



 InDepth FastenerPRO 



**SMART
FASTENER
VALIDATION**



INTRODUCTION

Fasteners such as bolts, rivets, pins, spotwelds etc. are typically represented using 1D beam elements in finite element (FE) analysis. Material specifications and dimensions are assigned to these beam elements. However, this simplified modeling approach for fasteners in linear static analysis often results in inaccurate element stresses and their assessment. Instead, forces and moments derived from the FE analysis of the 1D beam elements are used for factor of safety (FOS) calculations.

InDepth FastenerPro is an advanced fastener validation software that provides an automated method for FOS evaluation and optimization for numerous fasteners within complex structures subjected to multiple load cases. The software efficiently scans through the direct output files of FE solvers to compute the FOS of all fasteners.



OVERVIEW

The fasteners are evaluated for the following failure criteria:

- Tension
- Slip
- Shear
- Combined Tension and Slip
- Combined Tension and Shear

By default, fasteners are evaluated as per the following methods and standards. FOS is computed for both static and dynamic* loading scenarios:

- Shigley Methodology
- AISC/RCSC
- GB-50017
- Other standards in future releases.

*Fatigue FOS evaluated in Shigley method only based on available endurance data.

Built-in Bolt Database along with flexibility of using external bolt data:

- Inch Series - SAE Gr5, SAE Gr7, SAE Gr8, ASTM A325, ASTM A354 GR BC, ASTM A354 GR BD and ASTM A490.
- Metric Series - ISO CL 8.8, ISO CL 10.9, ISO CL 12.9.
- HUCK® Bolts and Blind Rivets
- Other fasteners can be included upon request.

InDepth FastenerPro is FE solver neutral. Default output data file from following solvers can be interfaced as input file using the softwares' GUI.

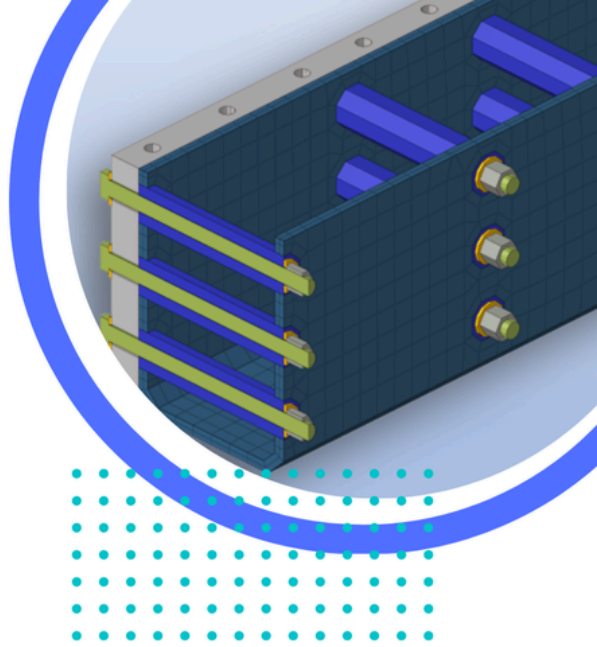
- Nastran/OptiStruct (.f06)
- ABAQUS Standard (.dat)
- LS-Dyna (elout, secforc)
- SolidWorks (.csv)
- User input from solver independent text file (.txt) with structured loads info.
- Other solvers can be supported upon request.

InDepth FastenerPro

BOLT PRYING & JOINT STIFFNESS

Since contacts between clamped parts and bolt head are generally not included in linear static simulations, FE analysis generates bending moment in the beam elements representing the bolts. InDepth FastenerPro converts this bending moment into an equivalent axial force (Prying Force). This equivalent axial force is used in tensile FOS calculations.

Default conservative joint stiffness value is used for FOS calculation per Shigley. Can be updated by user using the joint stiffness calculator available in the exported excel file. Calculator uses the Rotscher pressure cone method with constant frustum angle of 30° as available in Shigley's Mechanical Engineering Design.



GUI & RESULTS

Intuitive GUI allows easy import of fastener load data from FE solvers and selection of load cases for FOS evaluation. Ordered beam element numbering or structured naming of materials in the FE input file facilitates automatic fastener grade and size assignment. Suggested input parameters and FOS requirements in the software based on test data and best practices from previous experiences in the field. Flexibility for user to modify these parameters as needed and obtain FOS for thousands of fasteners across numerous load cases in seconds.

