

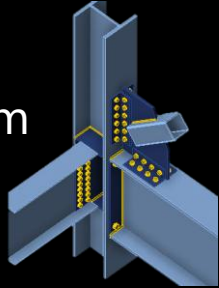


**Bridge & Infrastructure
Design with AASHTO:
New Concrete Workflows
in IDEA StatiCa v26.0**



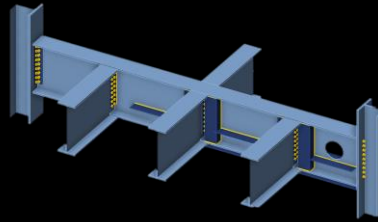
Connection

Design all steel connections from standard to complex joints



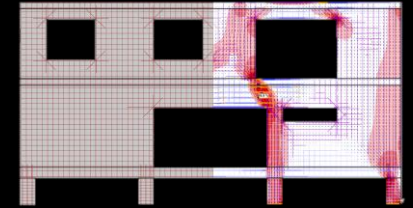
Member

Critical Beam and column design



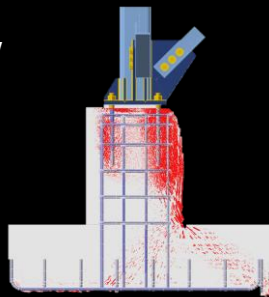
Detail

Replace STM when designing:
Transfer beams
Shear walls
Corbels
Walking columns



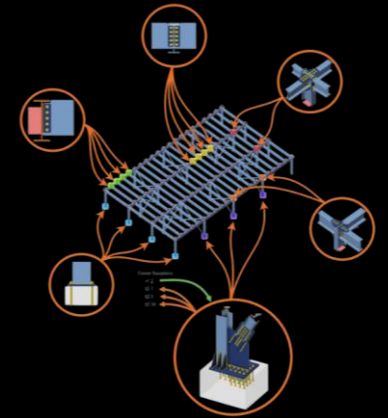
Connection + Detail

Complete base plate workflow including steel and concrete reinforcement design to avoid concrete breakout



Checkbot

Integration of 3rd party apps analysis models or BIM models with IDEA StatiCa applications



AGENDA

Design of concrete structures

Transportation structures with IDEA StatiCa

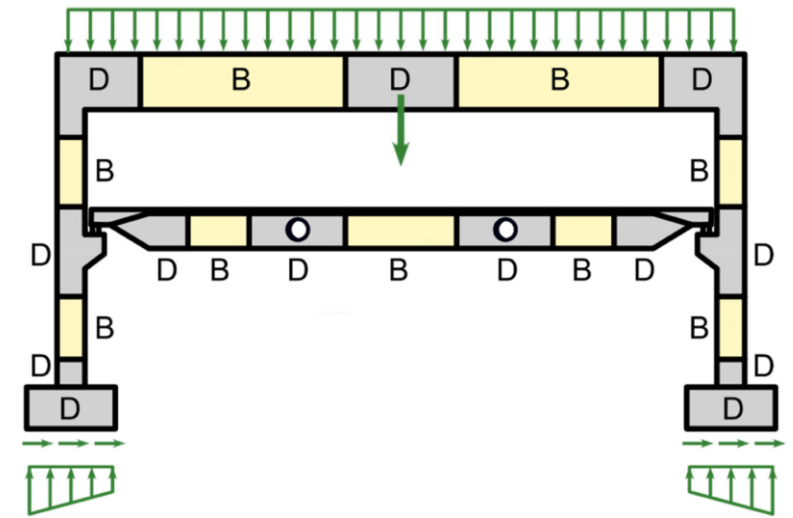
Overview of Version 26

Q&A session

STRUCTURAL DESIGN OF CONCRETE STRUCTURES

B-Regions: sections of the structure that can be designed with beam theory

D-Regions: Discontinuity regions where stress flow is unknown. Where traditional beam theory becomes unreliable.



DISCONTINUITY REGIONS= STRUT&TIE METHOD

Design codes (ACI, AASHTO) provide guidelines to use strut and tie method for the design of D-Regions

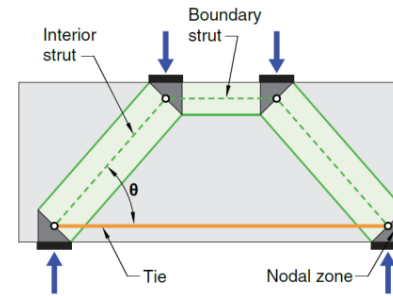
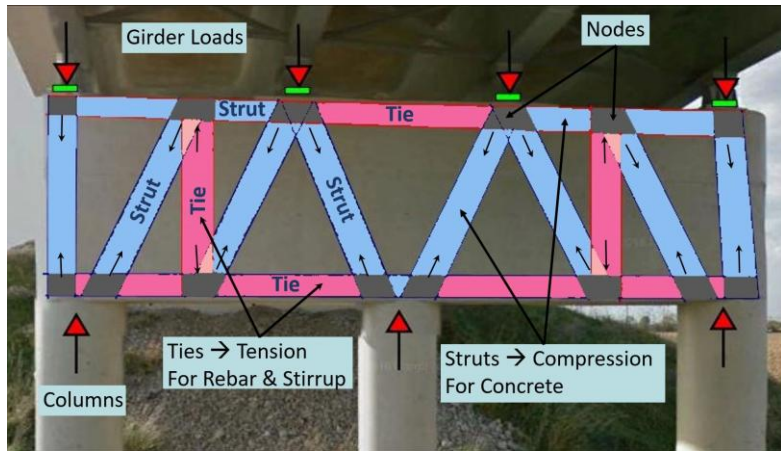
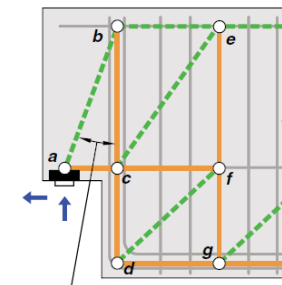
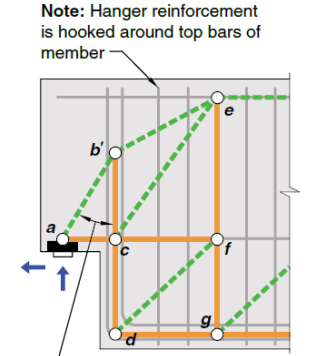


Fig. R23.2.1—Description of strut-and-tie model.



(a) Invalid strut-and-tie model



(b) Adjusted strut-and-tie model to satisfy 23.2.7

Fig. R23.2.7—Strut and-tie model of dapped connection illustrating adjustment to comply with 23.2.7.

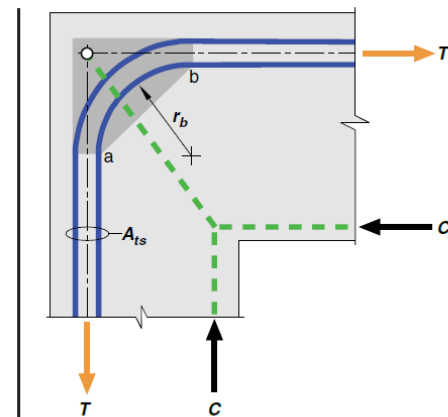
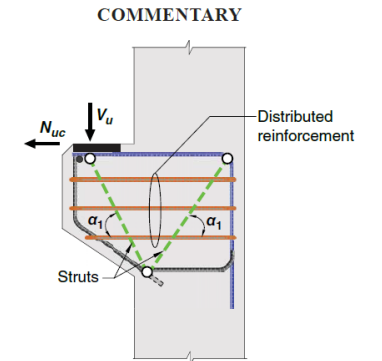


Fig. R23.10.4—Curved-bar node with two layers of reinforcement (nodal zone is shaded).



Distributed reinforcement crossing interior struts. Note that α_1 is different for the two struts above; the minimum distributed reinforcement ratio is controlled by the smaller angle α_1 .

Fig. R23.5.1—Distributed reinforcement crossing interior struts.

STRUT&TIE

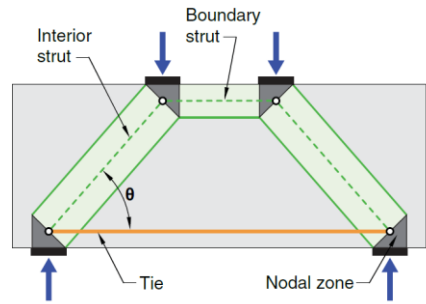
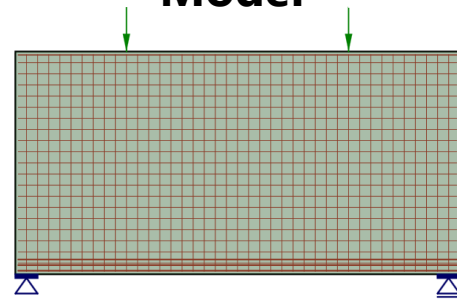
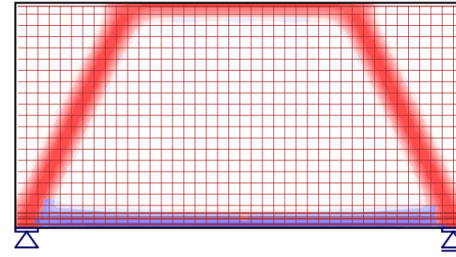


Fig. R23.2.1—Description of strut-and-tie model.

