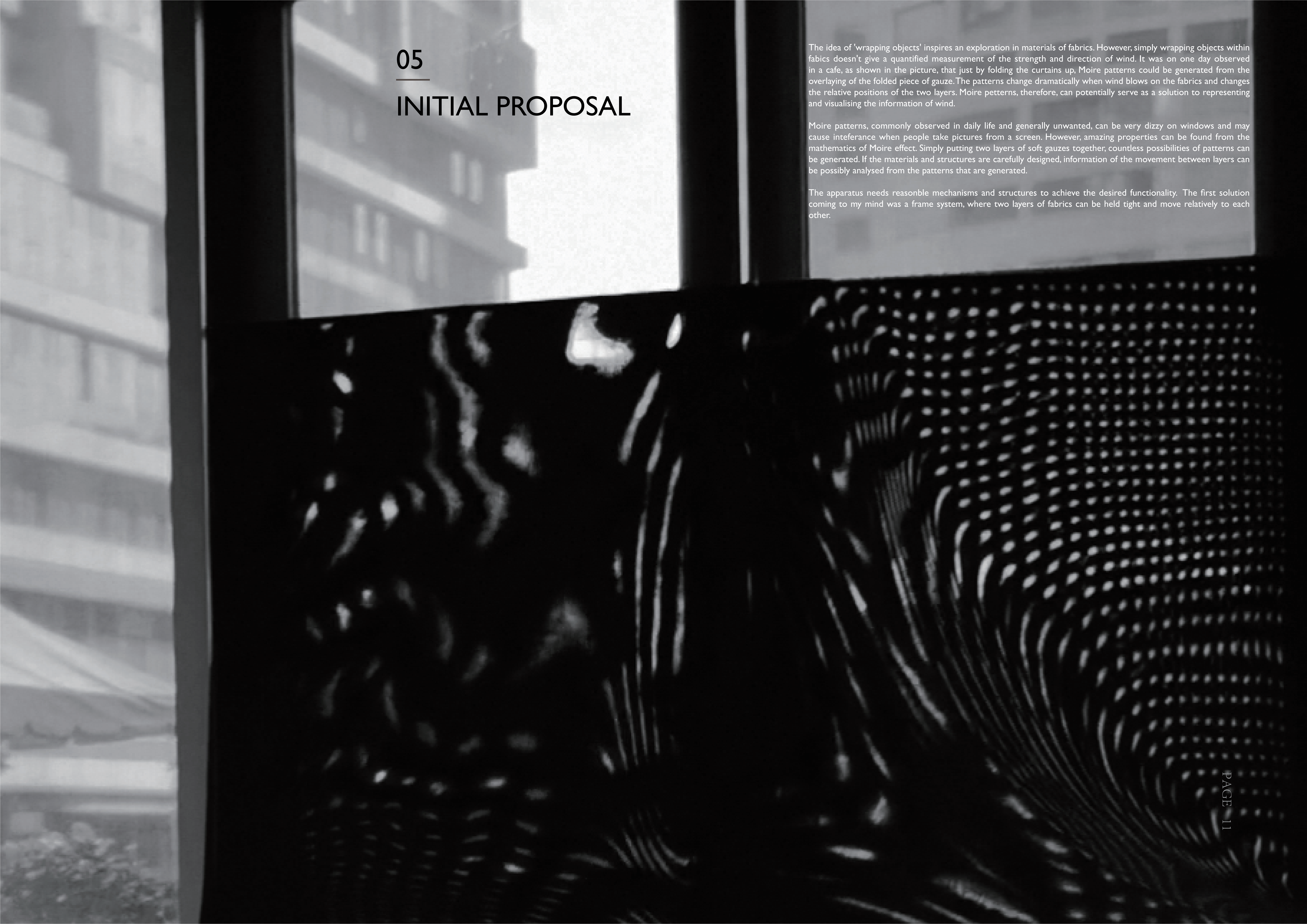


05

INITIAL PROPOSAL

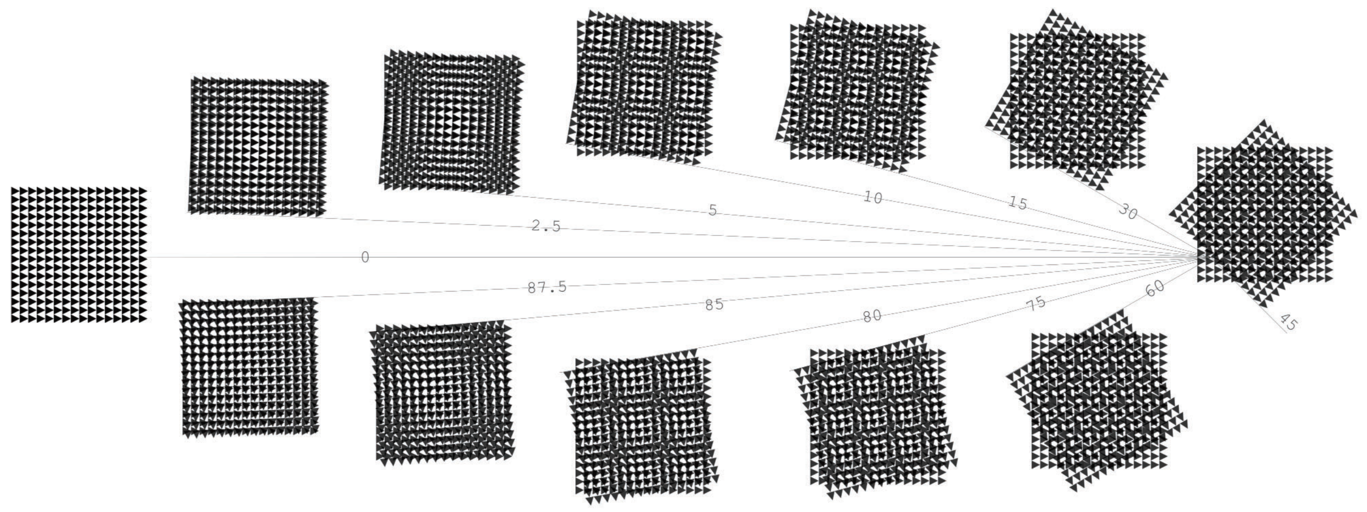
The idea of 'wrapping objects' inspires an exploration in materials of fabrics. However, simply wrapping objects within fabics doesn't give a quantified measurement of the strength and direction of wind. It was on one day observed in a cafe, as shown in the picture, that just by folding the curtains up, Moire patterns could be generated from the overlaying of the folded piece of gauze. The patterns change dramatically when wind blows on the fabrics and changes the relative positions of the two layers. Moire petterns, therefore, can potentially serve as a solution to representing and visualising the information of wind.

Moire patterns, commonly observed in daily life and generally unwanted, can be very dizzy on windows and may cause inteferance when people take pictures from a screen. However, amazing properties can be found from the mathematics of Moire effect. Simply putting two layers of soft gauzes together, countless possibilities of patterns can be generated. If the materials and structures are carefully designed, information of the movement between layers can be possibly analysed from the patterns that are generated.

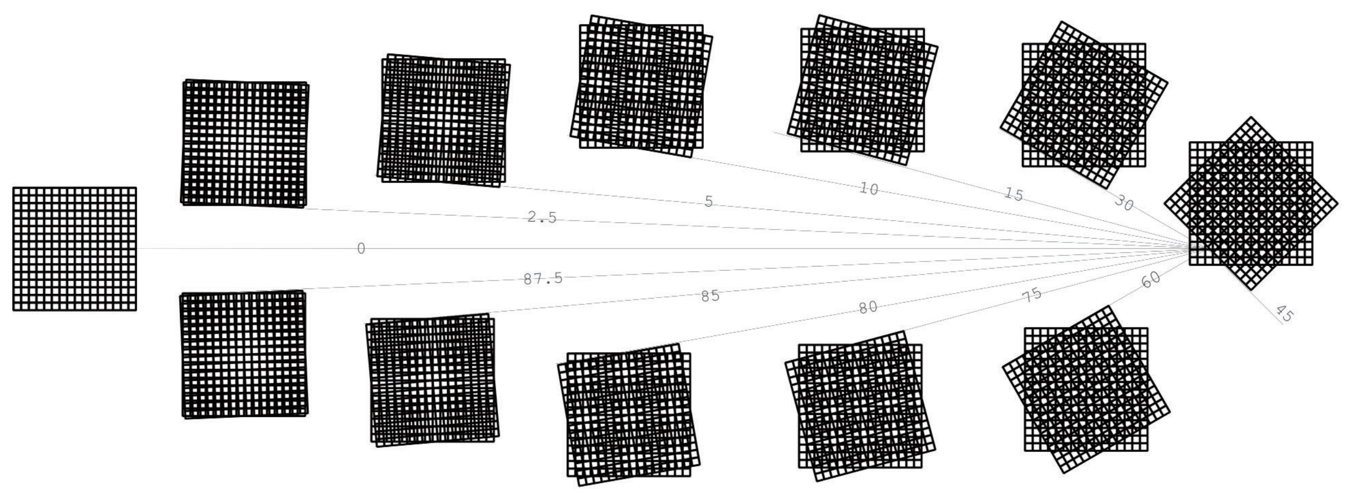
The apparatus needs reasonble mechanisms and structures to achieve the desired functionality. The first solution coming to my mind was a frame system, where two layers of fabrics can be held tight and move relatively to each other.

5.1 EXPERIMENT

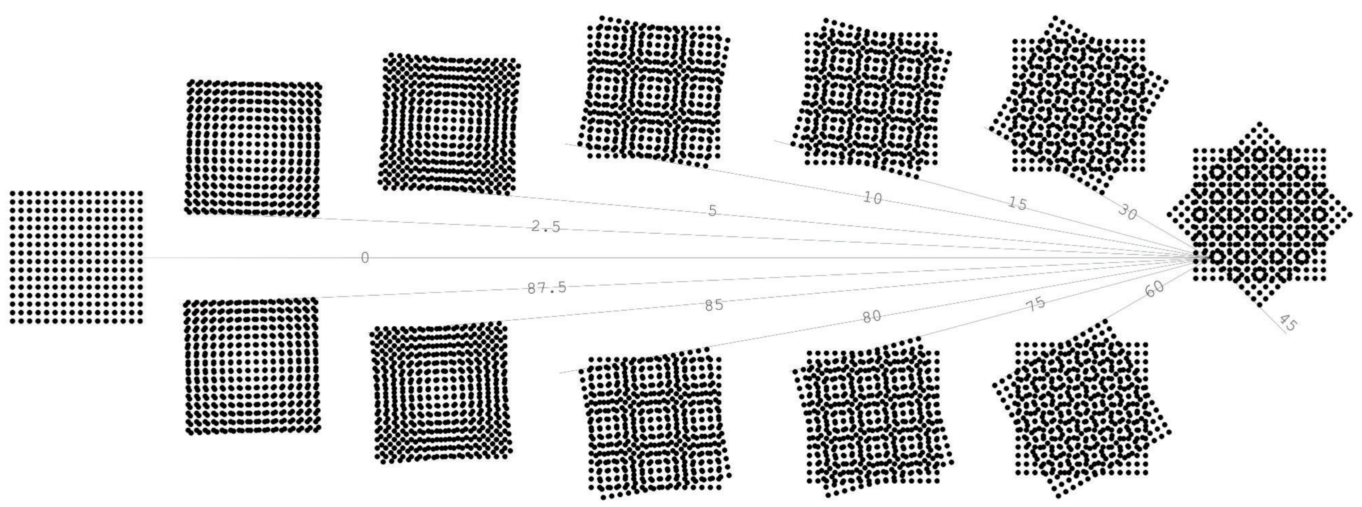
5.1.1 SHAPES



16*16



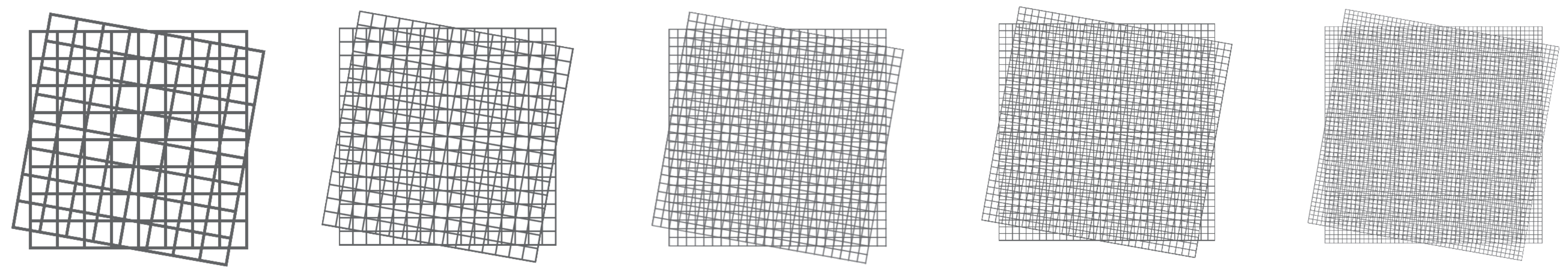
16*16



16*16

The experiment shows that whether the shapes are grids, triangles or dots,
the results of the patterns will exhibit similarly as long as the sizes of the materials are similar.

