

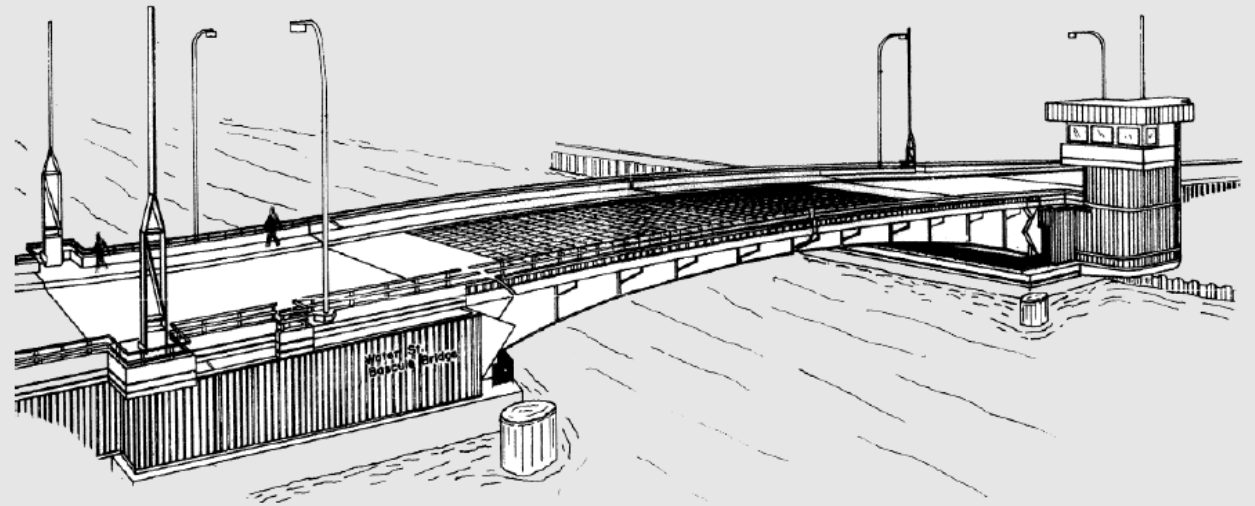


# Using BrR for Rating Bascule Bridges

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AASHTOWare 2023 RADBUG

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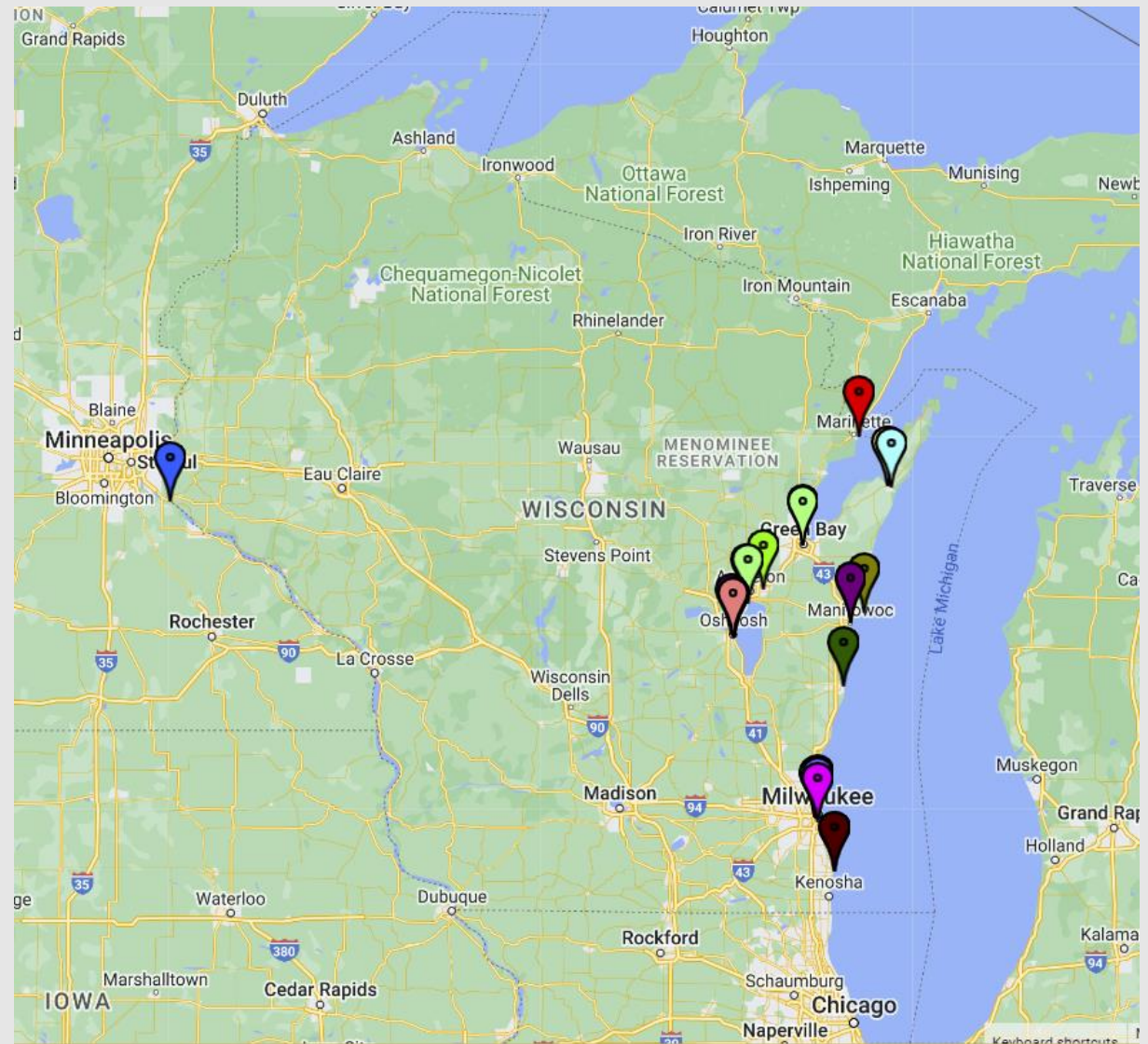


# What is a Bascule bridge?

- Type of movable bridge
  - Rotates (or rolls) span to create unlimited vertical clearance
- The lifting span is called a “leaf”
  - May consist of single (shown) or double leaf



