20-3 RESTRAINERS AT SUPPORT JOINTS

Introduction

The primary purpose of restrainers is to prevent unseating of bridge spans. Pipe seat extenders are the preferred (and in some cases required) method of preventing unseating since they increase the relative displacement capacity of bridge frames. However, cable or bar restrainers may also be used to prevent unseating, or when it is necessary to limit relative displacement between bridge frames. Cable or bar restrainers may also be used to prevent unseating of simply supported bridge spans. A secondary purpose of restrainers is to limit damage to bearings and joint seals during moderate seismic events. Bridge Design Aids (BDA) 14-1 provides guidance for designing restrainers, and the Seismic Design Criteria (SDC) Section 7.2.6 provides the requirements for placing restrainers on new bridges.

Adequate lengths of cables or bars should be used in order to assure sufficient elongation capacity. The Caltrans hinge restrainer design method described in BDA 14-1, should be used to ensure that joint movements are kept within acceptable limits and restrainers work within the elastic range. Insufficient elongation ability can cause premature failure of the restrainers while restrainers that are too long may not prevent unseating.

Restrainers for New Structures

Cable Restrainer Unit - Type 2

Based on the requirements of the project specific criteria or the SDC, the engineer should determine the total number of longitudinal cable restrainers required and the total number of cable units needed (see BDA 14-1). The restrainers should be placed for symmetry giving a balanced design. Permanent access openings shall be provided and the restrainers should be placed in the fewest bays possible in order to reduce the number of access openings needed to facilitate inspection and repair. Details for cable restrainers and access openings can be found on Standard Detail Sheets XS7-410, XS7-420 and XS1-310.

When placing restrainers on new structures with post-tensioned superstructure spans, the engineer should consider the shortening of the spans. Furthermore, restrainers must not be anchored prior to completion of the pre-stressing operation.

Sufficient thermal information should be on the plans. Based on a given timeframe, this will allow the engineer to determine the anchor gap. The gap should be shown on the plans similar to dimensions used for joint seal movements. For an example, the engineer is referred to to BDA 14-5.

Cable Restrainer Unit – Type 5

Standard Detail Sheet XS7-510 provides restrainer details for pre-cast girder superstructures.

High Strength Rods

Bridges designed to the standards of the SDC typically have very large seat widths and as a result, are able to accommodate substantial differential movements at expansion joints. This type of movement may damage bearing pads and joint seals even in moderate seismic events. High strength rods are effective in limiting differential movements at expansion joints and the engineer may wish to consider using them. However, there are no standard details for high strength rods and therefore details must be developed individually for each project.

Energy Considerations

Cables and high strength rods acting elastically in tension do not dissipate any significant amount of energy. They store energy as they are stretched but impart it back to the structure as the segments move back together. However, in some situations such as when it is necessary to limit damage to the ends of girders, it may be advantageous to allow yielding of bar restrainers. The yielding of bars at very low strains is effective for dissipating energy.

Restrainers for Retrofit of Existing Bridges

MTD 20-4 requires the use of pipe seat extenders on short seat hinges ($\leq$ 6 inches) in order to prevent unseating. It should be noted that while pipe seat extenders are effective in preventing unseating, they do not reduce the differential movements at a hinge and as a result, bearings and joint seals could be damaged when using only pipe seat extenders. In order to reduce this type of damage, it is usually desirable to limit an expansion joint's differential movement in a seismic event and cable restrainers are the preferred method of retrofit for this situation. The engineer may consider using both pipe seat extenders and cable restrainers together as this will both prevent unseating and limit differential movements at the hinge.

When using both pipe seat extenders and cable restrainers, it is often advantageous to place cable restrainers through pipe seat extenders, as this will reduce the amount of coring through the hinge. BDA 14-5 provides a typical detail. Pipe seat extenders and cable assemblies should be oriented so that the normal service level movements of the bridge are not resisted. Typically they would be placed parallel to the girders.

When designing restrainers, the engineer must also ensure that the member the cable assembly

is anchored against (typically a hinge diaphragm or bent cap) has sufficient capacity to resist all forces (including impact and rebound) from the cables. For most existing bridges, a concrete bolster is required.

In cases where it is not practical to install pipe seat extenders, the engineer may use cable restrainers to prevent the deck spans from becoming unseated. BDA 14-1 provides guidance for restrainer design. The methods of installation are similar to steel deck bridges and are described below.

