We check structures according to standards

Software: What is SDC Verifier?

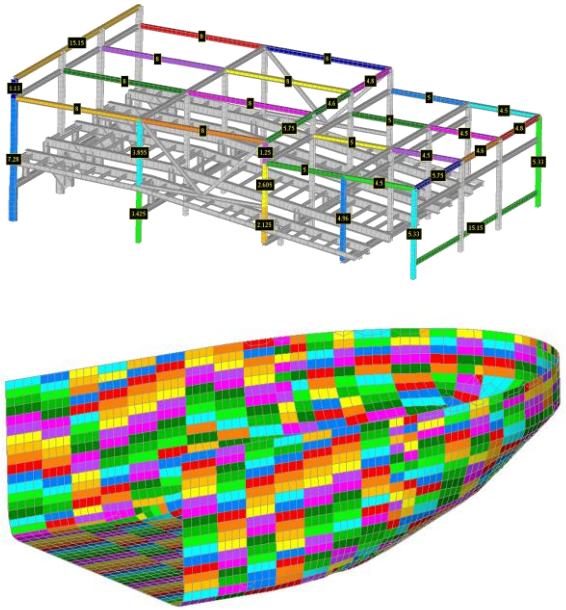
Load Combination

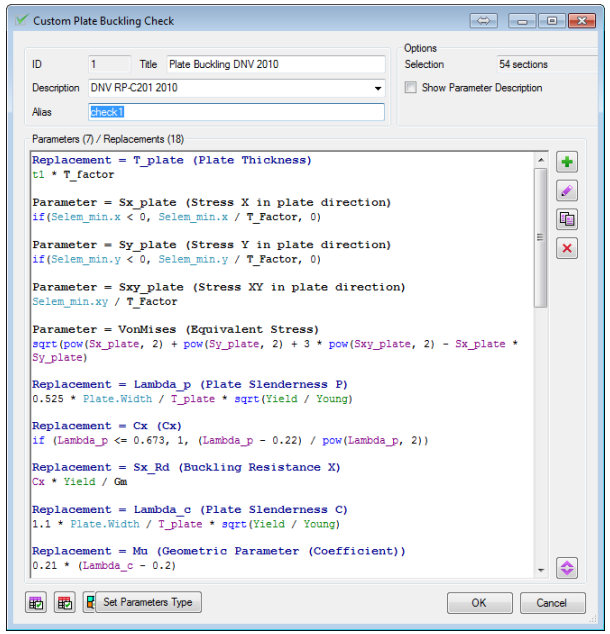
Recognition

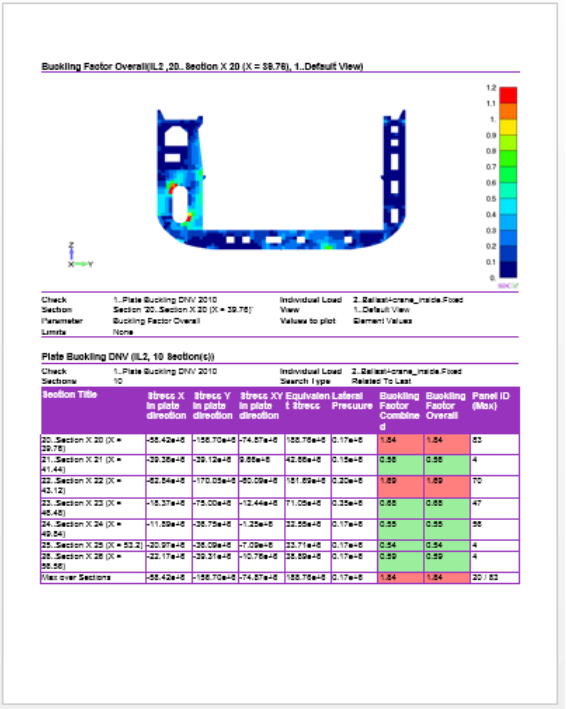
Checks

Reports

	IL1	IL2	IL3	IL4
LC1_Long_forestay_1	1.43			
LC1_Long_forestay_2	1.43			
LC1_Long_forestay_3	1.43			
LC1_Long_forestay_4	1.43			
LC1_Long_short_1		1.43		
LC1_Long_short_2		1.43		
LC1_Long_short_3		1.43		
LC1_Long_short_4		1.43		
LC1_Short_forestay_1			1.43	
LC1_Short_forestay_2			1.43	
LC1_Short_forestay_3			1.43	
LC1_Short_forestay_4			1.43	
LC1_Long_short_1				1.43
LC1_Long_short_2				1.43
LC1_Long_short_3				1.43
LC1_Long_short_4				1.43







SDC Verifier is an extension for

Seamless integration with:

FEMAP

Coming soon for:

SIMCENTER ANSYS®

Load combinations: example from Standard

Software

Load Combination

Recognition

Checks

Reports

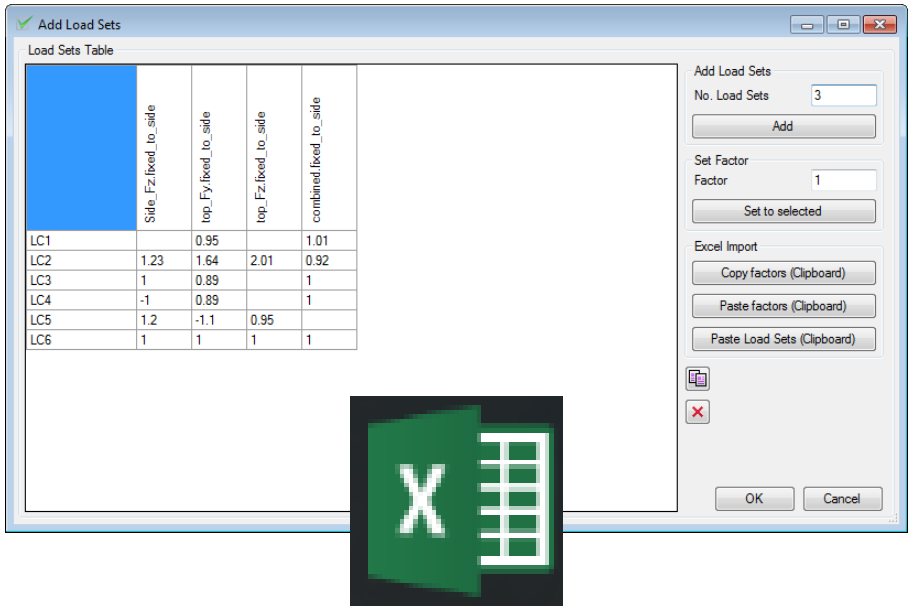
19 Individual loads

3 Load Groups

18 Load Sets

Table 10 — Loads, load combinations and partial safety factors

Categories of loads	Loads f_i			i	Ref.	Load combinations A					Load combinations B						Load combinations C								
						Partial safety factors γ_p	A1	A2	A3	A4	Partial safety factors γ_p	B1	B2	B3	B4	B5	Partial safety factors γ_p	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C9
Regular	Gravitation acceleration, Impacts	Mass of the crane		1	4.2.2.1	*)	ϕ_1	ϕ									1				1	1	1	1	1	1
		Mass of the hoist load		2	4.2.2.2	1,34	ϕ_2	ϕ													1	1	1	1	1	-
		Masses of the crane and the hoist load, travelling on uneven surface		3	4.2.2.3	1,22	-														-	-	-	-	-	-
	Acceleration from drives	Masses of the crane and the hoist load	Hoist drives excluded	4	4.2.2.4	1,34	ϕ_5	ϕ_5	-	ϕ_5	1,22	ϕ_5	ϕ_5	-	ϕ_5	-	1,1	-	-	ϕ_5	-	-	-	-	-	-
			Hoist drives included	5			-	-	ϕ_5	-		-	-	ϕ_5	-	-		-	-	-	-	-	-	-	-	-
	Displacements			6	4.2.2.5	**)	1	1	1	1	**)	1	1	1	1	1	**)	1	1	1	1	1	1	1	1	1
Occasional	Environmental actions	In-service wind loads		7	4.2.3.1	-	-	-	-	-	1,22	1	1	1	1	1	1,16	-	-	1	-	-	-	-	-	-
		Snow and ice loads		8	4.2.3.2	-	-	-	-	-	1,22	1	1	1	1	1	1,1	-	1	-	-	-	-	-	-	-
		Temperature variations		9	4.2.3.3	-	-	-	-	-	1,16	1	1	1	1	1	1,05	-	1	-	-	-	-	-	-	-
	Skewing			10	4.2.3.4	-	-	-	-	-	1,16	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
						γ_p					γ factors γ_p						γ factors γ_p									
Exceptional	Hoisting a grounded load			11	4.2.4.1	-	-	-	-	-	-	-	-	-	-	-	1,1	ϕ_2	-	-	-	-	-	-	-	-
	Out-of-service wind loads			12	4.2.4.2	-	-	-	-	-	-	-	-	-	-	-	1,16	-	1	-	-	-	-	-	-	-
	Test loads			13	4.2.4.3	-	-	-	-	-	-	-	-	-	-	-	1,1	-	-	ϕ_6	-	-	-	-	-	-
	Buffer forces			14	4.2.4.4	-	-	-	-	-	-	-	-	-	-	-	1,1	-	-	-	ϕ_7	-	-	-	-	-
	Tilting forces			15	4.2.4.5	-	-	-	-	-	-	-	-	-	-	-	1,1	-	-	-	-	1	-	-	-	-
	Emergency cut-out			16	4.2.4.6	-	-	-	-	-	-	-	-	-	-	-	1,1	-	-	-	-	-	ϕ_5	-	-	-
	Failure of mechanism			17	4.2.4.7	-	-	-	-	-	-	-	-	-	-	-	1,1	-	-	-	-	-	-	ϕ_5	-	-
	Excitation of the crane foundation			18	4.2.4.8	-	-	-	-	-	-	-	-	-	-	-	1,1	-	-	-	-	-	-	-	1	-
	Erection ,dismantling and transport			19	4.2.4.9	-	-	-	-	-	-	-	-	-	-	-	1,1	-	-	-	-	-	-	-	-	1
Overall safety factor γ_f						-	1,48				-	1,34					-	1,22								
Resistance coefficient γ_m						1,1	-				1,1	-					1,1	-								



	A	B	C	D	E
1	LC1		0,95		1,01
2	LC2	1,23	1,64	2,01	0,92
3	LC3	1	0,89		1
4	LC4	-1	0,89		1
5	LC5	1,2	-1,1	0,95	
6	LC6	1	1	1	1
7					