Model



Design tools



Stresses (Concrete and rebar)

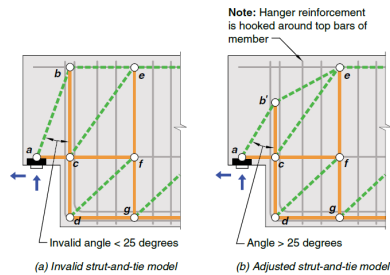
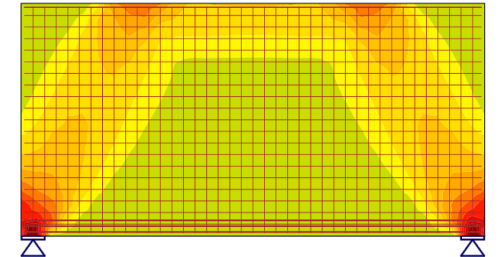
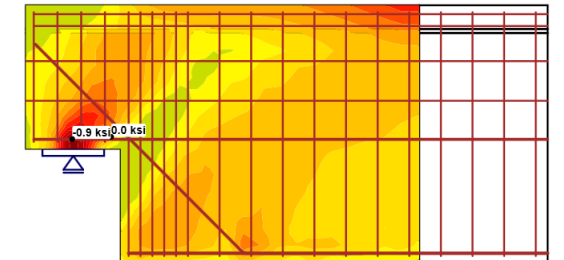
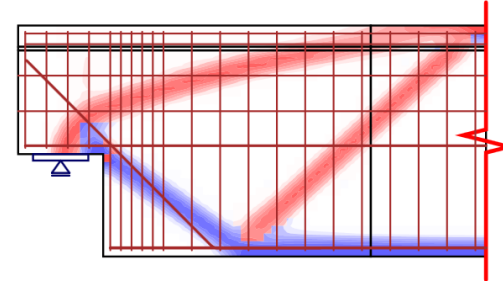
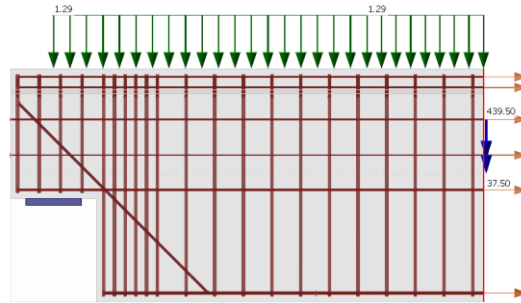
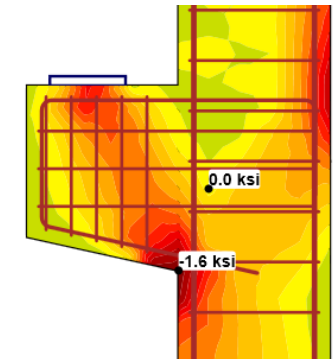
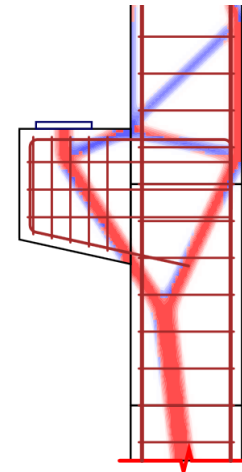
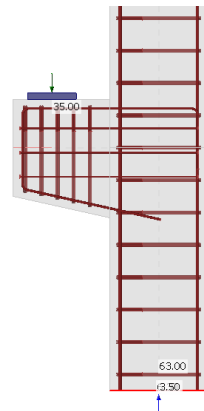
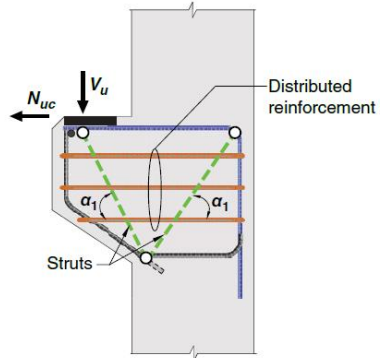


Fig. R23.2.7—Strut-and-tie model of dapped connection illustrating adjustment to comply with 23.2.7.



COMMENTARY



STRUT&TIE

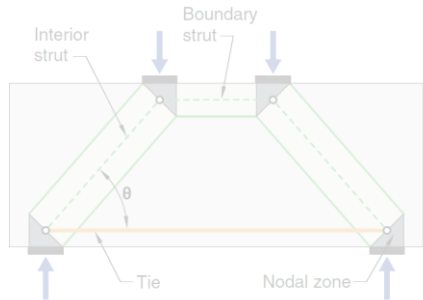


Fig. R23.2.1—Description of strut-and-tie model.

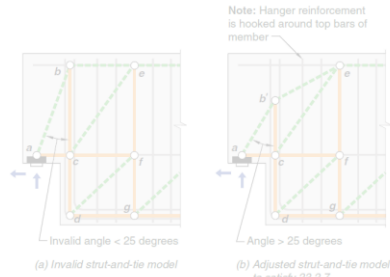
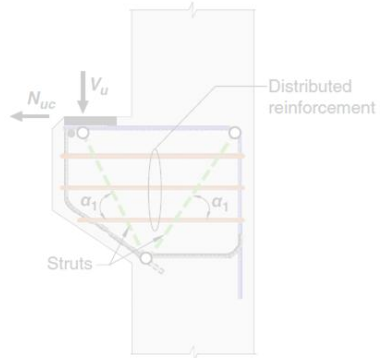


Fig. R23.2.7—Strut-and-tie model of dapped connection illustrating adjustment to comply with 23.2.7.

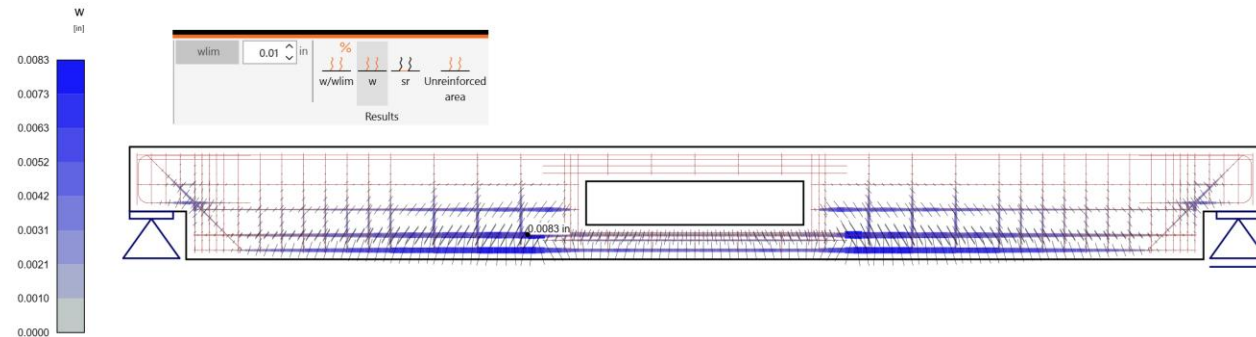
COMMENTARY



Deflections



Crack width



IMEG – WALKING COLUMNS

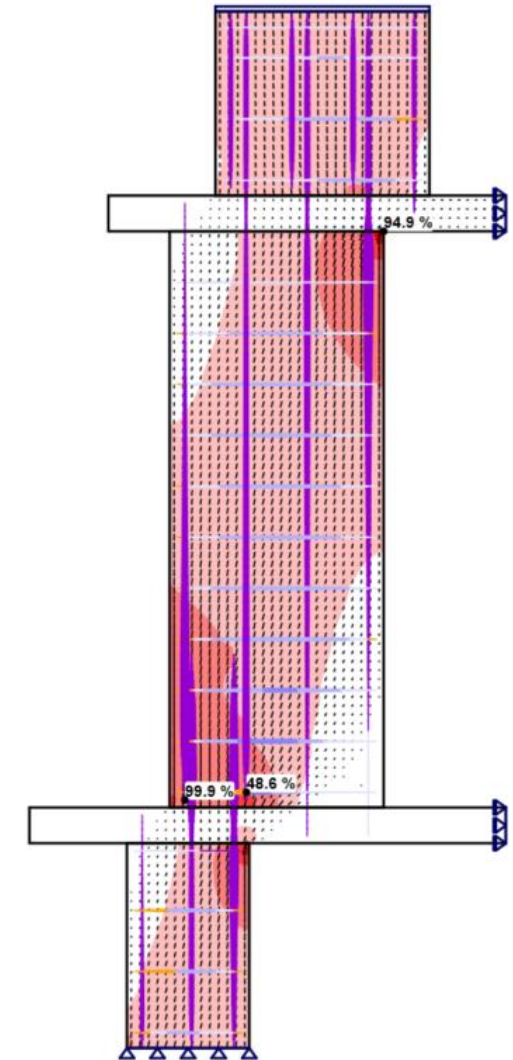
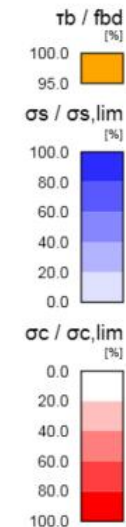
IMEG used Detail 2D to model as-built walking columns

Model was used to:

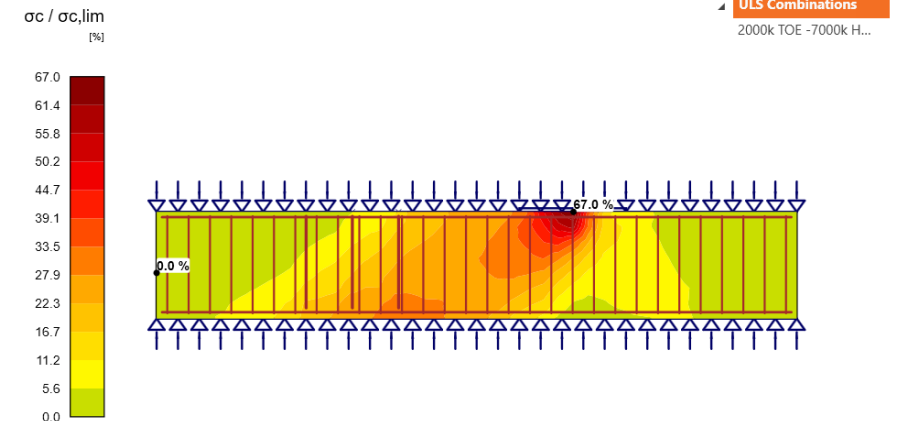
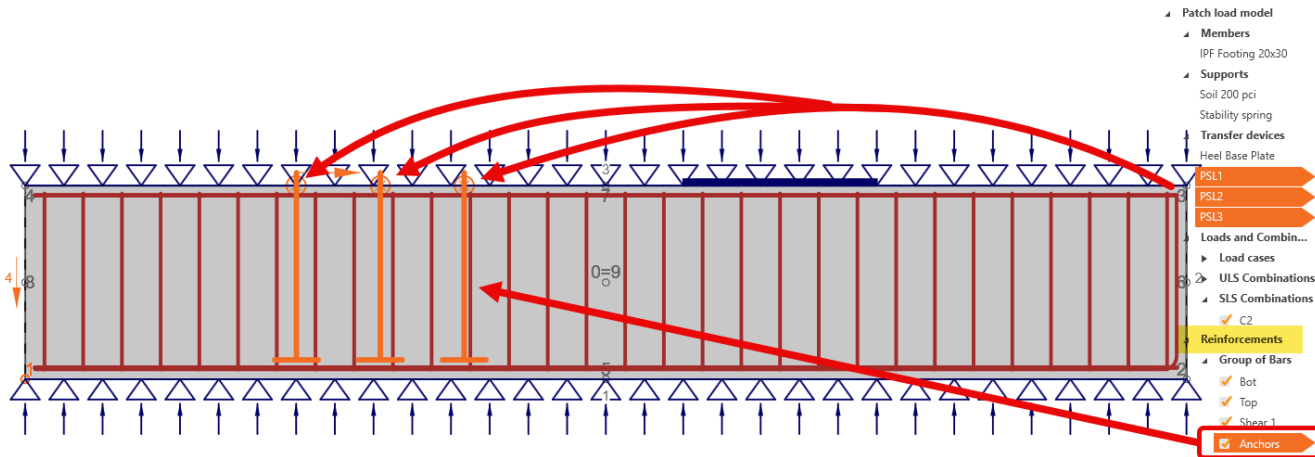
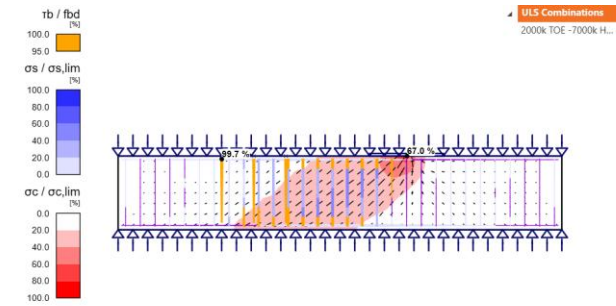
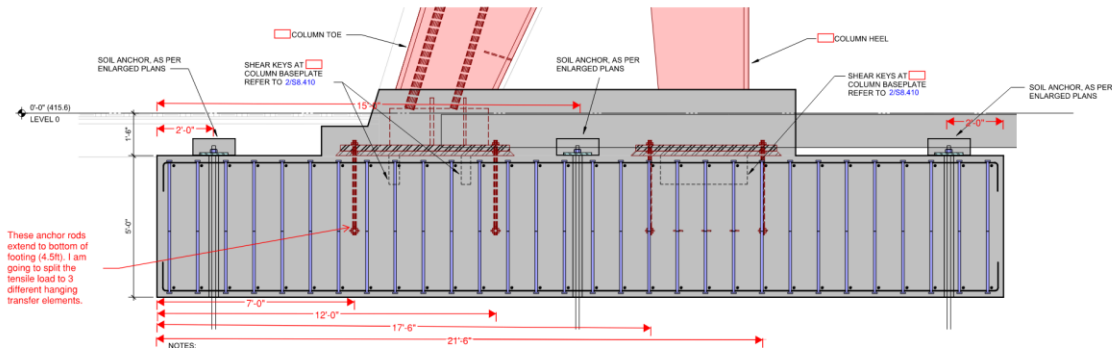
- ✓ Compare results with **ACI 318-14** strut and tie hand calculations
- ✓ Verify **load transmission**/bearing through floor
- ✓ Verify **kick forces** applied to floors from column walks
- ✓ Determine **tension splitting zones** from bottle struts in column walks to verify extents of carbon fiber reinforcement

Case study

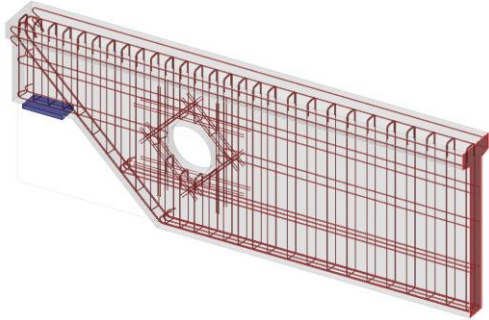
✓ ULS:			
Concrete	C1	✓	94.9%
Reinforcement	C1	✓	48.6%
Anchorage	C1	✓	99.9%
✓ SLS:			
Crack width	C2	✓	36.9%
Deflection	C3	✓	17.6%



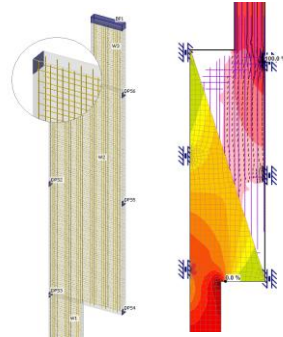
MAT FOUNDATION –STRUT&TIE MODEL VERIFICATION



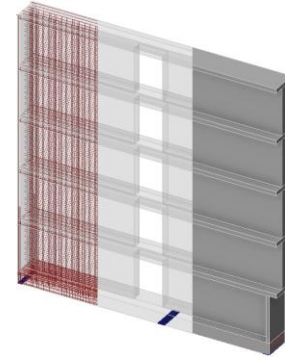
WHAT CAN BE DESIGNED WITH IDEA STATICA DETAIL?



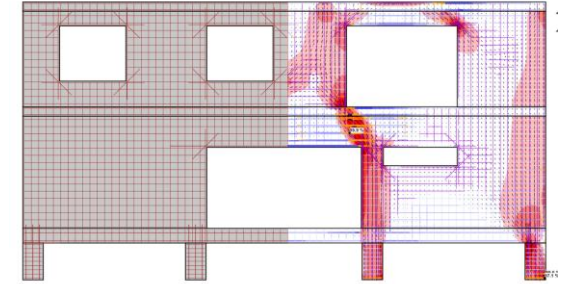
Dapped end with opening



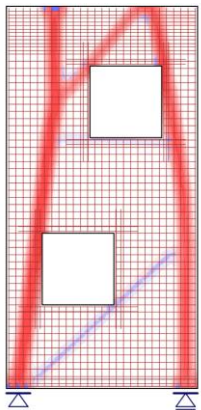
Walking column



concrete 5-floor wall with openings



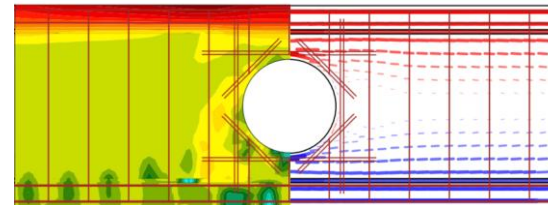
Reinforced concrete wall with openings



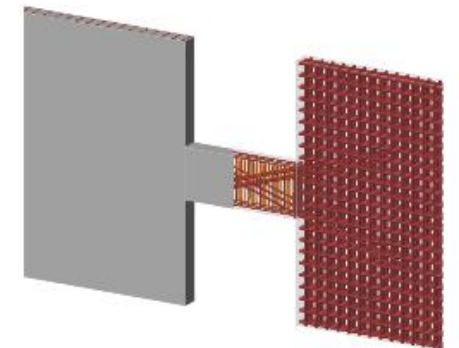
Wall with non-aligned openings



Pier caps

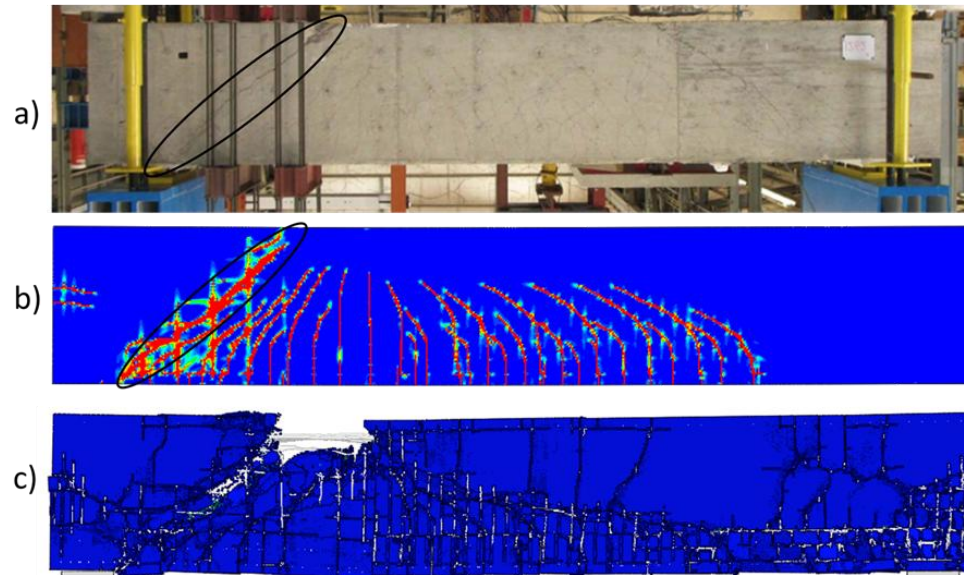
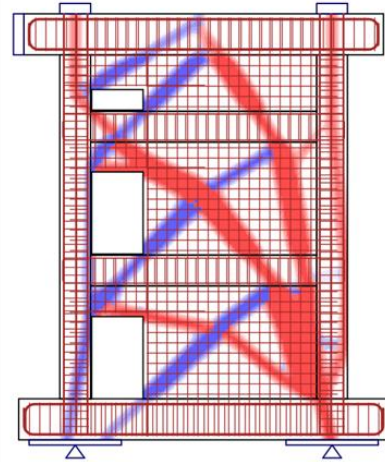
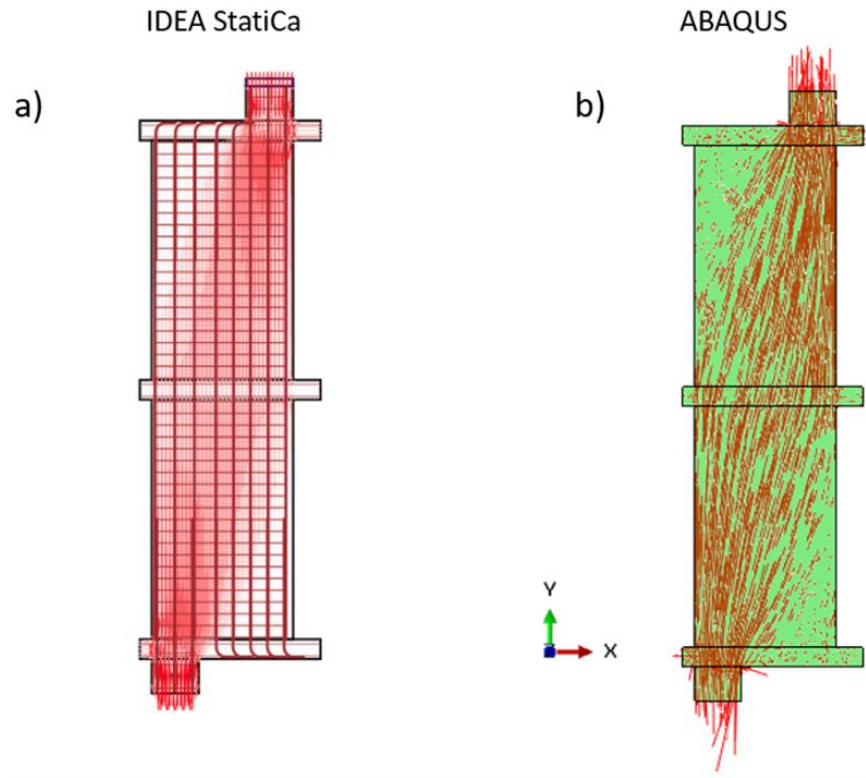


Beam with opening



Coupling beam

UNIVERSITY VERIFICATION STUDIES



D-REGIONS – AASHTO LRFD BRIDGE DESIGN SPECIFICATION

distance between the extreme compression fiber and the centroid of the primary longitudinal reinforcement.

