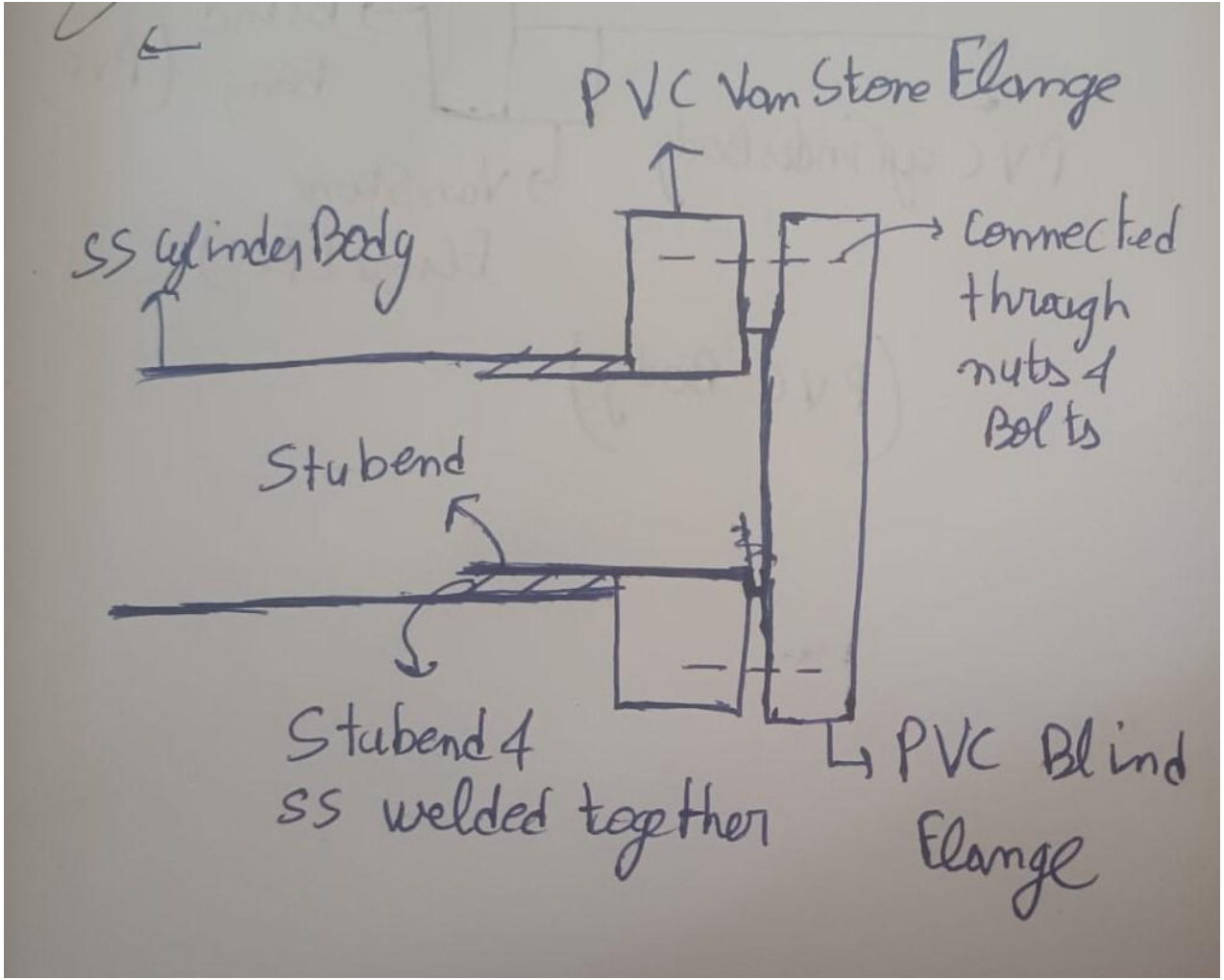
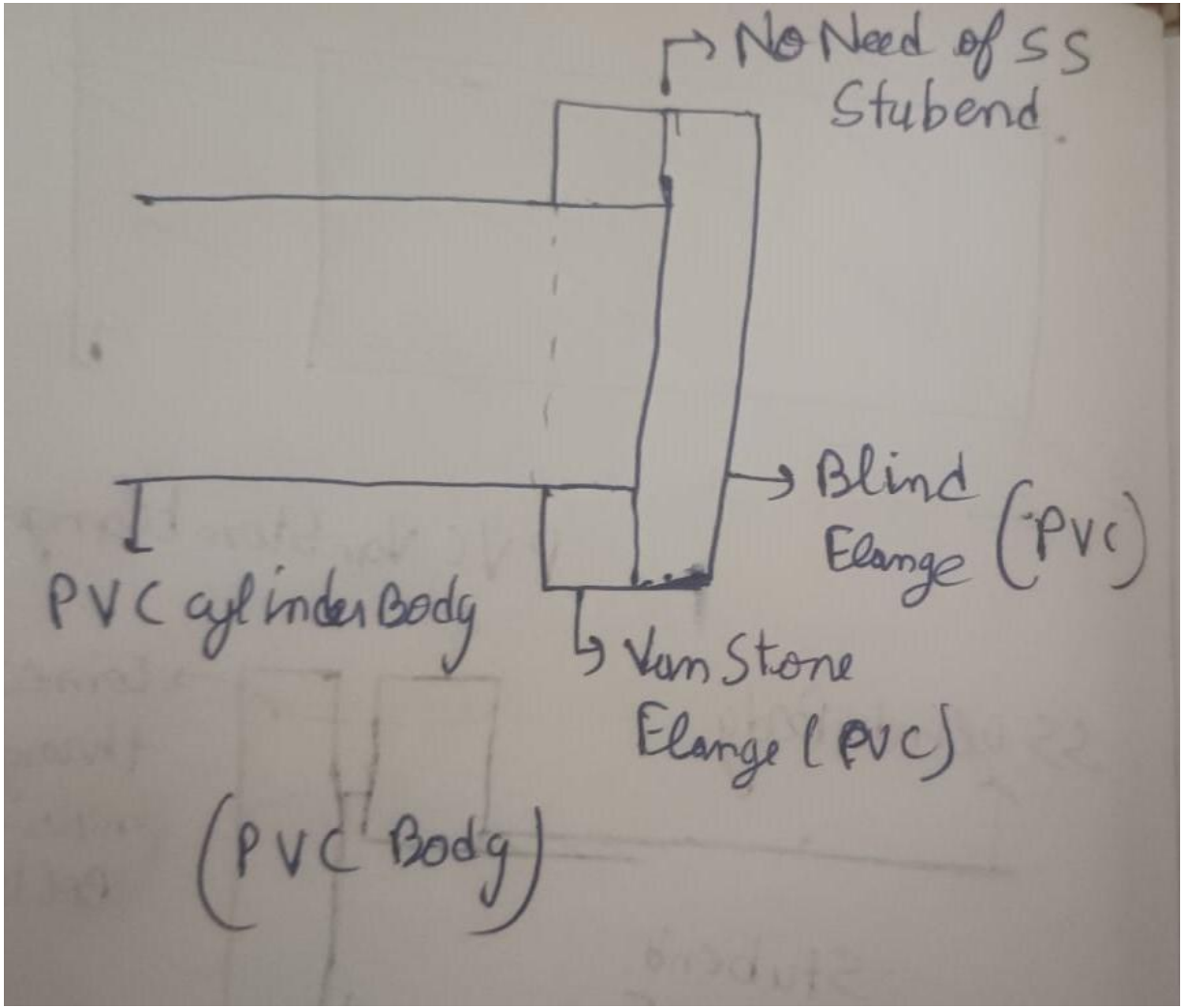