Curved Bridges

On curved existing bridges, segments of superstructures that aren't adequately restrained act independently and may separate when shaken. If the bearings or other means of transverse restraint fail, longitudinal restrainers (if installed) may act as tension members in a large horizontal beam (*see Figure 1*). In these situations, restrainers should generally be placed as close to the edge of the structure as possible so they can offer the maximum amount of resistance. New bridges shall meet the requirements of the SDC.

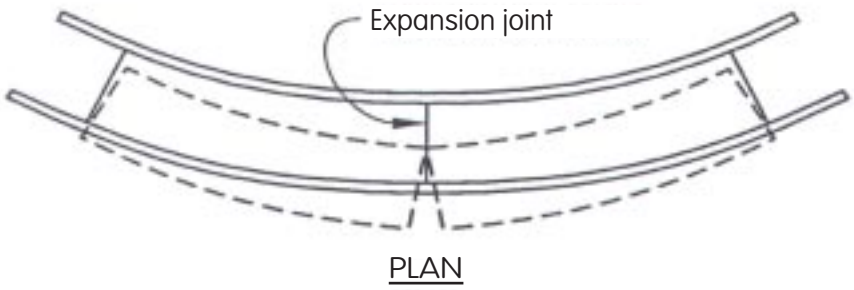


Figure 1

Steel Superstructures

Connecting the ends of girders together in adjacent spans may be satisfactory for short steel structures with only a few spans and wide bent caps and there is minimal risk of the girders separating from the bents. This detail can also be used when there is concern that the additional longitudinal forces produced by connecting the girders to the bent caps (see Figure 2) may cause unacceptable damage to the columns. In these situations, the engineer must ensure there is adequate seat length. Although the bearings could fail, the superstructure's fall is limited and the bridge may remain serviceable. When the columns have sufficient capacity to resist the longitudinal forces from the superstructure, the girders should be connected to the bent caps (see Figure 3). The engineer must also check the capacity of the steel girders and ensure that the restrainers do not produce forces that the girder is not able to resist, and check that vertical clearances meet minimum requirements. See Figures 4 and 5 for typical details for restrainer brackets on steel girders.

