A Cover for an Umbrella

Group members:
E/19/265
E/19/256
E/19/248
E/19/239
E/19/235

2.

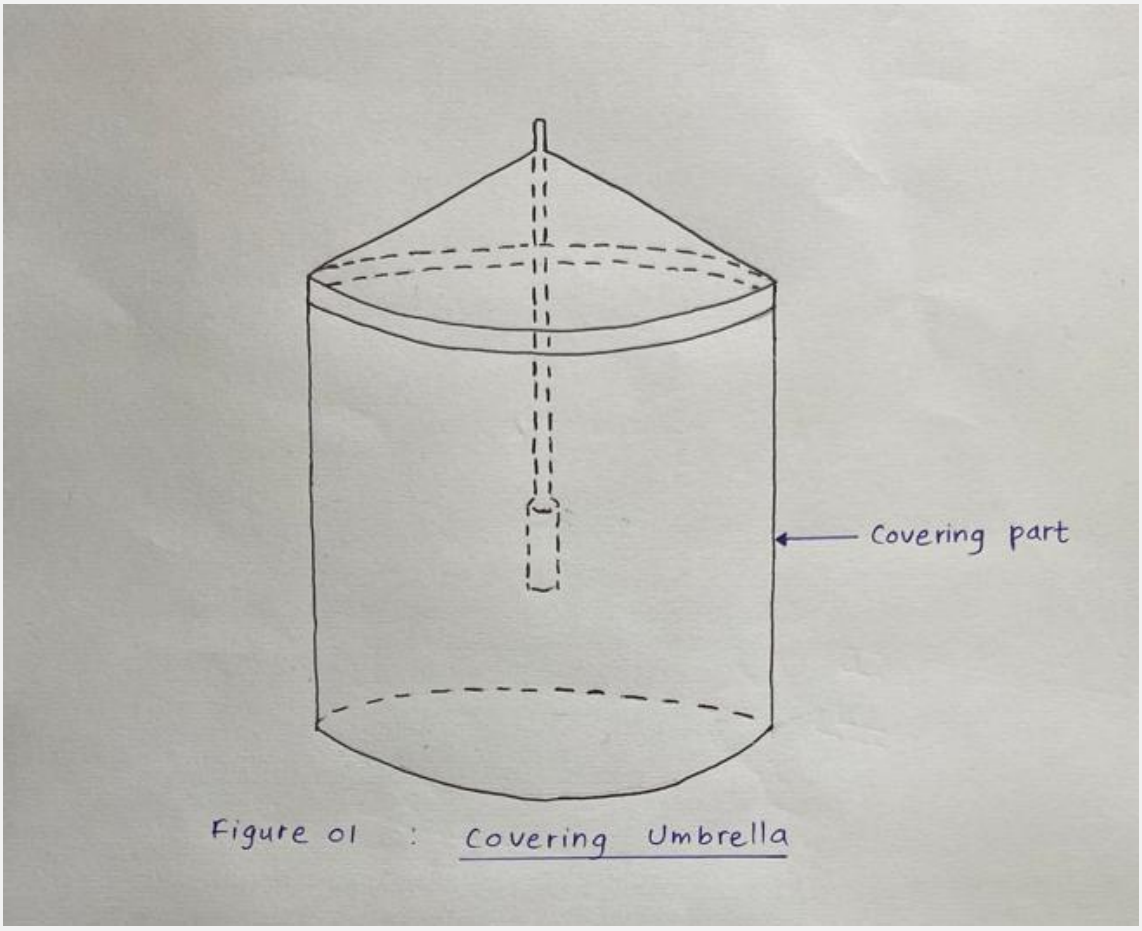


Figure 01 : Covering Umbrella

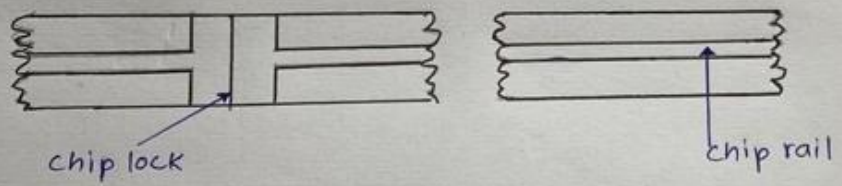


Figure 02 : chip rail with lock

Figure 03 : chip

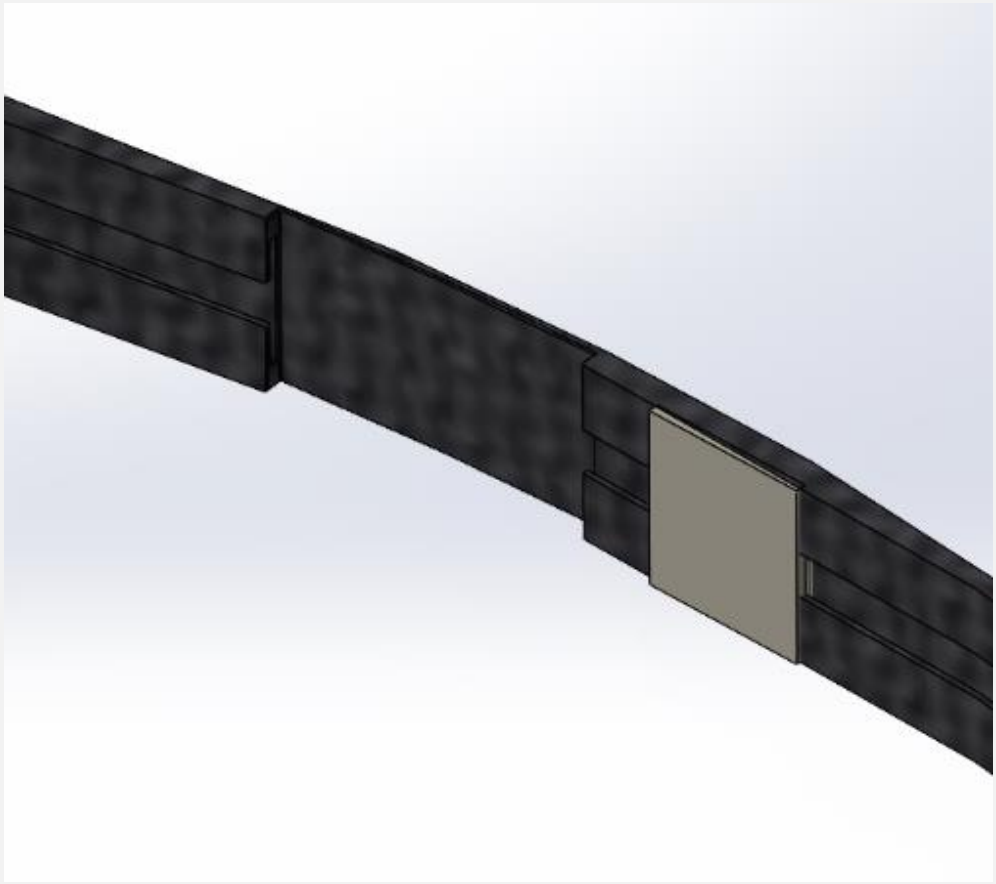
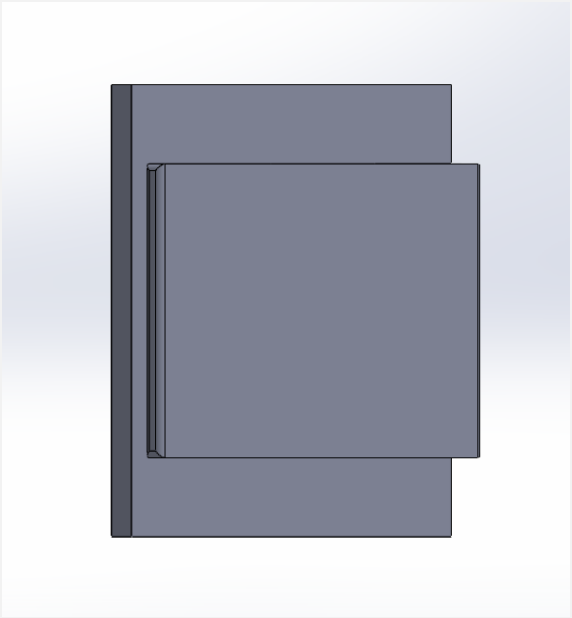


