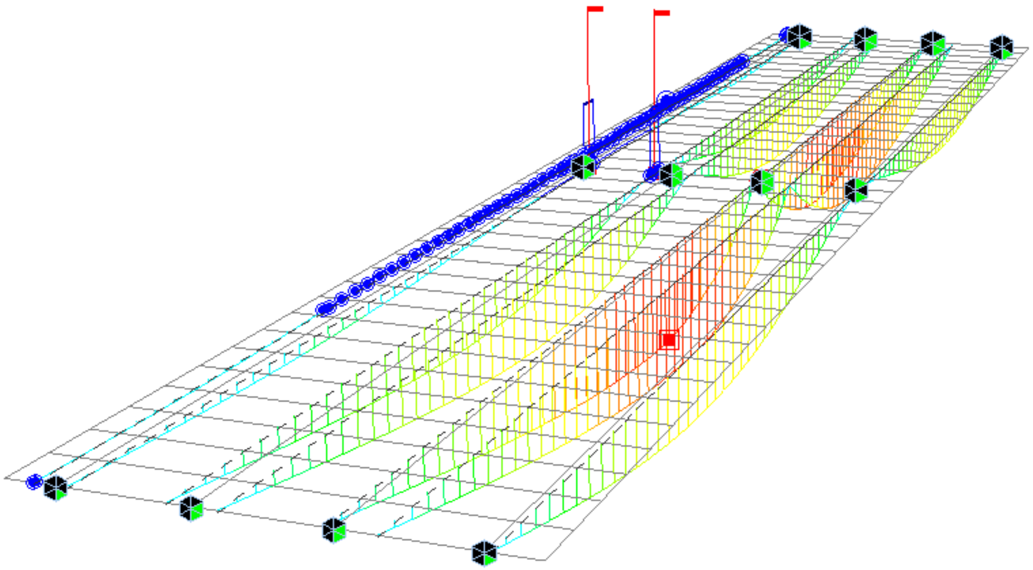
Straight Steel Composite Bridge



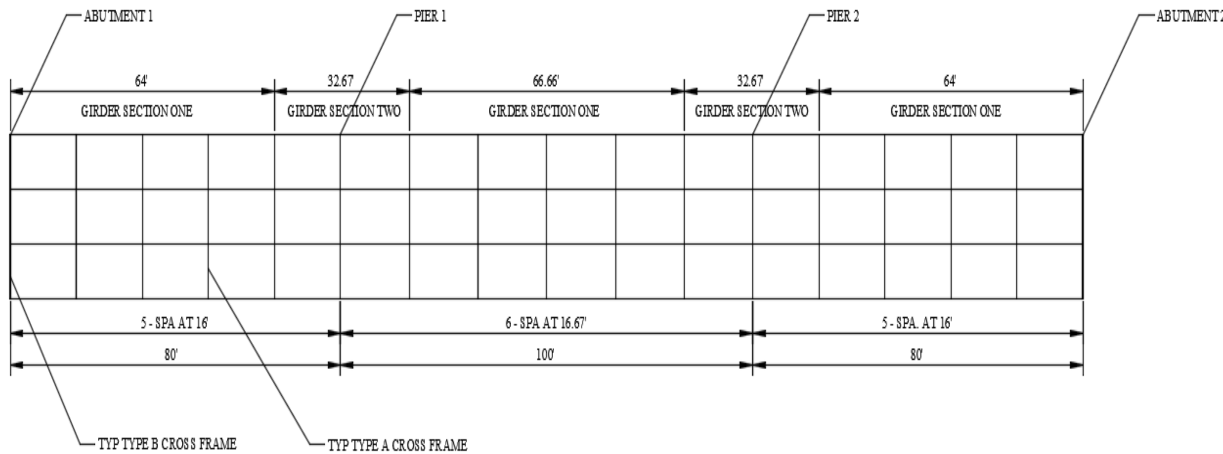
Overview

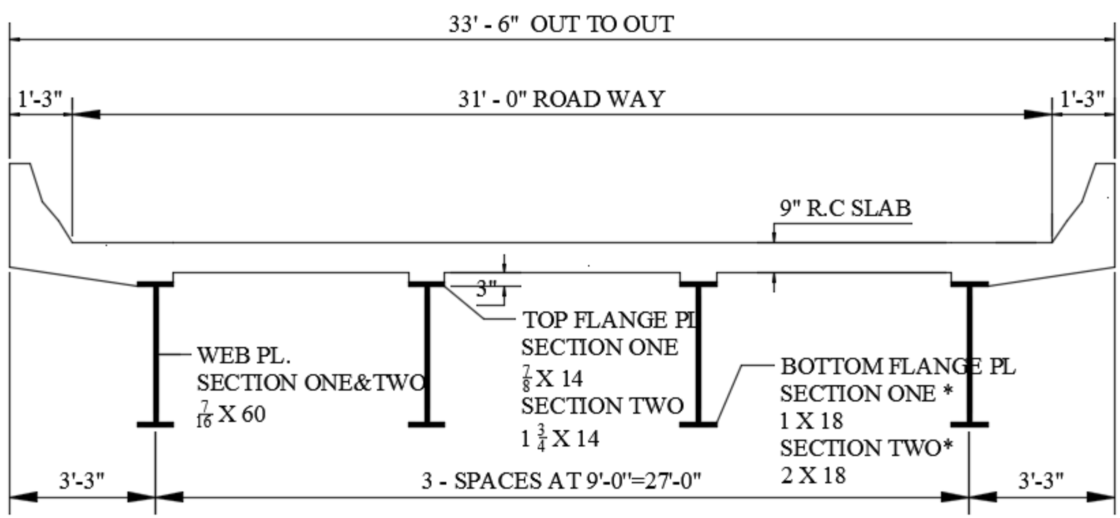
- **Bridge overview**
  - ✓ *3 span continuous composite girder bridge*
  - ✓ *Span length: 1@80 ft, 1@100ft & 1@80ft*
  - ✓ *Carriageway width: 31 ft*
  - ✓ *Unit system: Kip, ft*
- **Tutorial Overview**
  - ✓ *Steel Composite Girder Bridge Wizard*
    - *Geometry, property, boundary, load, & construction stage set up.*
  - ✓ *Moving Load*
- **Result Evaluation**
  - ✓ *Moving Load Analysis Result*

Program Version	Civil 2015 V2.1
Revision Date	February 6, 2015
Unit	English Unit (kip, ft, inch)

1. Bridge Specifications

- *Bridge type: Straight bridge*
- *Span length: 80 ft, 100ft, 80ft*
- *Road way: 31 ft*
- *Spacing of cross beams: 16ft, 16.7ft*

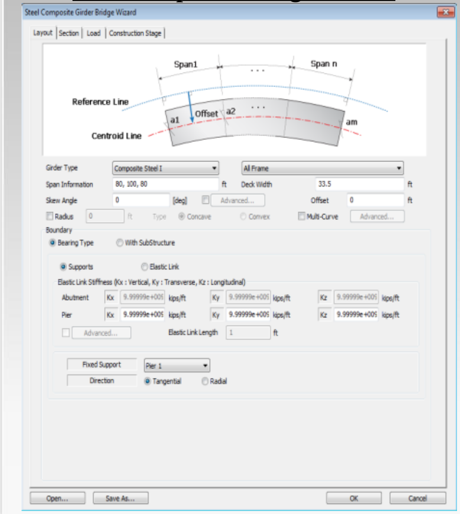




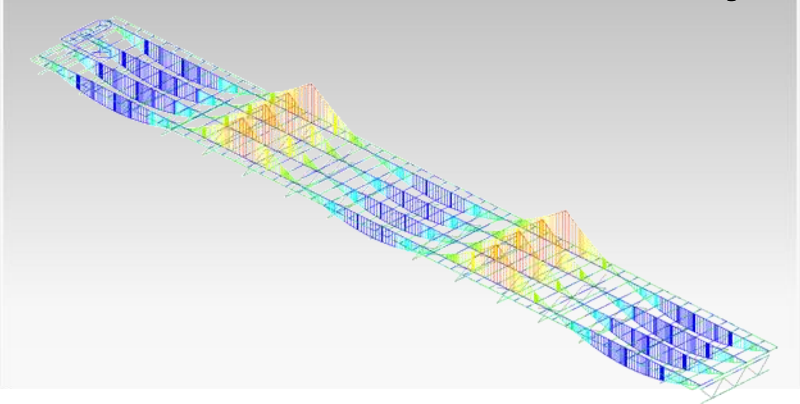
2. Purpose

This tutorial is for describing how to define load rating details and observe load rating result extracted in Excel Spreadsheet format. This tutorial mainly focuses on load rating procedure and extracting excel spreadsheet. Prerequisite steps, such as modeling, static & moving load analysis, and design check, are available in separate tutorials in following link. https://drive.google.com/open?id=0B-wfdCwh0wJfYUFkMTV6TEs2aHc&authuser=0

