



A beautiful prestressed precast concrete parking facility - one of the many parking garages that use Voss Bearing Pads.



Another new domed sports palace taking shape in the sun belt with Voss Bearing Pads in the plans.



A set of Voss Bearing pads will support each of these twin T's in the construction of this new parking garage in Chicagoland.

Marina Towers, a Chicago landmark, alive and well, resting on Voss Bearing Pads.

Voss
ENGINEERING

Voss Engineering, producers of Bearing Pads for over thirty years, continues to research and develop the best available products in the industry.

In 1984 Voss Engineering recovered some 26 year-old pads for testing to determine long term strength qualities. They were Sorbtex™ duck layer fabric pads that came from a bridge under repair. Testing showed they retained 90% of their original strength properties. The pads had been supplied by Voss Engineering to the Illinois Tollway Authority in 1958. Since that time countless Voss bearings have gone into numerous projects ranging from parking structures and stadiums to bridges and commercial buildings. In fact, in many construction projects throughout the country where two structural elements are mated together harmoniously, you might just find a Voss bearing pad doing its job - pads such as our Sorbtex™ duck layer fabric pad, the Vossco™ ROF pad, the Neosorb™ unreinforced chloroprene pad, and Voss Slide Bearings (TEFLON®).

The Voss commitment to product quality and service to the customer continues uppermost in our corporate priorities. Our in-house test equipment allows us to simulate field conditions (*up to 105 KIPS compression and 25 KIPS lateral load*) and provide customers with solutions to their specific bearing problems. We are dedicated to continued research and development to keep the finest possible bearing pads available to the industry.

Such a product is **FIBERLAST.**

Bearing pads are commonly used in standard construction, precast and prestressed concrete bridges and buildings, as well as machinery and equipment foundations. They are designed to:

- distribute vertical loads uniformly over bearing areas to eliminate highly localized stresses and resulting structural damage
- allow horizontal and/or rotational movements at the bearing surfaces to reduce the effects of temperature, creep and shrinkage
- achieve a longer life than steel bearings which in the past have commonly failed due to corrosion
- isolate shock loads on structural members
- minimize vibrations between contacting surfaces.

Elastomeric Bearing Pad Types

Elastomeric bearing pads may be generally classified into two groups: plain pads (unreinforced) and reinforced pads. Plain pads are generally made in single layers from materials such as chloroprene, chloroprene formulated with other elastomers and natural rubber.

Reinforced elastomeric bearing pads are made by several different methods. One example is duck reinforced pads made of closely spaced layers of woven fabric bonded with nitrile or chloroprene elastomers (Sorbtext™). These are commonly used for building or bridge applications as well as shock and vibration isolation. Random Oriented Fiber (ROF) is another reinforced pad (Vossco™) used extensively for bear-

ings in the precast concrete industry and other construction applications including bridges.

FIBERLAST Bearing Pads

FIBERLAST bearing pads offer engineers and designers a new choice in ROF pads. With today's ever increasing structural needs and higher load requirements, a pad had to be developed that could meet these rigid demands and remain cost effective. FIBERLAST is such a product. Made of high quality ozone resistant virgin elastomer combined with synthetic fibers, FIBERLAST pads have been extensively tested to demonstrate that their performance characteristics are superior to comparable ROF or AASHTO grade unreinforced chloroprene pads.

FIBERLAST TEST PROGRAM

An extensive laboratory test program was undertaken to evaluate the structural performance properties of the new FIBERLAST ROF pad material. The tests were performed by Wiss, Janney, Elstner Associates, Inc., Northbrook, Illinois, under the direction of Donald W. Pfeifer, Vice President. The tests were designed and performed by Gilbert T. Blake, Senior Engineer, and Joseph Zachorowski, Specialist. Prior to undertaking the laboratory testing, a literature review^{1,2,3,4,5} was made to establish the state-of-the-art in structural design considerations for elastomeric pads. Significant factors identified in the literature which need to be considered in the design process are as follows:

- Stress-strain behavior of uniformly loaded pads.
- Stress-strain behavior of nonuniformly loaded pads.

