AutoPIPE Vessel のご紹介

（圧力容器や熱交換器用の設計システム）

伊藤忠テクノソリューションズ株式会社

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AutoPIPE Vessel

（圧力容器や熱交換器用の設計システム）

・圧力容器、熱交換器、タンク、エアークーラーの自動設計
・移送、運転、地震等の様々な条件下での設計に対応
・詳細な図面、レポート、積算を一つのソフトで実現
・各種設計ツールとのインターフェース

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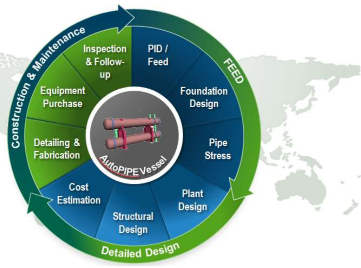
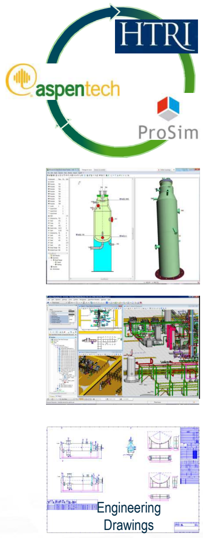
圧力容器

タンクや
ボイラー

熱交換器





設計規格

EPCにおける優位性

- 高い技術力を備えたエンジニアの生産性を最大化
- 世界市場をサポート
- 分散されたプロジェクトチームのコラボレーションを強化

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各国の設計コードに対応

規格や基準

French	American	British	German	Russian	European
CODAP NFE NV PS	ASME VIII div 1&2 UBC ASCE TEMA - EJMA API 650 API 661	PD5500 BSI CP3 BS 6399	AD Merkblaetter DIN	GOST R 52857 GOST 28759 GOST 51273	EN 13345 EN1591 EN1092 EN1759 EN 1991-1-4 EN 1998

関連規格

局部荷重の設計
PD5500 Annex G, WRC 107-297, EN13445, GOST, Roark and Zick Formula

地域の地震･風荷重
Canada NBC, Indian, ASCE, UBC, EN, GOST, British, Brazilian NBR, Spanish NBE

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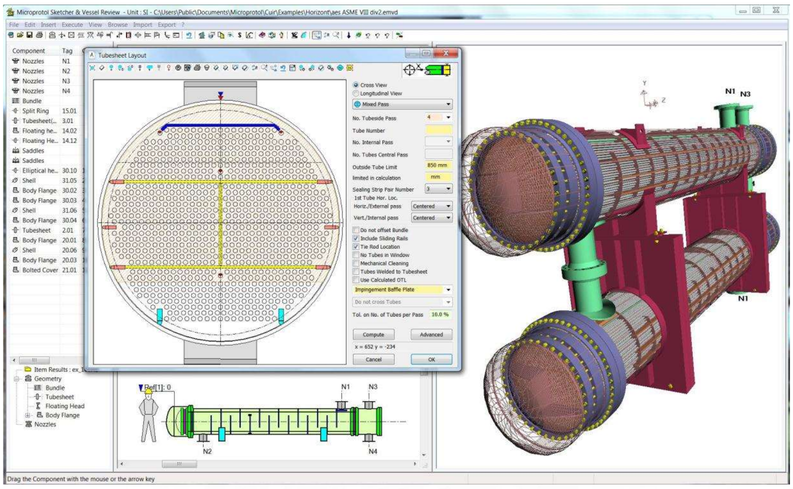
ユーザインターフェース



シェル&チューブ式熱交換器の例

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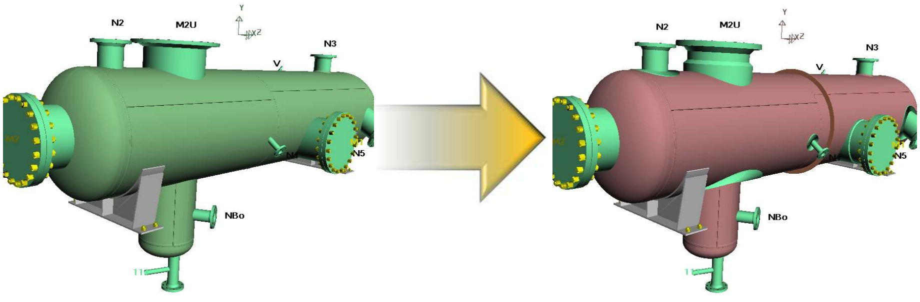
板厚等の自動設計