Panel Finder. Recognition of sections

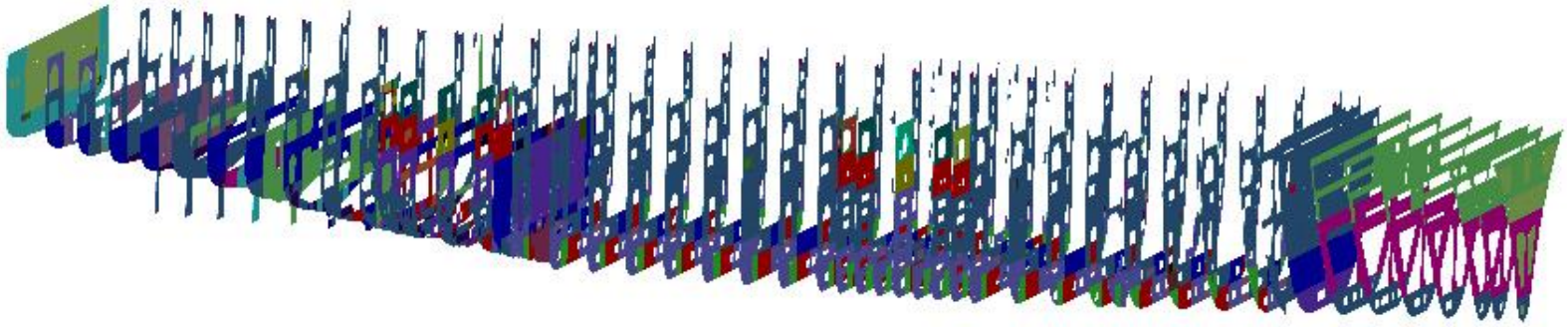
Software

Load Combination

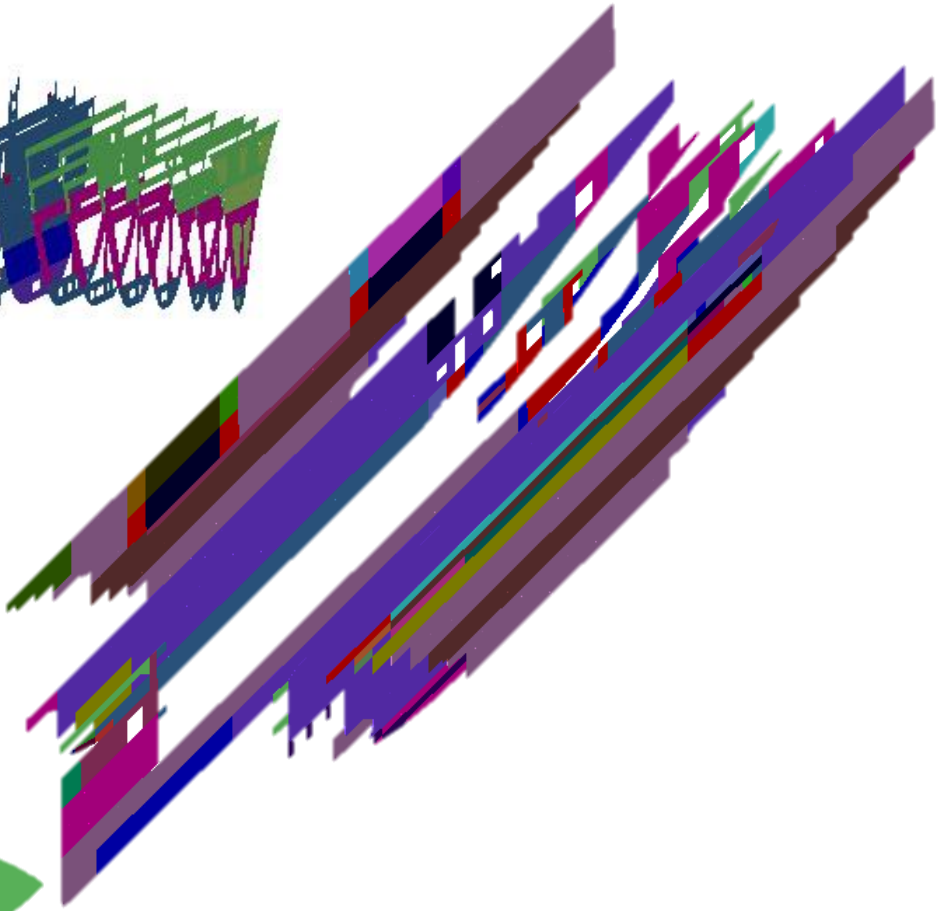
Recognition

Checks

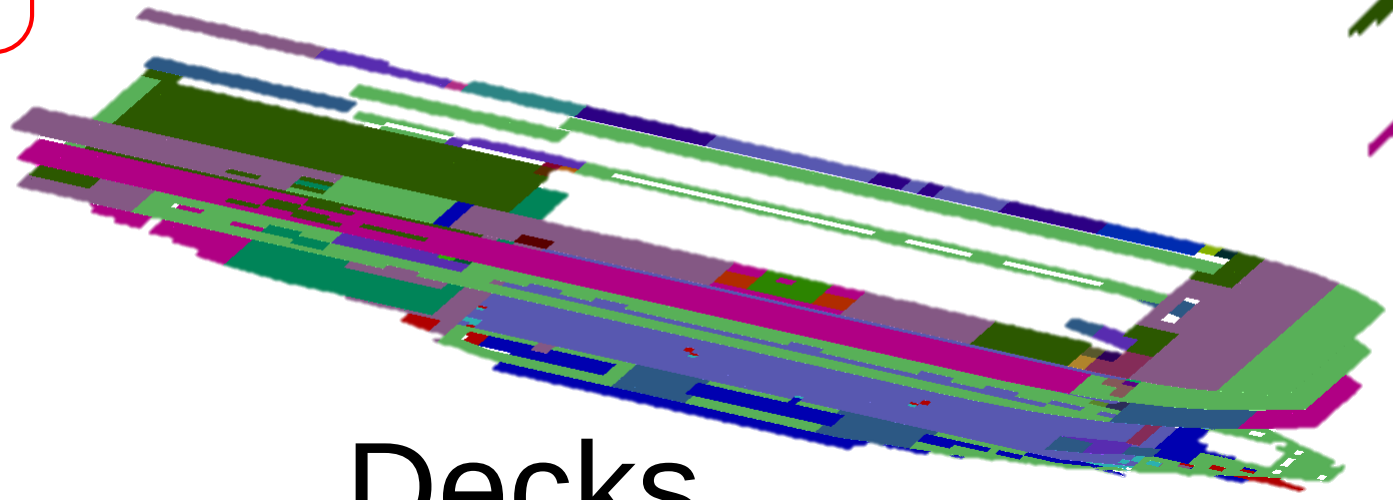
Reports



Frames



Longitudinals



Decks

Panel Finder. Recognition of plates

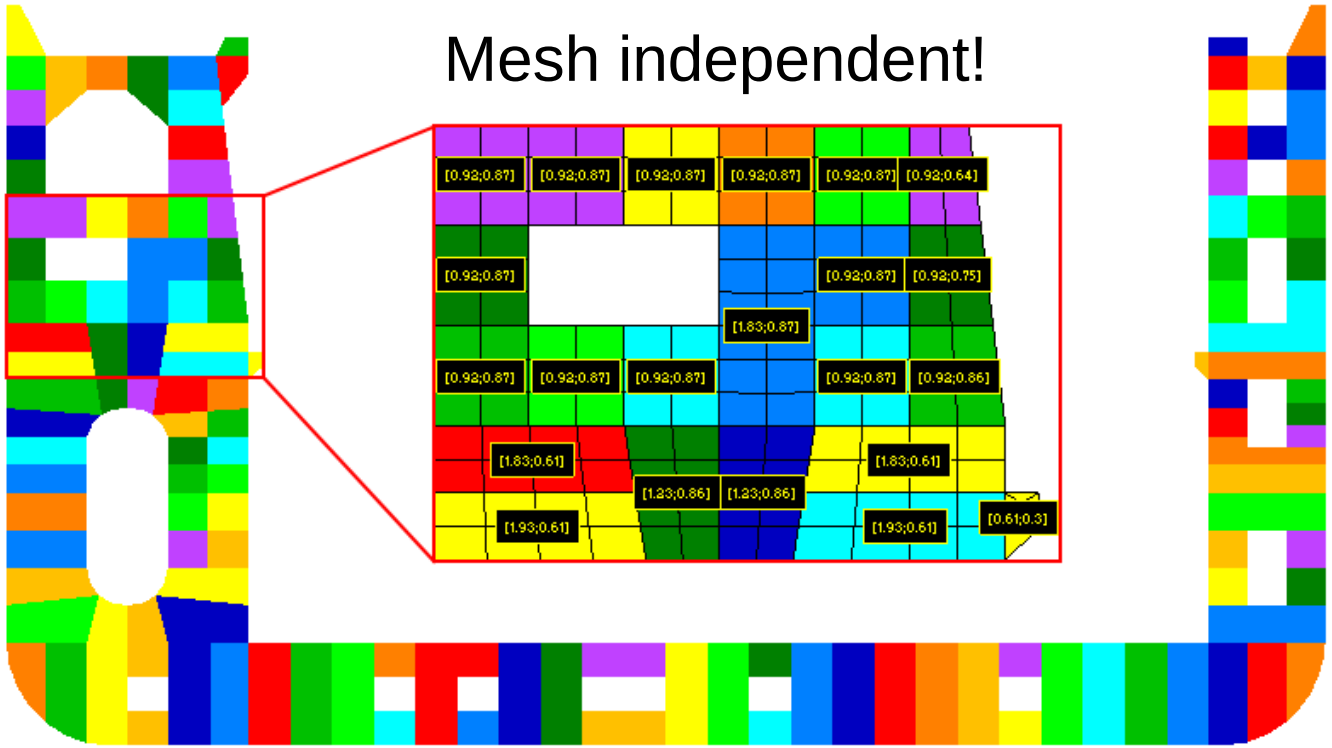
Software

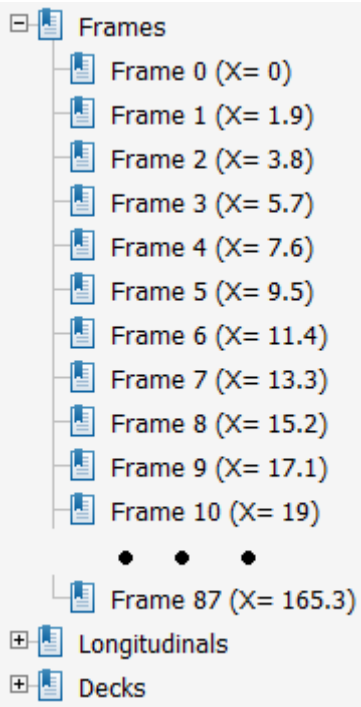
Load Combination

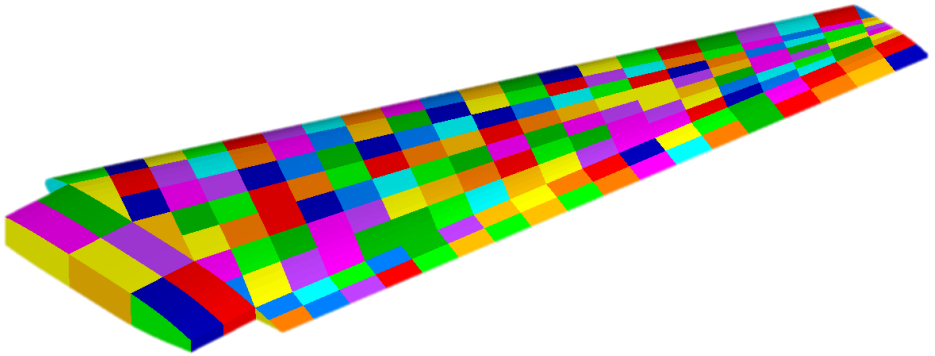
Recognition

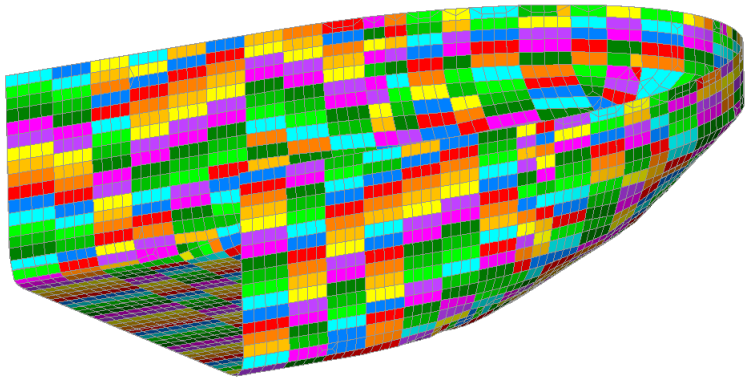
Checks

Reports









Recognition of panels and stiffeners

Software

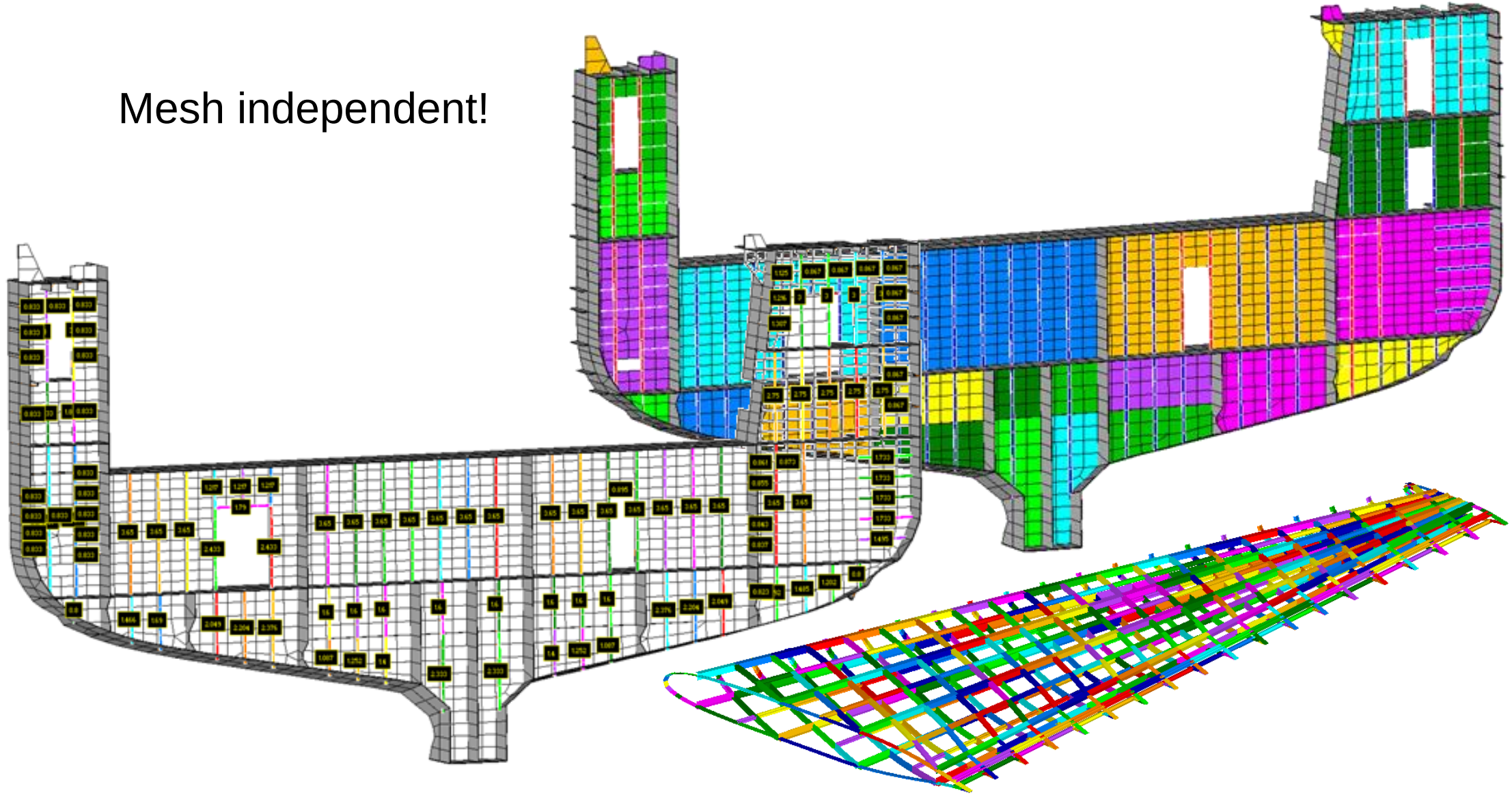
Load Combination

Recognition

Checks

Reports

Mesh independent!