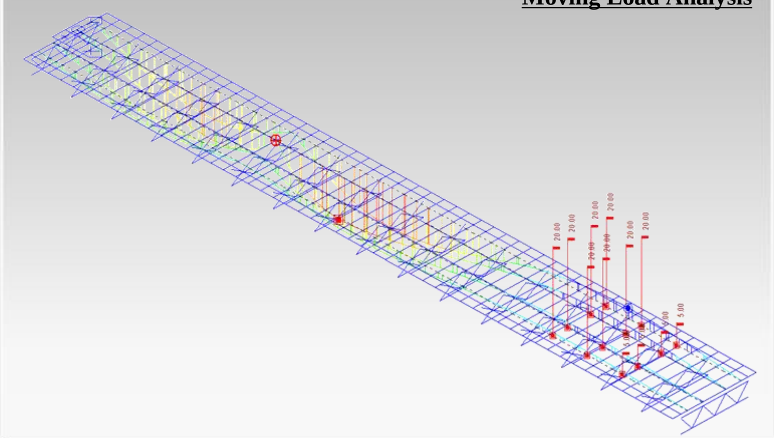
Steel Composite Bridge Wizard



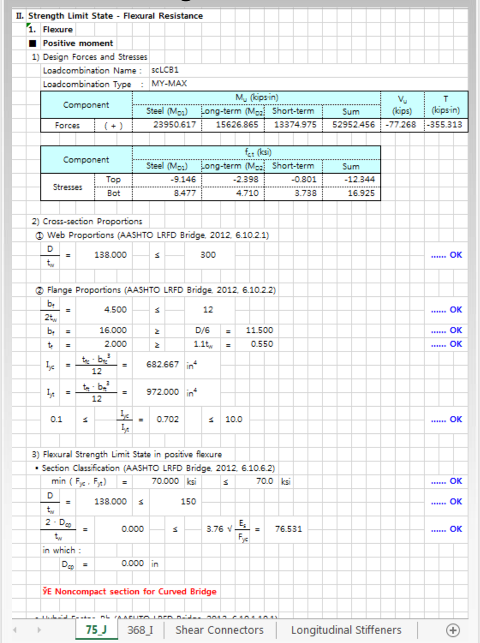
Moment Diagram



Moving Load Analysis

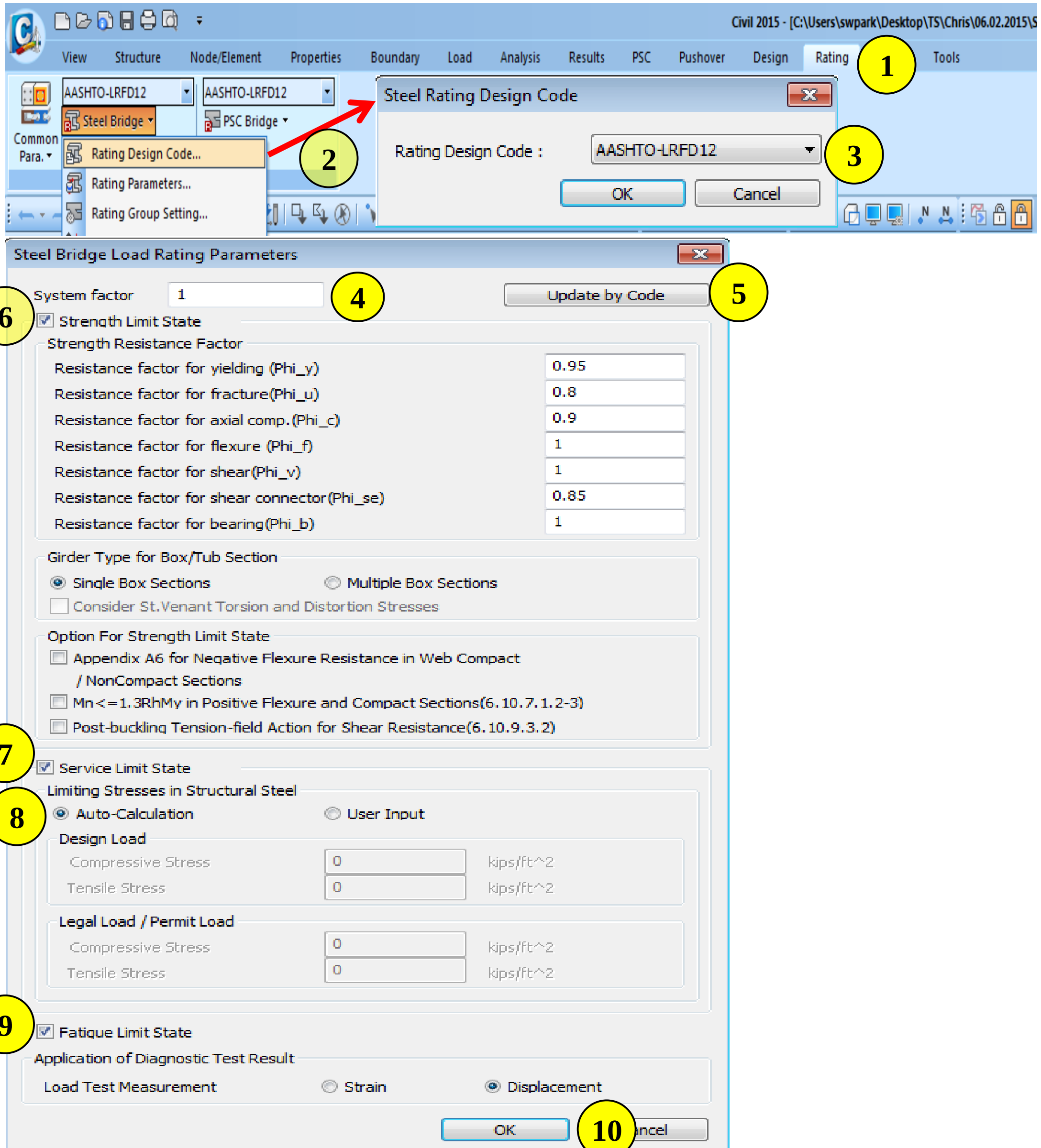


Design Check Result



Outline

Step3. Define Rating Parameters



1. Click Rating Tab

2. Click Rating Design Code.

3. Select AASHTO-LRFD 12

4. Enter System factor: 1

5. Click Update by Code

(Resistance factors can be manually modified at user's preference)

and users can modify each Resistance factor with their preference.

6. Check on Strength Limit State

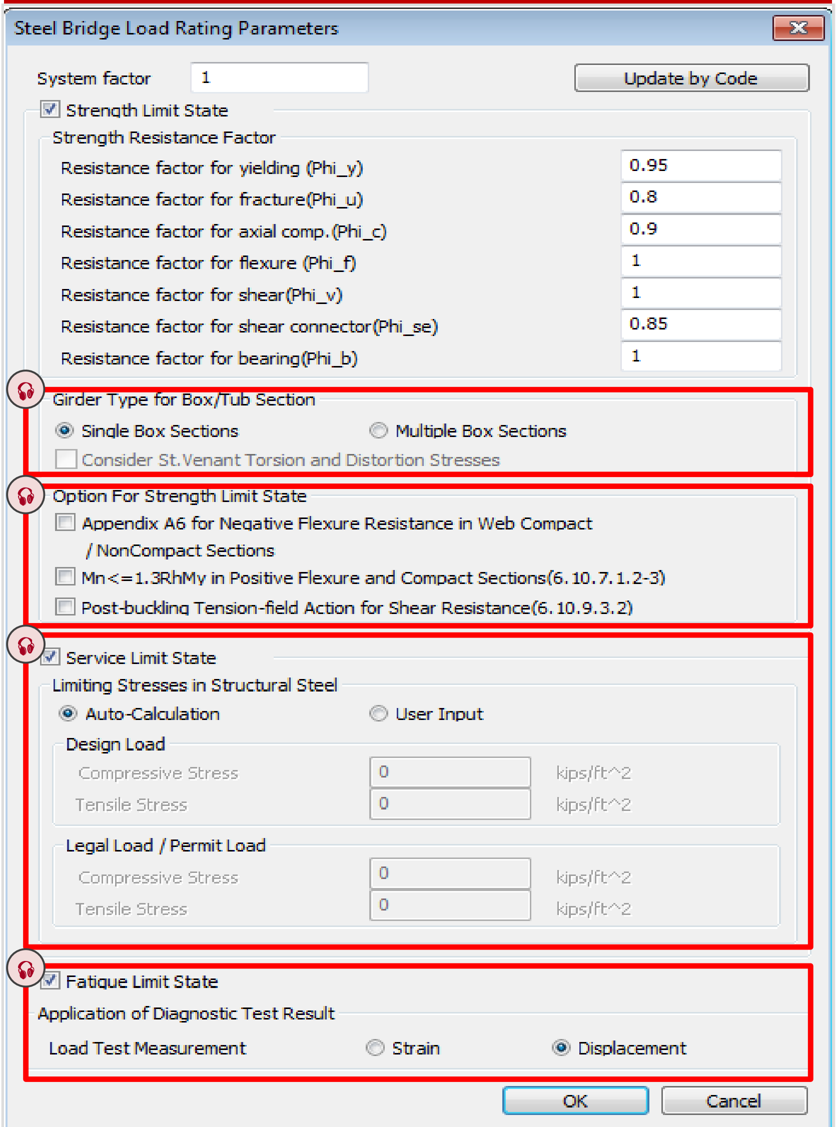
7. Check on Service Limit State

8. Check on Auto-Calculation

9. Check on Fatigue Limit State

10. Click OK

3.A. Load Rating parameter Information



Girder Type for Box/Tub Section

- In Multiple Box Section, St. Venant Torsion and Distortion stresses are optional according to Article 6.11.2.3.
- In Single Box Section, St. Venanat Torsion and Distortion are automatically considered.

Option For Strength Limit State

- Appendix A6…option is applied for the flexural strength of straight composite I-Sections in negative flexure with comp act / noncompact webs.
- Mn value is restricted to 1.3RhMy under positive flexure in a continuous span based on three conditions stated in Articl e 6.10.7.2-3.

Service Limit State

- In Auto-Calculation, the limiting stresses are automatically calculated as follows:

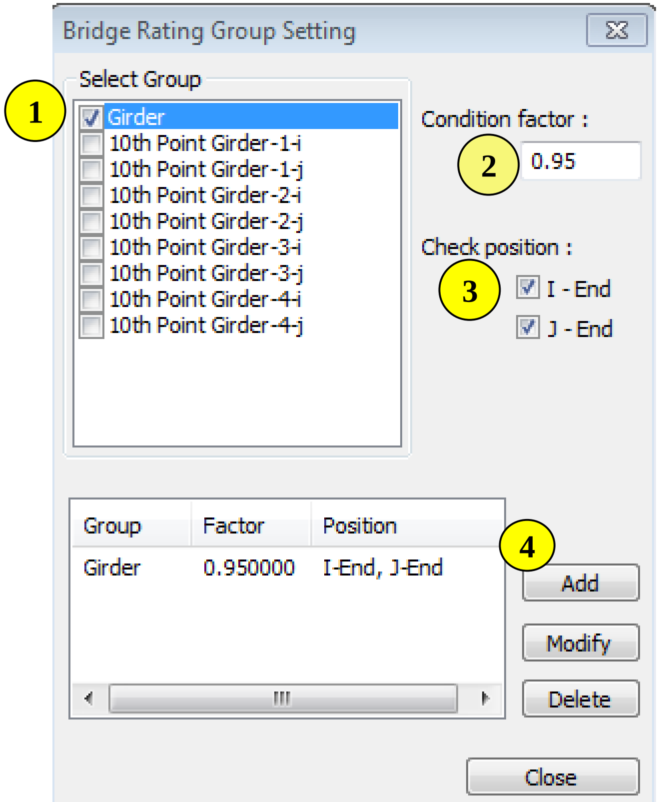
Design Load: $f_R=0.95\ R_h F_{yf}$
Legal/Permit Load: $f_R=0.95\ F_{yk}$

- In User input, the limiting stresses can be manually inputted for design load and legal/permit load respectively. The allowed compressive stress and tensile stress of the steel girder need to be inputted.

