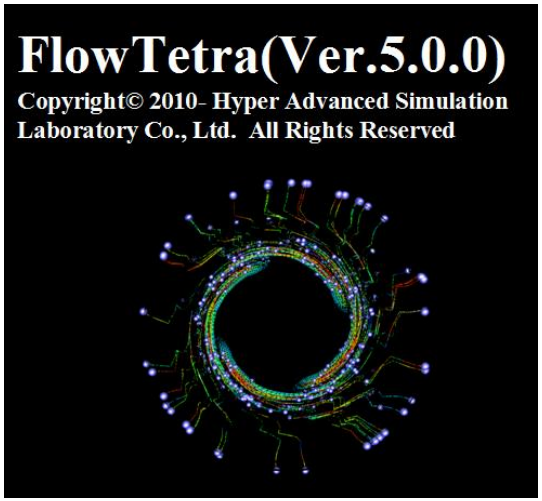
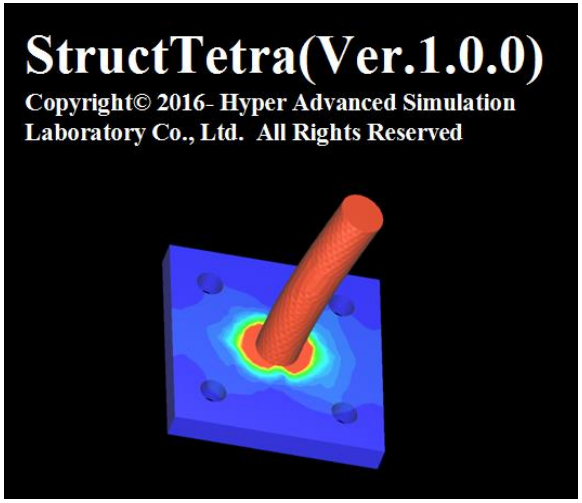
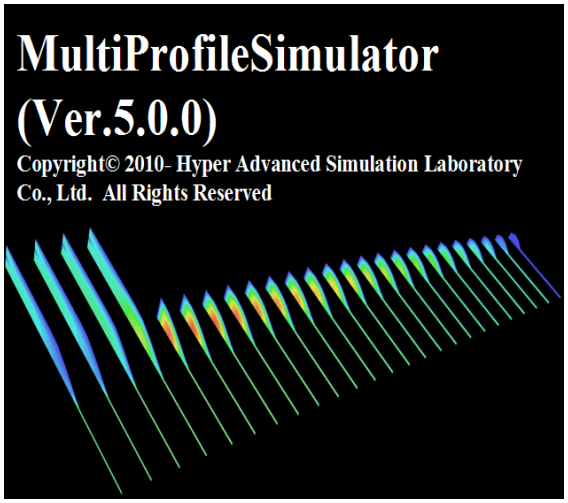
FlowSimulator3D(Ver.5.0.0)
改良成果資料（発表用ダイジェスト版）







2016/11/25

株式会社HASL

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汎用2.5D FEM 熱流動解析プログラム

Multi purpose 2.5D FEM
thermal flow analysis program

3D FEM 構造解析プログラム

3D FEM
structure analysis program

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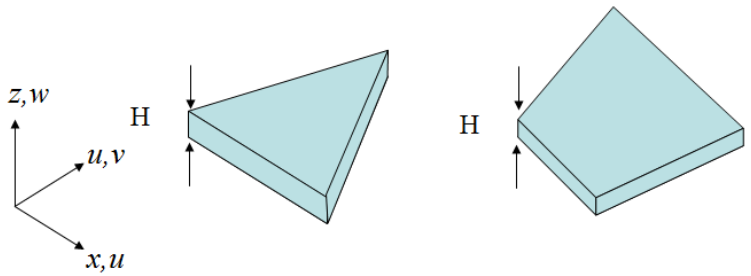
汎用2.5D FEM 熱流動解析プログラム

Finite Element Libraries

平板要素

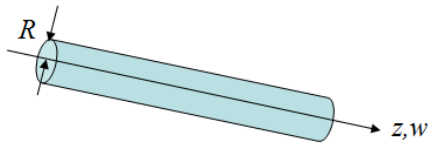


$$\langle u\rangle = -S\left(\frac{\partial p}{\partial x}\right), \quad \langle v\rangle = -S\left(\frac{\partial p}{\partial y}\right), \quad \langle w\rangle = -S\left(\frac{\partial p}{\partial z}\right).$$

$$S = \frac{1}{H}\left(\gamma - \frac{\beta^2}{\alpha}\right) \qquad \alpha = \int_{-H/2}^{H/2}\frac{1}{\eta}dh, \quad \beta = \int_{-H/2}^{H/2}\frac{h}{\eta}dh, \quad \alpha = \int_{-H/2}^{H/2}\frac{h^2}{\eta}dh.$$

$$\frac{\partial}{\partial x}\left(S\frac{\partial p}{\partial x}\right) + \frac{\partial}{\partial y}\left(S\frac{\partial p}{\partial y}\right) + \frac{\partial}{\partial z}\left(S\frac{\partial p}{\partial z}\right) = 0$$

円管要素



$$\langle w\rangle = -S\left(\frac{\partial p}{\partial z}\right) \qquad S = \frac{1}{2R^2}\int_0^R \frac{r^3}{\eta}dr$$

$$\frac{\partial}{\partial z}\left(S\frac{\partial w}{\partial z}\right) = 0$$

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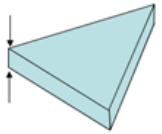
Pre-processing

