AASHTOWare™ BRIDGE DESIGN AND RATING

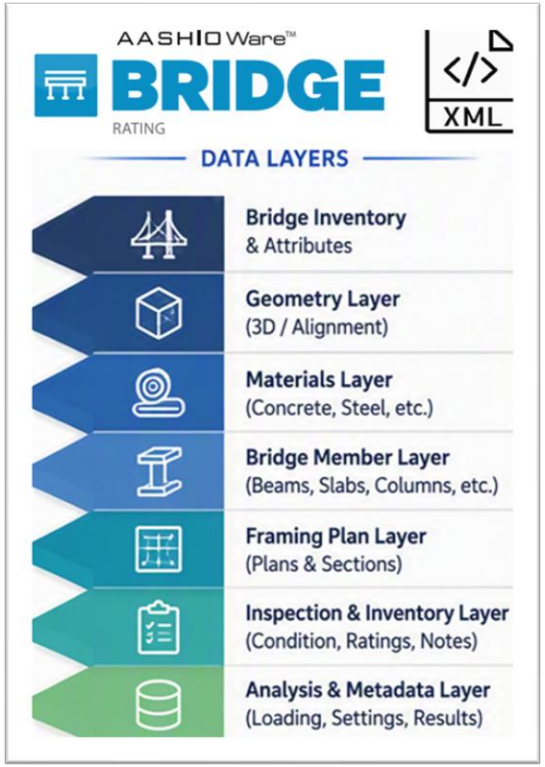
Gresham Smith

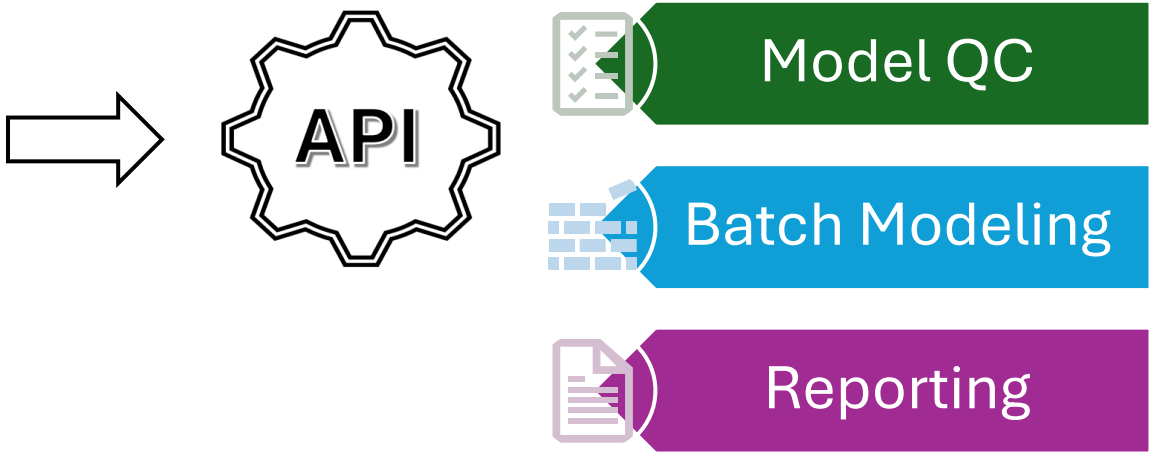
Beyond the BrDR Interface: API, Automation, and Scalable Load Rating Workflows

Yun Lin, PE, PhD, Gresham Smith

August 18, 2026

API-Powered Bridge Load Rating Ecosystem

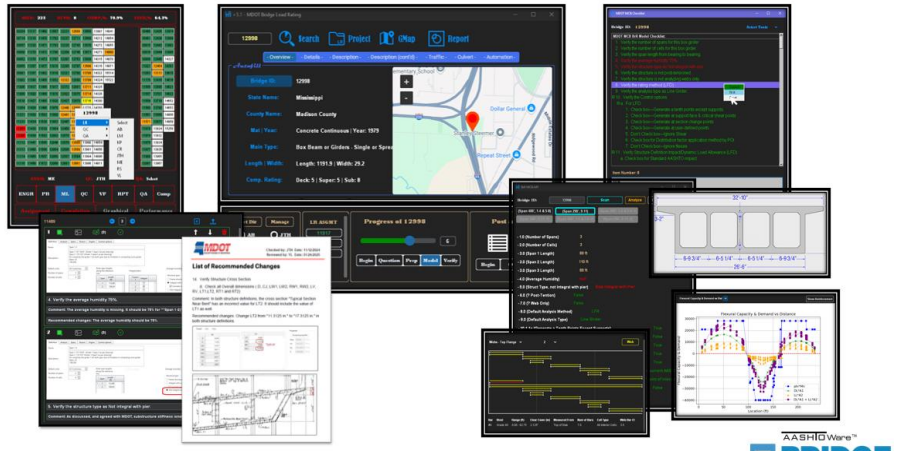




Expanding the AASHTOWare Bridge Ecosystem

2025 RADBUG

QC Workflow with LRM (Load Rating Management)



2025 Rating and Design User Group Meeting

2026 RADBUG/BrMUG

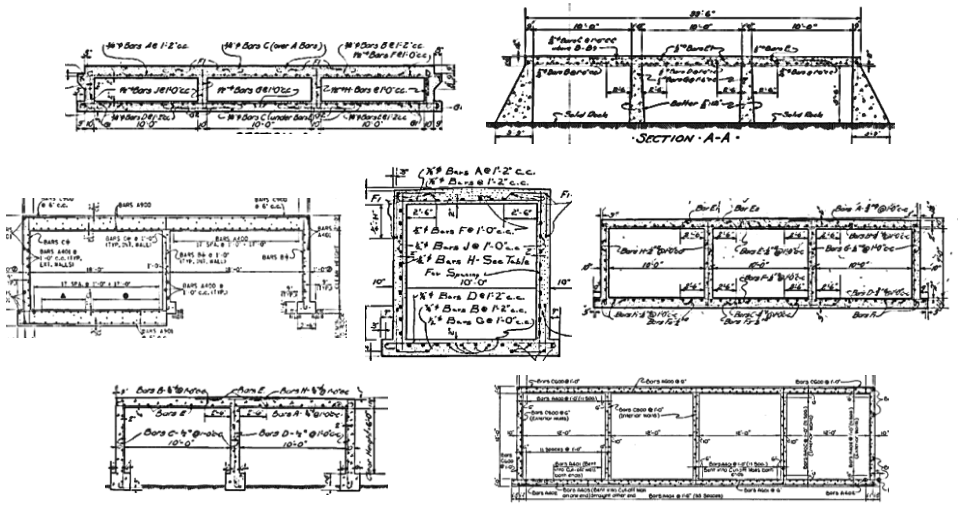
- Culvert Load Rating in Bulk
- Ideas for API-powered UI designs
  - RC T-beam
  - Steel plate girder
- Full Workflow for PSC Beam
  - Creating a model
  - QC and Result interpretation

When Manual Modeling Doesn't Scale

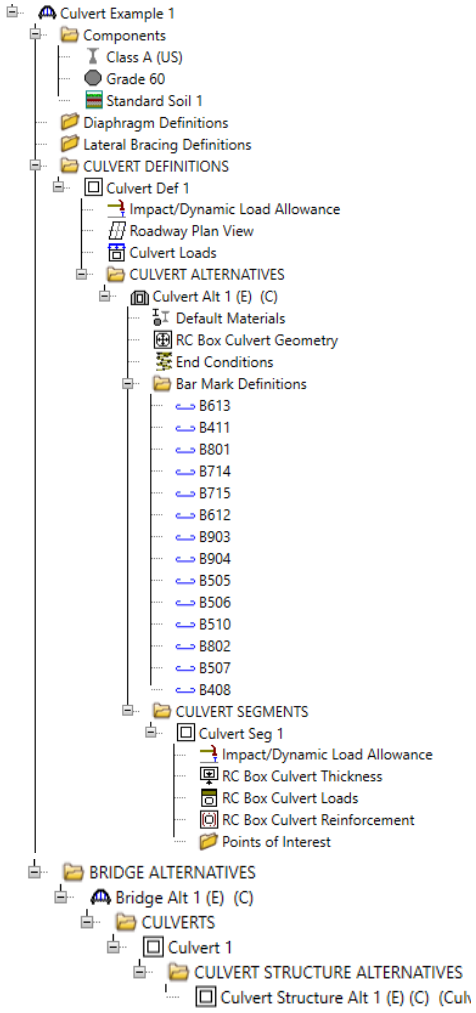
Tennessee Statewide Culvert Load Rating

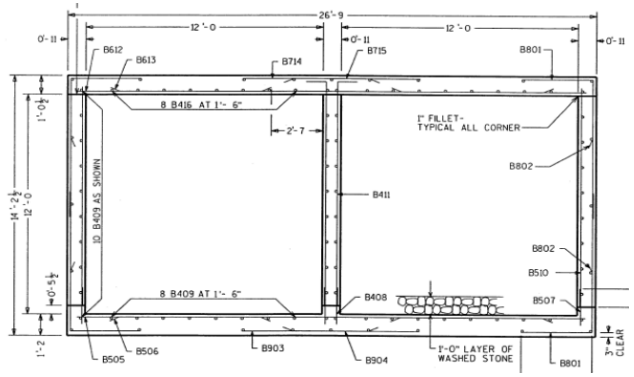
9000 Culverts to Model

1000+ Standard Designs



Pain Point: Manually Model Each Structure



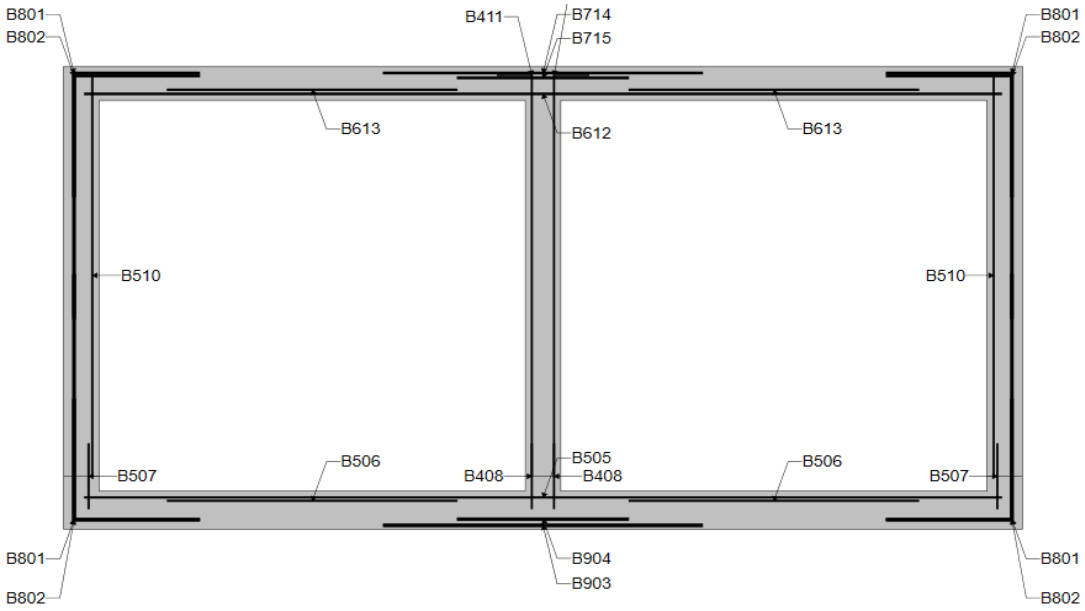


BILL OF BARS

THE FIRST OR FIRST AND SECOND DIGIT OF THE MARK SIGNIFIES THE BAR SIZE. THE DIMENSION IN THE BENT COLUMN IS THE OUT TO OUT HORIZONTAL LEG OF A "L" SHAPED BAR.

