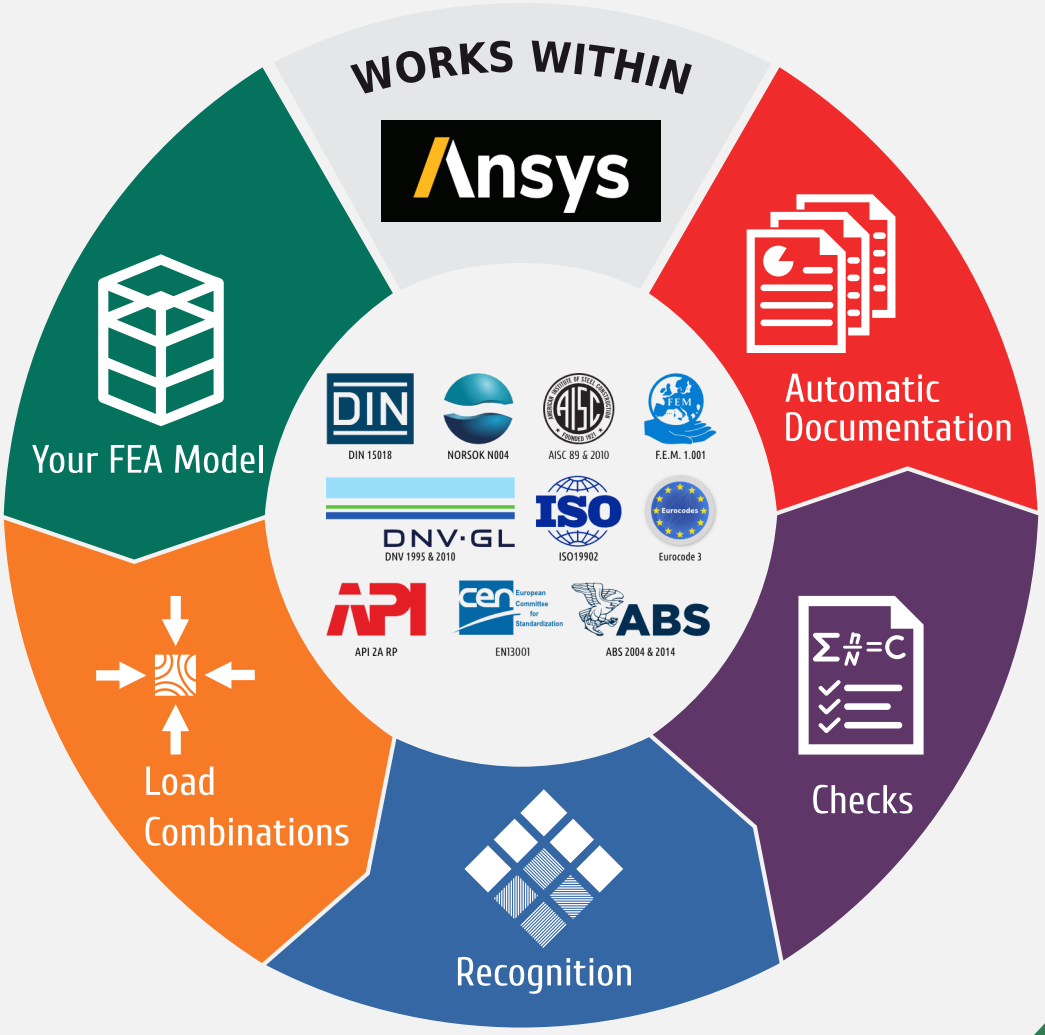
SDC VERIFIER



STRUCTURAL VERIFICATION ACCORDING TO STANDARDS

ANSYS ADVANCED SOLUTION PARTNER

SDC VERIFIER

STANDARDS VERIFICATION FOR ANY MAJOR INDUSTRY

DIN 15018 · NORSOK N004 · AISC 89 & 2010 · F.E.M. 1.001 · DNV 1995 & 2010 · ISO19902 · Eurocode 3 · API 2A RP · EN13001 · ABS 2004 & 2014

OIL AND GAS · **OFFSHORE AND MARINE** · **HEAVY LIFTING** · **CIVIL ENGINEERING** · **MACHINERY EQUIPMENT** · **AEROSPACE**

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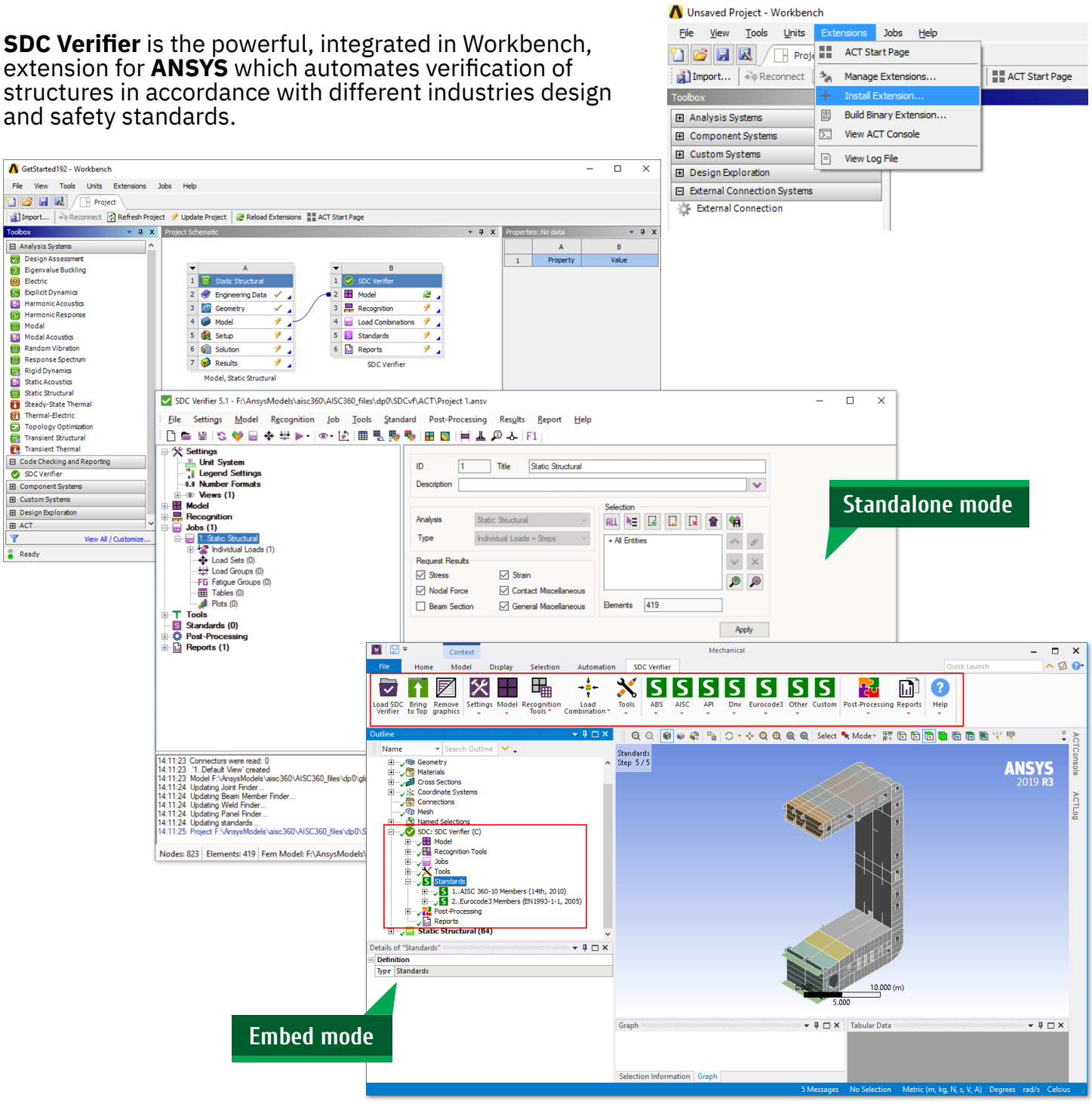
Ansys offers an advanced engineering analysis environment for simulation of complex engineering problems. **SDC Verifier** together with Ansys makes the calculation procedure more transparent and facilitates checking of a complete set of load cases according to predefined design code rules or own standards. Full model description and all calculations are presented in reports. Consequences of updates to the design can be reviewed and compared with the original design using the report regeneration.

CONTENT

SDC VERIFIER FOR ANSYS

SDC Verifier is the powerful, integrated in Workbench, extension for **ANSYS** which automates verification of structures in accordance with different industries design and safety standards.



EXTENSIBLE MODULES

Get only what you need. If you need only specific features — you can acquire only specific modules of the program. Also available in **ANSYS App Store**.

