6.11 CAMBER OF STEEL-CONCRETE COMPOSITE GIRDERS

6.11.1 GENERAL

This BDM addresses camber components and camber diagrams for a steel-concrete composite girder to achieve its designed deck profile grade under full dead load and normal temperature. Two examples are provided to illustrate camber diagrams which are required to be shown on project plans.

6.11.2 DEFINITIONS

Screed Camber—The recommended amount that the screed grade must be raised above the designed deck profile grade for the deck pours to achieve the designed grade. It includes components of deck dead load, deck shrinkage, and added dead load.

Web Camber—The adjustment to the girder geometry during fabrication in a horizontal or no-load condition. It includes all seven camber components.

6.11.3 CAMBER COMPONENTS

Camber of a steel-concrete composite girder is developed from the following components. Each dead load camber component has the same magnitude as its corresponding deflection component but with the opposite direction.

1. *Deck Dead Load*: Deflection due to the weight of the deck slab concrete. The dead load of the cast-in-place concrete deck between steel girder flange edges must be increased by 10 percent for the optional stay-in-place metal forms as specified in Article 3.5.1 of *AASHTO-CA BDS* (AASHTO, 2017; Caltrans, 2019). It is assumed that all deck concrete is placed at once under unshored construction (i.e., the deck slab dead load is resisted by the steel girder section only).

2. *Deck Shrinkage*: Deflection due to concrete shrinkage after the deck concrete has set. The shrinkage deflection usually occurs within two to four months after deck concrete pour. In absence of refined analysis, it should be taken as 10 percent of the deflection due to the deck slab dead load.

3. *Added Dead Load*: Deflection due to the weight of curbs, barriers, wearing surfaces, soundwalls, utilities, and future overlay of 35 psf as specified in Article 3.5.1 of *AASHTO-CA BDS* (AASHTO, 2017, Caltrans, 2019). Added dead load is resisted by the long-term composite girder section using transformed section properties with

three times the ratio of modulus of elasticity of steel to that of concrete (3*n*).

4. *Girder Dead Load*: Deflection due to the weight of the steel girder, diaphragms and cross frames, and other attachments. It is assumed that all steel girders are erected at once under unshored construction (i.e., the steel girder dead load is resisted by the steel girder section only).

5. *Vertical Curve:* Correction for the profile grade with a vertical curve on the structure. The correction value is the difference between the vertical curve profile grade and the grade of the chord line between supports. The value should be listed as negative or positive, depending on whether the curve is a crest (+) or a sag (-).

6. *Horizontal Curve:* Correction for a straight girder on a horizontally curved alignment, in which the girder is a chord between supports and the deck profile grade along the top of girder will not be parallel to the deck profile grade along the curve. This correction is equal to the cross slope or super-elevation times the mid-ordinate for the span. This component should be included so that the fillet thickness will remain constant.

7. *Additional Camber:* This is a correction to make the girder web cambered so that it will be parallel to the deck profile grade. Structures constructed on a sag vertical curve may therefore have girder webs with a negative camber. An exception is an overcrossing with a sharp horizontal curve. For this case, the depth of fillet at the supports must be increased so that the deflected girder will not appear to be sagging.

6.11.4 CAMBER DIAGRAMS

The screed camber and web camber diagrams include a camber value table for each girder presented to the nearest 0.01 ft in the plans in a format similar to Figures 6.11.4.1 and 6.11.4.2. Camber values at each quarter of span and in-span hinge must be listed. Camber values are measured upwards from the reference line except when shown negative (-), measured downwards.

6.11.4.1 Screed Camber

The screed camber (SC) curve values assume that all steel in the structure has been erected at once and the deck concrete is placed at once with no consideration for composite action caused by the sequence of concrete placement. The camber values also make no provisions for the temperature change during the day that may cause noticeable changes in the deflected shape.

The actual screed camber will be determined by the Engineer during the construction phase because there may be approved variances from basic assumptions for camber component calculations.

6.11.4.2 Web Camber

The purpose of the web camber (WC) is to make the top of girder web approximately parallel to the top of the deck. This results in a uniform depth of fillet, except for fabrication tolerances, and makes for simplification of deck forms.

The web camber curve is referenced from a chord line between supports. For cantilever girder bridges with suspended spans (two hinges per span), the camber value is referenced from a straight line between the hinges for the suspended span portion of the bridge. The chord and straight line references intersect the top of the girder web at the centerline of supports (bearings, hinges, or bents).

