

Section 7 – Bridge Seismic

300, 200 and 135 KIP Pipe Seat Extender (Retrofit)

XS Sheet Numbers

XS7-081, XS7-082, XS7-083

Description of Component

The designer of an existing hinge retrofit shall choose one of the three available XS sheets depending on the structural needs. The seismic displacement demand is the primary design parameter. The XS sheet should be chosen that best matches the expected hinge opening from the seismic analysis. The three drawings are stand alone and represent different allowable hinge dead weight loads with associated allowable hinge opening values. It is encouraged to use the least amount of pipes necessary to avoid excessive damage to the existing hinge diaphragms. A minimum of two pipe seat extenders is needed. The dead load weight is the load that the pipes will see should the existing hinge seat become completely unseated. The three XS sheets have an unseating load capacity of 300 kip, 200 kip or 135 kip per pipe. The only other difference of the three XS sheets, besides the dead load capacity, is the allowable hinge opening distance to prevent bending failure of the 8 inch XX-Strong pipes due to excessive moment demand.

This retrofit of existing bridge expansion hinges is primarily for hinges that have seats of 14 inches or less. The bottom of cored hole shall be placed 6 inches above the existing hinge seat to avoid damage to support and to take advantage of the thicker deck section. The deck incorporates more reinforcement than the soffit thus providing better bearing capacity. The 6 inch clearance should be above any elastomeric bearing pads, stirrups, main transverse steel and the cover concrete. The box girder seat height can be measured from the outside the bridge on both sides. With this distance and knowing the soffit thickness from the access opening the bottom of the cored hole can be accurately determined inside the box girder. This design can also be used for structures that have no soffit. Some of the existing hinge shear reinforcement will be cut by the 10 inch diameter. Cored hole and the new added bolster will help replace this lost reinforcement.

Standard Drawing Features

Sheet Name	Maximum Dead Load per Pipe	Allowable Movement Rating (hinge opening)
XS7-081	300 kip	8 inches
XS7-082	200 kip	12 inches
XS7-083	135 kip	18 inches

The designer can choose which drawing to use that works best for the particular hinge being retrofit taking into account the expected hinge opening distance. The 1-1/2 inch

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diameter HS rods will create a “hard stop” for the seat extenders so as not to allow any further opening of the hinge.

The 1-1/2 inch diameter HS rods are designed to take a large force as they are engaged but for larger structures alternative seat extenders may be needed to meet the expected hinge opening.

Design/General Notes

Pipe Shear Capacity

$$V_{cap} = 0.6 (\text{Pipe Area}) (f_{ye}) \quad F_{ye} = F_y R_y = 35 (1.6) = 56 \text{ ksi}$$

Area of Pipe = 21.3 square inches (Use $\frac{1}{2}$ cross sectional area as effective)

$$V_{cap} = 0.9 (.6) (21.3/2) 56 = 322 \text{ kip}$$

Pipe Bending Capacity (12 inch opening example)

$$M_p = Z f_{ue}$$

M_p = Max Allowable Moment, Z = Plastic Section Modulus, f_{ue} = Expected Ultimate Stress

$f_{ue} = f_y R_y$ (from Steel Committee: $R_y = 1.6$) Note: assume no tensile forces acting

$$M_p = 52.8 \text{ in}^3 (35 \text{ ksi} \times 1.6) = 2957 \text{ kip-in}$$

Available cantilever distance

$$\text{Moment Capacity} = X (200 \text{ kip}) = 2957 \text{ kip-in}$$

$$X = 14.8 \text{ inches, Use 12 inches}$$

Case Study

Number of Pipes needed for typical Hinges

American River Bridge (24-88L/R)

6 feet deep box girder bridge, Frame 2R – 78 feet wide, 10 girders, bent to hinge 98 feet

Weights

$$\text{Hinge diaphragm} = 73.6 \text{ kip} \quad \text{Girders} = 236.7 \text{ kip} \quad \text{Deck} = 318.5 \text{ kip}$$

$$\text{Soffit} = 269.5 \text{ kip} \quad \text{Barrier rail} = 29.4 \text{ kip} \quad \text{Overlay} = 69.6 \text{ kip}$$

$$\text{Internal diaphragm} = 14.3 \text{ kip} \quad \text{Bolster} = 30.5 \text{ kip}$$

$$\text{Total Wt. on hinge seat} = 1042 \text{ kip}$$

Number of pipes needed at 135 kip per pipe = 8

Number of pipes needed at 200 kip per pipe = 6

Number of pipes needed at 300 kip per pipe = 4

Airport Drive OC (50-266)

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6 feet deep box girder bridge, 39 feet – 8 inches wide, 5 girders, bent to hinge 92 feet

Weights

Hinge diaphragm = 38.3 kip Girders = 112.5 kip Deck = 154.1 kip

Soffit = 107.5 kip Barrier rail = 27.6 kip Overlay = 33.8 kip

Internal diaphragm = 7.7 kip Bolster = 20.0 kip

Total Wt. on hinge seat = 502 kip

Number of pipes needed at 135 kip per pipe = 4

Number of pipes needed at 200 kip per pipe = 3

Number of pipes needed at 300 kip per pipe = 2

Contract Specifications

Caltrans Standard Specification Section 60 Existing Structures and Section 51 Concrete Structures

Restrictions on Use of Standard Drawings

If the bridge superstructure is less than 48 inches in depth, then a special design may be considered for the pipe placement.