FAST

Fully Designed in under 90 seconds



設計前

設計後

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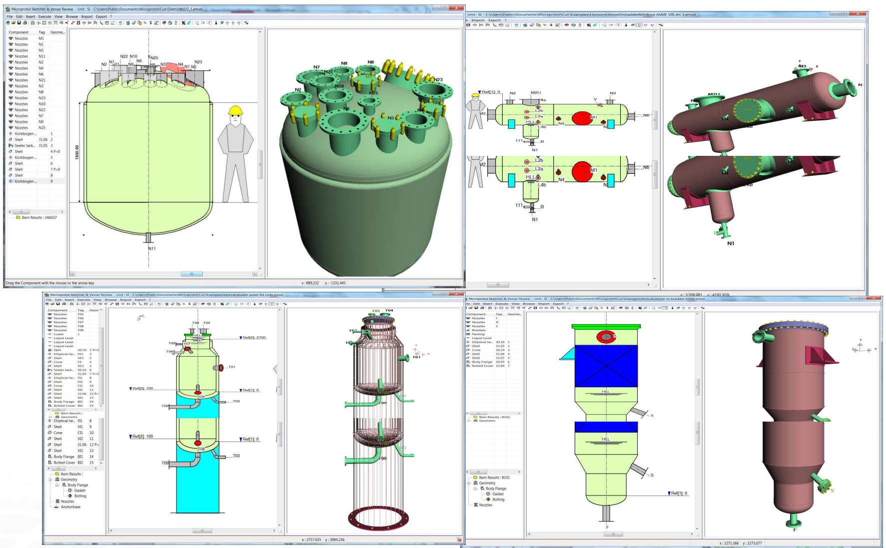
圧力容器のモデル例



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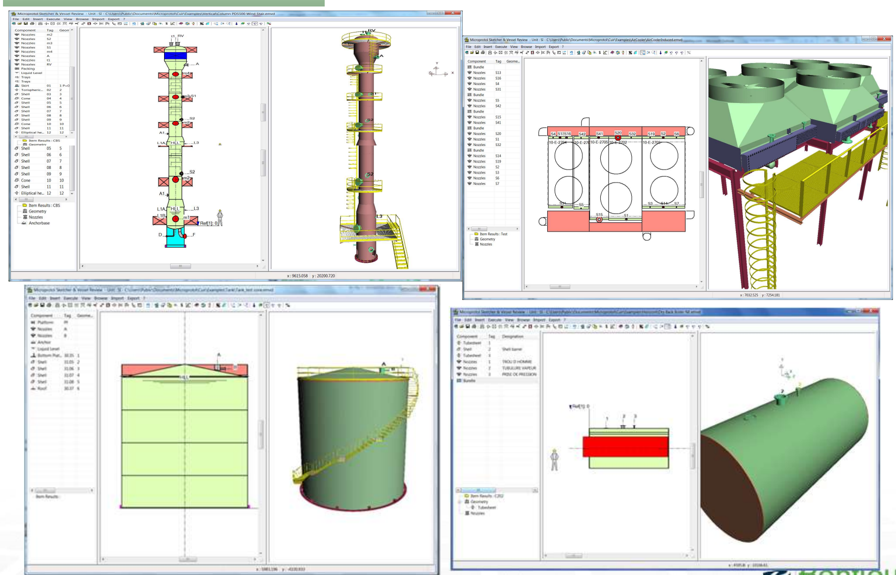
他の容器等のモデル例