Figure 04: Chip, lock and chip rail



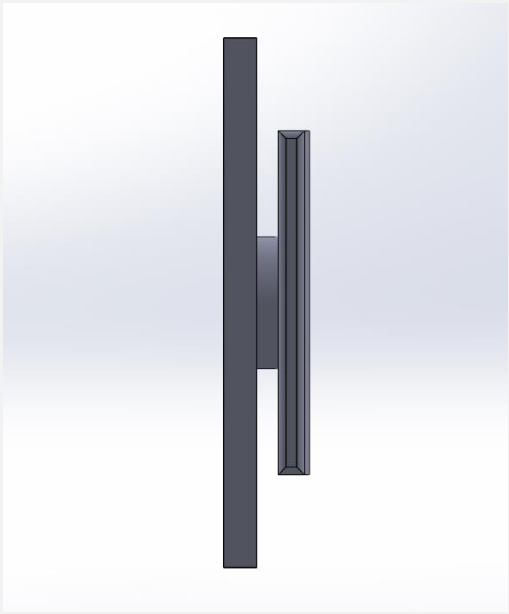


Figure 05: Chip

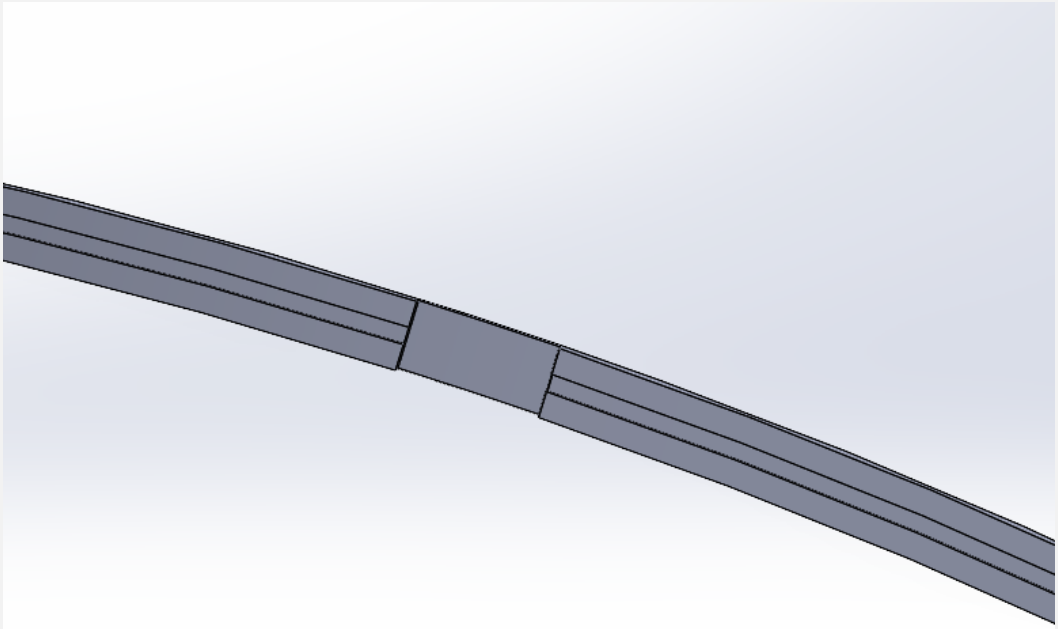


Figure 06: Chip rail

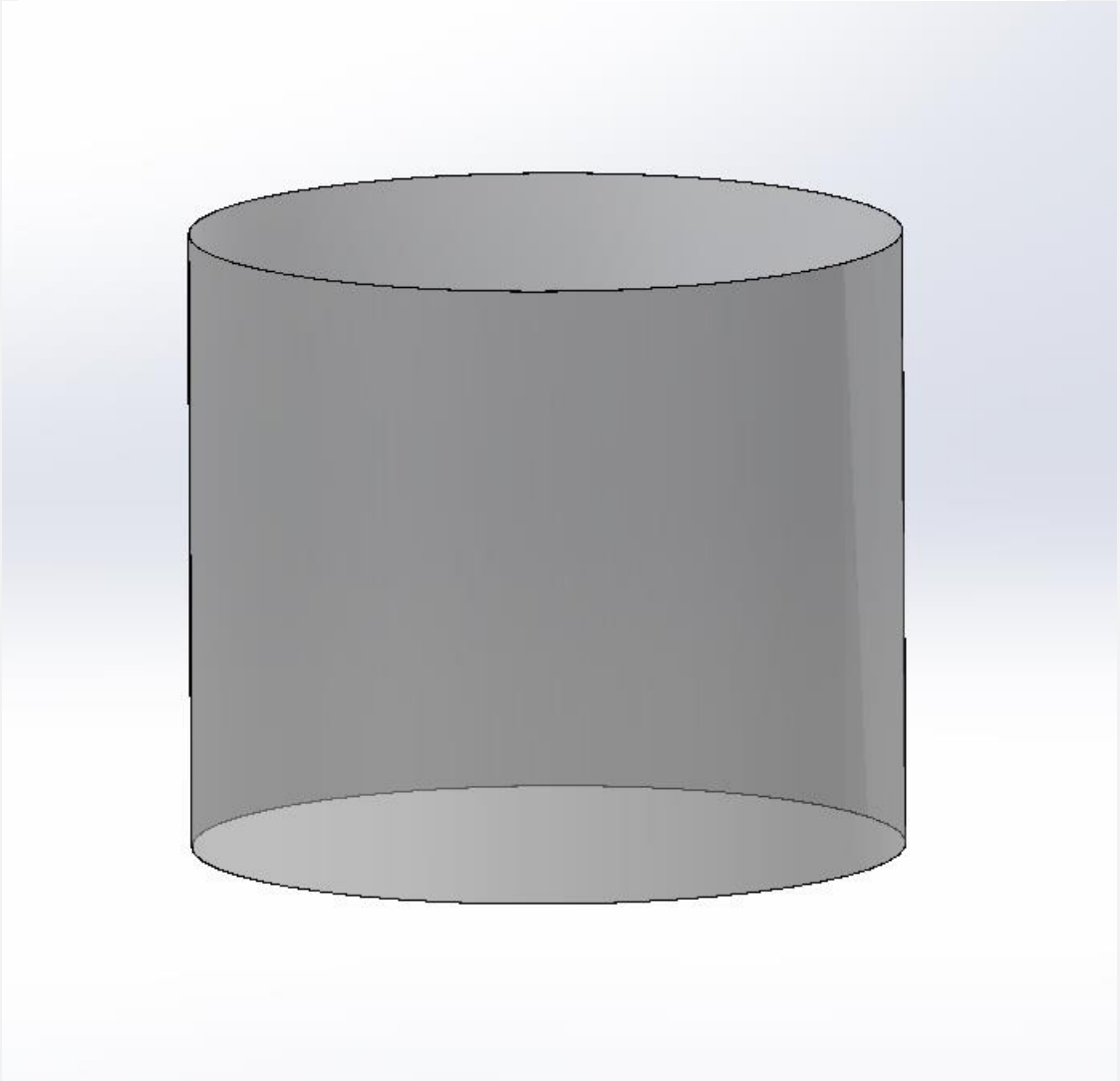


Figure 07: Cover

Chip rail lock system

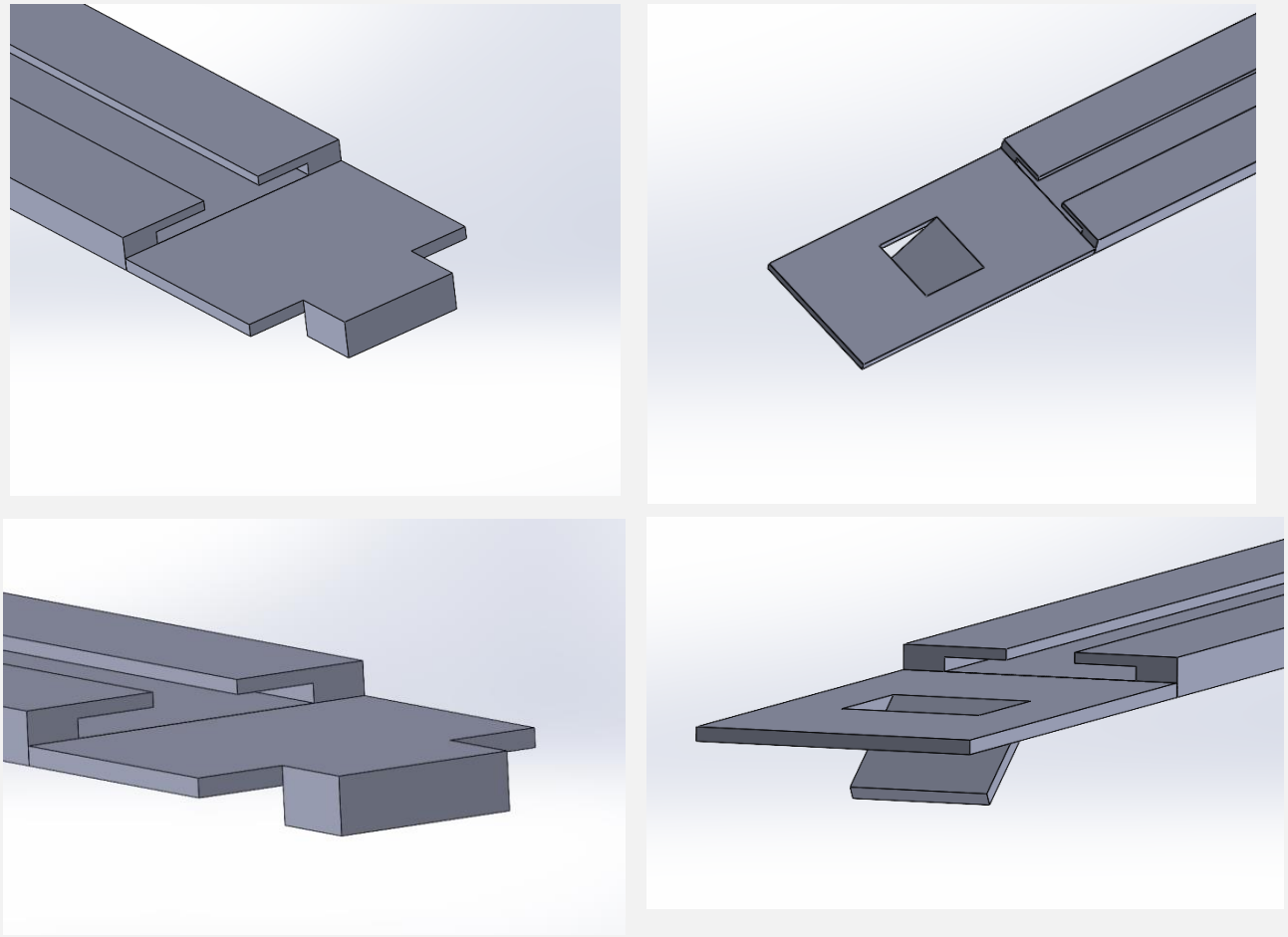


Figure 08: Chip rail lock

3.

Table 01: Failure Modes of Components

Component	Type of loading	Modes of failures
Chip	Tension	Tensile Shearing
Chip Rail	Tension	Tensile Shearing
Covering Cloth	-	-
Lock of the Chip Rail	Tension Shear	Tensile Shear

4. Data:

- Density of air is 1.225 kg/m^3
- The height of the cover is 1m
- Average wind speed is 5 m/s
- The maximum tension appear on chip rail is 5N
- The diameter of an umbrella is 0.92m.
- The height of the chip rail is 25mm.

5. Assumptions:

- No friction between attaching parts

6 & 7.

Table 02: Material Properties Of components

Component	Material	Strengths (MPa)			F.o.s.
		Yield	Shear	Bearing	
Chip	PVC	60	50	80	4
Chip Rail	Flexible PVC	30	30	60	4
Covering Cloth	Polyester	-	-	-	-
Lock of the Chip Rail	PVC	60	50	80	4

8.