Recognition of joints

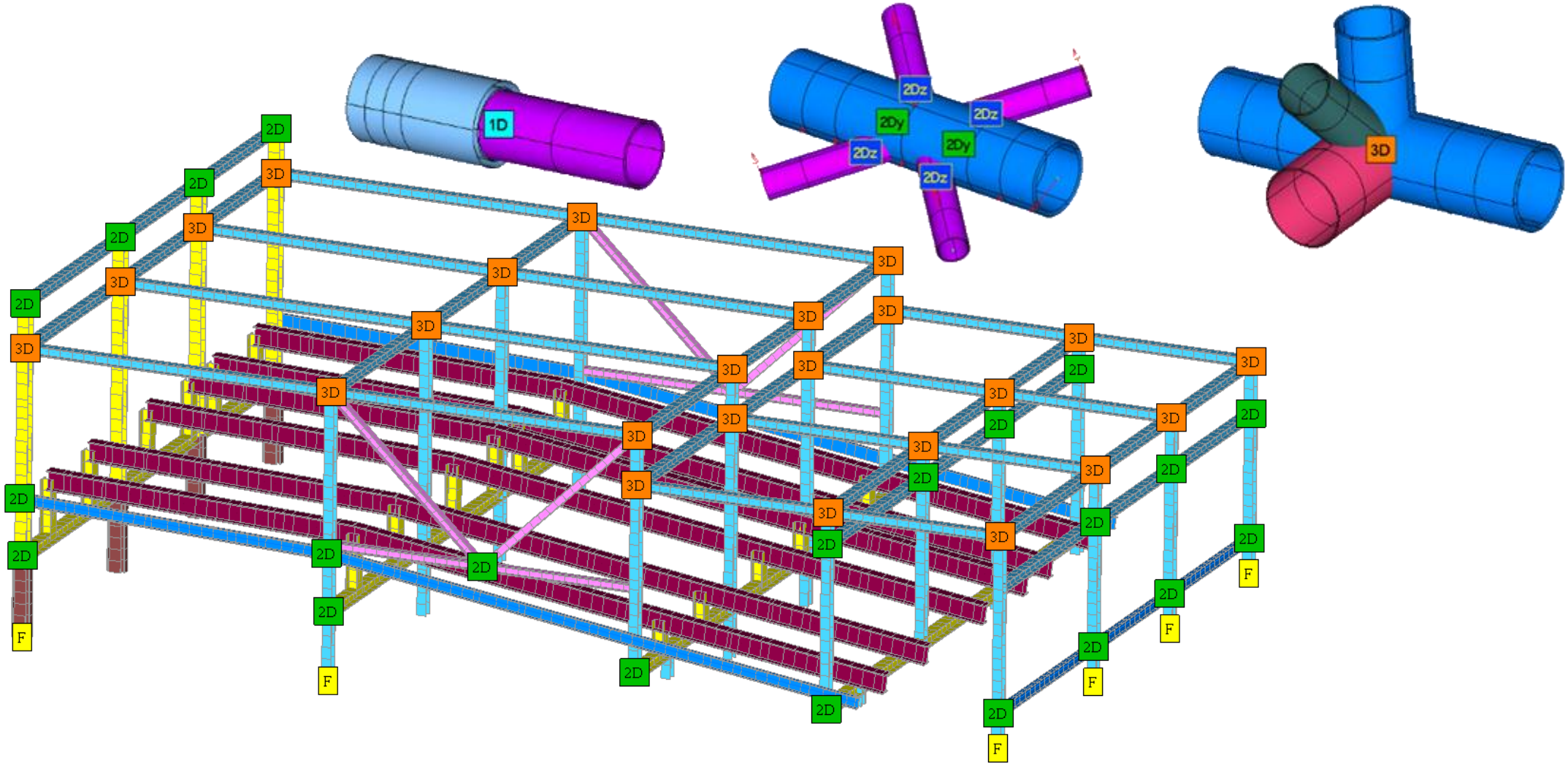
Software

Load Combination

Recognition

Checks

Reports



Joints are used to determine buckling lengths and for Joint Checks

Recognition of beam members

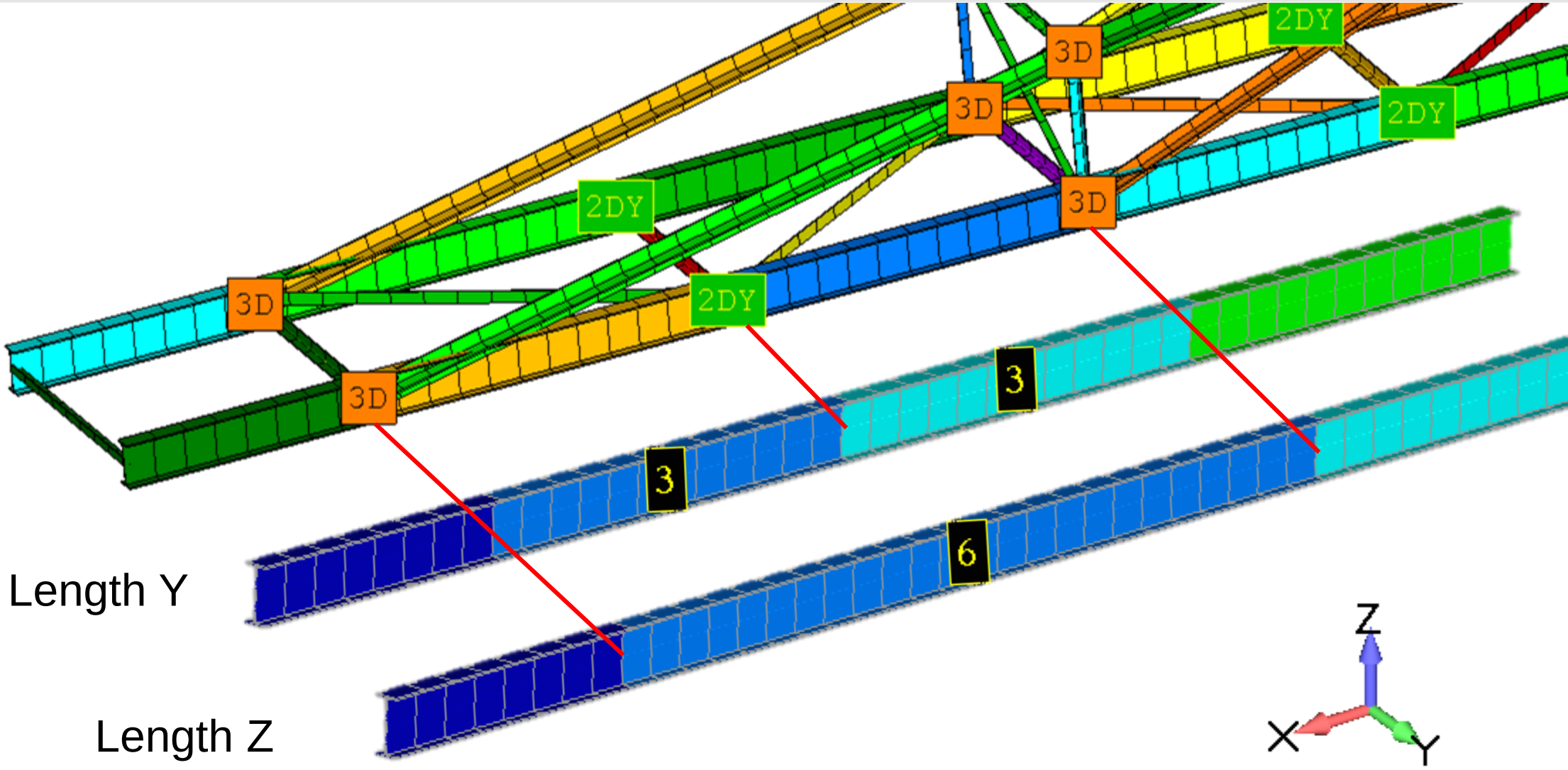
Software

Load Combination

Recognition

Checks

Reports



Recognitions of welds

Software

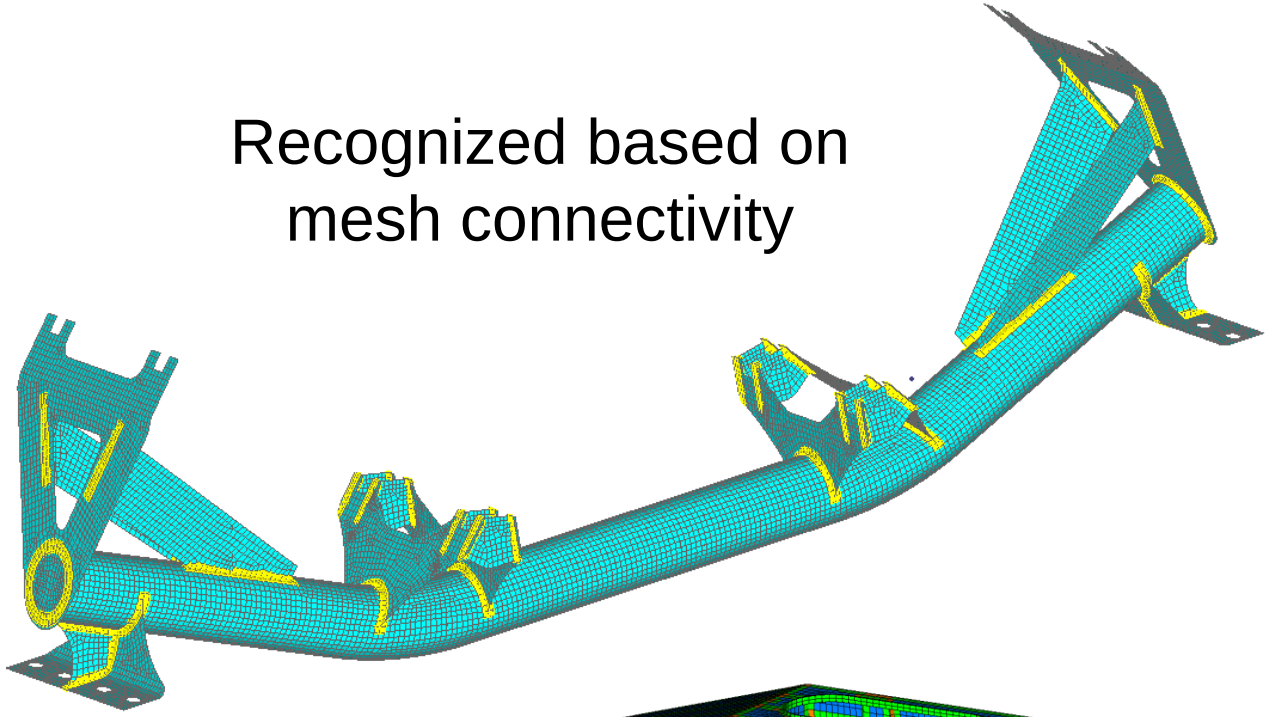
Load Combination

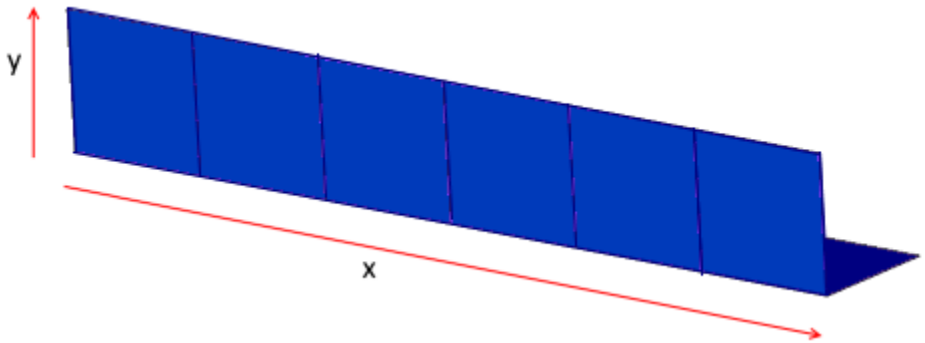
Recognition

Checks

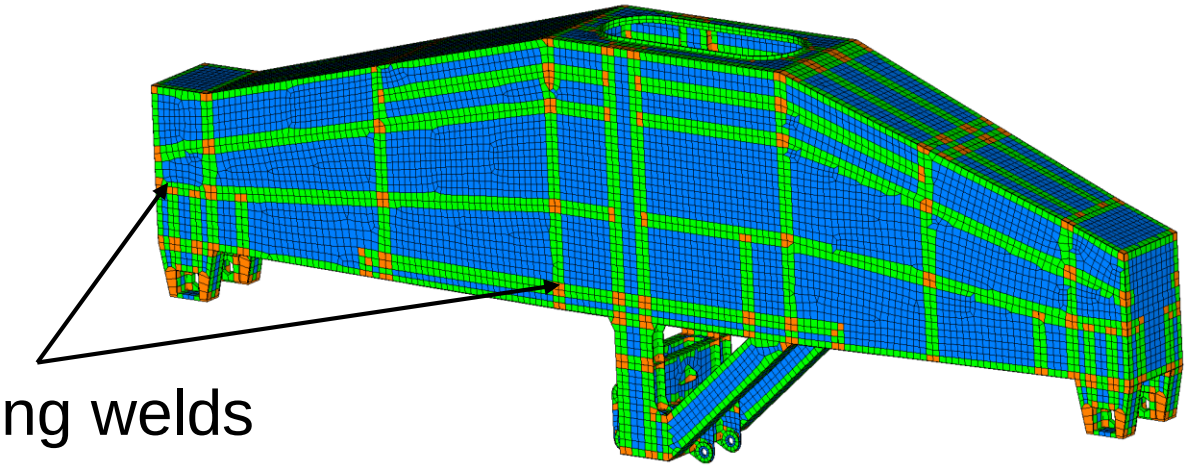
Reports

Recognized based on mesh connectivity





Convert stresses into weld direction:
Sx – parallel to the weld
Sy - perpendicular