WELD STRENGTH

BEAM BUCKLING

PLATE BUCKLING

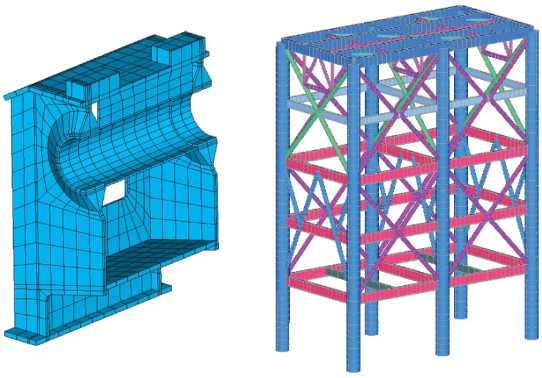
FATIGUE

REPORT

https://sdcverifier.com

Complete verification procedure of the structure is stored. In case of design changes it requires only one click to generate the updated report

1 FEA Model



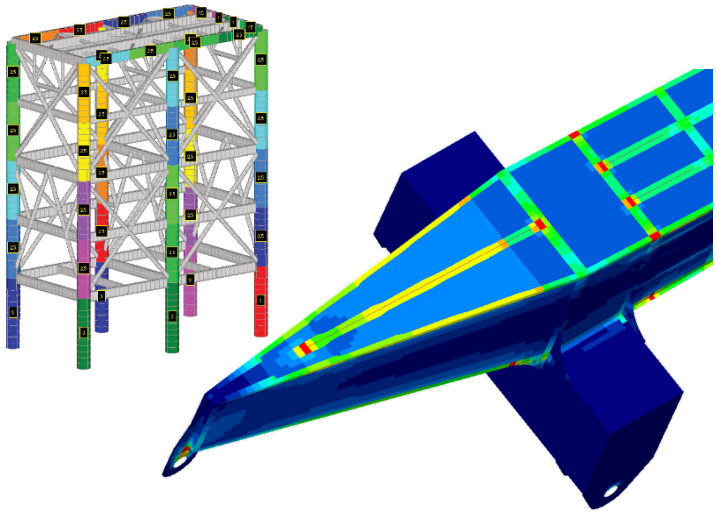
2 Load Combinations

Edit Load Sets

	Safety Factor	IL1..IL1	IL2..IL2	IL3..IL3	IL4..IL4	IL5..IL5	IL6..IL6	IL7..IL7	IL8..IL8	IL9..IL9	IL10..IL10	IL11..IL11	IL12..IL12
LC1_Long_forestay_1	1.33	1.43				1.1		-1.1				-1.1	
LC1_Long_forestay_2	1.33	1.43				1.1		-1.1				-1.1	
LC1_Long_forestay_3	1.33	1.43					1.1	-1.1				-1.1	
LC1_Long_forestay_4	1.33	1.43					1.1	-1.1				-1.1	
LC1_Long_short_1	1.33		1.43			1.1			-1.1				-1.1
LC1_Long_short_2	1.33		1.43			1.1			-1.1				-1.1
LC1_Long_short_3	1.33		1.43				1.1		-1.1				-1.1
LC1_Long_short_4	1.33		1.43				1.1		-1.1				-1.1
LC1_Short_forestay_1	1.33			1.43		1.1				-1.1			
LC1_Short_forestay_2	1.33			1.43		1.1				-1.1			
LC1_Short_forestay_3	1.33			1.43			1.1			-1.1			
LC1_Short_forestay_4	1.33			1.43			1.1			-1.1			

OK Cancel

3 Recognition



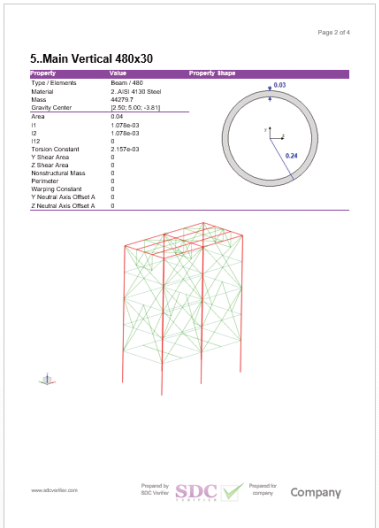
4 Checks

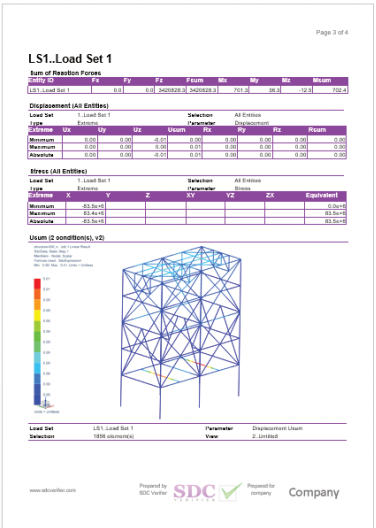
Add Custom Check

```
Replacement = BeamI_Mn_Major (BeamI Mn Major)
Switch(BeamI.Slender_Type_Webs, compact, F2_F3.Mn, noncompact, F4.Mn, slender, F5.Mn)

Parameter = Mn_Major (Mn Major)
Switch(SDCSectionType, sdc_IBeam, BeamI_Mn_Major, sdc_CircleBeam, Circle.Mn, sdc_BoxBeam, Box.
Mn_Major)

Parameter = Mn_Minor (Mn Minor)
Switch(SDCSectionType, sdc_IBeam, F6.Mn, sdc_CircleBeam, Circle.Mn, sdc_BoxBeam, Box.Mn_Minor)

Parameter = Bending_Major (Bending Major)
if(VerticalAxis = AxisY, AbsMax(Mbend1[Top], MBend1[Bot]), AbsMax(Mbend2[Top], Mbend2[Bot]))

Parameter = Bending_Minor (Bending Minor)
if(VerticalAxis = AxisY, AbsMax(Mbend2[Top], Mbend2[Bot]), AbsMax(Mbend1[Top], MBend1[Bot]))

Parameter = Uf_Major (Uf Major)
if((SDCSectionType = sdc_IBeam or SDCSectionType = sdc_BoxBeam or SDCSectionType =
sdc_CircleBeam) and Double_Symmetric = true, Abs(Bending_Major / (F_b * Mn_Major)),
NotSupported)
```

Clear results Debug OK Cancel

5 Reports





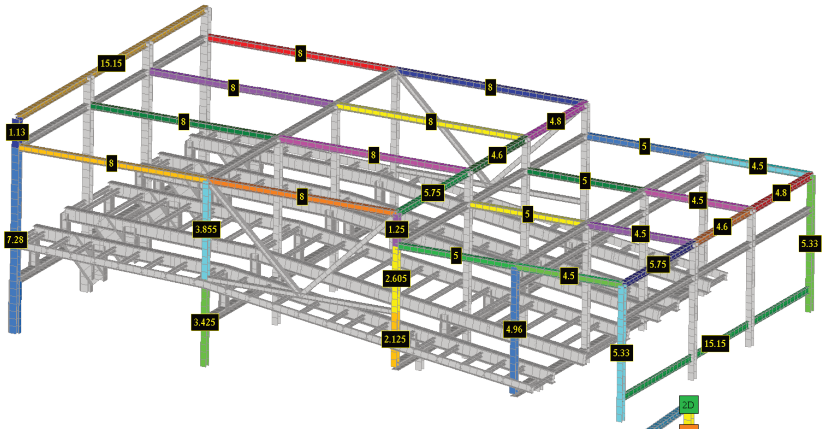
MEMBER CHECKS. BUCKLING LENGTH RECOGNITION. DEFLECTION CHECK

SDC Verifier implements the following standards for checking large *(offshore)* lattice structures:

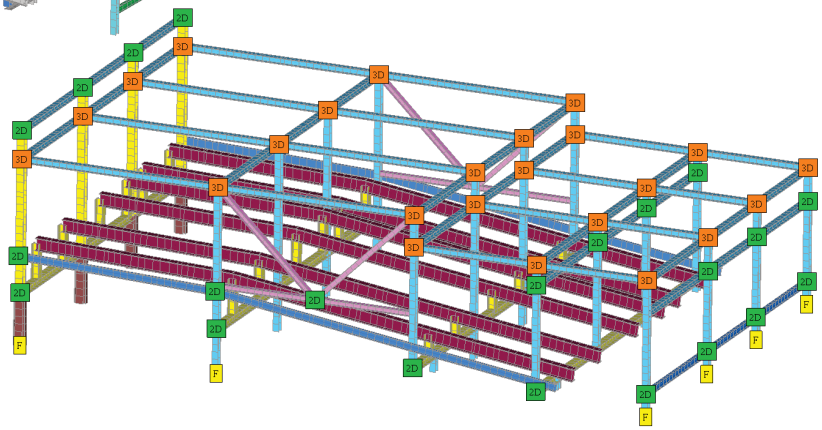
AISC/ANSI 360-10 *(Specification for Structural Steel Buildings)*, **API RP 2A** *(Planning, Designing, and Constructing Fixed Offshore Platforms – Working Stress Design)*, **Eurocode 3** *(Design of steel structures)*, **ISO 19902** *(Petroleum and natural gas industries – Fixed steel offshore structures)* and **Norsok N-004** *(Design of steel structures)*

AISC 89 & 2010

API RP 2A RP

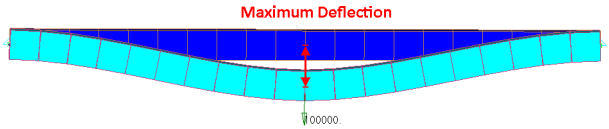


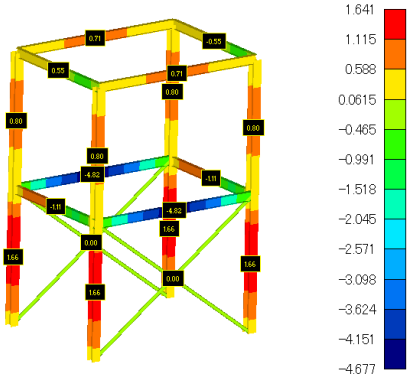
Beam Member Finder tool recognizes beam members *(buckling)* lengths automatically for 3 directions *(Y, Z and torsional)*



SDC Verifier calculates **Buckling length** between the Joints and it does not depend on the model mesh.