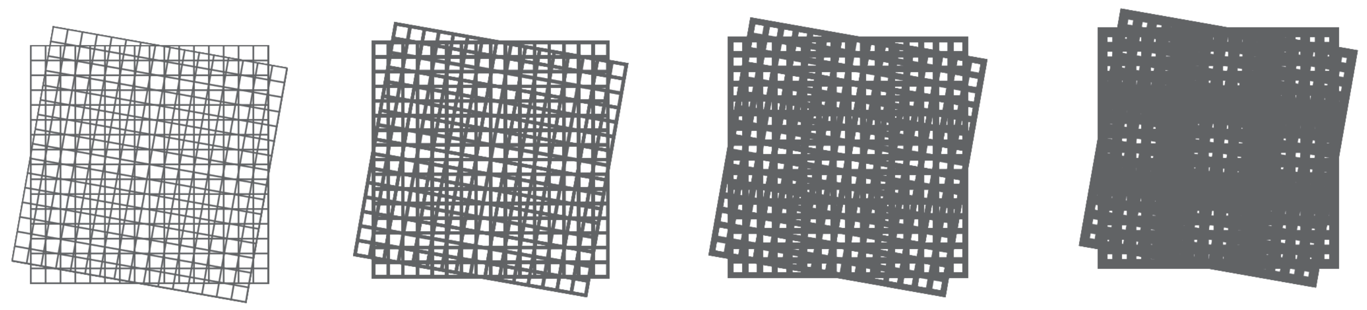
5.1.2 NUMBER OF GRIDS



8*8 16*16 25*25 32*32 50*50

The resultant patterns are denser with denser grids for each layer.
Materials with larger sizes and finer grids might result in less obvious patterns.

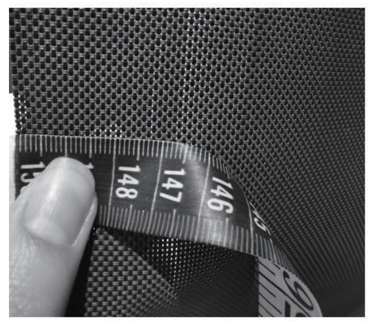
5.1.3 THICKNESS



1:8 1:3 1:1.33 1:0.5

'1:n' denotes the proportion of areas of black and white.
With thicker grids, moire effects are more obvious.
But the frequences of patterns do not change.

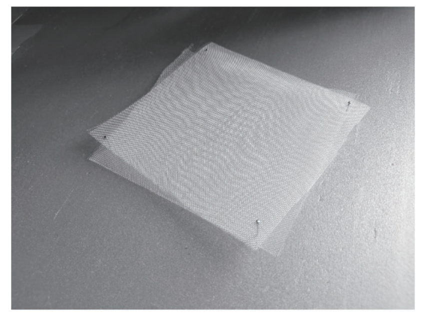
5.1.4 MATERIAL



size: 1mm*1mm,thick
colour: dark
material: flax
stiffness: moderate
weight: heavy

size: 1mm*1mm,thin
colour: dark
material:nylon
stiffness: soft
weight: light

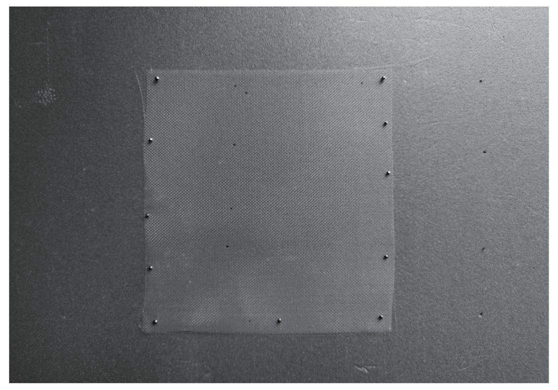
size: 0.7mm*0.7mm,thin
colour: light
material:cotton
stiffness: soft
weight: light

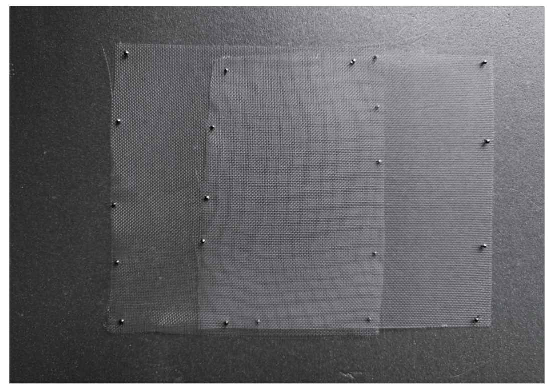


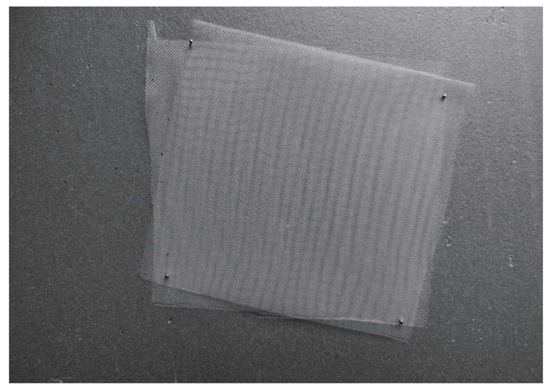
size: 0.5mm*0.5mm,thin
colour: light
material: fiberglass & PVC
stiffness: moderate
weight: light

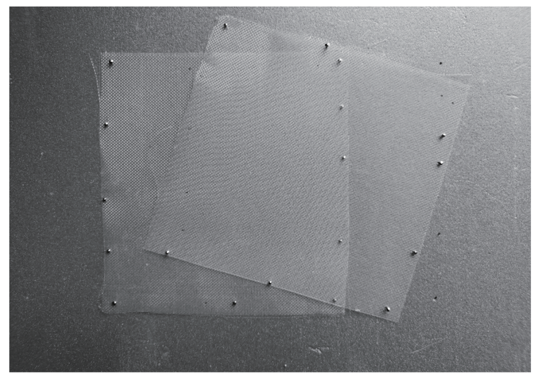
Although thicker materials can achieve more obvious Moire effects,
the weight of them are generally heavier, and thus less sensitive to subtle wind.
Light 0.5mm*0.5mm fibre made of PVC & fiberglass is chosen,
not only because the weight and density of grids are ideal,
but because it is more stiff and requires less structural support as well.

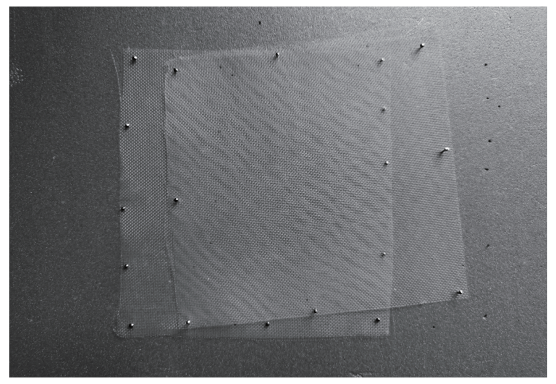
5.1.5 MOVEMENT

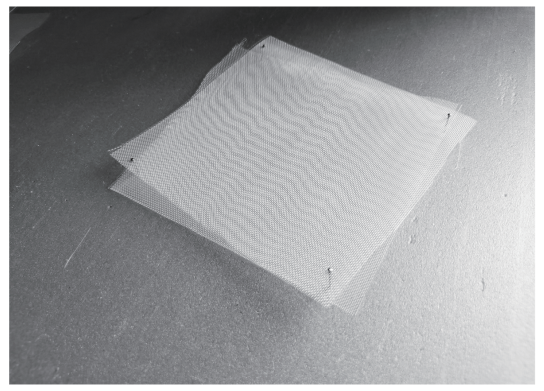
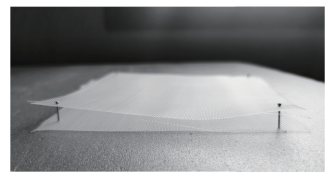

Original material

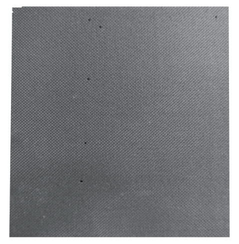
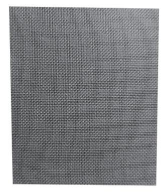

Horizontal translation

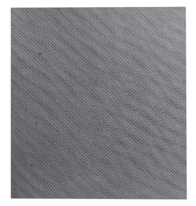
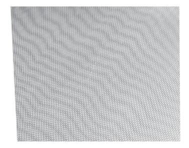

Rotation(small angle)

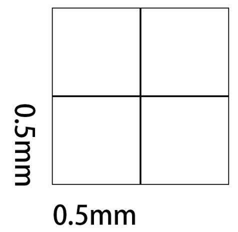

Rotation(larger angle)
Patterns less obvious

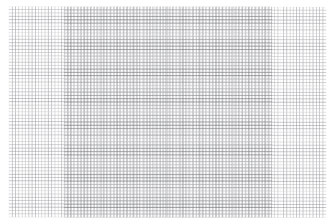
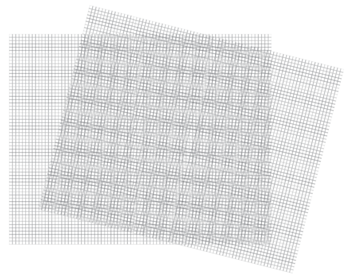
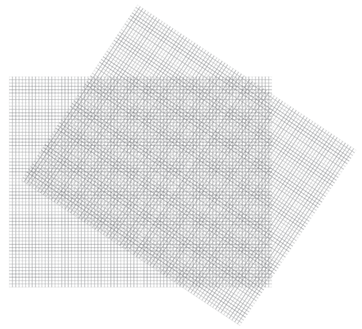
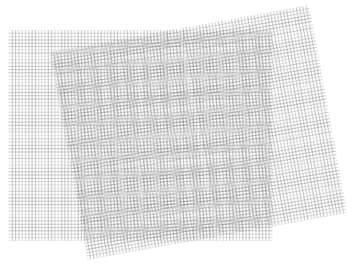
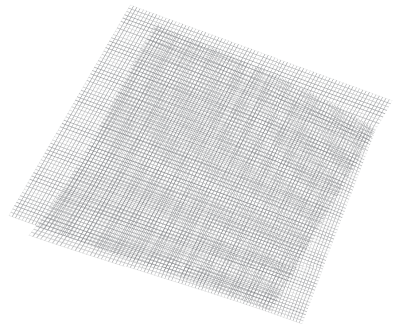

Rotation

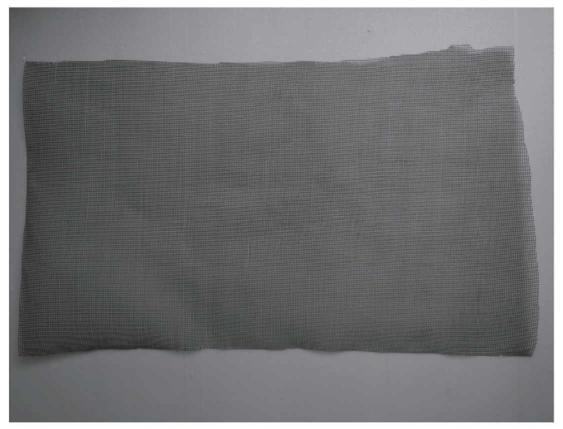


Keeping 1cm between the layers
Patterns still visible, but dimmer

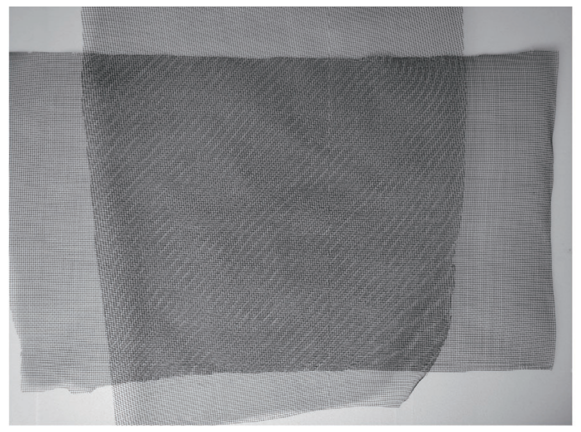
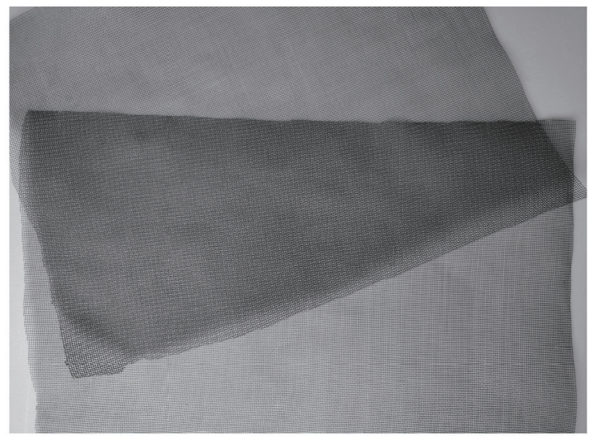
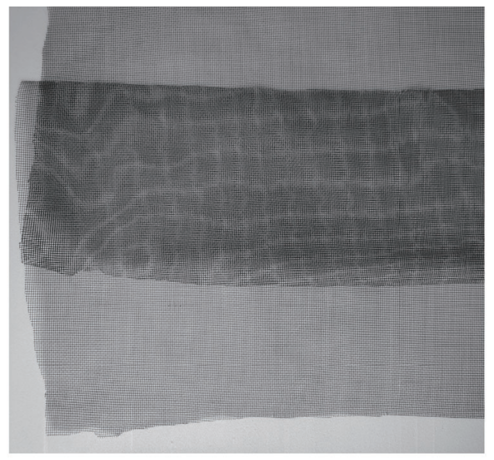
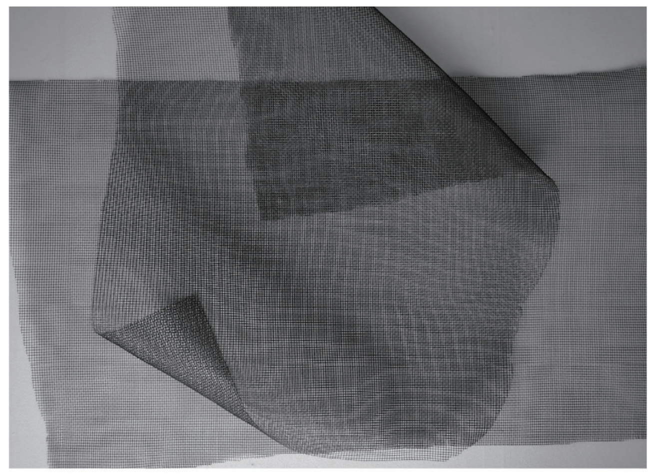



