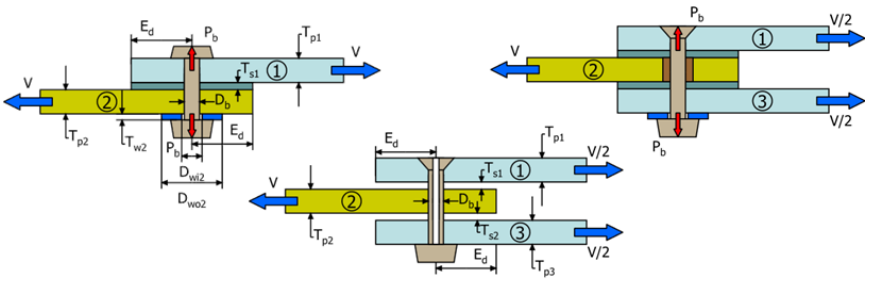
StressCheck®

Smart Application: Single Fastener Analysis Tool

SFAT provides accurate computation of **the joint stiffness**, plate stresses, and fastener loads for single or double shear lap joints connected by a single fastener. Through a **simple and intuitive interface**, the user can provide engineering input data from which SFAT automatically builds, solves, and post-processes a fully 3D StressCheck® finite element mesh using its robust contact algorithm.

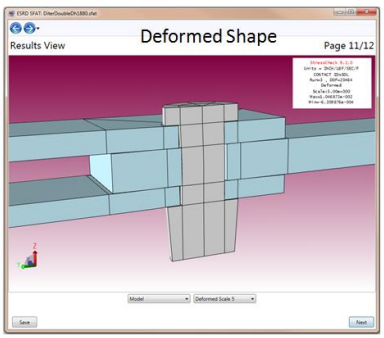
SFAT Highlights

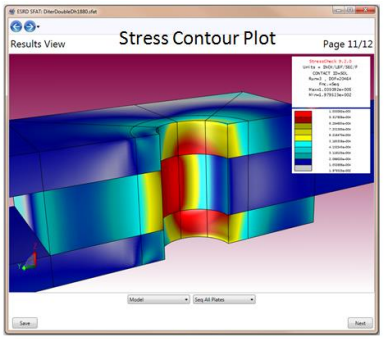
SFAT analyzes single and double shear joints composed of both **metal and composite plates**, providing the option to model laminates ply-by-ply or homogenized. Fastener heads may be protruding or countersunk (including hollow shafts) and the analysis supports neat fit, interference fit, and clearance fit. Additional input options include shimmed and un-shimmed gaps, bushings, and washers. Shear load and fastener pre-load can be specified as loading conditions.



SFAT Results

SFAT computes the joint stiffness, fastener bending moment, shear and axial loads, maximum first principal stress, and the von Mises stress around the hole of each isotropic plate. Convergence information is provided for these quantities to assess **the reliability of results**. An interactive 3D viewer displays deformation and stress contour plots which can be dynamically manipulated by the user. All models and solutions created by SFAT can be exported as StressCheck files for further analysis.





"SFAT is an excellent tool for understanding the complex behavior of a bolted joint connection under a wide variety of configurations. The ease of use and detail of the analysis are state of the art."

Dr. Herb Smith
Boeing Research and Technology

Key Benefits

- Simulate high quality 3D contact without spending time building a finite element mesh.
- A simplified and intuitive user interface allows input of fastener data in pre-defined templates with **step by step validation feedback**.
- Solution time is reduced from hours to minutes when compared with standard FEA.
- Solution quality is guaranteed using p-extension with the StressCheck solver.
- The modeling approach has been validated with experimental results.
- A built-in 3D results display provides interactive viewing of the mesh and stress fringe contours.

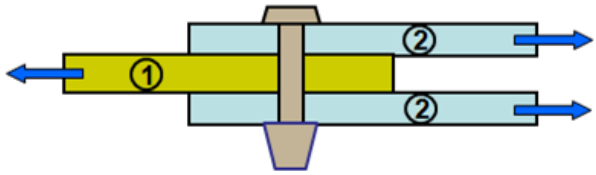
SINGLE FASTENER ANALYSIS TOOL

SFAT Validation Using Experimental Results

Experimentally determined joint stiffness* was compared with the joint stiffness computed from the 3D-contact model implemented in SFAT for several double shear joints. The results are shown in the figure below. Since the dimensions of the fastener head and nut were not available in the reference, the standard values implemented in SFAT were used for the computations. With the exception of two configurations, the difference between predicted and measured joint stiffness is less than 10%.

Specimen No.	Materials		Dimensions [in]				Fasteners		Kjoint [kip/in]		diff [%]
	1	2	t_1	t_2	Wp	Ed	d	Type	Test	SFAT	
IDS01	Aluminum	Aluminum	0.2008	0.0984	0.9843	0.50	0.1969	A1	595	603	1.31
IDS03	Titanium	Titanium	0.2126	0.0984	0.9843	0.50	0.1969	A1	816	821	0.69
IDS05	Aluminum	Aluminum	0.0984	0.0394	0.9843	0.50	0.1969	A1	433	335	-22.65
IDS06	Aluminum	Aluminum	0.2008	0.2008	0.9843	0.50	0.1969	A1	664	621	-6.49
IDS07	Aluminum	Aluminum	0.3976	0.2005	0.9843	0.50	0.1969	A2	688	554	-19.48
IDS08	Aluminum	Aluminum	0.2008	0.0984	1.5748	1.00	0.3150	A1	828	749	-9.45
IDS09	Aluminum	Aluminum	0.2008	0.0984	1.2598	0.50	0.2500	A1	664	636	-4.26
IDS10	Aluminum	Aluminum	0.2008	0.0984	0.9843	0.50	0.1969	B1	664	707	6.49
IIDS02	Aluminum	Aluminum	0.1575	0.0787	0.9449	0.50	0.1890	C1	549	498	-9.38

Types of Fasteners
A = Titanium Bolt
B = Steel Bolt
C = Aluminum Rivet
1 = Protruding Head
2 = CSK Head



*Heimo Huth, *Influence of Fastener Flexibility on the Prediction of Load Transfer and Fatigue Life for Multiple-Row Joints*. Fatigue in Mechanically Fastened Composite and Metallic Joints, ASTM STP 927, 1986.

Deployment Options

SFAT is available as a StressCheck module or as a stand-alone 64 bit application accessible through the StressCheck Tool Box (SCTB) framework. A complete developer's API is included with the SFAT installation for automation and custom .NET application development.

SCTB deploys FEA-based Smart Applications for the analysis of structural details such as single and multiple fastener joints or laminated composite plates. Each Smart App provides convergence information to ascertain the quality of the numerical solution obtained with StressCheck.