Design chip

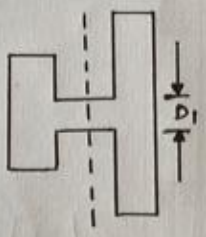


Figure 09: chip breaking due to tension

Average wind speed(V) = $5\ ms^{-1}$

Density of Air (ρ) = $1.225\ kgm^{-3}$

Area subjected to force (A) = $2R \times H$

$= 2 \times 0.46 \times 1$

$= 0.92\ m^2$

Force, F = $A \rho v^2$

$= 0.92 \times 1.225 \times (5)^2$

$= 28.175$

Allowable tensile stress, τ_{all} = $\frac{60}{4}$

$= 15\ Mpa$

$\tau_{all} \geq \frac{F}{A}$

$15 \times 10^6 \geq \frac{28.175}{\frac{\pi}{4}(D_1)^2}$

$D_1 \geq 1.546 \times 10^{-3}\ m$

Chip breaking due to shear

Allowable shear stress, $\tau_{all} = \frac{50}{4}$

$= 12.5 \text{ Mpa}$

Force $= 28.175 \text{ N}$

$$\tau_{all} \geq \frac{F}{A}$$

$$12.5 \times 10^6 \geq \frac{28.175}{\pi \frac{D_1^2}{4}}$$

$$D_1 \geq 1.694 \times 10^{-3}$$

$\therefore$ Selected $D_1 = 3 \text{ mm}$

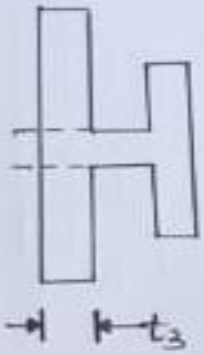


Figure 10

Allowable shear stress $= \frac{50}{4}$ Mpa

$= 12.5$ Mpa

Area $= \pi D_1 t_3$

$= \pi (3 \times 10^{-3}) t_3$

Force $= 28.175$ N

$\tau_{all} \geq \frac{F}{A}$

$12.5 \times 10^6 \geq \frac{28.175}{\pi (3 \times 10^{-3}) t_3}$

$t_3 \geq 2.39 \times 10^{-4}$ m

$\therefore \quad t_3 = \underline{3 \text{ mm}}$

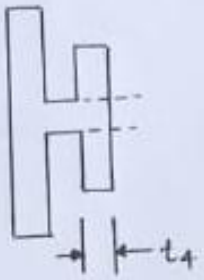


Figure 11

Allowable shear stress $= \frac{50}{4}$ Mpa

$= 12.5$ Mpa

Area $= \pi D_1 t_4$

$= \pi (3 \times 10^{-3}) t_4$

Force $= 28.175$ N

$\tau_{all} \geq \frac{F}{A}$

$12.5 \text{Mpa} \geq \frac{28.175}{\pi (3 \times 10^{-3}) t_4}$

$t_4 \geq \frac{28.175}{12.5 \times 10^6 \times \pi \times 3 \times 10^{-3}}$

$t_4 \geq 2.39 \times 10^{-4}$ m

$t_4 = \underline{\underline{3 \text{mm}}}$

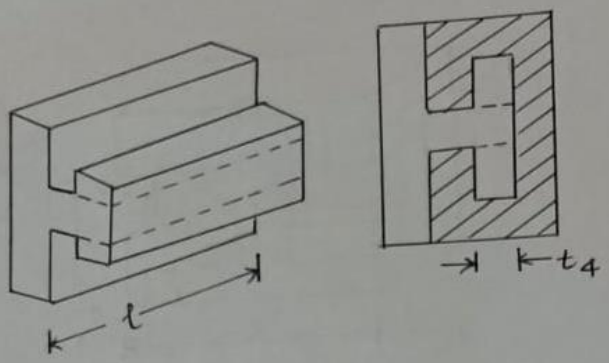


Figure 12

Allowable shear stress, $\tau_{all} = \frac{30}{4}$

$= 7.5$ Mpa

Area subjected to force $= 2 \times l \times t_4$

force $= 28.175$ N

$\tau_{all} \geq \frac{F}{A}$

$7.5 \times 10^6 \geq \frac{28.175}{2 \times l \times 3 \times 10^{-3}}$

$l \geq 6.26 \times 10^{-4}$ m

$\therefore l = \underline{\underline{25 \text{ mm}}}$

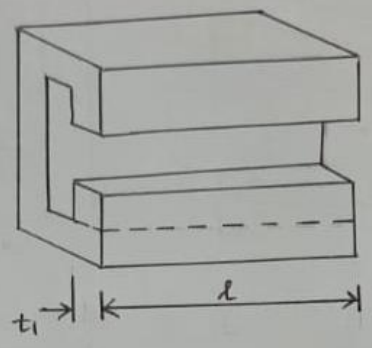


Figure 13

Allowable shear stress, $\tau_{all} = \frac{30}{4}$

$= 7.5$ Mpa

Area $= \cancel{2bt}$

$= 2t_1 l$

Force $= 28.175$

$\tau_{all} \geq \frac{F}{A}$

$7.5 \times 10^6 \geq \frac{28.175}{2t_1 l}$

$7.5 \times 10^6 \geq \frac{28.175}{2t_1 \times 25 \times 10^{-3}}$

$t_1 \geq 7.51 \times 10^{-5}$ m

$t_1 = \underline{\underline{3 \text{ mm}}}$

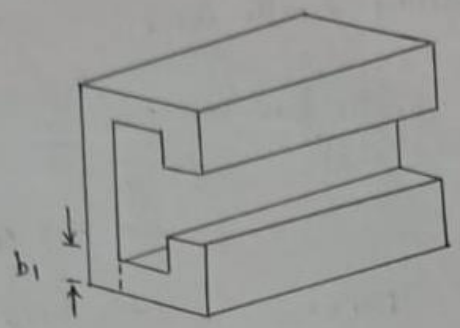


Figure 14

considering the shear force,

Allowable shear stress $= \frac{30}{4}$

$= 7.5 \text{Mpa}$

Area $= b_1 l$

Force $= 28.175 \text{ N}$

$\tau_{all} \geq \frac{F}{A}$

$7.5 \times 10^6 \geq \frac{28.175 \text{ N}}{b_1 \times 25 \times 10^{-3}}$

$b_1 \geq 1.50 \times 10^{-4} \text{ m}$

$b_1 \geq 1.5 \times 10^{-1} \text{ mm}$

$b_1 = \underline{\underline{5 \text{ mm}}}$

considering tensile force,

Allowable tensile ~~force~~ stress = $\frac{30}{4}$

τ_{all} = 7.5 Mpa

Force = 28.175 N

Area = $b_1 l \times 2$

$\sigma_{all} \geq \tau$

$\geq \frac{F}{A}$

$7.5 \times 10^6 \geq \frac{f}{A}$

$7.5 \times 10^6 \geq \frac{28.175}{2 \times b_1 \times 25 \times 10^{-3}}$

$b_1 \geq 7.51 \times 10^{-5}$ m

$b_1 = \underline{\underline{5 \text{ mm}}}$

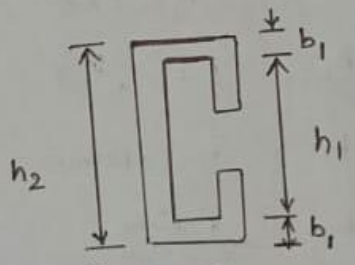


Figure 15 :