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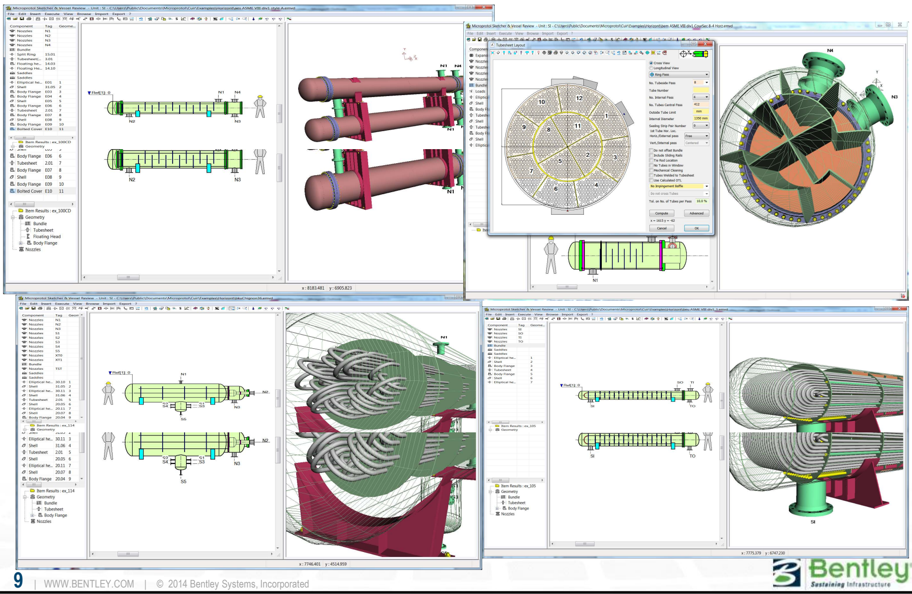
熱交換器のモデル例



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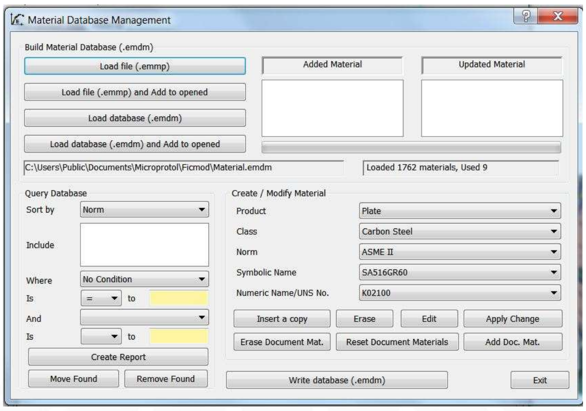
各種規格の材料のデータベースを登録

- ASME, BS, DIN, EN, GOST
- データの追加・修正が可能

ASME SETTING THE STANDARD

BSI

cen



Добровольная РСТ сертификация

DIN

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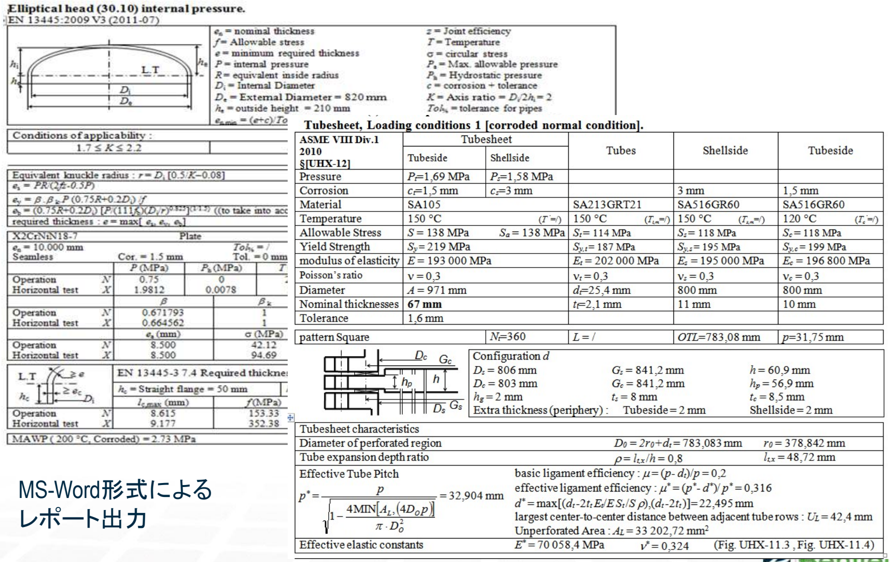
結果レポートの出力