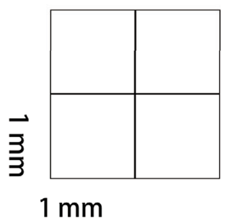


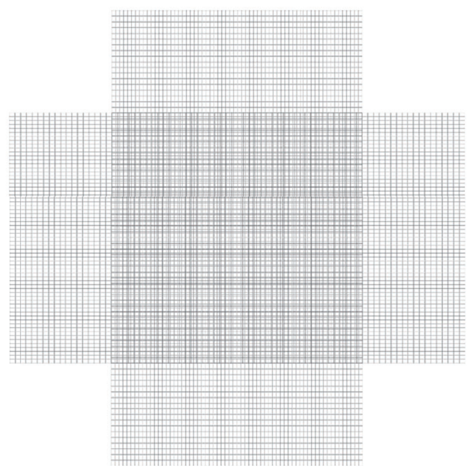
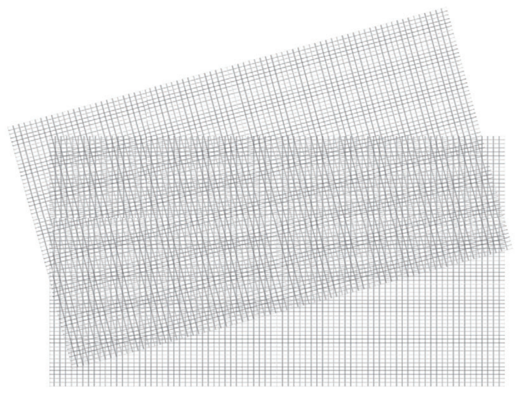
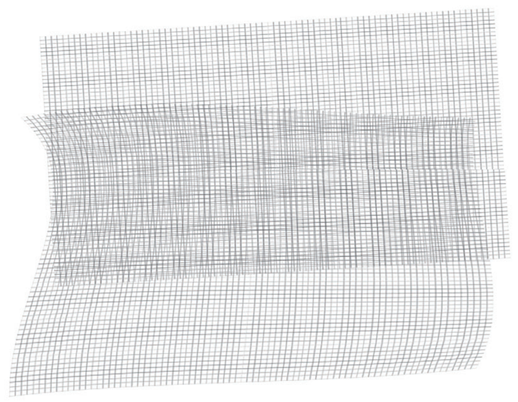
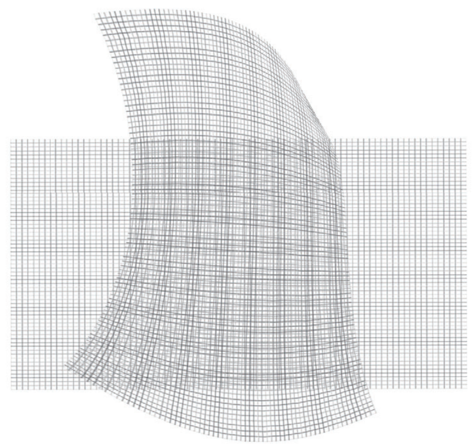






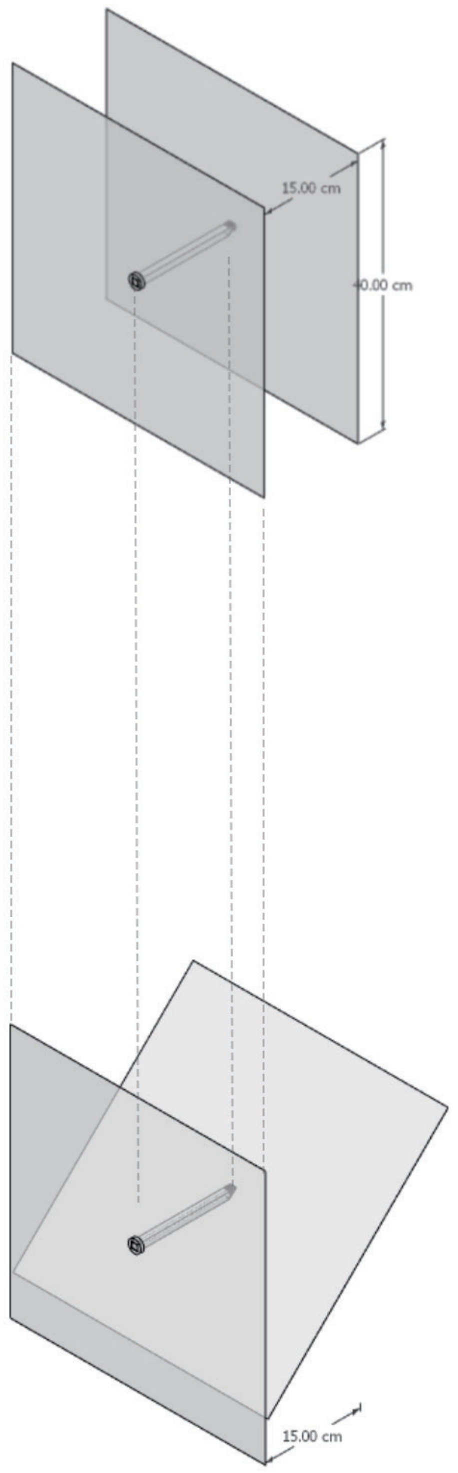

Original material

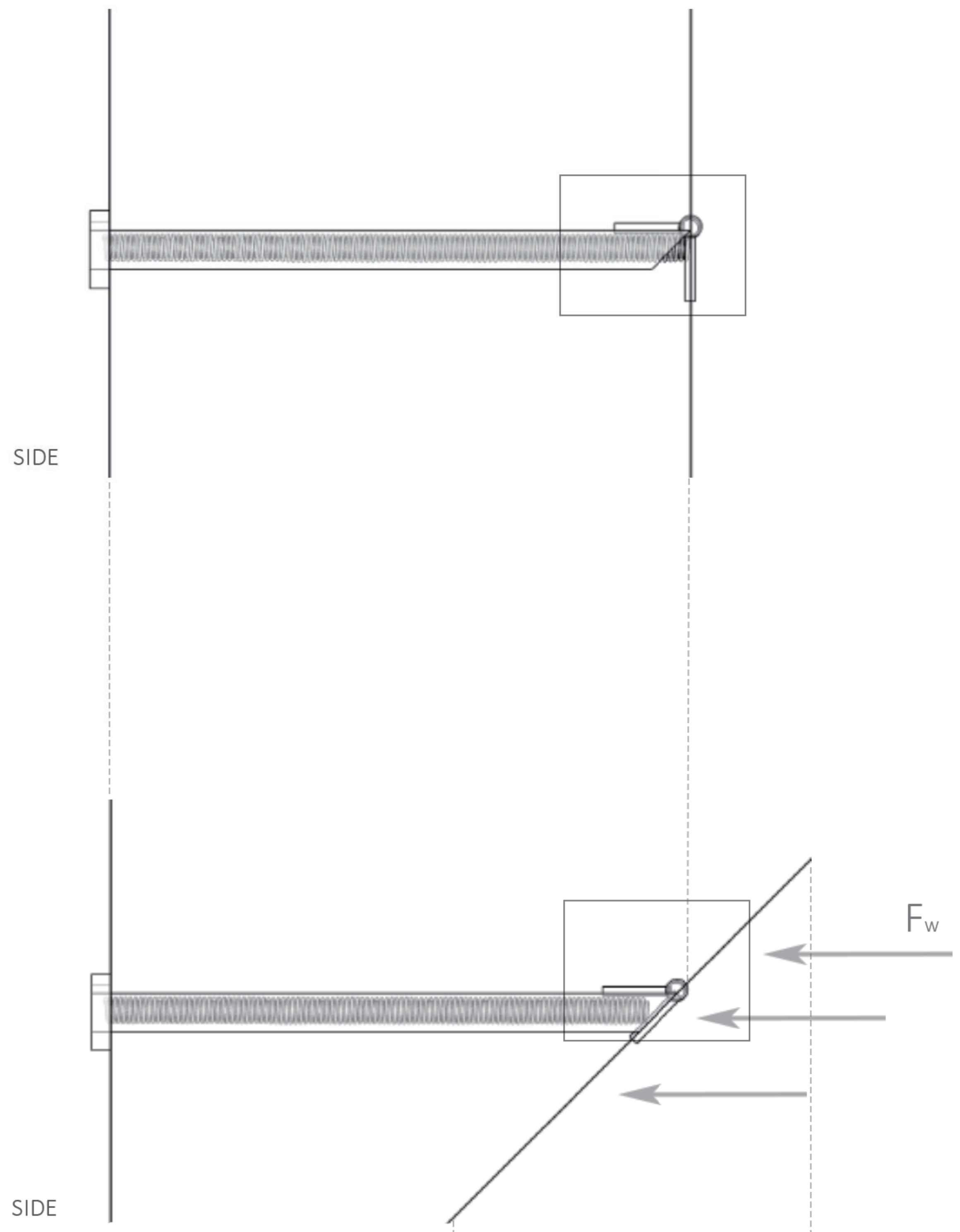
The experiments of moving, rotating and flexing materials show that Moire effects are obvious in general as long as the two layers are not too far away from each other. The angle of observing also plays an important part.

