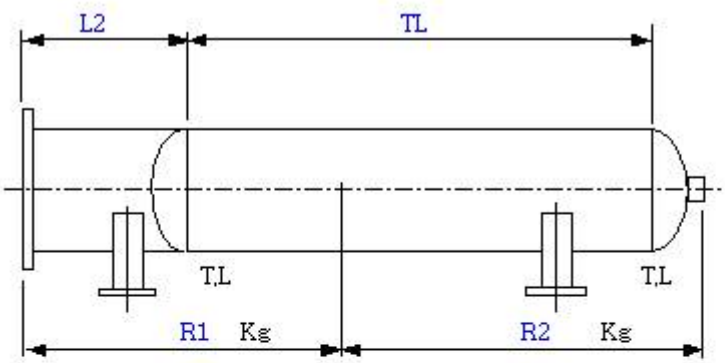
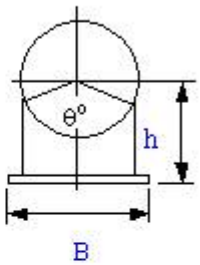
FABRICATION ENGINEERING

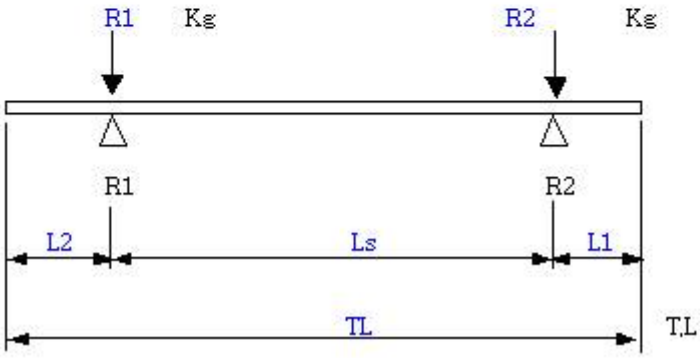
SHIPPING SADDLE DESIGN AND STRESS CHECK(ZICK'S METHOD)

DESIGN DATA PGM RUN ***V1.0***

* DESCRIPTION	PV-001		* ITEM NO.	PES21	
TRANSPORTATION LOADING DATA					
* APPLIED LOAD PER SADDLE, R1	30000	Kg	* APPLIED LOAD PER SADDLE, R2	32000	Kg
* VERTI. DIRECTION (HEAVE LOAD), FACTOR Fv	1.5		* LONGI. DIRECTION (PITCH LOAD), FACTOR Fi	0.5	
* TRANS. DIRECTION (ROLL LOAD), FACTOR Ft	0.7				
SHIPPING SADDLE DESIGN DATA					
* INTERNAL DESIGN PRESSURE, P	0	Kg/Cm^2	* EXTERNAL DESIGN PRESSURE,Pe	0	Kg/Cm´
* T.L TO SADDLE CENTER, L1	2000	mm	* T.L TO SADDLE CENTER, L2	2300	mm
* DESIGN TEMPERATURE, T	20	o	* SHELL THICKNESS, ts	15	mm
* ALLOW. BEARING PRESSURE OF CONCRETE	175	Kg/Cm^2	* SHELL I.D	4900	mm
* SHELL JOINT EFFICIENCY, E	1		* SHELL LENGTH, TL (T.L TO T.L)	18000	mm
* SHELL MATERIAL	A516-70		* SADDLE MATERIAL	A285-C	
* TOP FLANGE THICKNESS, tf	16	mm	* WEB PLATE THICKNESS,tw	16	mm
* RIB PLATE THICKNESS,tr	16	mm	* BASE PLATE THICKNESS,tb	25	mm
* SADDLE WIDTH AT TOP FLANGE SECTION,b	224	mm	* BASE PLATE LENGTH, B	4321	mm
* SADDLE WIDTH AT BASE PLATE SECTION,b	250	mm			
* SADDLE HIGHT FROM BASE BOTTOM TO BELOW SADDLE	250	mm	* SADDLE CONTACT ANGLE, ¢	120	o
* SADDLE RIB TO RIB MAX. DISTANCE,rw1	300	mm	* SADDLE RIB Q'TY BOTH SIDE	18	







RESULT OF CALCULATION

A. TRANSPORTATION LOADING CALCULATION

* Gross weight (Excluding shipping saddle), Wt	62,000	Kg	* The greater reaction force between R1, R2	32,000	Kg
* Vertical direction load (Heave Load),FV= Fv x Wt			* Vessel center to base bottom, h	2,756	mm
=1.5*32000				48,000	Kg