$h_2 = 25$ mm,

$h_1 = h_2 - 2b_1$

$= 25 - 2(5)$

~~$h_1 = h_1$~~

$h_1 = \underline{\underline{15 \text{ mm}}}$

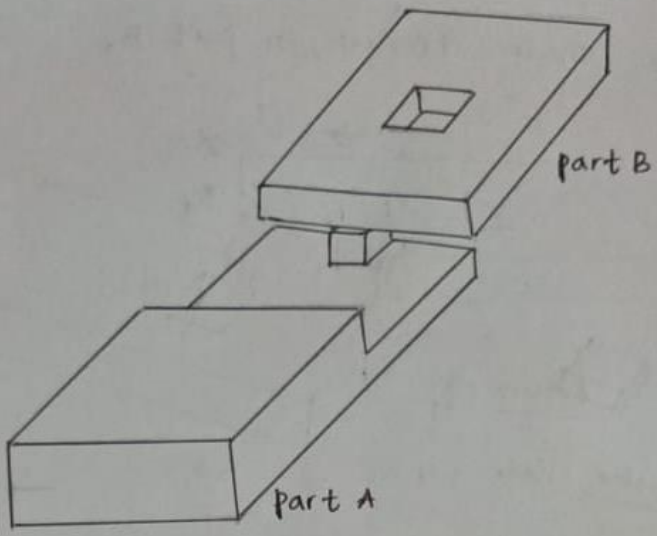


Figure 16 : Lock of the chip rail

considering the Tensile strength, for part B

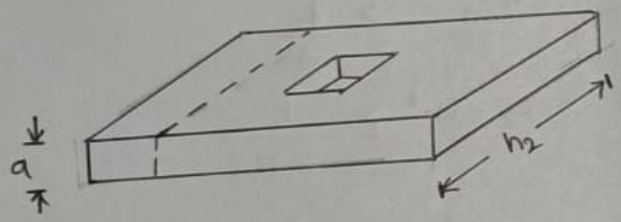


Figure 17

Allowable tensile stress, $= \frac{60}{4}$

$= 15$ Mpa

Tensile force $= 5$ N

Area $= a \times h_2$

$= 25 \times 10^{-3} a$

$\tau_{all} \geq F/A$

$15 \times 10^6 \geq \frac{5}{25 \times 10^{-3} a}$

$a \geq 1.33 \times 10^{-5}$ m

$a = \underline{\underline{3 \text{ mm}}}$

Considering the shear strength, for part B,

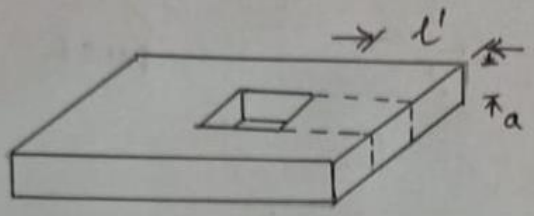


Figure 18

Allowable shear stress $= \frac{50}{4}$

$= 12.5 \text{ Mpa}$

Shear Force $= 5 \text{ N}$

Area $= a \times l' \times 2$

$\tau_{all} \geq \frac{F}{A}$

$12.5 \times 10^6 \geq \frac{5}{2l'a}$

$l' \geq \frac{5}{2 \times 3 \times 10^{-3} \times 12.5 \times 10^6}$

$l' \geq 6.667 \times 10^{-5} \text{ m}$

$l' = \underline{5 \text{ mm}}$

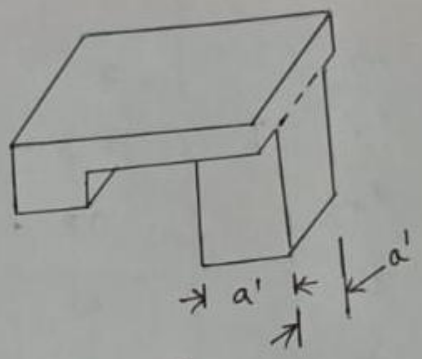


Figure ; 19

considering Part A,

Allowable shear stress $= \frac{50}{4}$

$= 12.5 \text{ Mpa}$

Force $= 5 \text{ N}$

Area $= a' \times a'$

$\tau_{all} \geq F/A$

$12.5 \times 10^6 \geq \frac{5}{(a')^2}$

$a' \geq 0.632 \times 10^{-3}$

$a' = \underline{\underline{10 \text{ mm}}}$

9.

Table 03: Results

Component	Symbol	Value (mm)
Chip	D_1	303
	t_3	03
	t_4	03
	t_1	03
	h_1	15
Chip rail	h_2	25
	b_1	05
	l	25
lock	a	03
	l'	05
	a'	10
Covering cloth	H	01
	D	920

10.

