

2011

AASHTO Guide Specifications for

LRFD Seismic Bridge Design

2nd Edition

2014

Interim Revisions

AMERICAN ASSOCIATION OF
STATE HIGHWAY AND
TRANSPORTATION OFFICIALS

AASHTO
THE VOICE OF TRANSPORTATION

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INSTRUCTIONS AND INFORMATION

General

AASHTO has issued interim revisions to *AASHTO Guide Specifications for LRFD Seismic Bridge Design*, Second Edition (2011). This packet contains the revised pages. They are not designed to replace the corresponding pages in the book but rather to be kept with the book for quick reference.

Affected Articles

Underlined text indicates revisions that were approved in 2013 by the AASHTO Highways Subcommittee on Bridges and Structures. ~~Strikethrough text~~ indicates any deletions that were likewise approved by the Subcommittee. A list of affected articles is included below.

All interim pages are printed on pink paper to make the changes stand out when inserted in the second edition binder. They also have a page header displaying the section number affected and the interim publication year. Please note that these pages may also contain nontechnical (e.g. editorial) changes made by AASHTO publications staff; any changes of this type will not be marked in any way so as not to distract the reader from the technical changes.

Please note that in response to user concerns, page breaks are now being added within sections between noncontiguous articles. This change makes it an option to insert the changes closer to the affected articles.

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5.6.2

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SECTION 1: INTRODUCTION

1.3—Flowcharts

Revise paragraph 4 as follows:

The flowcharts in Figure 1.3-1 address the design of bridges using the Type 1 design strategy. The flowchart in Figure 1.3-1 guides the designer on the applicability of the Guide Specifications and the seismic design procedure for bridges in SDC A and single-span bridges. Figures 1.3-2 through 1.3-4 show seismic design procedure flowcharts for bridges in SDC B through D, respectively. Figure 1.3-5 shows foundation design and detailing flowcharts.

SECTION 2: DEFINITIONS AND NOTATION

2.2—Notation

Delete and revise the following notation:

~~K_{DED} = stiffness of the ductile end diaphragm (kip/in.) (7.4.6)~~

~~K_{SUB} = stiffness of the substructure (kip/in.) (7.4.6)~~

R = maximum expected displacement ductility of the structure; response modification factor (4.3.3) (7.2) (7.2.2) ~~(7.4.6)~~

SECTION 3: GENERAL REQUIREMENTS

3.3—Earthquake-Resisting Systems (ERS) Requirements for SDCs C and D

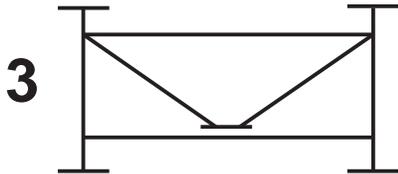
Revise bullet 2 as follows:

- **Type 2**—Essentially Elastic Substructure with a Ductile Superstructure: ~~This category applies only to steel superstructures, and ductility is achieved by ductile elements in the pier cross frames. This category applies only to straight, nonskewed, steel I-Section composite girder superstructures with ductile cross-frames at the supports. The use of this strategy shall be approved by the Owner and based on a case-specific design criteria and methodology.~~

In Article C3.3, add the following as paragraph 2 corresponding to Article 3.3 bullet 2, “Type 2:”

The use of this strategy requires the Owner’s approval and a case-specific design criteria and methodology because the design guidelines are under development and there is a lack of practical experience with ductile cross-frames.

In Figure 3.3-2, replace identification label of element Number 3 (shown) as follows:



Ductile end diaphragms in superstructure (Article 7.4.6)

Ductile cross-frame at the supports in the superstructure (Article 7.4.6)

SECTION 4: ANALYSIS AND DESIGN REQUIREMENTS

4.3.3—Displacement Magnification for Short-Period Structures

Add the following to the end of Article 4.3.3:

For steel substructures using a Type 1 design strategy, the response modification factor, R , may be used in lieu of the maximum local member displacement ductility demand, μ_D , in Eq. 4.3.3-1.

4.11.1—Capacity Design

Revise the last paragraph of Article 4.11.1 as follows:

For SDC C or D, exception to capacity design requirements using provisions for conventional plastic hinge formation in the substructure elements is permitted for the following:

- The seismic resisting system includes the fusing effects of an isolation device (Type 3 global design strategy),
- ~~A ductile end diaphragm is incorporated into the transverse response of a steel superstructure (Type 2 global design strategy; see Article 7.2.2), and~~
- A foundation situated in soft or potentially liquefiable soils where plastic hinging is permitted below ground.