Crossing welds

Recognize chord, braces and gaps. Brace Classifications

Software

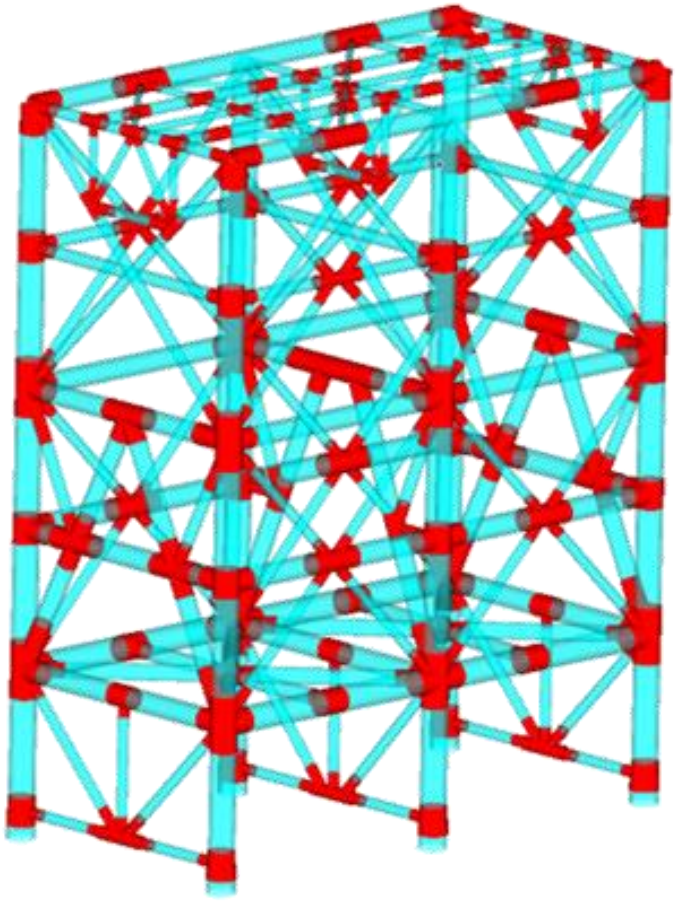
Load Combination

Recognition

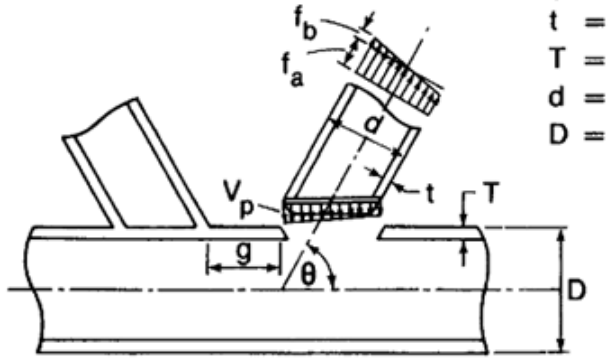
Checks

Reports

Recognize Brace, Chord and Gap

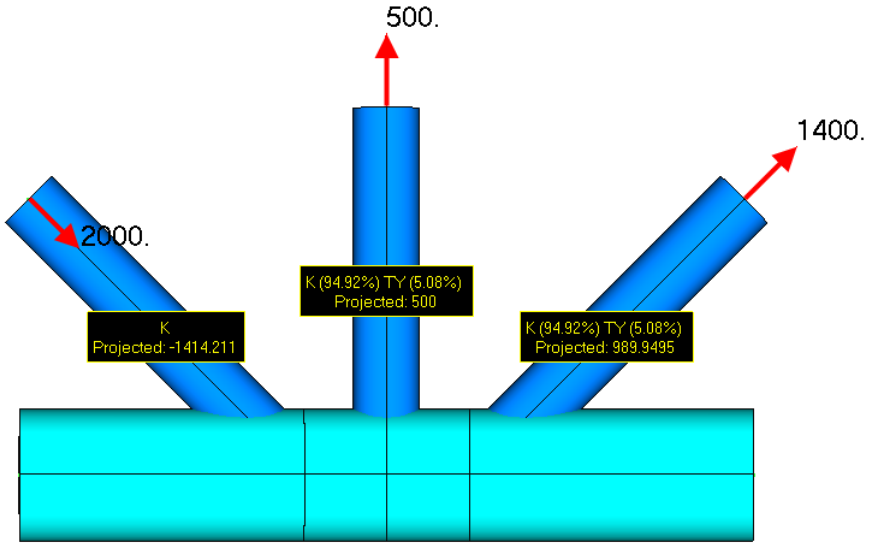


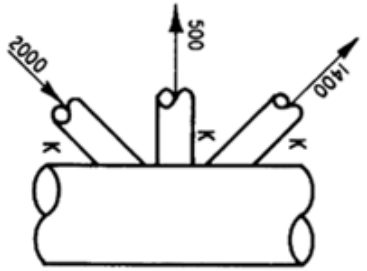
θ = BRACE ANGLE (measured from chord)
g = GAP
t = BRACE THICKNESS
T = CHORD THICKNESS
d = BRACE DIAMETER
D = CHORD DIAMETER



$$\tau = \frac{t}{T} \qquad \beta = \frac{d}{D} \qquad \gamma = \frac{D}{2T}$$

Brace classification (load dependent)

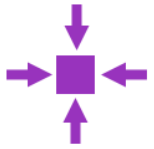




Connection ID	Brace Number	Joint Type
1	#1 (ElemID = 27)	K
	#2 (ElemID = 13)	K (94.92%) TY (5.08%)
	#3 (ElemID = 19)	K (94.92%) TY (5.08%)

Implemented standards

Software



Load Combination

Recognition

Checks

Reports

Beam Buckling

AISC 360-10

Eurocode3

API RP 2A

ISO 19902

Norsok N004

Fatigue

FEM 1.001

DIN 15018

Eurocode3
EN13001

Plate Buckling

ABS 2004 &
2014

DNV 1995 &
2010

Checks are open

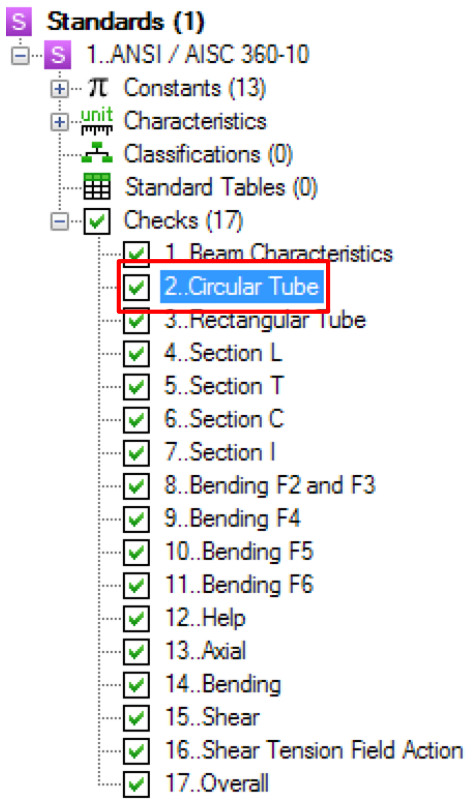
Software

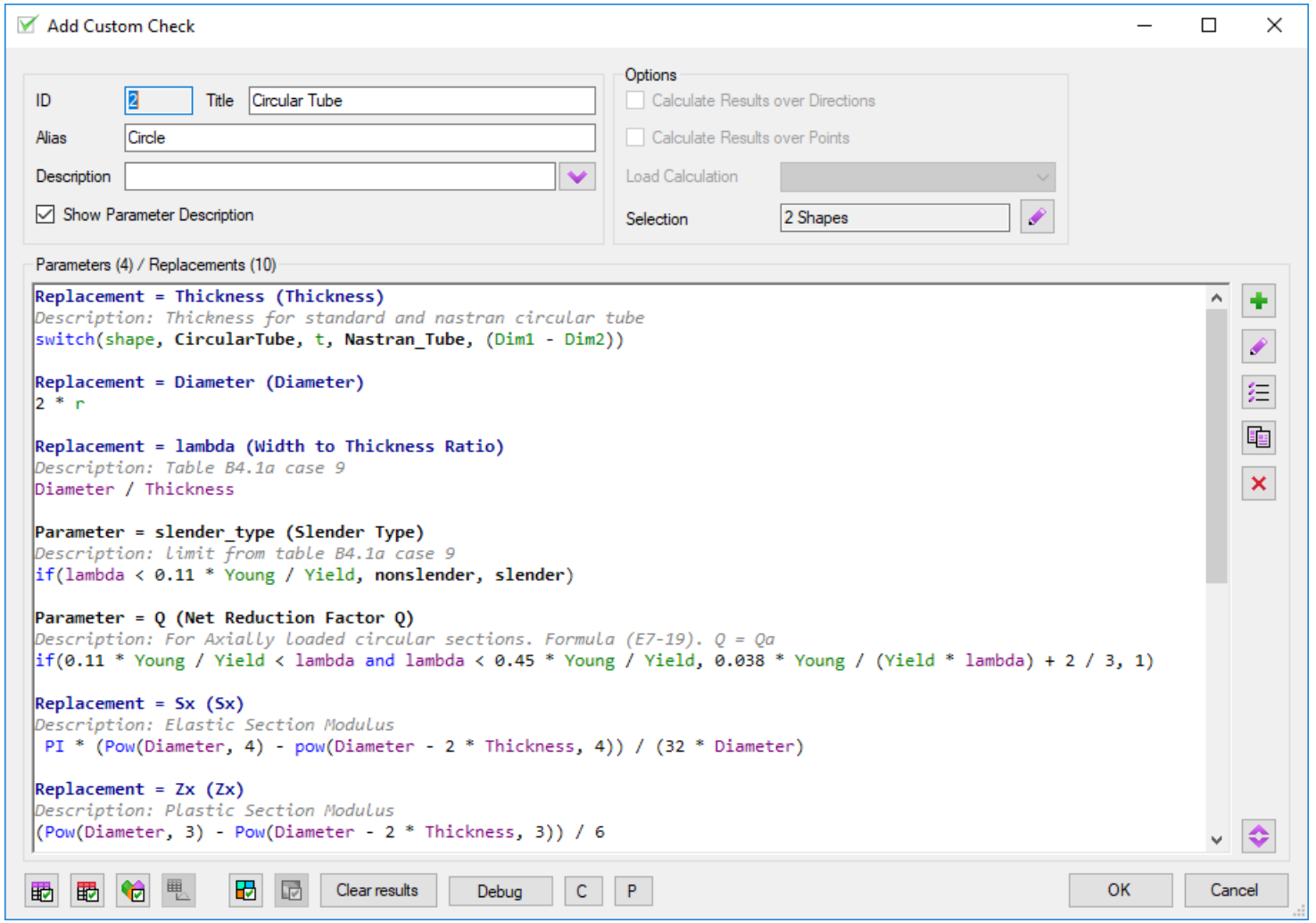
Load Combination

Recognition

Checks

Reports





Formulas can be preview/modified in editor (and included into report)

Fatigue Checks

Software

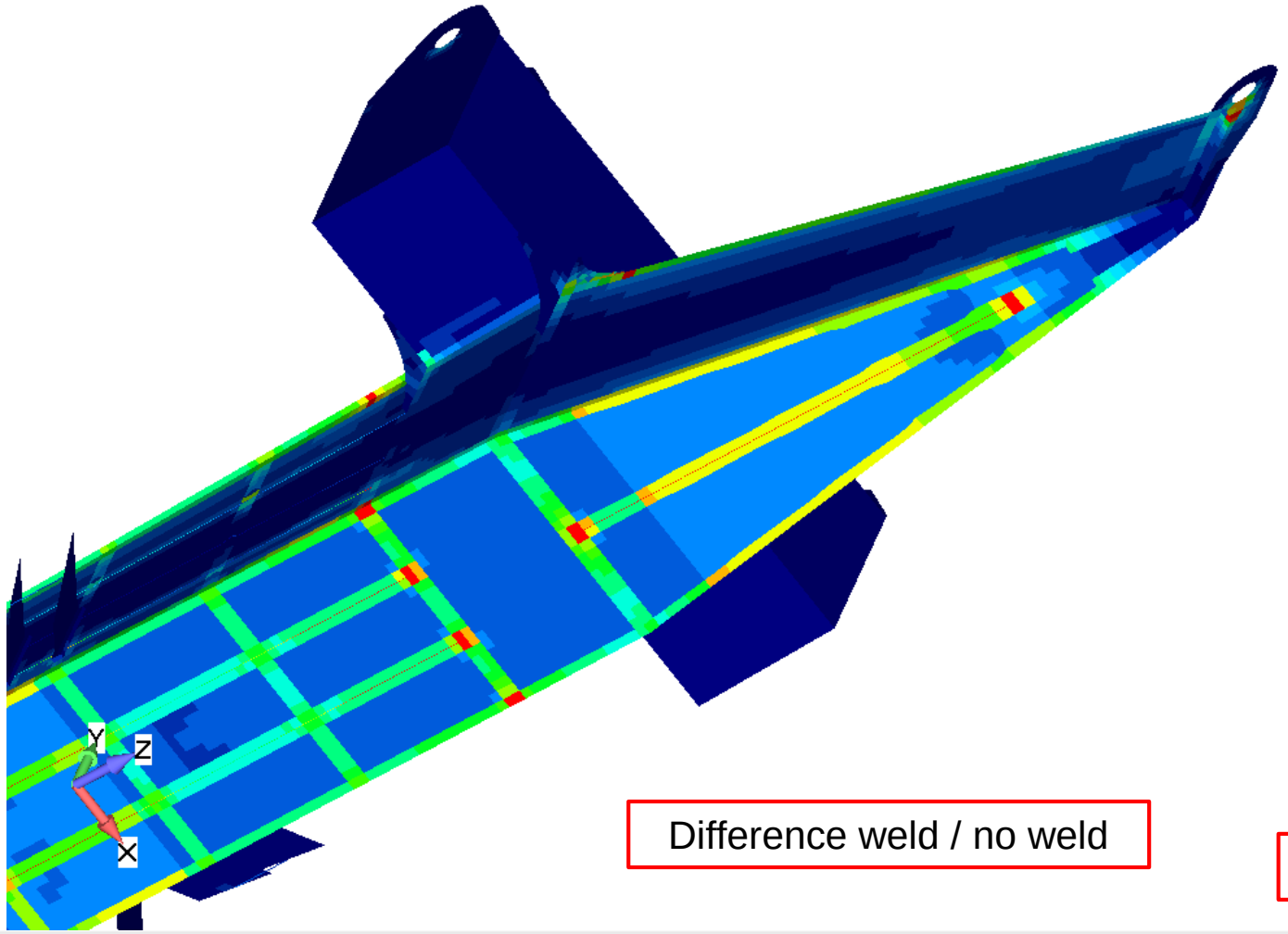
Load Combination

Recognition

Checks

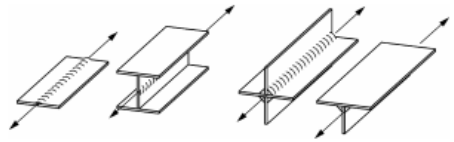
Reports

Fatigue check according to Eurocode 3 / EN13001 / FEM 1.001

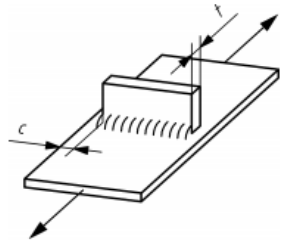


Difference weld / no weld

Table D.3 — Welded members - (4

Detail No.	$\Delta\sigma_c$ $\Delta\tau_c$ N/mm^2	Constructional detail
3.7	m = 3	 Normal stress in weld direction
	180	Continuous weld, quality level B
	140	Continuous weld, quality level C
	80	Intermittent weld, quality level C