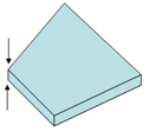
流動面形状

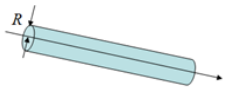
1) 3D CAD → STL ファイル→*.25msh



2) 3D CAD → STL, or IGESファイル → Netgen→*.25msh

3) MPS preprocessor →*.25msh





*.25msh:2.5D FEMプログラム入力用メッシュファイル
MPS : Multi Profile Simulator

肉厚情報設定

1) Flow Tetra preprocessorを利用して設定

2) MPS preprocessorを利用して設定

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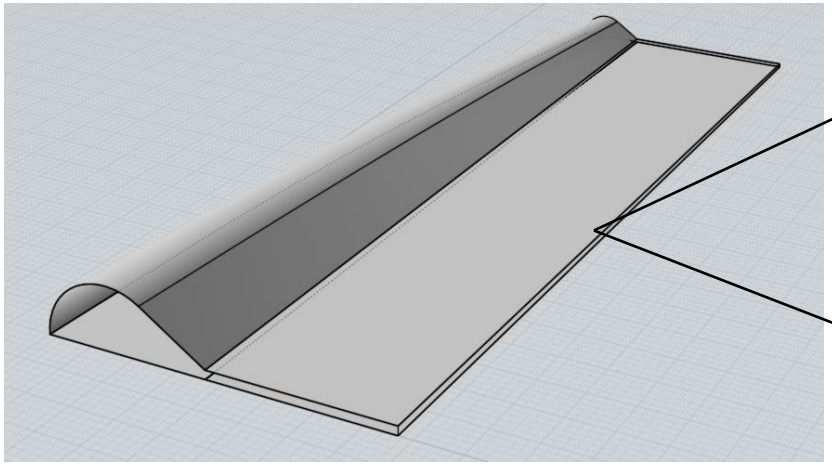
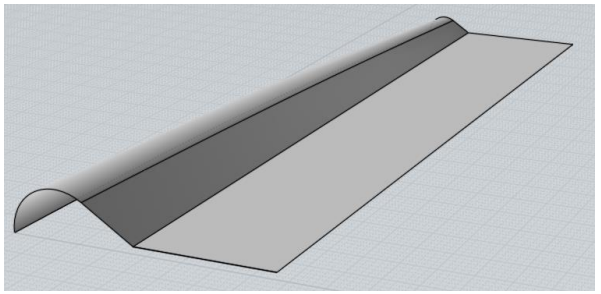
流動面形状の作成と肉厚情報設定例

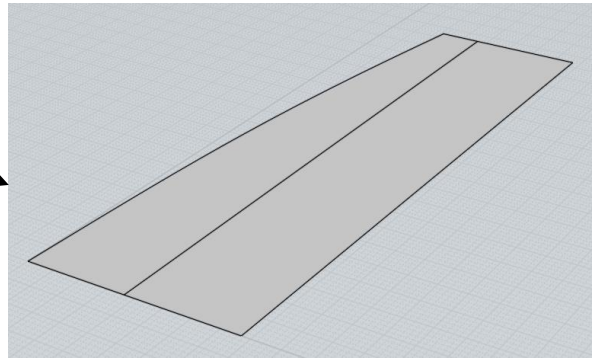


CADで定義した流路形状

2面に分離



肉厚設定用形状情報



2.5D メッシュ作成用形状情報

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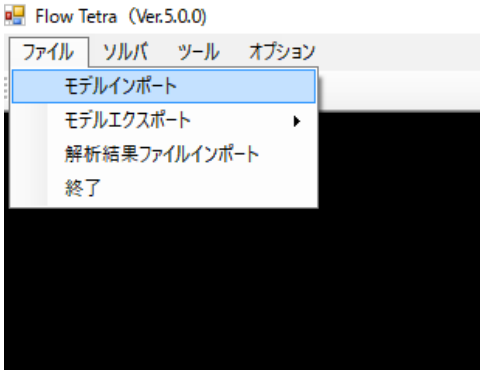
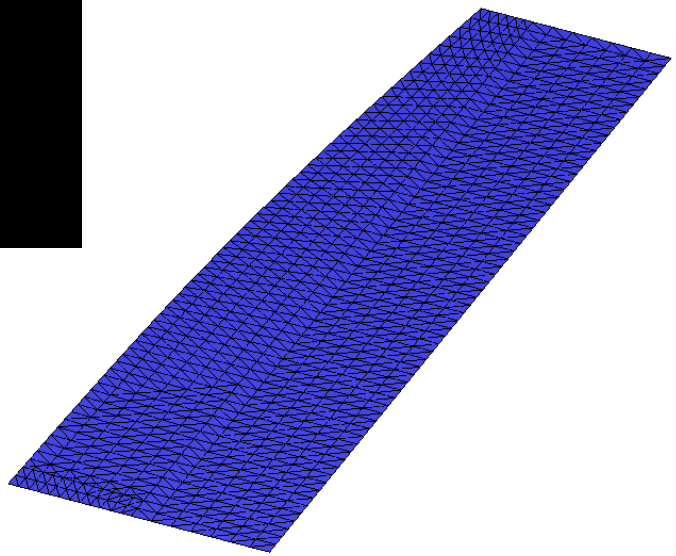
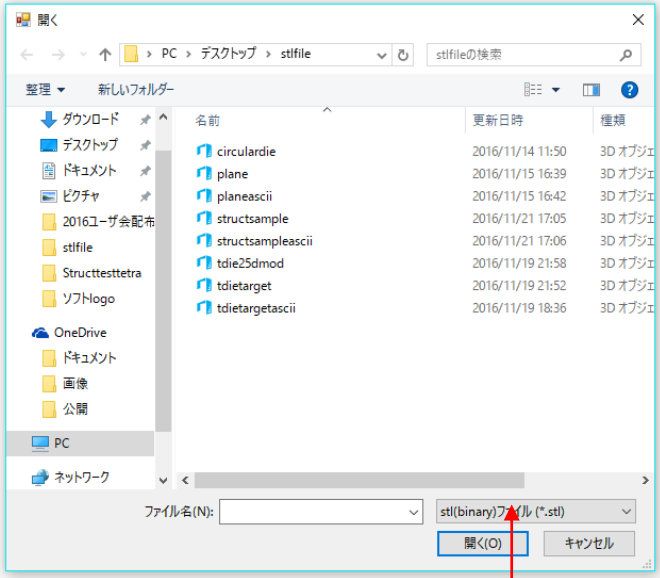
2.5D メッシュ作成用形状情報をSTLファイル形式で出力した後、Flow Tetraにインポート