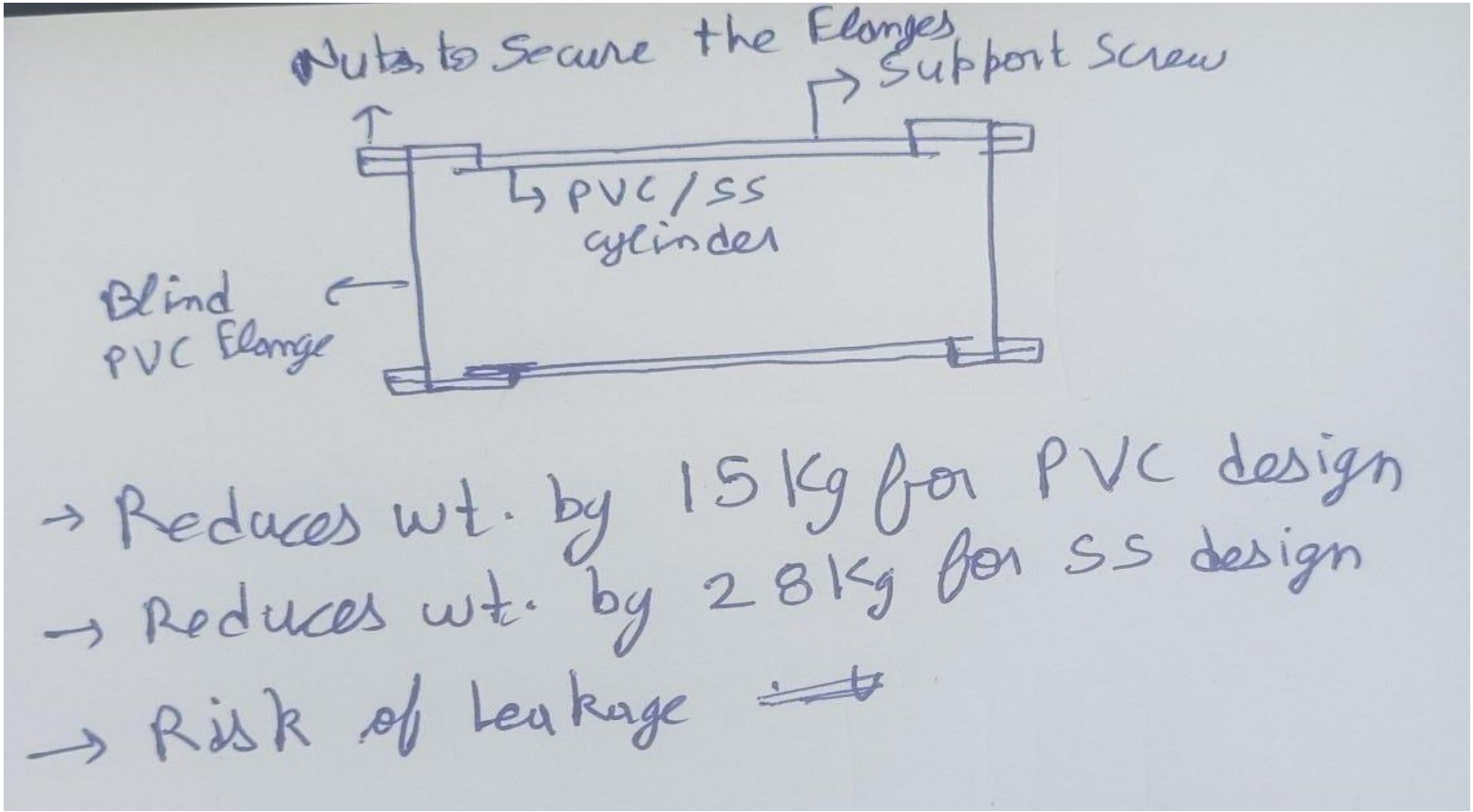
Structural Team