- Horizontal shear resistance behavior due to deformation and friction characteristics of uniformly loaded pads.
- Creep properties of uniformly loaded pads.
- Effective coefficient of friction.

In the test program compression tests were made on pads with sizes of 4 x 4 x 1/2 in., 4 x 4 x 1/4 in., 5 x 5 x 3/8 in. and 8 x 14 x 3/8 in. These four pad sizes have shape factors of 2, 4, 3.3 and 6.8, respectively. The pads were tested between steel-to-steel, steel-to-concrete and concrete-to-concrete bearing surfaces. Besides uniform loading tests, two nonuniformly loaded conditions were tested. All tests were conducted in triplicate making a total of 108 compression specimens.

Horizontal shear tests were made using uniform compressive stresses of 500, 1000 and 1500 psi on pads with sizes of 4 x 4 x 1/2 in. and 4 x 4 x 1/4 in. The pads were tested between steel-to-concrete and concrete-to-concrete bearing surfaces. A total of 36 shear tests were made.

Creep tests were also made in triplicate using a constant compressive stress of 1500 psi on pads with a size of 4 1/4 x 4 1/4 x 1/2 in. and a shape factor of about 2. The loads were maintained on these pads for 120 days using standard 50-ton creep frames in accord with ASTM C512 methods. Photographs of the various tests in progress are shown on the inside back cover.



ENGINEERING

FIBERLAST SPECIFICATIONS

Made of high quality ozone resistant virgin elastomer combined with synthetic fiber.

Material properties of the new FIBERLAST bearing pads are tabulated below and discussed in detail in this catalog.

1. Hardness (Shore A)..... 80 ± 5
Heat Aging (per ASTM D573)
 70 hrs. @ 212°F in forced air oven
 Durometer, Point Change.....10 pt. max
2. Compression
 minimum ultimate strength.....8000 psi
3. Shear Modulus (G)..... 230 ± 30 psi
 Based on tests conducted at 70° to 80°F under uniform compressive stresses of 500, 1000 and 1500 psi and at an applied horizontal shear plus slip strain of 50 percent. This value is applicable to both concrete-to-concrete and steel-to-concrete surfaces.
 G is constant in all directions parallel to the bearing plane.
4. Tensile Strength
 (ASTM D412, Die C)..... 1000 ± 100 psi
Tensile strength for elastomeric materials is commonly related to the ability of the edges of plain nonreinforced bearing pads to withstand the tensile stresses induced by undesirable bulging of the pad during application of high compressive loads. Thus, nonreinforced chloroprene pads and some ROF pads must be designed to account for bulging and shape factor effects. Tests in 1988 on the new FIBERLAST pad material have demonstrated that this ROF material is

relatively insensitive to bulging effects for shape factors ranging from 2 to 7. This performance is in contrast to the behavior reported in the June 1985 PCI Technical Report No. 4, "Criteria For Design of Bearing Pads," on a different ROF pad material.¹

- Ozone Resistance** (per ASTM D1149)
 Exposed 50 hrs. @ 100 pphm @ 100°F
 Tensile Strength.....725psi min.
Heat Aging (per ASTM D1149)
 70 hrs. @ 212°F in forced air oven
 Tensile Strength, %Change.....-25% max.

5. Elongation:
Ultimate Elongation, %40% min.
Ozone Resistance (per ASTM D1149)
 Exposed 50 hrs @ 100 pphm @ 100°F
 Elongation.....40% min.
Heat Aging (per ASTM D573)
 70 hrs. @ 212°F in forced air oven
 Elongation, % Change.....-25% max.

6. Oil Imersion
 Oil Immersion per ASTM D4711
 70 hrs. @ 212°F in ASTM #3 oil
 Volume Change, %.....125% max.
7. Thickness tolerance ± 1/16" or 15%, whichever is greater.