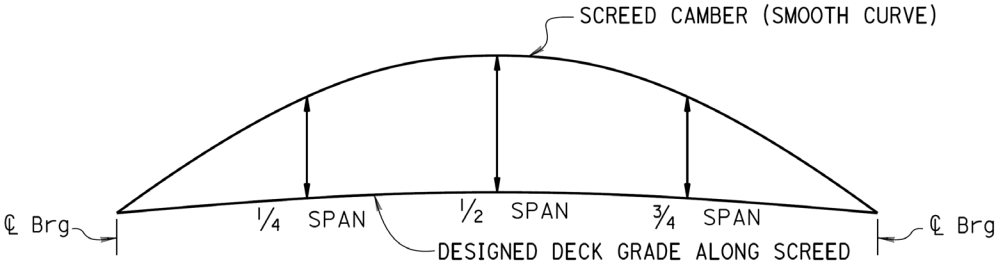
The camber values assume that field splices of the girders will be made in a no-load condition.

Special consideration should be given to box sections, especially box sections with sloping webs. The camber should be defined as the vertical displacement of the sloping web.

When the contractor's erection procedure varies from the design assumption of no-load field splices, the contractor is required to submit revised cambers and stress calculations with the shop drawings.

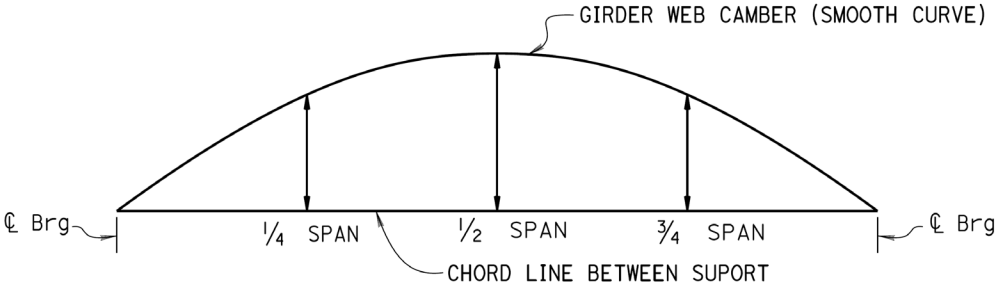
6.11.5 REFERENCES

1. AASHTO. (2017). *AASHTO LRFD Bridge Design Specifications*, 8th Edition, American Association of State Highway and Transportation Officials, Washington DC.
2. Caltrans. (2019). *California Amendments to AASHTO LRFD Bridge Design Specifications*, Eighth Edition, California Department of Transportation, Sacramento, CA.



ADJUST SCREED GRADES TO SC CURVE SHOWN BEFORE THE START OF ANY DECK CONCRETE PLACEMENT AND AFTER ERECTION OF ALL GIRDERS THAT INFLUENCE DEFLECTIONS.

SCREED CAMBER DIAGRAM
NO SCALE



FABRICATE GIRDER WEB TO WC CURVE SHOWN WHEN PERFORMING FABRICATION IN A NO-LOAD CONDITION.