PVC Van Stone Flange
SS Cylinder Body
connected through nuts & Bolts
Stubend
Stubend & SS welded together
PVC Blind Flange


No Need of SS Stubend
Blind Flange (PVC)
PVC cylinder Body
Van Stone Flange (PVC)
(PVC Body)

2nd Design Idea

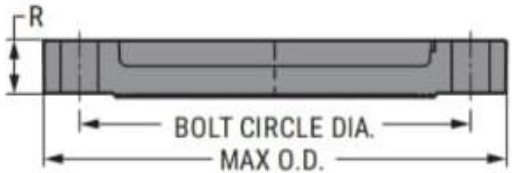


Weight Table of MSS SP-43 Type B Stub End

Normal Pipe Size inches	ASME B16.9 Stub End			
	Sch. 40S	Sch. 5S	Sch. 80S	Sch. 10S
1/2	0.12	0.06	0.13	0.08
3/4	0.15	0.07	0.17	0.09
1	0.20	0.09	0.25	0.15
1 1/4	0.30	0.13	0.35	0.20
1 1/2	0.38	0.16	0.46	0.25
2	0.55	0.25	0.75	0.40
2 1/2	0.80	0.35	1.00	0.50
3	1.10	0.50	1.50	0.60
4	1.80	0.70	2.50	1.00
5	2.50	1.00	3.50	1.25
6	3.70	1.60	5.50	1.95
8	5.90	2.50	10.0	3.10
10	10.5	4.00	14.0	4.90
12	15.0	6.60	20.0	7.10
14	15.5	6.40	20.5	7.80
16	18.0	7.90	24.0	9.00
18	21.0	9.30	28.0	10.5
20	23.5	12.0	31.0	13.5
24	28.5	16.5	38.0	19.0