Application of Diagnostic Test result

- Adjustment factor resulting from the comparison of measured test behavior with the analytical model can be calculated. Select between strain and displacement obtained form the diagnostic test. Measure value can be entered in Diagnostic Test Result Menu

Step4. Define Bridge Rating Group Setting



1. Check on Girder

2. Define Condition factor

3. Check position I-End and J-End

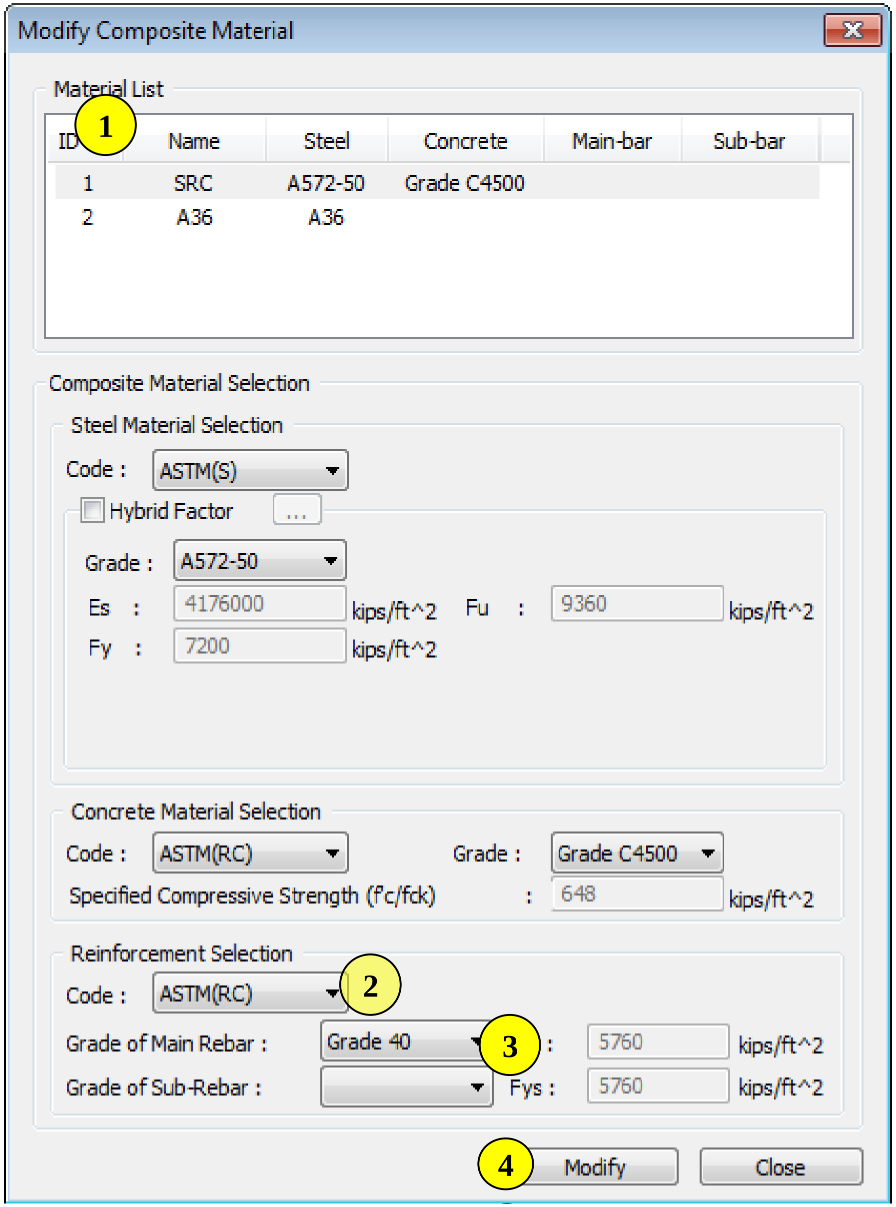
4. Click Add button

- Selected Groups are targeted for the design of the Rating Factor. Structural groups com posed of SRC material properties are shown in the list after performing an analysis.
- Different values of condition factor can be applied to different structure groups of elements.
- Condition Factors

Condition Description	NBI Rating	ϕ_c
good or satisfactory	6 or higher	1.00
fair	5	0.95
poor	4 or lower	0.85

*The Manual For Bridge Evaluation-6A.4.2.3

Step5. Modify Composite Material



- The objective of this tool is to check whether material property is defined as SRC or not. In order to perform Design Check and Load Rating, for steel composite bridge, only SRC material is allowed to be used. Furthermore, In Modify Composite Material, the steel prop erties for concrete reinforcement are defined.
- For resisting negative moment occurring aro und supports, reinforcing steels in Concrete deck is recommended

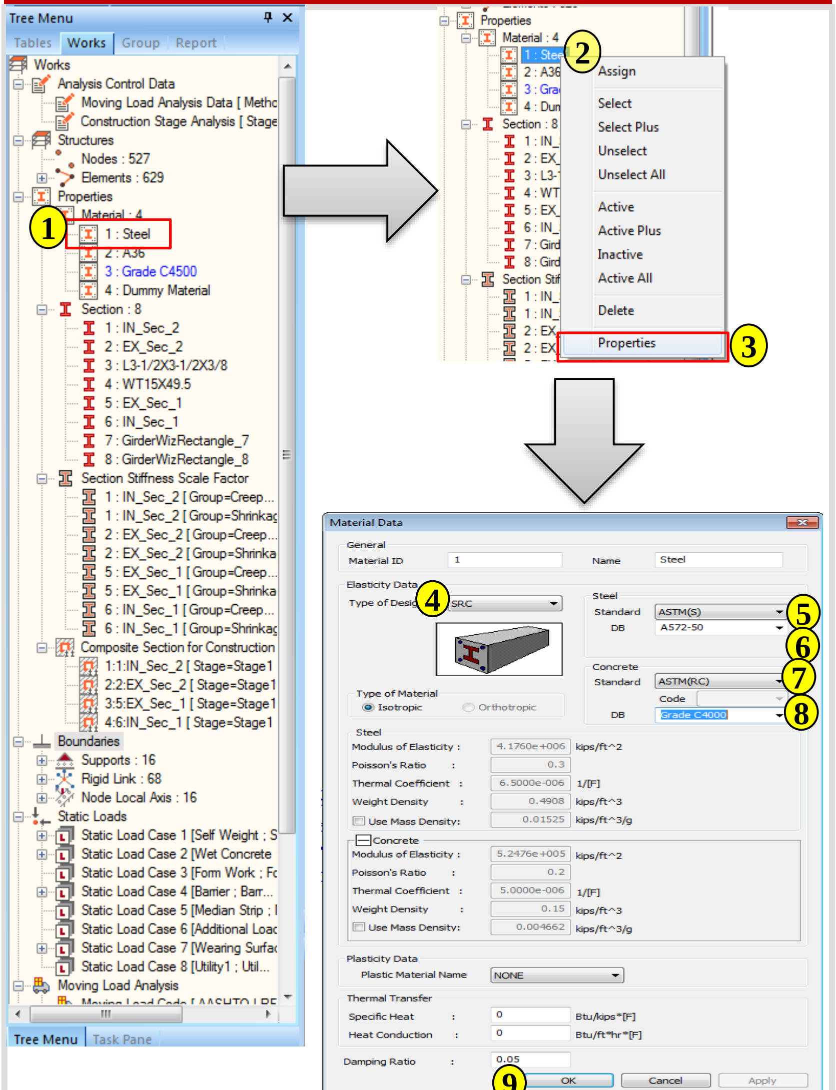
1. Check steel composite Section is defined to SRC

2. Code: ASTM(RC)

3. Grade of Main Rebar: Grade 40

4. Click Modify button

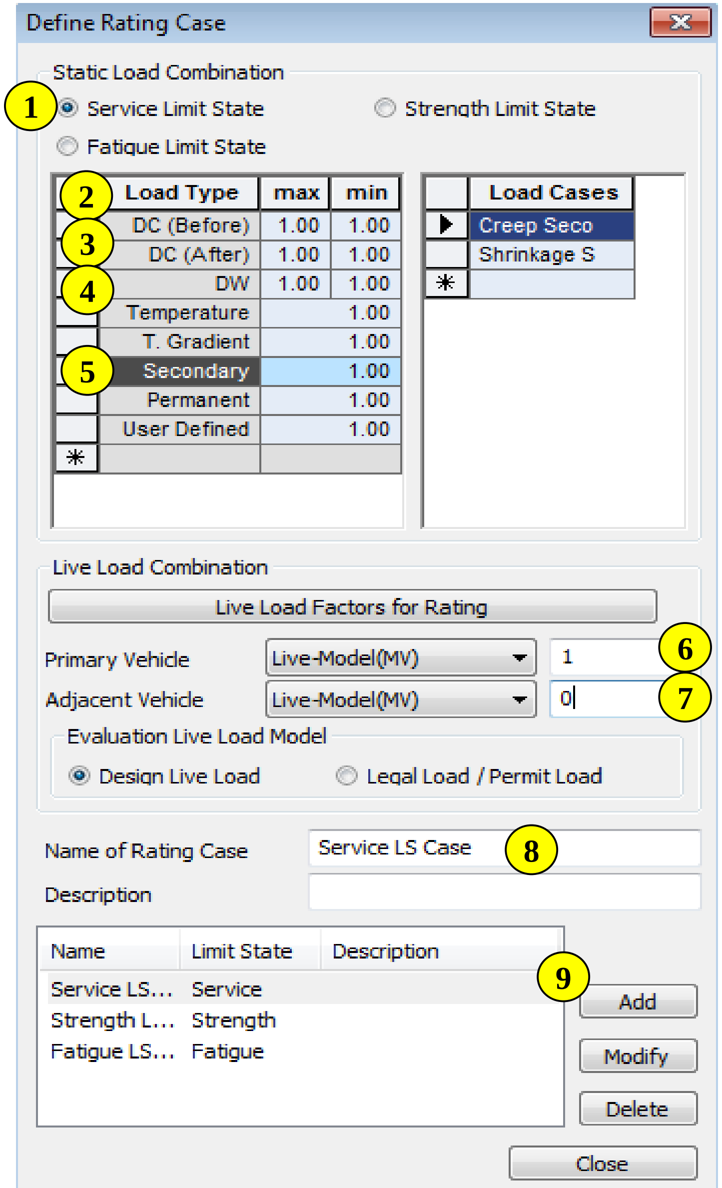
5.A. Modify Composite Material



Static load analysis and moving load analysis does not require users to select SRC as steel composite materials. Even if the girders are not defined as SRC, there is a way to enter SRC property into the girders at ease.