Elliptical head (30.10) internal pressure.
EN 13445:2009 V3 (2011-07)

e_n = nominal thickness
f = Allowable stress
e = minimum required thickness
P = internal pressure
R = equivalent inside radius
D_i = Internal Diameter
D_e = External Diameter = 820 mm
h_e = outside height = 210 mm
$e_{a,min} = (e+c)/To$
z = Joint efficiency
T = Temperature
σ = circular stress
P_a = Max. allowable pressure
P_h = Hydrostatic pressure
c = corrosion + tolerance
K = Axis ratio = $D_i/2h_i$ = 2
Tol_{h_c} = tolerance for pipes

Conditions of applicability :
$1.7 \le K \le 2.2$

Equivalent knuckle radius : $r = D_i\,[0.5/K-0.08]$
$e_s = PR/(2fz-0.5P)$
$e_y = \beta . \beta_k . P\,(0.75R+0.2D_i)/f$
$e_b = (0.75R+0.2D_i)\,[P/(111f_b)(D_i/r)^{0.825}]^{(1/1.5)}$ ((to take into acc
required thickness : $e = \max[\,e_s, e_y, e_b]$

X2CrNiN18-7 Plate
e_n = 10.000 mm
Seamless Cor. = 1.5 mm Tol_{h_c} = / Tol. = 0 mm

		P (MPa)	P_h (MPa)
Operation	N	0.75	0
Horizontal test	X	1.9812	0.0078

		β	β_k
Operation	N	0.671793	1
Horizontal test	X	0.664562	1

		e_a (mm)	σ (MPa)
Operation	N	8.500	42.12
Horizontal test	X	8.500	94.69

EN 13445-3 7.4 Required thicknes
h_c = Straight flange = 50 mm

		$l_{c,max}$ (mm)	f (MPa)
Operation	N	8.615	153.33
Horizontal test	X	9.177	352.38

MAWP (200 °C, Corroded) = 2.73 MPa

Tubesheet, Loading conditions 1 [corroded normal condition].

ASME VIII Div.1 2010 §[UHX-12]	Tubesheet Tubeside	Tubesheet Shellside	Tubes	Shellside	Tubeside
Pressure	P_t=1,69 MPa	P_s=1,58 MPa			
Corrosion	c_t=1,5 mm	c_s=3 mm		3 mm	1,5 mm
Material	SA105		SA213GRT21	SA516GR60	SA516GR60
Temperature	150 °C	(T'=/)	150 °C ($T_{t,m}$=/)	150 °C ($T_{s,m}$=/)	120 °C (T_c'=/)
Allowable Stress	S = 138 MPa	S_a = 138 MPa	S_t = 114 MPa	S_s = 118 MPa	S_c = 118 MPa
Yield Strength	S_y = 219 MPa		$S_{y,t}$ = 187 MPa	$S_{y,s}$ = 195 MPa	$S_{y,c}$ = 199 MPa
modulus of elasticity	E = 193 000 MPa		E_t = 202 000 MPa	E_s = 195 000 MPa	E_c = 196 800 MPa
Poisson's ratio	ν = 0,3		ν_t = 0,3	ν_s = 0,3	ν_c = 0,3
Diameter	A = 971 mm		d_t=25,4 mm	800 mm	800 mm
Nominal thicknesses	**67 mm**		t_t=2,1 mm	11 mm	10 mm
Tolerance	1,6 mm				
pattern Square		N_t=360	L = /	OTL=783,08 mm	p=31,75 mm

Configuration d
D_s = 806 mm G_s = 841,2 mm h = 60,9 mm
D_c = 803 mm G_c = 841,2 mm h_p = 56,9 mm
h_g = 2 mm t_s = 8 mm t_c = 8,5 mm
Extra thickness (periphery) : Tubeside = 2 mm Shellside = 2 mm

Tubesheet characteristics		
Diameter of perforated region	$D_0 = 2r_0+d_t$ = 783,083 mm	r_0 = 378,842 mm
Tube expansion depth ratio	$\rho = l_{t,x}/h$ = 0,8	$l_{t,x}$ = 48,72 mm