The deflection of members is one of the checks that should be performed for serviceability limit state design. With the help of **Beam Member Finder** tool SDC Verifier automatically recognizes beam member lengths:





SDC Verifier contains all the necessary tools to perform the deflection check quickly directly within Ansys. The automatic beam member recognition, result transformation and the usage of the envelope results of a load group reduce the calculation and postprocessing time significantly.

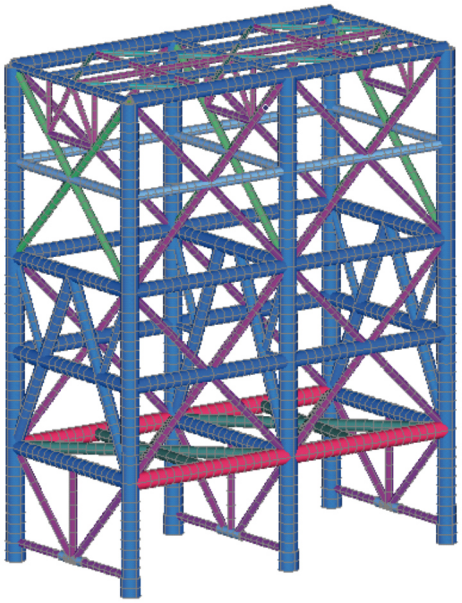
https://sdcverifier.com

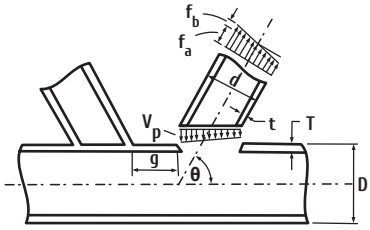
ISO 19902

Eurocode 3

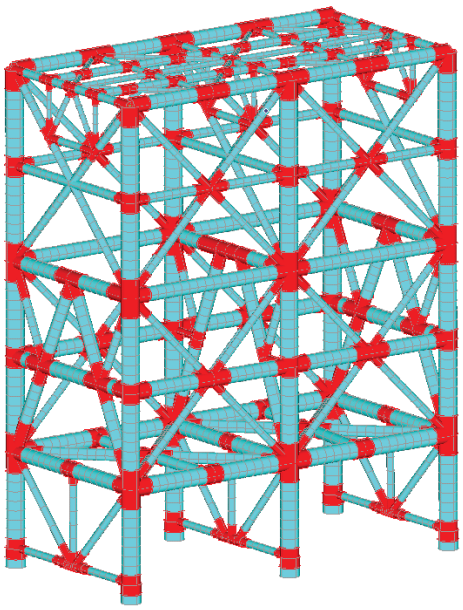
Norsok N004

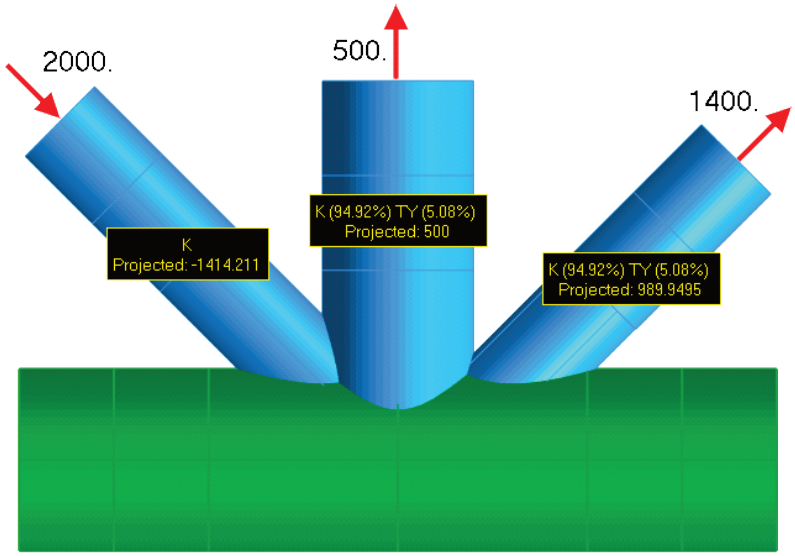
With the help of **Joint Finder** tool it is possible to perform verification of the tubular joints according to the following standards: **API RP 2A, Eurocode3, ISO 19902 and Norsok N-004**.

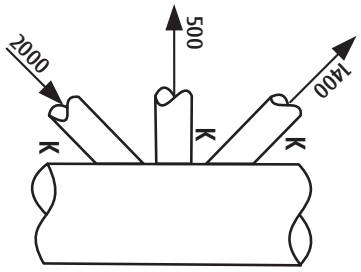




SDC Verifier calculates Brace classification *(depends on the load pattern)* for each load situation automatically, which significantly speeds-up the verification process.







Connection ID	Brace Number	Joint Type
1	#1 (ElemID = 27)	K
	#2 (ElemID = 13)	K (94.92%) TY (8.08%)
	#3 (ElemID = 19)	K (94.92%) TY (8.08%)

AUTOMATIC RECOGNITION OF SECTIONS, PANELS, PLATE FIELDS, STIFFENERS AND GIRDERS

DNV·GL

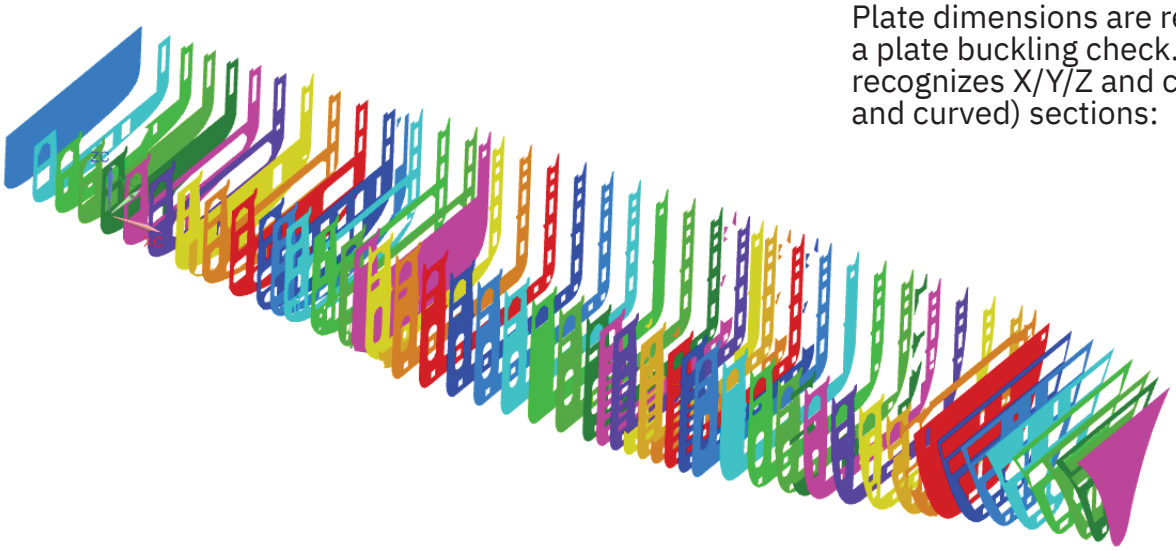
DNV 1995 & 2010

ABS

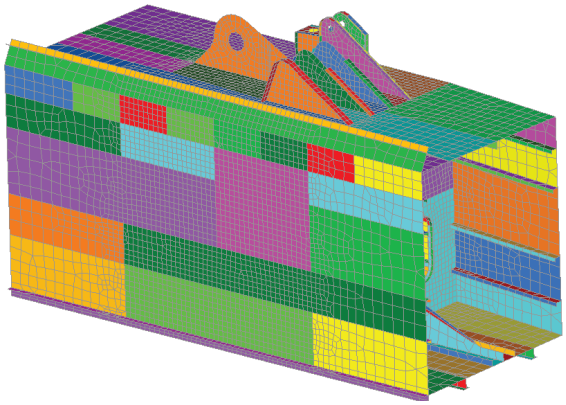
ABS 2004 & 2014

Plate buckling strength is an important aspect in offshore steel construction design. Each plate should be checked as it influences on the strength and stability of the whole construction. In SDC Verifier plates can be checked against buckling according to the ABS 2004/2014 and DNV RP-C201 2010 rules:

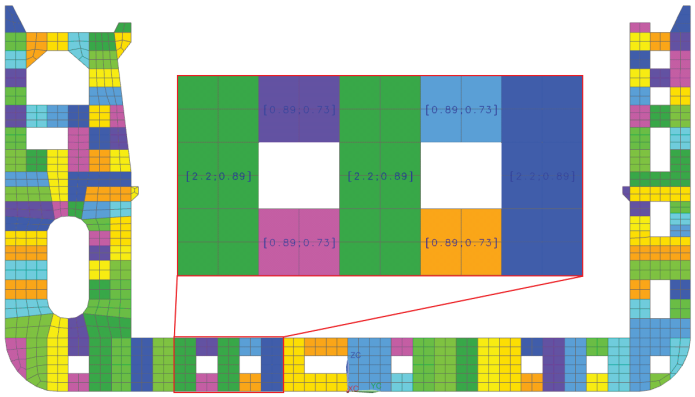
Plate dimensions are required to perform a plate buckling check. Panel Finder recognizes X/Y/Z and custom (inclined and curved) sections:



The recognition is based on the mesh connectivity and can be performed on any structure using plate *(shell)* elements:



Plates with their dimensions are recognized automatically for each section:



The results can be presented over sections (frames/longitudinals/decks) and results which are above the limit are highlighted with red:

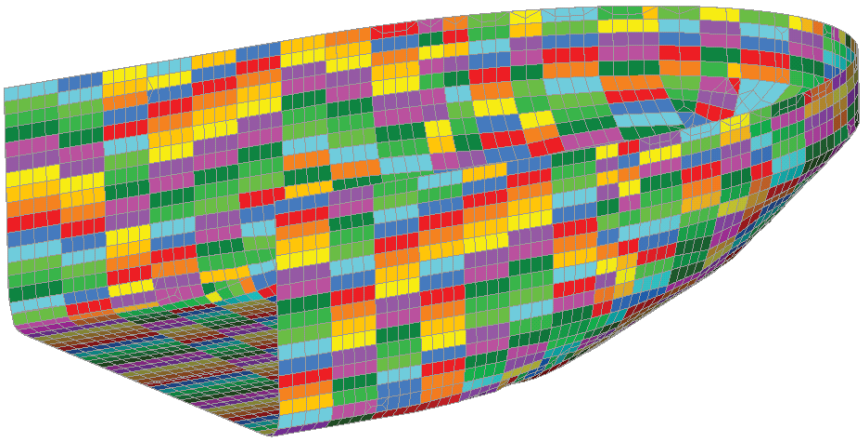
Buckling(LS2, 5 Sections)

Standard	10..Plate Buckling DNV 2010	**Check**	1..Plate Buckling (Element Avg)
Load Set	2..Load Set 2	**Sections**	5
Search Type	Related To Last		

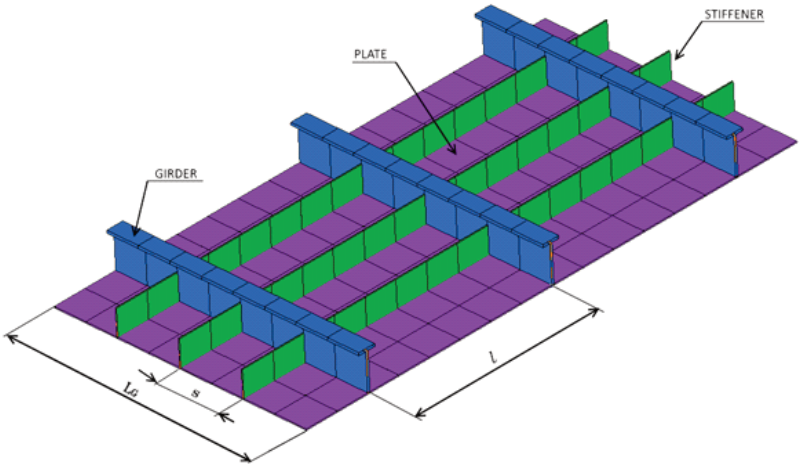
Section Title	Stress X in plate direction	Stress Y in plate direction	Stress XY in plate direction	Equivalent Stress	Buckling Factor Combined	Buckling Factor Overall
1..Section X 1 (X = 70) [MaxID=86]	-62.0e+6	-38.3e+6	-38.4e+6	85.8e+6	0.952	0.976
2..Section X 2 (X = 71.68) [MaxID=10]	-7.2e+6	-31.6e+6	-8.1e+6	31.9e+6	0.335	0.579
3..Section X 3 (X = 73.36) [MaxID=63]	-57.0e+6	-42.5e+6	-44.3e+6	92.3e+6	1.034	1.017
4..Section X 4 (X = 75.04) [MaxID=9]	-7.2e+6	-31.5e+6	-8.1e+6	31.9e+6	0.334	0.578
5..Section X 5 (X = 76.72) [MaxID=67]	-63.7e+6	-38.9e+6	-39.2e+6	87.8e+6	0.993	0.996
Max over Sections [3 / 63]	-57.0e+6	-42.5e+6	-44.3e+6	92.3e+6	1.034	1.017

PLATE BUCKLING AND STIFFENER BUCKLING CHECKS

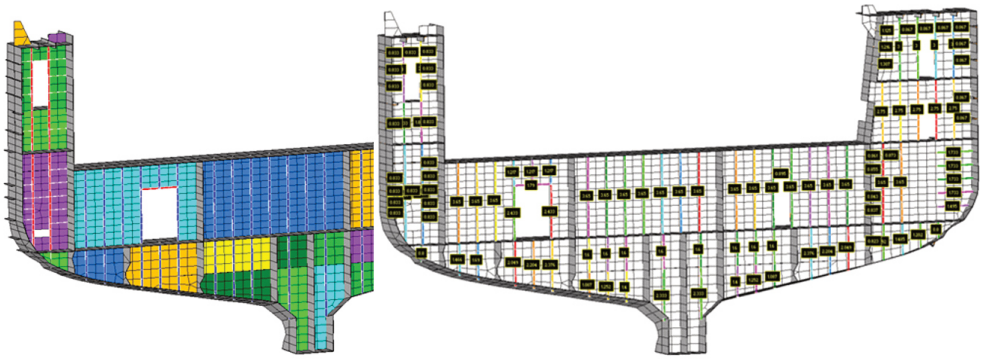
Colored plots with labels *(dimensions)* make it easy to preview the results of the tool. The following plot presents buckling plates on a part of the hull *(curved section)*.

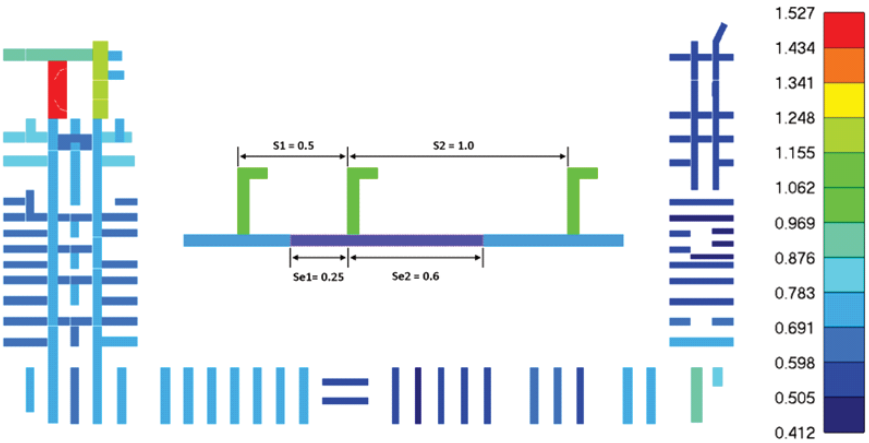


Stiffened Panel Finder — recognizes sections, panels, plates, stiffeners and girders and their dimensions automatically. This tool is an advanced version of the Panel Finder.



In the figure below panels, simple stiffeners (marked in blue) and girders or stiffeners which support also other stiffeners (marked in red) are plotted.





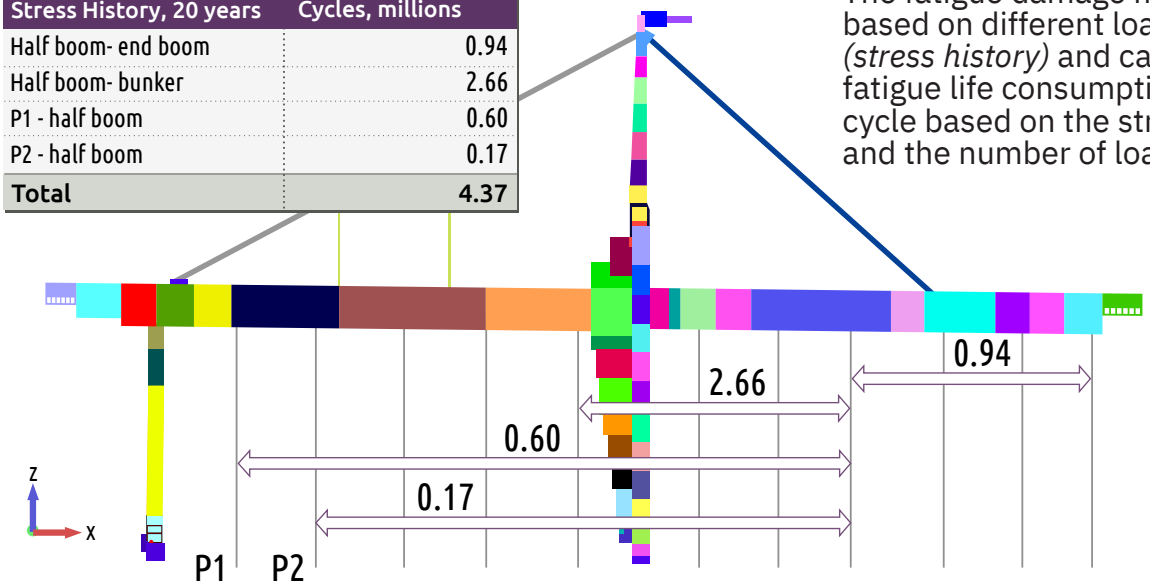
Effective Width — calculates the plate effective width for every load situation. The Effective width is used in the stiffener buckling check according to DNV-RP-C201 2010