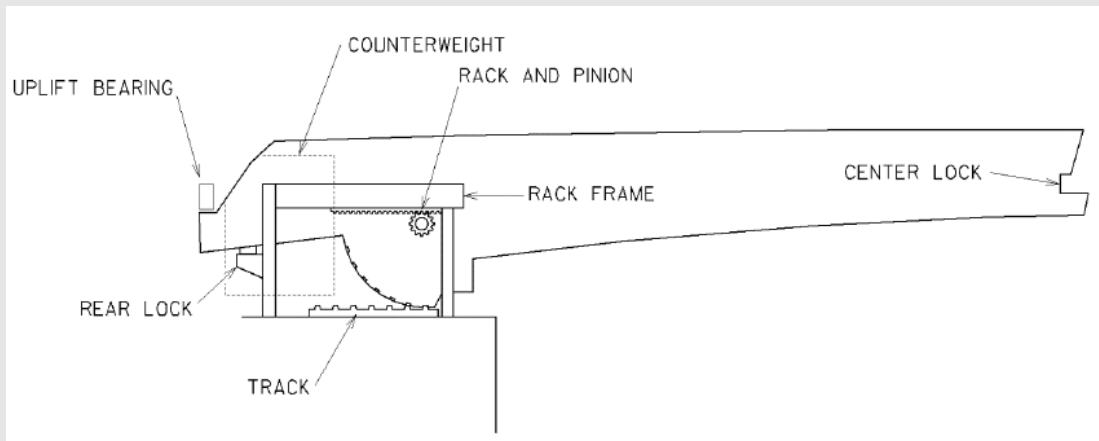
- 32 bascule type movable bridges in Wisconsin's inventory
- Located predominantly along Lake Michigan and Fox River Valley communities
  - Supports fishing, manufacturing and shipping industries





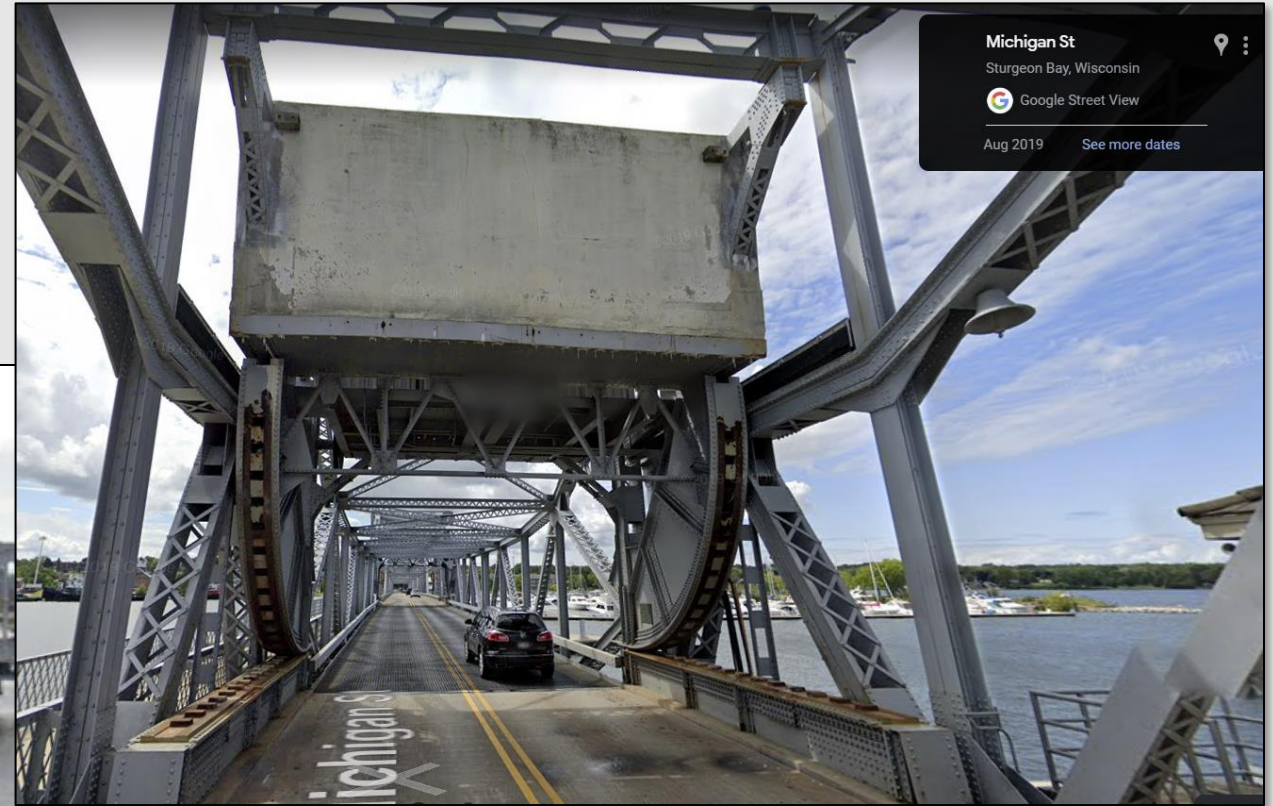
# Main Load Carrying Members

- A Girder-Floorbeam-Stringer (GFS) system
  - w/ unique support conditions
- Secondary elements



