Design And Development of Air Caster

Guided by :-

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POINTS TO BE COVERED……….

- Material handling
- Problem definition
- Air caster
- Design of air caster
- Part modeling
- manufacturing

MATERIAL HANDLING

- Material handling is the movement of material from one place to another by means of proper material handling equipment.

- It may be picking up more putting down, moving horizontally or vertically up or in any inclined plane, of any kind in their raw, semi-finished or finished state.

Problem Definition

- To develop a flexible material handling equipment for movement of the heavy loads by the application of small effort
- To develop such material handling equipment which does not damage the floor.
- To carried out the design, part modeling and development of 100kg air caster.

AIR CASTER

- An **Air film technology** is a "relatively new" concept which offers a different way of **moving heavy machines**. The principle of air film technology is to cause loads to float on a floor surface using compressed air as the only power source.

- Air caster is developed for taking the advantages of pneumatic lifting. An **air caster** is a pneumatic lifting device used to move heavy loads on flat, non-porous surfaces.

- Its operation is similar to a hovercraft, as it uses a thin layer of air as a way to float a very small distance off the ground.

Working principle :

Stage-1 Air filling

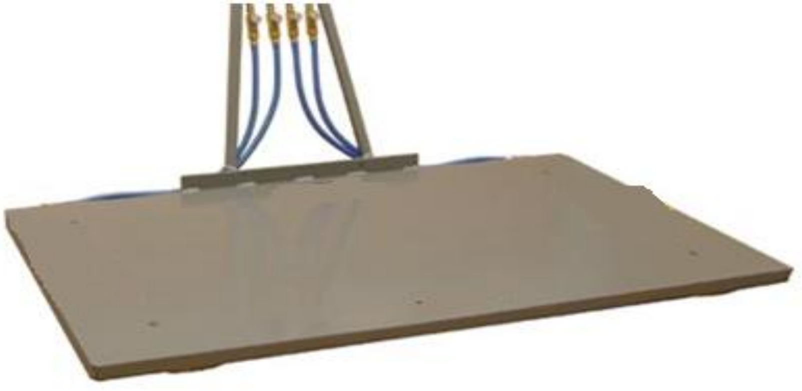
Stage-2 Air bag inflation

Stage-3 Air Escapes and Air film formation

Air caster benchmarking:

framed types structure:

Pallet Type Structure:



DESIGN OF AIR CASTER

The general procedure to solve a design problem is as follows:

1. Need of Air Caster

The air caster is selected for specific job movement application is due to the following reason.

- Not availability of crane.
- Low floor loading
- Least cost movement.
- Omni directional movement can achieve.

2. Job Parameters.

- Weight -100 kg (gross weight)
- Job size - less then 1000x1000mm.

3. Material selection[10]

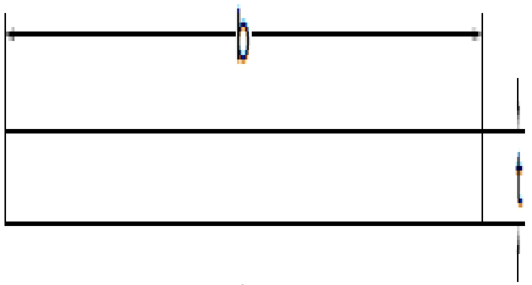
Factors to be considered during selection of material are as follow:

- Availability
- Economy
- Transportation cost
- Quality of material
- Required properties (mechanical, electrical, thermal etc.)

Sr. No	Material	[σ_{ut}]	[σ_b]	[σ_y]
1	Mid steel	431 Mpa	151.04Mpa	274.68Mpa
2	Butyl Rubber	5.53Mpa	-	-
3	High tensile carbon steel	829.71Mpa	-	-
4	Laminated plywood	31Mpa	-	13.8Mpa

4. Design Calculations:

❑Design Calculations for Base plate


Cross Section of Base Plate

$l = 1000mm$

$b = 1000mm$

$w = 981N$

$[\sigma_b] = 151.04Mpa$

Load w is uniformly distributed on the base plate.