AUTOMATIC WELDS RECOGNITION. FATIGUE CHECKS AND WELD STRENGTH

Eurocode 3 | DIN 15018 | F.E.M 1.001

Fatigue is a progressive structural damage of materials under the cyclic loading. **SDC Verifier** implements the following standards *(based on the Palmgren-Miner S-N curves)*: **Eurocode 3** *(Design of steel structures)*, **F.E.M 1.001** *(Rules for the Design of Hoisting Appliances)* and **DIN 15018** *(Cranes. Steel structures. Verification and analyses)*

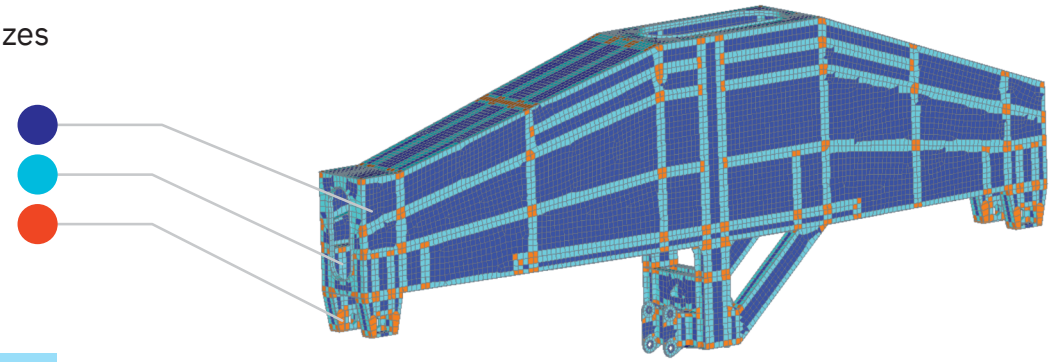
Stress History, 20 years	Cycles, millions
Half boom- end boom	0.94
Half boom- bunker	2.66
P1 - half boom	0.60
P2 - half boom	0.17
Total	**4.37**



The fatigue damage method is based on different loading patterns *(stress history)* and calculates fatigue life consumption for each cycle based on the stress variation and the number of load cycles.

Weld Finder recognizes automatically:

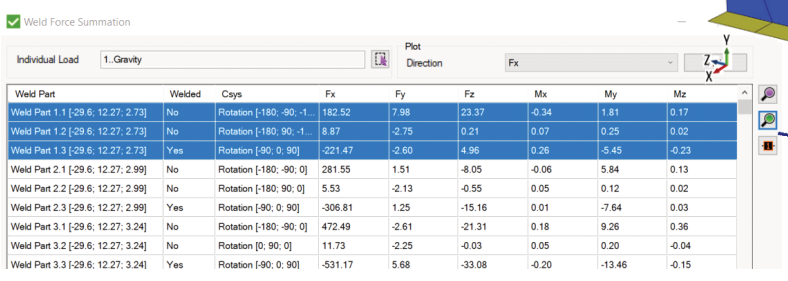
- non-welds
- welds
- crossing welds



DNV 1995 & 2010

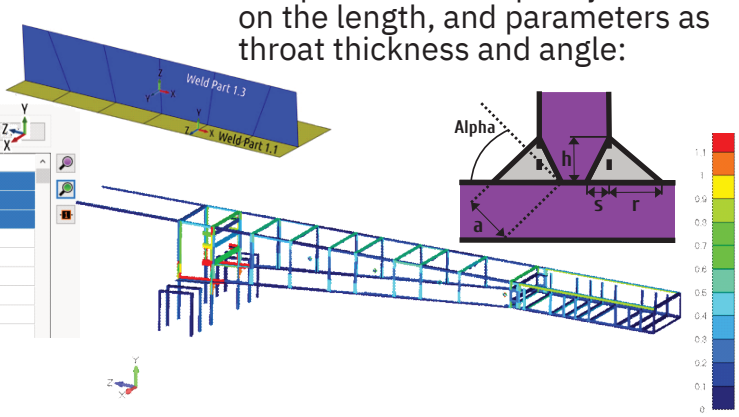
SDC Verifier performs a strength check according to **DNV-OS-C101/C201**.

The forces/moments of each element of the weld are summarized into the local weld coordinate system:



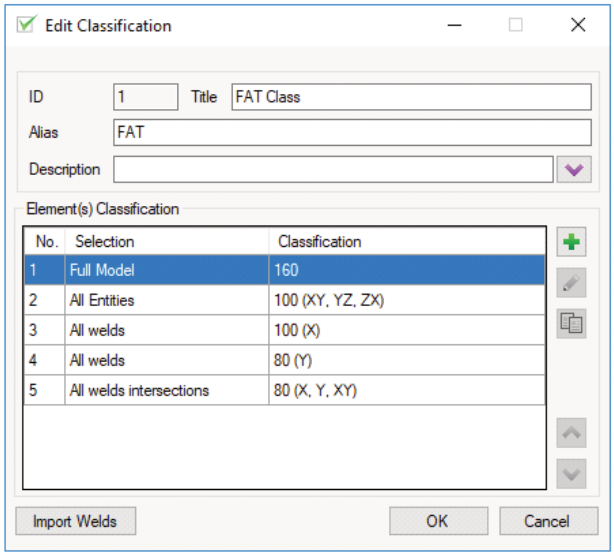
Weld Part	Welded	Csys	Fx	Fy	Fz	Mx	My	Mz
Weld Part 1.1 [-29.6; 12.27; 2.73]	No	Rotation [-180; -90; -1...	182.52	7.98	23.37	-0.34	1.81	0.17
Weld Part 1.2 [-29.6; 12.27; 2.73]	No	Rotation [-180; 90; -1...	8.87	-2.75	0.21	0.07	0.25	0.02
Weld Part 1.3 [-29.6; 12.27; 2.73]	Yes	Rotation [-90; 0; 90]	-221.47	-2.60	4.96	0.26	-5.45	-0.23
Weld Part 2.1 [-29.6; 12.27; 2.99]	No	Rotation [-180; -90; 0]	281.55	1.51	-8.05	-0.06	5.84	0.13
Weld Part 2.2 [-29.6; 12.27; 2.99]	No	Rotation [-180; 90; 0]	5.53	-2.13	-0.55	0.05	0.12	0.02
Weld Part 2.3 [-29.6; 12.27; 2.99]	Yes	Rotation [-90; 0; 90]	-306.81	1.25	-15.16	0.01	-7.64	0.03
Weld Part 3.1 [-29.6; 12.27; 3.24]	No	Rotation [-180; -90; 0]	472.49	-2.61	-21.31	0.18	9.26	0.36
Weld Part 3.2 [-29.6; 12.27; 3.24]	No	Rotation [0; 90; 0]	11.73	-2.25	-0.03	0.05	0.20	-0.04
Weld Part 3.3 [-29.6; 12.27; 3.24]	Yes	Rotation [-90; 0; 90]	-531.17	5.68	-33.08	-0.20	-13.46	-0.15

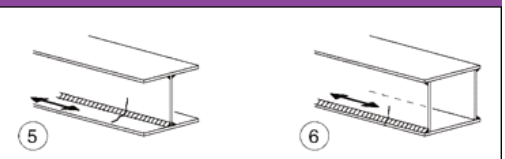
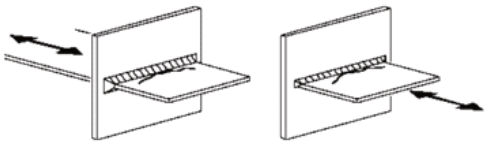
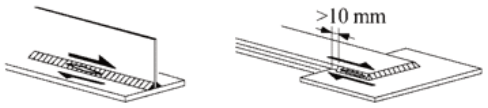
The load on the total weld is compared to the capacity based on the length, and parameters as throat thickness and angle:

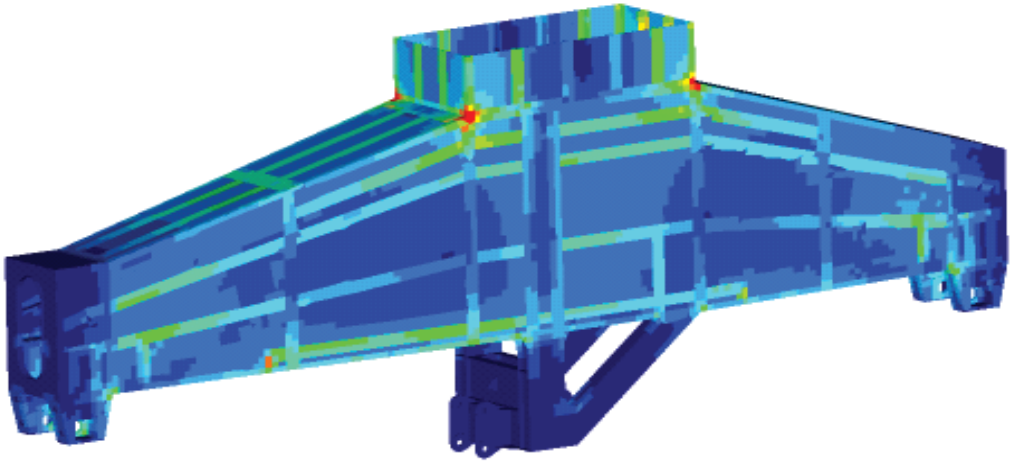


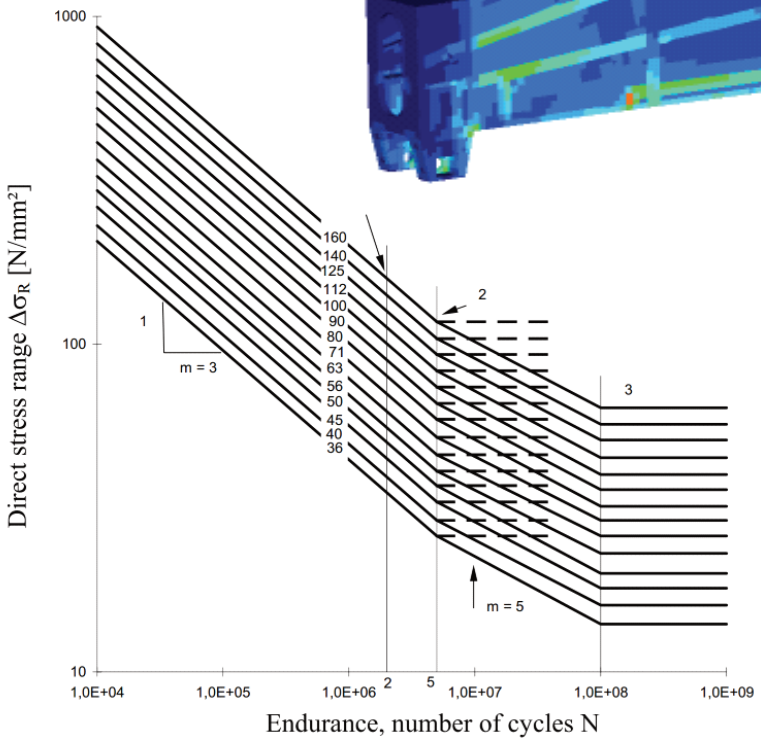
https://sdcverifier.com

The notch group classification or fatigue strength of the welds depends on the quality and the stress direction, along the weld (X), perpendicular to the weld (Y) and the shear (XY). Stresses are converted into weld direction automatically by the weld finder.



Detailed Category	Constructional detail
100	
80	
80	

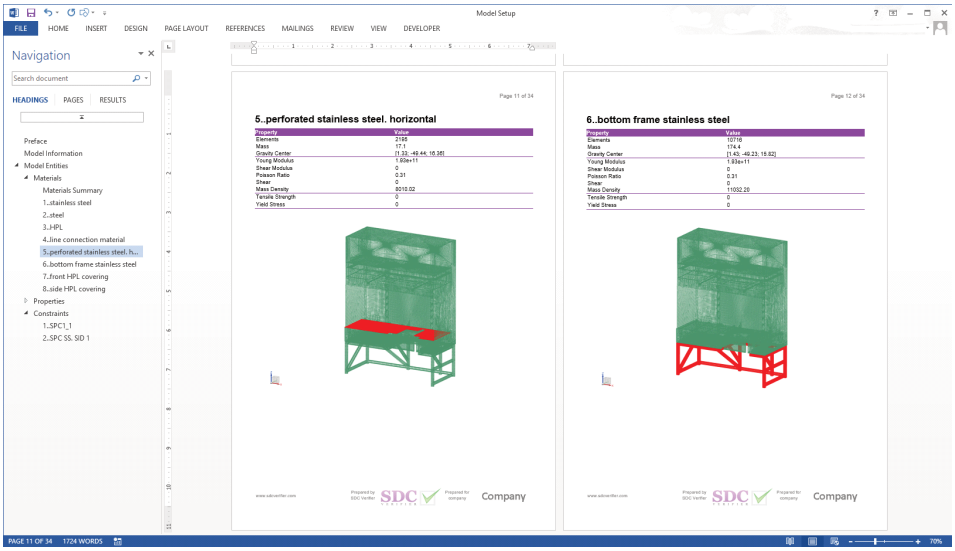




REPORT. MODEL SETUP

Preparing a full calculation report is one of the most time-consuming parts of the project. An engineer has to make the same routine processes to create calculation report from project to project. SDC Verifier allows the process of report generation to be done automatically, reducing time expenses.

Description of materials and properties data (including mass overview). Elements related to material/property are highlighted:



Description of applied loads and constrains, mass overview over materials/ properties/groups:

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Constraints

This paragraph contains information about constrained parts of the model.

1..SPC1_1

Definition	Count	DOF
SPC1_1	72 nodes	Tx Ty Tz

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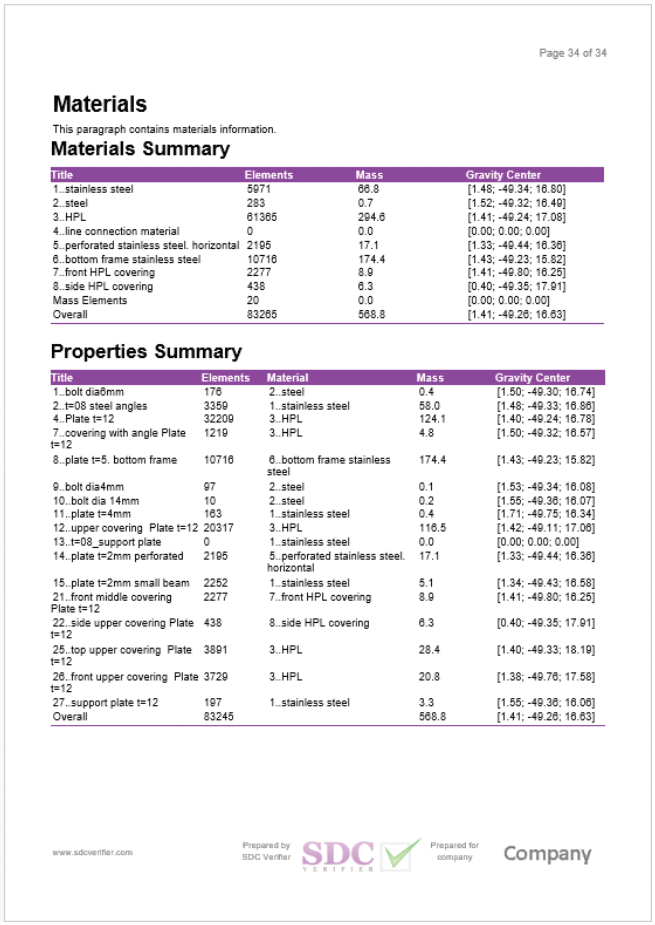

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Materials

This paragraph contains materials information.

Materials Summary

Title	Elements	Mass	Gravity Center
1..stainless steel	5971	66.8	[1.48; -49.34; 16.80]
2..steel	283	0.7	[1.52; -49.32; 16.49]
3..HPL	61366	294.6	[1.41; -49.24; 17.08]
4..line connection material	0	0.0	[0.00; 0.00; 0.00]
5..perforated stainless steel. horizontal	2195	17.1	[1.33; -49.44; 16.36]
6..bottom frame stainless steel	10716	174.4	[1.43; -49.23; 15.82]
7..front HPL covering	2277	8.9	[1.41; -49.80; 16.25]
8..side HPL covering	438	6.3	[0.40; -49.35; 17.91]
Mass Elements	20	0.0	[0.00; 0.00; 0.00]
Overall	83265	568.8	[1.41; -49.26; 16.63]

Properties Summary

Title	Elements	Material	Mass	Gravity Center
1..bolt dia6mm	176	2..steel	0.4	[1.50; -49.30; 16.74]
2..t=08 steel angles	3359	1..stainless steel	58.0	[1.48; -49.33; 16.86]
4..Plate t=12	32209	3..HPL	124.1	[1.40; -49.24; 16.78]
7..covering with angle Plate t=12	1219	3..HPL	4.8	[1.50; -49.32; 16.57]
8..plate t=5. bottom frame	10716	6..bottom frame stainless steel	174.4	[1.43; -49.23; 15.82]
9..bolt dia4mm	97	2..steel	0.1	[1.53; -49.34; 16.08]
10..bolt dia 14mm	10	2..steel	0.2	[1.55; -49.36; 16.07]
11..plate t=4mm	163	1..stainless steel	0.4	[1.71; -49.75; 16.34]
12..upper covering Plate t=12	20317	3..HPL	116.5	[1.42; -49.11; 17.06]
13..t=08_support plate	0	1..stainless steel	0.0	[0.00; 0.00; 0.00]
14..plate t=2mm perforated	2195	5..perforated stainless steel. horizontal	17.1	[1.33; -49.44; 16.36]
15..plate t=2mm small beam	2252	1..stainless steel	5.1	[1.34; -49.43; 16.58]
21..front middle covering Plate t=12	2277	7..front HPL covering	8.9	[1.41; -49.80; 16.25]
22..side upper covering Plate t=12	438	8..side HPL covering	6.3	[0.40; -49.35; 17.91]
25..top upper covering Plate t=12	3891	3..HPL	28.4	[1.40; -49.33; 18.19]
26..front upper covering Plate t=12	3729	3..HPL	20.8	[1.38; -49.76; 17.58]
27..support plate t=12	197	1..stainless steel	3.3	[1.55; -49.36; 16.06]
Overall	83245		568.8	[1.41; -49.26; 16.63]