Effective Tube Pitch
$$p^* = \frac{p}{\sqrt{1-\frac{4\mathrm{MIN}[A_L,(4D_O p)]}{\pi \cdot D_O^2}}} = 32{,}904\ \text{mm}$$
basic ligament efficiency : $\mu = (p-d_t)/p = 0{,}2$
effective ligament efficiency : $\mu^* = (p^*-d^*)/p^* = 0{,}316$
$d^* = \max[(d_t-2t_t E_t/E\ S_t/S\ \rho),(d_t-2t_t)] = 22{,}495$ mm
largest center-to-center distance between adjacent tube rows : U_L = 42,4 mm
Unperforated Area : A_L = 33 202,72 mm²
Effective elastic constants E^* = 70 058,4 MPa ν^* = 0,324 (Fig. UHX-11.3 , Fig. UHX-11.4)

MS-Word形式による
レポート出力

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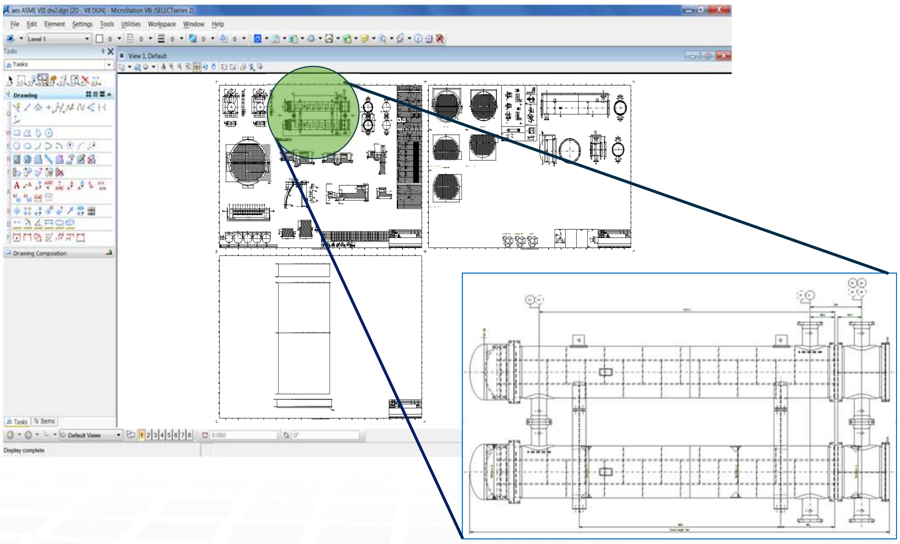
図面出力



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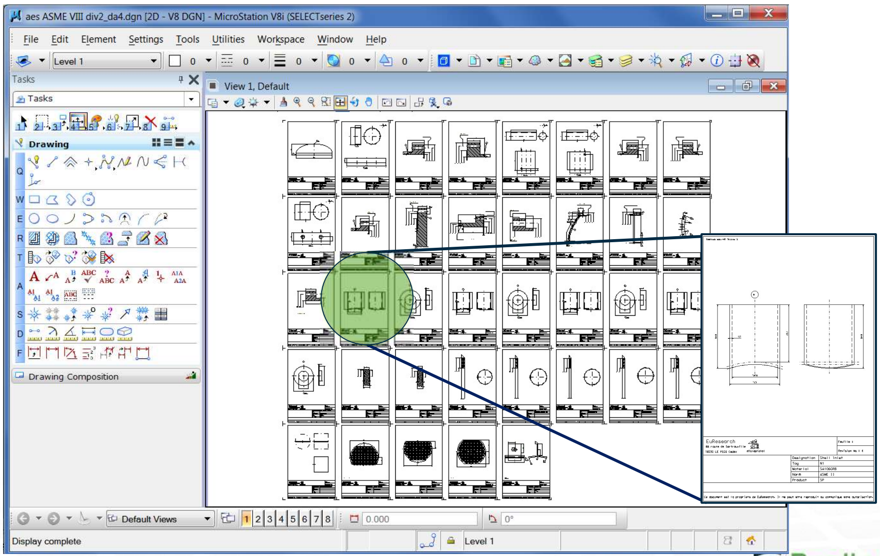
図面出力