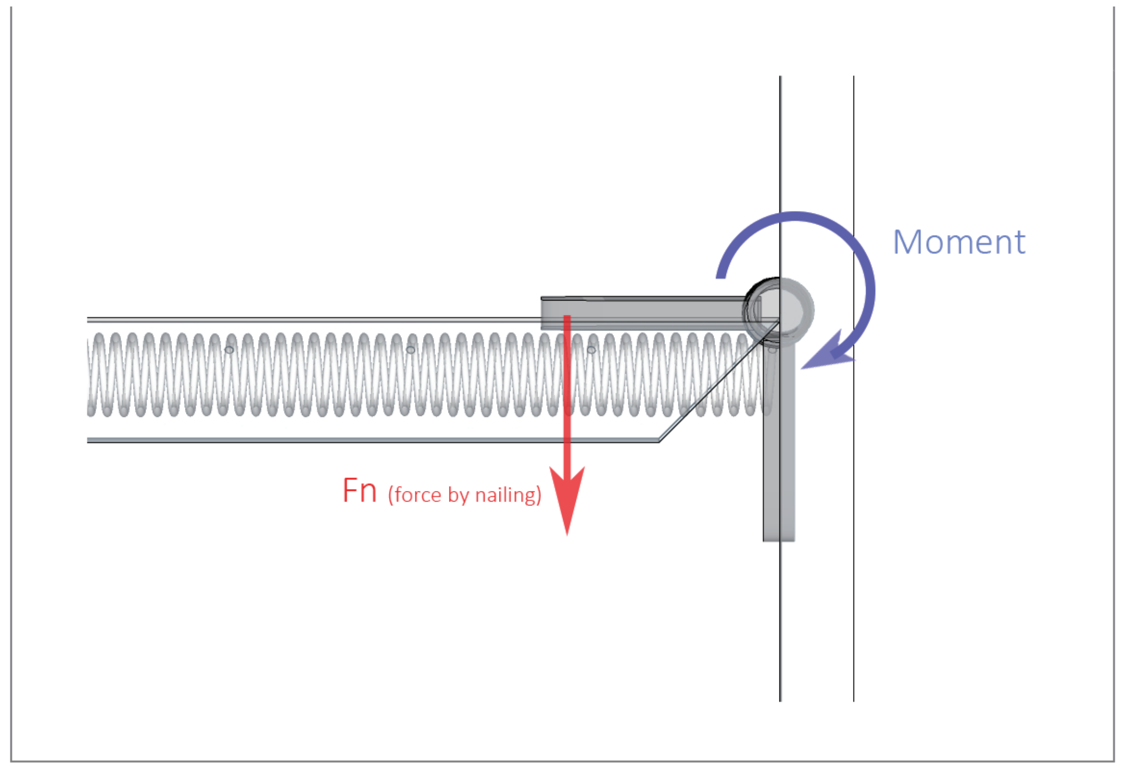


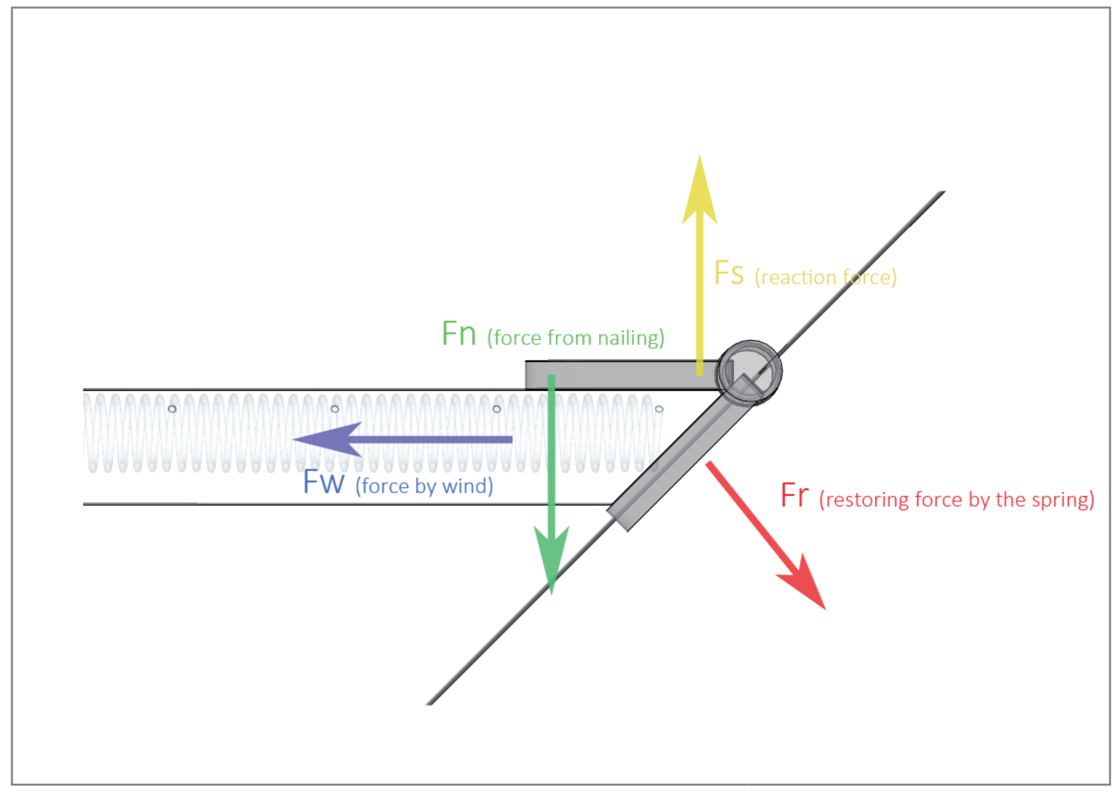







Rotation: 45 degrees

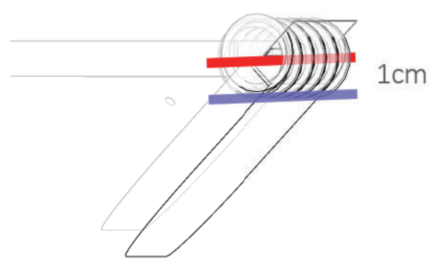


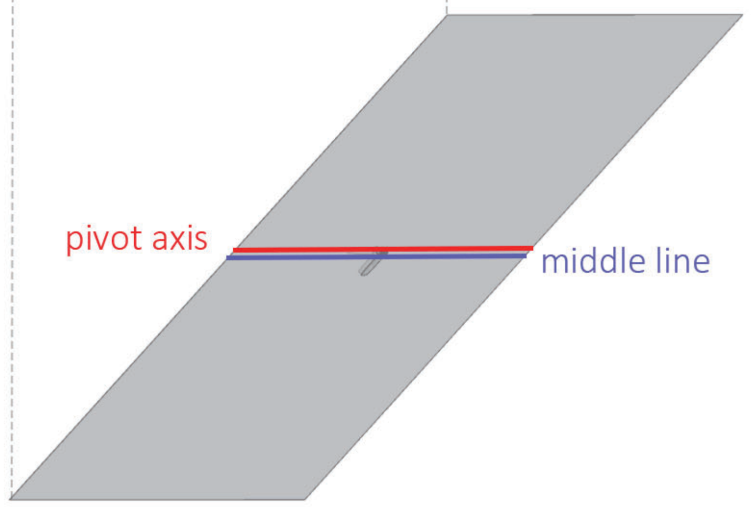




5.2 MECHENISM

The mechanism of the apparatus is inpired by the cercus structure of insects. One layer is fixed, while the other is rotatable at a certain angle and to a certain direction. When no force is exerted on the surface, the spring inside the connecting tube keeps the layer in its vertical position.





Fw=Pw*A=0.5* ρ*Vw²*A

ρ=Pa/(Rs*T)

where Fw : wind force
Pw: pressure of wind
A: area
ρ: density of air
Vw: wind speed
Pa: absolute pressure
Rs: specific gas constant
T: absolute temperature

$A=40*1=40cm^2$

$\rho\sim=1.2250\ kg/m^3$ (typical air density near the sea)

$Fw=2.45*10^{-5}*Vw^2$

For a typical wind speed Vm=10mph

$Fw=2.45*10^{-5}*4.47^2=4.9*10^{-4}N$

And the reaction force provided by the spring:

$Fs=Fw=4.9*10^{-4}N$

By Hooke's law,

Fs=-kx, where x is the displacement and K is Hooke's coefficient

so $k=(4.9*10^{-4})/(0.5*10^{-2})=0.0979\ N/m$

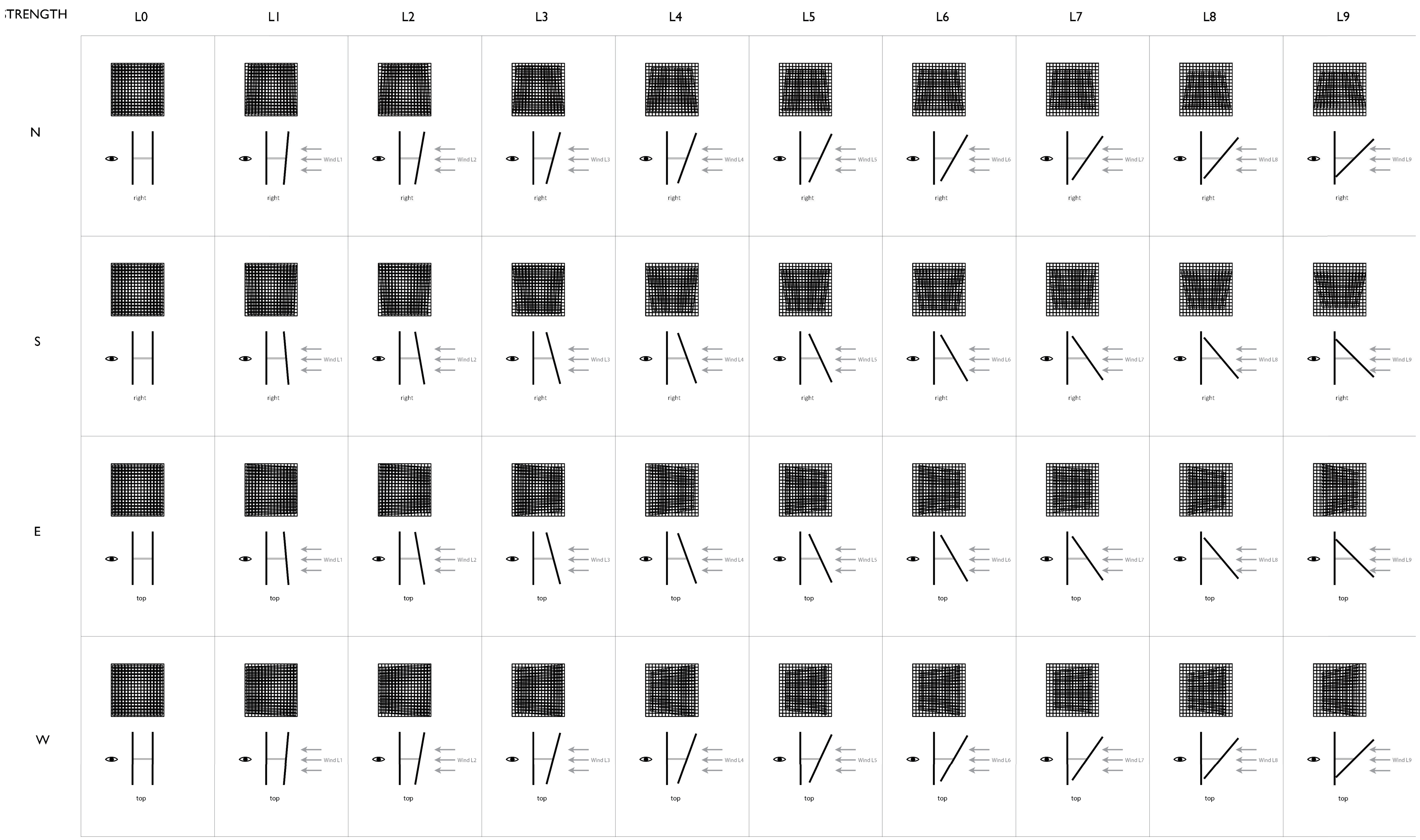
The maximum value of stiffness of the spring can then be decided.

5.2 MECHANISM: CHART

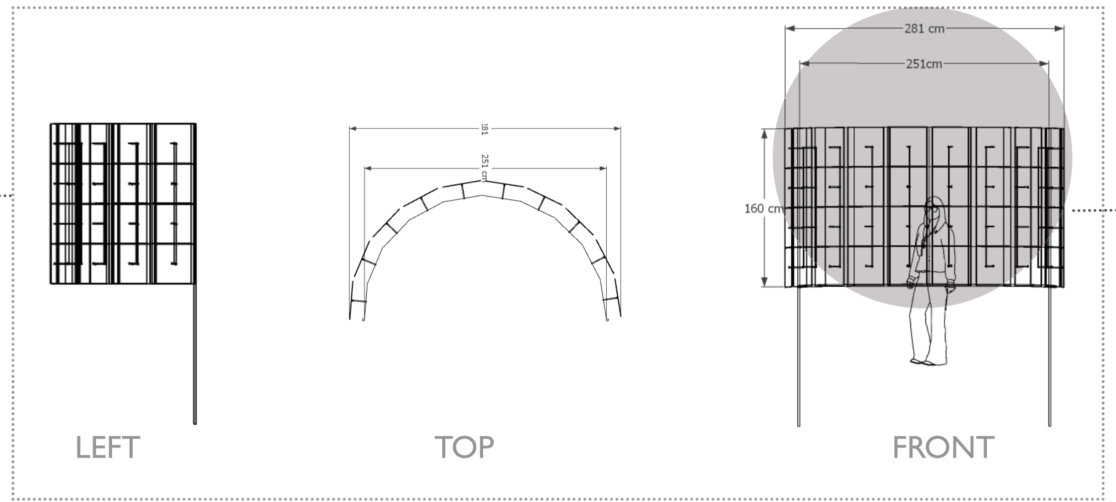
This chart shows the corresponding patterns to different relative positions of layers. As the mechanism introduced before, one layer is fixed and the other can be 'pushed' by wind from a certain direction at a certain angle, forming a specific pattern, which is like a 'code' of the information of wind. The angles have been split into 5°, 10°, 15°..., 45°. The strength of wind has been split into 9 categories accordingly. With the increase of strength of wind, the pressure on the layers would be greater, and thus rotate the layers about their axes. If the wind has reached a specific strength, layers with strength level below it would exhibit coded patterns. The higher-level layers, however, would not move, and thus the patterns remain unchanged.