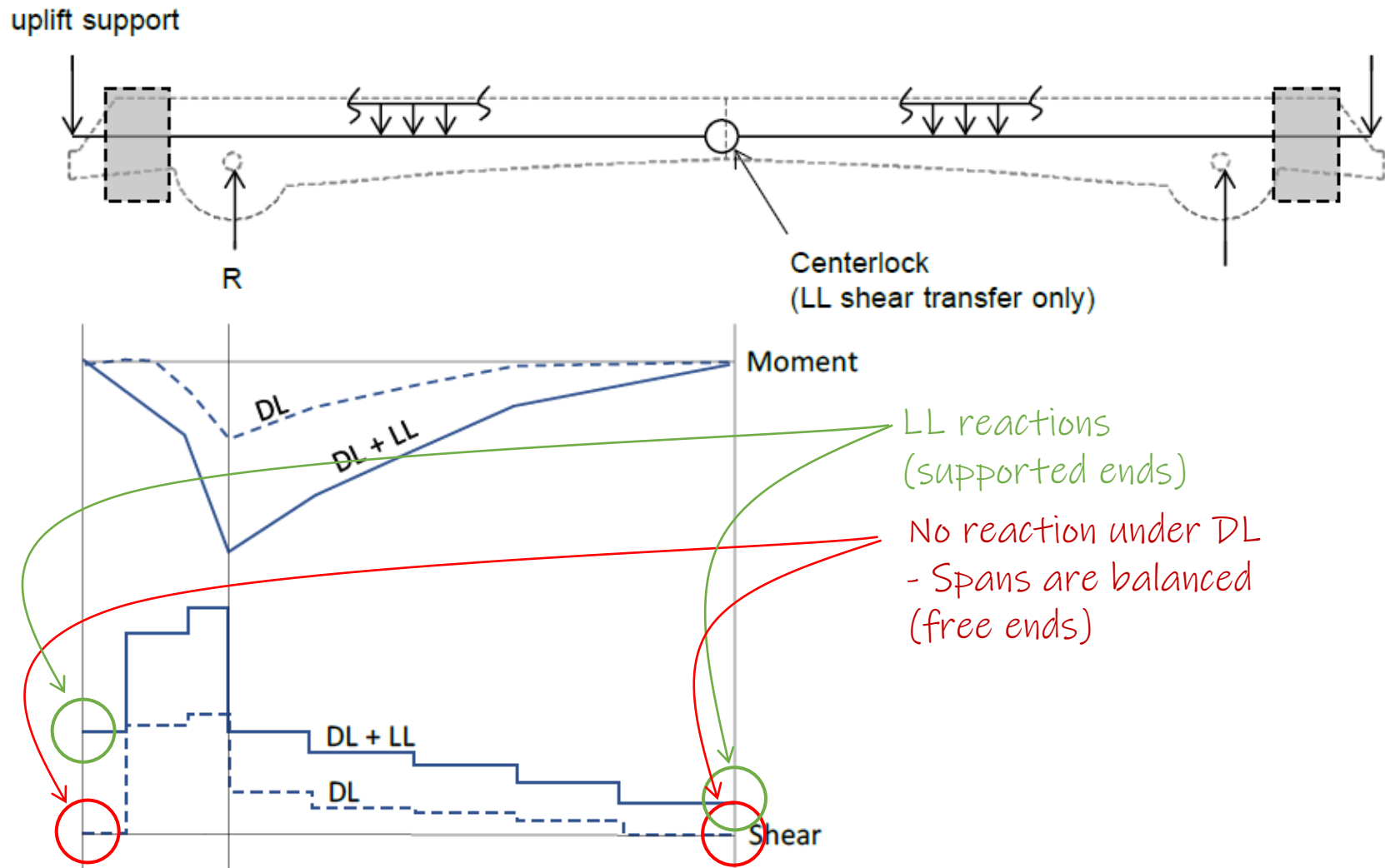
# Counterweight

- Massive block of concrete
- Usually below the deck
- Keeps machinery modest



# Support Conditions

- Large counterweight balances forward span
  - Girder is balanced under Dead Load
- When closed the two leaves are locked at the center (centerlock)
  - Live Load reactions present at centerlock and uplift bearing



# Using BrR to Load Rate a Double-Leaf Bascule

The screenshot shows a software interface for defining a new superstructure. On the left, a list of options includes:

- Girder System Superstructure
- Girder Line Superstructure
- Floor System Superstructure
- Floor Line Superstructure
- Truss System Superstructure
- Truss Line Superstructure
- Reinforced Concrete Slab System
- Concrete Multi-Cell Box Superstructure

An orange arrow points to the 'Floor System Superstructure' option. Below the list is a preview image labeled 'Girder Floorbeam Stringer'.

The main panel displays the following information:

- Project ID: B360142
- Structure Name: Double Leaf Rolling Bascule - GFS-BASCULE
- Date: 11/12/14

The technical drawing shows a cross-section of the bascule with the following dimensions:

- Overall width: 50'-0"
- Deck thickness: 7"
- Travelway widths: 12'-0" (each of four travelways)
- Travelway labels: Travelway 1, Travelway 2, Travelway 3, Travelway 4
- Bottom chord spacing: 3'-0", 3'-0", 3'-4", 3'-4", 3'-4", 3'-4", 3'-4", 3'-4", 3'-4", 3'-4", 3'-4", 3'-4", 3'-4", 3'-4", 3'-0", 3'-0"
- Bottom chord total length: 52'-0"
- Bottom chord member type: W 18x40



# What makes a bascule different than other GFS type structures?

- Stringers

- Number of stringers can be different between units
- Concrete and open steel grid deck

- Floorbeams

- Section varies btwn floorbeams (sometimes a truss FB)
- Twice the impact applied to end floorbeam (nearest centerlock)