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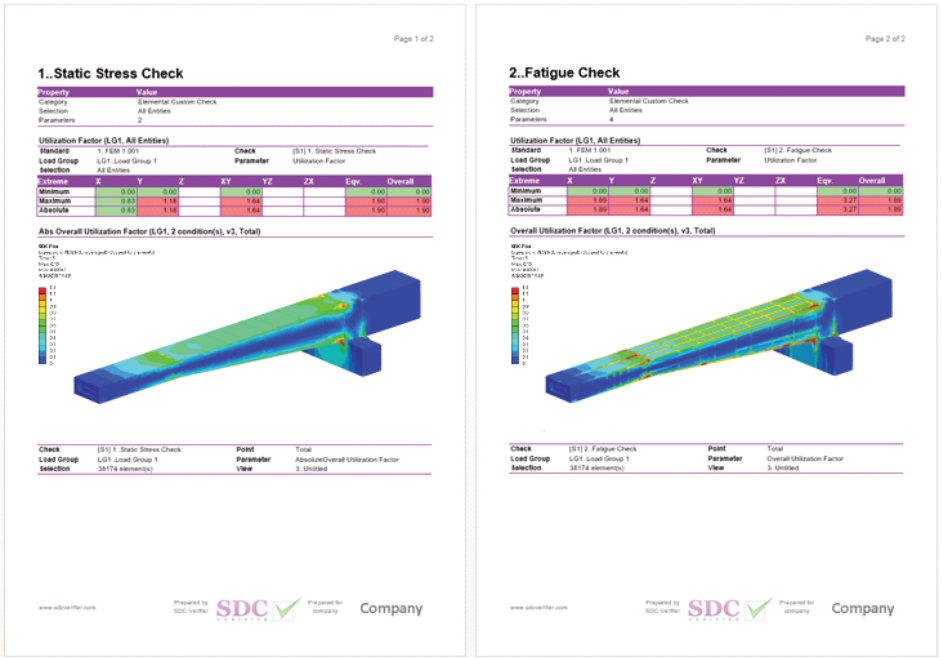
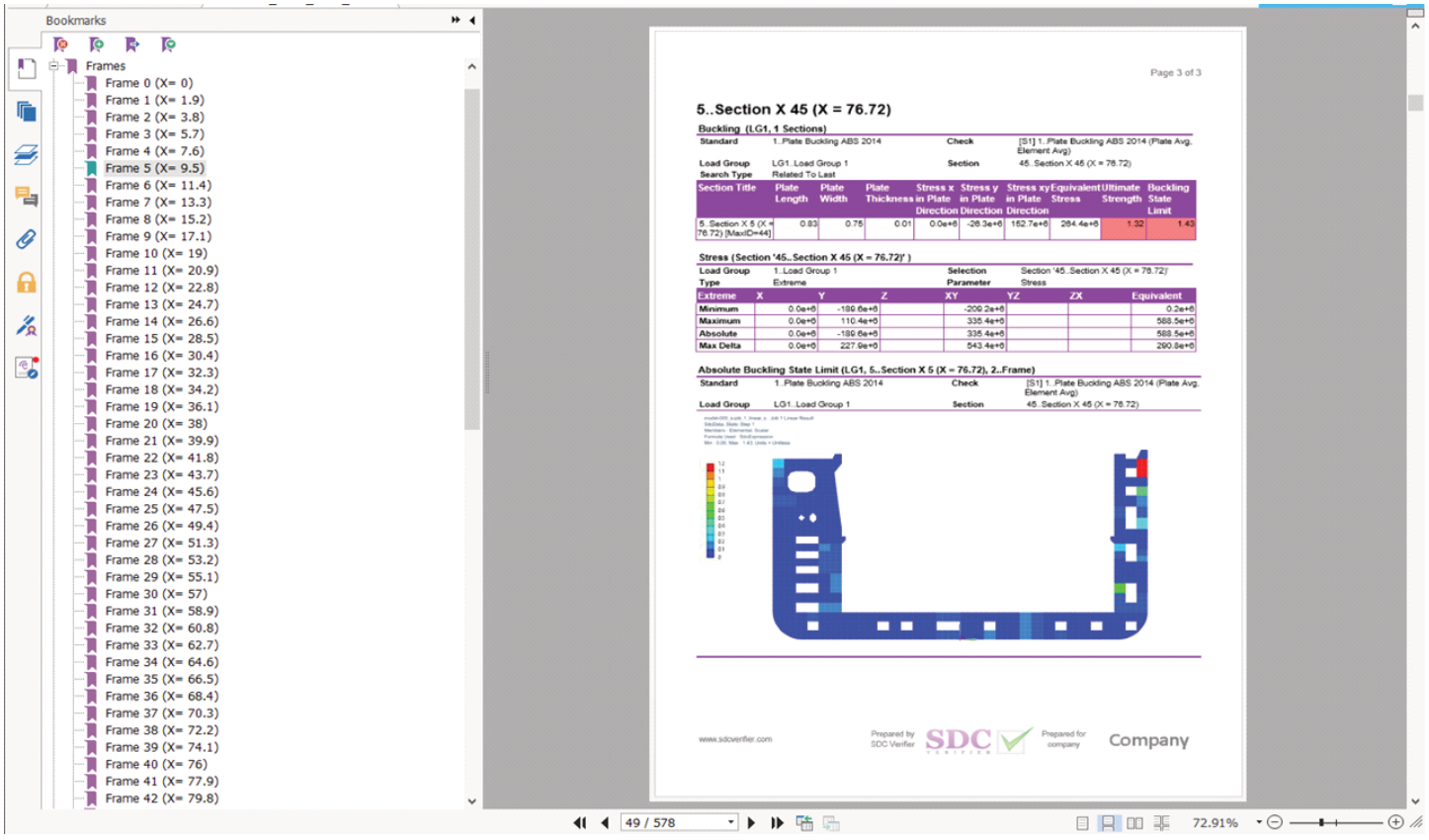
Results contain plots and tables. It is possible to view detailed results for each entity, extreme results on selection and advanced tables to compare load results:



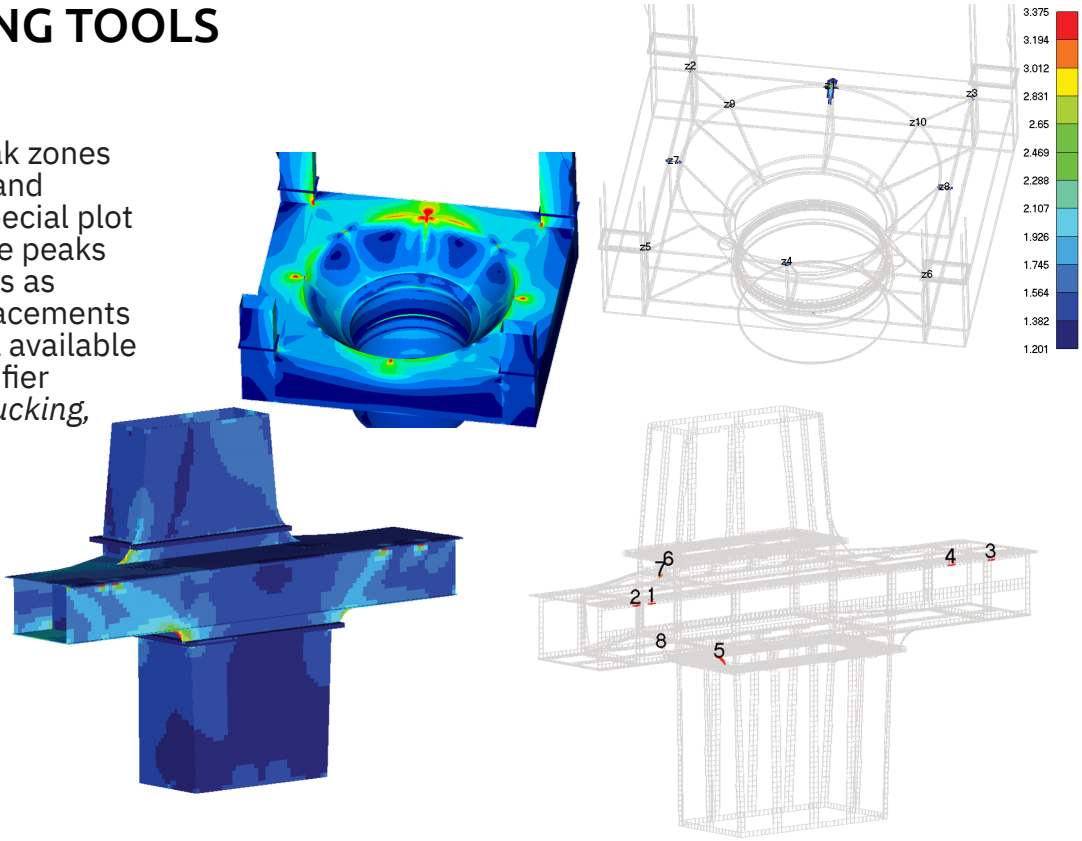
A complete setup, with headings and bookmarks, enables a quick navigation through the reports.