FAT class parallel to the weld

3.28	m = 3	 Continuous component to which parts are welded transversally
	112	Double fillet weld, quality level B*
	100	Double fillet weld, quality level B
	90	Double fillet weld, quality level C
	71	Single fillet weld, quality level B, C
	71	Partial penetration V-weld on remaining backing, quality level B, C

FAT class perpendicular to the weld

Plate Buckling

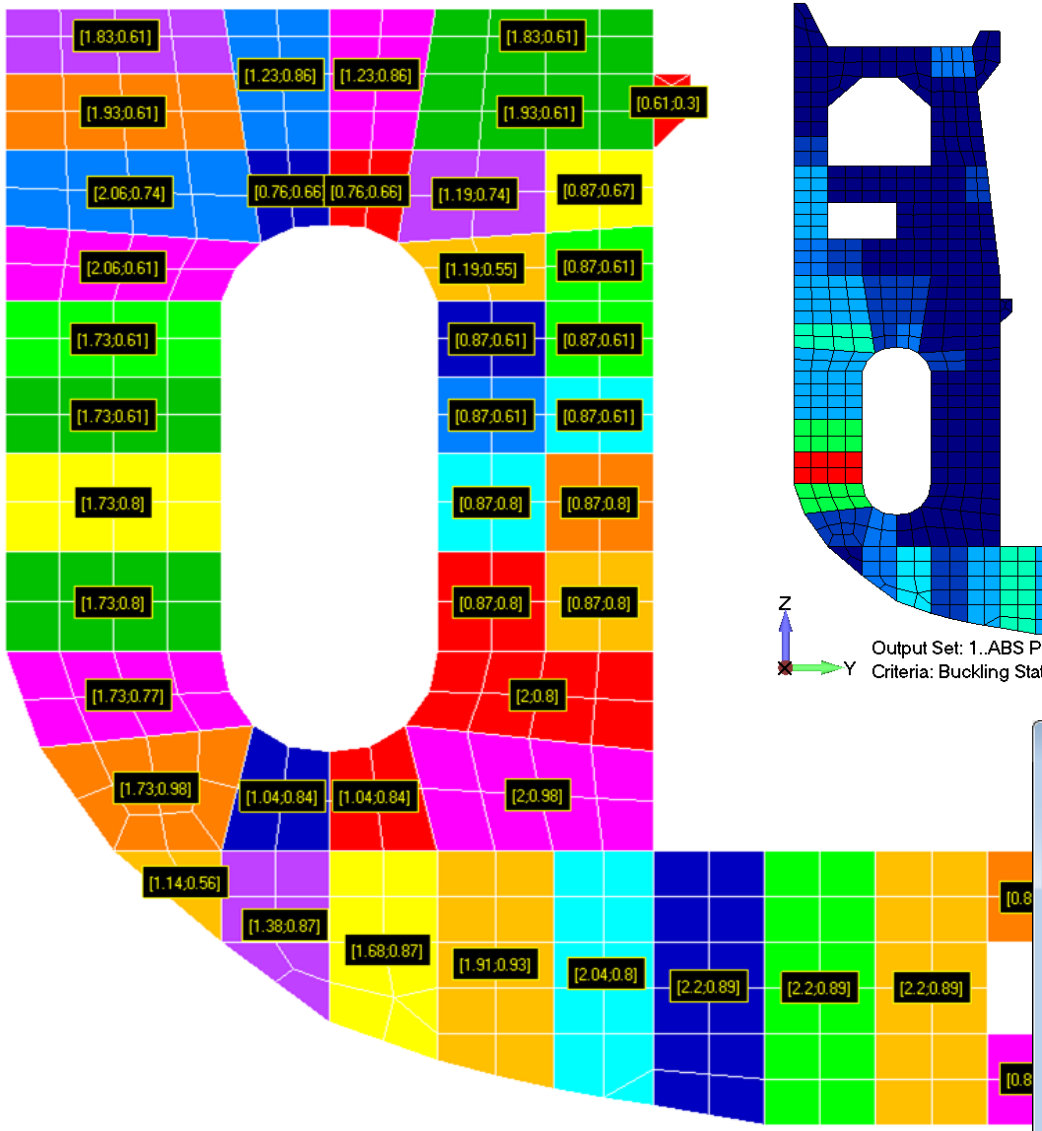
Software

Load Combination

Recognition

Checks

Reports



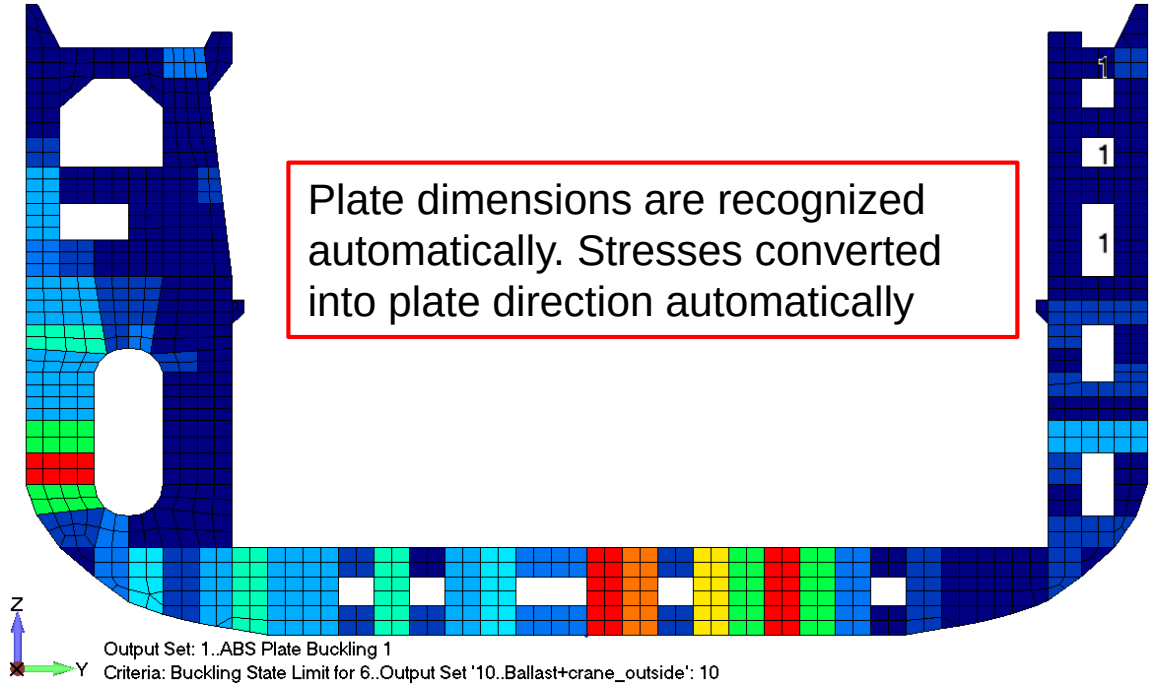


Plate dimensions are recognized automatically. Stresses converted into plate direction automatically

Plate Buckling Table

Select Load

Load: 6..Output Set '10..Ballast+crane_outside' — Select

Panel Name	Critical Sx	Critical Sy	Critical Txy	Buckling State	Ultimate	Ultimate	Ultimate	Ultimate Strength
57..Section X 57 (X = 39.76)	2.17e08	2.16e08	1.26e08	1.60	2.18e08	2.18e08	1.26e08	0.64
1..Plate 1 (Y = -8.5; Z = 1.12)	1.77e08	1.04e08	1.17e08	0.55	1.96e08	1.07e08	1.19e08	0.51
2..Plate 2 (Y = 13.73; Z = 4.2)	1.45e08	1.46e08	1.15e08	0.05	1.64e08	1.59e08	1.20e08	0.05
3..Plate 3 (Y = 13.66; Z = 3.4)	1.78e08	1.76e08	1.20e08	0.06	1.97e08	1.86e08	1.23e08	0.05
4..Plate 4 (Y = -0.89; Z = 0.37)	1.66e08	8.14e07	1.14e08	0.29	1.82e08	9.88e07	1.18e08	0.18
5..Plate 5 (Y = 0.45; Z = 1.1)	1.24e08	4.63e07	1.06e08	1.60	1.52e08	8.17e07	1.11e08	0.53
6..Plate 6 (Y = -13.72; Z = 13.68)	1.54e08	1.41e08	1.16e08	0.02	1.71e08	1.53e08	1.20e08	0.02

Fill Table — Close

Beam Buckling

Software

Load Combination

Recognition

Checks

Reports

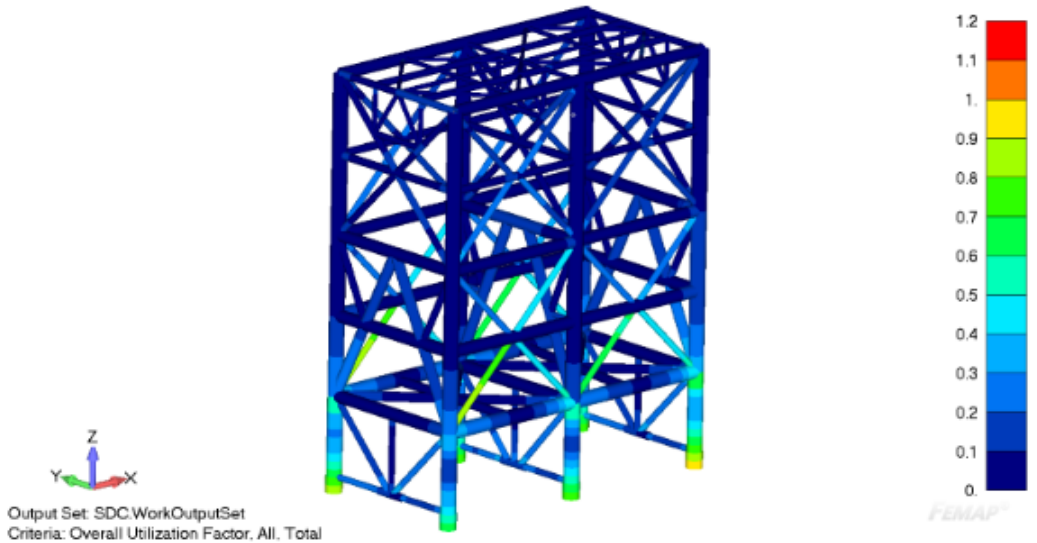
- Standards (1)
  - 1..ISO 19902 (1st, Dec 2007)
    - Constants (14)
    - Characteristics
    - Classifications (0)
    - Standard Tables (0)
    - Checks (9)
      - 1..Dimensions
      - 2..Limits
      - 3..Axial Stress Check
      - 4..Bending Stress Check
      - 5..Shear Stress Check
      - 6..Hydrostatic
      - 7..Axial and Bending Check
      - 8..Overall Check
      - 9..Joint Check ISO

All (LG1, 2 Shapes)

Standard	2..ISO 19902 (1st, Dec 2007)	**Check**	7..Overall Check
Load Group	1..Envelop	**Selection**	2 Shapes

Extreme	Absolute Axial Um	Absolute Bending Um	Absolute Shear Um	Absolute Shear Torsional Um	Absolute Axial and Bending Um	Overall Utilization Factor
Minimum						
Value	0.00	0.00	0.00	0.00	0.00	0.00
Element ID	514	1493	1338	514	1493	514
Load	LS2	LS2	LS2	LS2	LS2	LS2
Maximum						
Value	0.70	0.66	0.21	0.06	0.92	0.92
Element ID	930	2409	2409	760	981	981
Load	LS2	LS2	LS2	LS2	LS2	LS2
Absolute						
Value	0.70	0.66	0.21	0.06	0.92	0.92
Element ID	930	2409	2409	760	981	981
Load	LS2	LS2	LS2	LS2	LS2	LS2

Absolute Overall Utilization Factor (LG1, 2 Shapes, 1..Default View)



Output Set: SDC.WorkOutputSet
Criteria: Overall Utilization Factor, All, Total

Check	7..Overall Check	**Point**	Total
Load Group	1..Envelop	**Parameter**	Absolute Overall Utilization Factor
Selection	2 Shapes	**View**	1..Default View