- Bascule Girder

- Varying section
- Support conditions

*Requires some workaround in BrR*





# What makes

# than other GFS

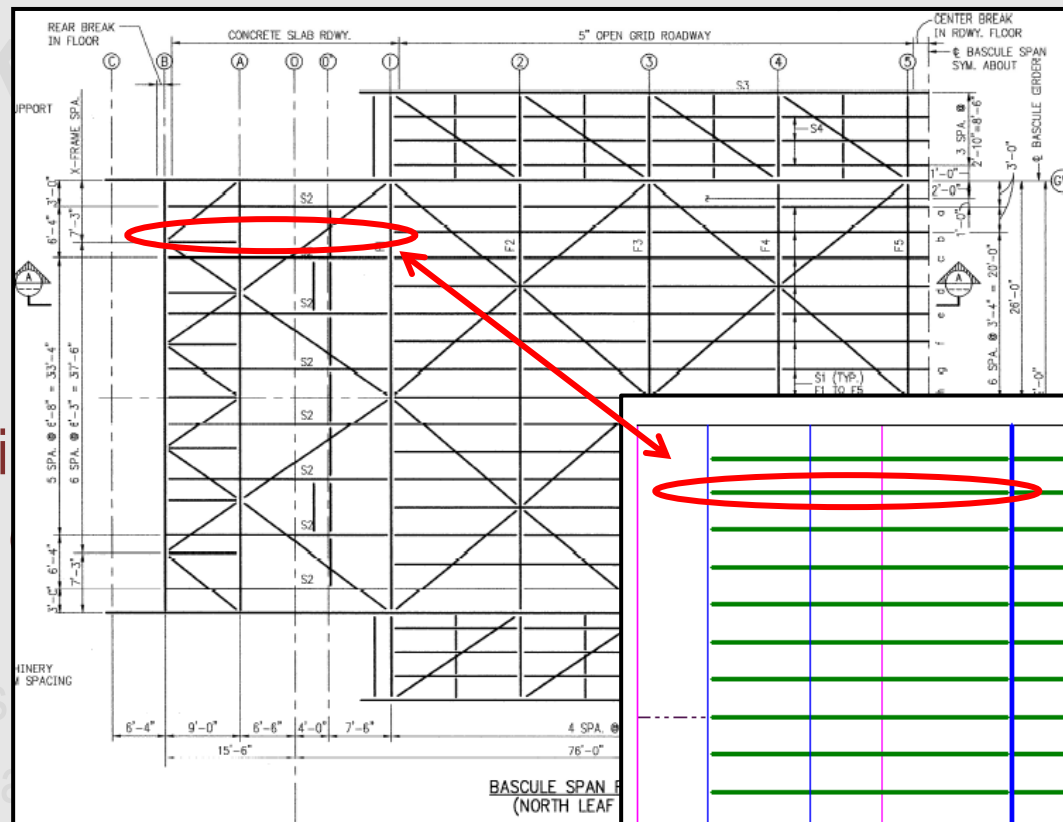
- Stringers

- Number of stringers
- Concrete and

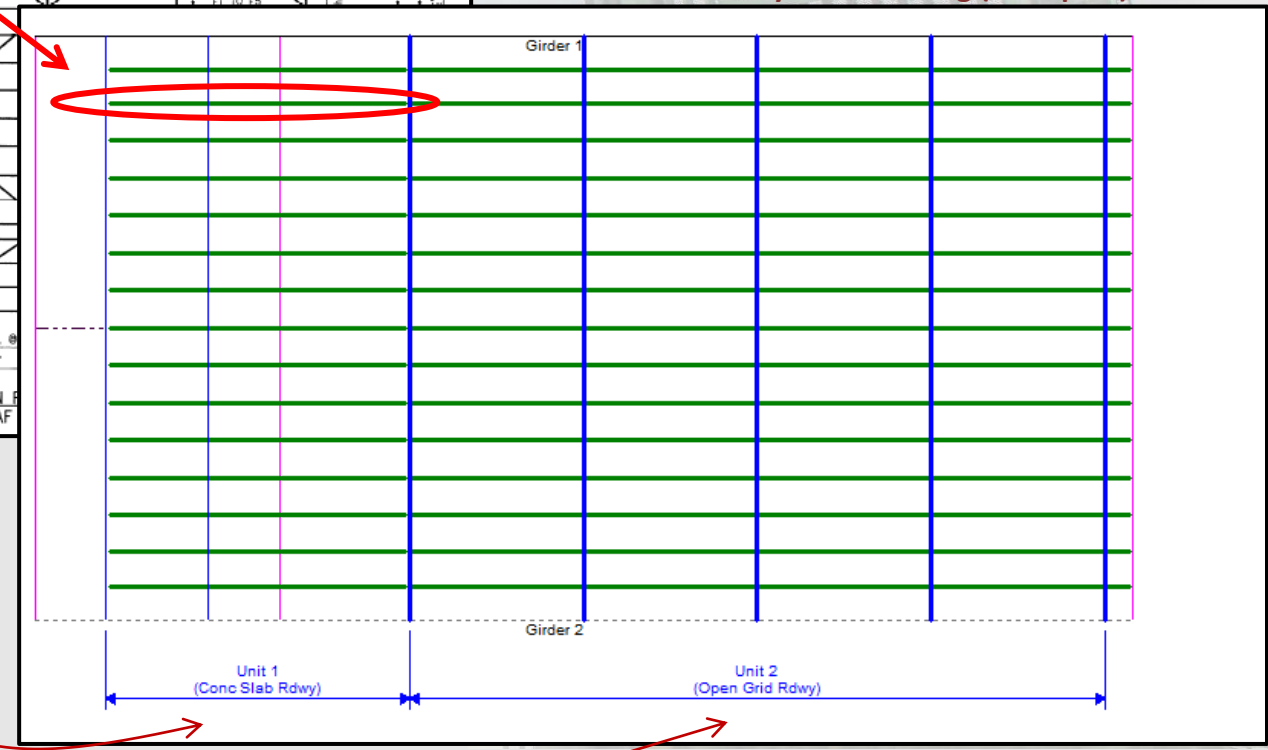
- Floorbeams

- Section varies
- Twice the impact (centerlock)

The codified distribution factors for concrete and open steel grid decks are different.  
Ta. 3.23.1 (Std Spec - LFR) or Ta.4.6.2.2.2b-1 (LRFD)



- Number of stringers different between units
  - BrR doesn't allow
- Adjust ghost stringer DF to zero
- Adjust actual stringer DF to actual spacing (and increase DL)
  - The additional stringer DL to offset machinery room loading (from plan)



# What makes a bascule girder different than other GFS type

- Stringers

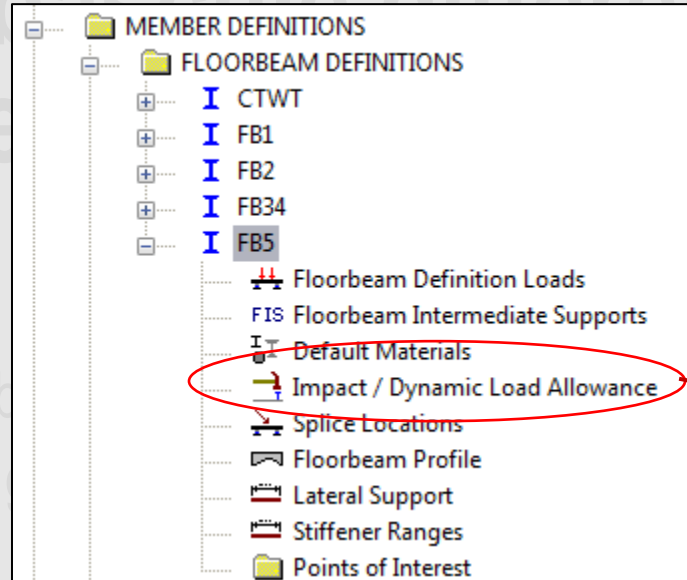
- Number of stringers can be
- Concrete and open steel

- Floorbeams

- Section varies btwn floorbeams (sometimes a truss FB)
- Twice the impact applied to end floorbeam (nearest centerlock)

- Bascule Girder

- Varying section
- Support conditions



Standard Impact Factor

For structural components where impact is to be included per AASHTO 3.8.1, choose the impact factor to be used:

Standard AASHTO impact  $I = \frac{50}{L + 125}$

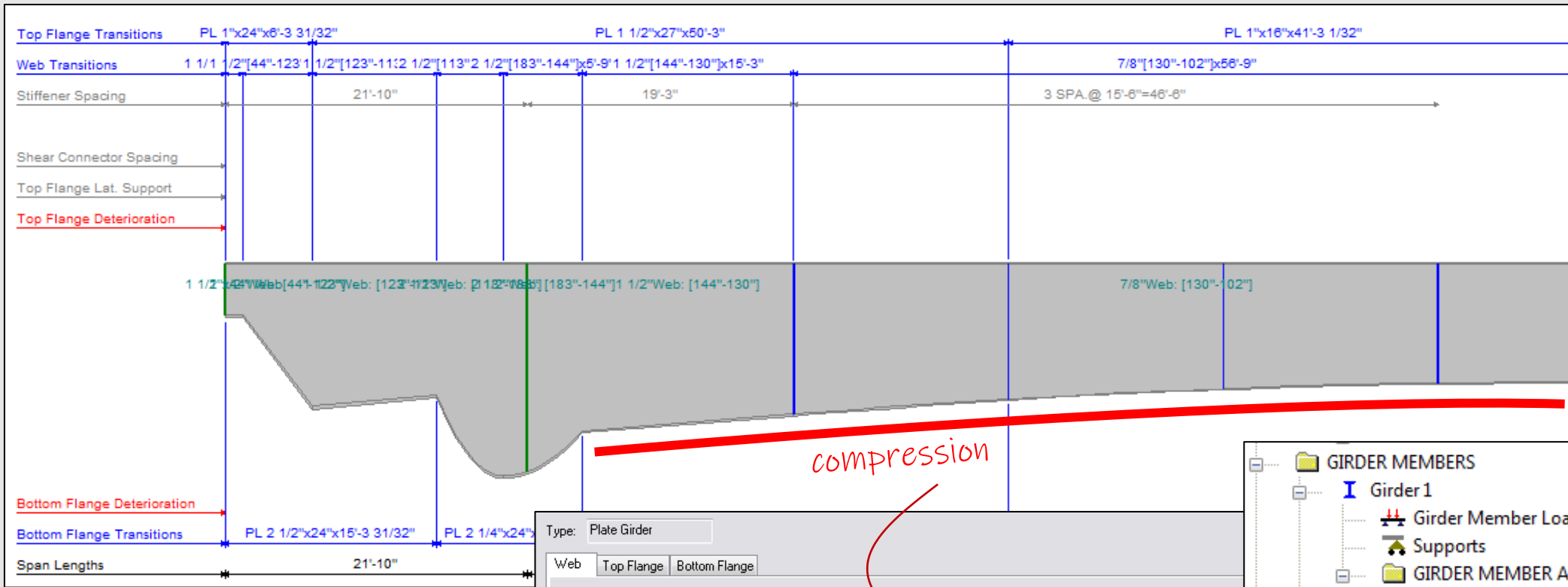
Modified impact = 2.000 times AASHTO impact

Constant impact override = 0.0 %

LRFD Dynamic Load Allowance

Fatigue and fracture limit states: 15.0 %

All other limit states: 33.0 %



## • Bascule Girder

- Varying section

- Support conditions

Type: Plate Girder

Web    Top Flange    Bottom Flange

Begin Depth (in)	Depth Vary	End Depth (in)	Thickness (in)	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Material	W/R
44.00	Linear	44.0000	1.5000	1	0.00	1.25	1.25	Grade 36	-- N
44.00	Linear	123.0000	1.5000	1	1.25	5.08	6.33	Grade 36	-- N
123.0	Linear	113.0000	1.5000	1	6.33	9.00	15.33	Grade 36	-- N
113.0	Parabolic Convex	183.0000	2.5000	1	15.33	4.75	20.08	Grade 36	-- N
183.0	Parabolic Convex	144.0000	2.5000	1	20.08	5.75	25.83	Grade 36	-- N
144.0	Linear	130.0000	1.5000	2	4.00	15.25	19.25	Grade 36	-- N
130.0	Parabolic Concave	102.0000	0.8750	2	19.25	56.75	76.00	Grade 36	-- N

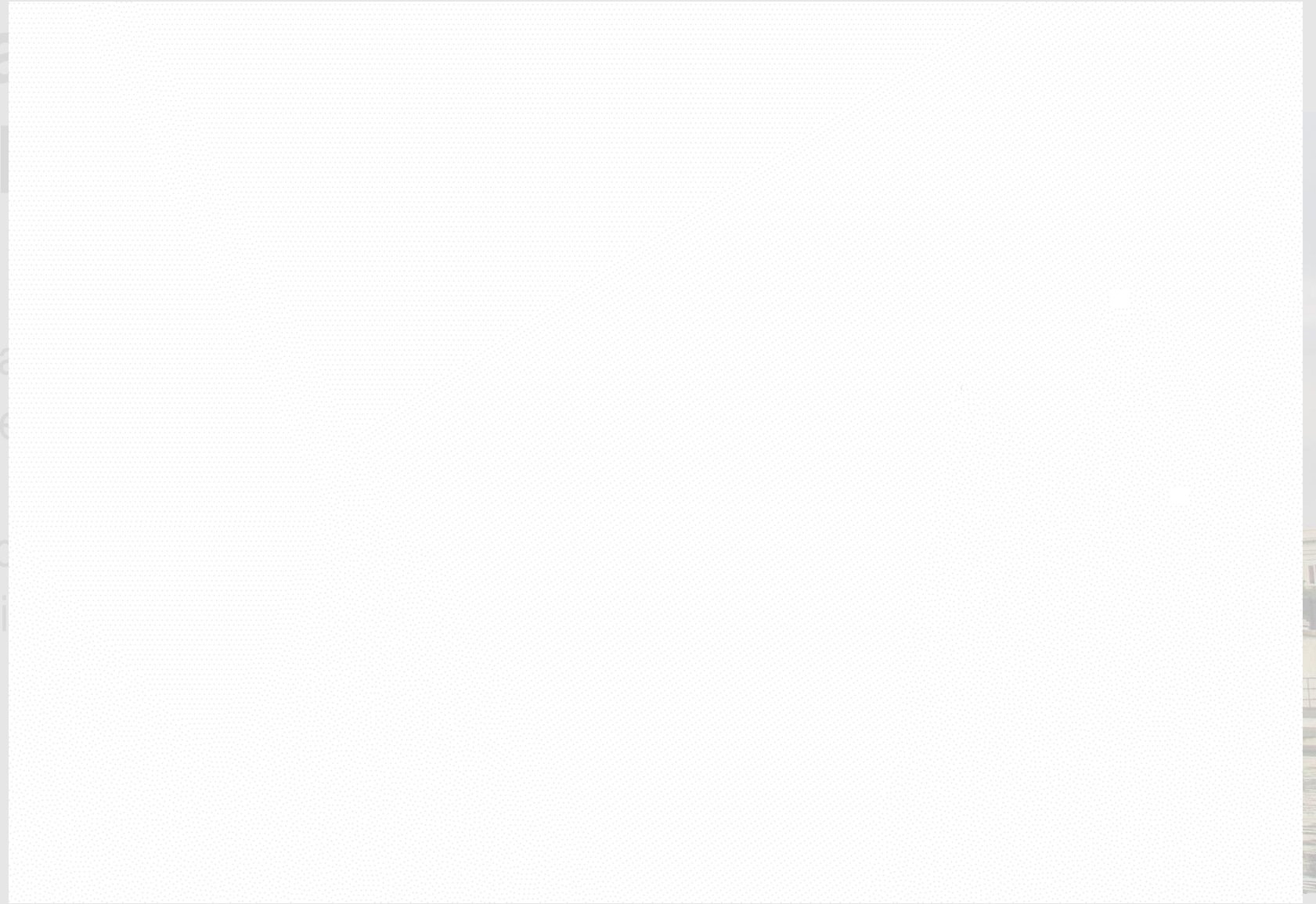
GIRDER MEMBERS

- Girder 1
  - Girder Member Loads
  - Supports
  - GIRDER MEMBER ALTERNATIVES
    - Bascule girder (E) (C)
      - Default Materials
      - Impact / Dynamic Load Allowance
      - Live Load Distribution
      - Splice Locations
      - Girder Profile
      - Lateral Support
      - Stiffener Ranges
      - KNEE Knee Braces**
      - Bearing Stiffener Locations
      - Points of Interest
      - Deterioration Profile