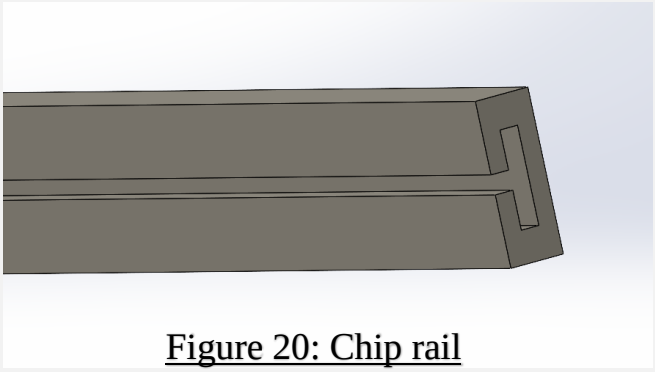


Figure 20: Chip rail

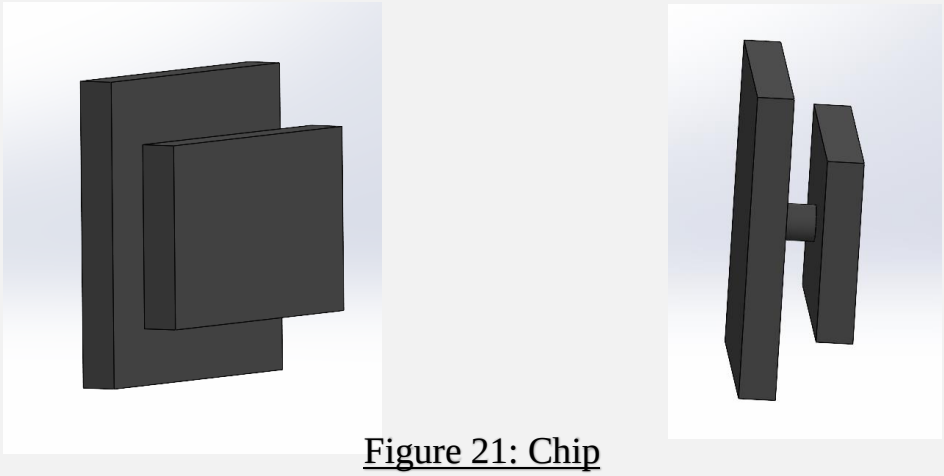


Figure 21: Chip

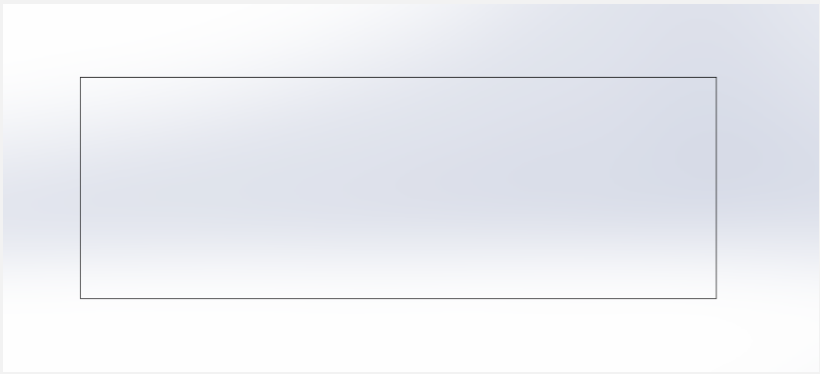


Figure 22: Polyester cloth