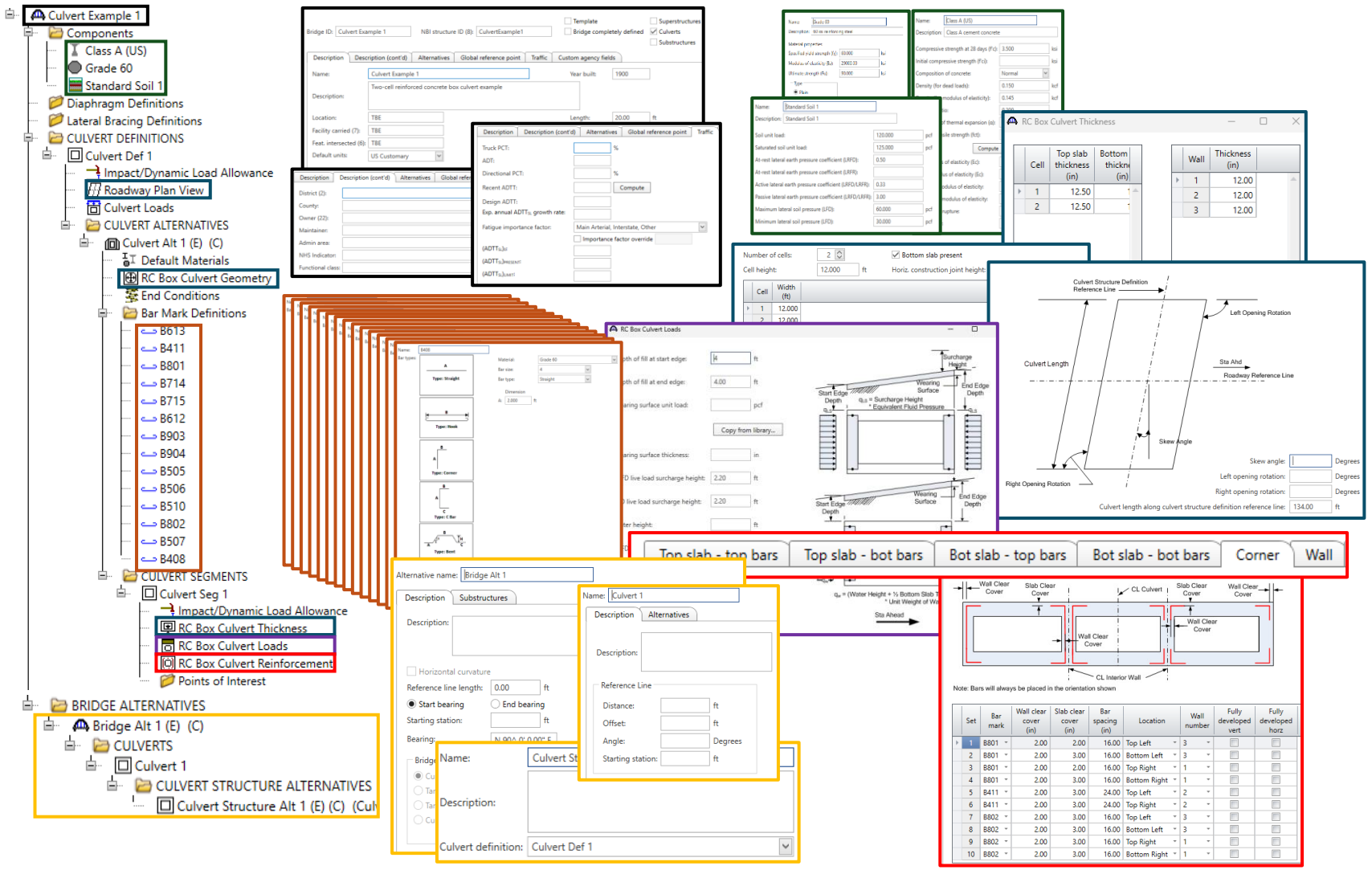
MARK	NUMBER REQ'D.	LENGTH	BENT	CUTTING DIAG.	LOCATION
⚠ B801	416	11 -2	3-7	NO	CORNERS
⚠ B802	400	7-4	3-7	NO	CORNERS
⚠ B903	76	9-0	NO	NO	BOTTOM SLAB TRANS.
⚠ B904	72	4-10	NO	NO	BOTTOM SLAB TRANS.
⚠ B505	124	25-10	NO	NO	BOTTOM SLAB TRANS.
⚠ B506	240	8-2	NO	NO	BOTTOM SLAB TRANS.
B507	296	2-0	NO	NO	WALLS-DOWELS VERT.
B408	136	2-0	NO	NO	WALLS-DOWELS VERT.
B409	320	33-0	NO	NO	TOP&BOTTOM SLAB & WALL
B510	296	12-4	NO	NO	WALLS VERT.
B411	136	13-4	1-0	NO	WALLS VERT.
⚠ B612	84	25-10	NO	NO	TOP SLAB TRANS.
⚠ B613	360	8-2	NO	NO	TOP SLAB TRANS.
⚠ B714	116	9-0	NO	NO	TOP SLAB TRANS.
⚠ B715	182	4-10	NO	NO	TOP SLAB TRANS.
B416	64	33-0	NO	NO	TOP SLAB LONGIT.
B417	4	26-4	NO	NO	HEADERS HORIZ.
B318	72	3-1	YES	NO	HEADER STIRRUPS VERT.
B519	267	4-0	NO	NO	VERT.CONST.JOINT

⚠ B801 BARS MAY BE SUBSTITUTED FOR B802 BARS.
B903 BARS MAY BE SUBSTITUTED FOR B904 BARS.
B505 BARS MAY BE SUBSTITUTED FOR PAIRS OF B506 BARS
B612 BARS MAY BE SUBSTITUTED FOR PAIRS OF B613 BARS
B714 BARS MAY BE SUBSTITUTED FOR B715 BARS.



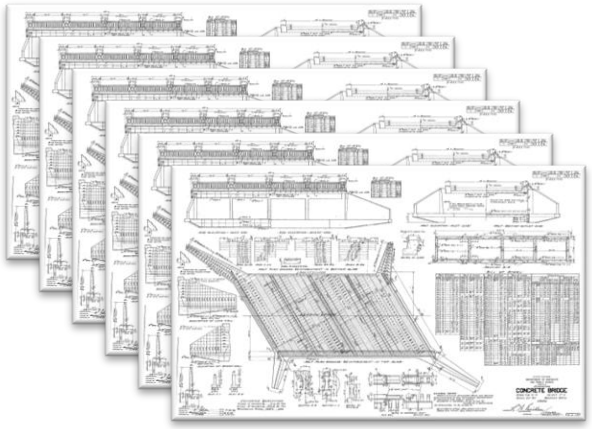
Gresham Smith

Pain Point: Manually Model Each Structure

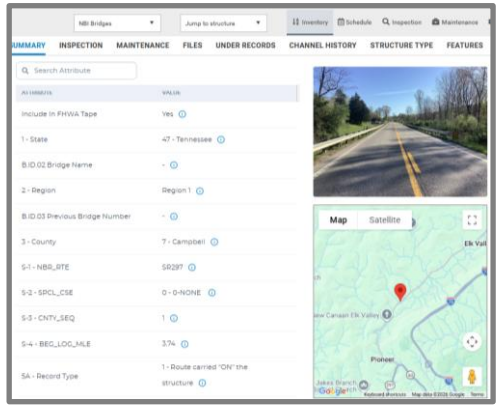


- General Info
- Material Properties
- Culvert Geometries
- Culvert Loads
- Rebar Definition
- Rebar Placement
- Bridge Alternatives