2.5D メッシュ作成用形状STLファイル情報

STL(binary)ファイルの
インポート機能を新規実装

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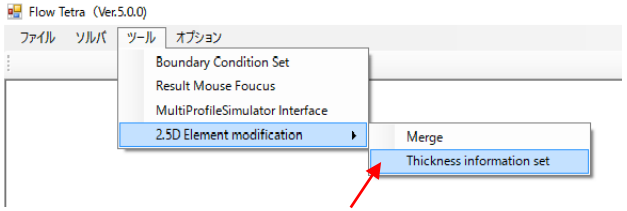
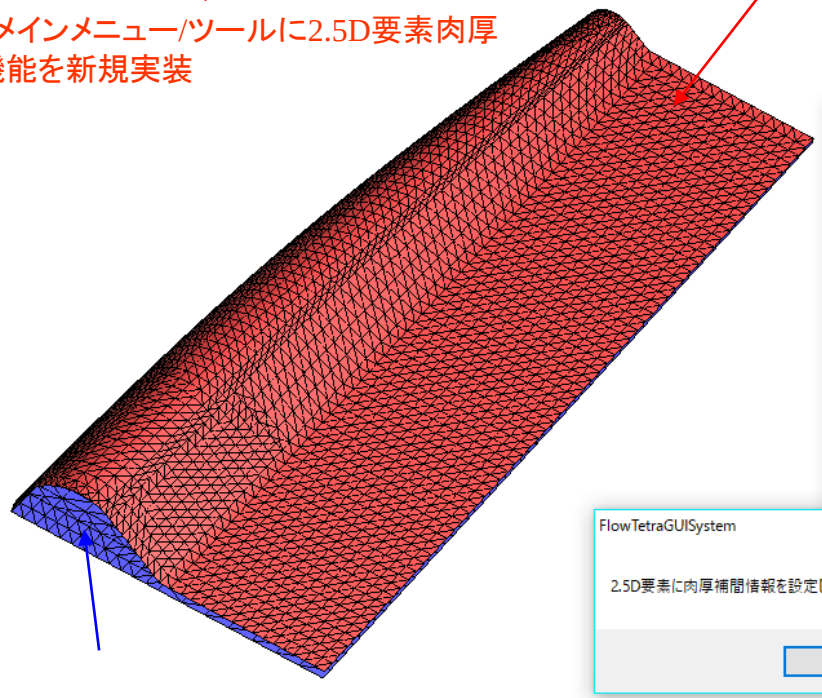
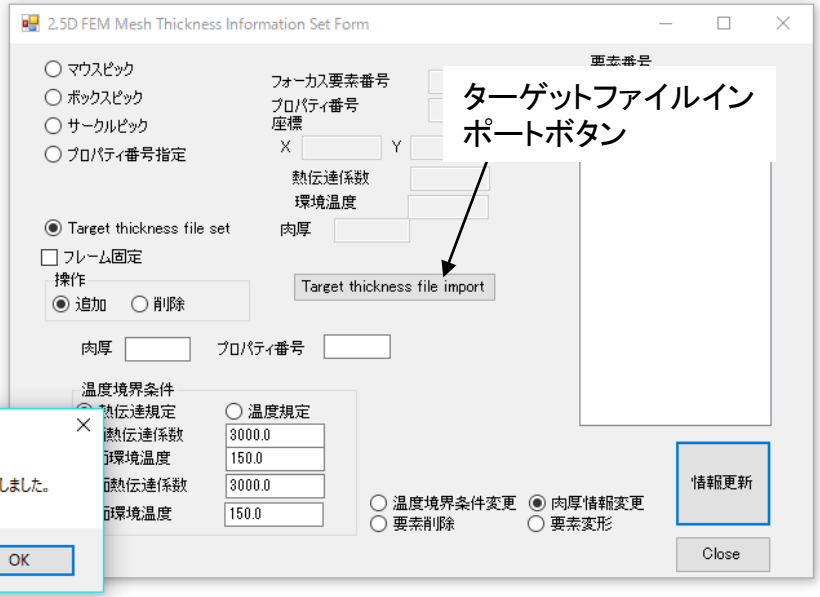


Flow Tetra メインメニュー/ツールに2.5D要素肉厚情報設定機能を新規実装

Target file information of thickness calculation (STL binary file)