Well-known Type C Stub Ends, Stub End EN 1092-1 Type 36 Suppliers in India, View MSS SP-75 Short Radius Stub End Type A Lengths.

BLIND FLANGE

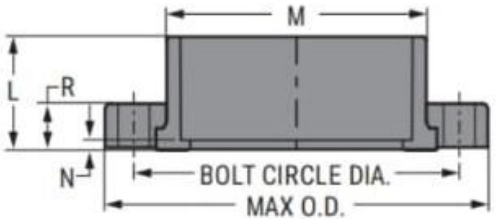


Part Number		Size	R	Bolt Circle Dia.	No. of Bolt Holes	Bolt Size	Min. Bolt Length	Max. O.D.	Approx. Wt. (Lbs.)	
PVC	CPVC								PVC	CPVC
853-005	853-005C	1/2	9/16	2-3/8	4	1/2	2	3-1/2	.21	.21
853-007	853-007C	3/4	5/8	2-3/4	4	1/2	2	3-7/8	.28	.30
853-010	853-010C	1	3/4	3-1/8	4	1/2	2-1/4	4-1/4	.41	.47
853-012	853-012C	1-1/4	23/32	3-1/2	4	1/2	2-1/4	4-5/8	.37	.40
853-015	853-015C	1-1/2	23/32	3-27/32	4	1/2	2-1/2	5-1/16	.50	.52
853-020	853-020C	2	27/32	4-3/4	4	5/8	3	5-31/32	.82	.88
853-025	853-025C	2-1/2	1	5-1/2	4	5/8	3-1/4	7	1.61	1.63
853-030	853-030C	3	1-1/16	6	4	5/8	3-1/4	7-1/2	1.63	1.69
853-040	853-040C	4	1-5/32	7-1/2	8	5/8	3-1/2	9-1/16	2.42	2.98
853-060	853-060C	6	1-3/8	9-1/2	8	3/4	4	11	4.36	4.45
853-080	853-080C	8	1-7/16	11-3/4	8	3/4	4-1/2	13-1/2	6.83	7.20
853-100	853-100C	10	1-11/16	14-1/4	12	7/8	5	16	11.32	11.80
853-120	853-120C	12	1-11/16	17	12	7/8	5	19	15.49	17.20

Flange Van Stone Style (continued)

(Two Piece)

Socket



Part Number		Size	L	M	N	R	Bolt Circle Dia.	No. of Bolt Holes	Bolt Size	Min. Bolt Length	Max O.D.	Approx. Wt. (Lbs.)	
PVC	CPVC											PVC	CPVC
854-025	854-025C	2-1/2	2	3-1/2	3/16	31/32	5-1/2	4	5/8	3-1/4	7	5/8	
854-030	854-030C	3	2-1/8	4-1/4	1/4	1-1/16	6	4	5/8	3-1/4	7-1/2		
854-040	854-040C	4	2-1/2	5-1/4	1/4	1-1/8	7-1/2	8	5/8	3-1/2	9	2.68	2.84
854-050	854-050C	5	3	6-1/4	3/8	1-1/8	8-1/2	8	3/4	3-3/4	10-1/8	3.35	3.60
854-060	854-060C	6	3-3/8	7-9/16	7/16	1-9/32	9-1/2	8	3/4	4	11	4.54	4.67
854-080	854-080C	8	4-3/8	9-5/16	9/32	1-3/8	11-3/4	8	3/4	4-1/2	13-1/2	6.69	7.06
854-100	854-100C	10	5-11/16	11-3/4	21/32	1-5/8	14-1/4	12	7/8	5	16	11.45	11.76
854-120	854-120C	12	7-1/4	13-3/4	5/8	1-1/2	17	12	7/8	5	19	16.78	18.50
854-140	854-140C	14	7-1/2	15-1/2	1/2	2	18-3/4	12	1	5-1/2	21	26.84	28.42
854-160	854-160C	16	8-3/4	17-3/4	3/4	2-3/8	21-1/4	16	1	6-1/2	23-1/2	37.64	24.81
854-180	854-180C	18	9	20	1/4	2-3/8	22-3/4	16	1-1/8	6-1/2	25	45.33	46.48