Joint Check

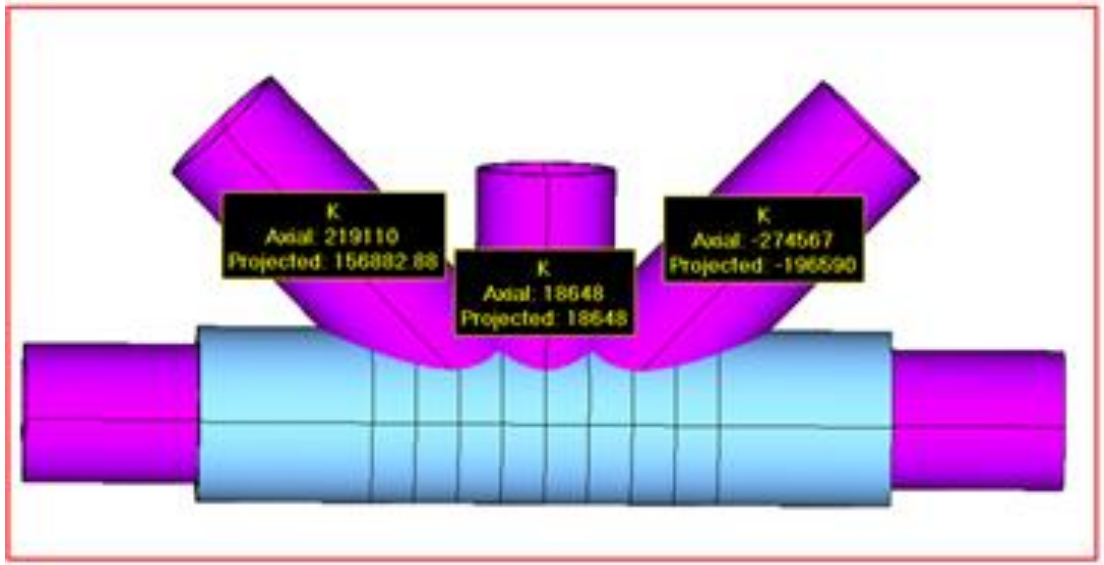
Software

Load Combination

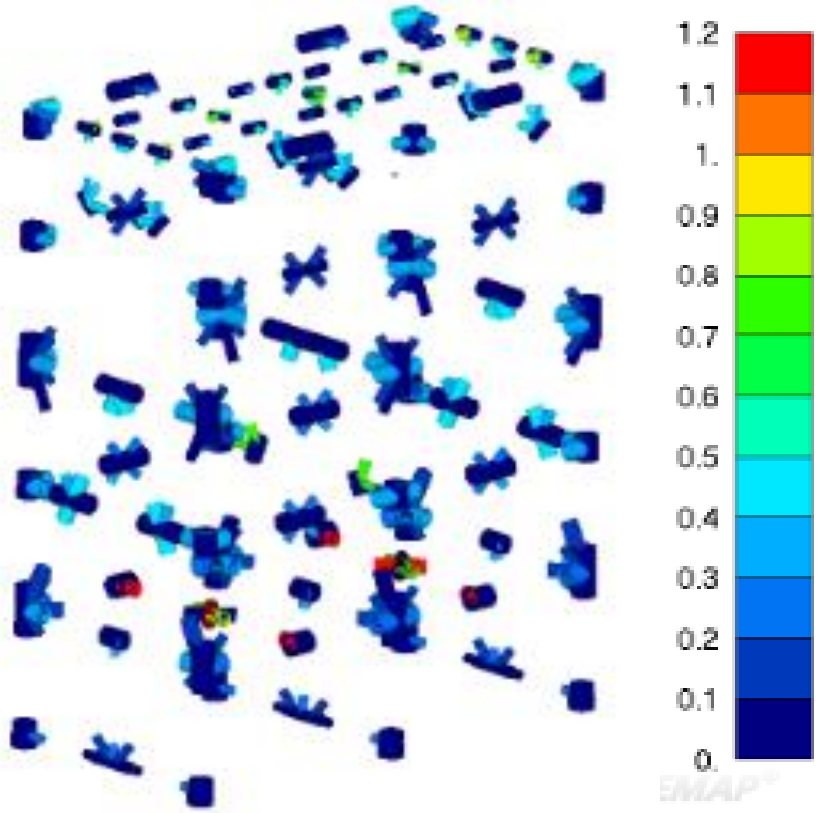
Recognition

Checks

Reports



Brace Classification
(depends on loading)



Check	8..Joint Check	**Load Set**	2..All loads combination
Connections	144	**View**	1..Default View
Parameter	Overall Utilization Factor		

Joint Check according to API RP 2A, ISO 19902 and Norsok N004 standards

Custom check: Rivet and bolt check example

Software

Load Combination

Recognition

Checks

Reports

Add Custom Check

ID 1 Title Unity Check

Description

Use check results in other checks (Alias) check0

Options

Calculate Results over Directions

Calculate Results over Points

Load Calculation All Loads

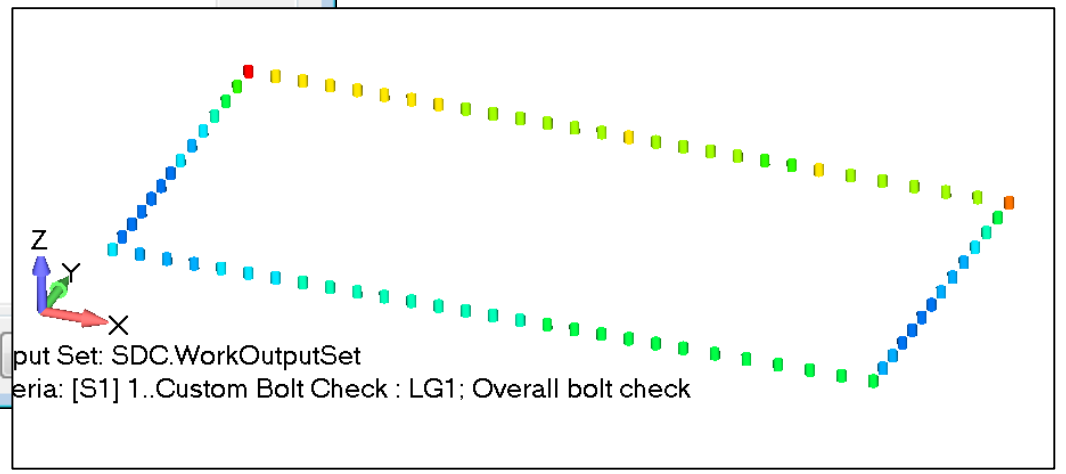
Selection All Entities

Parameters (3)

```
Parameter = F_shear_a (Allowable shear)
Description: Allowable shear force
All: Min( F_Prestress, F_Prestress - AbsMax( Faxial[Top], Faxial[Bot])) * mu

Parameter = F_shear (Shear force)
All: Sqrt(Pow(FShear1[Top],2)+ Pow( FShear2[Top],2))

Parameter = Uf_shear (Bolt shear force check)
All: F_shear / (F_shear_a / SafetyFactor)

Parameter = Uf_axial (Axial bolt force check)
All: AbsMax(FAxial[Top], Faxial[Bot]) / ((0.7 * F_prestress) / SafetyFactor)

Parameter = Uf_total (Overall bolt check)
All: absmax(abs(Uf_shear),abs(Uf_axial))
```

Clear results

Extreme	Allowable shear	Shear force	Bolt shear force check	Axial bolt force check	Overall bolt check
Minimum					
Value	21.5e+3	0.1e+3	0.00	-0.87	0.01
Element ID	86503	79922	79922	86503	79932
Load	LS4	LS5	LS5	LS5	LS5
Maximum					
Value	48.0e+3	34.2e+3	1.15	0.87	1.15
Element ID	79508	86567	86543	86503	86543
Load	LS8	LS5	LS4	LS4	LS4
Absolute					
Value	48.0e+3	34.2e+3	1.15	0.87	1.15
Element ID	79508	86567	86543	86503	86543
Load	LS8	LS5	LS4	LS4	LS4



Reports in Microsoft Word and Power Point

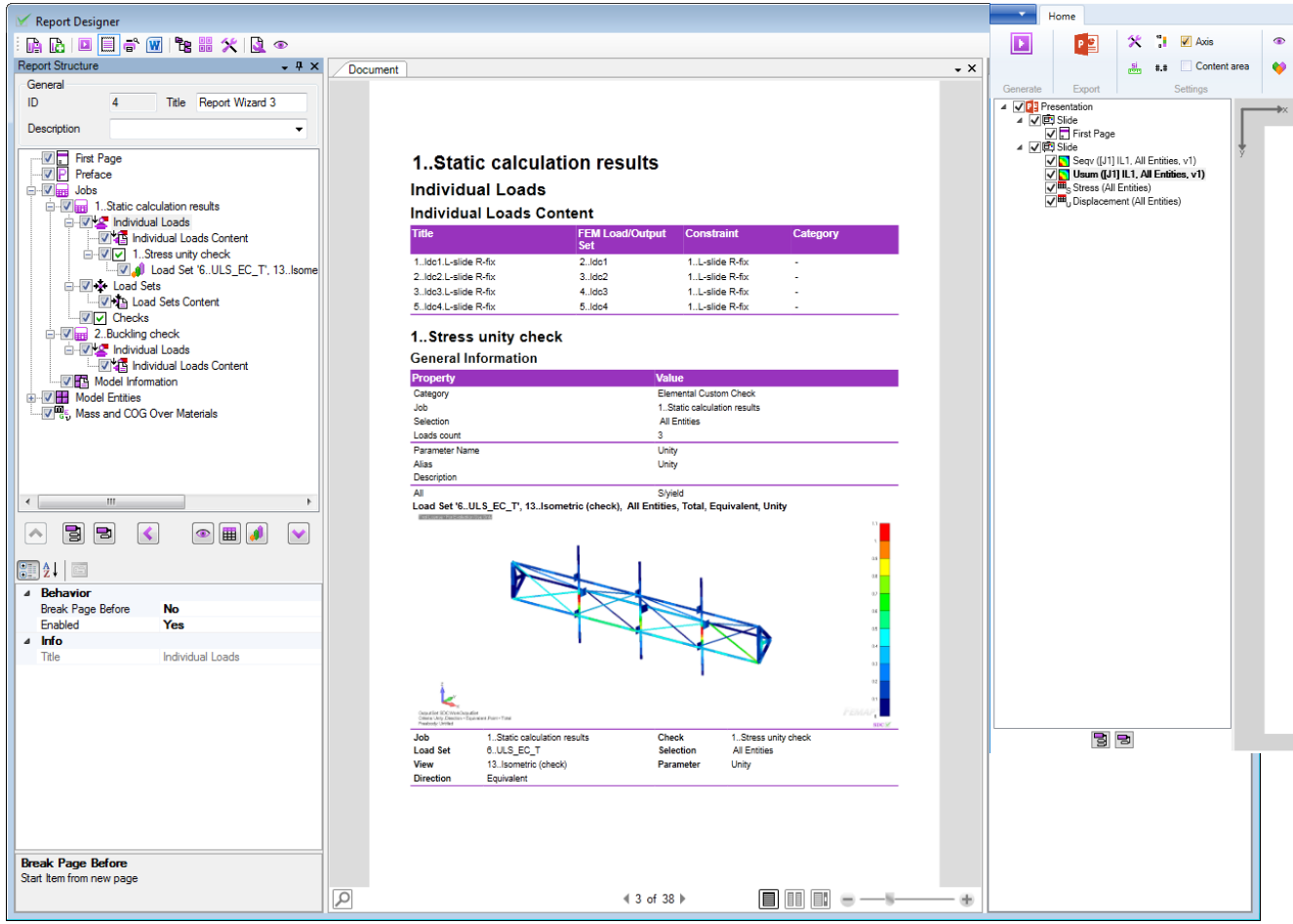
Software

Load Combination

Recognition

Checks

Reports



Complete reports

Presentations

Model Description

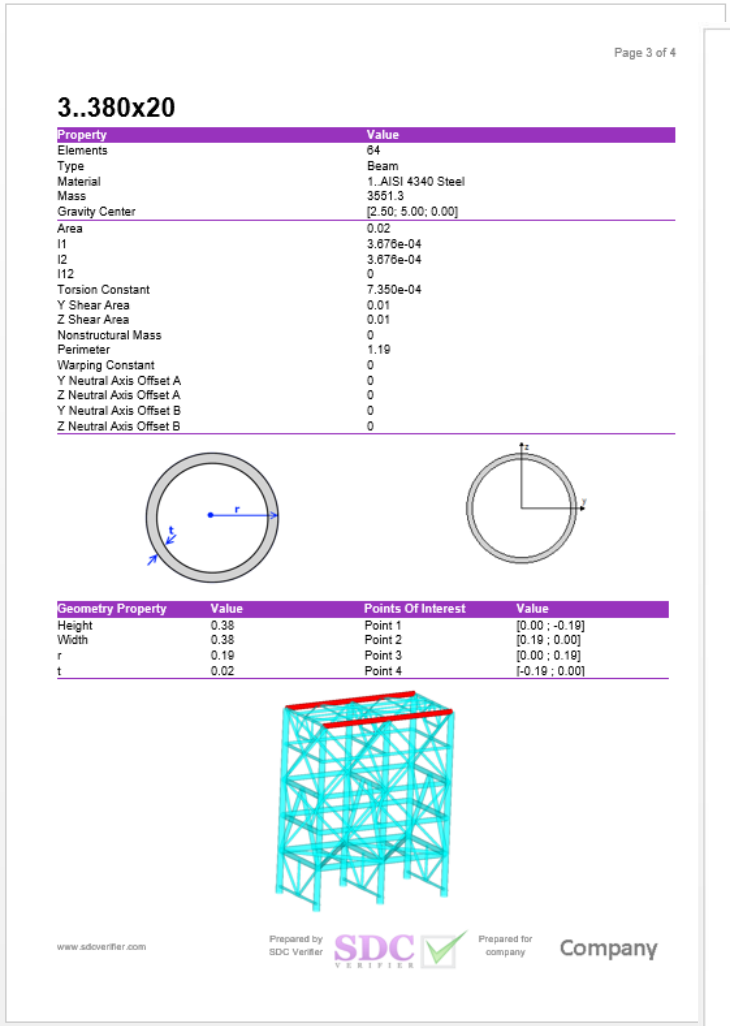
Software

Load Combination

Recognition

Checks

Reports



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3..380x20

Property	Value
Elements	64
Type	Beam
Material	1..AISI 4340 Steel
Mass	3551.3
Gravity Center	[2.50; 5.00; 0.00]
Area	0.02
I1	3.676e-04
I2	3.676e-04
I12	0
Torsion Constant	7.350e-04
Y Shear Area	0.01
Z Shear Area	0.01
Nonstructural Mass	0
Perimeter	1.19
Warping Constant	0
Y Neutral Axis Offset A	0
Z Neutral Axis Offset A	0
Y Neutral Axis Offset B	0
Z Neutral Axis Offset B	0