A Repeatable Workflow for Large-Scale Load Rating



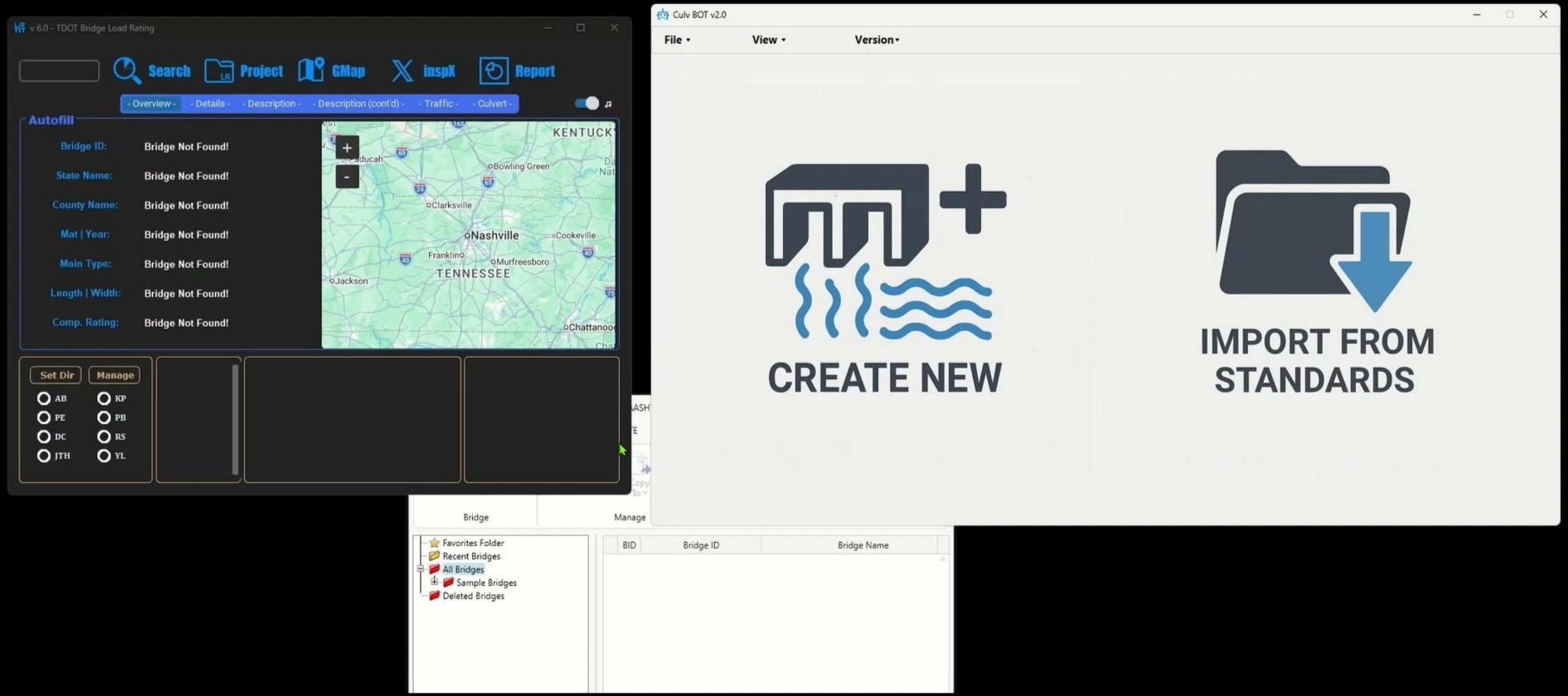
	Sheet_#	Descr	STD_Year	Skew_deg	No_of_cel	CJ_h_in	Cell_h_ft	Cell_w_ft	TS_t_in	Crest_in	BS_t_in	W_ext_t_in	W_int_t_in
1	A-0-1	2@10x4	1928	60	2	n/a	4	10	10.5	1.5	0	10	10
2	A-0-7_a	2@10x7	1928	60	2	-14	7	10	12	1.5	14	10	10
3	A-0-7_b	2@10x6	1928	60	2	-15	6	10	13.5	1.5	15	12	12
4	A-0-7_c	2@10x7	1928	60	2	-15	7	10	13.5	1.5	15	12	12
5	A-0-7_d	2@10x8	1928	60	2	-15	8	10	13.5	1.5	15	12	12
6	A-0-8	2@10x7	1928	60	2	-12	7	10	10.5	1.5	12	10	10
7	A-0-45	3@8x3	1928	0	3	-10	3	8	9	1	10	9	9
8	A-0-46	3@8x5	1928	-30	3	-10	5	8	9	1	10	9	9
9	A-0-47	2@10x6	1928	45	2	n/a	6	10	10.5	1	0	10	10
10	A-0-54	2@10x9	1928	60	2	-12	9	10	10.5	1.5	12	10	10
11	A-0-65	3@10x5	1928	0	3	-12	5	10	10.5	1.5	12	10	10
12	A-0-76	4@10x6	1928		4	-12	6	10	10.5	1.5	12	10	10



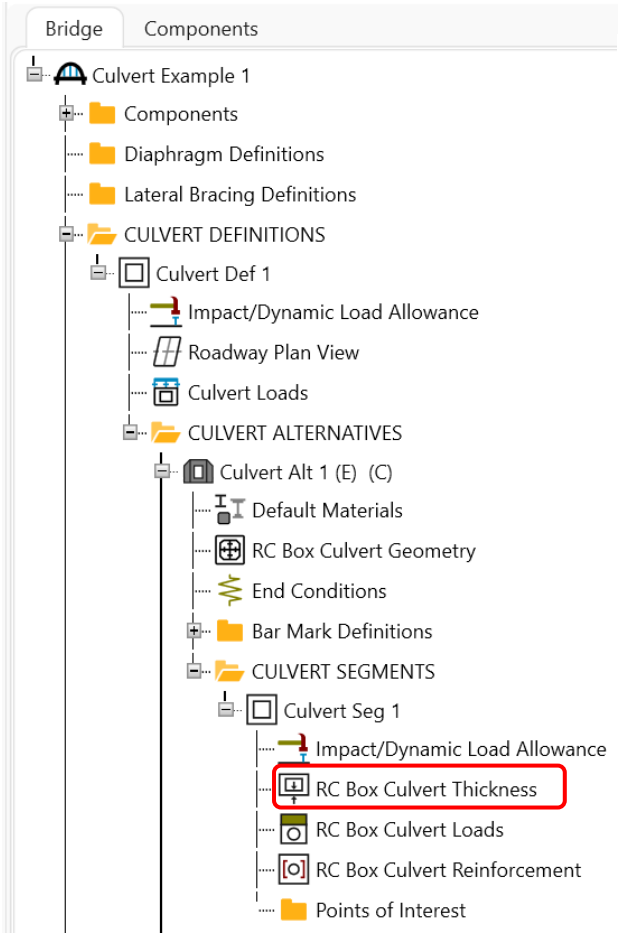
Web-scraping

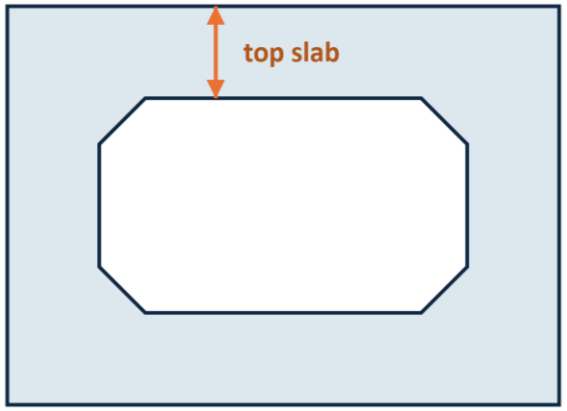
AASHTOWare Bridge Design & Rating

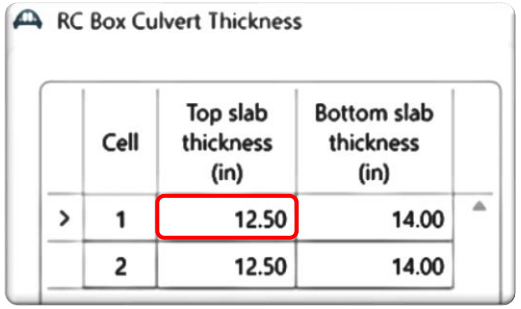
XML


v 6.0 - TDOT Bridge Load Rating
Search
Project
GMap
inspX
Report
- Overview -
- Details -
- Description -
- Description (cont'd) -
- Traffic -
- Culvert -
Autofill
Bridge ID: Bridge Not Found!
State Name: Bridge Not Found!
County Name: Bridge Not Found!
Mat | Year: Bridge Not Found!
Main Type: Bridge Not Found!
Length | Width: Bridge Not Found!
Comp. Rating: Bridge Not Found!
KENTUCKY
Bowling Green
Clarksville
Nashville
Cookeville
Franklin
Murfreesboro
TENNESSEE
Jackson
Chattanooga
Set Dir
Manage
AB
PE
DC
JTH
KP
PB
RS
YL
Culv BOT v2.0
File
View
Version
CREATE NEW
IMPORT FROM STANDARDS
Bridge
Manage
Favorites Folder
Recent Bridges
All Bridges
Sample Bridges
Deleted Bridges
BID
Bridge ID
Bridge Name

Pushing a Value Through the BrDR API







`AASHTO.BrDR.Domain.Bridge`

`AASHTO.BrDR.Sys.Units`

DoBridge

`.BridgeAltList[0].CulvertList[0].CulvertStructAltList[0]`

`.GetStructDef()` **DoCulvertStructDef**

`.GetAsBuiltCulvertAlt()` **DoCulvertAlt**

`.GetCulvertDef()` **DoReinforcedConcreteBoxCulvertDef**

`.CulvertDefSegmentList[0]`

DoCulvertDefReinforcedConcreteBoxSegment

`.CulvertDefReinforcedConcreteBoxSegmentCellList[0]`

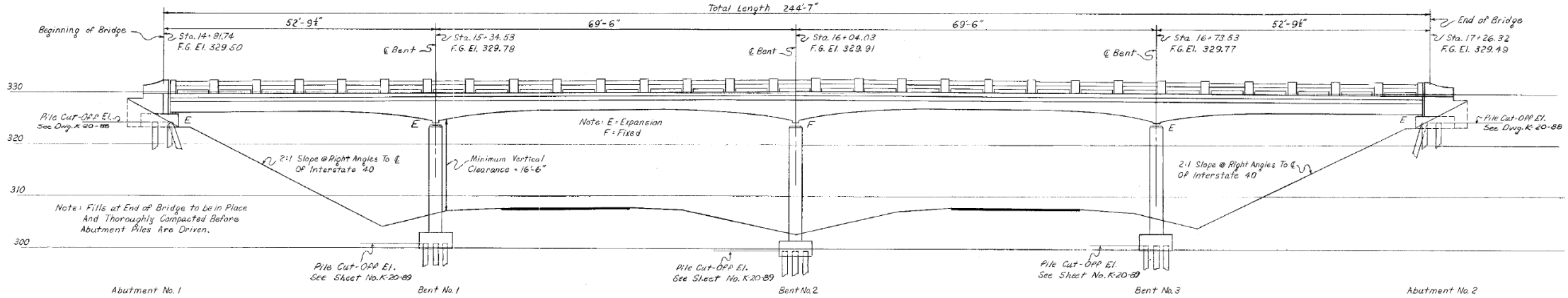
DoCulvertDefReinforcedConcreteBoxSegmentCell