1. ***Click Steel Icon on Tree Menu***
2. *Right Click*
3. *Click Properties*
4. *Type of Design*
5. *Select Standard: ASTM(S)*
6. *Select DB: A572-50*
7. *Select ASTM(RC)*
8. *Grade C4000*
9. *Click Ok button*

Step6. Define Rating Case(Service Limit State)



1. Check on Service Limit State

2. Select Load Type: DC(Before)

2-1. Select Load Case: Dead Load(CS)

3. Select Load Type: DC(After)

3-1. Select Load Cases: Erection Load 1(CS)

4. Select Load Type: DW

4-1. Select Load Cases: Erection Load 2(CS)

5. Select Load Type: Secondary

5-1. Select Load Cases: Creep Secondary(CS)

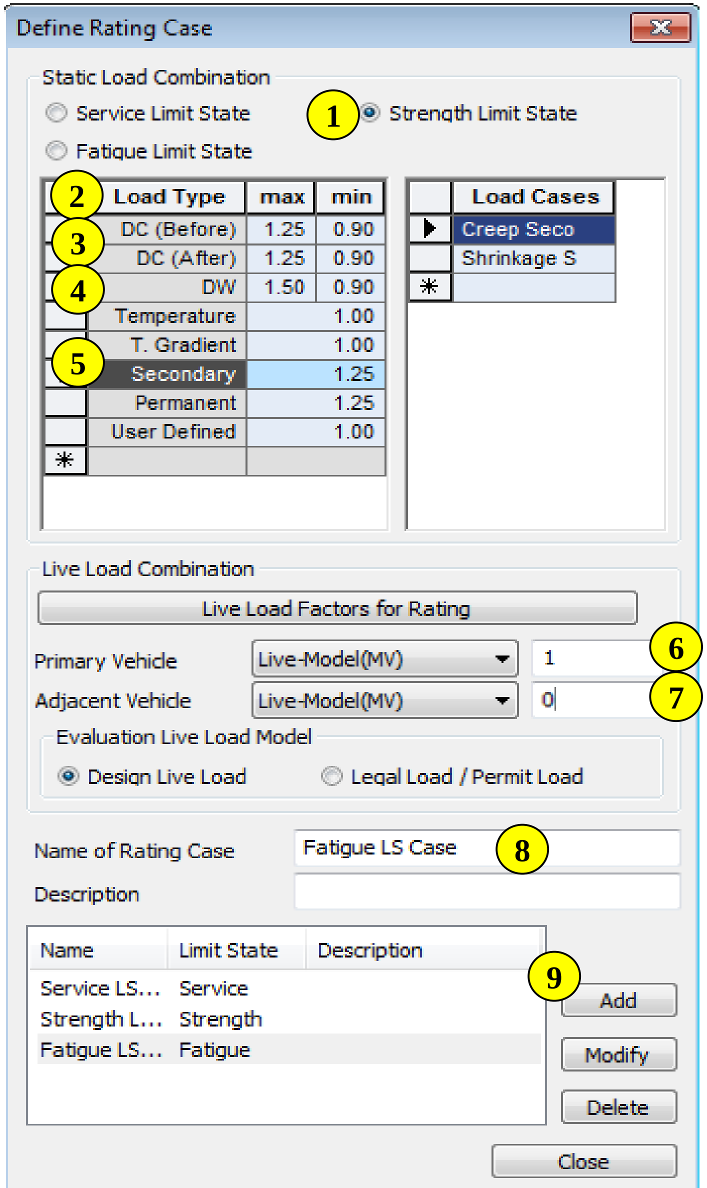
6. Primary Vehicle: 1

7. Adjacent Vehicle: 0

8. Name of Rating Case: Service LS Case

9. Click Add button

Step6-1. Define Rating Case(Strength Limit State)



1. Check on Strength Limit State

2. Select Load Type: DC(Before)

2-1. Select Load Case: Dead Load(CS)

3. Select Load Type: DC(After)

3-1. Select Load Cases: Erection Load 1(CS)

4. Select Load Type: DW

4-1. Select Load Cases: Erection Load 2(CS)

5. Select Load Type: Secondary

5-1. Select Load Cases: Creep Secondary(CS)

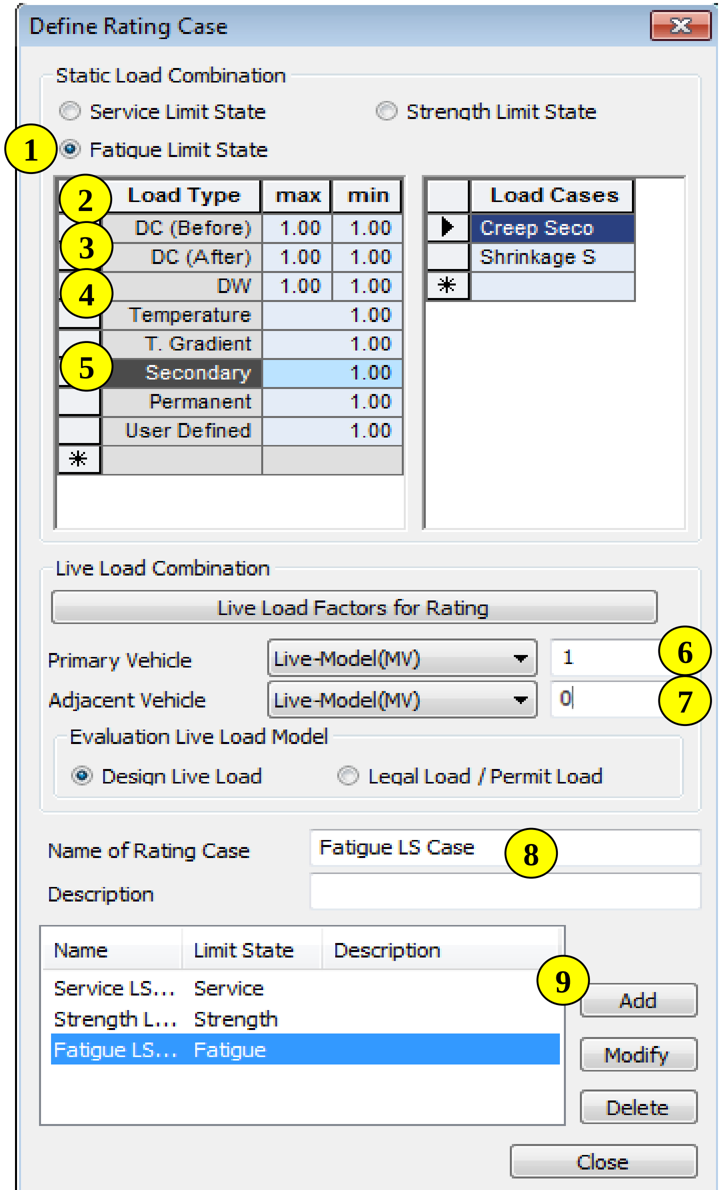
6. Primary Vehicle: 1

7. Adjacent Vehicle: 0

8. Name of Rating Case: Strength LS Case

9. Click Add button

Step6-2. Define Rating Case(Fatigue Limit State)



1. Check on Fatigue Limit State

2. Select Load Type: DC(Before)

2-1. Select Load Case: Dead Load(CS)

3. Select Load Type: DC(After)

3-1. Select Load Cases: Erection Load 1(CS)

4. Select Load Type: DW

4-1. Select Load Cases: Erection Load 2(CS)

5. Select Load Type: Secondary

5-1. Select Load Cases: Creep Secondary(CS)