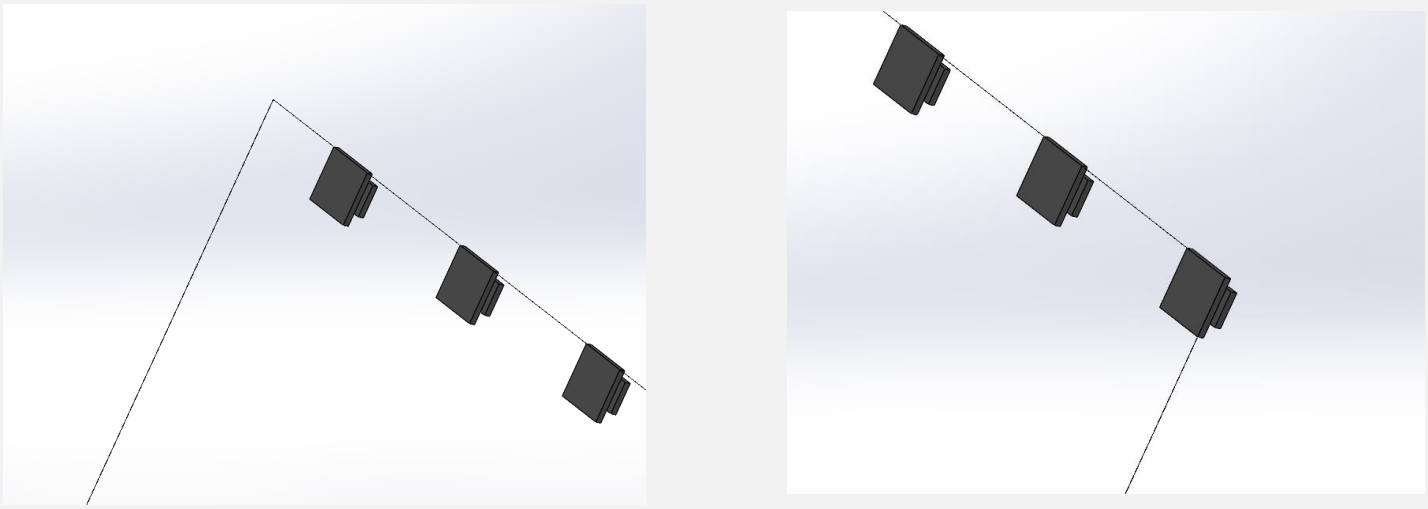


Figure 23: Polyester cloth with attached chips

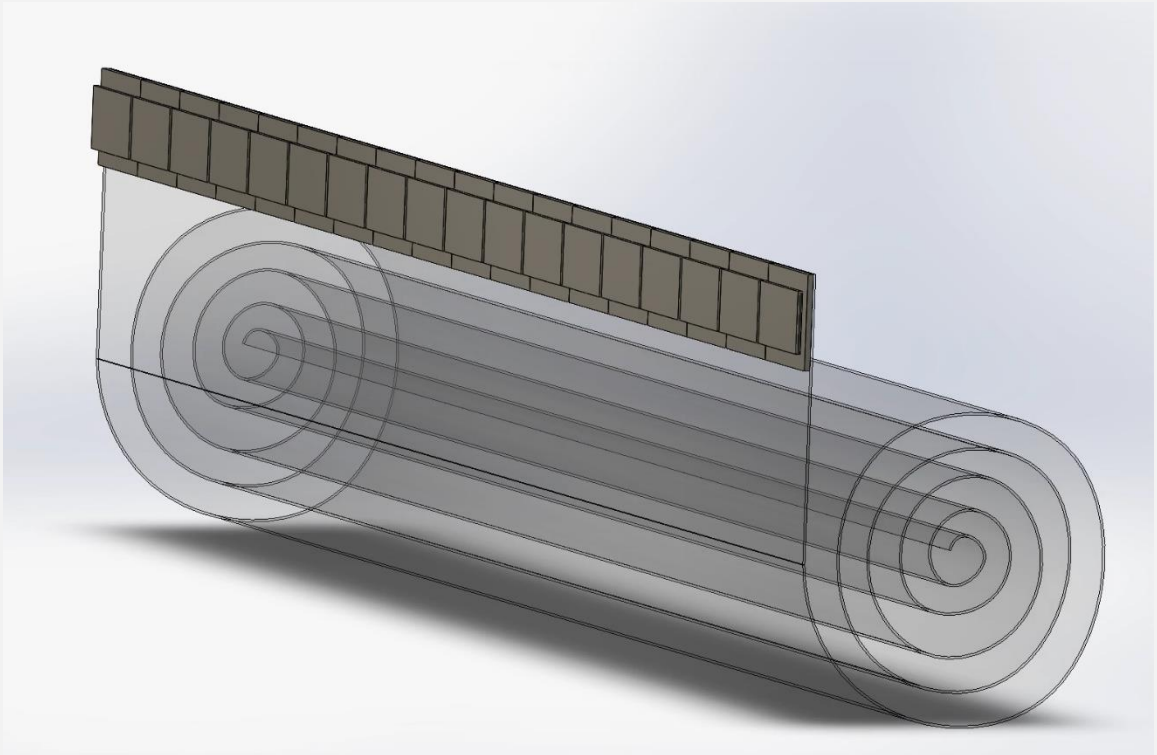
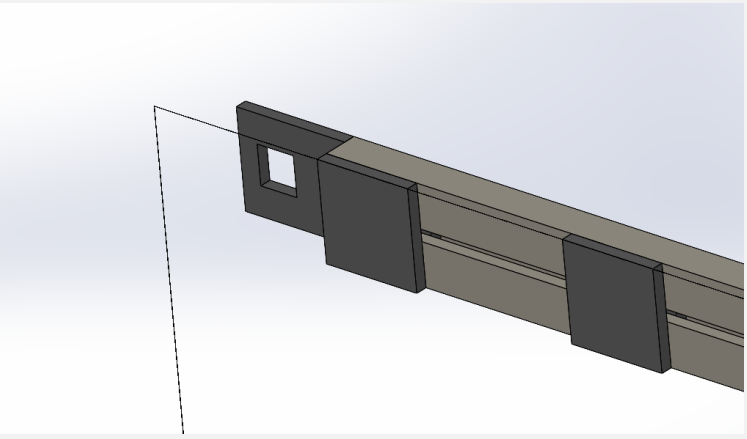