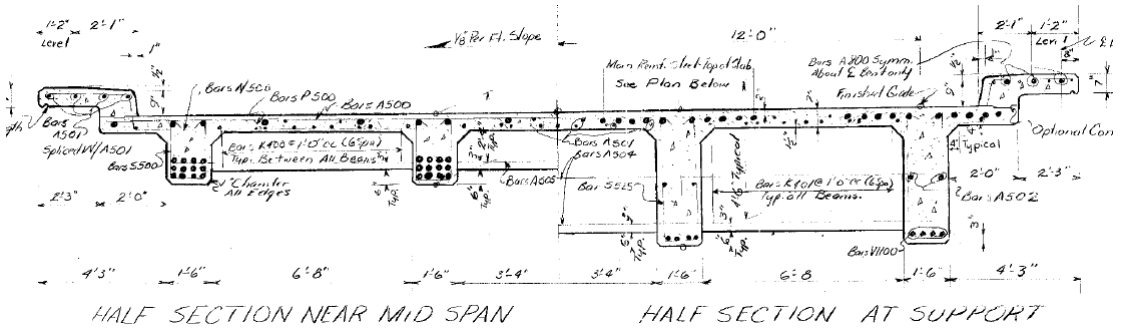
RC Box Culvert Thickness — TopSlabThick, BottomSlabThick

```
cell.TopSlabThick.SetValue(8.0, LengthUnits.IN);
```

Exploring New Ways of Modeling

Modeling Reinforced Concrete T-Beams





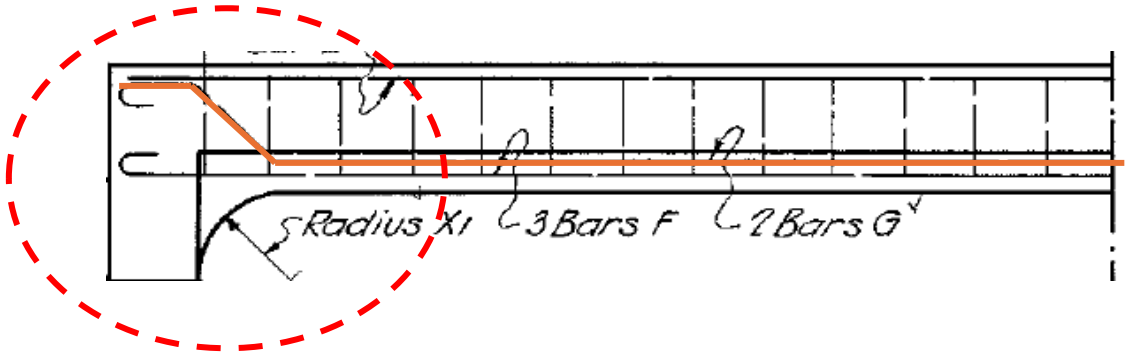
HALF SECTION NEAR MID SPAN HALF SECTION AT SUPPORT

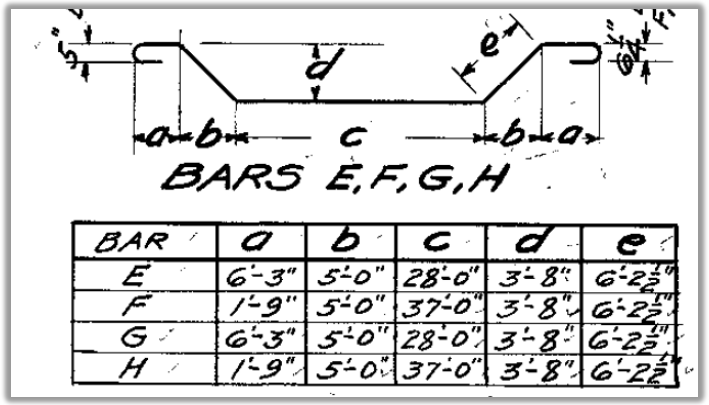
Gresham Smith

Converting Design Information into Model Inputs

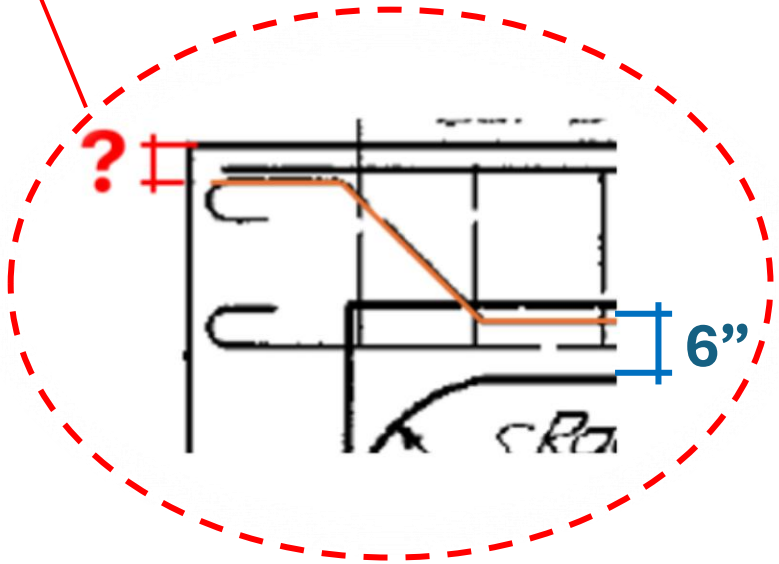
Section | Web depth | Reinforcement

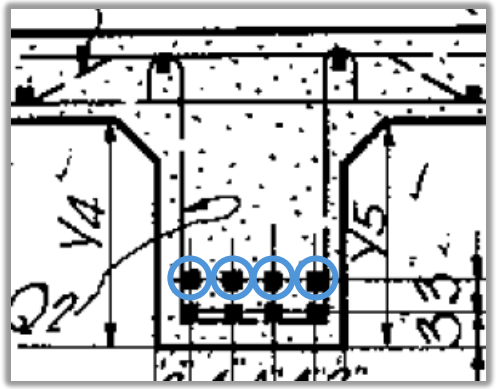
	Set	Bar mark	Invert	Measured from	Distance (in)
	1	D Bars 1 1/4" Sq. (#11)	☐	Bottom of Girder	3.0000
▸	2	G Bars 1 1/8" Sq. (#10) Cut	☑	Top of Girder	4.5625





BAR	a	b	c	d	e
E	6'-3"	5'-0"	28'-0"	3'-8"	6'-2½"
F	1'-9"	5'-0"	37'-0"	3'-8"	6'-2½"
G	6'-3"	5'-0"	28'-0"	3'-8"	6'-2½"
H	1'-9"	5'-0"	37'-0"	3'-8"	6'-2½"





Live preview

PLAN

CROSS-SECTION

3D VIEW — FROM ABOVE

3D VIEW — FROM BELOW (LOOKING UP)

3 spans · total **180'**
5 girders · bays 7.5/7.5/7.5/7.5'
deck **36'** · OH 3/3'

✓ Bridge Definition | ✓ Materials | ✓ Component Definition | Typical Section & Load | ✓ Beam Alternative | Assembly

Tee Section For This Beam

Sections are defined once under **Component definition → Beam section** and picked here. A section carries the **widths only** — no height — so the same section can serve a shallow beam and a haunched one.

RC Tee 37/14

RC Tee 37/14 assigned to G1. The section stores no height — depth comes from the profile below.

Beam Profile — G1 (Exterior) PRISMATIC

Depths and stations are **typed** — the numbers on the drawing, or the grid below. The one gesture here is the shape of a ramp: **drag a sloped part of the soffit** — pull it away from the straight line for **Parabolic Concave**, push it back onto the line for **Linear**. Double-click the soffit to add a handle. The round markers are read-outs and are not clickable.

Shape

Prismatic | Haunched

Update beam | ↺ Revert | • unsaved changes

BrDR Beam Profile Rows — This Is Exactly What Gets Written. Drawn From The Shape Above, And Editable Like BrDR's Web Depth Grid: Type In Any Cell And The Shape Follows. Greyed Cells Are Derived (End Distance = Start + Length; End Depth Follows Begin Depth While Depth Vary Is None) Or Pinned To The Bridge Ends.

Build checklist

Bridge Definition 4/4
- ✓ Bridge identity
- ✓ Spans & skews
- ✓ Girders & spacing
- ✓ Deck

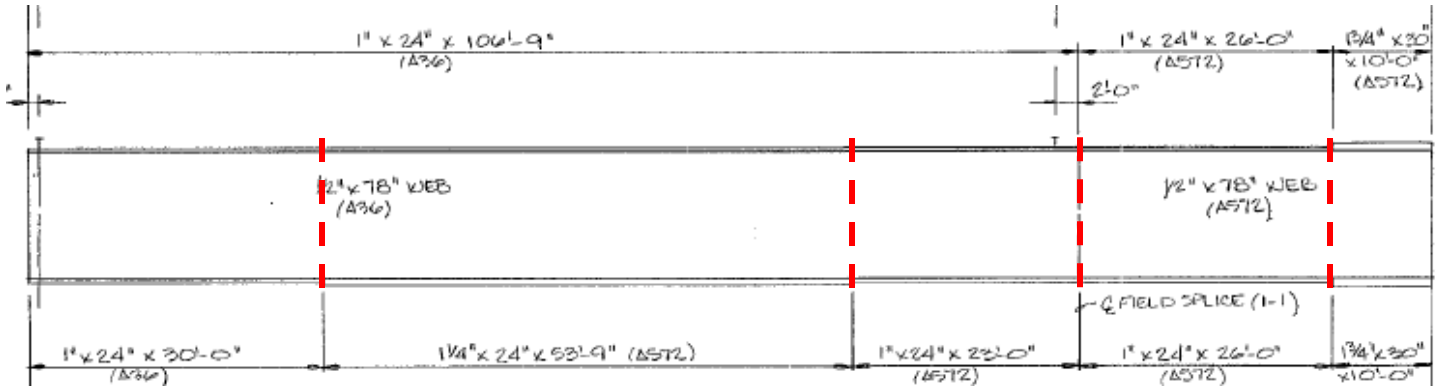
Materials 2/2
- ✓ Cast-in-place concrete — CIP Concrete (3 ksi)
- ✓ Reinforcing steel — Grade 40

Components 4/4
- ✓ Appurtenances — STD-1-1
- ✓ Stirrup definition — #4-2leg-90d
- ✓ Diaphragm definition — Mid Diaph 36"x9", Sup Diaph 42"x12"
- ✓ Beam section — RC Tee 37/14

Typical Section & Load 4/5
- ✓ Load case definition
- ✓ Deck (thickness & material)
- ✓ Travelway
- ✓ Wearing surface
- ☐ Member loads