2.5D Mesh information



ターゲットファイルを利用した肉厚自動設定機能

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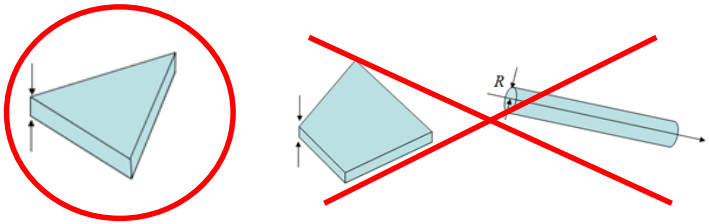
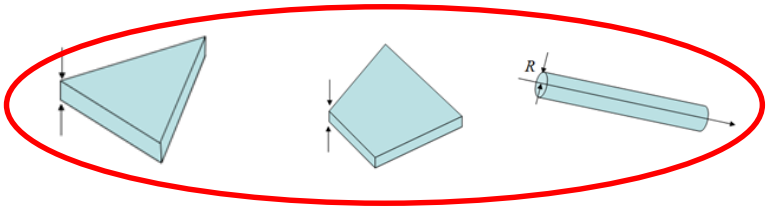
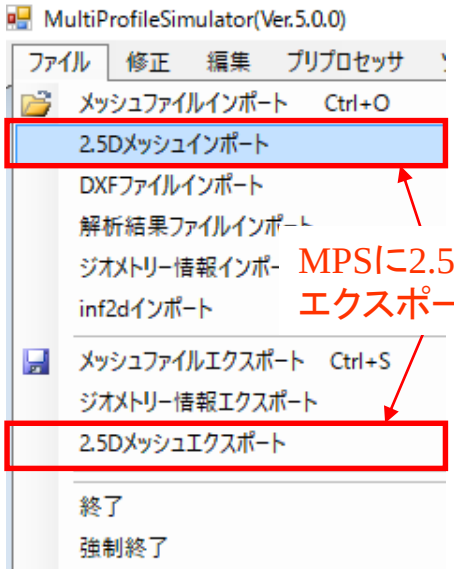
CAD STL ファイル形式

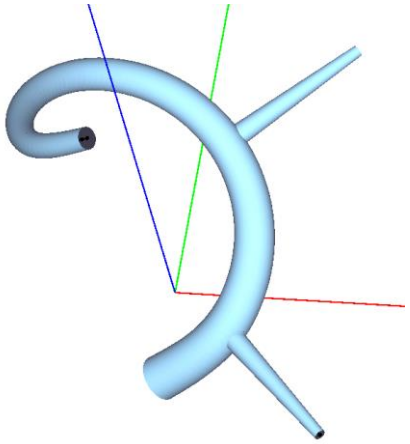


CAD STL ファイル形式&
MPS preprocessor

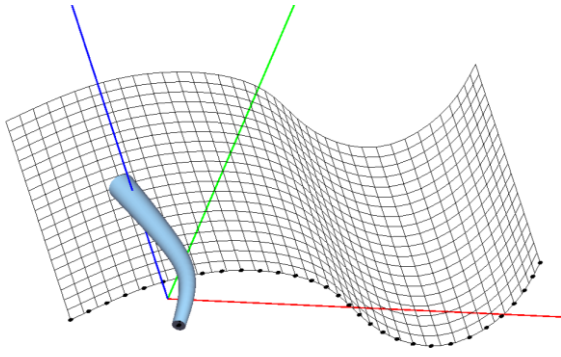




MPSに2.5Dメッシュインポート/
エクスポート機能を新規実装



円管要素



円管要素＋平面（四角形）要素

MPS preprocessor を利用した2.5Dモデリング例

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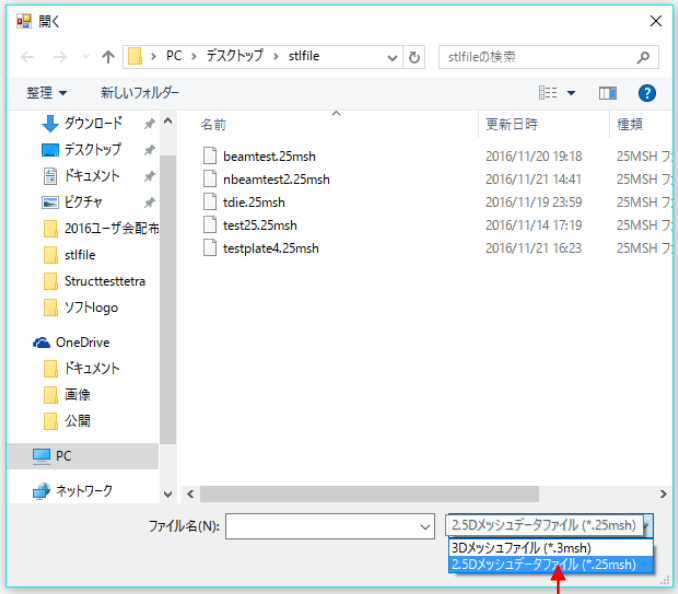
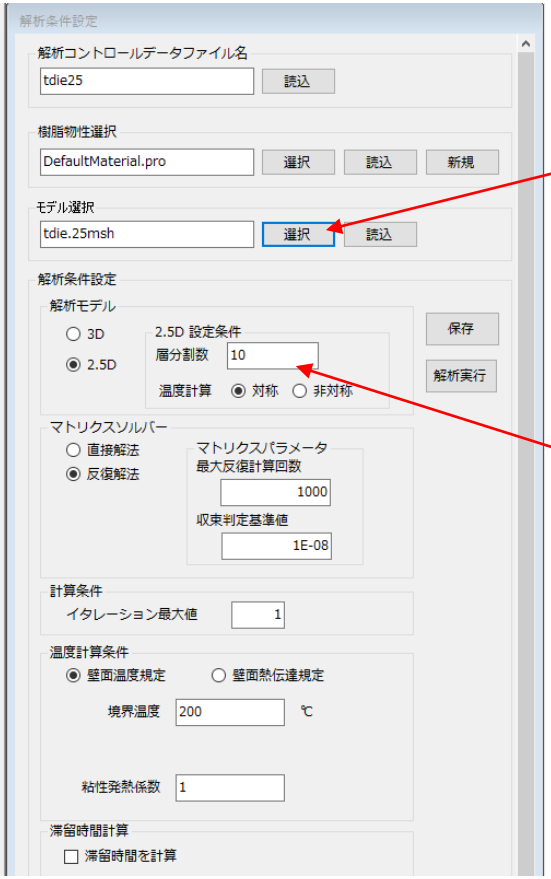
Analysis