$$M_{max} = wl^2/8$$

$$= 122.625*10^3 N.mm$$

$$I = bt^3/12$$

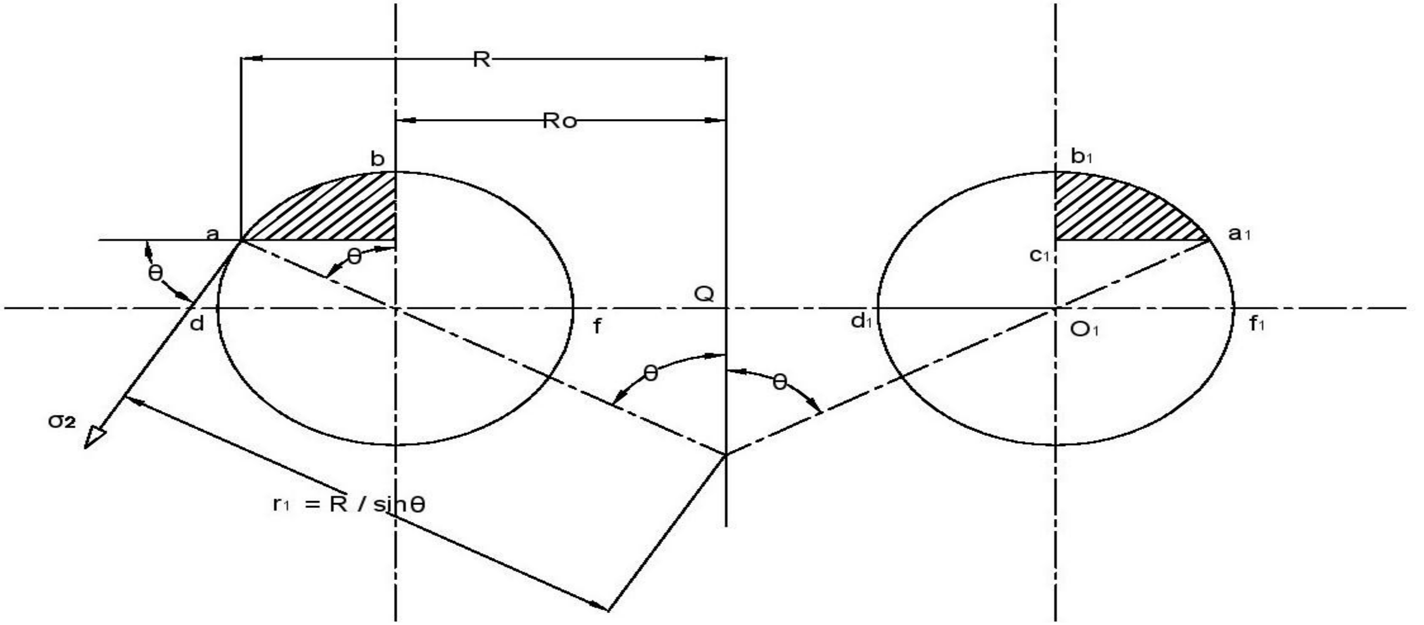
$$= 83.33t^3 mm^4$$

$$[\sigma_b] = (M_{max} / I)*(t/2)$$

$$t = 2.21mm$$

Thickness of baseplate is **3mm**.

❑Design Calculations for Air Bag[11]



Toroidal Shaped Pressure Vessel

r = 43.75mm.

R_o = 81.25mm.

$[\sigma_1] = 0.345$Mpa

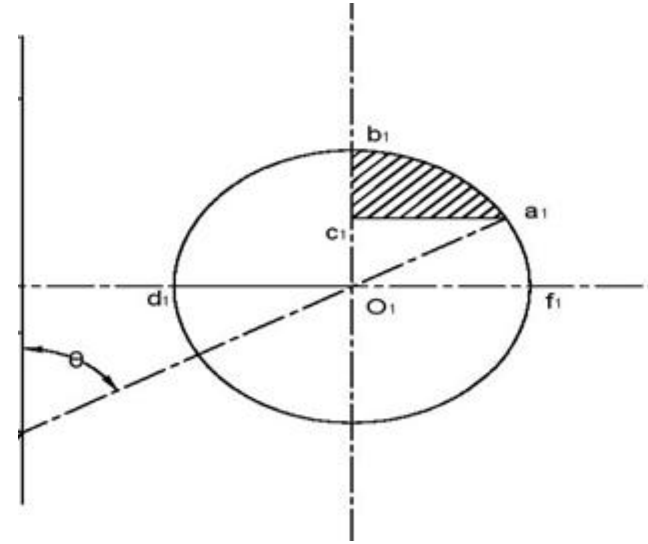
$[\sigma_2] = 0.69$Mpa

$P = W/A$

$= 245.25/(\pi/4) * 120^2$

$= 0.02168\ N/mm^2$

$= 0.022\ N/\ mm^2$



Considering triangle $a_1o_1c_1$

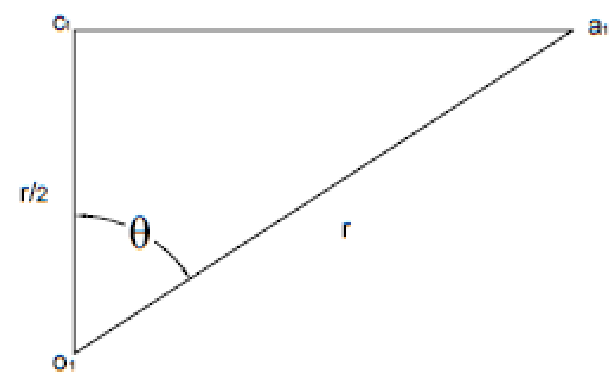
$o_1c_1 = r/2 = 21.875mm$

$a_1o_1 = r = 43.75mm$

According to Pythagoras theorem

$(a_1o_1)^2 = (o_1c_1)^2 + (c_1a_1)^2$

$c_1a_1 = 37.88mm$



Meridional angle Θ:

$\sin \Theta = c_1a_1 / a_1o_1$

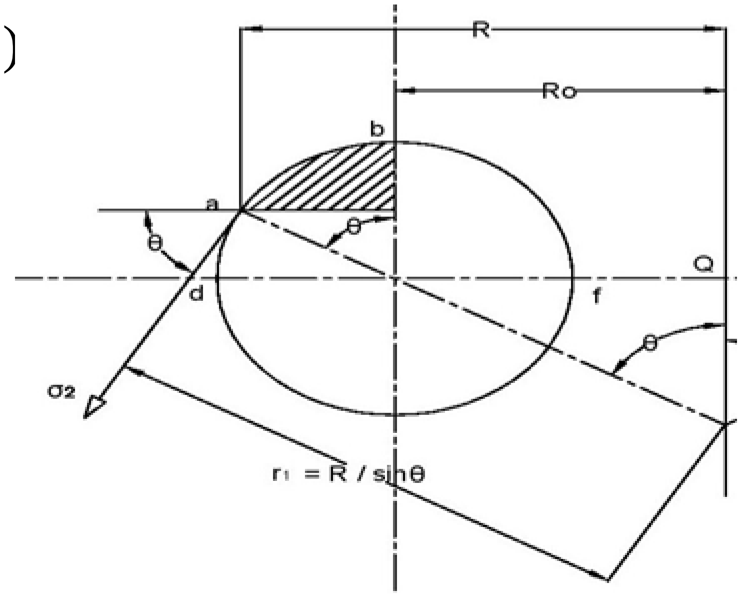
$\sin \Theta = 0.866$

$\Theta = 59.99^0$

Hoop stress [σ_2] :

[σ_2] = (p*r*2*R_o)+(r*sin Θ)/(2*t*R_o) (r*sin Θ)

t = 1.49mm



Radius at any point (Q-a): R

$R = R_o + (r*\sin\Theta)$

= 119.13mm

Longitudinal stress :[σ_1]

[(σ_1*sinΘ)/R] + (σ_2/r) = (p/t)

t = 1.20mm

Considering maximum value,

Hence, thickness of torus air bag **t=1.49mm=1.5mm**

- **Design calculation for fasteners:**

- design of bolt for centre plate

$D = 75mm.$

$d_c = 4.773mm.$

$n = 3$

$p = 0.022N/mm^2$

Force acting on centre plate

$F = (\pi/4) * D^2 * P$

$= 97.19N$

Resisting force by 3 number of bolts

$F = (\pi/4 * d_c^2 * \sigma_t * n)$

$\sigma_t = 1.8106\ N/mm^2$

Tensile stress in bolt is less then**[σ_{ut}]= 829.71**N/mm^2 ,hence bolts of **coarse series M6** are safe for center plate.

- design of bolt for supporting ring

  D_i = 250mm

  D_o = 310mm

  d_c = 6.466mm

  n = 8

Force acting on supporting ring

$F =[(\pi/4)*(D_O^2-D_I^2)$

F = 580.56N

Resisting force by 8 number of bolts

$F = (\pi/4*d_c^2*\sigma_t*n)$

$\sigma_t = 2.21 N/mm^2$

Tensile stress in bolt is less then**[σ_{ut}]= 829.71**N/mm^2 ,hence bolts of **coarse series M8**are safe for center plate.

❑Air Calculations:

d =0.375 inch

C_d =1.0

p = 13+14.7=27.7psi

T = 75^o F standard

c = 0.86

N = 4

$$Q = 0.5303*[(A* C_d * p)/T]$$

Q = 0.021624 lbs/s

To convert the mass flow rate in volume flow rate divide by density factor 0.07494 lbs/ft^3