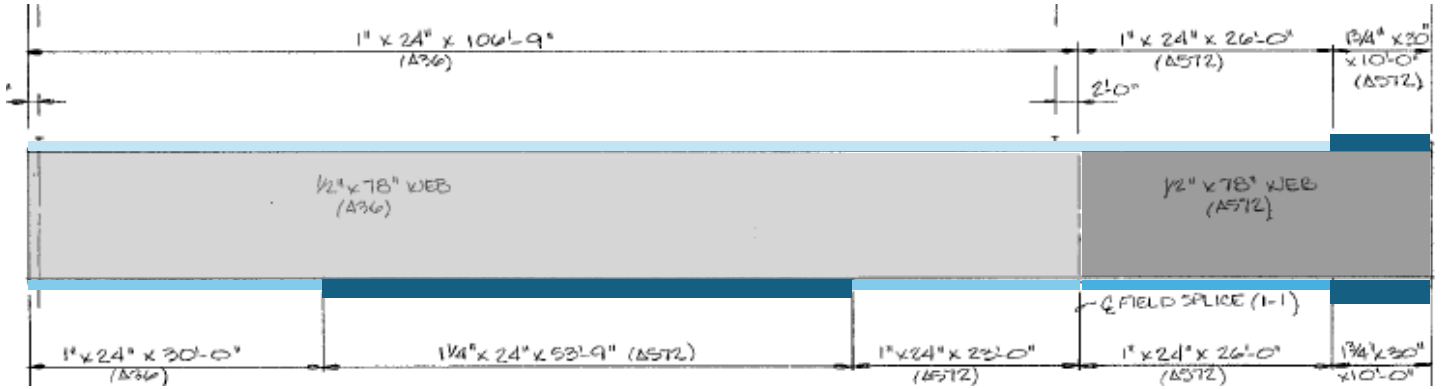
Beam Alternative 25/30
- G1
  - ✓ Description
  - ✓ Factors
  - ✓ Control options
  - ✓ Impact
  - ✓ Beam details
  - ☐ Reinforcement
- G2
  - ✓ Description
  - ✓ Factors
  - ✓ Control options
  - ✓ Impact
  - ✓ Beam details
  - ☐ Reinforcement
- G3

Improving Plate Girder Modeling



1. Top Flange: W, T, Mat
   Bot Flange: W, T, Mat
   Web: T, Mat

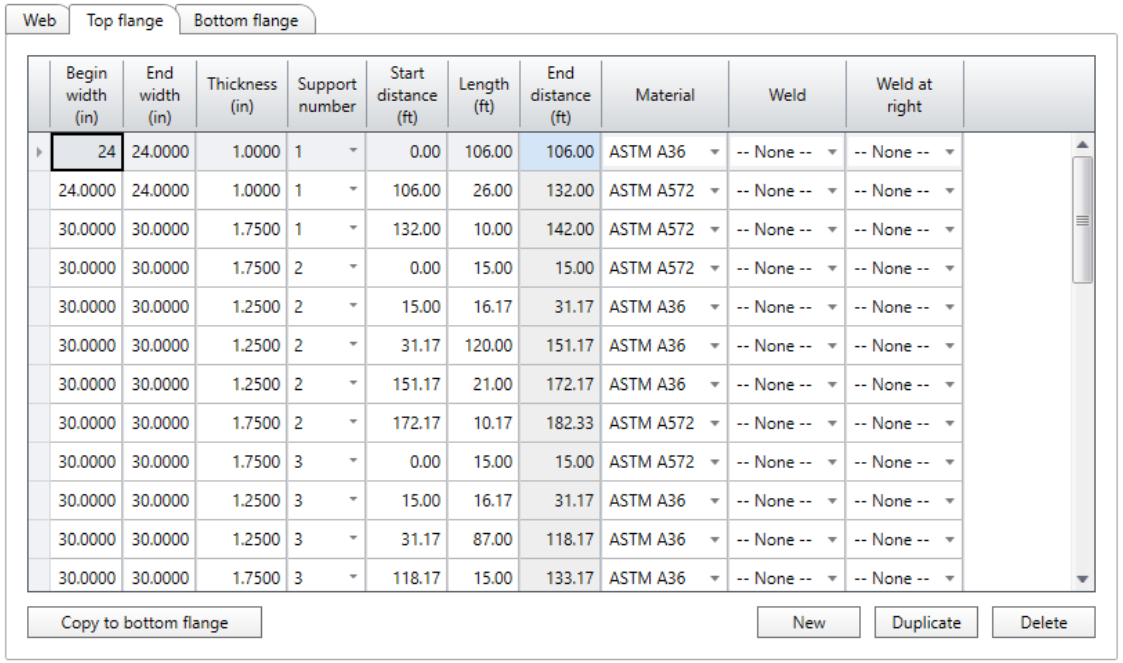
2. Assembly: I → Range



Each Plate:

1. W, T, Mat
2. Length and Location

Enhancing Schedule - Based Modeling



A GUI that Enables

- Model creation through visual interaction
- Real-time confirmation of modeling actions
- Automatic alignment and fit-up
- Easy editing and validation

Live preview

PLAN

CROSS-SECTION

3D VIEW — FROM ABOVE

3D VIEW — FROM BELOW (LOOKING UP)

3 spans · total **340'**
5 girders · bays 7.5/7.5/7.5/7.5'
deck **36'** · OH 3/3'

✓ Bridge Definition | ✓ Materials | ✓ Component Definition | Typical Section & Load | ✓ Beam Alternative | Assembly

Sections are defined once under **Component definition → Beam section** and picked here. A section carries the **widths only** — no height — so the same section can serve a shallow beam and a haunched one.

Beam Profile — G1 (Exterior) HAUNCHED

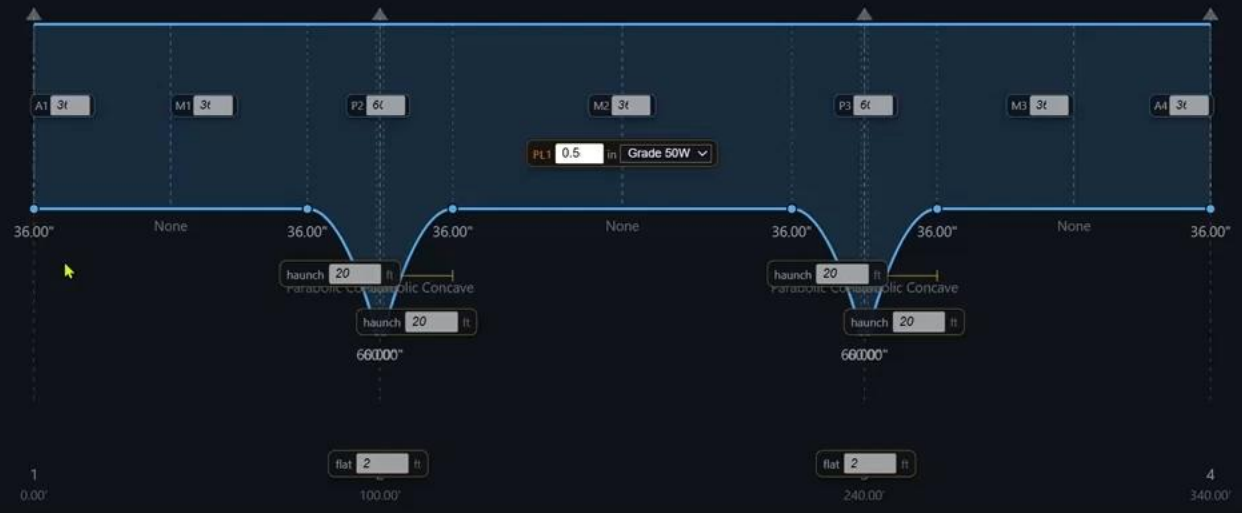
Drag a **handle** up/down to change depth, left/right to move it along the beam (it snaps to supports and quarter points). **Drag a sloped part of the soffit** — pull it away from the straight line for **Parabolic Concave**, push it back onto the line for **Linear**. Double-click the soffit to add a handle.

Web | Flanges | Stiffeners

Shape

Prismatic | Haunched | Add web splice

Haunch lengths are the horizontal run of the ramp back from the support. **Flat at pier** holds the pier depth for that length, centred on the support (0 = a point).



BrDR Beam Profile Rows — Exactly What Gets Written, And Editable Like BrDR's Web Depth Grid: Type In Any Cell And The Shape Follows.

Begin depth (in)	Depth vary	End depth (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Web splice
36.00	None	36.00	0.5	1	0.0000	79.0000	79.0000	Grade 50W	—
36.00	Parabolic Conc	60.00	0.5	1	79.0000	20.0000	99.0000	Grade 50W	—
60.00	None	60.00	0.5	1	99.0000	2.0000	101.0000	Grade 50W	—

Build checklist

Bridge Definition 4 / 4
- ✓ Bridge identity
- ✓ Spans & skews
- ✓ Girders & spacing
- ✓ Deck

Materials 3 / 3
- ✓ Cast-in-place concrete — CIP Concrete (4 ksi)
- ✓ Reinforcing steel — Grade 60
- ✓ Structural steel — Grade 50W, Grade 36

Components 2 / 2
- ✓ Appurtenances — STD-1-1
- ✓ Diaphragm definition — Mid Diaph 0.65k, Sup Diaph 1.2k, Abut Diaph 0.9k

Typical Section & Load 4 / 5
- ✓ Load case definition
- ✓ Deck (thickness & material)
- ✓ Travelway
- ✓ Wearing surface
- ☐ Member loads