ALL PRODUCT IS CERTIFIED TO ABOVE SPECIFICATIONS BY VOSS ENGINEERING, INC., CHICAGO, ILLINOIS

DESIGN CHARACTERISTICS

Bearing pad design procedures are usually based upon service loads. Design guidelines for bearing pads are available in the 1985 PCI Design Handbook.⁴ The guidelines presented in this Manual are patterned after the PCI Design Handbook guidelines and proposed specifications included in the Oct. 1987 NCHRP Report 298.²

Compressive Stress

The allowable compressive stress, σ_c , for uniformly loaded, single layer ROF pads which are free to slip, suggested by the PCI⁴, is as follows:

$$\sigma_c = 1000 + 100S \leq 1500 \quad (1)$$

where:

σ_c = compressive stress on loaded area, psi

S = shape factor of actual loaded area

Shape factor is a nondimensional

relationship associated with the bulging caused by compressing a bearing pad. It is an important factor in plain pad design where significant bulging of the pad can lead to failure.

Shape Factor is defined as:

$$S = \frac{l_1 w_1}{2t(l_1 + w_1)} \quad (2)$$

where:

l_1 = loaded length of pad, in.

w_1 = loaded width of pad, in.

t = thickness of pad, in.

Equation (1) was based on extensive test data developed in 1984 from ROF pads with shape factors of 2 to 5. These pads were sensitive to shape factor variation when uniformly loaded to 1500 psi and compressive strains of 30 to 40 percent were developed.

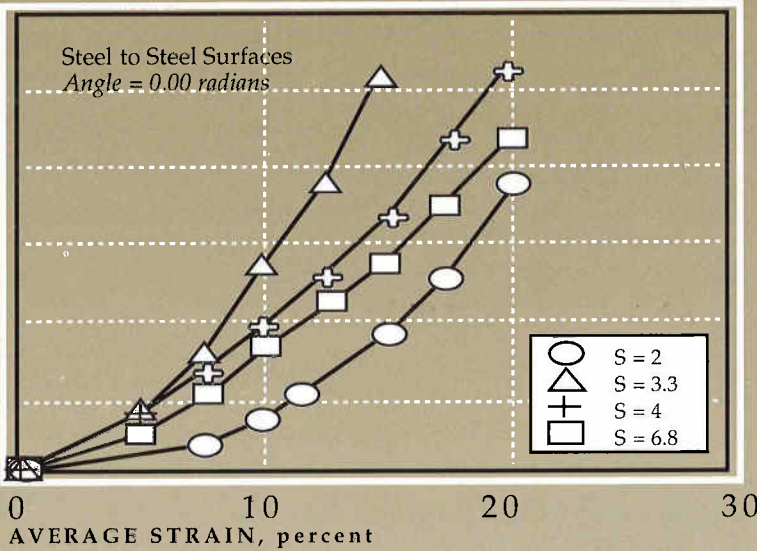
The newly developed FIBERLAST pad was found to be relatively insensitive to shape factor (from 2 to 7). When uniformly loaded to 1500 psi, the compressive strains were 11 to 20 percent.

Compressive strains can also be influenced by the friction characteristics of the surfaces in contact with the pads. As a result, surfaces most commonly encountered in building or bridge construction were tested.

Typical FIBERLAST uniform compressive stress-strain curves averaged from three tests are shown in Figs. 1, 2 and 3 for various steel and concrete surface combinations and shape factors ranging from 2 to 7. These data from 36 tests indicate that the average compressive strain for a uniform 2000 psi stress level will be about 15 to 18 percent for these shape factors and surface loading conditions. A review of these data indicates that shape factor does not produce a consistent pattern nor significant detrimental effects on the strain behavior common to plain nonreinforced pads and other ROF pads.