With the help of the Report designer, it is possible to completely control structure of the report and easily preview and modify it. A variety of tools helps to create a huge amount of plots and tables quickly.

POSTPROCESSING TOOLS

Peak Finder finds all peak zones based on output results and presents them using a special plot and a summary table. The peaks for any simple FEA results as stresses, strains or displacements can be found, but also all available results from the SDC Verifier checks *(Fatigue, Beam Bucking, etc.)*



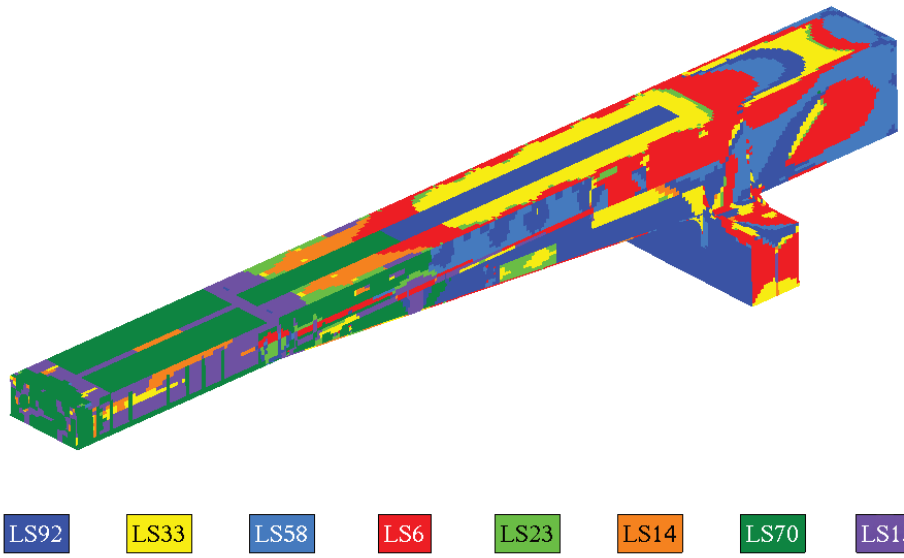
Zone	Value	Zone	Value
Zone 1 (Elements: 2)	1.45	Zone 5 (Elements: 15)	1.41
Zone 2 (Elements: 2)	1.44	Zone 6 (Elements: 1)	1.21
Zone 3 (Elements: 2)	1.43	Zone 7 (Elements: 3)	1.09
Zone 4 (Elements: 2)	1.42	Zone 8 (Elements: 1)	1.01

Governing loads tool extracts the critical loads out of a large group of load combinations. Instead of checking all the situations focus on important ones and reduce calculation time.

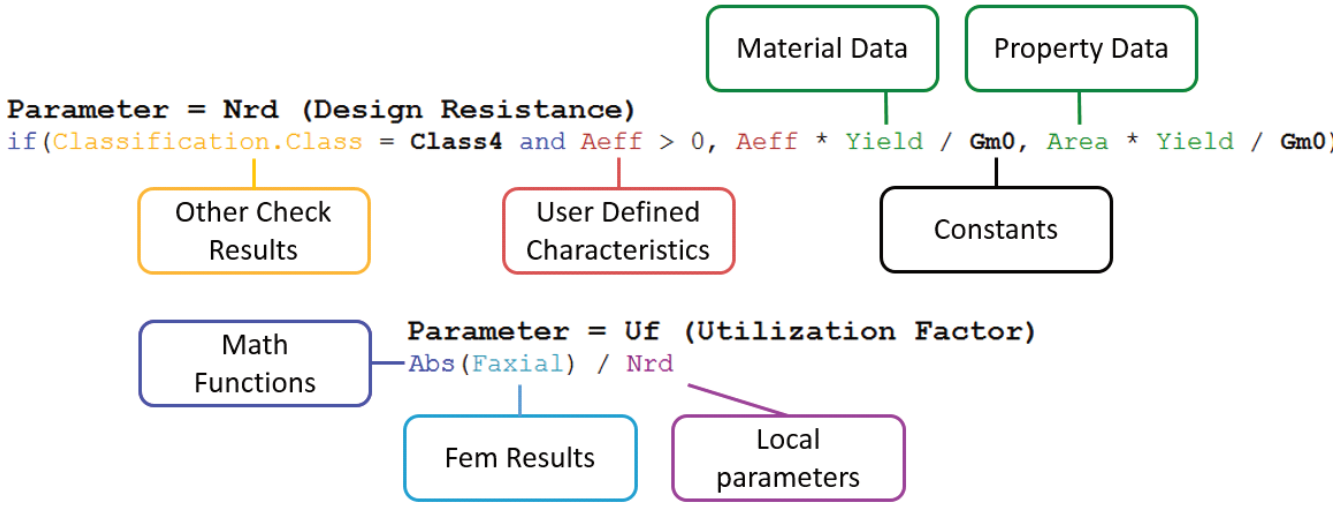
From 132 to 8 load cases

132

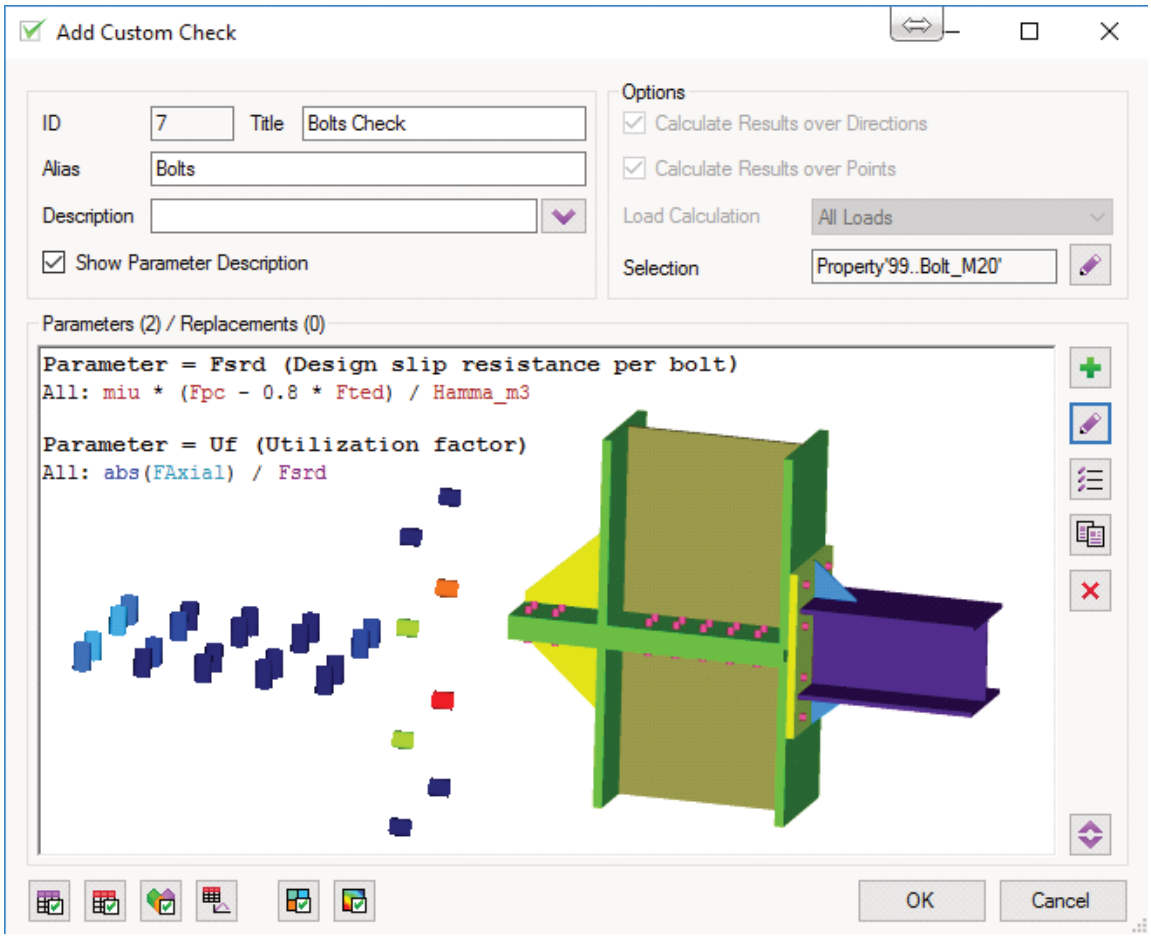
8



The checks in SDC Verifier are completely customizable. With the help of the formula editor, user-defined formulas can be created based on results, model properties and recognized dimensions.



The following example demonstrates a verification of bolted connections. The Axial Force of bolts is compared with the bolt design resistance:



SDC VERIFIER

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STRUCTURAL VERIFICATION ACCORDING TO STANDARDS

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