Beam Alternative 5 / 5
- ✓ Beams on girder lines — G1, G2, G3, G4, G5

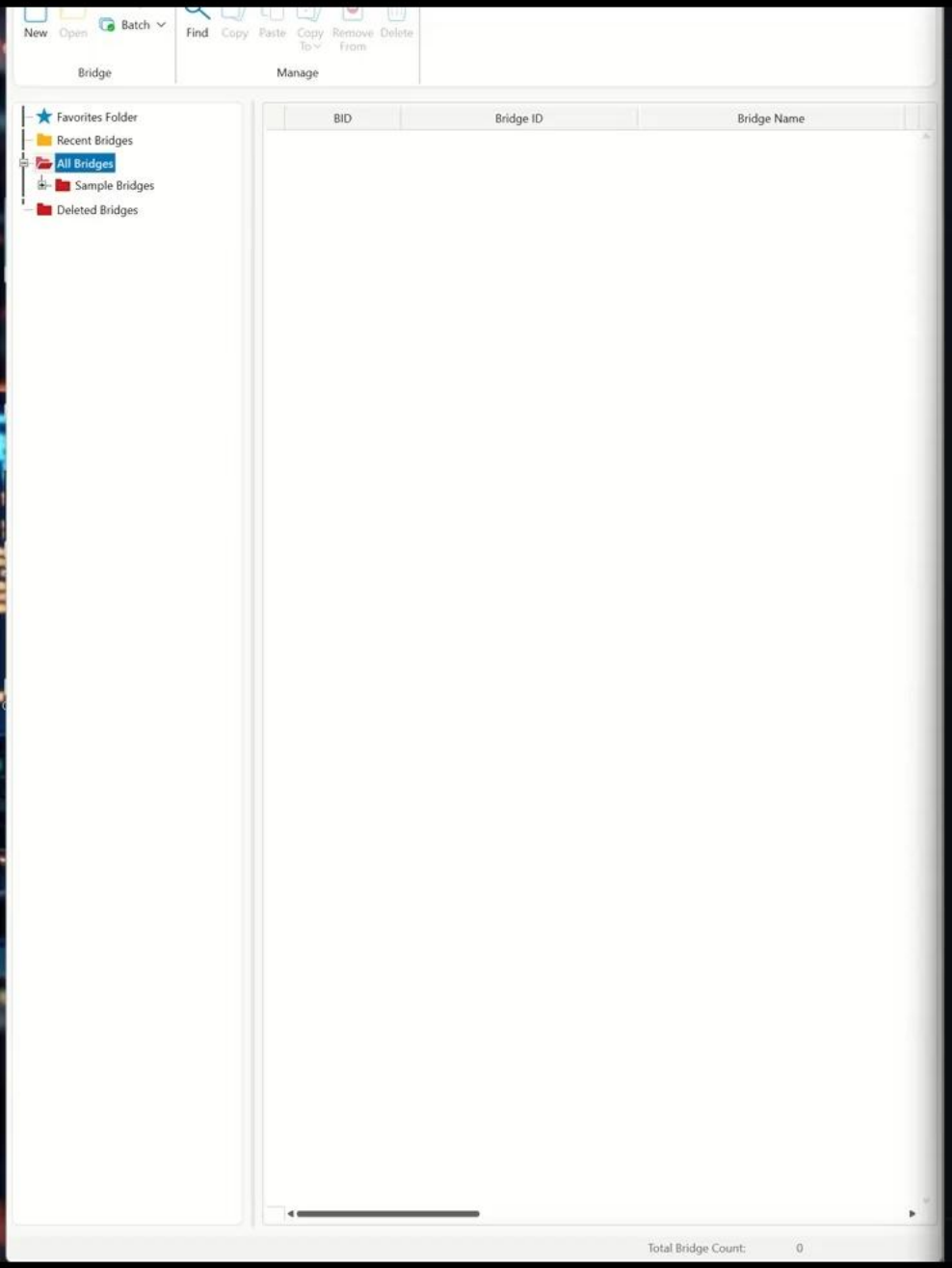
Rethinking Model Creation

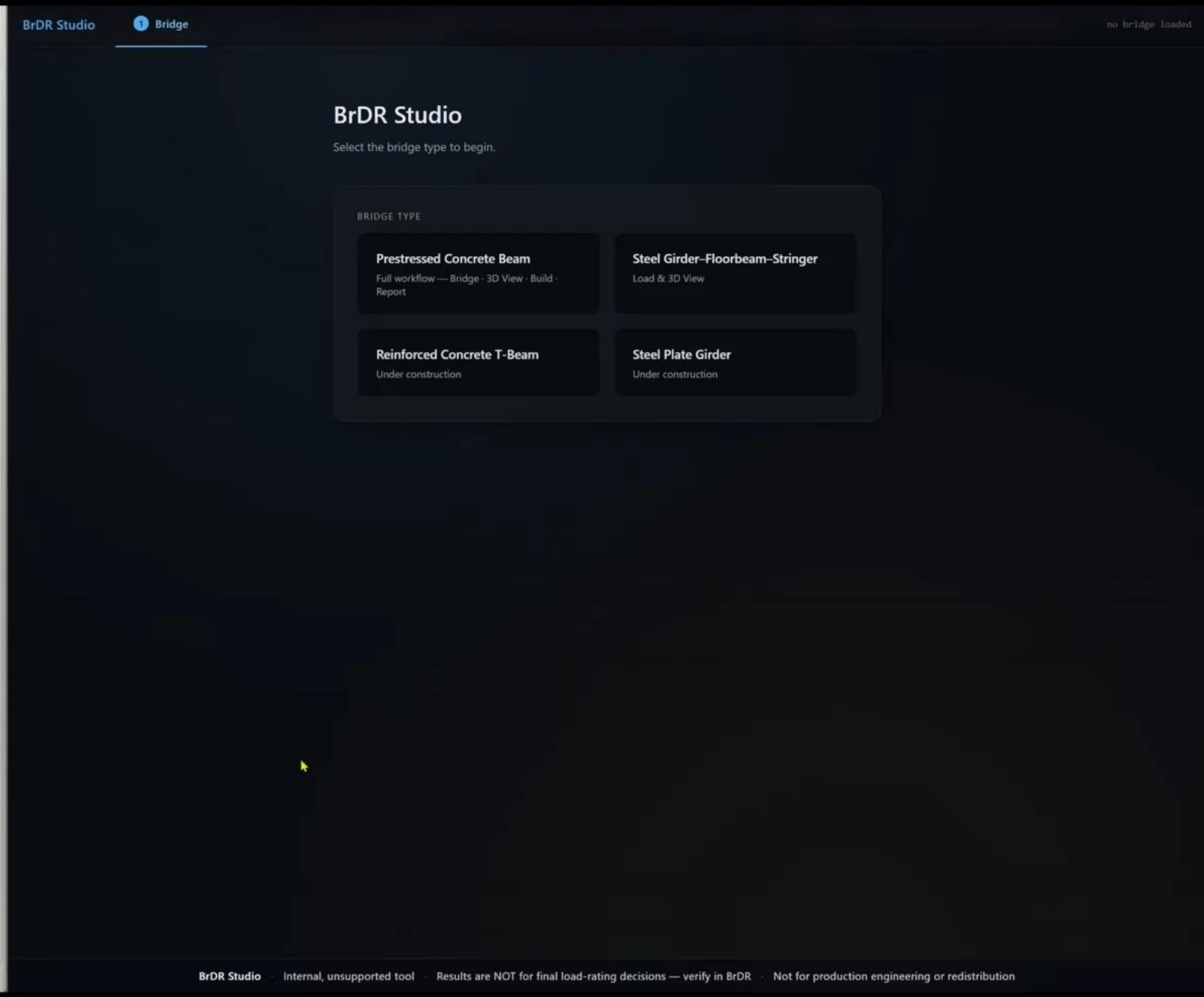
Step 1: Define Components

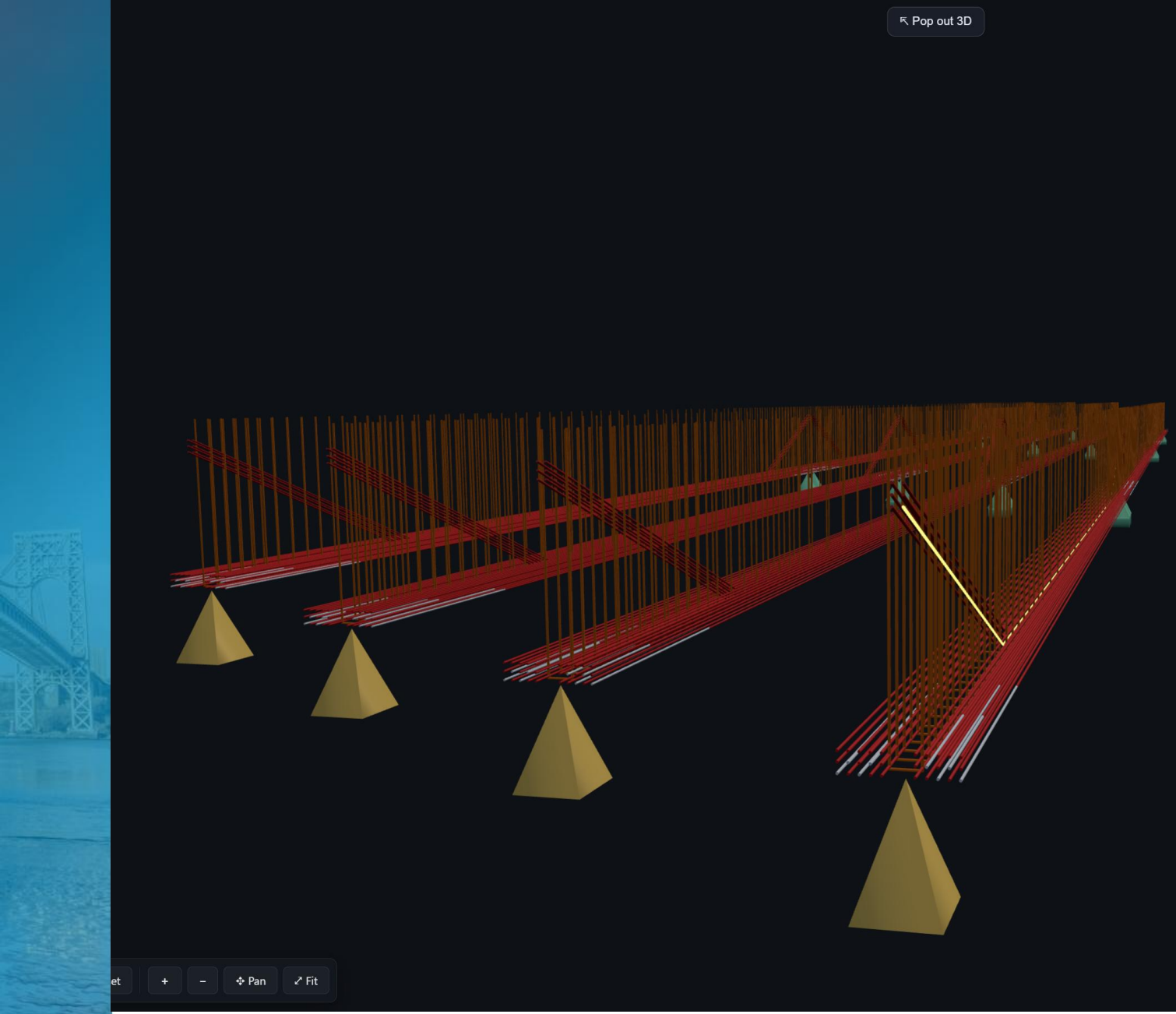
- Re-group components from a load rater's mindset
- Intuitive model creation with real-time visual confirmation
- Generate structured component data

Step 2: Model Assembly

- Drag-and-drop model assembly
- Assemble components into structured bridge data
- Create BrDR models through the API