The screenshot shows the InDepth FastenerPro 2025.0 software interface. At the top, there are tabs for Settings, FE Units, Import, Select, Solver, and Export. The Settings tab is active, showing options like Customize, Reset All, English, FE Results, FE Model, Load Cases, Bolt Data, Calculate, Reset Calc., Results Excel, FOS HW ASCII, Include LC, and Load Case Excel. Below the tabs, there is a STATUS section with a green message: "Calculation of resultant successful", "Calculation finished", "Calculating FoS...", and "Calculation finished". Below the status, there is a TABLES section with a table of results. The table has columns for Bolt Location, Element Id, Bolt Type, Bolt Dia, Clamp Load, SF NoSlip, FoS Slip, SF w/ Slip, FoS Shear, Axial, Corresponding BM, Thread Bolt Len, Unthread Bolt Len, Bolt Stiffness, and Bolt Head. The table contains 8 rows of data.

Bolt Location	Element Id	Bolt Type	Bolt Dia	Clamp Load	SF NoSlip	FoS Slip	SF w/ Slip	FoS Shear	Axial	Corresponding BM	Thread Bolt Len	Unthread Bolt Len	Bolt Stiffness	Bolt Head
	10230000	S4E GR 8	0.25	2863.91	91.29	6.27	91.29	17.68	3.03	0.65	0.00	0.00		0.38
	10230001	S4E GR 8	0.25	2863.91	107.03	5.35	107.03	15.08	2.23	2.15	0.00	0.00		0.38
	10230002	S4E GR 8	0.25	2863.91	111.81	5.12	111.81	14.43	1.37	0.59	0.00	0.00		0.38
	10230003	S4E GR 8	0.25	2863.91	74.69	7.67	74.69	21.60	1.49	0.12	0.00	0.00		0.38
	10230004	S4E GR 8	0.25	2863.91	83.17	6.89	83.17	19.40	2.61	0.18	0.00	0.00		0.38
	10230005	S4E GR 8	0.25	2863.91	97.28	5.89	97.28	16.59	3.17	0.43	0.00	0.00		0.38
	10230006	S4E GR 8	0.25	2863.91	131.56	4.25	131.56	12.27	1.61	2.06	0.00	0.00		0.38
	10230007	S4E GR 8	0.25	2863.91	92.02	6.22	92.02	17.54	1.85	1.92	0.00	0.00		0.38
	10230008	S4E GR 8	0.25	2863.91	109.51	5.23	109.51	14.73	1.55	1.09	0.00	0.00		0.38

Fastener FOS results are exported as an excel file. Precise presentation and color coding of results allows easy identification of critical joints. Editable Excel file allows progressive fine tuning of calculation parameters and on-the-spot changes to bolt size, bolt grade etc. to accommodate design iterations.

HIGHLIGHTS



Versatile Software

Evaluate and optimize the Factor of Safety (FOS) for a wide range of fasteners – such as bolts, rivets, pins, and spot welds.



Blazing Fast

Intelligently reads FEA solver output files with data for thousands of fasteners from numerous load cases, and calculates FOS in seconds.



Evaluation Standards

Shigley Method, AISC/RCSC and GB-50017 in the current release. VDI-2230, Eurocode-3 and EN-13814 in future releases.



FEA Solver Neutral

Supports output from popular FEA solvers such as Nastran, OptiStruct, Abaqus, LS-Dyna, SolidWorks, and more - using a solver neutral file format.



Built-In Fastener Database

Typical SAE, ASTM, and ISO Bolts.
HUCK® Bolts and Blind Rivets.
Option to import custom data as needed.



Calculated Data

Provides FOS in tension, shear, slip, combined tension/slip and combined tension/shear. And, for both static and dynamic loading scenarios.



Intuitive GUI

Streamlines user interactions by being visually clear and easy to navigate, reducing the learning curve significantly.



Excel Integration

All the raw and calculated data can be exported to an Excel spreadsheet for custom post-processing (screening, iterations, reporting etc.)



FOS Visualization

Export HWASCII file from excel to visualize the FoS in Altair HyperView.



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