In Article C4.11.1, revise paragraph 1 and add a new paragraph 2 as follows:

The objective of these provisions for conventional design is that inelastic deformation (plastic hinging) occurs at the location in the columns (top or bottom or both) where they can be readily inspected and repaired. To achieve this objective, all members connected to the columns, the shear capacity of the column, and all members in the load path from the superstructure to the foundation, should be capable of transmitting the maximum (overstrength) force effects developed by plastic hinges in the columns. ~~The exceptions to the need for capacity design of connecting elements are:~~

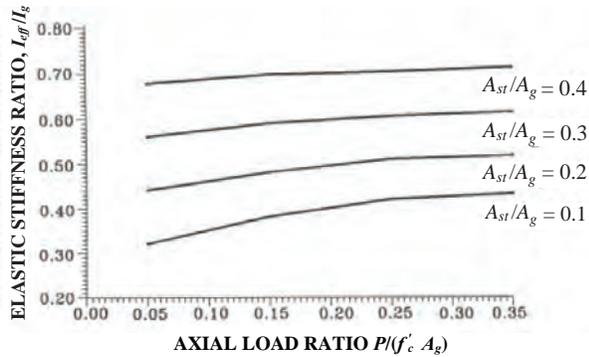
- ~~Where seismic isolation design is used, and~~
- ~~In the transverse direction of columns when a ductile diaphragm is used and piers when ductile cross frames (Type 2 strategy) are used.~~

When seismic isolation (Type 3 strategy) is used, capacity design using provisions for conventional plastic hinge formation (Type 1 strategy) for connecting elements is not necessarily required. In this case, the substructure should be designed to resist the maximum lateral force generated by the isolation bearings (using the maximum system property modification factors as defined in the *AASHTO Guide Specifications for Seismic Isolation Design*) and the inertial forces of the substructure elements in an elastic manner. However, the Designer is referred to the paragraphs below for design force increase considerations which are intended to provide additional conservatism for cases where Type 1 capacity design methods are not used.

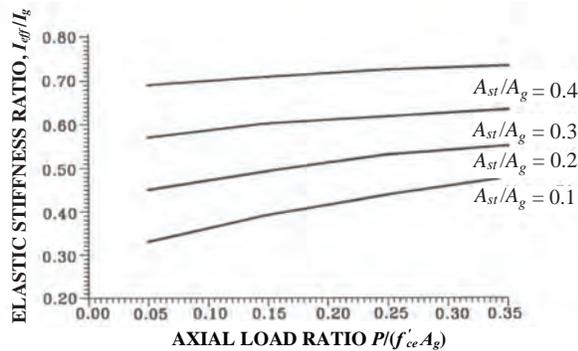
SECTION 5: ANALYTICAL MODELS AND PROCEDURES

5.6.2— $E_c I_{eff}$ and $(GA)_{eff}$ for Ductile Reinforced Concrete Members

Revise Figure 5.6.2-1. Delete the following:



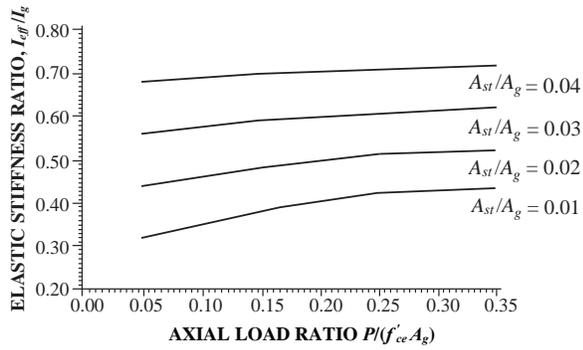
(a) Circular Sections



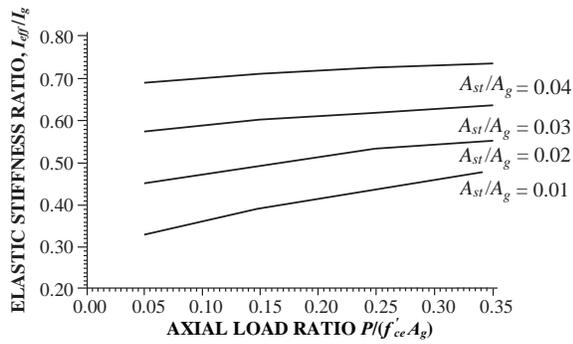
(b) Rectangular Sections

Figure 5.6.2-1—Effective Flexural Stiffness of Cracked Reinforced Concrete Sections

And replace with this:



(a) Circular Sections



(b) Rectangular Sections

Figure 5.6.2-1—Effective Flexural Stiffness of Cracked Reinforced Concrete Sections

SECTION 7: STRUCTURAL STEEL COMPONENTS

Table of Contents

Change the title of Article 7.4.6 as follows:

~~Ductile End Diaphragm in Slab on Girder Bridges~~

Ductile Cross-Frames

7.1—General

In paragraph 3, bullet 3, replace the term “end diaphragms” with “support diaphragms.”