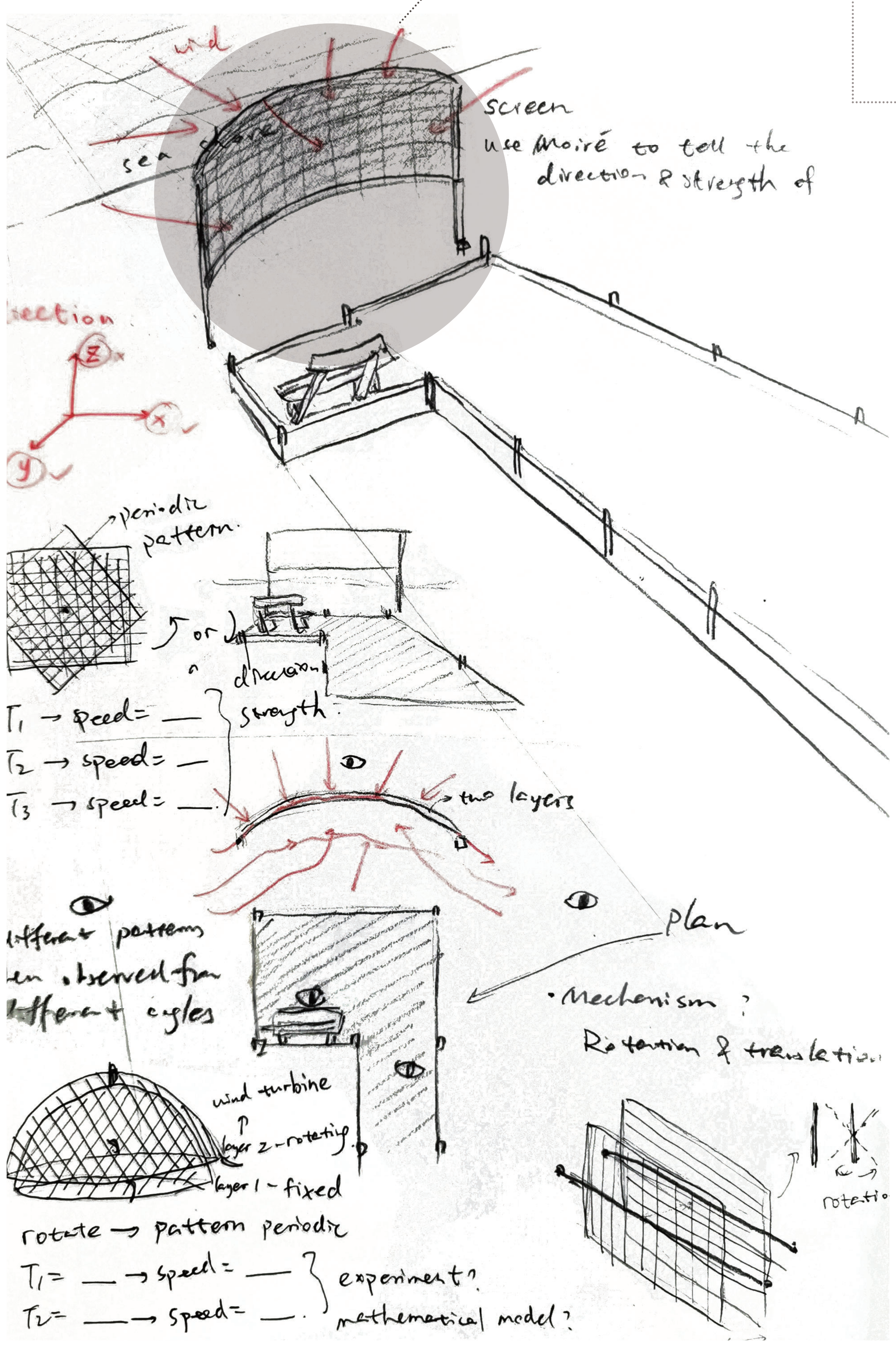
The y-axis of the chart indicates the direction of wind. The sloped ends of tubes, as demonstrated in the mechanism, are opened to different directions, and the layers rotate accordingly.

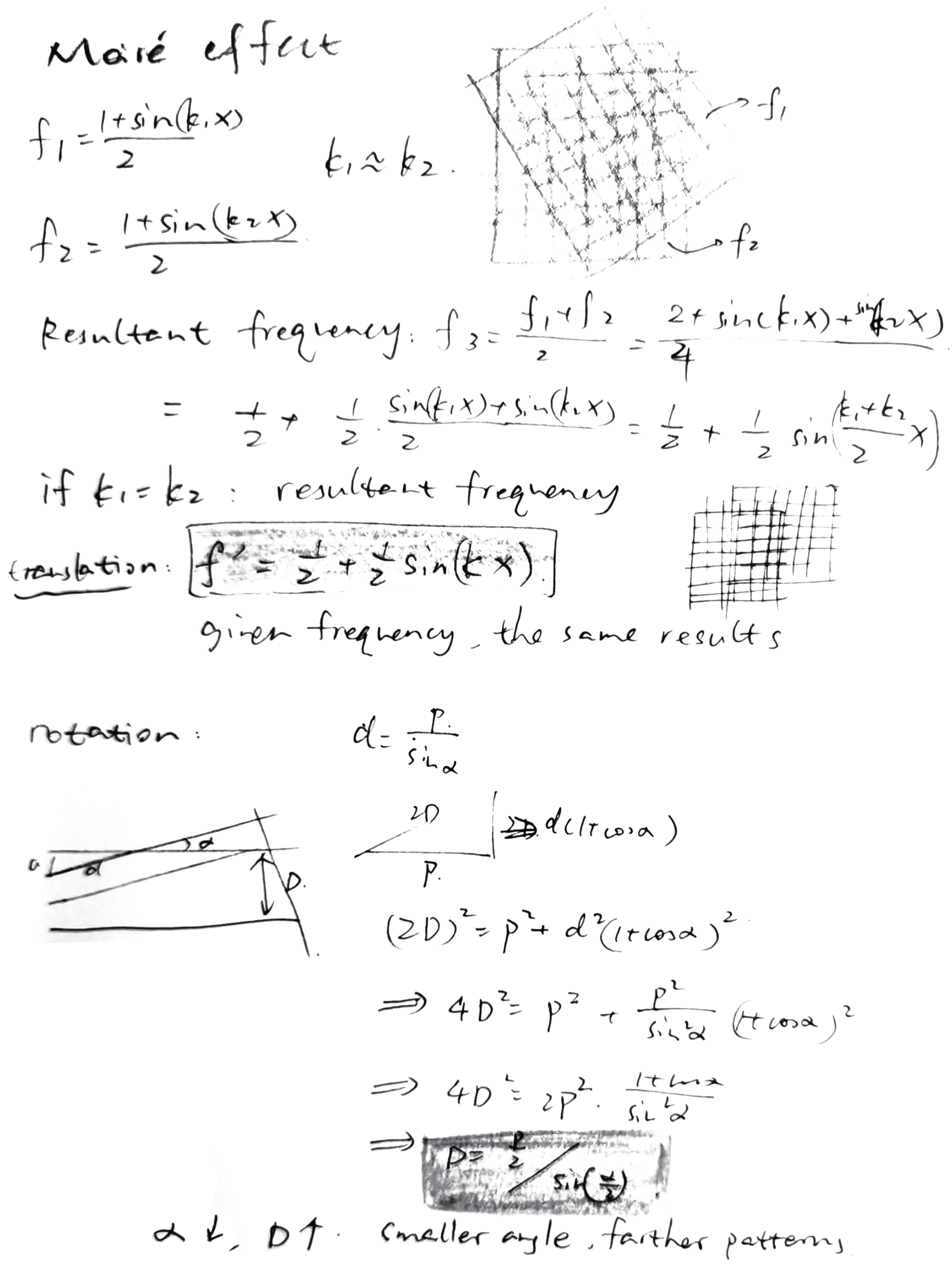
The chart therefore can demonstrate both where the wind comes from, and the level of strength of wind. By putting the layers together, a screen where people can 'read' wind, can be built.