# What makes a typ

- Stringers
  - Number of stringers ca
  - Concrete and open ste
- Floorbeams
  - Section varies btwn flo
  - Twice the impact appli  
(centerlock)
- **Bascule Girder**
  - Varying section
  - **Support conditions**

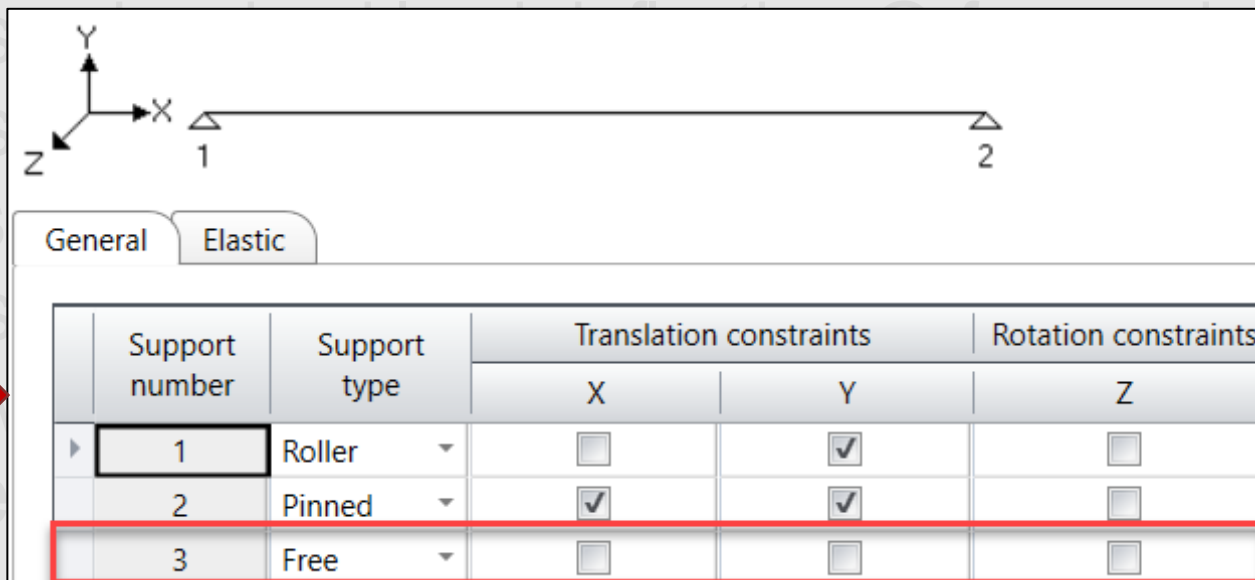


# Modeling Steps

- Step 1 – model a single leaf
- Step 2 – balance the bascule girder
- Step 3 – record service dead load deflection @ free end
- Step 4 – record service live load deflection @ free end and calc spring stiffness
- Step 5 – record service dead load deflection with spring and apply corrective DL force
- Step 6 – verify results

# Modeling Steps

- Step 1 – model a single leaf ← A benefit to this approach is reduced modeling
- Step 2 – balance the bascule girder
- Step 3 – record s
- Step 4 – record s
- Step 5 – record s
- Step 6 – verify re



Initial support conditions →

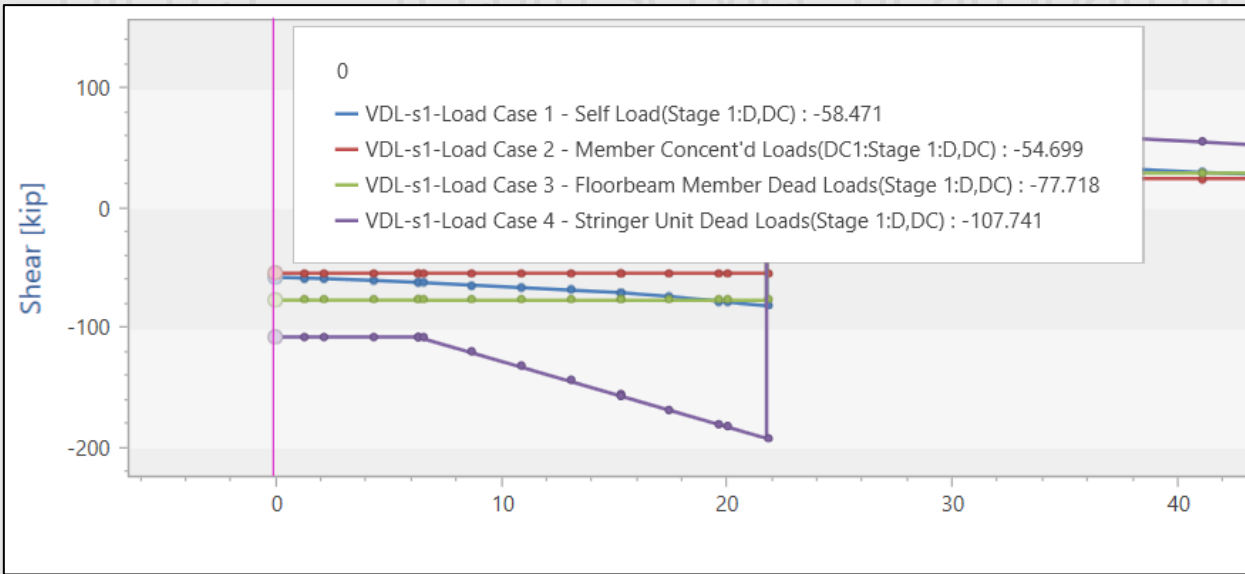
Support number	Support type	Translation constraints			Rotation constraints
		X	Y	Z	
1	Roller	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
2	Pinned	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
3	Free	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	



# Modeling Steps

- Step 1 – model a single leaf
- Step 2 – balance the bascule girder
- Step 3 – record service dead load deflection @ free end and calc

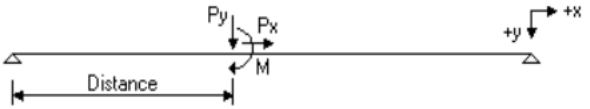
At this point the bascule self weight should include everything but the counterweight (and machinery room) and will result in a large reaction at the uplift bearing