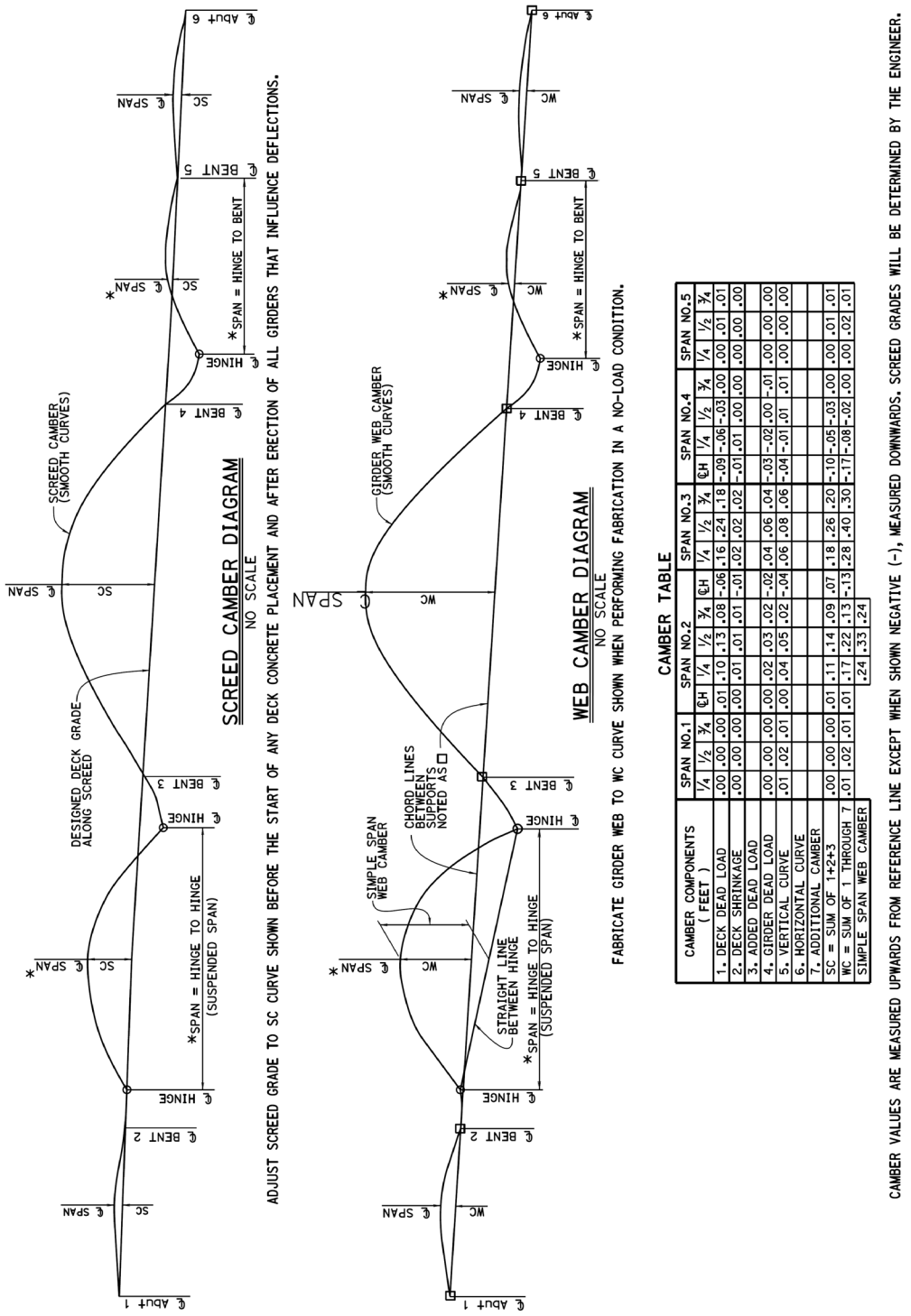
WEB CAMBER DIAGRAM
NO SCALE

CAMBER TABLE

CAMBER COMPONENTS (FEET)	¼ SPAN	½ SPAN	¾ SPAN
1. DECK DEAD LOAD			
2. DECK SHRINKAGE			
3. ADDED DEAD LOAD			
4. GIRDER DEAD LOAD			
5. VERTICAL CURVE			
6. HORIZONTAL CURVE			
7. ADDITIONAL CAMBER			
SC = SUM OF 1+2+3			
WC = SUM OF 1 THROUGH 7			

CAMBER VALUES ARE MEASURED UPWARDS FROM REFERENCE LINE EXCEPT WHEN SHOWN NEGATIVE (-), MEASURED DOWNWARDS. SCREED GRADES WILL BE DETERMINED BY THE ENGINEER.

Figure 6.11.4.1 Camber Diagram for Simply Supported Girders



CAMBER TABLE

CAMBER COMPONENTS (FEET)	SPAN NO.1			SPAN NO.2				SPAN NO.3				SPAN NO.4				SPAN NO.5			
	¼	½	¾	℄H	¼	½	¾	℄H	¼	½	¾	℄H	¼	½	¾	¼	½	¾
1. DECK DEAD LOAD	.00	.00	.00	.01	.10	.13	.08	-.06	.16	.24	.18	-.09	-.06	-.03	.00	.00	.01	.01
2. DECK SHRINKAGE	.00	.00	.00	.00	.01	.01	.01	-.01	.02	.02	.02	-.01	.01	.00	.00	.00	.00	.00
3. ADDED DEAD LOAD	.00	.00	.00	.00	.02	.03	.02	-.02	.04	.06	.04	-.03	-.02	.00	-.01	.00	.00	.00
4. GIRDER DEAD LOAD	.01	.02	.01	.00	.04	.05	.02	-.04	.06	.08	.06	-.04	-.01	.01	.01	.00	.00	.00
5. VERTICAL CURVE																		
6. HORIZONTAL CURVE																		
7. ADDITIONAL CAMBER																		
SC = SUM OF 1+2+3	.00	.00	.00	.01	.11	.14	.09	.07	.18	.26	.20	-.10	-.05	-.03	.00	.00	.01	.01
WC = SUM OF 1 THROUGH 7	.01	.02	.01	.01	.17	.22	.13	-.13	.28	.40	.30	-.17	-.08	-.02	.00	.00	.02	.01
SIMPLE SPAN WEB CAMBER					.24	.33	.24											

CAMBER VALUES ARE MEASURED UPWARDS FROM REFERENCE LINE EXCEPT WHEN SHOWN NEGATIVE (-), MEASURED DOWNWARDS. SCREED GRADES WILL BE DETERMINED BY THE ENGINEER.

Figure 6.11.4.2 Camber Diagram for Continuous Girders