*.3msh→既往Flow Tetraの3D解析

*.25msh→新規Flow Tetraの2.5D解析



Flow Tetra 解析条件設定フォームのモデル選択で2.5D FEMメッシュ情報を選択。

肉厚方向分割数を設定

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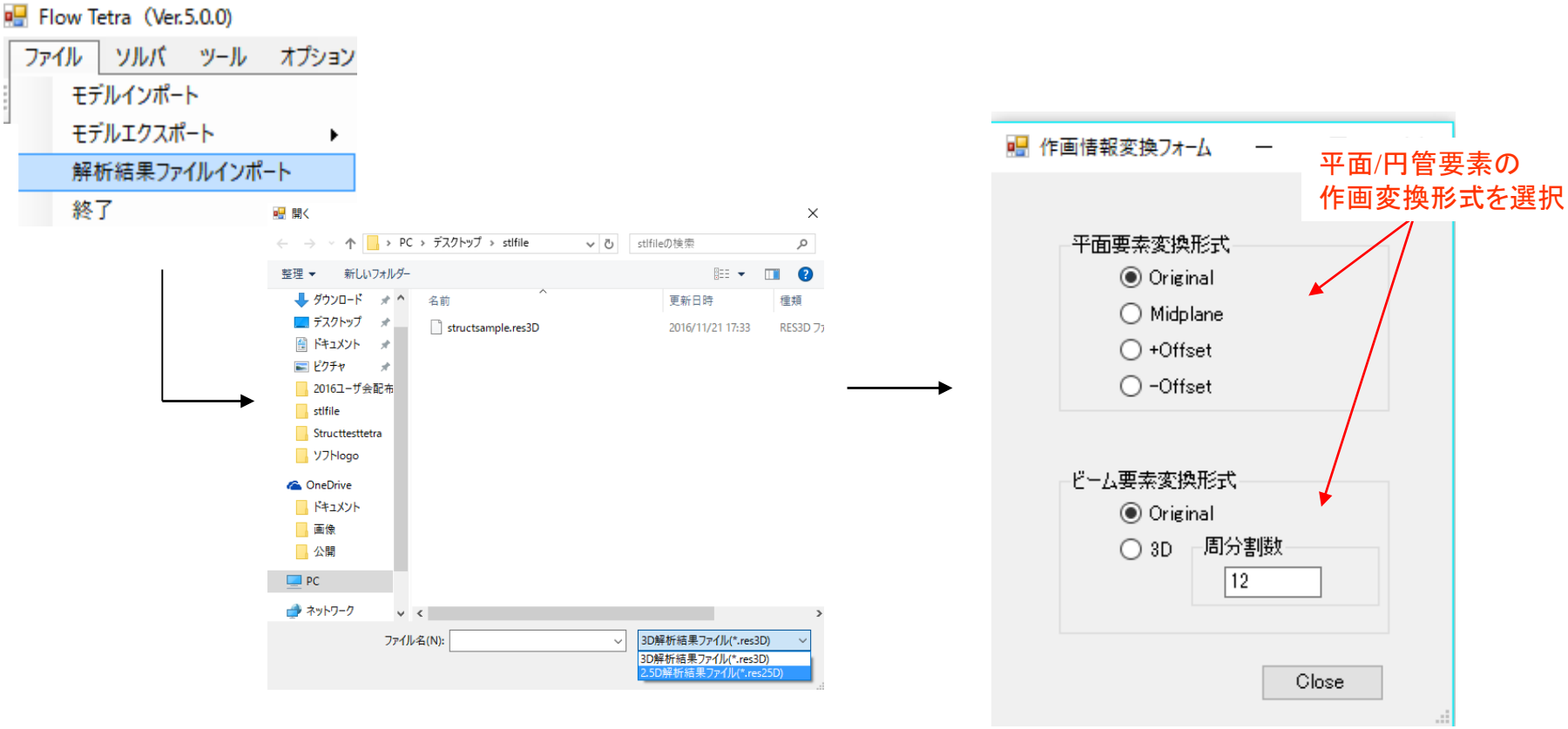
Post-processing