New
Open
Batch
Find
Copy
Paste
Copy To
Remove From
Delete
Bridge
Manage
Favorites Folder
Recent Bridges
All Bridges
Sample Bridges
Deleted Bridges
BID
Bridge ID
Bridge Name
Total Bridge Count: 0


BrDR Studio
1 Bridge
no bridge loaded
BrDR Studio
Select the bridge type to begin.
BRIDGE TYPE
Prestressed Concrete Beam
Full workflow — Bridge · 3D View · Build · Report
Steel Girder–Floorbeam–Stringer
Load & 3D View
Reinforced Concrete T-Beam
Under construction
Steel Plate Girder
Under construction
BrDR Studio · Internal, unsupported tool · Results are NOT for final load-rating decisions — verify in BrDR · Not for production engineering or redistribution



LAYERS

STRUCTURE
- Deck
  - Bays
- Girders
  - All None
  - G1
  - G2
  - G3
  - G4
- Diaphragms
- Supports

ROADWAY
- Wearing surface
- Travelway
- Striped lanes
- Appurtenances

REINFORCEMENT
- Composite deck (Std)
- Composite deck (LRFD)
- Deck rebar (Std)
- Deck rebar (LRFD)
- Stirrups
- Strands
- Rebar (mild steel)
- Interior diaphragms

ANNOTATIONS
- Transverse dims
- Longitudinal dims

ANALYSIS
- Diagnostics

SCENE
- Grid
- Axes

CONDITION
- Loss profile

+ Add loss

Save losses

Copy loss text

STRAND

Strand #6

G4-S1 · Harped and Debonded · harped · mid (1,6)

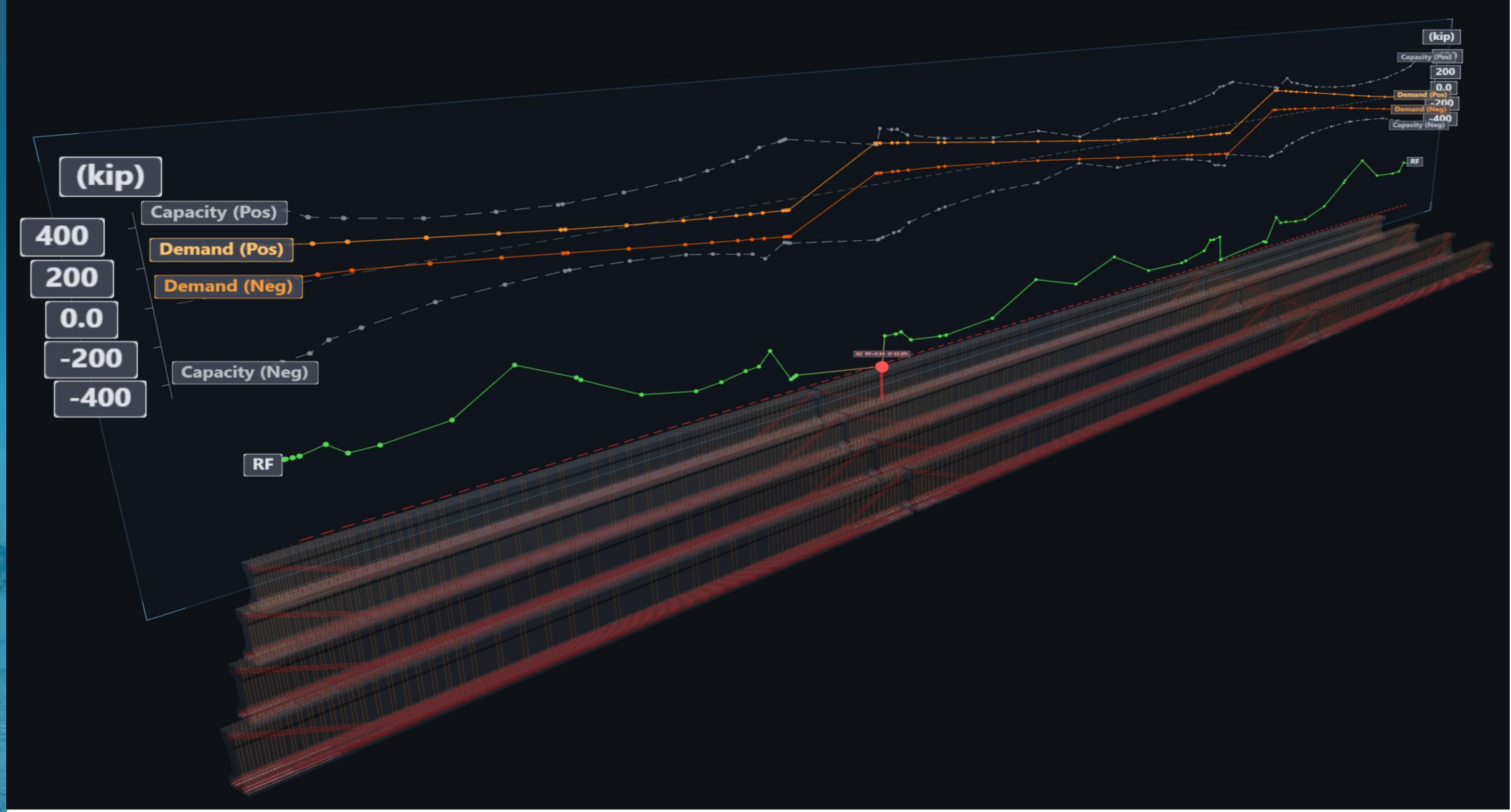
CONTINUITY

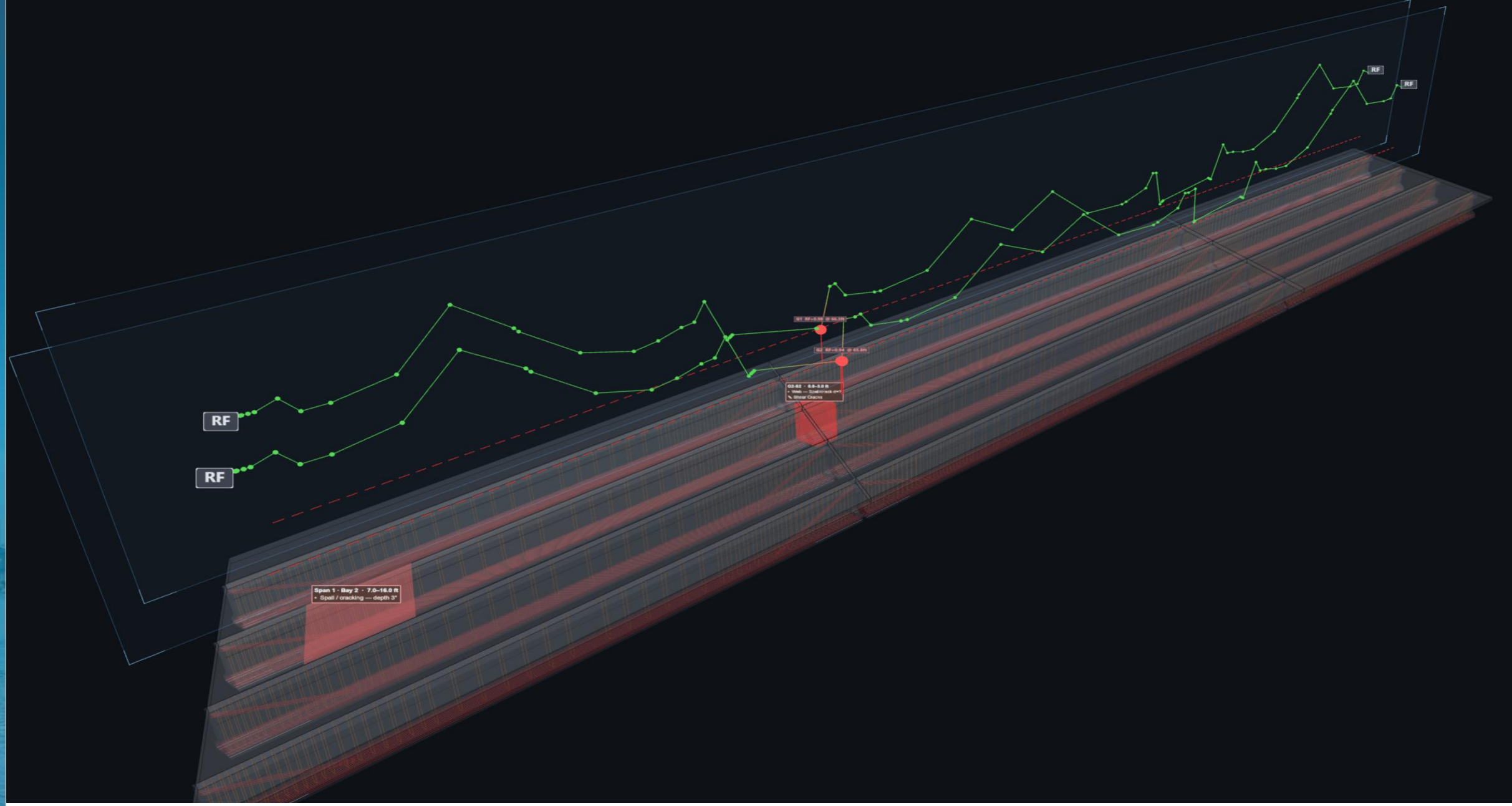
Extends past left	No
Extends past right	No