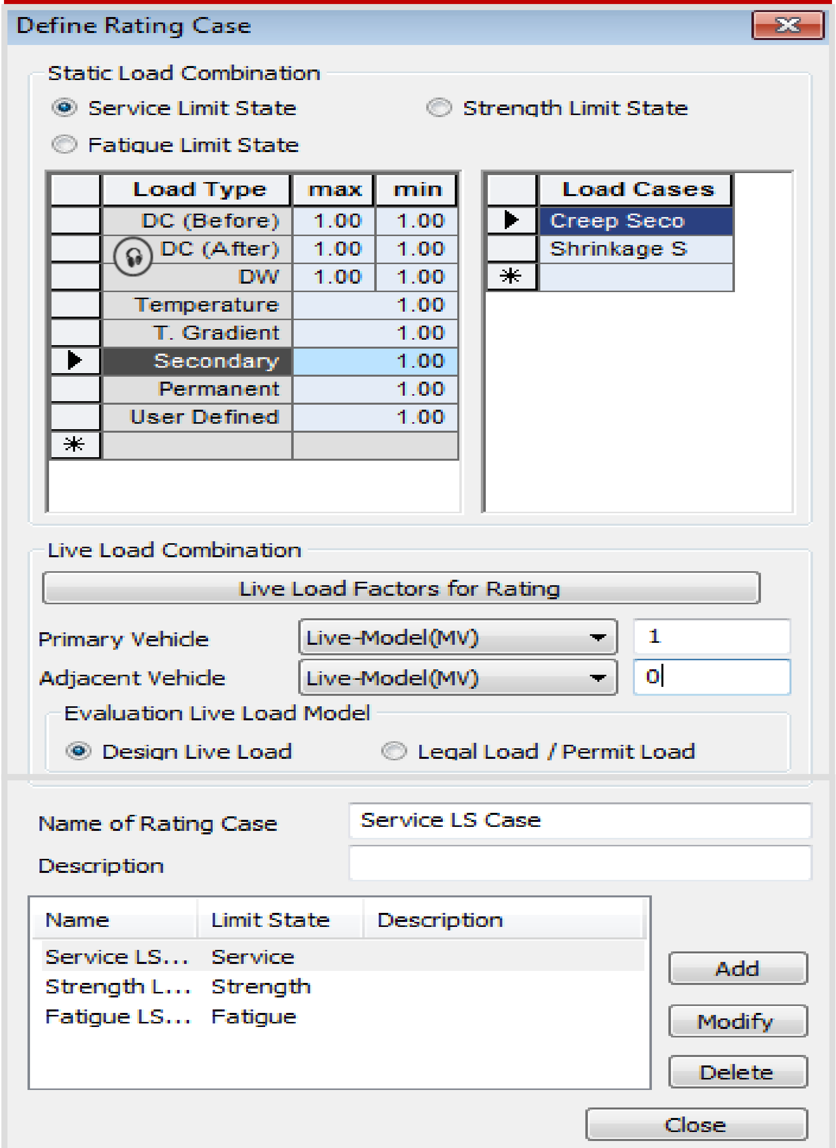
6. Primary Vehicle: 1

7. Adjacent Vehicle: 0

8. Name of Rating Case: Strength LS Case

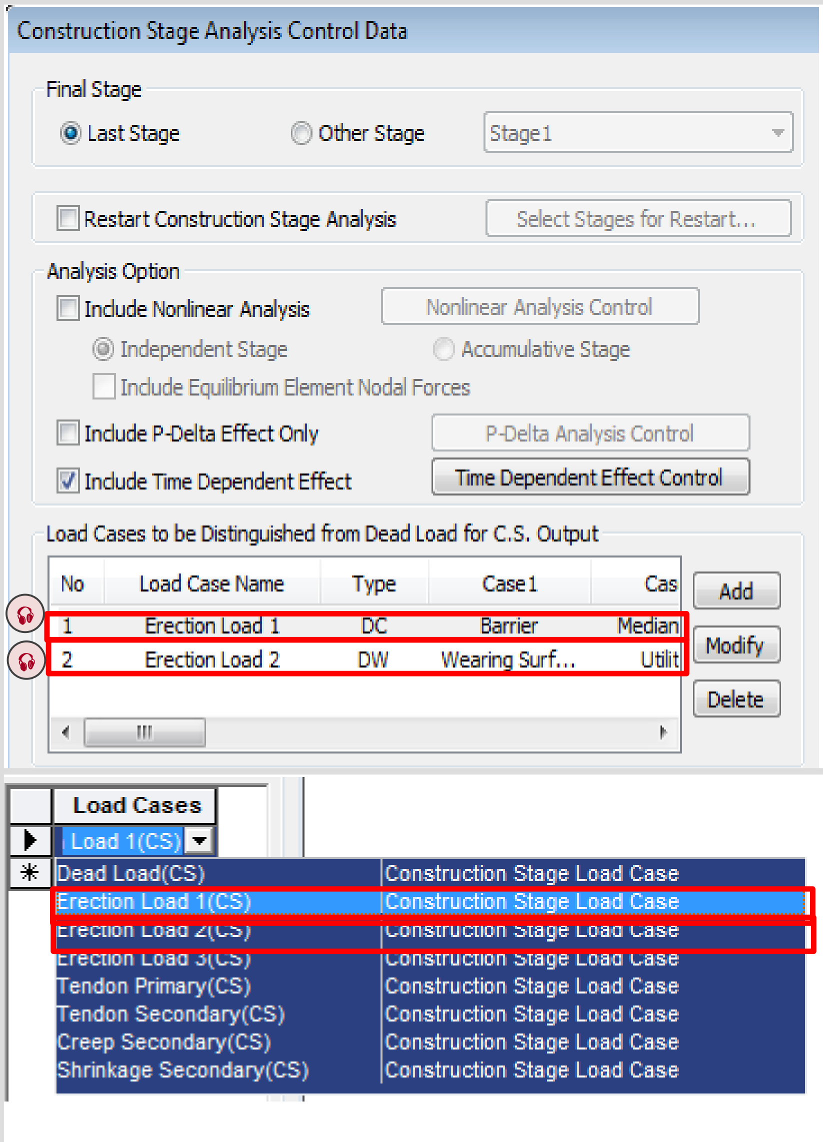
9. Click Add button

6.A. Define Rating Case



Whenever Load cases cannot be selected on the dialog box, click other load types and then get back to the load type you want to take. For example, suppose that you would like to enter creep secondary (CS) into Secondary Load type and you could not see the load case options, select other load type such as DW or DC(After) and get back to Secondary load type. Load Cases options will be available.

6.B. Define Rating Case

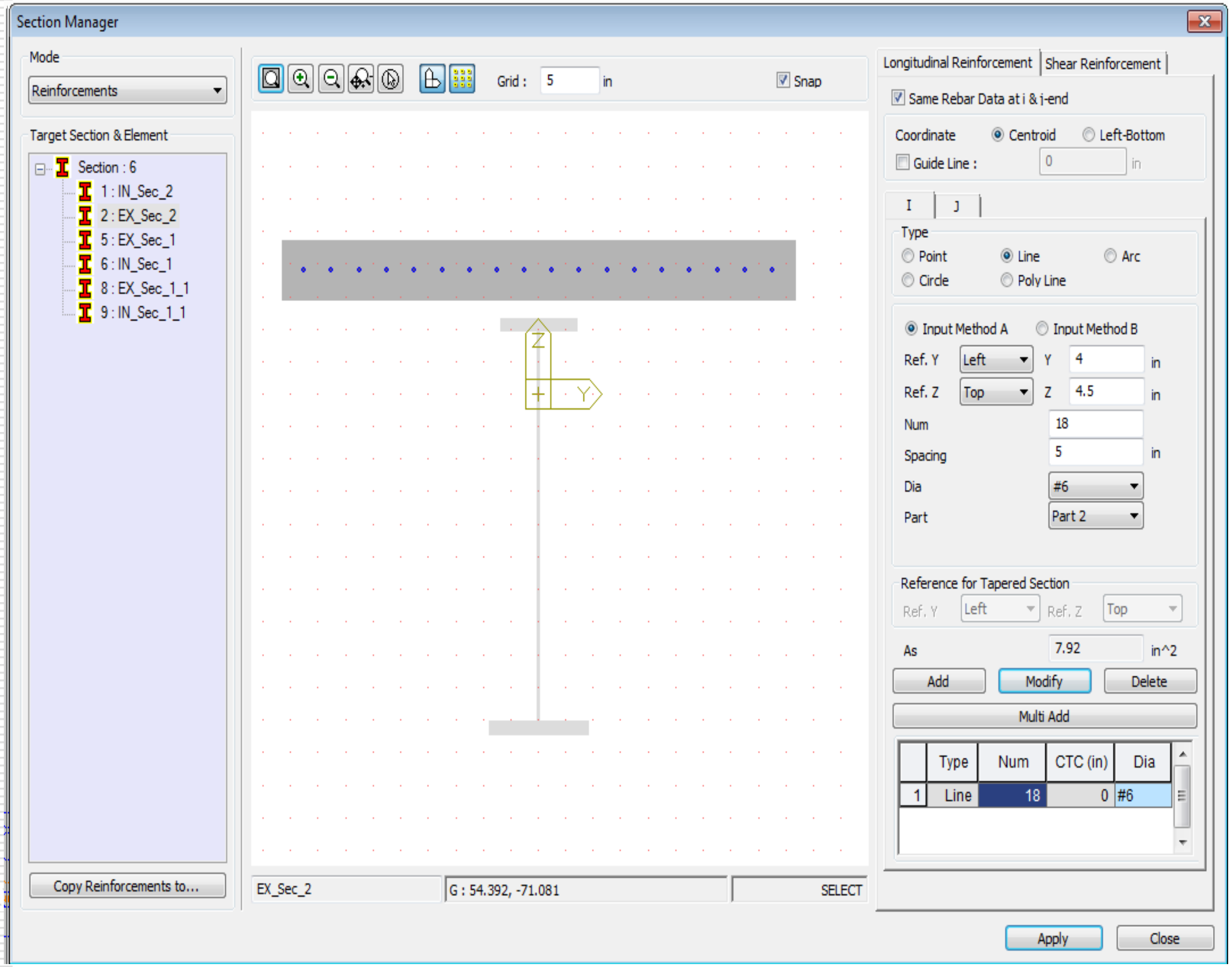


The Common mistake committed by beginners is not to define erection Load properly. Erection load comes from Construction stage Load Case. So, users must check it before defining Load Cases in Define Load Case window.