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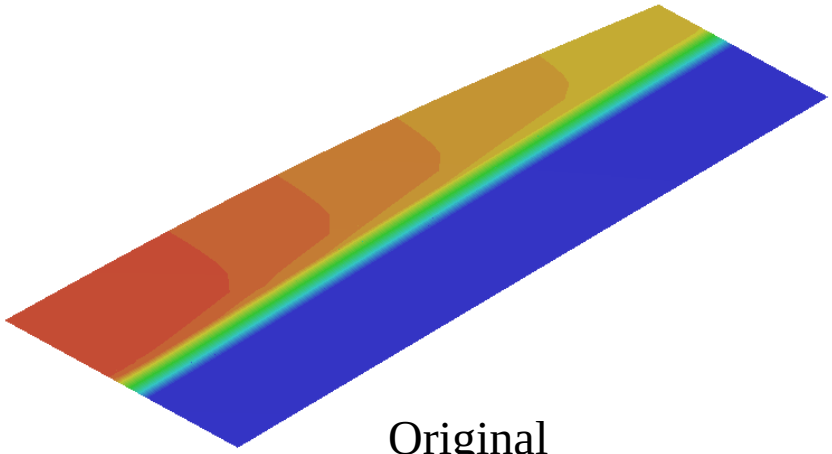
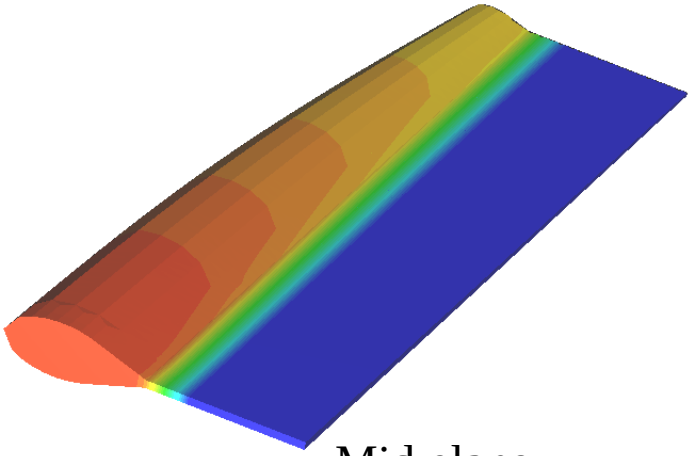
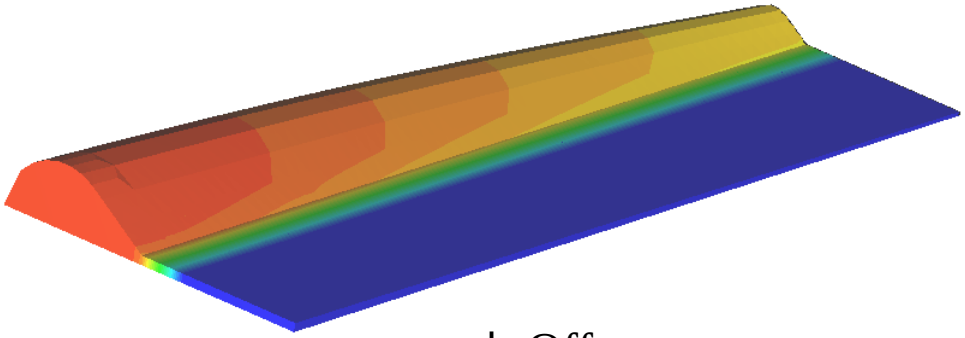