Q= 0.2885 CFS

Assuming that flow of air is equally divided in each caster Hence,

q = 0.2885/4

= 0.07213 CFS

Net area required for escaping the air by each caster: A_{net}

$$q = C * A_{net} * \sqrt{(2/\rho * p)}$$

$$A_{net} = 1.3147 \times 10^{-3}\ ft^2$$

Area of Hole to escape the air: A_{hole}

$$A_{hole} = A_{net}/N$$

$$A_{hole} = 3.2868 \times 10^{-5}\ ft^2$$

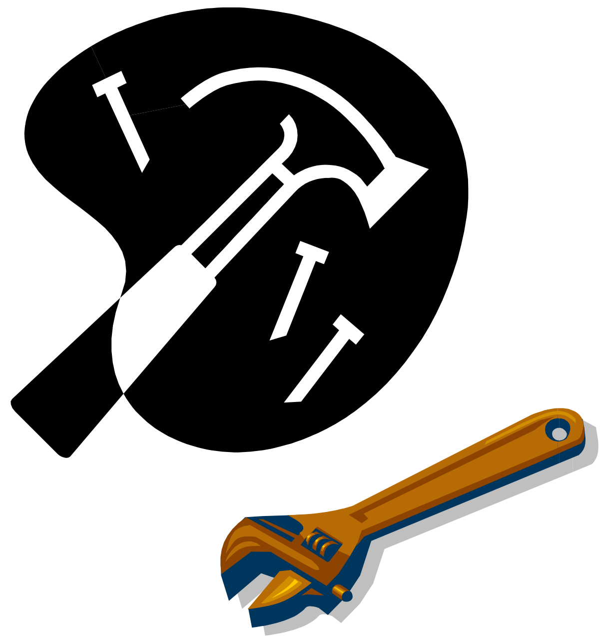
Diameter of single hole :d

$$A_{hole} = (\pi/4) * d^2$$

d = 0.006469 ft

= 1.97mm

PART MODELING & MANUFACTURING

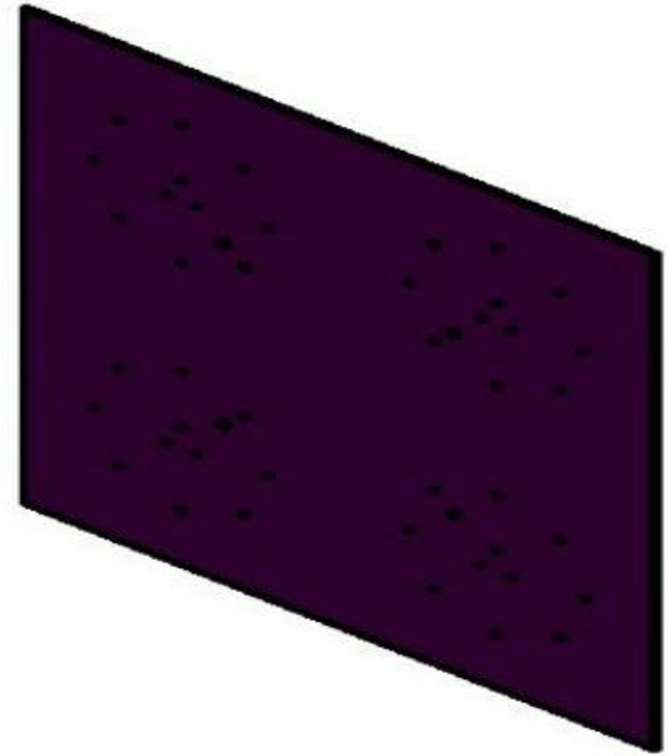


S.R NO	PART NAME	MATERIAL	QTY.
1	BASE PLATE	M.S	1
2	AIR BAG	BUTYLE	4
3	FASTENERS : M6 M8	HIGH TENSILE CARBON STEEL	12 32
4	LOAD LANDING PLATFORM	PLYWOOD	1
5	SUPPORTING RINGS	M.S	4
6	LANDING PLATFORM SUPPORT	M.S	9

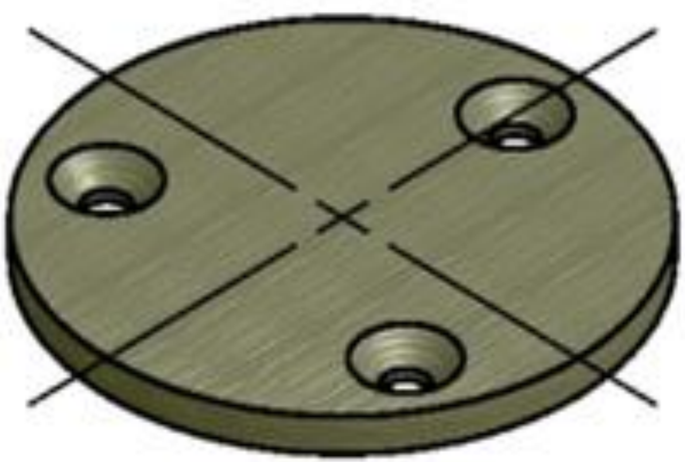
S.R NO	PART NAME	MATERIAL	QTY.
7	5-WAY JUNCTION	M.S	1
8	ELBOWS	BRASS	5
9	NIPPLES	BRASS	2
10	HOSE PIPE	-	1
11	AIR CONVEYING PIPE	M.S	1
12	CENTRE PLATE	M.S	4

BASE PLATE

- Base plate is most supporting element of system which hold & locate all other elements.
- Drilling has done for the location of elements by nut-bolts(44 holes) on **Radial Drilling M/C**.
- Other 4 holes of Φ16 are made as a inlet of **system fluid**.
- Ultimately grinding has done to remove the burr.



CENTRE PLATE

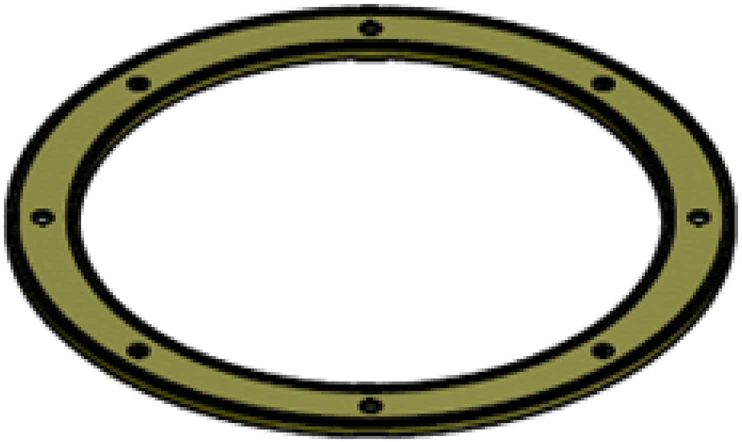


➢The round piece of 79mm diameter is cut from the M.S sheet of 5mm thickness by **Oxy-Acetylene Gas Cutting** process.

➢**Centre Lathe** is used to make the diameter sharp 75mm.

➢3 holes of 6mm diameter are made by **Drilling M/C**.