* Longitudinal direction load (Pitch Load), FL=Fix ((R1 or R2)×h)/Ls

=0.5*((30000+32000*2756)/1370	6,236	Kg

* Tranverse direction load (Roll Load),FT= Ftx((Wt x h) / (Ro × SIN(θ / 2))

=0.7*((32000*2756)/(2465*sin((120/2)*3.14159/180)))	28,919	Kg

COMBINED LOAD (ASSUME THAT THE PITCH LOAD(FL) AND ROLL LOAD(Ft) OCCUR SIMULTANEOUSLY)

HEAVE & PITCH LOAD ,FV + FL =

=48000+6,236	54,236	Kg

HEAVE & ROLL LOAD ,FV + FT =

=48000+28,919	76,919	Kg
* GOVERNING LOAD PER SADDLE, Q1 =	76,919	Kg

B. CHECK OF STRESSES IN SHELL-ZICK'S METHOD

*Shell Young Modulus, Es	2,052,964	Kg/Cm^2	* Shell allowable tension stress, Sa	1,406.1	Kg/cm^
*Shell yield stress, Sy	2,671.7	Kg/Cm^2	* Saddle allowable stress, Ba	1,103.8	Kg/cm^
* 0.5*Dm	2,457.5	mm	* If, A<0.5*Dm, or	Stiffened	

1.LONGITUDINAL BENDING STRESS AT MID-SPAN

Max.Bending moment, M= Q*(3 xL^2+ 6×R^2− 6×H^2−12×Ah×L−16×Ah×H)/4×(3×L +4×H)

=76,919*(3*18000^2+6*2,458^2−6*1,232.5^2−12*230 *18000−16*2300*1,232.5)/(4*(3*18000+4*1,232.5))	149,114,316	Kg−mm

SECTION MODULUS, π × R^2× t'

=3.14159*2,458^2*15		284,595,362	mm3
S1= (P × R) / (2 × t') + M / Z			
=(0*2,458)/(2*15)+(149,114,316/284,595,362)*100	TENSION	52.4	Kg/cm^
Judgement / Allowable stress	O.K	1,406.1	Kg/cm^
Shell external Allowable stress (FROM TABLE CS-2), A=0.125/(Ro / t')		"B"	
Factor "A" =0.125/(2465/15)	0.000761	224	Kg/cm^
S1'= (P × R) / (2 × t') - M / Z			
=(0*2457.5)/(2*15)-(149,114,316/284,595,362)*100	COMPRESS	-52.4	Kg/cm^
Judgement / Allowable stress	O.K	766.0	Kg/cm^

2.LONGITUDINAL BENDING STRESS OVER SADDLE WITHOUT STIFFENER RING

Max.Bending moment, M= Q*(8×Ah×H + 6×Ah²- 3×R²+ 3×H²)/(2×(3×L + 4×H))

=76,919*(8*2300*1,232.5+6*2300^2-3*2457.5^2+3*1,232.5^2)/(2*(3*18000+4*1,232		26,664,599	Kg-mm
S1= (P×R) / (2×t) + M / (K1×R2×t)			
=(0*2457.5)/(2*15)+(26,664,599/(0.335*2457.5^2*15))*100	TENSION	87.9	Kg/cm^
Judgement / Allowable stress	O.K	1,406.1	Kg/cm^
S1'=(P×R) / (2×t) - M / (K7×R2×t)			
=(0*2457.5)/(2*15)-(26,664,599/(0.603*2457.5^2*15))*100	COMPRESS	-48.8	Kg/cm^
Judgement / Allowable stress	O.K	766.0	Kg/cm^

3.LONGITUDINAL BENDING STRESS OVER SADDLE WITHOUT STIFFENER RING

S2 =((K_2 × Q_1 / (R × t)) × (L - 2 × Ah) / (L + 4 / 3 × H		166.7	Kg/cm^
Judgement / Allowable stress (0.8 × Sa)	O.K	1,124.9	Kg/cm^

4.CIRCUMFERENTIAL STRESS AT THE HORN OF SADDLE WITHOUT STIFFENER RING

S3 - Q_1 /{ 4 x t x (b1 + 1.56 ×√(R x to))} - 3×K6 ×Q1 / (2		-244.9	Kg/cm^
Judgement / Allowable stress (1.5 × Sa)	O.K	2,109.2	Kg/cm^