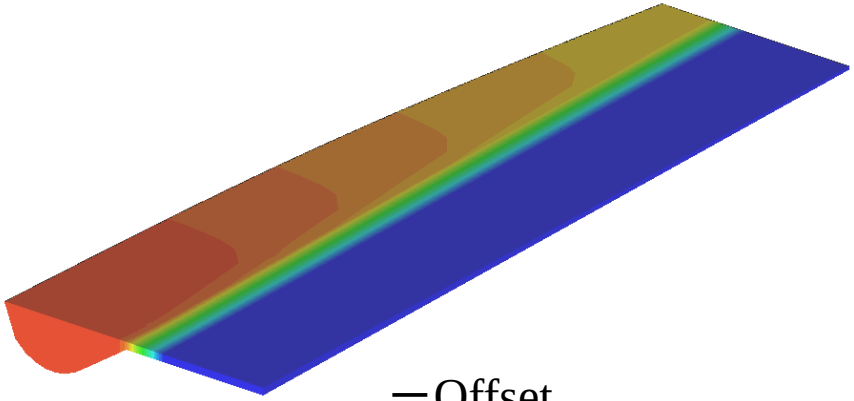
Original



Mid plane



＋ Offset



－Offset

様々な変換形式を利用した解析結果（圧力分布）の表示例

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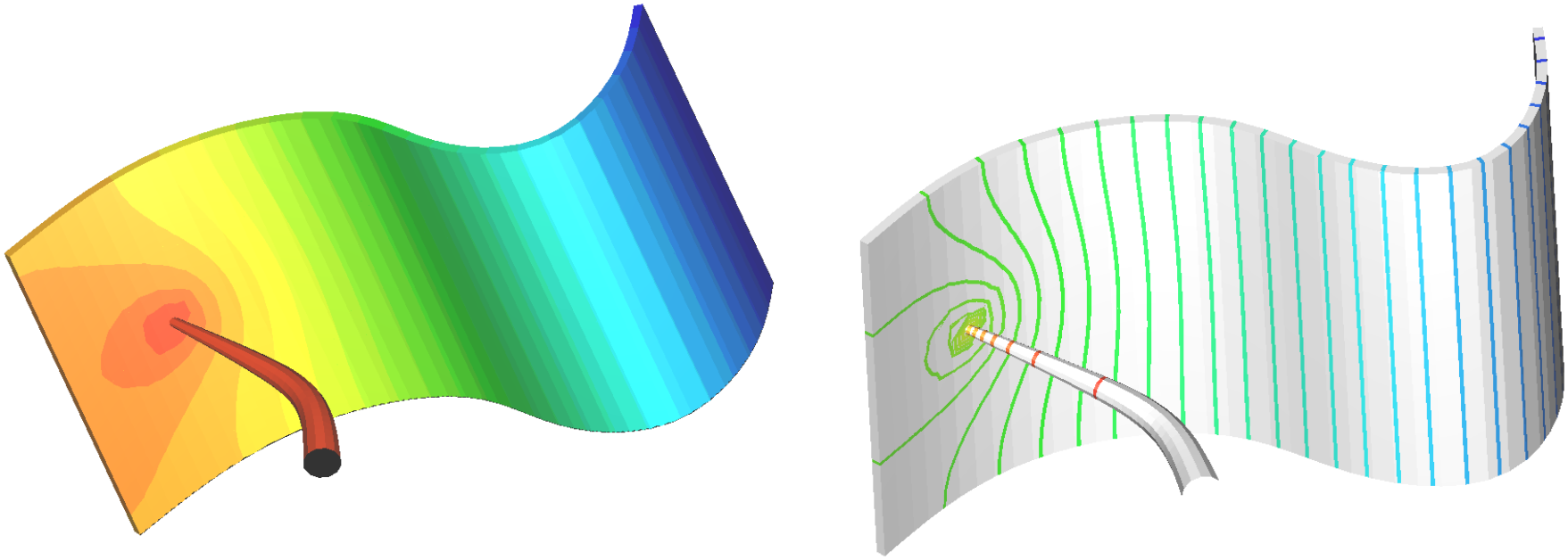

円管/平板結合モデル解析結果（圧力分布）の表示例

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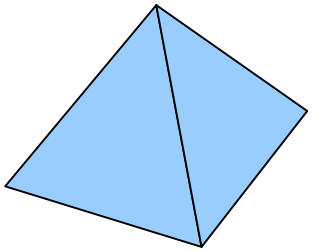
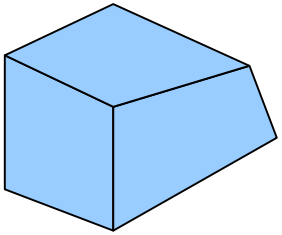
3D FEM 構造解析プログラム(Struct Tetra)

Finite Element Libraries



3D 四面体要素

NETGENと3D-CAD 情報を利用して自動生成



3D 六面体要素

MPS Preprocessorを利用したMapped meshing

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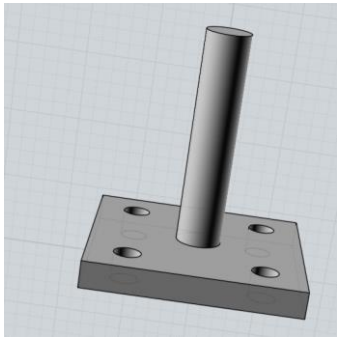
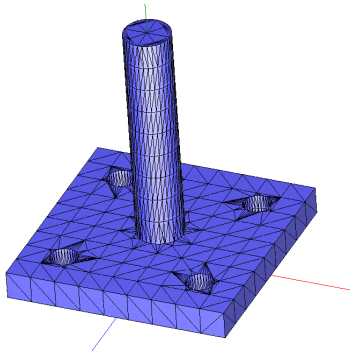
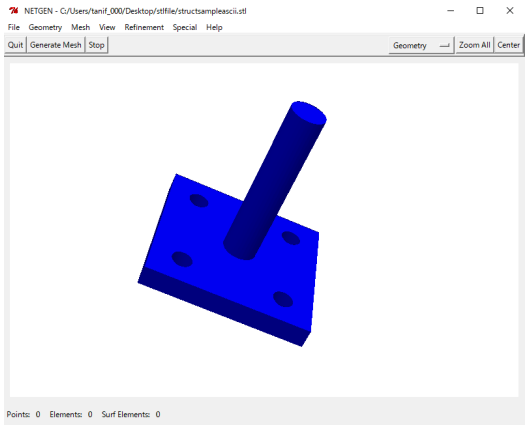
Pre-processing



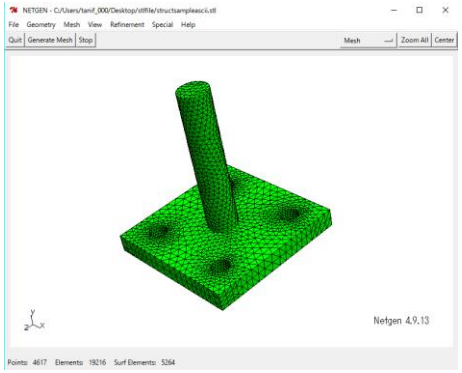
3D-CAD



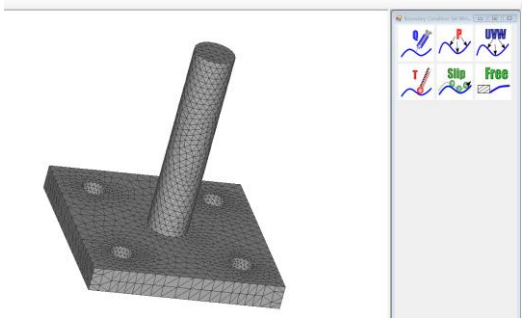
STL(ASCII)