In order check Construction Stage Load Case, go to Analysis Tab>> Construction Stage>>Construction Stage Analysis Control Data

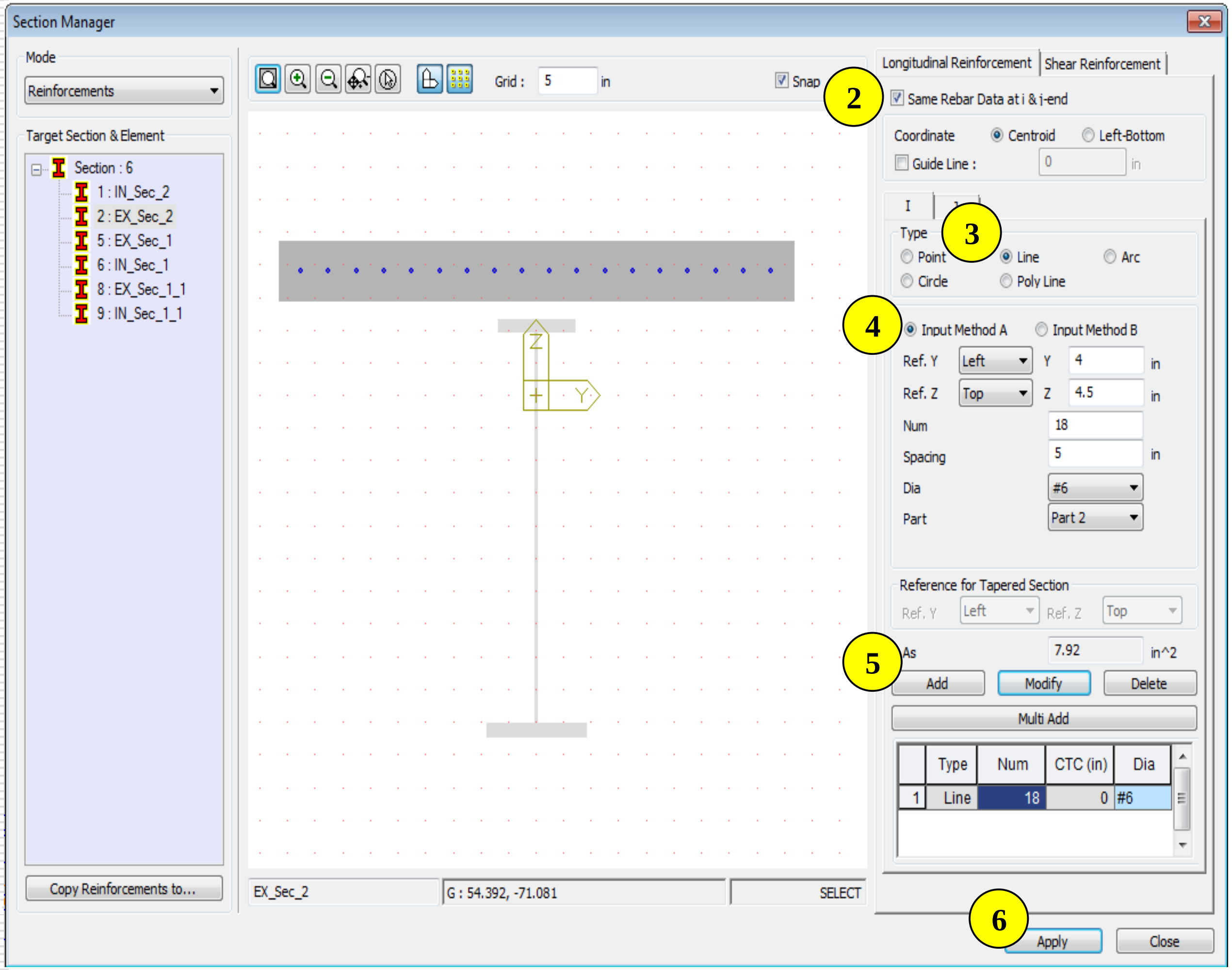
- If users have used Steel Girder Wizard, the default construction stage load cases are automatically defined in Midas Civil.
- For example, Erection Load 1 is defined as DC(Barrier and Median Strips), and Erection Load 2 is defined as DW(Wearing Surface load).

Step 7. Longitudinal Reinforcement



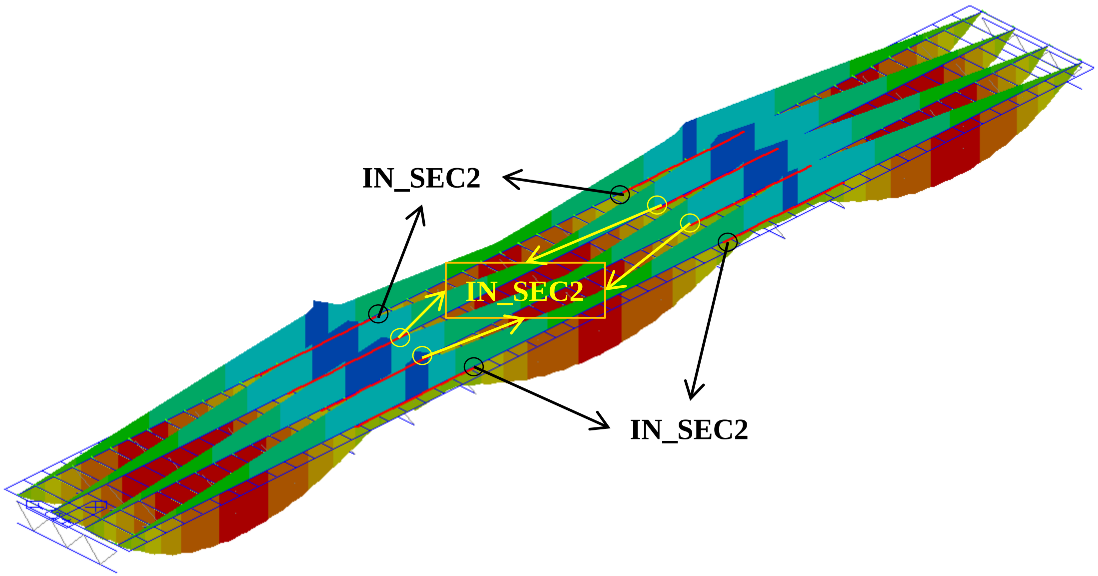
1. ***Rating>Longitudinal Reinforcement***
2. *Check the box for Same Rebar Data*
3. *Click Line*
4. *Ref. Y: Left, Ref. Z: Top, Y: 4in, Z: 4.5in, Num: 21, Spacing: 5in, Dia: #6,*
5. *Click Add*
6. *Click Apply*

Step 7-1. Longitudinal Reinforcement



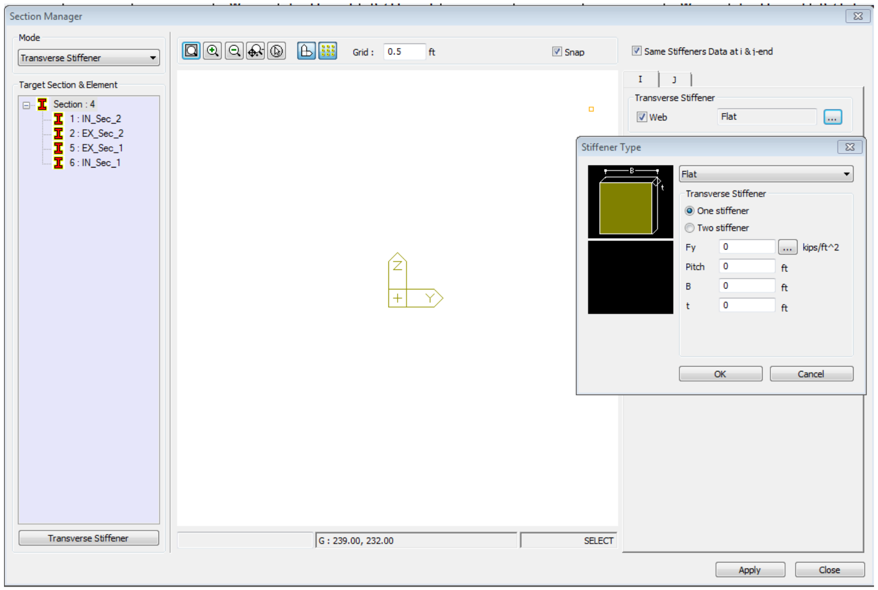
1. ***Rating>Longitudianl Reinforcement***
2. *Check the box for Same Rebar Data*
3. *Click Line*
4. *Ref. Y: Left, Ref. Z: Top, Y: 4in, Z: 4.5in, Num: 18, Spacing: 5in, Dia: #6,*
5. *Click Add*
6. *Click Apply*

7.A. Steel Reinforcement



Through running Mvall: Live-Model(Moving Load), Negative moment takes place at the IN_Sec2 and EX_Sec2. So, Steel Reinforcement in the concrete deck is conducted.

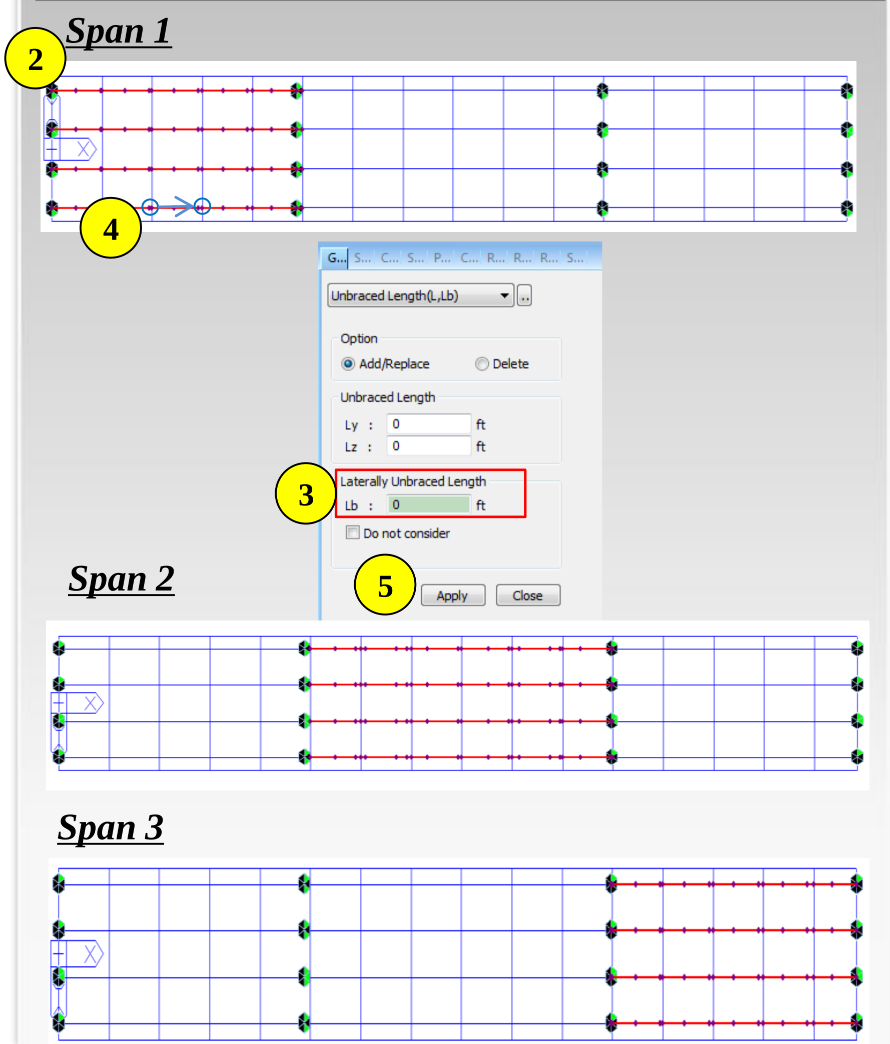
Step 8. Transverse Stiffener



As shown above, the dialog box in which users can arrange transverse stiffeners in steel composite section. When the transverse stiffeners are installed, the existence and spacing between stiffeners determine whether the web is stiffened or unstiffened under strength limit state. In this tutorial, transverse stiffeners aren`t defined.