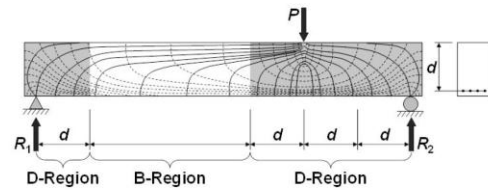


Figure 5.5.1.2.1-1— Stress Trajectories within B- and D-Regions of a Flexural Member (adapted from Birrcher et al., 2009)

D-Regions shall be taken to encompass locations with abrupt changes in geometry or concentrated forces. Based upon St. Venant's principle, D-Regions may be assumed to span one member depth on either side of the discontinuity in geometry or force.

Where the effective depth changes along the component the length of the D-Regions should be varied accordingly.

stress can be assumed at approximately one member depth from a load or geometric discontinuity. In other words, a nonlinear stress distribution exists within one member depth from the location where the discontinuity is introduced (Schlaich et al., 1987). D-Regions are therefore assumed to extend approximately a distance d from the applied load and support reactions in Figure 5.5.1.2.1-1. In the case of the reaction at an interior support, the disturbed region extends a distance d on each side of the reaction.

B-Regions occur between D-Regions, as shown in Figure 5.5.1.2.1-1. Plane sections are assumed to remain plane within B-Regions according to the primary tenets of beam theory, implying that a linear distribution of strains occurs through the member depth. The beam is therefore dominated by sectional behavior, and design can proceed on a section-by-section basis (i.e., sectional design). For the flexural design of a B-Region, the compressive stresses (represented by solid lines in Figure 5.5.1.2.1-1) are conventionally assumed to act over a rectangular stress block, while the tensile stresses (represented by dashed lines) are assumed to be carried by the longitudinal steel reinforcement.

5.8.2.3—Factored Resistance

The factored resistance, P_u , of a node face and ties shall be taken as that of axially loaded components:

$$P_u = \phi P_n \quad (5.8.2.3-1)$$

where:

- ϕ = resistance factor for tension or compression, specified in Article 5.5.4.2, as appropriate
- P_n = nominal resistance of a node face or tie (kip)

5.8.2.4—Proportioning of Ties

5.8.2.4.1—Strength of Tie

C5.8.2.4.1

The nominal resistance of a tie in kips shall be taken as:

$$P_n = f_y A_n + A_{ps} [f_{pe} + f_y] \quad (5.8.2.4.1-1)$$

where:

- f_y = yield strength of nonprestressed longitudinal reinforcement (ksi)
- A_n = total area of longitudinal nonprestressed reinforcement (in.²)
- A_{ps} = area of prestressing steel (in.²)
- f_{pe} = effective stress in prestressing steel (ksi)

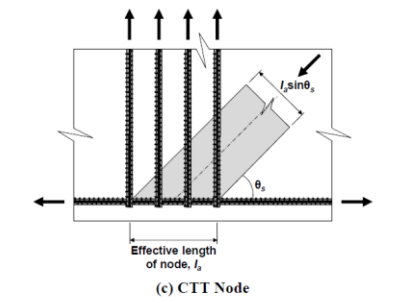
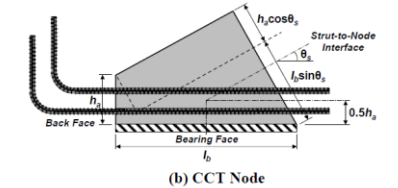
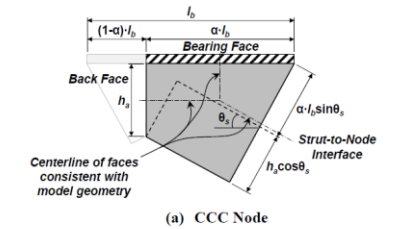
The sum of f_{pe} and f_y in Eq. 5.8.2.4.1-1 shall not be taken greater than the yield strength of the prestressing steel.

5.8.2.4.2—Anchorage of Tie

C5.8.2.4.2

The tie reinforcement shall be anchored to transfer the tension force therein to the node regions of the truss in accordance with the requirements for development of reinforcement as specified in Articles 5.9.4.3 and

The ties must be properly anchored to ensure that the tension force can be fully developed and that the structure can achieve the resistance assumed by the STM. For a tie to be properly anchored at a node region, the yield



IDEA STATICA NOW SUPPORTS AASHTO

Sample projects

AASHTO Material models

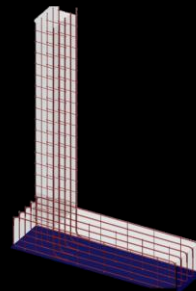
Stress-strain diagrams for serviceability

Resistance load factors (general approach to the D-regions)

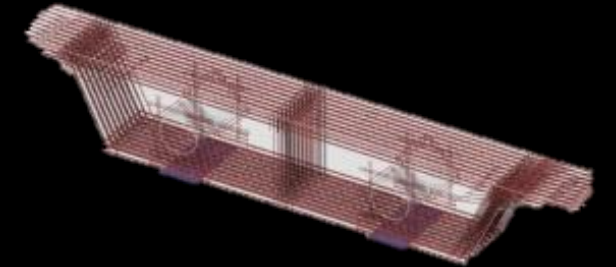
Strength limit state checks (material utilization ratio, bond stress)

Service limit state checks (short and long term)

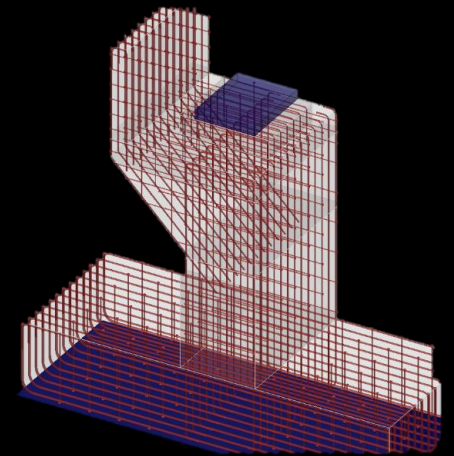
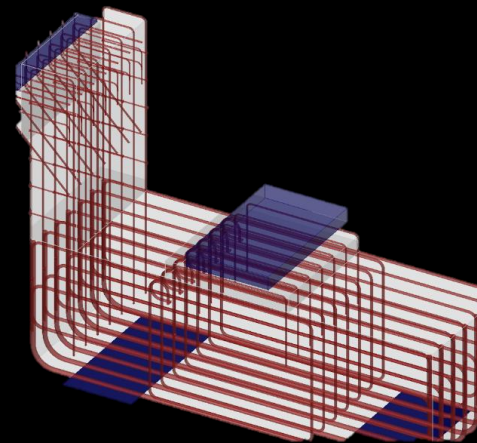
Deflection, Crack Width



Retaining walls



Box girder Diaphragms



Bridge sub-structure details

SUPERSTRUCTURE DETAILS

The screenshot displays the IDEA StatiCa DETAIL software interface, which is used for creating and detailing reinforcement models. The interface is divided into four main stages:

- 1. Model type:** Shows options for 2D and 3D modeling. The 2D option is currently selected.
- 2. Class:** Shows various superstructure detail classes. The selected class is "Super structure details".
- 3. Topology:** Shows different reinforcement topologies. The selected topology is "Bridge frame joint". Other options include "Blister", "Dapped end bottom", "Dapped end top", and "Cross section change".
- 4. Parameters:** Shows the configuration parameters for the selected model. The design code is set to "AASHTO".

The parameters section includes the following settings:

Parameter	Value
Name	
Description	
Design code	AASHTO
Initial Settings	
Concrete	6000
Reinforcement	Grade 75
Prestressing	270K-S7-0.6"
Bolt Grade	F1554 Gr. 55
Concrete cover [in]	1"15/16
Rounding	Imperial

A large orange arrow indicates the flow from the selected topology to the final 3D reinforcement model, which is shown in a 3D perspective view. A "Create" button is located at the bottom right of the interface.

DIAPHRAGMS

New

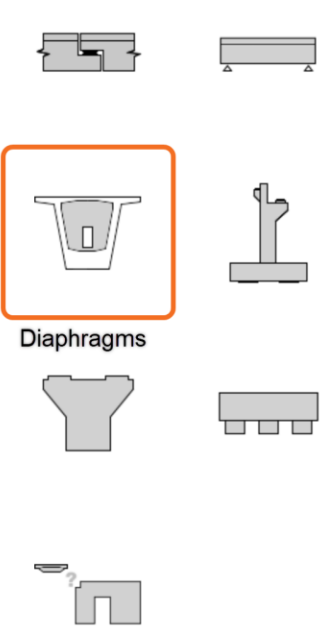
1. Model type

2D

3D

2. Class

Diaphragms



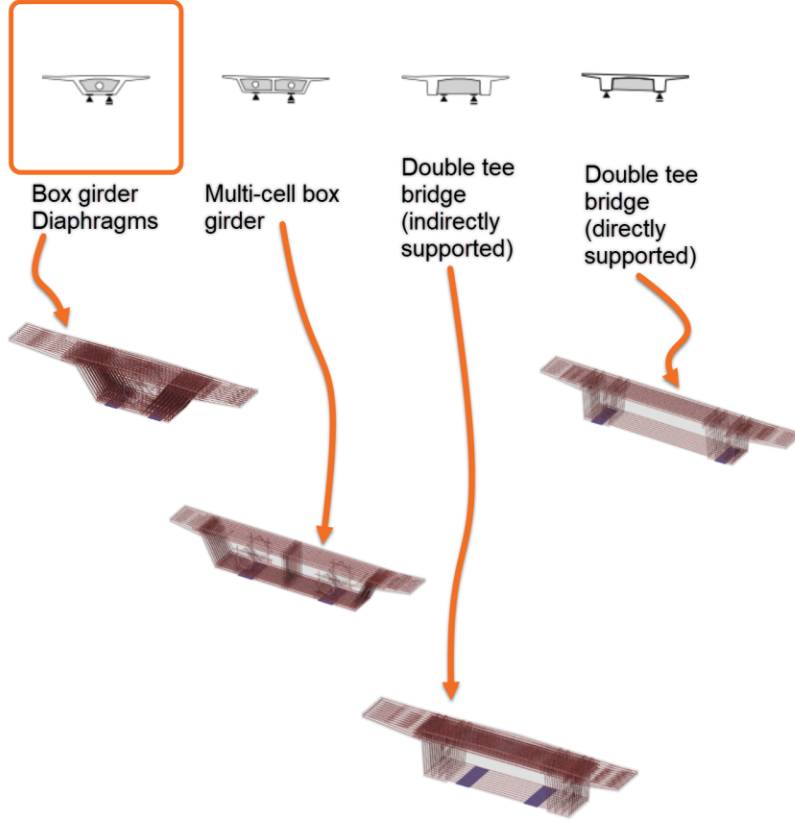
3. Topology

Box girder Diaphragms


Multi-cell box girder

Double tee bridge (indirectly supported)