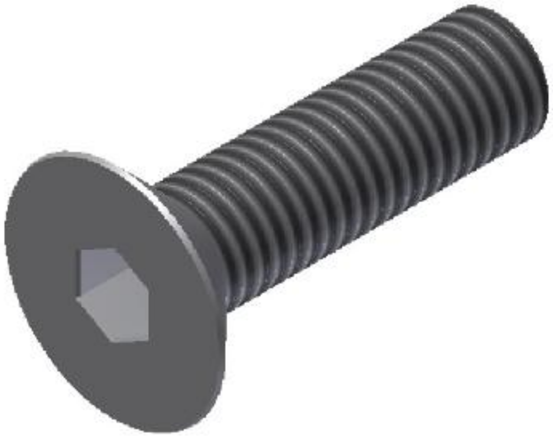
SUPPORTING RINGS



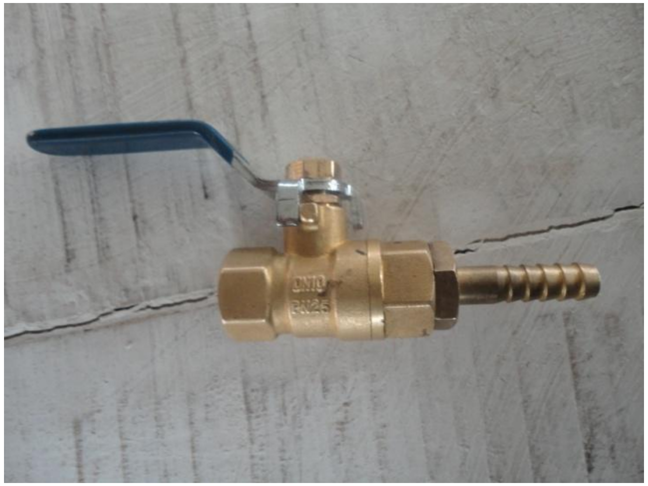
- Initially 4 number of rings are cut from M.S sheet of 5mm thickness by **Oxy-Acetylene Gas Cutting** process.
- The outer &inner diameter of the rigs are made on **Centre Lathe**.
- 8 number of holes each ring are made on **Drilling M/C**.