Figure 24: Polyester cloth, when not in use



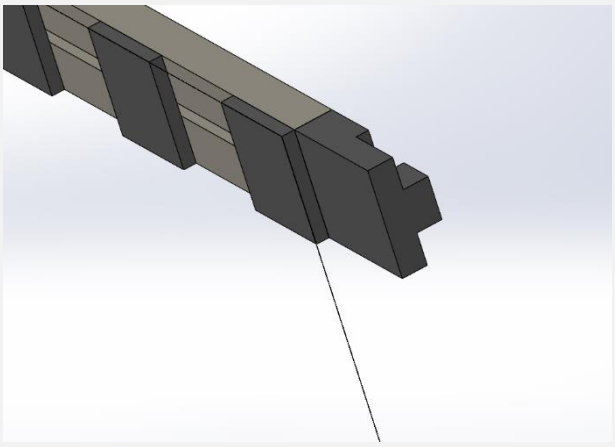
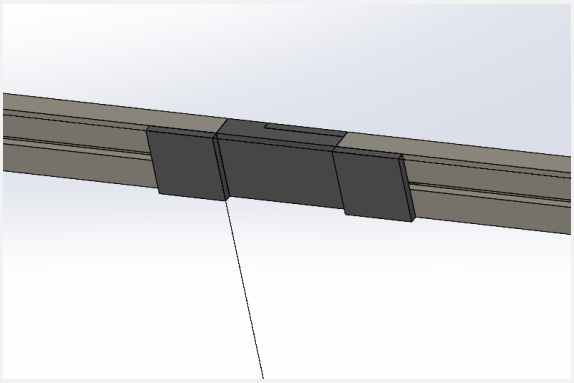


Figure 25: Assembled parts



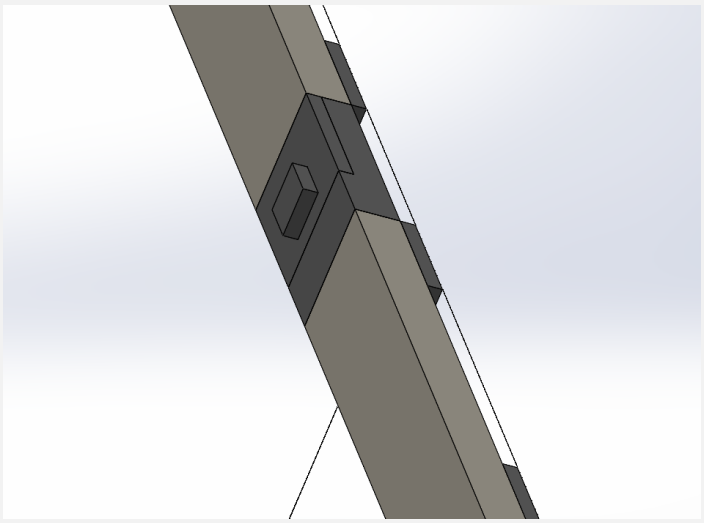


Figure 26: Lock

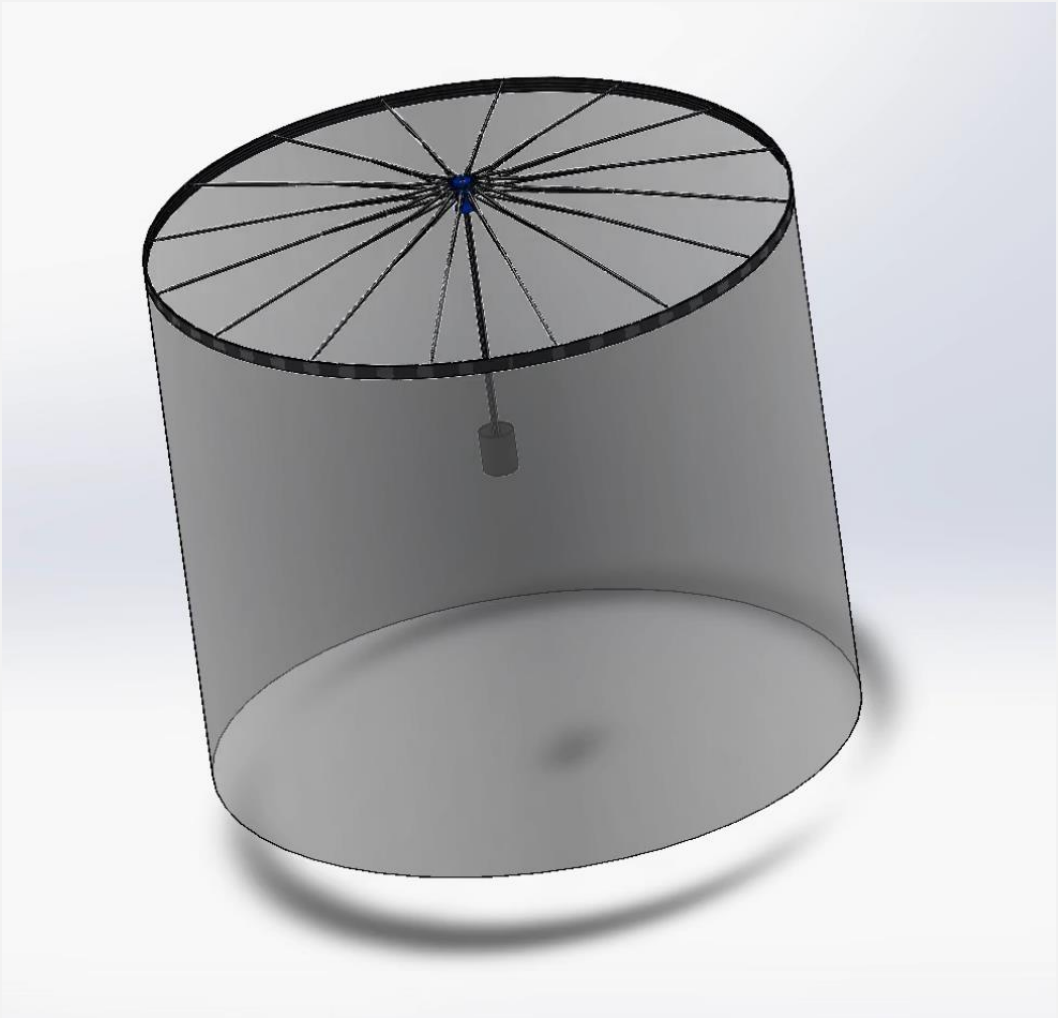


Figure 27: Covered Umbrella