Double tee bridge (directly supported)



4. Parameters

Name		
Description		
Design code	 AASHTO	▼
Initial S		
Concrete	6000	↻
Reinforcement	Grade 75	↻
Prestressing	270K-S7-0.6"	↻
Bolt Grade	F1554 Gr. 55	↻
Concrete cover [in]	1"15/16	
Rounding	Imperial	▼

ABUTMENT IN BRIDGES

New

1. Model type

2D

3D

2. Class

Bridge abutments

3. Topology

Spread footing abutment

Abutment on piles

Corbel abutment

Retaining wall

4. Parameters

Name

Description

Design code

Initial Settings

Concrete

Reinforcement

Prestressing

Bolt Grade

Concrete cover [in]

Rounding

Create

PIER CAPS

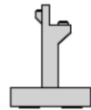
New

1. Model type



3D

2. Class



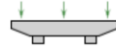
Pier caps



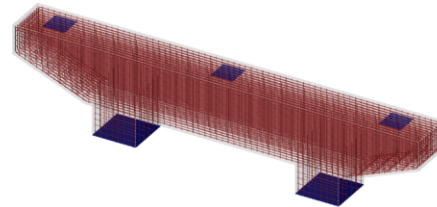
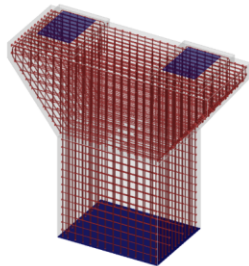
3. Topology



Pier cap -
single pile



Pier cap -
multiple
piles



4. Parameters

Name

Description

Design code



AASHTO

Initial Se

Concrete

Reinforcement

Grade 75



Prestressing

270K-S7-0.6"



Bolt Grade

F1554 Gr. 55



Concrete cover [in]

1"15/16

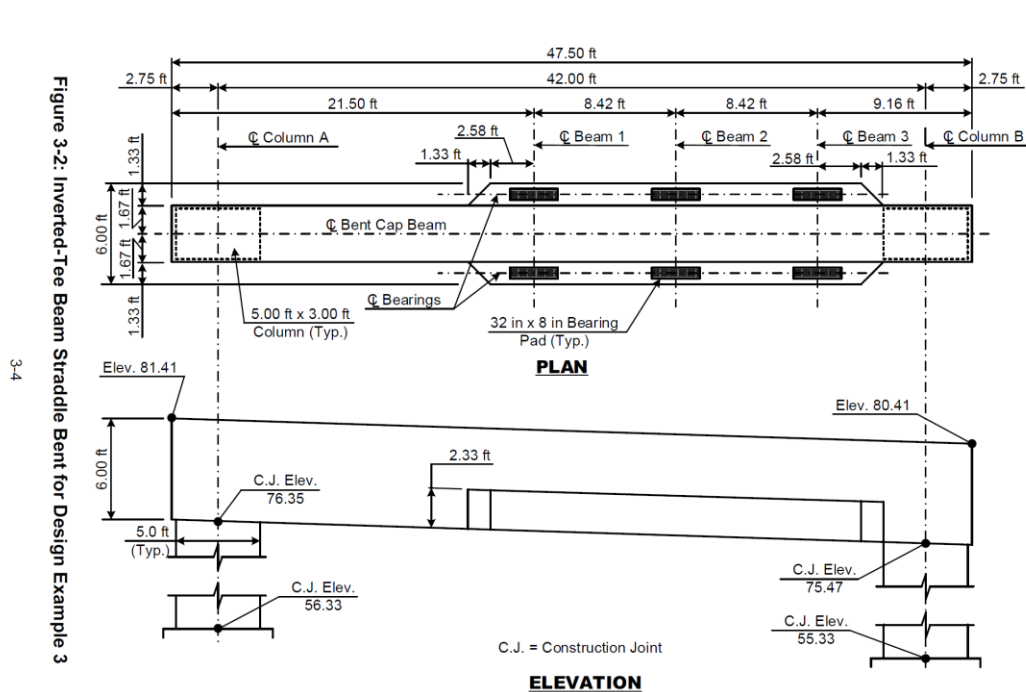
Rounding

Imperial



INVERTED-TEE MOMENT FRAME STRADDLE BENT CAP

The inverted-tee bent cap beam is part of a moment frame straddle bent, which will carry a **flyover ramp over a highway below.**



FHWA-NHI-130126
Strut-and-Tie Modeling (STM) for Concrete Structures

Design Example 3 - Inverted-Tee Moment Frame
Straddle Bent Cap

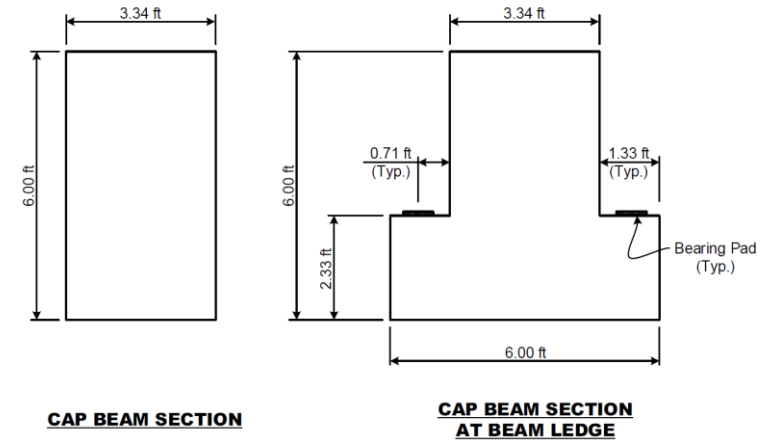


Figure 3-1: Typical Sections of Straddle Bent Cap Beam

Colorito, A., Wilson, K., Bayrak, O., and Russo, F. (2017). "Strut-and-Tie Modeling (STM) for Concrete Structures, Design Examples. FHWA-NHI-17-071, NHI Course No. 130126." FHWA, Washington, DC

INVERTED-TEE MOMENT FRAME STRADDLE BENT CAP

- This design example requires the use of **global and local strut-and-tie models** to fully model the flow of forces within the cap beam.
- $f'_c = 6.0$ ksi
- $f_y = 60.0$ ksi

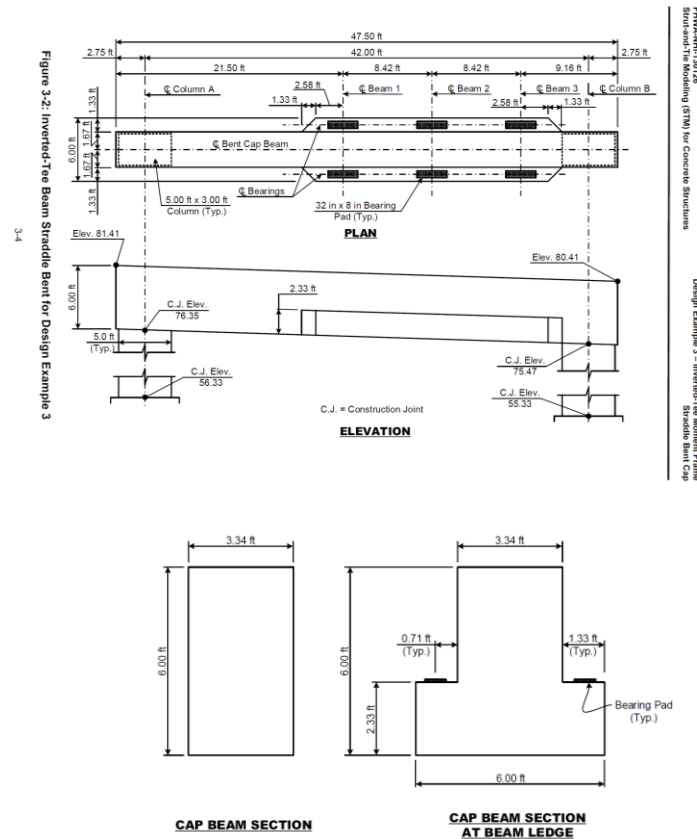


Figure 3-1: Typical Sections of Straddle Bent Cap Beam

LOAD ANALYSIS

Detail App load comb setup:

Strength combination =

1.25xSelf weight

+

Factored beam loads

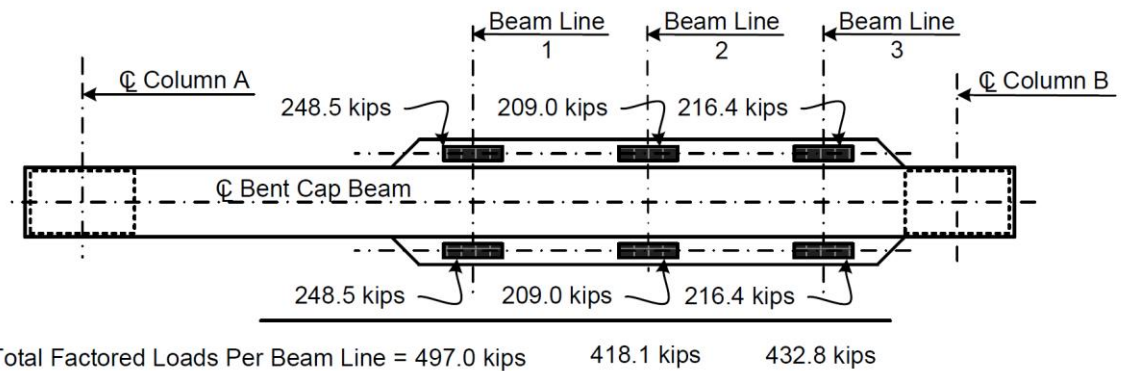
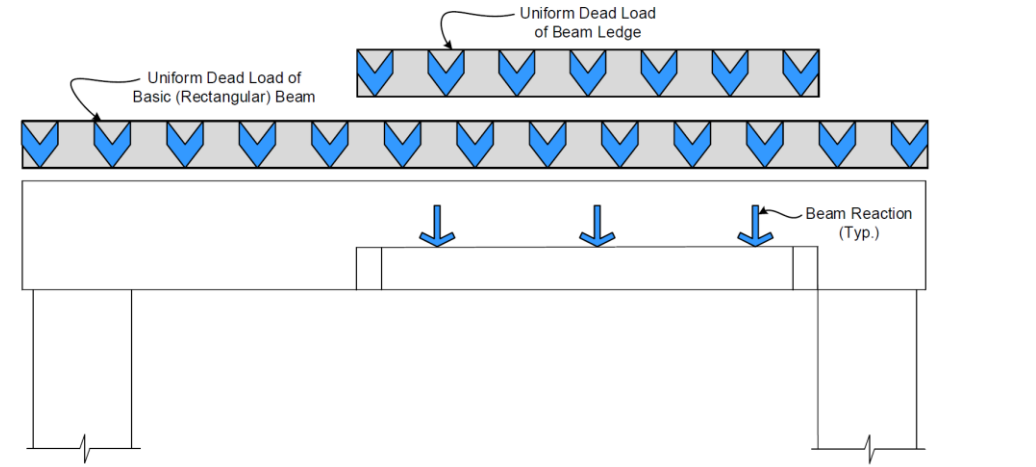
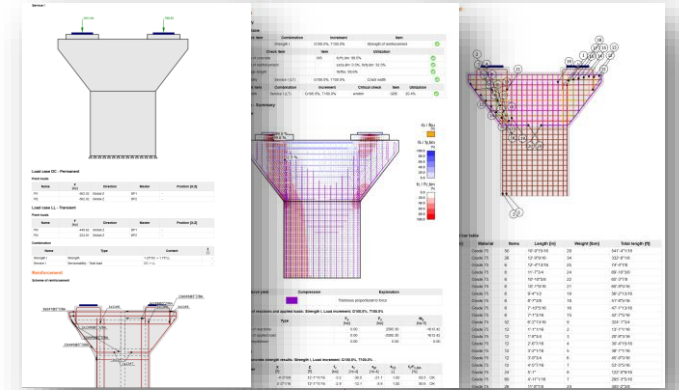
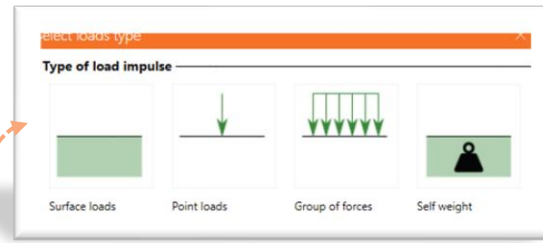
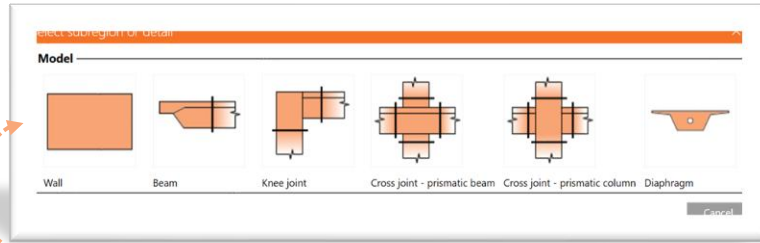


Figure 3-4: Factored Beam Loads per Beam Line

STEP-BY-STEP PROCESS



Set up the **geometry** (select general wall section or beam element)

Set up the **supports**

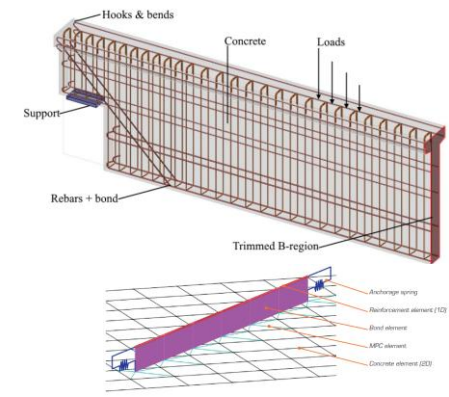
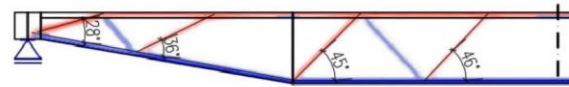
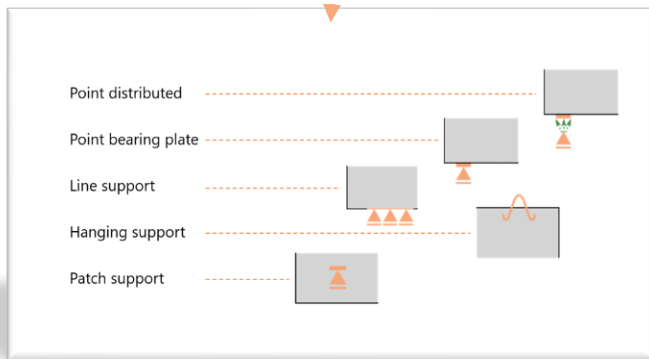
Set up the **load cases and load combinations** (strength and serviceability)

Linear analysis
Run **topology optimization**

✓ NON-Linear analysis
Pre-design steel **reinforcement**

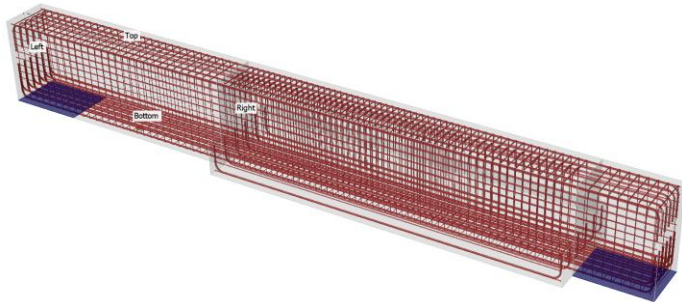
Reinforcement design iterations

Report



MODELS PREPARED

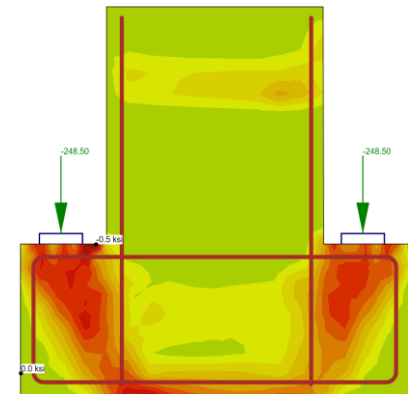
Frame as beam element



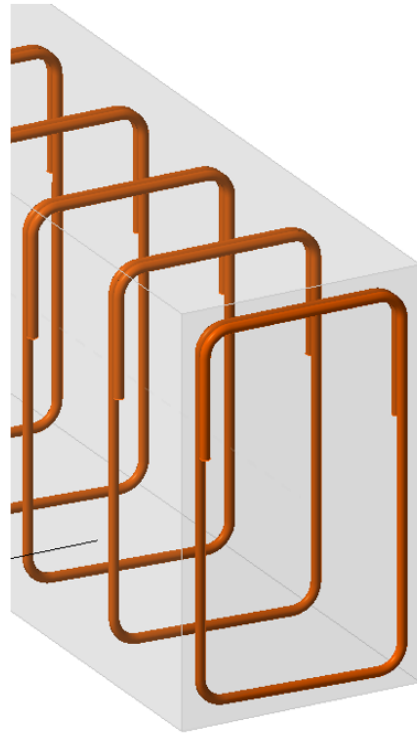
Frame as wall element



Section of the inverted tee (ledge beam)

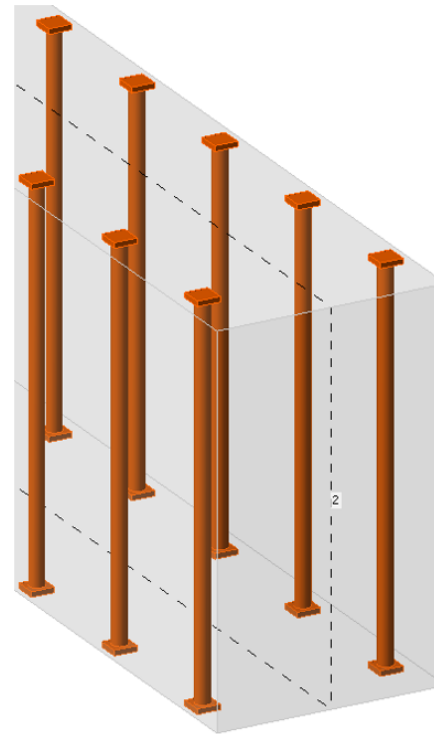


DEFINITION OF STIRRUPS: BEAM VS WALL



Beam with stirrups

=



Wall with perfectly bonded bars

SUMMARY

Verify and prove your strut and tie model's w/topology optimization

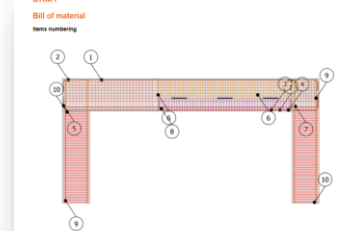
Comply with AASHTO Specs for **bridge concrete details**

Design for **strength and service** combinations:

- ✓ Concrete compressive strength
- ✓ Steel reinforcement strength and development length
- ✓ Deflection and crack width