AIR BAG

FASTENERS

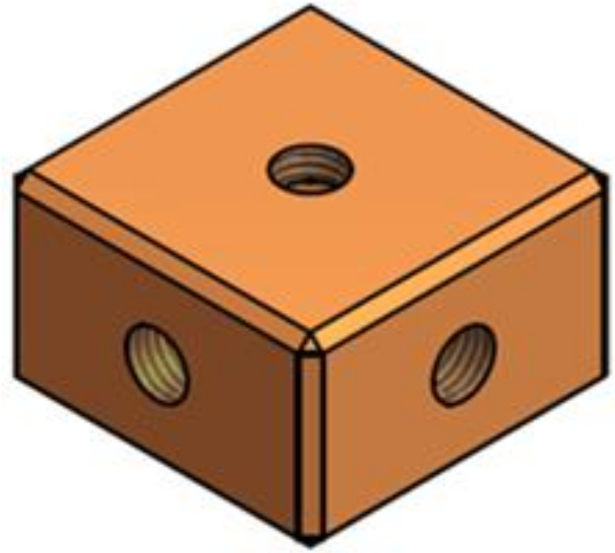


ELBOWS



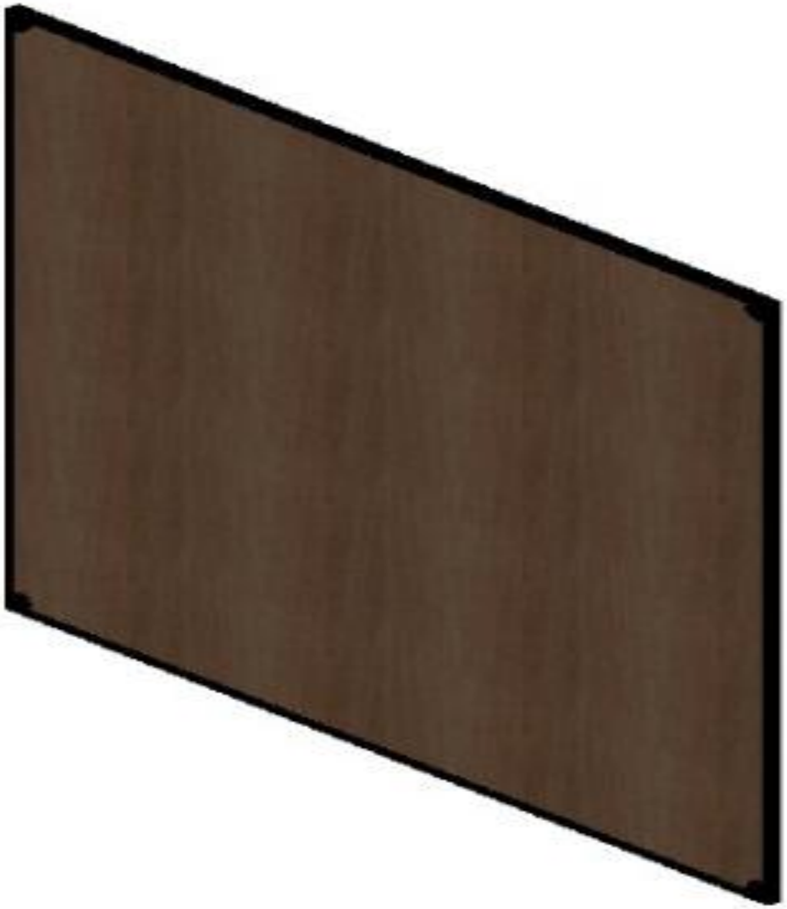
HOSE PIPE

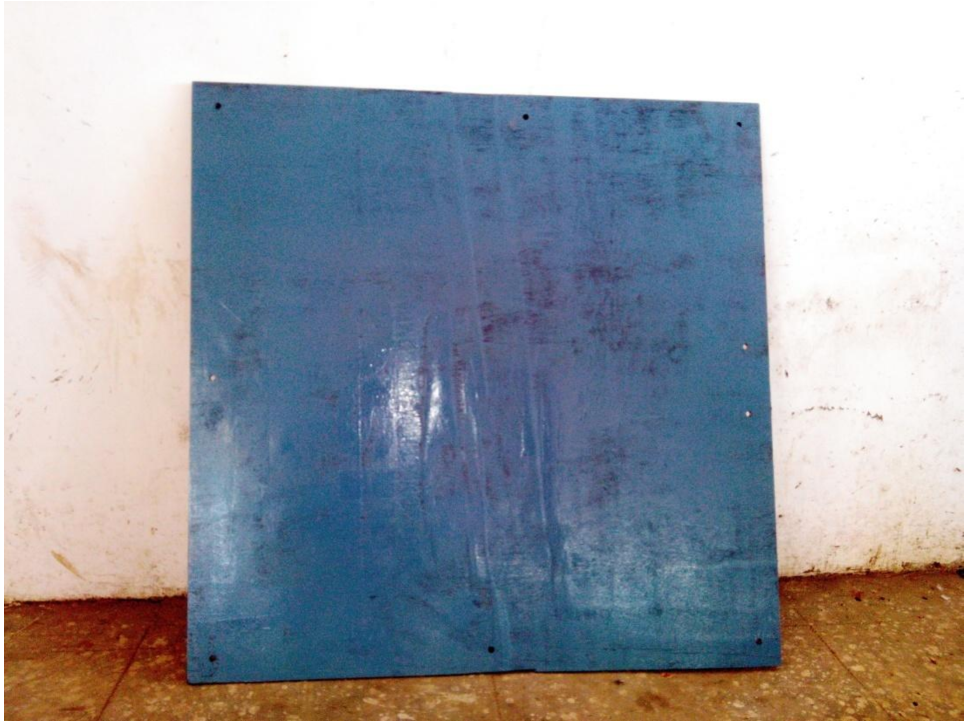
FLOW REGULATING VALVE



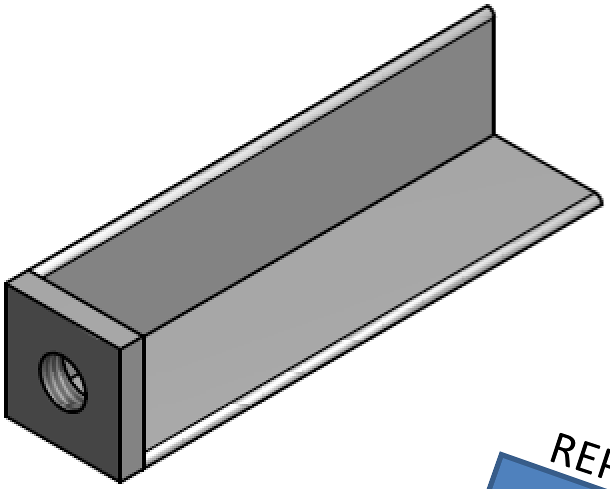
5-WAY JUNCTION

AIR CONVEYING PIPE





LOAD LANDING PLATFORM



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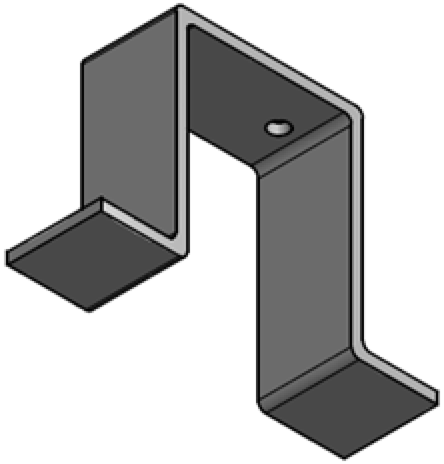
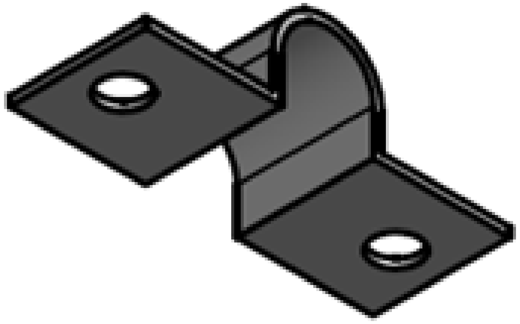
LANDING PLATFORM SUPPORT

