinforced at intervals of $\frac{1}{2} \pm \frac{1}{8}$ in. (12.7 ± 3.2 mm). Reinforcement was fabric or 20-gauge (0.91-mm) mild steel with a minimum ultimate tensile strength of 700 lb/in. (122.5 kN/m) at top and bottom of pad and 1,400 lb/in. (245 kN/m) within the pad.

Polyester-Reinforced Pads

Compressive deflection of polyester-reinforced pads is difficult to predict accurately for 4 reasons.

1. Magnitude of deflections of polyester-reinforced pads is much greater than that of steel- or fiberglass-reinforced pads because of the relative tensile flexibility of the polyester fabric.
2. Compressive stiffness decreases as overall pad thickness increases.
3. Compressive creep of polyester-reinforced pads under sustained dead load stresses is 2 to 3 times that of steel- or fiberglass-reinforced pads because of polyester fabric creep.
4. Compressive deflections due to live load cycling tend to remain in the pad after the live load is removed.

Translation and ultimate strength properties of polyester-reinforced pads are similar to those of fiberglass-reinforced pads.

Fiberglass- and Steel-Reinforced Pads

The following conclusions hold for fiberglass- or steel-reinforced pads:

1. Compressive deflections can be reliably predicted within the normal range of construction tolerances;
2. Compressive stiffness is not significantly dependent on overall pad thickness;
3. Compressive creep under sustained dead load stresses is approximately 25 percent of initial deflection after 10 years of service;
4. Compressive deflections due to live load cycling tend to diminish after live load is removed;
5. Ultimate compressive strength is more than 1,600 lb/in.^{2} (11 040 kPa) (mode of failure is fabric tearing or steel yielding);
6. Under a nominal compressive load of 800 lb/in.^{2} (5516 kPa), fiberglass- or steel-reinforced pads may be subjected to rotational forces until compressive strain at an extreme edge is 0 without damaging the pad; and
7. Shear modulus is approximately 100 lb/in.^{2} (690 kPa) at 70 F (21 C). This value is not significantly dependent on pad size, shape, skew angle, or compressive stress.

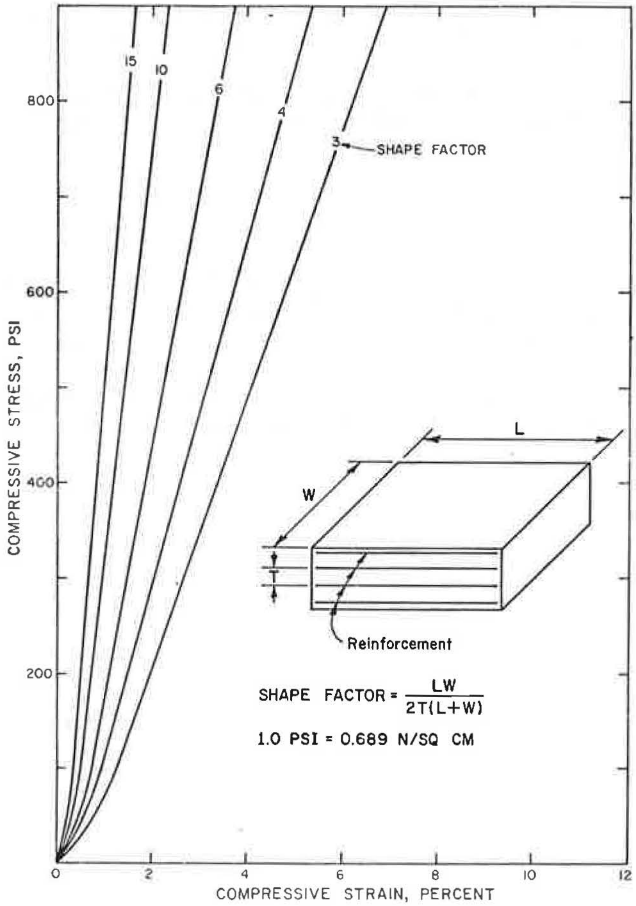
RECOMMENDATIONS

Polyester-reinforced pads more than 1 in. (25 mm) in thickness should not be used in bridge bearings because they make it difficult to predict compressive deflection.

For pad thicknesses normally used in bridge construction, steel- or fiberglass-reinforced pads should be specified in accordance with the specifications presented elsewhere (3).

Compressive deflections for steel- or fiberglass-reinforced pads should be predicted by using the data shown in Figure 1. The accuracy of these curves is considered to be

Figure 1. Recommended compressive stress-strain curves for steel- or fiberglass-reinforced pad of 55 durometer neoprene.



well within the range of normal construction tolerances. If long-term compressive creep is to be included in the prediction, then the values obtained from Figure 1 should be increased by 25 percent. For special situations requiring extreme accuracy, sample pads should be tested to determine the stress-strain behavior of each lot of pads.

Further research is needed to improve specifications and test methods used to ensure the quality of bridge-bearing pads. Based on field performance to date, current specifications and test methods result in high-quality pads, but these requirements vary considerably throughout the nation. Some tests are difficult or expensive to perform, and, in some cases, requirements may be unnecessarily conservative and restrictive. Research is needed to develop simple and inexpensive test methods of performance requirements.

If further research is contemplated for large bearing pads, careful consideration must be given to test method details (3).

The recommendations on pad thickness were implemented by the California Department of Transportation in late 1972. Since that time, there have been no reports of adverse performance of fiberglass-reinforced pads.

ACKNOWLEDGMENTS

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