~298 kips in uplift

# Modeling Steps

Girder Member Loads



Pedestrian load:  lb/ft

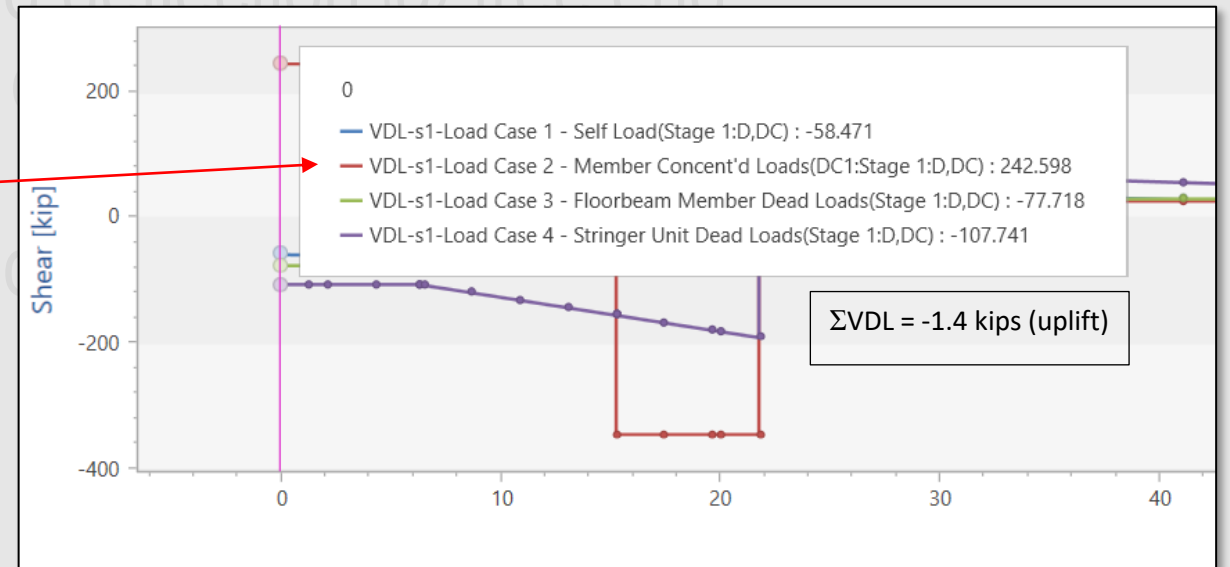
Uniform   Distributed   Concentrated   Settlement

Load case name	Support number	Distance (ft)	Px (kip)	Py (kip)	M (kip-ft)
DC1	1	6.33		295.00	
DC1	1	15.33		295.00	
DC1	2	11.50		4.00	
DC1	2	27.00		6.70	
DC1	2	42.50		6.70	
DC1	2	58.00		6.70	
DC1	2	73.50		4.00	

Add until small uplift ~2 kips  
Appropriate (tip heavy)

Counterweight loads

Sidewalk/ppt loads



# Modeling Steps

- Step 1 – model a single leaf
- Step 2 – balance the bascule girder
- Step 3 – record service dead load deflection @ free end

$\Delta_{tip} = 1.11''$





# Modeling Steps

- Step 1 –
- Step 2 –
- Step 3 –
- Step 4 –
- Step 5 –
- Step 6 –

The live load deflection in the cantilevered state represents the stiffness of a single leaf (no assistance from the second leaf – because it isn't modeled) were the second leaf modeled, we'd expect the maximum deflection to be cut in half (or nearly)

Supports

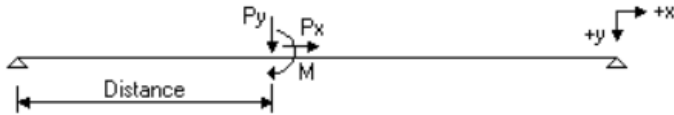
General Elastic

Support number	Support type	Translation constraints	
		X	Y
1	Roller	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2	Pinned	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Roller	<input type="checkbox"/>	<input checked="" type="checkbox"/>

General Elastic

Support number	Translation spring constant (kip/ft)		Rotation spring constant (kip-in/rad)	Override computed Z rotation spring constant
	X	Y	Z	
1				<input type="checkbox"/>
2				<input type="checkbox"/>
3		600.0000		<input type="checkbox"/>

Iteratively adjust spring stiffness to cut LL deflection in half (or consider 40% reduction)



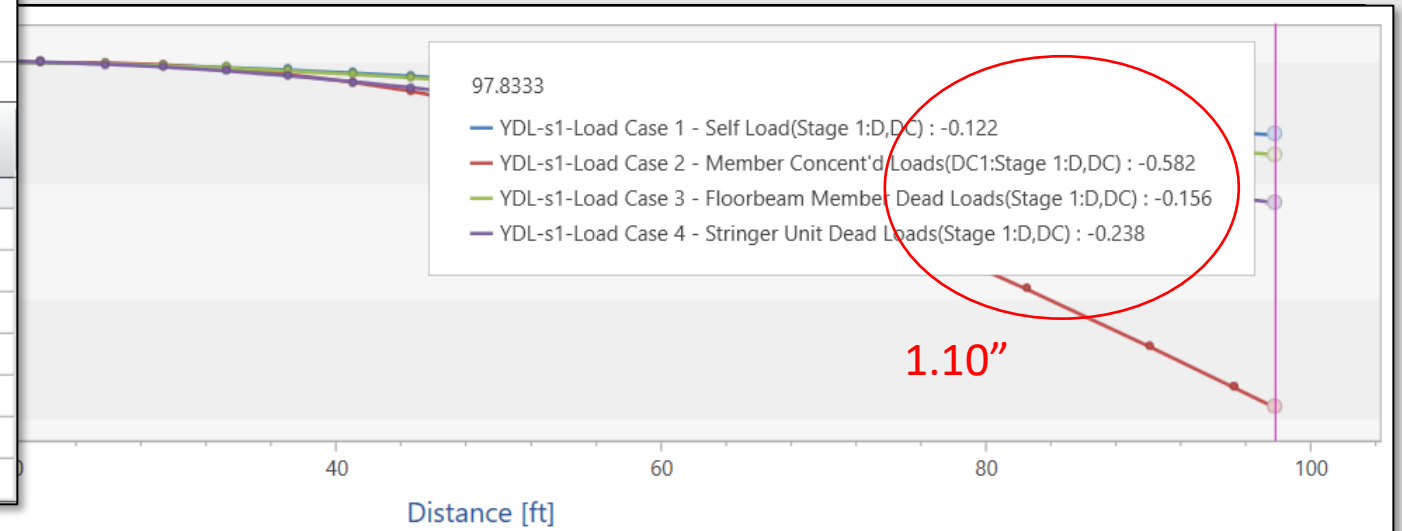
Pedestrian load:  lb/ft

Uniform   Distributed   Concentrated   Settlement

Load case name	Support number	Distance (ft)	Px (kip)	Py (kip)	M (kip-ft)
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DC1	2	42.50		6.70	
DC1	2	58.00		6.70	
DC1	2	73.50		4.00	
DC1	1	6.33		295.00	
DC1	1	15.33		295.00	
DC1	2	76.00		54.00	