Deliver complete calculation packages: **bill of material and CAD details**



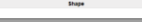

DRM1
Bill of material
Items numbering

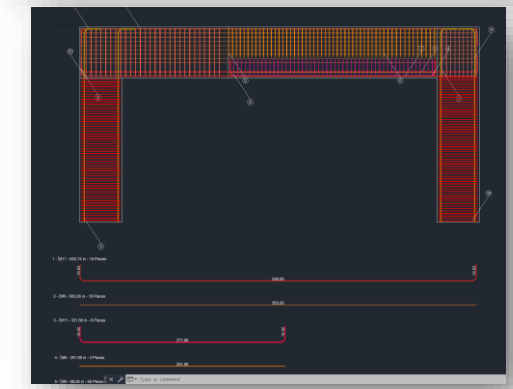
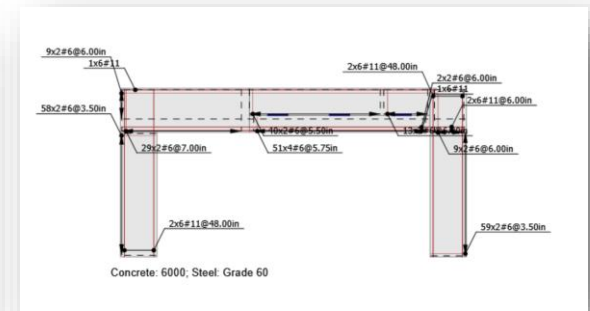


Brief reinforcement bar table

Index	Ø [in]	Material	Items	Length [ft]	Weight [lbs]	Total length [ft]
1	#11	Grade 60	18	622.74	207	894.10
2	#6	Grade 60	18	463.59	71	644.59
3	#11	Grade 60	6	331.66	147	165.03
4	#6	Grade 60	4	291.68	37	17.23
5	#6	Grade 60	18	68.06	9	538.97
6	#6	Grade 60	106	48.10	5	534.24
7	#6	Grade 60	18	79.03	9	105.03
8	#6	Grade 60	200	24.02	3	460.38
9	#11	Grade 60	24	293.84	100	607.70
10	#6	Grade 60	234	56.96	7	1093.23

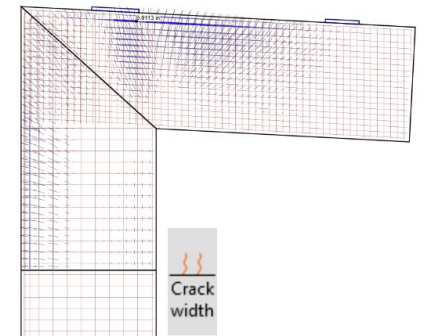
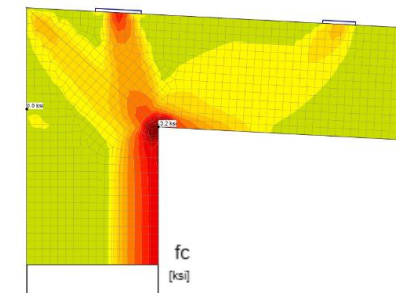
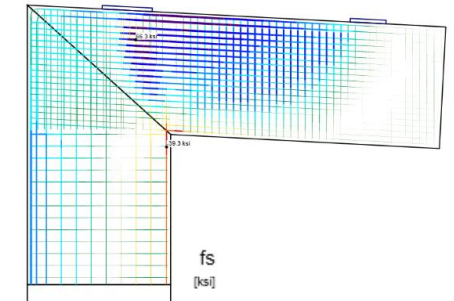
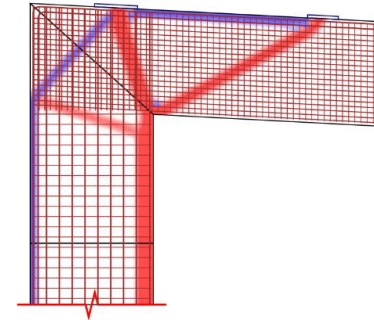
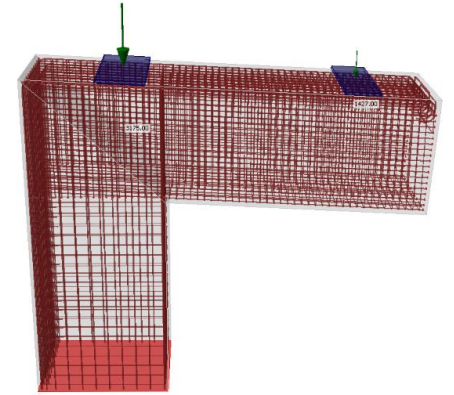
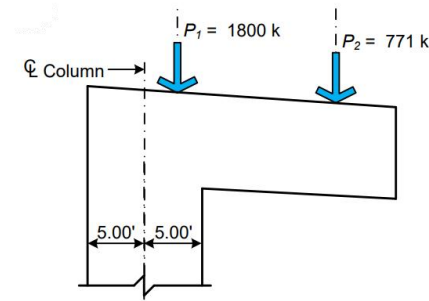
Detailed reinforcement bar table

Parameter	Value	Shape
Index	1	
Ø [in]	#11	
Material	Grade 60	
Number of items	18	
Length [ft]	622.74	
Weight [lbs]	207	
Total length [ft]	894.10	
Parameter	Value	Shape
Index	2	
Ø [in]	#6	
Material	Grade 60	
Number of items	18	
Length [ft]	463.59	
Weight [lbs]	71	
Total length [ft]	644.59	
Parameter	Value	Shape
Index	3	
Ø [in]	#11	
Material	Grade 60	
Number of items	6	
Length [ft]	331.66	
Weight [lbs]	147	
Total length [ft]	165.03	
Parameter	Value	Shape
Index	4	
Ø [in]	#6	
Material	Grade 60	
Number of items	4	
Length [ft]	291.68	
Weight [lbs]	37	
Total length [ft]	17.23	



DOWNLOAD VERSION 26.0 NOW!

- AASHTO ready tutorials
 1. Cantilever bent cap
 2. Inverted-tee moment frame straddle bent cap



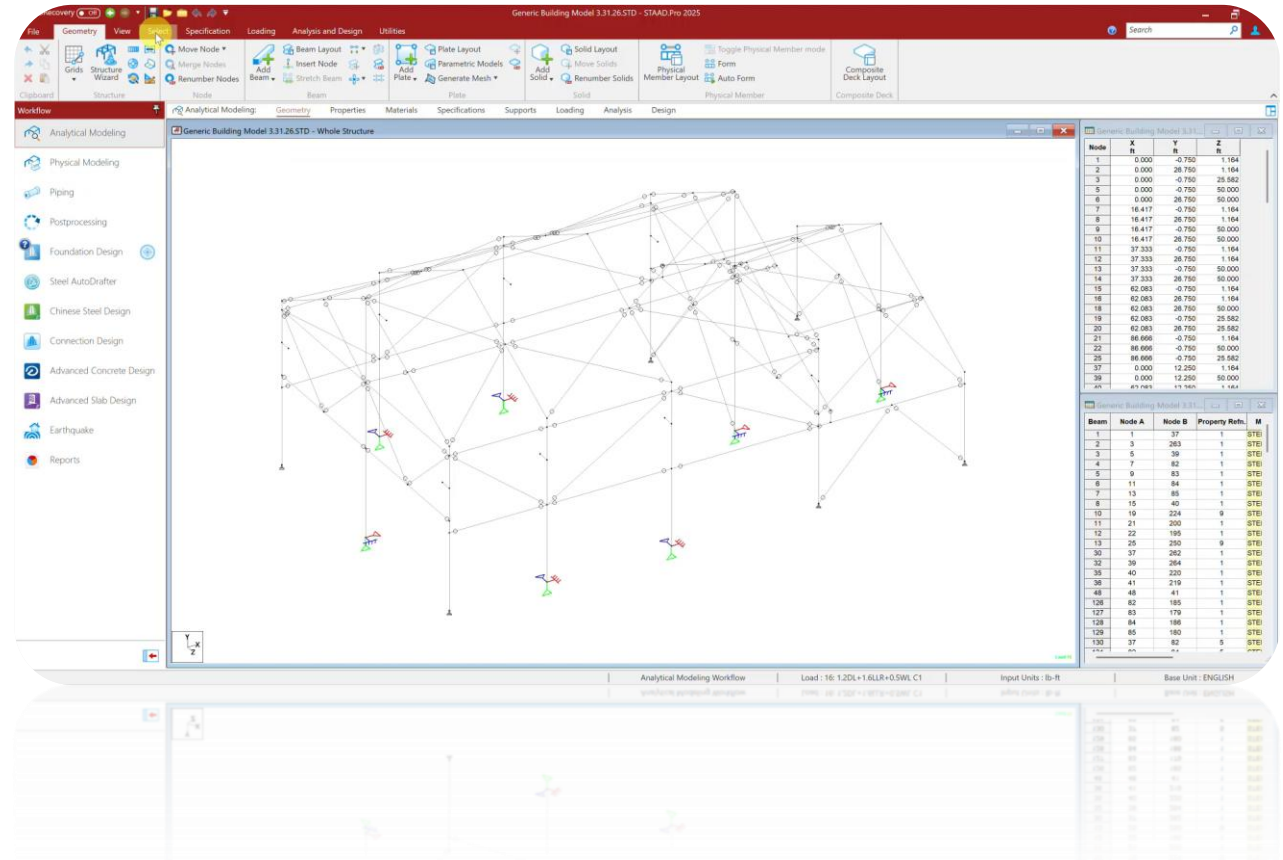
VERSION 26

- ❑ Checkbot 3D Scene improved
- ❑ Utilization ratio prediction for connections
- ❑ Detail 3D: Anchor checks, failing members explanation, surface support reactions
- ❑ Detail 3D model update from Connection app
- ❑ Complete solution for embedded plates