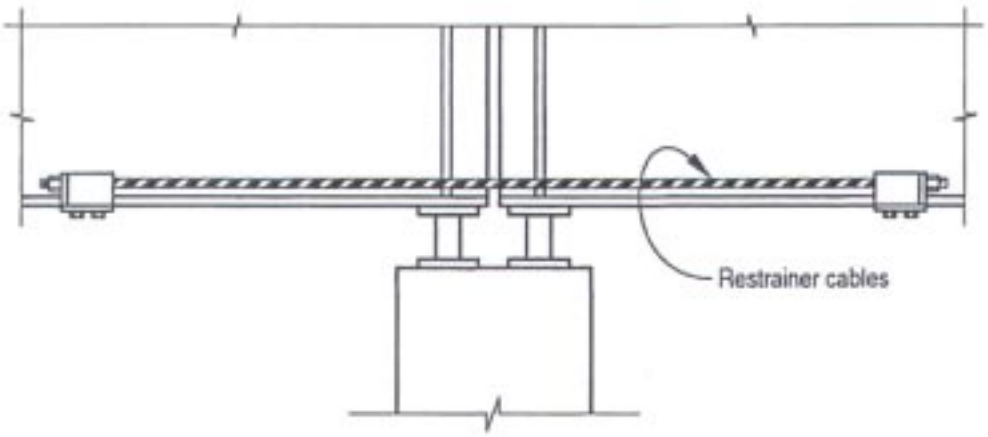


Figure 2

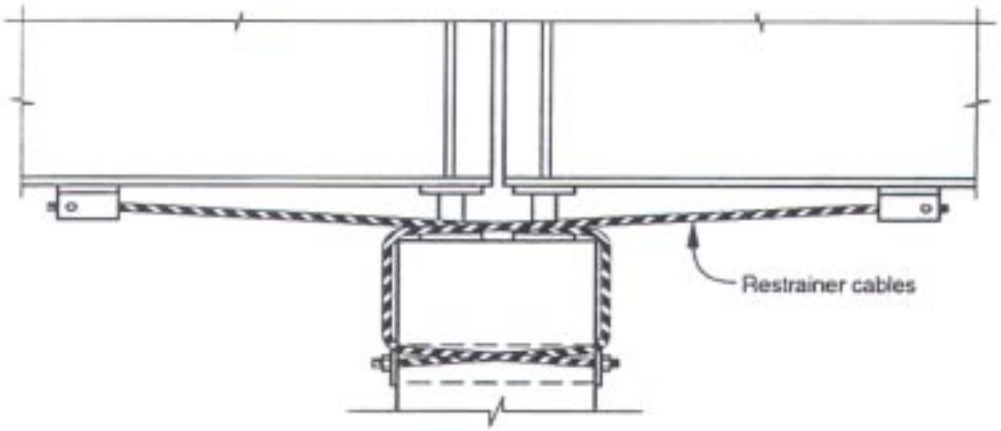


Figure 3

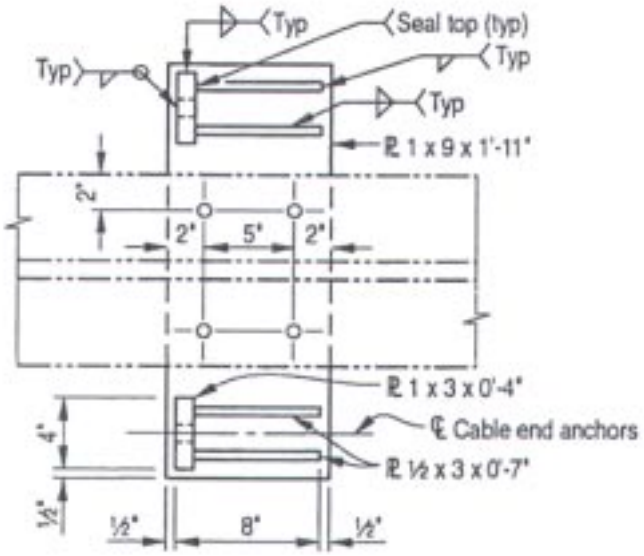
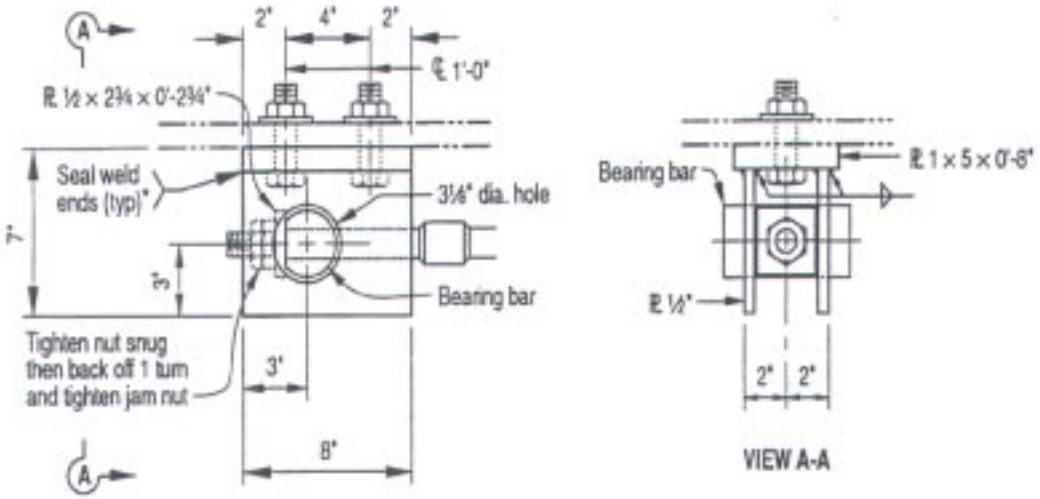


Figure 4



*Alternate: Extend 1 x 5 x 0'-8" plate and use fillet weld.

Figure 5

References

1. California Department of Transportation, Seismic Design Criteria
2. California Department of Transportation, Bridge Standard Detail Sheets XS1-310, XS7-410, XS7-420 and XS7-510
3. California Department of Transportation, Bridge Design Aids 14-1 and 14-5.
4. California Department of Transportation, Bridge Memo To Designers 20-4

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