NETGEN



3D Tetra solid elements



Struct Tetra preprocessor
（荷重/拘束条件設定）

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Analysis

・線形構造解析のため反復計算不要（安定高速演算）

・溶融高分子材料と比較すると圧倒的に公開情報が豊富

代表的な材料の機械的物性

材料名	ヤング率 GPa	ずれ弾性率 GPa	ポアソン比	体積弾性率 GPa	圧縮率 1/Pa
亜鉛	108.4	43.4	0.249	72	$1.4\times10^{(-11)}$
アルミニウム	70.3	26.1	0.345	75.5	$1.33\times10^{(-11)}$
インバール	144.0	57.2	0.259	99.4	$1.0\times10^{(-11)}$
カドミウム	49.9	19.2	0.3	41.6	$2.4\times10^{(-11)}$
金	78.0	27.0	0.44	217.0	$0.461\times10^{(-11)}$
銀	82.7	30.3	0.367	103.6	$0.97\times10^{(-11)}$
コンスタンタン	162.4	61.2	0.327	156.4	$0.64\times10^{(-11)}$
黄銅(真鍮)	100.6	37.3	0.35	111.8	$0.89\times10^{(-11)}$
スズ	49.9	18.4	0.357	58.2	$1.72\times10^{(-11)}$
青銅(鋳)	80.8	34.3	0.358	95.2	$1.05\times10^{(-11)}$
ジュラルミン	71.5	26.7	0.335	-	-
チタン	115.7	43.8	0.321	107.7	$0.93\times10^{(-11)}$
鉄(軟)	211.4	81.6	0.293	169.8	$0.59\times10^{(-11)}$
鉄(鋳)	152.3	60.0	0.27	109.5	$0.91\times10^{(-11)}$
鉄(鋼)	201-216	78-84	0.28-0.30	165-170	$(0.61-0.59)\times10^{(-11)}$

出典：http://mh.rgr.jp/memo/mq0100.htm

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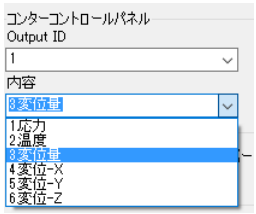
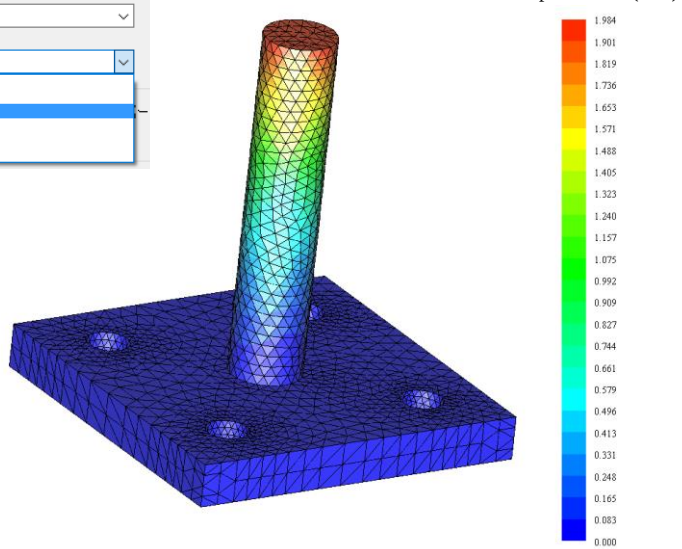
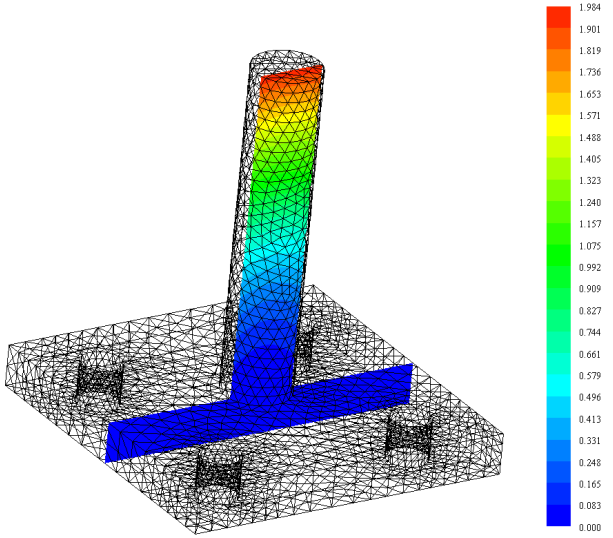
Post processing

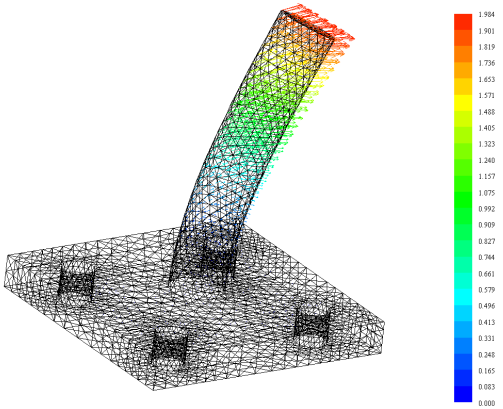




各種計算量のSurface contour



各種計算量のSlice contour



変位ベクトルと変形図

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