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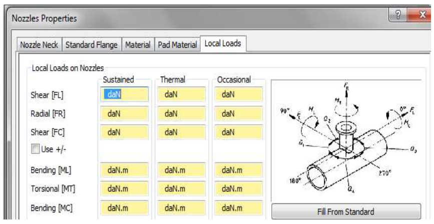
ノズル接合部の局部応力計算

- WRC107, PD5500に対応
- 長期、熱、短期の荷重分類ごとに計算
- AutoPIPEのアンカー反力のインポート機能



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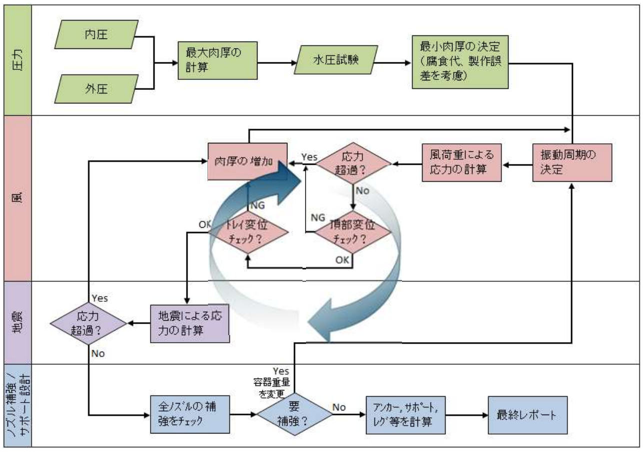
ワークフローと最適化



- すべての条件が満足するまでコンポーネントの厚さを計算

設置、つり上げ、運転、試験、停止

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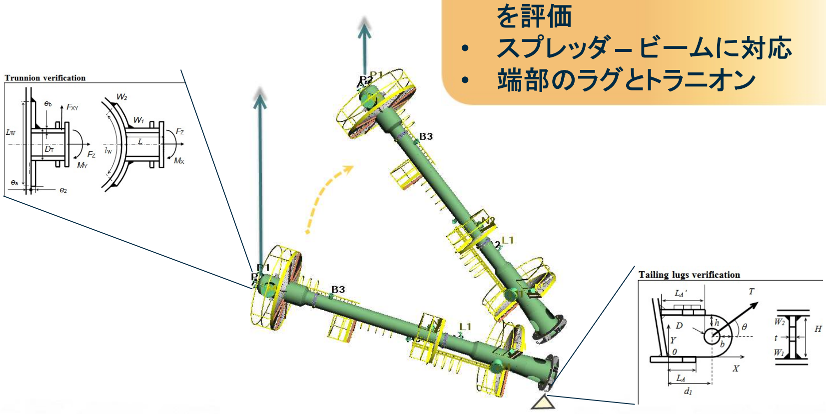
つり上げ

- 10度ごとの傾斜に対して、つり上げ部の容器・ノズルの局部応力を評価
- スプレッダ－ビームに対応
- 端部のラグとトラニオン



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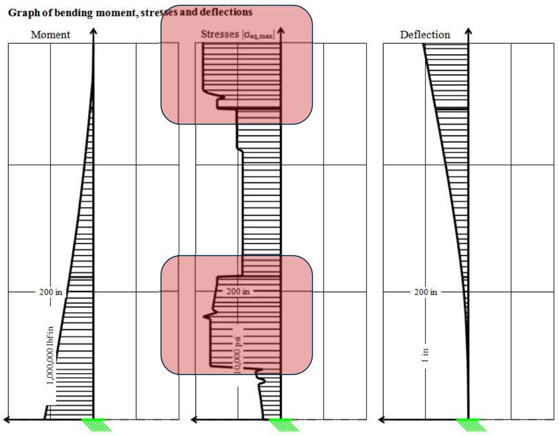
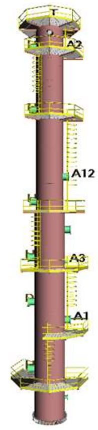
容器のモーメントや変位のグラフィック表示