# Modeling Steps

The addition of a spring will reduce the DL deflection. This needs to be offset with a concentrated load at the tip



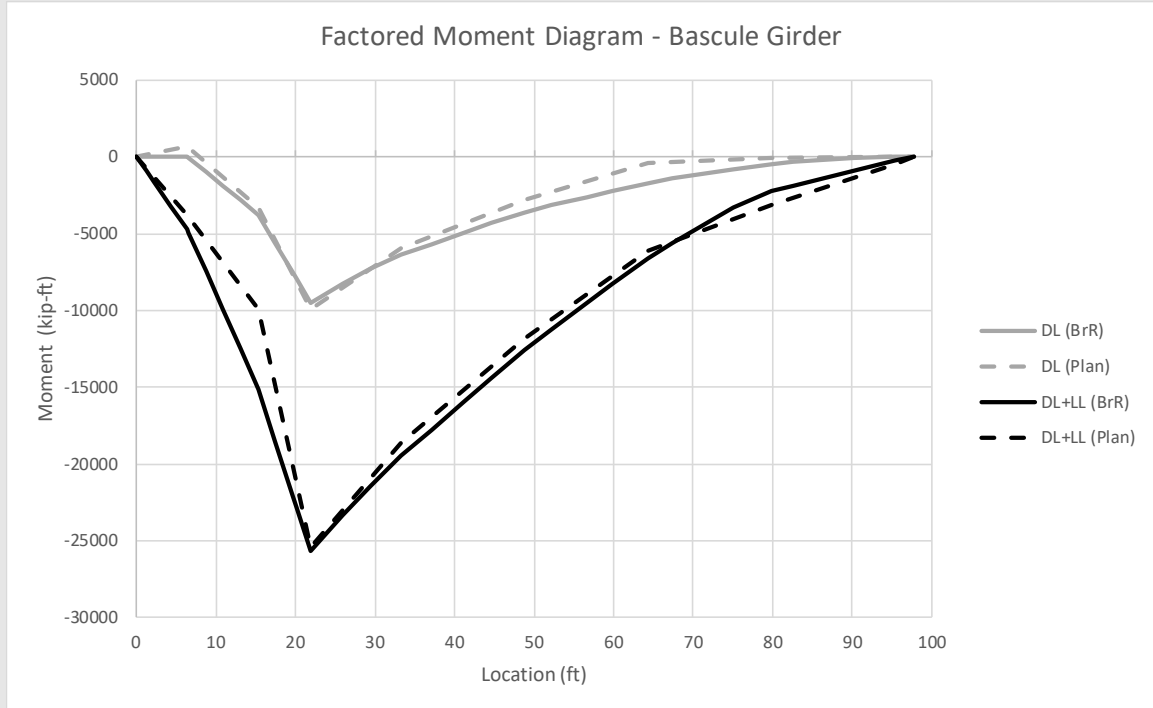
• Step 5 – record service dead load deflection with spring and apply corrective DL force

• Step 6 – verify results

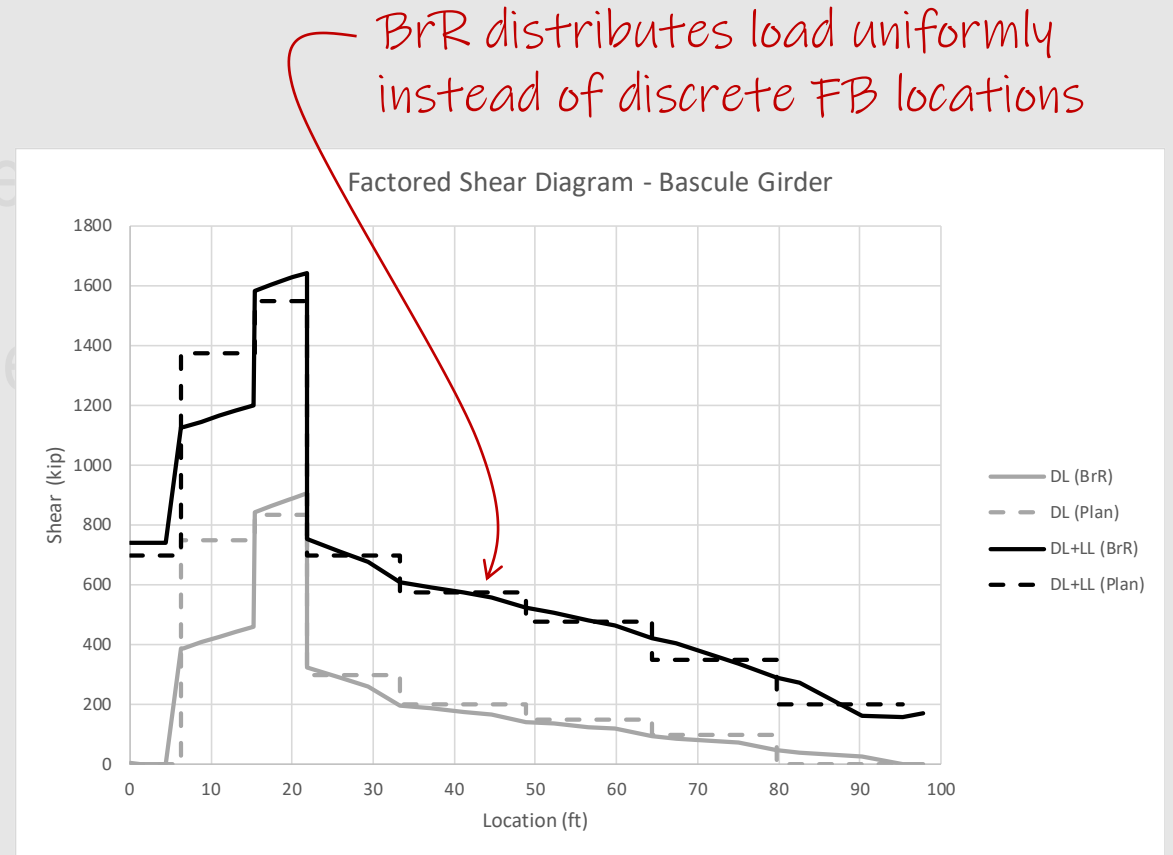
$$(1.11 - 0.57) / (12'' /') * 600 * 2 = 54k$$

You can determine the corrective force by taking the difference between deflection recorded in step 3 (1.11") and here (0.57"), multiplied by the spring constant ... (x2 because two leaves)

# Modeling Steps



- Step 6 – verify results



# Thank you! Questions?

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