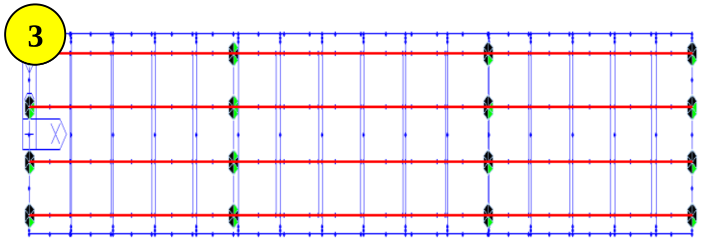
Step 9. Unbraced Length

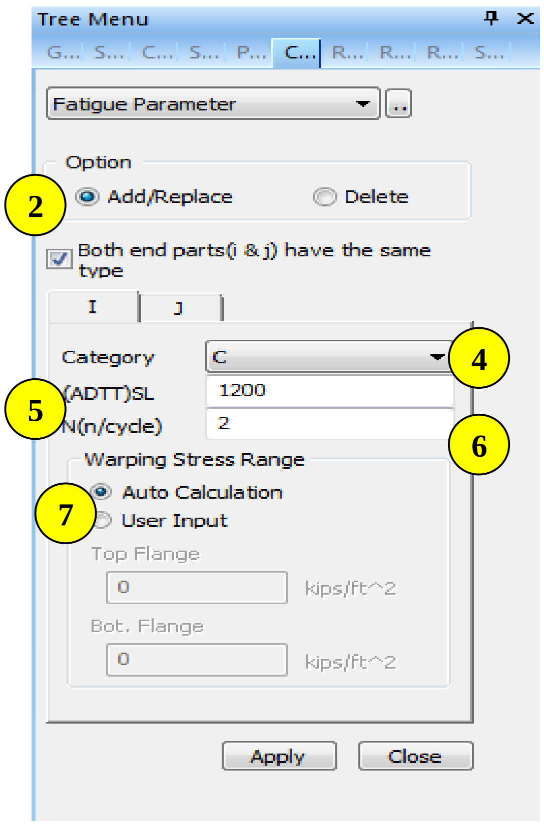
If each span has a different unbraced length, unbraced length must be different depending on span information.



1. ***Rating > Unbraced length***
2. *Select Span 1 by using Select by Window or Select by Polygon*
3. *Click Lb box*
4. *Select the unbraced Length or type the length*
5. *Click Apply*
6. *The same procedure will be conducted to Span 2 and Span3*

Step10. Fatigue Parameter





1. Properties> Fatigue Parameter

2. Click Add/Replace

3. Select the whole girders

4. Select Category: C

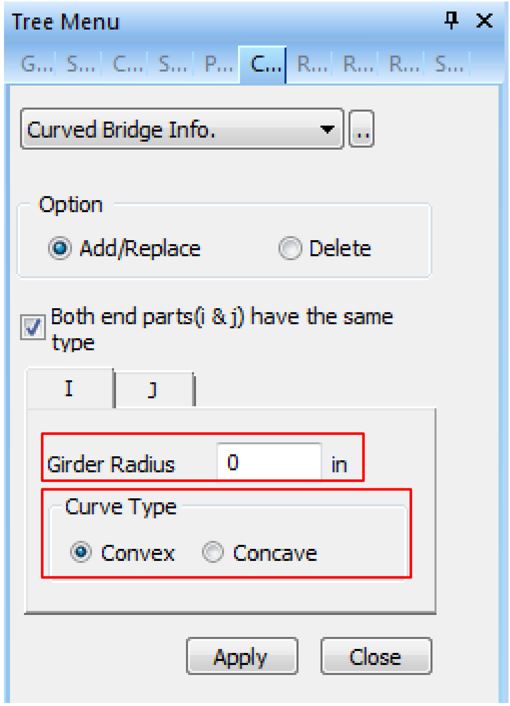
5. (ADTT)SL: 1200

6. M(n/cycle): 2

7. Warping Stress Range: Auto Cal

- Category: Category defined by 75yr-(ADTT)SL equivalent to inf inite life(Table 6.6.1.2.3-2)
- $(ADTT)_{SL}$: Number of trucks per day in a single-lane averaged over the design life(3.6.1.4.2)
- N : Number of cycles per truck passage, value can be taken from table6.6.1.2.5-2

Step11. Curved Bridge Information



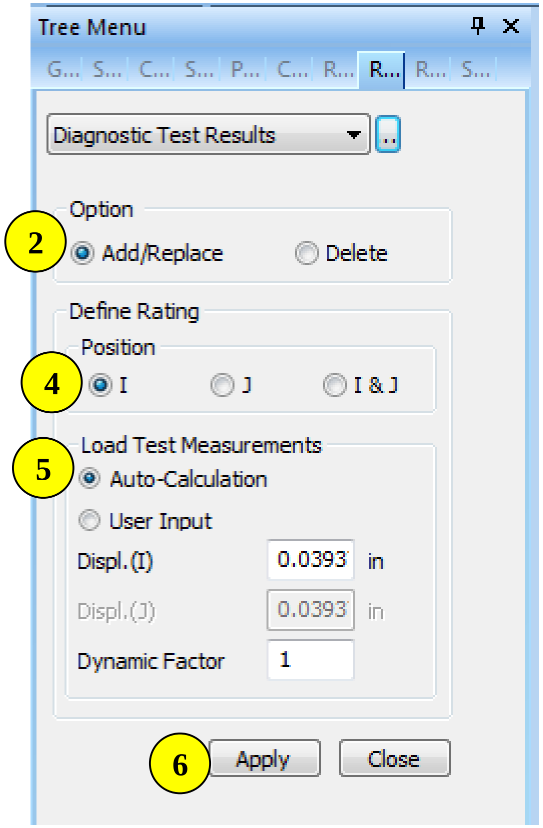
- Radius is used for the review of shear connector`s pitch and the moment of inertia of area for the longitudinal stiffener attached to web
- Curve Type-Convex, Concave

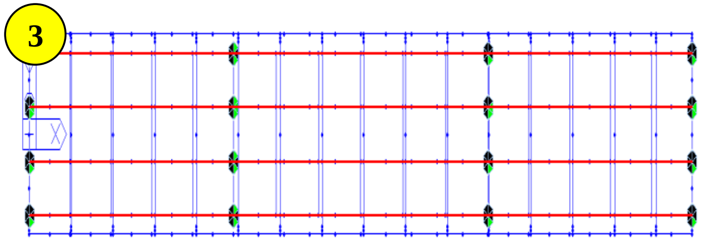
✓ If convex is selected, Left stiffener is on the side of the web away from the center of curvature and Right stiffener is on the side of t he web toward the center of curvature

✓ If concave is selected, the opposite case of the convex is applied. The Left and Right are determined based on the progressing dire ction of the cross section.

*Note: This model is a straight bridge. So, this tutorial does not con sider Curved Bridge Information

Step12. Diagnostic Test Result





- Adjustment factor resulting from the comparison of measured test behavior with the analytical model can be considered to calculate the load-rating factor based on the test result.
- Auto Calculation: Deflection and K_b are inputted manually for th e diagnostic test to calculate adjustment factor.
- User input: The Adjustment Factor, k, is inputted by users. K is used to calculate the factored load-rating factor(8.8.2.3.1-1)

1. Properties> Diagnostic Test Result

2. Option: Add/Replace

3. Select the whole girders

4. Select position: I

5. Load Test Measurements: Auto-Calculation

6. Click Apply button

Step13. Rating Design Result Tables

1. *Rating>Steel Bridge>Perform Rating Design*
2. *Rating>Steel Bridge>Rating Design Result Table*

Service Limit State Summary

	Rating Case	Component	Minimum Rating Factor	Location	Relative Location	Allowable Stress (kips/ft^2)	Demand (kips/ft^2)	Point	Dead(Before)		Dead(After)	Short Term	Pri. LL
									Factor	Stress (kips/ft^2)	Stress (kips/ft^2)	Stress (kips/ft^2)	Stress (kips/ft^2)
	Service LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	Compression	86.0282	319 - I	-	6840.0000	-837.1356	Top	1.0000	-756.9201	-10.4377	-69.7778	-69.7778
▶	Service LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	Tension	6.9685	319 - I	-	6840.0000	1427.4744	Bottom	1.0000	620.8668	29.8920	776.7156	776.7156

Strength Limit State Summary

	Rating Case	Positive/ Negative	Minimum Rating Factor	Location	Relative Location	LRFD Resistance Factor	Demand, Mu (ft*kips)	Capacity, PhiMn (ft*kips)	Demand, fbu (kips/ft^2)	Capacity, PhiFn (kips/ft^2)	DC(Before)		DC(After)	
											Factor	Force (ft*kips)	Factor	Force (ft*kips)
▶	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MA	Negative	5.1006	403 - I	-	1.0000	-336.6924	4588.1723	0.0000	0.0000	1.2500	-254.9106	1.2500	-12.3336