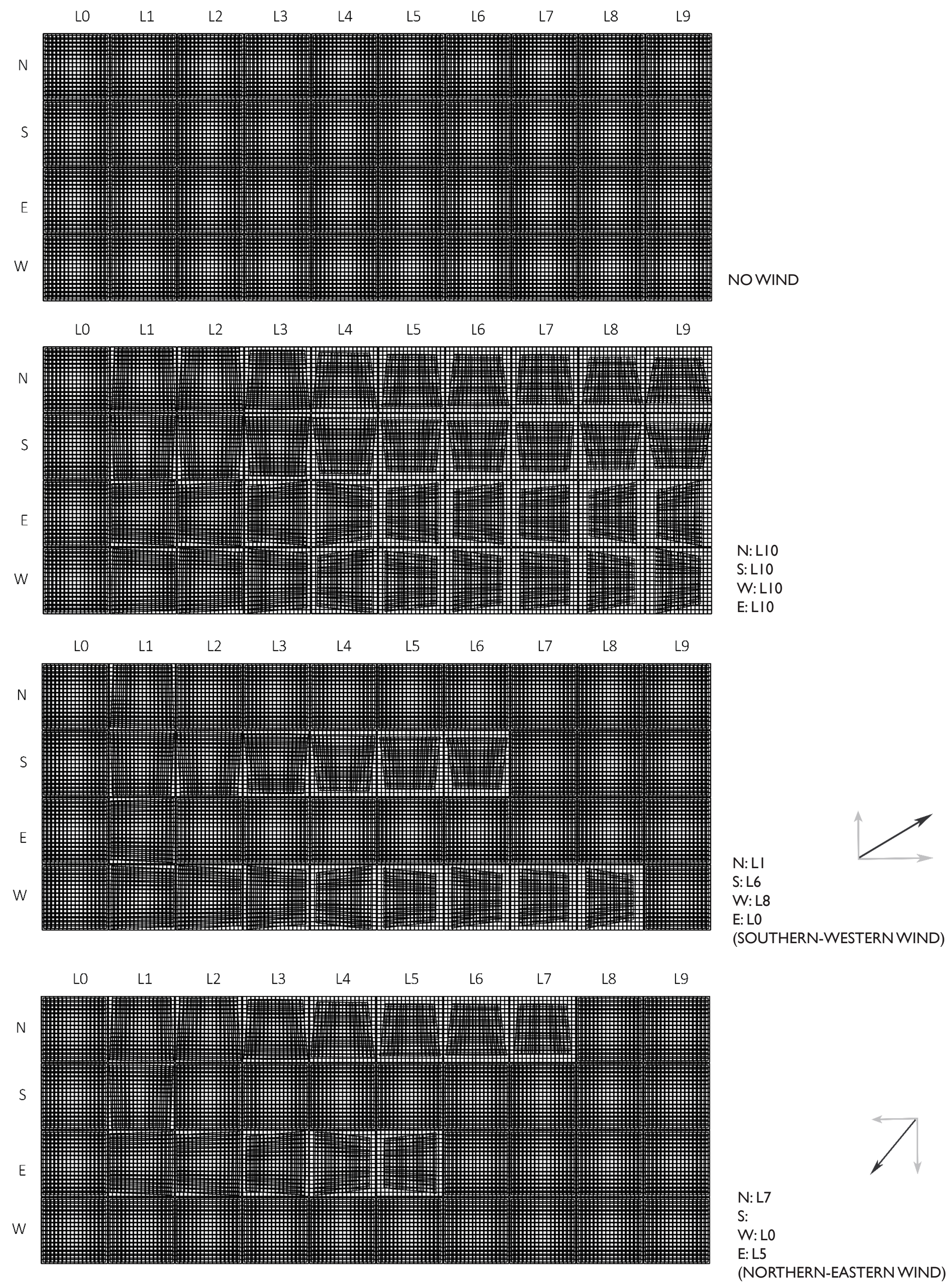


5.4 OVERALL STRUCTURE



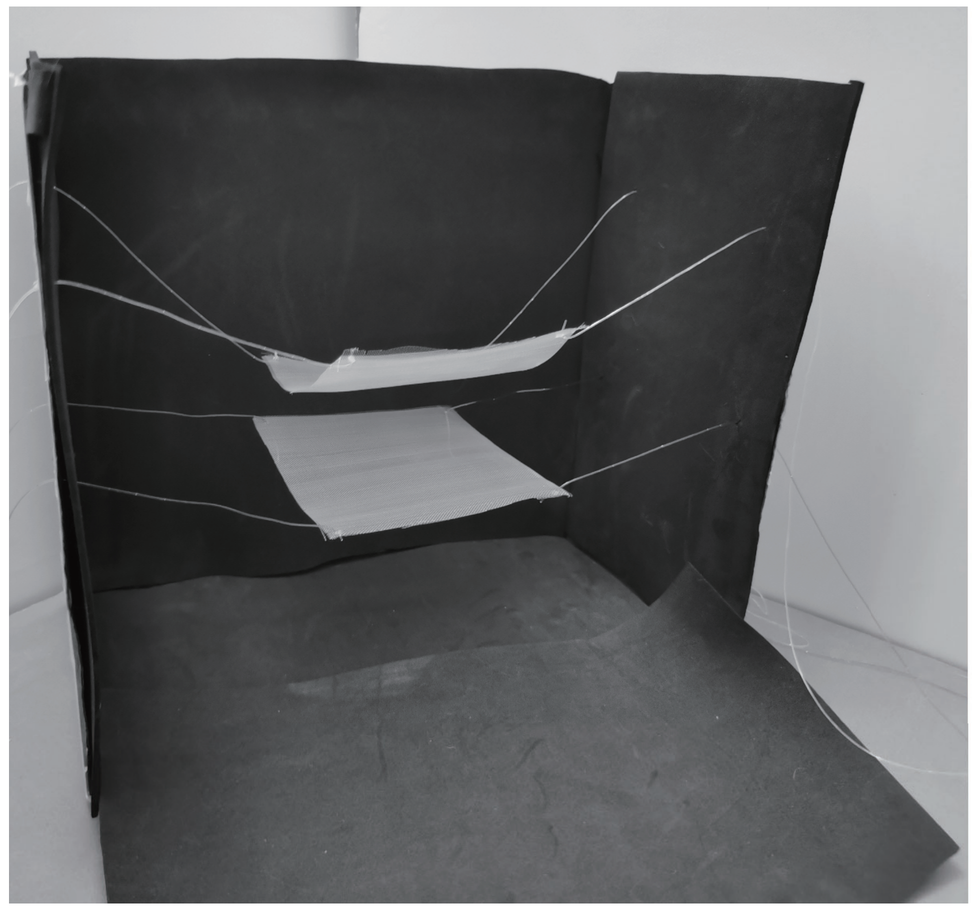


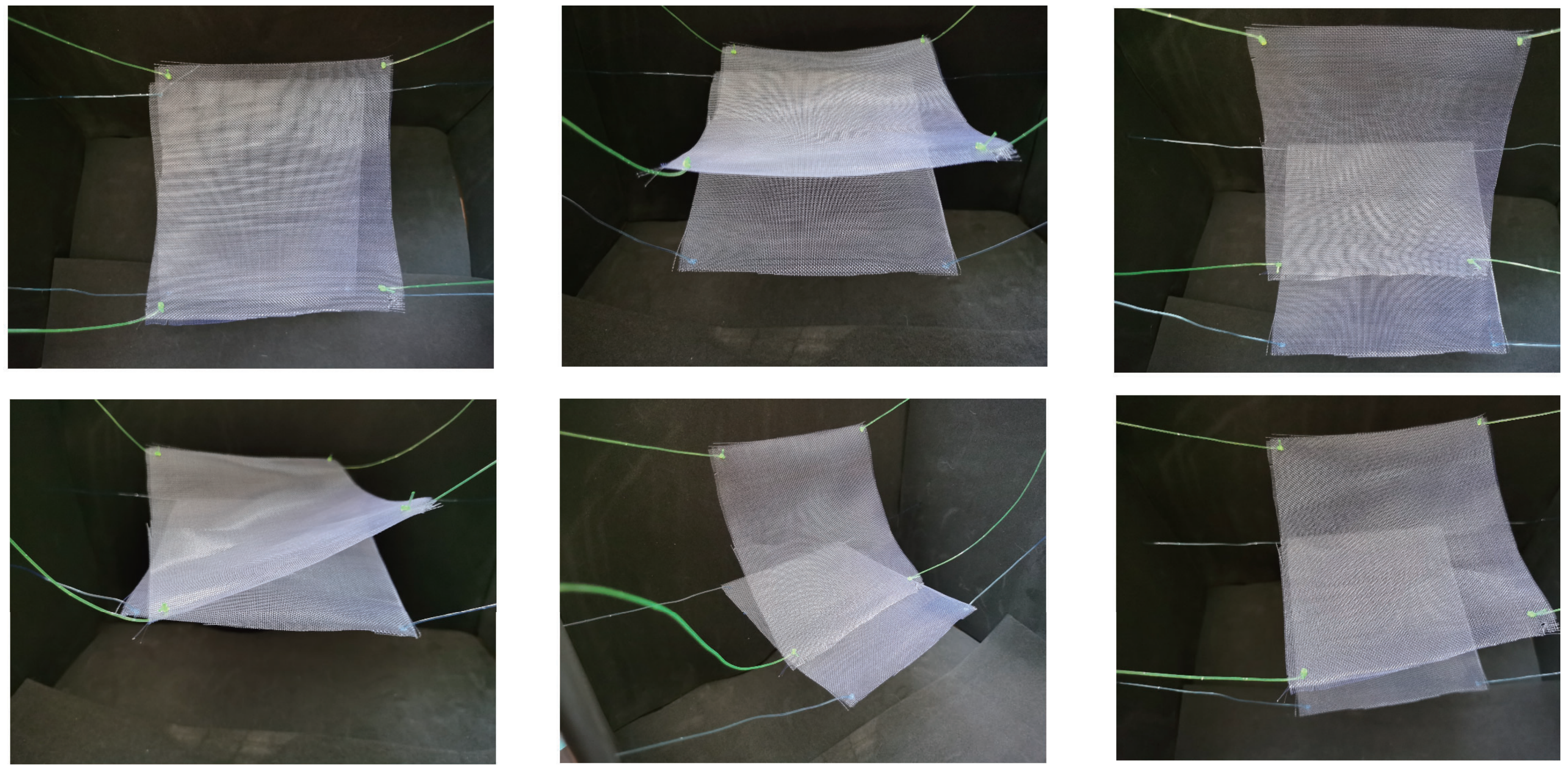




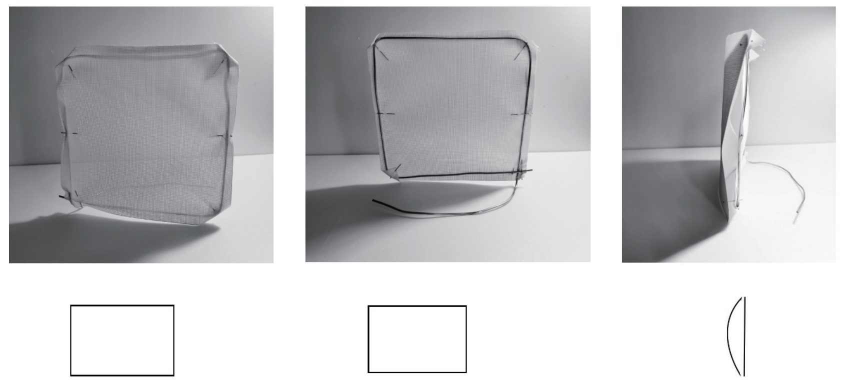
6.1 MECHANISM

It is observed in the boundary-condition test that by flexing the top layers of the fabrics, Moire effect is much more obvious and exhibits more changes in patterns. The mechanism is then designed to be more free-style, and no bespoke 'codes' will be assigned for each wind condition. The fabrics can move freely according to wind, and then the information of wind can be visualised through the apparatus .