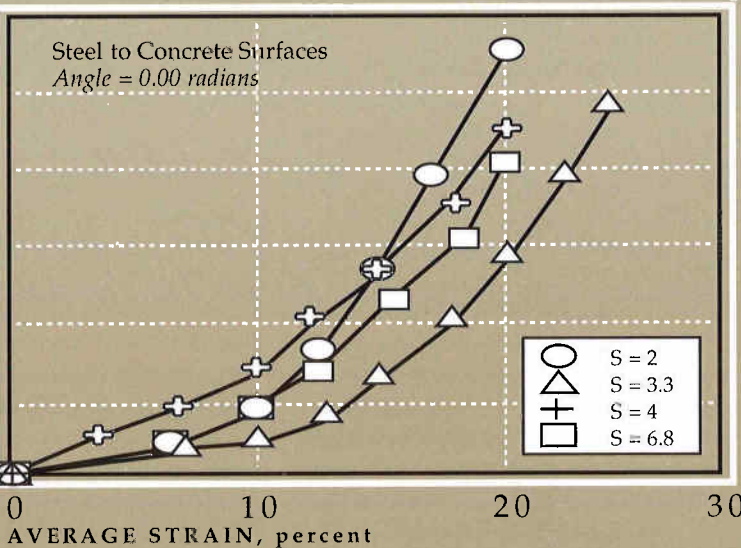
PAD STRESS, psi

Fig. 1 **FIBERLAST UNDER UNIFORM LOADING**



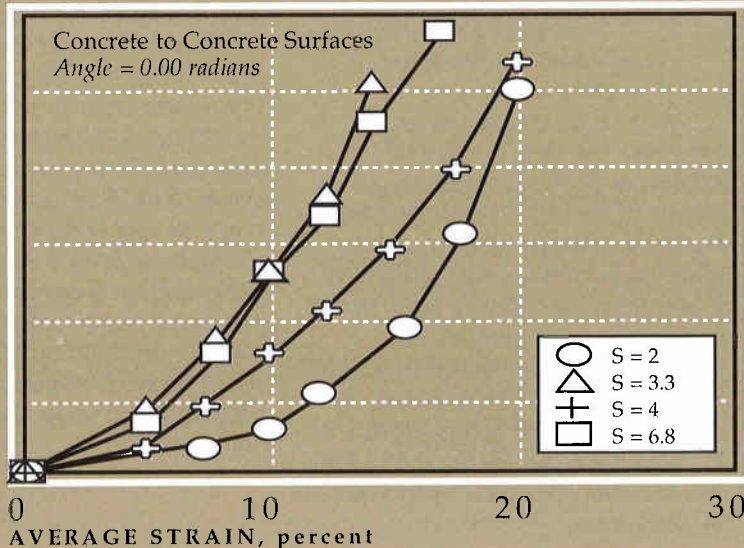
PAD STRESS, psi

Fig. 2 **FIBERLAST UNDER UNIFORM LOADING**



PAD STRESS, psi

Fig. 3 **FIBERLAST UNDER UNIFORM LOADING**



Compressive Strain

Average compressive strain is defined as follows:

$$\epsilon_c = \frac{\Delta_c}{t} \quad (3)$$

where: ϵ_c = compressive strain, in./in.

Δ_c = instantaneous compression shortening of pad, in.

t = original bearing pad thickness, in.

The total average compressive strain during the life of the pad is the sum of the initial compressive strain due to instantaneous dead and live loads, and the long-term compressive strain due to creep. Instantaneous compressive strains for FIBERLAST pads when loaded uniformly to 2000 psi between concrete and steel surface combinations range from 12 to 23 percent and average about 15 to 18 percent, irrespective of the bearing surface and shape factor. Long-term creep data for FIBERLAST pads uniformly loaded to 1500 psi with a shape factor of 2 are shown in Fig. 4. These creep data show about 9 percent creep strain after 120 days of sustained loading. Thus, the creep strain can vary from approximately 39 to 75 percent of the instantaneous compressive strain. The total long-term compressive strain can range between 21 to 32 percent of the original pad thickness if loaded continuously to the full service load design stress of 2000 psi. Since bearing pads are generally under sustained working stresses due to dead load only, the total long-term compressive strain of the pads would be less than the 21 to 32 percent range.

Nonuniformly Loaded Bearing Pads in Compression (Rotation)

Bearing pads are often loaded nonuniformly as shown in Fig. 5. The total angular difference θ , between the two structural member bearing surface planes is referred to as rotation.

Rotation is significant because it causes the load to be nonuniformly distributed over the bearing pad. Under some conditions, only a portion of the pad may be loaded as shown in Figs. 5, 6 and 7. This causes high stresses in the area where the load is in contact with the pad. For this reason, the amount of rotation