E L E M I N A T E D C O M P O N E N T S



CLAMP SUPPORT



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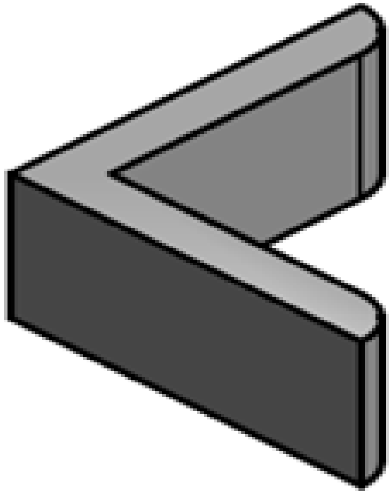
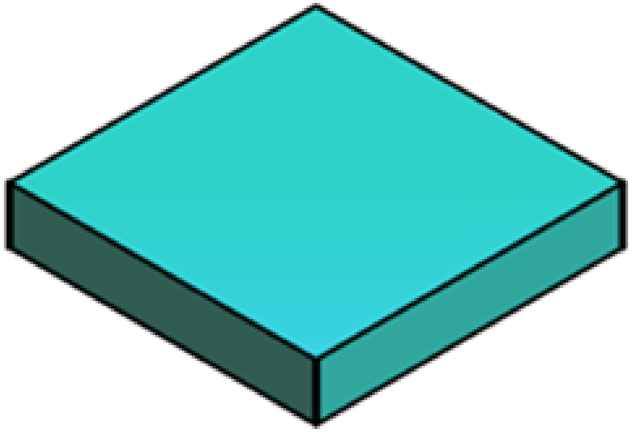
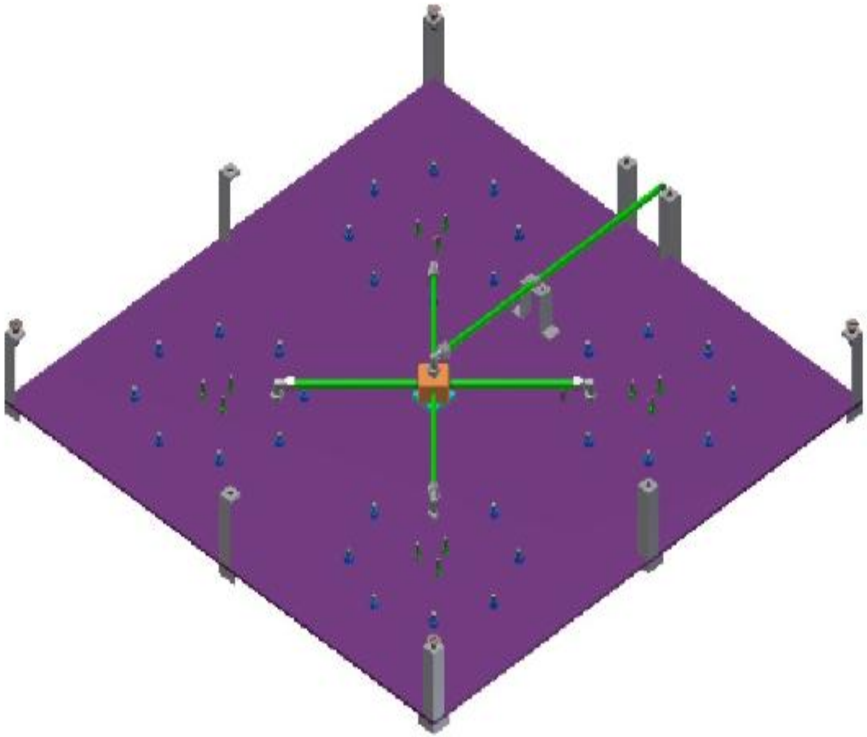