- 容器のどの部分で大きな応力や変位が発生するかを簡単に確認

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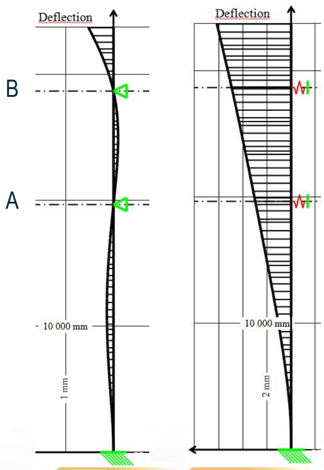
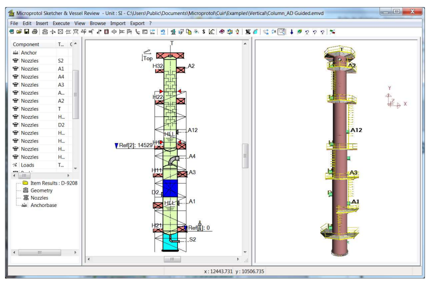
サポートの剛性を考慮した計算

- アンカーとガイド



Rigid Flexible



位置	剛のサポート (N)	フレキシブル サポート(N)	% 差
アンカー	7 310	11 548	58%
A	2 282	2 970	30%
B	13 230	7 382	56%
周期 (s)	0.279	0.056	357%

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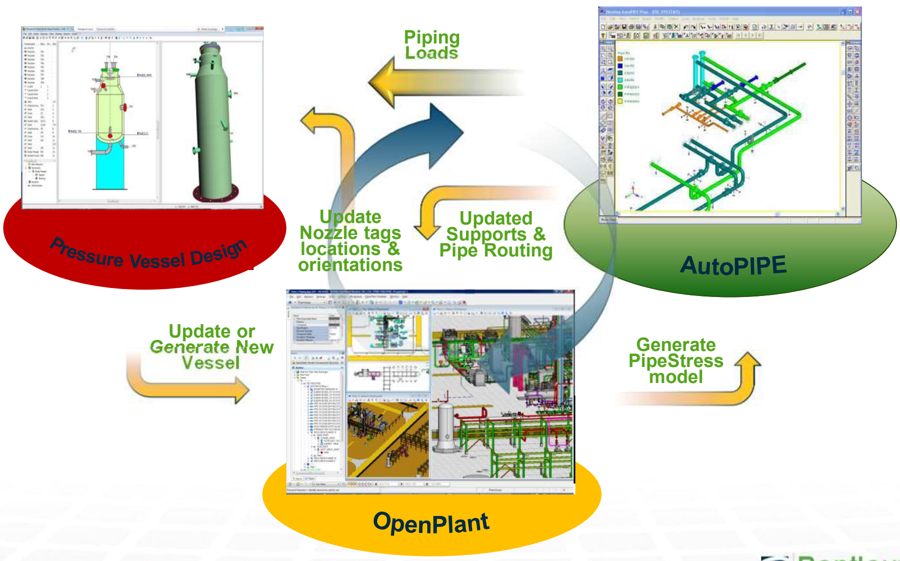
AutoPIPEやOpenPlantとのインターフェース（Future）



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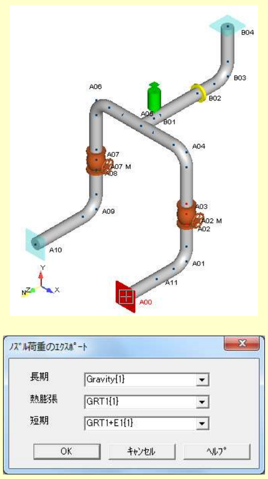
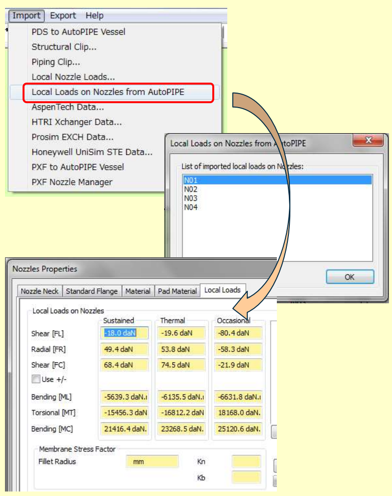
AutoPIPEのアンカー反力のインポート