5.CIRCUMFERENTIAL STRESS AT BOTTOM OF SHELL WITHOUT STIFFENER RING

S3 = K5 × Q_1 / [to × { b1 + 1.56 × √(R × to) }]		744.4	Kg/cm^
=0.76*76,919/(15*(224+1.56*(2457.5*15)^0.5))*100	O.K	1,335.9	Kg/cm^

C. DESIGN OF SADDLE SUPPORT

1.ALLOWABLE STRESS

	TENSION	BENDING	SHEAR	
SUPPORT	1,265.5	1,392.1	843.7	Kg/cm^
SHELL	1,603.0	1,763.3	1,068.7	Kg/cm^

1.SUPPORT PAD THICKNESS

β = (180 - θ / 2) × π / 180

=(180-1/2)*3.14159/180	2.094	Radian

VERTICAL UNIFORM FORCE (P), (Q_1 / Ro) × [(1 + cosβ) / (π - β + sinβ × cosβ)]

=(76,919/2,465.0)*(((1+cos(2.094))/(3.14159-2.094+sin(2.094)*cos(2.094)	25.4	kg/mm

CONSIDERING THE THREE EDGES FIXED WITH WEB & RIBS AND ONE EDGE SIMPLY SUPPORTED, WITH WELDMENT. (PER CASE 9a OF TABLE 26 ; ROARK'S FORMULAS FOR STRESS & STRAIN)

a / (b/2)	2.679
β	0.7

q = UNIFORM LOAD, P × a / (a × b)

=25.4*16/(16*224)*100		11.34	Kg/cm^

Required thickness, tf = √(β × q × b²/ fb)

=(0.70*11.34*(224/2)^2/1392.072)^0.5	O.K	8.5	Kg/cm^

2.WEB PLATE THICKNESS (SADDLE PLATE)

THE MAX. ALLOWABLE HEIGHT OF 1 inch WIDE STRIP COLUMN, ha = tw × √[1500 × (12.655 × tw − P) / P]

=16*((1500*(12.655*16-25.4)/25.4))^0.5	O.K	1,636.1	mm

2-1.SPLITTING LOAD

Ks = [(1 + cosβ − 0.5 × sin²β) / (π − β + sinβ × cosβ)]

=((1+cos(2.094)-0.5*(sin(2.094))^2)/(3.14159-2.094+sin(2.094)*cos(2.094		0.2035

Fsp = Ks × Q_1

=0.2035*76,918.8		15,654.7	Kg

AREA RESISTING SPLIT FORCE , Ae = tw × hw + tf × b1

=(16*250)+(16*224)		7,584.0	mm^2

Ss = Fsp / Ae

=15,654.7/(7,584.0/100)	O.K	206.4	Kg/cm^

2-2.BUCKLING STRESS CHECK

be = 25.4 × di × tw / [di × tw + 2 × tr × (b − 25.4)]

=25.4*300*16/(300*16+2*16*(224-25.4))		10.93	mm

Buckling Stress, Sbc = 1.28 × π²× E / [12 × (1 − 0.3²) × (di / tw)²]

=1.28*(3.14159)^2*2,052,964.0/(12*(1-0.3^2)*(300/16)^2)		6,755.6	Kg/cm^

Sbc = The smaller of Sbc or Sy		2,671.7	Kg/cm^
Section area of one stiffener rib, As		3,328.0	mm^2

Allowable buckling load, Fb = n × (As + 2 × be × tw) × Sbc

=18*((3,328.0+2*10.9*16)/100)*2,671.7		1,768,648.1	Kg/cm^

Therefore, if Fb > Q1, then "O.K", else Check !		O.K

2-3.CHECK BEARING PRESSURE (CONCRETE)

Pb = Q_1 / (b × B)

=76,918.8/(250.0*1,392.1/100)	O.K	22.1	Kg/cm^

3. BASE PLATE THICKNESS

CONSIDERING THE THREE EDGES FIXED WITH WEB & RIBS AND ONE EDGE SIMPLY SUPPORTEDWITH WELDMENT. (PER CASE 9a OF TABLE 26 ; ROARK'S FORMULAS FOR STRESS & STRAIN)

a / (b/2)	2.679
β	0.7

q = UNIFORM LOAD, P × a / (a × b)

=25.4*16/(16*224)*100		11.34	Kg/cm^

Required thickness, tw = √(β × q × b²/ fb)

=(0.70*11.34*(224/2)^2/1392.072)^0.5	O.K	8.46	Kg/cm^

TYPE-2

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