In Article C7.1, replace the last paragraph with the following:

Bridge bearings may not resist lateral loads in a uniform manner, especially in bridges with relatively flexible support diaphragms or cross-frames. Bearings that are subjected to greater demands may be damaged prior to those subjected to lesser demands. Damaged bearings may transfer a different amount of load to the girders than undamaged bearings. Non-uniform bearing demands should be taken into account in the design of the support diaphragms or cross frames. Also, a significant change in the load distribution between abutments and piers may occur and should be considered in the design.

7.2—Performance Criteria

Replace paragraph 4 with the following:

Seismic design forces for individual members designed as earthquake resisting elements (ERE) to respond in a ductile manner shall be determined by dividing the unreduced elastic seismic forces by the appropriate response modification factor (R) specified in the *AASHTO LRFD Bridge Design Specifications*. A combination of orthogonal seismic forces equivalent to the orthogonal seismic displacement combination specified in Article 4.4 shall be used to obtain the seismic force demands.

Add the following paragraph to the end of Article C7.2:

The Type 2 design strategy using ductile cross-frames is intended to limit the transverse demands acting on the substructure but do not significantly alter the longitudinal demands. A Type 2 strategy alone may not be a feasible method of addressing both longitudinal and transverse seismic demands. In the longitudinal direction, a Type 1 or Type 3 strategy may be required to accommodate seismic demands.

7.2.2—Type 2

Replace Article with the following:

For Type 2 structures, the Designer may, with the Owner's approval, design a ductile superstructure and an essentially elastic substructure using case-specific criteria and methodology.

When the Type 2 system consists of ductile cross-frames at supports, the substructure shall be designed to resist a force in the transverse direction of the bridge that includes at least the sum of the following:

- Overstrength lateral resistance of the ductile cross frame using the expected material properties,
- Lateral resistance of the frame action generated between the girders and deck, and
- Inertial forces of the girders and substructure.

Where a Type 2 strategy is used, the substructure shall be detailed such that it has the capacity to respond in a ductile manner in both the longitudinal and transverse directions.

Insert the following new commentary:

C7.2.2

The use of ductile cross-frames at the supports of steel superstructures may be an effective means of accommodating transverse seismic demands. Longitudinal demands must be accommodated by using other means, such as a Type 1 strategy (ductile substructure) or the longitudinal restraint offered by the abutments (see Article 5.2.3). However, due to the lack of specific analytical or experimental data substantiating this strategy, the Designer is required to develop appropriate criteria and methodologies, which are to be approved by the Owner before employing this strategy.

Seismic demands on the substructure must consider all of the applicable force components. These forces include those associated with inelastic resistance of ductile cross-frames as well as inertial effects of the structure below the deck. Demands in the longitudinal direction, including potential inelastic demands, must also be considered. Because the design guidelines for a Type 2 strategy are still under development, ductile detailing of the substructure elements in both the transverse and longitudinal direction is required. The extent of the inelastic action in the substructure and subsequent ductile detailing requirements is developed in a case-specific manner.

7.4.6—Ductile Cross-Frames

Rename Article 7.4.6 as shown above and replace the text with the following:

When permitted by the Owner, ductile cross-frames may be used to accommodate transverse seismic demands. Ductile cross-frames shall be designed using a case-specific criteria and methodology.

Ductile cross-frames shall only be used for bridges satisfying the following requirements:

- I-Section girders (rolled or built up) with composite cast-in-place concrete decks,
- Shear stud connectors provided throughout the length of the girders including the negative moment regions of continuous structures,
- No skew,
- No horizontal curvature, and
- Uniform width and girder spacing.

Insert the following new commentary:

C7.4.6

At this time, the use of ductile cross-frames at the bridge supports to address transverse seismic demands is considered to be experimental and developments are ongoing. Refer to Articles 4.11.1 and C7.2.2 for additional information and design requirements.