AutoPIPEからアンカー反力を出力



AutoPIPE Vessel でアンカー反力の読込



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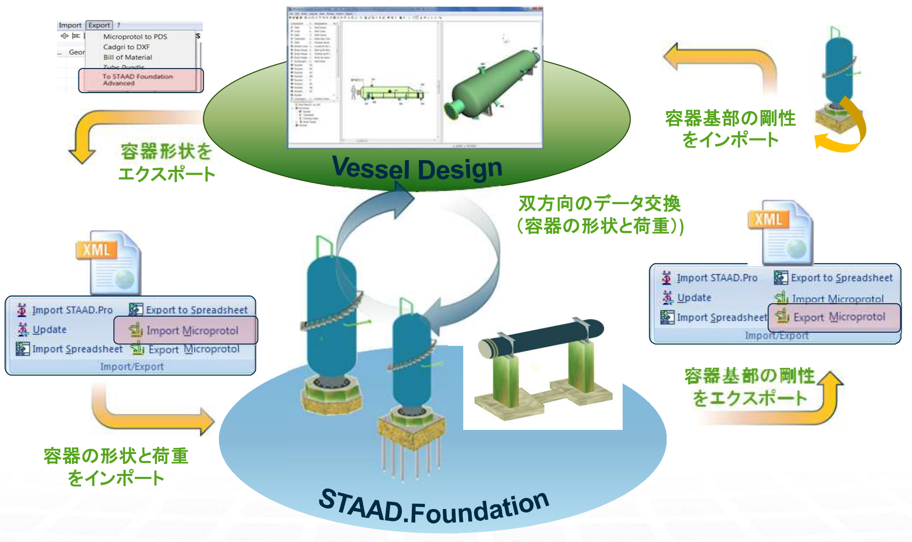
STAAD.Foundationとのインテグレーション(Future)



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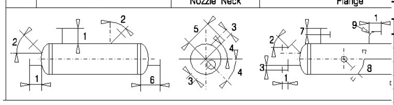
集計、積算

Tag	Designation	Diam. (Nozzle Neck)	Thk. (Nozzle Neck)	/axis (Flange)	Nom. d. (Flange)	Type (Flange)	C									
3N	Channel Inlet	NPS 10	9.27	890	NPS 10	WN	300		13 x130	428			270	890		20.06
4N	Channel Outlet	NPS 10	9.27	890	NPS 10	WN	300		13 x130	428			90	890		20.06
1N	Shell Inlet	NPS 10	12.7	890	NPS 10	WN	300		13 x130	428			270	890		31.06
2N	Shell Outlet	NPS 10	12.7	890	NPS 10	WN	300		13 x130	428			90	890		31.06
N4	Channel Outlet	NPS 10	9.27	890	NPS 10	WN	300		13 x130	428			90	890		20.06
N3	Channel Inlet	NPS 10	9.27	890	NPS 10	WN	300		13 x130	428			270	890		20.06
N2	Shell Outlet	NPS 10	12.7	890	NPS 10	WN	300		13 x130	428			90	890		31.06
N1	Shell Inlet	NPS 10	12.7	890	NPS 10	WN	30									



図面に部品情報を出力

I	J	K	L	M
Global Estimate				
		Hour	**Rate**	**Total Cost**
Manufacturing				
Cut & Prepare		256,93	18,30	4 701,82
Roll & Prepare		7,37	19,80	145,93
Assembly		217,74	18,30	3 984,64
Welding		246,02	21,30	5 240,23
Tube Welding		0,00		0,00
Grind & Backgouge		38,89	18,30	711,69
PWHT		0,00	16,80	0,00
Machining		307,81	19,80	6 094,64
Radial Drilling		20,65	18,30	377,90
CNC Machining		48,20	19,80	954,36
Prepare and dispatch		43,85	19,80	868,23
Project Management		338,73	24,30	8 231,14
Total		**1526,2**		**31 310,56**
Engineering		44,14	24,30	1 072,60
Inspection		105,38	21,30	2 244,59
Follow Up				
Project Management	5%	76,3	10,00	763,10
Technical review	5%	76,3	10,00	763,10
Total		**302,1**		**4 843,39**
Sub Contract		**Quantity**	**Rate**	**Total Cost**

Excel に積算用のデータを出力

AutoPIPE Vessel のご紹介

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