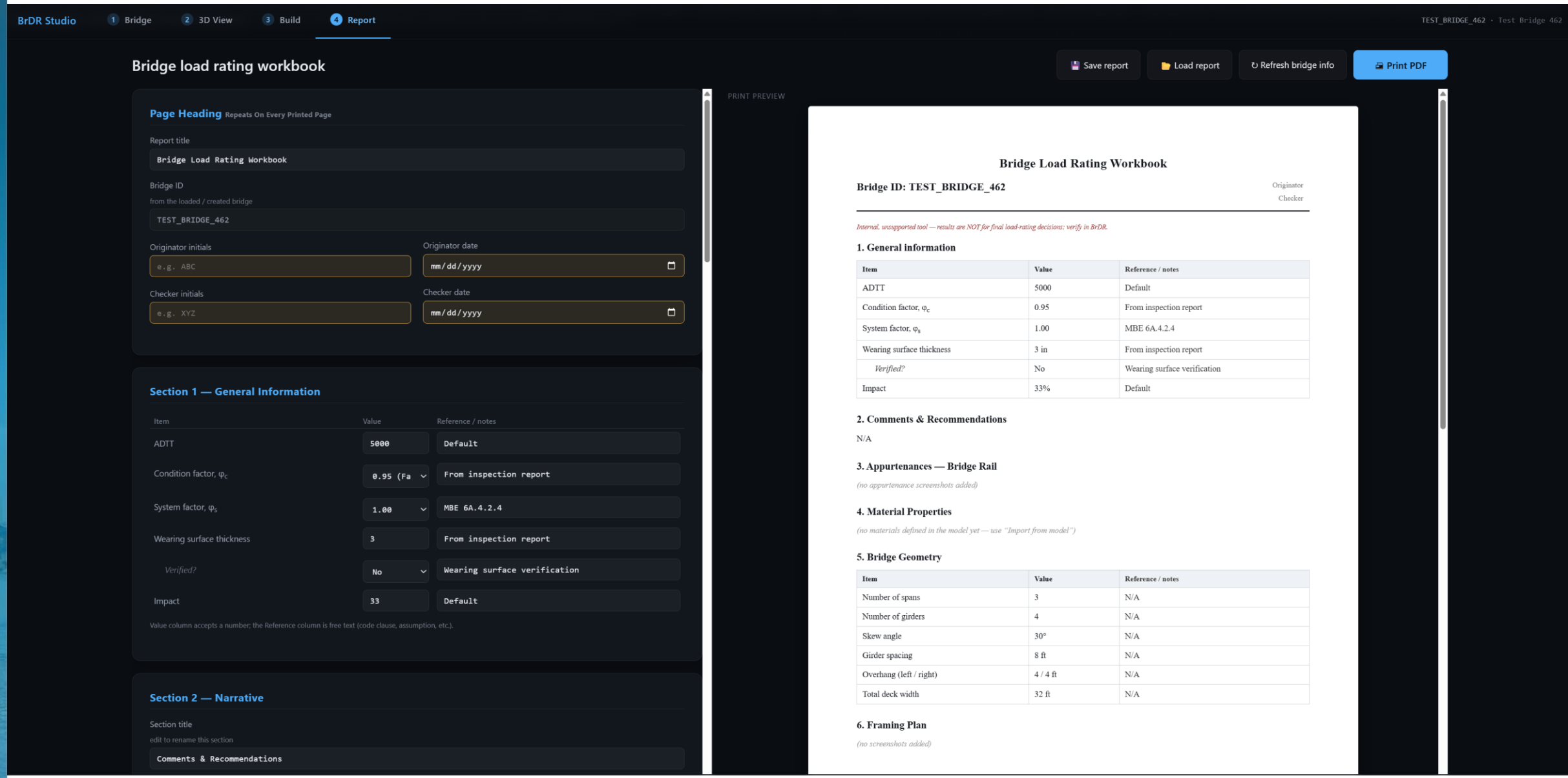
PRESTRESS PROPERTIES — PS PROP 1/2"(7W-270)LR

Loss method	AASHTO Approximate
P/S strand material	1/2" (7W-270) LR
Jacking stress ratio	0.75
P/S transfer stress rt.	–
Transfer time	24 hr
Age at deck placement	7 day
Final age	3000 day
Include elastic gains	No
%DL (AASHTO Approx.)	0 %
Minimum loss	–
Lump sum continuous	–
Lump sum composite	–
Lump sum final	–

CROSS-SECTION

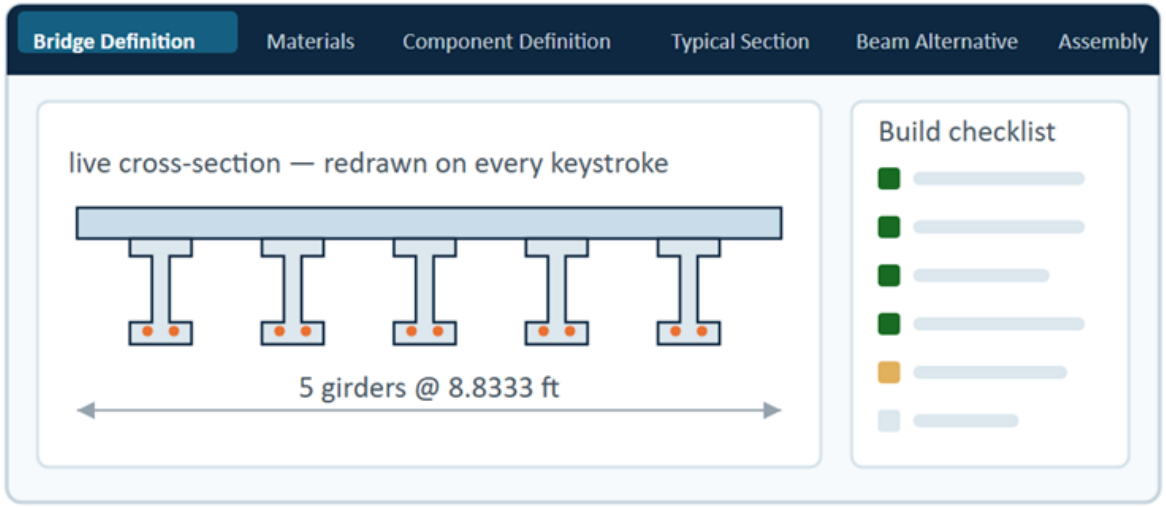

(kip)
Capacity (Pos)
Demand (Pos)
Demand (Neg)
Capacity (Neg)
RF
400
200
0.0
-200
-400


RF
RF
RF
RF
Span 1 · Bay 2 · 7.0–16.0 ft
• Spall / cracking — depth 3"


BrDR Studio
1 Bridge
2 3D View
3 Build
4 Report
TEST_BRIDGE_462 · Test Bridge 462
Bridge load rating workbook
Save report
Load report
Refresh bridge info
Print PDF
Page Heading Repeats On Every Printed Page
Report title
Bridge Load Rating Workbook
Bridge ID
from the loaded / created bridge
TEST_BRIDGE_462
Originator initials
e.g. ABC
Originator date
mm/dd/yyyy
Checker initials
e.g. XYZ
Checker date
mm/dd/yyyy
Section 1 — General Information
Item
Value
Reference / notes
ADTT
5000
Default
Condition factor, φc
0.95 (Fa
From inspection report
System factor, φs
1.00
MBE 6A.4.2.4
Wearing surface thickness
3
From inspection report
Verified?
No
Wearing surface verification
Impact
33
Default
Value column accepts a number; the Reference column is free text (code clause, assumption, etc.).
Section 2 — Narrative
Section title
edit to rename this section
Comments & Recommendations
PRINT PREVIEW
Bridge Load Rating Workbook
Bridge ID: TEST_BRIDGE_462
Originator
Checker
Internal, unsupported tool — results are NOT for final load-rating decisions; verify in BrDR.
1. General information
Item
Value
Reference / notes
ADTT
5000
Default
Condition factor, φc
0.95
From inspection report
System factor, φs
1.00
MBE 6A.4.2.4
Wearing surface thickness
3 in
From inspection report
Verified?
No
Wearing surface verification
Impact
33%
Default
2. Comments & Recommendations
N/A
3. Appurtenances — Bridge Rail
(no appurtenance screenshots added)
4. Material Properties
(no materials defined in the model yet — use "Import from model")
5. Bridge Geometry
Item
Value
Reference / notes
Number of spans
3
N/A
Number of girders
4
N/A
Skew angle
30°
N/A
Girder spacing
8 ft
N/A
Overhang (left / right)
4 / 4 ft
N/A
Total deck width
32 ft
N/A
6. Framing Plan
(no screenshots added)

Designed for the Rater, Structured for the API

Built for the load rater, not for the database



Everything lands in one file

```
{
  "bridgeId": "26SR0500015",
  "numSpans": 3,
  "spanLengthsFt": [48.3542, 56, 48.3542],
  "numGirders": 5,
  "girderSpacingsFt": [8.8333, …],
  "supportSkewsDeg": [-9.563, …],
  "beamDefinitions": [
    { "name": "G1",
      "beamDetails": {
        "spanDetail": [ {
          "beamShape": "AASHTO TYPE II",
          "strandLayout": [ 12 strands ],
          "shearVert": [ 16 ranges ],
          "mildSteel": [ … ]
        } ]
      }
    } ]
}
```

Common Themes Across All Examples

Addressing pain points

- Culverts: When manual modeling doesn't scale
- T-Beams & Plate Girders: When simple inputs require complex interpretation
- PSC Beams: Connecting the entire workflow through the API

These Solutions Enable

✅ Reduced repetitive work
✅ Improved model quality and consistency
✅ Increased engineer confidence
✅ Better user experiences
✅ More time to interpret inspection findings and apply engineering judgement

Creating Better Work Experiences

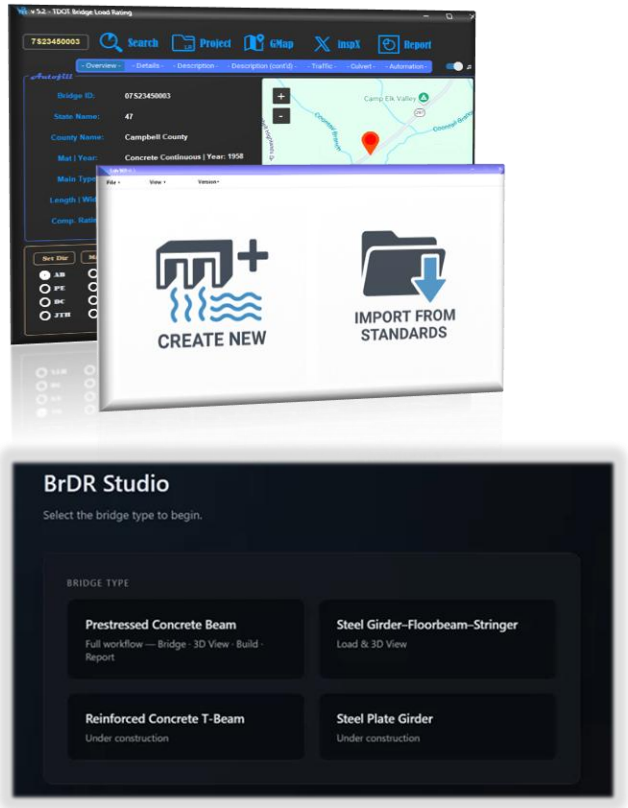
Less time building models.

More time applying engineering judgment.

More value delivered to our clients.

Making load rating:

- More Efficient
- More Confident
- More Enjoyable



Questions:

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