Compressive Deflections of Fiberglass or Steel Reinforced Elastomeric Bearing Pads

Elastomeric Bearing Pads consist of alternate layers of elastomer and steel sheet or fiberglass fabric reinforcement.

The compression deflections for steel and fiberglass reinforced elastomeric bearing pads can be reliably predicted within the normal range of construction tolerances. Transportation Laboratory tests have found that compressive strain is dependent upon two factors - compressive stress and shape factor. In addition, tests showed that compressive stress/strain behavior of fiberglass or steel reinforced pads is not significantly dependent upon overall pad thickness. In most situations the compressive deflection of the pad will be so small as to not effect the profile of the bridge. However, in the case of a hinge the magnitude of the deflection should be investigated, as it may be significant.

Attachment No. 1 of this Bridge Construction Memo shows two tables with families of curves which can be used to predict compressive deflection based on stress, shape factor, and strain. There is a separate table for fiberglass reinforced or steel reinforced pads which apply regardless of overall pad thickness. If long term compressive creep is to be included in the prediction, the strain values obtained from Attachment No. 1 should be increased by 25 percent.

Lab tests have shown that fiberglass and steel reinforced pads recover from dynamic creep caused by live loads. Therefore, dead load stress only will be considered in determining compressive deflection. Current bridge design practice limits the nominal compressive stress on a pad to 800 psi due to dead load and live load, not including impact. For steel reinforced pads with a shape factor $\geq 7.5$, the average pressure shall not exceed 1000 psi. For calculating compressive deflection in the field, a dead load stress of 600 psi should be used. If a more accurate value of dead load stress is desired, contact the Structures Design Section responsible for your contract plans.

For special situations where extreme accuracy is desired, sample pads can be tested by the Transportation Lab to determine the stress/strain behavior of each lot of pads.
Sample Calculation

Consider a 12" x 18" x 4" fiberglass reinforced bearing pad
Assume compressive stress of 600 psi

\[
\text{Shape Factor} = \frac{\text{width x length}}{\text{width + length}} = \frac{12(18)}{12 + 18} = 7.20
\]

From Attachment No. 1

Strain = 4.0% = .040

Compressive deflection including long term creep of 25% is equal to:

\[
\text{(Total Pad Thick.)} \times \text{(Strain)} \times (125\%) = 4.00 \times .040 \times (1.25) = .20" 
\]

Say 3/16"

The bearing pad thickness shown on the plans will be that for fabric reinforced pads. Note that steel reinforced bearing pads are thicker than the corresponding fabric reinforced pads. If the thickness of a fabric reinforced pad is T (inches), the thickness of the corresponding steel reinforced bearing is 1.15 T. See Attachment No. 2 for a table of thicknesses for Steel Reinforced pads. For pads more than 1/2 inch thick, it is the responsibility of the contractor to notify the Engineer in writing of the type of pad to be used. Bearing seat elevations must be set to correspond to the bearings to be used.
MEMO TO DESIGNERS:

Background

Our policy has been to standardize on 1/2” layers of elastomer. Until recently, we used very thin steel plates and a minimal elastomer cover at the top and bottom for the steel reinforced pads. The minimal thickness of cover and of steel was ignored and the bearing-thickness shown on the plans was the sum of the 1/2-inch thick layers. This resulted in a simple, standard Caltrans procedure for the design and manufacture of both the fabric reinforced and steel reinforced bearing pads.

The steel reinforcement option was removed from the 1981 Standard Specifications because the bearing manufacturers could not properly mold the bearing with the thin steel plates.

Current Policy

The current specifications for elastomeric bearings permit the use of the steel reinforced bearing as an option. However, the proper design of the steel reinforced bearings requires 14 gauge (0.075 inch) steel plates, full 1/2-inch elastomer layers between the plates and a 1/4-inch cover top and bottom. Therefore, the steel reinforced bearing will always be thicker than the corresponding fabric reinforced (fiberglass) bearing pad.

Design

There is no change in the design procedure. The designer will continue to design for the required number of 1/2-inch layers and call out the thickness of the bearing as the sum of the 1/2-inch thick layers. In permitting the use of the steel reinforced bearing as an option, the specifications require that the contractor notify the Resident Engineer of their choice. If the steel reinforced bearing is selected, the bearing seat elevation will be adjusted (lowered) by the Resident Engineer to allow for the increased thickness. The minor increase in compression on the steel plates due to the 1/8" side cover may be ignored.

For most cast-in-place concrete, precast concrete and steel superstructures, there should be no difficulty in adjusting the bearing seat elevation at the time the contractor selects the bearing type. In general, there is no need for the designer to be concerned with the choice.

For some applications, the designer may want to limit the bearings to only one of the two types. If this is done, indicate the type selected on the plans as follows:

"Elastomeric Bearing Pads (fabric reinforced)" or,
"Elastomeric Bearing Pads (steel reinforced)"
Steel reinforced bearings are recommended where anchor bolt holes are required through the bearings. To assist the designer, the total thickness for steel reinforced bearings is tabulated below:

<table>
<thead>
<tr>
<th>Design Thickness</th>
<th>Number of 1/2&quot; Layers</th>
<th>Number of Steel Plates</th>
<th>Actual Minimum</th>
<th>Thickness Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>2</td>
<td>2</td>
<td>1.15</td>
<td>1.29</td>
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<td>1.5&quot;</td>
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<td>8</td>
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<td>4.86</td>
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</tbody>
</table>

![Diagram of steel laminated elastomeric bearing](attachment:diagram.png)