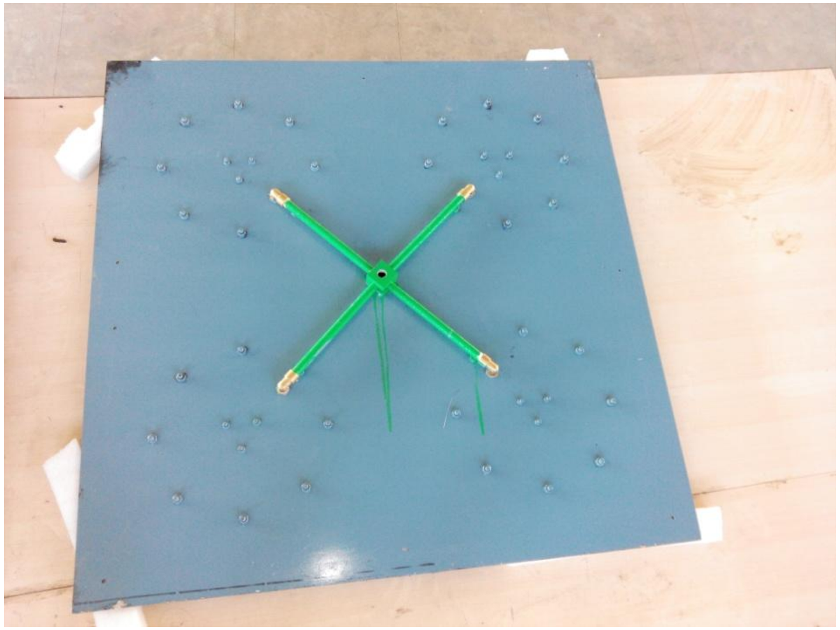
PROTECTIVE PAD

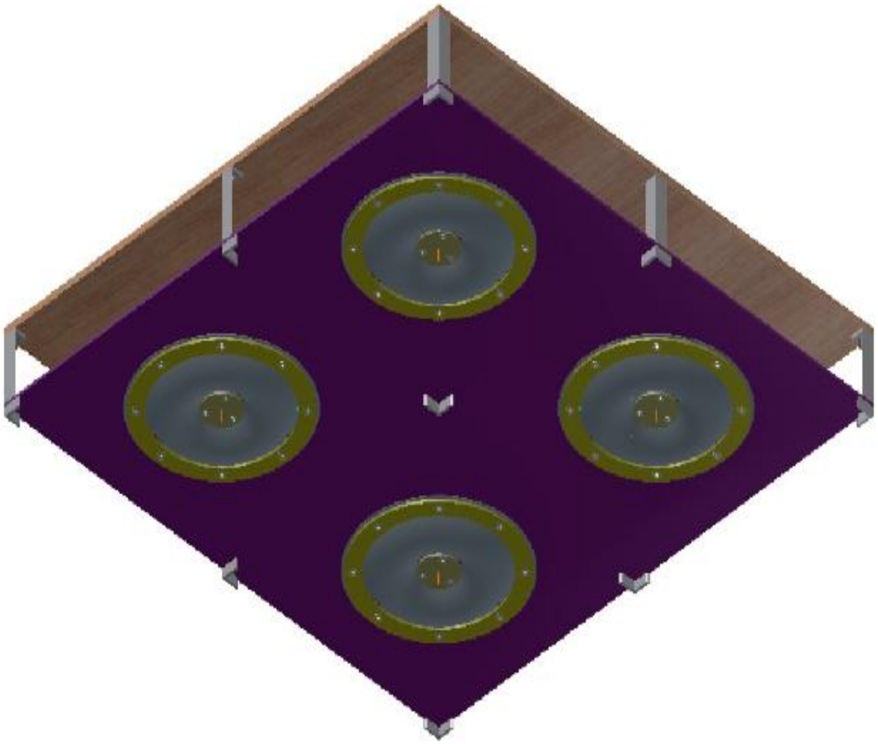


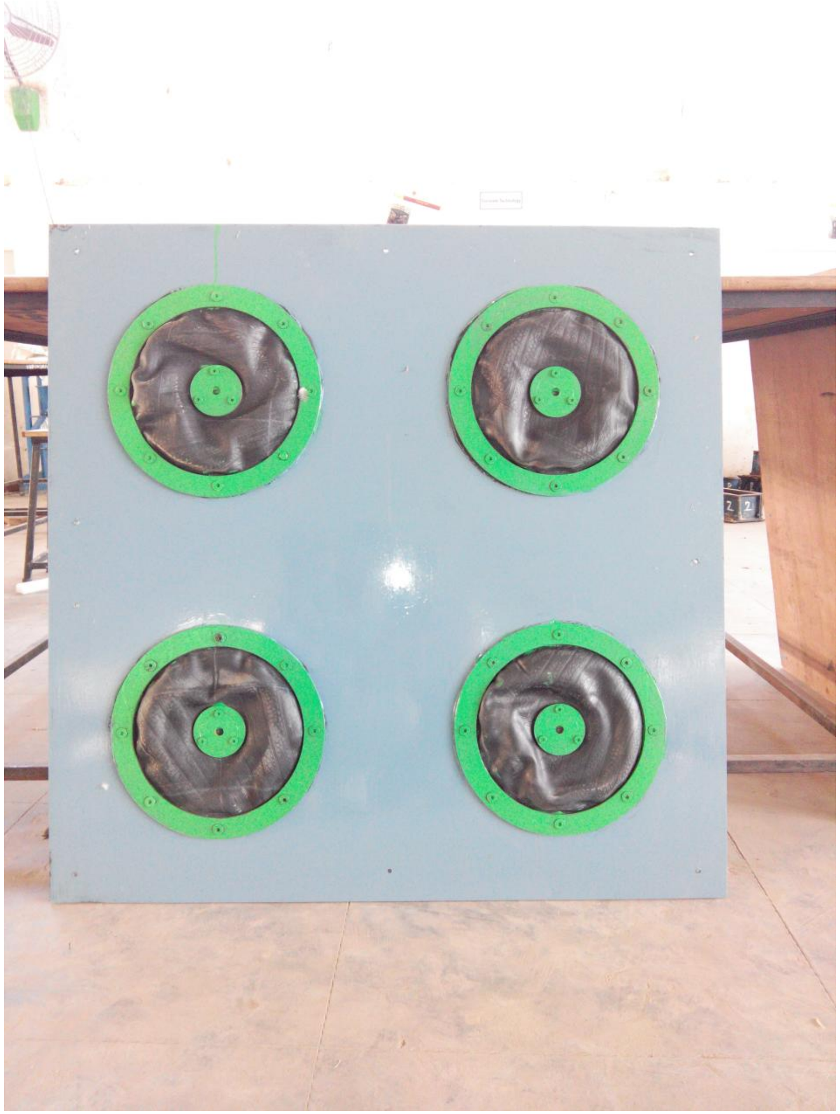
JUNCTION SUPPORT

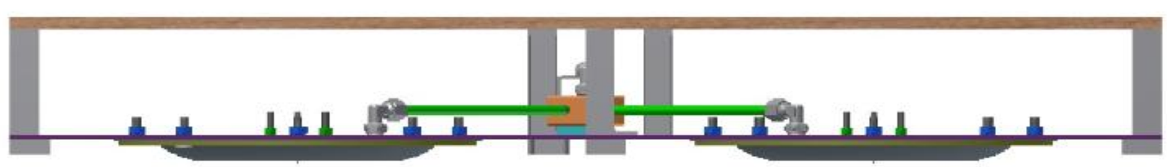
Assembly:











Performance Trial on Two Stage Reciprocating Air Compressor

CONCLUSION

•After following design procedure we got system parameters as……….

Pressure requirement :- 13psi

Base plate:- 1000 x1000x5mm

Load landing platform:-1000x1000x12mm

Centre plate:- Ø 75mm

Supporting ring:- Ø 250mm internal

Ø310mm outer

Air escaping holes in air bag:- Ø1.97mm

Fasteners:- M6 &M8

Elbows, hose pipe, air conveying pipe:-3/8 inch

•As the system is designed for 100kg's(gross),but after taking performance trial we got that the system can efficiently works even with 120kg's(gross).

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THANK YOU