*Note: Element 226-i is determined to be N.G

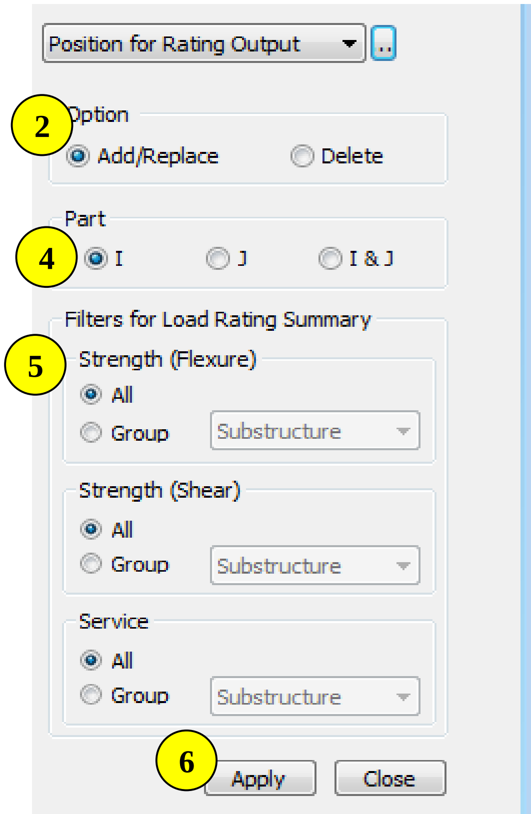
Flexure Limit State Summary

	Group	Elem.	Part	Relative Location	Positive/Negative	Rating Case	LRFD Resistance Factor	System Factor	Condition Factor	Rating Factor	Check
	Girder	211	I[3]	-	Negative	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MIN)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	77.0899	OK
	-	211	I[3]	-	Positive	-	-	-	-	-	-
	-	211	J[217]	-	Negative	-	-	-	-	-	-
	Girder	211	J[217]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	17.8462	OK
	-	212	I[217]	-	Negative	-	-	-	-	-	-
	Girder	212	I[217]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	17.8462	OK
	Girder	212	J[218]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	8.5736	OK
	-	212	J[218]	-	Negative	-	-	-	-	-	-
	-	213	I[218]	-	Negative	-	-	-	-	-	-
	Girder	213	I[218]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	8.5736	OK
	-	213	J[24]	-	Negative	-	-	-	-	-	-
	Girder	213	J[24]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	8.3581	OK
	Girder	214	I[24]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	8.4136	OK
	-	214	I[24]	-	Negative	-	-	-	-	-	-
▶	-	214	J[219]		Negative	-	-	-	-	-	-
	Girder	214	J[219]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	7.3594	OK
	-	215	I[219]	-	Negative	-	-	-	-	-	-
	Girder	215	I[219]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	7.3594	OK
	Girder	215	J[220]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	6.2795	OK
	-	215	J[220]	-	Negative	-	-	-	-	-	-
	-	216	I[220]	-	Negative	-	-	-	-	-	-
	Girder	216	I[220]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	6.2795	OK
	-	216	J[35]	-	Negative	-	-	-	-	-	-
	Girder	216	J[35]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	6.1723	OK
	Girder	217	I[35]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	6.1689	OK
	-	217	I[35]	-	Negative	-	-	-	-	-	-
	-	217	J[221]	-	Negative	-	-	-	-	-	-
	Girder	217	J[221]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	6.8985	OK
	-	218	I[221]	-	Negative	-	-	-	-	-	-
	Girder	218	I[221]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	6.8985	OK
	-	218	J[222]	-	Negative	-	-	-	-	-	-
	Girder	218	J[222]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	7.5440	OK
	Girder	219	I[222]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	7.5440	OK
	-	219	I[222]	-	Negative	-	-	-	-	-	-
	-	219	J[46]	-	Negative	-	-	-	-	-	-
	Girder	219	J[46]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	7.6553	OK
	-	220	I[46]	-	Negative	-	-	-	-	-	-
	Girder	220	I[46]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	7.6648	OK
	Girder	220	J[223]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	11.2703	OK
	-	220	J[223]	-	Negative	-	-	-	-	-	-
	-	221	I[223]	-	Negative	-	-	-	-	-	-
	Girder	221	I[223]	-	Positive	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(+)_TG(+)_A.V(My-Max)	1.0000	1.0000	0.9500	11.2703	OK

Shear Strength Rating Factor

	Group	Elem.	Part	Relative Location	Rating Case	LRFD Resistance Factor	System Factor	Condition Factor	Rating Factor	Check
	Girder	211	I[3]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.0743	OK
	Girder	211	J[217]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.2532	OK
	Girder	212	I[217]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.2532	OK
	Girder	212	J[218]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.4321	OK
	Girder	213	I[218]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.5291	OK
	Girder	213	J[24]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.5386	OK
	Girder	214	I[24]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	4.1564	OK
	Girder	214	J[219]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	4.4410	OK
	Girder	215	I[219]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	4.4410	OK
	Girder	215	J[220]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MIN)_T(+	1.0000	1.0000	0.9500	4.5069	OK
	Girder	216	I[220]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MIN)_T(+	1.0000	1.0000	0.9500	4.8877	OK
	Girder	216	J[35]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MIN)_T(+	1.0000	1.0000	0.9500	4.8549	OK
	Girder	217	I[35]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	4.4841	OK
	Girder	217	J[221]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	4.2109	OK
	Girder	218	I[221]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	4.2109	OK
	Girder	218	J[222]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	3.9070	OK
	Girder	219	I[222]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	3.8039	OK
	Girder	219	J[46]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	3.7592	OK
	Girder	220	I[46]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.2572	OK
	Girder	220	J[223]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.1041	OK
	Girder	221	I[223]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.1041	OK
	Girder	221	J[224]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.9236	OK
	Girder	222	I[224]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.8894	OK
	Girder	222	J[57]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.8503	OK
	Girder	223	I[57]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.3569	OK
	Girder	223	J[225]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.2409	OK
	Girder	224	I[225]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.2409	OK
	Girder	224	J[226]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.0955	OK
	Girder	225	I[226]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	0.9822	NG
	Girder	225	J[68]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.0153	OK
	Girder	226	I[68]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.1873	OK
	Girder	226	J[227]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.3348	OK
	Girder	227	I[227]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.3348	OK
	Girder	227	J[228]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.4581	OK
	Girder	228	I[228]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.5082	OK
	Girder	228	J[229]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.5082	OK
	Girder	229	I[229]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.5082	OK
	Girder	229	J[79]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	1.5390	OK
	Girder	230	I[79]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.0626	OK
	Girder	230	J[230]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.0988	OK
	Girder	231	I[230]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.0988	OK
	Girder	231	J[231]	-	Strength LS Case_DC-Before(MAX)_DC-After(MAX)_DW(MAX)_T(	1.0000	1.0000	0.9500	2.3286	OK

Step14. Position for Rating Output



Referring to the previous slide, Element 226-i is determined to be N.G through shear strength rating factor.

1. Properties> Position for Rating Output

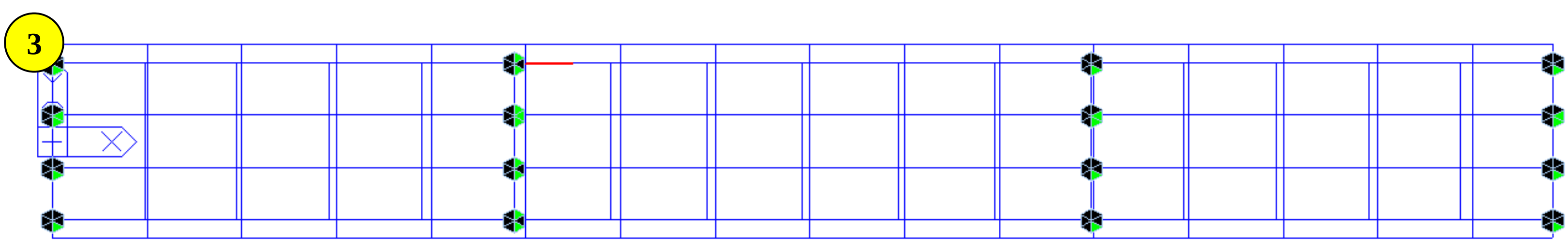
2. Option: Add/Replace

3. Select Element 226-i

4. Select position: I

5. Strength(Flexure & Shear), Service: All

6. Click Apply button



Step15. Excel Report

1. Rating>Steel Bridge>Excel Report

AASHTO LRFR Check Result

1. Flexure

1) Rating Factor

Elem.	Part	Lcom	Positive/ Negative	M/f	Capacity	Dead Load Demand	Live Load Demand	Rating Factor
29	I	HL - 93 Inventory	Positive	M	61364.559	48076.893	28449.875	0.467
		-	Negative	-	-	-	-	-

Where,

M/f { "M" : Flexure is checked with moment unit (kips·in)
"f" : Flexure is checked with stress unit (ksi)

$$R.F = \frac{\text{Capacity} - \text{Dead Load Demand}}{\text{Live Load Demand}}$$

▪ Measure Type : Displacement

Elem.	Part	Lcom	Positive/ Negative	ε_c / Δ_c (in)	ε_t / Δ_t (in)	K_a	K_b	K	Rating Factor
29	I	HL - 93 Inventory	Positive	0.000E+00	1.000E+00	0.000	1.000	1.000	0.467
		-	Negative	-	-	-	-	-	-

in which :

ε_c (Δ_c) : maximum calculated strain (displacement) of top or bottom position

$K = 1 + K_a \times K_b$

$$K_a = \frac{\varepsilon_c}{\varepsilon_t} - 1$$

2. Shear

1) Rating Factor

Elem.	Part	Lcom	Capacity (kips)	Dead Load Demand (kips)	Live Load Demand (kips)	Rating Factor
29	I	HL - 93 Inventory	375.105	-81.923	-66.117	4.434

Where,

$$R.F = \frac{\text{Capacity} - \text{Dead Load Demand}}{\text{Live Load Demand}}$$

▪ Measure Type : Displacement

Elem.	Part	Lcom	ε_c / Δ_c (in)	ε_t / Δ_t (in)	K_a	K_b	K	Rating Factor
29	I	HL - 93 Inventory	0.000E+00	1.000E+00	0.000	1.000	1.000	4.434

in which :

ε_c (Δ_c) : maximum calculated strain (displacement) of top or bottom position

$K = 1 + K_a \times K_b$

$$K_a = \frac{\varepsilon_c}{\varepsilon_t} - 1$$