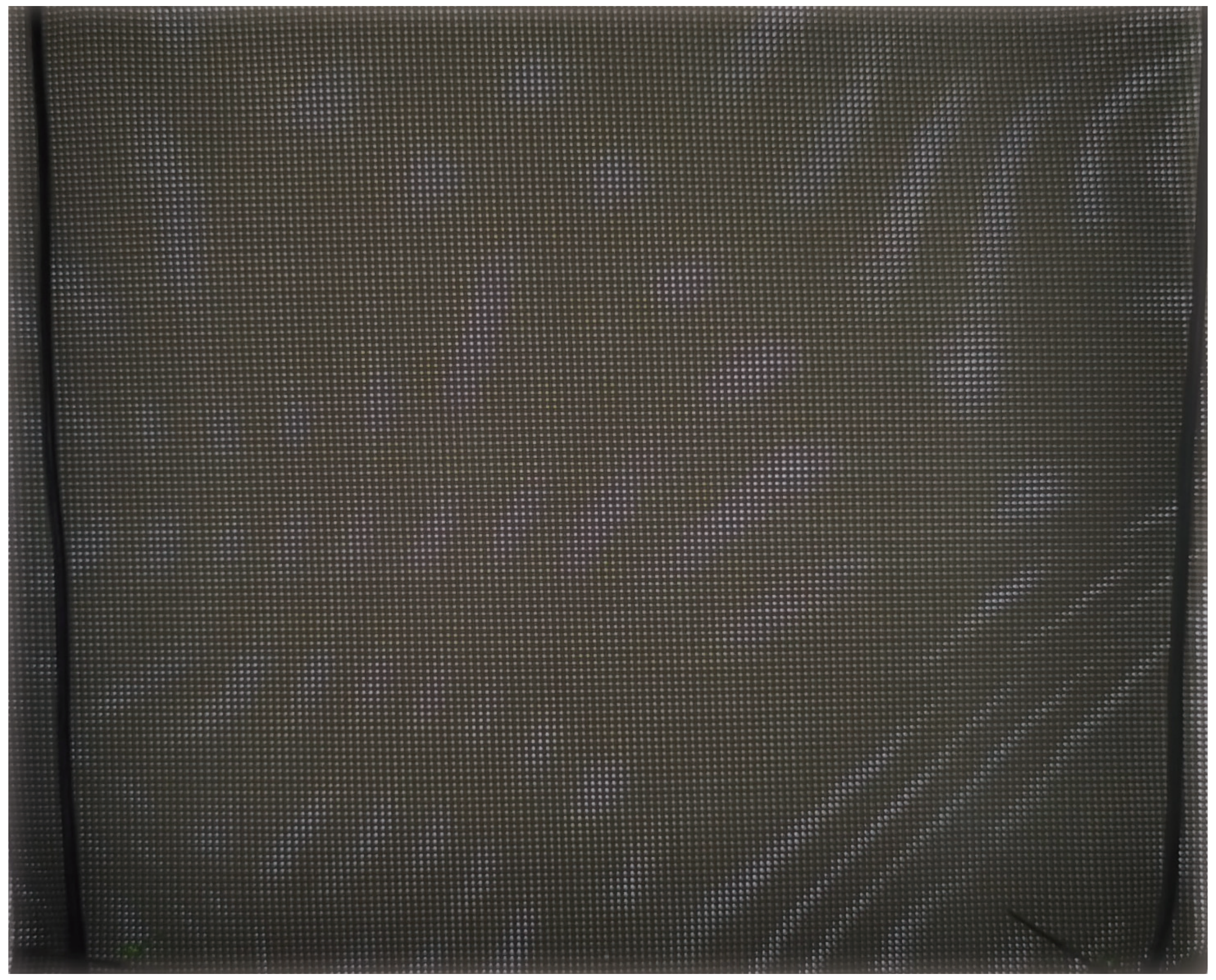


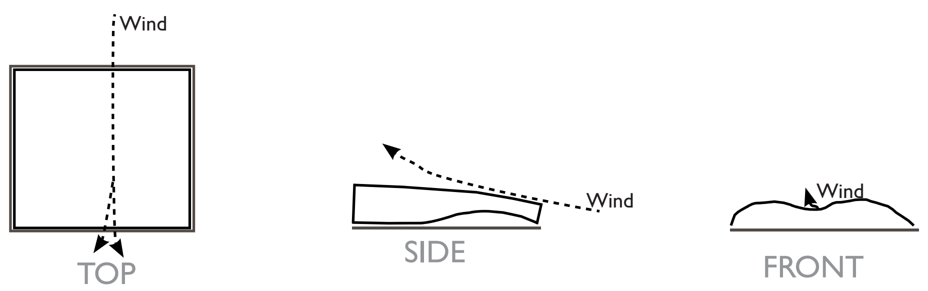


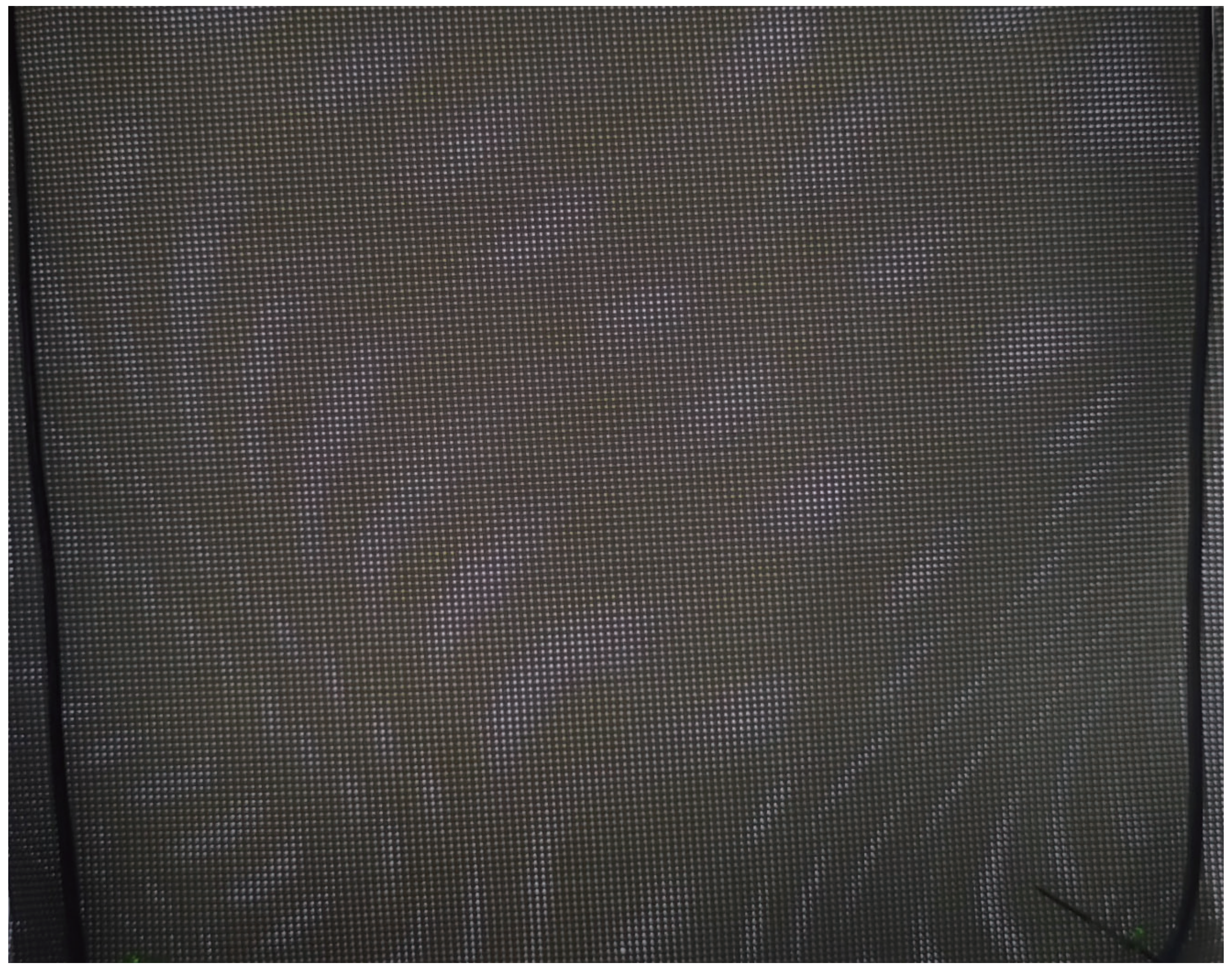
Boundary Test

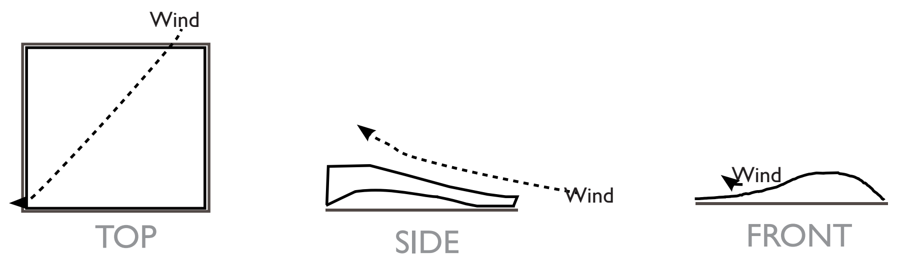


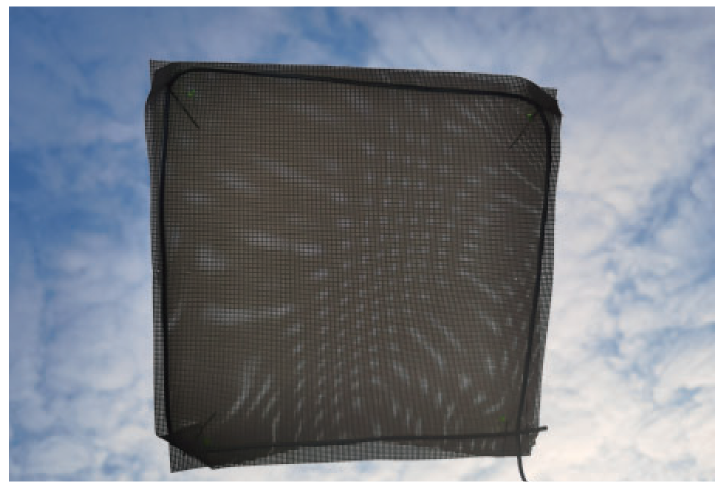
Frame: front   Frame: back   Frame & two layers: side



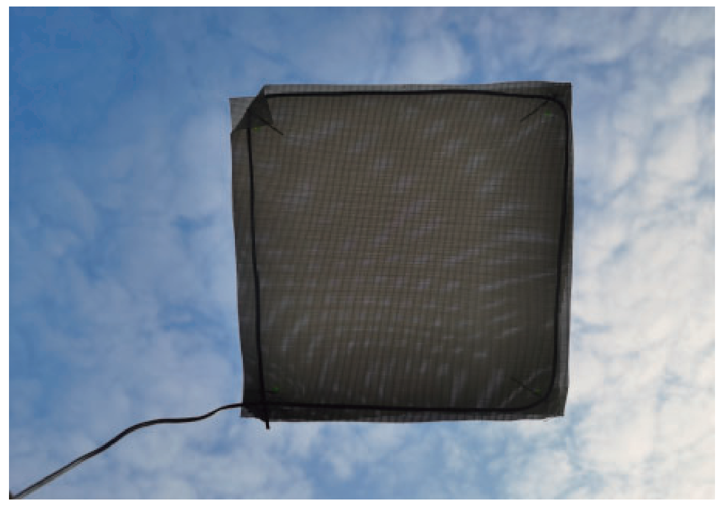
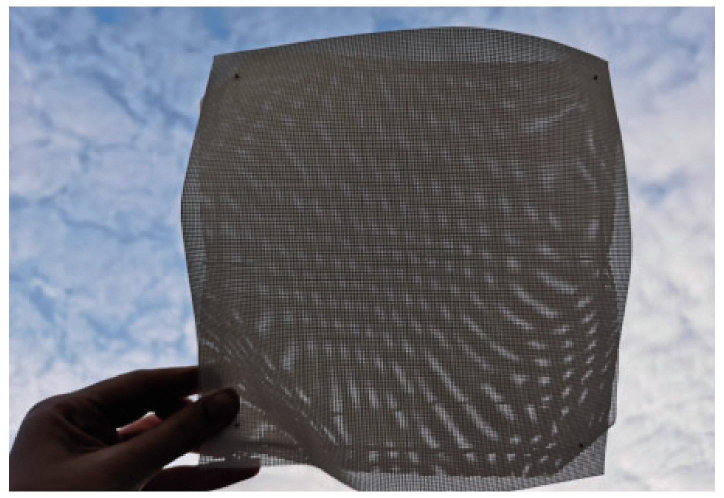


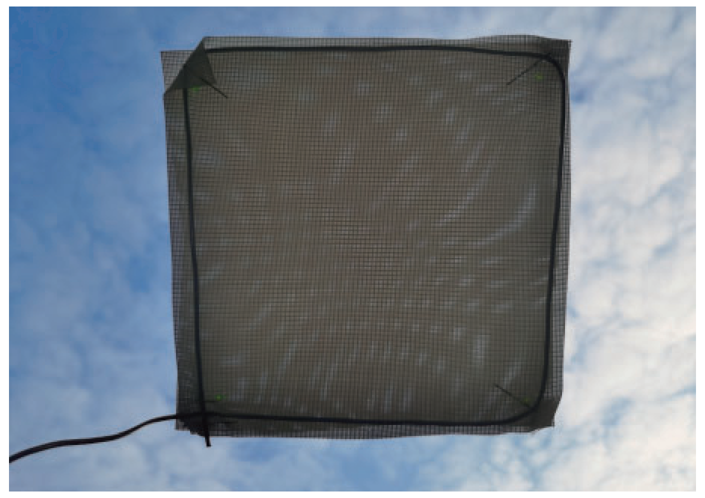
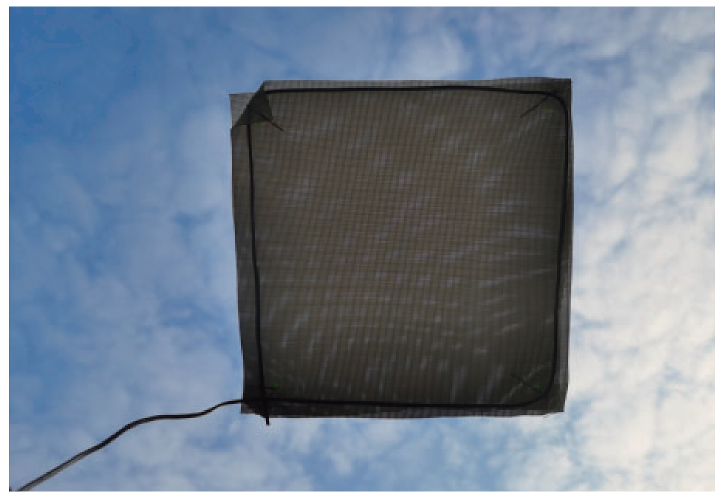