Flanges

SS Stub End - Pipe Size: 12 in = 30.48 cm - 6.6 kg (SCH 5s)
PVC Blind Flange: 12 in = 30.48 cm - 7.2 kg
PVC Van Stone Flange: 12 in - 7.5 kg

Total Flange Wt for SS Body = 44 kg
Total Flange Wt for PVC Body = 31 kg

Calculation for Minimum Length for a given Radius of Cylinder (to float when water fully evacuated from Ballast Tank)

L = Length of Cyclinder
R = Outer Radius
t = Thickness
ρ_w = Water Density
ρ_m = Material Density
m_{other} = Other mass in the vehicle
g = Gravitatioanl Acceleration

Buoyant Force > Total Weight of Vehicle

$$\pi R^2 L \rho_w g > \rho_m g \pi L (R^2 - (R-t)^2) + m_{\text{other}} g$$

PVC

```
ClearAll["Global`*"]
R = (0.32385 / 2); (*Fixing Radius (in m)*)
t = 0.003; (*Thickness (in m)*)
d = 1000; (*Density of Water (in kg/m^3)*)
S = 1380; (*Density of Steel (in kg/m^3)*)
g = 9.81; (*Gravity (in m/s^2)*)
m = 40; (*Other mass like, flanges, powerpack, propeller,
etc (in kg)*)
```

In[218]:=
```
kveq = Pi * (R^2) * L * d * g > S * Pi * L * (R^2 - (R - t)^2) * g + m * g && R > 0;
Reduce[kveq, L]
```

··· Reduce: Reduce was unable to solve the system with inexact coefficients. The answer was obtained by solving a corresponding exact system and numericizing the result.

Out[219]=
```
L > 0.5115181262968964`
```

In[220]:=
```
L = 0.6; (*Chosen Length (in m)*)
M = S * Pi * L * (R^2 - (R - t)^2) + m (*Total mass of vehicle (in kg)*)
```

Out[221]=
```
42.50382232721425`
```

In[235]:=
```
ClearAll["Global`*"]
R = (0.32385 / 2); (*Fixing Radius (in m)*)
t = 0.003; (*Thickness (in m)*)
d = 1000; (*Density of Water (in kg/m^3)*)
S = 7850; (*Density of Steel (in kg/m^3)*)
g = 9.81; (*Gravity (in m/s^2)*)
m = 55; (*Other mass like, flanges, powerpack, propeller,
etc (in kg)*)
```

In[242]:=
```
kveq = Pi * (R^2) * L * d * g > S * Pi * L * (R^2 - (R - t)^2) * g + m * g && R > 0;
Reduce[kveq, L]
```

Out[243]=
```
L > 0.9380270192501678`
```

In[245]:=
```
L = 1; (*Chosen Length (in m)*)
M = S * Pi * L * (R^2 - (R - t)^2) + m (*Total mass of vehicle (in kg)*)
```

Out[246]=
```
78.73792906839599`
```

Grade of Steel - 5s

Pipe size	OD in inches		
10	10.75	Wall Thickness	0.134
		Weight / Foot	15.19
		Inside Diameter	10.428
		Burst Pressure	1745
12	12.75	Wall Thickness	0.156
		Weight / Foot	21.07
		Inside Diameter	12.438
		Burst Pressure	1713

Wall thickness, OD, ID - inches
Weights - pounds/foot
Burst pressure - PSI (PSI - atm conversion factor = PSI/14.696
1 pounds/foot = 1.488kg/m

PVC

Size (in.)	Wall Thickness (in.)	Inner Diameter (in.)	Outer Diameter (in.)	Weight / Foot (lbs/ft.)
				PVC
10	0.365	10.02	10.75	7.55
12	0.406	11.938	12.75	10.01
14	0.438	13.124	14	11.8
16	0.5	15	16	15.43

Wall thickness - 1.03 cm
Inner diameter - 30.3 cm
Outer diameter - 32.3 cm
Weight / m = 14.88 kg/m