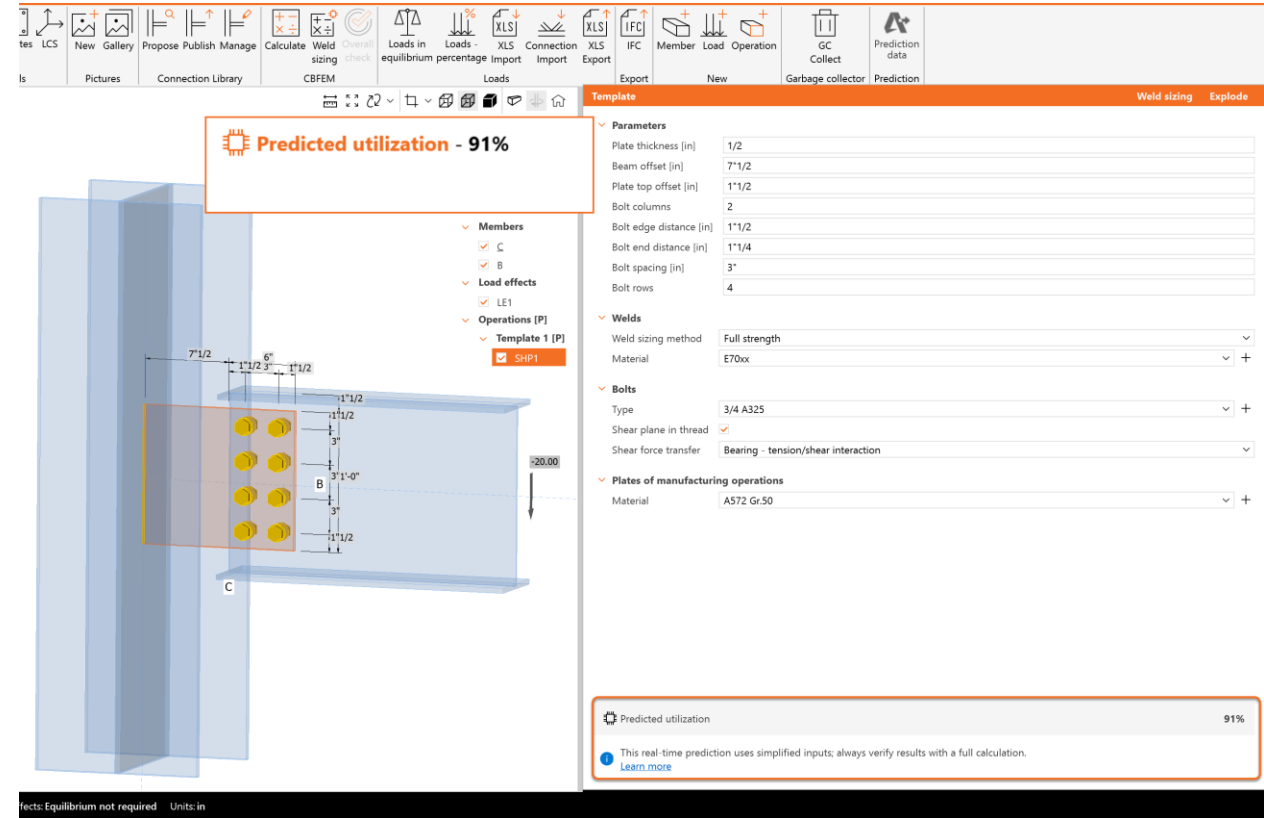
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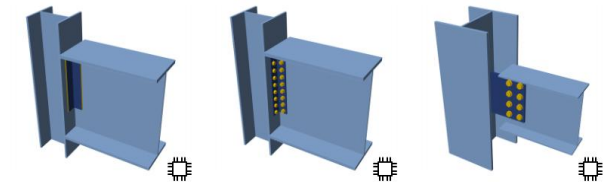


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- ❑ Complete solution for embedded plates



Utilization considers steel components, forces, welds, bolts



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3D DETAIL

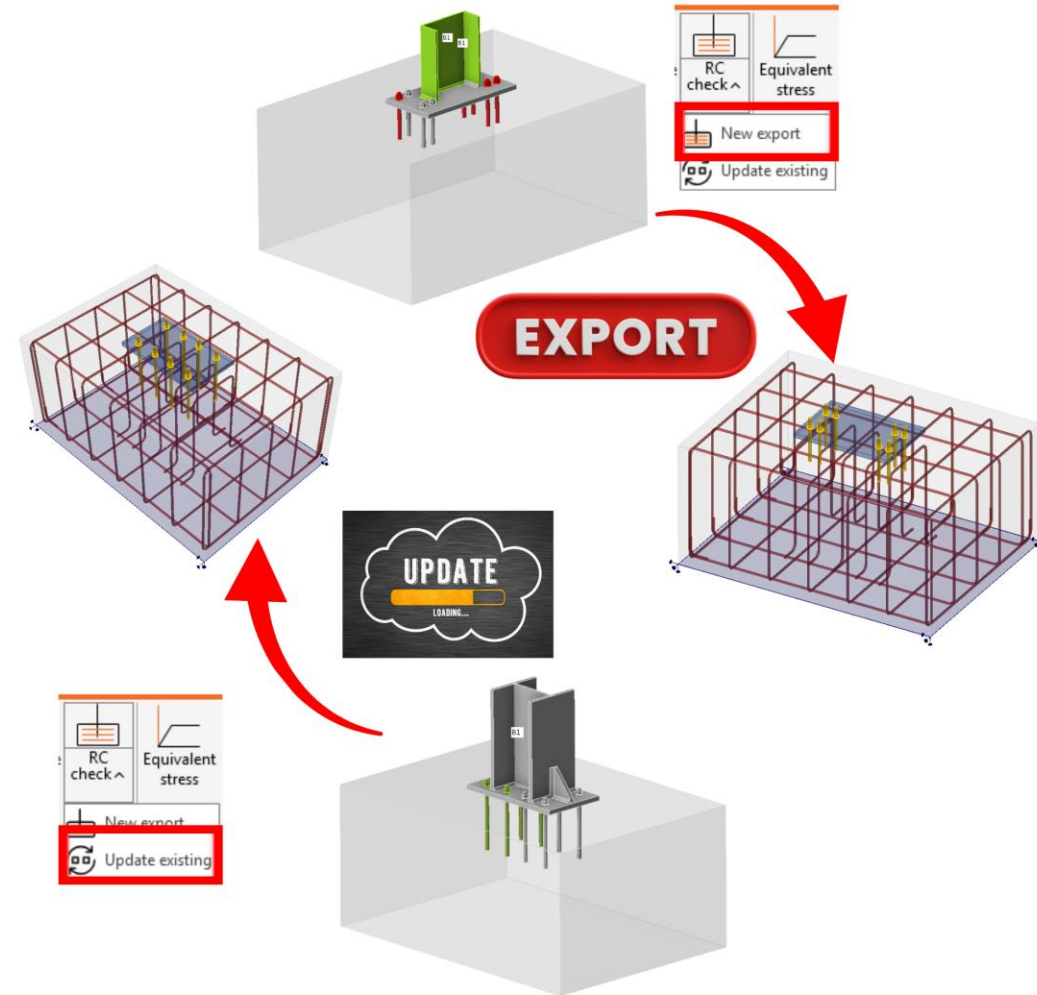
The screenshot displays the '3D DETAIL' software interface. On the left, a 3D model of a steel connection is shown with a red highlight on a vertical member. A red arrow points from the 'Failing elements' section to this member. The 'Failing elements' section shows a list of nonconformities: AN3 (Concrete crushing at the anchor-concrete...) and C1 (The calculation stopped because Concrete crushing at the anchor-concrete interface due to shear has reached the limit.).

The 'REPORT' section shows a table of results for 'Extreme ULS: C1 (G14.3%)'. The table has columns for 'Check item', 'Item', and 'Utilization'. The row for 'Failing anchors' shows 'AN3' and 'F bear / F bear,lim: 100.0 %' with a red 'X' icon.

Check item	Item	Utilization
> Failing anchors	AN3	F bear / F bear,lim: 100.0 %

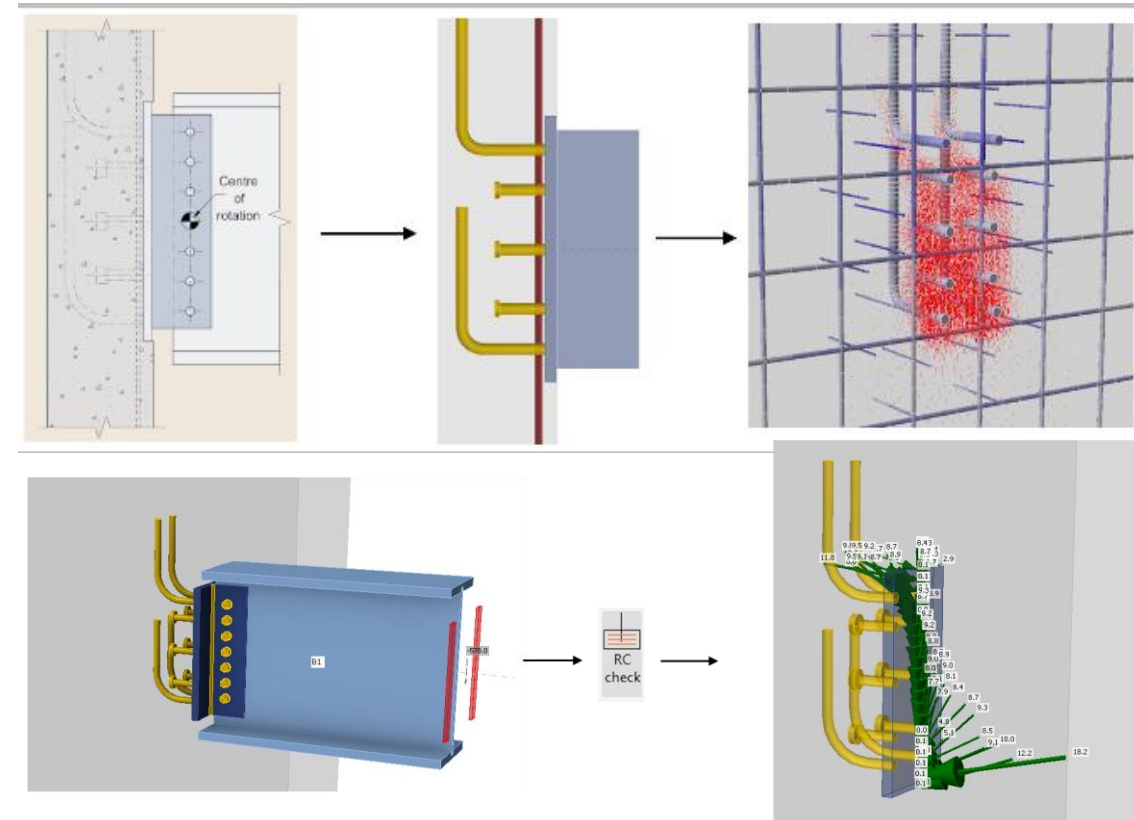
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- ❑ Complete solution for embedded plates



NEXT STEPS: BRIDGE ENGINEER TOOLKIT

Technology Toolkit for Bridge Engineers

NEWS

Technology Toolkit for Bridge Engineers

May 21, 2026 | Author: [Andrea Castelo](#)

[CONCRETE](#) [Detail 2D](#) [Detail 3D](#) [Bridges](#) [Concrete Topics](#)

This article is also available in:

To help accelerate your onboarding into bridge design workflows, we've compiled some of the most valuable resources for bridge engineers using advanced analysis methods in IDEA StatiCa.

Quick Links

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- 2 Download project [example models](#)
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Review the resources below to see how bridge engineers can use IDEA StatiCa Detail to design, verify, and optimize reinforced concrete bridge components using AASHTO workflows.

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