Geometry Property	Value	Points Of Interest	Value
Height	0.38	Point 1	[0.00 ; -0.19]
Width	0.38	Point 2	[0.19 ; 0.00]
r	0.19	Point 3	[0.00 ; 0.19]
t	0.02	Point 4	[-0.19 ; 0.00]

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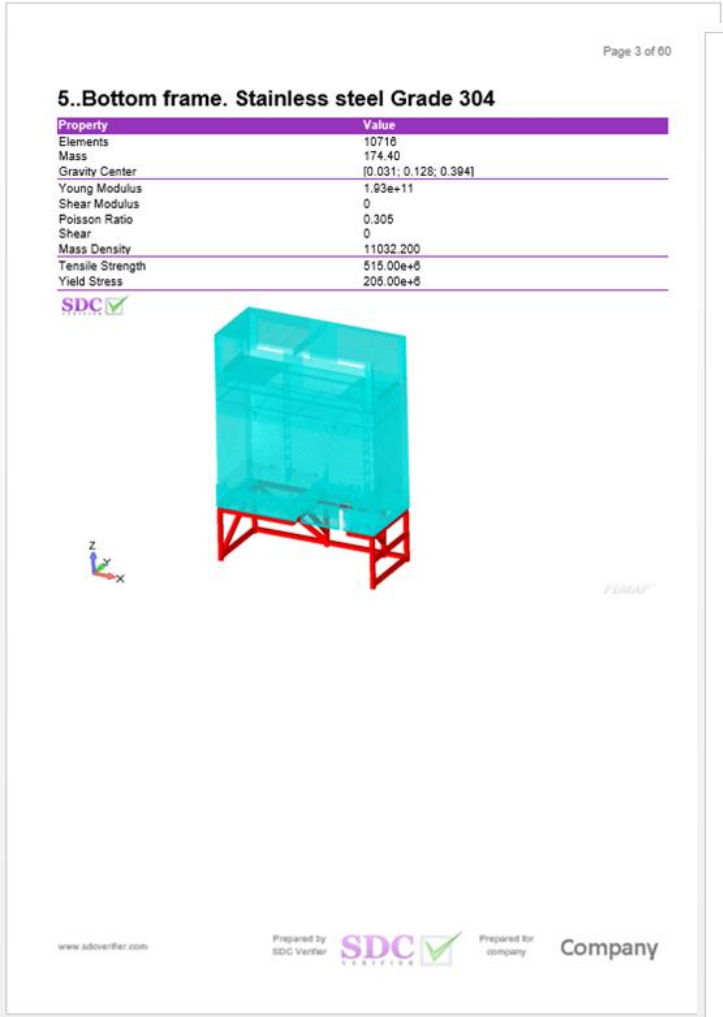
Property



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5..Bottom frame. Stainless steel Grade 304

Property	Value
Elements	10716
Mass	174.40
Gravity Center	[0.031; 0.128; 0.394]
Young Modulus	1.93e+11
Shear Modulus	0
Poisson Ratio	0.305
Shear	0
Mass Density	11032.200
Tensile Strength	515.00e+6
Yield Stress	205.00e+6

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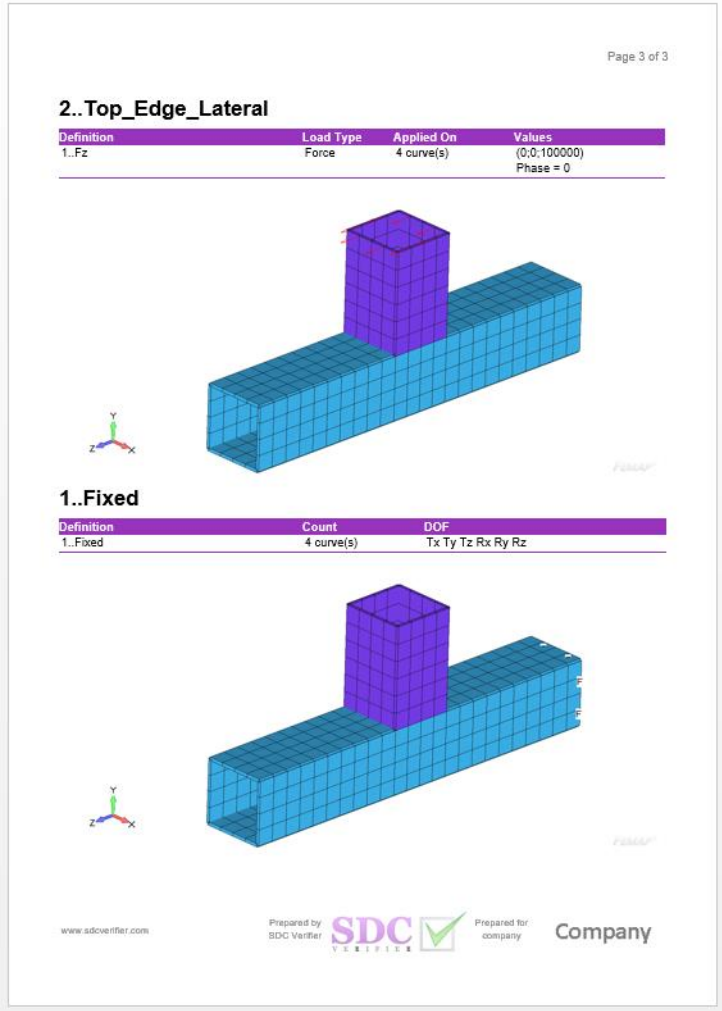
Material



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2..Top_Edge_Lateral

Definition	Load Type	Applied On	Values
1..Fz	Force	4 curve(s)	(0;0;100000) Phase = 0