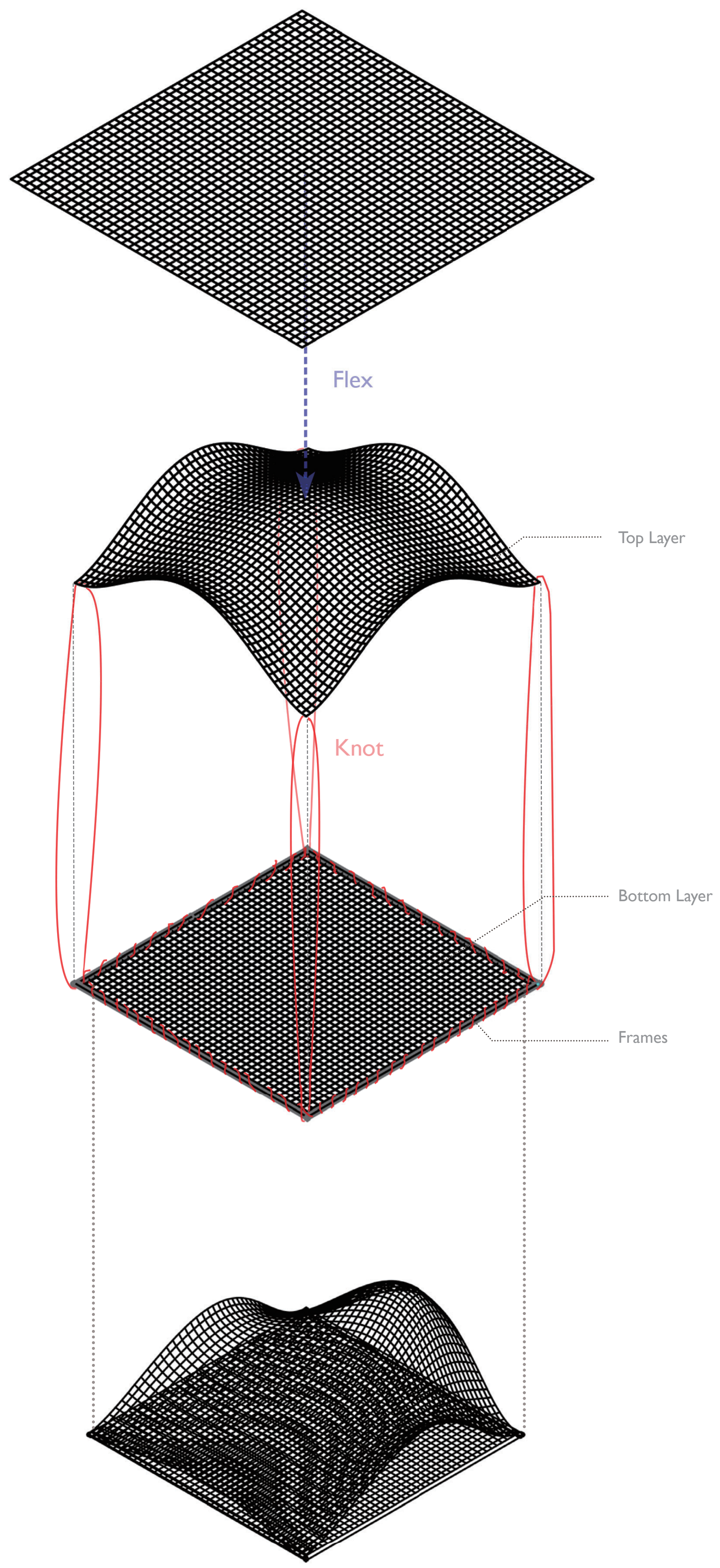


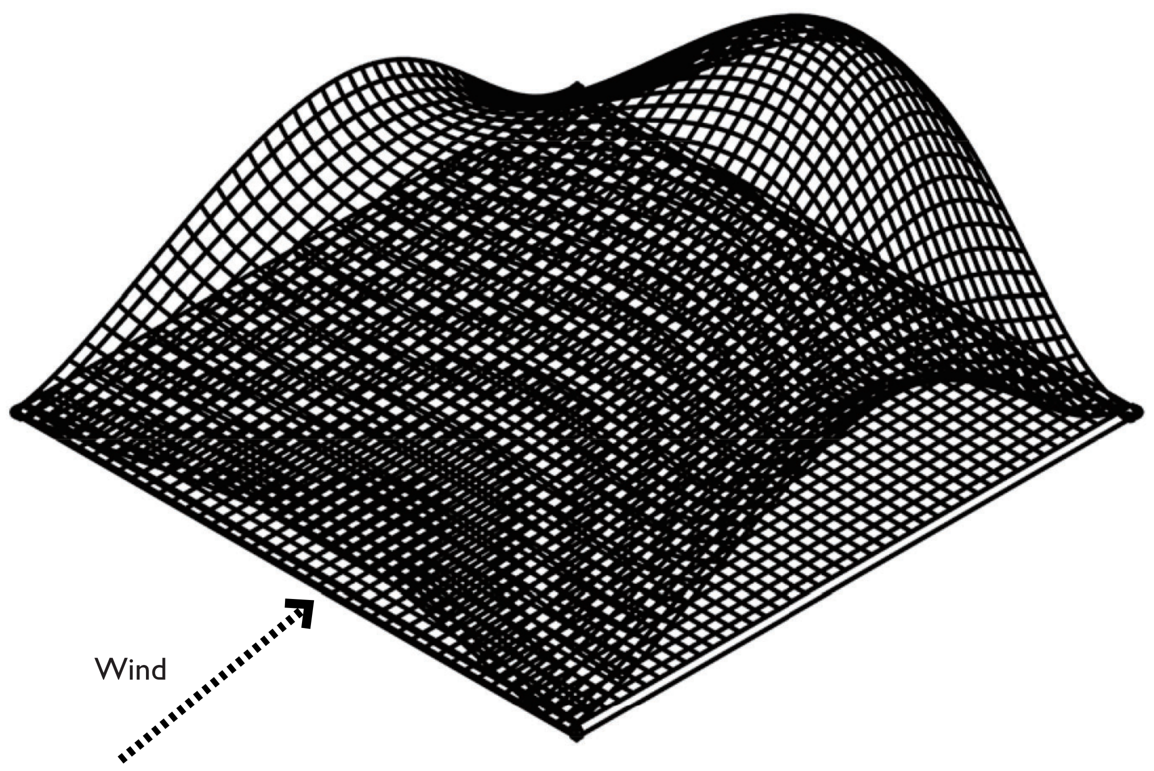


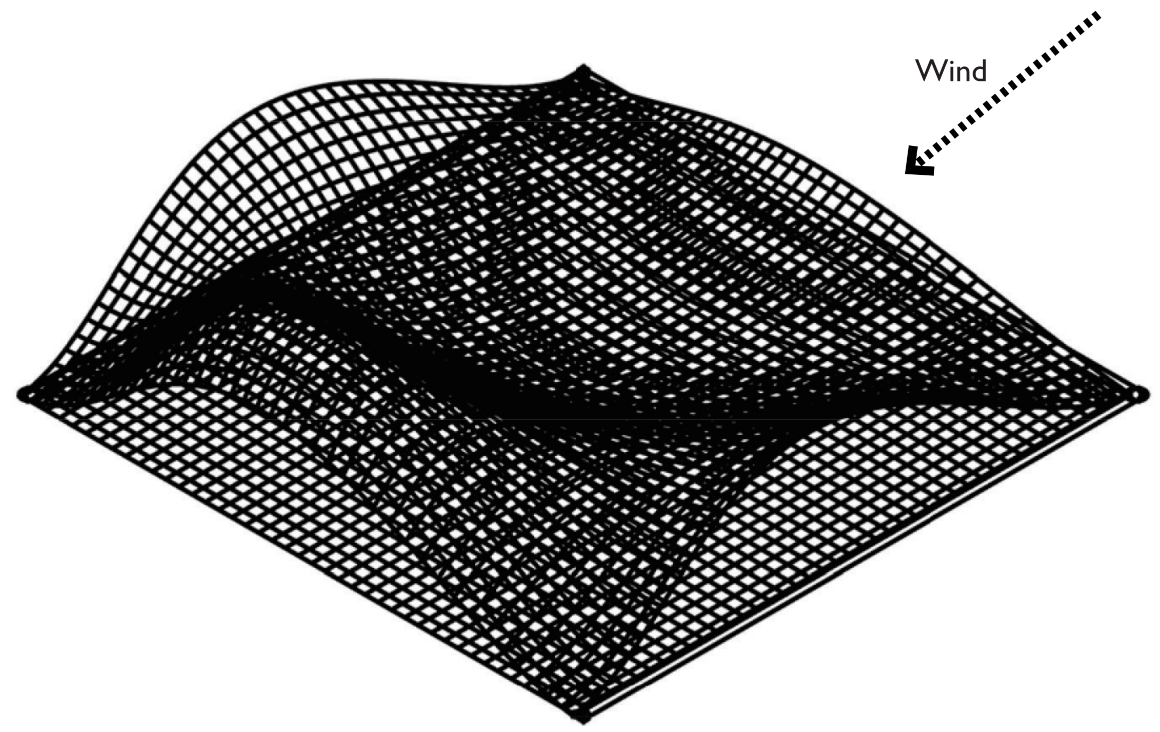


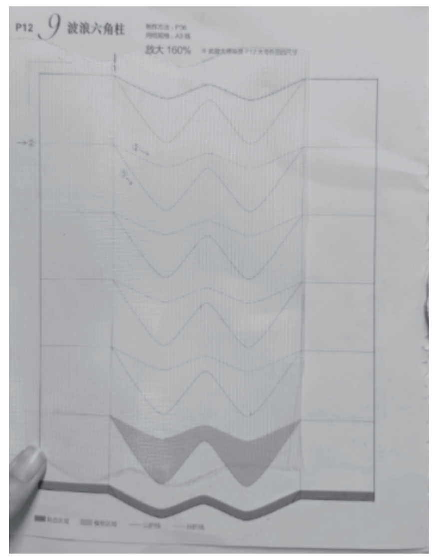




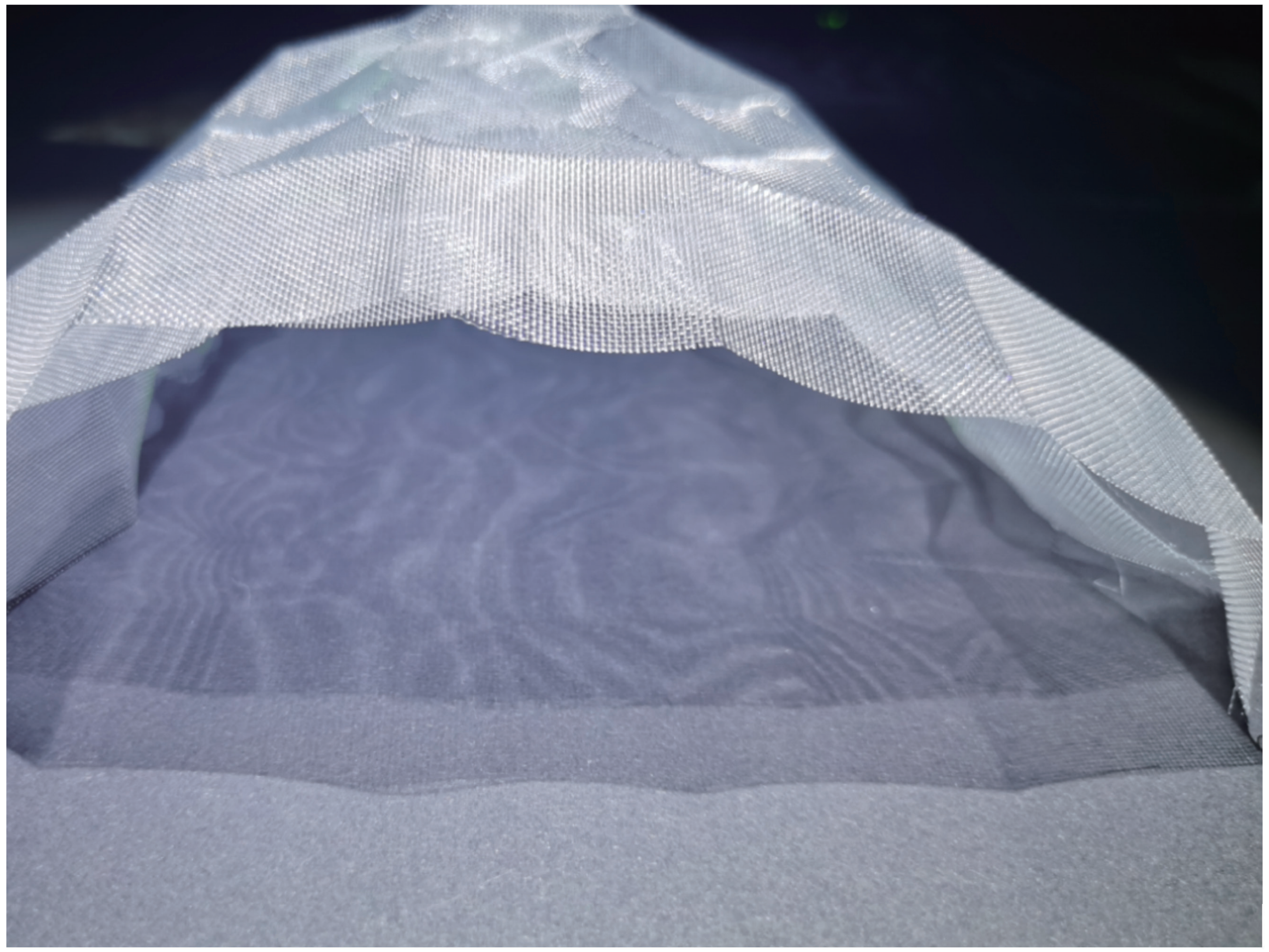

Flex
Top Layer
Knot
Bottom Layer
Frames


Wind

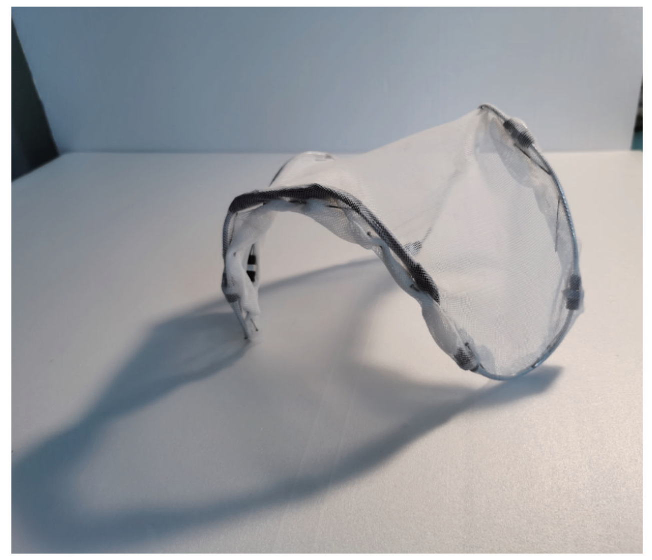

Wind

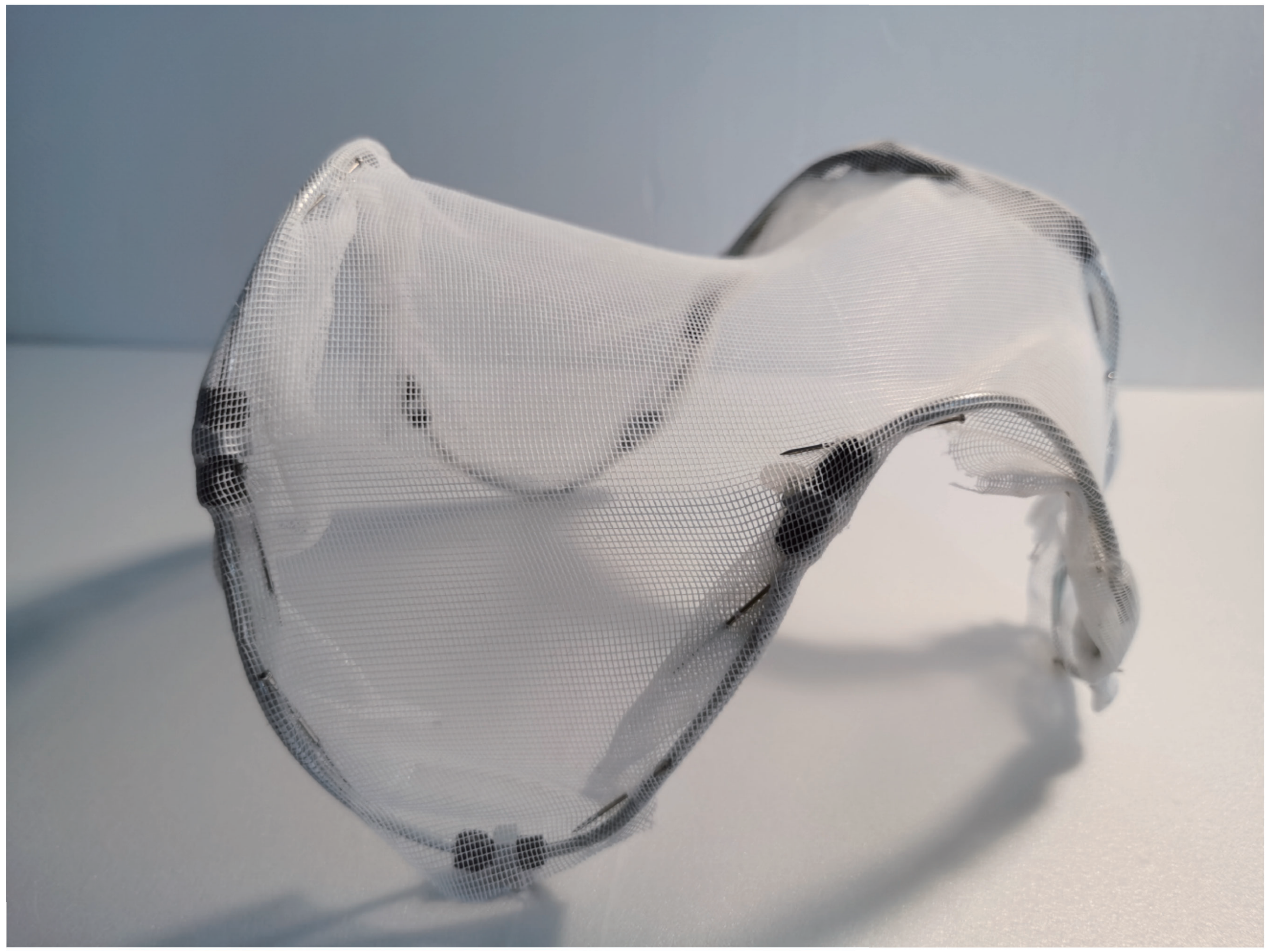
6.2 OVERALL STRUCTURE





Origami can serve as a solution for support. By folding two 10cm* 10cm pieces of fabric and overlay them with each other, wavey curves can be formed on the surface of the structure and shadows cast on the ground may indicate informtion of the wind blowing on the surface. However, this only applies to small-scale structures, because the fabric is not rigid enough to support larger weight.





A folded circle framework can serve as another solution to enabling the structure to be freestanding. Three 'feet' stablises the structure, and continuous serfaces are attached to the framework. This design is then further developed.