1..Fixed

Definition	Count	DOF
1..Fixed	4 curve(s)	Tx Ty Tz Rx Ry Rz

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Boundary conditions

Full calculation report

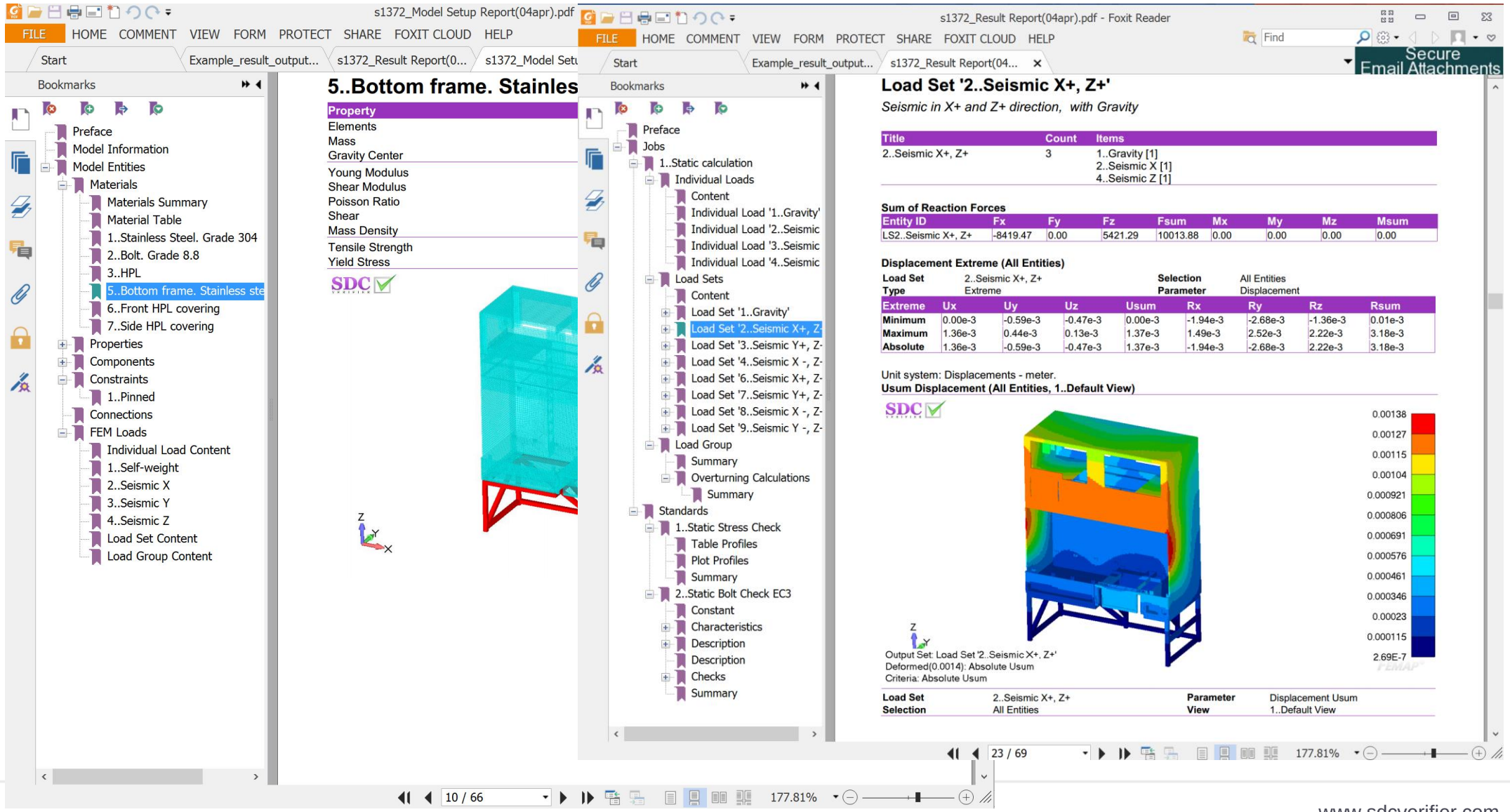
Software

Load Combination

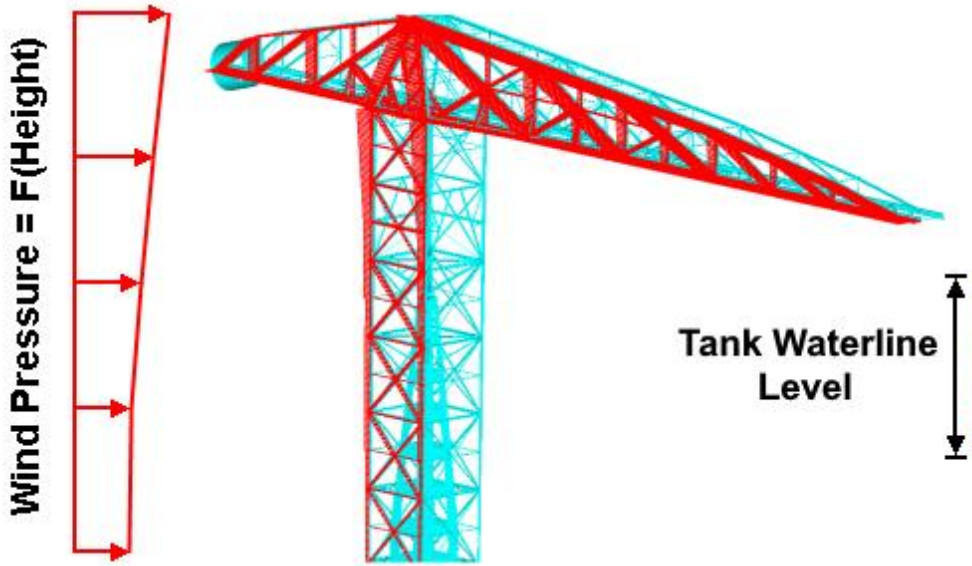
Recognition

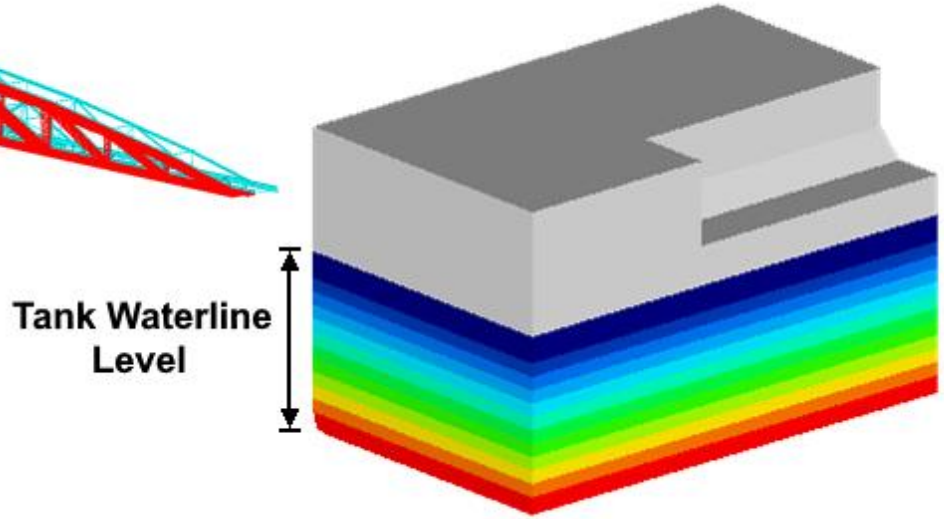
Checks

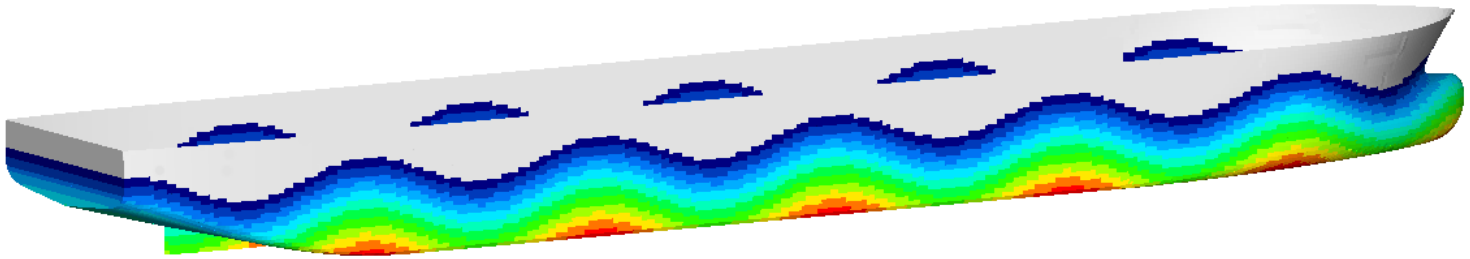
Reports



Wind and buoyancy loads







Wave Properties

Include Wave

Height	8
Length	2
Angle, deg	30
Phase, deg	0

General

Density 1025

Calculate waterline using model mass

Calculate waterline using predefined mass 0

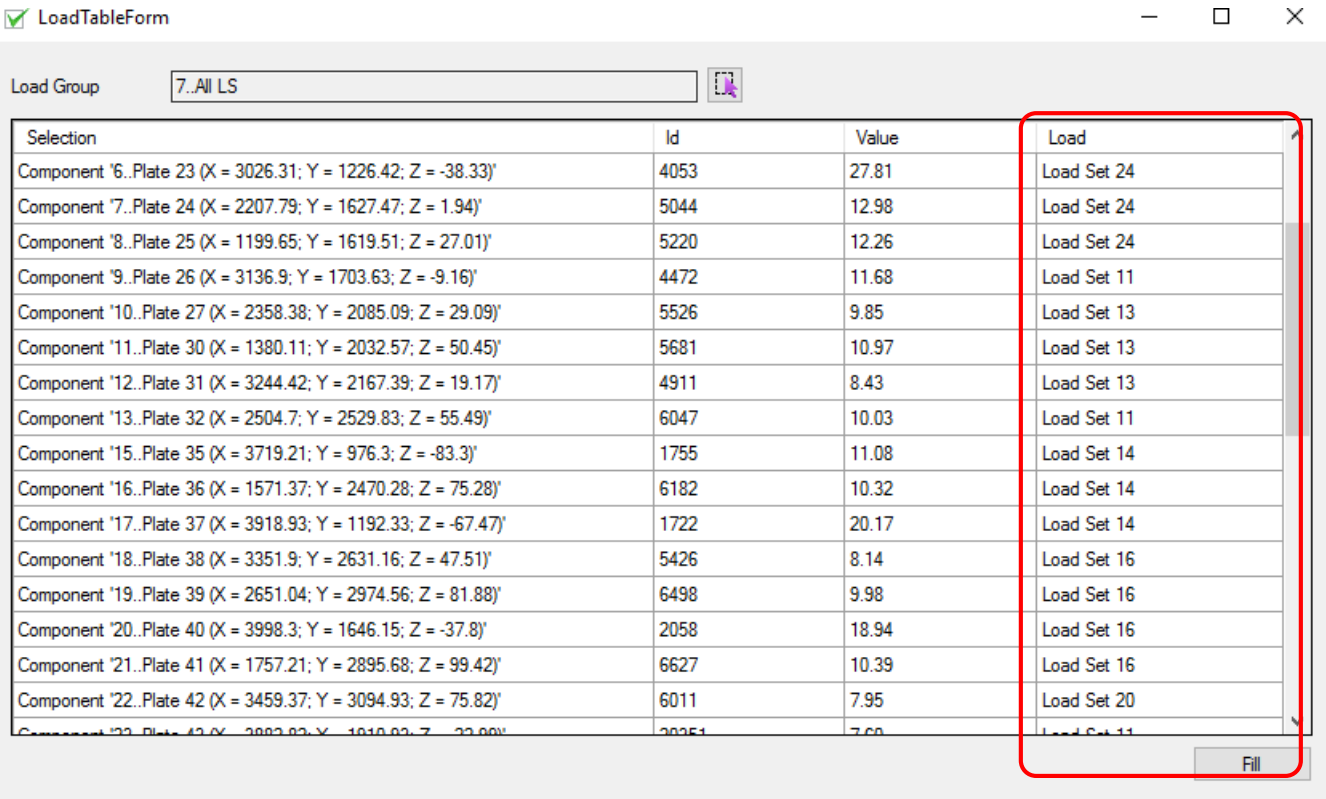
Use predefined Waterline 0

Profile 1..Hydroload Profile 1

Buoyancy (water level calculation) including wave parameters

Relevant load cases

List maximum load per component



Selection	Id	Value	Load
Component '6..Plate 23 (X = 3026.31; Y = 1226.42; Z = -38.33)'	4053	27.81	Load Set 24
Component '7..Plate 24 (X = 2207.79; Y = 1627.47; Z = 1.94)'	5044	12.98	Load Set 24
Component '8..Plate 25 (X = 1199.65; Y = 1619.51; Z = 27.01)'	5220	12.26	Load Set 24
Component '9..Plate 26 (X = 3136.9; Y = 1703.63; Z = -9.16)'	4472	11.68	Load Set 11
Component '10..Plate 27 (X = 2358.38; Y = 2085.09; Z = 29.09)'	5526	9.85	Load Set 13
Component '11..Plate 30 (X = 1380.11; Y = 2032.57; Z = 50.45)'	5681	10.97	Load Set 13
Component '12..Plate 31 (X = 3244.42; Y = 2167.39; Z = 19.17)'	4911	8.43	Load Set 13
Component '13..Plate 32 (X = 2504.7; Y = 2529.83; Z = 55.49)'	6047	10.03	Load Set 11
Component '15..Plate 35 (X = 3719.21; Y = 976.3; Z = -83.3)'	1755	11.08	Load Set 14
Component '16..Plate 36 (X = 1571.37; Y = 2470.28; Z = 75.28)'	6182	10.32	Load Set 14
Component '17..Plate 37 (X = 3918.93; Y = 1192.33; Z = -67.47)'	1722	20.17	Load Set 14
Component '18..Plate 38 (X = 3351.9; Y = 2631.16; Z = 47.51)'	5426	8.14	Load Set 16
Component '19..Plate 39 (X = 2651.04; Y = 2974.56; Z = 81.88)'	6498	9.98	Load Set 16
Component '20..Plate 40 (X = 3998.3; Y = 1646.15; Z = -37.8)'	2058	18.94	Load Set 16
Component '21..Plate 41 (X = 1757.21; Y = 2895.68; Z = 99.42)'	6627	10.39	Load Set 16
Component '22..Plate 42 (X = 3459.37; Y = 3094.93; Z = 75.82)'	6011	7.95	Load Set 20

Automatically Reduce relevant load sets to calculate

Load Group '1..Overall'

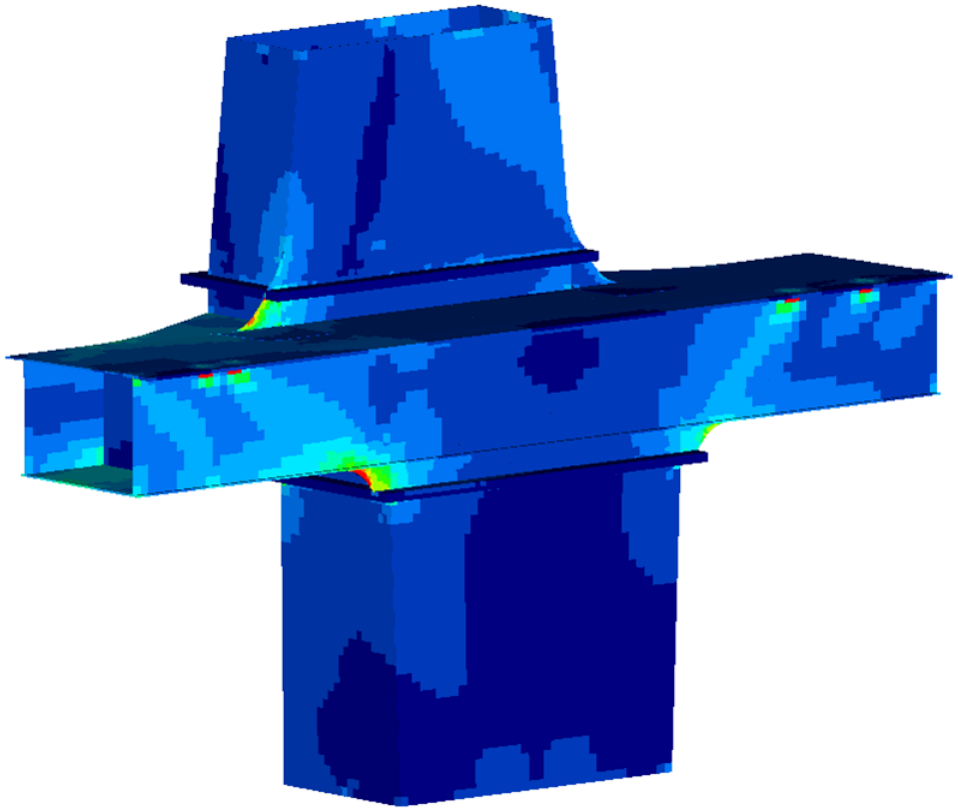
Title	Count	Items
1..Overall Safety Factor = 1	132	Load Set '1..LC1s_Tip load.1' [1] Load Set '2..LC1s_Tip load.2' [1] Load Set '3..LC1s_Tip load.3' [1] Load Set '4..LC1s_Tip load.4' [1] Load Set '5..LC1s_Middle Bridge.1' [1] Load Set '6..LC1s_Middle Bridge.2' [1] Load Set '7..LC1s_Middle Bridge.3' [1] Load Set '8..LC1s_Middle Bridge.4' [1] ... ... Load Set '129..LC2c_storm1' [1] Load Set '130..LC2c_storm2' [1] Load Set '131..LC2c_storm3 ' [1] Load Set '132..LC2c_storm4' [1]

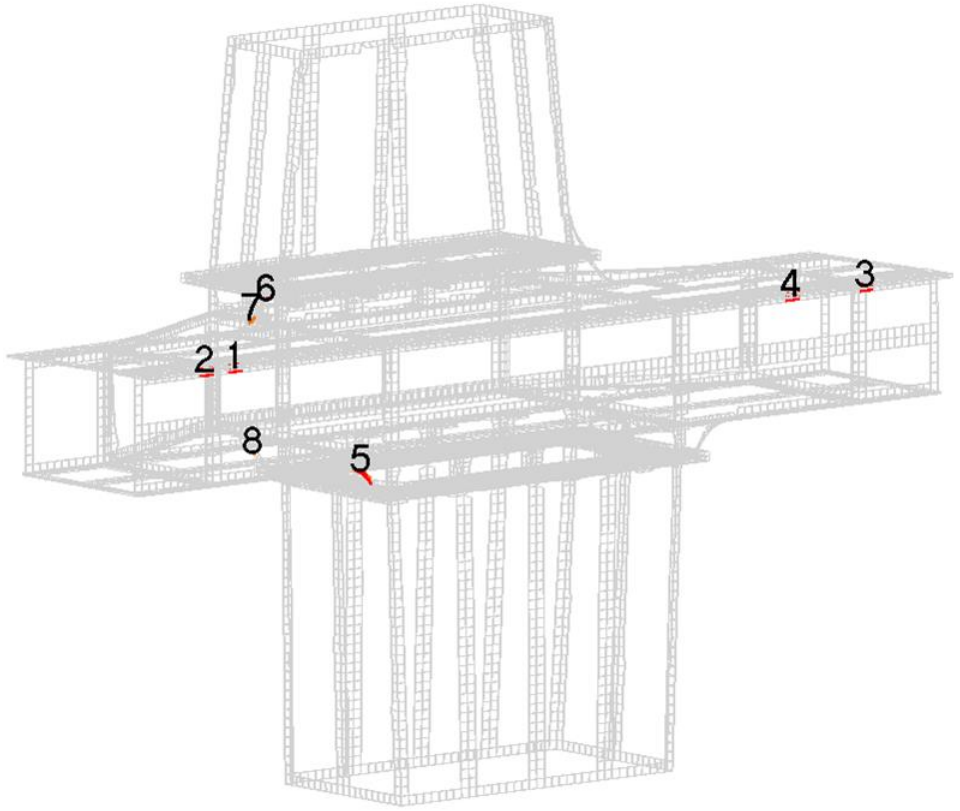
From 132 to 9 load cases

Load Group '2..Governing Loads (LG1..Overall)'

Title	Count	Items
2..Governing Loads (LG1..Overall) Safety Factor = 1	9	Load Set '2..LC1s_Tip load.2' [1] Load Set '1..LC1s_Tip load.1' [1] Load Set '4..LC1s_Tip load.4' [1] Load Set '5..LC1s_Middle Bridge.1' [1] Load Set '3..LC1s_Tip load.3' [1] Load Set '12..LC1s_Backside.4' [1] Load Set '11..LC1s_Backside.3' [1] Load Set '6..LC1s_Middle Bridge.2' [1] Load Set '8..LC1s_Middle Bridge.4' [1]

Peak finder (including automatic report)





Never miss a hotspot!

Zone	Value	Zone	Value
Zone 1 (Elements: 2)	1.45	Zone 5 (Elements: 15)	1.41
Zone 2 (Elements: 2)	1.44	Zone 6 (Elements: 1)	1.21
Zone 3 (Elements: 2)	1.43	Zone 7 (Elements: 3)	1.09
Zone 4 (Elements: 2)	1.42	Zone 8 (Elements: 1)	1.01

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